Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

Indian Standard

JIB CRANES — CODE OF PRACTICE

ICS 53.020.20

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002
FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Cranes, Lifting Chains and Its Related Equipment Sectional Committee had been approved by the Mechanical Engineering Division Council.

This standard covers mechanical and electrical aspects related to design, manufacture, erection and testing of the jib cranes required for the shop floor and general workshop applications like pillar, wall bracket jib cranes including moving cantilever wall cranes.

There is no ISO/IEC Standard on the subject. This standard has been prepared based on indigenous manufacturers data/practices prevalent in the field in India.

The new classifications of cranes now coming into effect as per IS 13834 (Part 1) : 1994 ‘Cranes — Classification: Part 1 General’ and the classification presently in use can approximately be compared as follows:

<table>
<thead>
<tr>
<th>Old Classification</th>
<th>New Classification as per IS 13834 (Part 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>M 1</td>
</tr>
<tr>
<td>II</td>
<td>M 4</td>
</tr>
<tr>
<td>III</td>
<td>M 6</td>
</tr>
</tbody>
</table>

Classification of jib cranes of each mechanism shall be determined in accordance with IS 13834 (Part 4) : 1993 ‘Cranes — Classification : Part 4 Jib cranes’ limited to M6 (old class III) only.

For ease of reference this standard has been divided into four sections as follows:

- Section 1 Mechanical aspects
- Section 2 Structural aspects
- Section 3 Electrical requirements
- Section 4 Inspection and testing

The Indian Standards listed in Annex A are necessary adjuncts to this standard.

The composition of the Committee responsible for formulation of this standard is given at Annex E.
1 SCOPE
This Code covers mechanical, electrical inspection and testing requirements relating to the design, manufacture and erection of stationery swiveling jib cranes of all types for shop floor and general purpose applications.

2 REFERENCES
The standards listed below contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<table>
<thead>
<tr>
<th>IS No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>325:1996</td>
<td>Specification of three phase induction motors (fifth revision)</td>
</tr>
<tr>
<td>807:1976</td>
<td>Code of practice for design, manufacture, erection and testing</td>
</tr>
<tr>
<td></td>
<td>(structural portion) of cranes and hoists (first revision)</td>
</tr>
<tr>
<td>1231:1974</td>
<td>Dimensions of three phase foot mounted induction motors (third</td>
</tr>
<tr>
<td></td>
<td>revision)</td>
</tr>
<tr>
<td>1875:1992</td>
<td>Carbon steel billets, blooms, slabs and bars for forgings (fifth</td>
</tr>
<tr>
<td></td>
<td>revision)</td>
</tr>
<tr>
<td>2062:1992</td>
<td>Steel for general structural purposes (fourth revision)</td>
</tr>
<tr>
<td>2223:1983</td>
<td>Dimensions of flange mounted ac induction motor (first revision)</td>
</tr>
<tr>
<td>3177:1999</td>
<td>Code of practice for electric overhead travelling cranes and</td>
</tr>
<tr>
<td></td>
<td>gantry cranes other than steel work cranes (second revision)</td>
</tr>
<tr>
<td>3832:1986</td>
<td>Hand operated chain pulley blocks (second revision)</td>
</tr>
<tr>
<td>3938:1983</td>
<td>Specification for electric wire rope hoists (second revision)</td>
</tr>
<tr>
<td>4460 (Parts 1 to 3):</td>
<td>Gears — Spur and helical gears</td>
</tr>
<tr>
<td></td>
<td>calculation of lead capacity (first revision)</td>
</tr>
</tbody>
</table>

3 TERMINOLOGY

3.1 General
For the purpose of this standard the definitions given in IS 13473 (Part 1) and following text shall apply. If there are common terms, the definitions given in this standard, shall prevail.

3.2 Normal Service Conditions
Normal service condition shall satisfy the following conditions:

a) Indoor and outdoor applications should be with normal air of normal humidity and free from contamination.

b) Ambient temperature should be between 0°C and 40°C and if the service conditions are beyond the normal conditions, suitable de-rating factors shall be applied.

c) Altitude should not exceed 1,000 m above sea level.

4 TECHNICAL INFORMATION

4.1 Information to be Supplied with the Enquiry or Order
Information regarding the conditions under which the jib crane is to be used together with particulars laid down in Annex B, shall be supplied with the enquiry or order.

4.2 Information to be Supplied by the Manufacturer
The manufacturer shall supply with the tender information regarding the construction of the jib crane, according to the proforma laid down in Annex C, including clearance diagrams, loads and turning moments on foundation and mounting due to eccentric loading.
4.3 Information to be Provided Prior to Installation and Commissioning of the Crane

The manufacturer shall provide the following information while commissioning the crane:

a) General arrangement drawing showing all leading dimensions and installation details,
b) Circuit and wiring diagram,
c) Operating and maintenance instructions,
d) Recommended spares list,
e) Test certificate,
f) Full technical detail of wire rope used, and
g) Any other information mutually agreed to between the manufacturer and the purchaser.

5 MARKING AND LOAD INDICATION

5.1 Identification

The crane shall bear one or more plaques on which the following information shall be inscribed:

a) Manufacturer's name;
b) Machine serial No.;
c) Year of manufacture;
d) The word 'Jib Crane' followed by a blank space, so that the purchaser may conveniently insert his code number, if any;
e) The safe working load, in kgs; and
f) Last date of test.

5.1.1 Name Plate

This plaque shall be readily legible from the ground or floor level and shall be located in a prominent position on jib arm.

SECTION 1
MECHANICAL ASPECTS

6 DESIGN OF CRANE MECHANISM

6.1 General

The design of the component parts of the mechanism relating to each jib crane motion shall include due allowance for the effects of the duty which the mechanism will perform in service.

6.2 The design of crane mechanism shall be as per Section 2 of IS 3177. However, duty classification for jib cranes shall be limited to M6.

6.3 Selection of Components

All components shall be selected or designed under loads and loading conditions specified in 7.3 of Section 2 of IS 3177.

6.4 Mechanical Details

In designing the mechanism of the crane, special care shall be taken so that all the components are easily accessible for inspection, maintenance and ease of replacement with minimum down time. Each mechanism of jib crane shall preferably be modular in construction with built-in facilities for easy dismantling and maintenance of each assembly as an independent unit. Sizes of all components like wheels, brakes, sheaves, etc shall be selected from preferred number series.

6.5 Structural Aspects

6.5.1 The crane shall be designed in accordance with IS 807 for the jib column and jib arm of the crane.

6.5.2 The structural steel material for jib crane structure shall conform to IS 2062 and IS 8500.

6.5.3 The boom of the jib crane shall be from section or fabricated type with rolled sections or tubular sections.

6.5.4 The design of the boom shall be such that the vertical deflection caused by the maximum rated load with the hoist at the maximum jib radius position on the boom, shall not exceed 1/250 of the boom length. The measurement of the deflection shall not be taken on the first application of the load, but on subsequent applications.

