## 1. GENERAL

### 1.1 *SCOPE*

This Code of Practice relates to the use in building works of hot rolled steel sections and plates and normalised tubular shapes.

The provisions of this Code of Practice are not deemed to apply to chimneys, bridges, docks piers or wharves, nor to structures designed on an experimental basis, except in so far as provided in 5.1.3 and Appendix A.

### 1.2 *BRITISH STANDARDS AND CODES OF PRACTICE*

Any reference to a British Standards Institution publication should be construed as follows:—

(*a*) where a data is included in the reference, the reference is to the edition of that date, together with any amendments, supplements and addenda published at 30th June, 1986;

(*b*) where no date is included in the reference, the reference is to the edition current at 30th June, 1986 together with any amendments, supplements and addenda published at that date;

(*c*) any reference to any publication is a reference to so much only as is relevant in the context in which such a publication is quoted.

## 2. DEFINITIONS

For the purposes of this Code of Practice the following definitions shall apply:

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|---|---|
| BEAM or GIRDER | Any structural member which supports load primarily by internal resistance to bending. |
| DEAD LOAD | The weight of walls, floors, roofs, finishes, permanent partitions and other permanent construction. |
| EFFECTIVE LATERAL RESTRAINT | Restraint which will produce sufficient resistance in a plane perpendicular to the plane of bending to restrain a loaded beam from buckling to either side at the point of application of restraint. |
| ENGINEER | The person responsible for the design and satisfactory completion of the structure, as covered by this Code of Practice. |
| FOUNDATION | That part of the building or structure in direct contact with and transmitting loads to the ground. |
| H-SECTION | A section with one central web and two plain flanges which has an overall depth not greater than 1.2 times the width of the narrower flange. |
| HIGH STRENGTH FRICTION GRIP BOLTS | High strength friction grip bolts are bolts of high tensile steel, used in conjunction with high strength nuts and hardened steel washers, which are tightened to a pre-determined shank tension in order that the clamping action thus afforded will transfer loads in the connected members by friction between the parts in contact and not by shear or bearing in the bolts. |
| HYBRID | Composed of elements of more than one strength grade of steel. |
| I-SECTION | A section with one central web and two plain flanges which has an overall depth greater than 1.2 times the width of the narrow flange. |
| IMPOSED LOAD | In respect of a building—all loads other than the dead load, but excluding wind load. |
| WIND LOAD | All loads due to the effects of wind pressure or suction. |
| LOAD FACTOR | The numerical value by which the load which would cause failure of the structure is divided to give the permissible working load on the structure. |
| PARTITION | An internal vertical structure which is employed solely for the purpose of subdividing any storey of a building into sections, and which supports no load other than its own weight. |
| STRUT | A steel pillar, stanchion, or column or other compression member. |
| WHEEL LOADS | The static weights imposed by the wheels when the appliance of which the wheels form part is fully loaded. |
| YIELD STRESS | The yield stress in tension specified in the appropriate material specification for the particular thickness of material. |

2.1 *NOTATION*

The notations used in this Code of Practice have the following meanings with respect to the structure, member or condition to which the clause is applied, unless otherwise defined elsewhere in this Code.

$b_1$ is the outstand of a flange or stiffener beyond the line of connections to a web or other line of support

$b_2$ is the width of a flange between two adjacent lines of connections to other parts of a member, or other line of support

$C_o$ is Eulers critical stress

D is the overall depth of a section measured parallel to the web

$d_1$ is (1) for the web of a beam without horizontal stiffners—the clear distance between flanges, neglecting fillets, or the clear distance between inner toes of the flange angles as appropriate

or (2) for the web of a beam with horizontal stiffners—the clear distance between the horizontal stiffners and the tension flange, neglecting fillets, or the clear distance between inner toes of the tension flange angles, as appropriate

$d_2$ is twice the clear distance from the neutral axis of a beam to the compression flange neglecting fillets or the inner toes of the flange angles, as appropriate

