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Study of Seismic Loading Behavior with Variation In Storey Height

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***Abstract:*— Analysis of structural performance of a building plays a vital role in its efficient design and resistance to withstand earthquakes. Weight of a building is a major factor in its performance against seismic loading. The seismic load assessment is a very important factor in the performance of the building under the action of earthquakes of different magnitudes and according to these loads; the buildings are designed [4]. One of the main criteria of a structurally sound building is that, it should meet all the functional requirement of the user, for all given parameters, in other words it should be efficient in all respect. The objective of this study is to compare the lateral (seismic) loads subjected to each floors of four G+5 RC framed buildings of storey heights 3.5m, 4.0m, 4.5m and 5m keeping the plan dimension of the buildings same. The buildings are considered to be located in zone V region. The lateral loads are calculated by vertically distributing the design base shear acting on the buildings using equivalent static load method conforming IS 1893(part 1): 2002. The study results revealed the fact that the lateral load values acting on a particular floor level does not necessarily increase with the increase in height of the buildings especially when the difference in heights are not significant.**

I. INTRODUCTION

Base Shear is an estimate of the maximum expected lateral force that will occur due to seismic ground motion at the base of the structure. A calculation of the base shear depends on Soil condition at the site, Proximity of significant seismic ground motion, Probability of significant seismic ground motion, The level of ductility, total weight of the structure and The fundamental (natural) period of vibration of the structure when subjected to dynamic loading and is calculated using the following equation

$V_b = A_h \times W$

Where A_h is the design horizontal seismic coefficient and is given by

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

Where,

Z= Zone factor and is calculated as per (table 2, clause 6.4.2, IS: 1893, part 1, 2002)

Value of $\frac{S_a}{g}$ is calculated (As per clause 6.4.5, IS: 1893, part 1, 2002).

The value of $\frac{S_a}{g}$ depends upon the approximate fundamental natural period for RCC frame and is given by

$T = \frac{0.09h}{\sqrt{d}}$, where h is the overall height of building and d is the base dimension.

I= Importance factor=1.0 for residential building and (As per table 6, clause 6.4.2, IS: 1893, part 1, 2002)

R= Response Reduction Factor. Ductile detailing is assumed for the structure and the value of R is taken equal to 5.0 (As per table 7, clause 6.4.2, IS: 1893, part 1, 2002).

II. METHODOLOGY

Four G+5 RC framed buildings, rectangular in plan with storey height 3.5m, 4.0m, 4.5m and 5.0m respectively were designed and the seismic loading behavior in a particular floor of different buildings was studied. The value of dead load and live load were taken as per the value given in IS 875 part 1 and IS 875 part 2. Slab was designed as per IS 465-2000. Substitute frame method was used to perform gravity load analysis and portal method was used for lateral load analysis.Load combination was done as per IS 456-2000 and the critical value were chosen for the design of the structural elements [3]. Limit state method of design was used and the design was done as per IS 456-2000.

2.1 Material properties

Table 1Material properties used to design the building

Materials	Properties
Concrete type	M30
Rebar	Fe500, Fe250
Unit wt. of concrete	25kg/mm3
Unit wt. of infill	20 kg/mm3
Characteristic Strength, fck	30 N/mm2

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2.2 Sectional properties

Table2: Sectional Properties of the various members

Material Properties	Dimensions (mm)
Beams	300×350
Column1	400×450
Column 2	500×550
Slab	150
External walls	250
Internal walls	200
Parapet	250×2000

Where, column1 are the columns in roof, 4th, 3rd and 2nd level. Column2 are the columns in ground floor and first floor.

