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Review Article

Review on Axial Forces acting on Column Members of Multistoried Building

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Abstract

In India, construction plays a very important role with the introduction of high-rise structures that has been increasing gradually. Along with this, the structure should be strong enough that each element should be economic and strong. The Reduction of Axial forces in Columns in Multistory building using Optimum size change approach is a new idea. It reduces the size of columns at the different levels of the building to reduce its self-weight. On other hand, the structural weight should be minimized when the self-weight of the same will be reduced and proved to be an economic structure. Concluding this, it is necessary to prepare various software models to analyze the structure and get the results regarding reduction of axial forces without disturbing the strength and durability of structure.

Keywords: *Axial forces, Columns, Strength, Durability, Software Models, High-Rise Structures*

Introduction

As it has been predefined that column is the vertical stiffness component and it transfers the load from level to level of the floor and ultimately transfers the same to the ground. As this component is generally made up of R.C.C., steel, timber, composite materials, etc. as per the requirement of the uniformity. In R.C.C. structure, concrete is basically a key component and an artificial stone, well modeled, transfers load as per its designed capacity. R.C.C. column is the spinal cord when discussing specific Multi-storey's building. Changing the size of the column member can reduce the weight of the structure but not sufficient to withstand the vertical loads and to bear the lateral load as well. The same thing would happen with concrete beam specifications. Changing the size of the beam member in a multistoried building can reduce the weight of the structure but not sufficient to withstand the vertical loads and to bear the lateral load as well since the main work of this member is to transfer the loads to the subsequent downward members.

Axial Force

If a load is functional to the building lengthways the distance or vertical to the layer of the associate, then it is named as the axial load or the force substitute that concludes the centroid or symmetrical axis of a building. This will be calculated in kilo pounds.

The axial force is supposed to be nil, on one occasion there will be not any outside straight forces acting on a structure. The alteration in nature of the axial forces with reverence to the shear and moment is that the axial forces are morally tension or compression in nature and performances over the member axes. The stress can be premeditated for the force applied to the rod. Formulation to compute the stress is as below.

$$\sigma = \frac{F}{A} \quad \text{.....Eq. 1}$$

Here, σ will be stress, F is force, and A is cross-sectional area of rod.

Axial Force Diagram

It is a plan which signifies the axial force vividly with decent measure and symbol. The symbol and measure mention the ordinate and nature of axial force at respectively point along the length of the associate.

Nature of diagram:

1) In the point where there is a force applied, the diagram deviations brusquely.
2) The force continuously acts along the length of the building.
3) The nature of forces is compressive or tensile only.
4) The sign convention is very unpretentious, if one direction is taken as positive, then the other will be negative.

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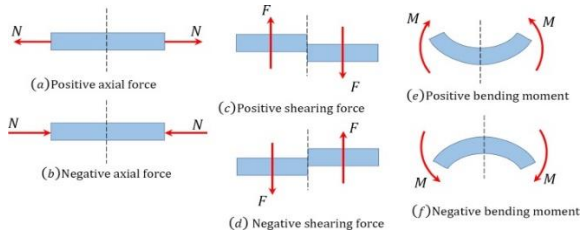

Fig 1: Axial Forces in member

Review of Literature

Albert Philip, Dr. S. Elavenil (2017)

A high rise building has to be designed to resist lateral loads due to wind or earthquake. Interior structural system or exterior structural system provides the lateral load resistance to the structure. The shape, structure and material used also influence the behaviour of structure against lateral loading. In this study three dimensional analytical models of G+12 storied buildings have been generated for regular and the results it is concluded that story displacements increases linearly with height of the building; maximum storey drift is observed at second floor for irregular structure and at fourth floor for regular structure; maximum storey shear force was observed between ground floor and second floor for regular structure and at ground floor for irregular structure and the value decreases linearly with height; storey stiffness varies non - linearly for both the structures with maximum values at ground floor.

Viktor castlenrist, Stefan svensson (2016)

This paper summarizes the methodology which is based on idealized calculation models and idealized finite element models, especially focused on the dynamical properties, natural frequencies and accelerations of the building. In recent years it has been seen that in society, there has been vast changes related to economics, urbanization, and architectural changes has become the greater interest for the construction of high-rise buildings. Up to that time Construction of skyscrapers was limited in Sweden. The challenges are faced during designing and construction of high-rise buildings. Table 1 shown below shows the idealized and complete model representation.

Table 1: Idealized and Complete model representation (Viktor castlenrist et. al.)

	Idealised model [Hz]	Complete model [Hz]	Change [%]
First mode, weak direction	0.35	0.39	11
Second mode, stiff direction	0.56	0.57	2
Second mode, weak direction	1.54	1.90	23
Second mode, stiff direction	1.91	2.11	11
First mode, torsional direction	2.38	1.16	105

Priyanka Soni, Purushottam & et. al. (2016)

The present paper work was made in the interest of studying and analysis of various research works involved in enhancement of shear walls and their behavior towards lateral loads. As shear walls resists major portions of lateral loads in the lower portion of the buildings and the frame supports the lateral loads in the upper portions of building which is suited for soft storey high rise building, buildings which are similar in nature constructed in India. Also, it is necessary to manually calculate, is more time consumable as seen in reference paper both manually and software based are calculated but have concluded and obtained results approximately. So the use of software is affordable.

