Seismic Response of RC Building with Different Types of Bracings and Shear Wall in Different Seismic Zones

K.B. Mohankumar and Vinayak Vijapur

Abstract--- *This work focuses on comparison of seismic analysis of* G+12 *building stiffened with bracings and shear wall. The performance of the building is analyzed in Zone* III, *Zone* IV *and Zone* V, *with soil type* II *(Medium). The study includes understanding the main consideration factor that leads the structure to perform poorly during earthquake in order to achieve their appropriate behavior under future earthquakes. The analyzed structure is symmetrical,* G+12, *Special RC moment-resting frame (SMRF). Modeling of the structure is done as per ETABS 2015 software. Time period of the structure in both the direction is retrieve from the software and as per IS 1893(part 1):2002 seismic analysis has undergone. The Lateral seismic force of RC frame is carried out using linear static method as per IS 1893(part 1): 2002 for different earthquake zones. The scope of present work is to understand that the structures need to have suitable Earthquake resisting features to safely resist large lateral forces that are imposed on them during Earthquake. Shear walls are efficient, both in terms of construction cost and effectiveness in minimizing Earthquake damage in structure. Also the braced frames can absorb great degree of energy exerted by earthquake. The results of the performance and the analysis of the models are then graphically represented and also in tabular form and is compared for determining the best performance of building against lateral stiffness by arrangement of two types of bracings and shear wall. A comparative analysis is done in terms of Base shear, Displacement, Modal time period and modal frequency, Storey acceleration and storey drift.*

Keywords--- *RC Building, Bracings, Shear Wall, Bare Frame, Response Spectrum, ETABS 2015.*

I. INTRODUCTION

MULTI storey is a building that has many floors above the earth in the building. Multi storey structures aim to increase the floor area of the structure without increasing the area of the land that building is built on therefore multi storey structures saves the land space more effectively especially where space is limited and expensive. Upper floors are repetition of lower floors and identical upper stories are more free from stress sound and bad smell and dust. The major part in the design of multi storied structure is to resist the lateral loads along with gravity load. Because it also governs the resulting oscillatory can reduce wide range responses in the building. Earth quake is one of the great natural calamities trust upon the mankind since time immemorial and destroys lot of things as at one time. India also experiences some of the most severe earthquake and Indian sub-continent also experience most serve earthquake in the world. Seismic analyse of structure is one of the important parameter to be considered for all type of structures which account for the inelastic behaviour. Seismic response are computed by non-linear static analysis of the structure subjected to increasing lateral forces with an invariant height whose distribution until a predetermined target displacement is reached.

The parameter that is used to find out the lateral stiffness of a building is the ratio as the maximum deflection at the top storey of building to the total height of the structure. Different structural elements can be used to increase the lateral stiffness and to decrease the drift. These Elements improve the lateral stiffness of the structure and also reduce the drift. Bracings are used to resist the structure against horizontal forces. The bracing are transfers the load and transmit it to the foundation. The bracing carries both tension as well as compression thus reduces the bending movement and shear forces in the columns. Bracing system holds the building stable by transferring the loads to the ground and is used to resist against the lateral loads. Diagonal bracing system is sufficiently efficient elements for developing the stiffness and resistance against the wind loads Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral loads. The shear wall structures have been recognized as one of the most efficient structural system for such a purpose.

The following are some of the lateral load resisting system adopted in the building.

a. Moment Resistant Frames.
b. Braced Frames.
c. Shear Wall Structures.
d. Tube Structures.

K.B. Mohankuma., PG Student, Department of Civil Engineering, Government Engineering College, HAVERI, Karnataka, India. E-mail:4362mohan@gmail.com

Vinayak Vijapur, Assistant Professor, Department of Civil Engineering, Government Engineering College, HAVERI, Karnataka, India. E-mail:vinayaka_pv@yahoo.co.in

DOI:10.9756/BIJMMI.8153

II. Method of Analysis of Structure

The seismic analysis should be carried out for the buildings that have lack of resistance to earthquake forces. Seismic analysis will consider dynamic effects hence the exact analysis sometimes become complex. However for simple regular structures equivalent linear static analysis is sufficient one. This type of analysis will be carried out for regular and low rise buildings and this method will give good results for this type of buildings. Dynamic analysis will be carried out for the building as specified by code IS 1893-2002 (part1). Dynamic analysis will be carried out either by Response spectrum method or site specific Time history method. In present study analysis is carried out using Response spectrum method.

