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CODE OF PRACTICE FOR DESIGN, MANUFACTURE, ERECTION AND TESTING (STRUCTURAL PORTION) OF CRANES AND HOISTS

(First Revision)

(Incorporating Amendment No. 1)

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

Price Group 9

Indian Standard

CODE OF PRACTICE FOR DESIGN, MANUFACTURE, ERECTION AND TESTING (STRUCTURAL PORTION) OF CRANES AND HOISTS

(First Revision)

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Indian Standard

CODE OF PRACTICE FOR DESIGN, MANUFACTURE, ERECTION AND TESTING (STRUCTURAL PORTION) OF CRANES AND HOISTS

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 27 August 1976, 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 covers design of structural portion of cranes and hoists and specifies permissible stresses and other details of design in order to ensure economy in design and reliability in operation. To deal with the subject conveniently, cranes have been broadly classified into four classes depending upon their duty and number of hours in service per year. The correct classification of a crane is important and should be the joint responsibility of the purchaser and the manufacturer. For guidance a few typical cranes have been classified and shown in Appendix A.

0.3 This standard was first published in 1963. In this revision the permissible stresses for members subjected to fluctuations of stress have been aligned with IS : 1024-1968*, thus, introducing the number of cycles of operation for fatigue calculations. The limits of camber have also been specified.

0.4 This standard is the first in the series of standards relating to cranes and covers the structural design. The other standards in the series covering the mechanical and electrical portions are as follows:

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

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*Code of practice for use of welding in bridges and structures subject to dynamic loading.

0.5 This standard keeps in view the manufacturing and trade practices followed in the country in the field. Assistance has also been derived from the following publications:

DIN 120 : 1936 (Sheet 1) Basic principles of structural details for steel parts of cranes and crane tracks, fundamental of construction. Deutscher Normenausschuss.

BS 2573 : Part 1 : 1960 Specification for permissible stresses and rules for crane design, Part 1 Structures. British Standards Institution.

AISE Standard No. 6-1969 Specification for electric overhead cranes for steel mill service.

0.6 This edition 2.1 incorporates Amendment No. 1 (February 1984). Side bar indicates modification of the text as the result of incorporation of the amendment.

0.7 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.

SECTION I GENERAL

1. SCOPE

1.1 This code covers the structural portion of the design manufacture, erection, and testing of all cranes and hoists, whether riveted or welded.

1.2 This standard does not apply to:

a) lifts;

b) conveyors for the conveyance of materials by means of rubber or other types of belts, chains with battens or scrapers, chains with buckets and similar other appliances; and

c) elevators for the conveyance of materials by means of buckets and similar other appliances.

NOTE — It is not intended that this code shall apply to crane runway girders and supports which form an essential part of the structural frame of a building or structure. The design of such girders should be according to the requirements of IS : 800-1962†.

2. TERMINOLOGY

2.0 For the purpose of this standard, the definitions given in IS : 5532-1969‡ in addition to the following, shall apply.

*Rules for rounding off numerical values (*revised*).
†Code of practice for use of structural steel in general building construction (*revised*).
‡Glossary of terms for cranes.

2.1 Crane — A specially designed structure equipped with mechanical means for moving a load by raising and lowering by electrical or manual operations and, whilst the load is in such a state of motion or suspension, transporting it.

2.2 Hoist — A mechanical appliance whose principal function is the raising and lowering of loads, and shall cover all kinds of hoists, including friction, direct-geared, skip and ship hoists, pulley rope and chain blocks.

2.3 Dead Load — The weight of the crane structural steelwork moving on crane runway girders with all material fastened thereto and supported by it permanently.

2.4 Live Load — The external static load variable in magnitude, position or direction, with respect to the member of structure under consideration. Also called working load.

NOTE — The weight of the trolley (crab) changes its position with reference to the members of the structure and shall, therefore, be considered as live load.

2.5 Rated Lifted Load — The rated lifted load from the mechanism design considerations shall mean the external load lifted and handled by the crane and shall include in addition to the safe working load, weight of rope and lifting tackles such as magnets, grabs, lifting beams, book blocks, but shall exclude wind load.

2.6 Dynamic Effect —The effects on the structure caused by inertia or sudden load application such as acceleration, declaration, breaking, impact and bumping.

2.7 Safe Working Load — The maximum external load excluding the weight of the lifting tackles under specified conditions for which the crane may be used. This may be a variable quantity for a jib crane. If the grab forms an integral part of the suspended gear, then the weight of the gear shall also be included in the safe working load.

2.8 Wind Load — The forces produced by the velocity of wind which is assumed to act horizontally.

2.9 Service Condition — A crane shall be deemed to be under service condition when it is handling in any or all of its motions, a load up to and including the maximum load for which the crane has been designed and, where exposed to wind, is subjected to the stresses resulting from wind velocity specified for safe operation of the crane.

2.10 Basic and Permissible Stresses — All permissible stresses specified in IS : 800-1962*, IS : 806-1968†, IS : 816-1969‡, IS : 1024-1968§

*Code of practice for use of structural steel in general building construction (*revised*).

†Code of practice for use of steel tubes in general building construction (*first revision*).

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

§Code of practice for use of welding in bridges and structures subject to dynamic loading.

and IS : 4000-1967* are the basic stresses for purpose of this code. The permissible stresses in this code are basic stresses multiplied by duty factor and fluctuation factor as applicable.

2.11 Overloading — The load in excess of safe working load expressed as a percentage of the latter which the crane may be subjected to during testing provided for in **13**.

2.12 Slewing Load — Forces induced with respect to axis of rotation due to dead and live loads on the rotating parts of a slewing crane.

2.13 Radius — The horizontal distance from the central line of the lifting hook before loading to the centre about which the jib slews.

2.14 Reach — The horizontal distance from the centre line of the unladen hook to the nearest point of the chassis/underframe with respect to hook.

2.15 Stability Reach — The distance of the jib head pin from the point of intersection of the nearest base line and the vertical plane passing through the centre line of the jib. (The dimension will vary for different positions of the hook in the course of one revolution during slewing, but for the purpose of calculating the stability the maximum value of this dimension is taken.)

2.16 Stability Base — The effective span of the supporting base.

2.17 Blocking-Up Base — The effective span of the supporting base when outriggers, jacks or blocks are used to increase stability by virtue of making contact with the ground at points farther from the centre line of the crane than the normal wheels or tracks.

2.18 Main Hoist Motion —The motion which raises and lowers the load (the full load which the crane is authorized to carry) and the motor doing this work is termed the hoist motor.

2.19 Auxiliary Hoist Motion — When an additional hoisting motion smaller than the main hoisting motion is embodied in a crane, it is known as an auxiliary hoist motion and its motor is termed the auxiliary hoist motor.

2.20 Cross Traverse Motion — The motion of the trolley or crab across the crane span is known as the cross traverse motion and the motor causing such motion, the cross traverse motor.

2.21 Longitudinal Travel Motion — The motion of the whole crane on its gantry or tracks is known as the longitudinal travel motion and the motor causing this motion is termed the longitudinal travel motor.

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

3. GENERAL REQUIREMENTS

3.1 Materials

3.1.1 *Structural Steel* — Structural steel shall conform to IS : 226-1975*, IS : 961-1975† or IS : 2062-1969‡ as appropriate.

3.1.1.1 Any structural steel other than those specified in **3.1.1** may be used provided that the permissible stresses and other design provisions are suitably modified.

3.1.2 *Rivets and Bolts* — Rivets, bolts, nuts and washers shall conform to the following Indian Standards as appropriate:

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*)
IS : 1929-1961	Specification for rivets for general purposes (12 to 48 mm diameter)
IS : 2155-1962	Specification for rivets for general purposes (below 12 mm diameter)
IS : 3138-1966	Specification for hexagonal bolts and nuts (M42 to M150)
IS : 3757-1972	Specification for high-tensile friction grip bolts (*first revision*)
IS : 6610-1972	Specification for heavy washers for steel structures
IS : 6623-1972	Specification for high tensile friction grip nuts
IS : 6639-1972	Specification for hexagon bolts for steel structures
IS : 6649-1972	Specification for high tensile friction grip washers

3.1.3 *Softwood and Hardwood Timbers* — All timbers used in the construction of cranes and their supporting structures shall be carefully selected from those timbers proved satisfactory in service and complying with IS : 3629-1966§.

3.1.3.1 For structures which are likely to be exposed to weather, the more durable species only shall be used.

*Specification for structural steel (standard quality) (*fifth revision*).
†Specification for structural steel (high tensile) (*second revision*).
‡Specification for structural steel (fusion welding quality) (*first revision*).
§Specification for structural timber in building.

3.1.4 *Concrete* — All concrete forming part of the foundations of structures of a crane shall comply with the appropriate requirements of IS : 456-1964*. For the foundations, a minimum grade of M150 concrete shall be used, the levelling course below the foundation may be in grade M100 concrete.

3.1.4.1 The cement used in the foundations shall be ordinary rapid-hardening, and low heat portland cement complying with IS : 269-1967†, or portland blast furnace slag cement complying with IS : 455-1967‡, or portland pozzolana cement complying with IS : 1489-1967§.

3.1.5 Other materials used in association with steel work such as steel forgings, welding electrodes, etc, shall, where appropriate Indian Standard specifications for the materials exist, comply with such specification.

SECTION II LOADS

4. LOADS

4.1 The crane shall be designed to support the most severe combinations of the loads given in **4.2** for the section concerned which may occur simultaneously, with the working load in the most unfavourable position, and with any abnormal loads which may have been included in the purchaser's supplemental specifications.

4.2 Each of the following items shall, where applicable, be taken into account:

a) Dead load;

b) Live load, working load (any abnormal load specified by the purchaser shall also be included in this);

c) Factors for dynamic effects to suit classification of cranes and hoist (*see* **4.4.4.1**);

d) Slewing effect;

e) Wind load (in case of outdoor cranes) (*see* **4.7**);

f) Seismic effect;

g) Erection loads (*see* **4.8**);

h) Temperature effects (*see* IS : 800-1962||); and

j) Luffing effect (in the case of jib cranes).