6.5.5 The column of the jib crane shall be made of heavy duty steel tube or fabricated/lattice structure to ensure minimum deflection at full load. Proper bearing housing block, for housing required bearing for supporting the boom, shall be provided at the top or at suitable location.

6.5.6 The jib arm support bearing will be either anti-friction ball/roller bearings (or bush type bearing) as per design/client’s requirements.

6.5.7 Base plate of the column should be provided with drilled holes of appropriate size for fixing the jib crane on the foundation and bolts.

6.5.8 The foundation bolts shall be so designed, that 50 percent of the bolt provided are capable of taking full load of the jib crane turning moments with impact.

6.5.9 The design of column and boom of the self supported jib crane should be such that over all deflection of the jib crane does not exceed the following limit, when the hoist along with full load is at extreme boom radius:

\[
\frac{\text{Boom length (} L \text{) + Column height (} H \text{)}}{300}
\]
6.5.10 The connection between the boom and the pillar shall be designed suitably to give proper end fixing to the boom and to ensure that the play between moving members is kept to the minimum.

6.5.11 Match marks shall be provided on each part of the structure to facilitate erection and alignment of the crane at the site.

6.6 Slew Drive for the Jib Crane

6.6.1 Slew drive for jib crane will be by manual pull or by motorized electrical as required by the purchaser.

6.6.2 For motorized slew drive, the driving mechanism shall consist of electric motor, which shall be connected to gear box of suitable ratio and capacity by means of a fluid coupling or flexible coupling to take care of over riding. The pinion mounted on the output shaft of the gear box shall engage the ring gear of the pillar for transmitting the torque to the jib. The speed at the tip of the jib boom should be restricted to 15 m/min. Any other design of the slew drive may be employed with mutual consent.

6.6.3 The brake shall be mounted on the input or extension shaft of the gear box. In addition end stoppers are to be mounted on the pillar, suitable limit switches shall be provided in order to restrict the angle of rotation of the jib.

6.6.4 The slew motion of manually operated jib crane shall be carried out by means of pull chain, fixed at the end of the boom.

6.7 Track Wheels

6.7.1 Single flange straight or taper tread type wheels shall be used for under slung type trolley motion. The side clearance between the runway beam flange and wheel shall be 3 to 4 mm on either side.

6.7.2 The wheels shall be made of forged/cast/rolled steel. The minimum hardness of the wheels shall be 250 BHN.

6.8 Bearings

6.8.1 Ball and roller anti-friction bearings shall be used throughout, unless otherwise specified by the purchaser. However, the selection of bearings shall be as per 8.7 of IS 3177.

6.8.2 Anti-friction spherical bearings and ball thrust bearings shall be provided for supporting boom.

6.9 Brakes

Electro-magnetic (EM) brakes of fail-safe type shall be provided for hoist cross travel (CT) and slew mechanism.

6.10 Guards

All couplings open bearings, open slip rings, etc, shall be provided with sheet metal covers opening on strong hinges.

7 SELECTION OF COMPONENTS

7.1 Bearings

7.1.1 Design

Due allowance shall be made for impact and side thrusts while selection of bearings. Wherever necessary, spherical seating type separate thrust bearings of suitable dimensions shall be used.

7.1.2 Ball and Roller Bearings

Life of ball and roller bearings shall be calculated in accordance with the manufacturer’s recommendations and based on the equivalent running time.

7.2 Couplings

7.2.1 All couplings shall be as per 8.9 of IS 3177 and made from steel and shall be designed to suit the maximum torque that may be developed.

7.2.2 Alignment shall be such that solid couplings mate accurately. Flexible/ fluid couplings shall be initially aligned with the same accuracy as solid couplings.

7.2.3 Flexible coupling of fail safe type shall be fitted between motor shafts and gear box extension shafts in case of electric hoist.

7.3 Shafts and Keys

7.3.1 General

Shafts and axles shall have ample strength and rigidity and adequate bearing surfaces. They shall, where necessary, be finished smoothly and if shouldered, shall be provided with fillets of as large a radius as possible and/or be suitably tapered.

7.3.2 Material

All shafts shall be made of suitable quality of steel as per 8.2.1 of IS 3177.

7.3.3 Shaft Keys

Keys, key ways and splines shall be either involute or straight sided and shall conform to the relevant Indian Standards (see Annex A). Keys shall be so fitted and secured that they cannot work loose in service.

7.4 Gearing

7.4.1 Design

Gears shall be designed in accordance with IS 4460 (Parts 1 to 3) using as a minimum duty factor
7.4.2 Types

The gears in power operated motions shall be machine cut and shall conform to relevant Indian Standards (see 7.3.3 and Annex A).

7.4.2.1 All gear shall be made from steel (cast or forged) of 45/55C8 material conforming to IS 1875.

7.4.2.2 Worm wheels or worm wheel rims shall be of bronze or brass and worm shaft shall be of steel of 55C8 material of IS 1875.

7.4.3 Fixing

Keys in gear trains shall be so fitted and secured that they cannot work loose in service. Bores for gears and pinions shall be fine machined or ground to size after any heat treatment that may be necessary.

7.5 Gear Boxes

7.5.1 Gear boxes shall be so designed that the gears which they enclose will be automatically lubricated. The gears shall be easily dismantlable and the boxes shall be oil-tight as far as it is reasonably practicable. Grease filled gear boxes shall be properly sealed to avoid the dust from contaminating the grease in the gear box.

7.5.1.1 They shall be of rigid construction and fitted with inspection covers and lifting lugs wherever necessary. Facilities for oil filling, adequate breathing drainage and means of indicating clearly the correct oil levels shall be provided.

7.5.1.2 Gear box legs/face shall be machined and shall be seated and positively located on appropriate level surface, preferably machined except where it is integral or shaft mounted. As far as possible the gear boxes shall be independent modular units. The surface hardness of pinion shall be between 266 to 300 BHN and that for gear shall be between 217 to 255 BHN. Difference of hardness of pinion and gear must not be less than 20 BHN.

7.5.2 Material for Gear Boxes

Material for the gear box casing shall be cast iron, cast steel or mild steel, conforming to the relevant Indian Standards (see 7.3.3, 7.4.2 and Annex A). The fabricated gear cases shall be stress relieved before machining.

7.6 Brakes

7.6.1 Brakes shall be capable of bringing the fully loaded jib crane hoist safely to rest in shortest possible time with least possible shock and shall arrest the motion under all service conditions (see 8.12.1 of IS 3177).

