Code for Lifting Appliances in a Marine Environment

August 2013

(Effective 1 February 2014)

LIFE MATTERS

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Lloyd's Register

LIFE MATTERS

A guide to the Rules

Code for Lifting Appliances in a Marine Environment

Introduction

These Rules are published as a complete book.

Numbering and Cross-References

A decimal notation system has been adopted throughout. Five sets of digits cover the divisions, i.e. Section, sub-Section and paragraph. The textual cross-referencing within the text is as follows, although the right hand digits may be added or omitted depending on the degree of precision required:

(a) In same Section, e.g. *see* 2.1.3 (i.e. down to paragraph).
(b) In another book, e.g. *see* Pt 5, Ch 1,3 of the (*name of book*) (i.e. down to Section).

The cross-referencing for Figures and Tables is as follows:

(a) In same Section, e.g. as shown in Fig. 3.5.1 (i.e. Chapter, Section and Figure Number).
(b) In another book, e.g. *see* Table 2.7.1 in Pt 3, Ch 2 of the (*name of book*).

Rules updating

These Rules are published and changed through a system of Notices. Subscribers are forwarded copies of such Notices when the Rules change.

Current changes to the Rules that appeared in Notices are shown with a black rule alongside the amended paragraph on the left hand side. A solid black rule indicates amendments and a dotted black rule indicates corrigenda.

August 2013
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Chapter Contents

CODE FOR LIFTING APPLIANCES IN A MARINE ENVIRONMENT

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General Regulations

■ *Section 1*

1.1 Lloyd's Register Group Limited is a registered company under English law, with origins dating from 1760. It was established for the purpose of producing a faithful and accurate classification of merchant shipping. It now primarily produces classification Rules.

1.2 Classification services are delivered to clients by a number of other members subsidiaries and affiliates of Lloyd's Register Group Limited, including but not limited to: Lloyd's Register EMEA, Lloyd's Register Asia, Lloyd's Register North America, Inc., and Lloyd's Register Central and South America Limited. Lloyd's Register Group Limited, its subsidiaries and affiliates are hereinafter, individually and collectively, referred to as 'LR'.

■ *Section 2*

2.1 Lloyd's Register Group Limited is managed by a Board of Directors (hereinafter referred to as 'the Board').

The Board has:

appointed a Classification Committee and determined its powers and functions and authorised it to delegate certain of its powers to a Classification Executive and Devolved Classification Executives;
appointed Technical Committees and determined their powers, functions and duties.

2.2 LR has established National and Area Committees in the following:

Countries:
Australia (via Lloyd's Register Asia)
Canada (via Lloyd's Register North America, Inc.)
China (via Lloyd's Register Asia)
Egypt (via Lloyd's Register EMEA)
Federal Republic of Germany
(via Lloyd's Register EMEA)
France (via Lloyd's Register EMEA)
Italy (via Lloyd's Register EMEA)
Japan (via Lloyd's Register Group Limited)
New Zealand (via Lloyd's Register Asia)
Poland (via Lloyd's Register (Polska) Sp zoo)
Spain (via Lloyd's Register EMEA)
United States of America (via Lloyd's Register North America, Inc.)

Areas:
Benelux (via Lloyd's Register EMEA)
Central America (via Lloyd's Register Central and South America Ltd)
Nordic Countries (via Lloyd's Register EMEA)
South Asia (via Lloyd's Register Asia)
Asian Shipowners (via Lloyd's Register Asia)
Greece (via Lloyd's Register EMEA)

■ *Section 3*

3.1 LR's Technical Committee is at present composed of a maximum of 80 members which includes:
Ex officio members:

- Chairman and Chief Executive Officer of Lloyd's Register Group Limited ....
- Chairman of the Classification Committee of Lloyd's Register Group Limited ....

Members Nominated by:

- Technical Committee ....
- Royal Institution of Naval Architects 2
- Institution of Engineers and Shipbuilders in Scotland 2
- Institute of Marine, Engineering, Science and Technology 2
- Institute of Materials, Minerals and Mining 1
- Honourable Company of Master Mariners 2
- Institution of Engineering and Technology 1
- Institute of Refrigeration 1
- Welding Institute 1
- Shipbuilders' and Shiprepairers' Association 2
- The Society of Consulting Marine Engineers and Ship Surveyors 1
- Community of European Shipyards Associations 1
- Society of Maritime Industries 2
- European Marine Equipment Council 1
- Chamber of Shipping 1
- Greek Shipping Co-operation Committee 1
- International Association of Oil and Gas Producers 1

3.2 In addition to the foregoing:
(a) Each National or Area Committee may appoint a representative to attend meetings of the Technical Committee.
(b) A maximum of five representatives from National Administrations may be co-opted to serve on the Technical Committee. Representatives from National Administrations may also be elected as members of the Technical Committee under one of the categories identified in 3.1.
(c) Further persons may be co-opted to serve on the Technical Committee by the Technical Committee.

3.3 All elections are subject to confirmation by the Board.

3.4 The function of the Technical Committee is to consider:
(a) any technical issues connected with LR's marine business;
(b) any proposed alterations in the existing Rules;
(c) any new Rules for classification;
Where changes to the Rules are necessitated by mandatory implementation of International Conventions, Codes or Unified Requirements adopted by the International Association of Classification Societies these may be implemented by LR without consideration by the Technical Committee.

3.5 The term of office of the Chairman and of all members of the Technical Committee is five years. Members may be re-elected to serve an additional term of office with the approval of the Board. The term of office of the Chairman may be extended with the approval of the Board.

3.6 In the case of continuous non-attendance of a member, the Technical Committee may withdraw membership.

3.7 Meetings of the Technical Committee are convened as often and at such times and places as is necessary, but there is to be at least one meeting in each year. Urgent matters may be considered by the Technical Committee by correspondence.

3.8 Any proposal involving any alteration in, or addition to, Part 1, Chapter 1 of Rules for Classification is subject to approval of the Board. All other proposals for additions to or alterations to the Rules for Classification other than Part 1, Chapter 1, will following consideration and approval by the Technical Committee either at a meeting of the Technical Committee or by correspondence, be recommended to the Board for adoption.

3.9 The Technical Committee is empowered to:
(a) appoint sub-Committees or panels; and
(b) co-opt to the Technical Committee, or to its sub-Committees or panels, representatives of any organisation or industry or private individuals for the purpose of considering any particular problem.

■ *Section 4*

4.1 LR's Naval Ship Technical Committee is at present composed of a maximum of 50 members and includes:
Ex officio members

- Chairman and Chief Executive Officer of Lloyd's Register Group Limited

Member nominated by:

- Naval Ship Technical Committee;
- The Royal Navy and the UK Ministry of Defence;
- UK Shipbuilders, Ship Repairers and Defence Industry;
- Overseas Navies, Governments and Governmental Agencies;
- Overseas Shipbuilders, Ship Repairers and Defence Industries;

4.2 All elections are subject to confirmation by the Board.

4.3 All members of the Naval Ship Technical Committee are to hold security clearance from their National Authority for the equivalent of NATO CONFIDENTIAL. All material is to be handled in accordance with NATO Regulations or, for non-NATO countries, an approved equivalent. No classified material shall be disclosed to any third party without the consent of the originator.

4.4 The term of office of the Naval Ship Technical Committee Chairman and of all members of the Naval Ship Technical Committee Chairman is five years. Members may be re-elected to serve an additional term of office with the approval of the Board. The term of the Chairman may be extended with the approval of the Board.

4.5 In the case of continuous non-attendance of a member, the Naval Ship Technical Committee may withdraw membership.

4.6 The function of the Naval Ship Technical Committee is to consider technical issues connected with Naval Ship matters and to approve proposals for new Naval Ship Rules, or amendments to existing Naval Ship Rules.

4.7 Meetings of the Naval Ship Technical Committee are convened as necessary but there will be at least one meeting per year. Urgent matters may be considered by the Naval Ship Technical Committee by correspondence.

4.8 Any proposal involving any alteration in, or addition to, Part 1, Chapter 1 of Rules for Classification of Naval Ships is subject to approval of the Board. All other proposals for additions to or alterations to the Rules for Classification of Naval Ships, other than Part 1, Chapter 1, will following consideration and approval by the Naval Ship Technical Committee, either at a meeting of the Naval Ship Technical Committee or by correspondence, be recommended to the Board for adoption.

4.9 The Naval Ship Technical Committee is empowered to:

(a) appoint sub-Committees or panels; and
(b) co-opt to the Naval Ship Technical Committee, or to its sub-Committees or panels, representatives of any organisation or industry or private individuals for the purpose of considering any particular problem.

■ *Section 5*

5.1 LR has the power to adopt, and publish as deemed necessary, Rules relating to classification and has (in relation thereto) provided the following:

(a) Except in the case of a special directive by the Board, no new Regulation or alteration to any existing Regulation relating to classification or to class notations is to be applied to existing ships.
(b) Except in the case of a special directive by the Board, or where changes necessitated by mandatory implementation of International Conventions, Codes or Unified Requirements adopted by the International Association of Classification Societies are concerned, no new Rule or alteration in any existing Rule is to be applied compulsorily after the date on which the contract between the ship builder and shipowner for construction of the ship has been signed, nor within six months of its adoption. The date of 'contract for construction' of a ship is the date on which the contract to build the ship is signed between the prospective shipowner and the ship builder. This date and the construction number (i.e. hull numbers) of all the vessels included in the contract are to be declared by the party applying for the assignment of class to a newbuilding. The date of 'contract for construction' of a series of sister ships, including specified optional ships for which the option is ultimately exercised, is the date on which the contract to build the series is signed between the prospective shipowner and the ship builder. In this section a 'series of sister ships' is a series of ships built to the same approved plans for classification purposes, under a single contract for construction. The optional ships will be considered part of the same series of sister ships if the option is exercised not later than 1 year after the contract to build the series was signed. If a contract for construction is later amended to include additional ships or additional options, the date of 'contract for construction' for such ships is the

date on which the amendment to the contract is signed between the prospective shipowner and the ship builder. The amendment to the contract is to be considered as a 'new contract'. If a contract for construction is amended to change the ship type, the date of 'contract for construction' of this modified vessel, or vessels, is the date on which the revised contract or new contract is signed between the Owner, or Owners, and the shipbuilder. Where it is desired to use existing approved ship or machinery plans for a new contract, written application is to be made to LR. Sister ships may have minor design alterations provided that such alterations do not affect matters related to classification, or if the alterations are subject to classification requirements, these alterations are to comply with the classification requirements in effect on the date on which the alterations are contracted between the prospective owner and the ship builder or, in the absence of the alteration contract, comply with the classification requirements in effect on the date on which the alterations are submitted to LR for approval.

(c) All reports of survey are to be made by surveyors authorised by members of the LR Group to survey and report (hereinafter referred to as 'the Surveyors') according to the form prescribed, and submitted for the consideration of the Classification Committee.

(d) Information contained in the reports of classification and statutory surveys will be made available to the relevant owner, National Administration, Port State Administration, P&I Club, hull underwriter and, if authorised in writing by that owner, to any other person or organisation.

(e) Notwithstanding the general duty of confidentiality owed by LR to its client in accordance with the LR Rules, LR clients hereby accept that, LR will participate in the IACS Early Warning System which requires each IACS member to provide its fellow IACS members and Associates with relevant technical information on serious hull structural and engineering systems failures, as defined in the IACS Early Warning System (but not including any drawings relating to the ship which may be the specific property of another party), to enable such useful information to be shared and utilised to facilitate the proper working of the IACS Early Warning System LR will provide its client with written details of such information upon sending the same to IACS Members and Associates.

(f) Information relating to the status of classification and statutory surveys and suspensions/withdrawals of class together with any associated conditions of class will be made available as required by applicable legislation or court order.

(g) A Classification Executive consisting of senior members of LR's Classification Department staff shall carry out whatever duties that may be within the function of the Classification Committee that the Classification Committee assigns to it.

■ *Section 6*

6.1 No LR Group employee is permitted under any circumstances, to accept, directly or indirectly, from any person, firm or company, with whom the work of the employee brings the employee into contact, any present, bonus, entertainment or honorarium of any sort whatsoever which is of more than nominal value or which might be construed to exceed customary courtesy extended in accordance with accepted ethical business standards.

■ *Section 7*

7.1 LR has the power to withhold or, if already granted, to suspend or withdraw any ship from class (or to withhold any certificate or report in any other case), in the event of non-payment of any fee to any member of the LR Group.

■ *Section 8*

8.1 When providing services LR does not assess compliance with any standard other than the applicable LR Rules, international conventions and other standards agreed in writing.

8.2 In providing services, information or advice, LR does not warrant the accuracy of any information or advice supplied. Except as set out herein, LR will not be liable for any loss, damage or expense sustained by any person and caused by any act, omission, error, negligence or strict liability of LR or caused by any inaccuracy in any information or advice given in any way by or on behalf of LR even if held to amount to a breach of warranty. Nevertheless, if the Client uses LR services or relies on any information or advice given by or on behalf of LR and as a result suffers loss, damage or expense that is proved to have been caused by any negligent act, omission or error of LR or any negligent inaccuracy in information or advice given by or on behalf of LR then LR will pay compensation to the client for its proved loss up to but not exceeding the amount of the fee (if any) charged for that particular service, information or advice.

8.3 LR will print on all certificates and reports the following notice: Lloyd's Register Group Limited, its affiliates and subsidiaries and their respective officers, employees or agents are, individually and collectively, referred to in this clause as 'Lloyd's Register'. Lloyd's Register assumes no responsibility and shall not be liable to any person for any loss, damage or expense caused by reliance on the information or advice in this document or howsoever provided, unless that person has signed a contract with the relevant Lloyd's Register entity for the provision of this information or advice and in that case any responsibility or liability is exclusively on the terms and conditions set out in that contract.

8.4 Except in the circumstances of section 8.2 above, LR will not be liable for any loss of profit, loss of contract, loss of use or any indirect or consequential loss, damage or expense sustained by any person caused by any act, omission or error or caused by any inaccuracy in any information or advice given in any way by or on behalf of LR even if held to amount to a breach of warranty.

8.5 Any dispute about LR services is subject to the exclusive jurisdiction of the English courts and will be governed by English law.

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■ *Section 1* Introduction

1.1 Application

1.1.1 It is a requirement of most National Authorities that lifting appliances are approved, examined, tested and certified by a competent person or organisation before being taken into use and thereafter are periodically surveyed to maintain the validity of the certification.

1.1.2 Lloyd's Register's (LR) certification is internationally accepted and, where requested, LR will undertake the necessary certification of lifting appliances and subsequent surveys to ensure compliance with the statutory Regulations.

1.1.3 In certain cases, a National Authority requires its own certification to be used. Where authorised, LR is also able to arrange the issue of these certificates which may be in addition to the LR certification if so desired by the Owner.

1.1.4 Ships or offshore units fitted with appliances built in accordance with this Code in respect of structural and machinery requirements may be eligible for Special Features class notations. These notations will be retained so long as the appliances are found upon examination at the prescribed surveys to be maintained in accordance with LR's requirements, *see* 1.3.

1.1.5 This Code is applicable to marine lifting appliances, including:

(a) derrick and derrick crane systems;
(b) launch and recovery appliances for survival craft and rescue boats;
(c) cranes;
(d) launch and recovery systems for diving operations;
(e) lifts and ramps;

where these are installed on ships or offshore units for the following purposes:

- on ships, for handling cargo, equipment and personnel;
- on barges and pontoons, e.g., a floating crane;
- on fixed or mobile offshore installations, for transferring equipment;
- on ships or fixed or mobile offshore installations, for handling manned submersibles and diving systems;
- on ships, for transferring goods or personnel from one deck level to another;
- on ships and offshore installations for evacuation in an abandon ship/installation situation.

1.1.6 The Code is also applicable to shiplift and transfer system installations on which vessels are raised and lowered by means of winches or jacks when docked on an articulated or rigid platform structure.

1.1.7 Lifting appliances and applications not defined above will be considered on the general basis of the Code.

1.1.8 These requirements are based on the understanding that:

(a) the appliance and/or equipment will at all times be properly loaded in accordance with the designer's instructions and the loading conditions approved by LR.
(b) where the appliance and/or equipment is to be certified but not classed, the design criteria specified conclude that Periodical Survey procedures, at least equivalent to LR's, will be adhered to by the Owner or the equipment operator.
(c) the appliance and/or equipment will at all times be properly operated by trained and authorised personnel.
(d) the appliance and/or equipment will be maintained by qualified and authorised personnel.
(e) compliance with these requirements does not absolve the designers and/or manufacturers of their contractual responsibilities to the client for compliance with the specification and the overall design and in-service performance of the appliance and/or equipment.

1.1.9 The interpretation of the Code is the sole responsibility, and at the sole discretion, of LR. Any uncertainty in the meaning of the requirements of the Code is to be referred to LR for clarification.

1.1.10 It is the responsibility of the Owners, Operators, designers, manufacturers and any repairers that they fully acquaint themselves with the scope of these requirements and associated obligations laid down herein, and have satisfied themselves that these requirements are sufficient for their purposes.

1.1.11 The Code embodies both the general requirements for compliance with major statutory Regulations for such applications, and the detailed requirements of LR either as an authorised body issuing statutory certificates or as an independent authority issuing its own form of certification.

1.1.12 It is emphasised that the Code deals primarily with the structural aspects of the lifting appliance. Driving mechanisms and similar mechanical parts are the responsibility of the designers of the gear, but tests to demonstrate 'fail safe' operation will be required during commissioning trials, *see* Chapter 9.

1.1.13 It is also emphasised that any item such as a mast or crane pedestal, which is permanently fitted to a ship's structure and which is designed to support a lifting appliance, does constitute part of the classed ship and is to comply with the appropriate classification requirements, even where the lifting appliance itself is not classed or certified by LR.

1.2 Certification

1.2.1 The certification adopted by LR is the recognised form recommended by the International Labour Office (I.L.O.) and is also in accordance with current relevant directives of the European Community (EC).

1.2.2 It is the responsibility of the Owner or Operator to ensure that they comply with statutory requirements. Particular attention is drawn to the specific requirements of some authorities who do not accept surveys carried out by ship's officers but require all surveys and certification to be carried out by nominated organisations such as LR.

1.2.3 Attention is also drawn to the more stringent requirements of certain authorities with respect to cranes offshore and lifting arrangements for diving operations.

1.2.4 It is LR's interpretation of the intention of current National Regulations that every lifting appliance, including oil hose derricks, stores cranes and engine room cranes, is to be certified and compliance with this is strongly recommended to the Owner.

1.2.5 The minimum requirements for the issue by LR of certification in accordance with the Code are:

(a) Plan approval of the structural arrangements.
(b) Verification of materials.
(c) Verification of manufacturer's certificates for loose gear, ropes, etc.
(d) Survey of the appliance.
(e) Testing of the appliance when installed on board.

1.2.6 The above procedure is also to be applied so far as practicable in the case of existing appliances where LR's certification is required, *see* Ch 12,3.3.1.

1.2.7 Any request for LR's services is to make it quite clear if compliance with any specific Regulations, Standard or Code is required. This is necessary for initial, periodical and any specific type of survey requested.

1.2.8 National and International Regulations require lifting appliances to receive Periodical Surveys and testing to maintain the validity of the certification.

1.2.9 Provided that the original certification is valid, up to date and was issued by a competent authority, LR will, upon request, carry out the necessary survey requirements, issue appropriate certificates and endorse the register of lifting appliances carried by the ship.

1.2.10 The requirements for Periodical Surveys are given in Chapter 12.

1.3 Classification

1.3.1 Ships and offshore installations built in accordance with LR's Rules with respect to hull and machinery are eligible to be assigned a class in the *Register Book* and continue to be classed, as long as it is found upon examination at the prescribed surveys that they are maintained in accordance with the Rules.

1.3.2 Ships or offshore units classed with LR and fitted with lifting appliances built in accordance with the requirement of this Code will be eligible to be assigned Special Features class notations in the *Register Book* as listed in Table 1.1.1.

Table 1.1.1 Special features class notations associated with lifting appliances

Lifting appliance	Special features class notation	Remarks
Derricks, derrick crane or cranes on ships	**CG**	Optional notation Indicates that the ship's cargo gear is included in class
Cranes on offshore installations	**PC**	Optional notation Indicates that the installation's platform cranes are included in class
Lifts and ramps on ships	**CL** **PL** **CR**	Optional notations Indicate that the ship's cargo lifts (CL), passenger lifts (PL) or cargo ramps (CR) are included in class
Lifting appliances fitted to military naval ships	**LAP**	Optional notation Indicates that lifting appliances have been designed and built in accordance with this Code (or equivalent standard), but where it is not mandated by the LA notation
Lifting appliances forming an essential feature of the vessel, e.g., cranes on crane barges or pontoons, some lifting arrangements for diving on diving support ships, etc.	**LA**	Mandatory notation Indicates that the lifting appliance is included in class

1.3.3 Where the lifting appliance is considered to form an essential feature of a classed ship, the Special Feature class notation **LA** will, in general, be mandatory.

1.3.4 In other cases, classification is optional and may be assigned at the request of the Owner on compliance with the appropriate requirements, *see also* Chapter 5.

1.3.5 Proposals to class lifting appliances on unclassed ships or offshore units will be specially considered.

1.3.6 The minimum requirements for classification of a lifting appliance are:

(a) Plan approval of the structural, electrical, control and mechanical arrangements in accordance with LR's requirements.
(b) Verification of materials.
(c) Verification of manufacturer's certificates and testing of loose gear, ropes and fittings.
(d) Survey of the lifting appliance.

(e) Testing of the lifting appliance on installation.
(f) Subsequent Periodical Surveys of the lifting appliance as required by Chapter 12.

1.3.7 Classification also fully meets the relevant requirements for statutory certification of the lifting appliance.

1.3.8 It should be noted that certain moveable support structures for loading and discharge arrangements, such as the rotating support boom for a dredger discharge pipe, are considered an essential feature of the ship and are included in the classification of the ship. A separate notation is not assigned.

1.4 Equivalents

1.4.1 Recognised International or National Standards for the design of installations will be accepted as equivalent to the Code requirements, provided LR is satisfied in each case that the standard adequately takes into account all the forces resulting from the intended mode of operation. The relevant Standard is to be specified in the submission.

1.4.2 Recognised International or National Standards for components or fittings will generally be accepted as equivalent to the requirements of this Code.

1.4.3 Alternative arrangements or fittings which are considered to be equivalent to the requirements of this Code will be accepted.

1.5 Calculations

1.5.1 Designers may be required to submit calculations for consideration when scantling plans are submitted for approval.

1.5.2 Where finite element/computer analysis forms the basis of the designer's determination of scantlings, details of the analysis package and software are to be specified, together with the basic design criteria, to assist in LR's approval procedures.

1.5.3 LR's direct calculation procedures may include the use of suitable and appropriate spreadsheet and 'calculation routine' techniques and tools.

1.5.4 LR's direct calculation procedures within the Lloyd's Register's Plan Appraisal Systems for Ships (LR.PASS) facilities may be used to assist in the design process. The available procedures and facilities are presented in the report summarising LR.PASS.

1.5.5 Where approval is required for appliances of novel design or with features not covered by this Code, LR may require additional calculations to be carried out.

1.6 Materials and fabrication

1.6.1 Materials intended for the construction of lifting appliances are to be in accordance with one of the following:
(a) LR's *Rules for the Manufacture, Testing and Certification of Materials* (hereinafter referred to the Rules for Materials).
(b) A recognised National or International Standard that includes materials which are equivalent to those specified in the Rules for Materials, and where the approval and survey requirements are in compliance with Chapter 1 and Section 1 of subsequent Chapters, of the Rules for Materials as appropriate.
(c) A recognised National or International Standard that includes materials which are equivalent to those specified in the Rules for Materials, but where the approval and survey requirements will not comply with the requirements of Chapter 1 and Section 1 of subsequent Chapters, of the Rules for Materials as appropriate. In this case, materials will be subject to additional testing under LR survey prior to acceptance for any project. This is not permitted for lifting appliances subject to Classification.
(d) Material specifications that have no equivalent to the Rules for Materials will be subject to special consideration by LR.

1.6.2 Fabrication and non-destructive examination of lifting appliances is to be in accordance with the Rules for Materials and specific requirements of this Code. Where alternative fabrication standards are proposed these are to provide equivalence to the requirements of Rules for Materials.

■ *Section 2* Definitions

2.1 Safe Working Load (SWL) of a lifting appliance

2.1.1 This is the maximum static load which the appliance is certified to lift whilst correctly rigged and operating simultaneously:
(a) In the appropriate Service Category.
(b) Within the designed *Geometrical Limit*.

2.1.2 The SWL of a lifting appliance is sometimes referred to as the working load limit.

2.2 Safe Working Load (SWL) of a lifting component (loose gear)

2.2.1 This is the certified load for which the component has been designed and tested. This certified load is to be not less than the maximum load to which the component will be subjected when the appliance of which it forms part is operating at its SWL.

2.3 Service category

2.3.1 **Standard service category**. This is the least onerous operational category which can be adopted for the purpose of ascertaining the safe working load (SWL) of any appliance. It is to embrace all of the following conditions:

(a) The ship on which the appliance is installed adopting a heel of 5° in addition to a trim of 2°, each in such a direction as to affect adversely the lifting capacity of the appliance. In certain instances, angles of heel and trim less than 5° and 2° respectively will be accepted, provided the designers can show that in normal service it will not be possible for the vessel to exceed these values.

(b) The appliance being operated whilst situated on a ship which is within the confines of a harbour.

(c) The appliance being operated in wind speeds not exceeding 20 m/s, corresponding to a wind pressure not exceeding 250 N/m^2.

(d) The load being free of any external constraints to its motion whilst it is being acted upon by the lifting appliance.

(e) The nature of the lifting operations, in terms of their frequency and dynamic character, being compatible with the *Factored Loads* permitted by the Code for the type of appliance concerned.

2.3.2 **Specified service category**. This is an operational category which is specified by the designer or Operator for the purpose of designing the appliance for the safe working load (SWL). It is more onerous than the Standard Service Category by virtue of any of the following operational and environmental conditions being applicable:

(a) The angles of heel and/or trim of the ship on which the appliance is situated being greater than those specified for the Standard Service Category.

(b) The appliance being operated whilst situated on a ship which is not sheltered from the action of sea waves.

(c) The appliance being operated in wind speeds exceeding 20 m/s, corresponding to a wind pressure exceeding 250 N/m^2.

(d) The load not being at rest at the time when the appliance commences the lift.

(e) The load not being free of external constraints to its motion whilst being acted upon by the lifting appliance.

(f) The nature of the lifting operations, in terms of their frequency and dynamic character, not being compatible with *Factored Loads* permitted by this Code for the type of appliance concerned.

2.4 Geometrical limit

2.4.1 This is any designed geometrical configuration of the lifting appliance in which a maximum stress which is not greater than the permissible stress occurs in one or more of the component parts of the appliance when the latter is lifting its safe working load (SWL). It is possible for an appliance to be certified for a range of safe working loads in association with a corresponding range of *Geometrical Limits*.

2.5 Factored load

2.5.1 This is the load (excluding any wind increment) which is considered to act on a lifting appliance for the purpose of designing its component parts. It comprises the *Live Load* multiplied by factors which allow for the frequency with which the appliance is used (as represented by the *Duty Factor*) and the effects of accelerations of the system which have not been specifically determined and separately allowed for (as represented by the *Dynamic Factor*).

2.6 Duty factor

2.6.1 This is a design factor which makes allowances for the frequency with which a lifting appliance is used. The *Duty Factor* is the factor by which the sum of all the static and dynamic loads acting on the system (excluding wind loading) must be multiplied to give the *Factored Load*.

2.7 Dynamic factor

2.7.1 This is a factor by which the *Live Load* is multiplied to represent the load on the system due to all dynamic effects which have not been explicitly determined and separately allowed for.

2.8 Live load

2.8.1 This is the sum of the Safe Working Load (SWL) of an Appliance and the static weight of any component of the appliance which is directly connected to, and undergoes the same motion as, the safe working load during the lifting operation.

2.9 Dead load

2.9.1 This is the self-weight of any component of the lifting appliance which is not included in the *Live Load*.

2.10 Design stress

2.10.1 This is the maximum stress permitted by the Code to which any component part of a lifting appliance may be subjected when the appliance is lifting its Safe Working Load (SWL), that is, when the appliance is subjected to the appropriate factors plus specified lateral and wind loads.

Section 3 Plans and information to be submitted

3.1 Derrick systems

3.1.1 The following plans and information are to be submitted for approval:

(a) A rigging plan clearly indicating the layout of the swinging derricks, heavy lifts derricks or union purchase systems and the position of the individual items of loose gear.
(b) A diagram of forces for each derrick rig and, in the case of union purchase working, the working range and data specified in Chapter 2.
(c) Scantling plans of masts and derrick posts and stays where fitted. (Note that these are classification items where the ship is classed with LR.)
(d) Scantling plans of derrick booms including head and heel fittings.
(e) Details of goosenecks, span and cargo swivels, guy eyeplates, and similar fittings.
(f) A list of blocks, chains, shackles, hooks, etc., indicating material, safe working load (SWL), proof load (PL) and the standard to which they have been manufactured.
(g) A list of steel wire and fibre ropes giving size, construction, finish and certified breaking loads.
(h) The material specification for steels to be used in the masts, derrick booms and associated fittings.

3.2 Davit systems

3.2.1 The following scantling plans are to be submitted for examination:

(a) A general arrangement.
(b) A reeving arrangement.
(c) Davit arm structural drawings.
(d) Details of hydraulic cylinders.
(e) Trackway, stool or 'A' frame structural drawings.
(f) Heel or rollerpin details (as applicable).
(g) Winch drawings including details of gears, brakes, clutches, other torque transmitting components and support arrangements.
(h) Loose gear details, including all sheaves and shafts.
(j) Material specifications.
(k) Designer's calculations.

3.2.2 In addition, each submission for approval is to state clearly the:

(a) Weight of the empty lifeboat/rescue boat and equipment;
(b) Weight of survival craft/rescue boat with full complement of passengers and equipment;
(c) Longitudinal centre of gravity of each lifeboat/rescue boat;
(d) Weight and centre of gravity of each davit arm;
(e) Final angle of list in damaged condition (only if exceeding 20°, *see* Ch 3,1.2.15);
(f) Embarkation position (applied only to passenger ships);
(g) Hoisting and lowering speeds;
(h) Maximum outreach of davit from ship's side;
(j) Ship's Flag Administration.

3.3 Crane systems

3.3.1 The following plans and calculations are to be submitted for approval:

(a) Calculations (or equivalent) clearly indicating the basis of design, operating criteria, rated capacities, weights and centres of gravity of the crane parts, and relevant National Standards.
(b) Scantling plans of all main structural items comprising the crane, including the jib, tower, platform, gantry, bogies, slewing ring, pedestals, rails and stowage arrangements.
NOTE
Pedestals and rails permanently attached to the vessel are classification items where the ship is classed with LR.
(c) Scanting plans and details of hydraulic cylinders.
(d) Details of sheaves, axles, pivot pins, wheels, spreader beams, slewing ring, slewing ring bolts, and similar items.
(e) Details of blocks, chains, shackles, hooks and other loose gear, indicating material, safe working load (SWL), proof loads (PL) and the standard to which they have been manufactured.
(f) The size, construction, finish and certified breaking loads of steel wire ropes.
(g) The material specification for steels to be used in the crane and pedestal construction.

3.3.2 In the case of diving systems covered by this Section, additional information is to be submitted with respect to approval of the winches and electrical and control systems. This information is detailed in LR's *Rules and Regulations for the Construction and Classification of Submersibles and Diving Systems* (hereinafter referred to as Rules for Submersibles), *see also* Chapters 9 and 10.

3.3.3 Plans as listed in 3.6.1 are to be submitted for classed cranes/systems.

3.4 Shiplifts

3.4.1 **Structural aspects**. The following plans are to be submitted for approval:

(a) Structural plans of the platform.
(b) Structural plans of the transfer system if it is required that this is to be included in the certification or class of the installation.
(c) Upper and lower sheave housings.
(d) Winch bedplate.
(e) Rope or chain specification.
(f) The material specification for steels used in the construction.

3.4.2 In addition, the following plans and information are required for reference purposes:

(a) Calculations clearly indicating the basis of design, nominal lifting capacity, maximum distributed load weights and centres of gravity of the component parts and any other relevant design criteria.
(b) Platform assembly.
(c) Arrangement of decking.
(d) Rail arrangement and details.
(e) Hoist and rigging arrangements.
(f) Cradle and block arrangements.
(g) Welding specifications.

3.4.3 **Mechanical, electrical and control aspects**. The plans as listed in 3.6.1 are to be submitted for approval, *see also* Chapters 9 and 10.

3.5 Lifts and ramps

3.5.1 The following plans are to be submitted for approval:
(a) All main structural plans.
(b) Details of sheaves and sheave supports.
(c) Calculations clearly indicating the ratings, vehicle loads, wheel centres, tyre prints, working range and angles, design specification, weights and centres of gravity of the component parts.
(d) Particulars of hydraulic rams and operating system, if fitted.
(e) Reeving arrangements.
(f) The size, construction, finish and certified breaking loads of ropes and chains.
(g) The material specification for steels to be used in the construction.
(h) Stowage arrangements.

3.5.2 In addition to the foregoing, the following information is required with respect to lifts:
(a) Typical layout including car construction and guide rail details.
(b) Typical entrances.
(c) Loading door fire test certificate.
(d) Works test certificates for motors.
(e) Typical wiring and explanatory diagrams including safety devices.

3.6 Mechanical, electrical and control aspects

3.6.1 The following plans are to be submitted for approval, *see also* Chapters 9 and 10.
(a) Diagrammatic plan of hydraulic or pneumatic systems, where fitted.
(b) Plans of winch gearing, shafts, clutches, brakes, coupling bolts, welded drums, and similar items and their materials and stresses.
(c) Plans of circuit diagram of electrical system, showing load currents and ratings of all electrical equipment, types and sizes of cables, rating type and make of all protecting devices.
(d) Arrangement plan and circuit diagram of switchboard.
(e) General arrangement of control centre.
(f) Schematic diagrams of control panels.
(g) Details of alarms and protection circuits.

3.6.2 In addition, the following information is required for reference purposes: calculations of short-circuit currents and main busbars, sub-switchboard busbars and the secondary side of transformers.

Contents

■ *Section 1* General

1.1 Application

1.1.1 The requirements of this Chapter are to be complied with in cases where Lloyd's Register (LR) is requested to issue a Register of Ship's Lifting Appliances and Cargo Handling Gear for derrick systems.

1.1.2 Masts, derrick posts and similar supporting structures for cargo handling devices are classification items and are to comply with the relevant Sections of this Chapter whether or not LR is also requested to issue the *Register of Ship's Cargo Gear and Lifting Appliances*. *See* Pt 3, Ch 9,6 of the *Rules and Regulations for the Classification of Ships* (hereinafter referred to as the Rules for Ships).

1.1.3 The requirements given in this Chapter are applicable to the following types of derrick system:

- Swinging derricks.
- Union purchase rigs.
- Derrick cranes (although Chapter 4 may be applicable to certain types of derrick crane as defined in 5.1.1).

Derricks of special design will be considered on the general basis of these requirements.

1.1.4 Typical arrangements of swinging derrick systems are shown in Fig. 2.1.1 and Fig. 2.1.2. These arrangements are given for illustration only and to indicate the nomenclature used in the systems.

1.2 Equivalents

1.2.1 Alternative arrangements or fittings which are considered to be equivalent to those specified in this Chapter will be accepted.

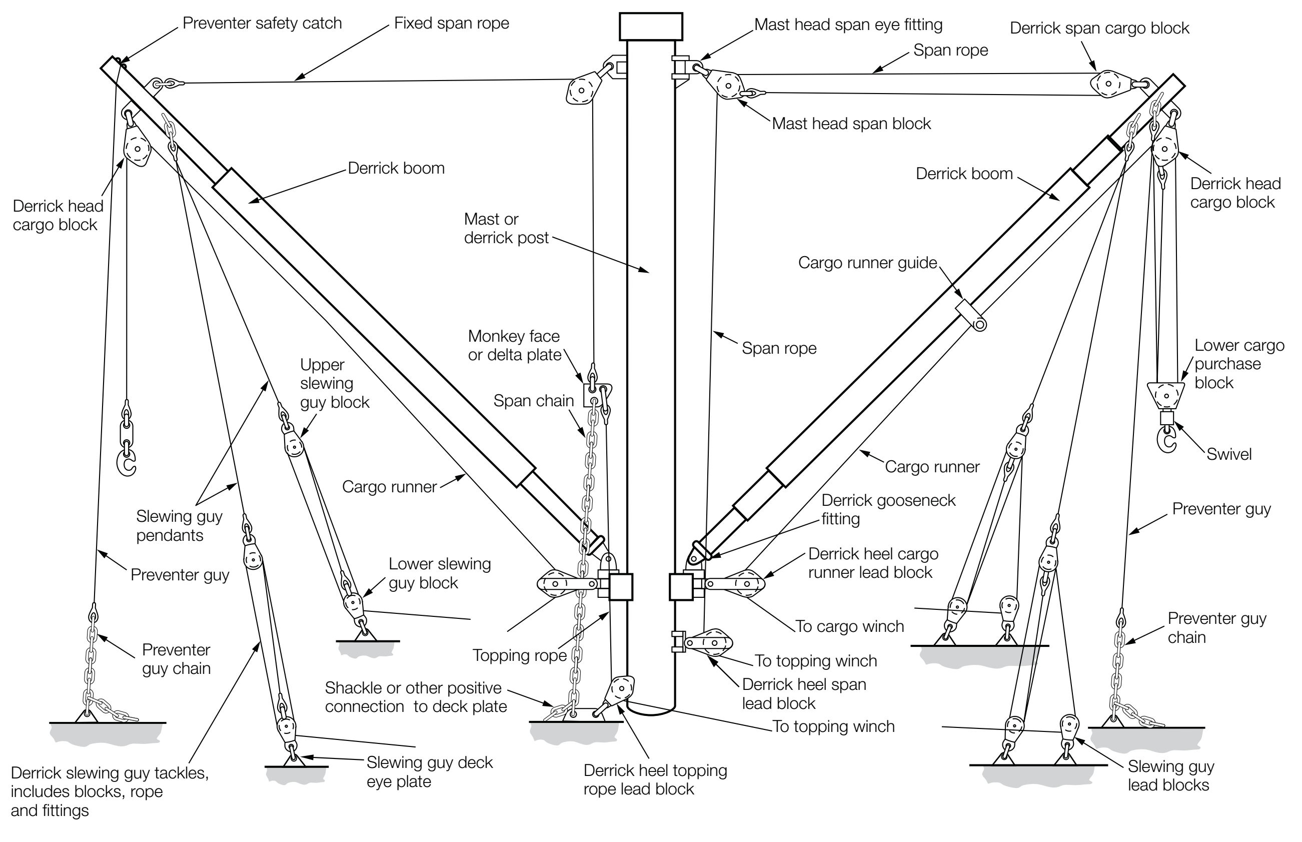


Fig. 2.1.1 Typical rigs for light loads

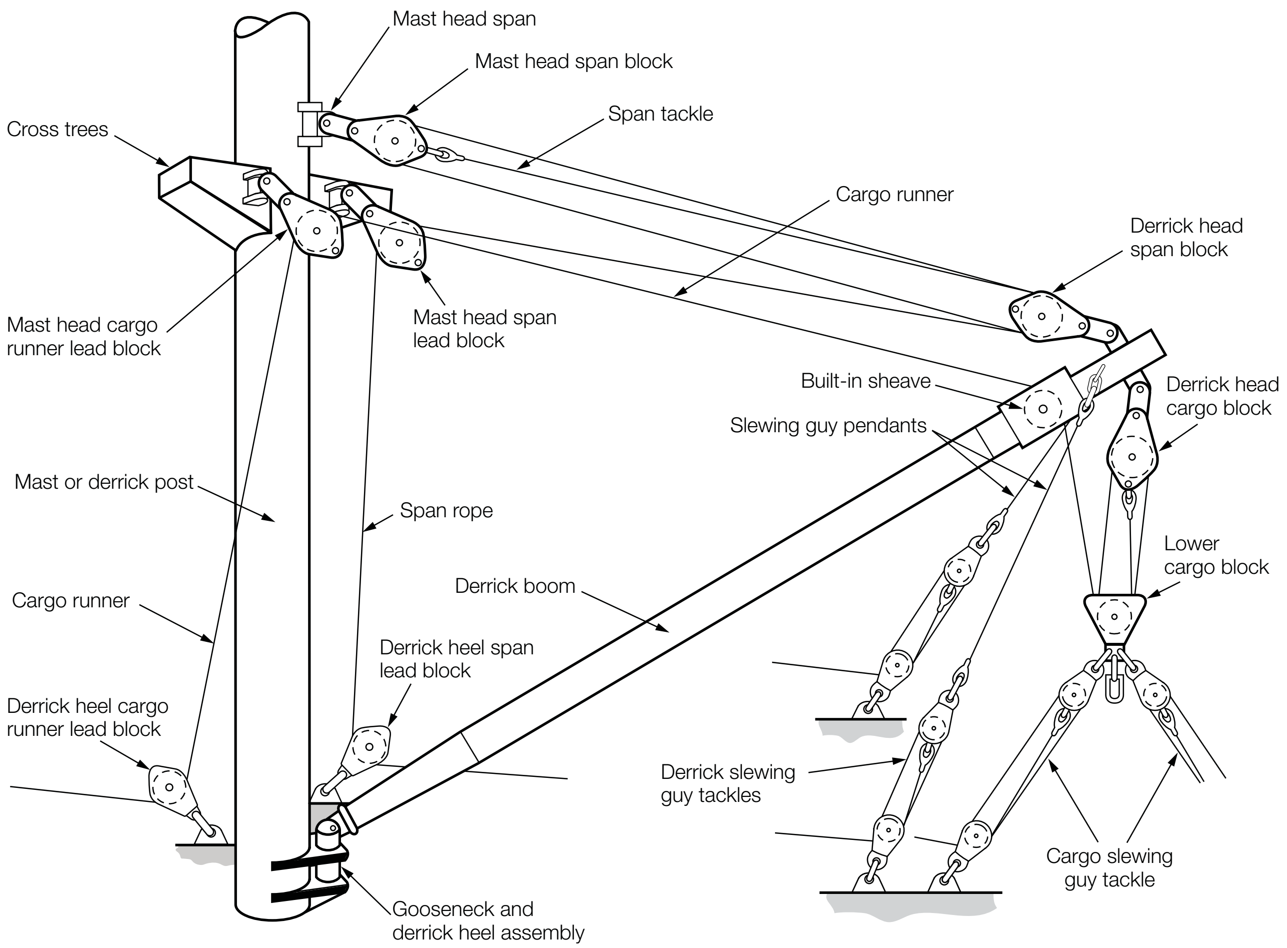


Fig. 2.1.2 Typical rig for heavy loads

1.2.2 International or National Standards will be considered as an alternative basis for approval, provided LR is satisfied that these are at least equivalent to the criteria specified in this Chapter.

1.3 Additional calculations

1.3.1 Where the derrick system incorporates novel features, LR may require additional calculations or model testing to be carried out.

1.3.2 Direct calculations using computer programs may be used as an alternative to the calculation procedures of this Chapter. Where programs other than those available from LR are employed, the assumptions made and the calculation procedures used are to be submitted for approval. Where calculations using these procedures are made, the results are to be included with the plans submitted for approval.

1.4 Information to be submitted

1.4.1 The plans and information listed in Ch 1,3 are to be submitted for approval.

1.4.2 It is recommended that the information be presented in the form of a *Cargo Gear Particulars Book* and that a copy be placed on board the ship. *See* Ch 13,2.1.

1.4.3 Plans of masts and derrick posts are required to be approved for classification purposes, and these plans, together with a Rigging Plan and diagrams of forces, are to be submitted in all cases, whether or not LR's *Register of Ship's Lifting Appliances and Cargo Handling Gear* is to be issued.

1.5 Materials

1.5.1 Materials are to comply with the requirements of Ch 1,1.6.

1.5.2 Steel for masts, derrick posts and associated items included in the classification of the hull is to comply with the requirements of the Rules for Materials. The grade of steel is to comply with the requirements of Table 2.1.1, or Charpy impact test requirements are to comply with Tables 4.2.18 to 4.2.20 in Chapter 4 as appropriate.

Table 2.1.1 Impact grade requirements for classed structures

Thickness, in mm	Grade
$t \leq 20,5$	A/AH
$20,5 < t \leq 25,5$	B/AH
$25,5 < t \leq 40$	D/DH
$40 < t$	E/EH

1.5.3 Steel for derrick booms and associated fittings is to comply with LR's requirements as in 1.5.2 or with an appropriate National Standard, *see* Ch 1,1.6.

1.5.4 Steel castings and forgings are to be normalised or otherwise heat-treated at a temperature and according to a method appropriate to the material and size of the item.

1.5.5 Cast, forged and fabricated items, are to be so designed and constructed as to minimise stress concentrations. Fabricated items are to be designed to ensure good penetration of welds and adequate accessibility for non-destructive examination as necessary.

1.6 Symbols and definitions

1.6.1 The nomenclature adopted for the principal items comprising the derrick system is shown in Fig. 2.1.1 and Fig. 2.1.2.

1.6.2 The following symbols are used throughout this Chapter:

σ_y = the yield stress of the material under consideration, in N/mm^2 (kgf/mm^2)

σ_u = the ultimate tensile strength of the material under consideration, in N/mm^2 (kgf/mm^2)

L = the length of the derrick boom measured from the centre of the derrick heel pin to the centre of the derrick head span eye or equivalent position, in metres

H = the length of the mast, or derrick post measured from the centre of the derrick heel pin to the centre of the mast head span eye or equivalent position, in metres

S = the distance from the centre of the mast head span eye to the centre of the derrick head span eye, in metres

W = the load on the hook of the derrick system and usually to be taken as the safe working load of the system, in tonnes.

1.6.3 Remaining symbols are defined as they occur.

■ *Section 2* Design criteria

2.1 Operating range for derricks

2.1.1 Calculations are to be made for derrick systems with the derrick booms at the maximum and minimum angles for which the system is to be certified. These angles are to be taken as follows:

(a) Maximum angle to the horizontal:
70° generally, but a greater angle may be specified.

(b) Minimum angle to the horizontal:
  - (i) SWL not exceeding 15 t:
30° generally, but a lesser angle may be specified. In no case is the angle to be less than 15°.
  - (ii) SWL exceeding 15 t:
30° generally, but a greater angle may be specified. In no case is the angle to be greater than 45°.

2.1.2 The length of the derrick boom is to be such as to give adequate coverage of the cargo hatch and sufficient outreach beyond the ship's side, within the limiting angles given in 2.1.1.

2.1.3 The lengths of derrick booms for union purchase systems are to be sufficient to provide the coverage of the hatch and outreach beyond the ship's side as required by 4.2.1. The angles of inclination of the booms are to remain within the limits given in 2.1.1.

2.2 Inclination of the ship

2.2.1 For swinging derrick and union purchase systems, a basic angle of heel of 5° and a trim of 2° are assumed for the ship. Provided these angles are not exceeded, they may generally be ignored in the calculation of forces and tensions in the derrick system and in the masts and derrick posts.

2.2.2 The angles of heel and trim of the ship with its largest loaded derrick (or derricks if more than one can be used at one time) swung fully outboard are to be calculated. Where the calculation shows that the ship would have a greater angle of heel or trim than 5° or 2° respectively, the actual angles are to be taken into consideration. This calculation is NOT to be taken to mean that LR accepts responsibility for the stability of the ship. Stability is a matter to be agreed between the Builder, designer and Owner and may be subject to National Regulations.

2.2.3 For derrick cranes, a basic angle of heel of 5° and a trim of 2° is generally to be included in the calculations. Greater or lesser angles may be specified provided these angles are clearly stated in the certificates.

2.3 Weight of boom and tackle

2.3.1 The weight of the derrick boom and tackle is to be included in the calculations for all union purchase rigs and for swinging derricks and derrick cranes where the SWL exceeds 15*t*. Where available, the actual weight of the derrick boom and tackle is to be used. Alternatively, an estimated value equal to 10 per cent of the SWL of the system when rigged as a swinging derrick or derrick crane is to be applied at the derrick boom head.

2.4 Friction allowance

2.4.1 For calculation purposes, a combined allowance for sheave friction and wire stiffness is to be made as follows:

- Blocks with plain or bushed sheaves: 5 per cent
- Blocks with ball or roller sheaves: 2 per cent

Allowances for sheaves with low friction bearings will be specially considered.

2.4.2 The appropriate percentage is to be applied cumulatively to the parts of the rope supporting the load. Coefficients for estimating the rope tension are given in Table 2.2.1 and in association with Fig. 2.2.1.

2.4.3 As an alternative, the coefficients of rope tensions may be determined as follows:

$$P_{\text{hoisting}}(\mu, i, j) = \frac{1}{\sum_{k=0}^{i-1} (1+\mu)^k} (1+\mu)^{i-1} (1+\mu)^{j-1} \quad \text{if } j \neq 0$$

$$= \frac{1}{\sum_{k=0}^{i-1} (1+\mu)^k} \quad \text{otherwise}$$

$$P_{\text{lowering}}(\mu, i, j) = \frac{1}{\sum_{k=0}^{i-1} \frac{1}{(1+\mu)^k}} \; \frac{1}{(1+\mu)^{i-1}} \; \frac{1}{(1+\mu)^{j-1}} \quad \text{if } j \neq 0$$

$$= \frac{1}{\sum_{k=0}^{i-1} \frac{1}{(1+\mu)^k}}$$

Table 2.2.1 **Coefficients of rope tension**

Number of parts supporting the load	Friction allowance per sheave %	Static rope pull	Hoisting						Lowering					
			P_0	P_1	P_2	P_3	P_4	P_5	P_0	P_1	P_2	P_3	P_4	P_5
			F_0	F_1	F_2	F_3	F_4	F_5	F_0	F_1	F_2	F_3	F_4	F_5
1	2	1,00	—	—	1,02	1,04	1,06	1,08	—	—	0,98	0,96	0,94	0,92
	5		—	—	1,05	1,10	1,16	1,22	—	—	0,95	0,91	0,86	0,82
2	2	0,500	0,495	0,505	0,515	0,525	0,536	0,547	0,505	0,495	0,485	0,476	0,467	0,457
	5		0,488	0,512	0,538	0,565	0,593	0,623	0,512	0,488	0,465	0,443	0,421	0,401
3	2	0,333	0,327	0,340	0,347	0,354	0,361	0,368	0,340	0,327	0,320	0,314	0,308	0,302
	5		0,317	0,350	0,357	0,386	0,405	0,425	0,350	0,317	0,302	0,288	0,274	0,261
4	2	0,250	0,243	0,258	0,263	0,268	0,273	0,279	0,258	0,243	0,238	0,233	0,229	0,224
	5		0,232	0,269	0,282	0,296	0,311	0,327	0,259	0,232	0,221	0,210	0,200	0,191
5	2	0,200	0,192	0,208	0,212	0,216	0,221	0,225	0,208	0,192	0,188	0,185	0,181	0,178
	5		0,181	0,220	0,231	0,243	0,255	0,267	0,220	0,181	0,172	0,164	0,156	0,149
6	2	0,167	0,159	0,175	0,179	0,182	0,186	0,189	0,175	0,159	0,155	0,152	0,149	0,146
	5		0,147	0,188	0,197	0,207	0,217	0,228	0,188	0,147	0,140	0,133	0,127	0,121
7	2	0,143	0,135	0,152	0,155	0,158	0,160	0,164	0,152	0,135	0,132	0,129	0,127	0,124
	5		0,123	0,165	0,173	0,181	0,191	0,200	0,155	0,123	0,117	0,111	0,106	0,101
8	2	0,125	0,117	0,134	0,137	0,139	0,142	0,145	0,134	0,117	0,114	0,112	0,110	0,108
	5		0,105	0,147	0,155	0,162	0,171	0,179	0,147	0,105	0,100	0,095	0,090	0,086
9	2	0,111	0,103	0,120	0,123	0,125	0,128	0,130	0,120	0,103	0,101	0,099	0,097	0,095
	5		0,091	0,134	0,141	0,148	0,155	0,163	0,134	0,091	0,086	0,082	0,078	0,075
10	2	0,100	0,091	0,109	0,111	0,114	0,116	0,118	0,109	0,091	0,090	0,088	0,086	0,084
	5		0,080	0,123	0,130	0,136	0,143	0,150	0,123	0,080	0,076	0,072	0,069	0,065
11	2	0,091	0,082	0,100	0,102	0,104	0,106	0,108	0,100	0,082	0,081	0,079	0,077	0,076
	5		0,070	0,115	0,120	0,126	0,133	0,139	0,115	0,070	0,067	0,064	0,061	0,058
12	2	0,083	0,075	0,093	0,095	0,097	0,099	0,100	0,093	0,076	0,073	0,072	0,070	0,069
	5		0,063	0,108	0,113	0,118	0,124	0,131	0,108	0,063	0,060	0,057	0,054	0,052
13	2	0,077	0,068	0,086	0,088	0,090	0,092	0,094	0,086	0,068	0,067	0,066	0,064	0,063
	5		0,057	0,101	0,107	0,112	0,117	0,123	0,101	0,057	0,054	0,051	0,049	0,046

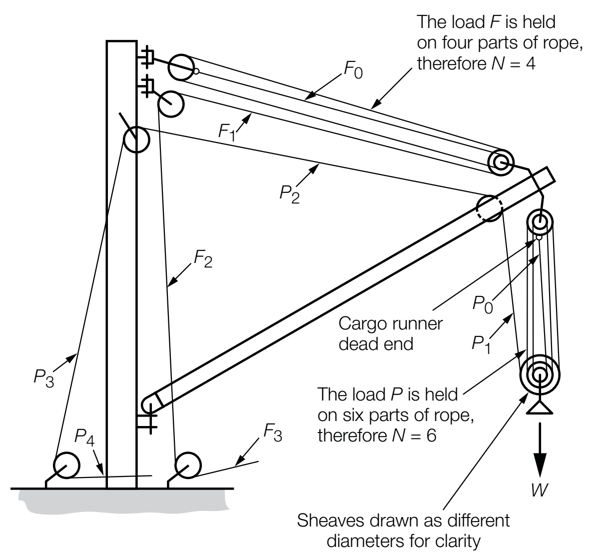


Fig. 2.2.1 Coefficients of rope tension

where

μ = percentage of friction (e.g., 2 per cent for roller bearings)
i = number of parts supporting the load
j = location in drive system (e.g., *see* Table 2.2.1 where P_j is defined).

2.5 Factor of safety for ropes

2.5.1 Wire ropes are to have a breaking load not less than the maximum tension in the rope multiplied by a factor obtained from Table 2.2.2.

Table 2.2.2 Factors for wire ropes

Item	Factor
(1) Running rigging: Cargo runner Span tackle Slewing guys Preventer guys Schooner guys	$\dfrac{10^4}{(8{,}85 \times \text{SWL}) + 1910}$ but not greater than 5 or less than 3
(2) Standing rigging: Mast stays	As for running rigging but need not exceed 3,5
NOTE SWL is the safe working load of the derrick or derrick crane with which the rope is to be used. For standing rigging, SWL is the highest safe working load of any derrick or derrick crane supported by the mast.	

2.5.2 Natural fibre ropes used in derrick systems, where permitted, are to have a breaking load not less than the maximum tension in the rope multiplied by 8.

2.5.3 Man-made fibre ropes, where permitted for standing rigging, are to have a breaking load not less than the value obtained from Table 2.2.2 multiplied by 1,25.

■ *Section 3*
Swinging derrick systems

3.1 General

3.1.1 A swinging derrick system comprises a derrick boom pivoted at its heel and supporting the load from a head fitting. The boom is raised or lowered (luffed) by means of a span rope between the boom head and a suitable fixed point, usually a mast or derrick post. The boom is moved laterally (slewed) by guy ropes attached at the boom head.

3.1.2 Swinging derricks may be divided into two categories:
(a) Light derricks, having a SWL of 15 t or less.
(b) Heavy derricks having a SWL exceeding 15 t.

3.2 Operating conditions

3.2.1 Calculations are to be made with the derrick boom at its lowest and highest operating angles to the horizontal, subject to the requirements of 2.1.1.

3.2.2 Where more than one arrangement of the rig is proposed for the derrick, calculations are to be made for each arrangement.

3.3 Force diagrams and calculations

3.3.1 Where force diagrams are prepared, the vertical load at the derrick boom head is to be taken as the SWL of the rig plus an allowance for the weight of the boom and tackle as required by 2.3.

3.3.2 The tension in the cargo runner is to be calculated using the factors given in Table 2.2.1 for the appropriate friction allowance for the blocks and number of parts of the runner in each section of the purchase.

3.3.3 Using this information, a polygon of forces may be drawn and the resultant force in the span tackle and thrust in the derrick boom determined.

3.3.4 A typical set of force diagrams is shown in Fig. 2.3.1.

3.3.5 Where the cargo runner is parallel to the span tackle between the boom head and mast head, the tension in the runner provides partial support for the system. This force, called the ‘span relief’ is deducted from the total span force in order to determine the load in the span tackle. Consequently, in order to find the maximum load in the span tackle, the system is to be considered in the lowering operation and the span relief is to be W x P_2. All other forces in the rig are to be calculated for the hoisting operation.

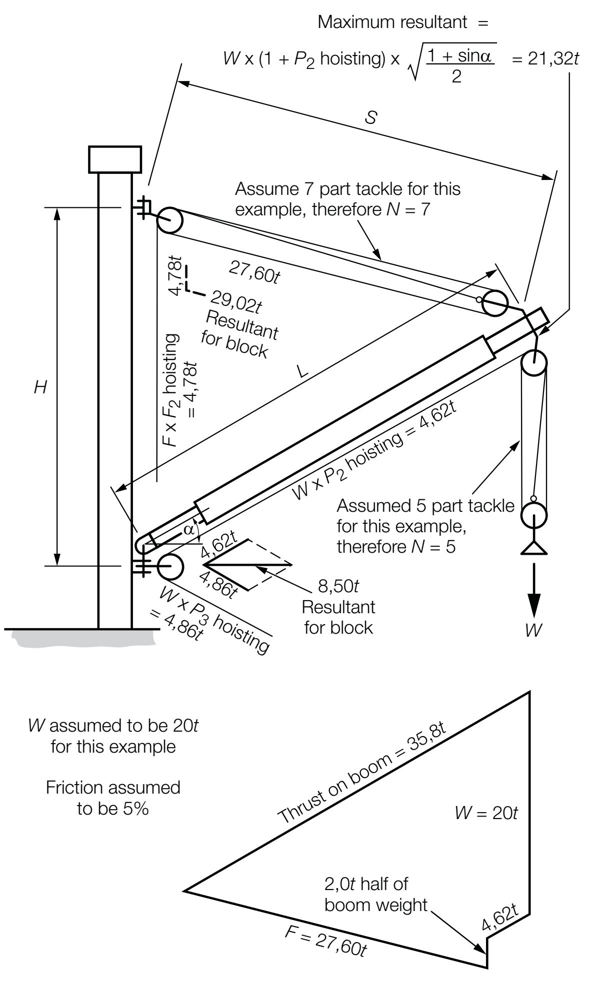


Fig. 2.3.1
Typical calculation of forces in the derrick system

3.3.6 The required breaking load of each rope is found by multiplying the maximum calculated tension by the appropriate factor of safety from Table 2.2.2.

3.3.7 The resultant loads in each of the blocks in the rig may be determined by drawing the appropriate polygons of forces as shown in Fig. 2.3.1.

3.3.8 The resultant forces in the system may be determined by direct calculation as an alternative to the preparation of force diagrams.

3.3.9 Fittings, loose gear and ropes are to comply with the requirements of Chapter 8.

■ *Section 4*
Union purchase arrangements

4.1 General

4.1.1 Where the derricks are arranged for operation in union purchase, the maximum resultant loads in the system are to be determined, in accordance with the requirements of this Section.

4.1.2 The scantlings and arrangements of the derrick system are to be determined for union purchase operation and for operation as single slewing derricks. Each part of the rig is to be suitable for the most severe loading to which it may be subjected.

4.1.3 The union purchase rig is generally to be designed so that the operation is possible on either side of the ship. A typical rig is shown in Fig. 2.4.1.

4.1.4 Union purchase rigs may be designed on the basis of either:
(a) minimum headroom below the triangle plate; or
(b) maximum included angle between the cargo runners.

4.1.5 The following criteria are to be complied with at all times:
(a) Minimum operating angle of either derrick is to be not less than 15° to the horizontal, and it is recommended this angle is not less than 30°.
(b) Minimum headroom to the triangle plate is to be not less than 4,0 m where the SWL(U) of the rig does not exceed 2,0 t, or 5,0 m for higher values of SWL(U).
(c) The maximum included angle between the cargo runners is not to exceed 120°.
(d) The outreach beyond the midship breadth of the ship is to be not less than 4,0 m.

4.1.6 The minimum headroom is defined as the least vertical in distance at any stage in the operating cycle of the rig, from the highest point of the ship's deck structure (usually the top of the hatch coaming or the ship side bulwark or rails) to the centre of the triangle plate.

4.2 Working range of the rig

4.2.1 The derrick booms are to be of sufficient length and to be so positioned as to cover the required working area of the hatch while complying with the criteria given in 4.1.5.

4.2.2 For this purpose, the booms are to be such that the boom heads may be located at the positions listed in Table 2.4.1. These arrangements are illustrated in Fig. 2.4.2(a) and (b) for hatches with one pair and two pairs of derricks respectively.

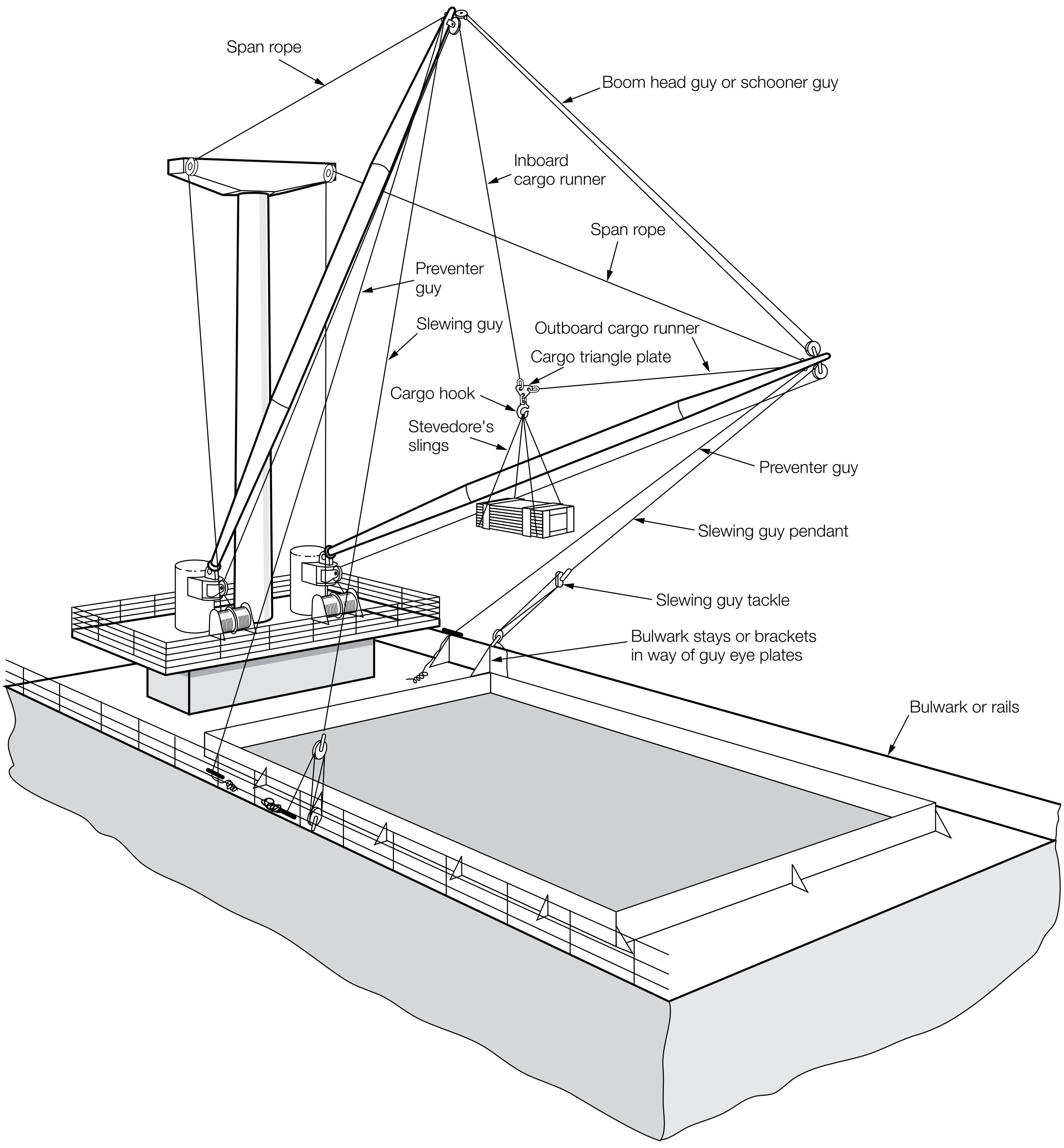


Fig. 2.4.1 Typical union purchase rig

4.2.3 Calculations of the forces and resultant loads in the system are to be made as follows:

(a) Based on maximum headroom:
Outboard boom, *see* Table 2.4.1.
Inboard boom, *see* Table 2.4.1, Case 1

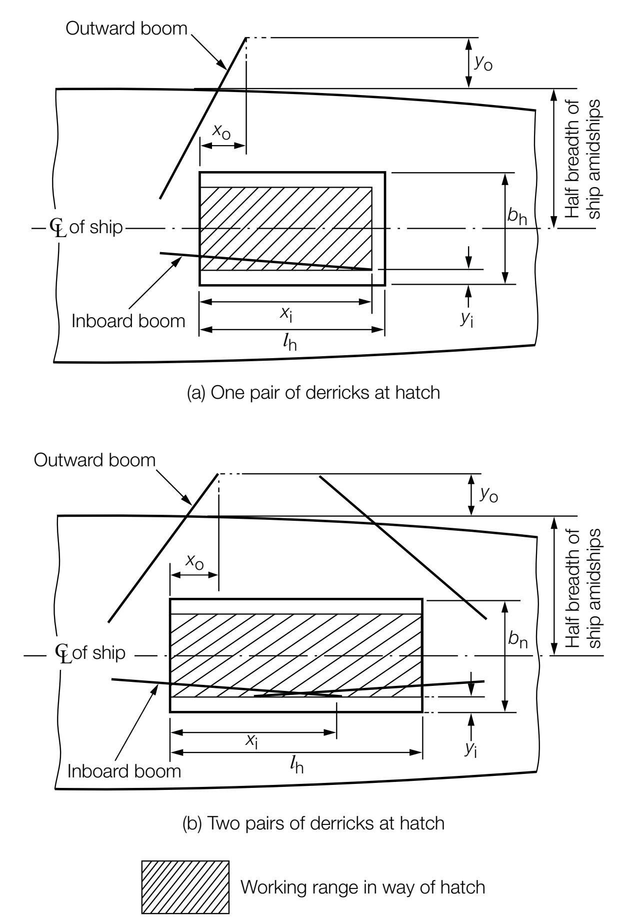
(b) Based on maximum included runner angle:
Outboard boom, *see* Table 2.4.1.
Inboard boom, *see* Table 2.4.1, Cases 1 and 2 (that is, two calculations are required).

4.2.4 Where, at the request of the Owner, the rig is to operate over a working range different from that given in 4.2.2, including instances where the rig is designed for use in one fixed position only, calculations are to be made for the extreme positions of the specified range. The boom positions are to be clearly defined in the *Register of Ship's Lifting Appliances and Cargo Handling Gear*. In all instances, the arrangement is to comply with the limiting criteria given in 4.1.5.

Table 2.4.1 Boom head positions for union purchase calculations

Boom and direction	Symbol	Number of pairs of booms at the hatch: One	Two
		Dimension, in metres	
Outboard boom			
Transverse	y_o	4	4
Longitudinal	x_o	0,25l_h	0,20l_h
Inboard boom:			
Case 1 Transverse	y_j	1	1
Case 1 Longitudinal	x_j	0,75l_h	0,67l_h
Case 2 Transverse	y_j	0,25b_h	0,25b_h
Case 2 Longitudinal	x_j	0,375l_h	0,33l_h

NOTES
1. For illustration of positions and symbols used, *see* Fig. 2.4.2.
2. Case 2 is applicable to operation in the maximum included angle mode only.
3. l_h and b_h are defined as the length and breadth respectively of the hatch openings, in metres.



(a) One pair of derricks at hatch

(b) Two pairs of derricks at hatch

Fig. 2.4.2 Positions of derricks for union purchase

4.2.5 It may be assumed that the maximum forces will be associated with the extreme positions of the rig. Intermediate positions within the working range need not, in general, be examined.

4.2.6 The derrick booms are to be restrained by the use of preventer guys which are to be attached to eyeplates at the boom head or looped over the boom. The slewing guys are to be slackened off once the rig is set up and only the preventer guys are to be taken into account with regard to the calculation of forces in the rig.

4.2.7 It is recommended that the deck eyeplate for the preventer to the inboard derrick should be approximately abreast the derrick head. The eyeplate for the preventer to the outboard derrick is to be positioned so as to obviate the risk of jack-knifing, *see* Fig. 2.4.5, and to avoid excessive guy tension.

4.2.8 The boom heads are to be connected by a boom head or schooner guy, the safe working load of which is to be as required by 8.4.6. Alternative arrangements will be considered.

4.3 Calculation of forces

4.3.1 The dimensions and other particulars required for the calculation of forces in the rig are indicated in Fig. 2.4.3.

4.3.2 Where the forces are to be determined by the construction of force diagrams, it is recommended that the following procedure be adopted, corresponding to the parts of the typical diagrams as labelled in Fig. 2.4.4:
(a) Projected plan of the rig.
(b) True side elevations of the derrick booms.
(c) Lines of the cargo runners at the minimum headroom position.

