The design of a steel structure may be divided into two stages. First the size of the individual members is determined in relation to the induced forces and bending moments. Then all necessary bolted or welded connections are designed so that they are capable of transmitting the forces and bending moments. In this manual we will concentrate on the design of the main structural elements.

Three methods of design are included in BS 5950 Part 1:

Simple design This method applies to structures in which the end connections between members are such that they cannot develop any significant restraint moments. Thus, for the purpose of design, the structure may be considered to be pin-jointed on the basis of the following assumptions:

(a) All beams are simply supported.

(b) All connections are designed to resist only resultant reactions at the appropriate eccentricity.

(c) Columns are subjected to loads applied at the appropriate eccentricity.

(d) Resistance to sway, such as that resulting from lateral wind loads, is provided by either bracing, shear walls or core walls.

Rigid design In this method the structure is considered to be rigidly jointed such that it behaves as a continuous framework. Therefore the connections must be capable of transmitting both forces and bending moments. Portal frames are designed in this manner using either elastic or plastic analysis.

Semi-rigid design This is an empirical method, seldom adopted, which permits partial interaction between beams and columns to be assumed provided that certain stated parameters are satisfied.

The design of steel elements dealt with in this manual will be based upon the principles of simple design.

It is important to appreciate that an economic steel design is not necessarily that which uses the least weight of steel. The most economical solution will be that which produces the lowest overall cost in terms of materials, detailing, fabrication and erection.

5.2 Symbols

The symbols used in BS 5950 and which are relevant to this manual are as follows:

A area
A_g gross sectional area of steel section
A_v shear area (sections)
B breadth of section
b outstand of flange
b_1 stiff bearing length
D depth of section

d depth of web
E modulus of elasticity of steel
e eccentricity
F_c ultimate applied axial load
F_v shear force (sections)
I_x second moment of area about the major axis
I_y second moment of area about the minor axis
L length of span
L_E effective length
M larger end moment
M_A maximum moment on the member or portion of the member under consideration
M_b buckling resistance moment (lateral torsional)
M_{cx}, M_{cy} moment capacity of section about the major and minor axes in the absence of axial load
M_e eccentricity moment
M_o mid-length moment on a simply supported span equal to the unrestrained length
M_u ultimate moment
M_x maximum moment occurring between lateral restraints on a beam
$\bar{M}$ equivalent uniform moment
m equivalent uniform moment factor
n slenderness correction factor
P_c compression resistance of column
P_{crip} ultimate web bearing capacity
P_v shear capacity of a section
p_b bending strength
p_c compressive strength
P_w buckling resistance of an unstiffened web
p_y design strength of steel
r_x, r_y radius of gyration of a member about its major and minor axes
S_x, S_y plastic modulus about the major and minor axes
T thickness of a flange or leg
t thickness of a web or as otherwise defined in a clause
u buckling parameter of the section
v slenderness factor for beam
x torsional index of section
Z_x, Z_y elastic modulus about the major and minor axes
β ratio of smaller to larger end moment
γ_f overall load factor
γ_ℓ load variation factor: function of $\gamma_{\ell 1}$ and $\gamma_{\ell 2}$
γ_m material strength factor
γ ratio M/M_0, that is the ratio of the larger end moment to the mid-length moment on a simply supported span equal to the unrestrained length
δ deflection
ε constant $(275/p_y)^{1/2}$