7.6.2 Brake Drums and Shoes

The wearing surface of all brake drums shall be machined and shall be cylindrical, smooth and free from defects. Brake linings shall be effectively and permanently secured to the brake shoes during the effective life of the lining and shall be protected from water, grease, oil, or other adverse effects. Alternatively suitable disc type brakes may be used.

7.6.3 Springs

Springs for electro-magnetic (EM) brakes shall be the compression type and shall not be stressed in excess of 80 percent of the torsional elastic limit of the material.

7.6.4 Traverse Motion

Every electrically operated traversing motion shall be fitted with an electric/electro-magnetic brake. Limit switches for the traversing motion may be provided by agreement between the supplier and the purchaser.

7.6.5 Adjustments

Brakes shall be provided with a simple and accessible means of adjustment to compensate for wear.

7.6.6 Lifting Devices

Lifting devices on such jib cranes shall be electric hoist as per IS 3938 or chain pulley block as per IS 3832. The hoisting and traversing motions shall be governed by IS 3832 and IS 3938 respectively.

8 GUARDING AND WEATHER PROTECTION

8.1 Guarding

All gear wheels, pinions and chain drives shall be encased unless such parts are so situated in relation to the structure of the crane so as to be as safe as if complete encasement were provided.

8.1.1 Effective guards shall be provided wherever necessary for revolving shafts, couplings and external gears.

8.2 Weather Protection

For outdoor cranes, all electrical and mechanical equipment shall be adequately protected from the weather. All weather proof covers shall be easily removable type.

8.3 Painting

8.3.1 Before dispatch of the jib crane, the complete crane covering, structural, mechanical and electrical parts shall be thoroughly cleaned of all dirt, grease,
scale and rust. A single coat of primer shall be given to all parts exposed to weathering effects which are not already treated earlier or effectively lubricated. At least one additional finishing coat of paint for indoor cranes and at least two additional finishing coats of paint for outdoor cranes, of colour of customer’s choice, shall be given on all primer painted surfaces.

8.3.2 All moving parts up to the height of 5 m from working level or ground shall be painted in golden yellow colour. The bright exposed parts of the crane shall be given one coat of rust inhibitor. Interior of all gear boxes shall be painted with one coat of oil resisting paint. Areas that are inaccessible after assembly or erection shall be treated before assembly or erection.

8.3.3 Where the jib cranes are supplied for use in abnormal working conditions, special protection may be necessary as may be agreed with the user.

8.3.4 Any additional requirements regarding painting shall be as agreed to between the purchaser and the manufacturer.

9 LUBRICATION
Provision shall be made for lubricating all bearings and for gears, chain and sprocket arrangements.

10 LOAD INDICATION AND LOAD LIMITING DEVICES
10.1 Load indication and limiting devices are recommended if weights of objects to be lifted are not known accurately. When fitted they shall sense the load on the crane by means other than the current consumed by hoist motor. If the load lifted is more than safe working load (SWL), load limiting devices shall stop further hoisting operation till the excess load is removed or reduced.

10.2 Purchaser should indicate in the enquiry of load indication and load limiting devices are to be fitted on crane.

SECTION 2
STRUCTURAL ASPECTS

11 STRUCTURAL CONSIDERATIONS

11.1 General
The structural members of the cranes shall be designed in accordance with IS 807.

11.2 The bottom flange of crane girders over which the hoist travels with the load, is subjected to stresses in bending resulting from the concentrated external load and uniformly distributed mass of the girder. Further added are the stresses due to local bending under a concentrated load of wheel pressure. The jib flange is treated as a plate of infinite length rigidly attached to the web along one edge while the other is free.

11.2.1 The procedure for calculation for the combined stresses due to bending and local bending is given in Annex D.

SECTION 3
ELECTRICAL REQUIREMENTS

12 GENERAL
It is necessary that the following particulars are observed in installation and operation of electrical equipment of the cranes so that safety in the operation is ensured:

   a) Power voltage used shall not exceed 440 V,
   b) All motors, controllers and switch frames shall be earthed,
   c) All electric equipment shall be thoroughly protected from dirt, grease and oil and where exposed to the weather shall be thoroughly protected against the weather,
   d) Guards for live parts shall be substantial and so located that they cannot be deformed so as to make contact with the live parts, and
   e) Name plates shall be fixed in such a manner that it is difficult to remove them.

13 MOTORS

13.1 Torque
The pullout torque of any motor supplied at rated voltage shall preferably be not less than 2.5 times the rated torque.

13.2 Limiting Speeds
Limiting speeds for motors shall not exceed those specified by the motor manufacturer.

13.3 Rating and Enclosure
The rating shall be such that, under the specified service conditions, the temperature rise does not exceed the limits specified in IS 325.

13.3.1 All crane motors shall be totally enclosed with or without fan cooling arrangement and shall conform to IS 1231 or IS 2223 as appropriate. The enclosures shall suit the specified service conditions and shall be stipulated with the enquiry or order. Motors shall be foot or flange mounted type.
13.4 Design and Construction
Motors shall be of robust construction and shall be suitable for frequent reversal, braking and acceleration.

13.4.1 Mounting
Motor shall be so located that the brush gear and terminals are accessible for inspection and maintenance and does not restrict the normal ventilation.

13.4.2 Terminals
Motor leads shall be brought out from the motor frame to terminals in the terminal box fixed to the motor frame.

13.5 Selection of the motor power shall be in accordance with 10.7.2 of IS 3938.

14 PENDANT PUSH BUTTON CONTROL SWITCH

14.1 General
Crane control shall be designed so that remote control may be effected by means of a push button pendant switch push button control shall consist of fully magnetic reversing type contactors operated by a momentary contact type push button. The push button shall return to off position, when the pressure is released by the operator. A separate button or a single combination button with suitable arrangement shall be provided for obtaining each speed of multi-speed hoists. The directional contactors shall be mechanically or electrically interlocked.

14.2 Accessibility
All controllers shall be so disposed that the contacts and terminal arrangements are readily accessible for inspection and maintenance purpose.

14.3 Control Switch
The pendant switch shall be capable of withstanding rough handling without being damaged and the cover shall be effectively secured.

14.4 Suspension of Pendant Switch
The weight of the pendant shall be supported independent of the electric cable by means of chain or wire rope. If the pendant is metallic it shall be effectively earthed.

NOTE — A chain or hook does not provide an effective earth connection and should not be relied upon for that purpose.

14.5 The push button station shall be clearly marked as per Table 1 to indicate the function of each button. Push button control voltage shall be not be more than 115 V ac (see 11.6 of IS 3938).

