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BRITISH STANDARD 327 : 1964

SPECIFICATION FOR POWER-DRIVEN DERRICK CRANES

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POWER-DRIVEN DERRICK CRANES

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BRITISH STANDARDS INSTITUTION

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The Institution desires to call attention to the fact that this British Standard does not purport to include all the necessary provisions of a contract.

In order to keep abreast of progress in the industries concerned, British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the committees charged with the revision of the standards to which they refer.

A complete list of British Standards, numbering over 4000, indexed and cross-indexed for reference, together with an abstract of each standard, will be found in the Institution's Yearbook.

This standard makes reference to those British Standards in Appendix C the numbers of which are italicised.

British Standards are revised, when necessary, by the issue either of amendment slips or of revised editions. It is important that users of British Standards should ascertain that they are in possession of the latest amendments or editions.

The following B.S.I. references relate to the work on this standard:
Committee reference MEE/41 and MEE/41/1
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CO-OPERATING ORGANIZATIONS

The Mechanical Engineering Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

- *Admiralty
- *Associated Offices' Technical Committee
- Association of Consulting Engineers (Incorporated)
- Association of Mining Electrical and Mechanical Engineers
- British Chemical Plant Manufacturers' Association
- British Compressed Air Society
- *British Electrical and Allied Manufacturers' Association
- British Gear Manufacturers' Association
- British Internal Combustion Engine Manufacturers' Association
- *British Iron and Steel Federation
- British Mechanical Engineering Federation
- British Railways Board
- Crown Agents for Oversea Governments and Administrations
- D.S.I.R.—National Engineering Laboratory
- Electricity Council, The Generating Board and the Area Boards in England and Wales
- Engineering Equipment Users' Association
- Gas Council
- *High Commission of India
- Institute of Marine Engineers
- Institute of Petroleum
- *Institution of Civil Engineers
- Institution of Gas Engineers
- Institution of Heating and Ventilating Engineers
- *Institution of Mechanical Engineers
- Institution of Mechanical Engineers (Automobile Division)
- *Institution of Production Engineers
- Locomotive and Allied Manufacturers' Association of Great Britain
- London Transport Board
- Machine Tool Trades Association
- *Ministry of Labour (H.M. Factory Inspectorate)
- *Ministry of Power
- *Ministry of Public Building and Works
- *Ministry of Transport
- National Coal Board
- National Physical Laboratory (D.S.I.R.)
- Radio Industry Council
- *War Office

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this standard:

Aluminium Federation
 Association of Crane Makers
 British Constructional Steelwork Association
 British Transport Docks Board
 Contractors Plant Association
 Dock and Harbour Authorities Association
 D.S.I.R.—Building Research Station
 Electrical Trades Union
 Engineer Surveyors' Association
 Excavator Makers' Association
 Federation of Civil Engineering Contractors
 Institute of Welding
 Institution of Engineering Inspection
 Institution of Structural Engineers
 National Federation of Building Trades Employers
 Individual Companies

BRITISH STANDARD SPECIFICATION FOR POWER-DRIVEN DERRICK CRANES

FOREWORD

This British Standard forms one of a series relating to cranes and excavators. As with all other British Standards for cranes, the primary object of the specification is to ensure reliability and safety, without placing restrictions on the general design of cranes or methods employed in their construction.

Other standards in this series are:

- B.S. 357. Power driven travelling jib cranes (rail mounted low carriage type).
- B.S. 466. Electric overhead travelling cranes for general use in factories, workshops and warehouses.
- B.S. 1757. Power-driven mobile cranes.
- B.S. 1761. Single bucket excavators.
- B.S. 2452. High pedestal or portal jib cranes.
- B.S. 2573. Permissible stresses in cranes. Part 1. Structures.
- B.S. 2799. Power-driven rail-mounted tower cranes.
- B.S. 3579. Heavy duty electric overhead travelling and special cranes for use in steelworks.

During the revision of the standard the drafting Committee decided that it should no longer apply to cranes of the 'tower derrick' type, as it was considered that these cranes should preferably be covered by another specification. It was also decided that the standard for hand-operated derrick cranes, being obsolete, should be withdrawn, but a supplement has been included giving the requirements for converting existing hand-operated cranes to electric power operation.