4.3.3 The force diagrams may be constructed on these geometrical diagrams as follows. For illustration, values corresponding to a unit load on the rig are shown in Fig. 2.4.4.
(a) The runner tensions and components of tension at the boom heads are determined from Fig. 2.4.4(c).
(b) The horizontal component of runner tension is marked off and the horizontal components of boom thrust and of guy tension are derived from Fig. 2.4.4(a).
(c) The vertical component of boom thrust and the guy tension may now be determined, *see* Fig. 2.4.4(a).
(d) The compression in the boom and the tension in the span rope are determined from Fig. 2.4.4(d), using the horizontal component of boom thrust and the total of the vertical forces, which are:
  - Vertical component of runner tension, as in (a).
  - Vertical component of guy tension, as in (c).
  - Weight of boom and tackle, *see* 2.3.1.

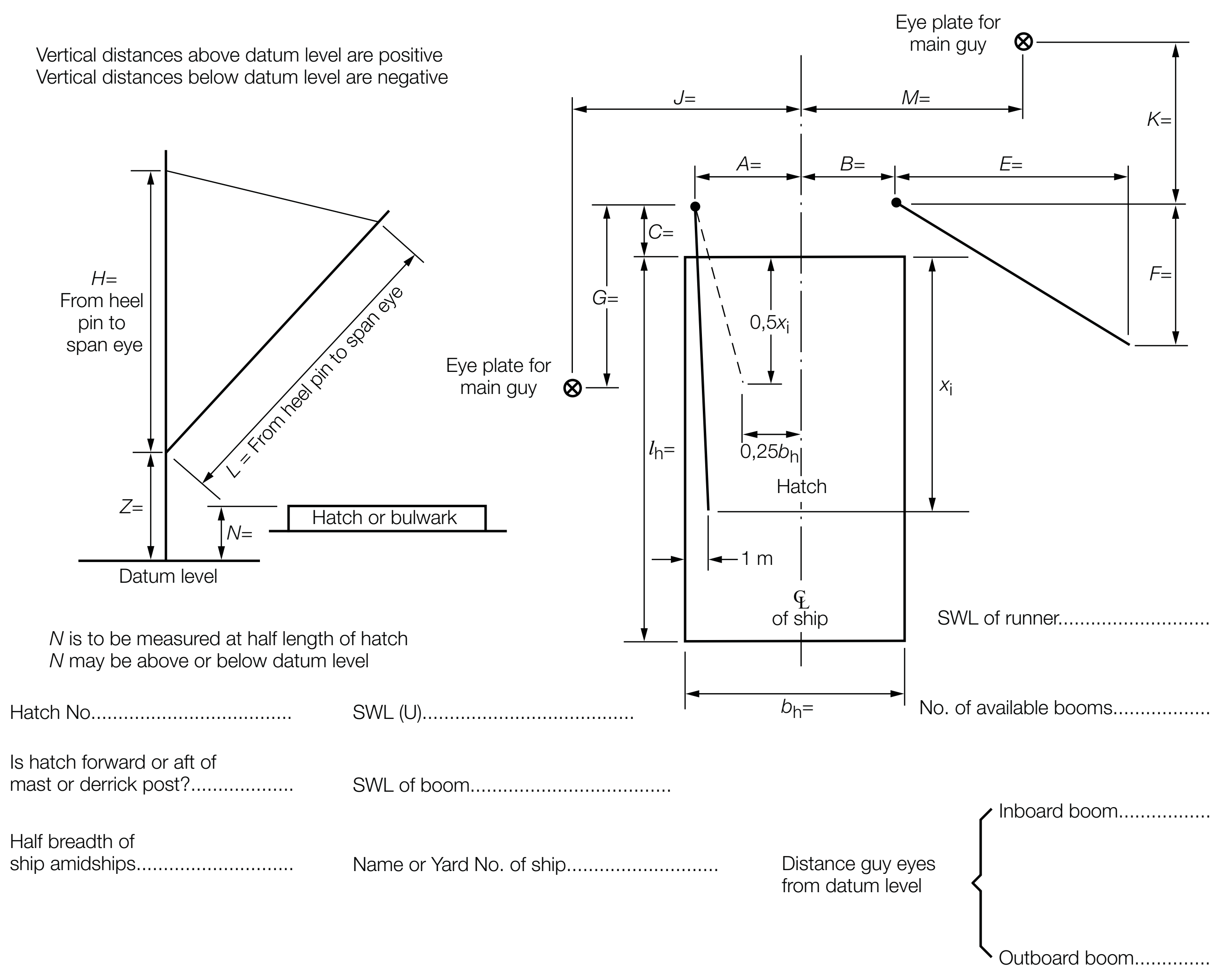


Fig. 2.4.3 Typical data sheet

4.3.4 Where a diagram of the character shown in Fig. 2.4.5 is obtained (this is where the diagram does not 'close'), the boom is in danger of jack-knifing. The boom will be in danger of jack-knifing if the total vertical load is less than the span tension x tan α, where α is the angle of the boom to the horizontal. Where this situation arises, the eyeplates for the preventer guys are to be repositioned. In general, it is recommended that the position of the guy eyeplate for the outboard boom is such that the load due to the vertical components of the runner and guy forces (but not the boom weight) is at least equal to span tension x tan α.

4.3.5 As an alternative to the graphical procedure, the forces in the rig may be determined by direct calculation.

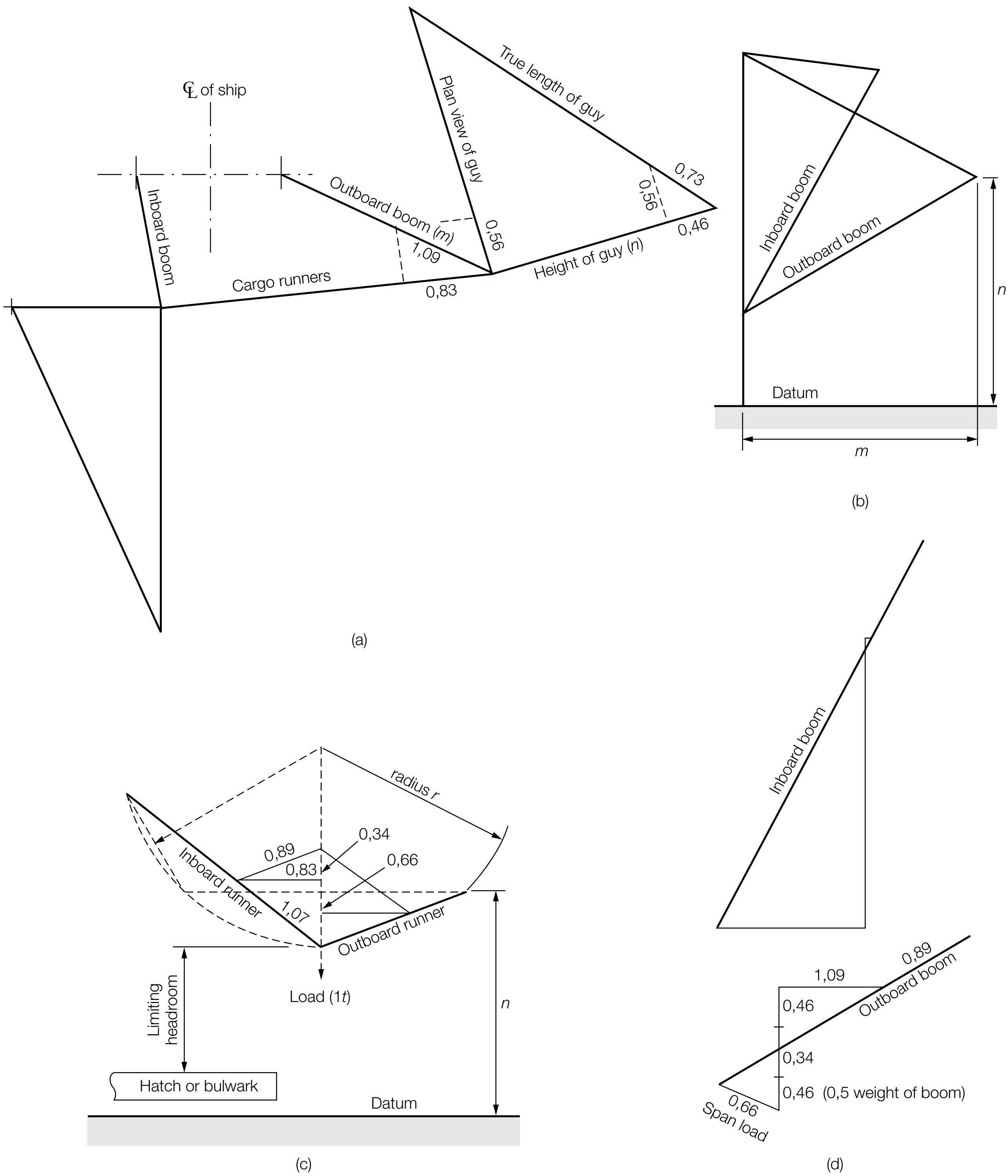


Fig. 2.4.4 Typical union purchase calculations

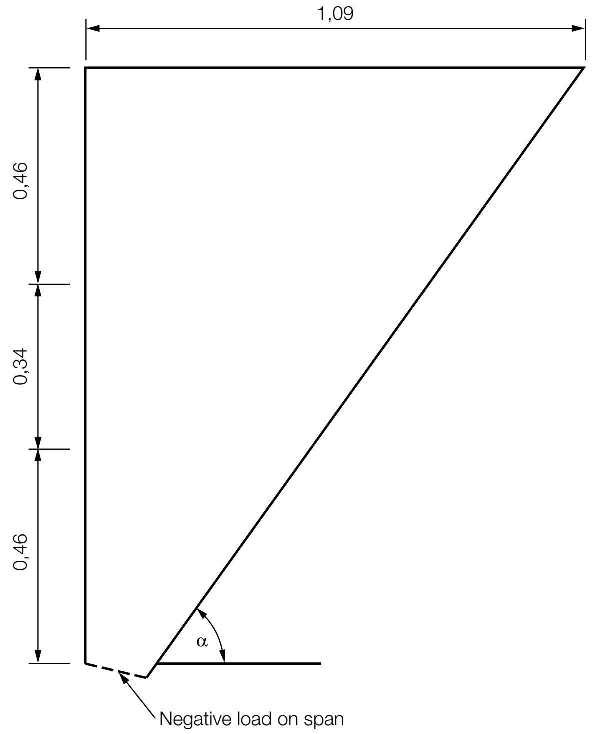


Fig. 2.4.5
Form of diagram when beam is in danger of jack-knifing

Section 5
Derrick cranes and derricks of special design

5.1 General

5.1.1 In general, a derrick crane may be described as a conventional derrick fitted with one of the following modifications:

(a) Twin span tackles so designed that the derrick can be slewed without the use of separate guys.
(b) A system for topping (luffing) the derrick boom other than by means of span ropes.
(c) The cargo and/or the span winches built into the derrick boom and moving with it.
(d) A system for slewing the derrick boom by applying a torque to a slew ring or trunnion.

Where more than one of the above modifications is fitted, the system will normally be considered as a deck crane and the requirements of Chapter 4 will apply.

5.1.2 Derricks of special design but not designated as derrick cranes are to comply with the requirements of this Section where they are applicable.

5.1.3 Attention is drawn to the fact that many of the designs and variations of design incorporated in derrick cranes and special derrick systems incorporate patent features.

5.1.4 Derrick cranes and derricks of special design are to be examined for the operating range and angles of inclination of the ship as specified in Section 2. Force diagrams or calculations are to be prepared as required by Section 3. More detailed calculations may, however, be required to support proposals for unusual systems.

5.2 Twin span tackles

5.2.1 Twin span tackles are to include:

(a) Two separate span tackles each attached to the head of the boom, directly or via outriggers, and operated by independent winches.
(b) Two span tackles led to a topping winch and a slewing winch. The topping winch shortens equally on both spans and the slewing winch shortens one span while paying out the other, *see* Fig. 2.5.1.

The two sections of the tackles may be attached to the cross trees of a mast or they may be fitted to two separate derrick posts. Where two separate posts are used, the boom is sometimes arranged so that it can pass through the vertical position between the posts and so be available to work hatches both forward and aft of the posts.

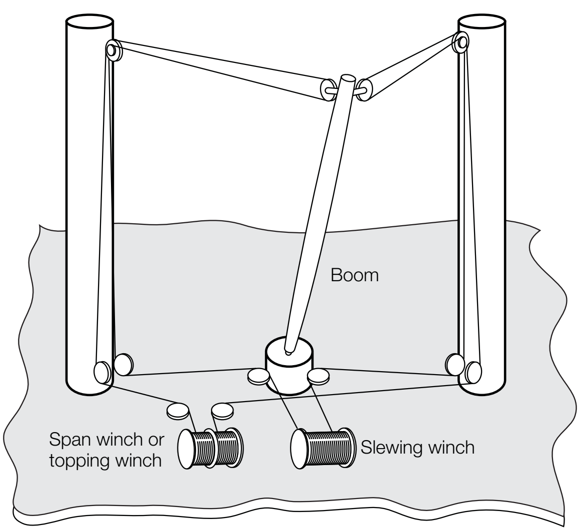


Fig. 2.5.1 Span tackles with winch

5.2.2 Where twin span tackles are fitted, they are to be so arranged that the minimum distance of the span tackle from the vertical through the boom gooseneck is not less than one ninth of the boom length. This distance is to be measured horizontally at right angles to the line of action of the span tackle, or to the section of the span tackle under consideration, *see* Fig. 2.5.2. This minimum separation can be achieved by one or more of the following means:

(a) by limiting the slewing angle of the boom; or
(b) by fitting outriggers to the boom head; or
(c) by fitting hinged or fixed outriggers, or their equivalent to the derrick posts, mast house or cross tree; or
(d) by a combination of one or more of the above.

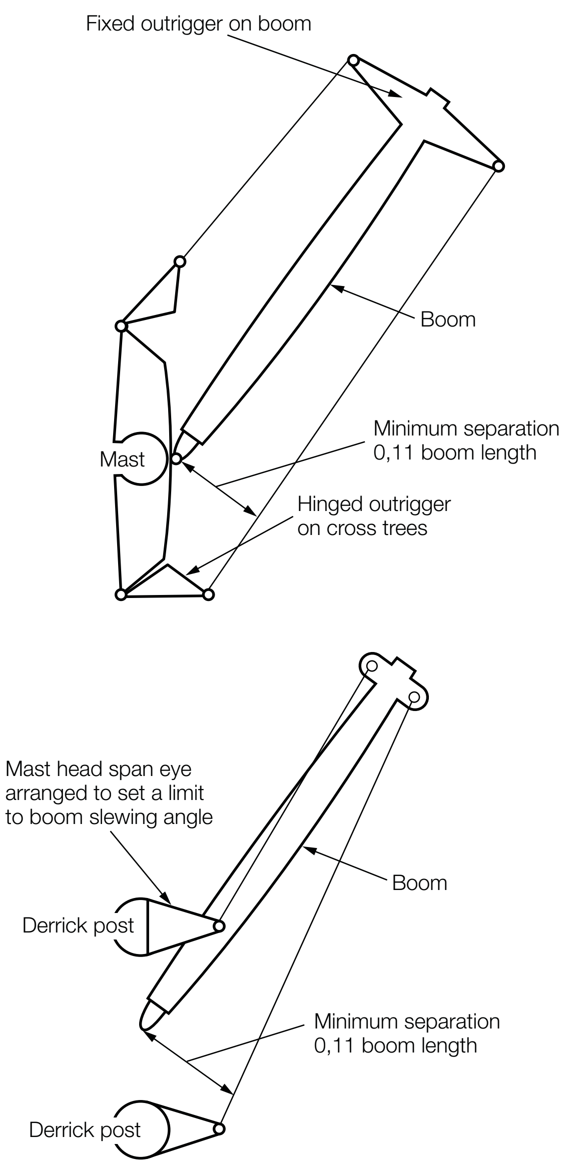


Fig. 2.5.2 Minimum separation

5.2.3 Alternatively, the stability of the system may be demonstrated by calculation or by model tests.

5.2.4 Where the slewing angle of the boom is to be restricted, this may be done by moving the position of the mast head span eyeplate away from the transverse plane through the gooseneck into a position that will be vertically above the derrick boom when the boom is in its limiting position. Alternatively, limit switches may be installed to provide automatic cut-out of the slewing system. Limiting the slewing angle of the boom by means of a stop fitted to the boom heel or by allowing the boom to come up against a shroud or other obstruction cannot normally be recommended as these methods tend to induce large transverse bending moments in the boom or to cause local indentations and consequential failure of the boom tube.

5.2.5 In general, where twin span tackles are fitted, the strength of each is to be sufficient to support the boom plus the safe working load in the boom's fully outboard position. Where, however, it can be shown that it is not possible for either span tackle to become slack in service, the strength of each tackle may be based on the maximum calculated span tension but is to be taken as not less than two thirds of the total span tension. Calculations in this respect are to be submitted by the manufacturer of the derrick crane.

5.2.6 Where the derrick boom is fitted with a cross-head and the span tackles are each connected by strops to both ends of the cross-head, then the required breaking load of each of the strops may be based upon 80 per cent of the maximum load in the span tackle.

5.3 Slewing guys

5.3.1 Slewing guys may be fitted in addition to twin span tackles and may take any one of the following forms:

(a) Guys of the normal type.
(b) Guys which are so rigged that topping the boom will not alter the transverse position of the boom head relative to the centreline of the ship.
(c) One or more bights of the span wire led down from the boom head span block, around a block at deck or bulwark level and back up to the boom head span block again.

5.3.2 Where a guy is led from an eyeplate on the deck around a block at the boom head and then to an eyeplate on the mast, a calculation or diagram of forces is to be prepared with the boom in its highest working position in order to check that the boom is not liable to jack-knife.

5.3.3 The required safe working load of the slewing guys of normal type is to be determined from 8.4 on the basis of the SWL of the derrick system. Where a derrick crane is of the type described in 5.1.1(c), the nominal SWL for this purpose is to be increased by 25 per cent.

5.4 Derrick booms

5.4.1 The scantlings of derrick booms are generally to be determined in accordance with Section 6.

■ *Section 6* Derrick booms

6.1 General

6.1.1 The requirements of this Section are applicable to the following types of tubular derrick boom:

(a) **Parallel boom**. A boom which is of uniform diameter and thickness over its full length.
(b) **Tapered boom**. A boom which has a mid-section of uniform diameter and thickness welded to tapered end sections.

(c) **Stepped boom**. A boom which has a mid-section of uniform diameter and thickness reducing towards the ends in one or more steps. The change of section may be obtained by cressed, lapped or stepped construction.

6.1.2 Proportions for tapered and stepped derrick's booms are illustrated in Fig. 2.6.1. Alternative arrangements will, however, be accepted where it may be shown that the resulting strength of the boom is adequate. Derricks of unusual design or incorporating special features will be considered on the general basis of these requirements.

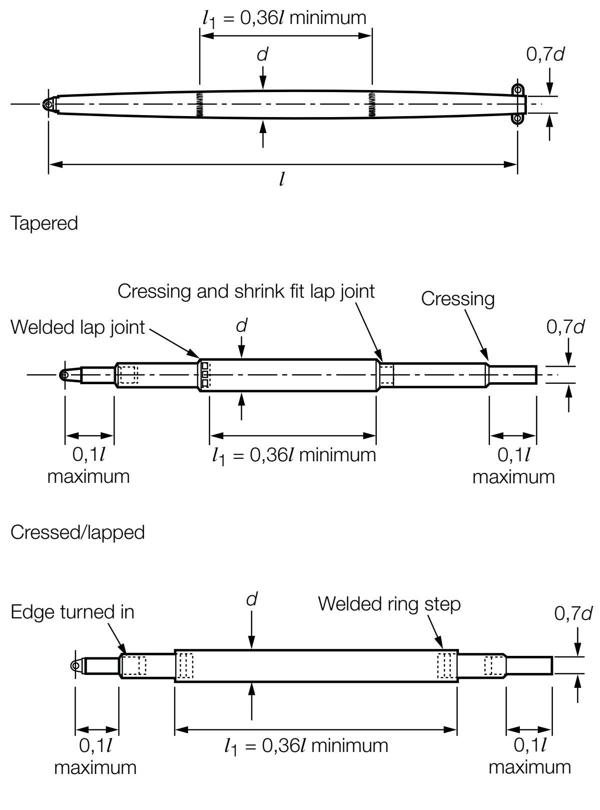


Fig. 2.6.1 Forms of booms

6.1.3 The scantlings of derrick booms are to be determined on the basis of the axial thrust and the maximum combination of bending moments applied to the boom, as derived from the force diagrams and calculations for the derrick system.

6.1.4 Steel for derrick booms is to comply with the requirements of 1.5.3. Derrick booms intended for a SWL of 60*t* or more are to be suitably heat-treated after welding where considered necessary. For mild steel booms, this may normally be confined to the region of highly loaded welded connections. The requirements for higher tensile steel booms will depend on the materials specification.

6.2 Determination of forces

6.2.1 The axial thrust in the derrick boom is to be determined from the force diagrams or calculations of forces for the derrick system, *see* Sections 3, 4 and 5.

6.2.2 The bending moments acting on the boom are to be calculated for conditions with the boom in its lowest and its highest working positions.

6.2.3 The determination of vertical end bending moments for typical derrick head arrangements is illustrated in Fig. 2.6.2. The bending moment is to be calculated approximately at the point of intersection of the axis of the boom with the line joining the points of action of the cargo and span loads and this may be taken as reducing linearly from this point to zero at the derrick heel.

6.2.4 For built-in sheaves, where the sheave pin intersects the axis of the boom, the value of *h* is to be taken as zero.

6.2.5 Horizontal bending moments arising from slewing or preventer guys attached to the derrick boom head may generally be neglected.

6.2.6 Where the derrick is fitted with a cross-head or outrigger, consideration is to be given to the bending and torsional moments which may arise where the span force is not equally distributed between the span tackles. In general, the boom is to be designed to resist the bending moments induced when supported by one span tackle only.

6.3 Boom scantlings

6.3.1 The following symbols are used in this sub-Section:

d = external diameter of the boom in the mid length region, in mm
l = overall length of the derrick boom, in mm
l_1 = length of the parallel part of the boom, in mm
r = effective radius of gyration of the boom, in mm
t = wall thickness of the boom in the mid length region, in mm
A = cross-sectional area of material of the boom in the mid length region, in mm^2
A_e = cross-sectional area of material of the boom at the boom head, in mm^2
I = moment of inertia of the boom in the mid length region, in mm^4
I_e = moment of inertia of the boom at the head, in mm^4
Z = section modulus of the boom in the mid length region, in mm^3
Z_e = section modulus of the boom at the boom head, in mm^3.

6.3.2 The slenderness ratio $\left(\frac{l}{r}\right)$ of the boom is not to exceed 180. It is recommended that the slenderness ratio be less than 150.

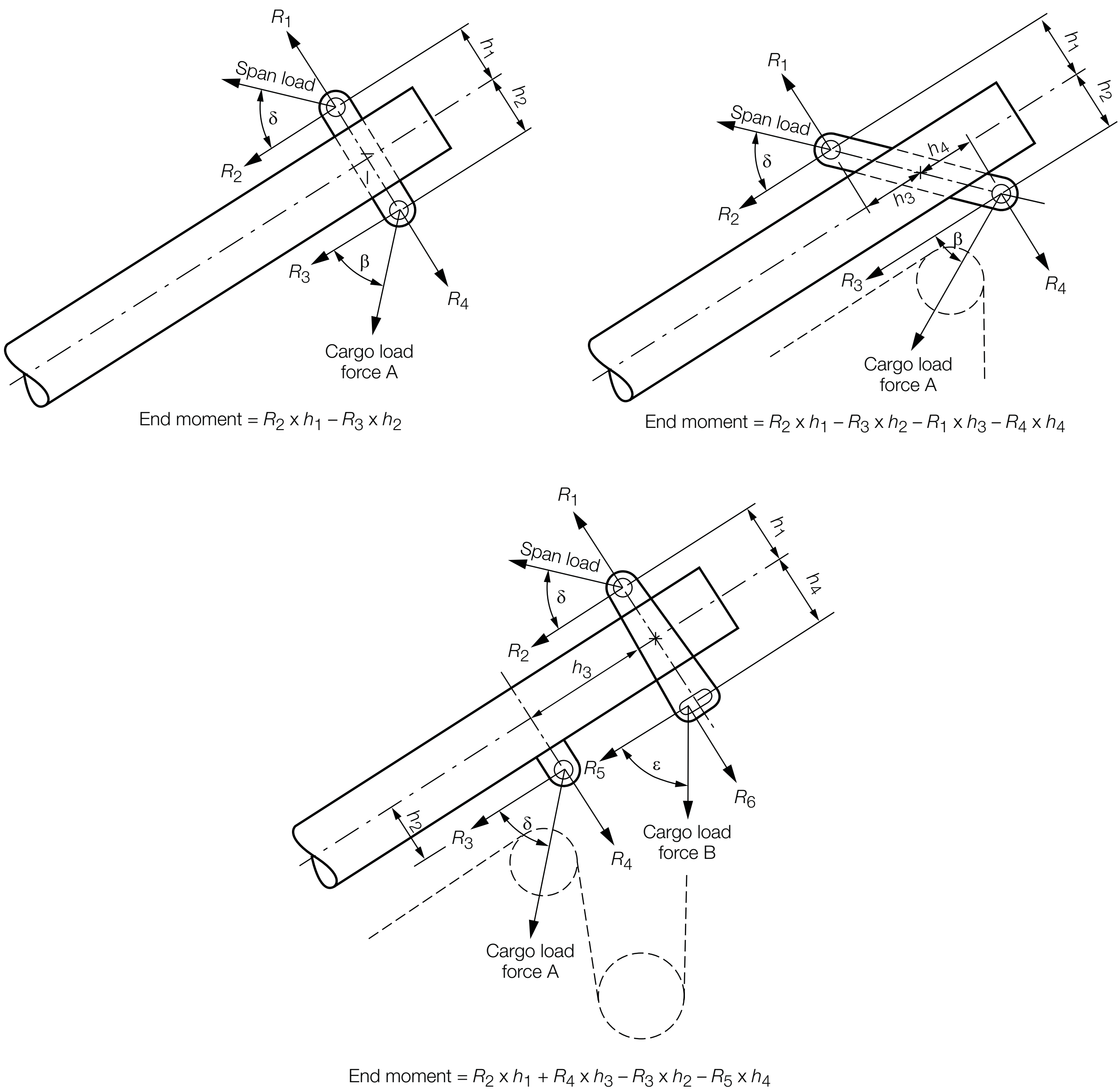


Fig. 2.6.2 Determination of end bending moment

6.3.3 The wall thickness of the boom at mid length is to be not less than:

$$t = 2 + \frac{d}{70} \text{ mm}$$

The wall thickness at ends is to be such that the cross-sectional area of material is not less than 0,75*A*.

6.3.4 The moment of inertia at the derrick head, I_e, is to be not less than 0,40I.

6.3.5 Where the derrick boom is tapered or stepped, an effective radius of gyration, *r*, is to be determined from:

$$r = \sqrt{\frac{c\,I}{A}} \text{ mm}$$

where

$$c = 0{,}17 + 0{,}33u + 0{,}5\sqrt{u} + \frac{l_1}{l}(0{,}62 + \sqrt{u} - 1{,}62u)$$

$$u = \sqrt{\frac{I_e}{I}}$$

where l_1 is greater than 0,5l. The value of *c* is to be obtained by interpolation between *c* calculated for l_1 = 0,5l and *c* = 1 at l_1 = 0,8l.

6.3.6 The bending moment acting on the boom is to be taken as:

(a) At mid length, the sum of:

(i) The self-weight bending moment, taken as:

$M_{sw} = 9{,}30 \times 10^{-6} A\, l^2$ Nmm

(ii) One half of the applied bending moment in the vertical plane acting at the boom head.

(b) At the boom head:

The applied bending moment in the vertical plane, *see* 2.3.1 and 6.2.3.

6.3.7 Where significant horizontal bending moments are likely to be applied to the boom, they are to be taken into account in the calculation.

6.3.8 The critical stress, σ, in N/mm² for the derrick boom is to be determined from:

$$\sigma_c = \frac{\sigma_y + (1+\eta)\,\sigma_e}{2} - \sqrt{\left(\frac{\sigma_y + (1+\eta)\,\sigma_e}{2}\right)^2 - \sigma_e\left(\sigma_y - \frac{1{,}2M}{Z}\right)}$$

where

$\eta = 0{,}003 l/r$

$\sigma_e = \dfrac{\pi^2 E}{\left(\dfrac{l}{r}\right)^2}$ N/mm²

$E = 2{,}06 \times 10^5$ N/mm² for steel

M = the vector sum of applied bending moments, in Nmm, derived from 6.3.6(a) or (b) and 6.3.7.

6.3.9 The maximum allowable thrust, T, in the boom is to be determined from the critical stress and a factor of safety, F, such that:

$$\sigma_c = \frac{\sigma_c A_x}{F} \times 10^{-4} \text{ tonnes}$$

where

A_x = the cross-sectional area of material at the section under consideration, in mm²

F = (i) at mid length $1{,}85 + \left(\dfrac{90}{35+T}\right)$ but $2{,}333 \le F \le 3{,}85$

(ii) at ends 1,85

(iii) at intermediate positions:
by parabolic interpolation between the values at mid length and at the boom head.

6.3.10 Where T lies between 10 and 160 tonnes, the value T for the mid length region may be determined from:

$$T = \sqrt{\left(\frac{154{,}75 \times 10^4 - \sigma_c A}{3{,}7 \times 10^{-4}}\right) + 18{,}92 \times 10^{-4}\,\sigma_c\, A} - \left[\frac{154{,}75 \times 10^4 - \sigma_c A}{3{,}7 \times 10^{-4}}\right] \text{ tonnes}$$

6.3.11 For the purpose of making a first approximation to the required scantlings for a boom, thrust coefficients are tabulated in Table 2.6.1 and Table 2.6.2. The maximum allowable thrust, before making allowance for applied bending moments, is approximately:

thrust = (t – 1,5) x coefficient tonnes

Having selected a suitable boom diameter and wall thickness, the allowable thrust, taking into account the applied bending moment, is to be determined in accordance with the method given above.

6.4 Construction details

6.4.1 In way of head and heel fittings, the wall thickness is to be not less than 5,0 mm or 0,025 x tube diameter at that point, whichever is the greater. Proposals to fit stiffening in lieu of increased plate thickness to meet this requirement will be considered.

6.4.2 Where internal access for welding of the derrick tube is impracticable, means of obtaining full penetration welds are to be agreed.

6.4.3 Lap joints are to be not less than half the boom diameter at that point in extent. Where the lap is welded, this is to be achieved by slot welds of at least 75 mm length and twice the boom wall thickness (but not less than 25 mm) in breadth. Where step joints are adopted, the inner tube is to extend into the outer tube a distance of not less than the diameter of the outer tube or 450 mm, whichever is the lesser. The end of the inner tube is to be stiffened by a steel ring not less than 40 mm in width and of thickness sufficient to give a sliding fit within the outer tube, *see* Fig. 2.6.3.

6.4.4 Welds are to be sound, uniform and substantially free from defects. The throat thickness of fillet welds on lapped joints is to be not less than 0,7 times the thickness of the inner plate forming the joint.

6.4.5 Derrick booms are to be sealed to minimise corrosion to their internal surfaces. Where practicable, derrick booms are to be painted internally or otherwise treated to reduce corrosion, after the completion of all welding.

6.4.6 Derrick boom cross-heads, brackets for cargo runner and span tackle blocks and similar structures are to be of such a design that the combined stress does not exceed $0{,}56\sigma_y$.

Table 2.6.1 Boom thrust coefficients (mild steel σ_y = 235 N/mm^2)

Boom diameter, in mm	Boom length, in metres										
	6,0	7,5	9,0	10,5	12,0	13,5	15,0	16,5	18,0	19,5	21,0
152,4	1,36	0,94	0,68	—	—	—	—	—	—	—	—
159,0	1,55	1,06	0,77	—	—	—-	—	—	—	—	—
165,1	1,73	1,18	0,86	—	—	—	—	—	—	—	—
168,3	1,83	1,25	0,91	0,70	—	—	—	—	—	—	—
177,8	2,14	1,48	1,07	0,82	—	—	—	—	—	—	—
193,7	2,71	1,93	1,39	1,05	0,83	—	—	—	—	—	—
219,1	3,71	2,78	2,05	1,53	1,19	0,96	—	—	—	—	—
244,5	4,78	3,77	2,87	2,19	1,70	1,34	1,10	—	—	—	—
267,0	5,75	4,72	3,72	2,88	2,25	1,79	1,45	1,20	—	—	—
273,0	6,02	4,99	3,96	3,09	2,42	1,93	1,56	1,29	—	—	—
298,5	7,14	6,14	5,05	4,05	3,22	2,58	2,10	1,73	1,45	—	—
323,9	8,27	7,30	6,21	5,12	4,15	3,36	2,74	2,27	1,90	1,61	1,38
355,6	9,69	8,77	7,71	6,57	5,47	4,51	3,72	3,09	2,60	2,20	1,89
368,0	10,25	9,35	8,30	7,16	6,03	5,01	4,16	3,47	2,91	2,47	2,18
406,4	11,99	11,14	10,15	9,03	7,85	6,71	5,67	4,79	4,05	3,45	2,96
419,0	12,57	11,73	10,76	9,65	8,47	7,30	6,22	5,27	4,48	3,82	3,29
457,2	14,31	13,52	12,60	11,55	10,39	9,18	7,99	6,90	5,93	5,11	4,41
508,0	16,65	15,89	15,03	14,06	12,96	11,77	10,53	9,32	8,18	7,15	6,2
558,8	18,80	18,19	17,46	16,55	15,52	14,39	13,18	11,92	10,67	9,50	8,41
609,6	20,75	20,17	19,53	18,81	18,02	16,99	15,83	14,59	13,32	12,06	10,85

NOTE
Intermediate values may be obtained by interpolation but extrapolation is not permitted.

Table 2.6.2 Boom thrust coefficients (higher tensile steel σ_y = 355 N/mm^2)

Boom diameter in mm	Boom length, in metres										
	6,0	7,5	9,0	10,5	12,0	13,5	15,0	16,5	18,0	19,5	21,0
152,4	1,56	1,01	0,72	—	—	—	—	—	—	—	—
159,0	1,80	1,15	0,82	—	—	—	—	—	—	—	—
165,1	2,04	1,30	0,92	—	—	—	—	—	—	—	—
168,3	2,17	1,39	0,98	0,73	—	—	—	—	—	—	—
177,8	2,61	1,67	1,15	0,87	—	—	—	—	—	—	—
193,7	3,45	2,24	1,54	1,12	0,88	—	—	—	—	—	—
219,1	5,05	3,40	2,35	1,70	1,28	1,02	—	—	—	—	—
244,5	6,88	4,86	3,42	2,48	1,87	1,45	1,16	—	—	—	—
267,0	8,60	6,39	4,61	3,37	2,53	1,97	1,57	1,28	—	—	—
273,0	9,07	6,83	4,96	3,64	2,74	2,12	1,69	1,38	—	—	—
298,5	11,05	8,77	6,13	4,94	3,74	2,90	2,31	1,87	1,55	—	—
323,9	13,00	10,79	8,47	6,48	4,97	3,87	3,08	2,49	2,06	1,73	1,47
355,6	15,41	13,35	10,98	8,70	6,82	5,37	4,28	3,47	2,86	2,39	2,03
368,0	16,34	14,34	11,99	9,65	7,63	6,04	4,83	3,92	3,23	2,70	2,29
406,4	18,96	17,39	15,16	12,73	10,41	8,42	6,83	5,58	4,61	3,85	3,26
419,0	19,73	18,28	16,20	13,77	11,39	9,29	7,57	6,21	5,14	4,30	3,64
457,2	22,03	20,71	19,07	16,99	14,51	12,15	10,09	8,38	6,99	5,87	4,98
508,0	25,04	23,85	22,40	20,64	18,64	16,31	13,93	11,81	10,00	8,49	7,25
558,8	28,02	26,92	25,61	24,04	22,20	20,16	18,08	15,73	13,56	11,68	10,07
609,6	30,97	29,95	28,74	27,32	25,64	23,74	21,68	19,59	17,55	15,35	13,40

NOTE
Intermediate values may be obtained by interpolation but extrapolation is not permitted.

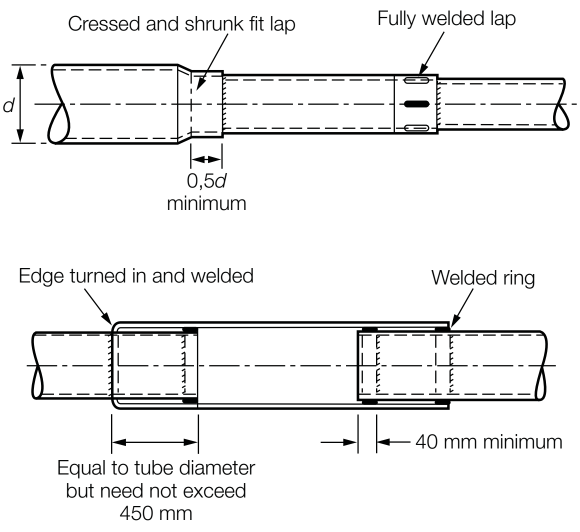


Fig. 2.6.3 Steps and joints in booms

■ *Section 7*
Masts and derrick posts

7.1 General

7.1.1 The scantlings of masts and derrick posts intended to support derrick booms and similar lifting appliances are to be determined from the highest combination of stresses expected to arise when the gear is used in its most severe operating condition. Materials are to comply with 1.5.2.

7.1.2 The requirements of this Section apply to stayed or unstayed single masts of conventional design. The term ‘mast’ is used to include derrick post, king post or similar structure.

7.1.3 Calculations are to be made with the derrick booms at the operating position which results in the maximum stresses on the mast. For masts supporting derricks, angles of heel and trim of the ship in this condition of less than 5° and 2° respectively may be ignored. Where these angles are exceeded, and in all cases where the mast supports derrick cranes or derricks of special design, the actual angles are to be taken into account in calculating the stresses in the mast.

7.1.4 The angle of heel, ψ, of the ship is to be calculated for the specified condition of loading using the applicable stability data or may be approximated from:

$$\psi = \frac{57{,}3 \times \Sigma\ (\text{SWL} \times \text{Lever})}{\text{Displacement} \times \text{GM}} \text{ degrees}$$

where

SWL = the safe working load of each derrick operating simultaneously, in tonnes
Lever = the corresponding distance of the load on that derrick from the centreline of the ship, in metres
Displacement = the lightweight plus 50 per cent of the deadweight of the ship, in tonnes
GM = the transverse metacentric height of the ship in that condition, before lifting the load, in metres.

7.1.5 Direct calculation procedures may be accepted as an alternative to the methods indicated in this Section.

7.1.6 Special consideration on the general basis of these requirements will be given to the scantlings and arrangements where:

(a) The mast is of portal, bipod, lattice or other less common design, or is supported by rigid stays capable of being loaded in compression.
(b) Significant forces other than those resulting from cargo gear loads will be acting on the mast.

7.1.7 In such cases, fully detailed stress calculations are to be submitted and these calculations are to take account of:

(a) All horizontal, vertical and torsional forces.
(b) Deflections of the structure.
(c) Variations in the moment of inertia of the parts of the structure.
(d) The effects of outriggers and similar structures.
(e) Elasticity and sag in stays, where fitted.

7.1.8 A stayed mast is one that is supported wholly or partly by one or more stays. The term ‘stay’ includes shrouds, forestays, backstays and similar supports. Where a stayed mast is so designed that the stays are only required to be set up when loads exceeding a specified value are to be lifted, this fact is to be clearly indicated on:

- The plans submitted for approval.
- The lifting appliance certificates.
- The cargo gear particulars book.
- The mast itself.

7.1.9 The length of the mast, l, is to be measured from the uppermost deck or supporting deckhouse through which it passes. Arrangements where a deckhouse is specifically designed to give no effective support to the mast in either the transverse or the longitudinal directions will be specially considered.

7.1.10 The minimum outside dimensions of the mast at the level of the supporting deck are to be not less than $\left(\frac{l}{27}\right)$.

This dimension is to be maintained up to the level of the gooseneck fitting where this is entirely supported by the mast.

7.1.11 Where the mast is fitted with stays, the minimum outside dimension of the mast at a point midway between the supporting deck and the lowermost stay is to be not less than $\left(\frac{l}{30}\right)$, but consideration will be given to reduce dimensions where it can be shown that no danger of crippling exists under service conditions of combined thrust, bending moment and torque.

7.1.12 The wall thickness of the mast is to be not less than the greatest of the applicable values determined from Table 2.7.1.

Table 2.7.1 Minimum thickness of mast plating

Item	Minimum thickness, in mm
Curved plates	$0{,}32 \dfrac{d\sqrt{\alpha\ \sigma_y}}{350 + 2 \times SWL}$ or $\dfrac{d\sqrt{\alpha}}{100}$ or 7,5
Flat plates	$0{,}32 \dfrac{b\sqrt{\alpha\ \sigma_y}}{220 + 2 \times SWL}$ or $\dfrac{b\sqrt{\alpha}}{60}$ or 7,5

NOTES
1. Where
   SWL = the safe working load of the largest derrick operating on the mast, in tonnes
   d = maximum outside diameter of the mast at the position under consideration, in mm. Where the mast is not circular, d is to be taken as the maximum diameter of the circle of which the plate forms a part
   b = width of flat plate, in mm, but is to be taken as not less than 60% of the width of the mast at that point measured parallel to the flat plate
   α = the ratio $\dfrac{\text{actual total stress at that point}}{\text{maximum allowable stress}}$
2. Where stiffeners are fitted, b may be taken as the mean spacing of stiffeners. The required scantlings of the stiffeners to resist instability under end loading will be considered.

7.2 Symbols

7.2.1 The symbols used throughout this Section are defined in 1.6.2.

7.3 Loading and allowable stresses

7.3.1 Calculations are to be made for the least favourable combinations of loading which may be imposed by the derrick systems. The following combinations are generally to be considered:

(a) Swinging derrick systems and derrick cranes:
   (i) For mast with one or two derricks:
   One or both derricks plumbing one hatch;
   One or both derricks slewed outboard on one side of the ship.
   (ii) For mast with three or more derricks:
   Two derricks plumbing one hatch;
   Two derricks slewed outboard on one side of the ship.
   (iii) For mast with a heavy derrick fitted:
   The heavy derrick plumbing the hatch;
   The heavy derrick slewed outboard.

(b) Union purchase systems:
   (i) One pair of derricks plumbing one hatch;
   (ii) One pair (or two pairs if fitted) of derricks with the load outboard on one side of the ship.

7.3.2 Where any other combination of operating derricks is proposed or where it is possible for the greatest stresses to arise at other positions of the derricks, the resultant loads are to be considered.

7.3.3 The effects of wind, ice and the normal motion of a ship in a seaway may generally be ignored in the calculations.

7.3.4 Where it is intended to operate the derrick system in a specified service category, *see* Ch 1,2.3.2, the resulting additional forces imposed on the system will be specially considered.

7.3.5 The maximum allowable combined bending and direct stress is not to exceed the value given in Table 2.7.2. The maximum allowable shear stress is not to exceed 0,58 times the value given in Table 2.7.2.

Table 2.7.2 Allowable stresses in masts

Item	Allowable stress, in N/mm^2
(1) Stayed mast:	
SWL ≤ 10 t	$0{,}50\sigma_y$
SWL ≥ 60 t	$0{,}625\sigma_y$
10 < SWL < 60 t	by interpolation
(2) Unstayed mast:	
SWL ≤ 10 t	$0{,}55\sigma_y$
SWL ≥ 60 t	$0{,}675\sigma_y$
10 < SWL < 60 t	by interpolation
(3) Cross trees, outriggers, etc:	
SWL ≤ 10 t	$0{,}55\sigma_y$
SWL ≥ 60 t	$0{,}675\sigma_y$
10 < SWL < 60 t	by interpolation
(4) Mast under steady load	$0{,}625\sigma_y$
(5) Mast of controlled design with SWL ≥ 60 t	$0{,}83\sigma_y$

NOTES
1. SWL for masts is to be taken as that of the largest derrick operating on the mast.
2. SWL for cross trees, outriggers, etc., is to be taken as that of the largest derrick actually supported by the cross tree.
3. Masts designed solely for the purpose of supporting conveyor belt arms, grain suction tubes and similar items are considered to be working under steady load.

7.3.6 For masts of controlled design, where it is proposed to adopt the maximum stress value of $0{,}83\sigma_y$ permitted by item (5) of Table 2.7.2, the following requirements are to be met:

(a) A detailed stress calculation is to be made.
(b) All scantlings are to be based on the guaranteed minimum thickness of the materials used.
(c) Full account is taken in the calculations of heel and trim of the self-weight of the gear, including guys.
(d) The effect of any guy tension which could occur in operation is to be included.

(e) Means are to be provided for controlling the tension in the stays, if fitted.
(f) The mast, fittings and loose gear are to be manufactured to high engineering standards.

7.4 Stress calculations – Unstayed masts

7.4.1 The forces imposed on the mast by the cargo runner, span tackle and gooseneck are to be determined from the force diagrams or calculations prepared in accordance with Section 2. The resulting stresses in the mast are to be calculated taking into account the effect of any offsets in the lines of action of the forces.

7.4.2 The total stress (σ_t) at any particular location is to be taken as:

$$\sigma_t = \sqrt{(\sigma_b + \sigma_c)^2 + 3q^2} \quad \text{N/mm}^2$$

where

σ_b = the bending stress at that location due to the bending moments acting on the mast

σ_c = the direct compressive stress at that location due to the vertical components of force. In general, the weight of the mast and cross trees may be ignored in this calculation

q = the shear stress due to torque in the mast. The effect of torque need only be considered where cross trees are fitted.

7.4.3 The total stress is to be determined at each change of plate thickness or other change of section along the mast. It is recommended that a plot or table of stress to a base of mast length be prepared. At no point is σ_t to be greater than the allowable stress determined from 7.3.5.

7.5 Stress calculations – Stayed masts

7.5.1 Calculations are to be prepared for the conditions with the derrick operating parallel to the centreline of the ship and when slewed to the most outboard operating position. Other positions are to be examined where the arrangement of stays is such that higher stresses can be expected in the system.

7.5.2 The forces acting on the mast resulting from the cargo runner, span tackle and gooseneck are to be determined from the force diagrams or calculations prepared in accordance with Section 2. Where cross trees are fitted or where the vertical separation of the highest and lowest points of attachment of the mast head span cargo lead blocks and the stays exceed 0,1H m, the calculations of forces will be specially considered. A fully detailed direct calculation may be required.

7.5.3 In the absence of stays, the mast will deflect under the influence of the imposed forces. Where stays are fitted, they will extend under tension, with the amount of elongation being related to the deflection of the mast at the point of attachment of the stays.

7.5.4 The distribution of forces in the mast and stays may therefore be obtained by consideration of:
(a) The equilibrium between the deflection of the mast and the corresponding elongations of the stays.
(b) The equilibrium between the imposed loads on the mast and the reactions in the mast and the stays.

7.5.5 The bending moment (BM) in a single-stayed mast and the tension (T) in the stay are to be determined as follows:

$$BM = (P - T\cos\phi)\,x$$

$$T = \frac{P\sec\phi}{1 + \left(\dfrac{3E_p\, I\, l_1}{E_s\, A\, l^3 \cos^2\phi}\right)}$$

where

ϕ = the angle of the stay to the horizontal in degrees

A = the cross-sectional area of the stay, in m^2

x = the distance below the mast head about which bending moments are to be calculated, in metres

l = the height of the mast/stay attachment above the deck, in metres

l_1 = the length of the stay, in metres

E_p = the Young's modulus of steel for the mast, in N/m^2

E_s = the Young's modulus of steel for the stay, in N/m^2

I = second moment of area for the mast section, in m^2

P = the component of force acting on the mast head, in Newtons.

7.5.6 These calculations are to be made using appropriately defined co-ordinate axes. Attention is drawn to the importance of assigning the correct sign to the angles and dimensions used. Any stay which would be required to work in compression is to be ignored.

7.5.7 Elongation of the stays is to be calculated on the basis of the area enclosed by a circle of diameter equal to the nominal diameter of the rope in association with an effective modulus of elasticity of 61300 N/mm^2 (6250 kgf/mm^2). Consideration will, however, be given to the use of a higher modulus of elasticity where this is demonstrated by suitable tests to be applicable.

7.5.8 The total stress in the mast at any particular location is to be determined in accordance with 7.4.2 and 7.4.3. Attention is drawn to the fact that increased stiffness of the mast leads to a rapid increase in stress in the mast with a corresponding reduction in the effectiveness of the stays. It is desirable, therefore, to design the mast for the required section modulus in association with the least practicable moment of inertia.

7.6 Construction details

7.6.1 Masts are to be supported by at least two decks and are to be effectively scarfed into the main hull structure. The hull structure is to be suitably reinforced. A deckhouse may be considered as a support provided it is of adequate strength.

7.6.2 Alternative means of achieving efficient support for the mast will be considered. Where brackets are fitted to the deck at the mast heel, they are to be of sufficient size to provide an adequate path for loads to be carried to the underdeck stiffening and surrounding structure.

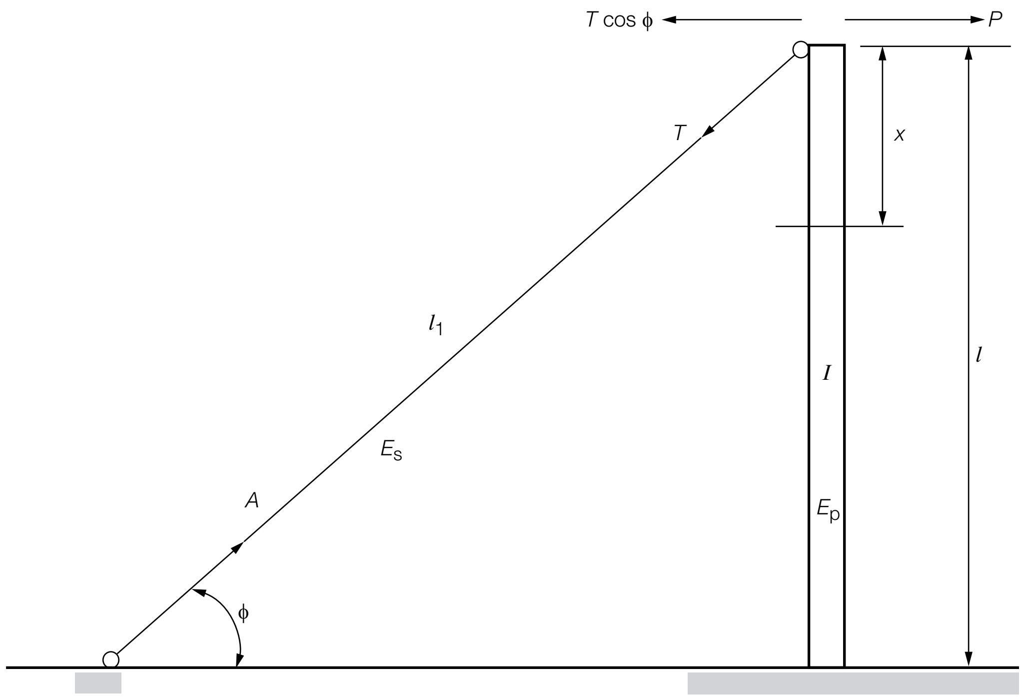


Fig. 2.7.1

7.6.3 Where the lower part of the mast is integral with the deckhouse, the plating is to be increased in thickness and additional stiffening fitted to ensure adequate strength and resistance to plate buckling. Openings are, in general, to be avoided in these areas, but where required are to be well rounded and suitable edge stiffening is to be fitted.

7.6.4 In general, mast scantlings are not to be reduced inside deckhouses.

7.6.5 Cross trees, outriggers, brackets on bridge fronts and similar structures are to be of such design that the stresses on them resulting from the cargo gear and any other significant forces do not exceed the values in 7.3. The design is also to be such as to minimise the moments acting on the mast. Attachment to the mast is to be such as to avoid distortion of the mast under load. Local stiffening, doublers or diaphragm plates are to be fitted to the mast as necessary.

7.6.6 Special attention is to be paid to the structural continuity and abrupt changes of the section are to be avoided. Manholes, lightening holes and other cut-outs are to be avoided in way of concentrated loads and areas of high shear. Where required, openings are to be well rounded, suitably framed and stiffened.

7.6.7 Adequate reinforcement is to be fitted in way of concentrated loads. The toes of brackets and corners of fittings are not to land on unstiffened panels of plating. Suitable arrangements are to be made to avoid notch effects.

7.6.8 Care is to be taken in the design of masts and fittings to reduce the likelihood of water collecting in inaccessible parts of the structure. Drains or other means are to be provided to remove any water which might otherwise accumulate. All parts are to be accessible for inspection and painting except where closed box construction is adopted.

7.6.9 Welding and weld details are to comply with the requirements of Pt 3, Ch 10 of the Rules for Ships.

7.6.10 Where a mast is intended to support a derrick with a SWL exceeding 25 t, all welded joints below a distance of 3,0 m above the uppermost supporting deck, or to the level of the derrick heel if more than 3,0 m, are to be examined by non-destructive crack or flaw detection methods.

7.6.11 Where higher tensile steel is used, preheating or other heat treatments may be required at the Surveyor’s discretion and will normally be required for all ring seams on masts supporting derricks with a SWL exceeding 60 t. Non-destructive methods of examination may be required in areas of high stress in way of fittings at the Surveyor’s discretion.

7.6.12 Lightning conductors are to be fitted to masts having wood, aluminium or plastic topmasts or where a break in electrical conductivity occurs in other arrangements.

7.7 Stays

7.7.1 Wire rope stays are to be in one length and their construction is to comply with the requirements of Chapter 8.

7.7.2 The scantlings of the stay are to be such as to provide the tensile force and elongation to meet the requirements of 7.5. The breaking load of wire rope stays is to be not less than 3,5 times the maximum calculated force on that stay. Man-made stays are to have a breaking load not less than 4,38 times the maximum calculated force.

7.7.3 Stays are to be arranged so that they do not foul running rigging or derrick booms when in service and are to be set up with an initial tension of about 30,0 N/mm^2 (3,0 kgf/mm^2).

7.7.4 The connection of the stay to a deck, bulwark, house or mast is to be such as to allow rotation at the point of attachment and is to be designed so that the stay cannot become disconnected while the derrick system is in use.

7.7.5 It is undesirable to connect stays to the ends of cross trees where deflection under load may significantly affect the load bearing efficiency of the stay.

■ *Section 8* Fittings for masts and derrick booms

8.1 General

8.1.1 The application of fixed fittings, ropes and loose gear in derrick systems is to comply with the requirements of this Section. The items themselves are to be manufactured in accordance with the requirements given in Chapter 8.

8.1.2 Effective continuity of materials is to be maintained in the bearing brackets for fittings and abrupt changes of plate thickness are to be avoided. Care is to be taken to avoid pockets in which water may collect. The connection to the mast or derrick boom is to provide an easy transfer of load into the surrounding structure and to minimise hard spots and sources of stress concentration.

8.1.3 All welds are to be sound, uniform and free from undercutting or other defects. Care is to be taken to ensure adequate weld penetration. Effective arrangements are to be made for the inspection of finished welds. The extent of examination by non-destructive methods is to be to the Surveyor's satisfaction.

8.1.4 All bearing surfaces are to be machined to ensure a smooth finish and a good fit. Adequate and accessible means of lubrication are to be provided.

8.2 Goosenecks and derrick heel assemblies

8.2.1 The gooseneck bearing assembly is to be such that:

(a) The gooseneck pin is secured in position to prevent displacement under normal operating conditions.

(b) Brackets and supporting structure are adequate to support the forces from the derrick boom operating at the maximum and minimum angles. Edges of brackets are to be stiffened as necessary to resist distortion.

(c) Where the gooseneck is supported by a mast, a diaphragm or equivalent stiffening is fitted, or the width of brackets or other attachments is not less than two thirds of the diameter of the mast at that level.

8.2.2 Derrick heel fittings are to be such that:

(a) The axis of the derrick heel crosspin cuts the axis of the derrick boom. Design incorporating a small offset will be specially considered.

(b) The derrick heel crosspin is secured to prevent displacement under normal operating conditions.

8.2.3 Trunnions and other alternatives to goosenecks will be specially considered.

8.2.4 Adequate means are to be provided for the lubrication of all bearing surfaces and their protection from contamination by dirt or excessive water. Such protection is not to make inspection of the assembly unreasonably difficult.

8.3 Cargo runner and span tackle

8.3.1 The cargo runner is to be of sufficient length to ensure that with the derrick rigged for lifting, the maximum safe working load is to be that at least two turns remain on the winch barrel when the derrick is at either:

(a) its highest working position and lifting from the tank top or lowest level from which it can be operated;

(b) its maximum overside position and lifting from a lighter with the ship at its light waterline.

The cargo runner is to be securely attached to the winch barrel.

8.3.2 The length of the span tackles is to be such that at least two turns remain on the winch barrel when the derrick is at its position of maximum outreach, or one turn when the derrick is in its stowed position. Where single rope spans are fitted, the span rope may be led to a topping winch or be fitted with a span chain securely attached to the deck eyeplates by a shackle or screw pin. Where span chains are fitted, the links are to be of sufficient size that the eye of a shackle can be passed through. Where the span rope is more than one part, it is to be led to a winch barrel or topping winch and securely attached to it.

8.4 Slewing and preventer guys

8.4.1 In general, each derrick boom is to be provided with two slewing guys where the SWL of the derrick does not exceed 20 tonnes or three guys for derricks with higher safe working loads. The safe working load of each guy is to be not less than that required by Table 2.8.1. Where three guys are required, deck fittings are to be provided so that two guys can be used on each side of the ship. For slewing guys used with derrick cranes, *see* 5.3.3.

Table 2.8.1 SWL of derrick boom slewing guys

SWL of derrick rig not exceeding, tonnes	SWL of each slewing guy, tonnes
1	1
2	1,5
3	2
4	2,5
5	3
6	3,25
9,5	3,5
12,5	3,75
15	4
60	25% of derrick SWL
75	15
over 75	20% of derrick SWL

8.4.2 Where the angle of the heel or trim in the operating condition exceeds 5° or 2° respectively, the requirements for slewing guys will be considered.

8.4.3 Alternative arrangements of slewing guys and proposals for reduced slewing guys where cargo slewing guys are fitted will be specially considered. Such arrangements are to be capable of operating at 5° heel and 2° trim or at greater angles where specified.

8.4.4 Natural or man-made fibre ropes may be used in the guy tackle (but not the guy pendant) provided the SWL of the guy does not exceed 4 t.

8.4.5 Where derricks are rigged for use in union purchase, preventer guys are to be fitted in addition to slewing guys. Preventer guys are to have a safe working load not less than the maximum guy tension derived from 4.3. Fibre rope is not to be used for preventer guys.

8.4.6 Boom head or schooner guys used for cross-connecting the heads of derricks in union purchase are to have a safe working load not less than 20 per cent of the SWL of the union purchase system, and not less than 1,0 t. These guys may be of steel wire or of fibre rope.

8.4.7 The hauling end of wire rope slewing guys is to be securely attached to a winch barrel when the derrick is being slewed under load.

8.4.8 Slewing guys are to be attached to the derrick boom and the deck eyeplate by a link, shackle or similar device so designed as to permit the guy to take up its varying positions while maintaining a straight lead. Leads are to be such that the guys will not foul rails, bulwarks or other obstructions when under load. Fairleads may be used.

8.4.9 Preventer guys are to be shackled on, or looped over the derrick head and shackled, or equivalent, to eyeplates on the deck or bulwark.

8.5 Swivelling and fixed eyeplates

8.5.1 Swivelling eyeplates are to be used for the attachment of span tackle and cargo runner lead blocks to the mast for all derricks where the safe working load is 3,0 t or more or where the load in the span tackle exceeds 5,0 t. They may also be used elsewhere.

8.5.2 Fixed eyeplates at the derrick head may be of the 'sword-fitting' type, providing a pair of eyeplates on opposite sides of the derrick tube, or the fitting may penetrate one side of the tube and be securely attached to internal structure.

8.6 Blocks

8.6.1 Swivels are to be arranged, as necessary, to ensure that blocks maintain their correct alignment.

8.6.2 The cargo runner lead block at the derrick heel is to have a duckbill or similar head fitting which prevents the block falling when the cargo runner is slack. This is to be arranged so as to allow the heel block to clear the derrick tube when the derrick tube is in its stowed position.

8.6.3 Snatch blocks may only be used as deck lead blocks.

8.6.4 Wood blocks may only be used with fibre ropes.

8.7 Cargo hooks

8.7.1 Cargo hooks are to be of such construction or shape, or are to be provided with an efficient device, so as to prevent displacement of the sling or load from the hook.

8.7.2 In general, 'C', (or Liverpool) type hooks may be used where the SWL of the derrick rig does not exceed 25 t. Cargo hooks of the Ramshorn type may be used in rigs of any SWL. Proposals to use other designs of hook will be considered.

8.8 Miscellaneous fittings

8.8.1 Where built-in sheaves are fitted to the derrick boom, the design of the sheave slot is to be such as to maintain continuity of strength of the boom tube. A typical arrangement is shown in Fig. 2.8.1 but alternative arrangements will be considered.

8.8.2 Where cargo runner roller guides are fitted to the derrick boom, they are to be such that:
(a) They are of adequate strength to resist distortion.
(b) Any tendency for the runner to chafe or jam in or between the rollers and their supports is minimised.
(c) There is adequate means of lubrication.

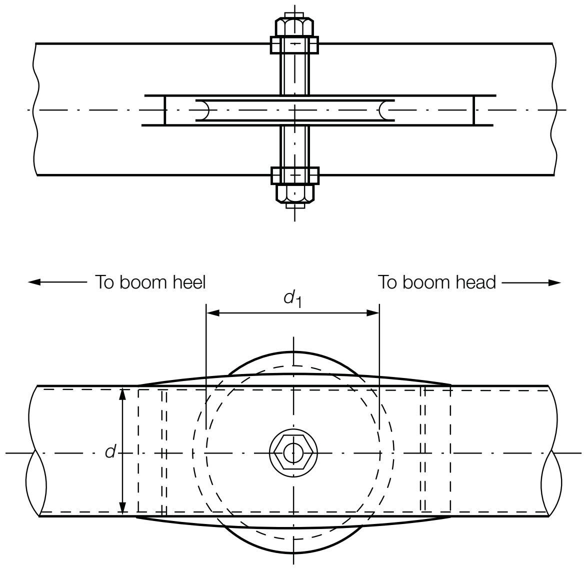


Fig. 2.8.1 Built-in sheaves

8.8.3 Where it is intended to loop preventer guys over the end of a derrick boom, a preventer safety catch is to be securely welded or otherwise fixed to the boom. This safety catch can take the form of the boom end sealing plate being extended, over part of its circumference, beyond the outer surface of the boom tube, or alternatively, a separate fitting can be used. Edges are to be smoothed.

8.9 Deck eyeplates

8.9.1 Sufficient eyeplates or equivalent attachments are to be provided for the safe operation of the derrick system and they are to be of suitable design and safe working load.

8.9.2 Eyeplates are not to be welded to the upper edge of the sheerstrake nor, in general, are they to penetrate the strength deck plating. Deck, bulwark or other plating is to be of sufficient thickness to withstand any shear forces that may be incurred in way of eyeplates due to asymmetrical loading of the eyeplate, and such plating is to be stiffened as necessary to prevent deformation under direct eyeplate loadings. The attachment of eyeplates and the adequacy of the supporting structure are to be to the Surveyor's satisfaction.

Launch and Recovery Appliances for Survival Craft and Rescue Boats

Contents

Section 1 General

1.1 General

1.1.1 The requirements of this Chapter are to be complied with in cases where Lloyd's Register (LR) is requested to certify the launch and recovery appliances for the following:
- Lifeboats 'Survival craft'.
- Life rafts 'Survival craft'.
- Rescue boats.
- Offshore life saving craft including hyperbaric lifeboats.
- Associated releasing arrangements.

1.1.2 Special consideration will be given to unconventional launch and recovery life saving systems.

1.1.3 The requirements of this Chapter are compatible with the requirements of the *International Convention for the Safety of Life at Sea 1974*, as amended. They also take into account various IMO MSC Resolutions/Circulars clarifying the requirements of Chapter III of the foregoing Convention.

1.1.4 Previous Conventions are not applicable to new davits except where such davits are replacements for an existing ship.

1.1.5 Where LR is required to certify a launch and recovery appliance on behalf of a National Administration whose requirements differ from those of the IMO Convention indicated in 1.1.3, the requirements of the National Administration concerned are to prevail.

1.1.6 This Chapter is the basis of approval by LR of the following types of davit:
- Roller-trackway.
- Hinged gravity.
- Stored energy.
- Single arm radial.
- Fixed arm cantilever.
- Free fall system.

1.1.7 Davit types not included above will be specially considered.

1.2 Survival craft davits

1.2.1 For all ships with the exception of passenger ships, lifeboats are to be boarded and launched directly from the stowed position and the davits are to be designed accordingly.

1.2.2 All lifeboats fitted to passenger ships are to be boarded and launched either directly from the stowed position or from an embarkation deck, but not both, and the davits are to be designed accordingly.

1.2.3 The launching mechanism is to be so arranged that it may be actuated by one person from a position on the ship's deck and from a position within the lifeboat.

1.2.4 When the lowering of a survival craft is controlled from within the craft by means of a control wire paid off from an auxiliary drum on the winch, the remote control mechanism is to be operationally demonstrated throughout the full launching range of the boat to the Surveyor's satisfaction.

1.2.5 To launch a survival craft in either its light or loaded condition, a davit is not to depend on any means other than gravity or stored energy generated from a source independent of the ship's power supplies. This does not apply to the launching appliance for lowering free-fall lifeboats by falls.

1.2.6 Where davit arms are recovered by power, limit switches are to be fitted to ensure that the power is automatically switched off before the arm reaches the stops in order to avoid overloading either the fall or the arms, unless the winch is designed to prevent such overloading.

1.2.7 The trackways of roller-trackway davit types are to be inclined at an angle of not less than 35° to the horizontal.

1.2.8 Davits are to be designed and maintained such that they remain fully effective under conditions of icing.

1.2.9 The ratios of the sheave diameter and winch drum diameter to the rope diameter are to be not less than 12:1 and 16:1 respectively for running wires.

1.2.10 The minimum thickness of plate and sections used in davit arms and frames is to be 6 mm.

1.2.11 Davits (including free-fall ramps) are to be capable of safely launching their fully equipped survival craft, both with its full complement of persons and also in the light condition, against the ship's trim of 10°, either fore or aft, and 20° list in either direction occurring simultaneously.

1.2.12 Davits fitted to ships of 20 000 gross registered tons and greater are to be capable of safely launching a lifeboat with the parent ship making five knots headway in calm water.

1.2.13 Single arm radial davits are to be capable of being slewed manually.

1.2.14 Davits fitted to oil tankers, chemical tankers or gas carriers are to be capable of operating at the final list angle on the lower side of the ship, calculated in accordance with the *International Convention for the Prevention of Pollution from Ships 1973*, as amended by the 1978 Protocol, where this exceeds 20° but does not exceed 30°.

1.2.15 A davit's launching winch system is to be capable of power recovery of the survival craft with its crew (i.e., 2 or 3 persons) at a minimum speed of 0,08 m/s to its stowage position with the ship at adverse list and trim angles of 5° and 2° respectively. In addition, auxiliary manual means of recovery are also to be provided for this condition, *see* 1.8.5. However, this does not apply to free-fall lifeboats.

1.2.16 Davits and their equipment are to be capable of lowering the survival craft in a controlled manner into the water at speed not less than that obtained by the following formula for the fully loaded condition, i.e., loaded with its normal equipment or an equivalent mass and a distributed mass equivalent to the number of persons it is permitted to accommodate, *see* 1.7.6.

$$S = 0,4 + 0,02H$$

where

S = speed of lowering, in m/s
H = height, in metres, from davit head to waterline with the ship in its lightest sea-going condition.

1.2.17 The minimum lowering speed of a life raft in the light condition (i.e., fully equipped but without persons on board), is to comply with the requirements of the National Administration concerned. The lowering speed of other survival craft in the light condition is to be $\geq$0,7 x S as calculated in 1.2.16.

1.2.18 The maximum lowering speeds for all survival craft in the light condition are not to exceed 1,0 m/s. Furthermore, the maximum lowering speeds in the fully loaded condition are not to exceed 1,0 and 1,3 m/s for life rafts and lifeboats respectively, unless different values are required by the relevant National Authority.

1.2.19 A free-fall launching system is required to employ an alternative controlled means of launching and a means of recovering the lifeboat by falls. Lifeboats are not to be launched in the free-fall mode where there is a risk of the presence of ice or insufficient depth of water. A notice to this effect should be displayed at the operating station.

1.2.20 The davits are to be arranged so that harmful accelerations are not experienced by the lifeboat occupants during launching.

1.2.21 Harmful acceleration is the rate of change of velocity experienced by the occupants which is in excess of levels calculated in accordance with the IMO test requirements of 1.1.3, or other recognised National or International Standards.

1.2.22 Where conditions are such that the free-fall operating mode is not necessary, a free-fall lifeboat is to be capable of being safely lowered in a 'controlled' manner with the ship inclined at a maximum list of 5° and a maximum trim of 2°.

1.2.23 The free-fall launching arrangement is to be a rigid structure with a ramp angle and length sufficient to ensure that the lifeboat effectively clears the ship.

1.2.24 Where a survival craft is designed to float free from its launching appliance, either by a weak link or by a hydrostatic release unit, the float free release of the survival craft from the stowed position is to be automatic.

1.3 Rescue boat davits

1.3.1 This Section covers davits that are used for launching and recovering lifeboats which may also be used as rescue boats, as well as davits that are solely dedicated to launching and recovering rescue boats only.

1.3.2 In addition to the requirements for survival craft davits in 1.2, all rescue boat davits are to meet the following requirements:

(a) The davits are to be capable of launching the rescue boat from the stowed position in not more than five minutes.
(b) The davits and winches are to be capable of power hoisting the rescue boat, loaded with its full rescue boat complement and equipment, from the water at a rate of not less than 0,3 m/s.