A. Response Spectrum Method

The representation of maximum response of idealized single degree freedom system having certain period and damping, during earthquake ground motions. This analysis is carried out according to the code IS 1893-2002 (part1). Here type of soil, seismic zone factor should be entered from IS 1893-2002(part1). The standard response spectra for type of soil considered is applied to building for the analysis in ETABS 2015 software. Following diagram shows the standard response spectrum for medium soil type and that can be given in the form of time period versus spectral acceleration coefficient (Sa/g).

III. Details of the Models

A. Input Parameter

The input data contains the material properties, size of the structural member, seismic zones as per IS 1893:2002, Loads which is to be considered for the study.

B. Super Structure

Multi-storied RC framed building of G+12 with different types of bracings and shear wall as well as bare frame models is considered for the analysis. All the structural members are considered to be of reinforced concrete of grade M30.

The material properties are given below:

The modulus of elasticity of concrete,

E = 27386N/mm^2

Density of concrete, $\dot{\rho}$ = 25 kN/m^3

Poisons ratio, μ = 0.2

Size of the structural members:

Beam = 0.23 m ×0.5 m

Column = 0.3 m ×0.6 m

Slab = 0.15 m thick

Bracing = ISMB 200

Shear wall = 0.2 m thick

Seismic zone III, IV, V

Zone factor Z = 0.16, 0.24, 0.36 (as per IS 1893:2002, Table 2)

Response reduction factor, R = 5

Importance factor, I = 1.5

C. Loads

For this study the gravity loads as well as earthquake load in global X and Y directions of the entire structural model is to be considered.

The loads are considered as per Indian standard codes are

Structural loads- IS 875:1987 part I, II

Earthquake loads- IS 1893:2002

Dead loads

Dead loads are taken as per IS 875:1987 part I

Unit weight of concrete = 25kN/m^3

Floor finish = 1 kN/m^2

Floor finish at terrace = 1.5 kN/m^2

Live load

Live loads are considered as per IS 875:1987 part II, Live load = 3.5 kN/m^2

Earthquake loads are considered as per IS 1893:2002

Zone factor Z = 0.16, 0.24, 0.36

Importance factor I = 1.5

Response reduction factor R = 5

D. Building Models

The modelling of the G+12 structural building with different types of bracings and with shear wall is done by using structural analysis software ETABS 2015. The models are shown in below figures

