BASE SHEAR CALCULATION OF RCC STRUCTURE

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ABSTRACT

The study includes the comparison of base shear of G+3 RCC structure. The calculation of static base shear for a structure with masonry and without masonry in different zones are carried out and then compared. The comparison of fundamental natural period of a structure in different zones are also done. The effect of earthquake on a structure is designed by using the codes IS 1893:2002 (Part–1).

Keywords*: *Base Shear, Storey Shear, Seismic Weight, Natural Period, Zone Factor

I. INTRODUCTION

An **earthquake** is sudden shaking of the earth surface caused by a source of disturbance inside the earth. Every year more than one lakh earthquakes occurs of magnitude higher than three. Due to earthquakes, more than 15 million human lives have been lost. In 1930, Richter developed the concept of earthquake magnitude and so it is called “Richter scale”. On the basis of recordings of earthquake ground motion, seismograph displays the value of magnitude of earthquake. Magnitude 4 or lower earthquakes cause very rare damage to buildings while magnitude 6 or more earthquakes can cause severe damage to some buildings. The largest earthquake measured was 9.5 magnitude on Richter scale. The immediate cause of most shallow earthquakes is the sudden release of stress along a fault or fracture in the earth's crust, resulting in movement of the opposing blocks of rock past one another. This movement may occur rapidly in the form of an earthquake or may occur slowly in the form of creep. Great explosions, landslides, volcanic eruptions, dashing of sea waves, heavy trucks, some large engineering projects, etc. cause minor earthquakes. Shock waves from a powerful earthquake can trigger smaller earthquakes in a distant location hundreds of miles away if the geologic conditions are favourable.

II. BASE SHEAR

Base shear is the maximum expected lateral force that will occur due to seismic ground acceleration at the base of the structure [1]. The base shear, or earthquake force, is given by the symbol “V_B”. The weight of the building is given as the symbol “W”.

$$\mathbf{V_B = A_h \times W}$$

V_B = Base Shear

A_h= Horizontal Seismic Coefficient

W = Total Weight of Structure

And

$$A_h = \frac{Z}{2} x \frac{I}{R} x \frac{S_a}{g}$$

Z = Zone Factor

I = Importance Factor

R = Response Reduction Factor

S_a/g = Average Response Acceleration Co-efficient

The adjustment factors depend on many things, like how tall the building is, what soil it is built on, how close it is to an earthquake fault, how important it is, how many people it can hold, what materials will be used to build it, and others. The weight of the building includes the structure itself plus permanent equipment and partitions, and in some cases a portion of stored items in the building or snow on the roof, or both. Calculations of base shear (**V_B**) depend on:

- Soil conditions at the site
- Proximity to potential sources of seismic activity (such as geological faults)
- Probability of significant seismic ground motion
- The level of ductility and over strength associated with various structural configurations and the total weight of the structure
- The fundamental (natural) period of vibration of the structure when subjected to dynamic loading.

Storey Shear is the sum of design lateral forces at all levels above the storey under consideration. The design base shear V_B computed shall be distributed along the height of the building as per the following expression:

$$Q_i = V_B \ x \ \frac{W_i h_i^2}{\Sigma W_i h_i^2} \quad [1]$$

Q_i = Design lateral force at floor i,

W_i = Seismic Weight of floor i,

h_i = Height of floor i from base

III.CALCULATION STEPS

STEP 1: To Determine "Z"

"Z" is the zone factor for Maximum Considered Earthquake (MCE) and service life of structure in a zone. The factor 2 in the denominator of "Z" is used so as to reduce the Maximum Considered Earthquake (MCE) zone factor to the factor for Design Basis Earthquake (DBE). [1]

Table 1 Zone Factor, Z [1]

Seismic Zone	2	3	4	5
Z	0.10	0.16	0.24	0.36

STEP 2: To determine "I"

"I" is a factor used to obtain the design seismic force depending upon the functional use of the structure, characterised by hazardous consequences of its failure, its post-earthquake functional need, historical value, or economic importance.

Table 2 Importance Factor, I [1]

Sr. No.	Structure	Importance Factor
1	Important service and community buildings, such as hospitals; schools; monumental structures; emergency buildings like telephone exchange, television stations, radio stations, railway stations, fire station buildings; large community halls like cinemas, assembly halls and subway stations, power stations	1.5
2	All other buildings	1.0

STEP 3: To determine "R"

"R" is the RESPONSE REDUCTION FACTOR. It is the factor by which the actual base shear force, which would be generated if the structure were to remain elastic during its response to Design Basis Earthquake shaking, shall be reduced to obtain the design lateral force.

STEP 4: To determine "S_a/g"

"S_a/g" is AVERAGE RESPONSE ACCELERATION COEFFICIENT. It is a factor denoting the acceleration response spectrum of the structure subjected to earthquake ground vibrations, and depends on natural period of vibration and damping of the structure.

