

Specification for

# Power driven overhead travelling cranes, semi-goliath and goliath cranes for general use

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- British Transport Docks Board
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- Mechanical Handling Engineers' Association
- Ministry of Defence
- National Federation of Building Trades Employers
- Welding Institute
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# Foreword

This British Standard has been prepared under the direction of the Mechanical Engineering Standards Committee. It supersedes BS 466:1960 which is withdrawn.

This standard was first published in 1932 and was revised in 1947 and 1960 and has now been updated to reflect current trends and technological progress within the industry; the major new provisions are:

- a) the introduction of the new classification system based on that adopted by the International Organization for Standardization (published as ISO 4301);
- b) the reference where appropriate to the design procedures contained in BS 2573-1 and BS 2573-2;
- c) the recommendation of preferred lifting capacities, lifting heights and working speeds.

SI units are adopted throughout this standard.

The new classification system provides a means of defining the anticipated duty of an appliance and its mechanisms which serves as the basis of agreement between the purchaser and the manufacturer, and supplies information on which much of the design analysis can be based. The classification of the appliance as a whole is first defined from the number of operating cycles and from the anticipated loading it will experience during its life; secondly the class of each mechanism of the appliance is defined, from their individual operating times and the loading that they will experience during their life. The duty of the appliance and its mechanisms is therefore fully defined to give a sound basis for rational design along with economic production.

It is important that the noise from cranes should be within levels that will avoid their endangering health, and Appendix E draws attention to Health and Safety Executive documents covering this subject.

As inadequate design and construction of crane gantries can seriously affect the safety and operation of the crane, it is important that careful consideration is given to their design and construction in accordance with BS 449.

Cranes are designed and constructed to operate satisfactorily on tracks that are within certain tolerances and Appendix F has therefore been included to bring the necessary information to the attention of gantry designers and erectors.

Appendix G gives details of United Kingdom and EEC legislation relating to electric overhead travelling cranes.

Appendix J comprises a list of British Standards for materials and equipment applicable to the manufacturing of cranes.

This standard forms one of a series for cranes; the other British Standards in the series are:

BS 327, *Power-driven derrick cranes.*

BS 357, *Power-driven travelling jib cranes (rail-mounted low carriage type).*

BS 1757, *Specification for power-driven mobile cranes.*

BS 1761, *Single bucket excavators of the crawler mounted friction-driven type.*

BS 2452, *High pedestal or portal jib cranes.*

BS 2573, *Rules for the design of cranes — Part 1 Specification for classification, stress calculations and design criteria for structures — Part 2 Specification for classification, stress calculations and design for mechanisms.*

BS 2799, *Power-driven tower cranes for building and engineering construction.*

BS 3579, *Heavy duty electric overhead travelling and special cranes for use in steel works.*

BS<sup>a</sup>, *Specification for wire rope hoists.*

BS<sup>a</sup>, *Slewing jib cranes.*

<sup>a</sup> In course of preparation.

Attention is drawn to BS 5744 which covers the safe use of cranes.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

**Compliance with a British Standard does not of itself confer immunity from legal obligations.**

#### **Summary of pages**

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 44, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

## Section 1. General

### 1 Scope

This British Standard specifies requirements for power-driven overhead travelling cranes, semi-goliath and goliath cranes for general use.

NOTE 1 Typical crane types are shown in Figure 1.

The clauses of this standard that deal specifically with the means of power do not apply to d.c., hydraulic or pneumatic powered cranes, but the remainder of the standard can be applied to the design and construction of cranes of these types where relevant.

This standard does not apply to fixed runways (usually single track) of the type dealt with in BS 2853 or jib cranes.

NOTE 2 The titles of the publications referred to in this standard are listed on the inside back cover.

### 2 Definitions

For the purposes of this British Standard, the following definitions apply.

