STUDY ON EFFECT OF BASE SHOCK FLUCTUATION ON MULTISTOREY RC FRAMED BUILDINGS

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Abstract
With the over consumption of construction material that we use in modern or traditional construction, we are degrading and damaging our natural resources in quest of raw materials for production of these construction materials. Now a day the increase in the construction of tall buildings, residential and commercial sector, and the new trend are towards taller and slender structures. Though the effect of wind and earthquake, base shock fluctuation becoming important for every structural designer to know. Every engineer is facing with the problem of providing stability, strength for loads like lateral loads. That's the reason wind as well as earthquake loading have become the influential factors in tall buildings. with the type of explosion we are facing in terms of population increase, it is also required to provide economical and safer habitat to our common man. Loads that are lateral loads play important role for drift. The drift must be taken into consideration for tall structure. The above mentioned are some of the key issues which affect the behavior of structure and economy of the building. This thesis focuses the effects of lateral loads on medium and tall buildings the storey forces, displacements, storey shear, story drift every part of are analyzed on every level of height on the building, Indian codal provision gives us the basic wind speed at 10m height for some important cities/towns. For the study a symmetrical building plan is used with 16 storeys and 31 storeys are analyzed and designed by using structure analysis software tool ETABS-2013. The study also includes the determination of base shear, displacement, storey drift, storey forces and the results are compared with them. These parameters have also considers the effect of shear wall. In order to design a structure to resist wind and earthquake loads, the forces on the structure must be specified.

Key words: Steel Slag, Waste Limestone Aggregates, M20 grade concrete, RC Frames, Sustainable Construction, Land Rehabilitation, Partial replacement etc.

I. INTRODUCTION

A. GENERAL

Rapid increase in the construction of tall buildings, commercial as well as residential building leads towards the construction of high rise buildings. Lateral loads similar to wind loads and earthquake loads are thus getting importance. Even though all the designers are facing the problems of getting possible strength and stability not in favour of lateral loads, one of the common used wall which is used for lateral load resisting in tall buildings is the shear wall. Vertical winds are known by the same name whereas the wind loads are known as horizontal winds. Anemometers measure the speed of wind, they are installed at the height of approximately 10 to 30 meters at meteorological observatories on the top of the ground. Thunderstorms, dust storms, cyclonic storms are powerful winds. In our Study we are examining ground plus 15 and ground plus 30 storey building and analyzing design under effect of earthquake and wind by the use of ETABS. Six different models are being analyzed, and thus proving that the shear wall models resist earthquake and wind loads.

Then the results are compared and analyzed to achieve the most suitable resisting system and economic structure against the lateral forces. The main factor which differentiates the high, medium and low rise buildings is the effect of lateral load because of the wind. For buildings of up to about 10 storied and of typical properties and the design is rarely affected by the wind loads. Above this height, however, the increase in size of the structural members, and the possible rearrangement of the structure to account for wind load, incurs a cost premium that increases progressively with height.

In the past few decades, the Population of India is getting a boom like anything else. It is this increasing population that made engineers to invent the new technologies, advances and structures in civil engineering. Conventional housing systems were not sufficient to accommodate the inhabitants, thus giving head to the need of high rise buildings, which can accommodate large number of habitants in the same given area. In view of the fact that multi-storeyed buildings are popularly constructed now a days for real estate and residential townships in urban areas, these areas are getting denser and denser day by day. Inhabitants are forced to live in tall buildings that must be able to provide them safety against the natural calamities such as an earthquake.

II. LITERATURE REVIEW

Anshuman. S, Dipendu Bhunia and Bhavin Ramjiyani , Civil and Structural Engineering, International Journal of Vol 2, (2011) There study shows in multi storey building the solution of shear wall. In some frame the provision of shear wall gives deflection of shear wall at the top and reduced to allowable deflection. Providing shear wall to some frames it is seen that wind forces and shear forces were reduced. Shear wall based on its elastic and elasto-plastic performance and found that the permissible deflection at the top and can reduce the deflection by giving shear wall to the frame at different location a study was conducted for this.

