SEISMIC DESIGN OF OPEN GROUND STOREY RC BUILDING

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Abstract: Open storey is the storey in which infill wall is absent. Open storey is functionally utilized for the parking purposes in a building. These buildings are not compatible for the earthquake point of view. Because the failure pattern of open storey is quite different from the infill storey. But due some land restraints on us, we have to construct the open storey especially in urban cities. And in such a condition IS 1893:2002 recommends a factor 2.5, which is multiplied to the moments and shear of the beam and column calculated under seismic condition. The objective of the present study is to review the applicability of the multiplication factor. In the present study a G+3 residential building is considered in seismic zone 4 with soft soil condition. Two separate models are prepared, in which one building is considered with an open ground storey and another building in considered with an infill wall. Both static and dynamic analysis is performed. From the result, it is concluded that multiplication factor is recommended by the IS 1893:2002 is ample high.

Key words: soft storey, weak storey, Equivalent static analysis, response spectrum analysis, time history analysis, infill masonry.

1. INTRODUCTION.

Open Storey: As it is clear from the name open storey are those storeys which are open. IS 1893:2002 further classified the storey as a soft storey and weak storey, accordingly to the lateral stiffness. IS Code 1893:2002 classifies a storey as soft storey, if the storey (open) lateral stiffness is less than 70 percent of the above or in the case of storey greater than three it is less than 80 percent of the average lateral stiffness of the storey above. And code classifies the weak storey, if the lateral strength of the open storey is less than 80 percent of the above storey. From the past studies we found out that the behaviour of open storey and infill storey against seismic is different. In soft storey plastic mechanism is formed at the top of the column and the column of open storey collapse down and in infill storey the failure pattern is quite different, in the infill storey force is distributed in the masonry and an arch action is formed cracks were developed in the masonry. IS 1893:2002 recommends a multiplication factor, which say take the bending moment and sheer force of column and beam is taken 2.5 times of the moments and shear force, for neglecting the effect of soft storey. Similarly other countries recommend this multiplication factor, but the value suggested by the other countries code is not constant. Therefore the objective of the current study is to find out the value of multiplication factor for low rise building. In the current study a G+3 low rise residential building in Zone 4 is considered, assuming the condition of soil is soft soil.

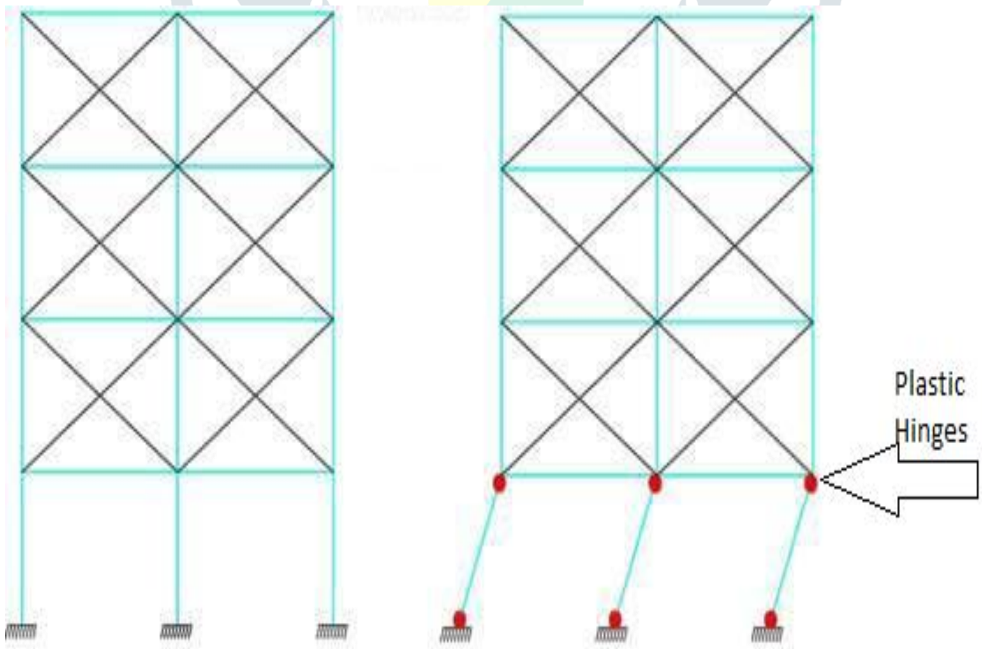

Figure No -1: Seismic behaviour of Open storey column. (Source: buildingresearch.com.np)

2. OBJECTIVES OF THE STUDY.

Following are the objectives of the study.