#### 2.1

##### **crab (or trolley)**

an assembly incorporating one or more lifting units that traverses the bridge of the crane

#### 2.2

##### **duty cycle**

a cycle of electrical input(s) to a motor(s) that commences when a load is picked up and ends when the crane picks up the next load

#### 2.3

##### **goliath crane**

a crane comprising a bridge supported by legs and capable of travelling on tracks at ground or deck level

#### 2.4

##### **semi-goliath crane**

a crane comprising a bridge supported at one end by leg(s) and at the other end by an end carriage(s) capable of travelling along tracks, one at ground or deck level and the other elevated

### 2.5 Operational characteristics of control

#### 2.5.1

##### **complete start**

operation of the controller by holding the control in a fixed position until nominal rated speed is reached

#### 2.5.2

##### **jogging operation**

operation of the controller to give partial starts

#### 2.5.3

##### **electrical braking**

motor torque applied in the direction opposite to the existing motion (i.e. as a braking torque)

#### 2.6

##### **overhead travelling crane**

a crane comprising a bridge supported by end carriages capable of travelling along elevated tracks

#### 2.7

##### **safe working load of a crane**

the maximum load that, under specified conditions, is permitted to be safely handled by the crane

NOTE This includes all lifting attachments, magnets, etc. but not the hook block (when fitted) (see Figure 2).

**2.8****safe working load of a lifting attachment**

the maximum load that, under specified conditions, is permitted to be safely handled by the lifting attachment (see Figure 2)

**2.9 Service conditions****2.9.1****in service**

the conditions that apply to a crane whilst it is in use unladen, or with any load up to the safe working load, or in physical readiness for use, and it is under the control of the crane driver

**2.9.2****out of service**

the condition that applies to a crane whilst no load is suspended and it is not under the control of the crane driver

**2.10****span**

the horizontal distance between the centres of the tracks that support the crane

**2.11****speeds of operation**

the ranges of speeds at which crane motions operate

NOTE The speeds of operation of crane motions are as follows:

|                                  |                    |       |
|----------------------------------|--------------------|-------|
| overspeed                        | greater than 100 % |       |
| full speed (nominal rated speed) | 100 %              |       |
| fast speed                       | 50 % to            | 100 % |
| slow speed                       | 15 % to            | 50 %  |
| creep speed                      | 0 % to             | 15 %  |

**2.12****top running crane**

an overhead travelling crane supported, for its long travel motion, on the top surface of elevated tracks on which it travels

**2.13****wheel base (of a crane)**

the distance between the centres of the wheels running on the same track. On end carriages with more than two wheels the wheel base is taken as the distance between the centres of the outside wheels

**2.14****wheel base (of a crab)**

the distance between the centres of the wheels on the same track

**2.15****underslung crane**

an overhead travelling crane supported, for its long travel motion, from the bottom flanges of tracks on which it travels

**2.16****bridge**

the structural member(s) on which the crab(s) is supported

NOTE The bridge may be cantilevered beyond the leg(s)/end carriages.

**2.17****hoisting**

the motion of lifting or lowering of the load in a vertical direction

**2.18****cross traverse**

motion of the crab(s) along the bridge

**2.19****long travel**

motion of the whole crane along the track

**3 Information to be provided****3.1 Information to be provided by the purchaser**

The purchaser should provide information in accordance with Appendix A to enable the crane manufacturer to offer the most suitable crane and equipment to satisfy the duty requirements and service conditions.

NOTE Attention is drawn to Appendix B where, to aid economic manufacture of the crane, it is recommended that lifting capacities, lifting heights and speeds of operation are selected from preferred values.

**3.2 Information to be provided by the manufacturer**

The manufacturer shall provide information to the purchaser of the crane being offered in accordance with Appendix C.

**4 Classification**

The classification of the crane as a whole and of each mechanism shall be based on the information provided in accordance with Appendix A and shall be determined in accordance with Appendix D.

**5 Service conditions**

**5.1 Normal service conditions.** For normal service conditions, the crane shall be supplied for:

- a) indoor use;
- b) use at ambient temperature between  $-10\text{ }^{\circ}\text{C}$  and  $40\text{ }^{\circ}\text{C}$  with no sources of high local heating, such as furnaces or radiant panel heaters;
- c) use at an altitude not exceeding 1 000 m above sea level;
- d) use in clean still air of normal humidity and free from contamination and deposits.