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*Code of practice for plain and reinforced concrete (*second revision*).

†Specification for ordinary, rapid-hardening and low heat Portland cement (*second revision*)

‡Specification for Portland blast furnace slag cement (*second revision*).

§Specification for Portland-pozzolana cement (*first revision*).

||Code of practice for use of structural steel in general building construction (*revised*).

NOTE — The structure as a whole and each part of it shall be designed to withstand the most adverse effect of any relevant combination of these loads which may occur at the same time with reference to:

a) crane under service condition,
b) crane out of service, and
c) crane being erected or dismantled.

4.3 Classification of Cranes and Hoists — For the purpose of design of their frames, every crane and hoist shall be classified with respect to the frequency of application and variation of magnitude of the load and the effect of impact. Such classification shall be determined in accordance with Table 1.

TABLE 1 CLASSIFICATION OF CRANES AND HOISTS

CLASSIFICATION NO.	WORKING PERIOD	EFFECTIVE LOAD	DYNAMIC EFFECT
(1)	(2)	(3)	(4)
1	Short	Low	Low
2	Long	Low	Low
	Short	High	Low
	Short	Low	High
3	Long	High	Low
	Long	Low	High
	Short	High	High
4 [*see* (a) under Note]	Long	High	High

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

a) All appliances used for raising or lowering persons irrespective of working period, effective load and dynamic effect should come under Classification No. 4.

b) 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.

c) 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.

d) 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 are each less than 100 m per minute, or 130 m per 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 crane 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.

4.3.1 The classification thus determined shall be assumed as the minimum corresponding to the intended duties of the crane or hoist. It shall be permissible, however, to select a classification commensurate with more severe duties as may be desired.

NOTE 1 — For the list of typical classification of cranes and hoist based on Table 1, *see* Appendix A.

NOTE 2 — For brief descriptions of some of the common types of cranes, *see* Appendix B.

NOTE 3 — While the classification determined by Table 1 is considered to apply generally to the whole of the structure of a crane and its supports, it is permissible for design purposes to classify any individual member in a lower classification where the case for relaxation can be substantiated. However, no such relaxation shall be permitted where it might be detrimental to the safety of the crane as used in its general class.

4.4 Factors for Dynamic Effects — In order to make allowance for the dynamic effects, the forces or loads acting upon cranes or any portion thereof shall be multiplied by the relevant factors shown in Table 2 according to the classification of the crane or hoist.

The force or load thus obtained shall be used as described below for each portion.

TABLE 2 FACTORS FOR DYNAMIC EFFECTS

*CLASSIFICATION NO.	DUTY FACTOR	IMPACT FACTOR (APPLIES IN) VERTICAL PLANE)	†FACTOR FOR HORIZONTAL FORCES
(1)	(2)	(3)	(4)
1	1.0	1.1	0.04
2	0.95	1.30	0.05
3	0.90	1.40	0.06
4	0.85	1.5	0.08

*Appendix A gives guidance for the grouping of various cranes for determining the classification of any crane of hoist or part thereof.

†These factors are applicable for cranes other than overhead cranes, for overhead travelling cranes **4.4.3.1** shall apply.

4.4.1 *Duty Factor* — Duty factors given in Table 2 which are related to crane classification, shall be applicable to the basic stresses derived from IS : 800-1962*, IS : 806-1968† and IS : 816-1969‡. The duty factors shall not be applicable to the basic stresses derived from IS : 1024-1968§.

*Code of practice for use of structural steel in general building construction (*revised*).

†Code of practice for use of steel tubes in general building construction (*first revision*).

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

§Code of practice for use of welding in bridges and structures subject to dynamic loading.

4.4.2 *Impact Factor* — The impact factor applied to the motion of the hook in a vertical direction covers inertia forces including shock. In calculating live loads in members of the structure, the rated lifted load shall be multiplied by the impact factor, values of which are given in Table 2 for the various classes of cranes. The impact factor shall not apply to the dead weight of the crane.

4.4.3 *Horizontal Forces*

4.4.3.1 *Overhead travelling cranes* —The girders of the crane shall have sufficient lateral strength and rigidity to enable them to withstand the horizontal forces.

For the purpose of calculation, the horizontal forces shall be assumed to be not less than:

a) $\frac{V}{1\,830}$ of the sum of the safe working load and the weight of the crab, the force being assumed to act at the level of the top of the traversing rails in the centre of the span when determining the flange load and at appropriate points of the span when determining the lateral bracing loads; and

b) $\frac{V}{1\,830}$ of the weight of each girder, inclusive or any attachments thereto, such as auxiliary girders or outriggers, platform and mechanism, the force being assumed to act as a uniformly distributed load throughout the length of the span.

In the fraction $\frac{V}{1\,830}$, V shall be the rated longitudinal travelling speed in metres per minute, and the value of the fraction shall not in any case be less than:

1/20 for Class 2 cranes,

1/15 for Class 3 cranes, and

1/10 for Class 4 cranes.

The stresses arising from these horizontal forces shall be considered in combination with those due to other loads and wind pressure.

4.4.3.2 *Cranes other than overhead travelling cranes* — The horizontal effects due to off-vertical lifting and natural sway of load in motion shall be determined by multiplying the rated lifted load by factors given in col 4 of Table 2.

The load thus derived shall be considered to act in any horizontal direction.

NOTE —The provision for horizontal effects in this clause is not with an idea to permit any intentional off-vertical lifting of loads in the use of cranes, but only to cater for such accidental effects which are not easily recognizable by the crane operator.

4.4.3.3 For mobile cranes, the horizontal effects due to the crane weight shall be determined by multiplying the static weight of such of the structure and mechanisms as are capable of travelling or traversing by factors given in co1 4 of Table 2.

The load thus derived shall be considered as acting in any horizontal direction of the surge of crane upon uneven ground.

4.4.4 *Fluctuations at Stress in Members*

4.4.4.1 Members which are subjected to fluctuations of stress are liable to suffer from fatigue failure and this may be caused by loads which are very much lower than those which would be necessary to cause failure under a single application. The fatigue cracks are caused primarily due to stress concentrations introduced by constructional details. Discontinuities such as bolt or rivet holes, welds and other local or general changes in geometrical form set up such stress concentrations from which fatigue cracks may be initiated, and these cracks may subsequently propagate through the connected or fabricated members.

All details shall, therefore, be designed to avoid, as far as possible, stress concentrations likely to result in excessive reduction of the fatigue strength of members or connections. Care shall be taken to avoid sudden changes of shape of a member or part of a member, especially in regions of tensile stress or local secondary bending.

Except where specifically stated to the contrary, the permissible fatigue stresses for any particular detail are the same for all steels.

4.4.4.2 When subjected to fluctuations of stress the permissible stresses shall be the basic stress stipulated in IS : 1024-1968* for different $\frac{f_{Min}}{f_{Max}}$ for different number of stress cycles and classes of constructional details. The following provisions shall also be considered while determining the permissible stress in members subjected to fluctuations of stress:

a) While computing the value of $\frac{f_{Min}}{f_{Max}}$ the effect of wind, temperature and secondary stress shall be ignored.

b) Where specific stress cycles could not be established, the design may be based on stress cycles indicated in Appendix A.

*Code of practice for use of welding in bridges and structures subject to dynamic loading.

c) For members of steel to Grade Fe 540-W of IS : 961-1975* fabricated or connected with bolts or rivets the construction details shall be considered as Class C of IS : 1024-1968†.

For members of steels conforming to IS : 226-1975‡ and IS : 2062-1969§ fabricated or connected with bolts or rivets the construction details shall be considered as Class D of IS : 1024-1968†.

d) The value of f_{Max} shall not exceed the permissible tensile or compressive fatigue stress as determined from IS : 1024-1968†. Where coexistent bending and shear stresses are present, f_{Max} shall be taken as the principal stress at the point under consideration (*see* **4.4.4.3**).

4.4.4.3 Under no circumstances shall f_{Max} exceed the permissible stresses as derived from IS : 800-1962||, IS : 806-1968¶ and IS : 816-1969**.

4.5 Slewing Effect — For the purpose of determining the effect of slewing in jib-type cranes, the acceleration or retardation at the jib head shall be assumed to be not less than 0.6 m/s^2.

4.6 Temperature Effect —Where any portion of a structure is not free to expand or contract under variations of temperature, allowance shall be made for the stresses resulting from this condition, the coefficients of expansion for each degree Celsius variations of temperature above or below normal being taken as and 0.000 012 for mild steel. Clause **8** of IS : 800-1962|| shall also apply.

4.7 Wind Load

4.7.1 *Basic Wind Pressure* — The basic wind pressures for different regions of India shall be obtained from IS : 875-1964††, except as specified below.

4.7.1.1 Unless otherwise specified, outdoor cranes shall be designed to operate under a steady wind pressure of 245P‡‡ (25 kgf/m^2) over the total exposed area of the crane. For the purpose of calculating wind effect on the lifted load, the area of the load may be taken as one square metre for every tonne of load lifted.

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*Specification for structural steel (high tensile) (*second revision*).

†Code of practice for use of welding in bridges and structures subject to dynamic loading.

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

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

||Code of practice for use of structural steel in general building construction (*revised*).

¶Code of practice for use of steel tubes in general building construction (*first revision*).

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

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

‡‡1P = 0.102 kgf/m^2.

4.7.1.2 *Form factors* — The basic wind pressures shall be considered as acting upon the various surfaces of the component parts of a crane structure, having regard to the shapes of such surfaces and their relative disposition to each other in the direction of the wind.

Total exposed areas normal to the wind direction shall be multiplied by the respective form factors set out in Table 3.