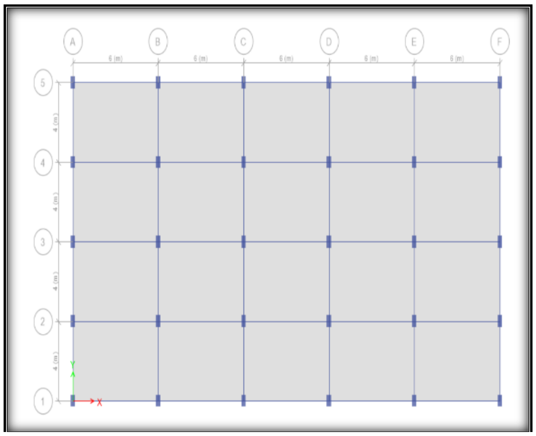

Figure 1: Plan of the Present Study

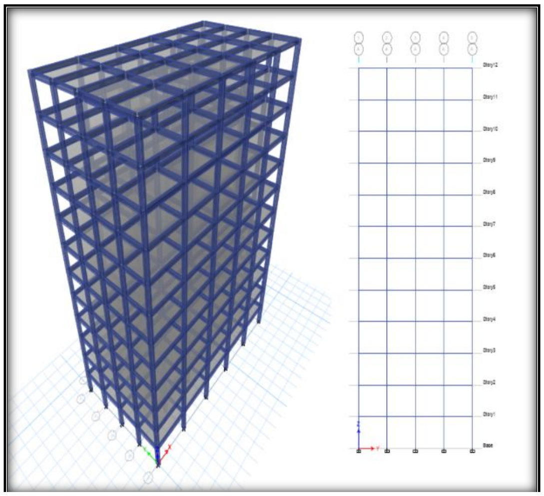

Figure 2: 3-D Model and Elevation of Bare Frame Model

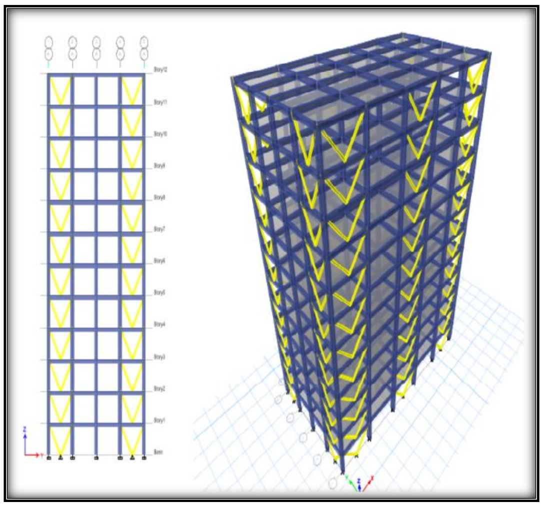

Figure 3: Elevation and 3-D Model of V Braced model

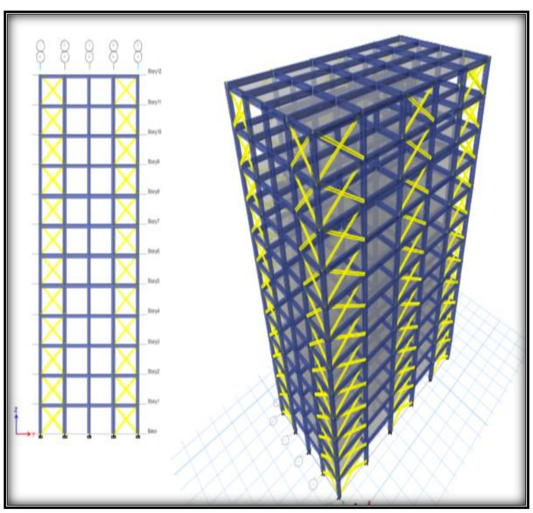

Figure 4: Elevation and 3-D Model of X Braced Model

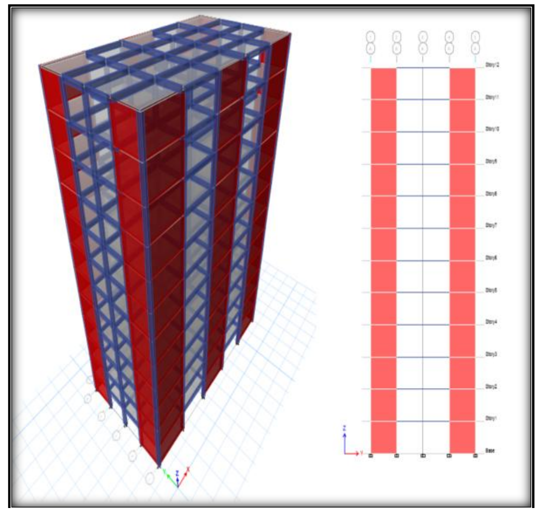

Figure 5: 3-D Model and Elevation of Shear Wall Model

IV. RESULTS

The research work is carried out to perform the seismic analysis ofRC Building with Different types of Bracings and Shear Wall in Different Seismic Zones due to earthquake excitation. The models of bare frame, V braced, X braced and shear wall models are developed using ETABS-2015 software. These four models are developed in different seismic zones such as zone III, IV and V. Each models has a G+12storey and located in soil type II (Medium). Analysis is performed by using Response spectrum method to know the base shear of each model in different seismic zones. The maximum displacement, storey drift, acceleration and time period are compared and discussion of the results is done in this chapter.