**5.2 Special service conditions**

**5.2.1 General.** The manufacturer shall take any special service conditions required by the purchaser into account and agree with the purchaser how he proposes to meet each of these requirements and any limitations imposed in consequence of the special conditions.

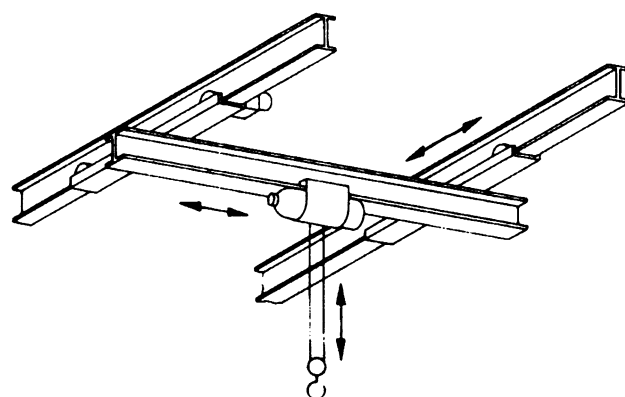
NOTE Attention is drawn to Appendix A which gives examples of special service conditions that may require special attention.

**5.2.2 Additional requirements**

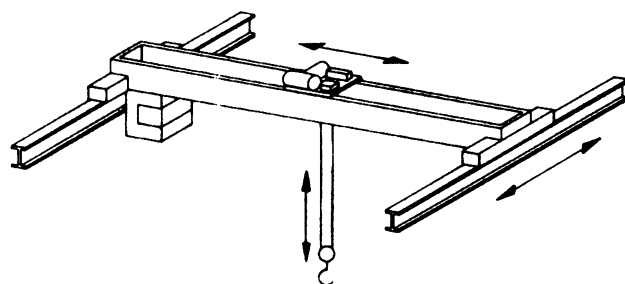
**5.2.2.1 Handling molten metal.** For cranes used for handling molten metal, the minimum classification for the lifting unit mechanism relative to the hazardous load shall be M5 (see Table 13) and the lifting rope shall have a metal core.

If the crane has excess capacity to a lower classification for other use, then the crane markings (see 4.5.1) shall specify the maximum permissible weight of the hazardous load, i.e. "Maximum full ladle weight ... tonnes".

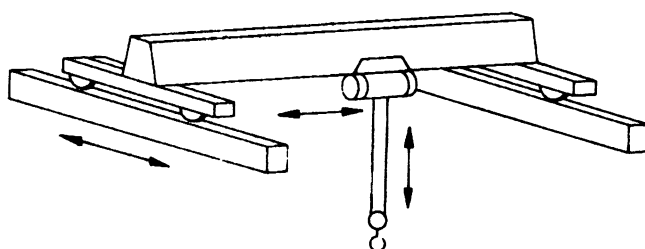
**5.2.2.2 Potentially explosive atmosphere.** Cranes for potentially explosive and flammable atmospheres shall be designed to meet the appropriate ignition protection requirements corresponding to the environmental conditions under which they will be required to work as specified in BS 5345.



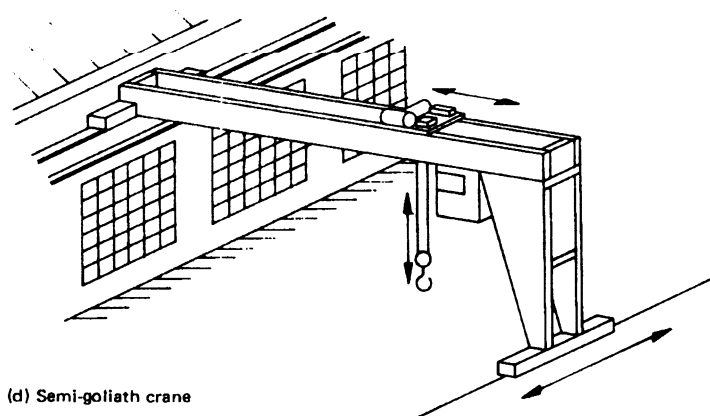
(a) Underslung crane (single girder)