TABLE 3 WIND LOADING FORM FACTORS

SL NO.	SURFACE OR COMPONENT PART OF THE CRANE STRUCTURE	FORM FACTOR
(1)	(2)	(3)
i)	Cabins, machinery house, counterweight boxes or similar prismatic shapes	1.2
ii)	Tower-like enclosed shapes, having a circular or approximately circular section wherein *$d \times \sqrt{p}$ is greater than 1.0	0.7
iii)	Cylindrical shapes, wire ropes, etc, wherein $d \times \sqrt{p}$ is less than 1.0	1.2
iv)	Trussed towers of rectangular cross section with direction of wind normal to one side of such structure, the exposed area being the projected area of all surfaces normal to the direction of wind†	3.0
v)	Trussed towers of rectangular cross section with the direction of wind‡ oblique to the exposed surfaces	3.0
vi)	Trussed towers of triangular cross section with the direction of wind‡ oblique to the exposed surface. Trusses and flat girders (other than those tower-like structures treated above)	3.0
vii)	For one truss or plate girder, or a parallel series thereof situated one behind the other in the direction of the wind, the windward truss or plate girder and also for surfaces girders which project beyond the windward girder — all surfaces normal to the direction of the wind	1.6
viii)	For the second and subsequent parallel trusses of plate girders normal to the direction of the wind and shielded by the windward truss or girder [provided that the distance between the trusses is less than the exposed width (that is measured in a vertical plate) of the truss members and the distances between the plate girders is less than the depth of the girder]	0.0
ix)	For the second and subsequent parallel trusses or plate girders normal to the direction of the wind and shielded by the windward truss or girder wherein the distance between them is greater than but does not exceed three times the distance given in item (viii)	1.2
x)	For the second and subsequent trusses or plate girders normal to the direction of the wind but more than three times the distance apart given in item (viii)	1.6

*d = diametre in m; p = basic wind pressure in kgf/m^2 (*see* IS : 875-1964§).

†To simplify the computation, it may be assumed that each side of the structure takes one-half of the wind load.

‡For oblique wind loading, the loadings shall be so distributed as that their components act at right angles and parallel to the surface of the structure.

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

4.7.1.3 *Cranes at rest in the unloaded condition* — Only outdoor cranes should be designed for conditions of maximum wind as given in IS : 875-1964* (or as stipulated by the purchaser to suit any special conditions) and may be assumed to be unloaded and at rest.

4.8 Erection Loads — Clause **7** of IS : 800-1962† shall apply.

4.9 Seismic Loads

4.9.1 The seismic coefficient in some important towns in India and the map of India showing seismic are given in IS : 1893-1970‡.

5. LOADING OF PLATFORMS AND STAIRS

5.1 Platforms in general are to be proportioned for a moving single load of 300 kg. This load can be neglected in the design of all constructional members (for example, principal girders) subjected to the loads specified under **4**. Railings are to be proportioned for a travelling horizontal single load of 30 kg acting on the rail iron.

5.2 In the case of stairs a single moving load of 100 kg shall be considered.

6. PERMISSIBLE STRESSES

6.1 The permissible stresses shall be lower of the values given in (a) and (b) below:

a) Basic stresses derived from IS : 800-1962†, IS : 806-1968§ and IS : 816-1969|| multiplied by duty factors given in Table 1; or

b) Permissible stresses in members subject to fluctuations of stress determined according to **4.4.4**.

6.2 The crane and its structural members shall be proportioned in such a way that the actual stresses, for the combination of loading causing most adverse effect on the members as specified in **4** arrived at by any of the accepted methods of calculation shall not exceed the permissible stress specified in **6.1**.

7. GENERAL DESIGN

7.1 The crane and its structural components shall be designed in accordance with the appropriate clauses in Section IV of IS : 800-1962† and in clause **6** of IS : 806-1968§.

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

†Code of practice for use of structural steel in general building construction (*revised*).

‡Criteria for earthquake resistant design of structures (*second revision*).

§Code of practice for use of steel tubes in general building construction (*first revision*).

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

7.2 Basic Stresses in Bending for Lattice Girders and Trusses

7.2.1 *Lattice Box Girders* — For lattice box girders having overall l/r_y not exceeding 140 and a depth to breadth ratio not exceeding 6, the basic stresses shall not exceed those given in IS : 800-1962*. Lattice box girders having a depth to breadth ratio exceeding 6 shall be designed as lattice trusses. The girder shall be stiffened to prevent distortion of the cross sectional shape when the girder deflects.

7.2.2 *Lattice Trusses* — The main compression members of a lattice truss shall be designed as axially loaded struts using the basic compressive stresses given in Table 2 of IS : 800-1962* and the effective lengths defined in **8**.

7.3 Maximum Slenderness Ratio

7.3.1 *Compression Members* — The ratio of the effective length l to the least radius of gyration for compression members shall not exceed 180 for main members and 240 for wind bracing and subsidiary members.

7.3.2 *Solid Web Girders* (*Plate Girders and Rolled Beams*) — The slenderness ratio l/r of a girder shall not exceed 300 and it shall not exceed 150 for cantilevers.

7.3.3 *Box-Plate Girders* — The ratio of effective length of the compression flange of the girder l to the breadth of flange of the girder b shall not exceed the following limits:

Riveted box-plate girders $l/b \leq 65$

Welded box-plate girders $l/b \leq 60$

7.4 Limiting Deflection

7.4.1 The deflection of members or the structure as a whole (without taking into consideration the impact factor) should not be such as would impair the strength or efficiency of the structure or lead to damage to finishing. In the case of overhead travelling cranes the girders shall be designed so that the vertical deflection caused by the safe working load and the weight of the crab in the central position (without taking into consideration the impact factor) shall not exceed 1/900 of the span.

7.4.2 *Camber* — Camber shall be nil or positive neutralizing the deflection. The limit shall be span/1 000 for EOT cranes and span/800 for hand-operated cranes.

7.5 Web Stiffeners — For the purpose of clause **21.7** of IS : 800-1962* which is generally applicable for designing crane details, diaphragms in the case of box-plate girders shall be treated as stiffeners.

*Code of practice for use of structural steel in general building construction (*revised*).

7.6 Connections — In general, clause **26** of IS : 800-1962* applies, but for the connections of bridge girders to end carriages in overhead cranes where it is essential that the girders have lateral end-fixity and resistance against torsional loads, clause **26.1.1** of IS : 800-1962* shall be applied.

8. EFFECTIVE LENGTHS

8.1 The effective length of struts, comparison flanges of rolled beams and plate girders, members of lattice girders and cantilever beams shall be as specified in IS : 800-1962*. For effective length of jibs, *see* Appendix C.

9. STABILITY

9.1 General — The following clauses shall apply to the crane and structure as a whole under the effects of wind pressure and/or load lifted. In determining the margin of stability, rail grips shall not be taken into account.

9.2 Stability Under Storm Conditions — The stability of a crane under storm conditions shall be such that the stabilizing moment is at least 1.25 times the overturning moment due to the maximum wind effects provided for under **4.7**.

9.3 Stability Under Service Conditions — The ratio of stabilizing moments to the overturning moments shall be not less than the values given below:

a)	Where the crane is equipped with an effective device that warns the driver when stabilizing moment has been reduced by more than 10 percent	1.25
b)	Where the crane is not so equipped	1.50
c)	Mobile or caterpillar cranes and cranes used in building or construction work not capable of freely lowering their loads with sufficient speed to avert the overturning of the crane in an emergency	1.50

9.3.1 The provisions under **9.3** are generally applicable except as provided below.

9.3.1.1 *Mobile cranes* (*road wheel or caterpillar track mounted*) — The margin of stability shall be calculated for the condition when the crane is working on hard level ground and the jib is in the position giving the greatest overturning moment. When pneumatic types are fitted, it shall be assumed that these are inflated to the correct working pressure.

*Code of practice for use of structural steel in general building construction (*revised*).

The margin of stability, expressed as a percentage, shall be not less than:

$$\frac{\text{Maximum stability reach}}{\text{Stability base}} \times 12$$

and shall be not less than 50 percent on a gradient of 1 in 40.

The stability reach will vary for different positions of the hook in the course of one revolution during slewing, but the maximum value of the dimensions shall be taken when computing the margin of stability (*see* **2.13** to **2.17** and Fig. 1 to 3).

NOTE —The margin of stability is the percentage additional load required to bring the crane to the condition of tipping when it is handling the safe working load at any radius.

For a crane designed to travel with load, the wheels or tracks shall be used to determine the 'stability base', but for cranes which require to be blocked up when dealing with loads, the blocking up base shall be deemed to be the base of support.

NOTE — The principal factor in the calculation of stability is the ratio of 'reach' to 'base', dimensions, and the factor of 12 in the above formula provides a suitable excess of righting moment over the maximum overturning moment to allow for normal working conditions such as braking forces, ground surface irregularities, and wind pressure on both crane and load.

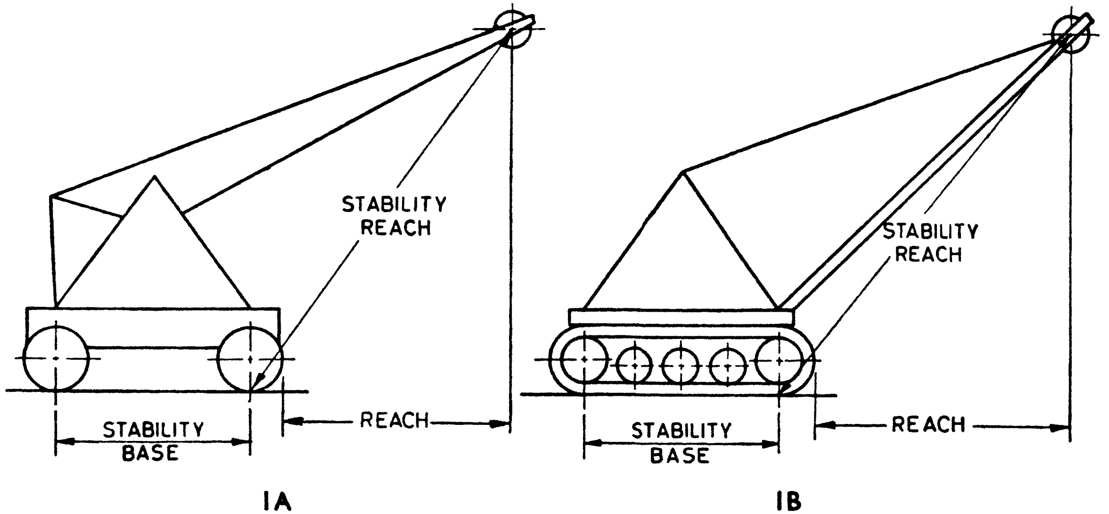
Cranes mounted on pneumatic types, except those which require the use of outriggers to enable them to handle their designed load, shall be stable with the rated loads in any position when one tyre is deflated.