Table 1 Marking of Push Button Station
(Clause 14.5)

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Equipment</th>
<th>Motion</th>
<th>Marking</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>HOIST</td>
<td>UP</td>
<td>UP</td>
</tr>
<tr>
<td></td>
<td>LOWER</td>
<td>⊣</td>
<td>LOWER</td>
</tr>
<tr>
<td>ii)</td>
<td>TROLLEY</td>
<td>LEFT</td>
<td>LEFT</td>
</tr>
<tr>
<td></td>
<td>RIGHT</td>
<td>⇒</td>
<td>RIGHT</td>
</tr>
</tbody>
</table>

14.6 An emergency mushroom head ‘STOP’ push button shall be provided on the pendant to control incoming power to the crane for emergency safety. In addition ‘START’ push button shall be provided to put on the power to the crane. Red and green indicating lights shall be provided on the pendant to indicate the status of incoming power.

15 CONTROL CIRCUITS

15.1 If the main supply is ac and the control circuits are supplied at reduced voltage preferably at 110 V, the supply to those circuits shall be from the secondary winding of an isolating transformer. One pole of this supply shall be earthed and the contactor and relay coils shall be connected to this pole, or other equally effective means shall be adopted to prevent malfunctioning owing to sneak circuits or earth faults.

15.1.1 All controls of hoist shall be so arranged that no motion is inadvertently started when the power is supplied after an interruption.

16 BRAKING

16.1 General
The braking may preferably be fail safe spring loaded electro-magnetic type. Electro-hydraulic brakes may be used on customer’s request.

16.1.1 Electro-magnetic Braking
The electro-magnetic brake(s) used shall apply automatically when power supply fails or when the push button is released to the ‘OFF’ position.

16.1.2 Electro-hydraulic Braking
Use of electro-hydraulic thruster operated brake is also permissible on all motions of the crane.

16.2 Brake Magnets
The terminals of brake magnets shall be protected from accidental contact and the connections and windings shall be effectively protected from mechanical damage. When necessary, magnets shall be provided with an efficient cushioning device. Two duties are recognized for both ac and dc, namely:

a) Continuous or heavy duty, and
b) Intermittent.
16.3 Brake Release
Appropriate mechanical, electro-hydraulic or any other alternative brake releasing gears may be used instead of brake magnets, if desired.

17 LIMIT SWITCHES
17.1 Limit switches shall be of the totally-enclosed quick-break type and where wired to three-phase motors, shall interrupt not more than two phases. Those incorporating a spring to provide quick breaking of the contacts shall be so designed and constructed that failure of the spring does not affect positive opening of the contacts.

17.1.1 Limit switches shall be of the series or shunt-type and shall permit the motor to be operated in the reverse direction, when the limit switch is opened. The limit switch after being tripped shall automatically reset itself within a reasonable distance travelled in the opposite direction. This does not prevent the use of the change over type limit switches, where the resetting is achieved by striker when moving in the opposite direction.

18 ELECTRICAL PROTECTIVE DEVICES
18.1 Contactor, Circuit-Breaker
Operated as minimum equipment of protection, an electro-magnetically operated contactor with inherent under voltage protection together with overload devices shall be provided.

18.1.1 The overload protection may be of the electro-magnetic type, with time delay or thermal overload relays in conjunction with high rupturing capacity fuses or thermal sensing devices, sensitive to motor temperature or to temperature and current, which are thermally in contact with the motor windings.

18.1.2 The number of overload devices and their position shall normally be in accordance with one of the arrangements shown in Table 2. But if specified by the purchaser other arrangements giving protection of not less than any of these shall be considered as complying with the standard.

Table 2 Normal Requirements for Number of Protection Devices for Motor Circuits
(Clause 18.1.2)

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>dc Supply</th>
<th>3 Phase ac Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>i) No line earthed</td>
<td>One line earthed</td>
<td></td>
</tr>
<tr>
<td>ii) 2 per motion in separate line</td>
<td>3 per motion in connected in the non-earthed line</td>
<td></td>
</tr>
</tbody>
</table>

19 CABLES AND CONDUCTORS
19.1 Cables
Rubber PVC or varnished cambric insulated cables used for jib crane wiring shall comply with the relevant Indian Standard. All cables shall be adequately protected against mechanical damage and from damage by weather. Where metal conduits or flexible tubes are used, their ends shall be screwed-in adequately, to prevent ingress of moisture.

19.2 Minimum Size of Cables
Cables having conductors complying with the relevant Indian Standard, smaller than 2.5 mm² (nominal) equivalent copper area of cross-section shall not be used for the power wiring of the motor. For control circuits and auxiliary wiring cables having a sectional area smaller than 1.5 mm² (nominal) equivalent copper area shall not be used.

19.3 Multi-Core Armoured Cables
Multi-core armoured power and control cables suitably clamped may be used to avoid conduits and troughings. Suitable clamping glands should be provided at both ends of each multi-core cable.

19.4 Outdoor Jib Crane Wiring
For outdoor jib cranes, except where flexible unarmoured cables are essential, cables shall be either armoured or enclosed throughout their length in galvanized trunking or conduit, either flexible or rigid. A flexible metallic tube or duct may not form an effective earth connection and shall not be used for that purpose.

19.5 Current Rating
19.5.1 Rating of the cable, in the circuit related to mechanism class M6, shall be not greater than the appropriate values given in the relevant Indian Standard for continuous duty, giving due considerations to ambient temperature, type of excess current, protection, grouping and disposition of cables and voltage drop. Cables in circuit related to mechanism class below M8 may be rated higher in accordance with Table 3.

Table 3 Higher Rating of Cables
(Clause 19.5.1)

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Mechanism Class</th>
<th>Stator Circuit Rating Multiplied by</th>
<th>Rotor &amp; Resistor Circuits Rating Multiplied by</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>i) M1, M2</td>
<td>2</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>ii) M3, M4, M5</td>
<td>1.7</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>iii) M6, M7</td>
<td>1.4</td>
<td>1.5</td>
<td></td>
</tr>
</tbody>
</table>
19.5.2 Consideration should be given to such factors as the ambient temperature, grouping and disposition of the cables, and to the limitations of voltage drop which influences selection of suitable cables.

20 EARTHING

20.1 The jib crane structure, motor frames and metal cases of all electrical equipment including metal conduit or cable guards, shall be effectively connected to earth at two different points.

20.2 Where the jib crane is connected to the supply by flexible cord or flexible cable, the crane shall be connected to earth by means of an earthing conductor enclosed with the current carrying conductors within the flexible cord or flexible cable.

21 GUARDS

21.1 Where there is any possibility of any person coming in contact with an exposed part of an electrical circuit, other than one operating at extra low voltage, such part shall be effectively guarded.

21.2 All reciprocating and moving parts which might constitute a hazard shall be guarded.

21.3 All guards shall be preferably of hinged type.

22 CONDUCTORS AND CURRENT COLLECTORS

22.1 General

The type of current collecting system for cross travel motion shall be provided as required by the purchaser.