(b) Top running crane (double girder)

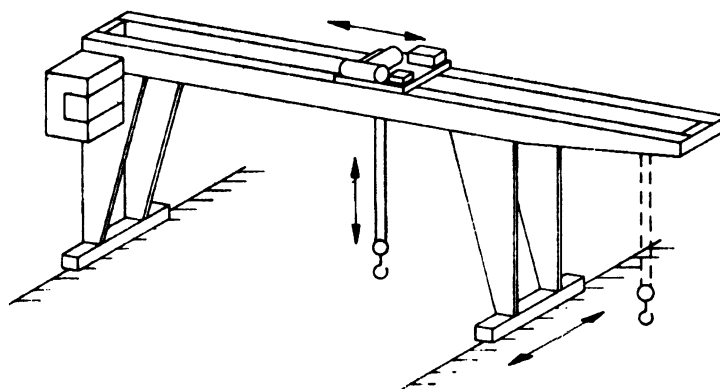


(c) Top running crane (single girder)

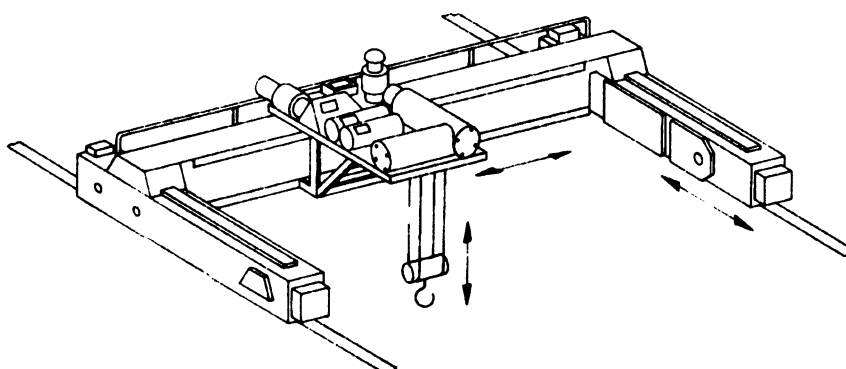


(d) Semi-goliath crane

Figure 1 — Typical crane types



(e) Goliath crane (with cantilevered extension)



(f) Offset crab crane

Figure 1 — Typical crane types (concluded)

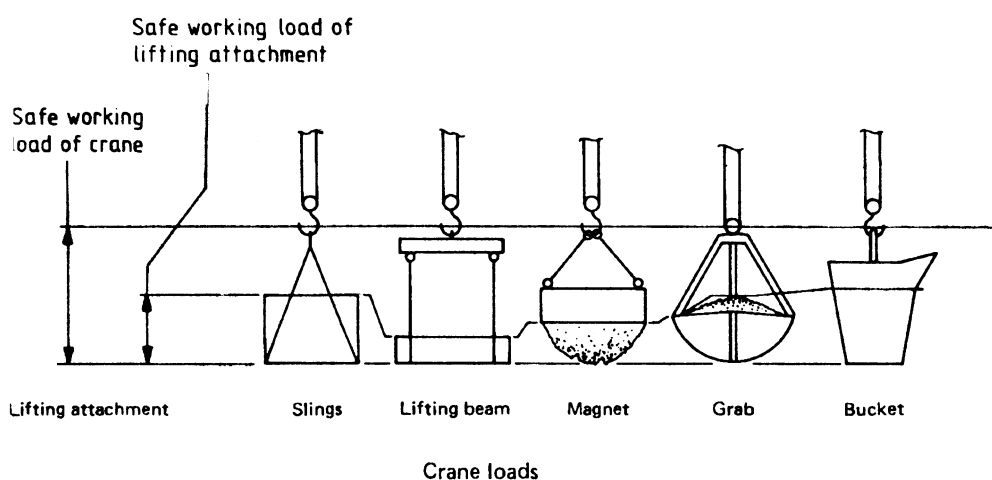


Figure 2 — Illustration of typical lifting attachments in relation to safe working load

### 5.2.2.3 Outdoor use

**5.2.2.3.1 Weather protection.** The manufacturer shall arrange weather protection for all electrical and mechanical equipment, as necessary, to meet the conditions specified.