Appendix C comprises a list of British Standards for materials and equipment applicable to the manufacture of cranes, and attention is drawn to Appendix D containing a list of statutory requirements affecting cranes.

NOTE. Where metric equivalents are stated the figures in British units are to be regarded as the standard. The metric conversions are approximate. More accurate conversions should be based on the tables in B.S. 350, 'Conversion factors and tables'.

SPECIFICATION

SECTION ONE : GENERAL

SCOPE

1. This British Standard covers power driven derrick cranes of the following types:

- | | |
|--|--------|
| a. Scotch derrick | Fig. 1 |
| b. Scotch derrick, rail mounted with or without power driven travelling motion | Fig. 2 |
| c. Scotch derrick mounted on gabbards or towers, fixed | Fig. 3 |
| or | |
| Rail mounted with or without power driven travelling motion | Fig. 4 |
| d. Guy derrick | Fig. 5 |

DEFINITIONS

2. For the purposes of this British Standard the following definitions apply:

Back stays. The structural members of a derrick crane which extend backwards and downwards from the top of the mast (or king post) to the outer end of the crane sleepers.

Basic stresses. Stresses given under the appropriate clauses and tables in B.S. 2573, 'Permissible stresses in cranes'.

Bowsill (or stringer). The horizontal structural members of a derrick crane which connect the sleepers at or near to the outer or stay ends forming with the sleepers a rigid triangle.

Clearance lines. Lines defining the area within which the crane should be designed to work with suitable clearances. Buildings or other structures shall not encroach within these lines.

Clearance lines should be related to the positions of the crane rails, ground level or other datum.

Dead load. Any load of constant magnitude and position which acts permanently on the structure or member.

Derricking or luffing. Angular movement of the crane jib in a vertical plane.

Fatigue. The tendency to fracture by means of a progressive crack usually initiated by a stress concentration under repeated alternating or cyclic stresses considerably below the tensile strength.

Fluctuating stresses. The varying stresses due to the combined effect of dead and live loads. These are of two kinds:

- a. Stresses which change in magnitude without change of direction are termed pulsating stresses.
- b. Stresses which reverse direction are known as alternating stresses.

Gabbards. A structural erection of vertical towers and, where necessary, inter-ties on which a Scotch derrick crane is erected. (See Fig. 3.) They may be in fixed positions or mounted on travelling bogies.

Gauge. The horizontal distance between the inside faces of the track rails.

Height of lift. The vertical distance between the ground level or datum level, and the lowest point of the throat of the hook when the hook is in the highest working position.

Hoisting. The motion of lifting or lowering of the load in a vertical direction.

Inertia forces. The forces produced by acceleration or retardation.

Jib. The member of a derrick crane structure which gives the load its radius and height of lift.

Jib length. The shortest distance between the fulcrum of the jib and the centre of the jib head pulley pin.

Level luffing. A luffing motion during which the load is automatically maintained at an approximately constant height.

Live load. Any load which gives rise to variation of stress in a member. Such variation may be due to change of position or magnitude, or both, of an externally applied load, or to the movement of the crane structure itself. Wind loads are excluded from this definition.

Local bending. The bending induced in a member of a lattice frame when subject to loads between panel points, such bending to be considered at panel and intermediate points.

Luffing. See derricking.

Mast (or king post). The vertical slewing structural member of a derrick crane to which is attached the slewing gear ring and jib foot.

Maximum permissible working stress. Stress numerically equal to the basic stress multiplied by the relevant duty and fluctuation factors as defined in B.S. 2573.

Radius. The horizontal distance measured between the centre line of the hook and a perpendicular projected through the centre of rotation.

Range of lift. The vertical distance between the highest and the lowest working positions of the hook.

Safe working load. The maximum load under specified conditions for which the crane may be used.

Sleepers. The horizontal structural members of a derrick crane which connect the crane sole-plate at the bottom of the mast to the bottom end of the back stays.

Slewing. Rotary motion of the crane jib or load about a vertical axis.

Stay glands (or similar eccentric fittings). Members which connect the back stays to the top of the mast (or king post).

Stress concentration. The localised increase of stress in any component due to a change of section or other cause.

Tail radius. The maximum distance between the centre of rotation and the tail of the slewing superstructure.