22.2 Trailing Cable Arrangement

In the trailing cable arrangement, the conductors shall be insulated flexible single or multiple core cables with permanent termination on the fixed part and moving part. The flexible trailing cables shall have sufficient length and shall be supported on trolley with clamps. The trolley shall run freely on a guide without undue stresses or wear on suspended cables.

22.3 Rating

Unless otherwise specified, the maximum current density shall not exceed 0.42 A/mm² for rolled steel section, 1.2 A/mm² for aluminum sections and 2.5 A/mm² for copper sections. The gap between the current collector and adjacent live or earth part shall not be less than 50 mm.

22.4 Cross Travel Current Collection System

22.4.1 General

Cross travel current collecting system shall be with bare conductors or with shrouded conductors or with trailing cable arrangement. The collection system shall be provided by the manufacturer.

22.4.2 Conductors

Cross travel conductors shall be arranged so that they are accessible for maintenance.

22.4.3 Collector Assembly

Collector assembly shall be rigidly mounted on the hoist trolley and shall be provided with reasonable accessibility to all parts for maintenance purpose.

SECTION 4

INSPECTION AND TESTING

23 GENERAL

23.1 If required by the purchaser and specified in the contract, the purchaser or his authorized representative shall have access to the manufacturer’s works at all reasonable time for the purpose of witnessing the manufacture, inspection and testing of all products concerned and or the complete crane.

23.2 Any work found defective or which is not in accordance with the drawings or of terms of this Code and/or the contract may be rejected by the inspector.

24 TESTS AT MANUFACTURER’S WORKS

24.1 All electrical and mechanical equipment shall be tested in accordance with the appropriate Indian Standard at either the crane maker’s or equipment manufacturer’s works and test certificates provided if required by the purchaser.

24.2 As the jib crane is designed and manufactured to suit customer’s location and foundations, and in some cases in existing columns, the manufactured crane shall be dimensionally checked at the manufacturer’s works, and also subjected to the visual inspection. The full load test and 25 percent overload test on hoisting, cross travel and slewing motion shall be done at customer’s site after installing the jib crane on the foundation or customers column.

24.3 Any other test required by the purchaser beyond those called for in the appropriate Indian Standard shall be subject to mutual agreement and shall be carried out at the purchaser’s expenses.

25 TESTS ON PURCHASER’S PREMISES

25.1 Insulation Tests

After erection, but before the jib crane is connected to the supply, the insulation of the electrical equipment shall be tested by a suitable instrument and any defects revealed shall be rectified.
25.1.1 The voltage required for the insulation resistance test shall be a dc voltage not less than twice the rated voltage.

25.1.2 Any reading less than 0.5 mΩ obtained with a 500 V dc Megger of the unregulated type shall be disregarded and the wiring under test shall be subdivided until a reading higher than 0.5 mΩ is obtained. Failure to obtain a higher reading shows an unsatisfactory state of the insulation.

25.1.3 The insulation resistance of each wiring circuit exclusive of connected apparatus shall be not less than 2 mΩ. If necessary, it shall be permissible to disconnect individual items of equipment while making this test.

25.1.4 The basic parameters like crane dimensions and clearance shall be verified. The height of lift shall be measured at site after erection.

25.1.5 The speed-load characteristics of the various motions of the crane offered by the manufacturer may be verified by the purchaser at his premises by actual loading such as no-load, half-load and full-loads. Any deviation shall be corrected by the manufacturer with a tolerance on speed of 10 percent in the working conditions.

25.2 Test of Operation

After the supply has been connected, and before the complete crane installation is put into commercial service tests shall be carried out to prove the following:

- a) Satisfactory operation of all control devices and in particular the correct operation of limit switches;
- b) Correctness of all circuits and interlocks and sequence of operations;
- c) Satisfactory operation of all protective devices;
- d) Satisfactory operation of each motion of the crane;
- e) Compliance of the crane with the specified performance requirements;
- f) Tolerance on specified speeds at full load shall be within ± 10 percent; and
- g) Deflection measurement test when the load is at extreme end of the boom.

NOTE — In the case of erection of jib crane by a party other than the supplier, the purchaser shall ensure that the erection of the jib crane, has been done according to the supplier’s recommendations/instructions.

26 OVER LOAD TESTS

26.1 After tests of operation, but before the crane is put into service, it shall, with overload relays appropriately set, be tested to lift and sustain a test load of 125 percent of the working load, when the load is located at the maximum boom radius.

26.2 During the overload test, each motion in turn shall be maneuvered in both directions and the crane shall sustain the load under full control. The specified speeds need not be attained but the crane shall show itself of dealing with the overload without difficulty.

ANNEX A
(Foreword)

LIST OF ADJUNCT INDIAN STANDARDS

A-1 MATERIALS

A-1.1 Steels and Castings

<table>
<thead>
<tr>
<th>IS No.</th>
<th>Title</th>
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<tbody>
<tr>
<td>210 : 1993</td>
<td>Grey iron casting (fourth revision)</td>
</tr>
<tr>
<td>1030 : 1998</td>
<td>Carbon steel castings for general engineering purposes (fifth revision)</td>
</tr>
<tr>
<td>1387 : 1993</td>
<td>General requirement for the supply of metallurgical materials (second revision)</td>
</tr>
<tr>
<td>1570 (Part 1) : 1978</td>
<td>Schedules for wrought steels:</td>
</tr>
<tr>
<td>(Part 2/Sec 1) : 1979</td>
<td>Steels specified by tensile and/or yield properties (first revision)</td>
</tr>
<tr>
<td></td>
<td>Carbon steels (unalloyed steels), Section 1 Wrought products</td>
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<table>
<thead>
<tr>
<th>IS No.</th>
<th>Title</th>
</tr>
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<tbody>
<tr>
<td>(Part 2/Sec 2) : 1987</td>
<td>Carbon steels (unalloyed steels), Section 2 Carbon wires with related properties (first revision)</td>
</tr>
<tr>
<td>(Part 3) : 1979</td>
<td>Carbon and carbon manganese free cutting steels (first revision)</td>
</tr>
<tr>
<td>(Part 4) : 1988</td>
<td>Alloy steels (alloy constructional and spring steels) with specified chemical composition and mechanical properties (first revision)</td>
</tr>
<tr>
<td>(Part 5) : 1985</td>
<td>Stainless and heat resisting steels (second revision)</td>
</tr>
<tr>
<td>(Part 6) : 1996</td>
<td>Carbon and alloy tools steels (first revision)</td>
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### IS No. | Title |
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<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>15419 : 2004</td>
<td>Steels for elevated temperature service (creep resistant steels)</td>
</tr>
<tr>
<td>1875 : 1992</td>
<td>Carbon steel billets, blooms, slabs and bars for forgings (fifth revision)</td>
</tr>
<tr>
<td>2062 : 1999</td>
<td>Steel for general structural purpose (fifth revision)</td>
</tr>
<tr>
<td>8500 : 1991</td>
<td>Structural steel micro-alloyed (medium and high strength qualities) (first revision)</td>
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#### A-1.2 Threaded Fasteners