The weatherproofing shall make allowances for the temperature rise of equipment under normal operating conditions.

The weatherproofing shall afford ready access for the routine inspection and maintenance of the protected equipment.

**5.2.2.3.2 Wind loads.** The crane shall be designed and constructed for in-service and out-of-service wind loads as specified in BS 2573-1.

NOTE If the siting of a particular crane affects the wind loadings as outlined in BS 2573-1, the purchaser should specify the actual wind loadings to be used in the design of the crane (see 3.1 and 5.2.1).

**5.2.2.3.3 Storm anchors.** The crane shall be provided with suitable means for anchoring when left unattended or under storm conditions.

**5.2.2.3.4 Brakes.** The long travel motion shall be fitted with a parking brake that shall be automatically applied when the crane is taken out of service. The cross traverse motion shall be fitted with a brake.

## Section 2. Structural

### 6 Permissible stresses in structures

**6.1 General.** The permissible stresses and design of crane structures shall comply with 6.2 and BS 2573-1.

**6.2 Inertia forces.** Inertia forces shall comply with BS 2573-1 with the exception that the horizontal inertia forces shall be taken as not less than  $1/15$  (nor more than  $1/5$  for metallic wheels on rails) of the vertical load on the driven or braked wheels.

For the purposes of structural analysis, the horizontal inertia force due to the weight of each bridge girder, inclusive of any attachments thereto, shall be taken as a distributed load on the bridge girder. For concentrated elements, such as crabs and large items of machinery, the loads shall be considered as forces concentrated at the respective centres of mass. The effect of the suspended load shall be considered as a concentrated force at the point of suspension.

### 7 Vertical deflection

The bridge shall be designed so that the vertical deflection caused by the safe working load and the weight of the hoist or crab in the central position shall not exceed  $1/750$  of the span.

### 8 Vibration of crane structure

Due consideration shall be given to the crane structure's vibration characteristics to avoid adverse effects on:

- a) accurate load positioning and control where these are critical;
- b) safety, comfort and working efficiency of the operator on cab-controlled cranes.

NOTE For further information, see DD 32.

### 9 Structural sections

**9.1 Corrosion allowance.** For cranes working outdoors or in other corrosive environments, a corrosion allowance shall be added to the thickness required for structural strength considerations.

**9.2 Exposure to accidental damage.** Special consideration shall be given to the thickness of members that are likely to be exposed to accidental damage. Any increase of thickness required for this purpose shall be additional to the corrosion allowance.

**9.3 Enclosed sections.** Larger enclosed sections shall be designed so that every part is accessible for periodic inspection, brushing and painting. Drain holes shall be provided where water is likely to collect. Smaller enclosed and tubular sections, where access is impracticable, shall be sealed to prevent the ingress of moisture. Where tubular members are drilled to take bolts, precautions shall be taken to ensure that the joints are waterproof.

## 10 Joints

The strength of a bolted joint at any section of a structural member shall be at least 1.25 times the minimum strength of the section required at that point.

## 11 Bridge girder

**11.1 Effective section.** Where the rail is secured to the top beam or flange of a crane bridge girder, the rail shall be regarded as part of the effective section of the beam or flange for load carrying purposes provided that:

- a) the means adopted to secure the rail are sufficient to resist the horizontal shear loading between the rail and the flange or beam under the applied loads, in addition to the lateral force resulting from the inertia of the lifting unit and load calculated in accordance with 6.2;
- b) any joints in the rail that are located within the middle third of the span are full penetration welds and any joints that are not full penetration welds are in such a position that the interruption of the rail area by the joint will not cause the stress in the remaining section of the girder to exceed the permissible maximum;
- c) when calculating the section contributed by the rail, allowance is made for 6 mm wear in the depth of the rail.

Where the rail is not secured as specified in a) or not welded as in b), the cross section of the rail shall not be included when calculating the effective section of the girder.

### 11.2 Effect of wheel loads

**11.2.1 General.** Consideration shall be given to localized effects of wheel loadings on the stresses in the bridge girder.