1.3.3 For davits that are solely dedicated to the launching and recovery of rescue boats, special consideration may be given to recovery arrangements which are dependent on the ship's power supply. These davits may be equipped for single point hoisting.

1.3.4 Special consideration may be given to the launching mechanism of a dedicated rescue boat being operable solely from a position on the ship's deck.

1.4 Offshore life saving systems

1.4.1 In general, the requirements of 1.2 and 1.3 may be applied to offshore operations.

1.4.2 The following additional requirements are applicable to any launch and recovery system used for handling survival craft (including hyperbaric lifeboats) and rescue boats, fitted to either fixed or mobile offshore installations. It should be noted that some National Authorities may have different requirements.

1.4.3 Davits are to be capable of launching a fully equipped survival craft with a full complement of persons against a high or low side list and trim of the installation of 15° simultaneously. Notwithstanding the foregoing requirement, davits intended for column-stabilised mobile drilling units should be capable of operating at the list and trim resulting from any damaged condition required by the relevant Chapter of the current IMO *Code for the Construction and Equipment of Mobile Offshore Drilling Units* (MODU Code).

1.4.4 All gravity davits are to be designed for a positive turning-out moment when the installation is adversely inclined at an angle of 25° high side list (HSL).

1.4.5 Davits for rescue boats are to be equipped with suitable shock absorbing or motion compensating arrangements to facilitate launching and hoisting of the boat in heavy seas.

1.4.6 Launching against high side list is not required for rescue boats. Otherwise, launching should be performed with the aid of gravity or with an arrangement coupled to the emergency power source.

1.5 Plan approval requirements

1.5.1 The plans and information to be submitted for examination is detailed in Ch 1,3.2.

1.6 Safety factors

1.6.1 The minimum safety factors (SF) required with respect to the minimum ultimate tensile stress (σ_u) of the materials used in the construction of the primary structural members and the loose gear are given in Table 3.1.1.

Table 3.1.1 Minimum safety factors

Item	SF required on σ_u	
	Direct stress	Sheer stress
Structural components	4,5	7,8
Loose gear	6,0	10,3
Release hooks	6,0	10,3

1.6.2 For steel in which $\sigma_y/\sigma_u \leq 0{,}7$, the allowable compressive stress, σ_a, in primary structural members is given by the following expression:

$$\sigma_c = \frac{\sigma_{cr}}{\text{SF x } \dfrac{\sigma_y}{\sigma_u}}$$

where

σ_{cr} = critical compressive stress, *see* Table 4.2.10 in Chapter 4

σ_u = minimum ultimate tensile stress, N/mm^2

σ_y = yield stress, N/mm^2

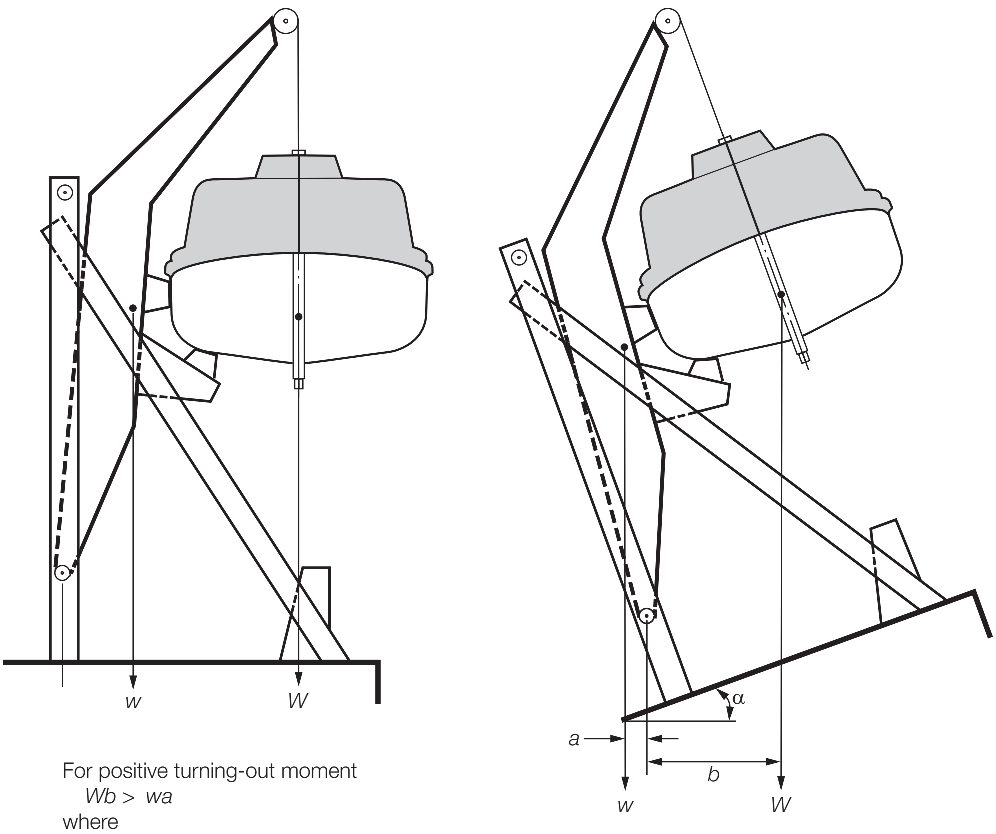
SF is given in Table 3.1.1.

1.6.3 Steels in which $\sigma_y/\sigma_u > 0{,}7$ will be specially considered.

1.7 Calculation of forces

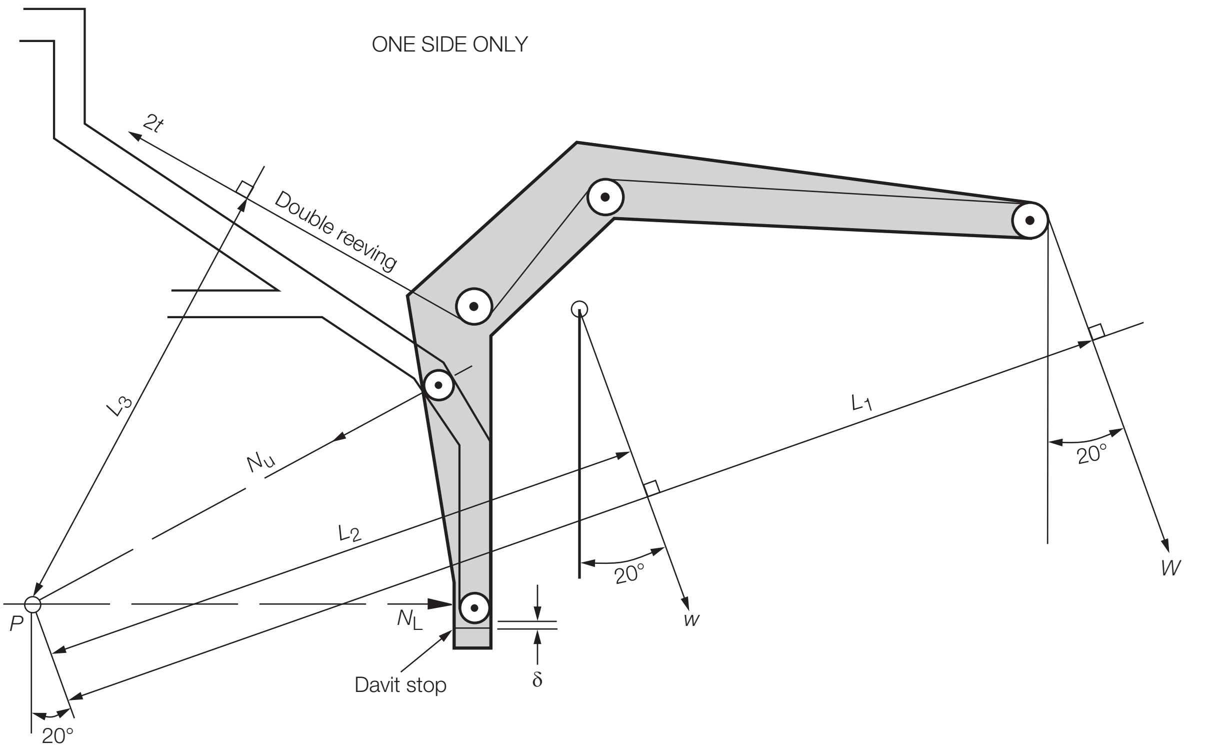
1.7.1 Force diagrams or calculations are required for the davit arm in its lowest position subject to both 20° low side list (LSL) (up to 30° for tankers in the damaged condition) for both the SWL and the weight of the davit arm. The torsion and lateral bending effects due to the 10° trim component are also to be considered (20° list component for radial arm davits).

1.7.2 Calculations are also required for the davit arm in its stowed position to ensure that a positive turning out moment exists with the ship at 20° HSL, *see* Fig. 3.1.1.



For positive turning-out moment
Wb > *wa*
where
W = weight of boat on each davit arm
w = self weight of each davit arm
α = maximum HSL angle
a and *b* are as shown

Fig. 3.1.1 Davit arm turning-out moments



Method of determining the maximum wire rope tension in a typical roller-track davit system with a double fall, and embarkation occuring at the 'turned-in' position.

where

Total lowering weight (inc. all passengers) = $2W$ kN

Weight on each davit arm = W kN

Self weight of each davit arm = w kN

Maximum tension in wire rope occurs when davit arm is braked a small distance δ just above the stop with lifeboat fully laden.

Taking moments about point P (the intersection of roller-track reactions N_u and N_L):

Maximum rope tension, $t = \dfrac{WL_1 = wL_2}{2L_3}$ kN

Safety factor required = 6

∴ Minimum breaking load required, T = $6t$ kN

Fig. 3.1.2 Roller-track system, maximum wire rope tension

1.7.3 The tension in the boat falls and forces in the davit arms are to be calculated using the appropriate friction allowance of the blocks and sheaves for both the following cases:

(a) The turning out/lowering of the fully equipped lifeboat and its total complement of persons, where applicable. For a roller-track system, *see* Fig. 3.1.2.

(b) The recovering of the fully equipped lifeboat and its crew to either the stowed position or to the embarkation deck.

1.7.4 The required breaking load of the boat falls is determined by multiplying the maximum calculated tension from 1.7.3(a) or 1.7.3(b) (whichever is greater), by a safety factor of 6.

1.7.5 The resultant loads on each of the blocks or sheaves in the rig are also to be determined by appropriate force diagrams or calculation.

1.7.6 For design purposes, the weight of one person is taken as 82,5 kg, except for passenger vessels which are to use 75 kg.

1.7.7 Friction in each sheave and pivot pin is to be taken as 5 per cent. However, sheaves having roller bearings may be taken as 2 per cent.

1.8 Davit winches

1.8.1 In general, davit winches are to comply with the requirements of Chapter 9 where applicable.

1.8.2 Winch structural members are to be designed to have a minimum safety factor of 4,5 in respect of the minimum ultimate tensile stress of the material when the maximum working load is applied.

1.8.3 Winches with multiple drums are to be so arranged that all the falls wind on or off the drums at the same rate when either hoisting or lowering.

1.8.4 Winches are to be provided with an efficient hand gear arrangement to enable the survival craft or rescue boat to be recovered manually. The hand gear handles and wheels are not to be rotated by the moving parts of the winch when being operated by power. This does not apply to free-fall lifeboats.

1.8.5 Every davit winch is to be fitted with brakes capable of stopping the maximum speed of descent of the survival craft or rescue boat and of holding it securely when loaded with its full complement of persons and equipment.

1.8.6 Winch brake pads are to be protected from water and oil, and an efficient means of preventing them from freezing is to be provided.

1.8.7 Manual brakes are to be so arranged that they are automatically applied unless held in the 'off' position by the Operator, *see also* 1.2.3.

1.9 Loose gear

1.9.1 For the purposes of this Chapter, the loose gear consists of the survival craft or rescue boat falls together with the blocks, shackles, links, padeyes, swivels, fastenings or any other fitting attached to the falls.

1.9.2 In general, the items of loose gear are to comply with the requirements of Chapter 8, or with a recognised National Standard.

1.9.3 Bowsing, griping and tricing tackles are not included in LR's approval. However, their adequacy should be operationally demonstrated to the Surveyor's satisfaction.

1.9.4 Each item is to be supplied with a manufacturer's certificate of test or is to be tested in accordance with the requirements of 1.9.10 and 1.9.11 to the Surveyor's satisfaction.

1.9.5 Wire rope falls are to be galvanised or heavily greased and are to be of a rotation resistant construction.

1.9.6 The use of stainless steel wire ropes will be specially considered, but generally are to be of a higher alloy composition, e.g., Inconel 625, Incoloy alloy 825, Duplex Ferralium 255. They are to comply with the requirements of 1.13.6. It is recommended that lower grades of stainless steel (e.g., SUS 304, SUS 316, etc.) are not used for lifeboat falls as they are subject to stress corrosion cracking, crevice corrosion and pitting.

1.9.7 The falls are to be of sufficient length to enable the survival craft or rescue boat to reach the water with three full turns remaining on the winch drum with the ship in her lightest sea-going condition and listed 20° in the adverse direction.

1.9.8 The ends of the falls are to be securely attached to the winch drum.

1.9.9 Wire rope terminations are to be manufactured and the termination process is to be in accordance with the requirements of the manufacturer and/or a National or International Standard. Wire rope grips are not to be used as the primary load bearing termination. Where used, the number of grips and their tightening torque is to be strictly in accordance with the manufacturer's and/or the National/International Standard requirements. The tightening torque is to be regularly checked.

1.9.10 Blocks, shackles, swivels and other fittings are to be designed to have a minimum safety factor in accordance with Table 3.1.1 with respect to the minimum ultimate tensile stress of the materials when the maximum working load is applied.

1.9.11 Each item of loose gear is to be proof-tested to 2,2 times its SWL (2,5 times its SWL for use offshore).

1.9.12 In addition, loose gear is to be prototype tested to 6 times its SWL to demonstrate its structural adequacy against failure.

1.10 Release hooks

1.10.1 Release hooks may be of the type fixed to the wire fall. These are generally used for single point suspension or of the type permanently attached to the craft being launched.

1.10.2 Release hooks for davit launched life rafts and dedicated inflatable/semi-rigid rescue boats are to comply with the following requirements:

(a) Only one type of release hook, or other release mechanism, is to be fitted to similar survival craft or rescue boats on board a ship.
(b) Each release hook and its mechanism is to be designed to have a minimum safety factor in accordance with Table 3.1.1, with respect to the minimum ultimate tensile stress of the materials used when the maximum safe working load of the hook is applied.
(c) The release mechanism is to be capable of releasing the craft in either the 'off-load' condition, i.e., when it is waterborne or when there is no load on the hooks, or, in the 'on-load' condition (however, this capability is to be adequately protected against accidental or inadvertent use).
(d) Release hooks are to be designed and maintained such that they remain fully effective under conditions of icing.
(e) A prototype release hook and its mechanism is to be proof loaded to 6 times its SWL, holding this load for at least 5 minutes. After removal of the load, the release mechanism is to be dismantled and examined for damage.
(f) A prototype release hook and its mechanism is to be proof-load tested by subjecting it to a steadily increasing load until failure occurs. This breaking load is to be recorded.
(g) Additionally, each release hook and its mechanism is to be 'dynamically' tested by lowering a proof-load of 1,1 times its SWL and abruptly applying the brakes when the lowering speed has been reached.

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Launch and Recovery Appliances for Survival Craft and Rescue Boats

1.10.3 Release hooks for lifeboats, combined liferaft/rescue boats and rigid rescue boats are to comply with the requirements of 1.10.2 and, in addition, a mechanism is to be fitted to each lifeboat or rescue boat to ensure that each hook is released simultaneously. The effectiveness of this is to be demonstrated to the Surveyor's satisfaction.

1.11 Materials

1.11.1 Davits, winches and loose gear are to be constructed of steel which complies with the requirements of the Rules for Materials. Alternatively, steels complying with a recognised National or International Standard may be used, provided they give reasonable equivalence to the Rule requirements, see Ch 1,1.6.

1.11.2 The selected steel grade is to provide adequate protection against brittle fracture, taking into account the material tensile stress, component thickness and the ship's intended service environment, and in general, the materials are to comply with the Charpy test requirements given in Tables 4.2.18 to 4.2.20 in Chapter 4.

1.11.3 Where a ship is intended for service in more severe environments (e.g., icebreakers in polar waters) the Charpy V-notch test requirements will be specially considered based on the minimum service temperature specified.

1.11.4 Steel or spheroidal graphite iron materials may be accepted for cast components. Grey cast iron is not a suitable material and may only be accepted for components after special consideration of the proposed application.

1.12 Testing

1.12.1 For the testing of loose gear and release hooks, *see* 1.9 and 1.10.

1.12.2 Prototype testing of survival craft (excluding free-fall) and rescue boat davits and winches is to comply with the following requirements:

(a) The davit with the arm in the outboard position is to be statically tested to 2,2 times the SWL. This test load is to be applied 10° either side of the vertical in the fore and aft direction, first with 0° list and then with both 20° HSL and 20° LSL conditions simulated.

(b) The davit is to be dynamically tested to 1,1 times the maximum load appropriate to the part of the operating cycle concerned, over the full operating range with the ship at 0° list. This test is to be repeated with a 20° HSL and 10° trim condition simulated e.g., for a lifeboat/rescue boat davit fitted to a passenger ship where embarkation occurs with the davit arm in the turned-out position, the tests are to be conducted with the loads indicated in Table 3.1.2.

(c) The dynamic tests in (b) are to be repeated with a test load equal to the weight of the fully equipped lightest craft, without persons, through at least one complete operating cycle in order to demonstrate satisfactory functioning of the davit under light conditions.

(d) For davits intended for installation on oil tankers, chemical tankers or gas carriers, all the foregoing tests are to be carried out at the final list angle (LSL only) where this is found to exceed 20°.

(e) A 'static' test load of 1,5 times safe working moment (SWM) is to be held on the winch brakes with the maximum number of turns of rope on the winch drum. This is to be demonstrated through at least one revolution of the winch drum.

(f) A 'dynamic' load test of 1,1 times SWL is to be lowered at maximum speed for at least three metres and stopped by abruptly applying the winch brakes. This test load should not drop more than one metre after the brake is applied and is to be repeated several times to achieve a cumulative lowering distance of at least 150 m.

(g) A 'recovery' test is to be performed if the winch is to be used with a rescue boat to demonstrate that the fully loaded rescue boat can be recovered at a rate not less than 0,3 m/sec. It should be demonstrated that the winch hand recovery gear can recover a maximum load equivalent to a fully loaded boat.

(h) After completion of the tests, the winch should be stripped for inspection.

Table 3.1.2 Prototype: Dynamic test factors

Boat position		Lifeboat	Rescue boat
From	To		
Stowed	Embarkation	1,1 × P_1	1,1 × P_1
Embarkation	Sea level	1,1 × P_2	1,1 × P_1
Sea level	Embarkation	1,1 × P_1	1,1 × P_2
Embarkation	Stowed	1,1 × P_1	1,1 × P_1

Symbols

P_1 = weight of the lifeboat or rescue boat (as appropriate) with full equipment and weight of operating crew

P_2 = weight of the lifeboat or rescue boat with full equipment and weight of crew and weight of passengers (i.e., SWL)

1.12.3 Production testing of survival craft (excluding free-fall) and rescue boat davits and winches is to comply with the following requirements:

(a) A 'static' load test of 2,2 times SWL is to be held by the davit in its fully outboard position at 0° list (2,5 times SWL for use offshore).

(b) A 'static' load test of 1,5 times SWL is to be held on the winch brakes.

(c) Each block and shackle supplied with the davit is to be tested to 2,2 times their individual SWL (2,5 times SWL for use offshore). When they are not supplied with a manufacturer's certificate, tests are to be witnessed and LR's certificate issued.

(d) All fall ropes should be supplied with a manufacturer's certificate of test indicating the breaking strength of the rope, which is to be not less than 6 times the maximum tension.

1.12.4 On board (installation) testing of survival craft (excluding free-fall) and rescue boat davits and winches is to comply with the following requirements:

(a) A 'dynamic' lowering test of 1,1 times SWL is to be carried out with the davit in the outboard position. When the maximum lowering speed is reached, the brakes are to be abruptly applied to demonstrate the adequacy of both the attachment to the supporting structure in way of the winch and to the davits. For ships with inboard embarkation, the test is to be conducted from this position.

(b) A 'dynamic' lowering test is to be performed with the lifeboat or rescue boat in the fully loaded condition to demonstrate that its entry into the water is not less than the figure calculated from the expression in 1.2.16 and is within the limit detailed in 1.2.18.

(c) The above test is to be repeated with the lifeboat or rescue boat in the 'light' condition (i.e., equipped but without personnel) to ensure that the frictional resistance of the winch, fall, blocks, etc., can be overcome. In this condition, the minimum entry speed of the boat is to comply with the requirements of 1.2.17.

(d) For a life raft in the 'light' condition, it is generally only necessary to demonstrate that it has sufficient weight to overcome the friction in the davit reeving system.

(e) It is to be demonstrated to the Surveyor's satisfaction that the davits and winches are able to recover and return the survival craft to its stowage position, with satisfactory operation of limit switches, and be properly secured. Additionally, it is to be demonstrated that the survival craft can be recovered and returned to its stowage position using the emergency hand gear.

(f) For rescue boat launching appliances, it is to be demonstrated that the rescue boat, with weight equal to its rescue complement, can be recovered using the davit winch at a rate not less than 0,3 m/s.

(g) It is to be demonstrated to the Surveyor's satisfaction that the remote control release mechanism inside the survival craft operates correctly.

1.12.5 Prototype testing of free-fall launching ramps and associated controlled launch auxiliary davits is to be carried out as follows:

(a) The ramp structure is to be tested in applying a static load of 2,2 times SWL in positions along the ramp which gives maximum stress in the ramp structure with simulated shipboard 20° HSL and LSL and 10° fore and aft trim.

(b) The auxiliary davit arm is to be statically tested on the ramp and in its outboard position to 2,2 times SWL, with simulated shipboard 20° HSL and LSL and 10° fore and aft trim.

(c) Additionally, the auxiliary davit arm is to be dynamically tested on the ramp to 1,1 times the maximum load appropriate to the part of the operating cycle concerned, over the full operating range with the ship at 0° list.

(d) The tests indicated in 1.12.2(c), (d), (e), (f) and (h) are also to be conducted for free-fall systems.

(e) The pressure parts of the hydraulically operated lifting system are to be hydrostatically tested to 1,5 times design pressure.

(f) If the ramp is an adjustable type, it is to be demonstrated that it may be satisfactorily adjusted with the free-fall lifeboat loaded to 1,2 times its fully laden weight.

1.12.6 Production and installation testing of a free-fall system is to be carried out in accordance with 1.12.3 and 1.12.4 except as follows:

(a) During a free-fall launch of the lifeboat, the water entry speed is to be such that no harmful forces are experienced by the lifeboat occupants.

(b) Each new free-fall lifeboat is to be loaded to 1,1 times its fully laden weight and launched by free fall with the ship on an even keel and in its lightest sea-going condition.

(c) During the 'controlled' mode of launching, the free-fall lifeboat is to be loaded to 1,1 times SWL and released by the operation of the launching controls on deck. When the lifeboat has reached its maximum lowering speed of not greater than 1,3 m/s, the brake is to be applied abruptly in order to demonstrate the attachment and adequacy of the support structure in way of the davit and winch.

(d) It is to be demonstrated that the lifeboat may be recovered to its stowage position and can be safely and properly secured.

1.12.7 Periodical re-testing in accordance with the installation testing described in 1.12.4 and 1.12.6 is to be carried out every five years. Attention is drawn to the applicable requirements in the IMO Life Saving Appliance (LSA) Code, as amended.

1.12.8 After any repair affecting the strength of the davit or winch, the appliance is to be subject to the 'dynamic' loaded lowering test described in 1.12.4(a).

1.13 Inspection and maintenance

1.13.1 Every survival craft or rescue boat davit is to be visually inspected once a week by the crew to ensure they are at all times ready for immediate use.

1.13.2 It is recommended that rescue boats, including lifeboats which double as rescue boats, are to be launched using their davits at least once every month. In all cases, this recommendation is to be complied with at least once every three months for both lifeboats and rescue boats. For lifeboats installed on offshore platforms, this recommendation is to be complied with at least once every two months.

1.13.3 Every davit and winch is to be constructed so as to reduce routine maintenance to a minimum. Those parts requiring regular maintenance are to be readily accessible and easily maintained by the ship's crew. Where possible, the use of maintenance free sealed bearings is to be adopted.

1.13.4 All parts subject to wear should be examined with respect to the manufacturer's recommendations and repaired or replaced as necessary.

1.13.5 All davits and winches are to be adequately protected against corrosion and are to be constructed so as to prevent incendive friction or impact sparking during launching.

1.13.6 Davit falls are to be inspected periodically and must be renewed every five years or sooner should their condition deteriorate.

1.13.7 A record of maintenance, repair and test should be kept for each davit.

1.14 Certification and documentation

1.14.1 The minimum requirements for the issue of LR certification for life-saving launch and recovery appliances are as indicated in Ch 1,1.2.5.

1.14.2 Testing of the appliance is to be in accordance with 1.12.

1.14.3 When LR is authorised by Governments or National Administrations to issue, on their behalf, statutory Safety Equipment Certificates on LR classed ships, all tests are required to be witnessed by LR.

1.14.4 Life-saving launch and recovery appliances are an integral aspect of a ship's list of safety equipment which is to satisfy LR's requirements prior to the issue of Safety Equipment Certification and Record of Safety Equipment (Report S.E.1).

Contents

■ *Section 1* Introduction

1.1 General

1.1.1 This Chapter is applicable to the crane types as generally indicated in 1.2.1. In addition, it covers all types of diving and submersible handling systems, both manned and unmanned.

1.1.2 Handling of Personnel (HoP) aspects of shipboard and offshore cranes are detailed in Section 6 of this Chapter.

1.1.3 Derrick cranes are not covered by this Chapter, and are to be in accordance with the requirements of Chapter 2.

1.1.4 Life Saving Appliances are not covered by this Chapter, and are to be in accordance with the requirements of Chapter 3.

1.2 Lifting appliances and crane types

1.2.1 This Chapter will be the basis of approval by Lloyd's Register (hereinafter referred to as LR) of the following types of crane or lifting appliance:

(a) Deck cranes mounted on ships for handling equipment, cargo or containers in harbour or sheltered water conditions.
(b) Gantry cranes mounted on ships for handling containers or cargo in in-harbour conditions.
(c) Floating cranes mounted on barges or pontoons for handling loads in harbour or sheltered water and open sea conditions.
(d) Grab cranes mounted on ships, barges or pontoons for operating in harbour or sheltered water and open sea conditions.
(e) Engine room, stores cranes, etc., mounted on ships for handling equipment and stores in harbour or sheltered water conditions.
(f) Cranes mounted on fixed or mobile offshore installations for transferring equipment, stores, etc., to and from supply ships.
(g) Cranes mounted on ships or mobile offshore installations for handling or transferring non-manned equipment in an open-sea or offshore environment, e.g., pipe handling (or transfer) cranes.
(h) Installations mounted on ships and fixed or mobile offshore installations for handling manned submersibles and diving systems.
(j) Heavy lift cranes mounted on vessels, pontoons and offshore installations. Heavy lift cranes are defined by the following:
   - Safe Working Load (SWL) ≥ 160 t;
   - Maximum of 1000 lifts per year having more than 80 per cent of the maximum SWL;
   - Influences the vessel inclination by more than 5° (if not compensated by ballasting).

1.2.2 Any crane or lifting appliance not covered by the description or environmental conditions in 1.2.1 will be specially considered.

1.3 Service category

1.3.1 The service category as defined in Chapter 1 must be clearly stated on all submissions together with all relevant design criteria.

1.3.2 It is considered that shipboard cranes will generally fall into standard service category, whereas offshore cranes, shipboard cranes operating in open sea conditions and submersibles handling systems will fall into the specified service category.

1.3.3 In the case of offshore cranes, the rating for the standard and specified service category, which, in general, will comprise load versus radius diagrams for various sea state conditions (usually expressed as significant wave height), is to be submitted for approval. Approval on the basis of standard service category only will not be permitted for cranes on offshore installations except where the crane is to be used solely for lifting operations on the installation itself and will also not be permitted for cranes operating in open sea conditions.

1.3.4 The service category applicable to the particular appliance will also apply to the supporting pedestal and foundations.

1.3.5 For shipboard cranes operating in open sea conditions, the design criteria (e.g., offlead angles, hoisting factors, etc.) and environmental conditions (e.g., significant wave heights) are to be considered as in Section 3. The requirements for slewing rings and materials are to be complied with as in Section 2 for shipboard cranes.

1.4 Alternative basis of approval

1.4.1 A recognised National or International Standard may be considered as an alternative basis for approval of cranes and other lifting appliances (as considered applicable), provided LR is satisfied in each case that the criteria are at least equivalent to the design criteria specified in this Chapter for the applicable service category.

1.4.2 The combination of design requirements from recognised National or International Standards with the requirements of this Code is not generally permitted. Where it is intended to apply to only certain parts of a recognised National or International Standard to lifting appliances, which are intended to be certified to this Code, special permission is to be requested.

■ *Section 2*
Shipboard cranes

2.1 General

2.1.1 This Section applies to shipboard cranes, generally described in 1.2.1(a) to (e), which are designed to operate in a harbour or sheltered water conditions where there is no significant movement of the ship due to wave action and the significant wave height is not greater than 0,6 m.

2.1.2 The forces and loads acting on the crane structure are to be determined in accordance with the operating and environmental conditions for which the crane is to be certified and must be clearly specified on all crane submissions, together with the speeds of all crane movements, braking times, lifting capacities, ranges, etc.

2.2 Load considerations

2.2.1 Consideration is to be given to the utilisation and duty of the particular type of crane or lifting appliance in the 'in-service' condition with respect to the following forces and loads:
(a) Dead loads.
(b) Live loads.
(c) Dynamic forces due to the various crane movements.
(d) Forces due to ship inclination.
(e) Load swing caused by non-vertical lift horizontal movement of the crane and load.
(f) Wind forces and environmental effects.
(g) Loads on access ways, platforms, etc.
(h) Snow and ice when considered relevant.

2.2.2 The crane structure and any stowed arrangements are also to be examined with respect to the stowage condition for the following criteria, as applicable:
(a) Forces due to the ship motion and inclination.
(b) Wind and environmental effects.
(c) Snow and ice.

2.3 Duty factor

2.3.1 Cranes are grouped depending on the nature of the duty they perform and each group is designated a duty factor, as given in Table 4.2.1.

Table 4.2.1 Duty factor, F_d

Crane types and use	Duty factor
Stores cranes Maintenance cranes Engine room cranes	1,0
Deck jib cranes Container cranes Gantry cranes Floating cranes	1,05
Grab cranes	1,20
Other lifting appliances	Special consideration

2.3.2 The duty factor, F_d, depends on the frequency of operation and the severity of the load lifted with respect to the appropriate safe working load of the crane concerned and is used to factor both the live and dead load components of loading. The factor assumes normal marine use, operating life not in excess of 6 x 10^5 cycles and that the crane or lifting appliance has been designed as per the principles of a low susceptibility to fatigue. Consideration is to be given to increasing these values where extra heavy duty is envisaged.

2.3.3 The reduction of the duty factor below the minimum values as in Table 4.2.1 is only permitted if sufficient evidence is provided that the load cycles and the severity of the load spectrum are below the assumed normal marine use. Alternatively, the duty factor may be calculated on the basis of a recognised National or International Standard (e.g., F.E.M. 1.001) upon agreement with LR.

2.3.4 Where appropriate, fatigue calculations are to be carried out in accordance with a recognised National Standard using load cycles and load spectrum agreed between the manufacturer and the Owner.

2.4 Basic loads

2.4.1 The basic loads applied to the crane comprise the dead load, L_g, and the live load, L_l, which are as defined in Chapter 1.

2.5 Dynamic forces

2.5.1 The dynamic forces due to hoisting are those imposed on the structure by shock and accelerating the live load from rest to a steady hoisting speed. To take this effect into account in the design, the live load is multiplied by a hoisting factor, F_h.

2.5.2 The hoisting factor is given by:

$F_h = 1 + C_l V_h$

where

V_h = hoisting speed, in m/s but need be taken as not greater than 1,0 m/s

C_l = a coefficient depending on the stiffness of the crane concerned

C_l = 0,3 for jib type cranes, and 0,6 for gantry type cranes.

A value of F_h is to be taken as not less than 1,10 for jib cranes and 1,15 for gantry cranes.

For grab duty, F_h is to be multiplied by 1,05.

Values of F_h plotted against hoisting speed, V_h, are given in Fig. 4.2.1.

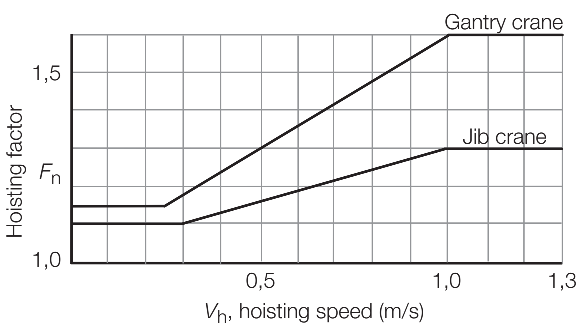


Fig. 4.2.1 Values of hoisting factor, F_h

2.6 Dynamic forces due to crane movements

2.6.1 Consideration is to be given to the forces which occur when a crane travels along a track or rails resulting in a vertical acceleration acting on the crane and its load together with the horizontal acceleration due to the crane changing speed whilst travelling.

2.6.2 The vertical acceleration is usually small, provided the rail and joints are level and smooth, and since it may be considered that it does not occur at the same time as the maximum dynamic force due to hoisting, it may generally be neglected.

2.6.3 The horizontal acceleration including that due to braking is to be supplied by the manufacturer. Where the acceleration is not available but speed and working conditions are known, the acceleration is to be obtained from the following formulae:

(a) For cranes with low travel speed (0,4–1,5 m/s)

$a_t = 0{,}075V_t + 0{,}07$

(b) For cranes with moderate to high travel speed (1,5–4,0 m/s) and normal acceleration

$a_t = 0{,}075V_t + 0{,}20$

(c) For cranes with travel speed (1,5–4,0 m/s) and high acceleration (0,4–0,7 m/s^2)

$a_t = 0{,}100V_t + 0{,}27$

where

a_t = acceleration, in m/s^2

V_t = travel speed, in m/s.

Where the speed is known but working conditions are not, the highest value of acceleration for the appropriate speed is to be used.

2.6.4 In cases where the crane drive control system ensures that motions such as hoisting, travelling or slewing cannot occur simultaneously and the loading caused by one motion is practically zero when the other motion starts, loadings due to hoisting, travelling motions or slewing do not need to be superimposed.

With respect to the load combination formula as given in the Code, this would result in:

Case 1a: F_h > 1,0 (Hoisting) –> L_{h2} (Travelling or slewing) = 0

Case 1b: F_h = 1,0 (Live load at rest) –> L_{h2} (Travelling or slewing) > 0

Case 2: Similar.

where

L_{h2} = the next most unfavourable horizontal load (usually due to travelling or slewing acceleration).

2.7 Slewing forces

2.7.1 The inertia forces acting on the load and crane structure resulting from slewing the crane are to be considered.

2.7.2 The slewing acceleration or, alternatively, the slewing speed and braking time, is to be supplied by the manufacturer. Where this is not available, the acceleration at the jib head of the crane, with the crane jib at maximum radius, is to be taken as 0,6 m/s^2.

2.7.3 The slewing acceleration is to be applied to dead weight and the SWL of the crane. The slewing acceleration is to be taken as 100 per cent of its nominal value up to 40 t SWL and can then gradually be reduced to 50 per cent of its nominal value until 160 t SWL. Beyond 160 t SWL, the slewing acceleration shall remain constant at 50 per cent of its nominal value. The SWL to determine the slewing acceleration is to be taken as the maximum SWL on the load versus radius charts. The graphical representation of the above can be found in Fig. 4.2.2.

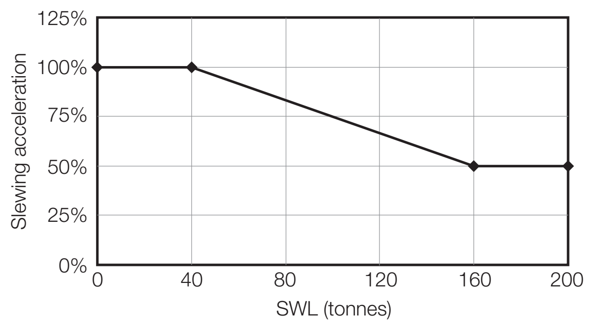


Fig. 4.2.2 Slewing acceleration

2.8 Centrifugal forces

2.8.1 In general, the effect of centrifugal force acting on the crane structure is small and may be neglected.

2.9 Transverse forces due to travel motions

2.9.1 Consideration is to be given to racking loads which occur when two pairs of wheels or bogies move along a set of rails and produce a couple formed by horizontal forces normal to the rail direction.

2.9.2 The value of the racking force, F_R, is calculated from the following formulae:

$$F_R = C_2 F_{VW}$$

where

F_{VW} = vertical load on wheel or bogie, in Newtons

C_2 = coefficient dependent on wheel track, t, and base, B, as follows:

(a) C_2 = 0,05 for values $t/b < 2,0$

(b) C_2 = 0,025 for values $2,0 < t/b < 8,0$

(c) C_2 = 0,20 for values $t/b > 8,0$

Fig. 4.2.3 gives the equilibrium of forces applied to the crane. Alternative calculation methods as detailed in recognised National or International Standards (e.g., F.E.M. 1.001, Booklet 9) may be considered.

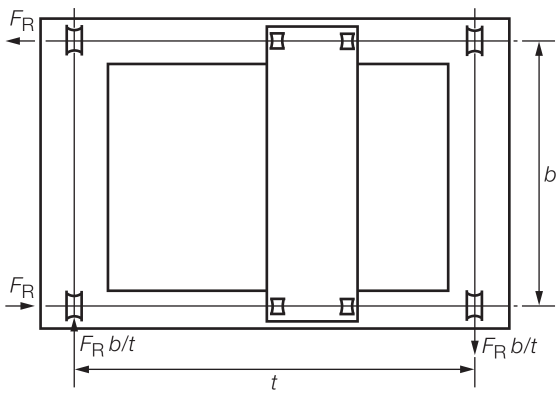


Fig. 4.2.3
Equilibrium of forces due to crane travelling along track

2.10 Buffer forces

2.10.1 Forces applied to the crane structure as a result of the crane coming into contact with buffers are to be considered. Where decelerating devices are fitted which operate before the crane reaches the end of the track, and providing such devices operate automatically and give effective deceleration to the crane at all times, the reduced speed produced by these devices may be used in the calculations.

2.10.2 For cranes where the load is free to swing, the forces are to be calculated equating the energy capacity of the buffer with the kinetic energy of the crane dead weight, i.e., excluding the live load, when the crane is travelling at 0,7 times its design speed.

2.10.3 For cranes where the load is restricted from swinging by rigid guides, the same method is to be used to calculate the forces but the dead weight plus live load is to be used in the calculation.

2.11 Forces due to ship motion

2.11.1 Shipboard cranes are to be designed to operate safely and efficiently in a harbour or sheltered water environment at an angle of heel of 5° and angle of trim of 2° occurring simultaneously.

2.11.2 Special consideration may be given where it is intended to operate a crane on a vessel at an angle of heel differing from 5° or an angle of trim differing from 2°. Where angles less than these are proposed, evidence is to be provided to demonstrate that such lesser angles cannot be exceeded in service.

2.11.3 In the stowed condition, the crane, its stowage arrangements and the structure in way are to be designed to withstand forces resulting from the following two design combinations:

(a) Acceleration normal to deck of ±1,0g
Acceleration parallel to deck in fore and aft direction of ±0,5g
Static heel of 30°
Wind of 63 m/s acting in fore and aft direction.

(b) Acceleration normal to deck of ±1,0g
Acceleration parallel to deck in transverse direction of ±0,5g
Static heel of 30°
Wind of 63 m/s acting in a transverse direction.

2.11.4 Alternatively, where the crane is to be fitted to a conventional ship and the ship's characteristics are known, the forces may be calculated using accelerations obtained from consideration of the ship's motions given in Table 4.2.2, together with the force due to a wind speed of 63 m/s acting in the most unfavourable direction.

2.11.5 The forces due to ship motions are to be determined in accordance with Table 4.2.3.

2.11.6 The following combinations of static and dynamic forces are to be considered:

(a) Rolling motion only:
Static roll + dynamic roll + dynamic heave (at roll angle φ).

(b) Pitching motion only:
Static pitch + dynamic pitch + dynamic heave (at pitch angle ψ).

(c) Combined motion:
Static combined + 0,8 (dynamic roll + dynamic pitch + dynamic heave (at roll angle φ) + dynamic heave (at pitch angle ψ)).

In each case, the component of force due to wind is to be included where applicable.

Table 4.2.2 Ship motions

Motion	Maximum single amplitude	Period in seconds
Roll	$\phi = \sin^{-1}\theta$ *see* Note	$T_r = \dfrac{0{,}7B}{\sqrt{GM}}$
Pitch	$\psi = 12e^{\frac{-L_{pp}}{300}}$	$T_r = 0{,}5\sqrt{L_{pp}}$
Heave	$\dfrac{L_{pp}}{80}$ m	$T_h = 0{,}5\sqrt{L_{pp}}$

where

θ = $\sin(\phi)$

= $\left(0{,}45 + 0{,}1\dfrac{L}{B}\right)\left(0{,}45 - \dfrac{L}{1270}\right)$

L_{pp} = length of ship between perpendiculars, in metres

B = moulded breadth of ship, in metres

GM = transverse metacentric height of loaded ship, in metres

ψ = is to be taken as not greater than 8°

NOTE

ϕ need not exceed 30° and is not to be taken less than 22°.

2.11.7 Proposals to use other values are to be substantiated by calculations and will be subject to special consideration.

2.12 Wind loading

2.12.1 The wind pressure, p, acting on the structure is given by the following formula:

$$p = 0{,}613 V_s^2$$

where

p = pressure, in N/m^2

V_s = wind speed, in m/s

The wind speed for the operating condition is to be taken as 20 m/s and for the stowed condition as 63 m/s.

2.12.2 Where it is anticipated that wind speeds in excess of those defined in 2.12.1 may occur, these higher wind speeds are to be considered.

2.12.3 The wind force acting on the suspended load is to be taken as 300 N per tonne of SWL, but where a crane is to be designed to handle loads of a specific shape and size the wind force is to be calculated for the appropriate dimensions and configuration.

Table 4.2.3 Forces due to ship motions

Source	Component of force, in Newtons		
	Normal to deck	Parallel to deck	
		Transverse	Longitudinal
STATIC			
Roll	$W\cos\phi$	$W\sin\phi$	$W\sin\psi$
Pitch	$W\cos\psi$		
Combined	$W\cos(0{,}71\phi)\cos(0{,}71\psi)$	$W\sin(0{,}71\phi)$	$W\sin(0{,}71\psi)$
DYNAMIC			
Roll	$0{,}07024W\dfrac{\phi}{T_r^2}y$	$0{,}07024W\dfrac{\phi}{T_r^2}z_r$	
Pitch	$0{,}07024W\dfrac{\psi}{T_p^2}x$		$0{,}07024W\dfrac{\psi}{T_p^2}z_p$
Heave:			
Roll	$0{,}05W\dfrac{L_{pp}}{T_h^2}\cos\phi$	$0{,}05W\dfrac{L_{pp}}{T_h^2}\sin\phi$	
Pitch	$0{,}05W\dfrac{L_{pp}}{T_h^2}\cos\psi$		$0{,}05W\dfrac{L_{pp}}{T_h^2}\sin\psi$

Symbols

y = transverse parallel to deck from centreline of ship to centreline of crane, in metres

x = longitudinal distance parallel to deck from centre of pitching motion, taken to be at longitudinal centre of flotation, to centreline of crane, in metres

z_r = distance normal to deck from centre of rolling motion, taken to be at the vertical centre of gravity of the ship, to the vertical centre of gravity of the crane, in metres

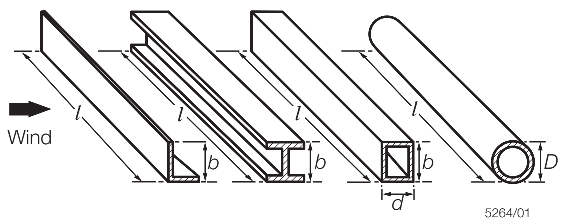
z_p = distance normal to deck from centre of pitching motion to centre of gravity of crane, in metres

W = weight of crane or its component part, in Newtons

ϕ and ψ are in degrees

Table 4.2.4 Force coefficient (C_f)

Type	Description		Aerodynamic slenderness *l/b* or *l/D*					
			≤5	10	20	30	40	≥50
Individual members	Rolled sections, rectangles, hollow sections, flat plates, box sections with *b* or *d* less than 0,5 m		1,30	1,35	1,60	1,65	1,70	1,80
	Circular sections, where	$D V_s < 6$ m^2/s	0,60	0,70	0,80	0,85	0,90	0,90
		$D V_s \geq 6$ m^2/s	0,60	0,65	0,70	0,70	0,75	0,80
	Box sections with *b* or *d* greater than 0,5 m	*b/d*						
		≥ 2,00	1,55	1,75	1,95	2,10	2,20	
		1,00	1,40	1,55	1,75	1,85	1,90	
		0,50	1,00	1,20	1,30	1,35	1,40	
		0,25	0,80	0,90	0,90	1,00	1,00	
Single lattice frames	Flat-sided sections		1,70					
	Circular sections, where	$D V_s < 6$ m^2/s	1,10					
		$D V_s \geq 6$ m^2/s	0,80					
Machinery houses, etc.	Rectangular clad structures on ground or solid base (air flow beneath structure prevented)		1,10					



Aerodynamic slenderness =

$$\frac{\text{length of member}}{\text{breadth of section across wind front}} = \frac{l}{b} \text{ or } \frac{l}{D}$$

$$\text{Section ratio (for box sections)} = \frac{\text{breadth of section across wind front}}{\text{depth of section parallel to wind flow}} = \frac{b}{d}$$

Fig. 4.2.4
Aerodynamic slenderness and section ratio

2.12.4 The wind force on the crane structure or individual members of the structure is to be calculated from the following expression:

$$F_w = A\, p\, C_f$$

where

A = the effective area of the structure concerned, i.e., the solid area projected onto a plane perpendicular to the wind direction, in m^2

p = wind pressure, in N/m^2

C_f = force coefficient in the direction of the wind

F_w = force due to the wind, in Newtons.

2.12.5 The force coefficient for various structural components is given in Table 4.2.4. The values for individual members vary according to the aerodynamic slenderness and, in the case of large box sections, with the section ratio. The aerodynamic slenderness and section ratio are given in Fig. 4.2.4.

2.12.6 Where a structure consists of a framework of members such that shielding takes place, the wind force on the windward frame or member and on the sheltered parts of those behind it are calculated using the appropriate force coefficient. The force coefficient on the sheltered parts are to be multiplied by a shielding factor η. The values of η vary with the solidity and spacing ratio of the framework. Values of η are given in Table 4.2.5 for the solidity and spacing ratio as defined in Fig. 4.2.5.

Table 4.2.5 Shielding factor (η)

Spacing ratio *a/b*	Solidity ratio A/A_e					
	0,1	0,2	0,3	0,4	0,5	≥ 0,6
0,5	0,75	0,4	0,32	0,21	0,15	0,1
1,0	0,92	0,75	0,59	0,43	0,25	0,1
2,0	0,95	0,8	0,63	0,5	0,33	0,2
4,0	1	0,88	0,75	0,66	0,55	0,45
5,0	1	0,95	0,88	0,81	0,75	0,68
6,0	1	1	1	1	1	1

2.12.7 Where a structure consists of a number of identical frames or members spaced equidistantly behind each other in such a way that each frame shields those behind it, the wind load is to be obtained from the following expression:

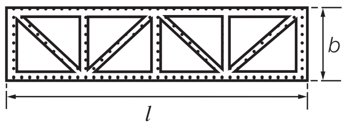
$$F = A\, p\, C_f \left(\frac{1 - \eta^n}{1 - \eta}\right)$$

where

η = shielding factor from Table 4.2.5, but η^n is to be taken as not less than 0,1

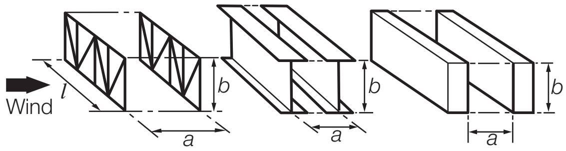
n = number of frames, but to be taken as not greater than 9.

(a) Solidity ratio



Solidity ratio $\frac{A}{A_e} = \frac{\text{area of solid parts (shown shaded)}}{\text{enclosed area}} = \frac{\Sigma A \text{ members}}{b \times l}$

(b) Spacing ratio



Spacing ratio $= \frac{\text{distance between facing sides}}{\text{breadth of member across wind front}} = \frac{a}{b}$

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Fig. 4.2.5 Solidity ratio and spacing ratio

2.12.8 For latticed tower structures, the 'face on' wind force based on the solid area of the windward face is to be multiplied by the following coefficients:

(a) For towers composed of flat-sided sections

$1{,}7p\ (1 + \eta)$

(b) For towers composed of circular sections where $D\ V_s < 6{,}0$ m^2/s:

$1{,}1\ p\ (1 + \eta)$

and $D\ V_s \geq 6{,}0$ m^2/s:

$1{,}4\ p\ (1 + \eta)$

where

D = the diameter of the section, in metres

V_s = the design wind speed, in m/s

The value of η is taken from Table 4.2.5 for a/b = 1,0 according to the solidity ratio of the windward face.

2.12.9 The maximum wind load on a square section tower occurs when the wind blows onto a corner and is to be taken as 1,2 times the 'face on' load.

2.12.10 Alternative proposals to calculate the wind load will be considered.

2.13 Snow and ice loads

2.13.1 In general, the effects of snow and ice loads acting on the crane structure may be neglected, although they are considered where a particular design or application indicates that these loads are significant.

2.14 Temperature effects

2.14.1 In general, temperature effects need only be considered with respect to the selection of the steels used in the construction of the crane, *see* 2.25.

2.15 Load combinations

2.15.1 The crane design is to be considered with respect to loads resulting from the following conditions:

Case 1 Crane operating without wind.
Case 2 Crane operating with wind.
Case 3 Crane in stowed condition.
Case 4 Crane subjected to exceptional loading.

2.15.2 **Case 1**. For the condition of the crane operating without wind, the design is to be considered with respect to a combination of dead load, live load and horizontal forces defined in 2.6 to 2.11, as given by the following expression:

$$F_d\ [L_g + F_h\ (L_l + L_{h1}) + L_{h2} + L_{h3}]$$

where

F_d = duty factor
L_g = dead load
L_l = live load
F_h = hoisting factor
L_{h1} = the horizontal component of live load due to heel and trim
L_{h2} = the next most unfavourable horizontal load (usually due to slewing acceleration)
L_{h3} = the horizontal component of dead load due to heel and trim.

2.15.3 **Case 2**. For the condition of the crane operating with wind, the design is to be considered with respect to a combination of dead load, live load and horizontal forces defined in 2.6 to 2.11, together with the most unfavourable wind load. This is given by the following expression:

$$F_d\ [L_g + F_h\ (L_l + L_{h1}) + L_{h2} + L_{h3}\ ] + L_w$$

where

L_w = the most unfavourable wind load.

2.15.4 **Case 3**. The crane is to be considered in its stowed condition when subjected to forces resulting from accelerations due to the ship's motions and static inclination, together with wind forces appropriate to the stowed condition. The effects of anchorages, locks and lashings, etc., are to be taken into consideration.

2.15.5 **Case 4**. The crane may also need to be considered with respect to the following exceptional load conditions:

(a) Coming into contact with buffers.
(b) Failure of the hoist wire or sudden release of load for cranes with counterweight (F_h, to be taken as –0,2).
(c) Test loading.

2.16 Stability

2.16.1 Travelling cranes, trolleys, grabs, etc., which are capable of travelling whilst loaded are to be examined with regard to stability against overturning for the following conditions:

(a) The worst operating condition as given by load combination Case 2, including forces resulting from an acceleration at deck level of 0,67 m/s^2 or maximum acceleration, if known.
(b) Consideration of sudden release of load in accordance with load combination Case 2, with the hoisting factor, F_h, taken as –0,2.

2.16.2 The overturning moment is to be not greater than 80 per cent of the stabilising moment.

2.16.3 Travelling cranes, etc., are to be provided with stowage locks or lashings or other means of resisting forces resulting from consideration of load combination Case 3.

2.16.4 Devices used for anchoring the crane or trolley to its track or rails may be taken into account in calculating the stability of travelling cranes only if:

(a) Such cranes or trolleys do not travel when loaded.
(b) The design of the rail and its anchoring devices are such that stability is achieved by use of efficient wheels and properly designed rails. Alternative devices will be considered.

2.16.5 Consideration is to be given to the following aspects of crane stability:

(a) Travelling cranes are to be provided with efficient stops at both limits of travel and are to be designed such that the crane will remain stable after contact with the stops under the most severe operating conditions.
(b) Travelling cranes are to be designed to prevent complete derailment or loss of stability in the event of a wheel or axle failure or sudden release of load.

2.16.6 Jib cranes are to be designed such that the jib does not 'jack-knife' under operational and test loads. Alternatively, suitable stops may be fitted to prevent the jib from 'jack-knifing'. Jack-knifing is to be considered using the following expression:

$$L_l + L_g + L_{h1} + L_{h3} + 1{,}2L_w$$

The components of the above expression are defined in 2.15.2.

2.17 Allowable stress – Elastic failure

2.17.1 The allowable stress, σ_a, is to be taken as the failure stress of the component concerned multiplied by a stress factor, F, which depends on the load case considered. The allowable stress is given by the general expression:

$$\sigma_a = F\sigma$$

where

σ_a = allowable stress
F = stress factor
σ = failure stress.

2.17.2 The stress factor, F, for steels in which $\sigma_y/\sigma_u \le 0{,}85$

where

σ_y = minimum yield stress of material
σ_u = minimum ultimate tensile stress of the material

are given in Table 4.2.6.

Table 4.2.6 Stress factor, *F*

Load case	Stress factor, *F*
1	0,67
2	0,75
3 and 4	0,85

2.17.3 For steel with $\sigma_y/\sigma_u > 0{,}85$, the allowable stress is to be derived from the following expression:

$$\sigma_a = 0{,}459F\,(\sigma_u + \sigma_y)$$
$$\tau_a = 0{,}266F\,(\sigma_u + \sigma_y)$$

where

τ_a = allowable shear stress
F = stress factor to be as defined in Table 4.2.6.

2.17.4 Steels with $\sigma_y/\sigma_u > 0{,}94$ are not generally acceptable and are specially considered.

2.17.5 The failure stress for the elastic modes of failure are given in Table 4.2.7.

Table 4.2.7 Failure stress

Mode of failure	Symbol	Failure stress
Tension	σ_t	$1{,}0\sigma_y$
Compression	σ_c	$1{,}0\sigma_y$
Shear	τ	$0{,}58\sigma_y$
Bearing	σ_{br}	$1{,}0\sigma_y$

2.17.6 For components subjected to combined stresses the following allowable stress criteria are to be used:

(a) $\sigma_{xx} \leq \sigma_a$

(b) $\sigma_{yy} \leq \sigma_a$

(c) $\tau_o \leq \tau_a$

(d) $\sigma_e = \sqrt{\sigma_{xx}^2 + \sigma_{yy}^2 - \sigma_{xx}\sigma_{yy} + 3\tau_o^2} \leq 1{,}1\sigma_a$

where

σ_{xx} = applied stress in x direction
σ_{yy} = applied stress in y direction
τ_o = applied shear stress.

2.17.7 The allowable bearing stress for rotatable and fitted pin connections are to be taken as per the allowable bearing stresses for fitted bolts given in Table 4.2.15. The allowable bearing stress for rotatable pin connections with dynamics or loose fit will be specially considered.

Ball and roller bearings are to be in accordance with a recognised National or International Standard.

The allowable bearing stress for other surface-to-surface contact (pressures) is to be taken as in 2.17 in combination with Table 4.2.7.

2.17.8 In the case where the structural analysis is carried out by means of detailed finite element models, higher allowable stresses may be applied as follows:

(a) $\sigma_{1.FE} \leq 1{,}1\sigma_a$

(b) $\sigma_{2.FE} \leq 1{,}1\sigma_a$

(c) $\tau_{o.FE} \leq 1{,}1\tau_a$

(d) $\sigma_{e.FE} \leq 1{,}1^2\sigma_a$

where

σ_1 = first principal stress
σ_2 = second principal stress
τ_o = shear stress

Higher allowable stresses, as defined here, may only be applied if the actual stresses are localised. In the case where the actual stresses may also be calculated by means of analytical methods, these higher allowable stresses are not applicable and 2.17.1 to 2.17.7 are to be applied.

2.18 Allowable stress – Compression, torsional and bending members

2.18.1 The allowable stress for compression members is to be taken as the critical compressive stress, σ_{cr}, multiplied by the allowable stress factor, *F*, as defined in Table 4.2.6. In addition to local failure due to the critical compression stress being exceeded, consideration is to be given to the overall ability of crane jibs to resist compression loading, *see* 2.19.

2.18.2 For members subjected to simple compression, the critical compression stress is given by the Perry-Robertson formulae as follows:

$$\sigma_{cr} = \frac{\sigma_y + (1 + \eta)\,\sigma_e}{2} - \sqrt{\left(\frac{\sigma_y + (1 + \eta)\,\sigma_e}{2}\right)^2 - (\sigma_y\,\sigma_e)}$$

where

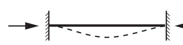
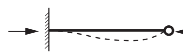
$$\sigma_e = \frac{\pi^2 E}{\left(\frac{K\,L}{r}\right)^2}$$

$$\eta = 0{,}001a\left(\frac{K\,L}{R} - 0{,}2\pi\sqrt{\frac{E}{\sigma_y}}\right)$$

E = Young's modulus
L = length of member
r = radius of gyration of member
a = Robertson's constant as in Table 4.2.9
σ_y = yield stress
K = constant dependent on the end constraint condition of the member and can be obtained from Table 4.2.8.

Values of critical compression stress are given in Table 4.2.10. Alternative methods to calculate the simple critical compression stress as per recognised National or International Standards or analysis taking into account second and higher order effects may be considered. In the case where the stability is calculated by means of second or higher order analysis, suitable imperfections are to be taken into account and the loads are to be multiplied by the inverse of the stress factor 1/*F* where the actual stress results are then to be compared with the yield stress of the component.

Table 4.2.8 Value *K*, for different constraint conditions

Diagrammatic representation	Restraint conditions	*K*
	Constrained against rotation and translation at both ends	0,7
	Constrained against rotation and translation at one end and translation only at other end	0,85
	Constrained against translation only at each end	1,0
	Constrained against rotation and translation at one end and against rotation only at other end	1,5
	Constrained against rotation and translation at one end and free to rotate and translate at other end	2,0
NOTE The above values for *K* are to be used for design purposes and are not the theoretical values.		

2.18.3 The values of Robertson's constant are given in Table 4.2.9. The slenderness ratio for members with constant radius of gyration is obtained from the following formulae:

$$s = \frac{K\,L}{r}$$

where

s = slenderness ratio
L = length of member
r = radius of gyration of member
K = a constant which depends on the end constraint conditions of the member and is obtained from Table 4.2.8.

For members with varying radius of gyration, an effective radius of gyration is to be calculated in accordance with 2.19.

Table 4.2.9 Values of Robertson's constant, *a*, for various sections

Type of section	Thickness of flange or plate, in mm	Axis of buckling	*a*
Rolled I section (universal beams)		xx yy	2,0 3,5
Rolled H section (universal beams) *See* Note 1	≤ 40 > 40	xx yy xx yy	3,5 5,5 5,5 8,0
Welded plate I or H sections *See* Notes 1, 2 or 3	≤ 40 > 40	xx yy xx yy	3,5 5,5 3,5 8,0
Rolled I or H section with welded flange cover plates *See* Notes 1 and 4		xx yy xx yy	3,5 2,0
Welded box sections *See* Notes 1, 3 and 4	≤ 40 > 40	any any	3,5 5,5
Rolled channel sections, rolled angle sections or T-bars (rolled or cut from universal beam or column)		any	5,5
Hot-rolled structural hollow sections		any	2,0
Rounds, square and flat bars *See* Note 1	≤ 40 > 40	any any	3,5 5,5
Compound rolled sections (2 or more I, H or channel sections, I section plus channel, etc.)		any	5,5
Two rolled angle, channel or T-sections, back-to-back		any	5,5
Two rolled sections laced or battened		any	5,5
Lattice strut		any	2,0

NOTES
1. For thicknesses between 40 mm and 50 mm, the value of σ_{cr} may be taken as the average of the value for thicknesses less than 40 mm and the value for thicknesses greater than 40 mm.
2. For welded plate I or H sections where it can be guaranteed that the edges of the flanges will only be flame-cut, *a* = 3,5 may be used for buckling about the y-y axis for flanges up to 40 mm thick and *a* = 5,5 for flanges over 40 mm thick.
3. Yield strength for sections fabricated from plate by welding reduced by 25 N/mm^2.
4. 'Welded box sections' includes those fabricated from four plates, two angles or an I or H section and two plates but not box sections composed of two channels or plates with welded longitudinal stiffeners.

2.18.4 For members subjected to combined bending and compression, the following stress criteria are to be used:

$$\frac{\sigma_b}{\sigma_t} + \frac{\sigma_c}{\sigma_{cr}} \leq F$$

where

σ_b = applied bending stress
σ_c = applied compression stress.

2.18.5 The effects of 'lateral torsional buckling', if applicable to the specific design, are to be taken into consideration by using the methods of recognised National or International Standards, as appropriate.

2.19 Crane jibs – Overall stability

2.19.1 In addition to individual members of the jib structure being examined with respect to buckling, crane jibs are to be considered with respect to critical compressive failure of the jib as a whole with regard to both plan and elevation planes.

2.19.2 The slenderness ratio is the effective length of the jib divided by the radius of gyration in the plane concerned. To allow for the variation in radius of gyration with length, an effective radius of gyration is to be calculated in accordance with 2.20.

2.19.3 The effective length of the jib is dependent on the constraint conditions at its ends. The conditions are different in plan view from those in elevation and are also dependent on the type of jib concerned, of which there are two types, rope supported and cantilever jibs.

Table 4.2.10 Values of σ_{cr} for steel for varying σ_y

Yield stress, in N/mm^2	240				260				360			
Robertson's constant, *a* / Slenderness ratio, *s*	2,0	3,5	5,5	8,0	2,0	3,5	5,5	8,0	2,0	3,5	5,5	8,0
20	239	239	238	237	259	258	257	255	356	353	350	345
30	234	230	224	218	253	248	242	234	348	339	328	316
40	228	220	210	199	246	237	226	214	337	322	305	286
50	221	209	195	181	238	225	210	194	323	301	278	256
60	212	196	180	163	228	210	192	174	302	275	249	225
70	200	182	163	146	214	193	174	156	272	245	219	196
80	185	165	147	131	196	175	155	138	237	213	190	170
90	167	148	131	116	175	156	138	122	202	182	164	147
100	149	132	117	103	154	137	122	108	171	156	141	127
110	131	117	103	92	134	121	107	96	146	134	122	111
120	115	103	92	82	117	106	95	85	125	116	106	97
130	101	91	82	73	102	93	84	76	108	101	93	85
140	89	81	73	66	90	83	75	68	94	89	82	76
150	78	72	66	59	79	74	67	61	83	78	73	68
160	70	65	59	53	71	66	60	55	73	69	65	61
180	56	53	48	44	57	53	49	45	59	56	53	49
190	51	48	44	40	51	48	45	41	53	51	48	45
200	46	44	40	37	47	44	41	38	48	46	44	41
210	42	40	37	34	42	40	38	35	43	42	40	38
220	39	37	34	32	39	37	35	32	40	38	37	35
230	35	34	32	29	36	34	32	30	36	35	34	32
240	33	31	29	27	33	31	30	28	34	32	31	30

2.19.4 For rope supported jibs, the effective length is to be calculated in the following manner:

(a) In elevation, the jib can be considered as being fixed against translation and free to rotate so that the effective length is taken as the actual length of the jib for all jib attitudes, i.e., $K = 1{,}0$.

(b) In plan, the lower end of the jib is to be considered as fixed against translation and rotation by the jib pivots and the head is to be considered as partially constrained with respect to translation by the hoist and luffing ropes, the constraint varying with the tension in these ropes and attitude of the jib. The effective length in plan view is given by

$l = L K$

where

l = effective length

L = the actual length of the jib

K = a constant equal to $2 - \left(\dfrac{R\,(D + C\,H)}{R_H\,D + C\,R_S\,H}\right)$

C is the ratio of load applied to the jib head by the luffing rope to that applied to the non vertical part of the hoist rope, and R, R_H, R_S, D and H are dimensions, in mm, as shown in Fig. 4.2.6.

2.19.5 The above method is considered satisfactory for conventional jibs. Alternatively, and especially for jibs of slender or very high strength steel designs, the construction is to be analysed taking into account second and higher order effects due to deflection of the structure by iterative or other suitable methods, and calculations submitted. In the case where the stability is calculated by means of second or higher order analysis, suitable imperfections are to be taken into account and the loads are to be multiplied by the inverse of the stress factor $1/F$, where the actual stress results are then to be compared with the yield stress of the component.

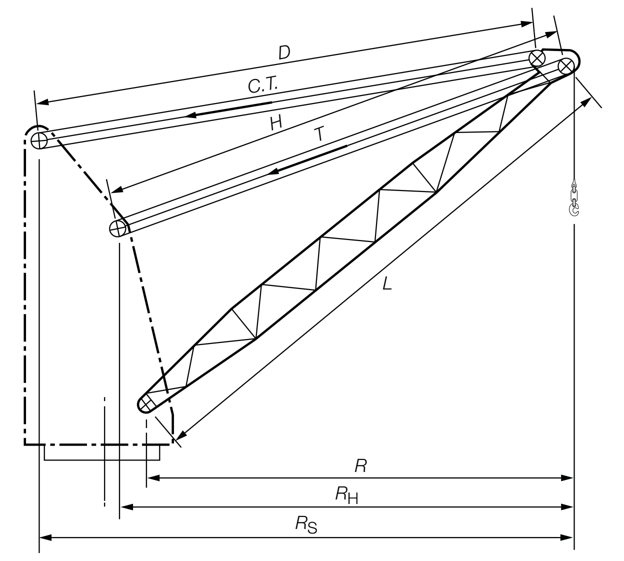


Fig. 4.2.6 Geometry for jib stability calculations

2.20 Slenderness ratio

2.20.1 The slenderness ratio of compression members is given by the general expression, i.e., $s = \frac{KL}{r}$. For members which have constant area and uniformly varying second moment of area and hence radius of gyration, such as crane jibs, an effective radius of gyration is to be considered. The effective radius of gyration is given by:

$$r_e = \left(\frac{I_e}{A}\right)^{1/2}$$

where

r_e = effective radius of gyration
I_e = $m\,I_2$
A = cross-sectional area of the currently analysed section using the formula in 2.18.4
I_2 = maximum second moment of area of member in the plane concerned and m is obtained from Tables 4.2.11 to 4.2.13, as appropriate.

2.21 Allowable stress – Plate buckling failure

2.21.1 The allowable stress is to be taken as the critical buckling stress σ_{cb}, σ_{bb}, or τ_b, as appropriate, of the component concerned multiplied by the stress factor, F, as defined in Table 4.2.6.

2.21.2 For components subject to compression stress, the critical buckling stress is given by:

(a) For $\sigma_{cb} < 0{,}5\sigma_y$

$$\sigma_{cb} = K_c E \left(\frac{t}{b}\right)^2$$

(b) For $\sigma_{cb} \geq 0{,}5\sigma_y$

$$\sigma_{cb} = \sigma_y \left(1 - \frac{\sigma_y}{4K_c E \left(\frac{t}{b}\right)^2}\right)$$

where

σ_{cb} = critical compression buckling stress
E = Young's modulus
t = plate thickness
b = plate width, i.e., normal to direction of stress
a = plate length
K_c = compression buckling constant, defined as follows:
for $\alpha \geq 1$:

$$K_c = \frac{\pi^2}{12\,(1-\mu^2)}\;\frac{8{,}4}{2{,}1} = 3{,}615$$

for $\alpha < 1$:

$$K_c = \frac{\pi^2}{12\,(1-\mu^2)}\left(\alpha + \frac{1}{\alpha}\right)^2$$

$$\alpha = \frac{a}{b}$$

μ = Poisson's ratio

The graphical representation of K_c is provided in Fig. 4.2.7.