- Analysis the G+3 Residential building according to the IS 1893:2002.
- Find out the applicability of multiplication factor.

3. BUILDING MODELLING.

All modelling and analysis are done on commercial software STAAD Pro.

Total number of storey considered is G+3. It is important to make a computational model to do analysis. For this STAAD PRO software is used. In this two models are considered, which are described as follow.

- G+3 RCC framed building with ground storey open.
- G+3 RCC framed building with no open storey.

4. BUILDING OVERVIEW.

- Number of Storey : G+3
- height of building : 12 m
- Height of each floor : 3 m
- Beam sizes : 400 x 600 mm
- Column sizes : 400 x 650 mm
- Slab thickness : 150 mm
- Floor Live Load : 2.0 Kn/m^2
- Grade of Concrete: M25
- Steel : Fe415

Seismic Parameters

- Zone : 4
- Importance Factor : 1
- Value of R : 5
- Soil type : Soft

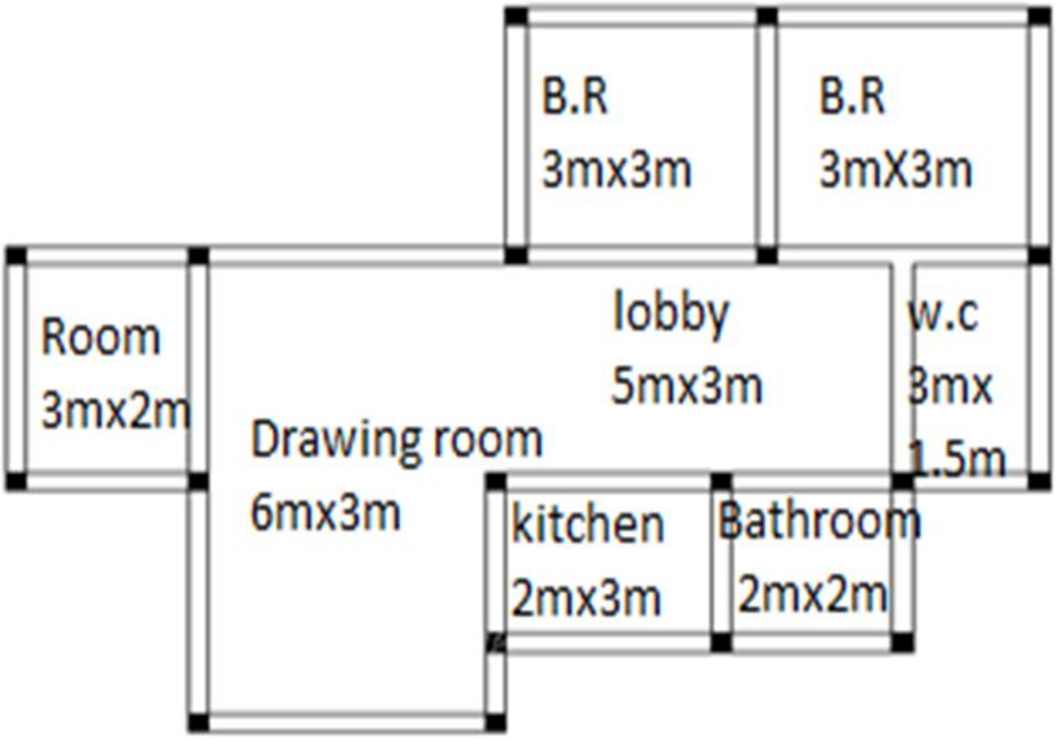

Figure No -2: Plan of building

5. METHODOLOGY.

In the present study the following methodology is used.