Track centre. The horizontal distance between the centres of each pair of track rails. (See M Fig. 4.)

Travelling. Motion applied to the movement of the whole crane.

Wind load. The load produced by the wind pressure.

INFORMATION TO BE SUPPLIED WITH ENQUIRY OR ORDER

3. All the necessary information regarding the conditions under which the crane is to be used, together with the information enumerated in Appendix A, shall be supplied with the enquiry or order.

If the crane is rail mounted the manufacturer shall not be responsible for the design of the track (see Appendix E).

INFORMATION TO BE SUPPLIED BY MANUFACTURER

4. The manufacturer shall supply with the tender the information enumerated in Appendix B.

SERVICE CONDITIONS

5. The crane shall be deemed to be under service conditions when it is operating without load or with a load up to the maximum safe working load. The effect of wind pressure shall be taken into consideration (see Clause 9).

The jib shall only be lengthened or shortened in a manner approved or recommended by the manufacturer and any such alteration in the length of the jib shall only be effected under the guidance of the manufacturer or other competent person. After such an alteration is made to the jib and before the crane is put into service, the safe working loads shall be re-assessed and the crane shall be re-tested in accordance with the requirements of Subclause 66c. A modified load plate shall be fixed on the crane showing the appropriate safe working loads for the changed length of jib. In addition, the automatic radius and safe load indicator and, if fitted, the approved type of visual and audible warning device, shall also be adjusted to operate for the re-assessed loading.

If the crane is rail mounted the recommendations regarding the track in Appendix E should be observed.

CLASSIFICATION AND DUTY

6. For the purpose of computing permissible stresses B.S. 2573 : Part 1 divides derrick cranes into three classes. The appropriate classes to which this British Standard applies are as follows:

TABLE 1. CLASSIFICATION AND DUTY

Class	Max. No. of hours in service per year for design purposes	Duty	Description of duty
1	1 000	Light	General use
2	2 000	Medium	General use
3	3 000	Heavy	Intermittent grabbing and magnet work

NOTE. Class 1 cranes are not regarded as suitable for grabbing and magnet duties. If a Class 2 crane is used for grabbing or magnet duties a reduced safe working load should be used, and it is recommended that the combined weight of the grab and contents or the magnet and load should not exceed 80 per cent of the safe working load at the given radius.

If a derrick crane has to be designed for over 3000 hours of service per year on continuous grabbing or magnet work the permissible stresses shall be computed as for Class 4 cranes in B.S. 2573 : Part 1.

IDENTIFICATION

7. For purposes of identification the crane shall bear the manufacturer's name and serial number, the year of manufacture, the number of this British Standard and the class of crane (as specified in Clause 6).

NOTE. Attention is drawn to the requirements of Clause 8 regarding the identification of cranes on which special materials have been employed.

MATERIALS

8. The materials used in the construction of the crane shall comply with the appropriate British Standards listed in Appendix C.

Timber shall not be used in any stress-bearing structural member of the crane, but it may be used, for example, in the construction of the cabin.

If special materials, such as high tensile steel or aluminium alloy, have been used in any member of the structure, the crane shall bear a notice to this effect and relevant members shall be appropriately marked.

WIND

9. The crane shall be designed in accordance with the requirements of B.S. 2573 : Part 1 taking into account the wind forces on the structure.

STABILITY

10. *a.* The anchoring and/or ballasting of the crane shall be such as to ensure that with the jib in any position the righting moment will be at least 50 per cent greater than the overturning moment imposed under service conditions. Under storm conditions the crane shall be stable (see Clause 9).

b. If ballast is used, the amount required to ensure stability shall be clearly and permanently shown on a notice in a suitable position. The load imposed by the ballast shall be applied symmetrically at the anchorages.

c. If bolts are used to secure the crane to each of its anchorages they shall be of such numbers, length and strength, and shall be arranged in such a manner, that stability of the crane will be assured (see also Clause 18).

As far as practicable the pull on the anchorage shall be applied symmetrically at the junction of the back stays and the sleepers.

If conditions necessitate an eccentric anchorage connection, the members affected shall be designed to withstand the additional bending stresses.

d. If the crane is rail mounted, the devices for anchoring the crane to the rails shall not be taken into account when determining the stability of the crane.

e. Provision shall be made on the travelling structure to prevent the stability being endangered in the event of a derailment or breakage of an axle or wheel.