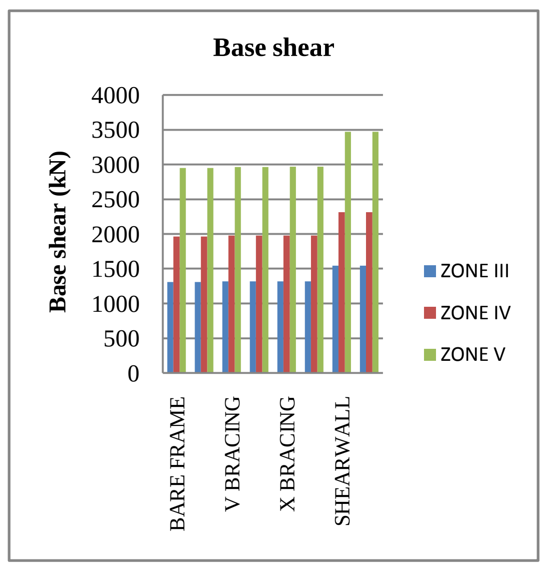

Figure 6: Base Shear in Different Zones

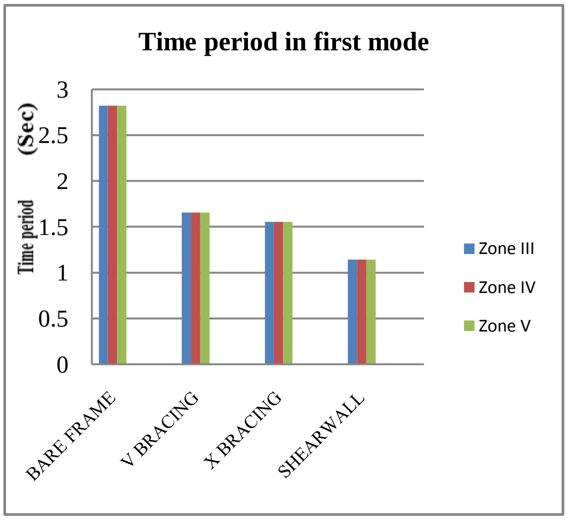

Figure 7: Time Period in First Mode

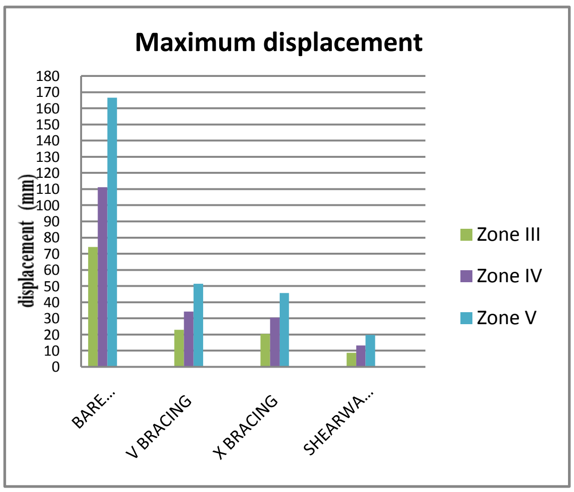

Figure 8: Maximum Displacement

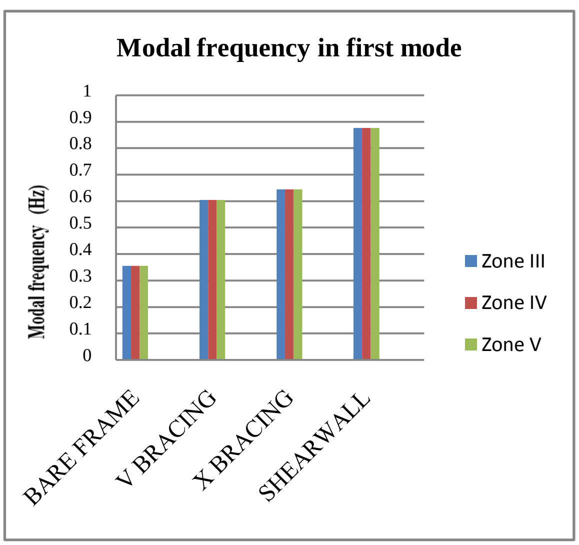

Figure 9: Modal Frequency in First Mode

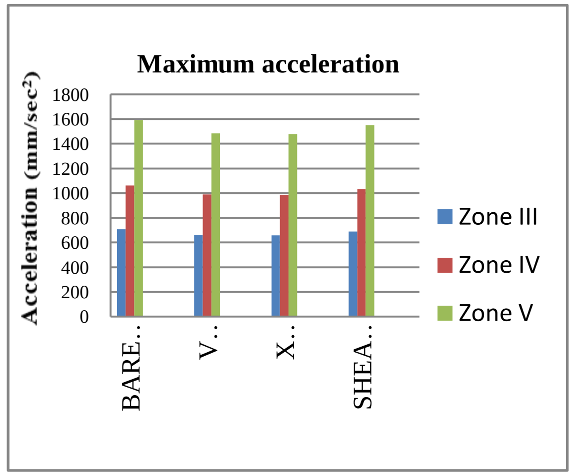

Figure10: Maximum Acceleration

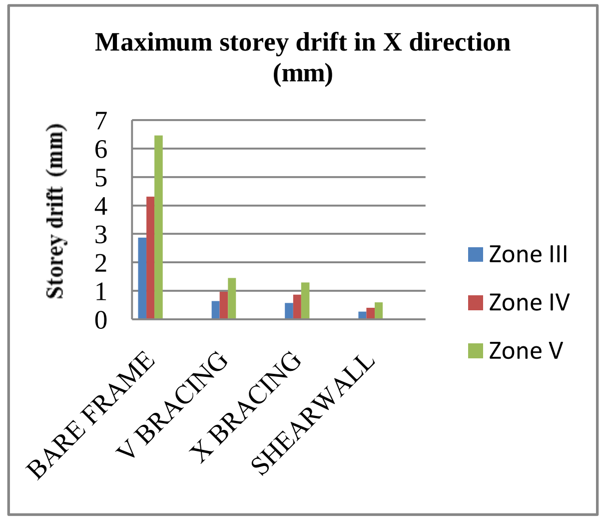

Figure11: Maximum Storey Drift

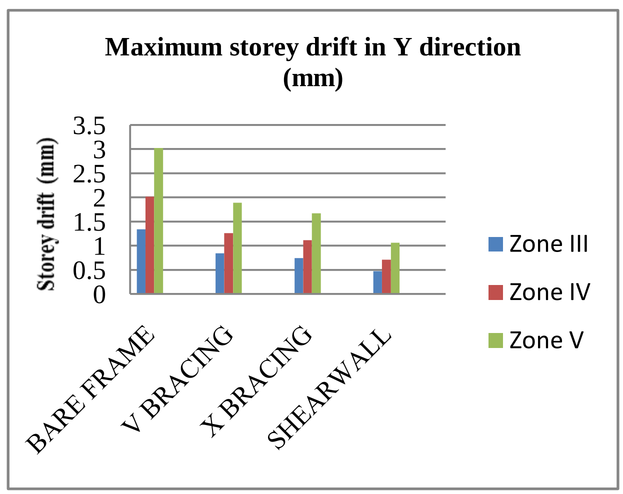

Figure12: Maximum Storey Drift in Y Direction

Table 1: Maximum Base Shear (kN)

Zone	*Bare Frame*	*V Bracing*	*X Bracing*	*Shear Wall*
III	1310	1316.57	1319.5	1542.58
IV	1964.9	1974.86	1979.2	2313.87
V	2947.4	2962.29	2968.8	3470.8

Table 2: Maximum Displacement in X Direction (mm)

Zone	*Bare Frame*	*V Bracing*	*X Bracing*	*Shear Wall*
III	74.1	22.9	20.3	8.8
IV	111.1	34.3	30.4	13.2
V	166.6	51.5	45.7	19.8