All cranes shall be stable in a backward direction when travelling forward or backward, and up or down a smooth hard gradient having the maximum slope specified by the manufacturer. They shall also be stable in any position without load when stationary on a gradient of 1 in 5. In all cases the jib shall be at the minimum working radius.

The cranes shall be stable with the jib removed when travelling on a gradient of 1 in 20.

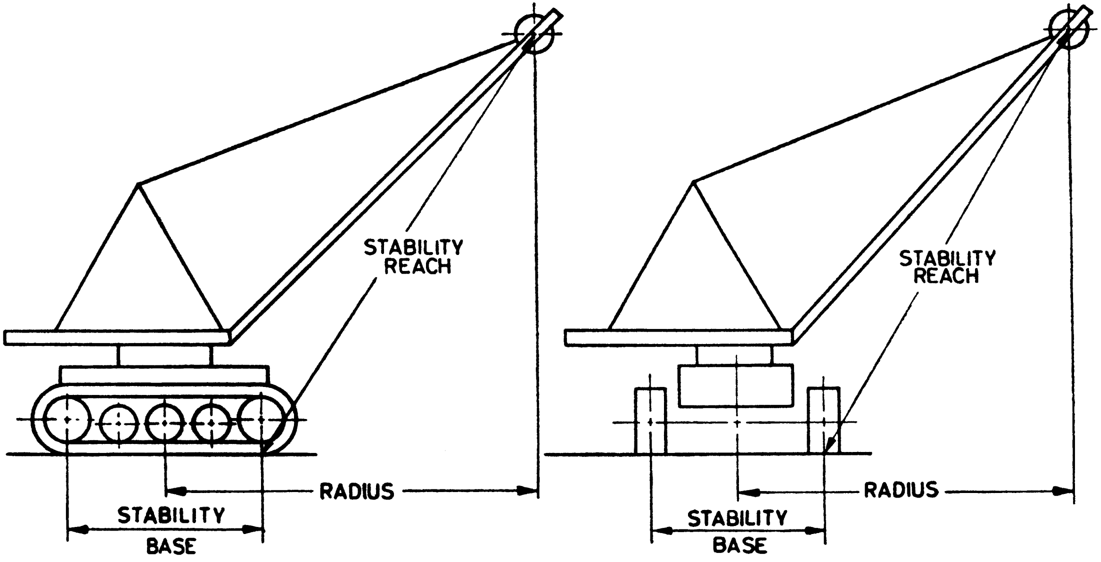
NOTE — It is recommended that in determining the stability of a crane used with a grab or magnet, an equivalent hook load of 1.33 times the combined weight of the load and the grab should be assumed.

9.3.1.2 *Floating cranes of all types, including pontoon butts, square or swimended, ship-shaped, self-propelled or dumb* — The stability of hulls of floating cranes shall be such that, under maximum condition of loading, the hulls shall have a reasonable excess righting (stabilizing) moment over the overturning moment imposed by the conditions of maximum loading with the crane jib in any position.

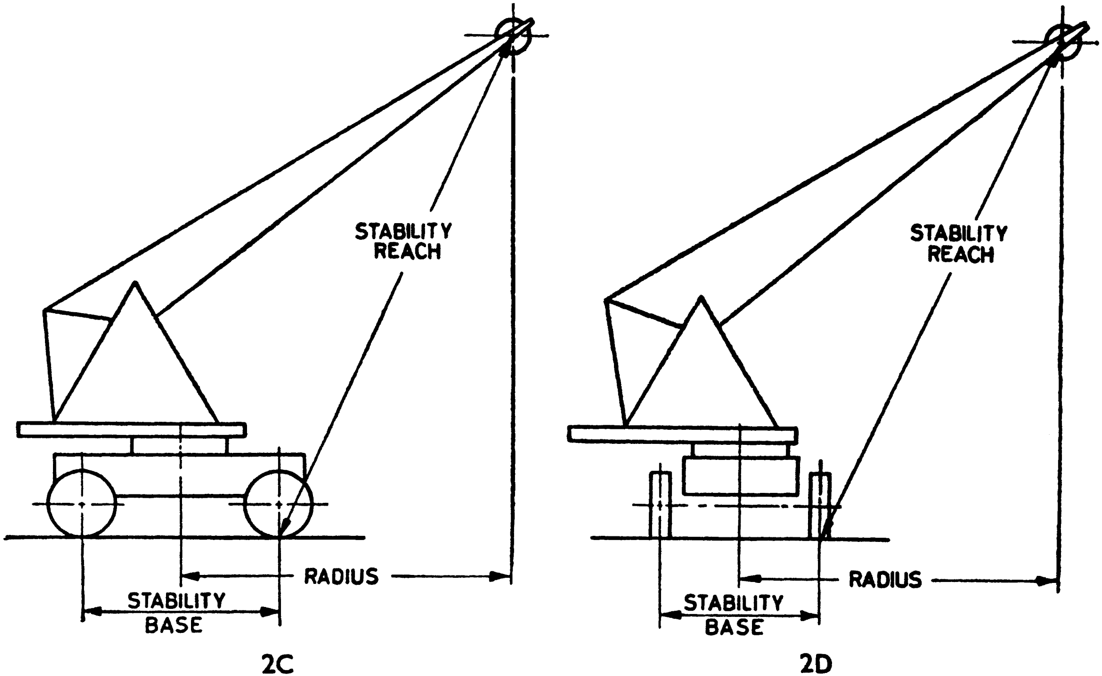


These diagrams illustrate typical examples but do not purport to include all possible alterations of jibs and chassis.

FIG. 1 ILLUSTRATIONS OF TERMS 'STABILITY BASE', 'STABILITY REACH' AND 'REACH' FOR NON-SLEWING 3- OR 4-POINT SUSPENSION CRANES

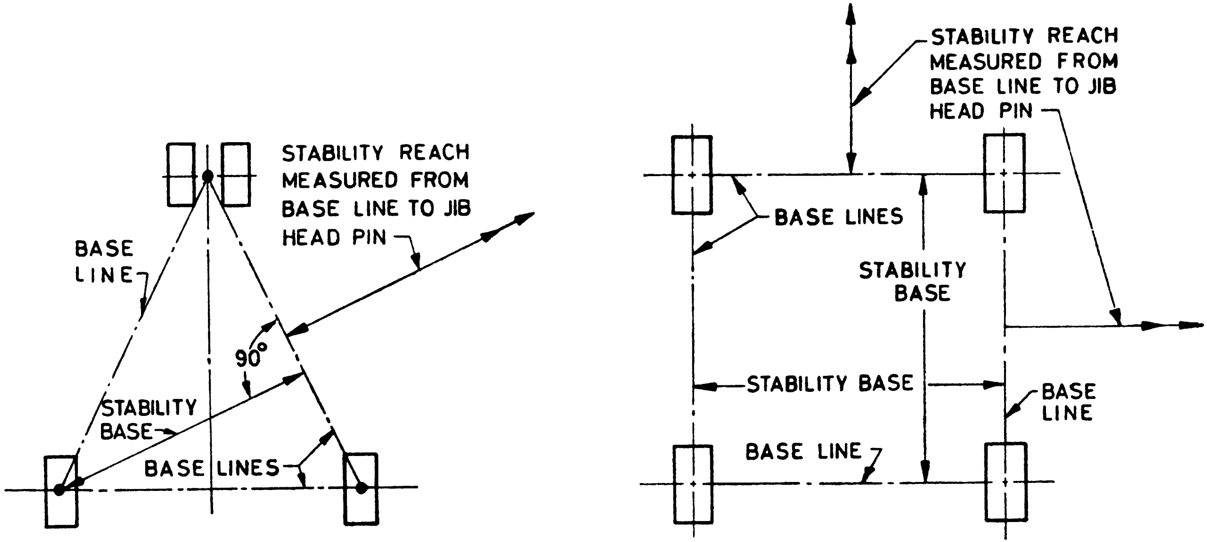

STABILITY REACH
RADIUS
STABILITY
BASE
STABILITY REACH
RADIUS
STABILITY
BASE

2A 2B



These diagrams illustrate typical examples but do not purport to include all possible alterations of jibs and chassis.

FIG. 2 ILLUSTRATIONS OF TERMS 'STABILITY BASE', 'STABILITY REACH' AND RADIUS FOR 4-POINT SUSPENSION SLEWING CRANES (INCLUDING LORRY-MOUNTED TYPE)



3A 3B

FIG. 3 ILLUSTRATIONS OF 'STABILITY BASE', 'STABILITY REACH' FOR 3- AND 4-POINT SUSPENSION SLEWING CRANES (DIAGRAMS OF PLAN VIEW)

The subdivision of the hulls by bulkhead shall be so arranged as to eliminate excess movement of loose water in the bottom. Any additional external trimming tanks shall be so arranged as to be fully water-borne when the floating crane as a whole is in normal trim. Provided that the foregoing conditions are satisfied, the angle of heel shall be limited to not more than 4 degrees or, alternatively, the free-board under maximum load conditions shall be limited to a minimum of 10 percent of the depth of the hull, whichever is greater.

9.3.1.3 In determining the stability of a crane used with a grab, a minimum equilibrium work load of 1.4 times the combined weight of the load and grab should be assumed.

10. CLEARANCE

10.1 Suitable clearances shall be provided for the safe operation of the crane.

11. RATIO OF CRANE SPAN TO END CARRIAGE WHEEL BASE

11.1 The wheel base shall be:

a) for cranes up to and including 20 m span, not less than one-fifth of the span;

b) for cranes over 20 m span and up to 25 m, not less than 4 m; and

c) for cranes of 25 m span and over, not less than one-sixth of the span.

12. FABRICATION AND ERECTION

12.1 The general provisions in Sections V and VI of IS : 800-1962* are also applicable to the fabrication and erection of cranes. Where welding is adopted, reference to appropriate provisions of the relevant Indian Standards codes of practice shall be made.