$d_3$ is the clear distance of web between root fillets

E is the Modulus of Elasticity for steel, taken as $2.0 \times 10^5$ MPa in this Code

$f_{bc}$ is the calculated compressive stress in a member due to bending about a principal axis

$f_{bt}$ is the calculated tensile stress in a member due to bending about a principal axis

$f_c$ is the calculated average stress in a member due to an axial compressive force

$f_e$ is the calculated equivalent stress in a member due to an axial compressive force

$f_t$ is the calculated average stress in a member due to an axial tensile force

$F_{ob}$ is the elastic buckling stress of a beam

L is the effective length

$p_b$ is the maximum allowable stress due to bending

$p_{bc}$ is the maximum allowable compressive stress due to bending in a member not subject to an axial force

$p_{br}$ is the maximum allowable bearing stress

$p_{bt}$ is the maximum allowable tensile stress due to bending in a member not subject to axial force

$p_c$ is the maximum allowable compressive stress in axial loaded members

$p_e$ is the maximum allowable equivalent stress due to the action of combined loadings

$p_q$ is the maximum allowable shear stress in a member

$p_{qv}$ is the maximum allowable average shear stress in a member

$p_t$ is the maximum allowable tensile stress in an axially loaded tensile member

$r_y$ is the radius of gyration of a section about its minor axis

t is the thickness of the web of a section

T is the effective thickness of the flange in a flanged section

$T_b$ is the stiffness of a braced structure

$T_u$ is the stiffness of the structure with the bracing system removed

$Y_s$ is the yield stress in tension for steel, in MPa

## 3. MATERIALS

3.1 *STRUCTURAL STEEL*

Structural steel should be of one of the following grades:

Grade 250—refers to a grade of steel with a nominal yield strength of 250 MPa and having similar chemical composition and mechanical properties to these specified in BS 4360 for Grade 43 steel.

Grade 350—refers to a grade of steel with a nominal yield strength of 350 MPa and having similar chemical composition and mechanical properties to these specified in BS 4360 for Grade 50 steel.

Grade 450—refers to a grade of steel with a nominal yield strength of 450 MPa and having similar chemical composition and mechanical properties to these specified in BS 4360 for Grade 55 steel.

and should be accompanied by Mill Certificates showing that the requirements of chemical composition and mechanical properties of BS 4360 are satisfied.

3.2 *ELECTRODES*

Electrodes should comply with the requirements of BS 639.

3.3 *BOLTS AND NUTS*

Bolts and nuts should comply with one of the following:

BS 3692
BS 4190
BS 4933

3.4 *WASHERS*

Plain washers should be made of steel. Taper or other specially shaped washers should be made of steel or malleable cast iron. (refer BS 4320)

3.5 *HIGH STRENGTH FRICTION GRIP BOLTS*

High strength friction grip bolts should conform to BS 4395: Parts 1 and 2 and their use should conform to BS 4604:Parts 1, 2 and 3.

## 4. LOADS

4.1 *DEAD, WIND AND IMPOSED LOADS*

The determination of dead loads, wind loads, and imposed loads should be in accordance with the Building (Construction) Regulations.

4.2 *DYNAMIC LOADS*

Where loads arising from machinery, runways, cranes and other plant producing dynamic effects are supported by or communicated to the building or part of the building, the forces produced by dynamic effects should be considered as additional imposed loads in the design of the building. In order to ensure due economy in design the Engineer should ascertain as accurately as possible the appropriate dynamic increase for all members affected.

For crane gantries, with a lifting capacity of less than 10 tonne, the following allowances may be deemed to cover all forces set up by vibration, shock from slipping of slings, kinetic action of acceleration and retardation and impact of wheel loads:

4.2.1 For loads acting vertically, the maximum static wheel loads should be increased by the following percentages:

| | |
|---|---|
| for electric overhead cranes | 25 per cent |
| for hand-operated cranes | 10 per cent |

4.2.2 The horizontal force acting transverse to the rails should be taken as a percentage of the combined weight of the crab and the load lifted as follows:

| | |
|---|---|
| for electric overhead cranes | 10 per cent |
| for hand-operated cranes | 5 per cent |

This force should be taken into account when considering the lateral rigidity of the rails and their fastenings.

