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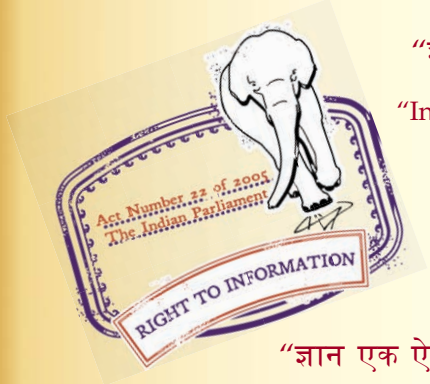

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Indian Standard

CODE OF PRACTICE FOR DESIGN OF TOWER CRANES

PART I STATIC AND RAIL MOUNTED

(First Reprint DECEMBER 1983)

UDC 621·873·25

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 8

November 1972

Indian Standard

CODE OF PRACTICE FOR DESIGN OF TOWER CRANES

PART I STATIC AND RAIL MOUNTED

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Indian Standard

CODE OF PRACTICE FOR DESIGN OF TOWER CRANES

PART I STATIC AND RAIL MOUNTED

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 15 March 1972, after the draft finalized by the Cranes and Allied Appliances Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard has been prepared to ensure that rail mounted tower cranes embody such fundamental principles of design as are essential to secure reliability and safety in operation.

0.3 All the necessary information regarding the conditions under which the cranes are to be used together with the particulars laid down in Appendix A shall be supplied with the enquiry or order. The manufacturer shall supply with the tender the information in accordance with *pro forma* laid down in Appendix B.

0.4 The standard keeps in view the manufacturing and trade practices being followed in the country in this field. Assistance has also been derived from BS 2799 : 1956 ' Specification for power-driven rail mounted tower cranes ' issued by the British Standards Institution.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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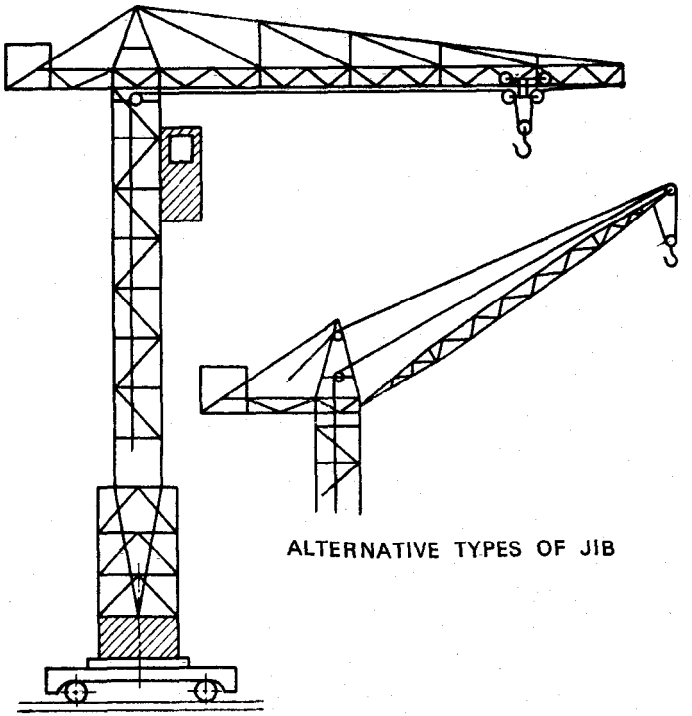
1. SCOPE

1.1 This standard covers power-driven cranes of the tower type. The crane may be static or rail mounted. The travelling motion of the crane may or may not, however, be power-driven and the jib may or may not be derricked (*see* Fig. 1 to 3 for examples of various types of these cranes).

*Rules for rounding off numerical values (*revised*).



NOTE — Tower may or may not slew with the jib.

FIG. 1 TOWER CRANE MOUNTED ON RAILS WITH COUNTERWEIGHT ALOFT

2. TERMINOLOGY

2.0 For the purpose of this standard, the definitions given in IS : 5532-1969* shall apply. However, for ready reference some of the definitions are given below.

2.1 Hoisting — The motion of lifting (or lowering) of the load in a vertical direction.

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

*Glossary of terms for cranes.

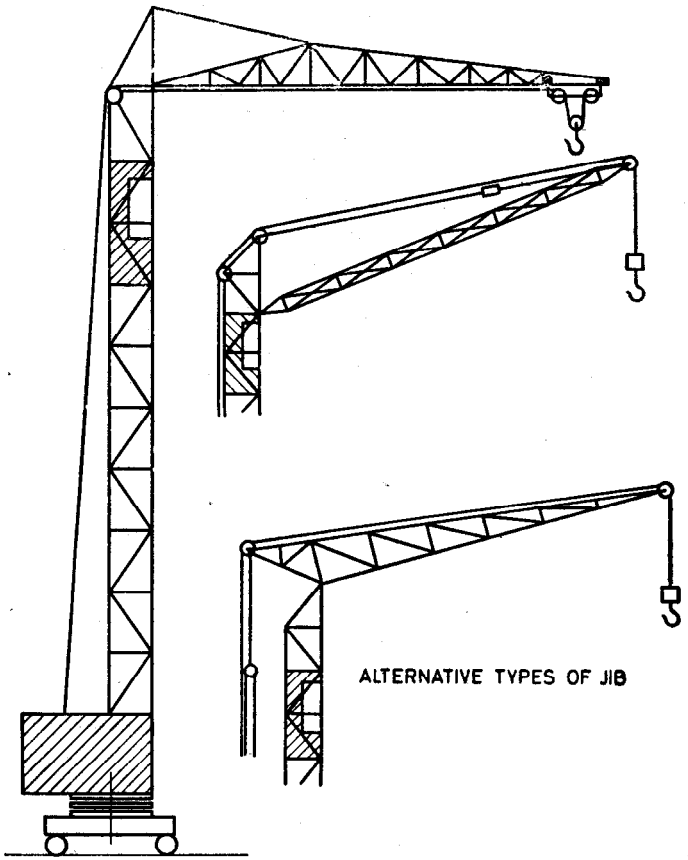


FIG. 2 TOWER CRANE MOUNTED ON RAILS WITH SLEWING TOWER

2.3 Derricking or Luffing — Angular movement of the crane jib in a vertical plane.

2.4 Travelling — Controlled movement of the whole crane along the track.

2.5 Traversing or Racking — The movement of the trolley along the jib.

2.6 Radius — The horizontal distance from the centre line of the lifting hook, when hanging vertically, to the centre line about which the jib slews.

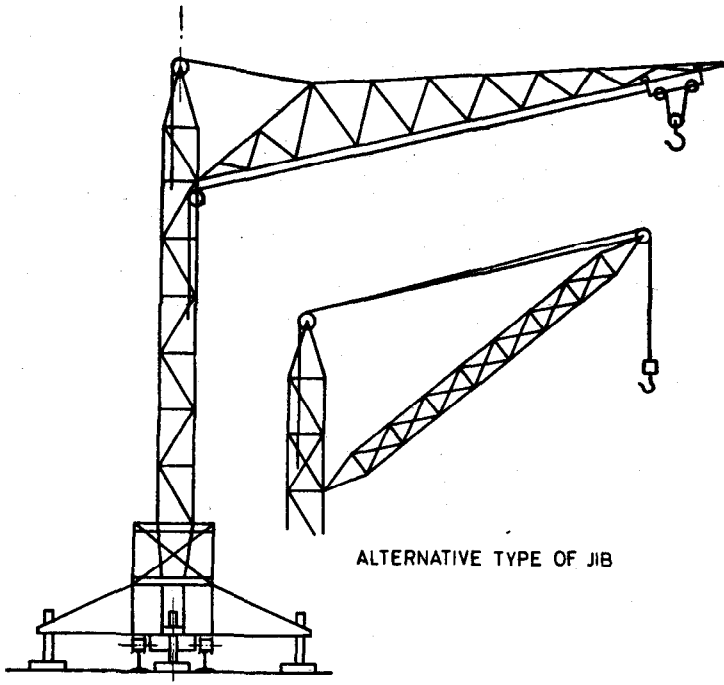


FIG. 3 TOWER CRANE MOUNTED ON RAILS AND STABILIZED BY OUTRIGGERS

2.7 Tower or Mast — That part of the crane structure which provides elevation and support for the jib mounting. The tower may or may not slew with the jib.