Alfa Rasikan et al; (2013).In this literature review they shows that a study was conducted behaviour of wind on tall building with inclusion of shear wall and without inclusion of shear wall the study is carried out. the displacement of included shear wall was 20% less than without inclusion of shear wall. The paper shows two models 15 storey and 20 storeys were analyzed and compare their displacement at top deflection. Study shows that results were compared at top of a 15 storey building displacement was reduced when shear wall is provided.

L.P. Swami and B. Dean Kumar (5.May 2010) effect of wind on tall building has discussed in this paper. Gust effectiveness factor method is rational and realistically analyzed and the wind pressure was known. Hence it is an important and valid point to be considered for the design of very tall buildings.

Kareem and T.Kijewski discussed the full-scale study of the behavior of tall buildings under wind and earthquake loads i.e. the fundamental differences between wind and earthquake demand. The study was carried on high rise 54 storied building and 76 storied building. The result obtained from analysis shows that wind and earthquake loads are different from each other and are also different from static load. The result indicate that earthquake load excite higher modes that produce less inter storey drift but higher acceleration which occurs for a relatively short time compare to wind loads. Although the acceleration under wind loads is lower than that of earthquake load. It occurs for longer period that become a comfort issue. However the drift under wind is larger which raises security issues. It seems that tall buildings designed for wind are safe under moderate earthquake loads.

Reinforced concrete frames in filled with masonry wall panels are common practice in developing countries like in Asia Pacific, where the region is more prone to seismic activities and utilization of land is at brisk pace. Generally the masonry infill wall elements are treated as non-structural elements during dynamic analysis and contribution of its mass is considered rather than considering its strength and stiffness properties. Structures in high seismic region are vulnerable to severe damage. Apart from high gravity loads, a structure has to withstand lateral loads which may develop high stresses.

In the modern context where forest cover is fast depleting and infrastructure and construction sector is consuming conventional resources at very high rate, attempts made in past few decades by undertaking several researches have established and substantially confirmed that bamboo could be a possible alternate of various conventional materials for housing and building construction segment and other infrastructure works.

The research and investigations reported in International Network for Bamboo & Rattan (INBAR 2002) [1], had revealed bamboo's advantages and disadvantages as a construction material. The advantages of bamboo are ecological value, competitive mechanical properties, social and economic value and low energy consumption. On the contrary part, disadvantages of bamboo are requirement of preservation and fire safety.

A review on the role of bamboo in green building design, presented by Reijenga Tjerk [2], had suggested the viability of bamboo to replace certain traditional construction materials, such as brick, steel, wood and concrete. Although, he mentioned the need of demonstration projects to convince people to use this miraculous grass on earth for design purpose, he provided sufficient examples of green buildings using bamboo for the design purpose.

III. METHODS OF ANALYSIS

A. The Location Of The Building Structure Is In Hyderabad.

The wind speed suggested by IS 875 (part-3) is 44 m/s for this location. The wind pressure is from the extents of the rigid diaphragms assigned to the slab elements. Also IS 1983(Part-1):2002 states that wind is not to be considered in chorus with earthquake or maximum flood or maximum sea waves. The load case combinations adopted are referred from IS 875(Part-3):1975,

(D.L + L.L + Wx) (D.L + L.L - Wx) (D.L + L.L + Wy) (D.L + L.L - Wy) (D.L + Wx)

(D.L - Wx) (D.L + Wy) (D.L - Wy)

B. Design wind speed(Vz)

The basic wind speed (Vz) for any shall be obtained and modified to include the following effects to get design wind velocity at any height (Vz) for the chosen structure:

1) Risk Level;
2) Terrain roughness, height and size of structure;
3) Local topography
4) It can be mathematically expressed as follows: Vz=Vb K1 K2 K3

Where,

Vz= design wind speed at any height z in m/s

K1= probability factor (risk coefficient)

