# Appendix

#### **Dead and Live Loads**

# International Building Code 2003 (IBC)

1607.1: According to IBC 2003, table 1607.1, the minimum uniformly distributed live loads and minimum concentrated live loads are as follow:

Occupancy or Use	Uniform (psf)	Concentrated (lbs)
Office building		
Office	50	2000
Lobbies and first-floor	100	2000
corridors		
Corridor above first	80	2000
floor		

**1607.5** <u>Partition Loads</u>, in office building where partitions are subjected to change, provision for partition weight shall be made, whether or not partitions are shown on the construction documents, unless the specified live load exceeds **80 psf** (3.83 KN/m2). Such partition load shall not be less than **20 psf** (0.96 KN/m2)

<u>Superimposed Dead load</u>: this type of load is based on engineering judgment. For Agricultural Hall and Annex, an assumption of **15 psf** will be made for the superimposed dead load.

#### <u>BS8110</u>

**2.1:** According to BS8110, Data Sheet 2, the imposed load on floors as follow:

Occupancy or Use	Uniform (KN/m2)	Concentrated
General Office	2.5 KN/m2 (52.2 psf)	2.7 KN ( 607 lbs)

Partitions 1 2 2

**9.1.3**: The weight of the partition should be included in the dead loads of the floors and it is convenient to consider such weights as equivalent uniformly distributed loads. For an office building, the minimum load is **1** KN/m2 or **20.5** lbs/ft2.

<u>Superimposed Dead load</u>: The same superimposed dead load will be assumed for the calculations (**15 psf**)

Load Combinations

#### ACI 318-02

**9.2.1** The required strength U shall be at least equal to the effect of factored loads in equations (1-7).

- 1- U = 1.4(D+F)
- 2- U = 1.2(D+F+T) + 1.6(L+H) + 0.5(Lr or S or R)
- 3- U = 1.2D + 1.6(Lr or S or R) + (1.01 or 0.8W)
- 4- U = 1.2D + 1.6W + 1.0L + 0.5(Lr or S or R)
- 5- U = 1.2D + 1.0E + 1.0L + 0.2S
- 6- U = 0.9D + 1.6W + 1.6H
- 7- U = 0.9D + 1.0 E + 1.6 H

Note:

- $\mathbf{D}$  = Dead loads, or related internal moments and forces
- $\mathbf{E}$  = Load effects of seismic forces, or related internal moments and forces
- $\mathbf{F}$  = Loads due to weight and pressure of fluids with well defined densities and controllable maximum height, or related internal moments and forces
- L= Live loads, or related internal moments and forces
- Lr = Roof live load, or related internal moments and forces
- $\mathbf{R}$  = Rain load or related internal moments and forces
- S = Snow load or related internal moments and forces
- $\mathbf{T}$  = Cumulative effect of temperature, creep, shrinkage, differential settlement, and shrinkage-compensating concrete.
- $\mathbf{U}$  = Required strength to resist factored loads or related internal moments and forces
- $\mathbf{W} =$ Wind load or related internal moments and forces

#### <u>BS8110</u>

**2.1**: Design Loads and strength, and partial safety factor (Data Sheet 1)

		Condition
	Dead + imposed load	1.4 Gk + 1.6 Qk + 1.4 En
Design	( + earth pressure)	
loads	Dead + wind load	1.4 (Gk + Wk + En)
	( + earth pressure)	
	Dead + imposed + wind	1.2 (Gk + Qk + Wk + En)
	load (+ earth pressure)	

Note:

 $\mathbf{G}\mathbf{k} = \mathbf{C}\mathbf{h}\mathbf{a}\mathbf{r}\mathbf{a}\mathbf{c}\mathbf{t}\mathbf{e}\mathbf{r}\mathbf{s}\mathbf{t}\mathbf{c}$ 

 $\mathbf{Q}\mathbf{k} =$ Characteristic imposed load

**En** = Characteristic earth and/or water load (if applicable)

Wk = Characteristic wind load

#### Openings in Slab Systems

ACI 13.4.1: Openings of any size shall be permitted in slab systems as long as the designed strength is equal to the required strength.

ACI 13.4.2.1: Openings of any size shall be permitted in the area common to intersecting middle strips, provided total amount of reinforcement equivalent to that interrupted by openings. This amount shall be added around the openings.