First of all the Zone is selected in which the building is considered, than plan is prepared. Once the plan is finalised then two models are prepared in STAAD PRO. In first model we considered the soft storey in ground, and in second no open storey considered. Once the model prepared then geometric property of column beam is assigned, and then provide the thickness to slab. Then the next step is to assign the load for the analysis. Then analysis is performed.

There are two types of seismic analysis process by which we find out the different parameters. The process is named as static and dynamic analysis. For dynamic analysis we have two methodologies one is response spectrum and another is time history analysis. All the static and dynamic analysis is considered in the present study.

Static Analysis:

Static analysis is also known by the name of Equivalent Static Analysis (ESA). This is the basic or the simplest procedure, this procedure is generally adopted for low rise building, because the earthquake forces are dynamic in nature and in ESA we only considered the static forces. This procedure is not satisfactory for Tall and important building. In ESA we calculate the seismic weight of the building and multiplied it with the seismic coefficient.

Response Spectrum analysis (RSA):

RSA method is used for multiple degrees of freedom. In RSA maximum modal response is combined to find out the ultimate response of the building. RSA analysis gives a maximum estimate of peak response. In RSA following methods are used for modal combination.

- SRSS Square root of sum of square: When modes are not closely spaced then SRSS method is used.
- CQC Complete quadratic equation: When modes are nearer then this method is used.

Time history Analysis (THA):

In THA we find the response of structure with respect to the time period. In Time history three types of graphs, acceleration, velocity and displacement are plotted with respect to time.

5.1 FUNDAMENTAL NATURAL PERIOD.

When an earthquake arrives a building starts shaking, time taken by a building to complete one cycle is known as the natural period of a building, and fundamental natural period is the period when a first (longest) vibration happens. IS 1893:2002 clauses no 7.6.1 gives an equation for the calculation of Fundamental natural period for a bare frame building.

$T_a = 0.075\ h^{0.75}$ for RC frame building.

And $T_a = 0.085\ h^{0.75}$ for steel frame building.

And for brick infill frame

$T_a = 0.09\ h/\sqrt{d}$

6. RESULT.

From the current study following result obtained.

A) **Fundamental natural period.**
1) For open storey in X and Y direction 0.48.
2) For infill storey in X direction 0.36 and 0.40 in y direction.

B) **Base shear**
1) Total base shear of OGS in X and Y direction from ESA method is 1056.89.
2) Total Base shear of OGS in X and Y direction from RSA method is 1056.89.
3) Total base shear of an Infill storey in X and Y direction from ESA method is 867.593.
4) Total base shear of an infill storey in X and Y direction from RSA method is 897.226.

C) **Maximum Bending Moment .(RSA)**
1) Maximum Bending moment of Open ground storey column (Ground storey) is 1016.99.
2) Maximum Bending moment of Open ground storey beam (Ground storey) is 338.835
3) Maximum Bending moment of Infill storey column (Ground storey) is 994.605.
4) Maximum Bending moment of Infill storey beam (Ground storey) is 317.397.

D) **Maximum Bending Moment .(RSA)**
1) Maximum Bending moment of Open ground storey column (Ground storey) is 83.431.
2) Maximum Bending moment of Open ground storey beam (Ground storey) is 74.734.
3) Maximum Bending moment of Infill storey column (Ground storey) is 74.73.
4) Maximum Bending moment of Open ground storey column (Ground storey) is 78.401.