K2= terrain, height and structure size factor

K3= topography factor

C. Terrain and Height Factor (K2)

1) Terrain

Terrain category should be selected due to the effect of obstruction and possesses the ground roughness surfaces. The direction of wind consideration depends on terrain category. Wherever sufficient meteorological information is available about the wind direction, the orientation of any building or structure may be suitably planned. Terrain in which a specific structure stands shall be assessed as being one of the following terrain categories:

1) Category 1 – structure is less than 1.5 m and has no obstruction at the average height of any object Exposed open terrain. NOTE – This category includes open sea coasts and flat treeless plains.

2) Category 2 – Open terrain with well scattered obstructions having height generally between 1.5 and

   10 m. NOTE – This is the criterion for measurement of regional basic wind speeds and includes airfields, open parklands and undeveloped sparsely built-up outskirts of towns and suburbs. Open land adjacent to seacoast may also be classified as Category 2 due to roughness of large sea waves at high winds.

3) Category 3 –In this category Terrain with numerous closely spaced obstructions having the size of building- structures up to 10 m in height with or without a few isolated tall structures.

D. Design wind pressure

The wind pressure at any height above mean ground level shall be obtained by the following relationship between wind pressure and wind speed:

Pz = 0.6 V2z

Where,

Pz= wind pressure in N/m2 at height z,

Vz = design wind speed in m/s at height z.

E. Discussion

Considering all the researches available till date, we can say that bamboo comes up with a lot of advantages with some disadvantages which can be overcome by giving proper treatment to the bamboo. Drawbacks like its moisture content and its water absorption capacity can be controlled by proper seasoning of bamboo, applying some external agents before using it as a construction material or reinforcement in concrete. If treated properly, Bamboo can be used as an excellent construction material and a viable replacement of steel as reinforcement. Bamboo reinforced slab panels may be used as replacement of brick wall and still can provide stability against earthquake. It is naturally grown material and take only 3-4 years to gain its full strength. As India ranks second only after China in production of Bamboo, it can serve as a solution to a lot of problems we are facing as a developing country. Considering the economic advantage bamboo possess over steel and its unique strength properties coupled with innovative ideas of its use can serve as a big step towards the era of sustainable construction..

F. Linear Static Method (Equivalent Static Method)

Earthquake analyses for the structure are carried by considering assumption that lateral (horizontal) forces are equivalent to the dynamic or actual loading. The overall horizontal force also called as base shear on the building is computed by considering fundamental period of vibration, structural mass and mode shapes. The total seismic base shear is divided along the total height of the structure by means of lateral or horizontal force according to the formulae specified by the code. The following method is suitable for building with low to medium height and steady conformation.

This method is the simplest approach for seismic analysis of multistoried structures. In this method, the structure is considered to be elastic when contacted with static force. The lateral static forces are placed individually in two principal axes i.e. transverse and longitudinal and resulting interior forces are mixed up using combination methods.

The building which is to be analyzed by linear static method should contain some criteria relating to its stiffness and geometrical regularity.

1) All members such as columns and walls which are resisting lateral loads should move from bottom to top.

2) The lateral stiffness and mass should not vary suddenly from bottom to top.

3) The certain values are to be maintained in the geometrical asymmetries in the height or in the layout plans.

This procedure is very suitable and simple for structural engineer to execute a seismic analysis for reasonable outcomes. This method is widely used for the buildings and structures which are having regularity conditions.