**ACI 13.4.2.2**: In the area common to intersecting column strip, not more than 1/8 the width of column strip in either span shall be interrupted by openings. Equivalent steel to the interrupted shall be added around the opening

**ACI 13.4.2.3**: In the area common to one column strip and one middle strip, not more than <sup>1</sup>/<sub>4</sub> of the reinforcement in either strip shall be interrupted by openings. Equivalent steel to the interrupted shall be added around the opening.

# BS8110:

# Slab Opening:

**6.1.3**: The slab around the openings in floors or roofs should be strengthen with extra reinforcement, **unless the opening is large compared with the span of the slab such as stair case or lift-wells in which case beams should be provided around the opening**. For small openings in solid slabs, the cross sectional area of the extra bars placed parallel to the principal reinforcement should be at least equal to the area of principal reinforcement interrupted by the opening. A bar should be placed diagonally across each corner of an opening. Holes for pipes, ducts and other services should be formed when the floor is constructed and the cutting of such holes should not be permitted afterwards, unless this is done under the supervision of a competent engineer.

# **Drop Panel**

**ACI 13.3.7.1**: Drop panel shall extend a distance greater than or equal to 1/6 of span length in each direction from the center of the support

ACI 13.3.7.2: The thickness of the drop panel below slab shall not be less than <sup>1</sup>/<sub>4</sub> of slab thickness.

# <u>BS8110</u>

**11.1.1**\_The length of each drop panel must not be less than 1/3 of the distance of the shorter span of the panel. The minimum thickness of the drop panels is determined from the consideration of ultimate bending moments, shear forces, and deflection.

# Minimum Slab Thickness without Interior Beams

# ACI Table 9.5 c

Yield Strength, psi	With Drop Panels		
	Exterior I	Panels	Interior Panels
60 000	Without Edge	Width Edge	
	Beams	Beams	
	ln/33	ln/36	ln/36

# Deflection

# ACI Table 9.5(b)

Type of member	Defection to be considered	Deflection limitation
Floors not supporting or	Immediate deflection due	
attached to non-structural	to live load	1/360 = 1 in
elements likely to be		
damaged by large deflection		
Floors construction	Total defection occurring	
supporting or attached to	after attachment of	
nonstructural elements	nonstructural elements (sum	1/480 = <b>0.75 in</b>
likely to be damaged by	of the long term deflection	
large deflection	due to sustained load and	
Floors construction	immediate deflection due to	
supporting or attached to	any additional live load)	1/240 = 1.5 in
nonstructural elements		
likely not to be damaged by		
large deflection		

# **BS8110:**

**8.1.a-** The final deflection of each horizontal member below the supports must not exceed span/250 (1.44 in) (This includes all time dependent effects such as creep and shrinkage as well as those of temperature).

**8.1.b-** The deflection occurring after the construction of a partition or the application of a finish should not exceed the lesser of span/350 (1.03 in) or 20 mm (0.7874) for non-brittle partitions and span/500 (0.72 in) or 20 mm (0.7874) for brittle materials.

Wind Loads

# ASCE 7-02

**6.1.4.1 Main Wind Force-Resisting System**. The design wind load of the main wind force-resisting system for an enclosed or patriotically enclosed or other structure shall not

be less than **10 psf** multiplied by the area of the building or structure projected onto a vertical plane normal to the assumed wind direction.

**6.1.4.2** Components and Cladding. The design wind pressure for components and cladding of buildings shall not be less than a net pressure of 10 psf acting in either direction normal to the surface.

#### **6.5 Analytical Procedure**

**6.5.1** In order to use analytical procedure, the building shall meet the following conditions:

1. The building shall have a regular shape as defined in section 6.2

2. The building shall not have response characteristics making it subject to acrosswind loading, vortex, shedding, instability due to galloping or flutter; or does not have a site location for which channeling effects or buffeting in the wake of upwind obstructions warrant special consideration.

**6.5.2 Limitations.** Analytical procedure takes into account the load magnification effect caused by gusts in resonance with along-wind vibrations of flexible buildings.

**6.5.2.1** Shielding. No reduction shall be allowed in velocity pressure due to apparent shielding afforded by buildings and other structures.

**6.5.2.2** Air-Permeable Cladding. Design wind loads determined from section 6.5 shall be used for Air-permeable cladding unless other wise approved by test data to use lower loads.