Table 4.2.11 ***m* factor for various values of I_1/I_2**

I_1/I_2	0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1,0
m	0,294	0,372	0,474	0,559	0,634	0,704	0,769	0,831	0,889	0,946	1,0

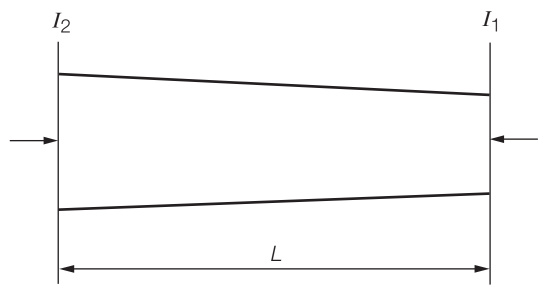


Table 4.2.12 ***m* factor for various values of I_1/I_2 and *a*/*L***

I_1/I_2	*a*/*L*					
	0,0	0,1	0,2	0,3	0,4	0,5
0,1	0,555	0,622	0,689	0,756	0,823	0,891
0,2	0,652	0,708	0,765	0,821	0,877	0,934
0,4	0,776	0,815	0,854	0,894	0,933	0,972
0,6	0,866	0,890	0,915	0,940	0,964	0,988
0,8	0,938	0,950	0,961	0,973	0,985	0,996
1,0	1,0	1,0	1,0	1,0	1,0	1,0

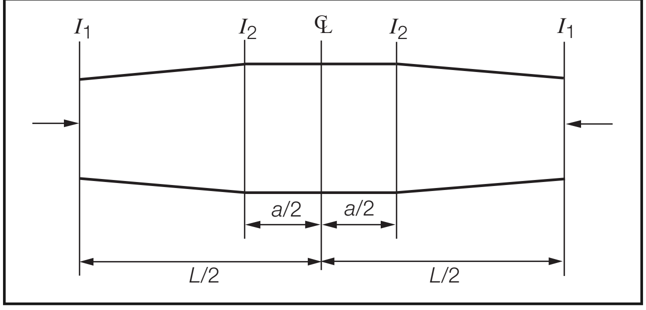
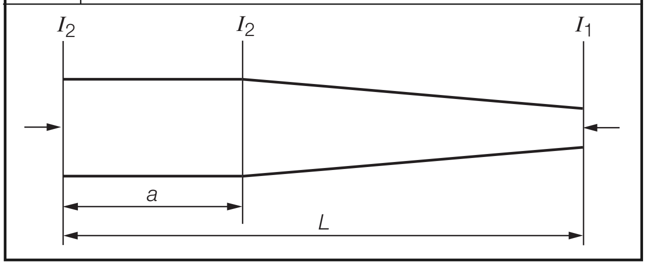


Table 4.2.13 ***m* factor for various values of I_1/I_2 and *a*/*L***

I_1/I_2	*a*/*L*					
	0,0	0,1	0,2	0,3	0,4	0,5
0,1	0,372	0,373	0,418	0,479	0,563	0,671
0,2	0,474	0,500	0,532	0,586	0,660	0,756
0,4	0,634	0,667	0,691	0,729	0,783	0,852
0,6	0,769	0,795	0,810	0,836	0,869	0,913
0,8	0,889	0,950	0,961	0,973	0,985	0,996
1,0	1,0	1,0	1,0	1,0	1,0	1,0



2.21.3 For components subject to shear stress the critical buckling stress is given by:

(a) For $\tau_b < 0{,}29\sigma_y$

$$\tau_b = K_s E \left(\frac{t}{b}\right)^2$$

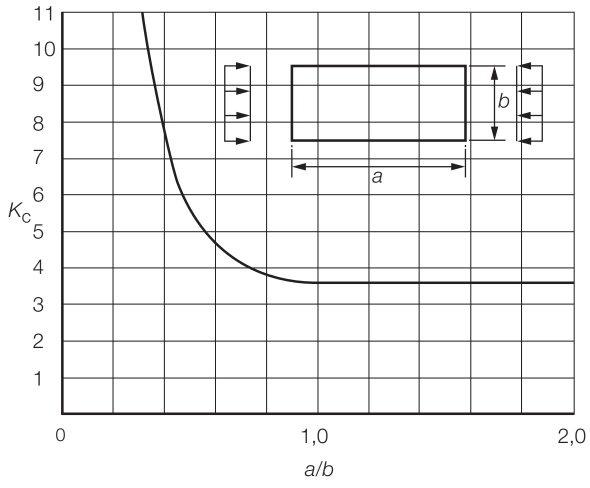


Fig. 4.2.7 Compression buckling constant K_c

(b) For $\tau_b \geq 0{,}29\sigma_y$

$$\tau_b = 0{,}58\sigma_y \left(1 - \frac{0{,}58\sigma_y}{4K_s E\left(\frac{t}{b}\right)^2}\right)$$

where

τ_b = critical shear buckling stress
b = smallest plate dimension
a = plate length corresponding to b
K_s = compression buckling constant, defined as follows:

for $\alpha \geq 1$:

$$K_s = \frac{\pi^2}{12\,(1-\mu^2)}\left(5{,}34 + \frac{4{,}0}{\alpha^2}\right)$$

for $\alpha < 1$:

$$K_s = \frac{\pi^2}{12\,(1-\mu^2)}\left(4{,}0 + \frac{5{,}34}{\alpha^2}\right)$$

$\alpha = \frac{a}{b}$

μ = Poisson's ratio

The graphical representation of K_s is provided in Fig. 4.2.8.

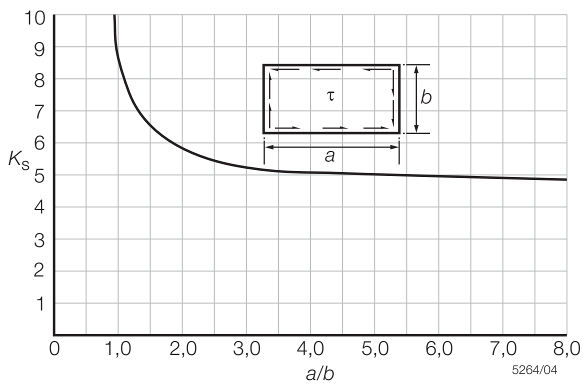


Fig. 4.2.8 Shear buckling constant K_s

2.21.4 For components subject to bending stress, the critical buckling stress is given by:

(a) For $\sigma_{bb} < 0,5\sigma_y$

$$\sigma_{bb} = K_b E \left(\frac{t}{b}\right)^2$$

(b) For $\sigma_{bb} \geq 0,5\sigma_y$

$$\sigma_{bb} = \sigma_y \left(1 - \frac{\sigma_y}{4K_b E \left(\frac{t}{b}\right)^2}\right)$$

where

σ_{bb} = critical buckling stress
b = plate width, i.e., normal to direction of stress
a = plate length, i.e., in the direction of stress
K_b = compression buckling constant, defined as follows:

for $\alpha \geq \frac{2}{3}$:

$$K_b = \frac{\pi^2}{12\,(1 - \mu^2)}\,23,9 = 21,6$$

for $\alpha < \frac{2}{3}$:

$$K_b = \frac{\pi^2}{12\,(1 - \mu^2)}\left(15,87 + \frac{1,87}{\alpha^2} + 8,6\alpha^2\right)^2$$

$\alpha = \frac{a}{b}$
μ = Poisson's ratio

The graphical representation of K_b is provided in Fig. 4.2.9.

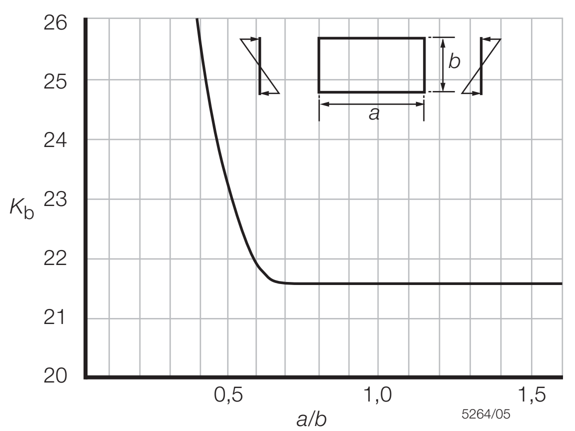


Fig. 4.2.9 Bending buckling constant K_b

2.21.5 For components subject to combined compression and shear stress, the following allowable stress criteria are to be met:

(a) $\sigma_c \leq F\,\sigma_{cb}$
(b) $\tau \leq F\,\tau_b$
(c) $\left(\frac{\sigma_c}{\sigma_{cb}}\right) + \left(\frac{\tau}{\tau_b}\right)^2 \leq F$

τ = applied shear stress
σ_c = applied compression stress.

2.21.6 For components subject to combined bending and shear stress, the following stress criteria are to be met:

(a) $\sigma_b \leq F\,\sigma_{bb}$
(b) $\tau \leq F\,\tau_b$
(c) $\left(\frac{\sigma_b}{\sigma_{bb}}\right)^2 + \left(\frac{\tau}{\tau_b}\right)^2 \leq F$

σ_b = applied compression stress.

2.21.7 For components subject to combined bending and compression stress, the following allowable stress criteria are to be met:

(a) $\sigma_c \leq F\,\sigma_{cb}$
(b) $\sigma_b \leq F\,\sigma_{bb}$
(c) $\left(\frac{\sigma_c}{\sigma_{cb}}\right) + \left(\frac{\sigma_b}{\sigma_{bb}}\right)^2 \leq F$

2.21.8 For components subject to combined compression, bending and shear stress, the following allowable stress criteria are to be met:

(a) $\sigma_c \leq F\,\sigma_{cb}$
(b) $\sigma_b \leq F\,\sigma_{bb}$
(c) $\tau \leq F\,\tau_b$
(d) $\left(\frac{\sigma_c}{\sigma_{cb}}\right) + \left(\frac{\sigma_b}{\sigma_{bb}}\right)^2 + \left(\frac{\tau}{\tau_b}\right)^2 \leq F$

2.22 Allowable stress – Buckling failure of thin walled cylinders

2.22.1 The allowable stress is to be taken as the critical buckling stress σ_{cb} or σ_{bb}, as appropriate, of the component concerned, multiplied by the allowable factor, F, as defined in Table 4.2.6.

2.22.2 For components subject to compression the critical buckling stress is given by:

(a) For $\sigma_{cb}{}^1 < 0,5\sigma_y$
$\sigma_{cb}{}^1 = K'_c\,E$
(b) For $\sigma_{cb}{}^1 \geq 0,5\sigma_y$

$$\sigma_{cb}{}^1 = \sigma_y\left(1 - \frac{\sigma_y}{4K'_c\,E}\right)$$

where

$\sigma_{cb}{}^1$ = critical compressive buckling stress
E = Young's modulus
r = average radius of tube
t = wall thickness
K'_c = compression buckling constant, *see* Fig. 4.2.10.

2.22.3 For components subject to bending the critical buckling stress is given by:

(a) For $\sigma_{bb}{}^1 < 0,5\sigma_y$
$\sigma_{bb}{}^1 = K'_b\,E$
(b) For $\sigma_{cb}{}^1 \geq 0,5\sigma_y$

$$\sigma_{bb}{}^1 = \sigma_y\left(1 - \frac{\sigma_y}{4K'_b\,E}\right)$$

where

$\sigma_{bb}{}^1$ = critical bending buckling stress
K'_b = bending buckling constant, *see* Fig. 4.2.11.

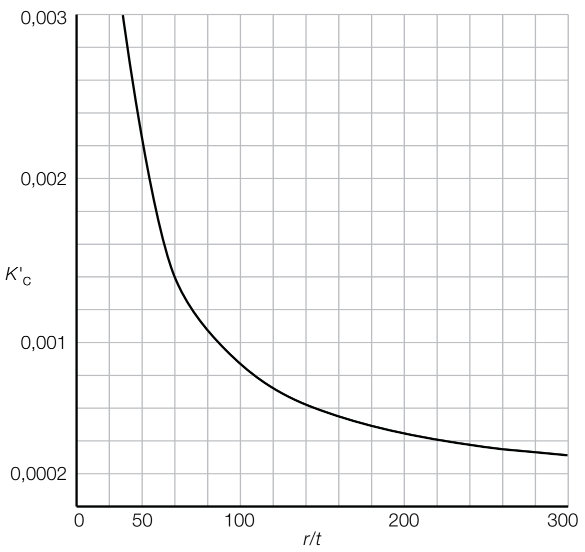


Fig. 4.2.10 Compressive buckling constant

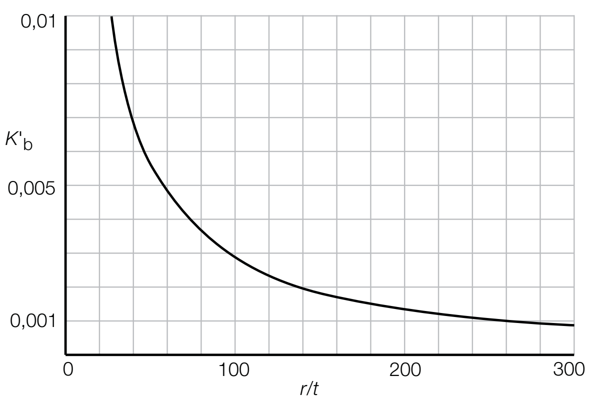


Fig. 4.2.11 Bending buckling constant

2.22.4 For components subject to combined compression and bending, the following allowable stress criteria are to be met:

$\sigma_c \leq F\,\sigma_{cb}{}^1$

$\sigma_b \leq F\,\sigma_{bb}{}^1$

$$\frac{\sigma_c}{\sigma_{cb}{}^1} + \frac{\sigma_b}{\sigma_{bb}{}^1} \leq F$$

2.22.5 Buckling calculations carried out in accordance with recognised National or International Standards will be considered.

2.23 Allowable stress – Joints and connections

2.23.1 For welded joints, the physical properties of the weld metal are considered as equal to the parent metal. For full penetration butt welds, the allowable stress is equal to the allowable tensile stress of the parent material.

2.23.2 For fillet welds and partial penetration welds, the allowable stresses are reduced. Values of these reduced stresses are given in Table 4.2.14. Where *F* is the stress factor, *see* Table 4.2.6. Fig. 4.2.12 shows the stresses in a typical fillet weld. The actual stress in the fillet welds is to be less than or equal to the allowable stresses and is to be evaluated as follows:

(a) Evaluation of perpendicular weld stresses:

$\sigma_\perp{}^{C\text{–}D} = \tau_\perp{}^{D\text{–}E} \leq 0{,}7F\,\sigma_y$

or

$\sigma_\perp{}^{D\text{–}E} = \tau_\perp{}^{C\text{–}D} \leq 0{,}7F\,\sigma_y$

(b) Evaluation of longitudinal weld stresses:

$\tau_{||} \leq 0{,}58F\,\sigma_y$

(c) Combined weld stresses

$\sqrt{\sigma_\perp{}^2 + \tau_\perp{}^2 + \tau_{||}{}^2} \leq 0{,}7F\,\sigma_y$

Table 4.2.14 Allowable stresses in welds

Type of weld	Allowable stress	
	Tension and compression	Shear
Full penetration butt weld	$1{,}0F\,\sigma_y$	$0{,}58F\,\sigma_y$
Fillet welds	$0{,}7F\,\sigma_y$	$0{,}58F\,\sigma_y$

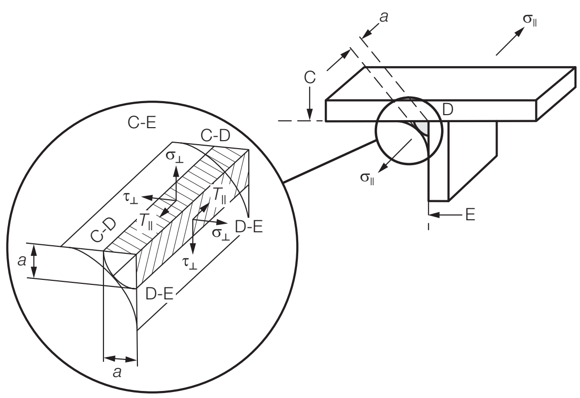


Fig. 4.2.12 Stresses in welds

2.23.3 The actual stress in fillet welds is to be calculated on the 'throat' dimension *a* of the weld (*see* Fig. 4.2.12).

2.23.4 The strength of joints using pre-tensioned bolts to transmit shear and/or tensile forces, e.g., high strength friction grip bolts, are to be determined in accordance with an appropriate and recognised National or International Standard.

2.23.5 For joints using precision bolts, defined as turned or cold finished bolts fitted into drilled or reamed holes whose diameter is not greater than the bolt diameter by more than 0,4 mm, the allowable stress due to the externally applied load is given in Table 4.2.15.

Table 4.2.15 Allowable stresses for fitted bolts

Type of loading	Allowable stress	
	Load cases 1 and 2	Load cases 3 and 4
Tension	$0,4\sigma_y$	$0,54\sigma_y$
Single shear	$0,38\sigma_y$	$0,51\sigma_y$
Double shear	$0,57\sigma_y$	$0,77\sigma_y$
Tension and shear $(\sigma_{yy}^2 + 3\tau^2)^{1/2}$	$0,48\sigma_y$	$0,64\sigma_y$
Bearing	$0,9\sigma_y$	$1,2\sigma_y$

2.23.6 The allowable stresses for non-fitted bolts are to be taken as per Table 4.2.16.

Table 4.2.16 Allowable stresses for non-fitted bolts

Type of loading	Allowable stress	
	Load cases 1 and 2	Load cases 3 and 4
Tension	$0,4\sigma_y$	$0,54\sigma_y$
Single shear	$0,32\sigma_y$	$0,43\sigma_y$
Double shear	$0,36\sigma_y$	$0,48\sigma_y$
Tension and shear $\sqrt{\sigma_{yy}^2 + 3\tau^2}$	$0,48\sigma_y$	$0,64\sigma_y$
Bearing	$0,7\sigma_y$	$0,9\sigma_y$

2.23.7 Where joints are subjected to fluctuating or reversal of load across the joint the bolts are to be pre-tensioned by controlled means to 70 per cent to 90 per cent of their yield stress.

2.23.8 Black bolts (ordinary grade bolts) are not to be used for primary joints or joints subject to fatigue.

2.23.9 Carbon steel bolts are to be specified in accordance with ISO 898 part 1. Bolts are to be selected within the range 8.8 to 10.9 (inclusive). Applications for use of 12.9 bolts will be subject to special consideration. Bolt materials in other materials such as stainless steels are to be specified in accordance with a National or International Standard.

2.23.10 Alternative proposals for the calculation of allowable bolt stresses in accordance with an appropriate and recognised National or International Standard will be specially considered. The requirements in the standard need to provide sufficient equivalence to the requirements given in this section and need to be agreed with LR.

2.24 Slewing ring and slewing ring bolting

2.24.1 The crane manufacturer is to submit plans of the slewing ring, the bolting arrangement, crane and pedestal structure in way of the slewing ring and calculations giving static and fatigue design loads and allowable stresses for the ring and bolting arrangement.

2.24.2 The ring mounting flanges are to be rigid and the bolting equally spaced around the complete circumference of the ring. Mating surfaces are, in general, to be steel to steel and packing material is not recommended between joint faces. Non-equally spaced bolts are only acceptable on the compression side of the crane house. The number of bolts on the compression side shall not be less than half of the number of bolts on the tension side.

2.24.3 Bolts are to be pre-tensioned by controlled means to 70 to 90 per cent of their yield stress. Pre-tensioning is to be in accordance with the bearing manufacturer's instructions and, in general, pre-tensioning by bolt torqueing up to bolt size M30 may be used. Beyond this, pre-tensioning must be carried out by hydraulic tensioning device and elongation of the bolts measured to determine pre-load. Alternative methods of pre-tensioning will be specially considered as long as they are reasonably technically equivalent to the above methods.

2.24.4 Slewing ring bolts are to comply with ISO 898-1 and in general not to exceed Grade 10.9. Special consideration may be given to the application of 12.9 bolts where adequate precautions are taken to minimise the risk of hydrogen embrittlement. Threads of all bolt grades are to be rolled after heat treatment to improve fatigue strength.

2.24.5 The load, due to external loading, on the most heavily loaded bolt is given by:

$$P = \frac{4M}{ND} - \frac{H}{N}$$

where
M = design overturning moment
H = design axial load
D = pitch circle diameter of bolts
N = number of bolts.

Alternative methods for the determination of P will be considered.

2.24.6 The allowable tensile stress for bolts to ISO 898-1 grade associated with the external loading of 2.24.5, and pre-tensioned in accordance with 2.24.5, are given in Table 4.2.17. Alternative methods as described in 2.23.4 may be considered.

Table 4.2.17 Allowable stress in ISO 898-1 bolts

International Standard ISO 898-1 designation	Allowable stress, in N/mm^2	
	Load cases 1 and 2	Load cases 3 and 4
8.8	256	343
10.9	360	482
12.9	432	579

2.24.7 The slewing rings are to comply with the Charpy V-notch impact test requirements as per 2.25.5, as applicable.

2.25 Materials

2.25.1 The crane is to be constructed of steel which complies with LR's requirements for hull structural steel. Alternatively, steels which comply with National specifications may be used, provided these specifications give equivalence to Rule requirement, *see* Ch 1,1

2.25.2 The selected steel grade is to provide adequate assurance against brittle fracture, taking into account the material tensile strength and thickness and the environment in which the crane is designed to operate, *see* Chapter 11, and is in general to comply with the Charpy V-notch impact test requirements given in Tables 4.2.18 to 4.2.20.

Table 4.2.19 Charpy V-notch test impact energy requirements for classed and certified lifting appliances

Minimum specified yield stress (N/mm^2)	Minimum average impact energy (J)	Sampling direction
235	27	*L*
275	31	*L*
355	34	*L*
460	40 (30)	*L* (*T*)
690	40 (30)	*L* (*T*)

2.25.3 The purchaser is to specify the lowest temperature of operation. The minimum design temperature (MDT) is to be taken as 10°C above the lowest temperature of operation. For worldwide service the lowest temperature of operation is to be taken as –20°C with corresponding MDT of –10°C.

Table 4.2.18 Charpy V-notch impact test temperature requirements for welded primary and secondary steel structure. Excludes stainless steel

	Minimum design temperature, *see* Note 1							
	–10°C *see* Note 2		–20°C		–30°C		–40°C	
	Required impact test temperature							
Thickness, mm	Primary	Secondary	Primary	Secondary	Primary	Secondary	Primary	Secondary
$t \leq 10$	0°C *see* Note 3	+20°C *see* Note 3	0°C	+20°C *see* Note 3	–20°C	–20°C	–20°C	–20°C
$10 < t \leq 20$	0°C *see* Note 3	+20°C *see* Note 3	–20°C	0°C	–20°C	–20°C	–40°C	–20°C
$20 < t \leq 25$	0°C	0°C	–20°C	0°C	–40°C	–20°C	–40°C	–20°C
$25 < t \leq 30$	–20°C	0°C	–40°C	–20°C	–40°C	–20°C	–40°C	–40°C
$30 < t \leq 40$	–20°C	0°C	–40°C	–20°C	–40°C	–20°C	–60°C	–40°C
$40 < t \leq 50$	–20°C	0°C	–40°C	–20°C	–60°C	–20°C	–60°C	–40°C
$50 < t \leq 60$	–40°C	–20°C	–60°C *see* Note 4	–20°C	–60°C	–40°C	–60°C	–40°C
$60 < t \leq 150$	–40°C	–20°C	–60°C *see* Note 4	–20°C	–60°C	–40°C	–60°C	–40°C

NOTES
1. For intermediate design temperatures the next lowest design temperature shown in the Table should be selected.
2. Worldwide service refers to minimum design temperature –10°C or above.
3. For carbon steels up to minimum specified yield strength of 235 N/mm^2, impact testing is not required unless the carbon content is above 0,23% and/or manganese content is below 2,5 x carbon content, in which case impact tests are to be carried out at +20°C.
4. For carbon and carbon manganese steels with a minimum specified yield strength of 355 N/mm^2 or below, the test temperature need not be taken lower than –40°C for plates delivered in the normalised condition only.

Table 4.2.20 Charpy V-notch impact test temperature requirements for non-welded components (excluding slew bearings) subject to tensile loading. Excludes stainless steels

	Minimum design temperature, *see* Note 1							
	–10°C *see* Note 2		–20°C		–30°C		–40°C	
	Required impact test temperature, *see* Note 3							
Thickness, mm	Primary	Secondary	Primary	Secondary	Primary	Secondary	Primary	Secondary
$t \leq 10$	Not required	Not required	0°C	Not required	–10°C	Not required	–20°C	0°C
$10 < t \leq 50$	0°C	Not required	–10°C	Not required	–20°C	0°C	–30°C	–10°C
$50 < t \leq 100$	–10°C	Not required	–20°C	0°C	–30°C	–10°C	–40°C	–20°C
$t > 100$	–20°C	0°C	–30°C	–10°C	–40°C	–20°C	–50°C	–30°C

NOTES
1. For intermediate design temperatures the next lowest design temperature shown in the Table should be selected.
2. Worldwide service refers to minimum design temperature –10°C or above.
3. For cast and forged components, the minimum specified average energy for Charpy V-notch tests is to be at least 27J. For rolled products the Charpy V-notch impact energy requirements are to comply with Table 4.2.19.

2.25.4 Special consideration may be given to proposals to use materials which do not meet the requirements of Tables 4.2.18 to 4.2.20 where it can be shown that satisfactory service experience has resulted from the particular materials and construction.

2.25.5 Slew bearing applications are to be forged materials and are to be delivered in the quenched and tempered condition. Materials typically used for slew bearing applications are 34CrNiMo6 or 42CrMo4 or equivalents. Where other material grades or manufacturing processes are proposed, special consideration will be required.

2.25.6 For worldwide ship operation, slew bearings are to be subject to a Charpy V-notch impact test at room temperature, the minimum average test requirement is 34J. For ship operations below –10°C the Charpy V-notch impact test minimum average requirement is 42J at a test temperature of –20°C.

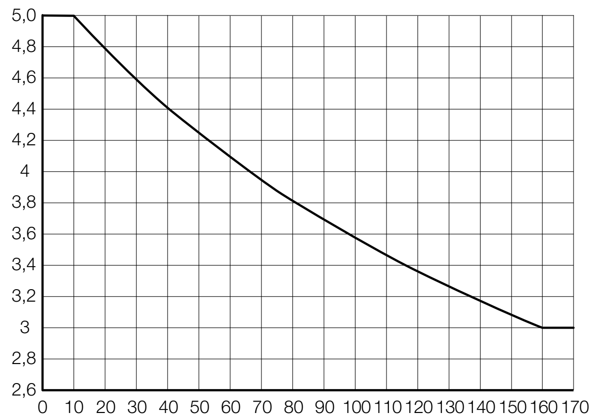


Fig. 4.2.13 Rope safety factor versus crane SWL

2.26 Rope safety factors and sheave ratio

2.26.1 The rope safety factor for both running and standing application for cranes with SWL greater than 10 t and less than 160 t is given by:

$$SF = \frac{10^4}{8{,}85\text{SWL} + 1910}$$

where
SF = minimum safety factor required
SWL = safe working load of crane, in tonnes

For cranes with SWL < 10 t, SF = 5,0
and SWL > 160 t, SF = 3,0.

This is represented graphically in Fig. 4.2.13.

The rope safety factor SF maybe reduced for Cases 3 and 4 (*see* 2.15.1 and Table 4.2.6) by a factor of $\frac{0{,}67}{0{,}85}$.

The safety factor SF for both the luffing and hoisting system is to be determined using the maximum SWL.

2.26.2 The required minimum breaking load of the rope is given by:

$$BL = SF \times L_r$$

where
BL = the required minimum breaking load of the rope
L_r = the load in the rope due to consideration of the unfactored live load, rope weights and jib weight as appropriate, taking due account of the number of parts in the rope system and the friction in the sheaves over which the rope passes.

2.26.3 The ratio of the bottom of the rope groove diameter of the sheave to wire rope diameter is defined in Table 8.3.4 in Chapter 8. The radius of the groove sheave is given in Ch 8,3.3.4.

2.26.4 The effects of sheave friction are to be taken into consideration by usually applying 2 per cent for ball or roller bearing sheave and 5 per cent for plain or bushed bearing sheaves. Lower friction values will be specially considered. For the calculation of reeving systems taking into account the effects of sheave friction, *see* Ch 2,2.4.

■ *Section 3* **Offshore cranes**

3.1 General

3.1.1 This Section applies to cranes which are designed to operate in offshore conditions. These are defined as open sea environment in which there is significant movement of the ship or installation (due to wave action) on which the crane is mounted or from which the crane is offloading. The sea state will, generally, be in excess of a significant wave height of 0,6 m.

3.1.2 Cranes mounted on fixed installations used solely for lifting operations on the installation itself may be considered as shipboard cranes as defined in Section 2. Where cranes are mounted on floating installations, horizontal and vertical accelerations, *see* 3.4.4, are to be applied in addition to the requirements of Section 2.

3.1.3 The requirements of Section 2 are to apply to offshore crane design except where specific requirements are defined in this Section.

3.1.4 The scope of this Section covers jib cranes and fixed structures used for lifting operations. Other lifting appliances will be specially considered on the general basis of these requirements if considered applicable and appropriate.

3.2 Service category and duty factor

3.2.1 The specified service category as per Ch 1,2.3.2 is to be applied. Due to the severe nature of the offshore environment the duty factor F_d is defined as 1,20 for all offshore cranes and other lifting equipment being used in open sea/offshore conditions. Alternative proposals to use lower duty factors shall be based on the principles as outlined in 2.3.2 to 2.3.4 and will be specially considered.

3.3 Dynamic forces

3.3.1 The dynamic force due to hoisting for offshore cranes is to include the effect of relative movement of the crane and load in addition to normal hoisting shock and dynamic effects.

3.3.2 The hoisting factor is considered to be dependent on the design operational sea conditions and which is to be defined by the significant wave height and is to be calculated from the following expression:

$$F_h = 1 + \frac{v_R}{g}\sqrt{\frac{K}{L_l}}$$

where

K = the crane system stiffness, in N/m

L_l = live load, in kg

v_R = $v_{HS} + \sqrt{v_D^2 + v_C^2}$ = relative velocity, in m/s

g = 9.81 m/s²

where

v_D = vertical velocity of load supporting deck (e.g., semi-submersible, vessel, fixed platform, etc.) from which the load is to be lifted

v_C vertical boom tip velocity at the jib head where the hoisting ropes leave the jib

v_H = minimum hoisting speed (defined in 3.6)

v_S = hoisting speed

v_{Hs} = v_H in the cases where $0{,}5v_S < v_H$

v_{Hs} = $0{,}5v_S$ in the cases where $0{,}5v_S \geq v_H$

The load supporting deck velocity v_D and crane jib tip velocity v_C are to be taken from a recognised National or International Standard (e.g., EN 13852) in the absence of project-specific data. The proposed velocities are to be agreed with LR.

The hoisting factor shall not be taken less than that defined in 2.5.2, but in no case shall the product of hoisting and duty factor be less than 1,30 for offshore cranes carrying out offboard lifts.

3.3.3 To calculate the crane system stiffness the following combination of structural elements are to be considered:

(a) hoist rope system;
(b) luffing rope system;
(c) pedestal;
(d) crane house;
(e) crane jib.

Other items maybe considered additionally only in the case where they are permanently installed on the crane. The stiffness of the wire rope is to be taken into account as per rope manufacturer's recommendations using the Young's modulus and the associated area of the wire rope.

3.3.4 When a motion compensator, shock absorber, or similar device is fitted, proposals to use lesser hoist factors will be specially considered. Means are to be foreseen which provide the crane driver with the operational status of the fitted device.

3.3.5 As an alternative to the method of determining the dynamic forces indicated in 3.3.1 to 3.3.4, consideration will be given to submissions based on a dynamic analysis of the crane and associated structure (e.g., by means of a motion response analysis).

3.4 Offlead/sidelead displacement, heel/trim angles and base accelerations

3.4.1 The design offlead and sidelead displacements are related to the significant wave height and are defined as follows:

(a) Offlead displacement, in metres:

$O = 2,5 + 1,5H_{1/3}$

where

$H_{1/3}$ = significant wave height, in metres

(b) Sidelead displacement, in metres:

$S = 0,5O$

The offlead displacement is defined as being in the jib luffing plane while the sidelead displacement is defined as transverse to the jib luffing plane. The offlead and sidelead displacements provided are to be considered at the load supporting deck location (e.g., offshore supply vessel load supporting deck). Proposals to use other values will be specially considered.

3.4.2 In addition to the operating conditions the crane and its stowage arrangements are to be designed to withstand the most severe combination of motions which can occur when the crane is stowed. In the case of ship mounted cranes, *see* Section 2.

3.4.3 The inclination of the crane base usually referred to as heel and trim angles shall be taken from a recognised National or International Standard (e.g., EN 13852) in the absence of project-specific data. The heel and trim angles are to be agreed with LR and consideration will be given to arrangements and methods to reduce the heel and trim angle (e.g., vessel ballasting, etc.).

3.4.4 The horizontal and vertical accelerations (which need to include dynamic roll and pitch) of the crane base shall be taken from a recognised National or International Standard (e.g., EN 13852) in the absence of project-specific data and are to be applied in the most unfavourable direction. The proposed horizontal and vertical accelerations are to be agreed with LR.

3.5 Load combinations

3.5.1 The basic loadcases are to be considered as per 2.15.1. Deviations from those loadcase definitions are provided in 3.5.2 and 3.5.3.

3.5.2 **Case 1**. For the condition of the crane operating without wind the design is to be considered with respect to a combination of dead load, live load and horizontal forces defined in 2.6 to 2.11, as given by the following expression:

$$F_d\,[L_g + F_h\,(L_l + L_{h1}) + L_{h2} + L_1]$$

where

F_d = duty factor
L_g = dead load
F_h = hoisting factor
L_l = live load
L_{h1} = the horizontal component of live load due to offlead, sidelead, heel and trim
L_{h2} = the horizontal component of dead load due to heel and trim
L_1 = the next most unfavourable load (e.g., due to slewing acceleration as defined in 2.15.2).

3.5.3 **Case 2**. For the condition of the crane operating with wind the design is to be considered with respect to a combination of dead load, live load and horizontal forces defined in 2.6 to 2.11, together with the most unfavourable wind load. This is given by the following expression:

$$F_d\,[L_g + F_h\,(L_l + L_{h1}) + L_{h2} + L_1 + L_2] + L_w$$

where

L_w = the most unfavourable wind load
L_2 = the next most unfavourable load (e.g., due to horizontal and vertical crane base acceleration).

3.5.4 The effects of offlead and sidelead are to be combined with the crane supporting deck inclinations (e.g., heel/trim) for the life load as defined by the following symbolic expressions:

α_{total} = $[O + \text{heel}]$ or $[O + \text{trim}]$

β_{total} = $[S + \text{trim}]$ or $[S + \text{heel}]$

For the dead load only the crane supporting deck inclination (e.g., heel/trim) is to be considered.

3.6 Hoisting speed

3.6.1 When a load is lifted from a ship, the load hoist speed is to be high enough to ensure that after the load is lifted a second wave does not cause the ship to re-contact the load.

3.6.2 The minimum hoisting speed is to be obtained from the following expression:

$$v_H = H\sqrt{v_D^2 + v_C^2}$$

where

v_H = the minimum hoist speed to avoid re-contact
H = factor to be taken from a recognised National or International Standard (e.g., EN 13852). The proposed factor is to be agreed with LR.

3.6.3 Special consideration will be given to heavy lift cranes as the minimum hoisting speeds defined in 3.6.2 might not be achievable.

3.7 Slew rings

3.7.1 In general, the ring is to be manufactured from a steel forging having an ultimate tensile strength of range 820 to 1100 N/mm^2 and an elongation, based on a gauge length of five diameters, of not less than 15 per cent.

3.7.2 For offshore installations with design temperatures down to –20°C, slew bearings require Charpy V-notch impact tests to be carried out at –20°C and achieve a minimum average energy of 42J. Special consideration will be applied to for design temperatures below –20°C.

3.7.3 Type testing, whereby a sample of the critical part of the ring is tested statically and with respect to fatigue to prove the adequacy of other rings manufactured to the same specification, standard and methods, is to be carried out for three roller type bearings and other designs where provision of fillet radii of the bearing surfaces are considered to introduce stress concentrations in a failure path which would result in the loss of the crane.

3.7.4 The ring is to be considered with respect to static loads resulting from the worst load combination of 2.15.1 and associated with an allowable stress obtained from test in accordance with 3.7.3 multiplied by a stress factor = 0,4.

3.7.5 The ring is also to be considered with respect to fatigue loading based on load combination Case 2 of 2.15.1, multiplied by a load spectrum factor of 0,7 and associated with an allowable stress determined from S-N curves obtained from the type testing of 3.7.3 on the basis of 2 x 10^6 cycles and multiplied by a stress factor = 0,67.

3.7.6 Slewing ring bolts are to comply with ISO 898-1 and in general, are not to exceed Grade 10.9. Threads of all bolt grades should be rolled after heat treatment to improve fatigue strength.

3.7.7 The bolts are to be pre-tensioned in accordance with 2.24.4 and are to be considered with respect to the static and fatigue design conditions of 3.7.4 and 3.7.5 taking due account of pre-tension.

3.7.8 Slew rings are to be manufactured at works approved by LR under LR survey with the following additional requirements:

(a) Slew ring material in the forged state and final bulk heat treated condition is to be tested to ensure compliance with the requirements of 2.25.3 and 2.25.5 and 3.7.2.
(b) Magnetic particle examination of the machine finished components of the ring to ensure that they are free from cracks, etc.

3.8 Materials

3.8.1 The requirements for selection of materials and associated impact toughness requirements are given in 2.25.

3.8.2 For minimum design temperatures below –40°C, methods of demonstrating acceptable toughness will be specially considered.

3.9 Rope safety factors

3.9.1 The rope safety factor *SF* for offshore cranes is to be determined from the following expression:

$$SF_{swh} = SF \frac{F_{h,swh}}{1,6}$$

where

SF_{swh} = safety factor required at significant wave height (swh), but is to be taken as not less than that obtained from 2.26

SF = safety factor obtained from 2.26

$F_{h,swh}$ = hoisting factor derived in accordance with 3.3.

The factor $\frac{F_{h,swh}}{1,6}$ is not to be taken less than 1,0.

3.9.2 The required breaking load of the rope is given by:

$$BL = SF_{swh} L_r$$

where

BL = required breaking load of the rope

L_r = actual load in the rope derived in accordance with 2.26.

NOTE

In the case of luffing ropes, the ratio $\frac{F_{h,swh}}{1,6}$ need only be applied to the live load component of the total rope tension.

3.10 Motion compensators

3.10.1 Where it is proposed to install a motion compensator or shock absorber device to reduce the impact load applied to the crane with a view to improving its rating, this will be specially considered and, in general, subject to the following procedure:

(a) Plans, calculations and proposed test procedures are to be submitted for approval.
(b) Units are to be manufactured and tested under survey.
(c) Testing to include 'in factory' tests under simulated design offshore conditions together with normal proof test requirements.
(d) For initial approval of new devices, the crane installation is to be instrumented to enable maximum load in hoist system to be monitored for various sea conditions and SWL and the result submitted for consideration.

3.11 Overload protection systems

3.11.1 Automatic Overload Protection Systems (AOPS) and Manual Overload Protection Systems (MOPS) in accordance with a recognised National or International Standard (e.g., EN 13852-1) shall be fitted. Alternative systems, methods or concepts to prevent overload of the crane will be specially considered. Proposals for heavy lift cranes, *see* 1.2.1(j), will also be specially considered.

■ *Section 4* Submersible handling systems

4.1 General

4.1.1 This Section applies to installations which are designed to launch and recover manned and unmanned submersibles in an open sea environment from ships or semi-submersible vessels. Generally, the sea state will not exceed Sea State 4 for man-submersible handling operations, but may be higher for unmanned operations. Special consideration will be given to cases where service in a more severe sea state is envisaged for manned diving operations.

4.1.2 The design requirements of Section 2 are to apply to all submersible handling systems except where specific requirements are defined in this Section.

4.1.3 A secondary means of recovery is to be provided for all manned diving systems that are dependent on the handling system for regaining the surface.

4.1.4 In addition to approving the structural arrangements for manned diving handling systems, details of the winches (main and secondary), including all torque transmitting components, are to be approved for the intended purpose or are to be submitted for approval.

4.2 Service category and duty factor

4.2.1 A duty factor, F_d, of 1,2 is to be used for all submersible handling systems, while the submersible is suspended over the side of the ship or in the moonpool. A reduced duty factor may be considered once the submersible is safely inboard the ship.

4.3 Basic loads

4.3.1 The live load, L_l, to be used for submersible handling systems is to be taken as the greater of:

(a) The maximum in-air weight of the submersible and exposed length of hoisting rope.

(b) The maximum weight of the exposed length of hoisting rope, together with the combined in-water weight of the submersible and submerged length of rope.

4.3.2 Where the handling system does not lift the submersible through the air/water interface, the live load may be taken as that defined in 4.3.1(b).

4.4 Dynamic forces

4.4.1 The hoisting factor, F_h, to be used for submersible handling systems incorporates the effects of the submersible passing through the water/air interface as well as accelerations from ship motions.

4.4.2 Where possible, the hoist factor is to be based on actual accelerations or from model predictions for the mother ship's behaviour, taking into account the ship's headings and the sea conditions.

4.4.3 Where actual accelerations or model predictions are not available, the minimum default values of hoist factor, F_h, for different sea conditions and with the submersible in various positions in the operating cycle are given in Table 4.4.1. Values of F_h for intermediate wave heights can be obtained by interpolation.

4.5 Offlead and sidelead angles

4.5.1 Submersible handling equipment operates in an open-sea environment where there is significant movement of the ship and/or submersible due to wave action. To allow for these conditions, an offlead and sidelead angle, assumed to be acting simultaneously, is to be used for design purposes, while the submersible is in the water, passing through the air/water interface, or splash zone. Values for the offlead and sidelead angles to be used for different sea conditions are found in Table 4.4.1.

4.6 Heel and trim angles

4.6.1 When the submersible is out of the splash zone the offlead and sidelead angles will not be acting. However, horizontal loads from the effects of the roll and pitch of the mother ship will still need to be considered to be acting on the submersible and self-weight of the handling system. These may be expressed as static angles of heel and trim and typical values for different sea states are given in Table 4.4.1. The horizontal components of force derived from the angles of heel and trim are to be multiplied by the hoist factor appropriate for the phase in the launch and recovery cycle.

4.7 Stowage arrangements

4.7.1 In addition to the operating conditions, the installation is to be designed to withstand the most severe combination of motions which can occur when the handling system is stowed. In the case of ship mounted installations, *see* 2.11.

4.7.2 The effects of 'green sea loading' on the structure will be subject to special consideration if required.

4.8 Materials

4.8.1 Materials are to comply with the requirements of 2.25.

4.9 Rope safety factors

4.9.1 The minimum safety factor for ropes used for manned submersibles is to be taken as 8,0 for steel wire ropes and 10,0 for man-made fibre ropes. Where manned diving operations take place in conditions in excess of Sea State 4, where the hoist factor, F_h, is greater than 1,7, the rope safety factor is to be increased as follows:

$$SF_{SWR} = 8{,}0 \times \frac{F_h}{1{,}7} \text{ for steel wire ropes, or}$$

$$SF_{synthetic} = 10 \times \frac{F_h}{1{,}7} \text{ for synthetic fibre ropes.}$$

4.9.2 The safety factor for wire ropes used for unmanned submersibles is to be obtained from 3.9 but is to be taken as not less than 6,0.

Table 4.4.1 Dynamic factors and design parameters for submersible handling

Position in launch/recovery cycle		Sea state 4 Significant wave height 2,0 m				Sea state 5–6 Significant wave height 3,9 m				Sea state 6 Significant wave height 5,0 m				Sea state 7 Significant wave height 7,0 m			
	F_d	F_h	Heel	Trim	Offlead/ Sidelead	F_h	Heel	Trim	Offlead/ Sidelead	F_h	Heel	Trim	Offlead/ Sidelead	F_h	Heel	Trim	Offlead/ Sidelead
	[1]	[1]	[°]	[°]	[°]	[1]	[°]	[°]	[°]	[1]	[°]	[°]	[°]	[1]	[°]	[°]	[°]
Submerged – near surface	1,2	1,7	6 *see* Note 1	3 *see* Note 1	10/10 *see* Note 2	2,25	8 *see* Note 1	4 *see* Note 1	10/10 *see* Note 2	2,5	10 *see* Note 1	5 *see* Note 1	10/10 *see* Note 2	2,72	12 *see* Note 1	6 *see* Note 1	12/12 *see* Note 2
Air/water interface	1,2	1,7	6 *see* Note 1	3 *see* Note 1	10/10 *see* Note 2	2,25	8 *see* Note 1	4 *see* Note 1	10/10 *see* Note 2	2,5	10 *see* Note 1	5 *see* Note 1	10/10 *see* Note 2	2,72	12 *see* Note 1	6 *see* Note 1	12/12 *see* Note 2
Outboard on rope – unlatched	1,2	1,6	6 *see* Note 3	3 *see* Note 3	—	2,1	8 *see* Note 3	4 *see* Note 3	—	2,3	10 *see* Note 3	5 *see* Note 3	—	2,5	12 *see* Note 3	6 *see* Note 3	—
Outboard latched	1,2	1,4	6 *see* Note 3	3 *see* Note 3	—	1,7	8 *see* Note 3	4 *see* Note 3	—	1,85	10 *see* Note 3	5 *see* Note 3	—	2,0	12 *see* Note 3	6 *see* Note 3	—
Inboard latched	1,05	1,3	6 *see* Note 3	3 *see* Note 3	—	1,5	8 *see* Note 3	4 *see* Note 3	—	1,6	10 *see* Note 3	5 *see* Note 3	—	1,7	12 *see* Note 3	6 *see* Note 3	—
Deck lifts unlatched	1,05	1,3	6 *see* Note 3	3 *see* Note 3	—	1,5	8 *see* Note 3	4 *see* Note 3	—	1,6	10 *see* Note 3	5 *see* Note 3	—	1,7	12 *see* Note 3	6 *see* Note 3	—

NOTES
1. Heel and trim to be applied to self-weight components only.
2. Offlead and sidelead angles to be applied to the suspended load.
3. Heel and trim to be applied to both suspended load and self-weight components.

Intermediate values by interpolation.

4.9.3 The safety factor for man-made fibre ropes used for unmanned submersibles is to be obtained from 4.9.2, multiplied by 1,25.

4.9.4 If in addition to the primary hoist rope, a secondary system of recovery is employed using another hoist rope, the minimum safety factor for this is to be not less than 5,0.

4.10 Transfer systems

4.10.1 Cradles and their rails that are used to transfer diving bells or submersibles from the deck to the transfer-under-pressure facilities are to be designed in accordance with Section 2, taking due account of the accelerations from ship motions, in both the operational and survival conditions.

4.11 Testing

4.11.1 The load testing requirements for manned diving handling systems are given in Ch 12,1.7.

4.11.2 The load testing requirements for unmanned submersible handling systems are given in Ch 12,1.6.

■ *Section 5* Pedestals and foundation

5.1 General

5.1.1 Crane pedestals for ship-mounted cranes are a classification item. Pedestals on offshore installations will be considered on the same basis as the main support structure.

5.1.2 The loading conditions as defined in Sections 2, 3 and 4 are to be applied in association with the allowable stress levels contained in this Section.

5.1.3 Pedestals, in general, are to be carried through the deck and satisfactorily scarphed into the hull or main support structure. Proposals for other support arrangements will be specially considered. For pedestals not carried through the decks, it is recommended that suitable gussets be provided between the pedestal and the deck to distribute loads to the deck structure.

5.1.4 The pedestal flange in way of the slew ring bearing is to be designed and be of a thickness to provide a rigid and level support for the bearing and bolting. Tolerances and arrangements proposed by the slew ring bearing manufacturer are to be adhered to.

5.1.5 Where it is considered necessary to introduce stiffening brackets to support the flange the spacing of the brackets is to be not greater than that achieved by positioning them between every second bolt.

5.1.6 This Section covers pedestal structure which is not part of the hull or main support structure of the pedestal. The hull or main support structure is to be designed as per LR's *Rules and Regulations for the Classification of Ships*.

5.2 Design loads

5.2.1 The pedestal is to be designed with respect to the worst possible combination of loads as detailed in the applicable parts of Sections 2, 3 and 4.

5.2.2 Stowage arrangements are to be taken into account when calculating the loads applied to the pedestal.

5.3 Allowable stresses

5.3.1 The allowable stress is to be taken as the failure stress of the component concerned multiplied by stress factor, F_p, which depends on the load case concerned. The allowable stress is given by the general expression:

$\sigma_a = F_p \sigma$

where

σ_a = allowable stress
F_p = stress factor
σ = failure stress as defined in Table 4.2.7.

5.3.2 The stress factors F_p for steel with $\frac{\sigma_y}{\sigma_u} \leq 0{,}85$ are given in Table 4.5.1.

where

σ_y = yield stress of material
σ_u = ultimate tensile failure stress of the material.

5.3.3 For steel where $\frac{\sigma_y}{\sigma_u} > 0{,}85$ the allowable stress is to be derived from the following expression:

$\sigma_a = 0{,}459 F_p (\sigma_y + \sigma_u)$
$\tau_a = 0{,}266 F_p (\sigma_y + \sigma_u)$

The stress factor F_p is defined in Table 4.5.1.

Table 4.5.1 Stress factor, F_p

Load case 1	Load case 2	Load case 3 and 4
F_p = 0,5	F_p = 0,57	F_p = 0,64

5.3.4 As an alternative to the stress factors F_p as defined in Table 4.5.1 the stress factors as defined in Table 4.5.2 can be applied, provided all of the following conditions are fulfilled:
(a) A fatigue analysis has been satisfactorily been carried out;
(b) Overload protection systems are installed;
(c) Means are provided to protect the driver's cabin.
The graphical representation of Table 4.5.2 has been provided in Fig. 4.5.1.

Table 4.5.2 Alternative stress factor, F_p

	Load case 1	Load case 2	Load cases 3 and 4
SWL ≤ 40 t	$F_p = 0{,}5$	$F_p = 0{,}57$	$F_p = 0{,}64$
40 t < SWL < 160 t	$F_p = \frac{SWL}{706} + 0{,}444$	$F_p = \frac{SWL}{667} + 0{,}510$	$F_p = \frac{SWL}{571} + 0{,}570$
SWL ≥ 160 t	$F_p = 0{,}67$	$F_p = 0{,}75$	$F_p = 0{,}85$

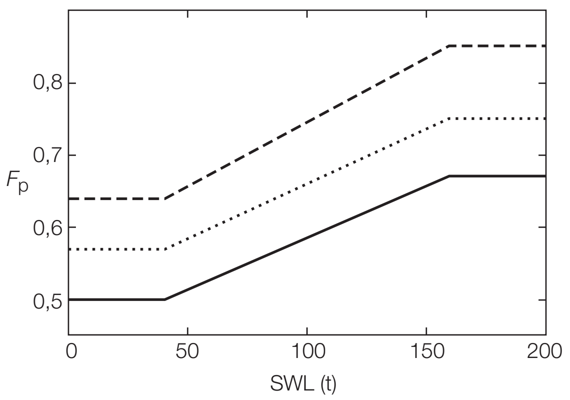


Fig 4.5.1 Stress factor, F_p

5.3.5 The allowable stresses for welds are to be as per Section 2.

5.3.6 Steels with $\frac{\sigma_y}{\sigma_u} > 0{,}94$ are not generally acceptable and will need to be specially considered.

5.3.7 The increase of the allowable stresses due to use of the finite element method is to be as per the principles of 2.17.5.

5.4 Materials

5.4.1 Crane pedestals are to be constructed of steels which conform to LR's *Rules for the Manufacture, Testing and Certification of Materials* and the *Rules and Regulations for the Classification of Mobile Offshore Units*, as appropriate.

5.4.2 The grade of steel for pedestals of ship-mounted cranes is to be selected in accordance with LR steel grades equivalent to Tables 4.2.18, 4.2.19 and Table 4.2.20 (as applicable) with the operating temperature chosen as being the lesser of either that from an assigned winterisation notation, or the defined minimum design temperature for the crane in operation.

5.4.3 The grade of steel for pedestals on offshore installations or manned submersible handling installations is to comply with the requirements of 3.8.

5.5 Pedestal flange

5.5.1 The bending stress in a pedestal flange (attached to a cylindrical pedestal) may be calculated as follows:

$$\sigma_f = \frac{5\sigma_{total}\, t_p\, e}{t_f^2} \le \sigma_a$$

where

σ_f = bending stress in flange
σ_{total} = total direct (i.e., bending and tension/compression) stress in pedestal wall below the flange
t_f = flange wall thickness (recommendation: $t_f \ge 3t_p$)
t_p = pedestal wall thickness below the flange
e = distance between bolt holes and centre of pedestal wall

The allowable stress is to be taken as in 5.3.

The above formula is intended for initial design calculations of the pedestal flange. In case other effects, e.g., horizontal loading, pre-tension in bolts, size and amount of holes in the flange, reinforcements, plate bending of the pedestal wall t_p, etc., are considered to have a significant influence on the pedestal flange design those effects need to be taken into consideration.

Alternative proposals for the calculation of pedestal flanges will be specially considered.

5.5.2 It is recommended that pedestal flanges be made of forged material. Where rolled plates are applied for pedestal flanges in place of forged material, recognised National or International Standards are to be used to assess the requirement for Z-grade material with the results of the assessment included in the design submission.

■ *Section 6* Handling of personnel

6.1 Introduction

6.1.1 Ships' deck cranes and offshore platform cranes, used for the occasional transfer of personnel between ship-to-ship or rig-to-ship, or for maintenance work, are to be certified as being suitable for personnel handling (often called man-riding) and the following minimum requirements are to apply. Other applications will be specially considered.

6.1.2 The handling of life saving appliances is not covered by these requirements.

6.1.3 It should be noted that these are the minimum requirements to certify this equipment for personnel handling operations. However, some National Administrations and offshore jurisdictions may have additional requirements with which this equipment will need to comply.

6.1.4 Reference is made to the requirements of Ch 9,4 regarding the machinery aspects of handling of personnel applications.

6.2 General requirements

6.2.1 The certification of personnel handling is based on the assumption that instructions for use are in place that cover all operational and emergency procedures including any conditions, precautions and limitations for the personnel handling.

6.2.2 The crane operator is to have a continuous direct means of communication with the personnel to be lifted or via a person who has direct visual contact with the personnel being lifted.

6.2.3 Personnel handling operations are to only be performed using baskets or carriers specially designed and certified for this purpose.

6.2.4 Personnel handling operations will normally be restricted to:
(a) Sea conditions where the significant wave height does not exceed 2 m;
(b) Conditions where the wind speed does not exceed 10 m/s;
(c) Visibility condition: daylight or equivalent.

6.2.5 The personnel handling SWL is not to exceed 50 per cent of the SWL for lifting of loads (e.g., cargo) at the actual outreach and (if applicable) also at the actual significant wave height. Personnel handling is not permitted in combination with lifting of load (e.g., cargo) operations.

6.3 Design requirements

6.3.1 The crane operator's control panel is to be equipped with a dedicated manual switch for the purpose of engaging personnel handling operations, including a continuous warning light indicating that the personnel handling mode is activated. Automatic or manual overload protection systems, if installed, are to be automatically switched off when the personnel handling is activated. For retrofits, alternative proposals will be specially considered.

6.3.2 The required minimum wire rope safety factor in connection with the personnel handling SWL is to be 10:1 for the hoisting and (where fitted) luffing system. Where a safety factor of 10:1 cannot be achieved on the luffing system, as may be the case for heavy lift cranes, a lower safety factor may be specially considered. The safety factor of 10:1 is related to the minimum breaking load of the wire rope.

6.3.3 The crane's hoisting and (where fitted) luffing winches are to be approved for personnel handling. Alternatively, details of the winches are required to be submitted for approval.

6.3.4 The crane's hoisting and (where fitted) luffing winches intended to be used for personnel handling operations are to be fitted with primary automatic type brakes. These are to be of the interlocking type, where a failure of the power source will cause the brake to be applied.

6.3.5 The hoisting and (where fitted) luffing winches are to be equipped with mechanically and operationally independent additional braking systems. The control system for these additional brakes is to be independent of the primary working brake. Both primary and secondary brakes are to be automatically activated in case of the emergency stop being activated or in the event of a power failure.

6.3.6 The additional brake system is to operate directly on the winch drum. Other proposals (e.g., a fully independent load path) will be specially considered.

6.3.7 The winch brakes are to be fitted with a manual override and means are to be provided to enable the recovery (hoisting or lowering) of the lifted personnel to safety from any position in the event of a power failure.

6.3.8 A minimum number of three wraps of steel wire rope are required to remain on the winch drum at all times.

6.3.9 Where hydraulic cylinders are used for luffing, folding or telescoping, they are to be fitted with non-return valves at both inlet and outlet manifolds to ensure that the cylinders remain in position in the event of a hydraulic failure. The required non-return valves are to be fitted directly to the cylinder ports.

6.3.10 Securable safety latches are to be fitted to the hooks.

6.4 Additional testing and survey requirements

6.4.1 Each of the two independent brakes is to be statically tested to at least 1,5 times the rated load for personnel handling and dynamically tested to at least 1,1 times the rated load for personnel handling.

6.4.2 A six-monthly thorough examination is required on all cranes and equipment used for personnel handling operations.

6.4.3 Before any personnel handling operation commences, an inspection of the crane and gear is required prior to use.

Contents

■ *Section 1* General

1.1 Application of these Rules

1.1.1 The requirements of this Chapter are applicable to shiplift platform and transfer systems, also called mechanical lift docks, as defined in 1.2.

1.1.2 The requirements are based on the understanding that:

(a) The shiplift will, at all times, be properly loaded in accordance with the designer's instructions and the loading conditions approved by Lloyd's Register (LR). Concentrations of loading greater than that indicated by the specified maximum distributed load, or for any loading situations or weather conditions which may result in the rated capacity of individual hoists being exceeded are not allowed for.

(b) Where the installation is to be certified but not classed, the design criteria specified assume that Periodical Survey procedures, at least equivalent to LR's, will be adhered to by the Owner. This is of particular importance with respect to ropes and chains used to raise the platform.

(c) The shiplift will at all times be properly operated by trained and authorised personnel.

(d) The shiplift will be maintained by qualified and authorised personnel.

(e) Compliance with the requirements does not relieve the designers and/or Builders/contractors of their contractual responsibilities to the client with regard to the specification and the overall design and in-service performance of the shiplift.

1.2 Scope of the Rules

1.2.1 The requirements of this Chapter are applicable to shiplift and transfer system installations in which vessels are raised and lowered by means of winches or jacks when docked on an articulated or rigid platform structure.

1.2.2 The vessel may be docked on a system of blocks, cradles or an air/hydraulic cushion arrangement for subsequent transfer.

1.2.3 Docking systems which incorporate a combination of both mechanical lift dock and floating dock principles will be specially considered on the basis of these requirements and LR's *Rules and Regulations for the Construction and Classification of Floating Docks*.

1.2.4 When specifically requested, end and side transfer arrangements will be examined and included in the class notation or certification issued. However, where the design concept of the platform involves an interaction or inter-dependence between the platform and transfer system, as in the case of a rigid platform with flexible ship support system, the transfer system will be considered as an essential and integral aspect of class or certification.

1.2.5 All civil engineering interface works, including hoist foundations, piling and associated sea-bed conditions, shore transfer pits and dockside structures, are excluded from LR's involvement.

1.2.6 These requirements do not apply to hoisting platforms used on vessels or to mechanical elevators used to lift people.

1.3 Classification procedure

1.3.1 Classification covers the design, construction, testing and subsequent Periodical Surveys of Shiplift and Transfer Systems to the extent indicated within these requirements and is achieved by way of the intervention of LR Surveyors at the appropriate stages of design, construction, installation, commissioning, and periodical examinations during service. The following procedure is to be adopted where LR classification is required:

(a) Approval of plans covering structural, electrical, mechanical, hydraulic and control engineering aspects of the installation.

(b) The material for primary structural steel adopted for a classed installation is required to comply with 3.1 of these requirements.

(c) Fabrication under Survey of steelwork, hoists and hydraulic cylinders at the place of manufacture, including verifying that approved materials and suitably qualified welders using approved weld procedures are employed in the fabrication.

(d) Survey at the factory to include the control panel (or MCC) and load pin for the load monitoring system.

(e) Certification on the appropriate forms of wire ropes and chains which are to be manufactured at a works approved by LR.

(f) Survey of the platform structure, hoists, electrical, control and hydraulic systems during installation and on-site assembly.

(g) Proof load and initial operational testing of the facility, as specified in 7.2 and 7.6.

(h) Periodical Surveys and tests, as specified in 8.7.

1.4 Certification procedure

1.4.1 Where certification, which is distinct from classification, of the shiplift and transfer system is requested, the procedures to be adopted are the same as those for classification outlined in 1.3, with the following exceptions:

(a) The material for primary structural steel adopted for certified installations is required to comply with 3.2 of these requirements.
(b) A class notation will not be assigned to certified shiplifts and transfer systems.
(c) Periodical Surveys after commissioning of the shiplift and transfer system need not be carried out by LR. However, the Owner's/designer's attention is drawn to 1.1.2(b) with respect to the need for ongoing Surveys.

1.5 Interpretation of the Rules

1.5.1 The interpretation of the Rules is the sole responsibility, and at the sole discretion, of LR. Any uncertainty in the meaning of the Rules is to be referred to LR for clarification.

1.6 Responsibilities of the Owner/Operator, Builder and designer

1.6.1 It is the responsibility and the duty of the Builder or main contractor to enable the Surveyors to satisfy themselves that the materials, workmanship and arrangements comply with the classification requirements, by arrangement for the Surveyors to be present at appropriate stages during the work and for presenting the items to be surveyed in such a way that the Surveyors are readily able to establish that all component/ sub-component items have been manufactured, assembled and tested in accordance with the appropriate requirements.

1.6.2 Surveys undertaken by LR, when providing services, are on the basis of periodical visits involving both monitoring and direct survey. It should be noted that LR's Surveyors will not, generally, be in continual attendance. Since construction and installation are continuous processes, the Builder has the overall responsibility to ensure and document that the construction meets LR's requirements, is in accordance with the approved drawings, and that any amendments agreed with LR's Surveyors have been complied with.

1.6.3 It is the responsibility of the Owners, Operators, designers, building contractors and any repairers to acquaint themselves fully with the scope of these requirements and associated obligations, and satisfy themselves that these requirements are sufficient for their purposes.

1.6.4 The attention of the Owner, Operators, Builders and designers is drawn to statutory requirements which may be imposed by the relevant National Authorities that may not be within the scope of classification or certification. If there is any conflict between local statutory requirements and those of LR then the local requirements will take priority without necessarily affecting LR classification/certification, provided the structural strength and safety aspects are not compromised.

■ *Section 2* Lifting capacity

2.1 Designated capacities

2.1.1 For the purposes of classification or certification, each shiplift and transfer system facility will be designated a lifting capacity on the following basis:

(a) Maximum distributed load (MDL):
  (i) This is the maximum load, in tonnes/metre, without any wind loading, which can be uniformly distributed along the centreline of the platform, or where docking is only via transfer cradles which are evenly distributed along the inner longitudinal transfer rails over the maximum docking length of the platform or which has been used in establishing the scantlings of the platform and capacity of the hoist units. It is to be taken as:
  (Capacity of one pair of hoists minus deadweight of the length of pontoon associated with these hoists) divided by the hoist spacing.
  (ii) For transfer systems that incorporate trestles and independent bogies, special attention is to be given to the local platform structure supporting any load concentrations from the trestle legs.
  (iii) The maximum distributed load (MDL) on the platform includes the weight of cradles, trestles or blocks used for supporting the ship.
  (iv) In addition, the MDL may also be expressed as being exclusive of the transfer system and this would relate directly to the weight distribution of the ships being docked.
(b) Maximum lifting capacity (MLC):
  (i) This is the maximum theoretical load, in tonnes, without wind loading, which can be lifted on the platform. It is to be taken as:
  MDL x maximum effective docking length.
  This capacity takes no account of dynamic loading or uncertainties in the weight distribution of the ship being docked and consequently this will not be used for operational purposes. Where specially requested, this value may be included in the certification issued for information purposes only.
(c) Nominal lifting capacity (NLC)
  (i) This is the maximum displacement, in tonnes, of a ship of normal form which can be lifted without exceeding the maximum distributed load for which the platform is designed, and is to be taken as:
  NLC = MDL x maximum effective docking length x a distribution factor.
  (ii) The NLC is calculated to provide Operators with a guide of the load to which the platform may be subjected from a ship of normal form, so that the MDL is not exceeded at any point on the platform during docking or transfer operations. This may be used, for example, when the weight distribution of the ship being docked is not accurately known.
  (iii) Normal form is taken to differentiate between conventional mono-hull ships, which would usually dock along the keel block centreline of the platform, and other ship forms such as catamarans, trimarans, swaths, semi-subs, ships with moonpools, etc., which would require specific blocking arrangements.

2.2 Distribution factor

2.2.1 The distribution factor is to ensure that the maximum distributed load is not exceeded anywhere along the effective length of the platform and to allow for dynamic factors. The following values are generally to be adopted:

(a) Platforms of articulated design (that have no longitudinal stiffness or bending rigidity) and incorporating conventional block, cradle or trestle arrangements :0,67.

(b) Platforms of articulated design incorporating flexible (fluid bed) cradles, or platforms of rigid design (a rigid design is one where moments are carried through the platform structure) incorporating flexible or rigid cradles: 0,83. Distribution factors in excess of 0,83, requested by the designer, will be specially considered.

2.2.2 Special consideration may be given to platforms with a fluid bed transfer system which is used to redistribute local peak ship loadings in excess of the MDL. Calculations in support of these requests must be submitted for consideration by LR.

2.3 Effective docking length

2.3.1 For ships with direct blocking, the maximum effective docking length on the platform is taken as the total length between hoists plus the length of end cantilevers. Each of these cantilevers is to be taken as not greater than 0,4 times the hoist spacing.

2.3.2 Special consideration will be given to cantilever overhangs that are greater than 0,4 x hoist spacing, where they are supported by the dockside during transfer operations.

2.3.3 For shiplifts where vessels dock directly on to transfer cradles, the docking length is typically less than the effective docking length where ships dock directly on the platform centreline. The effective docking length when docking directly on to the transfer system (cradles or trestles) occurs may be determined by:

- the number of cradles x cradle spacing; or
- the number of trestles x trestle spacing.

2.4 Documented capacities

2.4.1 The MDL and the NLC will appear on the certification issued. Where requested, the MLC will also be included in the certification for information purposes only.

2.4.2 The lifting capacities will be specially considered in cases where:

(a) The block or cradle arrangement is such that the loads are not applied along the centreline of the platform, i.e., asymmetric loading.

(b) The design incorporates different maximum distributed loads along the length of the platform.

Section 3
Materials of construction

3.1 Materials for classed installations

3.1.1 The materials used in the construction of classed shiplifts and transfer systems are to be manufactured and tested in accordance with the requirements of LR's *Rules for the Manufacture, Testing and Certification of Materials* (hereinafter referred to as the Rules for Materials). Materials for which provision is not made therein may be accepted, provided that they comply with a recognised National Standard and give reasonable equivalence to the appropriate LR grade. Chemical and mechanical tests may be considered necessary to verify equivalence to LR's Rules.

3.1.2 Structural steel in the primary load path, including pins and wheels, are to be supplied with 3.2 certification, in accordance with EN 10204 or equivalent.

3.1.3 Steel for the primary strength members is to comply with Table 5.3.1.

Table 5.3.1 Steel grades

Minimum design temperature	Thickness, in mm	Steel grade
Above 10°C	$t \le 40$ $40 < t \le 80$ $t > 80$	A/AH D/DH E/EH
10°C to 0°C	$t \le 20$ $20 < t \le 25$ $25 < t \le 40$ $t > 40$	A/AH B/AH D/DH E /EH
0°C to –10°C	$t \le 12{,}5$ $12{,}5 < t \le 25{,}5$ $t > 25{,}5$	B/AH D/DH E/EH
–10°C to –25°C	$t \le 40$	D/DH

3.1.4 Alternative proposals in respect of the notch toughness characteristics of the materials will be considered when the service location of the particular installation is such that low temperatures are not climatically probable.

3.2 Materials for certificated installations

3.2.1 Materials intended for the construction of lifting appliances are to be in accordance with recognised National or International Standards that include materials which are equivalent to those specified in the Rules for Materials, but where the approval and survey requirements will not comply with the requirements of Chapter 1 of the Rules for Materials and Section 1 of subsequent Chapters of the Rules for Materials, as appropriate, materials will be subject to additional testing under LR Survey prior to acceptance for any project.

3.2.2 The requirements with respect to toughness criteria are for classed installations, *see* Table 5.3.1 and Table 5.5.2.

3.2.3 Structural steel in the primary load path, including pins and wheels, is to be supplied with 3.1 certification in accordance with EN 10204 or equivalent.

Section 4 Machinery, control and operational features

4.1 Electrical and control engineering

4.1.1 The arrangements in respect of electrical and control engineering aspects of the installation are to comply with the requirements of Chapter 10.

4.2 Mechanical and hydraulic aspects

4.2.1 Mechanical and hydraulic aspects of the installation are to comply with the requirements of Chapter 9.

Section 5 Design loads and combinations

5.1 Dead loads

5.1.1 The self-weight including weight of all steelwork, rails, welding, paint systems and platform decking are to be taken into account in the calculations. Where timber decking is used, due consideration of the moisture content of the timber is to be taken into account.

5.2 Docking and transfer loads

5.2.1 The design is to be based on the maximum distributed load per metre applied as a keel block loading along the centreline of the platform, or along the inner set of transfer rails and/or trestle feet, where docking directly onto the platform does not occur. *See also* 2.7.2.

5.2.2 The loading imposed on the platform from the cradle or bogie wheels is to be applied during transfer operations as follows:

- over the entire docking length of the platform to the shore end of the platform for end transfer operations;
- over the entire length of side transfer rails for side transfer operations.

5.2.3 The block or cradle arrangement is, in general, to be such as to ensure that the pressure on the hull of a docked ship is not greater than that for which its structure is suitable. In general, this pressure will be the range between 200 to 230 t/m^2. Particular circumstances may, however, result in a greater or lesser pressure being appropriate.

5.2.4 The effects of the forces required to overcome friction in the transfer system are to be allowed for in the horizontal strength of the platform. The friction force is to be taken as not less than 1,5 per cent of the cradle wheel loads when roller bearings are fitted to the wheels, and 4 per cent when plain or bushed bearings are fitted.

5.3 Access and general decking loads

5.3.1 The access and decked-in areas of the platform are also to be designed for pedestrian and maintenance purposes to:

(a) a superimposed load of 5 kN/m^2, uniformly distributed; and
(b) a point load of 10 kN at any one point.

Higher values may be required to meet operational equipment criteria.

5.3.2 Where vehicular access is required, the decking and deck support structure are to be designed in accordance with Ch 6,2, as appropriate for the intended vehicles. These loadings will not normally influence the lifting capacity specified in Section 2.

5.4 Wind loads

5.4.1 Each shiplift and transfer system and its supporting arrangements is to be capable of withstanding:

(a) The loading from the wind on both the ship and platform from the specified maximum wind speed in which the shiplift will continue to operate.
(b) The loading from the wind on the platform from an extreme out-of-service wind speed based on a 1:50 year return period.