**11.2.2 Load directly over web.** When a wheel load is placed directly over the web of a bridge girder, it shall either be assumed to be distributed over a distance of three times the distance from the application of the wheel load to the point at which the stress is being calculated, taking into account any discontinuance in the materials, or a more detailed calculation shall be made.

Particular attention shall be given to all the resulting stresses passing through the connection between the web and the flange. If full penetration butt welds are not used for this connection, it shall not be assumed that there is direct contact between web and flange parent materials.

**11.2.3 Load between webs.** Where the wheel load is carried between the webs, that part of the flange plate between the webs shall not be assumed to give adequate support. If necessary, the flange plate shall be supported at intervals to transmit the load to the girder webs.

**11.2.4 Load on lattice girders.** Braced or lattice girders shall withstand, in addition to the direct tensile or compressive stresses in the flanges, the local bending stresses due to the maximum wheel or roller loads and their own weight between the panel points.

### 11.3 Braced and lattice girders

**11.3.1 Local bending moments.** Local bending moments used in the calculation of stresses shall be not less than  $WL/6$  at the panel centre and  $WL/12$  at the panel points where  $W$  is the total vertical load on the member arising from live load and the weight of the member, and  $L$  is the distance between panel points.

**11.3.2 Tension members.** Where single angle bars connected by one leg are used as tension members, the effective sectional area shall be taken as the net sectional area of the connected leg added to one-half of the sectional area of the free leg. When the outstand leg is cleated at the end connections, the net sectional area of the angle shall be taken.

**11.3.3 Compression members.** The latticing of compression members shall be proportioned to resist a transverse shear at any point in the length of the member not less than 2.5 % of the axial load in the member.

**11.3.4 Flat lattice bars.** The thickness of flat lattice bars shall be not less than  $1/40$  of the shortest distance between the centres of connections, in the case of single latticing, and  $1/60$  in the case of double latticing connected at the intersection.

## 12 End carriages

**12.1 Length.** The length of the end carriages shall be such that they prevent contact by any other part of the crane in the event of a collision between cranes on the same tracks or with the end stops.

**12.2 Wheelbase.** The wheelbase of an end carriage shall satisfy the following minimum requirements where applicable.

- a) *Top running crane.* The wheel base shall be not less than  $1/7$  of the crane span.
- b) *Underslung crane.* The wheel base shall be not less than  $1/7$  of the crane span where the travel speed of the crane is more than 40 m/min and  $1/8$  where the travel speed of the crane is 40 m/min or less.

**12.3 Withdrawal of track wheels.** End carriages shall be designed so as to enable the track wheels to be withdrawn readily.

## 13 Buffers

**13.1 Resilient buffers.** Resilient buffers shall be fitted to cross traverse and long travel motions unless motion limiting devices (see **21.2**) are provided or the speeds are less than 40 m/min.

**13.2 Two or more units on the same tracks.** Where two or more units (i.e. cranes or crabs) are on the same tracks, resilient buffers shall be provided between them unless anti-collision devices are fitted (see **21.2**) or the maximum potential collision speed is less than 40 m/min.

## 14 End stops

The manufacturer shall provide end stops on the crane bridge to prevent the crab(s) from over-traversing.

NOTE The purchaser will be responsible for providing stops on the gantry rail(s) to prevent over-travelling of the crane.

## 15 Drop stops

The end carriages and crab(s) shall be fitted with drop stops to prevent a drop of more than 25 mm in the event of breakage of a track wheel bearing or axle.

## 16 Access platforms, walkways, ladders and stairs

**16.1 General.** Access platforms, walkways, ladders, stairs, handholds and footholds shall be provided as necessary to give safe access to the driver's cabin (when fitted) and to parts of the crane requiring routine inspection and maintenance. Where these are mounted on or form part of the crane they shall be provided by the manufacturer.

NOTE 1 Where these do not form part of the crane, the responsibility for supply should be agreed between the manufacturer and the purchaser.

NOTE 2 Recommendations for headroom clearances, platform and walkway widths are given in Appendix H. (See also item 11 of Appendix C.)