2.8 Trolley or Crab — A carriage supported on four or more wheels for over or under slung running on a crane bridge girder(s) fitted with driving means for the transversing and hoisting motions. Power-operated crabs may be controlled from pendant push buttons or from an operator's cabin attached to the crab or crane structure.

2.9 Ballast — Dead weight added to the structure of a crane to secure stability.

2.10 Counterbalance — Dead weight added to the structure of a crane to balance the weight of the jib.

2.11 Overhauling Weight — A weight fitted to the hoisting rope above the lifting hook.

3. MATERIAL AND EQUIPMENT

3.1 The materials and equipment used in the construction of the cranes shall conform where applicable to the requirements specified in the appropriate Indian Standards given in Appendix C.

3.2 Timber shall not be used for any stress bearing part of the crane structure.

4. IDENTIFICATION AND RADIUS — LOAD INDICATION

4.1 The crane shall bear one or more plaques clearly visible from maximum radius and from ground level having the following permanent inscriptions:

a) Manufacturer's name, and
b) Maximum radius safe working loads and their appropriate radii.

4.2 A small plaque shall be located in a permanent place inside the cab bearing the following inscriptions:

a) Manufacturer's name,
b) Manufacturer's serial number,
c) Year of manufacture, and
d) Safe working load as under:
   1) Different lengths of jib,
   2) Different radii,
   3) Different angles of slewing,
   4) With or without outriggers, and
   5) Different change speed gear in hoisting motion.

4.3 Indication of Load at Different Radii — A load indicator and radius indicator shall be provided in full view of the operator giving information as regards radii and the appropriate working load thereof. In the case of variable jib lengths the indicator should be recalibrated and checked before putting the cranes into service.

4.4 A device shall be fitted to the crane, which will give an alarm to the driver when the safe working load is exceeded. The alarm shall be both visible and audible. This device should have provision for cutting off the power supply in the hoisting direction in case the load exceeds the over load limit.

5. SERVICE CONDITION

5.1 The crane shall be deemed to be under service conditions when it is on a level track and handling any load in the vertical plane up to and including the safe working load. The actual load shall also include the load imposed by the wind pressure as specified in IS : 807-1963*.

5.2 The lengthening or shortening of the jib by the user is not recommended and, when any alteration in the length of the jib is required, this shall be effected only under the guidance of the manufacturer or other competent person. When such an alteration is made to the jib the safe working loads of the crane shall be re-assessed, the crane retested and a load plate fixed on the crane showing the appropriate safe working loads for the changed length of the jib. The automatic radius and safe load indicator and, if fitted, the approved type of visual and audible warming device, shall be adjusted to operate for the re-assessed loading.

5.3 Some information on the track for the tower cranes is given in Appendix D.

5.4 Wind Effect

5.4.1 Under service conditions the crane structure shall be able to withstand a steady wind pressure of 25 kgf/m^2. The mechanism shall be designed for a steady wind pressure of 15 kgf/m^2.

5.4.2 Under static conditions, the crane structure shall be capable of withstanding a steady maximum wind pressure as specified in IS : 875-1964† in different zones of the country.

5.4.3 The wind pressure under either conditions shall be calculated with form factors given in Table 4 of IS : 807-1963*.

6. CALCULATION OF FORCES IN STEEL MEMBERS IN THE STRUCTURE

6.1 Classification — The tower cranes shall be classified into two classes that is Class 1 and Class 2 as given in Table 1.

6.2 Permissible Stresses — The structure of the crane shall comply with IS : 807-1963*. The factors of safety for wire ropes gearing and brakes shall be as specified in this standard.

6.3 Minimum Thickness — Where the calculated thickness of the member is less than 6 mm the thickness of the members of the crane structure, consisting of steel plates or rolled steel sections, shall be not less than the appropriate thickness given in Table 2.

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*Code of practice for design, manufacture, erection and testing (structural portion) of cranes and hoists.

†Code of practice for structural safety buildings : Loading standards (*revised*).

TABLE 1 CLASSIFICATION OF CRANES AND HOISTS

(*Clause* 6.1)

Classification No.	All Appliances Used for Raising or Lowering Persons		
	Working Period	Effective Load	Dynamic Effect
(1)	(2)	(3)	(4)
1	Short	Low	Low
2	Long	Low	Low
	Short	High	Low
	Short	Low	High

Note — In applying this table, the following may be considered:

a) The working period of any crane or hoist shall be considered to be short if it operates or may reasonably be expected to operate for less than 500 hours per annum, or long if it operates or may reasonably be expected to operate for more than 500 hours per annum. The term 'operates' signifies that the crane is actually under load or in motion, or both.

b) The effective load of any crane or hoist shall be considered to be low unless it lifts or may reasonably be expected to lift loads greater than two-thirds of its safe working load on more than 1 000 occasions per annum. The effective load shall otherwise be considered to be high.

c) In the case of overhead travelling cranes, dynamic effects may be considered low if the speed of travelling of both crab and crane or hoist is each less than 100 m, 130 m/minute if the active surfaces of the respective track rails are uninterrupted by gaps or joints. Dynamic effects shall be considered high if the crane or hoist or any part or motion thereof is used for any purpose or in any manner likely to produce greater shock effects than those caused by travelling on steel track rails at the aforesaid speeds.

Dynamic effects may be considered low for mobile cranes or mobile hoists having well-sprung road wheels and travelling at moderate speeds on surfaces not less regular than closely laid decking of sawn timber. Road wheels having approved pneumatic balloon tyres of the 'off-the-road' type may be considered equivalent to well-sprung road wheels.

Dynamic effects shall be considered high for other mobile cranes or mobile hoists.

6.4 The thickness of members made of tubes sealed at the ends shall be not less than 2·5 mm.

7. SLEWING

7.1 A slipping device shall be provided in the slewing mechanism, or other means adopted, in order to protect the structure and mechanism from shock and torque greater than that for which they have been designed.

TABLE 2 MINIMUM THICKNESS INCLUDING THE ALLOWANCE FOR CORROSION

(*Clause* 6.3)

(All dimensions in millimetres)

DESIGN THICKNESS	MINIMUM THICKNESS
(1)	(2)
Up to and including 3·5	5
Over 5 up to but not including 6	6

NOTE — The minimum thickness may be reduced to 3 mm on cranes of up to and including 1 ton maximum rated load capacity.

8. STABILITY

8.1 Stability in Service Condition — The crane shall be so designed that when in any working position and being subjected to a wind pressure of 25 kgf/m^2, the crane would not tip if the load on the hook were assumed to be twice the maximum safe working load.

8.1.1 Where the crane is so designed that the jib can be removed or replaced with the mast erected, the crane shall be stable without the use of blocks or guys throughout these operations.

8.2 Stability During Out-of-Service Conditions — The crane shall be designed to be stable when out-of-service while subjected to a steady maximum wind pressure for different zones as specified in IS : 875-1964* with the jib at the maximum working radius and free to slew. It is permissible to increase the effective span of the supporting base by the use of out-riggers, jacks or blocks, provided that they form a permanent part of the crane structure. Such out-riggers, jacks or blocks shall be constructed so as to permit them to make satisfactory contact with a firm base and provide adequate support.

8.2.1 The effect of fixing a crane to its rails or using of guys shall not be taken into account while calculating stability.

8.2.2 A notice shall be fixed in the cab and on the outside of the crane, clearly visible from the ground, giving instructions on what action shall be taken when the crane is left unattended, with special instructions on procedure when it is left in a position where the jib is prevented from slewing.

8.3 Backward Stability — To ensure adequate backward stability the centre of gravity of the crane shall be not away from the axis of rotation

*Code of practice for structural safety buildings : Loading standards (*revised*).

than 70 percent of the minimum radial distance from the axis of rotation to the backward tipping fulcrum. For this purpose the crane shall be assumed to be at rest on level track, without load and with the jib or trolley at its minimum working radius.