13. TESTING

13.1 Before putting the crane into operation, it shall have all motions tested with the hook carrying (a) the safe working load, and (b) 25 percent overload.

13.1.1 During the 25-percent overload test the geared speeds need not be attained but the crane shall show itself capable of dealing with the overload without difficulty.

*Code of practice for use of structural steel in general building construction (*revised*).

13.1.2 The deflection test shall be carried out with the safe working load at rest and with the crab in a central position. The measurement shall not be taken on the first application of the load. The datum line for measuring the deflection should be obtained by placing the crab on the extreme end of the crane span with smaller hook approach.

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

13.2 A certified record of the test figures shall be supplied to the purchaser.

APPENDIX A

[*Clauses* 0.2 *and* 4.4.4.2 (b)]

TYPICAL CLASSIFICATION OF CRANES AND HOISTS, IMPACT FACTOR AND FATIGUE FACTOR

The list of crane and hoist classification given below is intended to be typical only and is not to be used for the ultimate classification, for which purpose Table 1 shall be used:

Type of Crane	Description of Their Duty and Examples	Number of Hours in Service per Annum	Classification No.	Number of Cycles for Fatigue Calculations	Impact Factor (Applies in Vertical Plane)	Factor for Horizontal Forces
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Electric overhead travelling cranes	Cranes for occasional use only, such as engine and power house cranes, hand and light power operated cranes	Up to and including 1 000	1 or 2	10^5	1.1	*See* Clause **4.4.3.1**
	Medium-duty industrial cranes for intermittent use in stores and light machine shops, such as maintenance cranes, giant cranes; fixed and travelling gantries cranes; and ice works cranes	Up to and including 2 000	2	6×10^5	1.3	*See* Clause **4.4.3.1**
	For general use in factories, workshops and warehouses, such as heavy-duty industrial cranes for non-ferrous foundries, heavy engineering shops, stockyard, railways goods yards, light iron foundries; underslug jib cranes and mast cranes; machine shop secondary cranes; and shipbuilding cranes	Above 2 000 up to and including 3 000	2	6×10^5	1.3	*See* Clause **4.4.3.1**

Type of Crane	Description of Their Duty and Examples	Number of Hours in Service per Annum	Classification No.	Number of Cycles for Fatigue Calculations	Impact Factor (Applies in Vertical Plane)	Factor for Horizontal Forces
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Steelworks service and light process cranes, heavy-duty foundry works, light magnet and grabbing duty, such as overhead travelling cranes not elsewhere included; and travelling gantry derrick cranes	Over 3 000	3	2×10^6	1.4	*See* Clause **4.4.3.1**
	Continuous process cranes for steel-works, such as continuous magnet work, continuous grabbing duty, and skull breaker cranes (except light duty types)	Over 4 000	4	4×10^6	1.5	*See* Clause **4.4.3.1**
Electrically driven jib cranes mounted on a high pedestal or portal carriage	For lifting occasional heavy loads but whose use at full load is infrequent, such as fitting-out cranes; tower and portal cranes, and hammerheaded cranes, cupola hoists for light and medium cranes; and over-braced or underbraced jib cranes	Up to and including 2 000	2	6×10^5	1.3	0.05
	Cranes designed for the general working of cargo	Over 2 000 up to and including 3 000	2	6×10^5	1.3	0.05
	Cranes designed for grabbing and magnet duties, handling full rated load for long periods, such as lifting magnets	Over 3 000	3	2×10^6	1.4	0.06

Mobile power driven cranes	Ordinary duty, such as floating cranes, and stacking crane	Up to 2 000	2	6×10^5	1.3	0.05
	Severe duty as at decks, such as shipbuilding cranes, and sprung mobile cranes (other than vehicular used in building and construction works)	Over 2 000 up to and including 3 000	2	6×10^5	1.3	0.05
	Severe duty dock cranes, such as unsprung mobile cranes, back and front end loaders, and fork lift trucks	Over 3 000	3	2×10^6	1.4	0.06
Travelling jib cranes (contractor's type)	Ordinary duty	Over 2 000 up to and including 3 000	2	6×10^5	1.3	0.05
	Severe duty (power) vehicular cranes used in building and constructional works	Over 3 000	3	2×10^6	1.4	0.06
Derrick cranes	Hand operated	Up to and including 1 000	1	10^5	1.1	0.04
	Power-driven for ordinary duty	Up to and including 3 000	2	6×10^5	1.3	0.05
	Power-driven for severe duty as for grabbing duties or at docks	Over 3 000	3	2×10^6	1.4	0.06
Transporters	Ordinary duty	Up to and including 3 000	2	6×10^5	1.3	0.05
	Severe duty, such as grabbing or magnet work at high speed	Over 4 000	4	4×10^6	1.5	0.08

Type of Crane	Description of Their Duty and Examples	Number of Hours in Service per Annum	Classification No.	Number of Cycles for Fatigue Calculations	Impact Factor (Applies in Vertical Plane)	Factor for Horizontal Forces
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Miscellaneous	Naval cranes and excavators, such as cranes and hoists used in connection with underwater operations, and hoists for raising or lowering persons	Over 4 000	4	4×10^6	1.5	0.08
	Winches or hoists used in buildings and construction works, sheerlegs and gallows frames, shipbuilding cranes not elsewhere included, pile drivers and pile tilters, and monorail runway hoists	Over 2 000 up to and including 3 000	2	6×10^5	1.3	0.05
	Locomotive cranes, such as cranes and hoists used for pulling piles or sheel piles; catterpillar cranes; concentrates, ore, coal or cargo handling cranes; and logging cranes and logging winches	Over 3 000	3	2×10^6	1.4	0.06

APPENDIX B

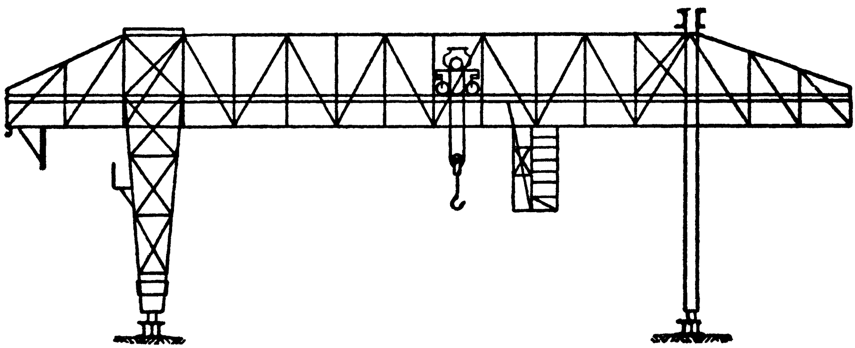
(*Clause* 4.3.1)

BRIEF DESCRIPTION OF SOME OF THE COMMON TYPES OF CRANES AND EXPLANATION OF TERMS

B-1. GANTRY CRANE

B-1.1 Gantry crane is essentially an elevated horizontal runway girder (or girders) connected at or near both ends to vertical or inclined members, fixed in location, or arranged to traverse along a fixed track, and having mounted on the girder (or girders) a trolley or crab equipped with a means for hoisting and capable of travelling along the girder (or girders).

NOTE — In addition to the usual type of gantry crane, cranes such as the Goliath with cantilever arms, the bridge type with overhung cantilevers, radial and stationary transporters, or bridges and other like appliances are covered by this definition.



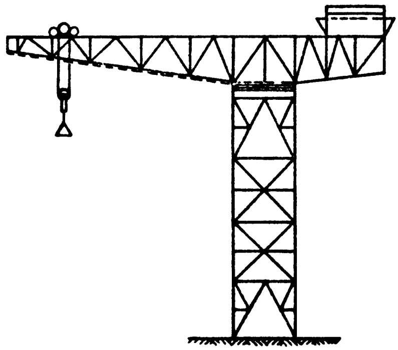
(Goliath with Cantilever Arms)

FIG. 4 GANTRY CRANE

B-2. CANTILEVER CRANE

B-2.1 Cantilever crane consists essentially of a vertical and a horizontal structural members, equipped with a hoisting mechanism fixed to the horizontal member, or a trolley or crab equipped with a hoisting mechanism travelling along such horizontal member. The horizontal member may be fixed to or rotate about the axis of the vertical member with its support arranged substantially through such axis. The crane as a whole may be fixed in location, or arranged to travel along a fixed track.

NOTE — Such cranes include the hammerhead, revolving cantilever, foundry wall cranes and other similar types.



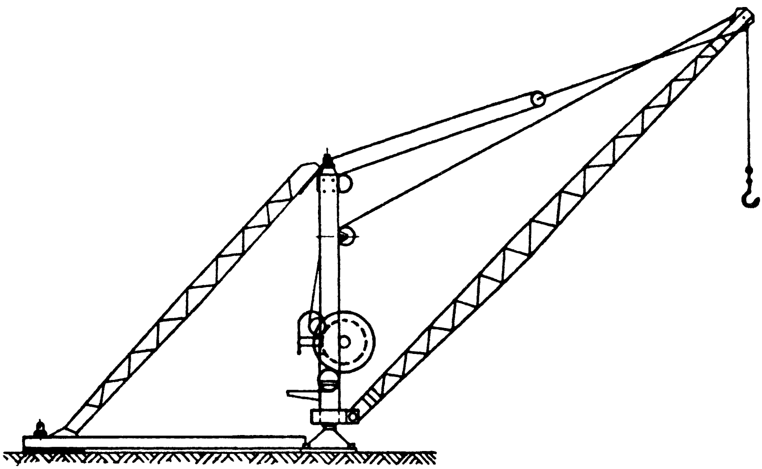
(Rotating Hammerhead Type also Known as Monotower Crane)

FIG. 5 CANTILEVER CRANE

B-3. JIB CRANE

B-3.1 Jib crane, used in conjunction with a hoisting mechanism, consists essentially of a structural member or a jib, horizontal or inclined, capable of carrying a load at its outer end, the jib being supported by a compression or tension member or a combination of both, a rope being considered a member.