SECTION TWO : STRUCTURAL

PERMISSIBLE STRESSES

11. The structure of the crane shall be designed and constructed to comply with the requirements of B.S. 2573 : Part 1.

JIBS

12. The jib and its attachments shall be designed and constructed in accordance with B.S. 2573 : Part 1 to withstand all the stresses arising under service conditions (see Clause 5) including the designed acceleration or deceleration, or a value of 1 ft/sec^2 (0.3 m/sec^2) whichever is the greater, measured at the jib head.

The jib feet and the members by which they are connected to the mast shall be of steel. This requirement shall not preclude the use of other suitable materials for the purpose of increasing pin bearing area.

If the jib is of lattice construction, sufficient diaphragm braces shall be provided for stiffening purposes.

BACK STAYS

13. Back stays shall be designed in accordance with B.S. 2573 : Part 1.

Wherever practicable, back stays shall be designed with their end fittings concentric with their axes. Where this cannot be arranged and bent glands or similar eccentric fittings are used, the bending stresses due to eccentricity shall be taken into consideration in the design of the fittings and back stays.

The derricking ropes and/or rods shall be arranged, so far as is practicable, to be clear of the stays for all working positions of the jib.

For all classes of crane the maximum stress in stay glands of the solid forged type should not exceed 10 tonf/in^2 (15.75 kgf/mm^2). This limiting allowable stress covers the known factors applicable to these members for the normal use of a crane. It should be noted that B.S. 2573 : Part 1 does not cover the design of stay glands and it is not considered practical to apply the general recommendations contained therein.

STRUTS, i.e. MASTS, JIBS, BACK STAYS AND SLEEPERS

14. Struts shall be designed in accordance with B.S. 2573 : Part 1.

The slenderness ratio l/r of strut members entirely of lattice construction shall not exceed 100.

For the purpose of this clause, if a strut consists of two channels or plated sections connected by latticing, the ratio l/r shall not exceed 100 in the latticed direction and 160 in the direction at right angles to the latticing.

The latticing and plating of a strut member shall be proportioned to resist the maximum transverse shear at any cross-section, such shear being assumed to be divided equally between the planes of bracing concerned. The value allowed, however, for transverse shear in the direction of the two axes of the strut as a whole shall in no case be less than $2\frac{1}{2}$ per cent of the maximum axial load under service conditions, plus the shear at such planes of bracing due to simultaneous transverse loads on the member.

JOINTS

15. a. *Strength of joints.* The calculated strength of riveted joints or joints made by friction grip bolts in structural members shall be not less than the net strength of the member.

The calculated strength of other bolted joints in structural members shall be not less than the net strength of the member plus 25 per cent.

The calculated stress in rivets and bolts shall be in accordance with B.S. 2573 : Part 1.

The calculated stress in welds and the design of welded joints shall be in accordance with B.S. 2573 : Part 1.

b. *Rivet and bolt holes* (except those for friction grip bolts). All rivet and bolt holes shall be drilled accurately and all arrises and burrs shall be removed from all holes before assembly.

The diameter of holes for rivets shall not exceed the corresponding diameter of rivets under the head by more than $\frac{1}{16}$ in (1.6 mm).

The diameter of holes for precision bolts shall not exceed the nominal diameter of the bolt by more than $\frac{1}{64}$ in (0.4 mm).

Where bolts are used in shear they shall be fitted into reamed holes. Black mild steel bolts shall not be used for joints in stress bearing members.

c. *Friction grip bolts.* Friction grip bolts shall comply with B.S. 3139 and shall be fitted in accordance with the recommendations of B.S. 3294.

d. *Rivet and bolt spacing.* The distance between the centres of rivets and bolts for stress-bearing parts shall be not less than $2\frac{1}{2}$ times the diameter of the rivet or bolt, and shall not exceed sixteen times the thickness of the thinnest outside plate or angle. Where two lines of staggered rivets or bolts are used in the same angle or flange, the maximum distance between the rivets or bolts on each line may be taken as 1.5 times those given above.

