

**Effect Of Response Reduction Factor & Natural Time Period On Base Shear**Sanjivkumar N.Harinkhede<sup>1</sup>, Akash G. Malusare<sup>2</sup>, Shankar D. Kharat<sup>1</sup><sup>1</sup>Civil Engineering, Sinhagad Academy of Engineering Pune<sup>1</sup>Civil Engineering, Sinhagad Academy of Engineering Pune<sup>2</sup>Civil Engineering, Zeal College of Engineering Narhe

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**Abstract** — Any building when subjected to an earthquake of a certain magnitude experiences a lateral force which is produced by seismic waves. This lateral force is termed as base shear and is dependent on various parameters like zone factor, response reduction factor, natural time period and seismic weight of a building. An attempt of calculating base shear by taking into considerations combinations of ordinary moment resisting frame (OMRF), special moment resisting frame (SMRF) and presence & absence of brick infill which also affects the value of base shear.

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**Keywords-** Base shear, brick infill, OMRF, SMRF, lateral force, frame

**INTRODUCTION**

India has had a number of world's greatest earthquakes in last century. In fact, more than 50% area is considered prone to damaging earthquakes. Base shear is an important factor in design of buildings in seismic zones. value of response reduction factor is different for OMRF and SMRF also natural time period is different for building with and without brick infill. Therefore base shear of a same building is calculated by taking different frames and brick infill conditions. A seismic weight and zone factor has been kept constant for all conditions.

Following are the four conditions considered to calculate base shear:

- 1) Base shear when SMRF and brick infill provided
- 2) Base shear when SMRF is provided without brick infill
- 3) Base shear when OMRF and brick infill provided
- 4) Base shear when OMRF is provided without brick infill

**\_Example\_** A frame is situated in zone V, Rcc building of 5 storey as shown in fig, the dead load is 12 KN/m<sup>2</sup> on the floor and 10 KN/m<sup>2</sup> on roof. Live load is 4 KN/m<sup>2</sup> and on the roof 1.5 KN/m<sup>2</sup>. Rcc building is residential building. Building is resting on medium soil.

Given :

- a)  $Z = 0.36$
- b) storey = 5
- c) DL on floors = 12 KN/m<sup>2</sup>
- d) DL on roof = 10 KN/m<sup>2</sup>
- e) LL on floors = 4 KN/m<sup>2</sup>
- f) LL on roof = 1.5 KN/m<sup>2</sup>
- g) importance factor (I) = 1.0 (residential building)

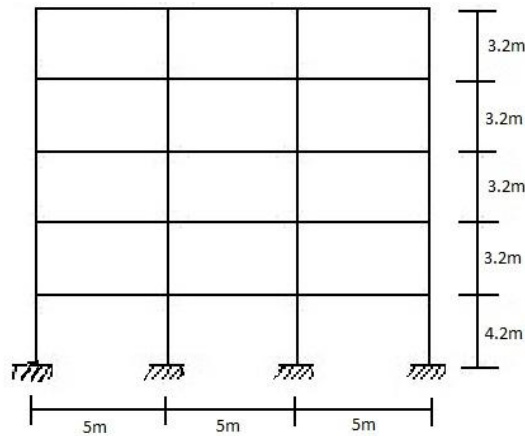


Fig. Elevation of structural frame

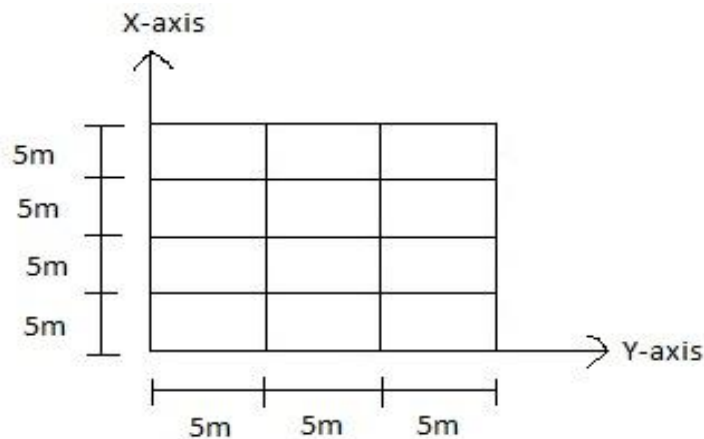


Fig. Plan of structural frame

A) calculation of seismic weight (W) :