5.4.2 The design wind speeds are to be based on local climatology data. Where the wind speeds are not defined by reliable local meteorological records, the following values may be used:

(a) 20 m/s for the normal in-service condition.
(b) 63 m/s for the out-of-service condition.

5.5 Seismic loading

5.5.1 Shiplifts located in areas of high earthquake risk are to be designed to be capable of withstanding the accelerations resulting from an Operating Basis Earthquake (OBE). This is the acceleration for which the installation is expected to remain operational. An event of this magnitude/intensity can be reasonably expected to be experienced at the site during the operating life of the installation.

5.5.2 Consideration of the maximum credible seismic event at the site may be required if catastrophic failure of the installation results in significant loss of life or unacceptable environmental damage.

5.6 Load combinations

5.6.1 Shiplift platforms and transfer systems are to be considered for the design loadings resulting from the following load cases:

(a) **Case 1: Operational: docking and transfer with no wind:**
The shiplift and transfer system are to be considered with respect to its self-weight plus the applied vertical load from the docked ship and transfer system, together with the horizontal loads resulting from the traction/friction loads during transfer operations.

(b) **Case 2: Operational: docking and transfer with wind:**
The shiplift and transfer system are to be considered with respect to its self-weight plus the applied vertical load from the docked ship and transfer system, together with the horizontal loads resulting from the in-operation wind speed (actual data to be provided or 20 m/s will be used) applied to both the ship and the platform, and also to traction/friction loads during transfer operations.

(c) **Case 3: Survival: ship on transfer system on land during extreme wind conditions:**
The transfer system is to be considered with respect to its self-weight plus the applied vertical load from the docked ship, together with the horizontal load resulting from the extreme wind condition (actual data to be provided or 63 m/s will be used) applied to both the ship and the platform. Where appropriate, consideration may also need to be given to the OBE (Operating Basis Earthquake) seismic event, either:
(i) separately; or
(ii) together with the extreme wind condition.

5.6.2 In way of platform bilge blocks, the platform structure is to be designed for the maximum loads resulting from **load case 2**. This load is to be not less than 20 per cent of the maximum distributed load per metre.

5.7 Allowable stresses

5.7.1 The allowable stress, σ_a, is to be taken as the failure stress of the component concerned, multiplied by a stress factor, *F*, which depends on the load case considered. The allowable stress is given by the general expression:

$\sigma_a = F\,\sigma$, or
$\tau_a = F\,\tau$

where
σ_a = allowable direct stress, in N/mm^2
τ_a = allowable shear stress, in N/mm^2
F = stress factor
σ, τ = failure stress, in N/mm^2.

5.7.2 The stress factors, *F*, for steels in which $\sigma_y/\sigma_u \leq 0{,}85$, are given in Table 5.5.1

where
σ_y = yield stress of material, in N/mm^2
σ_u = ultimate tensile stress of the material, in N/mm^2.

Table 5.5.1 Stress factor *F*

Load case	1	2	3
Stress factor, *F*	0,67	0,75	0,85

5.7.3 For steel with $\sigma_y/\sigma_u > 0{,}85$, the allowable stress is to be derived from the following expression:

$\sigma_a = 0{,}46\,(\sigma_u + \sigma_y)$
$\tau_a = 0{,}27F\,(\sigma_u + \sigma_y)$

where σ_a and τ_a are defined in 5.7.1.

5.7.4 Steels with $\sigma_y/\sigma_{u\,>\,0{,}94}$ are not generally acceptable and shall be specially considered.

5.7.5 The failure stresses for the elastic modes of failure are given in Table 5.5.2.

Table 5.5.2 Failure stress

Mode of failure	Symbol	Failure stress
Tension	σ_t	$1{,}0\sigma_y$
Compression	σ_c	$1{,}0\sigma_y$
Shear	τ	$0{,}58\sigma_y$
Bearing	σ_{br}	$1{,}0\sigma_y$

5.7.6 For components subjected to combined stresses, the following allowable stress criteria are to be used:

(a) $\sigma_{xx} < F\,\sigma_t$
(b) $\sigma_{yy} < F\,\sigma_t$
(c) $\tau_o < F\,\tau$
(d) $\sigma = \sqrt{\sigma_{xx}^2 + \sigma_{yy}^2 - \sigma_{xx}\,\sigma_{yy} + 3\tau_o^2} \leq 1{,}1F\,\sigma_t$

where
σ_{xx} = applied stress in x direction, in N/mm^2
σ_{yy} = applied stress in y direction, in N/mm^2
τ_o = applied shear stress, in N/mm^2.

5.7.7 The allowable stresses may be reduced in areas where openings or details in the structure may lead to the creation of stress concentrations.

5.7.8 For members subject to compression, the allowable axial stress for compression members is to be taken as the critical compressive stress σ_{cr}, determined in accordance with Ch 4,2.18.2 and multiplied by the allowable stress factor *F*, as defined in Table 5.5.1.

5.7.9 The allowable stress for plate buckling failure is to be as the critical buckling stress σ_{cb}, σ_{bb} or τ_b as appropriate and determined in accordance with Ch 4,2.21, and multiplied by the stress factor *F*, as defined in Table 5.5.1.

5.7.10 The allowable stress for joints and connections are to be in accordance with Ch 4,2.23 and multiplied by the stress factor *F*, as defined in Table 5.5.1.

5.7.11 The allowable stresses in sheaves, shackles and other loose items are to comply with the requirements of Chapter 6. Alternatively, they are to comply with a recognised National Standard.

5.7.12 Items of structure which are subjected to wind forces only, irrespective of load combination, may be determined on the basis of a stress factor of F = 0,85.

■ *Section 6* Rope and chain factors of safety

6.1 Rope factor of safety

6.1.1 The safety factor required for ropes used to raise and lower the platform is to be not less than 3:1 based upon the certified breaking strength of the rope and the maximum rope tension. The maximum rope capacity is to be calculated from the rated capacity of the hoists with an allowance for the cumulative effect of sheave friction and wire rope stiffness of 1,5 per cent for ball or roller bearings and 5 per cent for plain or bushed bearings. Sheave friction and wire rope stiffness loss numbers derived from field measurements of similar shiplift equipment will be considered, provided data is from both new and existing shiplift installations.

6.1.2 For shiplifts with side transfer facilities where the platform is held on the ropes during side transfer, the rope capacity will need to be based on the maximum hoist reaction from the MDL during the side transfer operation.

6.1.3 It is recommended that, where side transfer operations take place or where docked vessels may remain on the platform for extended periods, consideration be given to a locking or suspension device to transfer the platform loads directly to the supporting structure.

6.2 Chain safety factors

6.2.1 The safety factor required for chains used to raise and lower the platform is to be not less than 3:1 based upon the certified breaking strength of the chain and the maximum chain tension. The maximum chain tension is to be based upon the rated capacity of the hoists.

6.2.2 In view of the possibility of stress corrosion cracking, grade 80 or a similar type alloy chain is not to be used.

6.2.3 Increased safety factors may be required where:
(a) The hoisting speed of the platform exceeds 0,5 m/min.
(b) The mode of operation of the hoist system may produce significant shock loading.
(c) A less onerous inspection replacement programme than LR's is envisaged in the case of installations certified but not classed.

■ *Section 7* Testing

7.1 General

7.1.1 The test criteria specified in this Section are applicable to all installations where the control system has an acceptable method of measuring the actual load on each individual hoist and where over-hoist and overload cut-outs and levelling devices are fitted in accordance with Chapter 10.

7.1.2 The test criteria will be specially considered where an inherent feature of the design requires a departure from the safety control requirements.

7.1.3 In all cases, a detailed test procedure based upon the requirements of this Section is to be submitted for approval.

7.1.4 Loose gear, ropes and chains are to be in accordance with the requirements of Chapter 8.

7.2 Load tests

7.2.1 **Hoists**:
(a) Light running tests on each hoist unit are to be carried out at the manufacturer's works.
(b) For installations with a large number of identical hoists, consideration may be given to selective proof load testing, at the factory, provided that all hoists are fully load tested during the completed installation test. Proof loads are given in Table 5.7.1.
(c) For factory testing of the hoist units, the SWL detailed in Table 5.7.1 is to be taken as the single line tension to the winch.

Table 5.7.1 Proof loads for hoists and cradles

Rated capacity, SWL	Proof load, in tonnes
Up to 20 t	1,25 x SWL
Exceeding 20 t but not exceeding 50 t	SWL + 5
Exceeding 50 t	1,1 x SWL

7.2.2 **Transfer systems**:
(a) All end and side transfer cradles are to be proof load tested in accordance with Table 5.7.1, based upon the rated capacity of the cradles.
(b) Transfer systems that incorporate a series of trestles and bogies are also to be individually tested in accordance with Table 5.7.1, based upon the rated capacity of the trestles and bogies.
(c) For installations with a large number of cradles, consideration may be given to selective proof load testing of the cradles.

7.2.3 **Hydraulic cylinders**:
(a) Cylinders used in hoist platforms or in transfer system cradles and bogies are to be pressure tested at the factory to 1,5 x design pressure.
(b) Cylinders fitted to transfer cradles and bogies are to be proof load tested as part of the load test on the cradle or bogie.

7.2.4 **Platforms**:
(a) The platform is to be load tested following installation on site:
  (i) in an unloaded or partially loaded condition; and
  (ii) with 100 per cent of the MDL.
(b) The unloaded, or partially loaded, test is to be carried out to demonstrate the efficient operation of the platform systems.
(c) The 100 per cent MDL load test may be carried out in stages by testing opposite pairs or sets of hoists if the size of the installation makes testing the entire platform in one operation unreasonable.
(d) Where the 100 per cent MDL test is carried out in stages, it is to be ensured that each hoist unit is subjected to its rated capacity. This is of particular importance for platforms of rigid design.

7.3 Operational tests

7.3.1 In addition to the load tests required in 7.2, a complete operational test of the whole system is to be carried out with a vessel having a displacement approximately equal to the NLC of the installation. This test is to be performed over a complete operating cycle, that is, hoisting, docking, transfer ashore, transfer whilst ashore on transfer carriages (if appropriate), transfer back onto the platform and lowering.

7.3.2 Where, for practical considerations, it is not possible to test to the full nominal capacity, this test may be carried out with a reduced test load but not less than 60 per cent of the nominal lifting capacity.

7.3.3 Where only a limited operational test is carried out, the certification will be initially endorsed reflecting the limitation on testing and transfer operations that will be restricted to the tested displacement under 7.3.2 until such time as a ship of suitable displacement is available to test the installation to the full nominal lifting capacity. This operational test at 100 per cent of the nominal lifting capacity is generally to be carried out within one year of the completion of the test.

7.3.4 This re-test is to be witnessed by the Surveyor.

■ *Section 8* **Classification Regulations**

8.1 General

8.1.1 Shiplift and transfer systems built in accordance with LR's Rules in respect of structural and machinery requirements will be eligible for recommendation to the Classification Committee to have a class notation assigned, and will continue to be classed as long as they are found upon examination at the prescribed Surveys to be maintained in accordance with LR's requirements.

8.1.2 The Regulations for Classification and Periodical Surveys are given in Part 1 of LR's *Rules and Regulations for the Classification of Ships*. These Regulations will be applied to shiplifts and transfer systems, in so far as they are applicable, and are to be read in conjunction with the specific requirements given in this Chapter.

8.1.3 Where the proposed installation is novel in design, or involves the use of unusual materials, or where experience, in the opinion of the Classification Committee, has not sufficiently justified the principle or mode of application involved, special tests or examinations before and during service may be required. In such cases, the notation will be suitably amended to reflect this.

8.2 Characters of classification and Class Notation

8.2.1 Shiplift installations and transfer systems, when classed, will be assigned one or both of the following character symbols, as applicable:

✠ This distinguishing mark will be assigned, at the time of classing, to new installations constructed under LR's Special Survey, in compliance with the Rules and to the satisfaction of the Classification Committee.

A This character letter will be assigned to all installations which have been built or have accepted class status in accordance with LR's Rules and Regulations, and which are maintained in good and efficient condition.

8.2.2 A Class notation will be appended to the character of classification assigned to the installation and this will also indicate whether the transfer system is included in LR's classification. The character of classification and class notations assigned will, normally, be as follows:
(a) ✠**A** or **A** – Shiplift for service at ……. (port to be specified); or
(b) ✠**A** or **A** – Shiplift and transfer system for service at ….. (port to be specified).

8.3 Plan approval

8.3.1 Plans for the structural, electrical, mechanical, hydraulic and control engineering aspects of the design are to be submitted for approval. Supporting calculations are to be submitted as required and are to indicate clearly the proposed lifting arrangement for which approval is required. The minimum/maximum design temperatures, maximum operational wind speeds and seismic data are also to be submitted, as appropriate, before the work is commenced. Any subsequent modifications or additions to the scantlings or arrangements shown in the approved plans are also to be submitted for approval.

8.3.2 Upon satisfactory completion of the plan approval, a design appraisal document will be issued for each of the design aspects approved. The design appraisal document for the platform will indicate the designated capacities for which the platform is appraised. The design appraisal document for the hoist unit will state the maximum hoisting capacity of the unit.

8.4 Fabrication under Survey of the installation

8.4.1 New installations are, from the commencement of the work until completion and installation, to be examined by the Surveyor with respect to materials, workmanship and arrangements. The items to be surveyed at the site of manufacture include the platform and transfer system steelwork, hoists and hydraulic cylinders.

8.4.2 Verification is to include the use of approved materials and of those appropriately qualified welders, using approved weld procedures, who are employed during fabrication.

8.4.3 The requirements for weld procedure tests and weld inspection are to be agreed with the Surveyor. In general, however, it is recommended that non-destructive testing of welding to primary members is to be as follows:
(a) All fillet and butt welds in the area of support for sheave housings, transverse butt welds in main girders and similar critical areas. Butt welds to have 100 per cent MPI and US examination with 100 per cent MPI on fillet welds.
(b) 20 per cent of all other fillet welds in primary structural members to be subject to MPI.

8.4.4 Any items not in accordance with LR's requirements or the approved plans, or any material, workmanship or arrangement found to be unsatisfactory are to be rectified.

8.4.5 Upon satisfactory fabrication under survey of the platform, cradles, hoists, cylinders, etc., a release note will be issued indicating that the component or components have been fabricated in accordance with the approved plans using approved welding procedures. Any load testing undertaken at the fabrication works prior to dispatch will also be referenced on the release note.

8.5 Installation Survey and testing

8.5.1 Components fabricated on site are to comply with the requirements of 8.4.

8.5.2 After erection on site, the complete facility will be inspected by the attending Surveyor to check that the shiplift and transfer system have been installed in accordance with the approved plans and that any outstanding or remedial work required either at the factory or on site is to be completed satisfactorily.

8.5.3 Once this has been done, load testing and operational testing in accordance with 7.2.4 and 7.3 will be carried out.

8.6 Periodical Surveys

8.6.1 Periodical Surveys are to be carried out on a 5-yearly Continuous Survey on the basis of the requirements of 8.6.2 to 8.6.13.

8.6.2 20 per cent of main and secondary transverse and longitudinal girders are to be examined. This may require the removal of limit switch operating rods to enable submerged areas of the platform to be raised clear of the water. The examination is to include:
(a) The connection or seating arrangements at the junction of longitudinal and transverse girders for signs of work hardening and cracking and other defects.
(b) A general examination of protective coatings.
(c) Examination of the rails for alignment and signs of wear, giving particular attention to connecting arrangements and the connecting rail between the platform and shore.

Decking is to be removed as necessary to allow these examinations.

8.6.3 The Surveyor is to be satisfied with regard to the maintenance condition and lubrication of the hoist ropes. Concurrent with Periodical Surveys, the Surveyor is to carry out a complete *in situ* visual examination as far as is practicable for signs of corrosion, wear or broken wires:
(a) In general, wire ropes are to be renewed where there are 5 per cent or more of broken, worn or corroded wires in any length of ten rope diameters. However, reference is to be made to ISO 4309:2010 in determining specific discarded criteria.
(b) At the second Annual Survey and each subsequent year a minimum number of ropes is to be removed from installations as follows:

Up to 6 hoist units:	1 rope
8 to 20 hoist units:	2 ropes
More than 20 hoist units:	4 ropes

A test to destruction is to be carried out on a sample length selected by the Surveyor from each of the ropes being replaced. Where the test piece fails at breaking loads more than 10 per cent below the minimum required values, consideration will be given to the need to select for test and replacement some or all of the remaining ropes.
(c) It is the intention that all ropes be replaced in sequence at a rate determined by wear, chemical attack, corrosion or other forms of deterioration associated with the particular installation. For small installations, this will result in a replacement cycle of about 5 years. Proposals for the replacement cycle for large installations to exceed 10 years will be specially considered in the light of the test results obtained.

8.6.4 Where the Annual Survey incorporates the use of non-destructive examination equipment to inspect hoist ropes, the following procedures are to be adopted:

(a) The accuracy and reliability of the NDE equipment is to be demonstrated to the satisfaction of the Surveyor.

(b) Field tests are to be carried out to the Surveyor's satisfaction to verify the suitability of the equipment for the particular hoist and rope arrangement and rope speed.

(c) The annual rope Survey is to be as follows:

 (i) Complete visual inspection of all ropes for signs of broken wires. Particular attention is to be given to the condition of the ropes in way of the rope terminations as these areas are unlikely to be accessible to NDE equipment. *See* (d) Test A.

 (ii) NDE of a selected number of ropes using approved equipment operated by skilled personnel. The number of ropes selected for inspection is to be in accordance with 8.6.3(b) but not less than 10 per cent of the total number of ropes in the installation. Ropes are to be tested over their full length and are to be selected in accordance with a planned programme of inspection to ensure an even distribution of ropes, selected on an annual rotation basis. *See* (d) Test B.

 (iii) Two years after installation of the shiplift, one rope that has been subjected to NDE is to be selected for a test to destruction to verify the NDE results. Thereafter, one rope is to be selected for a break test each year. *See* (d) Test C.

(d) The results of the tests in (c) will be used to determine, to the satisfaction of the Surveyor, whether rope replacement or further testing is necessary for the particular installation. In general, the following criteria are to be used in determining the adequacy of the ropes to be retained in service:

 Test A

 The number of broken wires is not to exceed the guidance given in ISO 4309:2010 for the type of rope fitted.

 Test B

 The cross-sectional area is not be reduced by more than 10 per cent of the original area. Where the loss in area is found to be between 5 and 10 per cent, consideration is to be given to including these ropes in subsequent examinations in addition to ropes selected for normal annual NDE.

 Test C

 The reduction in breaking strength when the combined effect of metal loss, corrosion pitting and broken wires has been taken into account is not to exceed 10 per cent of the minimum specified rope breaking strength. The minimum specified rope breaking strength will be specified by the wire rope manufacturer.

8.6.5 The maintenance, condition and lubrication of hoist chains is to be to the satisfaction of the Surveyor. In general, any length of chain so worn that its mean diameter at its most worn part is reduced by 4 per cent or more from its nominal diameter is to be renewed.

8.6.6 20 per cent of the upper and lower sheaves, bearings, axles and housings are to be examined, with at least two complete sets of sheaves opened up for examination. All sheaves are to be opened up at least once in the 5-yearly Survey cycle. Attention is to be paid to lower blocks in way of drain holes and the attachment of sheave housings to upper and lower supports is to be examined.

8.6.7 Covers on 20 per cent of the hoists are to be removed to allow for the following inspections:

(a) The tooth alignment of open gears is to be checked.

(b) Main shaft pillow block bearings are to be opened up.

(c) Cap screws securing final spur wheels to the drum are to be checked and tightened with a torque spanner.

(d) Primary gears and all open gear shafts and bearings are to be examined.

(e) The hoist frame and bolting arrangements are to be examined.

8.6.8 Where the transfer system is included in the class notation, 20 per cent of the transfer bogies are to be examined.

(a) Wheels are to be examined for wear and the condition of linkages between bogies is to be checked.

(b) A random selection of 10 per cent of the axle pins to the bogie wheels is to be withdrawn for inspection for signs of excessive wear and other defects.

(c) The rails are to be examined for alignment and signs of wear and to verify the adequacy of the locating and locking arrangements.

8.6.9 An insulation resistance test (megger test) is to be carried out on all electrical systems, and all electrical cables are to be examined. In addition:

(a) Breakers, relays and all other mechanical electrical gear are to be examined.

(b) 20 per cent of electric motors including bearings and magnetic brakes are to be examined.

(c) All circuit-breakers to be tested for overload tripping.

(d) Air compressors for hoist ratchet and arrangement are to be generally examined together with the air tank.

(e) The efficiency of all safety devices is to be demonstrated.

8.6.10 At a convenient time close to each Periodical Survey, the Surveyor is to attend during a hoist and transfer operation at the facility to check the general operation of the installation.

8.6.11 Decking is not a class matter. However, the general condition of the decking may be reported.

8.6.12 Any other matter which may have a bearing on the class of the installation is also to be reported.

8.6.13 The requirements for Periodical Survey for small installations will be specially considered.

8.7 Classification of installations not built under Survey

8.7.1 Where classification is desired for a shiplift system not built under Survey, plans and information showing the materials of construction, arrangements and principal scantlings of the platform, hoists, cradles, etc., are to be submitted for approval.

8.7.2 A thorough Survey of the installation is to be carried out and is to include the following:

(a) A thorough examination of the steel structure. The scantlings of material present and the extent of any deterioration is to be recorded. Non-destructive testing is to be carried out in accordance with 8.4.3.

(b) A thorough examination of all the hoist ropes or chains, together with sheaves and hoist sets. Ropes or chains are to be renewed as may be required by 8.6.3. The requirements of 8.6.4(b) to (d) are to be applied and the initial extent of renewal is to be agreed with the Surveyor.

(c) A thorough examination of all the hoists and of the electrical and control system in accordance with 8.6.6, 8.6.7 and 8.6.9 respectively.

8.7.3 The installation is to be tested in accordance with Section 7.

8.7.4 Where the transfer system is to be included in the Class notation, the requirements of 8.6.8 are to be complied with, except that 25 per cent of the axle pins to the bogie wheels are to be withdrawn for inspection.

8.8 Certification requirements

8.8.1 The requirements for certified mechanical lift docks are for classed installations, with the exception of the provisions outlined in 1.4.

Ro-Ro Access Equipment

Chapter 6

Contents

■ *Section 1* Introduction

1.1 General

1.1.1 The requirements of this Chapter are to be complied with in cases where Lloyd's Register (LR) is requested to issue certification for the following Ro-Ro equipment:
(a) Cargo and vehicle lifts.
(b) External vehicle ramps.
(c) Internal vehicle ramps.
(d) Movable decks.
Where requested, the appropriate requirements of (a), (b) and (c) will be applied by LR for the examination of the opening and closing operation for other similar installations, such as stern or bow doors.

1.1.2 For classification requirements, particularly with respect to structural and watertight integrity of the ship, reference is to be made to the *Rules and Regulations for the Classification of Ships* (hereinafter referred to as the Rules for Ships). These requirements are to be applied in addition to those in 1.1.1.

■ *Section 2* Loading and design criteria

2.1 General

2.1.1 This Section applies to Ro-Ro equipment operated whilst the ship is in a harbour or sheltered water environment, and where cargo or vehicles may be stowed on it in its sea-going condition whilst the ship is at sea, i.e., *Standard Service Category*.

2.1.2 Where the equipment is designed to operate in conditions other than those defined in 2.1.1, the design is to be subject to special consideration, i.e., *Specified Service Category*.

2.1.3 The operating and stowed loading conditions are to be clearly specified in all submissions together with hoisting speeds and braking times.

2.1.4 For the operating condition, the equipment is to be considered with respect to the following forces and loads:
(a) Self-weight.
(b) Applied loading.
(c) Dynamic forces due to hoisting/lowering.
(d) Forces due to static inclination of the ship.

2.1.5 The structure, its support and locking mechanism are also to be examined with respect to the sea-going condition for the following criteria, appropriate to the ship's characteristics:
(a) Self-weight.
(b) Applied load due to vehicle or cargo loading.
(c) Forces due to ship motion and static inclination.
(d) Weather loading, where appropriate.

2.2 Basic loads

2.2.1 The self-weight load, L_W, is the load imposed on the hoisting mechanism by the weight of the structure and machinery.

2.2.2 The applied load, L_C, is the loading imposed on the structure by the cargo or vehicles.

2.2.3 The safe working load (SWL) is the maximum load for which the equipment is certified and is equal to the maximum value of L_C. For equipment that is manoeuvred unloaded, the SWL shall be taken as the self-weight of the structure for the determination of the required safety factors, where applicable.

2.3 Dynamic forces due to hoisting

2.3.1 To take account of acceleration and shock loading, the self-weight and applied load are to be multiplied by 1,20.

2.4 Forces due to ship motion

2.4.1 In general, Ro-Ro equipment is to be designed to operate in a harbour or sheltered water environment where there is no significant motion of the ship due to wave action.

2.4.2 For the operational condition, the Ro-Ro equipment is to be designed to operate safely and efficiently at an angle of heel of the ship of 5° and an angle of trim of 2°, acting simultaneously. If it is the intention to operate the Ro-Ro equipment at angles differing from the foregoing, it is to be designed for these angles and the certificate marked accordingly.

2.4.3 In addition to the loading/unloading conditions, the Ro-Ro equipment and its locking mechanisms are also to be designed to withstand the following forces in the sea-going condition:

(a) Acceleration normal to deck of ±1,0 *g*
Acceleration parallel to deck in fore and aft directions of ±0,5 g
Static heel of 30°.

(b) Acceleration normal to deck of ±1,0 *g*
Accelerations parallel to deck in transverse directions of ±0,5 g
Static heel of 30°.

2.4.4 Alternatively, where the Ro-Ro equipment is to be fitted to a conventional ship and the ship's characteristics are known, the forces may be calculated for the combination of static and dynamic forces of Ch 4,2.11 for the ship's motions and accelerations obtained from Tables 4.2.2 and 4.2.3 in Chapter 4.

2.5 Design loads

2.5.1 The design loads are to be consistent with the ship's loading manual and are to include the details of the number and spacing of vehicles the Ro-Ro equipment is designed to accommodate, the type of vehicles, their weight, axle loading, tyre print dimensions, and number and spacing of wheels and supports.

2.5.2 Due account is to be taken of asymmetric loading where applicable. Where it is intended to restrict the position of a load, such that the Ro-Ro equipment is equally loaded, physical barriers are to be used. Other proposals will be specially considered.

2.5.3 In addition to vehicle loading, the Ro-Ro equipment is to be considered with respect to minimum uniform deck loading (UDL) of 2,5 kN/m^2 appropriate to the deck or decks. In cases where the vehicle load is higher than the given minimum value, the UDL is to be increased accordingly.

2.5.4 The Ro-Ro equipment is to comply with the appropriate requirements of Pt 3, Ch 3 and Ch 11 of the Rules for Ships.

2.5.5 Where the Ro-Ro equipment forms part of the ship's watertight structure, it is to comply with the requirements of the Rules for Ships as appropriate.

2.5.6 Where the external Ro-Ro equipment is affected by wind load during the manoeuvring or in stowed position, it is to be considered and load combinations have to include the additional load as appropriate.

2.6 Allowable stress – Elastic failure

2.6.1 The allowable stress, σ_a is to be taken as the failure stress of the component concerned multiplied by a stress factor, *F*, which depends on the load case considered. The allowable stress is given by the general expression:

$$\sigma_a = F\sigma$$

where

σ_a = allowable stress
F = stress factor
σ = failure stress.

2.6.2 The stress factor, *F*, for steels in which $\sigma_y/\sigma_u \leq 0,85$ are given in Table 6.2.1:

where

σ_y = yield stress of material
σ_u = ultimate tensile stress of the material.

Table 6.2.1 Stress factor, *F*

Load case	Case 1	Case 2	Case 3/4
Stress factor, *F*	0,60	0,75	0,85

NOTE
Where an item forms part of the hull structure, the scantlings are to comply with the requirements of the Rules for Ships
Case 1: Harbour condition, loading and unloading
Case 2: Sea-going condition, loaded in-deck position or stowed unloaded
Case 3: Manoeuvring operation or test load

2.6.3 For steel with $\sigma_y/\sigma_u > 0,85$, the allowable stress is to be derived from the following expression:

$$\sigma_a = 0,459F(\sigma_u + \sigma_y)$$
$$\tau_a = 0,266F(\sigma_u + \sigma_y)$$

where

τ_a = allowable shear stress.

2.6.4 Steels with $\sigma_y/\sigma_u > 0,94$ are not generally acceptable and need to be specially considered.

2.6.5 The failure stress for the elastic modes of failure are given in Table 6.2.2.

Table 6.2.2 Failure stress

Mode of failure	Symbol	Failure stress
Tension	σ_t	$1,0\sigma_y$
Compression	σ_c	$1,0\sigma_y$
Shear	τ	$0,58\sigma_y$
Bearing	σ_{br}	$1,0\sigma_y$

2.6.6 For components subjected to combined stresses, the following allowable stress criteria are to be used:

(a) $\sigma_{xx} \leq F\,\sigma_t$

(b) $\sigma_{yy} \leq F\,\sigma_t$

(c) $\tau_o \leq F\,\tau$

(d) $\sigma_e = \sqrt{\sigma_{xx}^2 + \sigma_{yy}^2 - \sigma_{xx}\,\sigma_{yy} + 3\tau_o^2} \leq 1{,}1F\,\sigma_t$

where

σ_{xx} = applied stress in x direction

σ_{yy} = applied stress in y direction

τ_o = applied shear stress.

2.6.7 The allowable bearing stress is to be calculated as follows for all load cases 1 to 3:

$\sigma_{a.br} = 0{,}9\sigma_{br}$

2.6.8 In case the structural analysis is carried out by means of detailed finite element models, higher allowable stresses can be applied as follows:

(a) $\sigma_{xx/FE} \leq 1{,}1\sigma_{xx}$

(b) $\sigma_{yy/FE} \leq 1{,}1\sigma_{yy}$

(c) $\tau_{o/FE} \leq 1{,}1\tau_o$

(d) $\sigma_{e/FE} \leq 1{,}1\sigma_e$

Higher allowable stresses, as defined above, may only be applied if the actual stresses are localised. In case the actual stresses can also be calculated by means of analytical methods, the above higher allowable stresses are not applicable and 2.6.1 to 2.6.4 are to be applied.

2.7 Allowable stress – Plate buckling failure

2.7.1 The allowable stress is to be taken as the critical buckling stress of the component concerned multiplied by the stress factor, *F*, as defined in Table 6.2.1. The critical buckling stress is obtained by reference to Ch 4,2.21.

2.8 Required deck plating thickness

2.8.1 The deck plating thickness is to be in compliance with Pt 3, Ch 9,3 of the Rules for Ships.

2.9 Deflection criteria

2.9.1 The deflection of the Ro-Ro equipment or of any individual member with respect to Case 1 and 2, *see* Table 6.2.1, is to be limited to:

$$\frac{l}{200} \text{ mm}$$

where

l = distance between supports, in mm.

2.9.2 Where applicable, the deflection is to be further limited to ensure the watertight integrity of the ship is maintained.

2.10 Guide rails

2.10.1 Arrangements are to be provided to restrict horizontal movements of Ro-Ro equipment during operation, by guide rails or other means as applicable.

2.10.2 Where guide rails are fitted, they are to be such that the maximum deflection, resulting from horizontal components of load, is not greater than 6,0 mm. The working clearance between the Ro-Ro equipment and guide rail is to be such as to allow free vertical movement of the Ro-Ro equipment.

2.11 Stowage locks

2.11.1 Stowage locks are to be provided to resist the vertical, forward/aft and lateral loads as defined in 2.5.1 to 2.5.5. Arrangements are to be such that the locks do not loosen and impair the watertight integrity of the ship. Reference is made to the applicable requirements of the Rules for Ships.

2.12 Hoisting arrangements and items of loose gear

2.12.1 Where chains are used as part of the hoisting arrangement, they are to have a minimum safety factor of 4,0.

2.12.2 Where wire ropes are used as part of the hoisting arrangement as well as items of loose gear used therein, they are to have a safety factor given by:

$$SF = \frac{10^4}{8{,}85L + 1910}$$

but not less than 4,0 nor greater than 5,0

where

SF = minimum safety factor required

L = safe working load [tonne]

For the calculation of the safety factor, SF, only static forces need to be considered, with a friction allowance of 2 per cent for roller bearings.

2.12.3 In cases where the dynamic factor in sea-going conditions is greater than 1,6, the safety factor may be derived as follows:

SF = SF(Harbour) x Dynamic factor/1,6.

2.13 Materials

2.13.1 Materials are to comply with the requirements of Ch 1,1.6.

2.13.2 Where the Ro-Ro equipment is a classification item, the grade of steel selected in accordance with Table 2.1.1 in Chapter 2.

2.13.3 Where the Ro-Ro equipment is subject to certification only, the selected steel grade is to provide adequate assurance against brittle fracture taking into account the material tensile strength and thickness and the environment in which the Ro-Ro equipment is designed to operate and, in general, is to comply with the Charpy test requirements given in Table 4.2.18 in Chapter 4.

Section 3
Cargo and vehicle lifts

3.1 General

3.1.1 This Section applies to cargo and vehicle lifts operated whilst the ship is in a harbour or sheltered water environment and where cargo or vehicles may be stowed on them in the sea-going condition, i.e., *Standard Service Category*.

3.1.2 Where the lift is designed to operate in conditions other than those defined in 3.1.1, the design is to be subject to special consideration, i.e., *Specified Service Category*.

3.1.3 The lift is to be considered with respect to design loads and requirements stated in Section 2.

3.2 Load combinations

3.2.1 The lift is to be considered with respect to design loads resulting from the following conditions:
(a) Case 1 – Operating condition.
(b) Case 2 – Sea-going or stowed condition.
(c) Case 3 – Test load condition.

3.2.2 **Case 1**. The lift is to be considered with respect to the self-weight and applied load multiplied by a dynamic factor of 1,20, together with the horizontal forces as defined in 2.4.2. This is represented by the following expression:

$$1{,}2\,(L_w + L_c) + L_{h1} + L_{h2}$$

where
L_w = self-weight load
L_c = applied load
L_{h1} = factored load due to 5° heel
L_{h2} = factored load due to 2° trim.

3.2.3 **Case 2**. The lift is to be considered with respect to the forces resulting from the accelerations due to ship motion, together with the forces due to consideration of static inclination as defined in 2.4.3 or 2.4.4, together with weather forces appropriate to its stowed position. The lift can be loaded with cargo or can be stowed unloaded.

3.2.4 **Case 3**. The lift is to be considered with respect to forces due to the self-weight plus the test load, L_t, multiplied by a dynamic factor of 1,20. This case is represented by the following expression:

$$1{,}2\,(L_w + L_t)$$

where
L_t = SWL × proof load factor obtained from Ch 12,1.9.

Section 4
External vehicle ramps

4.1 General

4.1.1 This Section applies to movable external vehicle ramps (e.g., stern ramp, bow ramp and side ramp) installed on ships where the loading or unloading operation is carried out in a harbour or sheltered water, i.e., *Standard Service Category*.

4.1.2 Where the vehicle ramp is designed to operate in conditions other than those defined in 4.1.1, the design will be specially considered, i.e., *Specified Service Category*.

4.1.3 For the lowered position (harbour), the ramp is to be considered for the worst possible combination of angles and support arrangement (supported by the quay and/or its hoisting mechanism) with respect to the following forces:
(a) Self-weight.
(b) Applied load.
(c) Dynamic forces due to vehicle movement.
(d) Forces due to ship's static inclinations including twist of ramp by difference of roll/trim angle and quay.
(e) Lateral forces on hinges due to friction between ramp and quay.

4.1.4 For raising and slewing manoeuvres (harbour), the ramp is to be considered with respect to the following forces:
(a) Self-weight.
(b) Applied load, where appropriate.
(c) Dynamic forces due to hoisting/slewing.
(d) Forces due to ship's static inclinations.
(e) Environmental load as applicable.

4.1.5 For the sea-going condition, the stowed position or in cases of shell openings, the closed position of the ramp and its locking mechanism are to be considered with respect to the following forces:
(a) Self-weight.
(b) Applied load, where appropriate.
(c) Forces due to ship motion and static inclination.
(d) Environmental load as applicable.

4.1.6 The ramp is to be considered with respect to design loads and requirements stated in Section 2.

4.2 Basic loads

4.2.1 The self-weight load, L_w, is to be taken as the weight of the ramp and is to be multiplied by 1,2 to take account of the dynamic forces due to manoeuvring the ramp.

4.2.2 The applied load, L_c, is the static load on the ramp due to cargo or vehicles and is to be multiplied by 1,1 to take account of vehicle movement. In cases where ramps are designed such that this factor can be higher than 1,1, the factor will be specially considered.

4.2.3 When the ramp is manoeuvred whilst loaded, both L_w and L_c are to be multiplied by 1,2.

4.3 Slope of ramp

4.3.1 The slope of the ramp is not to exceed 1 in 10 and where the ramp is designed for ship to shore use, this angle is to include the effects of heel and trim defined in 2.4.2. Where a ramp is designed to operate at a greater slope, it will be subject to special consideration.

4.4 Load combinations

4.4.1 For ramps forming part of a shell, *see also* 4.1.5. The ramps are to be considered with respect to design loads resulting from the following conditions:

(a) Case 1 – Loading and unloading operating.
(b) Case 2 – Sea-going or stowed condition.
(c) Case 3 – Test load condition.
(d) Case 4 – Manoeuvring condition.

4.4.2 **Case 1**: The ramp is to be considered with respect to self-weight plus the applied load multiplied by 1,1, together with the horizontal forces as defined in 4.1.3. This is represented by the following expression:

$$L_w + 1{,}1L_c + L_{h1} + L_{h2} + L_{h3}$$

4.4.3 **Case 2**: Usually, external ramps are unloaded in the sea-going condition. For exceptional cases where the ramp is loaded, it is to be considered with respect to the forces resulting from the accelerations due to ship motion, together with the forces due to consideration of static inclination as defined in 4.1.5, together with weather forces as appropriate.

4.4.4 **Case 3**: The ramp is to be considered with respect to the forces due to the self-weight plus the test load. This case is represented by the following expression:

$$L_w + L_t$$

The ramp is further to be considered with respect to self-weight plus the applied test load multiplied by 1,2. This is represented by the following expression:

$$1{,}2\,(L_w + L_t)$$

where

L_t = SWL × proof load factor obtained from Ch 12,1.9.

In cases where the ramp is manoeuvred unloaded, the additional test load is derived as (1,25 – 1,00) L_w.

4.4.5 **Case 4**: The vehicle ramps are to be considered with respect to self-weight plus the applied load, where applicable, multiplied by 1,2, together with the horizontal forces as defined in 4.1.4. This is represented by the following expression:

$$1{,}2\,(L_w + L_c) + L_{h1} + L_{h2} + L_{h3} + L_{wind}$$

where

L_w = self-weight load
L_c = applied load (vehicle load/UDL)
L_{h1} = load due to 5° heel
L_{h2} = load due to 2° trim
L_{h3} = load due to ramp angle
L_{wind} = wind load

The wind speed for manoeuvring operation is not to be less than 20 m/s and where it is anticipated that it will exceed that, these higher wind speeds are to be considered.

4.5 Stowage locks and cleating devices

4.5.1 In general, the sea-going condition stowage locks and cleating devices are to be in compliance with the requirements of the Rules for Ships, as appropriate.

4.5.2 The locking cylinder must be of an approved type, fitted with an internal mechanical lock and is to be tested on board.

■ *Section 5* Internal movable vehicle ramps

5.1 General

5.1.1 This Section applies to movable internal vehicle ramps installed on ships where the loading or unloading operation is carried out in a harbour or sheltered water, i.e., *Standard Service Category*.

5.1.2 Where the internal ramp is designed to operate in conditions other than those defined in 5.1.1, the design will be specially considered, i.e., *Specified Service Category*.

5.1.3 For the the lowered position (harbour), the ramp is to be considered for the worst possible combination of angles and support arrangement (supported by the deck and/or its hoisting mechanism) with respect to the following forces:

(a) Self-weight.
(b) Applied load.
(c) Dynamic forces due to vehicle movement.
(d) Forces due to ship's static inclinations.

5.1.4 For raising and lowering manoeuvres (harbour), the ramp is to be considered with respect to the following forces:

(a) Self-weight.
(b) Applied load, where appropriate.
(c) Dynamic forces due to hoisting/lowering.
(d) Forces due to ship's static inclinations.

5.1.5 For the sea-going condition, the ramp, its supports and locking mechanism are to be considered with respect to the following forces:

(a) Self-weight.
(b) Applied load.
(c) Forces due to the ship motion and static inclination.

5.1.6 The ramp is to be considered with respect to design loads and requirements stated in Section 2.

5.2 Load combinations

5.2.1 The ramp is to be considered with respect to design loads resulting from the following conditions:

(a) Case 1 – Loading and unloading operating.
(b) Case 2 – Sea-going or stowed condition.
(c) Case 3 – Test load condition.
(d) Case 4 – Manoeuvring condition.

5.2.2 **Case 1**: The ramp is to be considered with respect to self-weight plus the applied load multiplied by 1,1, together with the horizontal forces as defined in 5.1.3. This is represented by the following expression:

$$L_w + 1{,}1L_c + L_{h1} + L_{h2} + L_{h3}$$

where

- L_w = self-weight load
- L_c = applied load (vehicle load/UDL)
- L_{h1} = load due to 5° heel
- L_{h2} = load due to 2° trim
- L_{h3} = load due to ramp angle.

5.2.3 **Case 2**: The movable internal ramp and locking mechanism are to be considered with respect to the force acting on the self-weight and applied load as appropriate resulting from accelerations due to ship motion and static inclination as follows:

(a) Loaded sea-going condition.
(b) Stowed unloaded condition.

5.2.4 **Case 3**: The internal ramp and locking mechanism are to be considered with respect for the forces due to the self-weight plus the test load. This case is represented by the following expression:

$$L_w + L_t$$

The ramp is further to be considered with respect to self-weight plus the applied test load as applicable to the lifting of the unloaded installation multiplied by 1,2. This is represented by the following expression:

$$1{,}2\ (L_w + L_t)$$

where

- L_t = SWL x proof load factor obtained from Ch 12,1.9.

5.2.5 **Case 4**: The ramp is to be considered with respect to self-weight plus the applied load, where applicable, multiplied by 1,2, together with the horizontal forces as defined in 5.1.4. This is represented by the following expression:

$$1{,}2\ (L_w + L_c) + L_{h1} + L_{h2} + L_{h3}$$

where

- L_w = self-weight load
- L_c = applied load (vehicle load/UDL)
- L_{h1} = load due to 5° heel
- L_{h2} = load due to 2° trim
- L_{h3} = load due to ramp angle.

5.3 Stowage locks

5.3.1 In general, for the sea-going condition, stowage locks are to be fitted.

5.3.2 In cases where the internal ramp is stowed unloaded and locked by interlocking the hoisting system, the arrangement must be specially considered.

5.3.3 The actuator that locks the hoisting system must be of an approved type, fitted with internal mechanical lock and has to be tested on board.

5.4 Ramp lifted with passenger

5.4.1 In cases where the ramp is lifting with a passenger, the SF for wire rope and items of loose gear must not be less than 6.

5.4.2 Means are to be provided that support the loaded ramp in a safe manner in the event of a failure of one hoisting rope, e.g., balanced double wire system. The loaded internal ramp must be supported in a safe manner and allow the passenger to get off safely.

5.4.3 A sign stating that passengers must be inside their vehicle during the operation is to be fitted.

5.4.4 Means are to be provided to prevent uncontrolled lowering in case of a hydraulic failure. Counter balance valves are to be fitted directly on the hydraulic cylinder.

5.4.5 Any Safety at Work requirements, stanchions, etc., are to be such that any risk of getting stuck is to be avoided. Remaining health and safety requirements of ILO or the appropriate National Flag Administration must be complied with as applicable.

5.4.6 A wheel deflector, preventing the cars from sliding backwards from the ramp during hoisting/lowering in harbour and during the sea-going condition, must be permanently installed. It is to be tested on board to the attending Surveyor's satisfaction.

5.4.7 In cases where a winch is used for a hoisting system, it is to be equipped with a mechanically and operationally independent secondary brake with separate circuits. The brake is to be automatically activated in case of an emergency stop or in the event of power failure.

5.4.8 The operator is to have a total view of the ramp during the hoisting/lowering operation.

■ *Section 6* Movable decks

6.1 General

6.1.1 This Section applies to movable vehicle decks installed on ships where the loading or unloading operation is carried out in a harbour or sheltered water, i.e., *Standard Service Category*.

6.1.2 Where movable vehicle deck is designed to operate in conditions other than those defined in 6.1.1, the design will be specially considered, i.e., *Specified Service Category*.

6.1.3 For loading and unloading (harbour), the movable vehicle deck is to be considered for the worst possible combination of angles with respect to the following forces:

(a) Self-weight.
(b) Applied load.
(c) Dynamic forces due to vehicle movement.
(d) Forces due to ship's static inclinations.

6.1.4 For raising and lowering manoeuvres (harbour), the movable vehicle deck is to be considered with respect to the following forces:
(a) Self-weight.
(b) Dynamic forces due to hoisting/lowering.
(c) Forces due to ship's static inclinations.

6.1.5 For the sea-going condition, the movable vehicle deck, its supports and locking mechanism are to be considered with respect to the following forces:
(a) Self-weight.
(b) Applied load.
(c) Forces due to the ship motion and static inclination.

6.1.6 For the stowed position, the unloaded panels and its locking mechanism are to be considered with respect to the following forces:
(a) Self-weight.
(b) Forces due to the ship motion and static inclination.

6.1.7 The movable vehicle deck is to be considered with respect to design loads and requirements stated in Section 2.

6.2 Load combinations

6.2.1 The movable vehicle deck is to be considered with respect to design loads resulting from the following conditions:
(a) Case 1 – Loading and unloading operating.
(b) Case 2 – Sea-going or stowed condition.
(c) Case 3 – Test load condition.
(d) Case 4 – Manoeuvring condition.

6.2.2 **Case 1**: The movable vehicle deck is to be considered with respect to self-weight plus the applied load multiplied by 1,1, together with the horizontal forces as defined in 6.1.3. This is represented by the following expression:

$$L_w + 1{,}1L_c + L_{h1} + L_{h2}$$

6.2.3 **Case 2**: The movable vehicle deck, its supports and locking mechanism are to be considered with respect to the forces acting on the self-weight and applied load, as applicable, resulting from accelerations due to ship motion and static inclination as follows:
(a) Loaded sea-going condition.
(b) Stowed unloaded condition.

6.2.4 **Case 3**: The movable vehicle deck, its support and locking mechanism are to be considered with respect to the forces due to the self-weight plus the test load. This case is represented by the following expression:

$$L_w + L_t$$

The movable vehicle deck is further to be considered with respect to self-weight plus the applied test load as applicable to the lifting of the unloaded installation multiplied by 1,2. This is represented by the following expression:

$$1{,}2\,(L_w + L_t)$$

6.2.5 **Case 4**: The movable vehicle deck is to be considered with respect to self-weight plus the applied load, where applicable, multiplied by 1,2, together with the horizontal forces as defined in 6.1.4. This is represented by the following expression:

$$1{,}2\,(L_w + L_c) + L_{h1} + L_{h2}$$

where
L_w = self-weight load
L_c = applied load (vehicle load/UDL)
L_{h1} = load due to 5° heel
L_{h2} = load due to 2° trim
L_t = SWL x proof load factor obtained from Ch 12,1.9.

6.3 Stowage locks

6.3.1 In general, for the sea-going condition, stowage locks are to be fitted.

6.3.2 In cases where the movable vehicle deck is stowed unloaded and locked by interlocking the hoisting system, the arrangement must be specially considered.

6.3.3 The actuator that locks the hoisting system must be of an approved type, fitted with internal mechanical lock and is to be tested on board.

6.3.4 Any Safety at Work requirements, stanchions, etc., are to be such that any risk of getting stuck is avoided. Remaining health and safety requirements of ILO or the appropriate National Flag Administration must be complied with as applicable.

6.3.5 The supporting arrangement is to be such that the movement at the edge of one panel relative to the next does not exceed 50 mm during loading or unloading operation.

Contents

Section 1 Introduction

1.1 General

1.1.1 The requirements of this Chapter are to be complied with in cases where Lloyd's Register (LR) is requested to issue certification for the following installations:
(a) Passenger lifts.
(b) Service lifts.

Section 2 Passenger lifts

2.1 General

2.1.1 This Section applies to electric and hydraulic powered lifts permanently installed in ships and employing an enclosed car suspended by ropes/chains or supported by hydraulic cylinders and running between rigid guides for the transfer of persons, or persons and goods, between the decks. It is recommended that the rated speed does not exceed 1,0 m/s and is to be limited to 1,0 m/s for hydraulic lifts and 0,63 m/s for positive drive lifts. Traction drive lifts designed for a higher rated speed will be specially considered.

2.1.2 The lift is to comply with the requirements of a recognised National or International Standard, e.g., EN81, ISO 8383 and any requirements of the National Authority of the country of registration and the requirements of this Section. Deviations from these Standards are to be stated by the manufacturer and require approval by LR and the Flag State.

2.1.3 The relevant design criteria, such as rated load, minimum stopping distance, buffer stroke, type of hoisting drive, type of safety gear and buffer are to be clearly specified in all lift submissions. For guidance regarding the submission of relevant plans and information required, *see* Ch 1,3.4. The certificates for the safety components are to be submitted for consideration.

2.1.4 The lift is to be designed such that it can be stowed, either manually or automatically, in the event of the specified operational conditions being exceeded.

2.1.5 For the operating conditions, the lift is to be designed with respect to the following forces:
(a) Self-weight of car and counterweight;
(b) Rated load;
(c) Dynamic forces due to lift motion; and
(d) Forces due to ship motion and static inclination.

2.1.6 For the stowed condition, the lift is to be designed with respect to the following forces:
(a) Self-weight of car and counterweight; and
(b) Forces due to ship motion and static inclination.

2.1.7 For the safety device operation or the car striking the buffers, the lift is to be designed with respect to the following forces:
(a) Self-weight of the car and counterweight;
(b) Rated load;
(c) Dynamic forces due to lift motion; and
(d) Forces due to static vessel inclination.

2.1.8 Materials are to comply with the requirements of Ch 1,1.6 and Chapter 11. The selected steel grade is to comply with the Charpy V-notch test requirements given in Ch 4,2.25.

2.2 Basic loads

2.2.1 The self-weight load, L_W, is the load imposed on the hoisting mechanism by the weight of the permanent components of the lift car structure and machinery.

2.2.2 The rated load, L_C, is the load imposed on the lift car by the passengers and is to be not less than that obtained from Table 7.2.1. The load L_C is to be evenly distributed over those three quarters of the car being in the most unfavourable position.

2.2.3 Where lifts are mainly intended to carry goods which are generally accompanied by persons, the design is to take into account the load to be carried (including eccentricities) and the weight of any handling device (if applicable) which may enter the car in addition to the requirements of Table 7.2.1.

2.3 Dynamic forces due to lift motion

2.3.1 The dynamic forces due to the operation of the lift are to be taken into account by multiplying the self-weight and rated load by an impact factor, *k*, which is to be obtained from Table 7.2.2.

2.3.2 The rated speed, minimum stopping distance and buffer stroke are to be obtained from the lift specification to which the lift is constructed. Fig. 7.2.1 provides typical buffer strokes.

2.4 Static and dynamic forces due to ship motion

2.4.1 Passenger lifts, their associated machinery and structure are to be designed to operate at sea with respect to the following conditions:
(a) Roll: ±10°, with 10-second period.
(b) Pitch: ±7,5°, with 7-second period.

Table 7.2.1 Rated load

Rated load, in kg	Maximum available car area, in m^2	Maximum number of passengers
100	0,40	1
180	0,50	2
225	0,70	3
300	0,90	4
375	1,10	5
400	1,17	5
450	1,30	6
525	1,45	7
600	1,60	8
630	1,66	8
675	1,75	9
750	1,90	10
800	2,00	10
825	2,05	11
900	2,20	12

NOTES
1. For intermediate loads, the area is determined by linear interpolation.
2. The maximum number of persons carried is given by $\frac{L_c}{75}$, rounded down to the nearest whole number, where L_c is the rated load.
3. If the rated load exceeds by more than 15% that indicated in the Table for maximum available car area, the maximum number of passengers permitted is to correspond to that area.
4. Recesses and extensions, even of height less than 1 m, whether protected or not by separating doors, are only permitted if their area is taken into account in the calculation of the maximum available car area.

Table 7.2.2 Impact factors

Impact	Impact factor	Value
Operation of instantaneous safety gear or clamping device, neither of the captive roller type	k_1	5
Operation of instantaneous safety gear; or Clamping device, both of the captive roller type; or Pawl device with energy accumulation type buffer; or Energy accumulation type buffer	k_1	3
Operation of progressive safety gear; or Progressive clamping device; or Pawl device with energy dissipation type buffer; or Energy dissipation type buffer	k_1	2
Rupture valve	k_1	2
Running	k_2	1,2
Auxiliary parts	k_3	*See* Note

NOTE
The value is to be determined by the manufacturer accounting for the actual installation.

2.4.2 In addition to the operational conditions, the lift, associated machinery and structure are to be designed to withstand the forces resulting from consideration of the following conditions when in stowed condition:

(a) Roll: ±22,5°, with 10-second period.
(b) Pitch: ±7,5°, with 7-second period.
(c) Heave: Amplitude = 0,0125L with 10-second period.

where

L is the Rule length of the ship (*see* Pt 3, Ch 1 of the Rules for Ships).

2.4.3 The above periods apply if no actual ship-specific data is available. If the ship characteristics are known, the periods may be calculated using Ch 4,2.11.4. The forces due to ship motion are to be calculated in accordance with Ch 4,2.11.5 and 2.11.6. For the stowage condition as in 2.4.2, the angles can also be calculated as per Ch 4,2.11.4 if the ship characteristics are known.

2.4.4 The forces due to ship motion are to be applied at the centre of the gravity of the car and counterweight and centre of the gravity of the rated load of the car in all three directions: neutral to deck (F_N), in transverse (F_T) and longitudinal direction (F_L), and are to be considered for all relevant stress proofs.

2.5 Load combinations

2.5.1 The lift and its associated mechanism and structure are to be considered with respect to design loads resulting from the following conditions:

(a) **Case 1**: The lift in the 'operating condition' is to be considered with respect to forces due to ship motion resulting from the conditions defined in 2.4.1 and 2.4.3, together with the normal to deck components of dead load and live load multiplied by the factor, k_2, to be obtained from 2.3.1. This is represented by the following expression:

$$k_2 (F_{N,Lw} + F_{N,Lc}) + F_{T,Lw} + F_{T,Lc} + F_{L,Lw} + F_{L,Lc}$$

where

$F_{N,Lw}$ = normal to deck force resulting from self-weight L_w

$F_{N,Lc}$ = normal to deck force resulting from rated load L_c

$F_{T,Lw}$ = transverse force due to the static component of roll resulting from L_w

$F_{T,Lc}$ = transverse force due to the static component of roll resulting from L_c

$F_{L,Lw}$ = longitudinal force due to the static component of pitch resulting from L_w

$F_{L,Lc}$ = longitudinal force due to the static component of pitch resulting from L_c

(b) **Case 2**: The lift in the 'stowed condition' (self-weight only) is to be considered with respect to the forces resulting from the accelerations due to the ship's motion as defined in 2.4.2 and 2.4.3. This is represented by the following expression:

$$F_{N,Lw} + F_{T,Lw} + F_{L,Lw}$$

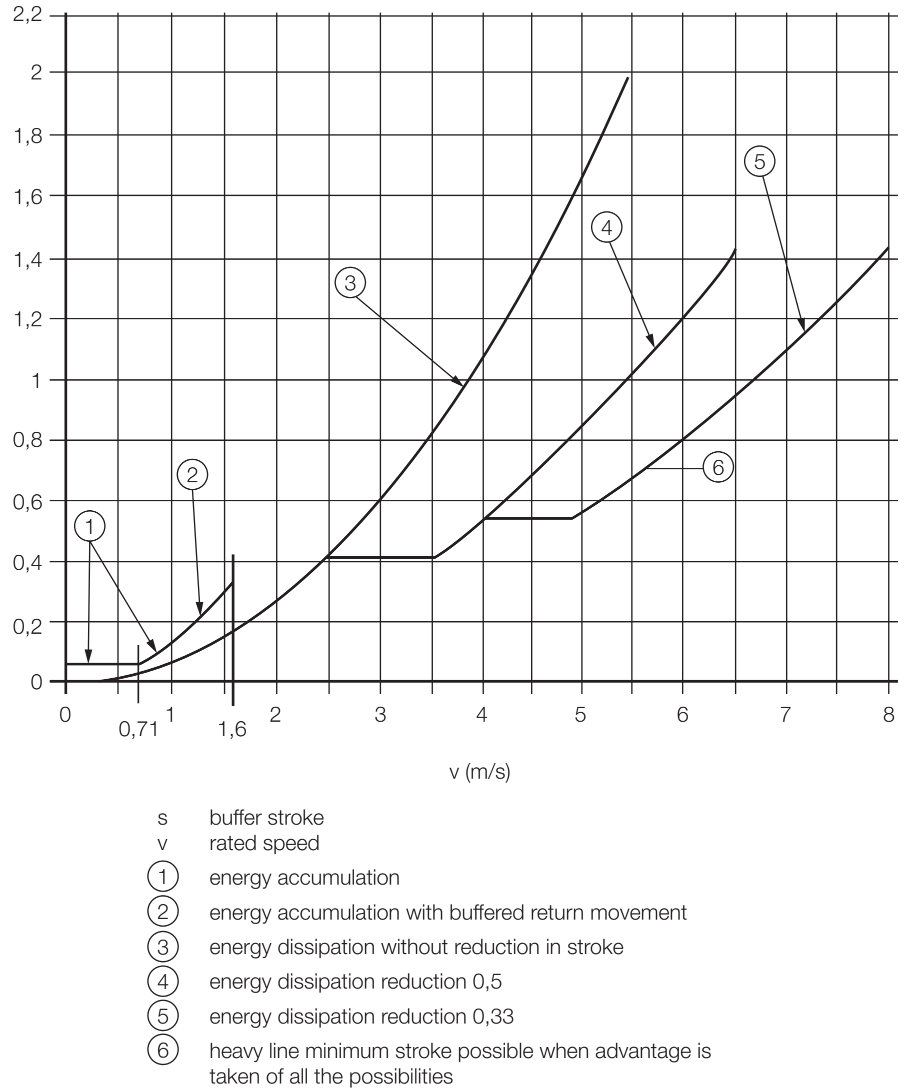


Fig. 7.2.1 Buffer strokes

(c) **Case 3**: The lift in the exceptional condition, e.g., buffer stroke, safety device operation or rupture valve operation, is to be considered with respect to the forces resulting from the inclinations due to ship motions, as defined in 2.4.1, together with the normal to deck components of dead load and live load multiplied by the factor k_1 which is to be obtained from 2.3.1. This is represented by the following expression:

$$k_1 (F_{stat,N,Lw} + F_{stat,N,Lc}) + F_{stat,T,Lw} + F_{stat,T,Lc} + F_{stat,L,Lw} + F_{stat,L,Lc}$$

where

$F_{stat,N,Lw}$ = normal to deck force resulting from static component of self-weight L_w

$F_{stat,N,Lc}$ = force normal to deck resulting from static component of the rated load L_c

$F_{stat,T,Lw}$ = transverse force resulting from the static component of roll angle resulting from L_w

$F_{stat,T,Lc}$ = transverse force resulting from the static component of roll angle resulting from L_c

$F_{stat,L,Lw}$ = longitudinal force resulting from the static component of the pitch angle due to L_w

$F_{stat,L,Lc}$ = longitudinal force resulting from the static component of the pitch angle due to L_c.

2.6 Allowable stresses

2.6.1 The allowable stress, σ_a, is to be taken as the failure stress of the component concerned multiplied by a stress factor, F, which depends on the load case considered. The allowable stress is given by the general expression:

$$\sigma_a = F\sigma$$

where

σ_a = allowable stress

F = stress factor

σ = failure stress.

2.6.2 The stress factor, *F*, for steels in which $\sigma_y/\sigma_u \leq 0{,}85$ is given in Table 7.2.3
where

σ_y = yield stress of material
σ_u = ultimate tensile stress of the material.

Table 7.2.3 Stress factor, *F*

Load case	Stress factor, *F*
Case 1	0,60
Case 2	0,75
Case 3	0,85

2.6.3 For steel with $\sigma_y/\sigma_u > 0{,}85$, the allowable stress is to be derived from the following expression:

$\sigma_a = 0{,}459F(\sigma_u + \sigma_y)$
$\tau_a = 0{,}266F(\sigma_u + \sigma_y)$

where

τ_a = allowable shear stress.

2.6.4 Steels with $\sigma_y/\sigma_u > 0{,}94$ are, generally, not acceptable and need to be specially considered.

2.6.5 The failure stress for the elastic modes of failure are given in Table 7.2.4.

Table 7.2.4 Failure stress

Mode of failure	Symbol	Failure stress
Tension	σ_t	$1{,}0\sigma_y$
Compression	σ_c	$1{,}0\sigma_y$
Shear	τ	$0{,}58\sigma_y$
Bearing	σ_{br}	$1{,}0\sigma_y$

2.6.6 For components subjected to combined stresses, the following allowable stress criteria are to be used:

(a) $\sigma_{xx} \leq \sigma_a$
(b) $\sigma_{yy} \leq \sigma_a$
(c) $\tau_o \leq \tau_a$
(d) $\sigma_e = \sqrt{\sigma_{xx}^2 + \sigma_{yy}^2 - \sigma_{xx}\,\sigma_{yy} + 3\tau_o^2} \leq 1{,}1\sigma_a$

where

σ_{xx} = applied stress in x direction
σ_{yy} = applied stress in y direction
τ_o = applied shear stress.

2.6.7 The allowable bearing stress for rotatable and fitted pin connections are to be taken as $\sigma_{a.br} = 0{,}8\sigma_y$ for Case 1 and Case 2 and $\sigma_{a.br} = 1{,}0\sigma_y$ for Case 3. The allowable bearing stress for rotatable pin connections with dynamics or loose fit will be specially considered. Ball and roller bearings are to be in accordance with a recognised National or International Standard. The allowable bearing stress for other surface-to-surface contact (pressures) is to be taken as in 2.6 in combination with Table 7.2.4.

2.6.8 In the case where the structural analysis is carried out by means of detailed finite element models, higher allowable stresses can be applied as follows:

(a) $\sigma_{xx.FE} \leq 1{,}1\sigma_a$
(b) $\sigma_{yy.FE} \leq 1{,}1\sigma_a$
(c) $\tau_{o.FE} \leq 1{,}1\tau_a$
(d) $\sigma_{e.FE} \leq 1{,}1^2\,\sigma_a$

Higher allowable stresses, as defined above, can only be applied if the actual stresses are localised. In the case where the actual stresses can also be calculated by means of analytical methods, these higher allowable stresses are not applicable and 2.6.1 to 2.6.7 are to be applied.

2.6.9 The allowable stress for plate buckling failure is to be taken as the critical buckling stress of the component concerned multiplied by the stress factor, *F*, as defined in Table 7.2.4. For the critical buckling stress *see* Ch 4,2.21.

2.7 Deflection criteria

2.7.1 The deflection of the car structural members is not to exceed *l*/600 mm.

2.7.2 The maximum permissible deflections for guide rails are as follows:

(a) 5,0 mm for guide rails on which safety gears are operating.
(b) 10,0 mm for guide rails without safety gears operating.

2.7.3 The car walls or doors in their closed position are to be able to resist without permanent deformation or elastic deformation greater than 15 mm a force of 300 N evenly distributed over a circular or square area of 500 mm^2, applied parallel to the deck from the inside towards the outside of the car. The doors are to be capable of operating normally after being subjected to this load.

2.7.4 The car roof is to withstand, without permanent deformation, a force of 2000 N representing two persons applied at any position, normal to deck and distributed over an area of 200 x 200 mm^2.

2.8 Guides

2.8.1 At least two steel guide rails are to be installed for each car and each counterweight or balance weight. The surface finish of the guide rails is to be sufficiently smooth to allow free running of the car and each counterweight.

2.8.2 The guide rails, their joints and attachments are to be designed to resist forces resulting from the load combinations as in 2.5.

2.8.3 The allowable stress for compression and bending in the guide rails is to be calculated in accordance with the methods described in Ch 4,2.18.

2.9 Safety gear

2.9.1 The car and counterweight are to be provided with a safety gear capable of operating only in a downward direction by gripping the guide rails. It is to be capable of stopping the fully laden car or counterweight at the tripping speed of the overspeed governor, even if the suspension device breaks. The car safety gear is to be tripped by an overspeed governor, but the counterweight safety gear may be tripped by failure of the suspension gear or by a safety rope, in case the rated speed does not exceed 1,0 m/s.

2.9.2 The car safety gear shall be:

(a) Of the progressive type if the rated speed of the life exceeds 1,0 m/s.

and may be:

(b) Of the instantaneous type with buffered effect if the rated speed is not in excess of 1,0 m/s.

(c) Of the instantaneous type if the rated speed does not exceed 0,63 m/s.

For hydraulic lifts, safety devices such as restrictors and rupture valves shall be provided.

2.9.3 The counterweight safety gear is to be of the instantaneous type if the rated speed is not in excess of 1,0 m/s and is to be of the instantaneous type with buffered effect in the case of rated speeds in excess of 1,0 m/s.

2.9.4 The jaws of safety devices are not to be used as guide shoes.

2.10 Overspeed governors

2.10.1 Tripping of the overspeed governors for the car safety gear is to occur at a speed of at least 115 per cent of the rated speed and less than the following:

(a) 0,8 m/s for instantaneous safety gears except for the captive roller type;

(b) 1,0 m/s for safety gears of the captive roller type;

(c) 1,5 m/s for instantaneous safety gear with buffered effect and for progressive safety gear used for rated speeds not exceeding 1,0 m/s; or

(d) $1,25v + 0,25/v$ for progressive safety gear for rated speeds exceeding 1,0 m/,

where

v = rated speed, in m/s.

2.10.2 The tripping speed of an overspeed governor for a counterweight safety gear is to be higher than that for the car safety gear but is not to exceed it by more than 10 per cent.

2.10.3 The force exerted by the overspeed governor when tripped is to be not less than the greater of:

(a) 300 N; or

(b) twice the force necessary to engage the safety gear.

2.10.4 The breaking load of the overspeed governor operating rope is to have a safety factor of 8:1 with respect to the force required to operate the safety gear. The rope is to be not less than 6,0 mm diameter and the ratio of the bottom of the sheave groove diameter to rope diameter is to be not less than 30:1.

2.11 Buffers

2.11.1 The car and counterweight are to be provided with buffers at their bottom limit of travel. When the car is resting on its fully compressed buffers, the free distance between the pit floor and the lower extension of the car floor is to be at least 0,5 m.

2.11.2 Energy accumulation type buffers are only to be used if the rated speed of the lift does not exceed 1,0 m/s. Energy accumulation type buffers with buffered return movement are to be used only if the rated speed of the lift does not exceed 1,6 m/s. Energy dissipation type buffers can be used at any rated speed of the lift.

2.11.3 Where energy accumulation type buffers with linear characteristics are used, the total possible stroke of the buffers are to be at least equal to twice the gravity stopping distance corresponding to 115 per cent of the rated speed, i.e.:

$S = 0,135V^2$, but not less than 0,065 m

where

S = stroke, in metres

V = rated speed, in metres/second.

Buffers are to be designed for the above stroke, under a static load between 2,5 and 4,0 times the self-weight of the car plus its rated load or the self-weight of the counterweight.

2.11.4 Where non-linear energy accumulation type buffers are used, the deceleration due to the buffers acting on a free-falling car (with the rated load in it and 115 per cent of the rated speed) is not to exceed $1,0g$ on average. The maximum deceleration is not to exceed $2,5g$ and the return speed of the car is not to exceed 1 m/s.

2.11.5 No permanent deformation after buffer contact is permitted.

2.12 Hoisting arrangements

2.12.1 Each lift is to have at least one engine of its own. The hoisting arrangements may consist of:

(a) Traction drive using sheaves and ropes; or

(b) Positive drive, consisting of:
  (i) Drum and rope without counterweight; or
  (ii) Sprocket and chain.

(c) Hydraulic cylinders, which are either directly or indirectly acting.

2.12.2 The ratio of the pitch diameter of sheaves, pulleys or drums and the rope diameter of the suspension rope is to be at least 39:1. Where drum drive is used, the drum is to be grooved and the fleet angle of the rope in relation to the groove is not to be greater than 4° either side of the groove axis.

2.12.3 Not more than one layer of rope is to be wound on the drum and when the car rests on its fully compressed buffers, one and a half turns of rope are to remain in the grooves.

2.12.4 The safety factor of the means of suspension, defined as the ratio of minimum breaking load of the rope/chain to the maximum load on the rope/chain when the car is at its lowest level and subjected to its rated load, is to be not less than:

(a) 12:1 in the case of traction drive with three ropes or more.
(b) 16:1 in the case of traction drive with two ropes.
(c) 12:1 in the case of drum drive or indirect hydraulic lifts.
(d) 10:1 in the case of suspension chains.

2.12.5 A device is to be fitted at one end of the hoisting arrangement to equalise the tension in the ropes or chains. In the case of a two rope/chain suspension, a device is to be fitted which stops the lift in the case of abnormal relative extension of one rope/chain. Positive drive lifts are to have a slack rope/chain detection device. If more than one hydraulic cylinder is provided, they are to be hydraulically connected to ensure pressure and compression force equilibrium in the hydraulic cylinder.

2.12.6 Where compensating ropes are used, the ratio between the pitch sheave groove diameter and diameter of the rope is to be not less than 30:1.

2.12.7 For traction sheaves, pulleys and sprockets, protection is to be provided to avoid:

(a) Bodily injury.
(b) The ropes/chains leaving the pulleys/sprockets, if slack.
(c) The introduction of objects between ropes/chains and pulleys/sprockets.

2.12.8 The junction between the rope and the rope termination is to be able to resist at least 80 per cent of the minimum breaking load of the rope.

2.12.9 The lift is to be provided with a braking system which operates automatically in the event of loss of the mains power supply or in the event of the loss of the supply to control circuits. Furthermore, it is to be equipped with an emergency operation device either working manually or with means of emergency electrical operation.