#### **6.5.3 Designed Procedure**

1- The basic wind speed V and wind directionality factor Kd shall be determined in accordance with section 6.5.4

2- An importance factor I shall be determine in accordance with section 6.5.5

3- An exposure category and velocity pressure exposure coefficient Kz or Kh as applicable shall be determined for each wind direction as defined in section 6.5.6

4- A topographic factor Kzt shall be determined as specified in 6.5.7

5- A gust effect factor G or Gf, as applicable, shall be determined as specified in 6.5.8

6- An enclosure classification shall be determined in accordance with section 6.5.9

7- Internal pressure coefficient GCpi shall be determined as specified in section6.5.11.1

8- External pressure coefficients Cp or GCpf, or force coefficients Cf, as applicable, shall be determined in accordance with section 6.5.11.2 or 6.5.11.3 respectively.

9- Velocity pressure qz or qh, as applicable, shall be detemined as specified in section 6.5.10

10- Designed wind load p or F shall be determined as defined in section 6.5.12

**6.5.4** Basic Wind Speed used in the determination of design wind loads on buildings shall be as given in Figure 6-1. The wind shall be assumed to come from any horizontal direction.

**6.5.4.4 Wind Directionality Factor.** The wind directionality factor, Kd, shall be determined from table 6-4. It shall only be applied when used in conjunction with load combinations specified in Sections 2.3 and 2.4.

**6.5.5 Importance Factor.** An importance factor, I, for the building shall be determined from Table 6-1 based on building categories listed in Table 1-1.

**6.5.6 Exposure**. For each wind direction considered, an exposure category that adequately reflects the characteristics of ground roughness and surface irregularities shall be determined for the site at which the building is be constructed.

**6.5.6.5.2** Components and cladding for buildings with a mean roof higher than 60 feet shall be designed using the exposure resulting in the highest wind loads for any wind direction at the site.

**6.5.7.2 Topographic Factor.** The wind speed-up effect shall be included in the calculation of design wind loads by using the factor Kzt:

#### Kzt = (1 + K1K2K3)2

Where K1, K2, K3 are given in Table 6-4

K1 = how steep the hill is
K2 = how far away is the hill
K3 = varies over the building height
Kzt-minimum = 1.0

**6.5.8.1 Gust Effect Factor**. The Gust effect factor for rigid structure can be taken **0.85** or using the equation bellow.

$$G = 0.925 \left( \frac{(1+1.7g_Q I_{\overline{z}}Q)}{1+1.7g_v I_{\overline{z}}} \right)$$
$$I_{\overline{z}} = c(33/\overline{z})^{1/6}$$

6.5.10 Velocity Pressure: Velocity can be calculated as followed

$$q_z = 0.00256 K_z K_{zt} K_d V^2 I (lb/ft^2)$$

6.5.12.2.1 Rigid Buildings of All Height. Design wind pressure can calculated as followed:

$$p = qGC_p - q_i(GC_{pi}) \ (\text{lb/ft}^2)$$

Assuming the positive internal pressure = zero, the equation becomes

 $p = q G C_p \ (\text{lb/ft}^2)$ 

where

$$q = q_z$$
 for windward walls evaluated at height   
z above the ground;

 $q = q_h$  for leeward walls, side walls, and roofs, evaluated at height h;

#### Seismic Loads

ASCE 7-02

#### Seismic Design Category

- Determine Seismic Group
- Determine Site Classifications
- Determine Ss and S1 (These are only for site class B)
- Adjust acceleration for other site classes
- Determine design spectral response acceleration parameters
- Determine Seismic Design Category

**9.1.3 Seismic Use Group**. All structures shall be assigned to Seismic Use Group: I, II, or III as specified in Table 9.1.3

		Selsmic Use Group		
		I	п	ш
Occupancy Category	I	X		
	п	X		
(Table 1-1)	ш		х	
	IV			х