Natural Period: Natural Period of a structure is its time period of undamped free vibration. The natural period of the structure is estimated for different type of structure as follows:

$T = 0.075h^{0.75}$ (RCC Frame without infill) [1]

$T = \frac{0.09h}{\sqrt{d}}$ (For infill frames) [1]

h = height of building in metres

d = base dimension of the building at plinth level in metres along the considered direction of the lateral force

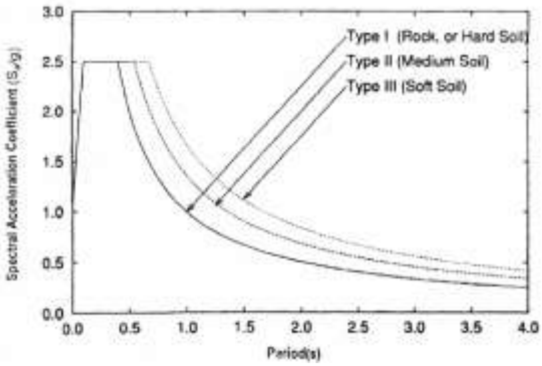
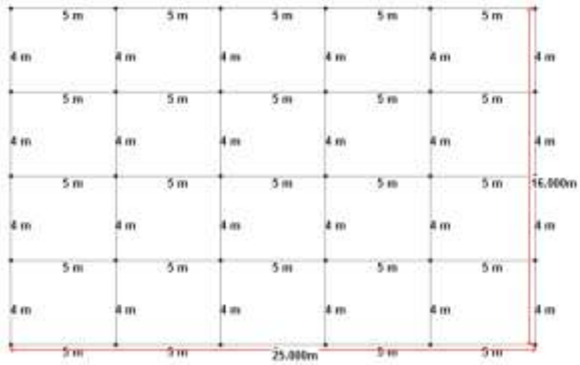


Fig.1 Response Spectra for Rock and Soil Sites [1]

I. PARAMETRIC STUDY



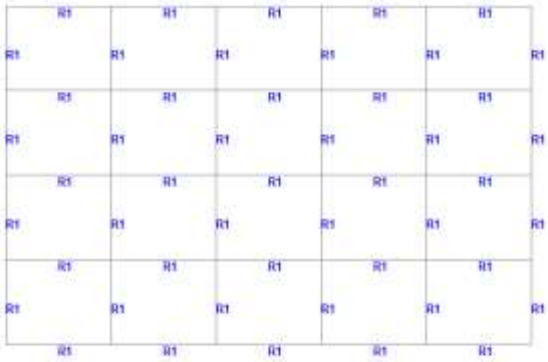


Fig.2 Plan Area of 25m x 16m building   Fig.3 Sectional Properties of 25m x 16m building

Table 3 Geometric and Sectional Properties of plan 25m x 16m building

Plan Area	**Member Properties**	**Size B x D (mm)**
25mx16m	Beams R1	230x300
	Columns	300x300
	Slab thickness	150
	Height of floor	3200

Table 4 Seismic Load Parameters for structure

Seismic Load Parameters	**Value**
Response Reduction Factor (R)	5.0
Importance Factor (I)	1.0
Type of soil strata	Medium

Case-1: Moment Resisting RCC frame without brick infill panels

Table 5 Comparison of Design Horizontal Seismic Coefficient and base shear of structure without masonry

Zone	Z	Time (sec), $T=0.075h^{0.75}$ IS 1893:2002	S_a/g	A_h	Weight of structure (kN)	Base Shear, $V_B=A_h x W$ (kN)
3	0.16	0.507	2.5	0.04	11588.9	463.556
5	0.36	0.230	2.5	0.09	11588.9	1043.00

Table 6 Comparison of storey shear in different zones for building without masonry

Floor	Zone-3 (kN)	Zone-5 (kN)
4	247.23	556.27
3	386.30	869.17
2	448.10	1008.2
1	463.556	1043,0

Case-2: Moment Resisting RCC frame with brick infill panels

Table 7 Comparison of Design Horizontal Seismic Coefficient and base shear of structure with masonry

Zone	Z	Time (sec), $T=\frac{0.09h}{\sqrt{d}}$ IS 1893:2002	S_a/g	A_h	Weight of structure (kN)	Base Shear, $V_B= A_h x W$ (kN)
3	0.16	0.507	2.5	0.04	25717.7	1028.708
5	0.36	0.230	2.5	0.09	25717.7	2314.593

Table 8 Comparison of storey shear in different zones for building with masonry

Floor	Zone-3 (kN)	Zone-5 (kN)
4	548.64	1234.4
3	857.26	1928.8
2	994.42	2237.4
1	1028.7	2314.6

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Fig.4 Base Shear Comparison Graph for zone-3 building with/without masonry

Figure 5 Base Shear Comparison Graph for zone-5 building with/without masonry

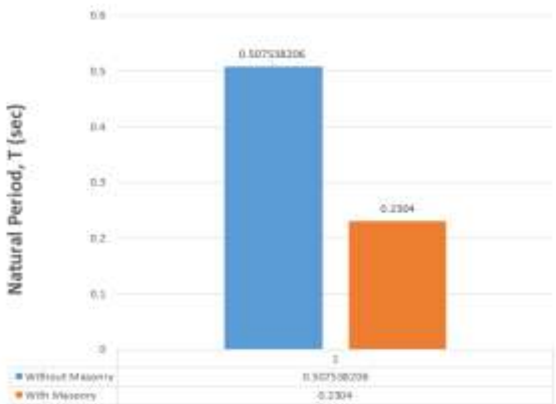

Figure 6 Time Period Comparison Graph for natural period of building with/without masonry

IV. CONCLUSION

The base shear of a building with masonry will be much higher than that of building without masonry. Therefore, the building with more seismic weight will be having high base shear and low natural period. The base shear of a building located in zone – 5 will be much higher than that of building in zone – 3.

REFERENCES

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