**16.2 Guard rails and toe boards.** The outer sides of platforms and walkways shall be securely fenced with toe boards and double tiered guard rails. The guard rails shall have a minimum height of 1 m above the walking surface and the toe board shall have a minimum height of 50 mm above the walking surface.

**16.3 Openings in platforms and walkways.** All openings in platforms and walkways shall be fenced as specified in **16.2**.

**16.4 Walkway surfaces.** Walkway surfaces shall be non-slip.

**16.5 Ladders.** Ladders shall comply with BS 4211 except that safety hoops are not required where equivalent protection is provided.

NOTE Ladders should not be less than 300 mm wide.

**16.6 Stairs.** Stairs shall comply with BS 5395 where applicable. Where space is limited, stairs shall in no case be less than 430 mm wide.

## 17 Emergency escape provision

Where a driver cannot descend safely from an elevated cabin by his normal route if the crane is stranded away from the normal access point, or in a case of emergency, an alternative means of escape shall be provided.

## 18 Driver's cabin

**18.1 General.** Where a driver's cabin is fitted, it shall have a clear headroom of not less than 1.80 m. The internal dimensions of the cabin shall provide for any control gear, or apparatus therein and give the driver adequate space for safe operation. Electric cables and hydraulic pipes shall be arranged to avoid accidental damage.

NOTE 1 The cabin should afford the driver as clear a view as possible of the load and the surroundings. The controls should be positioned so that the driver can readily operate the crane whilst viewing the load, irrespective of its position.

NOTE 2 Any special requirements for the driver's cabin should be the subject of agreement between the purchaser and the manufacturer. This should include requirements for protection against excessive heat radiation or toxic fumes or dust, the need for air conditioning or heating (see clause 37) and the provision of fire extinguishers, etc.

**18.2 Access.** Whenever access to the cabin is not via the crane bridge platforms but is directly from a fixed access point in the building, an access platform shall be provided, attached to the cabin, complete with handrails and safety gate or chain.

**18.3 Enclosure.** Control cabins shall be either open type or totally enclosed, depending on the operating conditions and the environment.

Totally enclosed cabins shall be fitted with safety glass and provision shall be made to prevent the driver from falling through the glass. The windows shall be arranged so that they can be cleaned.

Open cabins shall be provided with guard rails 1 m high or equivalent protection for the driver. Toe boards of 50 mm minimum height shall be fitted to the walking surface.

**18.4 Illumination.** Where natural or artificial illumination is inadequate, additional illumination shall be provided to afford safe access to the crane and to enable the driver to operate the crane safely.

**18.5 Audible warning device.** An audible warning device shall be fitted to cranes operated from a cabin to enable the driver to give warning to persons in the vicinity.

## Section 3. Mechanical

### 19 Permissible stresses in mechanisms

**19.1 General.** The permissible stresses and design of crane mechanisms shall comply with BS 2573-2.

#### 19.2 Wheels running on rails or tracks

**19.2.1 Lateral location.** Provision shall be made to ensure the lateral location of the wheels on the rails or tracks.

**19.2.2 Metal wheels.** Metal wheels shall be machined to size and any flanges tapered and radiused to ensure smooth running.

#### 19.3 Ropes and rope reeving components

##### 19.3.1 Wire ropes

**19.3.1.1 General.** Wire ropes shall comply with BS 302, BS 3530 or ISO 2408 with the exception that selection shall be based on the group classification of the mechanism (*M*) (see clause 4) and the requirements of BS 2573-2.

NOTE For ropes used on cranes that handle molten metal, see 5.2.2.1.

**19.3.1.2 Two or more ropes in a system.** Where two or more ropes are used in a system, means shall be provided for ensuring that the tensile forces in the ropes are distributed in the designed proportions.

##### 19.3.2 Rope drums

**19.3.2.1 Drum width.** Where a rope drum is of insufficient width to accommodate the rope in one layer, special arrangements shall be provided to ensure the correct reeling of the rope. The capacity of the drum shall be sufficient to ensure that for the height of lift specified;

- a) no fewer than two dead turns remain on the drum at each anchored end at the lower limit of hoisting;
- b) the drum will accommodate one further turn of rope at the upper limit of hoisting.