8.4 The weight and position of the ballast required to ensure stability shall be clearly and permanently shown in a prominent position, and adequate provision shall be made for accommodating and, where necessary, securely fixing such ballast.

8.4.1 Devices for anchoring the crane to the rails shall not be taken into account when determining the stability of the crane.

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

9. JIBS

9.1 The jib feet and the members by which they are connected to the mast or tower shall be of steel, except that cast iron may be used for the sole purpose of increasing the pin bearing area.

9.1.1 Diaphragm braces shall be provided for stiffening purposes when the jib is of lattice construction.

9.2 Jib and its attachments shall be designed to withstand the sum of the stresses arising under working conditions including:

a) all stresses due to load,

b) all stresses due to weight of the jib and its attachments,

c) accelerating and retarding forces acting horizontally at the jib head pin due to slewing of the load,

d) accelerating and retarding forces acting horizontally due to slewing of the jib,

e) stresses due to wind pressure of 25 kgf/m^2,

f) accelerating and retarding forces acting vertically and horizontally due to derricking of jib,

g) transverser shear stress due to 25 percent of maximum axis load, and

h) stress due to sudden application of slew and luff brakes.

10. FIXED CANTILEVER

10.1 The bottom boom of the cantilever shall be designed to withstand maximum compressive stresses and bending stresses between panel points.

10.2 The local bending stresses shall be calculated on the assumption of a beam freely supported at the ends and having a span three-quarters of the length between panel points. The bending moment at the panel points shall be assumed to be equal to that at the centre of the panel.

11. TOWERS AND MASTS

11.1 Towers and masts shall be designed to resist the bending, torsional and direct stresses induced therein under all the conditions described in IS : 807-1963*.

12. JOINTS

12.1 Strength of Joints — The calculated strength of riveted joints or joints made by friction grip bolt members shall be not less than the calculated net strength of the member.

12.1.1 The calculated strength of other bolted joints in structural members shall be 25 percent more than the net strength of the member.

12.1.2 The calculated stresses in rivets, bolts and walls shall not exceed the permissible stresses given in IS : 807-1963*. The welded joints shall be designed in accordance with IS : 816-1969†.

12.2 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 before assembly.

12.2.1 The diameter of holes for rivets shall not exceed the nominal rivet shank diameter by more than 1·5 mm. In the case of precision bolts the diameter of holes shall not exceed the nominal bolt shanked diameter by more than 0·5 mm.

12.2.2 Where machined bolts are used in the structure the plain shank part of the bolt shall be sufficiently long to ensure adequate bearing area for the load.

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

12.2.4 Tapered washers shall be used where bolts are employed on tapered surfaces, and tack welded.

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*Code of practice for design, manufacture, erection and testing (structural portion) of cranes and hoists.

†Code of practice for use of metal arc welding for general construction in mild steel (*first revision*).

12.3 Friction Grip Bolts — Friction grip bolts shall comply with IS : 3757-1966* and shall be fitted in accordance with the provisions of IS : 4000-1967†.

NOTE — If, after final tightening, a nut or bolt is slackened off for any reason, the bolt, nut and washer shall be discarded and not used again.

12.3.1 If friction grip bolts are used in joints which require to be disconnected and reconnected during dismantling and erection, the crane shall bear a notice to this effect.

12.4 Spacing of Rivets — The distance between the centres of rivets for stress-bearing parts shall be not less than $2\frac{1}{2}$ times the diameter of the rivet and shall not exceed sixteen times the thickness of the thinnest outside plate or angle. Where two lines of staggered riveting are used in the same angle or flange, the maximum distance between the rivets on each line may be taken as 1·5 times those given above.

12.4.1 The distance between centres of rivets and the sheared or hand flame cut edge of a plate shall be not less than 1·75 times the diameter of the rivet, and between the centre of the rivet and a rolled, machined or machine flame out edge shall be not less than 1·5 times the diameter of the rivet.

12.5 Welding — Welding shall conform to one of the following Indian Standards as applicable:

a) IS : 816-1969‡, and

b) IS : 6227-1971§.

13. SUPPORTS FOR ROTATING PART OF CRANE STRUCTURE

13.1 Rotating part of the crane structure shall be adequately supported and adjustments provided to maintain the desired alignment. Facilities shall be provided for access and lubrication.

14. WIRE ROPES

14.1 Unless otherwise specified or agreed to by the purchaser, wire ropes shall comply with the relevant Indian Standards (*see* Appendix C).

*Specification for high tensile friction grip fasteners for structural engineering purposes.

†Code of practice for assembly of structural joints using high tensile friction grip fasteners.

‡Code of practice for use of metal arc welding for general construction in mild steel (*first revision*).

§Code of practice for use of metal arc welding in tubular structures.

14.1.1 A test certificate of the wire ropes used shall be furnished by the manufacturer with full particulars of construction, breaking and tensile strength and the actual length used.

14.2 The factor of safety based on nominal breaking strength and rated lifted load shall not be less than 5 for Class 1 mechanism and 6 for Class 2 mechanism.

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

14.4 The derricking rope shall be of sufficient length wherever possible to permit the jib head being raised or lowered from ground level to the position during erection or inspection of the crane without the assistance of the hoisting rope.

14.5 The length of the hoist rope should be adequate to permit the jib to be brought to the ground level. In the case of multilayer winding the length of the wire rope should be double than that normally required.

14.6 Reverse bends shall be avoided as far as possible.

15. ROPE DRUMS

15.1 Material for Drums — Drums shall be made of cast iron, cast steel or mild steel conforming to the relevant Indian Standards. The minimum requirement is as follows:

a) Grey cast iron	Grade 20 of IS : 210-1970*
b) Cast steel	Grade 2 of IS : 1030-1962†
c) Mild steel	IS : 226-1969‡ or IS : 2062-1969§

15.2 Diameter of Drums and Pulleys — The diameter of each drum measured at the bottom of the groove shall be not less than that specified in Table 3, for rope speeds not exceeding 60 m/min. It is recommended that larger diameters should be used wherever possible.

15.2.1 For each increase in rope speed of 30 m/min, 5 percent of the basic figure should be added to the diameter of the drum.

15.3 Grooving of Drums — Rope drums shall be machined grooved and the contour at the bottom of the grooves shall be circular over an angle for approximately 120°. The radius of the groove shall be larger than the radius of the rope by not less than an appropriate amount given in Table 4.

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*Specification for grey iron castings (*second revision*).

†Specification for steel castings for general engineering purposes (*revised*).

‡Specification for structural steel (standard quality) (*fourth revision*).

§Specification for structural steel (fusion welding quality) (*first revision*).

TABLE 3 DRUM AND PULLEY DIAMETERS

(*Clauses* 15.2 *and* 16.1)

Rope Construction	Tensile Breaking Strength of Wire	Minimum Diameter of Drums or Pulley Classification of Crane Mechanism	
		Class 1	Class 2
(1)	(2)	(3)	(4)
	kgf/mm²		
6 × 19	160-175	18*d*	23*d*
	175-190	21*d*	27*d*
6 × 24	160-175	16*d*	19*d*
	175-190	18*d*	21*d*
6 × 37	160-175	15*d*	17*d*
	175-190	16*d*	19*d*

NOTE — d = rope diameter.

TABLE 4 RADIUS OF GROOVE IN DRUMS AND SHEAVES

(*Clauses* 15.3 *and* 16.3)

(All dimensions in millimetres)

Diameter of Rope		Increase Over Rope Radius
Over	Up to and Including	
(1)	(2)	(3)
—	16	1·0
16	24	1·5
24	29	2·0
29	—	3·0

15.3.1 The depth of the groove shall be not less than 0·35 times the diameter of the rope.

15.3.2 The grooves of the drum shall be so pitched that there is between adjacent turns of the rope a clearance of not less than:

a) 1·5 mm for ropes up to and including 12 mm diameter,

b) 2·5 mm for ropes over 14 up to and including 29 mm diameter, and

c) 3·0 mm for ropes over 29 mm diameter.

15.3.3 Grooving shall be finished smooth and shall be free from surface defects likely to injure the rope. The edges between the grooves shall be rounded.