i) dead load on each floor = Area X load intensity  
 $= (15 \times 20) \times 12$   
 $= 3600 \text{ KN}$

ii) dead load on roof slab = Area X load intensity  
 $= (15 \times 20) \times 10$   
 $= 3000 \text{ KN}$

iii) live load on each floor = Area X load intensity  
 $= (15 \times 20) \times 4 \times \left(\frac{50}{100}\right)$   
 $= 600 \text{ KN}$

Using clause 7.3.1, table no. 8 ( IS 1893: 2002)

iv) live load on roof slab = Area X load intensity  
 $= (15 \times 20) \times 1.5 \times \left(\frac{25}{100}\right)$   
 $= 112.5 \text{ KN}$

Seismic weight of building on each floor = D.L. + L.L  
 $= 3600+600$   
 $= 4200 \text{ KN}$

Seismic weight of building on roof slab = D.L. + L.L  
 $= 3000+112.5$   
 $= 3112.5 \text{ KN}$

$$\begin{aligned} \text{Total seismic weight} = W &= 1^{\text{st}} \text{ floor load} + 2^{\text{nd}} \text{ floor load} + 3^{\text{rd}} \text{ floor load} + 4^{\text{th}} \text{ floor load} + \text{roof slab} \\ &= 4200+4200+4200+4200+3112.5 \\ &= 19912.5 \text{ KN} \end{aligned}$$

1) Base shear when SMRF and brick infill provided:

Natural time period =

$$\begin{aligned} &= \frac{0.09h}{\sqrt{d}} \\ &= \frac{0.09 \times 17}{\sqrt{15}} \\ &= 0.395 \end{aligned}$$

Using clause 6.4.5 (IS 1893:2002)

$$\frac{S_a}{g} = 2.50 \quad \dots \text{ ( for medium soil)}$$

Calculation of design horizontal seismic coefficient ( $A_h$ ):

$$\begin{aligned} A_h &= \frac{z I S_a}{2 R g} \\ &= \frac{0.36}{2} \times \frac{1.0}{5} \times 2.50 \\ &= 0.09 \end{aligned}$$

Determination of design seismic base shear ( $V_B$ ):

Using clause 7.5.3 ( IS 1893:2002)

$$\begin{aligned} V_B &= A_h \cdot W \\ &= 0.09 \times 19912.5 \\ &= 1792.125 \text{ KN} \end{aligned}$$

Determination of design lateral force (Q):

Using clause 7.7.1 (IS 1893:2002)

$$Q = V_B \frac{w_i h_i^2}{\sum w_i h_i^2}$$

Storey	W <sub>i</sub> (kN)	H <sub>i</sub> (m)	W <sub>i</sub> h <sub>i</sub> <sup>2</sup>	$\frac{w_i h_i^2}{\sum w_i h_i^2}$	$Q = V_B \frac{w_i h_i^2}{\sum w_i h_i^2}$
5	3112.5	17	899512.5	0.363388	651.2361
4	4200	13.8	799848	0.323125	579.0802
3	4200	10.6	471912	0.190644	341.6585
2	4200	7.4	229992	0.092913	166.5114
1	4200	4.2	74088	0.02993	53.63881
= 2475352.5					

2) Base shear when SMRF is provided without brick infill:

Natural time period  $= 0.075 h^{0.75}$   
 $0.075 (17^{0.75}) = 0.62$

Using clause 6.4.5 (IS 1893:2002)

$$\frac{S_a}{g} = \frac{1.36}{T} = 2.19 \quad \dots \text{ ( for medium soil)}$$

Calculation of design horizontal seismic coefficient ( $A_h$ ) :

$$A_h = \frac{z I S_a}{2 R g} = \frac{0.36}{2} \times \frac{1.0}{5} \times 2.19$$

$$= 0.078$$

Determination of design seismic base shear ( $V_B$ ) :

Using clause 7.5.3 ( IS 1893:2002)

$$V_B = A_h \cdot W$$

$$= 0.07884 \times 19912.5$$

$$= 1569.90 \text{ KN}$$

Determination of design lateral force (Q) :

Using clause 7.7.1 (IS 1893:2002)

$$Q = V_B \frac{w_i h_i^2}{\sum w_i h_i^2}$$

Storey	W <sub>i</sub> (kN)	H <sub>i</sub> (m)	W <sub>i</sub> h <sub>i</sub> <sup>2</sup>	$\frac{w_i h_i^2}{\sum w_i h_i^2}$	$Q = V_B \frac{w_i h_i^2}{\sum w_i h_i^2}$
5	3112.5	17	899512.5	0.363388	570.4823
4	4200	13.8	799848	0.323125	507.2738
3	4200	10.6	471912	0.190644	299.2926
2	4200	7.4	229992	0.092913	145.8638
1	4200	4.2	74088	0.02993	46.98755
			<b>= 2475352.5</b>		

3)Base shear when OMRF and brick infill provided:

Natural time period

$$= \frac{0.09h}{\sqrt{d}}$$

$$= \frac{0.09 \times 17}{\sqrt{15}}$$

$$= 0.395$$

Using clause 6.4.5 (IS 1893:2002)

$$\frac{Sa}{g} = 2.50 \quad \dots \text{ ( for medium soil)}$$

Calculation of design horizontal seismic coefficient ( $A_h$ ) :

$$A_h = \frac{z I Sa}{2 R g}$$

$$= \frac{0.36}{2} \times \frac{1.0}{3} \times 2.50$$

$$= 0.15$$

Determination of design seismic base shear ( $V_B$ ) :

Using clause 7.5.3 ( IS 1893:2002)

$$V_B = A_h.W$$

$$= 0.15 \times 19912.5$$

$$= 2986.875 \text{ KN}$$

Determination of design lateral force ( $Q$ ) :

Using clause 7.7.1 (IS 1893:2002)

$$Q = V_B \frac{w_i h_i^2}{\sum w_i h_i^2}$$

Storey	Wi (kN)	Hi (m)	W <sub>i</sub> h <sub>i</sub> <sup>2</sup>	$\frac{w_i h_i^2}{\sum w_i h_i^2}$	$Q = V_B \frac{w_i h_i^2}{\sum w_i h_i^2}$
5	3112.5	17	899512.5	0.363388	1085.393
4	4200	13.8	799848	0.323125	965.1337
3	4200	10.6	471912	0.190644	569.4309
2	4200	7.4	229992	0.092913	277.519
1	4200	4.2	74088	0.02993	89.39801
			<b>= 2475352.5</b>		

4) Base shear when OMRF is provided without brick infill:

Natural time period  $= 0.075 h^{0.75}$   
 $= 0.075 (17^{0.75}) = 0.62$

Using clause 6.4.5 (IS 1893:2002)

$$\frac{Sa}{g} = \frac{1.36}{T} = 2.19 \quad \dots \text{ ( for medium soil)}$$

Calculation of design horizontal seismic coefficient ( $A_h$ ) :

$$A_h = \frac{z I Sa}{2 R g}$$

$$= \frac{0.36}{2} \times \frac{1.0}{3} \times 2.19$$

$$= 0.1314$$

Determination of design seismic base shear ( $V_B$ ) :  
 Using clause 7.5.3 (IS 1893:2002)