Table 3: Maximum Displacement in Y Direction (mm)

Zone	*Bare Frame*	*V Bracing*	*X Bracing*	*Shear Wall*
III	38	28	25.3	15.9
IV	57	41.9	37.9	23.8
V	85.5	62.9	56.9	35.7

Table 4: Time Period in First Mode (Sec)

Zone	*Bare Frame*	*V Bracing*	*X Bracing*	*Shear Wall*
III	2.821	1.656	1.553	1.141
IV	2.821	1.656	1.553	1.141
V	2.821	1.656	1.553	1.141

Table 5: Modal Frequency in First Mode (Hz)

Zone	*Bare Frame*	*V Bracing*	*X Bracing*	*Shear Wall*
III	0.355	0.604	0.644	0.877
IV	0.355	0.604	0.644	0.877
V	0.355	0.604	0.644	0.877

Table 6: Maximum Acceleration (mm/sec2)

Zone	*Bare Frame*	*V Bracing*	*X Bracing*	*Shear Wall*
III	708.2	659.68	657.2	689.55
IV	1062.3	989.52	985.8	1034.33
V	1593.45	1484.28	1478.69	1551.5

Table 7: Maximum Story Drift in X Direction

Zone	*Bare Frame*	*V Bracing*	*X Bracing*	*Shear Wall*
III	2.872	0.646	0.575	0.267
IV	4.308	0.969	0.863	0.4
V	6.462	1.454	1.294	0.6