15.4 Length of Drum — When the length of the hoisting rope to be wound on and off the drum under service conditions does not exceed 30 m, the drum shall be sufficiently wide to accommodate the rope in one layer. For single layer winding there shall be not less than two dead turns at the anchored end plus a spare groove at the other end in addition to the length of rope required for the specified length. 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 flange and an automatic rope guide capable of laying the rope in proper sequence shall be provided. Rope anchorages shall be readily accessible.

NOTE — Overlapping layers of rope are not recommended.

15.5 Flange — When the rope is fixed at both ends and the fall is from the centre of drum then the drum need not be provided with flange. When, however, the rope falls from one end of the drum, the fall end of the drum shall be flanged. When the rope is fully wound on the drum the flange shall project a distance not less than 2 rope diameter and in no case shall be less than 25 mm.

15.5.1 The provision of **15.5** does not apply if a spur wheel is secured to the drums and so forms one of the flanges.

15.6 The lead angle of the rope shall not exceed 5° (1 in 12).

16. ROPE PULLEYS

16.1 The diameter of pulleys at the bottom of the groove shall be not less than the diameter of the drums specified in Table 3. It is recommended that larger diameters should be used wherever possible.

16.2 The diameter at the bottom of the groove of each non-rotating compensating pulley shall be 9 times the diameter of rope for Class 1 mechanism and 12 times for Class 2 mechanism.

16.3 Rope pulleys shall be grooved to a depth not less than 1·5 times the diameter of the rope. The groove shall be finished smooth and shall be free from surface defects likely to injure the rope. The contour at the bottom of the groove shall be circular over an angle of 130 $\pm$ 5° approximately. The radius of the part of the groove shall be larger than the radius of the rope by not less than the appropriate amount given in Table 4.

16.4 Lead Angle — The angle between the rope and a plane perpendicular to the axis of the pulley shall not exceed 5° (1 in 12).

16.5 Pulleys shall be adequately guarded to retain the rope in the groove.

16.6 Guide pulleys or rollers shall be fitted with the jib and other parts of the structure, where required, for the purpose of preventing chafing of the ropes.

16.7 All pulleys funning loose on their shafts shall be provided with suitable bushes or bearings. Pulleys, where not easily accessible, shall be of the self-lubricating type.

17. LIFTING HOOKS

17.1 Lifting hooks shall comply with the relevant Indian Standards.

17.2 Hooks shall rotate upon ball or roller bearings and, if required, locking device shall be fitted to prevent rotation of the hook.

17.3 The hooks shall be provided with an efficient device to prevent displacement of the sling from the hook.

17.4 The safe working load shall be legibly stamped on a non-vital part of each hook and at the bottom block. A test certificate shall be supplied if required.

18. SHACKLES

18.1 Shackles shall conform to the relevant Indian Standards.

18.2 When the rope on the shackle is eccentric the allowable load shall be reduced depending upon the eccentricity of the load.

18.3 Test certificate shall be provided with each shackle.

19. OVERHAULING WEIGHT

19.1 When an overhauling weight is used on the rope it shall have a smooth bore and be bell-mouthed at the top and bottom unless the rope is efficiently served or otherwise protected, and provision shall be made for the examination of the part of the rope passing through the weight.

20. GEARING AND PAWLS

20.1 Material — All gears and pawls shall be of steel (cast or wrought) with the following exceptions:

a) Spur wheels for slewing, on cranes up to and including 1 tonne maximum rated load capacity, may be of cast iron,

b) Worm wheels may be made with cast iron centres and bronze rims, and

c) Spur wheels may be of cast iron centred with steel rim adequately secured.

20.2 Design — Gears shall be designed in accordance with the relevant Indian Standards.

20.2.1 The slewing race wheel may consist of a pin rack.

20.3 Fixing — Keys in gear trains shall be so fitted and secured that they cannot work loose in service.

20.4 Gear Boxes — Gear boxes shall be so designed that the gears which they enclose will be automatically lubricated; the gears shall be readily removable and the boxes shall be oil-tight as much as is reasonably practicable. They shall be of rigid construction and fitted with inspection covers and lifting lugs where necessary. Facilities for oil filling, adequate breathing, drainage and means of indicating clearly the correct oil levels shall be provided.

20.4.1 Gear box feet shall be machined and shall be seated and positively located on appropriately level surface, preferably machined, except where integral or shaft mounted. Provision should be made for other types of mountings also if used.

20.4.2 Material for the gear box shall either be cast iron, cast steel or mild steel fabricated. The material shall conform to the relevant Indian Standards (*see* Appendix C).

Gear box, if fabricated, shall be stress relieved.

20.5 Where worm gearing is used as a first-motion drive it shall have, under test, the same load and time rating as the driving motor and the temperature rise of the oil bath when measured by a thermometer shall not exceed 40°C above the temperature of the atmosphere.

21. SHAFTS AND AXLES

21.1 Shafts and axles shall have ample strength and rigidity and adequate bearing surfaces for their purposes. They shall, where necessary, be finished smoothly and, if shouldered, shall be provided with fillets of as large a radius as possible.

21.2 Shafts shall be made of steel of suitable quality.

21.3 Shaft Keys — Where practicable, keys, keyways and splines shall conform to the relevant Indian Standards. Splines shall be accurately machined. Use of tapered keys shall be avoided as far as possible.

22. LUBRICATION

22.1 Lubrication of Bearings Including Ball and Roller Bearings — All lubrication points shall be readily accessible. Gear trains shall be properly lubricated.

22.2 Centralized lubrication may be provided if required by the purchaser (*see* Appendix B). In this case provision shall be made at the bearings to vent excess lubricant pressure.

22.3 Lubricating nipples, pipes, and adopters shall generally comply with the relevant Indian Standards.

22.4 A lubricating chart in the maintenance manual shall be provided indicating all the lubricating points, the type of lubricant and recommended frequency of lubrication.

22.5 Grease lubricated ball and roller bearings shall in addition be packed with grease during initial assembly.

23. TRACK WHEELS

23.1 Track wheels may have cylindrical or tapered (conical) treads, with flanges or any other means, as and where necessary, to guide the crane effectively and to prevent derailment. The wheels shall be mounted in such a manner as to facilitate removal and replacement.

23.2 Material — Track wheels shall be of steel (cast or wrought) or shall have steel tyres shrunk-on cast iron or steel centres and registered.

23.2.1 The steel shall be medium carbon steel (0·6 percent carbon *Max*) and the hardness at the tread shall be between 300-350 *HB*.

NOTE — On request, the manufacturer shall supply the analysis of each cast for contents of carbon, silicon, manganese, sulphur and phosphorus.

23.3 Diameter of Wheels — The tread diameters of wheels shall preferably be standardized to sizes specified in IS : 1136-1958* commencing at 150 mm, in the order of preference specified therein.

The minimum tread diameter of the wheel may be calculated from the formula given below:

$$D = \frac{1{\cdot}5\ W}{a}$$

where

D = tread diameter of wheel in millimetres,

W = wheel load in kilograms, and

a = full width of rail head including radii in millimetres.

*Preferred sizes of wrought metal products.

23.4 Flanges — The dimensions of flanges of track wheels shall be not less than the values given in Table 5.

TABLE 5 FLANGE DIMENSIONS

(All dimensions in millimetres)

Diameter of Wheels		Depth of Flange	Thickness of Guiding Wheel Flange at Base
Over	Up to and Including		
(1)	(2)	(3)	(4)
—	300	15	15
300	500	20	20
500	1 000	25	25
1 000	—	30	30

23.4.1 The thickness of flanges of non-guiding wheels if flanged may be less than the values given in Table 5 to be determined by the crane manufacturer.

23.5 Width of Tread — The width of the wheel tread shall be greater than the rail head by an amount which shall suitably allow for the known variations in the gantry rail alignment and gantry track span dimensions.

24. CRANE ANCHORING

24.1 Means other than the normal travelling brake shall be provided to prevent the movement of the crane along its track when left unattended or under storm conditions at fixed points on the track. It should be possible to operate this device from ground level. Rail clamps should be provided in addition to anchoring device for fixing the crane at intermediate points on the track. These clamps should be electrically interlocated with travelling mechanism.