III. RESULTS AND DISCUSSIONS

The overall weight of the building was calculated by adding the weight of an individual element of the building. The weight of an individual element was found out by multiplying the volume of the member with its unit weight. Considered members contributing the overall weight of the building were slabs, beams, columns, walls and parapet [1] [2]. Live load and floor finish load were also taken into consideration. Referring to the overall weight of the building, the resulting base shear for different buildings is then calculated as per IS 1893. The calculations for the overall weight of the building and corresponding base shear for different buildings are shown in table 3. The base shear thus found out for different buildings is then distributed to different floors of the corresponding buildings. The base shear value at the particular floor of the different buildings is then compared. The value of the base shear at sixth floor of different buildings is shown in table 4. The base shear value at a particular floor of different buildings is represented graphically.

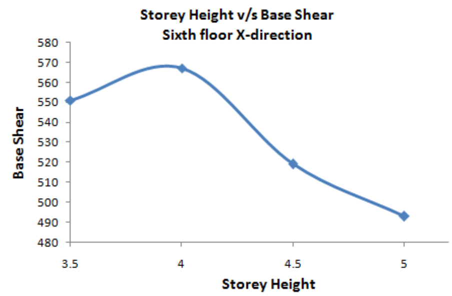
Table 3: Overall weight and design seismic load

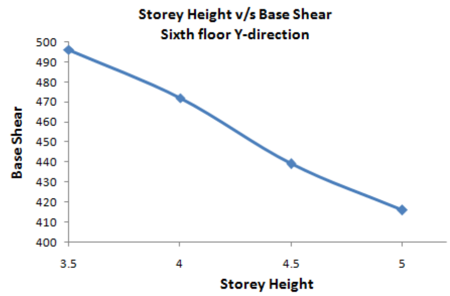
Building	Story Height (m)	Overall Height (m)	Overall Weight (kN)	Design seismic load (kN)	
				X-dir	Y-dir
Building1	3.5	21	15035	1687	1519
Building 2	4.0	24	16180	1767	1472
Building 3	4.5	27	17325	1642	1389
Building 4	5.0	30	18470	1579	1333

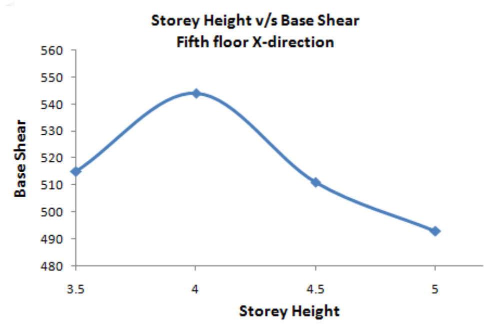
Table 4: Seismic load distribution table for 6th floor of different buildings

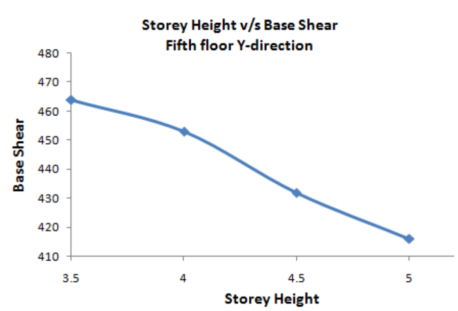
Building	Base Shear	
	X-direction	Y-direction
Building 1	551	496
Building 2	567	472
Building 3	519	439
Building 4	493	416

Graphical representation of base shear on each floor









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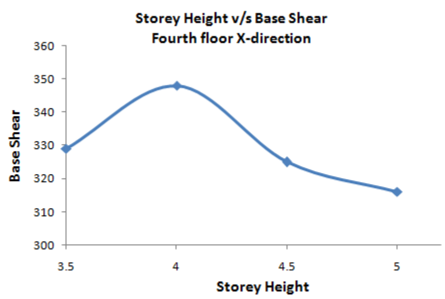