**19.3.2.2 Flanges.** The drum shall have flanges at both ends, except where a rope guide is fitted that effectively guides the rope into the drum grooves and ensures that it is retained therein. Flanges shall project not less than two rope diameters above the rope.

NOTE A gear or other wheel secured to the drum may be regarded as forming one of the flanges.

**19.3.2.3 Rope anchorages.** Rope anchorages shall be readily accessible.

**19.3.2.4 Drum surfaces.** Rope drum surfaces shall be finished smoothly and be free from surface defects liable to damage the rope.

**19.3.2.5 Grooves.** The contour at the bottom of the grooves shall be circular over a minimum angle of 120°. The radius of the groove shall be not less than 0.53 times the nominal diameter of the rope.

The groove pitch for single layering shall be not less than:

- a)  $1.08d$  for ropes of less than 38 mm diameter, where  $d$  is the nominal rope diameter; or
- b)  $d + 3$  mm for ropes of 38 mm diameter and above.

The groove pitch shall also ensure that the rope leaving the drum does not contact the adjacent turn of rope under any condition of operation.

The lead angle of the rope shall not exceed 1 in 12 either side of the helix angle of the groove in the drum.

### 19.3.3 Rope pulleys

**19.3.3.1 Rope pulley surfaces.** Rope pulley surfaces shall be finished smoothly and be free from surface defects liable to damage the rope.

**19.3.3.2 Grooves.** Rope pulleys shall be grooved to a depth not less than 1.5 times the diameter of the rope.

The contour at the bottom of the groove shall be circular over a minimum angle of 120° and have an included angle of 52°.

**19.3.3.3 Angle of fleet.** The angle of fleet between the rope and a plane perpendicular to the axis of the pulley shall not exceed 1 in 12 for the minimum pulley diameter to rope diameter ratio permitted by BS 2573-2.

NOTE For larger pulley diameter to rope diameter ratios, consideration should be given to decreasing this angle to prevent interference between the rope and the pulley flange.

**19.3.3.4 Pulley guards.** Pulleys carrying ropes that are likely to be unloaded in service shall be provided with guards to retain the ropes in the grooves.

**19.4 Lifting hooks.** Lifting hooks shall comply with BS 2903 or BS 3017 as applicable.

Swivelling hooks shall be mounted on anti-friction bearings.

NOTE 1 If required by the purchaser, hooks complying with BS 2903 may be provided with a device to prevent the displacement of the sling or the load from the hook.

NOTE 2 If required by the purchaser, a locking device may be fitted to prevent rotation of the hook.

**19.5 Shackles.** Shackles shall comply with the requirements for strength and safety specified in BS 3032 or BS 3551. Shackles used for attaching the hook shall be provided with screwed pins.

NOTE Slotted heads in countersunk screwed pins are not recommended.

If angularly loaded, shackles shall not be subjected to a load exceeding one-third of the specified proof load. When the shackle is a permanent fitting, the pin shall be effectively locked.

## 20 Brakes

**20.1 General.** Brakes shall comply with the following.

- a) Drums and discs shall be manufactured from hard wearing material. The rubbing surface shall be smooth and free from defects.
- b) Brake drums and discs shall have adequate thermal capacity for the duty required.
- c) The bearing pressure on the linings shall be conducive to uniform braking and long life.
- d) Power released brakes shall be applied automatically by spring(s) or weight(s) when the power supply to the brake is interrupted. Power applied brakes shall not be fitted without a back-up system of the power released type.
- e) Brakes shall be provided with means of adjustment to compensate for wear.
- f) Springs for electromechanical brakes shall be of the compression type and shall not be stressed in excess of 80 % of the elastic limit of the material.
- g) Under service conditions brakes applied by hand shall not require a force greater than 110 N (25 lbf) at the handle. Brakes applied by foot shall not require a force of more than 180 N (40 lbf) on the pedal.
- h) Brakes shall be protected from hostile environments likely to adversely affect their operation, including rain, oil and grease.