TABLE 9.1.3 SEISMIC USE GROUP

#### 9.4.1.2.1 Site Classification

Site Class	Vs	N or N <sub>ch</sub>	5 <sub>0</sub>
A Hard rock	>5000 ft/s (>1500 m/s)	not applicable	not applicable
B Rock	2500 to 5000 ft/s (760 to 1500 m/s)	not applicable	not applicable
C Very dense soil and soft rock	1200 to 2500 ft/s (370 to 760 m/s)	> 50	> 2000 psf (> 100 kPa)
D Stiff soil	600 to 1200 ft/s (180 to 370 m/s)	15 to 50	1000 to 2000 psf (50 to 100 kPa)
E Soil	<600 ft/s (<180 m/s)	<15	<1000 psf (<50 kPa)
Any profile with more than 10 ft of soil having the following characteristics: — Plasticity index PI > 20, — Moisture content $w \ge 40\%$ , and — Undrained shear strength $\overline{s}_{\mu} < 500$ psf			
F Soils requi eva	ring site-specific luation	<ol> <li>Soils vulnerable to potential failure or collapse</li> <li>Peats and/or highly organic clays</li> <li>Very high plasticity clays</li> <li>Very thick soft/medium clays</li> </ol>	

TABLE 9.4.1.2 SITE CLASSIFICATION

**9.4.1.2.4** Site Coefficients and Adjusted maximum Considered Earthquake Spectral Acceleration Parameters.

$S_{MS} = F_a S_s$	(Eq. 9.4.1.2.4-1)
$S_{M1} = F_v S_1$	(Eq. 9.4.1.2.4-2)

9.4.1.2.5 Design Spectral Response Acceleration Parameters.

$S_{DS} = \frac{2}{3}S_{MS}$	(Eq. 9.4.1.2.5-1)
$S_{D1} = \frac{2}{3}S_{M1}$	(Eq. 9.4.1.2.5-2)

Ss: the mapped maximum considered earthquake, 5% damped, spectral response acceleration at short periods as defined in section 9.4.1.2

S1: the mapped maximum considered earthquake, 5% damped, spectral response acceleration at a period of 1 second as defined in section 9.4.1.2

SDS: The design, 5% damped, spectral response acceleration at short periods as defined in section 9.4.1.2

SD1: The design, 5% damped, spectral response acceleration at a period of 1 sec as defined in section 9.4.1.2

SMS: the maximum considered earthquake, 5% damped, spectral response acceleration at short periods adjusted for site class effects as defined in section 9.4.1.2

TABLE 9.4.2.1a SEISMIC DESIGN CATEGORY BASED ON SHORT

PERIOD RESPO	NSE ACCEL	ERATIONS	
	Selsmic Use Group		
Value of S <sub>DS</sub>	I	н	ш
$S_{DS} < 0.167 g$	A	А	А
$0.167g \leq S_{DS} < 0.33g$	В	В	С
$0.33g \le S_{DS} < 0.50g$	С	С	D
$0.50g \le S_{DS}$	Da	$\mathbf{D}^{\mathbf{a}}$	$\mathbf{D}^{\mathbf{a}}$

9.5.5 Equivalent Lateral Force Procedure. It provides the required minimum standards
for the equivalent lateral force procedure of seismic analysis of structures.

9.5.5.2 Seismic Base Shear. Shall be determined as follow:

$$V = C_s W$$
 (Eq. 9.5.5.2-1)

Cs = the seismic response of coefficient determined in accordance with section 9.5.5.2.1 W = the total dead load and applicable portions of other loads as indicated in section 9.5.3

#### 9.5.5.2.1 Calculation of Seismic Response Coefficient.

$$C_s = \frac{S_{DS}}{R/I}$$
 (Eq. 9.5.5.2.1-1)

R = the response modification factor in table 9.4.1.2.5

I = the occupancy importance factor determined in accordance with section 9.1.4

Cs Shall not be greater than

$$C_s = \frac{S_{D1}}{T(R/I)}$$
 (Eq. 9.5.5.2.1-2)

But not less than

$$C_s = 0.044 S_{DS} I$$
 (Eq. 9.5.5.2.1-3)

T = the fundamental period of the structure (sec) determined in section 9.5.5.3

9.5.5.4 Vertical Distribution of Seismic Forces

 $F_x = C_{vx}V$  (Eq. 9.5.5.4-1)

and

$$C_{vx} = \frac{w_x h_x^k}{\sum_{i=1}^{n} w_i h_i^k}$$
(Eq. 9.5.5.4-2)

Cvx = vertical distribution factorV = total design lateral force or shear at the base of the structure, kip hi and hx = the height from the base to the level i or x k = an exponent related to the structure

9.5.5.5 Horizontal Shear Distribution and Torsion

$$V_x = \sum_{i=x}^{n} F_i$$
 (Eq. 9.5.5.5)

Fi = the portion of the seismic base shear V induced at level i