IV. RESULTS AND DISCUSSION

A. Displacement Result

Storey	WIND LOAD		EARTHQUAKE LOAD	
16	96.1	106.7	30.9	33.9
15	94.5	105.3	30.2	33.3
14	92.3	103.2	29.2	32.4
13	89.3	100.3	28	31.1
12	85.6	96.5	26.5	29.5
11	81.1	91.7	24.6	27.6
10	75.7	86.1	30.9	25.4
09	69.5	79.5	22.6	22.9
08	62.6	72.2	20.3	20.4
07	54.9	64	17.9	17.6
06	46.5	55	15.3	14.8
05	37.6	45.3	12.7	11.9
04	28.3	35	10	9
03	19	24.4	7.4	6.1
02	10.2	13.8	4.9	3.4
01	3.2	4.6	2.6	1.1
BASE	0	0	0.8	0

Table 4.1: storey displacements for model 1 along longitudinal and transverse directions

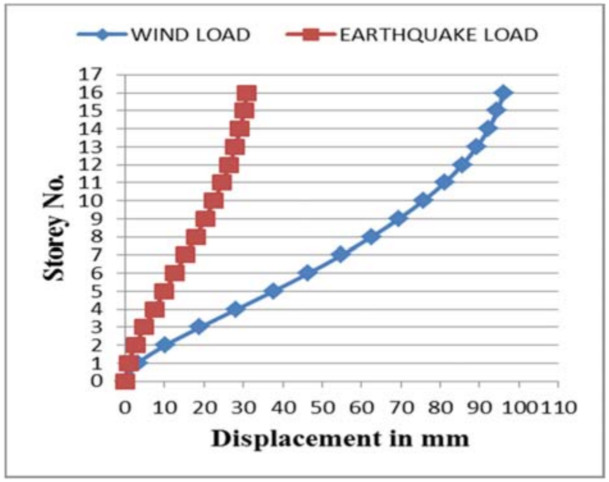

Figure. 1: Chart. 4.1: Storey wise displacement for building model-1 along longitudinal direction

B. Storey Displacements For Model 2 Along Longitudinal And Transverse directions

Storey No.	WIND LOAD		EARTHQUAKE LOAD	
16	16.7	14.8	15.8	15.9
15	15.5	13.8	14.6	14.7
14	14.3	12.7	13.4	13.5
13	13.1	11.6	12.2	12.3
12	11.8	10.5	10.9	11
11	10.6	9.4	9.7	9.8
10	9.3	8.3	8.4	8.5
09	8	7.2	7.2	7.3
08	6.8	6	6	6
07	5.6	5	4.8	4.9
06	4.4	3.9	3.8	3.8
05	3.3	2.9	2.8	2.8
04	2.3	2.1	1.9	1.9
03	1.4	1.3	1.2	1.2

Table 4.2: storey displacements for model 2 along longitudinal and transverse directions

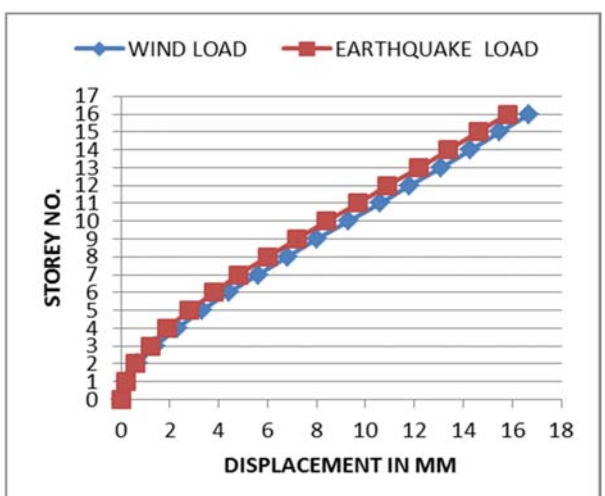

Fig. 3: Chart 4.2: Storey wise displacement for building model-2 along longitudinal direction

C. Storey Drifts

The permissible storey drift according to IS 1893 (Part 1):

2002 is limited to 0.004 times the storey height, so that minimum damage would take place during earthquake and pose less psychological fear in the minds of people. The maximum storey drifts of different models along longitudinal and transverse directions obtained from equivalent static analysis (ETABS) and fro, loads are shown in tables below.