25. GUARDING

25.1 Effective guards shall be provided for gear wheels, belt and chain drives, revolving shafts, fly-wheels, couplings, collars, projecting set screws, bolts or keys on any revolving shaft, wheel or pinion, unless those parts are made safe by design or by position or are effectively guarded by parts of the crane structure.

25.2 Design — The guard may be of sheet metal, perforated or expanded metal wire mesh, wood, pressed fibre, or other suitable material and shall

completely encase the parts concerned. The guards should be designed to allow for routine inspection and maintenance work.

25.2.1 The guard shall be constructed of material suitable to withstand the atmospheric conditions in the situation in which the guards are to be used, and shall be sufficiently rigid to resist distortion.

25.2.2 The guard shall be securely attached to a fixed support.

25.3 Thickness — The thickness of metal guard shall not be less than 1 mm and of wooden guards 18 mm.

NOTE — An increased thickness, or the use of corrosion resisting material, is desirable in damp and corrosive atmosphere.

25.4 Size of Openings and Clearance — The minimum clearance between the guard and the moving parts, and the size of opening in guards of perforated metal, woven wire, metal lattice of similar material shall be in accordance with the following requirements:

Size of Opening		*Minimum Clearance*
Over	Up to and Including	
mm	mm	mm
—	10	22
10	12	50
12	32	100
32	40	125

26. LADDERS AND PLATFORMS

26.1 Safe means of access shall be provided to the driver's cabin and to every place where any person engaged on the inspection, repair or lubrication of the crane, has to work; adequate hand-holds and foot-holds being provided where necessary. In particular:

a) a permanent steel ladder shall be provided for access to the top of the mast or tower, and the jib;

b) every platform shall be securely fenced with guard rails and toe boards;

c) sides of ladders shall extend to a reasonable distance beyond platforms, or some other reliable hand-hold shall be provided;

d) where a ladder is vertical and exceeds 10 m in height, it is recommended that intermediate resting places shall be provided between the platform and the foot of the ladder so that, where possible, uninterrupted lengths of the ladder do not exceed 10 m; and

e) it is recommended that vertical ladders, external to the structure, should have back-loops.

27. OPERATOR'S CABIN AND MACHINERY HOUSE

27.1 An operator's cabin having a clear height of 2 m shall be provided to afford the driver adequate protection from the weather; it shall allow a clear view of the load and jib in all possible positions while sitting. A seat shall be provided for the driver.

27.2 The means of access to the cabin shall be such as to ensure that there is no danger to the driver being trapped in the cabin. There should also be a separate exit for emergency use. Where access is through the floor, there should be sufficient room in the cabin for the driver to stand besides the trap and raise it without difficulty, and the trap door shall be of adequate size.

27.2.1 A fan, fire extinguisher, a gang or hooter shall be provided in the operator's cabin.

27.3 Cab — Control levers and pedals shall allow the driver, when in his normal driving position, ample room for operation. It shall afford as far as possible an unrestricted view of load and adequate all-round visibility.

27.4 If the vertical position of the control cabin is adjustable, the means of access and exit shall be effective at all levels. Means shall be provided for supporting the cabin without imposing a load on the cabin hoisting rope and if the hoisting mechanism for the cabin is hand-operated, an effective sustaining arrangement shall be provided.

27.5 The door of the cabin shall be fitted with a lock to prevent unauthorized entry when the crane is left unattended.

27.6 In the case of non-rotating cabins the operator's seat and controls should be mounted as a revolving platform.

28. BRAKE

28.1 Hand brakes, foot brakes, or electro-mechanical brakes shall be provided for the hoisting and derricking motions, and shall be designed to exert a restraining torque 25 percent greater than the torque transmitted under service conditions to the brake drum from the suspended safe working load, neglecting the losses in the transmission mechanism between the load and the brake.

28.2 The stresses in any part of the brake construction while such a restraining torque is being exerted shall not exceed one half of the stresses allowed for the material by this standard.

28.3 The temperature of the rubbing surfaces of the brake shall not exceed 100°C with fabric lining or 200°C with bonded asbestos or metal lining

after the safe working load has been raised and then lowered on the brake five times continuously through the specified lift, the speed of lowering being 25 percent greater than that of lifting.

28.4 The brakes, when of the electro-mechanical type, shall begin to apply the braking torque immediately the current is cut off from any cause during the effective life of the lining. A dashpot or other means may be provided to prevent shock.

28.5 A suitable brake or braking arrangement shall be provided for the travelling motion.

28.6 A suitable brake shall be provided for the slewing motion.

28.7 Weights — Brake weights whenever used shall be bolted securely to their levers and locked.

28.8 Brake Drums and Shoes — The wearing surface of all brake drums shall be machined and shall be cylindrically smooth and free from defects. Brake drums shall preferably be balanced. The hardness of the brake drums shall be 200 BHN.

28.9 Brake blocks and lining shall be protected from the action of water, grease and oil as far as possible. Braking linings shall be effectively and permanently secured during the effective life of the lining.

28.10 Adjustment — Brakes shall be provided with a simple and accessible means of adjustment to compensate for wear and removal for relining.

28.11 Where more than one lowering brake is provided, each brake shall be capable of exerting the full braking torque specified in **28.1** and shall be independently operated.

28.12 Brakes applied by hand shall not require a force greater than 15 kgf at the handle. Brakes applied by foot shall not require a force of more than 30 kgf on the pedal to exert the restraining torque referred to in **27.1**.

28.13 Locking Device — An automatic locking device capable of sustaining 50 percent above the safe working load shall be provided on a hand- or foot-operated brake.

28.14 An emergency holding brake shall be fitted in the load side when a change speed gear is fitted.

29. ELECTRODYNAMIC BRAKING

29.1 Where motions are driven by separate electric motors, electrodynamic braking is permissible to supplement the requirements of **27**.

29.2 Where electrodynamic braking is adopted, the conductors and the contact surfaces of the motor and the control gear shall be proportioned in a manner such that the additional duty will not cause them to overheat.

NOTE — Care should be taken not to confuse the electromechanical brake with the electrodynamic one. Although the former is often referred to as an automatic electric brake its action is mechanical and the braking effect is nullified electrically by a solenoid or electromagnet, or electrohydraulic thruster.

30. BRAKE MAGNETS

30.1 The terminals of brake magnets shall be protected from accidental contact and the windings shall be effectively protected from mechanical damage. Where necessary the magnets shall be provided with an efficient cushioning device.

30.2 Two types of duty are recognized for both ac and dc magnets, namely:

a) continuous or heavy duty, and

b) normal duty.

Since with an ac brake magnet the current in the coil is greater for the open position than for the closed, the ratings for ac are slightly different from dc as shown in Table 6.

TABLE 6 BRAKE MAGNET RATINGS

DUTY	dc MAGNETS	ac MAGNETS
(1)	(2)	(3)
Heavy duty	Suitable for being in circuit not more than 7·5 minutes out of every 15 minutes or 240 operations per hour	Suitable for being in circuit continuously where the brake coil operates in frequently For 240 operations per hour where the time that the brake coil is in circuit is not more than 5 minutes out of every 15 minutes
Normal duty	Suitable for 240 operations per hour where the time that the brake coil is in circuit is not more than 5 minutes out of every 15 minutes	Suitable for 240 operations per hour where the time that the brake coil is in circuit is not more than 5 minutes out of every 15 minutes

30.3 The brake magnets shall operate, for both duties, at the currents and voltages given in Table 7.

TABLE 7 BRAKE MAGNET OPERATING CURRENTS AND VOLTAGES

WINDING	dc MAGNETS	ac MAGNETS
(1)	(2)	(3)
Series:		
Series resistor control	Lift at 60 percent full load current	—
	Hold at 20 percent full load current	—
Potentiometer control	Lift at 40 percent full load current	—
	Hold at 20 percent full load current	—
Shunt	*Lift at 90 percent normal voltage	*Lift at 90 percent normal voltage
	*Hold at 50 percent normal voltage	*Hold at 50 percent normal voltage

NOTE 1 — Motor operated or electro-hydraulic brake releasing gear may be used in preference to brake magnets if desired.