4.2.3 Horizontal forces acting along the rails should be taken as a percentage of the static wheel loads which can occur on the rails, as follows:

| | |
|---|---|
| for overhead cranes, either electric or hand-operated | 5 per cent |

The forces specified in either 4.2.2 or 4.2.3 above should be considered as acting at the rail level and being appropriately transmitted to the supporting systems.

Gantry girders and their vertical supports should be designed on the assumption that either of the horizontal forces specified in 4.2.2 or 4.2.3 may act at the same time as the vertical load.

An increase of 10 per cent on the permissible stresses specified in this Code of Practice may be allowed for the combination of loadings specified in 4.2.1 and 4.2.2 above in respect of the design of the gantry girders and supporting structures. This increase is not however in addition to that permitted in 5.4.

In special cases, e.g. charging machines, and where more than one crane is in use on the gantry and where high speeds are attained, the above allowances should be reconsidered.

Structures or structural components which support hoisting devices with a lifting capacity of 10 tonnes or more, should be designed and constructed in accordance with the relevant provisions of BS 2573: Part 1.

In the event that BS 2573:Part 1 does not adequately cover any particular situation then the structure or structural component should be designed to the satisfaction of the Building Authority.

*Note:* For factors applicable to the allowable working stresses, and detailed design under fatigue conditions, see BS 153:Parts 3B and 4 and BS 5400:Part 10.

4.3 *COMBINED WIND AND DYNAMIC LOADS*

A reduction in wind loading may be allowed where the operation of three or more overhead cranes is to be provided in a structure. The supporting structure may be designed for the following load cases:

(1) the loads due to the operation of the single heaviest crane should be combined with the full wind load appropriate to the height of the structure.

(2) the loads due to the worst combination of crane loads should be combined with 60 per cent of the wind load appropriate to the height of the structure.

## 5. DESIGN AND DETAILS OF CONSTRUCTION

5.1 *GENERAL*

5.1.1 STEEL FRAMEWORK

Any part of a structure should be capable of sustaining the most adverse combination of static and dynamic forces which may reasonably be expected from dead, wind and imposed loads referred to in the Building (Construction) Regulations without the permissible stresses specified in this Code of Practice being exceeded.

Frames may be categorised as braced or unbraced depending on their mode of resistance to lateral load effects. If special structural elements such as shear walls, core walls, truss members etc., are used to resist the lateral loads then the frame is said to be *braced.* It is said to be *unbraced* if only the flexural rigidity of the members is relied upon to provide the lateral resistance.

For a bracing system to be effective the following relationship should be satisfied:

$$T_b/T_u >= 5$$

Where $T_b$ is the stiffness of the braced structure, and

$T_u$ is the stiffness of the structure with the bracing system removed.

If this condition is not fulfilled then the structure must be considered as unbraced.

5.1.2 VERTICAL LOAD—LATERAL DEFLECTION EFFECTS

Where a building is sensitive to the effects of lateral deflection the Engineer should take into account the additional actions induced by the lateral displacements of the points of application of the vertical loads. (P—$\Delta$ effects)

5.1.3 DESIGN OF FRAMEWORKS

Steel frameworks may be designed using the following methods:

(1) Simple design

This method applies to structures in which the end connections between members are such that they will not develop restraint moments adversely affecting the members and the structure as a whole and in which the structure may, for purposes of design, be assumed to be pin-jointed.

This method involves the following assumptions:

(*a*) beams are simply supported,

(*b*) all connections of beams girders or trusses are proportioned to resist the shear forces applied at the appropriate eccentricity,