<table>
<thead>
<tr>
<th>IS No.</th>
<th>Title</th>
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<tbody>
<tr>
<td>1364 (Part 1) : 1992</td>
<td>Hexagon head bolts, screws and nuts of product grades A and B:</td>
</tr>
<tr>
<td>1367 (Part 2) : 1992</td>
<td>Hexagon head bolts (size range M16 to M64) (third revision)</td>
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<tr>
<td>1367 (Part 3) : 1992</td>
<td>Hexagon head screws (size range M16 to M64) (third revision)</td>
</tr>
<tr>
<td>1367 (Part 4) : 1992</td>
<td>Hexagon nuts (size range M16 to M64) (third revision)</td>
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#### A-1.3 Wire Rope

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<tbody>
<tr>
<td>1856 : 1977</td>
<td>Steel wire rope for haulage purposes (second revision)</td>
</tr>
<tr>
<td>2266 : 2002</td>
<td>Specification for steel wire ropes for general engineering purposes (fourth revision)</td>
</tr>
<tr>
<td>2365 : 1977</td>
<td>Specification for steel wire suspension ropes for lifts, elevators and hoists (first revision)</td>
</tr>
<tr>
<td>2762 : 1982</td>
<td>Wire rope slings and sling legs (first revision)</td>
</tr>
<tr>
<td>3973 : 1984</td>
<td>Code of practice for selection, installation and maintenance of wire rope (first revision)</td>
</tr>
<tr>
<td>6594 : 2001</td>
<td>Technical supply conditions for steel wire ropes and strands (second revision)</td>
</tr>
</tbody>
</table>

#### A-2 MECHANICAL AND FABRICATION DETAILS

##### A-2.1 Keys and Keyways

<table>
<thead>
<tr>
<th>IS No.</th>
<th>Title</th>
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<tbody>
<tr>
<td>2048 : 1983</td>
<td>Specification for parallel keys and keyways (second revision)</td>
</tr>
<tr>
<td>2291 : 1990</td>
<td>Specification for tangential keys and keyways (third revision)</td>
</tr>
<tr>
<td>2292 : 1974</td>
<td>Specification for taper keys and keyways (first revision)</td>
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</table>
IS No. | Title |
---|---|
2293 : 1974 | Specification for Gib-head keys and keyways (first revision) |
6166 : 1971 | Thin taper keys and keyways |
6167 : 1971 | Thin parallel keys and keyways |
A-2.2 Welding |
816 : 1969 | Code of practice for use of metal arc welding for general construction in mild steel (first revision) |
818 : 1968 | Code of practice for safety and health requirements in electric and gas welding and cutting operations (first revision) |
822 : 1970 | Code of procedure for inspection of welds |
1024 : 1999 | Code of practice for use of welding in bridges and structures subject to dynamic loading (second revision) |
1323 : 1982 | Code of practice for oxy-acetylene welding for structural work in mild steel (second revision) |
A-2.3 Gears |
2467 : 1963 | Notation for toothed gearing |
2535 : 1978 | Basic rack and modules of cylindrical gears for general engineering and heavy engineering (second revision) |
3734 : 1983 | Dimensions for worm gearing (first revision) |
4460 | Gears — Spur and helical gears— Calculation of load capacity (first revision) |
(Parts 1 to 3) : 1995 |
6535 : 1979 | Data for procurement cylindrical bevel gears (first revision) |
7504 : 1995 | Gears — Cylindrical gears — Accuracies — Methods of inspection (first revision) |
10911 : 1984 | Method of inspection for straight bevel gears |
A-3 ELECTRICAL DETAILS |
A-3.1 Motors |
IS No. | Title |
---|---|
325 : 1996 | Specification of three phase induction motors (fifth revision) |
900 : 1992 | Code of practice for installation and maintenance of induction motors (second revision) |
1231 : 1974 | Dimensions of three phase foot mounted induction motors (third revision) |
2223 : 1983 | Dimensions of flange mounted ac induction motor (first revision) |
4691 : 1985 | Degrees of protection provided by enclosure for rotating electrical machinery (first revision) |
12075 : 1987 | Mechanical vibration of rotating electrical machines with shaft height 56 mm and higher, measurement, evaluation and limits of vibration severity |
A-3.2 Cables and Conductors |
694 : 1990 | Specification for PVC insulated cables for working voltages up to and including 1 100 V (third revision) |
1554 | Specification for PVC insulated (heavy duty) electric cables: |
(Part 1) : 1988 | For working voltages upto and including 1 100 V (third revision) |
(Part 2) : 1988 | For working voltages from 3.3 kV upto and including 11 kV (third revision) |
8130 : 1984 | Conductors for insulated electric cables and flexible cords (first revision) |
9968 (Part 1) : 1988 | Elastomer insulated cables : Part 1 For working voltages up to and including 1 100 V (first revision) |
A-3.4 Conduits |
9537 (Part 3) : 1983 | Conduits for electrical installation: Part 3 Rigid plain conduits of insulating materials |
### A-3.4 Switchgears

<table>
<thead>
<tr>
<th>IS No.</th>
<th>Title</th>
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<tr>
<td>3427:1997</td>
<td>ac metal enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 11 kV</td>
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<tr>
<td>10118 Code of practice for selection, installation and maintenance of switchgear and controlgear:</td>
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<td>(Part 1): 1982 General</td>
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<td>(Part 2): 1982 Selection</td>
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<td>(Part 3): 1982 Installation</td>
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<td>(Part 4): 1982 Maintenance</td>
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<tr>
<td>13118:1991 High voltage alternating current circuit breakers</td>
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<tr>
<td>13947 Low voltage switchgear and controlgear:</td>
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<tr>
<td>(Part 1): 1993 General rules</td>
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<tr>
<td>(Part 2): 1993 Circuit breakers</td>
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<tr>
<td>(Part 3): 1993 Switches, disconnectors, switch disconnectors and fuse combination units</td>
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</tr>
<tr>
<td>(Part 4/Sec 1): 1993 Contractors and motor starters, Section 1 Electro-mechanical contractors and motor starters</td>
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### A-3.5 Earthing

<table>
<thead>
<tr>
<th>IS No.</th>
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<tr>
<td>3043:1987 Code of practice for earthing (first revision)</td>
<td></td>
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### A-3.6 Cranes and Hoist