NOTE 2 — Where 3-phase motors are used the associated brake magnets should also be of the 3-phase type.

*This is intended to apply with hot coils corresponding to the duty cycle at normal voltage. The temperature rise of the brake magnet shall not exceed that allowed for the control equipment fitted [*see* IS : 1822-1967 'Specification for ac motor starters of voltage not exceeding 1 000 volts (*first revision*)'].

31. CONTROLS

31.1 All control handles and pedals shall be placed in convenient positions, which will allow the driver ample room for operation and admit a clear view of the resultant load movement. Controls shall be adequately protected to prevent accidental contacts with live parts.

31.2 The position of controls shall be such that when the driver is intentionally operating any control handle, he cannot readily operate any other control inadvertently.

31.3 The control levers shall be provided with stops and/or catches to ensure safety and facility of operation. Each control shall bear an indelible indication of the motion controlled and, wherever practicable, the direction of movement.

31.4 Where practicable, controller handles should move in the direction of the resultant load movement. Each controller shall be marked in a permanent manner to show the motion controlled and, wherever practicable, the direction of movement.

31.5 The control handles or pedals for the manual- or foot-operated brakes on the hoisting, derricking and slewing motions shall be so placed that the driver, when in his normal position, can operate them promptly.

31.6 Notching — Notching for the controller handle in the 'OFF' position shall be more positive than the notching in the other position. The handle may be provided with a lock, latch, dead man or spring return feature if specially requested by the customer.

32. MANUAL POWER

32.1 For power-driven cranes fitted with hand-operated mechanism on any motion, it shall be assumed that an operator, when turning a handle, exerts a mean force of 12 kgf continuously or 18 kgf as a maximum upon the handle and that the mean speed (at handles) is 45 m/min.

32.1.1 The changeover from power drive to hand drive should be electrically interlocated.

32.2 Handles shall be conveniently placed and it shall be assumed that not more than two operators, each exerting the effort described above, will operate any handle while the maximum load is being carried.

33. INTERNAL COMBUSTION ENGINES

33.1 Internal combustion engines shall comply with relevant Indian Standards on the 1-hour basis, and a silencer shall be fitted to the exhaust. The exhaust pipe shall be fitted in such a position that the exhaust fumes of the engine do not reach the driver. Fuel tank capacity shall be sufficient for at least 8 hours running on normal crane duty, and means shall be provided for ascertaining the amount of fuel contained in the tank.

33.2 When required by the purchaser, a spark-arrestor shall be fitted to the silencer.

33.3 The sump and lubrication system of the engine shall be so arranged that efficient lubrication is maintained to all bearings when the engine is operating in any plane inclined at an angle of 1 in 4 to the horizontal.

33.4 Provisions shall be made for draining off the water circulating system during frosty weather, the drain cocks being fitted in accessible position. The arrangement shall be such that it is not possible to leave pockets of water either in the system or the pump casing.

34. GENERATORS AND MOTORS

34.1 Ratings and Enclosures — The ratings shall be such that, under the specified service conditions, the temperature rise shall not exceed the limits specified in IS : 325-1970* for 3-phase induction motors or other relevant Indian Standards. This shall not preclude use of intermittent rated motors, if required.

34.1.1 The generators and motors shall be totally enclosed surface cooled or totally enclosed fan cooled type and whenever required shall be weather-proof.

34.2 Motors shall be suitable for reversing frequent acceleration and braking.

34.2.1 If it is intended to retard or stop the motion of a crane by electric braking, the motor shall be of suitable design to withstand this duty.

34.3 Mountings — Generators and motors shall be so located that the brush-gear and terminals are accessible for inspection and maintenance and normal ventilation is not restricted.

34.3.1 Test certificates shall be supplied if required by the purchaser.

34.4 Terminals — Generator and motor leads shall be brought out from the frame to terminals in the terminal box fixed to the frame.

35. CONTROLLERS AND RESISTORS

35.1 Controllers and resistors for direct current motors and alternating current slip ring induction motors shall comply with the requirements of IS : 1822-1967† except that, where series resistor control is used that is where there are no special slow-motion connections, the current with the hoisting controller at the first step shall not (unless otherwise specified) exceed 75 percent of that at full load, in the case of hoisting motors above 10 hp. For hoisting motors up to and including 10 hp the current with the hoisting controller at the first step shall not exceed full load current.

35.2 Unless otherwise specified, the current on the first step of the slewing controller (or the derricking controller) shall not exceed full load current.

35.3 The controllers and resistors shall be adequately protected to prevent accidental contract with live parts, and shall be so rated that the temperature rise does not exceed the limit specified in IS : 1822-1967† during the operation of the crane under service conditions.

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*Specification for three-phase induction motors (*third revision*).

†Specification for ac motor starters of voltage not exceeding 1 000 volts (*first revision*).

35.4 Resistors shall be so arranged that they are easily accessible for adjustment, examination and replacement.

35.5 A manually-operated main current controller when in the 'OFF' position shall disconnect all supply leads to the associated motors unless otherwise specified.

35.6 Each controller shall have mounted inside its cover a complete circuit diagram in durable form.

NOTE 1 — It is recommended that the resistors should be enclosed in ventilated housings and, where necessary, with sheet metal covers and that each resistor should be fitted with a terminal bar unless all terminals are brought out on one side of the resistor. The terminal bars shall be fitted in any case where the current rating is above 100 A.

NOTE 2 — In the working instructions to the crane driver it is desirable to mention that when heavy loads are being lifted the first step of the controller should be regarded as a transition notch.

36. ELECTRICAL PROTECTIVE GEAR

36.1 Iron-clad protective gear shall be provided as under:

a) When the aggregate horsepower of the two largest motors is less than 40 (or their aggregate current is less than 60 A), a manually-operated switch-fuse panel which is easily accessible may be used, and the minimum equipment on this panel shall be a main switch in association with high-rupturing capacity replaceable fuses for each motor. The number of poles in the main switch, and the number and position of fuses in the motor circuits shall be in accordance with Indian Electrical Rules or as may be otherwise directed by the purchaser.

b) When the aggregate horsepower of the two largest motors is 40 hp (or more or their aggregate current 60 A or more), a protective panel of the contactor type shall be provided and the minimum equipment on such a panel shall be as follows:

An airbreak, contactor type main circuit-breaker, together with magnetic type overload relays for each of the several motor circuits. The number of poles in the circuit-breaker and number and position of overload relays fitted shall be in accordance with Indian Electrical Rules for the protection of motors on ac or dc supplies, or as may be otherwise directed by the purchaser. A double-pole switch-fuse for controlling the operating coil circuit of the contactor shall be provided. A push button emergency stop shall be so placed that it can be used promptly in all cases by the operator for cutting off the main supply.

36.2 The main circuit-breaker shall be electrically interlocked with the controllers in such a way as to prevent the circuit-breaker being closed, unless all controllers are in the ' OFF ' position.

36.3 In case of ac 3 phase supply, single-phase preventors shall be provided to protect the motor in case of single phasing.

36.4 A diagram, in durable form, of connections of the protective panel shall be fixed to the inside of the cover.

37. ISOLATING SWITCH

37.1 For each electric crane which is supplied from an electric supply external to the crane an iron clad isolating switch shall be provided as close as possible to the crane end of the trailing cable through which the supply is brought to the crane. The isolating switch shall be fixed on the crane structure in such a position that it can be operated readily from ground level and the cover shall be interlocked with the switch so that it can be opened only when the switch is in the ' OFF ' position.

37.2 When the isolating switch is combined with the crane protective panel it shall be mechanically interlocked with the door giving access to the panel, and the incoming terminals shall be screened to prevent accidental contact when the door is opened. When not so combined a red label plate shall be attached to the cover of the protective panel, marked ' ISOLATE BEFORE OPENING COVER '.

38. LIMIT SWITCHES

38.1 Limit switches shall be provided to prevent the following:

a) Over-hoisting,
b) Over-lowering,
c) Over-derricking in both directions,
d) Over-traversing, and
e) Over-travelling.