NOTE — Such cranes include scotch or stiffleg derricks, guy derricks, locomotive, pedestal, travelling, wall, roof, luffing, bicycle or mono-rail jib, floating cranes, floating sheerlegs, and other similar types.



(Hand-Operated Scotch Derrick Type)

FIG. 6 JIB CRANE

B-4. OVERHEAD TRAVELLING CRANE

B-4.1 Overhead travelling crane consists essentially of a girder (or girders) attached at each end to carriages, travelling along elevated tracks fixed in location, and a trolley or crab equipped with a hoisting mechanism, travelling along such girder (or girders).

NOTE — Such cranes include overhead travellers with double trolleys or with an underhung jib, overhead charging machines, soaking pit strippers, ladle or magnet cranes, or other similar types.

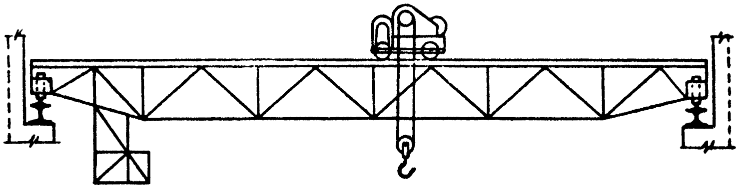


FIG. 7 ELECTRIC OVERHEAD TRAVELLING CRANE

B-5. PORTAL CRANE

B-5.1 Portal crane is a fixed or revolving type jib crane mounted upon a portal frame fixed in location or arranged to travel along a fixed track of rails at the same level, the portal frame consisting essentially of horizontal girders connected at both ends to vertical or inclined members of the same length.

NOTE — Such cranes include some types of wharf cranes and shipyard cranes (tower cranes).

B-6. SEMI-PORTAL CRANE

B-6.1 Semi-portal crane is a fixed or revolving type jib crane mounted upon a semi-portal frame fixed in location or arranged to travel along a fixed track of rails at different levels, the semi-portal frame consisting essentially of horizontal girders connected at both ends to vertical or inclined members of different lengths, of which the shorter members may consist only of the trolley running along the elevated rail.

B-7. MOBILE CRANE (POWER-DRIVEN)

B-7.1 Mobile crane (power-driven) includes all types of travelling jib cranes such as road wheel mounted, 'off-the-road' wheel mounted, or caterpillar tracked and capable of raising and/or lowering a load and travelling under its own power with speed limitations if the load is suspended (*see* Fig. 1, 2 and 3 for illustration of mobile crane).

NOTE — Fork lift trucks are not included under this definition.

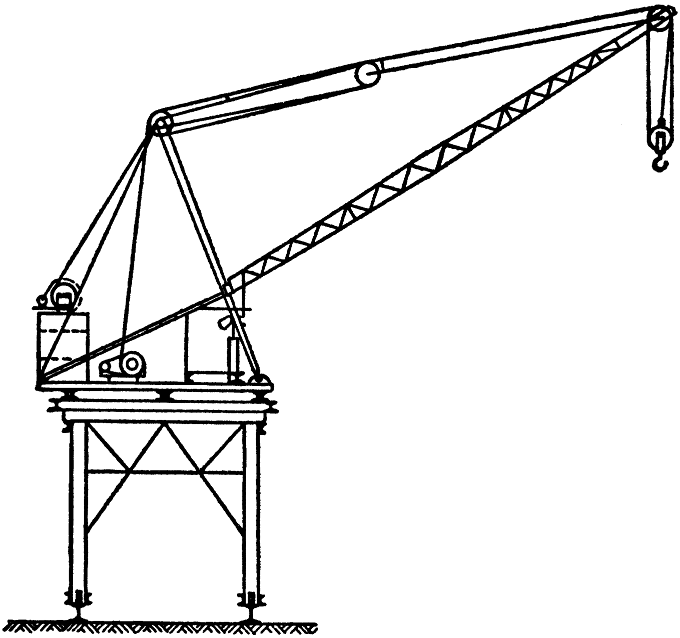


FIG. 8 PORTAL JIB CRANE

B-7.1.1 Mobile cranes, whether road wheel mounted, 'off-the-road wheel mounted, or tracked, are classified under the following types.

B-7.1.1.1 *Cranes other than lorry chassis mounted*

Type A *Mobile full-slewing crane* — a crane having a specially designed chassis on which is mounted a superstructure capable of unlimited slewing in either direction under load and of travelling under its own power with its load suspended at any position within its area of slewing.

Type B *Mobile part-slewing crane* — a crane otherwise similar to Type A but having a limited area of slewing in either direction.

Type C *Mobile non-slewing crane* — a crane otherwise similar to Type A but having a non-slewing superstructure, the slewing motion being obtained by manoeuvring the complete crane by means of the chassis steering and travelling mechanism.

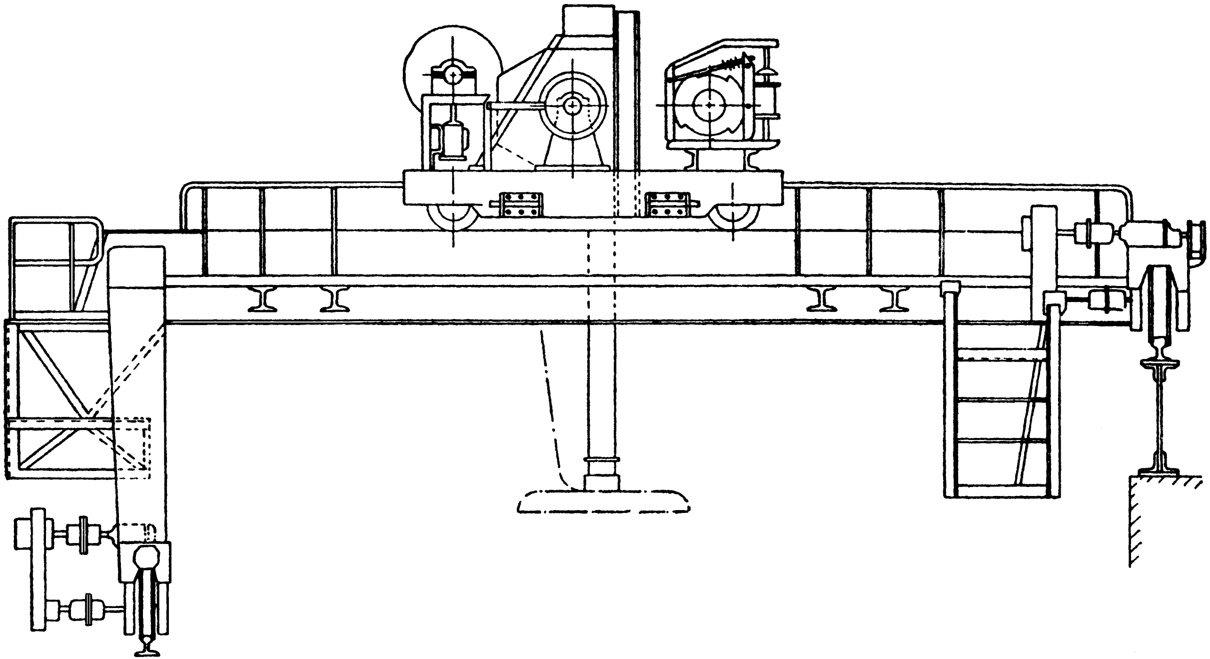


FIG. 9 SEMI-PORTAL CRANE

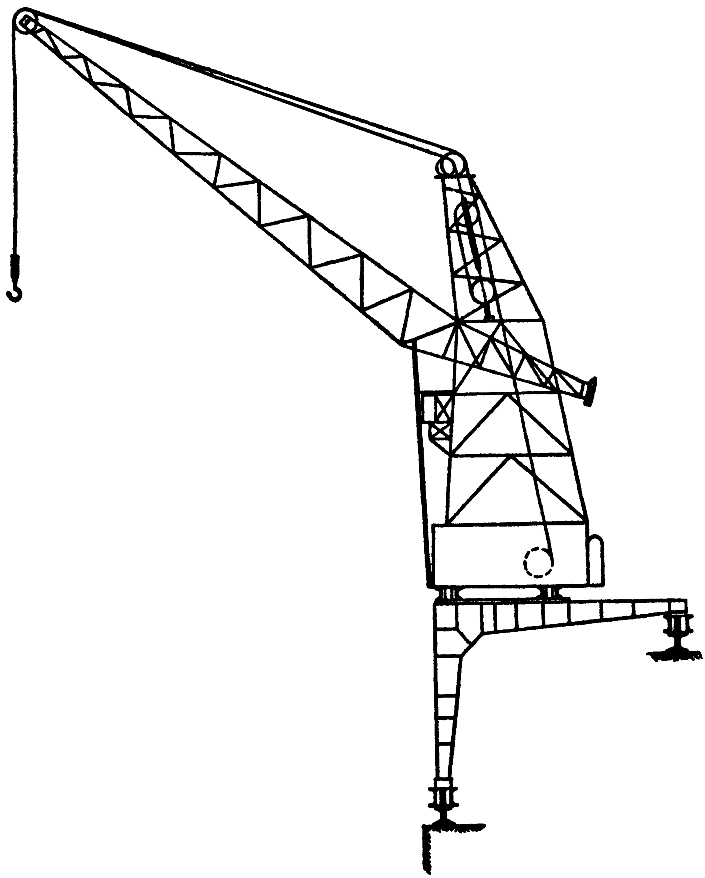


FIG. 10 SEMI-PORTAL WHARF CRANE

B-7.1.1.2 *Lorry chassis mounted cranes*

Type D *Lorry mounted mobile full-slewing crane* — a crane mounted upon a chassis having characteristics substantially the same as those of a lorry and possessing the usual lorry arrangement of engine transmission and road sheets or tracks with or without springs. The arrangement of the superstructure and handling of loads is similar to that of Type A.

Type E *Lorry mounted mobile part-slewing crane* — a crane having a chassis as described for Type D but possessing a superstructure and load handling capabilities as described for Type B.

Type F *Lorry mounted mobile non-slewing crane* — a crane having a chassis as defined for Type D but possessing a superstructure and load handling capabilities as defined for Type C.