<table>
<thead>
<tr>
<th>IS No.</th>
<th>Title</th>
</tr>
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<tbody>
<tr>
<td>807:1976 Code of practice for design, manufacture, erection and testing (structural portion) of cranes and hoists (first revision)</td>
<td></td>
</tr>
<tr>
<td>3177:1999 Code of practice for electric overhead travelling cranes and gantry cranes other than steel work cranes (second revision)</td>
<td></td>
</tr>
<tr>
<td>3832:1986 Hand operated chain pulley blocks (second revision)</td>
<td></td>
</tr>
<tr>
<td>3938:1983 Specification for electric wire rope hoists (second revision)</td>
<td></td>
</tr>
</tbody>
</table>

### ANNEX B

(Clause 4.1)

INFORMATION TO BE SUPPLIED WITH THE ENQUIRY OR ORDER

The following information in regard to the details of the crane shall be furnished by the purchaser at the time of enquiry or order:

**a) General**

1) Number of jib cranes
2) Whether manual/electrical for hoist/CT/swivel
3) Group classification of the mechanism
   i) Jib crane structure (see IS 807)
   ii) Hoist (see IS 3832 or IS 3938)
   iii) Cross traverse (see IS 3832 or IS 3938)
4) Safe working load, in tonnes:
   Hoist
5) Whether the crane is to work in an enclosed building or outdoors
6) Any abnormal atmospheric condition
   (soil bearing capacity/soil condition at site)
7) A write-up on application details
8) Type of jib crane desired/select from attached clearance diagrams
9) Any special requirements likely to affect design

**b) Jib Crane Performance**

1) Operating speeds (loaded), in m/min:
   i) Main hoist
   ii) Micro speed (if required)
   iii) Cross traverse
   iv) Slew motion at tip of boom (if motorized typed)
2) Type of control required
3) Boom length/effective working radius
4) Clear lift:
   i) above floor level ........................................
   ii) below floor level .....................................
5) Overall height restriction, if any ........................

c) Electrical Details
1) Power supply ac or dc:
   Volts ...................... No. of phases ......................
   frequency ..............................
   No. of wires ......................... Neutral (earthed or not) ........................................
2) Controls:
   i) Type of pendant — moving with hoist along the span of the jib
   ii) Control voltage — or stationery, mounted on column
3) Ambient temperature to degree centigrade :
   i) Maximum ........................................

d) Lifting Hook
Type of hook (standard single shank ‘C’ hook or rams horn type) :
1) Hoist .....................................................
2) If safety latch required ..................................
3) If hook swiveling lock required ..................................
4) Height of hook above floor level, \( h_1 \) : ..................
5) Drop of hook below floor level, \( h_2 \) : ...........

e) Any Special Requirement/Accessories
Such as lifting beam/hook lighting magnet, grab bucket, etc.

ANNEX C
(Clause 4.2)
INFORMATION TO BE SUPPLIED BY MANUFACTURER

The following details in regard to the crane should be supplied to the purchaser at the time of enquiry
and order. Letters in parentheses refer to those in Fig. 1 to Fig. 8:

a) Type of jib crane :
1) Jib crane structure .....................................
2) Hoist .....................................................
3) Cross traverse ...........................................

b) Safe working load:
1) Hoist .....................................................
2) Boom radius \( R \) ...........................................

c) Operating speeds (loading)
1) Hoist ..................................................... m/min
2) Micro speed (if applicable) ...................... m/min
3) Cross traverse ...........................................
4) Acceleration values for cross travel motions ......... (normal 10 m/s)
5) Slew motion at tip of boom ...................... m/min

d) Type of hook supplied:
Hoist .....................................................

e) Height of hook above floor level:
Hoist \( (h_1) \) ...........................................

f) Drop of hook below floor level:

<table>
<thead>
<tr>
<th>Motion</th>
<th>Quantity</th>
<th>Type</th>
<th>Metric Horse Power</th>
<th>Min rev</th>
<th>Enclosure</th>
<th>Rating</th>
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<tbody>
<tr>
<td>Hoist</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td>Cross</td>
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<tr>
<td>Travel</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
m) Details of controllers control panel and equipment
n) Control voltage ac ........................................
p) Particulars of safety devices
q) Net mass :
   1) Complete unladen jib crane......... tonnes

2) Complete unladen hoist .......... tonnes
r) Tools and accessories supplied ..............
s) Other information not scheduled above ........................................
t) General arrangement :
   Drawing number ........................................

--- Diagram ---

\[ L = \text{boom length} \]
\[ L_1 = \text{extension on other side} \]
\[ R = \text{effective radius} \]
\[ E = \text{hook approach} \]
\[ F = \text{hook approach} \]
\[ h = \text{head room of hoist} \]
\[ h_1 = \text{height of lift} \]
\[ h_2 = \text{lift below the floor level} \]
\[ D = \text{base diameter} \]

**FIG. 1 SELF SUPPORTED JIB CRANE ELECTRICALLY OPERATED 360° SWIVEL**
Fig. 2 Self Supported Jib Crane with Fabricated Column, Electrically Operated 180° Swivel.

\[ L = \text{boom length} \]
\[ R = \text{effective radius} \]
\[ E = \text{hook approach} \]
\[ F = \text{hook approach} \]
\[ h = \text{head room of hoist} \]
\[ h_1 = \text{height of lift} \]
\[ h_2 = \text{lift below the floor level} \]
\[ H = \text{overall height} \]
\[ \varnothing = \text{hole centres} \]
\[ D = \text{base dimension} \]
\[ L = \text{boom length} \]
\[ L_1 = \text{extension on other side} \]
\[ R = \text{effective radius} \]
\[ E = \text{hook approach} \]
\[ F = \text{hook approach} \]
\[ h = \text{head room of hoist} \]
\[ h_1 = \text{height of lift} \]
\[ h_2 = \text{lift below the floor level} \]
\[ H = \text{overall height} \]

**Fig. 3** King Post Type Jib Crane Electrically Operated 180° Swivel
Fig. 4 Self Supported Jib Crane with Counter Weight Fabricated Column Type Electrically Operated 360° Swivel

$L$ = boom length
$L_1$ = extension on other side
$R$ = effective radius
$E$ = hook approach
$F$ = hook approach

$h$ = head room of hoist
$h_1$ = height of lift
$h_2$ = lift below the floor level
$H$ = overall height
$D$ = base length
$d$ = hole centres
Fig. 5 Wall Mounted Bracket Type Jib Crane
Hand Operated 180° Swivel

- $L$ = boom length
- $L_1$ = extension on other side
- $R$ = effective radius
- $E$ = hook approach
- $F$ = hook approach
- $h$ = head room of hoist
- $h_1$ = height of lift
- $h_2$ = lift below the floor level
- $H$ = overall height
$L = \text{boom length}$