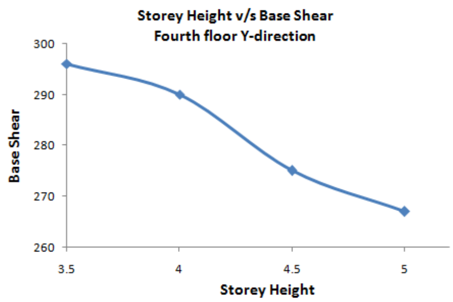

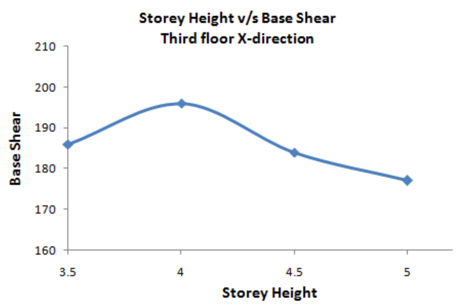

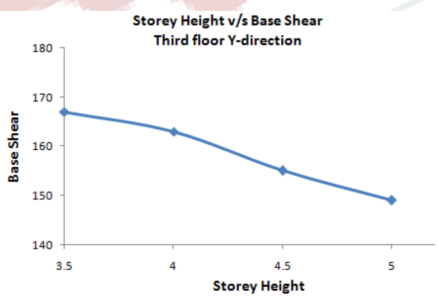

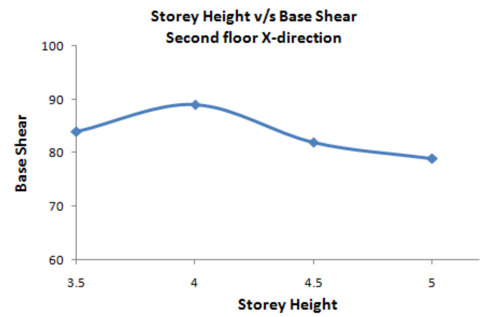

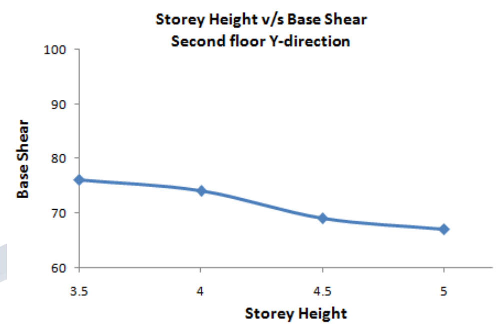

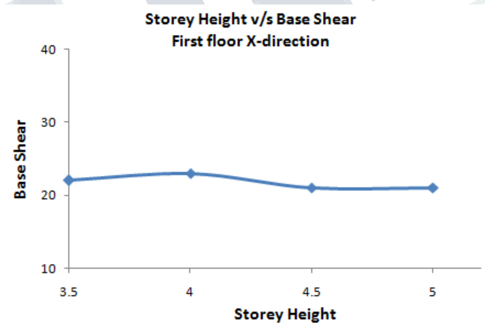

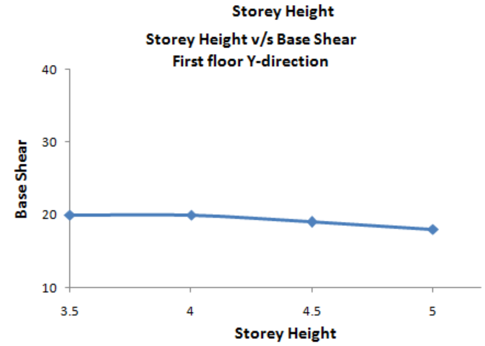

CONCLUSION

As evident from the results of the work it can be concluded that the overall weight of the buildings considered increases with increase in the height of the buildings. But as the increase in height per building is only 3m, the weight of the buildings does not increase significantly and moreover since the spectral acceleration coefficient (S_a/g) decreases following an increase in the natural period of higher buildings, the base shear eventually drops in a particular floor level as compared for buildings of height 21m to a height of 30m keeping the plan dimension of the building constant. It can also be concluded that the difference in the value of base shear in a particular floor of considered buildings goes on increasing with increase in floor level.

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