:ion factor at level x to account for variatio
;e of mechanical/electrical equipment with
within the *building*, as defined in Sentence
l),

'el x used to determine torsional sensitivity
in Sentence 4.1.8.11.(9),

value of B_x, as defined in Sentence
),

efficient for mechanical/electrical
, as defined in Sentence 4.1.8.17.(1),

sion of the *building* at level x
lar to the direction of seismic loading
dered,

:asured perpendicular to the direction of
loading between centre of mass and centr
t the level being considered,

ı-based site coefficient, as defined in
1.8.4.(4),

' to be concentrated at the top of the
defined in Sentence 4.1.8.11.(6),

ed site coefficient, as defined in Sentence

applied to level x, as defined in Sentence

ıt above the base (i = 0) to level i, n, or
y, where the base of the structure is the
h horizontal earthquake motions are
ı be imparted to the structure,

:ight (h_i - h_{i-1}),

ıportance factor of the structure, as
;entence 4.1.8.5.(1),

uction coefficient for base overturning
:fined in Sentence 4.1.8.11.(5)

uction coefficient for overturning
'el x, as defined in Sentence

in the *building*, i =1 for first level
;

is uppermost in the main portion of the

s under design consideration,

nt for higher mode effect on base
d in Sentence 4.1.8.11.(5),

:ment at level x, as defined in Sentence

storeys above exterior *grade* to level n,

rd Penetration Resistance for the top
to a rod energy efficiency of 60% of
ıaximum,

Acceleration expressed as a ratio to
:eleration, as defined in
.(1),

for clays,

R_d = ductility-related force modification factor reflecting the capability of a structure to dissipate energy through inelastic behaviour, as given in Article 4.1.8.9.,

R_o = overstrength-related force modification factor accounting for the dependable portion of reserve strength in a structure designed according to these provisions, as defined in Article 4.1.8.9.,

S_p = horizontal force factor for part or portion of a *building* and its anchorage, as given in Sentence 4.1.8.17.(1),

S(T) =design spectral response acceleration, expressed as a ratio to gravitational acceleration, for a period of T, as defined in Sentence 4.1.8.4.(6),

$S_a(T)$ = 5% damped spectral response acceleration, expressed as a ratio to gravitational acceleration, for a period of T, as defined in Sentence 4.1.8.4.(1),

SFRS = Seismic Force Resisting System(s) is that part of the structural system that has been considered in the design to provide the required resistance to the earthquake forces and effects defined in Subsection 4.1.8.,

s_u = average undrained shear strength in the top 30 m of *soil*,

T = period in seconds,

T_a = fundamental lateral period of vibration of the *building* or structure in seconds in the direction under consideration, as defined in Sentence 4.1.8.11.(3),

T_x = floor torque at level x, as defined in Sentence 4.1.8.11.(10),

V = lateral earthquake design force at the base of the structure, as determined by Article 4.1.8.11.,

V_d = lateral earthquake design force at the base of the structure, as determined by Article 4.1.8.12.,

V_e = lateral earthquake elastic force at the base of the structure, as determined by Article 4.1.8.12.,

V_p = lateral force on a part of the structure, as determined by Article 4.1.8.17.,

$\overline{V}_s$ = average shear wave velocity in the top 30 m of *soil* or *rock*,

W = *dead load*, as defined in Article 4.1.4.1., except that the minimum *partition* load as defined in Sentence 4.1.4.1.(3) need not exceed 0.5 kPa, plus 25% of the design snow load specified in Subsection 4.1.6., plus 60% of the storage load for areas used for storage, except that *storage garages* need not be considered storage areas, and the full contents of any tanks,

W_i, W_x = portion of W that is located at or is assigned to level i or x respectively,

W_p = weight of a part or portion of a structure, e.g., cladding, *partitions* and appendages,

δ_{ave} = average displacement of the structure at level x, as defined in Sentence 4.1.8.11.(9), and

δ_{max} = maximum displacement of the structure at level x, as defined in Sentence 4.1.8.11.(9).

4.1.8.3. General Requirements

(1) The *building* shall be designed to meet the requirements of this Subsection and of the design standards referenced in Section 4.3.

(2) Structures shall be designed with a clearly defined load path, or paths, that will transfer the inertial forces generated in an earthquake to the supporting ground.

(3) The structure shall have a clearly defined Seismic Force Resisting System(s) (SFRS), as defined in Article 4.1.8.2.

(4) The SFRS shall be designed to resist 100% of the earthquake loads and their effects.

(5) All structural framing elements not considered to be part of the SFRS must be investigated and shown to behave elastically or to have sufficient non-linear capacity to support their gravity loads while undergoing earthquake-induced deformations calculated from the deflections determined in Article 4.1.8.13.

(6) Stiff elements that are not considered part of the SFRS, such as concrete, masonry, brick or pre-cast walls or panels, shall be,

(a) separated from all structural elements of the *building* such that no interaction takes place as the *building* undergoes deflections due to earthquake effects as calculated in this Subsection, or

(b) made part of the SFRS and satisfy the requirements of this Subsection.