Type G *Semi-mobile crane* — a crane which substantially complies with the requirements of any of the above types except that it requires the use of outriggers to handle the designed maximum load, or has other limitations with regard to travelling with loads.

B-8. DERRICK OR GINPOLE

B-8.1 Derrick or ginpole is a strut with guys so arranged as to permit of the inclining of the strut in any direction, the load being raised or lowered by a hoisting mechanism.

B-9. GUY DERRICK

B-9.1 Guy derrick is a structure consisting of a mast capable of being rotated, and supported in a vertical position by not less than six guys. The mast carries a jib, the head of which is tied to the mast, the load being raised or lowered by a hoisting mechanism.

B-10. STIFFLEG (BUILDER'S) DERRICK

B-10.1 Stiffleg (builder's) derrick is a crane consisting of a mast, a jib connected to the base of the mast, and a hoisting mechanism, with the additional motions of slewing and (but not necessarily) luffing the jib.

The top of the mast is generally supported by two rigid inclined members (back legs) normally connected to the lower support of the mast by horizontal members (sleepers).

B-11. POST CRANE

B-11.1 It is a crane fixed in position and consisting of a vertical member supported at the top and bottom, a horizontal member rigidly connected to it and a hoisting mechanism, the whole being capable of being slewed. The hoisting mechanism may be arranged to operate at fixed or variable radius along the horizontal member.

B-12. TOWER CRANE

B-12.1 It is a crane of the fixed or travelling type which by virtue of the height of its supporting tower frame is capable of hoisting, luffing and slewing its loads over high obstructions.

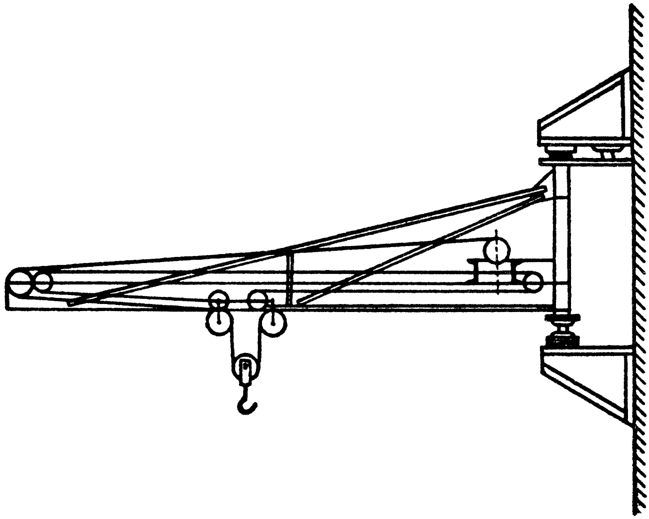


FIG. 11 POST CRANE (SWING JIB TYPE)

The crane may be supported upon and obtain its slewing motion from a slewing ring mounted upon a tower, or from a revolving member or a footstep bearing within the tower.

B-13. LOCOMOTIVE CRANE

B-13.1 Locomotive crane shall mean a crane having a specially designed wheel mounted frame carrying a superstructure capable of slewing, in either direction under load.

The crane shall be capable of travelling under its own power along a railway track with speed limitations if the load is suspended at any position within its area of slewing.

The larger cranes of this type, used for railway salvage purposes, are generally provided with outriggers.

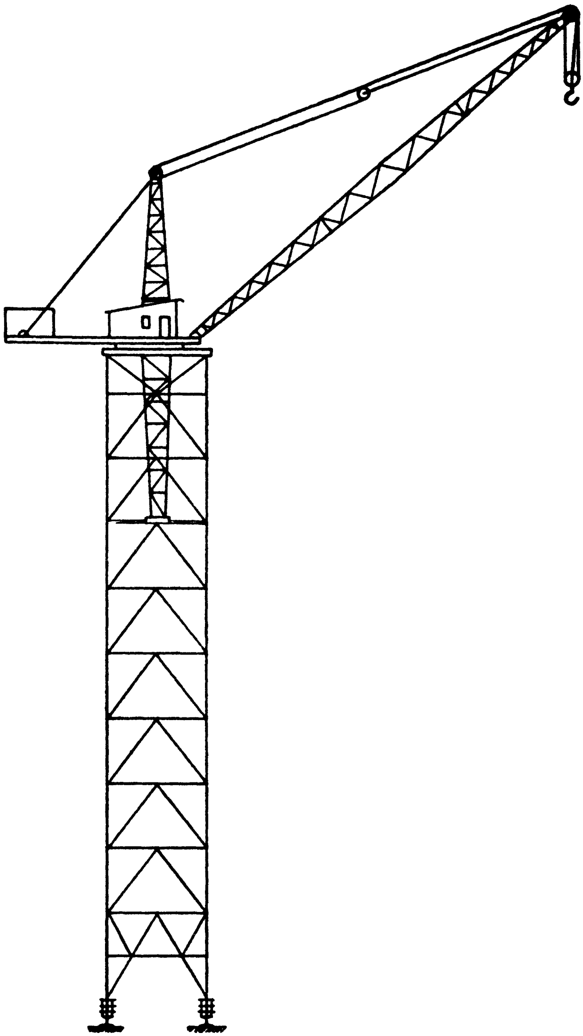


FIG. 12 TOWER CRANE (OR TOWER DERRICK CRANE)

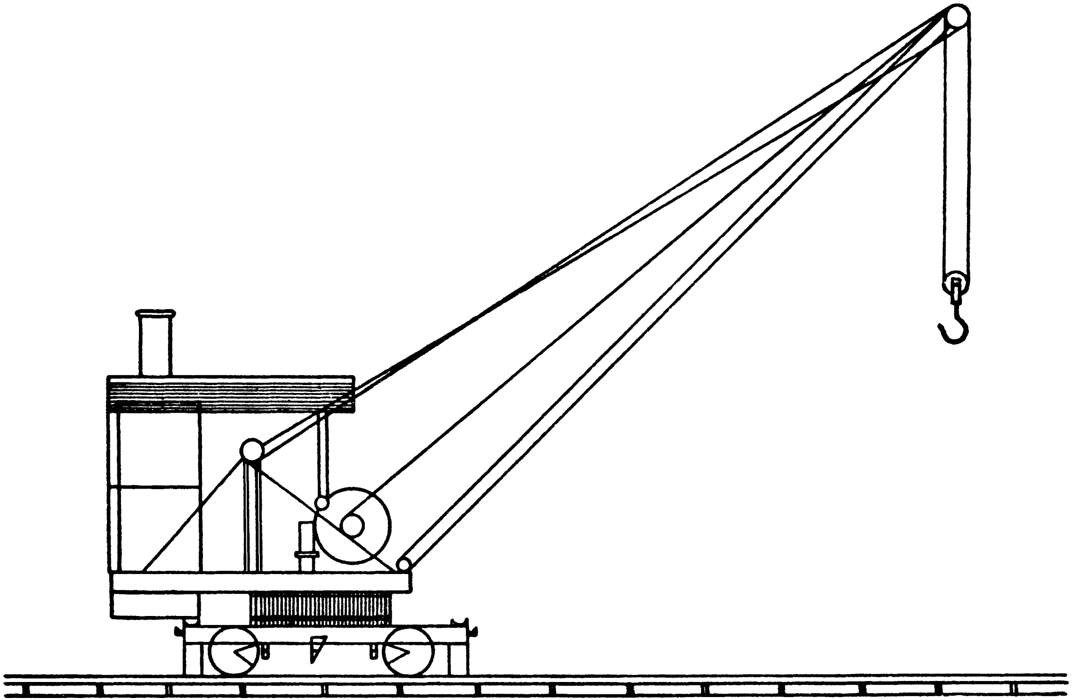


FIG. 13 LOCOMOTIVE CRANE ON RAILS

B-14. SHEER LEGS

B-14.1 Sheer legs are a pair of compression members inclined towards each other, rigidly connected at their upper ends, fixed in position, but not in direction, at their lower ends, and held in an inclined position, fixed or variable, by ties, and provided with a hoisting mechanism. Their principal function is raising and lowering of loads, but may include a limited luffing motion. They may be fixed or mobile (including pontoon-mounted).

B-15. CABLE-WAYS

B-15.1 Cable-Way (Fixed Type) — This is a system of one or more catenary cables supported at each end by fixed towers or masts, provided with a travelling carriage (flying fox) and a hoisting mechanism located at either tower or mast, by means of which carriage the load may be raised, traversed and lowered.

For this type, the load can be moved in a vertical plane only.

B-15.2 Cable-Way (Traveling Type) — This is a cable-way otherwise similar to the fixed type but provided with either two travelling towers, or one fixed and one travelling tower.

For this type, the load can be moved in both vertical and horizontal planes.

B-16. DRAGLINE EXCAVATOR

B-16.1 This is generally a track-mounted crane of the fully slewing and luffing self-propelled type, provided with an excavator bucket at the end of the main hoist line from the jib head and a haulage line from the bucket back to the winding mechanism at the foot of the jib.

Such excavators may be converted to jib cranes by removal of the bucket and its haulage line, with or without alterations to the length of the jib.

APPENDIX C

(*Clause* 8.1)

EFFECTIVE LENGTHS OF CRANE JIBS, CONSIDERED AS UNIFORM STRUTS

C-0. In this appendix, crane jibs are considered as uniform struts from the point of view of buckling in elevation and plan. The overall slenderness ratio (l/r) of the jib in each plane can be obtained by dividing the effective length of the jib by the least radius of gyration of the complete jib section occurring in the middle third of the actual length. It should be noted that the effective length and the radius of gyration taken must be those applicable to that plane of the jib for which the slenderness ratio is required.

The middle third of the actual length of the jib extends along the jib for a distance of $L/3$ measured from a point which is $L/3$ from the jib head.

C-1. ROPE SUPPORTED JIBS

C-1.1 The following refers only to luffing crane jibs in which the jib head is supported by the derricking rope, and the hoist rope runs over the jib head pulley. The side elevations of typical arrangements are shown in Fig. 14 to 16.