38.2 The contacts of limit switches shall be operated positively; switches in which the contracts are operated by a spring or gravity or both, on the withdrawal of a cam or similar device, shall not be used.

39. CABLE WIRING FOR POWER CIRCUIT

39.1 Cables — Rubber and polyvinyl chloride-insulated cables used for crane wiring should comply with the relevant Indian Standards (*see* Appendix C).

39.2 Protection — All cables shall be adequately protected against mechanical damage and metal trunking may be used if desired. Cable conduits shall comply with relevant Indian Standards (*see* Appendix C). If cables are drawn into a steel tube, the steel tube shall be heavy gauge welded or solid drawn screw joined.

39.3 Multicore Cables — Multicore power and control cables suitably clamped to the crane structure may be used. Suitable clamping glands should be provided at both ends of each multicore cable.

39.4 Current Rating — Ratings of the cables shall comply with the relevant Indian Standards. Where cranes are equipped with 1-hour rated motors, the stator or armature cables may be uprated by a factor of 1·4 above the ratings for continuous duty. Similarly, for cranes equipped with 0·5-hour rated motors, an uprating factor of 1·7 may be used. Where the cranes are equipped and intermittent duty rated motors, the factor for uprating the cable will be equal to $\sqrt{\frac{100}{IDF}}$ where *IDF* is the intermittent duty factor of the motor.

39.4.1 The cables for rotor or armature resistor circuits carry current during accelerating periods only and may, therefore, be further uprated. For 5-minutes rated resistors, the uprating factor of 2 may be used. For intermittent rated resistors, suitable uprating factors may also be applied.

39.4.2 Consideration should be given to such factors as the ambient temperature, grouping and disposition of the cables, and to the limitation of voltage drop, which will influence selection of suitable cables.

40. MAIN SUPPLY

40.1 The main supply may be obtained by flexible cable from plug boxes or fixed supply points.

40.2 Where flexible cables are liable to be run over by traffic, manually- or automatically-operated take-up gear shall be provided.

40.3 Where the power is supplied through a trailing cable, the cable should be so supported (where it terminates) that there is no appreciable mechanical strain on the electrical connections or the cable.

41. WIRING DIAGRAM

41.1 A wiring diagram of the crane shall be provided. On this diagram shall be given the rating of each of the motors, the cable sizes and such other information as tends to facilitate inspection and maintenance of the crane.

42. LIGHTING

42.1 Where provision is made for the connection of a handlamp, the voltage of the supply to the lamp shall not exceed 250 V dc or 25 V ac either between conductors or to earth. When the supply is ac the handlamp circuit shall be fed through a double-wound transformer with some part of the secondary winding earthed.

42.2 Where fixed lighting is required by the purchaser and where the lamps are arranged in series, double-pole switching shall be provided for each lamp circuit.

42.3 Safety Device — A load moment switch should be provided for limiting the moment developed by the lifted load.

42.3.1 An anemometer with electrically interlocating shall be provided to restrict the operation of the crane beyond the designed wind velocity.

42.3.1.1 Warning lamps for air traffic should be installed.

43. EARTHING

43.1 The crane structure, motor frames and metal cases of all electrical equipment, including metal conduit or cable armouring or guards, shall be efficiently bonded to facilitate earthing, and an earthing terminal shall be provided.

43.2 An earthing conductor shall be provided and a collector ring if electrical connection is required between the fixed and rotating structure of the crane.

44. TESTING

44.1 The insulation resistance of any circuit shall be not less than 2 MΩ.

44.2 Before it is put into service the tests given in Table 8 and such other tests as may be required by statutory regulations shall be applied to the crane on a level track, and a certified record of the test figures shall be supplied to the purchaser.

44.2.1 If required by the purchaser, the manufacturer shall carry out a test to verify under agreed conditions the stability as specified in **8.**

44.2.2 The setting of all load and/or radius indicators, where provided, shall be verified during the tests. This requirement shall also apply to cutouts and limit switches, where fitted.

44.3 The tests shall be carried out at a place to be agreed upon between the purchaser and the manufacturer, and when conducting acceptance tests the manufacturer shall be entitled to employ his own crane driver.

TABLE 8 TESTS

(*Clause* 44.2)

Test No.	Hoisting	Derricking or Traversing	Slewing	Travelling	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
1a	With the hook carrying the maximum S.W.L. appropriate to each speed, between the minimum and the maximum radii appropriate thereto.	Loads and radii as Test 1a (Col 2). The load is to be carried in both directions through the full range of derricking or traversing appropriate to the S.W.L.	Loads and radii as Test 1a (Col 2). Slewing motion to be tested in both directions, through the maximum angle for which the crane is designed to slew.	Loads and radii as Test 1a (Col 2). Travelling motion to be tested in both directions and with jib pointing fore and aft and at right angles to direction of travelling.	The speeds enumerated in Appendix B shall be substantially as specified.
1b	With the hook carrying the S.W.L. at the maximum radius.				
2a	With the hook carrying a load of 25 percent in excess of the S.W.L. between the minimum and the maximum radii appropriate thereto.	Loads and radii as Test 2a (Col 2). The load to be carried in both directions through the full range of derricking appropriate to the S.W.L.	Loads and radii as Test 2a (Col 2). Slewing motion to be tested in both directions through the maximum angle for which the crane is designed to slew.	Loads and radii as Test 2a (Col 2). Travelling motion to be tested in both directions and with jib pointing fore and aft and at right angles to direction of travelling.	During these tests the specified speeds need not be attained but the crane shall prove itself capable of dealing with the overload without difficulty. Not more than one cycle shall be performed with each overload which need not be lifted to a height greater than that necessary to bring load on to all the teeth of the gears.
2b	With the hook carrying a load of 25 percent in excess of the				

44.4 The requirement that the contract speeds of electric cranes shall be attained is contingent on the voltage and frequency of the electric supply, and the motors being correctly maintained.

45. PAINTING

45.1 Before despatch of the crane the complete crane covering structural, mechanical and electrical parts shall be thoroughly cleaned of all dirt, grease, scale and rust, and then given a single coat of primer. Mechanical and electrical components shall be given an additional finish coat of paint of colour of customer's choice. The exposed mechanical parts of the crane shall be given one coat of rust preventor.

45.2 Wood and metal surfaces bolted or riveted together shall be painted before assembly.

APPENDIX A

(*Clause* 0.3)

INFORMATION TO BE SUPPLIED WITH THE ENQUIRY OR ORDER

1. Type of Crane and Nature of Drive — electric, steam, or internal combustion engine (petrol or diesel).

2. Nature of Electricity Supply — ac or dc voltage, frequency in hertz, number of phases and number of wires, and

   a) Any local bye-laws that affect supply;
   b) Type and position of conductors or plug boxes;
   c) Are plug boxes to be supplied by purchaser?;
   d) If cable drum is required, state whether automatic or hand-operated; and
   e) Types and rating of motors (*see* IS : 325-1970*).

3. Capacity of Crane:

   a) Maximum safe working in tonnes at ..... m radius, and
   b) Safe working load in tonnes at maximum radius ..... m.

4. Maximum height of lift ..... m at ..... m radius

   Minimum height of lift .....m at ..... m radius

5. Working depth (below rail level) ..... m at ..... m radius.

*Specification for three-phase induction motors (*third revision*).

6. Speeds — Any special requirements should be indicated.

7. Additional specifications, surveys or statutory requirements to be complied with:

a) General,
b) Ropes and rope attachments, and
c) Electrical equipment (including heaters, limit switches, etc).

8. Type of work for which crane is intended.

9. Other requirements such as maximum tail radius and clearance under jib or cantilever together with sketches.

10. Nature of track on which crane is to run, if existing:

a) Distance between centres of track rails,
b) Weight and type of rails (heads proud or flush with ground),
c) Complete specification for rails and the method of fixing,
d) Maximum permissible wheel load, and
e) Radius of sharpest curve, if any.

11. If the crane is to be erected on site by manufacturer, and facilities available.

12. Any special local conditions under which the crane would have to operate for example extreme temperatures, corrosive atmospheres, high altitudes and exposed sites.