(7) Stiffness imparted to the structure from elements not part of the SFRS, other than those described in Sentence (6), shall not be used to resist earthquake deflections but shall be accounted for,

(a) in calculating the period of the structure for determining forces if the added stiffness decreases the fundamental lateral period by more than 15%,

(b) in determining the irregularity of the structure, except the additional stiffness shall not be used to make an irregular SFRS regular or to reduce the effects of torsion, and

(c) in designing the SFRS if inclusion of the elements not part of the SFRS in the analysis has an adverse effect on the SFRS.

(8) Structural modelling shall be representative of the magnitude and spatial distribution of the mass of the *building* and of the stiffness of all elements of the SFRS, including stiff elements that are not separated in accordance with Sentence 4.1.8.3.(6), and shall account for,

(a) the effect of cracked sections in reinforced concrete and reinforced masonry elements,

(b) the effect of the finite size of members and joints,

Table 4.1.8.11.
Higher Mode Factor, M_v, and Base Overturning Reduction Factor, J(1)(2)
Forming Part of Sentence 4.1.8.11.(5)

Column 1	2	3	4	5	6
$S_a(0.2)/S_a(2.0)$	Type of Lateral Resisting System	M_v For $T_a \le 1.0$	M_v For $T_a \ge 2.0$	J For $T_a \le 0.5$	J For $T_a \ge 2.0$
< 8.0	Moment-resisting frames or coupled walls(3)	1.0	1.0	1.0	1.0
	Braced frames	1.0	1.0	1.0	0.8
	Walls, wall-frame systems, other systems(4)	1.0	1.2	1.0	0.7
≥ 8.0	Moment-resisting frames or coupled walls(3)	1.0	1.2	1.0	0.7
	Braced frames	1.0	1.5	1.0	0.5
	Walls, wall-frame systems, other systems(4)	1.0	2.5	1.0	0.4

Notes to Table 4.1.8.11.:

(1) For values of M_v between fundamental lateral periods, T_a, of 1.0 and 2.0 s, the product $S(T_a) \cdot M_v$ shall be obtained by linear interpolation.

(2) Values of J between fundamental lateral periods, T_a, of 0.5 and 2.0 s shell be obtained by linear interpolation.

(3) A "coupled wall" is a wall system with coupling beams, where at least 66% of the base overturning moment resisted by the wall system is carried by the axial tension and compression forces resulting from shear in the coupling beams.

(4) For hybrid systems, values corresponding to walls must be used or a dynamic analysis must be carried out as per Article 4.1.8.12.

(6) The total lateral seismic force, V, shall be distributed such that a portion, F_t, shall be assumed to be concentrated at the top of the *building*, where F_t, is equal to $0.07\, T_a V$ but need not exceed 0.25 V and may be considered as zero, where the fundamental lateral period, T_a, does not exceed 0.7 s; the remainder, $V - F_t$, shall be distributed along the height of the *building*, including the top level, in accordance with the formula,

$$F_x = (V - F_t)\, W_x h_x \Big/ \left(\sum_{i=1}^{n} W_i h_i \right)$$

(7) The structure shall be designed to resist overturning effects caused by the earthquake forces determined in Sentence (6) and the overturning moment at level x, M_x, shall be determined using the formula,

$$M_x = J_x \sum_{i=1}^{n} F_i \,(h_i - h_x)$$

where,

$J_x = 1.0$ for $h_x \ge 0.6 h_n$, and

$J_x = J + (1 - J)(h_x / 0.6 h_n)$ for $h_x < 0.6 h_n$

where,

(8) Torsional effects that are concurrent with the effects of the forces mentioned in Sentence (6) and are caused by the following torsional moments shall be considered in the design of the structure according to Sentence (10):

(a) torsional moments introduced by eccentricity between the centres of mass and resistance and their dynamic amplification, or

↑ rigidity

(b) torsional moments due to accidental eccentricities.

(9) Torsional sensitivity shall be determined by calculating the ratio B_x for each level x according to the following equation for each orthogonal direction determined independently:

$$B_x = \delta_{max} / \delta_{ave}$$

where,

B = maximum of all values of B_x in both orthogonal directions, except that the B_x for one-*storey* penthouses with a weight less than 10% of the level below need not be considered,

δ_{max} = maximum *storey* displacement at the extreme points of the structure, at level x in the direction of the earthquake induced by the equivalent static forces acting at distances ± 0.10 D_{nx} from the centres of mass at each floor, and

δ_{ave} = average of the displacements at the extreme points of the structure at level x produced by the above mentioned forces.

(10) Torsional effects shall be accounted for as follows:

(a) for a *building* with B ≤1.7, by applying torsional moments about a vertical axis at each level throughout the *building* derived for each of the following load cases considered separately,