$$V_B = A_h \cdot W$$

$$= 0.1314 \times 19912.5$$

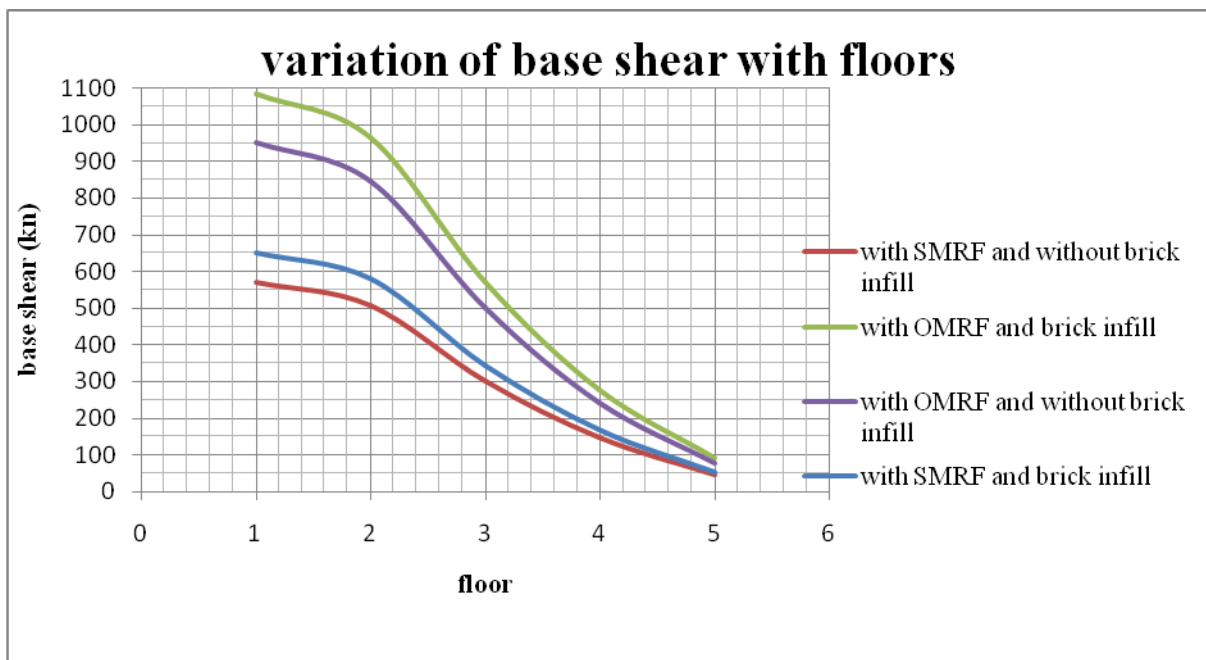
$$= 2616.50 \text{ KN}$$

Determination of design lateral force (Q) :  
 Using clause 7.7.1 (IS 1893:2002)

$$Q = V_B \frac{w_i h_i^2}{\sum w_i h_i^2}$$

Storey	W <sub>i</sub> (kN)	H <sub>i</sub> (m)	W <sub>i</sub> h <sub>i</sub> <sup>2</sup>	$\frac{w_i h_i^2}{\sum w_i h_i^2}$	$Q = V_B \frac{w_i h_i^2}{\sum w_i h_i^2}$
5	3112.5	17	899512.5	0.363388	950.8038
4	4200	13.8	799848	0.323125	845.4563
3	4200	10.6	471912	0.190644	498.821
2	4200	7.4	229992	0.092913	243.1064
1	4200	4.2	74088	0.02993	78.31258
			= 2475352.5		

Result :



**Conclusion :** From the above graph it is concluded that a building when designed with a special moment resisting frame and without brick infill faces the minimum base shear as compared to the building designed with any other combination

of the above. So for a region of high danger of earthquakes one can design a building with provision SMRF and without brick infill to have a low lateral force.

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