APPENDIX B

(*Clauses* 0.3, 22.2, and *Table* 8)

INFORMATION TO BE SUPPLIED BY THE MANUFACTURER

1. Type Offered — Drawing number.

2. Capacity of Crane — Loads and radii range of lift, above and below rail level.

3. Clearances required by crane structure for all positions of jib:

a) Jib length, and
b) Angle of slew.

4. Speeds:

	Speed in m/min at Safe Working Load of ..... tonnes
a) Hoisting, slow gear	....
b) Hoisting, fast gear	....
c) Slewing	....
d) Derricking or traversing	....
e) Travelling	....

5. Electric motors:

a) Particulars of power supply required;
b) Number of motors, type and enclosure;
c) B.H.P. and speed of motors at full load;
d) Class of rating, and limits of permissible temperature-rise (*see* IS : 325-1970*);
e) Maximum current demand from mains; and
f) Particulars of control gear, resistors and other equipment.

6. Internal combustion engines:

a) Make and type,
b) B.H.P. and speed,
c) Number of cylinders,
d) Two or four stroke,
e) Nature of fuel,
f) Cooling system, and
g) Method of starting.

7. Mechanical specification including brakes, gearing and bearings.

8. Travelling wheels:

a) Type,
b) Material,
c) Tread diameter, and
d) Width of tread.

*Specification for three-phase induction motors (*third revision*).

9. Ropes:

	Hoisting	*Derricking or Traversing*	*Other Ropes*
Number of falls	...	...	...
Quality of material	...	...	...
Description of wire	...	...	...
Construction	...	...	...
Diameter	...	...	...
Specified breaking strength	...	...	...
Factor of safety	...	...	...

10. Hook particulars.

11. Type of driver's cabin and machinery house.

12. Type of indicating and safety devices.

13. Tools and accessories supplied.

14. Approximate total weight, excluding ballast, in tonnes.

15. Weight of heaviest part, in tonnes.

16. Ballast, if any, to be supplied by
    Manufacturer: ... ... tonnes of material ... ...
    Purchaser: ... ... tonnes of material ... ...

    Details of size and construction should be supplied if necessary.

17. Method of transport and maximum dimensions of components.

18. Crane track (*see* also Appendix D):

    a) Distance between rail centres, or gauge,
    b) Rail section,
    c) Maximum load per wheel under service conditions,
    d) Minimum radius or radii of curve(s) at centre line of track,
    e) Increment on the gauge on curves,
    f) Minimum length of track and space required for erection of crane, and
    g) Maximum unit load under out rigger should be specified.

19. Manufacturer's comments on any information provided at 12 above.

APPENDIX C

(*Clauses* 3.1, 14.1, 20.4.2, 39.1 *and* 39.2)

LIST OF RELEVANT INDIAN STANDARDS AND CODES OF PRACTICE FOR MATERIALS AND EQUIPMENT

C-1. MATERIALS

C-1.1 Ferrous Materials

IS : 210-1970 Specification for grey iron castings (*second revision*).

IS : 226-1969 Specification for structural steel (standard quality) (*fourth revision*).

IS : 961-1962 Specification for structural steel (high tensile) (*revised*).

IS : 1030-1962 Specification for steel castings for general engineering purposes (*revised*).

IS : 1387-1959 General requirements for the supply of metals and metal products.

IS : 1875-1961 Specification for carbon steel, bars, billets, blooms and slabs for forgings.

IS : 2062-1969 Specification for structural steel (fusion welding quality) (*first revision*).

C-1.2 Bolts and Nuts

IS : 1363-1967 Specification for black hexagon bolts, nuts and lock nuts (dia 6 to 39 mm) and black hexagon screws (dia 6 to 24 mm) (*first revision*).

IS : 1364-1967 Specification for precision and semi-precision hexagon bolts, screws, nuts and lock nuts (dia range 6 to 39 mm) (*first revision*).

IS : 1367-1967 Technical supply conditions for threaded fasteners (*first revision*).

C-1.3 Wire Ropes

IS : 2266-1970 Specification for steel wire ropes for general engineering purposes (*first revision*).

IS : 2365-1963 Specification for steel wire suspension ropes for lifts and hoists.

IS : 3973-1967 Code of practice for selection, installation and maintenance of wire ropes.

C-2. MECHANICAL AND FABRICATION DETAILS

C-2.1 Keys and Keyways

IS : 2048-1962 Specification for parallel keys.

IS : 2291-1963 Specification for tangential keys and keyways.

IS : 2292-1963 Specification for taper keys and keyways.

IS : 2293-1963 Specification for gib-head keys and keyways.

IS : 2294-1963 Specification for woodruff keys and keyslots.

C-2.2 Welding

IS : 816-1969 Code of practice for use of metal arc welding for general construction in mild steel.

IS : 818-1968 Code of practice for safety and health requirement in electric and gas welding and cutting operations.

IS : 1024-1968 Code of practice for welding of structures subject to dynamic loading.

IS : 1323-1966 Code of practice for oxy-acetylene welding for structural work in mild steel (*revised*).

C-2.3 Gears

IS : 2467-1963 Notation for toothed gearing.

IS : 2535-1969 Specification for basic rack and modules of cylindrical gears for general engineering and heavy engineering (*first revision*).

C-2.4 Rivets

IS : 1929-1961 Specification for rivets for general purposes (12 to 48 mm dia).

C-3. ELECTRICAL DETAILS

C-3.1 Motors

IS : 325-1970 Specification for three-phase induction motors (*third revision*).

IS : 900-1965 Code of practice for installation and maintenance of induction motors (*revised*).

C-3.2 Cables and Conductors

IS : 434 (Part I)-1964 Specification for rubber-insulated cables: Part I With copper conductors (*revised*).

IS : 434 (Part II)-1964 Specification for rubber-insulated cables: Part II With aluminium conductors (*revised*).

IS : 693-1965 Specification for varnished cambric insulated cables (*revised*).

IS : 694 (Part I)-1964 Specification for PVC insulated cables (for voltages up to 1 100 V) : Part I With copper conductors (*revised*).

IS : 694 (Part II)-1964 Specification for PVC insulated cables (for voltages up to 1 100 V) : Part II With aluminium conductors (*revised*).

IS : 1596-1970 Specification for polythene insulated and PVC-sheathed cables (*first revision*).

IS : 1753-1967 Specification for aluminium conductors for insulated cables (*first revision*).

C-3.3 Conduits

IS : 1653-1964 Specification for rigid steel conduits for electrical wiring (*revised*).

IS : 2509-1963 Specification for rigid non-metallic conduits for electrical installations.

C-3.4 Switchgear

IS : 1822-1967 Specification for ac motor starters of voltage not exceeding 1 000 volts (*first revision*).

IS : 2147-1962 Degrees of protection provided by enclosures for low-voltage switchgear and control gear.

C-4. GENERAL CODES

C-4.1 Definition

IS : 5522-1969 Glossary of terms for cranes.

C-4.2 Codes of Practice

IS : 807-1963 Code of practice for design, manufacture, erection and testing (structural portion) of cranes and hoists.

IS : 3177-1965 Code of practice for design of overhead travelling cranes and gantry cranes other than steel work cranes.

IS : 4137-1967 Code of practice for heavy duty electric overhead travelling cranes including special service machines for use in steel works.

IS : 4573-1968 Code of practice for design of mobile cranes (all types).

IS : 4594-1968 Code of practice for design of portal and semi-portal wharf cranes (electrical).

APPENDIX D

(*Clause* 5.3)

TRACK FOR TOWER CRANES

D-1. As the track is of extreme importance to the safe operation of the crane, it is strongly recommended that each track should be designed by a competent person and regularly inspected.

D-1.1 The track should be level and should be secured to foundations or sleepers of strength and spacing adequate to take the maximum applied wheel pressure, and designed to suit the safe allowable bearing pressure on the ground.

D-2. It is further recommended that the following instructions should be included in the manufacturer's instruction book:

'At least one rail of the track should be electrically bonded at each joint by means of a copper tape or wire having a minimum cross-sectional area of 64 mm^2. This rail of the track should be effectively earthed.'

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

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Printed at Simco Printing Press, Delhi, India