U_x U_y U_x U_y

Storey	WIND LOAD		EARTHQUAKE LOAD	
	U_x	U_y	U_x	U_y
16	0.4	0.35	0.175	0.15
15	0.55	0.525	0.25	0.225
14	0.75	0.725	0.3	0.325
13	0.925	0.95	0.375	0.4
12	1.125	1.2	0.475	0.475
11	1.35	1.4	0.5	0.55
10	1.55	1.65	0.575	0.625
09	1.725	1.825	0.6	0.625
08	1.925	2.05	0.65	0.7
07	2.1	2.25	0.65	0.7
06	2.225	2.425	0.675	0.725
05	2.325	2.575	0.65	0.725
04	2.325	2.65	0.625	0.725
03	2.2	2.65	0.575	0.675
02	1.75	2.3	0.45	0.575
01	0.8	1.15	0.2	0.275
BASE	0	0	0	0

Table 3

V. CONCLUSIONS

1) A 16 storey building having model 1 model 2 model 3 when compare with wind and earth quake displacements in longitudinal direction. The wind displacements of model 2 and model 3 is reduced by 82.62% and 76.90% and earth quake displacement of model 2 and model 3 is reduced by 48.87% and 22.01%when compared with model 1.hence it is found that building with shear wall i.e. model 2 resist wind and earth quake load effectively.

2) A 16 storey building having model 1 model 2 model 3 when compare their wind and earth quake displacements in transverse direction. The wind displacements of model 2 and model 3 is reduced by 86.13% and 81.73% and earth quake displacement of model 2 and model 3 is reduced by 53.10% and 40.05%when compared with model 1.hence it is found that building with shear wall i.e. model 2 resist wind and earth quake load effectively.

3) Although A 31 storey building having model 4 model 5 model 6 when compare their wind and earth quake displacements in longitudinal direction. The wind displacements of model 5 and model 6 is reduced by 52.42% and 48.48% and earth quake displacement of model 5 and model 6 is reduced by 48.77% and 42.26%when compared with model 4.hence it is found that building with shear wall i.e. model 4 resist wind and earth quake load effectively.

4) A 31 storey building having model 4 model 5 model 6 when compare their wind and earth quake displacements in transverse direction. The wind displacements of model 5 and model 6 is reduced by 55.92% and 50.84% and earth quake displacement of model 5 and model 6 is reduced by 51.90% and 44.33%when compared with model 4.hence it is found that building with shear wall i.e. model resist wind and earth quake load effectively.

5) Lateral displacement values obtained from static method of analysis indicate that shear wall provision along longitudinal and transverse directions are effective in reducing the displacement values in the same directions.

6) The result show that wind and earth quake loads are different from each other indicates that

earth quake loads produce less inter storey drift compare with the wind load. Even if inter story drift ratios in tall buildings may be relatively small with no significant apparent issue for main force resisting system of structure similar conclusion were obtained with both the 16 storey and the 31 storey buildings.

7) From the comparison of story drift values it can be observed that maximum reduction in drift values is obtained when shear walls are provided at corners of the building.

8)Buildings should be designed in both directions independently for the critical forces of wind or earthquake separately. The total shear force and the moment at the base result from seismic analysis when loads acting normal to the short side may be greater than the other direction.

9) Composite structures are the best solution for high rise structure.

10) According to various researches conducted on different species of bamboo, it is revealed that Bamboo has adequate compressive strength, measured highest in the species Dendro calamus Strictus and Bambusa Vulgaris Schard.

11) It has tensile strength of about 1/3rd that of steel, providing ductility to this wonder grass. Therefore, it can be used in Steel as well as in R.C.C structures.

12) It is evident from previous researches that Bamboo reinforcement technique is absolutely cheaper than steel reinforcement technique especially for single storey structures. Considering its viability, there is a great wide scope for designing multi story structure using Bamboo reinforcement.

13) For severe lateral loads caused by wind load and or earthquake load, the reinforced shear wall is obvious. Because, it produces less deflection and less bending moment in connecting beams under lateral loads than all others structural system.

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