2.13 Lift trunk and motor room

2.13.1 In sections of the ship where the lift trunk is required to contribute against the spread of fire, the lift trunk and machinery spaces are to be completely enclosed, suitably ventilated and constructed to give fire protection in compliance with the requirements of SOLAS 1974, as amended.

2.13.2 Clearances around the car are also to be guarded or arranged to preclude the possibility of personnel falling between the car and trunk. In addition, when the counterweight rests on its fully compressed buffer, the free distance above the roof of the car is to be at least 0,75 m.

2.13.3 Only pipes and cables belonging to the lift may be installed in the trunk. Travelling cables are to be protected by an internally smooth metal trough which is to be provided with a slot having rounded edges to allow free passage of the cables leaving the lift car and be of sufficient width to allow passage of the free hanging loop of the travelling cable.

2.13.4 Where two or more lifts are fitted into one trunk, each car and its associated counterweight is to be separated by means of sheet steel over the full height of the trunk.

2.13.5 The lift trunk is not to be part of the ship's ventilation ducting but is to be ventilated by an independent system.

2.13.6 The trunk entrances are to be located to prevent the ingress of water or cargo into the trunk. The deck areas at entrances are to be non-slip and of approved material which will not readily ignite.

2.13.7 Where the lift is for the crew, the headroom of the trunk (the space above the car roof when the car is in its highest position) is to incorporate an escape hatch which opens outwards of at least 0,24 m^2 with a side length not less than 350 mm.

2.13.8 The floor of the pit is to be able to support the car buffer considering four times the static load being imposed by the mass of the fully laden car without permanent deformation. In addition, if accessible spaces do exist below the car, the counterweight or the balancing weight, the base of the pit is to be designed for an imposed load of at least 5 kN/m^2.

2.14 Lift car and counterweight

2.14.1 The car is to be constructed of steel or equivalent non-flammable material, have a non-slip floor and be provided with at least one handrail where access for persons is clearly available. A load plate is to be prominently displayed specifying the safe working load in persons and kilograms.

2.14.2 The car entrances are to be provided with doors of an imperforate type fitted with devices to prevent untimely opening and slamming. The clearance between the car and car door is to be not more than 6,0 mm.

2.14.3 Power operated doors are to be of the centre opening balanced type and manual doors of the two-panel centre opening type or concertina or telescopic type opening from one side only. Alternative arrangements which are considered to be of equivalent safety will be accepted. The effort needed to prevent the door from closing is not to exceed 150 N. Manual single sliding entrances of the concertina or telescopic type are to be fitted with devices to prevent slamming.

2.14.4 The car and counterweight are to be guided over their full travel, including overtravel and an independent guidance medium to limit car movement in the event of primary guidance failure.

2.14.5 Counterweights are to be constructed of steel or equivalent material and filler weights are to be securely clamped in position within steel frames. Concrete filler weights are not permitted. A suitable device is to be fitted to stop and support the counterweight in the event of rope failure.

2.14.6 Traction drive lifts are to incorporate a device to stop and support the car if:

(a) When a start is initiated, the lift machine does not rotate.
(b) The car or counterweight is stopped in a downwards movement by an obstruction which causes the ropes to slip on the driving pulley.

2.14.7 The device is to function in a time not greater than the lesser of the following values:

(a) 45 seconds.
(b) Time for the car to travel the full travel distance plus 10 seconds, with a minimum of 20 seconds if the full travel time is less than 10 seconds.

2.14.8 The device is not to affect either the inspection or electrical recall operation.

2.14.9 The lift is to be fitted with a device to prevent the lift operating in the event of overload in the car. The overload is defined as rated load plus 10 per cent with a minimum of rated load plus 75 kg.

2.15 Landing doors

2.15.1 Steel doors are to be fitted at all entrance stations. When closed, the doors are to provide fire resistance at least as effective as the trunk to which they are fitted.

2.15.2 Power operated doors are to be of the centre opening balanced type and manual doors of the two-panel centre opening type or concertina or telescopic type opening from one side only. Alternative arrangements which are considered to be of equivalent safety will be accepted. The effort needed to prevent the door from closing is not to exceed 150 N. Manual single sliding entrances of the concertina or telescopic type are to be fitted with devices to prevent slamming.

2.15.3 The doors, including their locks, are to have mechanical strength such that in the locked position they are to be able to resist, without permanent deformation or elastic deformation greater than 15 mm, a force of 300 N. The force is to be evenly distributed over an area of 500 mm^2 applied at right angles to the panel at any point on either face. The doors are to be capable of operating normally after being subjected to this load.

2.15.4 When the distance between consecutive landing doors exceeds 11 m, intermediate emergency doors are to be provided.

2.15.5 The horizontal distance between the sill of the car and the sill of the landing doors is not to exceed 35 mm.

2.16 Emergency means of escape

2.16.1 To enable crew to escape independently, the trunk is to be fitted with a ladder over its entire length leading to the escape hatch in the headroom.

2.16.2 For lifts intended solely for passengers, a suitable ladder is to be provided to give access to the lift car roof from a landing door. Another is to be provided to give access into the car from the emergency opening in the car roof. These ladders are to be kept in a watchkeeping room or another room accessible to competent persons.

2.16.3 A trap door in the roof of the lift car with suitable access to it from the inside is to be provided with an opening of at least 0,24 m^2, having a side length not less than 350 mm. Where the lift is solely for passengers, the trap door is to be fitted with a mechanical lock which can only be operated from the outside. Where the lift is solely for crew, the trap door is to be fitted with a mechanical lock which can be operated from inside and outside the car.

2.16.4 For crew lifts, an escape hatch is to be provided in the headroom of the trunk. Opening the hatch from the outside is only to be possible by means of a special key which is to be kept in a box immediately by the hatch.

2.16.5 Notices in English, other languages and pictographs as necessary, describing the escape routine, are to be fixed in the following locations:

(a) Inside the car.
(b) On the car roof.
(c) Inside the trunk, adjacent to every exit.

■ *Section 3* Service lifts

3.1 General

3.1.1 This Section applies to electric and hydraulic powered service lifts which are generally not to be accompanied by personnel. Service lifts may be operated whilst the ship is in a harbour or sheltered water environment (i.e., *Standard Service Category*) and/or when the ship is at sea (i.e., *Specified Service Category*).

3.1.2 This Section applies also to service lifts where cargo may be stowed on them in their stowed position whilst the ship is at sea.

3.1.3 Service lifts are in principle to be designed as per Section 2 unless otherwise stated in this Section.

3.1.4 For the operating condition within the confines of a harbour or sheltered waters, *see* 3.1.1. The service lift is to be considered with respect to the following forces and loads:

(a) Self-weight of car and counterweight (if applicable).
(b) Rated load and loading operations (if applicable).
(c) Dynamic forces due to cargo lift motion.
(d) Forces due to static inclination.

3.1.5 For the operating condition while the vessel is at sea (if applicable, *see* 3.1.1), the service lift is to be considered with respect to the following forces and loads:
(a) Self-weight of car and counterweight (if applicable).
(b) Rated load and loading operations (if applicable).
(c) Dynamic forces due to cargo lift motion.
(d) Forces due to ship motion and static inclination.

3.1.6 The service lift structure is also to be examined with respect to the stowed condition for the following criteria appropriate to the ship's characteristics:
(a) Self-weight of car and counterweight (if applicable).
(b) Rated load (if applicable, *see* 3.1.2).
(c) Forces due to ship motion and static inclination.

3.1.7 For the safety device operation or the service lift striking the buffers, the lift is to be designed with respect to the following forces:
(a) Self-weight of the car and counterweight (if applicable).
(b) Rated load.
(c) Dynamic forces due to service lift motion.
(d) Forces due to static vessel inclination.

3.2 Hoisting arrangements

3.2.1 The safety factor of the means of suspension, defined as the ratio of minimum breaking load of the rope/chain to the maximum load on the rope/chain when the car is at its lowest level and subjected to its rated load, is to be not less than 8:1 in the case of suspension chains and wire ropes.

3.3 Safety gear

3.3.1 The safety gear may be of the instantaneous type.

3.4 Landing and car doors

3.4.1 The car is to be fitted with a door. Alternative proposals to prevent the rated load from getting in contact with items outside the car (i.e., lift trunk) will be specially considered.

3.4.2 The landing doors are to be in accordance with 2.15.2. Alternative proposals to install manual single leaf doors will be specially considered.

3.5 Deviations from Section 2

3.5.1 The following parts from Section 2 are explicitly not applicable to service lifts:
(a) Table 7.2.1.
(b) 2.13.7.
(c) 2.15.4.
(d) 2.16.

Contents

■ *Section 1* General

1.1 Application

1.1.1 Fittings, loose gear and ropes are, in general, to be manufactured in accordance with International or recognised National Standards.

1.1.2 Tables of standard dimensions for certain fittings and items of loose gear are given in this Chapter. These dimensions are nominal and appropriate allowance is to be made for working tolerances. The symbols used are shown on sketches of typical designs of these items, which are given here for illustration purposes only.

1.1.3 Tables of minimum breaking loads for a range of steel wire ropes and fibre ropes are also given.

1.1.4 Alternative designs and designs for items not covered by appropriate standards will be considered on the general basis of the requirements of this Chapter.

1.1.5 For large items that exceed the scope of current National Standards, or where the standard formulae in this Code are not appropriate (e.g., ramshorn hooks on heavy lift applications), full calculations in support of the design of the item are to be submitted for consideration. Alternatively, a programme of prototype testing may be agreed to demonstrate the adequacy of the item.

1.1.6 The safe working load (SWL) of any item is to be not less than that required by the appropriate requirements of this Code for the position occupied by the item in the rig.

1.2 Materials and construction

1.2.1 Materials are to comply with the requirements of Ch 1,1.6.

1.2.2 Steel for bearing brackets and other items welded to the ship's structure (including to the masts, derrick posts and crane pedestals) is, generally, to comply with the requirements of the *Rules for the Manufacture, Testing and Certification of Materials* (hereinafter referred to as the Rules for Materials). The grade of steel is to be selected in accordance with LR steel grades equivalent to Table 4.2.18 and Table 4.2.20 in Chapter 4, with the operating temperature chosen as being the lesser of either that from an assigned winterisation notation or the defined minimum design temperature for the crane in operation.

1.2.3 Steel for other items is to comply with LR's requirements as in 1.2.2 or with an appropriate National Standard approved by LR as suitable for the intended purpose, *see also* Ch 1,1.6.

1.2.4 Where items are flame cut from solid material, they are subsequently to be machined or forged and machined as necessary and the faces are to be dressed to give a smooth finish. Attention is to be paid to the rolling direction of the plate.

1.2.5 Steel castings and forgings are to be normalised or otherwise heat-treated at a temperature and according to a method appropriate to the material and size of the item.

1.2.6 Cast, forged and fabricated items are to be so designed and constructed as to minimise stress concentrations. Fabricated items are to be designed to ensure good penetration of welds and to provide adequate accessibility for non-destructive examination (NDE).

1.2.7 Large cast items, e.g., large capacity hooks, are to be thoroughly examined by NDE to check that there are no internal defects in the casting nor any surface defects.

1.2.8 All bearing surfaces are to be machined to ensure a smooth finish and good fit. Adequate and accessible means of lubrication are to be provided.

1.2.9 Plain or bushed bearings are to be designed so that the mean pressure based on the projected area of the bearing does not exceed the values given in the appropriate Sections of this Chapter. Where roller, ball or similar bearings are fitted, the loading is not to exceed the value recommended by the manufacturer.

1.3 Testing and certification

1.3.1 The requirements for testing of finished equipment and certification are given in Chapter 12.

Section 2
Fittings

2.1 Gooseneck and derrick heel assemblies

2.1.1 The safe working load of the gooseneck and derrick heel assembly is to be taken as the least of the values determined separately for the gooseneck pin, the derrick heel lugs and the derrick heel crosspin. Standard dimensions for these items and for the gooseneck bearing bracket, with corresponding safe working loads, are given in Table 8.2.1 to Table 8.2.3 and the items are illustrated in Fig. 8.2.1 to Fig. 8.2.3.

2.1.2 Where arrangements other than those covered by the Tables or by recognised Standards are proposed, the dimensions of the components of the assembly are to be such that the stresses given in Table 8.2.4 are not exceeded.

2.1.3 Where a gooseneck pin is supported by two bearings, the diameter of the pin in way of the lower bearing may be reduced to $0{,}6d_1$, provided the bearings are spaced such that (a + b) is greater than $3{,}0d_1$, *see* Fig. 8.2.3 for illustration of these terms. Proposals for a greater reduction on large gooseneck pins will be specially considered.

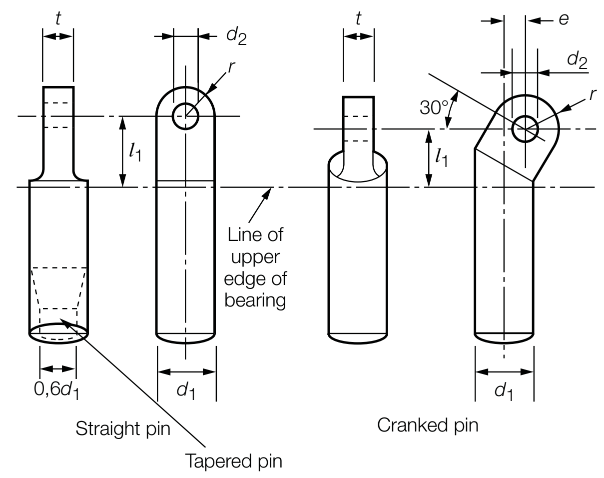


Fig. 8.2.1 Gooseneck pins

Table 8.2.1 Dimensions of gooseneck pins

Boom axial thrust, in tonnes	Straight pins d_1	Straight pins l_1	Cranked pins d_1	Cranked pins l_1	e	d_2	r	t
1,6	50	60	—	—	—	24	25	26
2,0	50	60	—	—	—	26	25	28
2,5	60	60	55	60	35	29	30	30
3,2	70	85	60	65	38	32	35	33
5,0	70	70	65	70	40	35	35	36
5,0	80	85	70	80	46	41	40	40
6,3	90	100	80	85	49	44	45	45
8,0	100	105	90	90	52	47	50	50
10,0	110	120	100	100	58	54	55	57
12,5	120	125	110	105	61	58	60	64
16,0	140	150	120	110	64	67	70	73
20,0	155	170	130	115	67	75	75	82
25,0	170	200	140	125	72	79	80	92
32,0	190	210	155	140	78	83	85	102
40,0	190	220	170	155	85	93	95	112
50,0	200	220	—	—	—	103	100	124
63,0	225	245	—	—	—	113	113	140
80,0	250	275	—	—	—	129	125	150
100,0	275	290	—	—	—	144	138	160

NOTES
1. All dimensions are given in millimetres and are illustrated in Fig. 8.2.1.
2. Straight gooseneck pins for axial thrusts exceeding 20 t are generally tapered, *see* 2.1.3.

Table 8.2.2 Dimensions of derrick heel assemblies

Boom axial thrust, in tonnes	a	b	c	r	t	d_2	$d_{crosspin}$
1,6	32	80	28	25	16	24	22
2,0	35	90	30	28	16	26	24
2,5	45	107	32	30	22	29	27
3,2	50	112	35	32	22	32	30
4,0	50	120	38	35	25	35	33
5,0	55	135	42	42	25	41	39
6,3	60	145	47	45	32	44	42
8,0	65	153	53	48	32	47	45
10,0	70	173	60	55	40	54	52
12,5	75	188	67	60	40	58	56
16,0	85	208	76	68	45	67	64
20,0	95	235	85	75	50	75	72
25,0	100	260	95	80	60	79	76
32,0	105	270	105	85	70	83	80
40,0	115	300	115	95	70	93	90
50,0	125	325	127	105	80	103	100
63,0	135	340	144	115	80	113	110
80,0	160	350	154	130	100	129	125
100,0	175	370	164	145	100	144	140

NOTES
1. All dimensions are given in millimetres and are illustrated in Fig. 8.2.2.
2. Values of *a* and *b* may be adjusted for other forms of rib stiffening.

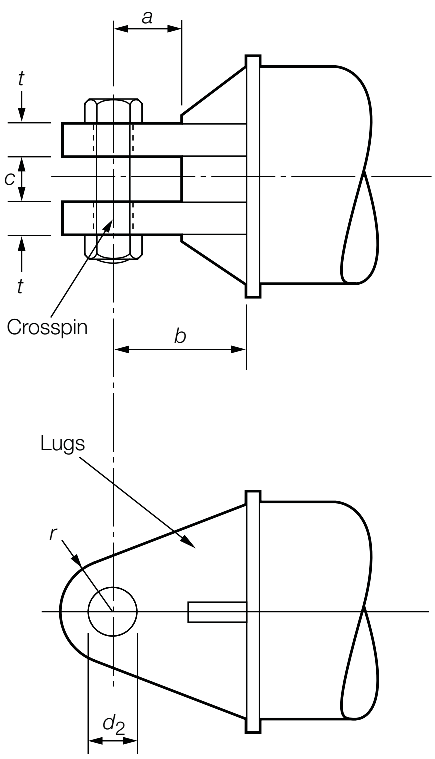


Fig. 8.2.2 Derrick heel assembly

Table 8.2.3 Dimensions of gooseneck bearing brackets

Gooseneck pin diameter, d_1	a	b	c	d_3	t_1	t_2
50	95	45	70	85	12	10
55	95	45	80	90	12	10
60	95	50	90	100	12	10
65	120	50	100	110	12	10
70	120	60	115	120	12	10
80	140	60	130	130	12	10
90	140	70	145	140	12	10
100	175	70	160	160	15	10
110	175	80	175	170	20	10
120	215	80	190	190	20	12
130	215	90	205	200	22	12
140	215	90	225	210	25	12
155	235	100	235	230	30	15
160	235	100	240	235	30	15
170	235	100	250	250	30	15
180	235	100	270	260	30	15
190	255	110	285	280	33	18
200	255	110	300	290	35	18
225	255	120	315	325	40	20
250	275	130	330	360	40	20
275	275	140	345	395	40	20

NOTES
1. All dimensions are given in millimetres and are illustrated in Fig. 8.2.3.
2. The width of bracket at the mast (dimension w in Fig. 8.2.3) is to be not less than 0,67 times the diameter of the mast at that point.

Table 8.2.4 Stresses in gooseneck and derrick heel assemblies

Item	Boom axial thrust, T, in tonnes		
	$T \leq 25$ N/mm^2	$25 < T$ 50 N/mm^2	$50 < T$ N/mm^2
Gooseneck pin: Bending plus direct stress	90	$40 + 2T$	140
Bearing pressure	$20 + 0{,}5T$	$20 + 0{,}5T$	45
Derrick heel crosspin: Shear stress	$25 + 0{,}4T$	35	35
Bending plus shear stress	$90 + T$	$90 + T$	140
Bearing pressure	$20 + 0{,}5T$	$20 + 0{,}5T$	45
Gooseneck pin collar: Horizontal bearing pressure	10 N/mm^2		
Minimum diameter	$1{,}15d_1$ mm		
Bearing bracket	Total stress in any part is not to exceed $0{,}45\sigma_y$		

2.2 Swivel bearing assemblies

2.2.1 The safe working load of the assembly is to be taken as the least of the values determined separately for the individual components. Standard dimensions for the trunnion, pin and bearing bracket with corresponding safe working loads are given in Table 8.2.5 and Table 8.2.6 and the items are illustrated in Fig. 8.2.4.

2.2.2 Where arrangements other than those covered by the Tables or by recognised Standards are proposed, the dimensions of the components of the assembly are to be such that the stresses given in Table 8.2.7 are not exceeded.

2.3 Fixed eyeplates

2.3.1 Fixed eyeplates at the derrick boom head are generally to be in accordance with the dimensions given in Table 8.2.8.

2.3.2 The dimensional details of the fittings may differ at opposite ends depending on the loads to be carried. Where the fitting is made continuous and of the larger thickness required by the Table, care is to be taken to ensure that this thickness is suitable for the proposed shackle or other attachment to the eyeplate.

2.3.3 It is highlighted that an increase in the dimension e_1 or e_2 will result in an increased bending moment on the derrick boom and this may result in increased scantlings.

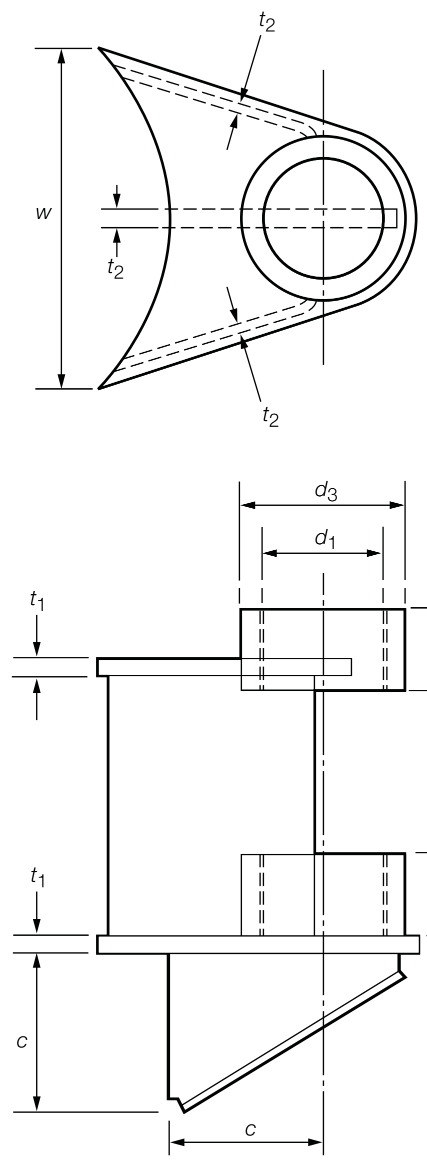


Fig. 8.2.3 Gooseneck bearing

2.3.4 Fixed eyeplates attached to the ship's structure for use with the cargo gear are to have dimensions generally in accordance with Table 8.2.9. Attention is to be given to the stresses which may arise from applied forces not in the plane of the eyeplate. Where the dimensions of the eyeplate differ from the Table values, the safe working load may be taken as:

$$\text{SWL} = \frac{0{,}04d^2\, t^2}{4d\,(b + 0{,}5d) + t\,(a + 0{,}4d)} \text{ tonnes}$$

where
dimensions a, b, d and t are illustrated in Fig. 8.2.6.
Where the cross-section of the eyeplate varies, the minimum value of (d x t) is to be used for the calculation.

2.3.5 Adequate support is to be provided by the ship structure in way of the eyeplate. Arrangements to give effective spread of the load into the surrounding structure may be required, *see also* Ch 2,8.9.

2.4 Built-in sheaves

2.4.1 Where a built-in sheave is fitted in the derrick boom, the diameter of the sheave is to be not less than that required for the rope nor less than 1,2 times the derrick boom diameter at that point. The material, construction and design of the sheave, sheave pin and supports are to be in accordance with Section 3.

Table 8.2.5 Dimensions of swivels

SWL, in tonnes	a	b	d_1	d_2	d_3	r_1	t_1	d_{pin}
2,0	75	90	34	65	25	25	22	32
4,0	95	110	42	80	33	33	30	40
6,3	110	130	47	90	42	43	40	45
8,0	120	150	52	100	48	48	45	50
10,0	130	170	57	110	52	55	50	55
12,5	140	190	62	120	56	60	55	60
16,0	150	215	68	130	65	65	60	65
20,0	170	240	78	150	74	70	65	75
25,0	180	270	83	160	78	75	70	80
32,0	190	300	93	180	86	85	80	90
40,0	210	330	103	200	96	95	90	100
50,0	235	380	113	220	106	105	100	110
63,0	260	410	123	240	116	115	110	120
80,0	295	480	134	260	131	135	125	130
100,0	330	540	144	280	146	148	140	140

NOTES
1. All dimensions are given in millimetres and are illustrated in Fig. 8.2.4.
2. SWL is the required SWL of the bearing assembly.

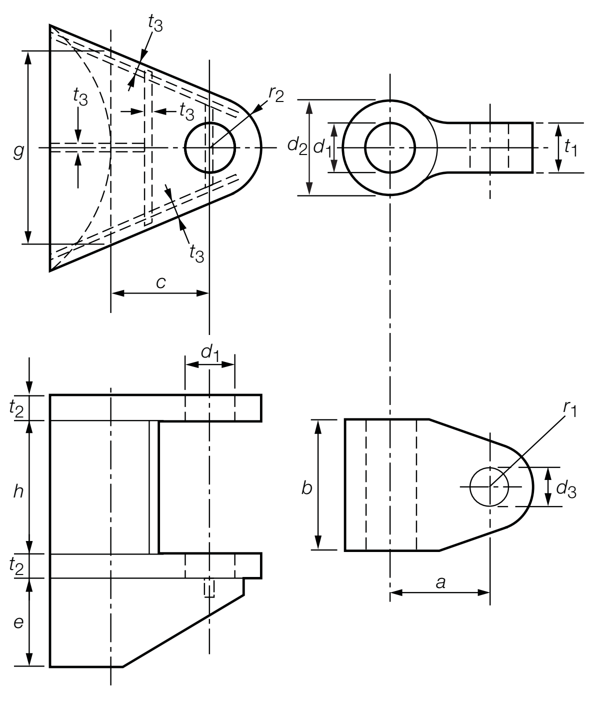


Fig. 8.2.4 Swivel bearing assemblies

Table 8.2.6 Dimensions of swivel bearing brackets

SWL, in tonnes	c	d_1	e	g	h	t_2	t_3	r_2
2,0	75	34	75	140	95	21	10	35
4,0	95	42	80	160	115	15	10	43
6,3	115	47	90	180	135	20	10	48
8,0	140	52	110	200	155	25	10	55
10,0	160	57	125	230	175	25	12	60
12,5	175	62	140	260	195	30	12	65
16,0	190	68	150	290	223	30	12	70
20,0	205	78	160	320	248	35	15	80
25,0	220	83	180	240	278	35	15	85
32,0	220	93	190	370	308	40	15	95
40,0	245	103	190	410	338	45	15	105
50,0	270	113	210	450	388	45	18	115
63,0	300	123	230	500	420	50	20	125
80,0	335	134	260	560	490	50	20	135
100,0	375	144	300	630	550	55	20	148

NOTES
1. All dimensions are given in millimetres and are illustrated in Fig. 8.2.4.
2. SWL is the required SWL of the bearing assembly.

Table 8.2.7 Stresses in swivel bearing assemblies

Item	Safe working load, in tonnes	
	SWL ≤ 25, N/mm^2	25 < SWL, N/mm^2
Swivel pin:		
Shear stress	25 + 0,4 SWL	35
Bearing pressure	40 + 0,6 SWL	55
Trunnion eyeplate:		
Shear pullout at hole	50	
Bearing bracket	Total stress on any part is not to exceed 0,45σ_y	

NOTE
Safe working load is the required SWL of the bearing assembly.

Table 8.2.8 Dimensions of fixed eyeplates at the derrick boom head

SWL, in tonnes	Oval eye *a*	Round eye *b*	e_1	t_1	*d*	r_2	e_2	t_2
2,0	50	27	50	25	25	25	40	22
2,5	55	29	54	25	27	28	40	25
3,2	66	33	57	30	30	30	45	28
4,0	77	36	65	35	33	33	50	30
5,0	87	41	70	40	39	38	55	35
6,3	91	45	75	40	42	43	60	40
8,0	101	51	80	50	48	48	70	45
10,0	117	56	90	50	52	55	75	50
12,5	128	61	100	60	56	60	80	55
16,0	145	67	115	60	65	65	85	60
20,0	157	73	125	70	74	70	95	65
25,0	170	80	135	80	78	75	100	70
32,0	194	88	150	90	86	85	110	80
40,0	220	98	170	100	96	95	120	90

NOTES
1. All dimensions are given in millimetres and are illustrated in Fig. 8.2.5.
2. The dimensions e1 and e2 are to be measured from the outside surface of the derrick boom tube, or the outside surface of the doubling plate, if fitted.

Table 8.2.9 Dimensions of eyeplates at ship's structure

SWL, in tonnes	*a*	*b*	*d*	*t*
1,0	35	22	16	16
1,6	42	24	20	20
2,0	50	27	25	25
2,5	55	29	25	25
3,2	66	33	30	30
4,0	77	36	35	35
5,0	87	41	40	40
6,3	91	45	40	40
8,0	101	51	50	50
10,0	117	56	50	50
12,5	128	61	60	60
16,0	145	67	60	60
20,0	157	73	70	70
25,0	170	80	80	80
32,0	194	88	90	90
40,0	220	98	100	100
50,0	240	108	110	110

NOTE
All dimensions are given in millimetres and are illustrated in Fig. 8.2.6.

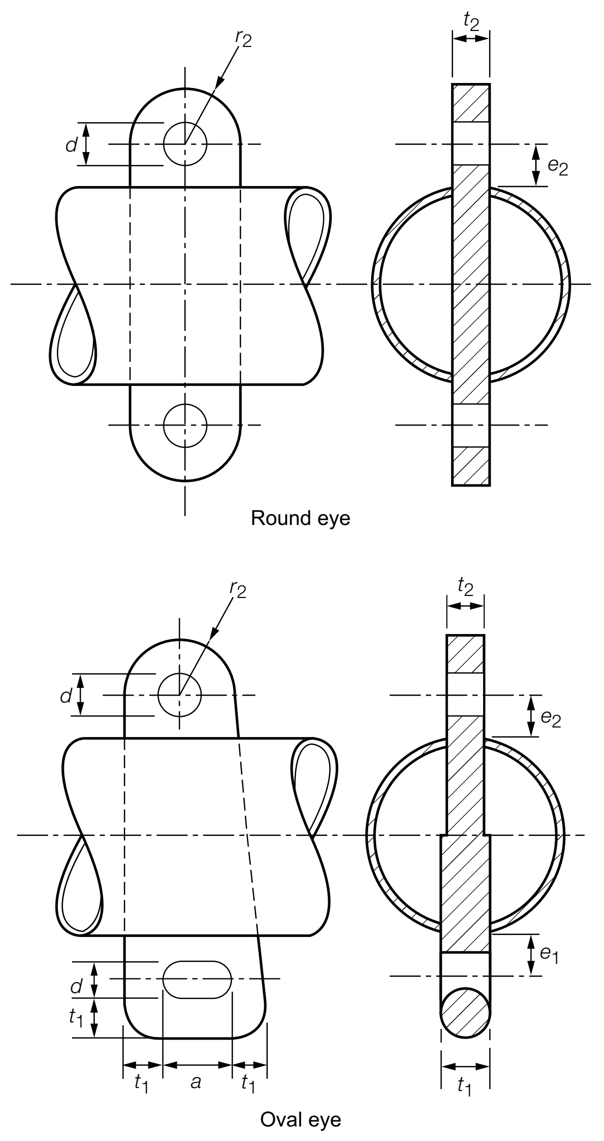


Fig. 8.2.5 Fixed eyeplates at the derrick boom head

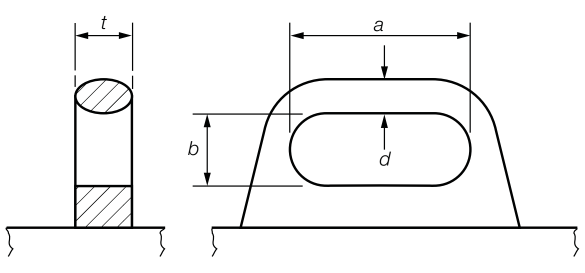


Fig. 8.2.6 Fixed eyeplate at the ship's structure

Section 3 Blocks

3.1 General

3.1.1 A typical cargo block is shown diagrammatically in Fig. 8.3.1 with the component items labelled for reference.

3.1.2 The ultimate strength of the block as an assembled unit is in no case to be less than five times the resultant load for which the block is designed. For blocks that are used in situations where the hoisting factor, F_h, for the lifting appliance is greater than 1,6, a block of larger nominal capacity is to be used such that the normal test load meets the requirements of Note 4 in Table 12.1.1.

3.1.3 The safe working load of each block is to be appropriate to its particular position in the rig and is to be not less than the resultant load determined in accordance with the appropriate Chapter of this Code. Blocks are not to be used in positions other than those for which they were approved without first confirming that their safe working load is at least that required for the proposed location.

3.1.4 The required safe working load of the block is to be determined by reference to the resultant load, *R*, imposed on the block at its particular position in the rig.

3.1.5 The safe working load of a single sheave block is assessed on one particular condition of loading, namely where the block is suspended by its head fitting and where the cargo load is attached to a wire passing around the sheave such that the hauling part is parallel to the part to which the load is attached, *see* Fig. 8.3.2. The SWL marked on the block is the weight, *W* in tonnes, that can safely be lifted by the block, when rigged in this way. The resultant load, *R*, on the head fitting (neglecting friction) is, however, twice the SWL marked on the block, i.e., 2*W* tonnes. The block and head fitting must, therefore, be designed to take a resultant force of 2*W* tonnes and the proof-load applied to the head fitting must be based on this resultant force. That is, the proof-load will be 4*W* tonnes.

3.1.6 When the same block is rigged as a lower cargo block (the load being attached to the head fitting), the SWL marked on the block is unchanged, but the resultant force on the head fitting is only *W* tonnes. As the block has been designed to withstand a resultant load on the head fitting of 2*W* tonnes, the block is safe to support a cargo load of 2*W* tonnes.

3.1.7 For single sheave blocks with beckets, the SWL marked on the block is to be not less than one half the resultant load on the head fitting.

3.1.8 Fig. 8.3.2 gives examples of the use of single sheave blocks and the method of obtaining their SWLs. In all cases with single sheave blocks, the shackle or link securing the block is to be marked with an SWL which is twice the SWL marked on the block.

3.1.9 The safe working load marked on any multiple sheave block is to correspond to the maximum resultant load on the head fitting of that block.

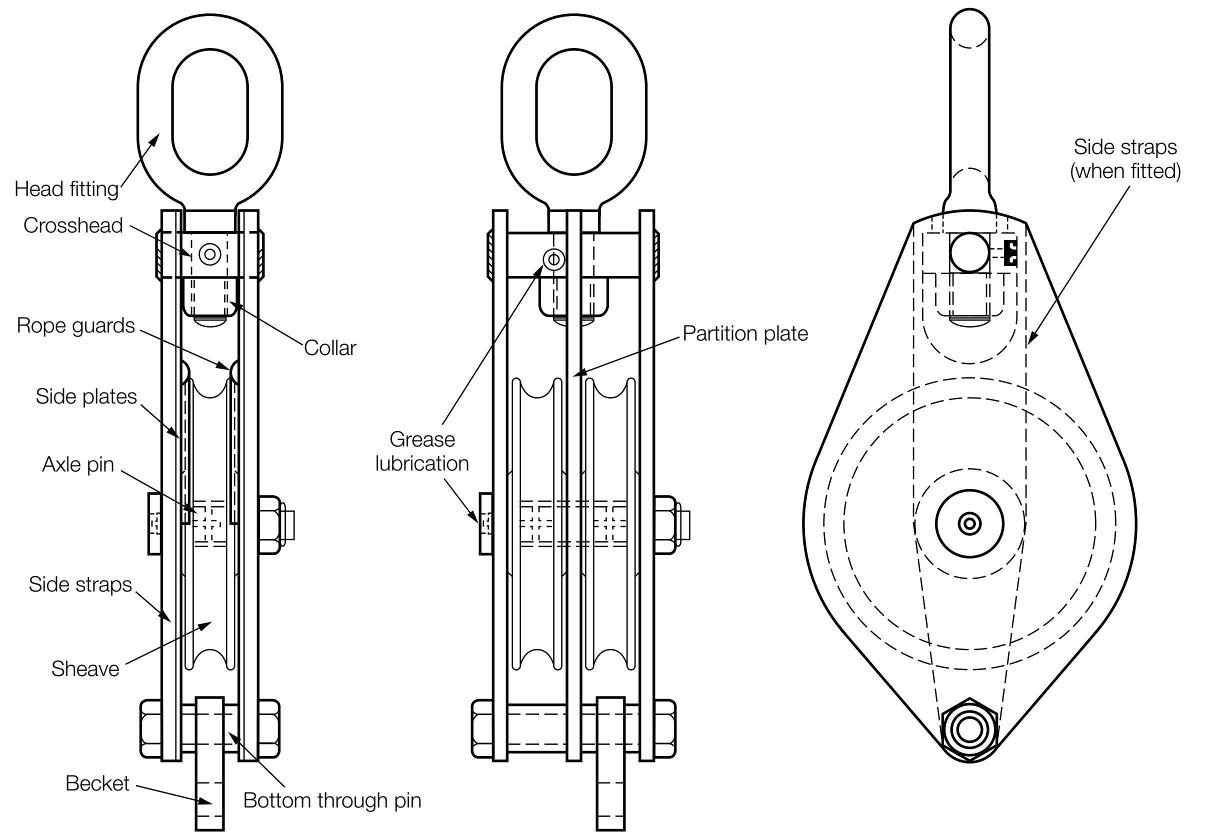


Fig. 8.3.1 Typical cargo block

3.2 Design loads and stresses

3.2.1 The percentage of the resultant load on the head fitting which is transmitted by a sheave is to be taken as not less than the value given in Table 8.3.1.

3.2.2 The percentage of the resultant load on the head fitting which is transmitted to the side straps and partition plates of the sheave is to be taken as not less than the value given in Table 8.3.2.

3.2.3 The load on a becket, where fitted, is to be taken as the maximum load to which it may be subjected in service.

3.2.4 The stresses in the component parts of the block are to be determined from the unfactored loads transmitted from the sheaves and straps and are not to exceed the values given in Table 8.3.3.

3.3 Materials and construction

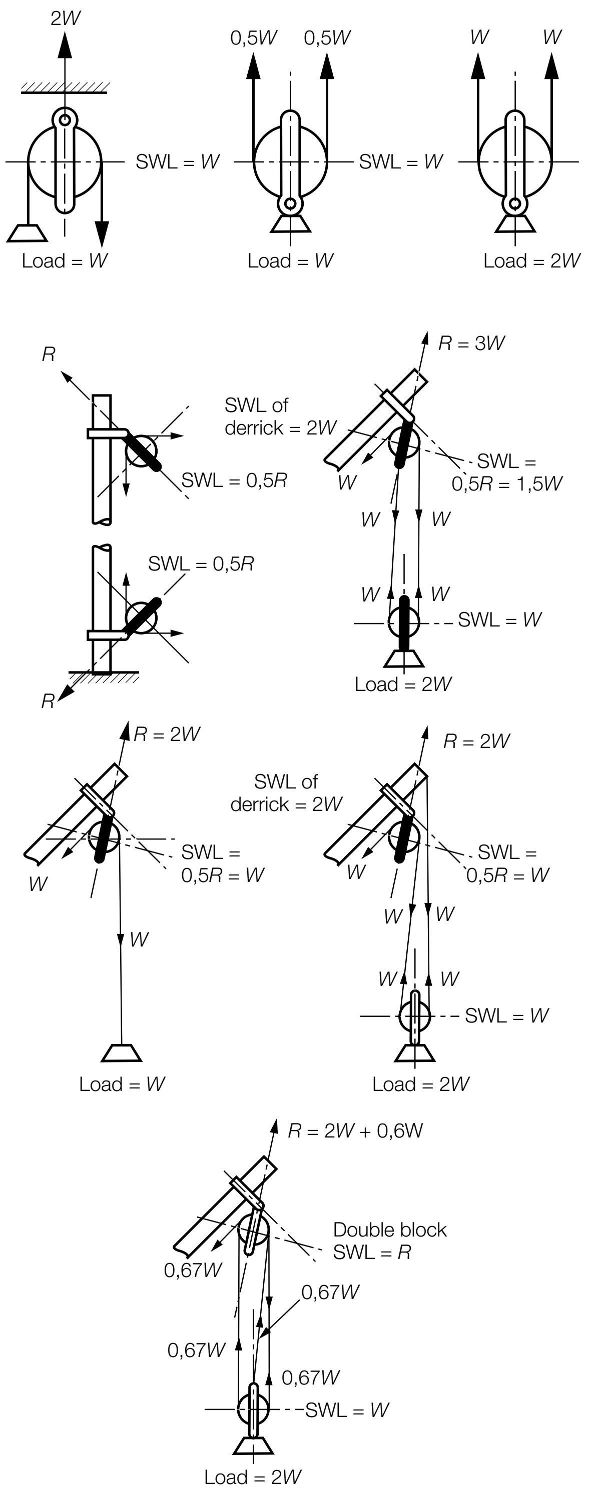
3.3.1 Sheaves may be forged or fabricated from steel plate. In general, castings in steel or spheroidal graphite iron may be accepted, but grey cast iron or malleable cast iron is not to be used for sheaves in the following circumstances unless specially agreed:

(a) Single sheave block having SWL greater than 10 t.
(b) Multiple sheave block having SWL greater than 20 t.
(c) Any block in the rig of a lifting appliance having SWL greater than 20 t.

3.3.2 Cast nylon sheaves may also be used for general cargo handling applications when the manufacturer indicates satisfactory service experience. However, attention is drawn to the fact that whilst tests have indicated longer service life for ropes used with cast nylon sheaves, the ropes do not exhibit the normal warning signs of broken wires and may break without external warning due to internal rope fatigue. Consequently, it is recommended that one steel sheave be included in the reeving arrangement, in addition to the steel winch drum.

3.3.3 The diameter of the sheave is to be measured to the base of the rope groove and is to be not less than what is given in Table 8.3.4.

3.3.4 The depth of the groove in the sheave is to be not less than three quarters of the rope diameter. A depth equal to the rope diameter is recommended. The contour at the bottom of the groove is to be circular over an angle between 120° and 135° with the corresponding opening angle to be between 60° and 45°. The radius of the groove is to be as recommended by the rope manufacturer for the size and application. The usual range of the radius of the groove is between 0,525d and 0,550d of the nominal rope diameter. In no case shall the radius be smaller than 50 per cent of the actual rope diameter.



NOTE
The values given in the above Figures are for convenience only as no account has been taken of friction.

Fig. 8.3.2 Safe working load of single sheave blocks

3.3.5 Side and partition plates and straps are to be castings or fabricated from steel plate. Malleable cast iron may be used when permitted for sheaves, *see* 3.3.1. The plates are to project beyond the sheaves to provide ample protection for the rope. Means are to be provided to prevent the rope from jamming between the sheave and the side or partition plates by minimising the clearance or by fitting suitable guards.

3.3.6 Snatch blocks are to be well designed and arrangements are to be provided to ensure that the block remains closed at all times when it is in use.

3.3.7 Crossheads and beckets may be cast, forged or machined from plate.

3.3.8 Axle pins are to be positively secured against rotation and lateral movement. The surface finish of the pin is to be suitable for the type of bearing to be used.

3.3.9 Provision is to be made for lubricating all bearings and swivel head fittings without dismantling the block and for withdrawing the axle pin for inspection.

3.4 Blocks for fibre ropes

3.4.1 Blocks intended for use with fibre ropes are not to be fitted with more than three sheaves and a becket or with four sheaves and no becket.

3.4.2 The diameter of the sheave measured to the base of the rope groove is generally to be not less than five times the nominal diameter of the rope. The depth of the groove is to be not less than one third the diameter of the rope. The contour at the bottom of the groove is to be of a radius in accordance with 3.3.4. However, for synthetic ropes, the manufacturer's recommendations are to be followed as this may vary with the type of construction and material used.

3.4.3 Proposals to use materials other than steel or iron castings for the sheaves and body of the block will be considered. Bearing pressures and stresses are to be appropriate to the materials used.

Table 8.3.1 Percentage load transmitted by a sheave

Type of block	Number of sheaves	Bushed or plain bearings Without becket	Bushed or plain bearings With becket	Roller or ball bearings Without becket	Roller or ball bearings With becket
Double	2	52	43	51	42
Treble	3	37	32	35	30
Fourfold	4	29	26	27	24
Fivefold	5	24	22	22	20
Sixfold	6	21	20	19	18
Sevenfold	7	19	18	17	16
Eightfold	8	17	16	15	14

NOTE
Friction allowance taken as 5% for bushed or plain bearings and 2% for roller or ball bearings.

Table 8.3.2 Percentage load on side plates or supporting straps

Type of block	Number of sheaves	Number of supports Inner	Number of supports Outer	Bushed or plain bearings Partition	Bushed or plain bearings Side strap	Roller or ball bearings Partition	Roller or ball bearings Side strap
Double	2	1	2	63	20	63	19
Treble	3	2	2	40	15	38	14
Fourfold	4	3	2	32	12	30	11
Fivefold	5	4	2	26	10	24	9
Sixfold	6	5	2	23	9	21	8
Sevenfold	7	6	2	21	8	18	7
Eightfold	8	7	2	19	7	16	6

NOTES
1. Friction allowance taken as 5% for bushed or plain bearings and 2% for roller or ball bearings.
2. Where a becket is fitted, the partitions and straps are to be designed to take account of the loads imposed on the block.

3.5 Hook blocks

3.5.1 Blocks that are integrated with a hook are known as hook blocks. As an alternative to the allowable stresses given in Table 8.3.3, the hook blocks are to comply with all the requirements below:

(a) The hook blocks are to be designed with a safety factor against the ultimate tensile strength as given below:
For hook blocks with SWL < 10 t, SF = 5,0
and SWL > 160 t, SF = 3,0.
For hook blocks with a SWL between 10 t and 160 t, the safety factor should be based on the equation below:

$$SF = \frac{10^4}{9{,}88SWL + 1753}$$

where
SF = minimum safety factor required
SWL = safe working load of hook block, in tonnes.

(b) The hook block is to be designed by applying the hoist factor and duty factor appropriate for the situation of operation and for the SWL of the hook and using the allowable stress criteria given in Ch 4,2.17, for cases 1 and 2.

(c) The hook block is to be designed for the applicable test load for the hook and using the allowable stress criteria given in Ch 4,2.17, for case 3.

Large hook blocks, well in excess of 160 t SWL, will be specially considered.

Table 8.3.3 Allowable stresses in blocks

Item	Allowable stress
Sheave bush to axle pin	Bearing pressure: Single sheave 39 N/mm^2 Multiple sheaves 31 N/mm^2
Axle pin to supporting straps and partitions	Bearing pressure: 154 N/mm^2
Axle pin and through bolts	Shear stress: Mild steel 62 N/mm^2 Higher tensile steel 77 N/mm^2 Bending stress: $0{,}35\sigma_y$ N/mm^2
Becket to through bolt	Bearing pressure: 39 N/mm^2
Straps and beckets, *see* Fig. 8.3.3	Shear pullout at end: 54 N/mm^2 on area 2 x (*a* x *t*) Tensile stress at side: Mild steel 77 N/mm^2 Higher tensile steel 85 N/mm^2 on area 2 x (*b* x *t*)
Tensile stress in shanks of head fittings (based on core area)	Mild steel: $R \leq 50 \sigma_t$ = 62 N/mm^2 $50 < R \leq 75 \sigma_t = (9{,}6R + 32)$ N/mm^2 $75 < R$ σ_t = 77 N/mm^2 Higher tensile steel: 85 N/mm^2
Collars and nuts of shanks	Bearing stress: 10 N/mm^2 Minimum diameter: $(1{,}5d + 3)$ mm

NOTES
1. Higher tensile steel is defined as steel having a tensile strength not less than 540 N/mm^2.
2. *R* = resultant load on the head fitting, in tonnes
   d = diameter of shank of head fitting, in mm.

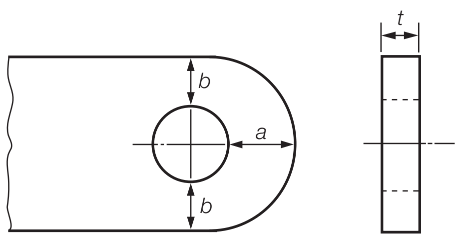


Fig. 8.3.3 Dimensions of straps

Table 8.3.4 Diameter of sheaves for wire rope

Rope use	Sheave diameter, in mm	
	Running ropes	Fixed span ropes
SOLAS LSA systems	12*d*	8*d*
Derrick systems Vehicle ramps	14*d*	10*d*
Cranes Derrick cranes Vehicle lifts Cargo lifts Mechanical lift docks Diving systems (excluding umbilicals) Other lifting appliances	19*d*	10*d*
Passenger lifts	39*d*	10*d*

NOTE
d is the diameter of the rope.

■ *Section 4* Spreaders and lifting beams

4.1 General

4.1.1 The safe working load of a spreader or lifting beam is to be the maximum load which the item is certified to lift. The SWL of the lifting appliance with which the spreader or lifting beam is to be used is to be adequate for the SWL of the beam plus its self-weight.

4.1.2 Steel used in the construction of the beam is to be of weldable quality in accordance with 1.2. The grade of steel is to be selected in accordance with Tables 4.2.18, 4.2.19 and 4.2.20 in Chapter 4, based on the minimum design temperature for the location where the beam will be used.

4.1.3 Special attention is to be paid to the structural continuity and abrupt changes of the section are to be avoided.

4.1.4 Adequate reinforcement is to be fitted in way of concentrated loads at lifting and load attachment points.

4.1.5 Welding and weld details are to be to the satisfaction of LR.

4.2 Loading and allowable stress

4.2.1 For beams and spreaders that are used solely in harbour situations, and where dynamic loading is minimal, they may be designed such that the maximum stresses do not exceed the following values when the beam is subjected to its unfactored SWL:

	SWL ≤ 10 t	SWL ≥160 t
Bending stress	$0,45\sigma_y$	$0,58\sigma_y$
Shear stress	$0,30\sigma_y$	$0,34\sigma_y$
Combined stress	$0,50\sigma_y$	$0,64\sigma_y$
Bearing stress	$0,50\sigma_y$	$0,78\sigma_y$

Intermediate values are to be determined by interpolation. Alternatively, they may be designed in accordance with 4.2.2.

4.2.2 For beams and spreaders that will be used in open-sea, offshore or in conditions where there is significant dynamic loading, they are to be designed by factoring the SWL and self-weight by a hoisting and duty factor appropriate to the situation. The resulting stresses are to comply with the allowable stress criteria described in Ch 4,2.17 and 2.18.

4.2.3 The wire ropes forming the slings for beams and spreaders are to have a minimum safety factor, SF, derived from Ch 4,2.26.1 or 3.9.1 (as applicable). The minimum breaking load of the sling is given by:

MBL = SF x L

where

MBL = minimum breaking load of rope

L = maximum static tension in the sling set.

4.2.4 The beam and components of frames are to be designed to ensure adequate lateral stability under load.

4.2.5 Where the beam is designed as a frame lifted by an arrangement of slings, the structure is to be designed to resist the compressive forces which are generated. In this respect, the factor of safety of each component against compressive buckling under the appropriate test load is to be not less than 1,3. *See* Chapter 12 for test loads.

■ *Section 5* Loose gear

5.1 Shackles

5.1.1 The safe working load of any shackle securing a block is to be not less than the SWL marked on the block, except in the case of single sheave blocks where the SWL is to be not less than twice that marked on the block.

5.1.2 The safe working load of any shackle used in another location is to be not less than the resultant load on the shackle.

5.1.3 Mild steel shackles are to be normalised after forging and before tapping and screwing. Higher tensile and alloy steel shackles are to be subjected to a suitable heat treatment.

5.1.4 Standard dimensions of Dee and Bow shackles are given for reference in Table 8.5.1 and Table 8.5.2 for the arrangements illustrated in Fig. 8.5.1.

Table 8.5.1 Dimensions of Dee shackles

Safe working load, in tonnes			Mild steel		Higher tensile steel	
	a	b	d_1	d_2	d_1	d_2
1,0	20	44	13	15	11	12
1,6	25	55	17	19	13	15
2,0	28	62	19	21	15	17
2,5	31	69	21	24	17	19
3,2	35	78	24	27	19	21
4,0	40	87	26	30	21	23
5,0	44	97	29	33	23	26
6,3	50	109	33	37	26	29
8,0	56	123	37	42	29	33
10,0	63	138	41	47	33	37
12,5	70	154	46	53	36	42
16,0	79	174	52	60	41	47
20,0	89	195	59	67	46	52
25,0	99	218	65	75	51	59
32,0	112	247	74	84	58	66
40,0	125	275	83	94	65	74
50,0	140	308	92	106	72	83
63,0	157	346	104	119	81	93
80,0	177	390	117	134	91	105

NOTES
1. All dimensions are given in millimetres and are illustrated in Fig. 8.5.1.
2. Higher tensile steel is defined as steel having a tensile strength not less than 540 N/mm^2.
3. Diameter d_3 is to be not less than $2d_2$.

5.1.5 Where the shackle is not manufactured in accordance with a recognised Standard, the safe working load may be taken as the lowest of the values derived from the following formulae:

Side of body:

$$\text{SWL} = \left(\frac{c\,d_1^3}{2r - a + 1{,}2d_1}\right)\left(\frac{2r}{2r + 0{,}5d_1}\right) \text{ tonnes}$$

Crown of body:

$$\text{SWL} = \left(\frac{c\,d_1^3}{a + d}\right)\left(\frac{2r + d_1}{2r + 0{,}4d_1}\right) \text{ tonnes}$$

Shackle pin:

$$\text{SWL} = \frac{c\,d_2^3}{a + d_1} \text{ tonnes}$$

where all dimensions are in millimetres and are illustrated in Fig. 8.5.1. The value of c is given in Table 8.5.3.

Table 8.5.2 Dimensions of Bow shackles

Safe working load, in tonnes	a	b	2_r	Mild steel d_1	Mild steel d_2	Higher tensile steel d_1	Higher tensile steel d_2
1,0	20	50	34	14	16	12	13
1,6	25	63	43	18	20	15	16
2,0	28	70	48	20	22	17	18
2,5	31	78	53	23	25	18	20
3,2	35	89	60	25	28	21	22
4,0	40	99	67	28	31	23	25
5,0	44	111	75	32	35	26	28
6,3	50	124	84	36	39	29	32
8,0	56	140	95	40	44	33	36
10,0	63	157	106	45	49	36	40
12,5	70	175	119	50	55	41	44
16,0	79	198	135	56	62	46	50
20,0	89	221	150	63	69	51	56
25,0	99	248	168	70	77	57	63
32,0	112	280	190	80	87	65	71
40,0	125	313	213	89	98	72	79
50,0	140	350	248	99	109	81	89
63,0	157	394	267	112	123	91	100
80,0	177	444	301	126	138	102	112

NOTES
1. All dimensions are given in millimetres and are illustrated in Fig. 8.5.1.
2. Higher tensile steel is defined as steel having a tensile strength not less than 540 N/mm^2.
3. Diameter d_3 is to be not less than $2d_2$.

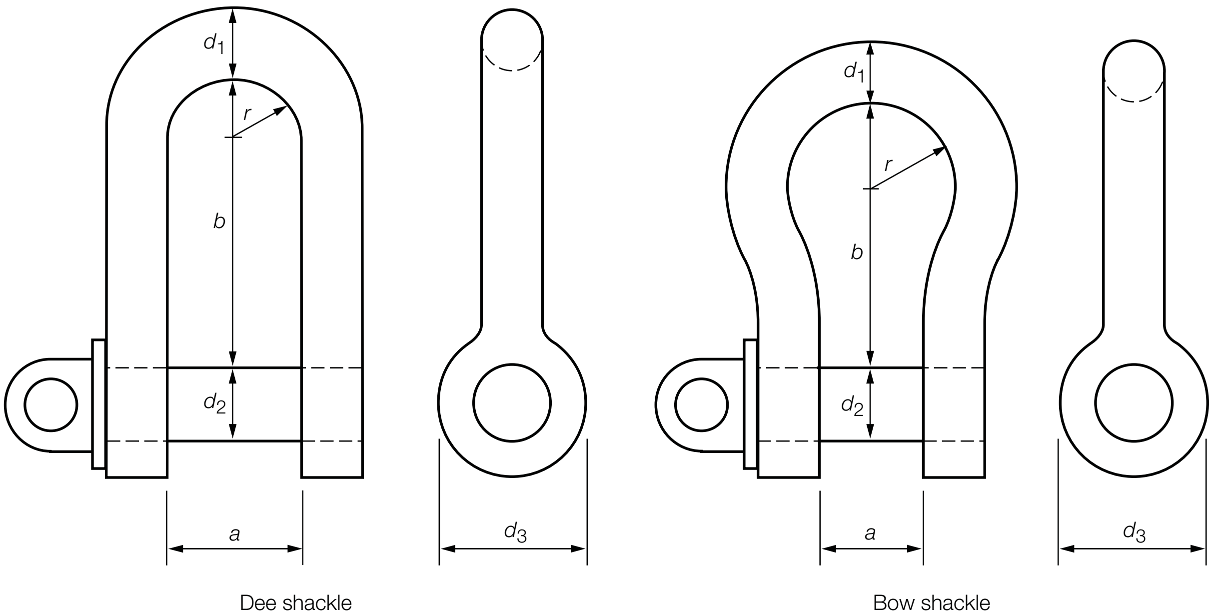


Fig 8.5.1 Shackles

Table 8.5.3 Values of *c* for shackles

Minimum tensile strength of steel, in N/mm^2	*c*		
	Side	Crown	Pin
330	0,0076	0,0082	0,0072
430	0,0105	0,0113	0,0099
540	0,0140	0,0151	0,0132

5.2 Hooks

5.2.1 The safe working load of a hook is the maximum load that the hook is certified to lift in service.

5.2.2 Hooks may be of the 'C' or Liverpool type or of the double armed Ramshorn type, as indicated in Fig. 8.5.2. In general, 'C' type hooks are not to be used for safe working loads exceeding 25*t*. Hooks manufactured to recognised National or International Standards could be accepted based on manufacturer's certification confirming the SWL and proof load as per Chapter 12 of the Code. Hooks with a SWL beyond those given in Tables 8.5.4 or 8.5.5 and/or hooks which do not comply with a recognised National or International Standard will be specially considered.

5.2.3 Hooks are to be forged from killed steel. Forged hooks can be normalised mild steel or suitably heat treated higher strength steel. Cast hooks are not generally permitted but special consideration will be given to large cast hooks that cannot be manufactured by the forging process.

Table 8.5.4 Dimensions of higher tensile steel 'C' hooks

Safe working load, in tonnes	*a*	*b*	*c*	*D*	*H*	*M*	*G*
1,0	124	78	6	31	26	17	17
1,6	156	98	8	39	33	21	20
2,0	176	110	8	44	37	24	25
2,5	196	123	10	49	41	27	25
3,2	219	138	12	55	46	30	30
4,0	247	156	12	62	52	34	30
5,0	279	176	14	70	59	38	35
6,3	311	196	16	78	66	43	40
8,0	351	221	18	88	74	48	45
10,0	391	246	20	98	82	54	50
12,5	439	276	22	110	92	60	55
16,0	495	311	24	124	104	68	60
20,0	555	349	28	139	117	76	70
25,0	622	392	32	156	131	86	80

NOTES
1. All dimensions are given in millimetres and are illustrated in Fig. 8.5.2.
2. Minimum material tensile strength σ_u 540 N/mm^2.

Table 8.5.5 Dimensions of higher tensile steel Ramshorn hooks

Safe working load, in tonnes	*a*	*b*	*c*	*D*	*H*	*M*	*G*
20	238	457	30	121	113	76	89
25	267	511	33	133	126	86	102
32	299	567	37	146	143	97	114
40	329	616	41	162	155	108	127
50	365	683	46	178	174	117	140
63	408	745	51	194	195	132	144
80	452	813	57	213	216	146	152
100	498	883	64	229	241	162	165

NOTES
1. All dimensions are given in millimetres and are illustrated in Fig. 8.5.2.
2. Minimum material tensile strength σ_u 540 N/mm^2.

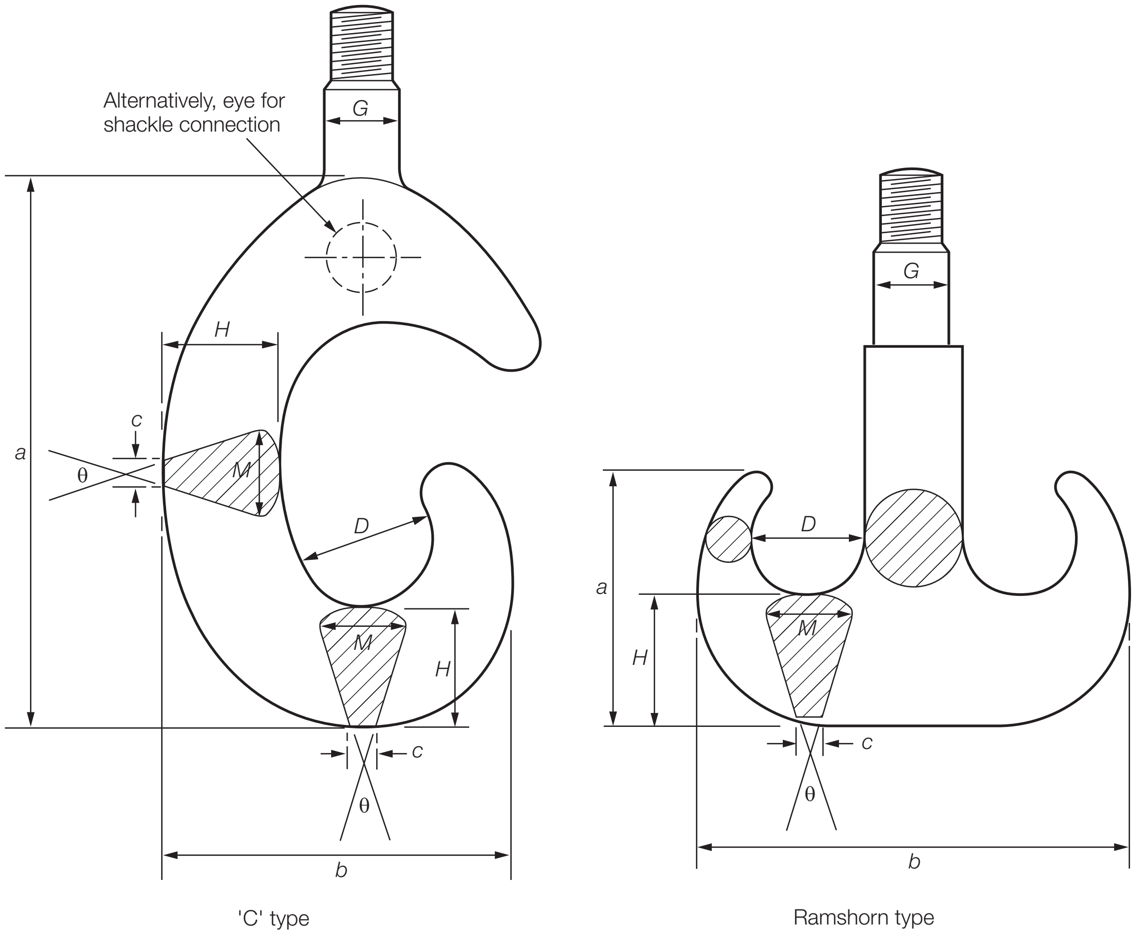


Fig. 8.5.2 Hooks

5.2.4 'C' type hooks are to be so designed as to reduce as far as possible the risk of the hook catching on an obstruction when hoisting and also the risk of the displacement of the load. An adequate safety catch is to be fitted across the jaw on all 'C' hooks.

5.2.5 Standard dimensions of 'C' type and Ramshorn hooks are given in Table 8.5.4 and Table 8.5.5 respectively for the arrangements as illustrated in Fig. 8.5.2.

5.2.6 Where the hook is not manufactured in accordance with a recognised Standard, the safe working load may be taken as:

SWL $= c\,k\,(H - 0{,}1D)^2$

where

the dimensions are measured in millimetres and are illustrated in Fig. 8.5.2. The values of c and k are to be obtained from Table 8.5.6 and Table 8.5.7.

5.2.7 The shank is to be such that the direct tensile stress complies with Table 8.3.3. Detailed design at the end of the threaded section is to be such as to minimise stress concentrations.

Table 8.5.6 Values of *c* for hooks

Minimum tensile strength of steel, in N/mm^2	*c*	
	'C' hooks	Ramshorn hooks
430	0,0011	0,0016
540	0,0015	0,0021

Table 8.5.7 Values of *k* for hooks

	θ							
	40°	30°	25°	20°	15°	10°	5°	0°
0,55	0,48	0,75	0,85	0,92	0,98	1,03	1,06	1,10
0,65	0,82	1,01	1,08	1,12	1,16	1,20	1,23	1,27
0,75	1,07	1,18	1,22	1,27	1,30	1,34	1,37	1,40
0,85	1,16	1,30	1,33	1,36	1,40			

5.2.8 The safe working load for Ramshorn hooks, derived in accordance with this Section, is appropriate for sling legs at an included angle not exceeding 90°. No increase in SWL is permitted for lesser included angles.

5.2.9 Hooks for special purposes, such as for lifting freight containers, are to comply with appropriate recognised National or International Standards.

5.3 Swivels and lifting eyes

5.3.1 The safe working load of the swivel or lifting eye is to be equal to the maximum load for which the item is certified.

5.3.2 Lifting eyes and lug fittings as detailed in this Section may be used in association with swivel bow pieces or with another item of loose gear such as a cargo block.

5.3.3 Swivels are to be fitted with plain bearings or with ball or roller thrust bearings.

5.3.4 Triangular lifting eyes are to be designed for an included angle between the sling legs not exceeding 90° and they are not to be used for single point loading. Ball or roller thrust bearings are to be incorporated in the swivel arrangements.

5.3.5 Standard dimensions for mild steel, swivel bow pieces, round, oval and triangular eyes and lug fittings are given in Table 8.5.8 to Table 8.5.11 for the arrangements illustrated in Fig. 8.5.3 to Fig. 8.5.6.

Table 8.5.8 Dimensions of bow pieces for swivels

Safe working load, in tonnes	*a*	*b*	d_1	d_2	*e*
1,0	37	64	13	20	20
1,6	46	80	16	25	25
2,0	53	92	18	25	29
2,5	60	104	21	30	32
3,2	67	116	23	30	36
4,0	74	128	26	35	40
5,0	83	144	29	40	45
6,3	92	160	32	40	50
8,0	104	180	36	45	56
10,0	117	204	41	55	64
12,5	131	228	46	60	71

NOTE
All dimensions are given in millimetres and are illustrated in Fig. 8.5.3.

5.3.6 Items whose dimensions differ from those given in Tables 8.5.4 to 8.5.11 may be designed in accordance with the requirements given in Table 8.5.12 and Table 8.5.14.

Table 8.5.9 Dimensions of round and oval eyes

Safe working load, in tonnes	Shank	Round		Oval			
	d_1	d_2	d_3	*b*	*g*	d_4	*e*
1,0	M18	11	24	48	21	12	14
1,6	M22	14	30	58	26	16	18
2,0	M24	16	34	58	26	16	18
2,5	M27	18	39	72	32	21	23
3,2	M30	20	44	72	32	21	23
4,0	M33	22	48	94	40	26	28
5,0	M36	25	54	94	40	26	28
6,3	M42	27	60	108	45	29	32
8,0	M45	31	68	115	49	32	35
10,0	M52	35	76	125	54	36	39
12,5	M56	39	86	144	60	41	44
16,0	M64			163	66	46	49
20,0	M72 × 6			173	72	56	54
25,0	M76 × 6			192	80	56	59
32,0	M80 × 6			216	90	60	64
40,0	M90 × 6			240	100	66	70
50,0	M100 × 6			264	110	74	78
63,0	M110 × 6			290	120	84	89
80,0	M120 × 6			325	135	94	99
100,0	M130 × 6			360	150	105	111

NOTE
All dimensions are given in millimetres and are illustrated in Fig. 8.5.4.

Table 8.5.10 Dimensions of triangular lifting eyes

Safe working load, in tonnes	Shank d_1	a	b	Top e	Top f	Side g	Side h	Bottom j	Bottom k
20	M72 x 6	475	400	48	95	66	95	94	95
25	M76 x 6	515	445	51	108	72	108	100	108
32	M80 x 6	565	500	55	120	79	120	108	120
40	M90 x 6	630	550	59	133	86	133	117	133
50	M100 x 6	675	600	64	146	94	146	127	146
63	M110 x 6	740	660	71	150	104	150	139	150
80	M120 x 6	815	725	78	158	115	158	153	158
100	M130 x 6	880	795	86	178	127	178	168	178

NOTE
All dimensions are given in millimetres and are illustrated in Fig. 8.5.5.

Table 8.5.11 Dimensions of lug fittings

Safe working load, in tonnes	Shank d_1	a	b	d_2	d_3
1,0	M18	19	8	17	35
1,6	M22	23	11	21	45
2,0	M24	26	12	23	50
2,5	M27	29	13	25	55
3,2	M30	32	14	28	60
4,0	M33	35	15	31	65
5,0	M36	39	18	37	75
6,3	M42	45	20	40	85
8,0	M45	49	23	46	95
10,0	M52	58	26	50	110
12,5	M56	64	28	54	120
16,0	M64	70	30	62	130
20,0	M72 × 6	74	33	70	140
25,0	M76 × 6	80	35	74	150
32,0	M80 × 6	90	40	82	170

NOTE
All dimensions are given in millimetres and are illustrated in Fig. 8.5.6.