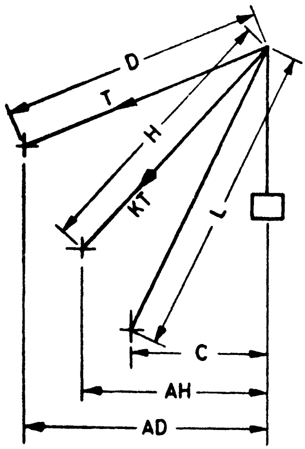


FIG. 14 GENERAL CASE FOR DETERMINING EFFECTIVE LENGTH OF JIB

a) *In Elevation* — Considering buckling in the luffing plane, it is clear that both ends of the jib of a luffing crane are fixed in position but free to rotate. For all positions of the jib the effective length can thus be taken as equal to the actual length ($l = L$).

b) *In Plan* — The lower end of the jib can be considered as completely restrained in the slewing plane by the jib pivots. The jib head is supported by the derricking rope and the hoist rope runs over the jib head pulley. The effective length of the jib in plan will thus depend upon the lateral restraint applied to the jib head by these supporting ropes, and will vary with the angle of the jib and the tensions in the two ropes.

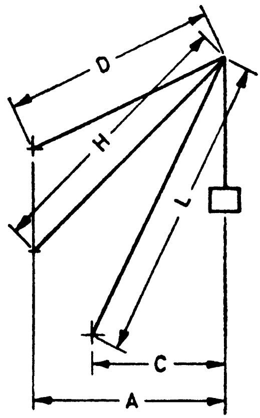


FIG. 15 SPECIAL CASE WHERE FIXED PULLEYS FOR DERRICKING AND HOIST ROPES ARE IN ONE VERTICAL LINE

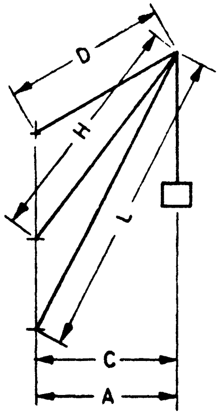


FIG. 16 SPECIAL CASE WHERE FIXED PULLEYS FOR DERRICKING AND HOIST ROPES ARE VERTICALLY ABOVE JIB PIVOT POINT

C-1.1.1 A general expression for determining the effective length of the jib in plan at any particular angle is given by:

$$l = L\left\{2 - \frac{C(D + K.H)}{A_H.D + K.A_D.H}\right\}$$

where

l = effective length of the jib (lateral buckling) in metres;

L = actual length of the jib in metres;

K = ratio of load (KT kgf) applied to jib head by the derricking rope to that applied by the non-vertical part (H) of the hoist rope (T kgf); and

C, D, H and A_H are dimensions in metres shown in Fig. 14.

C-1.1.2 Special case where the fixed pulleys for derricking rope and hoist rope are in one vertical line (Fig. 15).

The general expression above then simplifies to:

$l = L\left(2 - \frac{C}{A}\right)$, where A is the dimension in fact shown in Fig. 14.

C-1.1.3 Special cases where the fixed pulleys for derrick rope and hoist rope are vertically above the jib pivot point (Fig. 16).

As $C = A$, the effective length is then equal to the actual length for all positions of the jib.

C-2. CANTILEVER JIBS

C-2.1 The following refers only to cantilever crane jibs which are luffed by some means acting on an extension of the jib behind the jib pivot. The side elevations of typical arrangements are shown in Fig. 17 and 18.

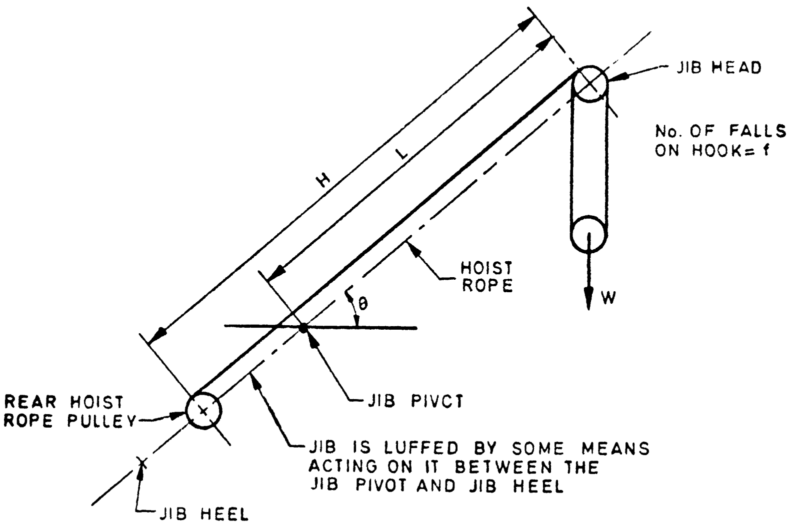


FIG. 17 CANTILEVER CRANE JIB WITH HOIST ROPE PARALLEL TO JIB AXIS

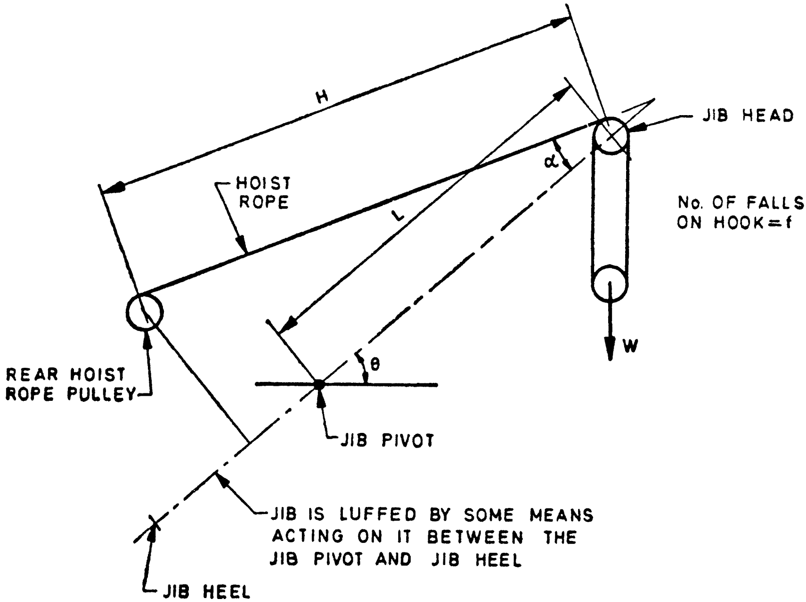


FIG. 18 CANTILEVER CRANE JIB WITH HOIST ROPE NOT PARALLEL TO JIB AXIS

a) *In Elevation* — Considering buckling in the luffing plane, the jib is not free to rotate about the jib pivot as movement of the lower end is prevented by the luffing mechanism. The lower end of the jib can thus be considered as encastred up to the jib pivot. The hoist rope provides the only restraint to deflection at the jib head.

b) *In Plan* — The lower end of the jib can be considered as completely restrained in the slewing plane by the jib pivots. The hoist rope again provides the only restraint to deflection at the jib head.

C-2.2 Both these cases are covered by the treatment which follows, the effective length ratio depending upon the tension in the hoist rope, its position, and the angular elevation of the jib.

C-2.2.1 Where the hoist rope runs parallel to the longitudinal axis of the jib (*see* Fig. 17).

The ratio of the effective length to the real length in elevation and plan can be obtained from Fig. 18 where it is plotted against ($1 + f \sin \theta$) for ratios of H/L from 0.7 to 1.30. In Fig. 19

f = number of falls on the hook

θ = angle of elevation of the jib

H and L are the dimensions shown in Fig. 17.

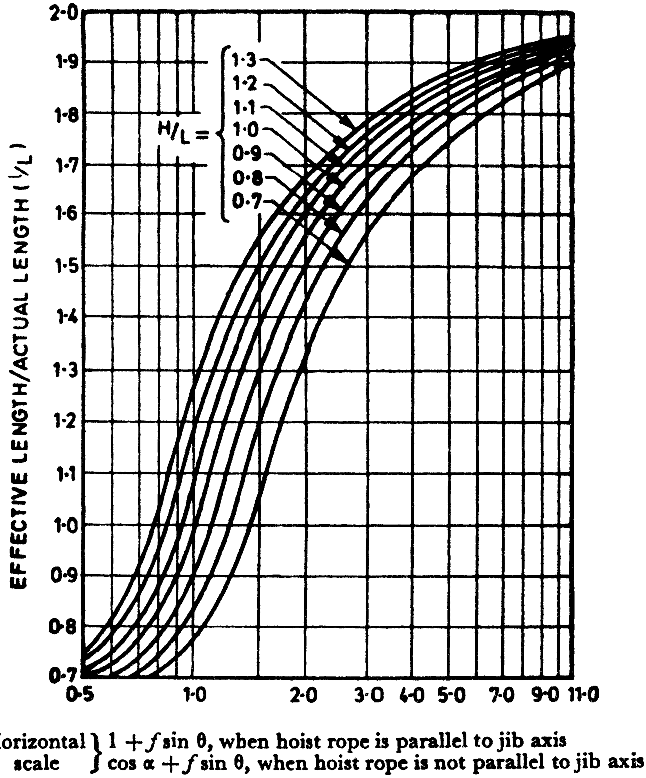


FIG. 19 RATIO OF EFFECTIVE LENGTH/ACTUAL LENGTH FOR CANTILEVER CRANE JIBS

C-2.2.2 Where the hoist rope does not run parallel to the longitudinal axis of the jib (*see* Fig. 18).

The ratio of the effective length to the real length in elevation and plan can be obtained from Fig. 18 where it is plotted against $\cos \alpha + f \sin \theta$ for ratios of H/L from 0.7 to 1.30. In Fig. 19

f = number of falls on the hook

θ = angle of elevation of the jib

α = angle in elevation at jib head between the hoist rope and longitudinal jib axis

H and L are the dimensions shown in Fig. 18.

NOTE — Attention is drawn to the Building Research Station paper 'Stiffness of a crane jib' by J. F. Eden and R. H. Wood, published in 'The Engineer', July 29th, 1960.

(*Continued from page* 2)

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