The distance between centres of rivets and bolts and the sheared edge of a plate shall be not less than 1.75 times the diameter of the rivet or bolt, and between the centre of the rivet or bolt and a rolled or planed edge shall be not less than 1.5 times the diameter of the rivet or bolt.

e. *Welding.* All welding shall comply with B.S. 1856 or B.S. 938.

MINIMUM SECTIONS

16. Plates, flat bars or angles used in the load bearing members of the structure shall be not less than $\frac{1}{4}$ in (6.3 mm) thick.

Steel tubes or other preformed sections which are sealed at the ends shall not be less than 0.128 in (10 s.w.g.) (3.25 mm) thick. Unsealed tubes shall be not less than $\frac{1}{4}$ in (6.3 mm) thick.

For corrosive conditions the above thicknesses shall be increased.

STRUCTURAL SECTIONS

17. The rolled steel sections used in the work shall be in accordance with the appropriate British Standard.

ANCHORAGE BOLTS

18. Anchorage bolts and nuts shall be of mild steel and shall be designed to transmit the loads associated with the required stability of the crane (see Clause 10). The maximum tensile stress shall not exceed 3 tonf/in² (4·72 kgf/mm²) for bolts up to and including 2 in (50 mm) diameter and 4½ tonf/in² (7·09 kgf/mm²) for bolts greater than 2 in (50 mm) diameter.

Screw threads should comply with B.S. 84 or B.S. 1580.

NOTE. The requirements of B.S. 2573 : Part 1 do not apply to anchorage bolts.

BOGIE FRAMES

19. The bogie frames shall be of rigid construction and designed to withstand the loads imposed on them. They shall be designed to take the crane sole-plate and sleeper-end attachments. The end bogies shall have sufficient area to carry the quantity of ballast required. (See Appendix A, Section 2.)

BRACING BETWEEN END BOGIES

20. A bracing shall be fitted to ensure that the distance between the end bogies is maintained. This bracing may take the form of a bowsill or part of the gabbard structure.

GABBARDS

21. The gabbards on which the crane is to be mounted shall be designed to resist the bending, torsional, direct and wind stresses induced therein under service and storm conditions and their structural strength shall conform with B.S. 2573 : Part 1.

MEANS OF ACCESS

22. a. General requirements. Safe means of access shall be provided to the driver's cab and to every place where any person engaged on the examination, repair, or lubrication of the crane has to work. Adequate handholds and foot-holds shall be provided where necessary.

b. Platforms. Every platform shall be securely fenced with guard rails having a minimum height of 3 ft 6 in (1·07 m) and toe boards.

c. Ladders. A permanent steel ladder shall be provided for access to the top of the mast. Sides of ladders shall extend to a reasonable distance beyond platforms or some other reliable handhold shall be provided.

Where a ladder is vertical and exceeds 30 ft (9·15 m) in height, it is recommended that intermediate resting places be provided between the platform and the foot of the ladder or that, where possible, uninterrupted lengths of the ladder do not exceed 30 ft (9·15 m).

It is recommended that vertical ladders should have back safety guards.

SECTION THREE : MECHANICAL**WIRE ROPES**

23. a. General requirements. Ropes shall comply with B.S. 302, 621.

The ratio between the nominal breaking load and the working load of a rope (except guying ropes) shall be determined by the following method:

The working load on the rope shall be considered as a static load. The ratio of the nominal breaking load of the rope to this load shall not be less than that set out in the following table, these ratios being considered sufficient to take into account the increased loads due to bending the rope and pulley bearing friction when the pulley sizes are not less than those given in Clause 29 and the ratio of pulley diameter to the effective pulley bearing diameter is not less than 6 : 1.

Class of crane	Ratio
1	5.0
2	5.0
3	6.0

If a derrick crane is designed for Class 4 working the ratio between the nominal breaking load and the working load shall be 7.0.

If a load is supported by more than one part of a rope, the tension shall be equal in each part.

Arrangements entailing reverse bends shall be avoided as far as possible.

So far as is practicable the derricking ropes shall be of sufficient length to permit the jib to be raised from or lowered to the horizontal position during the erection and inspection of the crane without the assistance of the hoisting rope.

b. Guying ropes for guy derrick cranes. The nominal breaking load of a guying rope used for guy derrick cranes shall be not less than $2\frac{1}{2}$ times the maximum tension induced therein under the conditions referred to in Clauses 5 and 9 on the basis that only one guying rope is opposing the load.