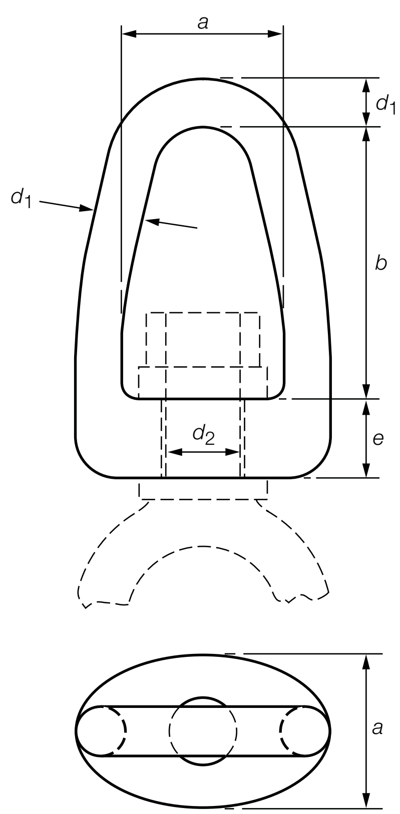


Fig. 8.5.3 Bow piece for swivel

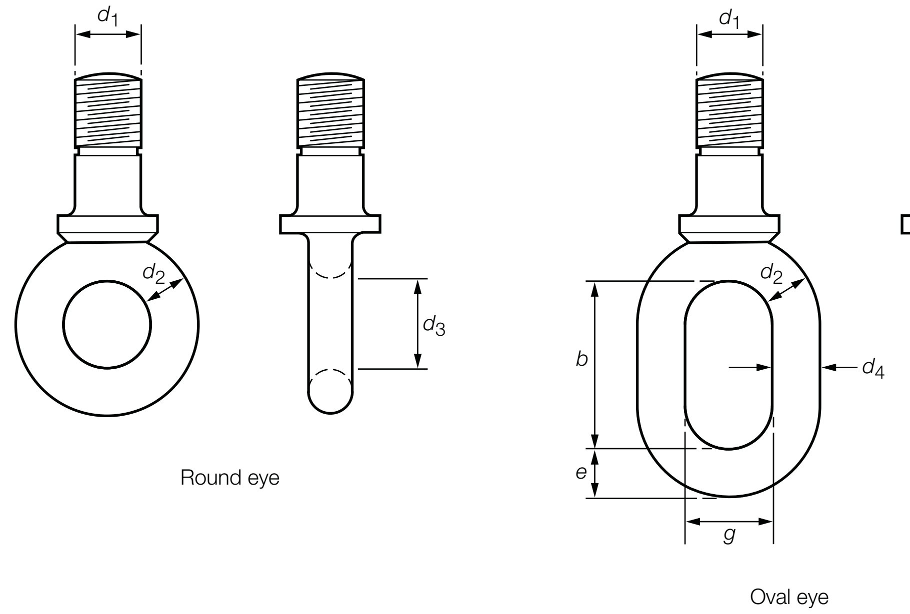


Fig. 8.5.4 Round the oval eyes

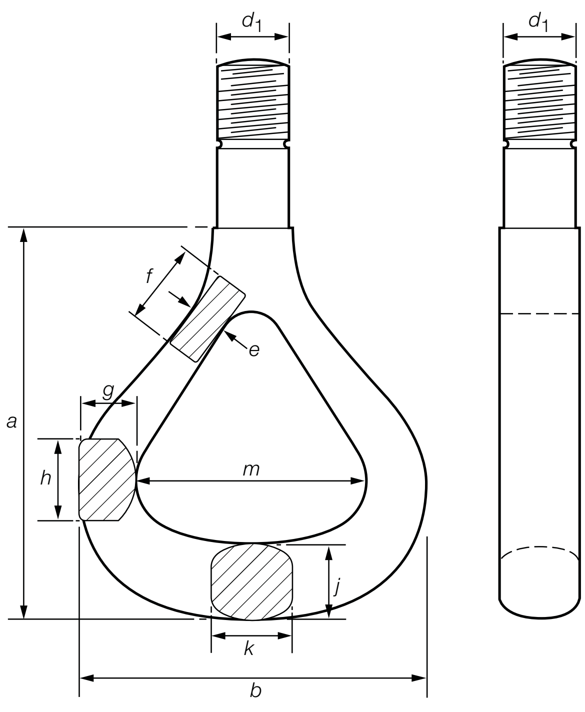


Fig. 8.5.5 Triangular lifting eye

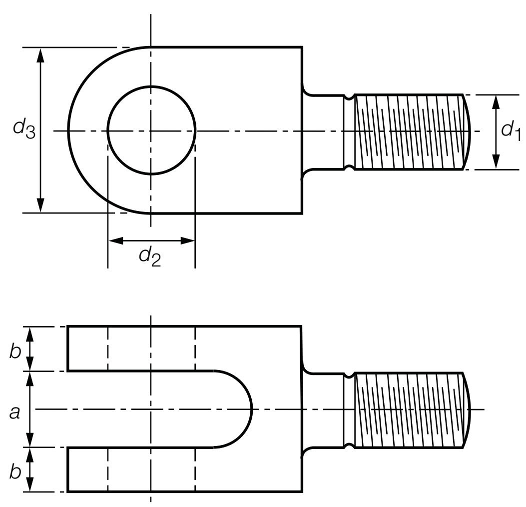


Fig. 8.5.6 Lug fitting

Table 8.5.12 Swivels and eyes

Item	Safe working load, in tonnes
Swivel bow piece	$\left(\dfrac{c\,d_1{}^3}{a + 0{,}4d_1}\right)\left(1{,}75 + \dfrac{a + d_1}{b + d_1}\right)$ where $b < 2{,}55d_1$, this value is to be multiplied by $0{,}22\left(2 + \dfrac{b}{d_1}\right)$
Round eye	$\dfrac{c\,d_2{}^3}{d_3 + 0{,}4d_2}$ where $d_3 < 2{,}55d_2$, this value is to be multiplied by $0{,}22\left(\dfrac{d_3}{d_2} + 2\right)$
Oval eye	$\dfrac{c\,d_4{}^3}{g + 0{,}4d_4}$ where $b < 2{,}55d_4$, this value is to be multiplied by $0{,}22\left(\dfrac{b}{d_4} + 2\right)$
Triangular eye	Top $0{,}0069e\,f$ Side $\dfrac{0{,}0138h\,g^2\,K}{m}$ Bottom $\dfrac{0{,}0138k\,j^2\,K}{m}$
Lugs	$0{,}0125b\,(d_3 - d_2)$
Shank	$c\,d_1{}^2$

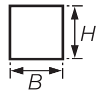
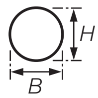
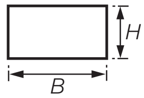
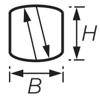
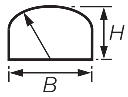
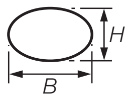
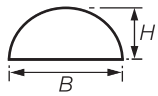
NOTES
1. All dimensions are given in millimetres and are illustrated in Fig. 8.5.3 to Fig. 8.5.6.
2. Values of c and K are given in Table 8.5.13 and Table 8.5.14 respectively.

Table 8.5.13 Values of *c* for swivel and eyes

Item	c	
	Mild steel	Higher tensile steel
Swivel bow piece	0,0066	0,0088
Round eye	0,0176	0,0236
Oval eye	0,0057	0,0076
Shank	0,00493	0,00625

NOTE
Higher tensile steel is defined as steel having a tensile strength not less than 540 N/mm^2.

Table 8.5.14 Form factors, *K*

Shape of section			K
Square	$H = B$		1,00
Circular	$H = B$		0,66
Rectangular	$H = 0{,}75B$ $H = 0{,}50B$		0,95 0,90
Radius at intrados and extrados	$H = 0{,}90B$		0,80
Radius at intrados only	$H = 0{,}70B$		0,75
Ellipse	$H = 1{,}25B$ $H = 0{,}75B$ $H = 0{,}50B$		0,66 0,65 0,64
Semi-circle	$H = 0{,}50B$		0,64

NOTE
Values for intermediate shapes may be obtained by interpolation.

5.4 Chains, links and rings

5.4.1 The overall dimensions of the links of chain are to be within the limits in Table 8.5.15.

5.4.2 The certified safe working load of short or long link chain is not to exceed the values derived from Table 8.5.16. Proposals for the use of alloy steel chains will be specially considered.

5.4.3 The safe working load for links or rings is to be not greater than the value obtained from Table 8.5.17.

5.5 Miscellaneous items

5.5.1 The triangle plate for use with a span chain or with union purchase cargo runners is to be provided with three holes of diameter not less than 1,25 times the diameter of the associated shackle pin. One of the holes may be extended as a slot to facilitate reeving of the shackle.

Table 8.5.15 Link chain limits

	Length	Breadth
Short link	4,5*d* – 5,0*d*	3,25*d* – 3,5*d*
Long link	7,0*d* – 9,0*d*	3,25*d* – 3,5*d*
Symbols		
d = nominal diameter of the chain		

Table 8.5.16 Safe working load of chain

Item and material	Safe working load, in tonnes
Short link	
Mild steel	$0{,}0094d_2$
Higher tensile steel	$0{,}0125d_2$
ISO Grade 40	$0{,}0161d_2$
Long link	
Mild steel	$0{,}0063d_2$
Higher tensile steel	$0{,}00825d_2$
NOTES 1. Where *d* is the nominal diameter of the chain, in mm. 2. ISO Grade 40 chain is to comply with the requirements of ISO/R 1834, 1835 and 1836 as appropriate.	

Table 8.5.17 Safe working load of links and rings

Item	Safe working load, in tonnes
Swivel bow piece	$\left(\dfrac{c\,d^3}{a + 0{,}4d}\right)\left(1{,}75 + \dfrac{a + d}{b + d}\right)$ where $b < 2{,}55d$, this value is to be multiplied by $0{,}22\left(2 + \dfrac{b}{d}\right)$
Rings	$\left(\dfrac{c\,d^3}{a + 0{,}4d}\right)$ where $a < 2{,}55d$, this value is to be multiplied by $0{,}22\left(2 + \dfrac{a}{d}\right)$
NOTES 1. All dimensions are measured in millimetres and are illustrated in Fig. 8.5.7. 2. The value of *c* is obtained from Table 8.5.18.	

Table 8.5.18 Values of *c* for links and rings

Minimum tensile strength of material, in N/mm^2	Value of *c*	
	Links	Rings
430	0,0053	0,0116
540	0,0071	0,0155

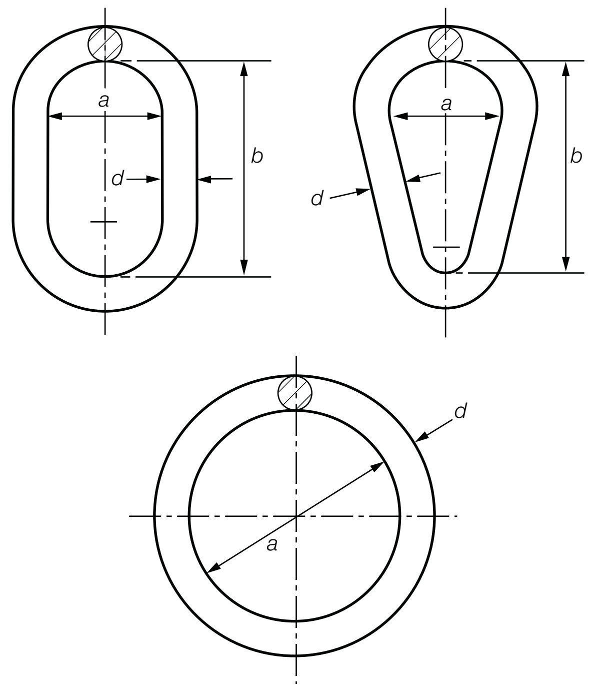


Fig. 8.5.7 Chain link and ring

5.5.2 The corners of the plate are to be radiused. The corner radius, measured from the centre of each hole is to be not less than the diameter of the hole. The thickness of the plate is to be not less than one half the width of the jaw of the associated shackle. The radius of the corners and thickness of the plate are to be such that, when subjected to the safe working load, the mean tensile stress in the material around the hole does not exceed (25 + SWL) N/mm^2, where the SWL is measured in tonnes.

5.5.3 Where a union purchase swivel assembly is formed of a ring to which the hook and runners are connected by swivels, the ring is to comply with 5.4.3.

5.5.4 Tubular bodies and end fittings of rigging screws are to be of steel having a tensile strength not less than 350 N/mm^2. The tensile stress in the body and in the shanks of the end fittings is not to exceed (25 + SWL) N/mm^2, where SWL is the safe working load, in tonnes, of the rigging screw.

■ *Section 6* **Steel wire ropes**

6.1 General

6.1.1 Steel wire ropes are generally to comply with the requirements of an International or recognised National Standard and are to be suitable for the use for which they are proposed in accordance with the manufacturer's recommendations.

6.1.2 Steel wire ropes are to be manufactured at works which have been approved by LR. A list of *Approved Manufacturers of Steel Wire Ropes* appears in LR's *Lists of Approved Manufacturers of Materials*. Proposals to use steel wire rope manufactured elsewhere will be specially considered.

6.2 Steel wire for ropes

6.2.1 The wire used in the manufacture of rope is to be drawn from steel manufactured by an approved process. It is to be of homogeneous quality and consistent strength and free from visual defects likely to impair the performance of the rope.

6.2.2 Ropes are to be constructed from individual wires with the following tensile strength grades, with the following range of strengths permitted, as indicated in Table 8.6.1.

Table 8.6.1 Tensile strength grades of wires

Nominal rope grade	Range of wire tensile strength, N/mm^2
1570	1370 to 1770
1770	1570 to 1960
1960	1770 to 2160
2160	1960 to 2160

6.2.3 The variation of breaking strength of individual wires for each of the above grades is to be in accordance with Table 8.6.2.

Table 8.2.2 Permitted variations in tensile strength

Nominal diameter of individual wire, d, mm	Permitted variation above nominal tensile strength, N/mm^2
$0,2 \le d < 0,5$	390
$0,5 \le d < 1,0$	350
$1,0 \le d < 1,5$	320
$1,5 \le d < 2,0$	290
$2,0 \le d < 3,5$	260
$3,5 \le d < 7,0$	250

6.2.4 The wire is to be galvanised by a hot dip or electrolytic process to give a continuous uniform coating. However, consideration will be given to the acceptance of non-galvanised and stainless steel wire in certain applications.

6.3 Construction and application

6.3.1 Each strand is to be uniformly made and free from slack wires. Core wires and fibre cores of strands are to be of sufficient size to enable the covering wires to be evenly laid.

6.3.2 The wires in a steel core are normally to be of similar tensile strength to that of the main strand, but wires of a lower tensile strength may be permitted. Fibre cores are to be of a suitable natural or man-made material.

6.3.3 The wire rope is to be uniformly made and the strands are to lie tightly on the core or on the underlying strands. The free ends of all wire ropes are to be secured against untwisting (serving). Wire ropes are to be thoroughly lubricated.

6.3.4 Wire ropes for running rigging are to be constructed of not less than six strands over a main core. Each strand is, generally, to consist of not less than 19 wires and may have a fibre or a wire core. Where the strand has a fibre core, the wires are to be laid around it in not less than two layers.

6.3.5 Wire ropes with four strands may be considered for running rigging, provided each strand is of an elliptical section and is constructed with at least 39 wires. Bending fatigue tests are to demonstrate that the fatigue life of the rope is at least equivalent to that of a similar six strand rope.

6.3.6 Wire ropes for standing rigging, guy pendants and similar applications are generally to be constructed of six strands over a wire core.

6.3.7 Four and six strand rope with Lang's lay construction will not normally be accepted for the hoisting system of any lifting appliance. They may, however, be used in purchases which are rotationally restrained, e.g., crane luffing systems or in shiplift winch systems.

6.3.8 Lang's lay construction is acceptable for high performance and compact multi-strand ropes as these ropes have good torsion resistance properties.

6.3.9 Types of construction and diameter ranges of standard round strand ropes are given in Table 8.6.3.

6.3.10 The construction and minimum breaking loads for some common rope types can be found in the current edition of ISO 2408.

6.3.11 Consideration will be given to the use of other constructions and nominal strengths and to the requirements for particular applications.

6.4 Splicing and terminal connections

6.4.1 The lengthening by splicing of ropes for standing or running rigging is not permitted.

Table 8.6.3 Types of construction and diameter ranges – Round strand

Rope designation	Rope construction	Type of main core	Available diameter range, in mm
6-stranded ropes			
6 × 7	6 (6 + 1)	fibre or steel	2 to 40
6 × 19	6 (12 + 6 + 1)	fibre steel	3 to 60 8 to 60
6 × 37	6 (18 + 12 + 6 + 1)	fibre	6 to 60
6 × 19 Seale	6 (9 + 9 + 1)	fibre or steel	8 to 60
6 × 19 Filler	6 (12 + 6F + 6 + 1)	fibre or steel	8 to 60
6 × 26 Warrington-Seale	6 (10 + 5/5 + 5 + 1)	fibre or steel	9 to 60
6 × 31 Warrington-Seale	6 (12 + 6/6 + 6 + 1)	fibre or steel	11 to 60
6 × 36 Warrington-Seale	6 (14 + 7/7 + 7 + 1)	fibre or steel	13 to 60
6 × 41 Warrington-Seale	6 (16 + 8/8 + 8 + 1)	fibre or steel	16 to 60
6 × 12	6 (12 + FC)	fibre	8 to 32
6 × 24	6 (15 + 9 + FC)	fibre	8 to 40
8-stranded ropes			
8 × 19 Seale	8 (9 + 9 + 1)	fibre or steel	8 to 60
8 × 19 Filler	8 (12 + 6F + 6 + 1)	fibre or steel	8 to 60
Multi-strand ropes			
17 × 7	11 (6 + 1) + 6 (6 + 1)	fibre or steel	8 to 38
18 × 7	12 (6 + 1) + 6 (6 + 1)		8 to 38
34 × 7	17 (6 + 1) +11 (6 + 1) + 6 (6 + 1)	fibre or steel	10 to 44
36 × 7	18 (6 + 1) +12 (6 + 1) + 6 (6 + 1)		8 to 40

6.4.2 The following methods of forming eye or loop splices are acceptable:

(a) Not less than three tucks with each whole strand of the rope and not less than two tucks with one half of the wires cut from each strand. In all cases, the strands are to be tucked against the lay of the rope.

(b) Four tucks with the whole strands of the rope and one tuck with each alternate strand of the rope, made over and under against the lay of the rope.

(c) A Liverpool type splice that has at least six tucks with each strand is only to be used where the wire rope is not subject to twisting, i.e., on span tackles, guys and pendants.

Other forms of splice will be accepted provided they can be shown to be as efficient, from all aspects, as those described above.

6.4.3 As an alternative to splicing; swages, ferrules, wedge and poured sockets, Flemish eyes or other types of acceptable terminal connections may be used. Such connections are to be approved, as required by Ch 12,1.3.6 and 1.3.7.

6.4.4 Wire rope grips (e.g., U-bolt wire rope clamps or bulldog grips) are not to be used for forming a primary load bearing rope termination on any lifting appliance, with the exception of passenger lifts, where the higher rope safety factors, the use of several hoist ropes and the fitting of the safety gear make this type of termination acceptable.

6.4.5 Where wire rope grips are permitted to be used (e.g., passenger lifts and control lines, etc.), particular care is to be taken to ensure that the correct size clamp for the rope is used and that they are also fitted with the correct orientation, tightening torque and minimum number, in accordance with a recognised National Standard, or the manufacturer's instructions. Terminations are to be tested to 2 x intended SWL.

6.5 Stainless steel ropes

6.5.1 Ropes constructed of stainless steel are not normally used for cargo handling operations but may have limited scope as running rigging for use on large commercial yachts. Where used, they are to be of ordinary or regular lay construction.

6.5.2 Stainless steel ropes are prone to pitting, crevice corrosion and stress corrosion cracking in a marine environment and when used are to be constructed from stainless steel wires with a minimum PREN of 30.

6.5.3 The use of stainless steel ropes does not remove the need for regular periodic rope inspections.

Section 7
Fibre ropes

7.1 General

7.1.1 Natural and man-made fibre ropes are to comply with the requirements of an International or recognised National Standard and are to be suitable for the use for which they are proposed.

7.1.2 Ropes may be manufactured from one of the following materials:

Natural fibre	Man-made fibre
Hemp	Polyester
Manila	Polyamide (nylon)
Sisal	Polypropylene
	Polyethylene
	Aramid
	HMWPE or UHMWPE

Proposals to use other materials will be specially considered.

7.1.3 In general, each length of rope is to be manufactured from only one type of natural or man-made fibre. The fibre is to be a long staple or continuous multi-filament, unadulterated and free from defects. Proposals to use a combination of materials or other types of fibre will be specially considered.

7.1.4 Weighting and loading matter is not to be added and any added lubricant is to be kept to the minimum. Any rot-proofing or water repellancy treatment is not to degrade the fibre nor is it to add to the weight or reduce the strength of the rope.

7.1.5 Where resin products, or other treatments, are used to improve the grip at terminations of synthetic ropes with very low coefficients of friction, they are not to degrade the fibre nor to add to the weight or reduce the strength of the rope.

7.1.6 Man-made fibres are to be adequately stabilised against degradation by ultraviolet light.

7.2 Application

7.2.1 Typical minimum breaking loads of natural fibre ropes are shown in Table 8.7.1 and man-made fibre ropes in Table 8.7.2. However, attention is drawn to the fact that the strength of man-made fibre ropes may vary appreciably between different manufacturers.

Table 8.7.1 Breaking loads of natural fibre ropes (3 strand)

Size of rope		Sisal	Manilla Grade 1	Hemp
Diameter, mm	Approximate circumference, mm	kN	kN	kN
16	51	18,0	20,3	17,0
18	57	21,4	24,4	22,5
20	63	28,5	32,5	26,5
22	69	34,0	38,6	31,5
24	76	40,7	45,7	37,5
28	88	53,3	61,0	50,5
32	101	68,8	79,0	65,0
36	113	87,0	96,5	81,5
40	126	104,2	119,4	100,0

7.2.2 Fibre ropes are not generally acceptable in the lifting appliance systems covered by this Code except for the following applications:

- Derrick systems:
  Slewing guy tackles (but not pendants) where the SWL of the guy does not exceed 4,0 t.
  Boom head guys in union purchase rigs.
- Launch and recovery systems for diving operations:
  Proposals for the use of synthetic fibre ropes for lifting purposes will be considered.
- Deep water exploration and ROV handling.
- Falls on the LSA or tender craft handling systems of large commercial yachts, where permitted by National Administrations.

7.2.3 The safety factor to be applied to fibre ropes is, generally, to be 25 per cent higher than the equivalent safety factor for a steel wire rope.

Table 8.7.2 Breaking loads of man-made fibre ropes (3 strand)

Size of rope		Man-made fibre			
Diameter, mm	Approximate circumference, mm	Sisal kN	Polyamide (nylon) kN	Polyester kN	Polyethylene kN
16	51	35,0	53,0	41,0	28,0
18	57	44,5	67,0	51,0	35,0
20	63	53,7	83,0	63,0	43,0
22	69	65,0	100,0	76,0	51,0
24	76	76,0	120,0	91,0	61,0
28	88	101,0	158,0	122,0	80,0
32	101	128,0	200,0	157,0	104,0
36	113	161,0	248,0	193,0	130,0
40	126	194,0	300,0	239,0	156,0

7.3 Splicing and terminal connections

7.3.1 The lengthening of fibre ropes by splicing is not permitted.

7.3.2 Eye splices are to consist of not less than:

(a) Natural fibre ropes:
Three full tucks and two tucks in which half the fibres in each strand have been cut away.

(b) Man-made fibre ropes:
- (i) Four full tucks and two tucks in which half the fibres in each strand have been cut away. The ends of the strands are to be fused.
- (ii) For synthetic ropes with low coefficients of friction, the manufacturer's advice for making an efficient termination is to be followed.

Contents

■ *Section 1* Introduction

1.1 General

1.1.1 This Chapter is applicable to all the lifting appliances covered in this Code.

1.1.2 Where the lifting machinery is to be included in the classification equipment of the installation, the following requirements are to be complied with. Where third party design verification is to be considered, the requirements of this Section may be considered for guidance purposes only.

1.1.3 Third party design verification is to be carried out in accordance with a specified National or International recognised design Standard or the submitted manufacturer's design specifications (with the exception of survival craft and rescue boats).

■ *Section 2* Design and construction of machinery

2.1 Plans and information to be submitted

2.1.1 Detailed design drawings are to be submitted, one copy of which will be retained by Lloyd's Register (LR).

2.1.2 Details of the proposed principles of operation of the equipment, together with the design specifications, including the applied loads of the lifting device to be appraised.

2.1.3 Calculations of the power and braking requirements of the winch system(s).

2.1.4 Detailed design plans and calculations of the machinery which include details of gearing, torque transmitting shafting together with all couplings (keys, splines, flanges, etc.), bearings, clutches and assembly details, rope drum including full fabrication details, braking device(s) and the attachment of the machinery to the supporting structure. An FE analysis of the rope drum strength evaluation is to be submitted for consideration in place of the rope drum design calculations. All material specifications and mechanical properties are to be provided for each component.

2.1.5 Details of the rope drum(s) storage under all operating conditions are to be advised, indicating the maximum number of rope layers to be considered under working conditions.

2.1.6 Details of the general arrangement, showing rope orientation and securing devices, and sectional arrangement of the machinery.

2.1.7 Diagrammatic arrangement plans of the hydraulic and pneumatic piping systems, where fitted, together with specifications of the principal components.

2.1.8 Where hydraulic power packs are of proprietary manufacture, they are to be LR Type Approved. Alternatively, operational parameters and detailed plans including materials lists and mechanical properties of the components of the system and any manufacturer's catalogues as applicable are to be submitted.

2.1.9 For electrically powered lifting equipment *see* Chapters 10 and 11.

2.1.10 Details of torque limiting and over-run/under-run limiting devices, where fitted.

2.1.11 If proprietary equipment, such as gearboxes or brakes, is to be included in the machinery, it is to be Type Approved by LR. Alternatively, operational parameters and detailed plans, including materials lists and mechanical properties of the components of the system and any manufacturer's catalogues as applicable, are to be submitted.

2.1.12 Details/plans of the foundation securing arrangements, including materials and mechanical properties, are to be submitted. Calculations demonstrating the strength of the foundation securing arrangements under the maximum loaded condition of the lifting appliance are to be submitted. These should include any dynamic effects on the system.

■ *Section 3* Mechanical design requirements

3.1 Factor of safety

3.1.1 A factor of safety of at least 1,5, based on the minimum ultimate tensile strength of the materials used in the load-bearing structural components and the torque transmission path of the machinery, is to be applied, unless stated otherwise elsewhere.

3.2 Power supply

3.2.1 The nominal output rating of the power supply is to provide a minimum factor of safety of 1,5 on the maximum power requirement of the system.

3.3 Rope drums

3.3.1 The design of rope drums is to take into consideration the following criteria:

(a) The maximum rope tension, taking into account dynamic loading conditions, friction effects and any environmental effects, as applicable.
(b) The maximum holding force during a static load test.
(c) The stalling force, corresponding to the maximum line load attainable due to an overload condition as it may occur in the event of snagging of the lifting hook or attached load.
(d) The number of turns of rope and the corresponding maximum and minimum number of rope layers on the drum.
(e) Where large lengths of rope are to be handled, the capacity of the drum should normally be designed to accommodate the rope on a maximum of three layers of rope. Where a greater number of rope layers is required, suitable spooling arrangements are to be considered. A single layer of rope is acceptable, provided the rope ends are adequately secured to anchor points.
(f) A minimum of three complete turns of rope is to remain on the rope drum at all times during normal operation.

3.4 Gears and gearboxes

3.4.1 Gearing is to be designed in accordance with BS 436–3 or ISO 6336 or an equivalent National or International Standard. The standards employed are to be identified in the submitted design calculations.

3.4.2 Proprietary gearboxes fitted to lifting appliances are to be LR Type Approved and their rating is to provide a factor of safety with at least 1,5 on the maximum rated load of the winch.

3.4.3 As an alternative to Type Approval, operational parameters and detailed plans, including materials lists and mechanical properties of the components of the gearbox and any manufacturer's catalogues as applicable, are to be submitted.

3.5 Shafting

3.5.1 Input, intermediate, output and gearing shafting is to comply with a specified recognised National or International Standard, which is to be identified in the submitted calculations. Shafting is to be designed to have adequate strength to obtain a minimum factor of safety of 1,5. When applicable, the shafting is to be assessed for fatigue in accordance with a recognised National or International Standard. Shafting is not to fail under extreme loading conditions during service.

3.6 Shafting connections

3.6.1 Splines, flanges, keys, etc., are to comply with a National or International Standard acceptable to LR. Conical interference fits for muff couplings, flanges, etc., are to be designed for a factor of safety against slippage of 2,0.

3.7 Brakes

3.7.1 Brakes fitted to lifting appliances are to be capable of holding a static load of 1,5 times the maximum rated load of the winch.

3.8 Clutches

3.8.1 Proprietary clutches fitted to lifting appliances are to be LR Type Approved and their rating is to provide a factor of safety at least 1,5 on the maximum rated load of the winch. Alternatively, operational parameters and detailed plans including materials lists and mechanical properties of the components of the system and any manufacturer's catalogues as applicable are to be submitted.

3.9 Bearings

3.9.1 The rating of anti-friction rolling bearings are to be in accordance with the manufacturer's recommendations for the relevant lifting appliance duty.

3.9.2 Plain and rolling contact (anti-friction) bearings are to be in accordance with BS 2573-2 or an equivalent National or International Standard acceptable to LR.

3.10 Slewing rings

3.10.1 Slewing rings are to be in accordance with BS 2573-2 or an equivalent National or International Standard acceptable to LR.

3.10.2 Where slewing rings employ anti-friction rolling bearings, they are to be in accordance with 3.9.

Section 4
Man-riding and personnel lifting machinery

4.1 Scope

4.1.1 In addition to Section 3, this Section specifies the requirements for the mechanical hoisting equipment for cranes and other equipment whose primary task is to perform unmanned operations but which may also be used for personnel lifting.

4.1.2 This Section does not cover the requirements for lifting appliances intended for manned diving operations.

4.1.3 It is the responsibility of the manufacturer that the lifting appliance is designed to meet relevant national or statutory requirements which may be applied in addition to the requirements of this Section.

4.2 Cranes and winches used for man-riding operations

4.2.1 All hoisting equipment is to be equipped with a suitable primary braking device, mechanically operable under all operational load conditions. The design brake force is not to be less than 120 per cent of the brake force required to support the specified overload test. Hydraulic locking of the drive motor, where fitted, is not to be considered as a primary mechanical brake or as a secondary brake when using cranes for man-riding operations.

4.2.2 The primary mechanical brake is to be automatically applied when the operating lever is in the 'off' or 'neutral' position. Brake action is to be progressive so as to avoid sudden dynamic shock loads to the system.

4.2.3 Primary mechanical brakes are to be fitted to both the boom and live load hoist winches. The live load for man-riding purposes is considered as the weight of the hook, suspended hoist wire, the basket and a maximum of 4 persons. An allowance of 100 kg is to be allocated for each person. The live load for personnel lifting is not to be greater than 50 per cent of the SWL, certified for normal unmanned lifts at the maximum operating radius of the lifting appliance.

4.2.4 The primary brake is to be applied automatically upon the failure of the power supply to the motor and/or control devices.

4.2.5 An independent secondary brake is to be fitted in both the boom and live load hoist winch systems. They are to be operable by the driver and are to arrest all crane hoist motions in the event of an emergency during man-riding operations. In winches driven by two motors both fitted with integral brakes, secondary braking is not required, provided that either motor/brake unit can provide the full personnel braking torque required by this Code. Where gearboxes are subjected to the braking torque, they are to be LR Type Approved, *see also* 2.1.11.

4.2.6 The primary automatic brake is to have a manual override to permit controlled lowering of the load using the secondary braking device or other means.

4.2.7 The primary and secondary braking devices are to be capable of being tested independently.

4.2.8 The secondary brake is to be applied directly to the drum or drum shaft, *see* 4.2.5.

4.2.9 The secondary brake capacity is to be based on the dynamic stopping requirements of the man-riding live load and a minimum factor of safety of 2,0 is to be applied.

4.2.10 An emergency stop is to be fitted, operable by the driver in the event of an emergency arising.

4.2.11 Any speed-change gearbox fitted is to be of the constant mesh type such that it is not possible to change the gear ratio while there is any load on the lifting system. Gearboxes, where fitted, are to be rated such that there is a factor of safety of at least 2,0 on the operational load.

4.2.12 Clutches or other means of disengaging the drive train are not to be fitted for this type of operation.

4.2.13 A factor of safety of at least 1,5, based on the minimum ultimate tensile strength of the materials used in the load bearing structural components and the torque transmission path of the lifting appliance machinery, is to be applied.

4.2.14 Manufacturer's Inspection Certificate 3.1 will be accepted for all torque bearing components integral to lifting machinery. In cases where gearing, etc., is exposed, demonstration of a material's suitability for operations at low temperature may be required.

Section 5
Manufacture and testing of machinery

5.1 Materials

5.1.1 Materials used in the manufacture of winch machinery are to be in accordance with an internationally recognised Standard. Manufacturer's documentation indicating compliance with a recognised Code or Standard will be accepted.

5.1.2 Materials for use in low temperature or hazardous environments are to be in accordance with a National or International Standard acceptable to LR. The Standard used is to be identified in the submitted specification.

5.2 Testing

5.2.1 Testing of lifting appliances is to be in accordance with Chapter 12.

Contents

■ *Section 1* Goal

1.1 Goal

1.1.1 Electrotechnical systems for lifting appliances are to be designed and constructed in accordance with the requirements of this Chapter in order to minimise danger to personnel in all foreseeable operating conditions.

■ *Section 2* Control, alarm and safety systems

2.1 General

2.1.1 The requirements of Sections 2, 3 and 4 apply to all permanently installed, power operated, lifting appliances specified in 2.2.2 which are intended to be classed. Where applicable, the relevant requirements for control, alarm and safety systems as stated in Pt 6, Ch 1,1 and 2 of the *Rules and Regulations for the Classification of Ships* (hereinafter referred to as the Rules for Ships) are to be complied with.

2.1.2 Where certification of a lifting appliance is required, the equipment is to be examined and tested under working conditions for compliance with the appropriate National or International Standard. Plans for control systems are not required to be submitted.

2.2 Documentation

2.2.1 Where control, alarm, or safety systems are intended for the lifting appliances listed in 2.2.2 the following documentation is to be submitted:

- General arrangement of the lifting installation.
- General arrangement of the control station and/or control cabinet(s).
- Description of operation with explanatory diagrams including details of operating medium, i.e., pneumatic, hydraulic or electric, including power packs and standby sources of power.
- Schematic diagrams of control circuits, interlocks and alarm systems.
- Details of safety devices including securing and latching arrangements.
- Test schedules (for both works testing and trials) which should include methods of testing and test facilities provided.

2.2.2 Documentation for the control, alarm and safety systems of the following lifting appliances is to be submitted:

- Lifts for passengers and crew.
- Lifts and ramps for cargo handling.
- Derrick winches.
- Derrick cranes.
- Mechanical lift docks.

2.3 Survey during construction

2.3.1 Control engineering systems including alarms and safeguards are to be tested in accordance with the approved test schedule to demonstrate that they are in good working order.

2.4 Classification of existing lifting appliances

2.4.1 Control engineering systems including alarms and safeguards are to be tested to the Surveyor's satisfaction to demonstrate that they are in good working order.

■ *Section 3* Control and supervision of lifts for passengers and crew

3.1 General

3.1.1 Alarms and safeguards are indicated in 3.2. Alternative arrangements which provide equivalent safeguards will be considered.

3.1.2 Control engineering equipment is to be capable of satisfactory operation when subject to a pitch or roll of 10° when lifting appliances are in operation. When lifting appliances are stopped, control engineering equipment is to withstand an inclination of 22,5° irrespective of location.

3.2 Alarms and safeguards

3.2.1 Means are to be provided to ensure safe and effective control of speed, direction and stopping of the lift car.

3.2.2 Interlocks are to be provided to prevent activation of the lift when:

(a) Car doors or parts thereof are not closed; or
(b) Shaft access doors or parts thereof are not closed.

3.2.3 Power-operated entrances are to be fitted with protective devices to prevent injury to passengers and crew.

3.2.4 In addition to the normal upper and lower landing stop controls, independent means are to be provided to stop the lift in the event of top or bottom overrun.

3.2.5 Lifts for passenger ships are to be provided with emergency arrangements to bring the lift cars to deck level for the escape of persons, in the event of a main power failure. The passenger lift cars may be brought to deck level sequentially in an emergency.

3.2.6 A safety device is to be fitted on the lift car and any counterweight to stop and hold their positions in the event of overspeed or failure of suspension ropes or their fastenings.

3.2.7 A safety device is to be fitted which will stop and hold the position of the lift car and any counterweight in the event of slack suspension ropes.

3.2.8 Means are to be provided to prevent the lift from being operated when the emergency escape hatch is open. The hatch is to be fitted with a key switch or equivalent to prevent accidental closure reactivating the control system.

3.2.9 Means are to be provided to prevent the lift from being operated in the event of an overload in the lift car. An overload is considered to occur when the rated load is exceeded by 10 per cent with a minimum of 75 kg.

3.2.10 In the event of an overload:
(a) Users shall be informed by an audible and/or visual signal in the car;
(b) Automatic power-operated doors shall be brought into the fully open position;
(c) Manually operated doors shall remain unlocked.

3.2.11 The lift car is to be provided with an alarm, or telephone, or equivalent means of communication.

3.2.12 A landing indicator is to be provided within the car and outside each entrance.

3.2.13 Means are to be provided to enable the lift car to be raised or lowered manually in the event of power failure. The direction of the lift car travel is to be clearly indicated at the manual control position.

3.2.14 Emergency lighting is to be provided in the lift car, lift motor room, trunk access points and lift trunk. This emergency lighting is to be switched on automatically if the normal supply of electric power fails.

■ *Section 4*
Control and supervision of lifting appliances for cargo handling

4.1 General

4.1.1 Lifting appliances for cargo handling as specified in 2.2.2 are to be provided with the controls, alarms and safety arrangements required by this Section as appropriate. Alternative arrangements which provide equivalent safeguards will be considered.

4.1.2 Means are to be provided to ensure safe and effective control of speed, direction and stopping of the lifting appliance or ramp.

4.1.3 Each control station is to be provided with means such that the operating area of the lifting appliance and the load being lifted can be observed.

4.1.4 An emergency stop, independent of the controls required by 4.1.2, is to be provided at each control station to stop the motion of the lifting appliances in an emergency. This emergency stop is to be clearly identified and suitably protected to prevent inadvertent operation.

4.1.5 An alarm is to operate in the event of failure of the operating power and means are to be provided to automatically hold the lifting appliance and load in position.

4.1.6 Indication of the operational status of running and standby machinery, if fitted, is to be provided at each control station.

4.2 Lifts and ramps

4.2.1 Arrangements are to be provided to prevent activation of the lift or ramp when:
(a) Any covers are not retracted.
(b) The lift is overloaded.
(c) Vehicle barriers are not closed.

4.2.2 Continuous audible and visual warning is to be given within the operational area during operation of the lift or ramp.

4.2.3 Where a lift or ramp is secured by retractable locks, means are to be provided to ensure that power is not disconnected until all locks have been engaged, and descent is not possible until all locks have been disengaged.

4.2.4 Where a quayside access ramp is fitted in addition to a stern door, the ramp is to be less than 10° to the horizontal before opening or closing of the stern door.

4.2.5 The maximum inclination of the access ramp when in its operating position is not to exceed a predetermined angle from the horizontal and an alarm is to operate should this maximum permitted angle be exceeded.

4.2.6 Where remotely controlled locks are used, alternative means are to be provided to secure the lift or ramp in the event of failure of the lock controls or latching mechanism.

4.2.7 A continuous safety trip wire or equivalent is to be fitted beneath the sides and ends of cargo lift platforms, and beneath the sides and ends of the deck openings. Means are to be provided automatically to stop and hold the lift platform in position immediately when the trip is operated.

4.3 Mechanical lift docks

4.3.1 Means are to be provided to indicate at each control station that the motion of the dock platform is maintained in the horizontal plane. An alarm is to give warning in the event that tilt or skew of the dock exceeds a predetermined limit.

4.3.2 In addition to the normal quay level stop units, independent means are to be provided automatically to stop the lift dock movement in the event of upper or lower overrun.

4.3.3 Where multiple winches or jacks are employed, means are to be provided to:
(a) Synchronise their operation.
(b) Display the load on individual units at each control station.

4.3.4 The total load on the dock is to be displayed at each control station.

4.3.5 Means are to be provided automatically to hold the dock platform in position and operate an alarm in the event of a slack hoisting rope or chain.

4.3.6 Where a dock is secured by retractable locks, pawls or latches, means are to be provided to ensure that power is not disconnected until all locks, pawls or latches have been engaged, and descent is not possible until all locks, pawls or latches have been disengaged.

4.4 Derrick winches

4.4.1 Where a speed change gear is fitted and the hoisting drum is free to rotate when the gear is in the neutral position, means are to be provided to prevent the gear accidentally disengaging during operation. An automatically applied brake is to operate on the drum side of the change gear when neutral is selected.

4.4.2 Where a single motor is employed to position both the jib and the load, means are to be provided to interlock the jib when the motor is being used for hoisting.

4.5 Cranes

4.5.1 Means are to be provided for the control of hoisting, luffing angle, slewing angle and the positioning of travelling cranes as applicable.

4.5.2 Means are to be provided for emergency operation, to enable any load to be safely lowered and positioned.

4.5.3 Protective devices are to be provided, as applicable, to operate alarms, automatically cut off operating power and hold the crane and load in position in the event of a failure of the operating controls for the following:
(a) Hoist travel.
(b) Hoist speed.
(c) Luffing angles.
(d) Slewing angles.
(e) Travel of crane along its track.
(f) Longitudinal and transverse movement of the trolley on its gantry.

4.5.4 For variable load/radius cranes, a load indicator which automatically displays a maximum safe load at a given radius is to be fitted. An alarm is to operate when the load reaches 95 per cent of the SWL and at 110 per cent of the SWL, motion in directions that would increase the overload is to be prevented automatically.

4.5.5 Slack rope switches are to be fitted to each rope system. A suitable time delay may be fitted when operating conditions necessitate this feature. Operation of a slack rope switch is to initiate an alarm,and automatically prevent motion in directions that would increase the length of slack rope or cause the rope to spool incorrectly.

4.5.6 Where controls are located on the crane mast, means are to be provided to enable the operator to summon help in an emergency.

4.5.7 In the case of travelling cranes, a continuous audible warning is to be given within the operational area when the crane is to move/is moving along its track.

4.5.8 In the case of offshore and floating cranes, the following is to be provided:
(a) A wind speed indicator and alarm when wind speed exceeds a predetermined limit for a given time.
(b) Crane level indication with operating limits, (when conditions of list or trim are specified).
(c) Means of communication between the crane operator and the signal person such that control of the crane is not impaired.
(d) A hook load indicator.

■ *Section 5* Electrical installations

5.1 Classification of lifting appliances

5.1.1 Electrical equipment is to comply with the requirements of a relevant National or International Standard, due consideration being given to the environmental conditions envisaged, e.g., in areas of high ambient temperature, de-rating may be necessary.

5.1.2 Installations are to be designed in accordance with Pt 6, Ch 2 of the Rules for Ships or with a recognised National or International Standard or Code of Practice.

5.1.3 All electrical equipment is to be installed and tested to the Surveyor's satisfaction. The testing and trials described in Pt 6, Ch 2,21 of the Rules for Ships are to be satisfactorily carried out as appropriate.

5.1.4 When the lifting appliance to be classed is a mechanical lift dock, the following documentation is to be submitted for consideration:

(a) Arrangement plan and circuit diagram of switchboard(s).
(b) Diagram of wiring system including cable size, type of insulation, normal working current in the circuits and the capacity, type and make of protective devices.
(c) Calculations of short-circuit currents at main busbars, sub-switchboard busbars and the secondary side of transformers.

5.2 Certification of lifting appliances

5.2.1 The electrical equipment is to be examined and tested for compliance with the appropriate National or International Standard.

Materials and Fabrication

Contents

■ *Section 1* General requirements

1.1 Scope

1.1.1 Materials used for the construction, or repair, of lifting appliances are to be manufactured and tested in accordance with the general procedures given in this Chapter and Ch 1,1.6.

1.1.2 Detailed requirements for the testing and inspection of steel wire rope and fibre rope are given in Chapter 8.

1.1.3 Proposals to use synthetic materials are to be submitted for consideration.

1.1.4 The material properties are to comply with the requirements given in the relevant Chapter dealing with design and/or shown on the approved plan.

1.1.5 Provision is made in this Chapter for requirements related to fabrication and related inspection of lifting appliances.

■ *Section 2* Fabrication of lifting appliances

2.1 Fabrication of classed lifting appliances

2.1.1 The fabrication and inspection of lifting appliances subject to ship Classification are to comply with the *Rules for the Manufacture, Testing and Certification of Materials* (hereinafter referred to as the Rules for Materials) and the appropriate Sections of this Code.

2.1.2 The extent of non-destructive testing is to comply with Table 12.3.1 in Chapter 12.

2.2 Fabrication of certified lifting appliances

2.2.1 **Re-testing of materials**:

(a) Check tests may be required at the discretion of the Surveyor.
(b) In general, the manufacturer's chemical analysis will be accepted but may be subject to occasional independent checks if required by the Surveyor.
(c) When mechanical check tests are required, the specified tests are to be carried out using calibrated machines which are maintained in a satisfactory and accurate condition.

2.2.2 **Rectification of defects**:

(a) In all cases, the removal of defects, and repair by welding where appropriate, are to be carried out to the satisfaction of the Surveyor.
(b) Surface imperfections may be removed by mechanical means as agreed with the Surveyor. After such treatment, the dimensions are to comply with an agreed National or International Standard and the area is to be proved free from defects. The work is to be completed to the satisfaction of the Surveyor.
(c) For steel castings, flame scarfing or arc-air gouging may be used, provided that pre-heating is used where necessary, the surfaces of the resulting depression are subsequently ground smooth and complete elimination of the defective material is confirmed by adequate non-destructive examination.
(d) Repair by welding is not to be carried out without the agreement of the Surveyor. Agreement of the Surveyor is to be obtained before the work is commenced.
(e) The complete removal of all defects is to be proved by suitable non-destructive examinations and the area is to be suitably prepared for welding.
(f) Welding is to be carried out using a qualified and approved procedure which is to include the selection of suitable welding consumables. Pre-heating and post-weld heat treatment may be necessary due to the particular chemical composition or dimensions of the weld repairs. The repairs are to be carried out by qualified welders under adequate supervision.

2.2.3 **Fabrication**:

(a) All standards related to weld procedures, qualification of welders, non-destructive test procedures, non-destructive test personnel qualifications and non-destructive acceptance criteria are to be agreed prior to the commencement of work.
(b) Welding procedures are to be in accordance with the Rules for Materials or an agreed National or International Standard. All welding procedures are to be qualified by testing and be approved by the Surveyor.
(c) Welding consumables are to be of a type approved by LR. A list of currently approved welding consumables is published in the CDlive section of LR's website at http://www.lr.org/.
(d) All welders are to be qualified to the satisfaction of the Surveyor in accordance with the Rules for Materials or other equivalent National or International Standard.
(e) Post-weld heat treatment is to be applied under the following conditions:
    (i) For steels with nominal yield strength below 420 N/mm^2 where the as-welded hardness exceeds 350 Hv.
    (ii) For steels with yield strength between 420 N/mm^2 and 690 N/mm^2 where the as-welded hardness exceeds 420 Hv.
    (iii) Welding of steel castings where the thickness of the casting at the weld exceeds 30 mm.
    (iv) Where weld thickness exceeds 65 mm.

Post-weld heat treatment may be omitted where the risk of fracture is demonstrated to be low or where the consequences of fracture are demonstrated to be tolerable.

(f) Following welding, visual inspection is to be carried out by qualified inspectors to ensure that welds are in accordance with the approved plan and comply with agreed acceptance criteria. Surveyors will conduct visual examination spot checks to confirm the overall quality of the welds against the approved plans and agreed acceptance criteria.

(g) In addition to visual checks, welds are to be non-destructively examined to verify their soundness. All non-destructive examinations (NDE) are to be carried out to a written procedure that is representative of the item under inspection and they are to be based upon a National or International Standard. Personnel carrying out non-destructive examination or interpreting the results of non-destructive examination are to be qualified to the appropriate level of a nationally recognised scheme such as ISO 9712, EN 473, PCN, ACCP or SNT-TC-1A. Level 1 personnel are not permitted to interpret results to Codes or Standards.

(h) The extent of NDE is to be in accordance with Table 12.3.1 in Chapter 12.

(j) The verification of dimensional compliance to approved drawings is to be verified by the Surveyor after machining and/or welding operations.

Contents

■ *Section 1* Testing

1.1 General

1.1.1 Every lifting appliance is to be tested and thoroughly examined before being taken into use for the first time or after any subsequent alteration or repair which may affect the strength of the appliance, or at certain Periodical Surveys as indicated in Section 3.

1.1.2 Every item of loose gear is to be proof tested and thoroughly examined before being taken into use for the first time or after any subsequent repair or alteration which may affect the strength of the item.

1.1.3 Where testing machines (e.g., dynamometers) are used to apply test loads, they are to be of a type approved by Lloyd's Register (LR) as suitable for the intended purpose. The machine is to be calibrated biennially by a recognised authority and the accuracy is to be within ±2 per cent. Testing machines are not to be used for initial testing; and although acceptable to LR for periodical re-testing or following repairs, some National Authorities will not accept this form of testing.

1.1.4 Where test weights are used to apply test loads, the weights are to be certified as accurate to within 2 per cent.

1.1.5 Water bags may be used instead of certified weights for testing lifting appliances. Where used, these are to be of a type suitable and certified for the purpose. The volume of water is to be measured using a calibrated flow meter which has been certified as accurate to within ±2 per cent. As an alternative, use of calibrated load cells certified as accurate to within ±2 per cent for determining the test loads could also be accepted. The flow meters and load cells are to be re-certified biennially.

1.1.6 Suitable precautions are to be taken before commencing the test to ensure the stability of the ship and the adequacy of the supporting structure to bear the test loads.

1.1.7 Measures are to be taken to ensure that the appliance can be controlled during the test and to avoid injury or damage which might occur in the event of failure under load.

1.1.8 Lifting appliances are generally to hold the test weights for at least 5 minutes, but this may be extended at the discretion of the Surveyor.

1.2 Loose gear

1.2.1 For the purpose of these requirements, loose gear is defined as including hooks, hook blocks, shackles, blocks, swivels, chains, rings and similar items not permanently attached to the lifting appliance. Lifting beams, spreaders, frames, grabs and similar items of equipment which are not an integral part of the lifting appliance are also considered as loose gear. Built-in sheaves and blocks and other items permanently attached to the lifting appliance are not considered as loose gear and the test on the complete system 'as rigged' will be accepted as the test on these items.

1.2.2 For all blocks (single and multi-sheave), the proof load is to be taken as the resultant load and applied to the head fitting of the block during the test. Where the block is fitted with a becket, the load applied to the becket during the load test of the block will be accepted as the proof test on the becket.

1.2.3 Sheave blocks that are permanently attached to, or integral with, the hook are called cargo hook blocks and are to be tested with a proof load for multi-sheave blocks as indicated in Table 12.1.1. The hooks are to be tested with a proof load for hooks as indicated in Table 12.1.1.

Table 12.1.1 Proof loads for loose gear

Item	Proof load, in tonnes
Single sheave block	4 x SWL
Multi-sheave blocks:	
SWL ≤ 25 t	2 x SWL
25 t < SWL ≤ 160 t	(0,933 x SWL) + 27
160 t < SWL	1,1 x SWL
Hooks, shackles, chains, rings, swivels, etc.:	
SWL ≤ 25 t	2 x SWL
25 t < SWL	(1,22 x SWL) + 20
Lifting beams, spreaders, frames, grabs:	
SWL ≤ 10 t	2 x SWL
10 t < SWL ≤ 160 t	(1,04 x SWL) + 9,6
160 t < SWL	1,1 x SWL

NOTES
1. The safe working load for a single sheave block, including single sheave blocks with beckets, is to be taken as one half of the resultant load on the head fitting.
2. The safe working load for a multi-sheave block is to be taken as the resultant load on the head fitting.
3. Where the item is to be used in diving operations, the proof load is to be 1,5 times the proof load value given above for the particular item.
4. Where the item is to be used for offshore use, the proof loads indicated are to be increased by the ratio F_h/1,6 where F_h is derived from Ch 4,3.3.
5. Single sheave blocks that have a resultant load greater than 25 t can have a reduced test load calculated on the basis of a multi-sheave block [(0,933 x RL) + 27 t].
6. Proof loads are shown graphically in Fig. 12.1.1.

1.2.4 After proof testing, all parts of the blocks are to be thoroughly examined for deformations, cracks, flaws, or other defects and to check that head fittings can swivel and sheaves rotate freely.

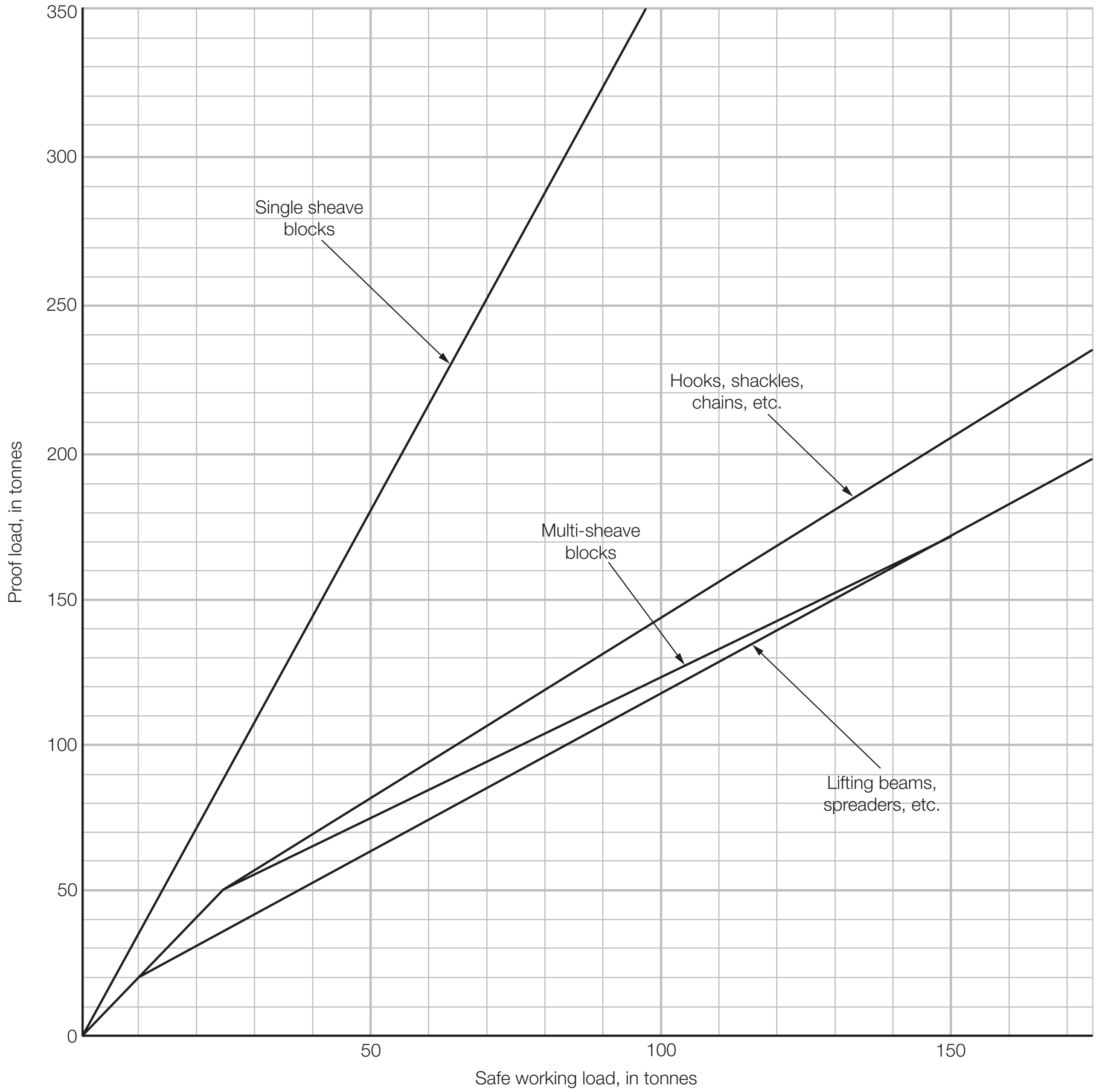


Fig. 12.1.1 Proof loads for loose gear

1.2.5 The proof load may be applied to a Ramshorn hook as indicated in Fig. 12.1.2(a) or (b), but in the latter case an additional load of half the proof load is subsequently to be applied as in Fig. 12.1.2(c).

1.2.6 Short and long link chain is to be subjected to a breaking test in addition to the proof test required by Table 12.1.1. One sample of length 910 mm is to be taken from each length of chain measuring 185 m or less and is to withstand a breaking load of 4 x SWL for the chain.

1.2.7 Where the design of a lifting beam, frame, or similar item is such that the load can be lifted and supported in more than one manner, each arrangement is to be separately tested. Alternative testing proposals outlining how all components will be loaded above their maximum design load (but not above the required test load) will be specially considered subject to the Surveyor's satisfaction. Hooks, shackles and blocks forming part of the lifting beam or frame are to be separately tested in accordance with Table 12.1.1.

1.2.8 Where the loose gear is for use in an offshore, open sea or diving application, the selection of the component of loose gear should take account of the higher proof loads required by Notes 3 and 4 of Table 12.1.1.

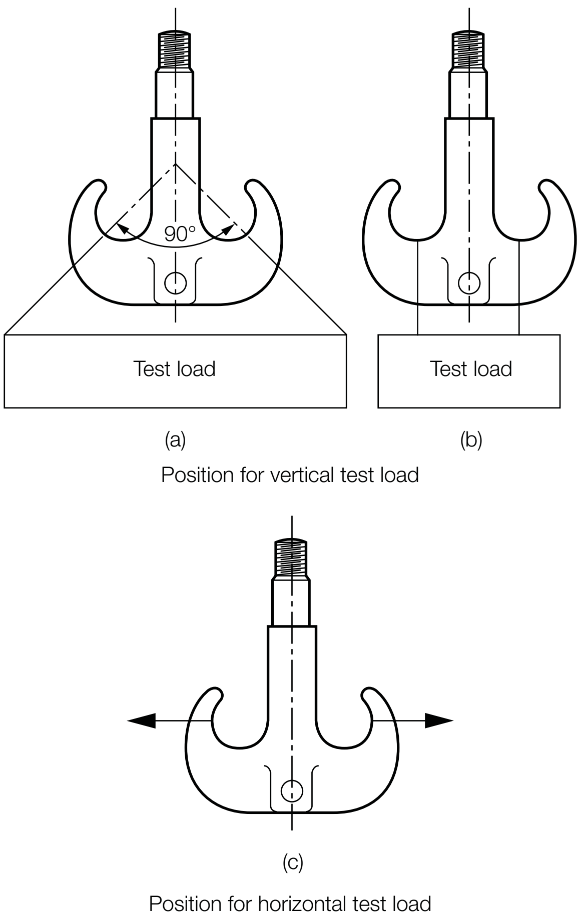


Fig. 12.1.2 Testing of Ramshorn hooks

1.3 Steel wire rope

1.3.1 Steel wire used in the construction of ropes is to be subjected to breaking, torsion and reverse bend tests and to tests for quality and adhesion of the zinc coating in accordance with ISO 2232 *Round Drawn Wire for General Purpose Non-alloy Steel Wire Ropes – Specifications* or with an acceptable equivalent. Where required, similar tests may be carried out on wires taken from samples of completed ropes.

1.3.2 Steel wire ropes are to be tested to determine the breaking load of the rope. Tests in accordance with International or recognised National Standards may be accepted and, in this respect, attention is drawn to the following International Standards:

- ISO 2408 *Steel wire ropes for general purposes – Minimum requirements*.
- ISO 3108 *Steel wire rope for general purposes – Determination of actual breaking load*.

1.3.3 The breaking load is to be determined by one of the following methods:

(a) Testing to destruction a sample cut from the completed rope.

(b) Testing the individual wires to destruction, summating the results and deducting a percentage for laying up.

This percentage is to be not less than as given in Table 12.1.2. Manufacturers adopting this method of testing will be required to arrange for occasional tensile tests to destruction to be carried out on completed ropes.

Table 12.1.2 Percentage deduction for laying up

Rope construction	Percentage deduction		
	Fibre core	Steel core	
		WSC	IWRC
6 x 710	12	17	—
6 x 19	14	16	21
6 x 37	17,5	20	25
6 x 19 Seale	16	—	23
6 x 19 Filler	16	—	23
6 x 26 Warrington-Seale	16	—	23
6 x 31 Warrington-Seale	16	—	23
6 x 36 Warrington-Seale	16	—	23
6 x 41 Warrington-Seale	16	—	23
6 x 12	10	—	—
6 x 24	13	—	—
17 x 7 and 18 x 7	22	22	—
34 x 7 and 36 x 7	25	25	—

NOTES
1. For construction and breaking loads of ropes, *see* Chapter 6.
2. WSC = wire strand core
IWRC = independent wire rope core.

1.3.4 Before a test sample is cut from the rope, it is to be securely seized or clamped so as to prevent any slacking of wires within the test length. The sample is to be of sufficient length to provide a clear test length in accordance with Table 12.1.3.

Table 12.1.3 Test length for steel wire ropes

Wire rope diameter, d, in mm	Test length, in mm
$d \leq 6$	300
$6 < d \leq 20$	600
$d > 20$	30d but need not exceed 1500 mm

1.3.5 Up to 80 per cent of the nominal breaking load may be applied quickly. Thereafter, the load is to be applied slowly and steadily until the maximum load is attained. Tests in which a breakage occurs adjacent to the grips may be neglected.

1.3.6 Terminal connections, where used, are to be of a type acceptable to LR. Initial tests are to be carried out on various sizes of connections to show that the strength of the completed termination is not less than:

- 95 per cent for ropes up to 50 mm diameter; or
- 90 per cent for ropes exceeding 50 mm diameter

of the breaking load of the original wire rope.

After completion, each terminal connection is to be proof tested to twice the SWL on the rope. However, for larger terminations where the safety factor on the rope is between 3,0 and 4,0, testing of the termination is not to exceed 50 per cent of the minimum breaking strength of the rope.

1.3.7 Poured zinc and resin sockets do not require proof testing, provided:

(a) The termination has been carried out by a competent person in accordance with a recognised procedure and material requirement.

(b) The sockets are in accordance with a recognised Standard and are certified.

1.4 Fibre rope

1.4.1 Fibre ropes are to be tested to determine the breaking load of the rope. Additional tests may be required, particularly in the case of ropes manufactured from man-made materials, in order to establish the suitability of the rope for its intended purpose.

1.4.2 Manufacture and testing are to be in accordance with international or recognised National Standards where appropriate.

1.4.3 The breaking load is to be determined by testing to destruction a sample cut from the completed rope. Alternative proposals will, however, be specially considered where a breaking test would be impracticable.

1.4.4 The minimum length of test sample is to be as given in Table 12.1.4. The sample is to be subjected to an initial tensile load as given in Table 12.1.4 and checked for diameter and evenness of lay-up. The load is then to be increased evenly and continuously by stretching the sample at the rate given in Table 12.1.4 until the sample breaks. Tests in which a breakage occurs within 150 mm of the grips may be neglected.

Table 12.1.4 Testing of fibre ropes

Material	Test length, in mm	Initial load, *see* Note	Speed of loading in mm/min
Natural fibre	1800	2	250 ± 50
Synthetic fibre	900	1	75 ± 25

NOTE
Initial load is expressed as a percentage of the nominal breaking load of the rope.

1.5 Derricks and derrick cranes

1.5.1 Following any preliminary part load tests considered necessary to ensure correct assembly and freedom of operation, each derrick in the system is to be tested with a test load in accordance with Table 12.1.5. The test is to be carried out using certified weights suspended from the cargo hook or lifting attachment, according to a procedure agreed with the Surveyor.

Table 12.1.5 Testing of derricks and cranes

SWL of derrick, crane or ROV handling system, in tonnes	Test load, in tonnes
Up to 20 t	1,25 x SWL
20 t < SWL ≤ 50 t	SWL + 5 t
50 t < SWL	1,1 x SWL

NOTE
Hand operated pulley blocks are to be proof tested to 1,5 x SWL.

1.5.2 During the test, hoisting and slewing operations are to be carried out at slow speed. The load is to be slewed as far as possible in both directions with the derrick boom at the lowest angle to the horizontal for which it has been approved, *see* Chapter 2.

1.5.3 In addition to verifying the adequacy of the derrick and the support structure, the test is to demonstrate the adequacy of the winch brakes, controls and any overload cut-out, safe load indicators, etc. The test is also to demonstrate that the test load can be held stationary when the winch drive is switched off, *see also* Chapter 9.

1.5.4 Where derricks have been approved for operation in union purchase, they are to be rigged and tested for working both port and starboard sides of the ship. The test is to be carried out for the headroom, runner angle and boom and guy positions for which the rig has been approved, with a test load in accordance with Table 12.1.5 for the SWL of the system in union purchase operation.

1.5.5 Following the overload test, the derrick is to be operationally tested with its safe working load. The derrick is to be operated over its full range of positions at normal speeds and it is to be demonstrated that all parts of the system are free to take up their correct positions and that all ropes run freely and reel up correctly on the winch drums.

1.5.6 After testing, the derrick system is to be thoroughly examined for deformations and other defects.

1.5.7 Derrick cranes are to be tested in accordance with 1.5.1 to 1.5.6, with the addition that the derrick crane is to be luffed at slow speed to its maximum operating angle to the horizontal while bearing the full test load.

1.5.8 Where twin span tackles are fitted to derrick cranes of patent type, the manufacturer may be required to demonstrate during testing with the SWL that the derrick boom has adequate stability when in the maximum slewed position for both maximum and minimum luffing angles under the maximum approved angles of heel and trim of the ship.

1.6 Cranes and ROV handling systems

1.6.1 Following any preliminary part load tests considered necessary to ensure correct assembly and freedom of operation, each crane or ROV handling system is to be tested with a test load in accordance with Table 12.1.5. The test is to be carried out using certified weights suspended from the cargo hook or lifting attachment, according to a procedure agreed with the Surveyor.

1.6.2 During the test the crane is to hoist, slew and luff the test load at slow speed. Gantry and travelling cranes together with their travelling trolleys, where appropriate, are to be traversed slowly over the full length of their track. ROV handling systems are to lift the test load through one complete operating cycle.

1.6.3 In the case of a variable load-radius crane, the tests are, generally, to be carried out for the appropriate safe working loads at maximum, minimum and an intermediate radius. Alternative proposals will, however, be considered.

1.6.4 Where the jib length may be increased by the insertion of additional lengths, the crane is to be tested for each jib length. Alternative testing proposals outlining how all components will be loaded above their maximum design load (but not above the required test load) will be specially considered subject to the Surveyor's satisfaction.

1.6.5 Where it is not practicable for the crane to raise the full test load, as may be the case for hydraulic cranes, a reduced test load may be accepted, but in no case is this to be less than 1,1 x SWL. Although acceptable to LR, this test at reduced load may not be acceptable to some National Authorities.

1.6.6 Following the overload test, the crane is to be loaded with its safe working load and operated over its full range of speeds in order to demonstrate the effective operation of the crane, the accuracy of overload and safe load indicators and the effectiveness of limit switches, etc.

1.6.7 Following the overload test, the ROV handling system is to be operated with its SWL over its complete operating cycle to demonstrate the effective operation of the handling system, the accuracy of overload and safe load indicators and the effectiveness of limit switches, etc.

1.6.8 Where the crane has been approved with hoisting factor of more than 1,6, the test loads indicated in Table 12.1.5 are to be increased by the ratio of F_h/1,6, where F_h is derived from Ch 4,3.

1.6.9 Where the ROV handling system has been approved with hoisting factor of more than 1,7, the test loads indicated in Table 12.1.5 are to be increased by the ratio of F_h/1,7, where F_h is derived from Ch 4,4.

1.6.10 After testing, the crane or ROV handling system is to be thoroughly examined for deformations and other defects.

1.7 Launch and recovery systems for diving operations

1.7.1 Upon completion of preliminary tests necessary to ensure correct assembly and freedom of operation, each lifting appliance used for raising, lowering or transferring manned submersibles or other manned diving systems is to be subjected to the following tests:

(a) A 'static' load test equivalent to 1,5 x SWL. In the case of cranes or A frames, this load is to be lifted at the maximum and minimum radii or inboard/outboard positions and at an intermediate position.

(b) A 'dynamic' load test equivalent to 1,1 x SWL. This test is to demonstrate that the hoist brake system is capable of stopping the load whilst being lowered at maximum speed to simulate a power failure.

(c) An 'operational' load test equivalent to 1,25 x SWL. This test is to be carried out over the full range of operation of the lifting appliance.

1.7.2 Where the diving system is approved with hoisting factor of more than 1,7, the test loads indicated in Table 12.1.5 are to be increased by the ratio of F_h/1,7, where F_h is derived from Ch 4,4.

1.7.3 If testing to values in excess of those defined in 1.7.1 and 1.7.2 is envisaged, a review of the launch and recovery system should be undertaken to ensure that overstressing does not occur.

1.7.4 For the purpose of these requirements, the safe working load of the appliance is to be taken as the greater of:

(a) The maximum in-air weight of the diving system, lifting frame and rope when it is at water surface; or

(b) The total submerged weight of the diving system, lifting frame and rope when it is at its maximum operating depth.

1.7.5 Following the overload test, the lifting appliance is to be operated with its SWL over the complete operating cycle to demonstrate the effective operation of the system, the accuracy of overload and safe load indicators and the effectiveness of limit switches, etc.

1.7.6 After testing, the lifting appliance is to be thoroughly examined for deformations and other defects.

1.7.7 Further tests in accordance with LR's *Rules and Regulations for the Construction and Classification of Submersibles and Diving Systems* (hereinafter referred to as the Rules for Submersibles) may be required and reference made to that publication. Where compliance with National Authority Regulations is required, specific reference should be made to the Regulations in case any additional or more onerous test requirements are appropriate.

1.8 Mechanical lift docks

1.8.1 The test requirements for mechanical lift docks are given in Chapter 5.

1.9 Lifts and ramps

1.9.1 Attention is drawn to the existence of statutory requirements of certain National Authorities for the testing of lifts, particularly of passenger lifts.

1.9.2 Each lift is to be tested with its applied or rated load, *see* Chapters 6 and 7, to demonstrate the satisfactory operation of the lift and all control and safety systems.

1.9.3 In addition, after installation and following any major repair, renewal or alteration, each lift is to be subjected to the following tests:

(a) For all lifts, the brake is to hold the lift with a proof load of 1,25 times the applied or rated load.
(b) The lift is to be operated through one complete round trip with a proof load of:
  (i) Passenger lifts: 1,1 times the applied or rated load.
  (ii) Cargo or vehicle lifts: in accordance with Table 12.1.6.