V. CONCLUSION

1. The base shear of the building will be maximum in the model IV (Shear wall model) compared to the all the models. The base shear increases as the zones changes from higher to lower.
2. Compared to the model I and model IV the base shear is increased by 15% and compared to the model II and model III, base shear is increased by 2.22% in zone III.
3. The displacement of the structure will be maximum in the model I (Bare frame model) at top storey. The displacement of the structure will be reduced by providing shear wall and bracings. Compared to the bracings systems, shear wall system gives less displacement result. But by providing the bracings systems the displacement of the building will be reduced as well as total weight of the structure will be reduced.
4. The displacement is reduced by 88.12% compared to the model I and model IV in X direction in seismic zone III. Compared to the model II the displacement is reduced by 11.35% in model III.
5. The ground acceleration of the building is reduced by providing various types of bracings and shear wall. By providing X type of bracing we can reduce the ground acceleration compared to other types of bracings and shear wall.
6. Model IV is 2.63% reduction in ground acceleration compared to the model I in seismic zone III with acceleration in X direction.
7. The storey drift is maximum in the model I (Bare frame model), the drift will be reduced by providing bracings and shear wall but shear wall gives less drift values compared to the bracings.
8. The storey drift is reduced by 64.82% in model IV compared to the model I in X direction with seismic zone III.

REFERENCES

[1]. K.S.K. Karthik Reddy et al. "A comparative Study on Behaviour of Mutistoried Building with Different Types and Arrangements of Bracing Systems", Vol. 2, No. 2, 2015.
[2]. R. Umesh, Biradar and Shivraj Mangalagi "Seismic Response of Reinforced Concrete Structure by Using Different Bracing Systems", IJRET, Vol. 3, No. 9, 2014.
[3]. B.D. Punith Kumar Naik, "Seismic Response of a 3-Dimensional Analysis of Multi Storey RC Frame with Steel Bracing as Lateral Load Resisting Systems", IJSETR, Vol. 4, No. 12, 2015.
[4]. S.R. Thorat and P.J. Salunke "Seismic Behavoiur of Multystorey Shear Wall Frame Versus Braced Concrete Frames", IJAME, Vol. 4, No. 3, 2014.
[5]. M. Sundar, Deshmukh and J.G. Kulkarni, "Analysis of Partially Braced Multistoreyed Building Frames Subjected to Gravity and Earthquake Loads", IJARSE, Vol. 2, No. 8, 2013.
[6]. R.J. Prajapati and V.R. Patel, "Effect Of Different Position Of Shear Wall On Deflection In High Rise Building", International Journal of Advances in Engineering & Technology, Vol. 6, No. 4, Pp. 1848, 2013.
[7]. BhosleAshwini Tanaji and A.N. Shaikh "Analysis of Reinforced Concrete Building with Different Arrangement of Concrete and Steel Bracing Systems", Vol. 12, No. 5, 2015.
[8]. P.P. Chandurkar and P.S. Pajgade "Seismic Analysis of RCC Building with and Without Shear Wall", IJMER, Vol. 3, No. 3, 2013.
[9]. Abhijeet Baikerikar and Kanchan Kanagali, "Study Of Lateral Load Resisting Systems Of Variable Heights In All Soil Types Of High Seismic Zone", IJRET, Vol. 3, No. 10, 2014.
[10]. Rajib Kumar Biswas et al. "Comparative Analysis of a 15 Story Flat Plate Building with and Without Shear Wall and Diagonal Bracing Under Wind and Seismic Loads", IOSR-JMCE, Vol. 9, No. 2, 2013.
[11]. Mohd Atif et al. "Comparative Study On Seismic Analysis Of Multi-storey Building Stiffened With Bracing And Shear Wall", Vol. 2, No. 5, 2015.

Codes / Standards

[12]. Indian Standard IS 1893(Part1) 2002, "Criteria for earthquake resistant design of structures", Part 1: General Provisions and Buildings, Fifth Revision, BIS, New Delhi, India.
[13]. Indian Standard, IS 875(Part 1)-1987, "Code of practice for design loads (other than earthquake) for building and structures" Part 1, Dead loads unit weights of building materials and stored materials, BIS, ManakBhawan, New Delhi, India.
[14]. Indian Standard, IS 875(Part 2)-1987, "Code of practice for design loads (other than earthquake) for building and structures" Part 2-Imposed loads, BIS, ManakBhawan, New Delhi, India.