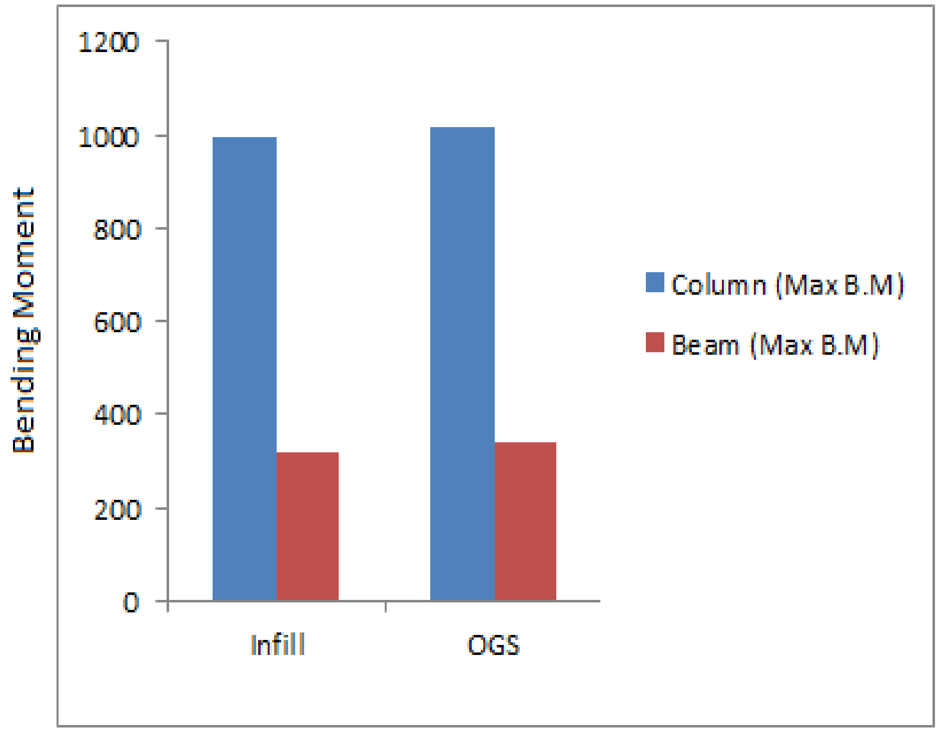

Figure No-3: Bending moment in Infill and OGS (RSA)

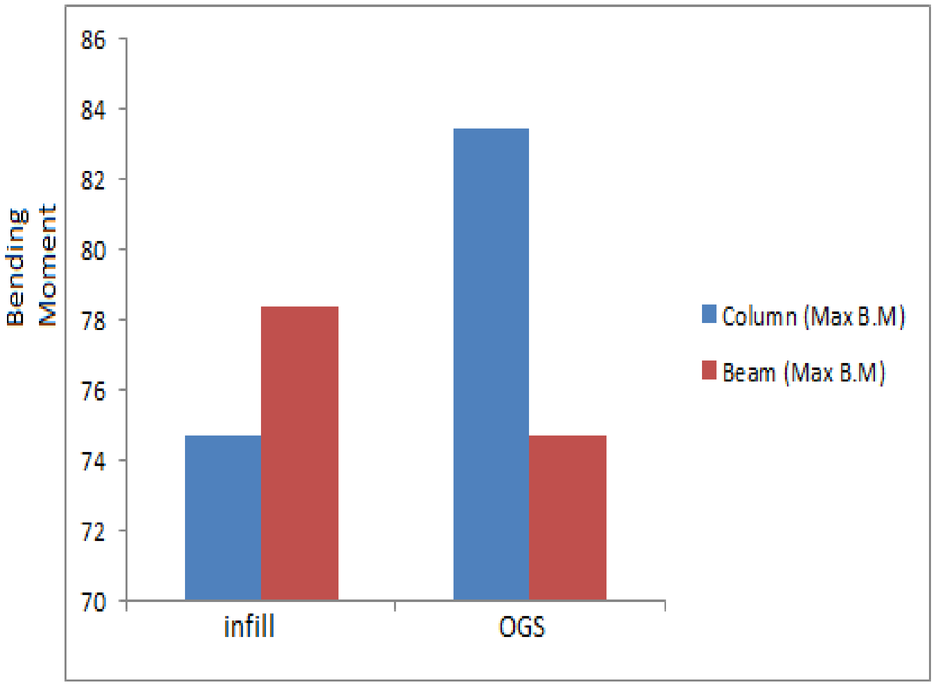

Figure No-4: Bending moment in infill and OGS (THA)

7. CONCLUSION.

From the present study we concluded that the value of base shear is low in ground storey and value of base shear rises as the number of storey increases.

Fundamental natural period for open ground storey is slightly higher in comparison of infill storey.

Multiplication factor for column and beam from RSA method is 1.02 and 1.06 and from THA is 1.11 and 1.04, which is comparatively very low from the value suggested by the IS Code 1893:2002.

8. ACKNOWLEDGEMENT.

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