Table 12.1.6 Test load for cargo or vehicle lifts

SWL, in tonnes	Test load, in tonnes
Up to 20 t	1,25 x SWL
20 t < SWL ≤ 50 t	SWL + 5 t
50 t < SWL	1,1 x SWL

1.9.4 Vehicle ramps which may be raised or lowered while loaded are to be tested as for vehicle lifts.

1.9.5 Vehicle ramps which are raised or lowered only when unloaded are to be tested after installation and following any major repair, renewal or alteration as follows:

(a) The brake is to hold the ramp in its most unfavourable position while the ramp is subjected to a load of 1,25 times its self-weight.
(b) The ramp is to be placed in its working position and subjected to a test load as given for vehicle lifts in 1.9.3(b).
(c) The ramp is to be operated through one complete operating cycle, unloaded, using the terminal stops only.

1.10 Re-testing

1.10.1 Re-testing of loose gear is to be carried out in the following circumstances:

(a) In the absence of an appropriate certificate indicating that the item has previously been tested;
(b) Following any repair or alteration which may affect the strength of the item;
(c) If the item's unique identification mark has become illegible;
(d) As required by the National Administration.

1.10.2 The re-test of loose gear is to be in accordance with 1.2.

1.10.3 Re-testing of derrick systems, derrick cranes, cranes, and ROV handling systems is to be carried out in the following circumstances:

(a) Following any structural repair, alteration or re-erection of the appliances;
(b) At every fifth Annual Thorough Survey, or in accordance with the requirements of the National Administration.

1.10.4 These tests need not be as extensive as the initial tests, but it must be demonstrated that the test load can be raised and lowered. It is preferable also for the derrick or crane to be slewed and luffed during the re-test, but this may be waived at the discretion of the Surveyor.

1.10.5 Re-testing of union purchase rigs is not essential, provided the derrick has been re-tested in single working and special attention is paid to the condition of the preventer guy eyeplate attachment to the deck.

1.10.6 Derricks and cranes having a safe working load not exceeding 15 t may be re-tested using a spring or hydraulic weighing machine, provided:

(a) The machine has an accuracy within ±2,0 per cent and the load is applied for at least five minutes with the indicator remaining constant;
(b) The derrick boom is placed in the most onerous certified operating position;
(c) The support point for the machine is adequately strengthened to avoid overstressing of the supporting structure; and
(d) This method of test is acceptable to the appropriate National and Port Authorities.

1.10.7 Lifting appliances used for raising, lowering or transferring manned submersibles or other diving systems are to be re-tested annually in accordance with 1.7. Re-testing will also be required following any structural repairs, alterations or re-erection of the appliance.

1.10.8 Lifts and ramps are to be re-tested at every fifth Annual Thorough Survey, depending on the requirements of the National Administration, and also when repairs or alterations have been carried out affecting the strength of the item. The re-test is to be in accordance with 1.9.3.

■ *Section 2* Marking

2.1 General

2.1.1 Each lifting appliance and each item of loose gear is to be clearly and permanently marked with its safe working load, with an identification mark to enable it to be readily related to its appropriate test certificate and with the mark of the Surveyor or manufacturer who carried out the proof test.

2.1.2 In view of the importance of ensuring that each item of loose gear has the correct safe working load for its particular position in the lifting appliance, and to facilitate the ordering of replacements, it is recommended that a Particulars Book or a fully detailed Rigging Plan and Block List be kept on board. Typical symbols used in rigging plans are given in Fig. 12.2.1.

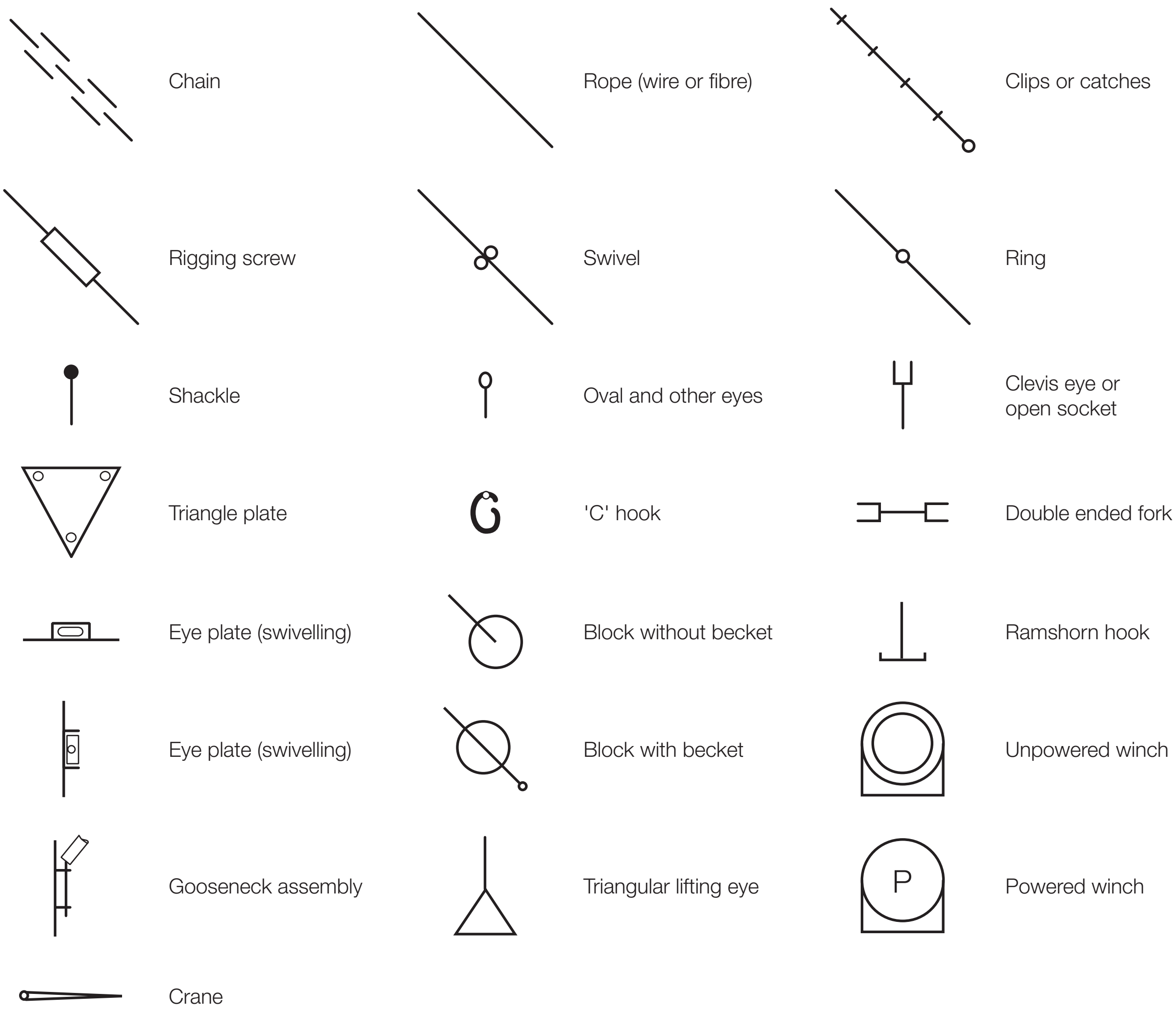


Fig. 12.2.1 Symbols for fittings used in key plans or rigging

2.2 Loose gear

2.2.1 Every item of loose gear, including lifting beams and similar items, is to be marked with:

(a) The safe working load of the item, in tonnes. For asymmetric lifting beams, the maximum reaction at each lifting point is also to be marked.
(b) An individual alphanumeric identification mark to relate it to its test certificate.
(c) A mark indicating the grade of steel in accordance with Table 12.2.1.
(d) The Surveyor's or manufacturer's stamp.
(e) For blocks, the maximum rope diameter for which the block is designed.
(f) For lifting beams and similar items, the tare weight in tonnes.
(g) Where appropriate, an identification mark corresponding to the position of the item on the ship's Rigging Plan.

2.2.2 Permanent identification marks or symbols are to be made, with stamps having rounded profiles (low stress stamps). The number of marks on an item is to be kept to the minimum.

Table 12.2.1 Material quality grade marks

Quality grade mark	Grade of steel	Ultimate tensile strength, in N/mm^2
L	Mild	300
M	Higher tensile	400
P	Alloy	500
S	Alloy	630
T	Alloy	800

2.2.3 The use of fractions and oblique strokes is to be avoided and a dot or hyphen is preferable to a dividing line. Values of SWL are, generally, to be marked to one place of decimals (except for 0,25 and 0,75) up to 100 t and in integers thereafter. The word 'tonnes' may be abbreviated to 't'.

2.2.4 Recommended sizes of marks are given in Table 12.2.2 based on the diameter of the part to be marked or on the SWL of the item as appropriate. Typical arrangements of marks are shown in Fig. 12.2.2.

Table 12.2.2 Size of marks

Item	Diameter of part to be marked, in mm	SWL of item, in tonnes	Recommended size of mark, in mm
Chains, links, rings, shackles, eyes (without collar), swivels	Less than 12,5		3,0
	12,5 to 26		4,5
	Over 26		6,0
Eyes (with collar), triangle plates, rope sockets, hooks, blocks		Up to 2	3,0
		2 to 8	4,5
		Over 8	6,0
Lifting beams, spreaders, frames		All	Minimum 75

2.3 Steel wire and fibre ropes, including slings

2.3.1 The following information is to be marked on a disc or tally attached to the rope or sling, or an approved electronic capture system:

(a) An individual identification mark to relate the rope to its test certificate.

(b) The Surveyor's or manufacturer's stamp.

2.3.2 Where the rope is fitted with a ferrule or socket, this is to be marked to relate it to the manufacturer's test certificate. The marks required by 2.3.1 may also be made on the ferrule or socket where appropriate.

2.3.3 Markings on slings are also to include the number of legs and the safe working load in straight lift and when the angle between the legs and the vertical is 45°.

2.3.4 The identification mark on synthetic or fibre slings is also to show its:

- SWL in straight lift;
- SWL when the angle between the legs and the vertical is 45°;
- Material;
- Nominal length;
- Manufacturer's or supplier's name.

2.4 Derricks, cranes and launch and recovery systems for diving operations

2.4.1 Every lifting appliance is to be conspicuously and permanently marked near the heel of the boom, jib or equivalent component with its safe working load and the minimum operating angle or limiting radius as indicated in Table 12.2.3.

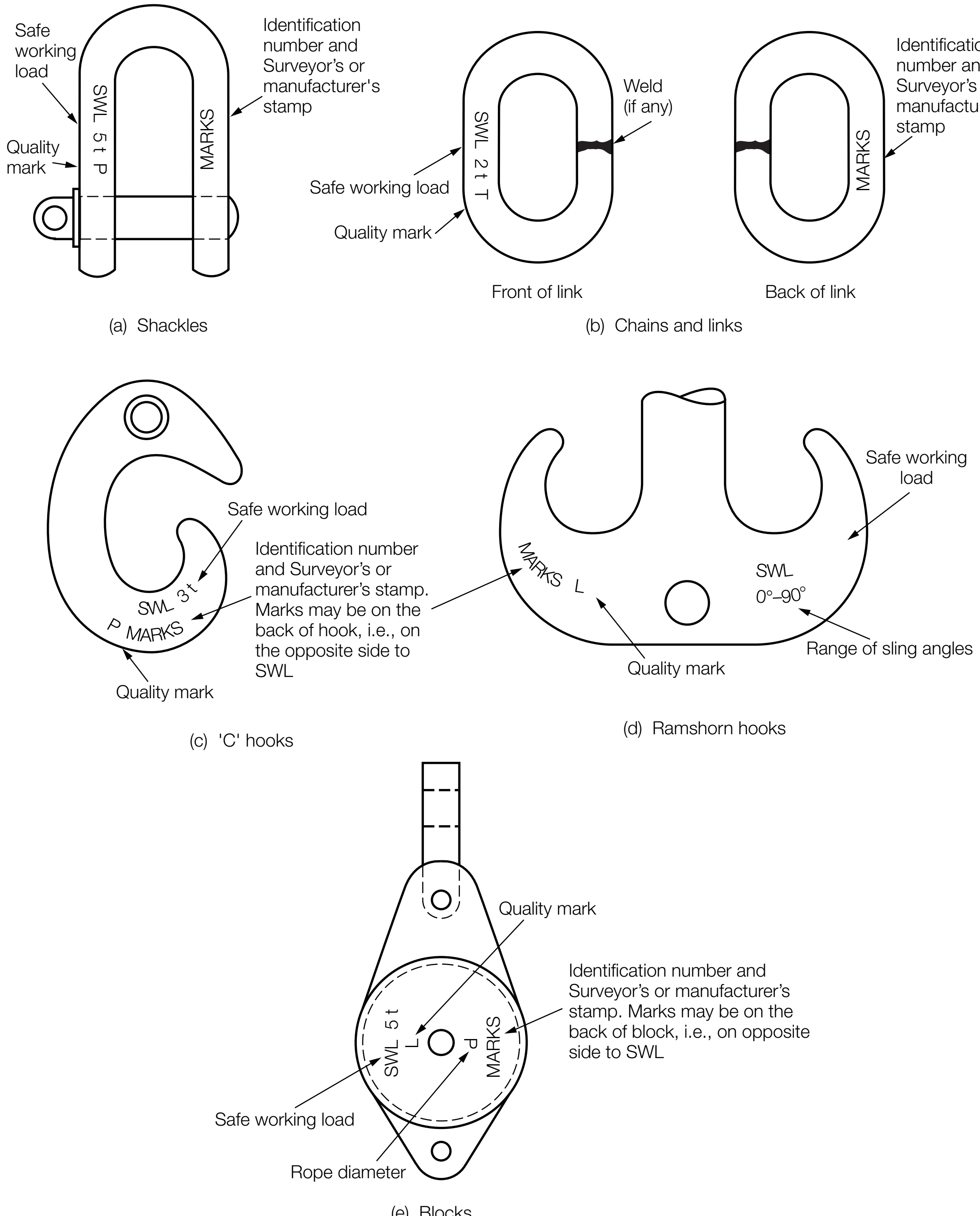
Table 12.2.3 Typical marks on lifting appliances

Description	Mark
Swinging derrick with boom as normally rigged	SWL 10 t (30°)
Swinging derrick with alternative rig	SWL 3/10 t (30°)
Derricks used in union purchase to be marked on inboard side of boom	SWL (U) 3 t
Crane of constant capacity over full range of radii	SWL 10 t (4 m/20 m radius)
Crane of variable load/radius characteristics	A plate indicating the characteristics is to be permanently attached to the crane

2.4.2 Where more than one method of rig is possible, or, for derricks, where union purchase operation is proposed, the safe working load for each method of rig is to be marked.

2.4.3 The letters and numbers are to be not less than 75 mm high and painted in yellow or white on a dark background or black on a light background.

2.4.4 The heel fitting of the appliance is to be marked with the number of the relevant test certificate and with the Surveyor's stamp. The stamps are to have rounded profiles (low stress stamps).



NOTE
For Material quality grade marks, *see* Table 12.2.1

Fig. 12.2.2 Typical marks for loose gear

■ *Section 3* Survey requirements

3.1 General

3.1.1 Where LR is requested to issue certification of lifting appliances, plans of the arrangements and scantlings of the installation are to be approved in accordance with the appropriate Chapter of this Code and an Initial Survey of the installation is to be carried out in accordance with 3.2 or 3.3 as appropriate.

3.1.2 Subsequent Periodical Examinations for the maintenance of the validity of the certification are to be carried out at the intervals and in the manner prescribed in 3.4.

3.1.3 Requests from the Owner for the deferment of thorough examinations will be considered and may be permitted in the circumstances given in 3.5.

3.1.4 Examinations following damage to the lifting appliance are to comply with 3.6.

3.1.5 Where the lifting appliances have also been assigned a class notation the surveys are also to comply with 3.7.

3.1.6 Requests for other examinations not specified above will be specially considered. Such examinations will, generally, be covered by separate instructions since they will normally involve the specific requirements of a National Authority.

3.2 Initial Survey of new installations

3.2.1 Materials used in the construction of the lifting appliance are to comply with Ch 1,1.6. Materials test certificates are to be made available.

3.2.2 The lifting appliance is to be examined during construction and the Surveyor is to be satisfied that the primary structural arrangements and workmanship are in accordance with the approved plans. Any details, required for further clarification or certification purposes, not in accordance with the approved plans or otherwise found to be unsatisfactory are to be rectified.

3.2.3 All welding is to be carried out in accordance with an approved WPS by suitably qualified welders and is to be to the satisfaction of the Surveyor, *see* Ch 11,2.

3.2.4 Non Destructive Examination (NDE) is to be carried out by suitably qualified operators to the satisfaction of the Surveyor. The minimum requirements for NDE are given in Table 12.3.1, but this may be extended at the discretion of the Surveyor.

3.2.5 Particular attention is to be given to the supporting structure for masts, crane pedestals and overhead runway beams. It is to be verified that the scantlings and arrangements are in accordance with approved plans.

Table 12.3.1 Minimum requirements for NDE

Weld category	Butt welds, *see* Note 1, 2		Fillet welds, *see* Note 1, 2
	Magnetic Particle Inspection, *see* Note 3	Ultrasonic Inspection	Magnetic Particle Inspection, *see* Note 3
Critical weld	100%	100%	100%
Primary weld	100%	20%	100%
Secondary weld	*see* Note 4	—	*see* Note 4

The following definitions are applicable:
Critical weld.
The failure of which will result in the loss of the lifting appliance or load being lifted, e.g., slewing bearing flange/crane pedestal weld, circumferential welds on slewing columns, mast fittings, rope termination brackets, jib heel welds, etc.
Primary weld.
Welds in primary load path members the failure of which may lead to the loss of the load being lifted, e.g., boom chord connection, connections of bracings to boom chords, connection of panel stiffeners to jib or slewing column
Secondary weld.
Non primary load path welding, e.g., attachment of accessways, platforms, service fittings (electrics, lighting), maintenance equipment, etc.

NOTES
1. The percentage of weld found in table is the percentage of total weld length to be tested with a specified technique.
2. All welds are to be subject to 100% visual inspection.
3. Dye penetrant testin is to be used in place of magnetic particle inspection for non-magnetic materials, i.e., aluminium, austenitic stainless steel, etc.
4. Extent of inspection to be agreed between the manufacturer and Surveyor.

3.2.6 All ropes used in the load path of the lifting appliance are to be examined in order to verify that:
(a) they have been manufactured and tested in accordance with the requirements of this Code, or to a recognised National or International Standard, by a manufacturer approved by LR;
(b) they can be individually identified by disc or tally and have the appropriate certificates;
(c) they are of the correct construction, diameter, lay and direction of lay, wire quality and have the correct certified minimum breaking strength; and
(d) rope terminations comply with 1.3.6.

Ropes that are supplied by a manufacturer not approved by LR may require further testing in the presence of the Surveyor before they can be accepted.

3.2.7 All loose gear for the installation is to be examined in order to verify that:
(a) the item has been designed, manufactured and tested in accordance with the requirements of this Code, or a recognised National or International Standard;
(b) the item is individually marked, load tested and certified; and
(c) the item is of the correct SWL for its proposed location in the installation, as indicated in the approved plans.

3.2.8 The lifting appliance is to be tested as required by Section 1. Cut-outs, controls and similar devices are to function correctly. After testing, the installation, including the supporting structure, is to be examined for deformation or distortion to the satisfaction of the Surveyor.

3.2.9 For certification purposes, factory testing of cranes cannot be accepted as an alternative to onboard testing after installation.

3.2.10 The *Register of Ship's Lifting Appliances and Cargo Handling Gear (LA.1)*, together with the *Certificate of Test and Thorough Examination of Lifting Appliances (LA.2)* may be issued upon satisfactory completion of the above procedures.

3.3 Initial Survey of existing installations

3.3.1 Where LR is requested to issue certification either to replace existing certification issued by another authority or because the original certification issued by another authority is lost or no longer valid, the following procedure is to be adopted:

(a) Plans and information of the scantlings and arrangements of the installation are to be submitted for approval. Where plans are not obtainable, adequate drawings are to be prepared by the Owner from dimensions and scantlings measured on board the ship.

(b) Certification of all loose gear is to be examined and, where certificates are missing, items are to be re-certified by proof testing and re-marked if necessary.

(c) A thorough examination of the complete installation and support structure is to be carried out.

(d) The installation is to be tested as required by Section 1.

3.3.2 The *Register of Ship's Lifting Appliances and Cargo Handling Gear (LA.1)*, together with the *Certificate of Test and Thorough Examination of Lifting Appliances (LA.2)* may be issued upon satisfactory completion of this procedure.

3.4 Periodical Thorough Examinations

3.4.1 It is a statutory requirement of most National Authorities that, following certification at the Initial Survey, the equipment is thoroughly examined regularly to maintain the validity of the certification. The interval between thorough examinations is to be not greater than 12 months, *see* Table 12.3.2. However, the Owner is also to ensure that they comply with any statutory requirements in this respect.

3.4.2 The procedure to be adopted at Periodical Thorough Examinations is as follows:

(a) Verification that the existing certification is valid, up to date and issued by a competent authority.

(b) Thorough examination of the lifting appliance and re-testing where required. Guidance on the extent of the examination can be found in Tables 12.3.3 to 12.3.6, as applicable.

(c) Endorsement of the *Register of Ship's Lifting Appliances and Cargo Handling Gear (LA.1)* or equivalent documents and issue of certificates as necessary.

Table 12.3.2 Intervals between Periodical Thorough Examinations

Lifting appliance	Survey type and interval
Cranes and derrick cranes	Annual Thorough Survey
Lifting appliances on fixed and mobile offshore installations	Annual Thorough Survey
Lifting appliances on fixed and mobile offshore installations used for manned diving operations	6-monthly Thorough Survey
Lifting appliances for manned diving systems	6-monthly Thorough Survey
Lifts – Manually operated	Annual Thorough Survey
Lifts – Powered	Annual Thorough Survey
Ramps	Annual Thorough Survey
Mechanical lift docks	*See* Chapter 4
NOTE Annual Thorough Surveys are to be held once in every 12-month period, unless otherwise stated by the ship's Flag Administration.	

Table 12.3.3 Limits of weardown and corrosion

Item	Limits	Remarks
Structural members	10% maximum at any point, based on the material thickness	—
Loose gear	5% on any diameter 2% on any diameter of a pin in a hole	Item may not be able to sustain the proof load
Wire ropes	Wire ropes may become unfit for service due to a number of factors: visible broken wires, change in diameter, strand fracture, deformation, damage and corrosion, both internal and external. The discard criteria will vary with the type of construction and rope size. In the absence of any criteria issued by the rope manufacturer, reference must be made to ISO 4309:2010 where clear discard criteria are given	—

3.4.3 In carrying out the thorough examination of the installation, parts which are found to be worn or corroded to a significant degree are to be replaced or repaired as appropriate. For guidance purposes, generally acceptable levels of weardown are given in Table 12.3.3, but earlier repair may be required where the circumstances warrant such action.

3.4.4 When no certification at all can be produced for the lifting appliances to be examined the periodical thorough examination is to be declined. However, certification can be issued subject to the procedures in 3.3 being satisfactorily completed.

3.4.5 The detailed requirements for survey of lifting appliances and associated loose gear are given in the following Tables:

- Table 12.3.4 Derrick systems.
- Table 12.3.5 Cranes (including derrick cranes) and launch and recovery systems for diving operations.
- Table 12.3.6 Cargo lifts and ramps.
- Table 12.3.7 Passenger lifts.

3.4.6 In determining the extent of the examination or dismantling, due regard is to be given to the standard of maintenance, state of lubrication and degree of use of the appliance.

3.5 Deferment of surveys

3.5.1 Where requested by the Owner, LR is willing to carry out a General Examination of the lifting appliances with a view to deferment of the Thorough Examination, provided:

(a) Agreement to the proposed deferment is granted by the National Authority of the Flag State of the ship. Certain national authorities have authorised LR to grant deferments without seeking specific agreement on each occasion.
(b) The certification is valid, up to date and issued by a competent authority.

3.5.2 The General Examination is to take the form of a visual inspection of the lifting appliances, but the Surveyor may at his discretion require components to be dismantled for more thorough inspection where considered necessary.

3.5.3 Many national authorities do not permit the deferment of Annual Thorough Examinations. Where permitted, it will be for no more than two months. This may also be unacceptable to some port authorities.

3.5.4 Such deferments will not extend the due dates of subsequent Periodical Surveys.

3.5.5 The deferment of the load test required every five years is not permitted.

3.5.6 Any aspects of the installation which are not considered suitable to continue in use during the period of deferment are to be noted in the endorsement to the *Register of Ship's Lifting Appliances and Cargo Handling Gear (LA.1)*.

3.5.7 Following inspection of the lifting appliances and the *Register of Ship's Lifting Appliances and Cargo Handling Gear (LA.1)*, a factual report is to be issued and this is to include a statement, where applicable, of the authority for granting the deferment.

3.6 Damage surveys

3.6.1 The stated cause of the damage is to be reported, together with details of the proposed repair and the extent of repair and re-testing actually carried out at the time. Where it is not possible to carry out, or to complete, the repair at the time, a suitable entry is to be made in the *Register of Ship's Lifting Appliances and Cargo Handling Gear (LA.1)* that the equipment is not to be used until satisfactory repairs and tests are completed.

3.6.2 Replacement items of loose gear are to be accompanied by a manufacturer's certificate or be tested, marked and certified (LA.3) by the Surveyor.

3.6.3 Replacement ropes are to be accompanied by a manufacturer's certificate or be tested, marked and certified (LA.4 or 5) by the Surveyor.

3.6.4 Care is to be exercised to ensure that the correct materials are used in the repairs. Reference may need to be made to the relevant plan approval office for confirmation.

3.6.5 The practice of allowing a damaged derrick or crane to continue in use at reduced capacity is not recommended, given the resulting inherent weakness of the structure and, in the case of a crane jib or derrick boom, the difficulty of assessing the effect of any indentation or unfairness upon the load carrying capacity.

3.6.6 Where the crane or derrick is structurally sound but damage has been sustained by the hydraulic system, the appliance may be temporarily down-rated until it can be repaired. In this case, the appliance may lift the maximum load of which it is capable. This would be considered as the new test load and the reduced SWL assigned accordingly. The *Register of Ship's Lifting Appliances and Cargo Handling Gear (LA.1)* is to be endorsed with the reduced capacity and a new LA.2 issued, until such time as the full capacity is reinstated after repair and test.

3.6.7 The equipment is to be re-tested in accordance with 1.10 after the repair has been completed and the Register of Ship's Cargo Gear and Lifting Appliances endorsed.

3.7 Classification surveys

3.7.1 Where the lifting appliances are to be assigned a class notation, the Initial Surveys are to be carried out in accordance with 3.2 or 3.3 as appropriate. When the required reports on completion of the survey have been received and approved by the Classification Committee, certificates of classification of the lifting appliances will be issued.

3.7.2 It is the responsibility of the Owner to ensure that all thorough examinations necessary for the maintenance of class are carried out at the proper time and in accordance with the instructions of the Classification Committee. LR will give timely notice to an Owner about forthcoming periodical thorough examinations by means of a letter or quarterly computer print-out. The omission of this notice, however, does not absolve the Owner from his responsibility to comply with LR's requirements for the maintenance of class.

Table 12.3.4 Annual Thorough Examination of derrick systems (*see continuation*)

	Item		Survey
1.	Certification	(a)	Check that certification, in the form of a Lifting Appliance or Cargo Gear Register Book issued by a competent body, exists for the rigs to be examined
		(b)	Check the Register for any outstanding endorsements, recurring problems, down-ratings, etc.
			If there is no evidence that the rigs have ever been certified, the thorough examination is to be declined and LR's certification services for existing rigs may be offered
2.	Arrangements		Check that arrangement of loose gear, rigging, guys, mast stays, etc., is as shown in Cargo Gear Particulars Book or Rigging Plan
3.	Derrick boom and mast fittings	(a)	Inspect lugs, fittings, brackets, etc., at derrick head and mast head
		(b)	Withdraw and inspect goosenecks, trunnion fittings, etc., together with their pins
		(c)	Withdraw other pins and inspect mast head span swivels, tumblers, etc.
		(d)	Check pins for deformation, wear, scoring or other defects
		(e)	Inspect any independent anchorages for heel blocks
		(f)	Check efficiency of lubrication to swivels, goosenecks, trunnions, etc.
4.	Fittings on deck	(a)	Inspect deck eyeplates, cleats, wire rope stoppers, etc., used in normal working, as indicated by the Master or Officer in charge, for wear or deformation
		(b)	Check weld attaching eyeplates to deck
5.	Derrick boom	(a)	Inspect for corrosion. (Where this is suspected, paint is to be removed as necessary.) Special attention is to be paid to the part of the boom which comes into contact with the crutch or housing
		(b)	Hammer test boom and, if then considered necessary, check thickness by drilling or other suitable method
		(c)	Look for any scars or dents and check that boom is not bent
		(d)	Where appropriate, check condition and free movement of the head and heel fittings. Where considered necessary, the boom may be manoeuvred through all its working positions
6.	Blocks	(a)	Verify that blocks are of the appropriate safe working load for the position in which they are rigged and properly certificated
		(b)	All blocks to be inspected. This may be carried out on board the ship, provided the necessary facilities are available. Where repair of the block is necessary, it is to be carried out in a properly equipped workshop
		(c)	Sheaves and pins are to be removed, but sheaves forming an integral part of the derrick boom may be examined *in situ*
		(d)	Load bearing parts of the block, including head fittings, are to be cleaned (the paint being removed where necessary) and inspected for signs of excessive or uneven wear, cracks, lack of lubrication or scoring of the rope groove
		(e)	The nut or collar of the shank or swivel head fittings is to be inspected to check that it is securely fastened and free from visible defects. The shank should turn freely by hand and wear is not to be excessive. The shank is to be removed if required
		(f)	Cheek and partition plates are to be examined for any signs of buckling, distortion, cracks, ovality in pin holes and sharp edges
		(g)	If any repair affects the strength of the block, or if a certificate of test is not available, or if the unique identification mark is illegible, the block is to be re-tested and certified
7.	Shackles, links, rings, hooks, triangle plates, etc.	(a)	Check all loose gear items can be identified against appropriate certificates. (LA.3 or equivalent)
		(b)	Examine under proper conditions and check for cracks, deformation, wear, wastage or other defects. Items are to be free from paint, grease, scale, etc.
		(c)	Confirm that material is recorded on test certificate. The certificate should distinguish between mild steel, higher tensile steel and alloy steel
		(d)	If deformation of the shackle is found, and re-setting is carried out, the shackle is to be suitably heat treated, re-tested and certified
		(e)	If the shackle pin is renewed, the whole shackle is to be re-tested and certified
8.	Wire ropes	(a)	Check all wire ropes can be identified against appropriate certificates. (LA.4 or equivalent)
		(b)	Check the general condition of each rope by examining as much of its length as is possible
		(c)	Check for broken or worn wires. Check for any signs of internal and external corrosion. Check for changes in rope diameter. Check for signs of any deformation (e.g., kinks, birdcaging, etc.), or of thermal damage. In general, the rope is to be replaced immediately if any of the discard criteria in ISO 4309:2010 are exceeded
		(d)	Inspect all rope terminations, splices, end fittings, etc., with particular attention to broken wires at ferrule connections. Any serving on splices is to be removed for the examination
		(e)	Liverpool splices are to be rejected on any rope where the ends are not secured against rotation
		(f)	Before re-rigging ensure that the wire rope has been lubricated
9.	Natural and man-made fibre ropes	(a)	Check all fibre ropes can be identified against appropriate certificates. (LA.5 or equivalent)
		(b)	Survey condition of rope
		(c)	Check for external chafe and cutting and for internal wear between the strands
		(d)	Check for local or general deterioration of natural fibre ropes due to mildew or rot
		(e)	Check ropes for chemical attack or other contamination

Table 12.3.4 Annual Thorough Examination of derrick systems (*conclusion*)

Item		Survey
10.	Chains	(a) Check all chains can be identified against an appropriate certificate (LA.3 or equivalent) (b) The chain is to be taken to a suitably equipped workshop for examination and examined after removal of paint, grease, scale, etc., and wire brushing (c) Check for deformation, wear or other defects. If links require renewal, the chain is to be suitably heat treated and re-tested. Replacement links are to be of equivalent material and strength to original (d) Confirm that material is recorded on test certificate. The certificate should distinguish between mild steel, higher tensile steel and alloy steel
11.	Re-testing	(a) Loose gear is to be proof tested if repairs have been carried out which affect its strength or if certificates are not available (b) Re-testing of the derrick is necessary at 5-yearly intervals, and after repairs have been carried out affecting its strength or otherwise as required by the Surveyors (c) If a component part of the derrick, such as a derrick heel pin, has been replaced, re-testing is not called for if the component has been tested individually to the resultant load which would have been imposed upon it if it had been tested *in situ* (d) Where the repaired or renewed item has not been tested, the derrick is to be re-tested (e) The test is also to demonstrate the effectiveness of limit switches, etc.
12.	Masts, derrick posts, guy posts, etc., and structure in way	The Periodical Survey requirements for classification are to be complied with, *see* Pt 1, Ch 3 of the Rules for Ships

Table 12.3.5 Annual Thorough Examination of cranes and launch and recovery systems for diving operations (*see continuation*)

Item		Survey
General note		These requirements should, in general, also be applied to derrick cranes
1.	Certification	(a) Check that certification, in the form of a Lifting Appliance or Cargo Gear Register Book issued by a competent body, or equivalent for offshore cranes, exists for the lifting appliances to be examined (b) Check the Register for any outstanding endorsements, recurring problems, down-ratings, etc. If there is no evidence that the appliances have ever been certified, the thorough examination is to be declined and LR's certification services for existing appliances may be offered
2.	Arrangement	Check reeving arrangement and hoist block assembly are as shown in Cargo Gear Particulars Book, Rigging Plan, or Manufacturer's Manual
3.	Fixed sheaves, blocks, axle pins and housings	(a) Determine that the sheaves are free from cracks. The extent of the examination is to be such that a reliable judgement can be made. Depending on access, it may be necessary to dismantle the item (b) Survey rope groove for scoring or uneven wear (c) Check that lubrication arrangements are in working order (d) Check security (keep plates, cotter pins, etc.) of fixed axle pins (e) Check for free rotation of sheave on axle pin (f) Check for excessive wear of axle pin and sheave bush. Check condition of housing and separation plates and for signs of ovality in the pin holes
4.	Jib heel pins	(a) Check lubrication for detrimental wear (b) Check security (keep plates, cotter pins, castle nuts, etc.) of heel pins
5.	Slewing rings for cranes on ships	(a) Listen to the bearing during slewing motion for any untoward noises. Also note the age of the bearing or its operational hours (if possible) and check against guidance in manufacturer's maintenance manual. Older bearings will be more prone to problems (b) Check any maintenance records for evidence of regular routine maintenance (c) Check condition and tightness (with a torque wrench) of all inner and outer bearing bolts, removing any protective caps if fitted. Sample bolts may be removed at the discretion of the Surveyor to check for the possibility of stress corrosion cracking (d) Review the results of the latest rocking test measurements or grease sample analysis carried out in accordance with the manufacturer's recommendations and check the recommended limits for either wear or metallic particle content are not being exceeded. This will give an indication of the wear in the bearing. These tests are usually carried out annually (e) Check the effectiveness of lubrication of the bearing. Is it reaching all parts of the bearing and pinions? Is it clean or contaminated? (f) Additional inspections are to be carried out where these are specified by the crane or slew ring manufacturer

Table 12.3.5 Annual Thorough Examination of cranes and launch and recovery systems for diving operations (*continued*)

	Item	Survey
6.	Slewing rings for cranes on offshore installations	Slewbearings used on offshore cranes in some jurisdictions (including the North Sea) should either be subject to periodic removal, strip-down and examination or be subjected to a system of *in situ* condition monitoring. Both possibilities are to be agreed with a competent person (CP) The period between removal and examination is to be agreed with the competent person and will depend on the type of bearing fitted. The minimum is usually every three years for basic bearings where no securing device (retainers which would prevent the crane from toppling off its pedestal in the event of a complete bearing failure) is fitted and which have no condition monitoring system fitted Upon removal of the bearing, the extent of the examination is to be agreed with the competent person. However, LR would expect the following to be included, as a minimum: (a) Examination of the raceway surfaces (b) Most bearings have hardened raceway surfaces and NDE through the whole depth of the softer core of the raceway is required to detect any internal flaws that could jeopardise the integrity of the bearing, including detachment of the hardened surface (c) Examination of all safety critical areas, e.g., the corner radii of the nibs on the internal raceway or on the flanges of the external raceway (d) Examine the condition of the rolling elements, their cages and seals (e) Examine the condition of the fasteners. These will generally be ISO 898/1grade 8.8 or 10.9 fasteners NOTE Grade 12.9 fasteners are not usually permitted offshore (f) Condition of any retaining device fitted Any refurbishment or repair must be done with the agreement of the bearing manufacturer and the competent person. The bearing is not to be replaced on the crane until a re-assembly certificate has been issued by the competent person If, in the opinion of the competent person, the original strength and capacity of the bearing has been compromised, the bearing is not to be put back into service **Condition Monitoring Systems.** Where condition monitoring systems are used in lieu of periodic removal and examination of slewbearings, they are to consist of the following four key elements: • Grease sampling. Samples of grease are to be taken from several dedicated points on the ring (usually from 4 places at 90° apart) each year (or as determined by the CP). The samples are to be analysed by a suitably qualified laboratory for metallic and water content and the results passed to the CP • Rocking tests are to be carried out by a qualified person in accordance with the crane manufacturer's recommendation to monitor the wear in the races and to check that they are within the limits prescribed by the crane manufacturer • Load history of the crane. The load history (history of all lifts and radii) is to be recorded by an approved data logger generally linked through the crane's Safe Load Indicator (SLI). This will show if the crane is working at mostly full or reduced capacity in its service • Fastener Checks. The condition of the bolts or studs, together with a check on their torques, and replacement history is to be recorded. The frequency of these is to be agreed with the CP The competent person is to review the results of all of the above and decide whether the slew bearing is fit to continue in service, or whether a more detailed examination is required or if replacement is necessary Other jurisdictions may have other requirements and these are to be followed as appropriate, but the requirements for ship crane slew bearings in (5) above are to be followed as a minimum
7.	Wire ropes	(a) Check all wire ropes can be identified against appropriate certificates. (LA.4 or equivalent) (b) Check the general condition of each rope by examining as much of its length as is possible (c) Check for broken or worn wires. Check for any signs of internal and external corrosion. Check for changes in rope diameter. Check for signs of any deformation (e.g., kinks, birdcaging, etc.), or of thermal damage. In general, the rope is to be replaced immediately, if any of the discard criteria in ISO 4309:2010 are exceeded (d) Inspect all rope terminations, splices, end fittings, etc., with particular attention to broken wires at ferrule connections. Any serving on splices is to be removed for the examination (e) Liverpool splices are to be rejected on any rope where the ends are not secured against rotation (f) Before re-rigging ensure that the wire rope has been lubricated
8.	Structure and general	(a) Check all structural bolts for tightness. Where bolts have been replaced, they are to be of the same type, size and quality as previously fitted (b) Survey foundation bolts for signs of corrosion and flange distortion (c) Check main welds for cracks. Initially by visual examination but NDE can be used at the Surveyor's discretion (d) Inspect the structure for corrosion, removing paint and carrying out hammer tests as necessary. If considered necessary, the thickness of structural items is to be checked by drilling or other approved method (e) Check jib, tower, support pedestal, gantry, etc., for any signs of local indentations, buckling, cracks or unfairness. Particular attention is to be given to connections of jib chords and transverses, hydraulic cylinder connections, sheave housing attachments, jib heel brackets and other areas where there is significant load input (f) In the case of travelling cranes, check rails, stops and stowage arrangements (g) Check jibs in way of their stowage crutched for signs of wear and indentations

Table 12.3.5 Annual Thorough Examination of cranes and launch and recovery systems for diving operations (*conclusion*)

Item		Survey	
9.	Shackles, links, rings, hooks, etc.	(a)	Check all loose gear items, including hook blocks, can be identified against appropriate certificates. (LA.3 or equivalent)
		(b)	Examine under proper conditions and check for cracks, deformation, wear, wastage or other defects. Items are to be free from paint, grease, scale, etc.
		(c)	Confirm that material is recorded on test certificate. The certificate should distinguish between mild steel, higher tensile steel and alloy steel
		(d)	If deformation of the shackle is found and re-setting is carried out, the shackle is to be suitably heat treated, re-tested and certified
		(e)	If the shackle pin is renewed, the whole shackle is to be re-tested and certified
10.	Chains	(a)	Check all chains can be identified against an appropriate certificate (LA.3 or equivalent)
		(b)	The chain is to be taken to a suitably equipped workshop for examination and examined after removal of paint, grease, scale, etc., and wire brushing
		(c)	Check for deformation, wear or other defects. If links require renewal, the chain is to be suitably heat treated and re-tested. Replacement links are to be of equivalent material and strength to original
		(d)	Confirm that material is recorded on test certificate. The certificate should distinguish between mild steel, higher tensile steel and alloy steel
11.	Rope drums	(a)	At least three turns of wire rope are to remain on the drum in all operating positions, including in the case of luffing ropes, when the jib is ‘crutched’
		(b)	Check that the anchorages of all wire ropes are effective
		(c)	Check drum for cracks and for defects liable to damage the rope
		(d)	Check the effective working of any fleeting device fitted
		(e)	Check drum flanges for bending or distortion. This is particularly appropriate for multi-layer spooling drums
12.	Hydraulic cylinders	(a)	Check for leaks and condition of hydraulic pipes and couplings
		(b)	Check piston rod for scoring and signs of deformation
		(c)	Check end pivot pins and bearings for any excessive wear and deformation, and the security of the pins
		(d)	Check that mounting brackets are free from deformation, cracks or damage
13.	Re-testing	(a)	Loose gear is to be proof tested if repairs have been carried out which affect its strength or if certificates are not available
		(b)	Re-testing of the crane is necessary at 5-yearly intervals and after repairs or modifications have been carried out affecting the strength or otherwise as required by the Surveyors. The test is to demonstrate satisfactory operation, efficiency of overload and weightload indicators, effectiveness of limit switches, etc.
		(c)	It is essential that the crane is operated at each survey to check hoist, slewing, luffing and travel motions, and the operation of limit switches for over-hoisting, over-lowering, luffing, slewing and travel
		(d)	Lifting appliances used for raising, lowering or transferring manned submersibles are to be re-tested annually and also following any structural repairs, alteration or re-erection of the appliance
		(e)	Lifting appliances used for raising, lowering or transferring manned bells or submarines are to be re-tested annually and also following any structural repairs, alteration or re-erection of the appliance

Table 12.3.6 Annual Thorough Examination of cargo lifts and ramps (*see continuation*)

Item		Survey	
1.	Certification	(a)	Check that certification, in the form of a Lifting Appliance or Cargo Gear Register Book issued by a competent body, exists for the lifts and ramps to be examined
		(b)	Check the Register for any outstanding endorsements, recurring problems, down-ratings, etc.
			If there is no evidence that the lifts or ramps have ever been certified, the thorough examination is to be declined and LR’s certification services for existing appliances may be offered
2.	Arrangements		Check that the reeving of wire ropes, chains or the arrangement of hydraulic cylinders is as shown on the reeving diagram or appropriate plans. Check marking on ramps of lifts with respect to ships loading booklet and Register of Ship’s Cargo Gear and Lifting Appliances
3.	Sheaves, sprockets, guide rollers, axle pins and bearings, etc.	(a)	Determine that sheaves, sprockets and guide rollers, etc., are free from cracks or scores and that they are free to rotate
		(b)	Survey rope grooves for scoring or uneven wear, and sprockets for signs of abnormal wear, hooking, etc.
		(c)	Check that lubrication arrangements are in working order
		(d)	Check axle pins and bearings with regard to deformation and excessive wear, and the security of the pins

Table 12.3.6 Annual Thorough Examination of cargo lifts and ramps (*continued*)

	Item		Survey
4.	Wire ropes	(a)	Check all wire ropes can be identified against appropriate certificates. (LA.4 or equivalent)
		(b)	Check the general condition of each rope by examining as much of its length as is possible
		(c)	Check for broken or worn wires. Check for any signs of internal and external corrosion. Check for changes in rope diameter. Check for signs of any deformation (e.g., kinks, birdcaging, etc.), or of thermal damage. In general, the rope is to be replaced immediately, if any of the discard criteria in ISO 4309:2010 are exceeded
		(d)	Inspect all rope terminations, splices, end fittings, etc., with particular attention to broken wires at ferrule connections. Any serving on splices is to be removed for the examination
		(e)	Before re-rigging ensure that the wire rope has been lubricated
5.	Chains	(a)	Check all chains can be identified against an appropriate certificate (LA.3 or equivalent)
		(b)	Inspect the chain, which is to be sufficiently free from grease and scale, etc., to enable a satisfactory examination to be made
		(c)	Check for deformation, wear or other defects. If links require renewal, the chain is to be suitably heat treated and re-tested. Replaced links are to be of equivalent material and strength to the original
		(d)	Confirm that material is recorded on the test certificate. The certificate should distinguish between mild steel, higher tensile steel and alloy steel
6.	Hydraulic cylinders, winches, etc., and attachments	(a)	Check for leaks and check condition of hydraulic pipes
		(b)	Check piston rods, pivot pins and bearings, etc., for excessive wear and deformation
		(c)	Determine that sheaves are free from cracks, scores, or uneven wear and they are free to rotate
		(d)	Check that mounting brackets are free from deformation, cracks or damage
7.	Main pivots, articulations, slewing bearings (if fitted), etc.	(a)	Check that all main pivots and bearings are free from excessive play
		(b)	Check that bearing surfaces are free from scoring, pitting, etc.
		(c)	Check that pivot pins do not have excessive wear or deformation, and the security of the pins is sound
		(d)	Check that lubrication arrangements are in working order
8.	Structure and general	(a)	Check all structural bolts for tightness. Where bolts have been replaced, they are to be of the same type, size and quality as previously fitted
		(b)	Check main welds for cracks. Initially by visual examination but NDE can be used at the Surveyor's discretion
		(c)	Inspect load bearing structure for corrosion, removing paint and carrying out hammer tests as necessary. If considered necessary, the thickness of structural items is to be checked by drilling or other suitable methods
		(d)	Check load bearing plating and main structural members for cracks and any signs of local indentation, buckling or unfairness
		(e)	Check structure in way of any stowage locks for wastage, cracks, deformation, etc.
9.	Shackles, links, etc.	(a)	Check all loose gear items can be identified against appropriate certificates. (LA.3 or equivalent)
		(b)	Check for cracks, deformation, wear, wastage or other defects. Items are to be free from paint, grease, scale, etc.
		(c)	Confirm that material is recorded on test certificate. The certificate is to distinguish between mild steel, higher tensile steel and alloy steel
		(d)	If deformation of the shackle is found and re-setting is carried out, the shackle is to be suitably heat treated, re-tested and certified
		(e)	If the shackle pin is renewed, the whole shackle is to be re-tested and certified
10.	Rope drums	(a)	At least three turns of wire rope are to remain on the drum in all operating positions
		(b)	Check that the anchorages of all wire ropes are effective
		(c)	Check drum for cracks and for defects liable to damage the rope
		(d)	Check the effective working of any fleeting device fitted
		(e)	Check drum flanges for bending or distortion. This is particularly appropriate for multi-layer spooling drums
11.	Operating locks, stowage locks, safety guards, etc.	(a)	Check that operating locks, safety guards and stowage locks operate effectively
		(b)	Check locking pins on latches, etc., and their respective location bearing parts for abnormal wear or deformation
		(c)	Ensure that hydraulic actuating cylinders, etc., are free from leaks, wear and abnormal deformation
		(d)	Ensure that mounting brackets, etc., are effective and securely attached to the ship or lift structure
12.	Guides	(a)	Check that the guides do not have excessive wear or deformation and that joints are secure
		(b)	Check that brackets attaching guides to ship structure are effective and in good order

Table 12.3.6 Annual Thorough Examination of cargo lifts and ramps (*conclusion*)

	Item	Survey
13.	Seals	Where weathertight seals are fitted, their general condition is to be satisfactory and their effectiveness is to be checked using a water spray test or other suitable method
14.	Re-test	(a) Re-testing of the lift or ramp is necessary at 5-yearly intervals, or as required by the National Authority, and when modifications and repairs have been carried out affecting the strength or as required by the Surveyor (b) It is essential that the lift or ramp is operated at each thorough examination throughout the full operational range for each mode of operation and to check that the limit switches, interlocks, guards and safety devices operate satisfactorily

Table 12.3.7 Annual Thorough Examination of passenger lifts (*see continuation*)

	Item	Survey
1.	Certification	(a) Check that certification, in the form of a Lifting Appliance or Cargo Gear Register Book or national forms issued by a competent body, exists for the passenger lifts to be examined (b) Check the Register for any outstanding endorsements, recurring problems, down-ratings, etc. If there is no evidence that the lifts have ever been certified, the thorough examination is to be declined and LR's certification services for existing appliances may be offered
2.	Arrangements	(a) Check that the reeving of wire ropes and chains and the arrangement of hydraulic cylinders are as shown on the appropriate plans (b) Check that the plate indicating the allowable load mounted inside the lift is in agreement with the appropriate plan(s) and as indicated in the Register of Ship's Cargo Gear and Lifting Appliances
3.	Sheaves, sprockets, guide rollers, axle pins and bearings, etc.	(a) Determine that sheaves, sprockets and guide rollers, etc., are free from cracks or scores and that they are free to rotate (b) Survey rope grooves for scoring or uneven wear. Survey sprockets for signs of abnormal wear, hooking, etc. (c) Check that lubrication arrangements are in working order (d) Check axle pins and bearings with regard to deformation and excessive wear, and the security of the pins
4.	Wire ropes	(a) Check all wire ropes can be identified against appropriate certificates. (LA.4 or equivalent) (b) Check the general condition of each rope by examining as much of its length as is possible (c) Check for broken or worn wires. Check for any signs of internal and external corrosion. Check for changes in rope diameter. Check for signs of any deformation (e.g., kinks, birdcaging, etc.), or of thermal damage. In general, the rope is to be replaced immediately if any of the discard criteria in ISO 4309:2010 are exceeded (d) Inspect all rope terminations, splices, end fittings, etc., with particular attention to broken wires at ferrule connections. Any serving on splices is to be removed for the examination (e) Before re-rigging ensure that the wire rope has been lubricated
5.	Chains	(a) Check all chains can be identified against an appropriate certificate (LA.3 or equivalent) (b) Inspect the chain, which is to be sufficiently free from grease and scale, etc., to enable a satisfactory examination to be made (c) Check for deformation, wear or other defects. If links require renewal, the chain is to be suitably heat treated and re-tested. Replaced links are to be of equivalent material and strength to the original (d) Confirm that material is recorded on the test certificate. The certificate should distinguish between mild steel, higher tensile steel and alloy steel
6.	Hydraulic cylinders, winches, etc., and attachments	(a) Check for leaks and check condition of hydraulic pipes (b) Check piston rods, pivot pins and bearings, etc., for excessive wear and deformation (c) Determine that sheaves are free from cracks, scores and uneven wear and that they are free to rotate (d) Check that mounting brackets are free from deformation, cracks and damage
7.	Landing and car doors	(a) Check that the landing and car doors operate satisfactorily (b) Check that interlocks on the doors operate effectively (c) Inspect the door and check that its fire-resisting capacity is unimpaired
8.	Car and counterweight	(a) Examine the car and counterweight for damage which could affect their operating efficiency or carrying capacity (b) Check that brackets for sheaves, guide rollers, wire terminations, etc., are secure and in good order (c) Inspect the car, including the car frame, and check that the fire-resisting capacity of the car is unimpaired

Table 12.3.7 Annual Thorough Examination of passenger lifts (*conclusion*)

	Item		Survey
9.	Lift trunk and well	(a)	Check that the lift trunk and well are free from debris or damage which could impair the satisfactory operation of the lift
		(b)	Check that trunk has not been damaged, is suitably ventilated and is totally enclosed such as to prevent passage of smoke and flame from one deck to another
10.	Guides and buffers	(a)	Check that the car and counterweight guides are not worn or distorted and that the joint plates are secure
		(b)	Check that brackets attaching guides to trunk are in good order
		(c)	Check that buffers are in good order and supports are sound
11.	Over-running devices and brakes		Check that over-running devices and brakes are operating satisfactorily and are in good order
12.	Safety gear		Check that safety gear for preventing the car from falling is secure and in good order. A test of the safety gear is to be carried out to demonstrate its effectiveness
13.	Safety equipment	(a)	Check that escape hatches, ladders, etc., are free from obstruction and in good order
		(b)	Check that the emergency telephone and warning system operate satisfactorily
		(c)	Check that all warning notices, etc., are legible and secure
14.	Re-test	(a)	Re-testing is necessary at 5-yearly intervals, or as required by the National Authority, and when modifications and repairs have been carried out affecting the strength, or as required by the Surveyor
		(b)	It is essential that the lift is operated at each annual thorough examination to check that the limit switches, interlocks, and safety devices operate satisfactorily

3.7.3 Periodical Thorough Examinations for the maintenance of class are to be carried out by LR’s Surveyors in accordance with 3.4. Certificates of class maintenance in respect of completed Periodical Thorough Examinations will be issued to Owners on application.

3.7.4 It should be noted that the intervals between Periodical Thorough Examinations of lifting appliances are determined by Statutory Regulations and deferments cannot exceed those permitted by 3.5.

Documentation

Contents

Section 1
General

1.1 Procedure

1.1.1 The procedure and requirements for the issue of certification by Lloyd's Register (hereinafter referred to as LR) are specified in Ch 1,2.

1.1.2 Certification of all lifting appliances, with the exception of mechanical lift docks and lifting gear for diving systems, is to be on the basis of the appropriate certificates detailed in this Chapter.

1.1.3 Mechanical lift docks whether classed or certified are to be covered by reports and certificates as laid down in Chapter 5.

1.1.4 Launch and recovery systems for diving operations are to be classed or certified as required by LR's *Rules and Regulations for the Construction and Classification of Submersibles and Diving Systems* (hereinafter referred to as the Rules for Submersibles).

1.1.5 Where the lifting appliance is also to be classed, the requirements of Ch 1,3 are to be complied with. The appropriate classification certificates are detailed in this Chapter.

1.2 Certificates for certification

1.2.1 Certificates are to be prepared, and are to be kept available, showing that:
(a) Satisfactory tests have been carried out on the individual items of loose gear and on each lifting appliance as rigged for its intended mode of operation.
(b) The required Periodical Surveys of each lifting appliance have been carried out.

1.2.2 The certificates issued by LR are based upon the I.L.O. series and are listed in Table 13.1.1 together with relevant comments.

1.2.3 LR's certification is internationally accepted but in certain cases a National Authority may require its own certification to be used. Where authorised, LR can also arrange the issue of these certificates, which may be in addition to LR's certification, if so desired by the Owner.

1.3 Classification certificates

1.3.1 Where the lifting appliance is to be classed, certificates of classification and subsequent certificates of class maintenance will be issued on compliance with the appropriate requirements. The certificates are listed in Tables 13.1.1 and 13.1.2.

1.3.2 The LA.1 is to have the appropriate class notation written on the front cover.

Documentation

Table 13.1.1 Certificates for certification

Certificate	LR Form Number	Title	Comments
LA.1	1365	Register of Ship's Lifting Appliances and Cargo Handling Gear	This is the document in which all the lifting appliances which have been certified are listed and subsequently, periodical, damage and other surveys are recorded. Certificates of examination and test of the lifting appliances and certificates for ropes and individual items of loose gear are to be attached to this document
LA.2	1380	Certificate of Test and Thorough Examination of Lifting Appliances	This certificate is to be used for all lifting appliances
			This certificate is to be re-issued following subsequent re-tests
LA.2U	1381	Certificate of Test and Thorough Examination of Derricks used in Union Purchase	Must be accompanied by LA.2
LA.3	1382	Certificate of Test and Thorough Examination of Loose Gear before being taken into use, and of such gear after it has been altered or required	Contents may be transferred from manufacturer's test certificate, the number of which is to be stated on the LA.3 Reference to 'altered or repaired' loose gear means alterations or repairs which affect the strength of the item
			A pulley block may be considered to include any special shackles or other fittings designed to fit and work exclusively with the block. These fittings may be tested with the block and should have the same certificate identification mark
			This certificate is also to be used for spreaders, lifting beams and similar items of equipment
			This certificate may be re-issued following subsequent periodical re-testing independent of the lifting appliance (i.e., workshop re-testing), if such re-testing is specifically required by a National Authority
LA.4	1383	Certificate of Test and Thorough Examination of Wire Rope, before being taken into use	Each length of wire rope is to be supplied with a certificate. The certificate may be made up from the master certificate supplied by the rope manufacturer with each coil of rope. In the absence of a master certificate, or if this cannot be related to the particular lengths of rope, then each length is to be tested and a LA.4 issued on the basis of these tests
LA.5	1384	Certificate of Test and Thorough Examination of Fibre Rope, before being taken into use	There is no equivalent I.L.O. form but a LA.5 is to be issued in all cases where fibre or man-made ropes are used
			The comments applicable to LA.4 also apply
—	—	Certificate of Classification of Lifting Appliances and Associated Gear	To be issued for all lifting appliances on board LR classed ships to which a class notation has been assigned

Table 13.1.2 Additional certificates for certification

Certificate	LR Form Number	Title	Comments
CG.11	1400	Certificate of Fitness of Cargo Gear	Issued only to Greek flag ships in accordance with Greek Presidential Decree, PD 131/81. To be issued after satisfactory completion of LAQC, *see* 2.5
CG.12	1707	Certificate for Personnel Lifts	Issued only to NIS flag ships in accordance with NMD – Class Instructions – NIS. To be issued upon completion of satisfactory plan approval, survey and test, *see* 2.5
Report 11 (NIS)	2586	Survey and Control of Personnel Lifts	Issued only to NIS flag ships in accordance with NMD – Class Instructions – NIS. To be issued upon completion of each survey of the lift, *see* 2.5
—	1124	Factual Report	Issued for ships over 15 years of age at the last port of lading before visiting the ports of Gulf Cooperation Council States including Saudi Arabia, *see* 2.5

Table 13.1.3 Additional certificates for launching and recovery arrangements for life-saving appliances, i.e., davits

Certificate	LR Form Number	Title	Comments
—	1124	Factual Report	To be issued upon satisfactory completion of all necessary surveys and testing including prototype testing
—	—	LR Type Approval Certificate	To be issued by Type Approval Department upon satisfactory completion of all necessary plan approval, surveys and testing including prototype testing
—	—	MED Type Approval Certificate	To be issued by Type Approval Department for arrangements intended for EU Flag vessels, upon satisfactory completion of all necessary plan approval, surveys and testing including prototype testing

Table 13.1.4 Additional certificates for offshore lifting appliances

Certificate	LR Form Number	Title	Comments
—	1123/1124	Factual Report	To be issued upon satisfactory completion of all necessary plan approval, surveys and testing, together with any appropriate national forms (e.g., Report of Thorough Examination as required by LOLER)
—	4120	Report of Examination of crane or other lifting appliances – Energy Services	To be issued upon satisfactory completion of all necessary surveys and testing
—	—	Certificates as required by National Administration	To be issued as required by relevant National Administration upon satisfactory completion of all necessary surveys and testing

■ *Section 2*
Certification procedure

2.1 Initial Surveys

2.1.1 Following satisfactory completion of all the conditions required for the issue of certification by LR, the *Register of Ship's Lifting Appliances and Cargo Handling Gear – LA.1*, or the equivalent National Authority form, is to be issued and the appropriate loose gear, rope and appliance test certificates attached.

2.1.2 Where LR's Surveyors have not witnessed the testing of loose gear, a manufacturer's certificate of test is to be supplied and the information entered on the appropriate certificates issued by the Surveyor.

2.1.3 Where part of a survey is carried out at a manufacturer's works away from the shipbuilding port, a report is to be issued covering the survey together with any loose gear certificates. The appropriate test certificate is only to be issued upon satisfactory completion of onboard tests and inspection.

2.1.4 The *Register of Ship's Lifting Appliances and Cargo Handling Gear* is to be endorsed in Parts I and II and, if specifically requested by the Owner, a factual report may also be issued.

2.2 Periodical Surveys

2.2.1 Provided the existing register is valid and up to date and complete with all certificates, it is to be endorsed upon satisfactory completion of the survey. It is normally sufficient to endorse the register and attach any new certificates, but a factual report may also be issued if requested by the Owner.

2.2.2 In view of the attitude that some National Authorities adopt with respect to the competence and independence of the person carrying out the survey, such as ship's officer, it is recommended that for registers issued by LR only LR's Surveyors carry out the survey if delays and inconvenience to Owners are to be avoided.

2.2.3 If re-testing is carried out, as in the case of an LAQC (every fifth or fourth year, depending on whether or not the ship has adopted the five-year cycle in accordance with ILO Convention 152), a new Form LA.2 is to be issued. Where the register is not on LR's forms the existing register is to be endorsed and LA.2 issued.

2.2.4 The appropriate section of the register is to be endorsed, Part I for the appliance and Part II for the loose gear.

2.2.5 LA.1 is to be issued as a replacement register for old or full LR Registers. The old book is to be stapled to the back of new LA.1 to maintain the service history.

2.2.6 LA.1 may be issued as a replacement register on an LR classed ship, where the existing lifting appliance register was originally issued by another competent authority which no longer exists, and which has become full. However, it is to be clearly endorsed on the front cover that it is issued as a replacement register for the register book (giving details of issuing authority, certificate number and date) and the old book is to be stapled to the back of new LA.1 to maintain the service history.

2.2.7 Where an LR Surveyor has carried out a thorough examination and witnessed load testing on LR classed ships whose lifting appliances were not originally certified by LR, LA.2 and LA.2U certificates are to be issued and the existing register book issued by a competent body is to be endorsed accordingly.

2.2.8 Occasionally, where the LR Surveyor witnesses, at Owner's/Flag Administration's request, load testing on lifting appliances not certified by LR, only a factual report (Form 1124) is to be issued and it should clearly be stated in the report that this does not constitute certification by LR.

2.2.9 'Condition of Class' is only to be imposed upon 'Classed' lifting appliances. For 'Certified' lifting appliances, where necessary, the memoranda/narrative section of the report is to be used.

2.2.10 Any replacement items of loose gear or ropes must be accompanied by a manufacturer's test certificate, *see also* 2.1.2.

2.3 Damage surveys

2.3.1 As for all surveys, before undertaking a damage survey it should be verified that the existing register is valid and up to date. It will not be possible for surveys to be undertaken by LR where the register is not available or not valid and up to date, except in exceptional circumstances.

2.3.2 The register is to be endorsed indicating the extent of the survey even if it was not possible to complete the repairs.

2.3.3 A factual report (Form 1124) is to be issued, clearly stating:
(a) Who requested the attendance.
(b) The stated cause of the damage.
(c) The extent and nature of the damage found.
(d) The extent and nature of repairs carried out and whether the repairs were complete.
(e) The test load applied.
(f) Whether any part of the gear is not to be used pending further action, replacement, etc.

2.4 Deferment of survey

2.4.1 Where a deferment of survey has been granted, see Ch 12,3.5, the register is to be endorsed and a factual report is to be issued.

2.5 Other surveys

2.5.1 Surveys not previously specified will be specially considered or will be covered by separate instructions, since they will normally involve the specific requirements of a National Authority.

2.6 Certification procedure

2.6.1 An overview over the certification process and the required and issued documentation is provided in Table 13.2.1.

Table 13.2.1 Minimum requirements for the certification of lifting appliances

Certification process step	Component	Required or issued documentation	References
0 General	Complete lifting appliance	N/A	Ch 1,1.2.5
1 Plan Approval	Structural arrangements	Design Appraisal Document (issued by LR)	Chapters 2, 4, 5, 6, 7, 8 and 9 (all as applicable)
	Hydraulic cylinders		Chapters 2, 4, 5, 6, 7, 8 and 9 (all as applicable)
	Winches (in case of handling of personnel applications)		Chapter 9 (as applicable)
	Loose gear items if not supplied in accordance with a recognised National or International Standard		Chapter 8 (as applicable)
	Other similar main components not listed in the above		Applicable Chapters to be defined depending on the nature of the component
2 Verification of materials Remark: Where materials are not manufactured at an LR approved works check testing will be required	Structural materials	'Manufacturer's certificate' as defined in Ch 1,3 of the *Rules for the Manufacture, Testing and Certification of Materials* (equivalent to inspection certificate EN 10204, 3.1)	LR *Rules for the Manufacture, Testing and Certification of Materials* (or approved equivalent) Relevant Chapters of this Code
	Winches (main load-bearing and safety-critical components)		
	Hydraulic cylinders (main load-bearing and safety-critical components)		
	Wire ropes		
	Other similar main components not listed in the above		
3 Verification of manufacturer's certificates and testing of loose gear, ropes and fittings	Loose gear	LA.3 (issued by LR)	Table 13.1.1 in Chapter 13
	Wire ropes	LA.4 (issued by LR)	Table 13.1.1 in Chapter 13
	Other associated items and fittings as appropriate	General inspection certificate (LR Form Number 1123 or 1124 issued by LR)	N/A
4 Survey of the lifting appliance	Complete lifting appliance (including loose gear, etc.)	General inspection certificate (LR Form Number 1123 or 1124 issued by LR)	N/A
5 Testing and survey of the lifting appliance on installation (on board)	Complete lifting appliance	LA.2 (or LA.2U) (issued by LR)	Table 13.1.1 in Chapter 13
6 Register of the Ship's Lifting Appliances and Cargo Handling Gear	Complete lifting appliance	LA.1 (issued by LR)	Table 13.1.1 in Chapter 13
7 Subsequent Periodical Surveys of the lifting appliance as required by Chapter 12	Complete lifting appliance	Endorsement of Parts I and II of the LA.1 or equivalent (endorsed by LR or a competent person or organisation)	Chapters 12 and 13 (as applicable)

Section 3
Classification procedure

3.1 General

3.1.1 When the required reports on completion of the Special Survey during construction of the lifting appliances which have been submitted for classification have been received from the Surveyors and approved by the Classification Committee, certificates of classification will be issued to the Builders or Owners.

3.1.2 Certificates of class maintenance in respect of completed Periodical Surveys will also be issued to Owners on application.

3.1.3 LR's Surveyors are permitted to issue provisional (interim) certificates provided the lifting appliance is, in their opinion, in accordance with the applicable requirements. Such certificates will embody the Surveyor's recommendations for continuation of class but in all cases are subject to confirmation by the Classification Committee.

3.1.4 In all cases, the necessary certificates for Certification will also be issued.

3.1.5 An overview of the classification process and the required and issued documentation is provided in Table 13.3.1.

Table 13.3.1 Minimum requirements for the classification of lifting appliances (*See continuation*)

Certification process step	Component	Required or issued documentation	References
0 General	Complete lifting appliance	N/A	Ch 1,1.3.6
1 Plan Approval	Structural arrangements	Design Appraisal Document (issued by LR)	Chapters 2, 4, 5, 6, 7, 8 and 9 (all as applicable)
	Electrical and control engineering arrangements		Chapter 10 (as applicable)
	Hydraulic cylinders		Chapters 2, 4, 5, 6, 7, 8 and 9 (all as applicable)
	Winches		Chapter 9 (as applicable)
	Loose gear items if not supplied in accordance with a recognised National or International Standard		Chapter 8 (as applicable)
	Hydraulic arrangements		Chapter 9 (as applicable)
	Other similar main components not listed in the above		Applicable Chapters to be defined depending on the nature of the component
2 Verification of materials Remark: Materials are required to be delivered from a Lloyd's Register approved works	Structural materials	'LR certificate' or 'Manufacturer's certificate validated by LR' as defined in Ch 1,3 of the *Rules for the Manufacture, Testing and Certification of Materials* (equivalent to inspection certificate EN 10204, 3.2)	LR *Rules for the Manufacture, Testing and Certification of Materials* Relevant Chapters of this Code
	Winches (main load-bearing components)		
	Hydraulic pipes/hoses		
	Hydraulic cylinders (main load-bearing and safety critical components)		
	Wire ropes		
	Gearing	'Manufacturer's certificate' as defined in Ch 1,3 of the *Rules for the Manufacture, Testing and Certification of Materials* (equivalent to inspection certificate EN 10204, 3.1)	
	Other similar main components not listed in the above	'LR certificate' or 'Manufacturer's certificate validated by LR, as defined in Ch 1,3 of the *Rules for the Manufacture, Testing and Certification of Materials* (equivalent to inspection certificate EN 10204, 3.2)	
3 Verification of manufacturer's certificates and testing of loose gear, ropes and fittings	Loose gear	LA.3 (issued by LR)	Table 13.1.1 in Chapter 13
	Wire ropes	LA.4 (issued by LR)	Table 13.1.1 in Chapter 13
	Other associated items and fittings as appropriate	General inspection certificate (LR Form Number 1123 or 1124 issued by LR)	N/A
4 Survey of the lifting appliance	Complete lifting appliance (including loose gear, etc.)	General inspection certificate (LR Form Number 1123 or 1124 issued by LR)	N/A
5 Testing and survey of the lifting appliance on installation (on board)	Complete lifting appliance	LA.2 (or LA.2U) (issued by LR)	Table 13.1.1 in Chapter 13
6 Register of the Ship's Lifting Appliances and Cargo Handling Gear	Complete lifting appliance	LA.1 (issued by LR)	Table 13.1.1 in Chapter 13

Table 13.3.1 Minimum requirements for the classification of lifting appliances (*conclusion*)

	Certification process step	Component	Required or issued documentation	References
7	Certificate of Classification	Complete lifting appliance	Certificate of Classification of Lifting Appliances and Associated Gear (issued by LR)	Table 13.1.1 in Chapter 13
8	Subsequent Periodical Surveys of the lifting appliance as required by Chapter 12	Complete lifting appliance	Endorsement of Parts I and II of the LA.1 (endorsed by LR)	Chapter 12 and 13 (as applicable)

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