$R = \text{effective radius}$

$E = \text{hook approach}$

$F = \text{hook approach}$

$h = \text{head room of hoist}$

$h_1 = \text{height of lift}$

$h_2 = \text{lift below the floor level}$

$H = \text{overall height}$

**FIG. 6 WALL MOUNTED BRACKET TYPE JIB CRANE**

**ELECTRICALLY OPERATED 180° SWIVEL**
FIG. 7  **ROTARY JIB CRANE WITH EXTENDED DERRICK BOOM**

$L =$ boom length  
$L_1 =$ extension on other side  
$R =$ effective radius  
$h =$ head room of hoist  
$h_1 =$ height of lift  
$h_2 =$ lift below the floor level  
$H =$ overall height  
$D \times D =$ base dimension
FIG. 8 MOVING CANTILEVER WALL CRANE ELECTRICALLY OPERATED

\[ L = \text{boom length} \]
\[ L_1 = \text{extension on other side} \]
\[ S = \text{effective radius} \]
\[ E = \text{hook approach} \]
\[ F = \text{hook approach} \]
\[ h = \text{head room of hoist} \]
\[ h_1 = \text{height of lift} \]
\[ h_2 = \text{lift below the floor level} \]
\[ H = \text{overall height} \]
\[ G = \text{support roller centres} \]
ANNEX D
(Clauses 11.2.1)

PROCEDURE FOR CALCULATING LOCAL BENDING OF THE BOTTOM FLANGE OF A MONORAIL TRACK

The bottom flange of monorail track over which the trolley of a hoist travels (see Fig. 9) is subjected to stresses in bending due to the mass of the girder proper and to the stress resulting from the local bending under a concentrated load \( P \) that is the wheel pressure. The girder flange is treated as a plate of infinite length rigidly attached to the web along one edge while the other is free. The bending stress set up in the section, at its bottom (at point \( B \) of Fig. 9) by the mass of the girder, properly suspended from the hanger brackets spaced at distance \( L \) apart can be calculated from:

\[
\sigma_y = \frac{M_{by} \gamma}{W_{xx}}
\]

where \( M_{by} \) is the bending moment set up by the combined effect of all the forces (concentrated external load and uniformly distributed mass of rail with weight of per unit length) at a section midway between the points of suspension:

\( W_{xx} \) is the section modulus of girder.

The stress resulting from the local bending in the root section can be estimated in plane \( xy \) by:

\[
\sigma_x = \frac{6 K_1 P}{t'^2_{root}}
\]

and in the plane \( yz \) by

\[
\sigma_y = \frac{6 K_2 P}{t'^2_{root}}
\]

where the stress at point \( A \) is regarded as being positive and that bottom of root section as negative.

The stress set up by local bending along the free end of the flange which is parallel to plane \( yz \) is determined from

\[
\sigma_{y,free} = \frac{6 K_1 P}{t'^2_{free}}
\]

where the stress at point \( B \) is regarded as being positive and that the top of the flange, as negative : \( K_1, K_2, K_3 \) are the coefficients varying with the ratio \( c/a \) and obtainable from the curve in Fig. 10; \( t'^{free} \) is the flange thickness at midsection (refer to Fig. 10 for \( K_1, K_2, K_3 \) values).

The point of maximum stress will be either at \( A \) or \( B \) depending on the position of the load \( P \).

The modified stress at point \( B \) is obtainable from

\[
\sigma_{B(mod)} = \sigma_{y,free} + \sigma_{y,b} \leq \sigma_{B(allowable)}
\]

The modified stress at point \( A \) can be obtainable on the basis of strain energy.

\[
\sigma_{A(mod)} = \sqrt{\sigma_x^2 + \sigma_y^2 + \sigma_{y,b}^2} \leq \sigma_{A(allowable)}
\]

where the allowable stress at point \( B \) of girder of mild steel conforming to IS 2062 quality is \( \sigma_{B(allowable)} = 1800 \text{ kg/cm}^2 \) and that point \( A \) is \( \sigma_{A(allowable)} = 2000 \text{ kg/cm}^2 \). An increase in the allowable stress is attributed to the effect of cold work resulting from the concentrated load imposed by the track wheels.
\( \sigma_{by} \) = bending stress induced at point 'B'.
\( M_{by} \) = bending moment induced by the combined effect of all the forces (concentrated external load \( P \) and uniformly distributed mass of monorail with weight of \( q \) per unit length \( l \)) at a section midway between the points of suspensions).
\( M_{syz} \) = section modulus of the monorail girder.
\( \sigma_y \) = stress resulting from local bending in the root section in plane \( xy \).
\( \sigma_z \) = stress resulting from local bending in the root section in plane \( yz \).
\( A \) = top surface of the girder bottom flange.
\( B \) = bottom surface of the monorail girder flange.
\( c \) = distance from centre of web at which concentrated load \( P \) is acting in cm.
\( \sigma_{A,allowable} \) = allowable stress at point 'A'.
\( \sigma_{B,allowable} \) = allowable stress at point 'B'.
\( t_{mean} \) = bottom flange thickness at mid section.
\( t_{root} \) = bottom flange thickness at the root.
\( a \) = half width of the bottom flange of the monorail
\( l \) = unit length of mono-rail, in cm
\( L \) = length of mono-rail beam at suspensions, in cm
\( q \) = weight per unit length of mono-rail, in kg/cm.

**Fig. 9** Designing of Mono-rail Track for Strength
NOTE — $K_1$, $K_2$, and $K_3$ = Coefficients varying with the ratio of $C/a$ and obtainable from curve as given in Fig. 10.

**Fig. 10 Value of Coefficients $K_1$, $K_2$, and $K_3$**
# ANNEX E

*(Foreword)*

## COMMITTEE COMPOSITION

Cranes and Lifting Chains Sectional Committee, MED 14

<table>
<thead>
<tr>
<th>Organization</th>
<th>Representative(s)</th>
</tr>
</thead>
<tbody>
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<td>SHRI K. MANICKAM <em>(Chairman)</em></td>
</tr>
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<tr>
<td>Auri Industries India (P) Ltd, Pune</td>
<td>SHRI N. VASUDEVA <em>(Alternate)</em></td>
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</tr>
<tr>
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<td>SHRI M. SUBBA RAO <em>(Alternate)</em></td>
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<tr>
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<td>SHRI VIJENDER SINGH <em>(Alternate)</em></td>
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<tr>
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<td>SHRI D. CHAKRABORTHY <em>(Alternate)</em></td>
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*(Continued on page 26)*
(Continued from page 25)

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Research Designs & Standards Organization, Lucknow
Reva Engineering Industrial (P) Ltd, New Delhi
Southern Structural Ltd, Chennai
Steel Authority of India Ltd, Bhilai
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SHRI MANISH NALWA (Alternate)

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SHRI M. L. CHOPRA, Director & Head (MED)

[Representing Director General (Ex-officio)]

Member Secretary
SHRI S. B. ROY

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