*As altered
Feb., 1970*

The minimum breaking load for guying ropes specified in this clause is fixed on the assumption that in service the guys will be arranged at 45° to the vertical and will be spaced not more than 60° apart in plan.

NOTE. For corrosive conditions consideration should be given to increasing the above ratios and to using ropes having an anti-corrosive coating.

LIFTING HOOKS

24. a. Lifting hooks shall comply with B.S. 482, B.S. 2903, B.S. 3017, B.S. 3033 or B.S. 3317 as applicable.

NOTE. For loads exceeding 40 tons, hooks of the ramshorn type, B.S. 3017, or of the triangular type, B.S. 3317, are preferable.

b. Swivelling hooks shall be mounted on anti-friction bearings suitable for the purpose.

c. If required, a locking device shall be fitted to prevent rotation of the hook.

SHACKLES

25. *a.* Shackles shall comply with B.S. 825 or B.S. 3032 as applicable.

b. If eccentric loading is unavoidable, shackles shall be subject to a load not exceeding one-third of the normal proof load.

NOTE. Countersunk screwed pins with slotted heads are not recommended for shackles.

OVERHAULING WEIGHT

26. If an overhauling weight is used on the rope it shall have a smooth hole and be bell-mouthed at the top and bottom unless the rope is efficiently served or otherwise protected. Provision shall be made for the examination of the part of the rope passing through the weight.

The weight shall be designed so as to avoid catching on obstructions.

STRETCHING SCREWS AND TURNBUCKLES FOR GUY ROPES OF GUY DERRICK CRANES

27. Stretching screws and turnbuckles shall be in accordance with B.S. 716. They shall be fitted with lock-nuts to prevent slacking back.

ROPE DRUMS

28. *a. General.* (i) Drums shall where possible accommodate in one layer the length of rope requisite for the range of lift. If the rope is wound on the drum in more than one layer the anchorage shall be located clear of the winding, preferably outside the flanges.

(ii) Drums shall be flanged at both ends and flanges shall project a distance not less than two rope diameters beyond the rope.

NOTE. A spur or other wheel secured to the drum can form one of the flanges provided it is adequately guarded.

(iii) The inclination of the rope at the point of lead off from a drum shall not exceed 1 in 12 each side of a centre line which represents the true lead off.

(iv) If a rope leads off against the helix angle of the drum care shall be taken to prevent the rope rubbing against a neighbouring turn.

NOTE. In extreme cases it may be necessary to increase the clearance between turns to comply with this requirement.

b. Drum diameters. For rope speeds not exceeding 200 ft/min (61 m/min) the diameter of each drum measured at the bottom of the rope groove shall be not less than that appropriate to the rope construction given in Table 2.

TABLE 2. MINIMUM DRUM DIAMETERS

Rope construction	Minimum drum (or pulley) diameter at bottom of groove (d = diameter of rope)
6×19	$18.8 d$
6×24	$17.6 d$
6×37	$15.2 d$

For each increase in rope speed of 100 ft/min (30.5 m/min) or part thereof, 5 per cent of the basic figure shall be added to the diameter of the drum given in Table 2.

c. Drum grooves. Rope drums shall be machine grooved and the contour at the bottom of the grooves shall be circular over an angle of not less than 120° . Grooving shall be finished smoothly and be free from surface defects liable to injure the rope.

The radius of the grooves shall exceed the radius of the ropes by not less than the values given in Table 3.

TABLE 3. MINIMUM GROOVE RADII

Diameter of rope (d)	Minimum amount by which groove radius shall exceed rope radius
Up to and including $\frac{5}{8}$ in (15.8 mm)	$\frac{1}{32}$ in (0.8 mm)
Over $\frac{5}{8}$ in but less than 1 in (25.4 mm)	$\frac{3}{64}$ in (1.2 mm)
1 in up to and including $1\frac{1}{8}$ in (28.6 mm)	$\frac{1}{16}$ in (1.6 mm)
Over $1\frac{1}{8}$ in (28.6 mm)	$\frac{3}{32}$ in (2.4 mm)

The grooves on the drum shall be pitched so that the clearance between adjacent turns of the rope is not less than the dimension given in Table 4.