Pushkar Rathod, Rahul Chandrashekar (2015)

The paper states that the Seismic analysis plays an important role in any type of structure. It is very important to consider seismic analysis in high earthquake prone areas. During an earthquake the high lateral movement of earth's crust the structure can be designed with the help of seismic analysis. By using ETABS any type of basic or a highly advanced structure can be evaluated which may be under static or dynamic conditions. ETABS is a main tool for analysis and designs, which can design simple 2D frames to modern skyscrapers therefore it is the one of the best software for building structures. Figure 2 shown below shows the drift change under seismic forces.

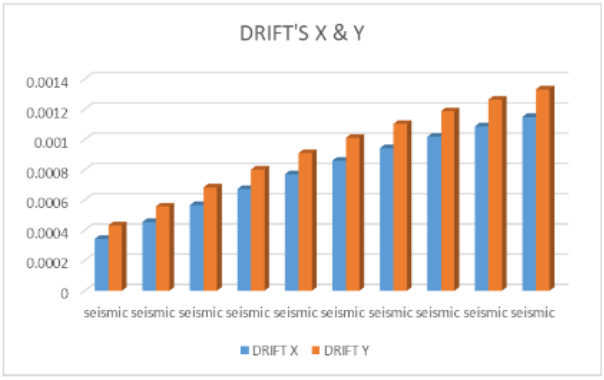

Fig. 2: Drift change under seismic forces (Pushkar Rathod et. al.)

N. Anand G. Prince Arulraj (2014)

A study was carried out to understand the behaviour of SCC beams of various grades exposed to elevated temperatures under flexural loading. The beams were exposed to a temperature of 90 Degree C. The heated specimens were cooled either by air or water. The research work was carried out for different grades of concrete. It is found from the results that the loss of strength of SCC beams of higher grades was more than that of the lower grade SCC beams. It was also found that the reduction in compressive, tensile and flexural

strength of the specimens depends on type of heating and cooling conditions. Higher grades will result in higher compressive strength and shear resistance. However the performance of high performance concrete may not be 1282 Fire Technology 2014 satisfactory when exposed to higher temperatures. Figure 3 shows the rate of heating.

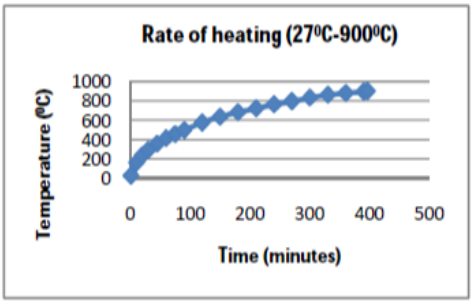

Fig. 3: Rate of heating (N. Anand et. al.)

Lu, X., Lu, X., Guan, H. & et. al. (2013)

In this paper, a finite element method based numerical model encompassing fiber-beam element model, multilayer shell model, and elemental deactivation technique is proposed to predict the collapse process of high-rise buildings subjected to extreme earthquake. The potential collapse processes are simulated for a simple 10-story RC frame and two existing RC high-rise buildings of 18-story and 20-story frame–core tube systems. The analysis results indicate that the proposed numerical model is capable of simulating the collapse process of existing high-rise buildings by identifying potentially weak components of the structure that may induce collapse. Figure 4 shown below shows the reinforcement area required in different levels.

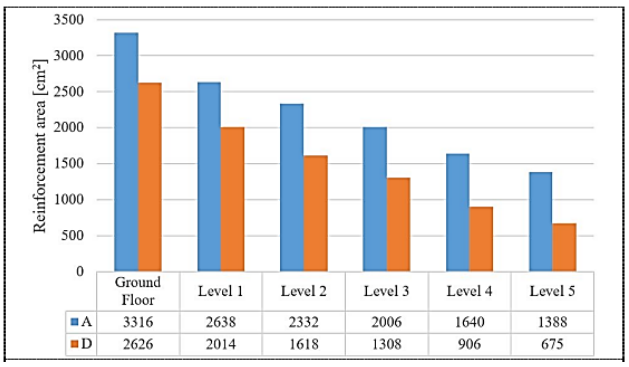

Fig. 4: Reinforcement area required in different levels (Lu, X. et. al.)

P. P. Chandurkar, P. S. Pajgade (2013)

The paper states that In the design of building structural walls, shear walls play an important role as major earthquake resistant members during seismic loadings. These walls provide a great potential for lateral load and offer resistance efficient bracing systems. The properties of these seismic shear walls is very important factor in the buildings therefore, it is very significant to calculate the seismic response of the walls suitably. In this paper determination of shear wall location in multi-storey buildings is observed. It has been considered with the help of 4 different models.

N R Shwetha, Naveen, Pampanna & et. al. (2013)

This paper includes design and estimation with the analysis of multi storey building under seismic load, Dead load and live load. The design of beams, columns and footings is carried out under seismic loads. The software has been adopted with its new features of data sharing and analysis and design. Completion of the analysis, design and estimation of a multi-storey building is the main aim of the paper. kani's method is being used to verify the results obtained through E tabs software. The fitness of structure is calculated by using the analysis result. E tab software is used for analysis.

Tiwari Darshita, Patel Anoop (2012)

Concrete is the most indisputable and indispensable material being used in infrastructure development throughout the world. Umpteen varieties of concrete were researched in several laboratories and brought to the field to suit the specific needs. For this, an experimental investigation of strength and durability was undertaken to use "Spent Fire Bricks" (SFB) and "Glass Powder" for partial replacement of fine aggregate in concrete. This paper recommends that glass powder and brick powder can be used as an alternate construction material to fine aggregate in concrete. Results of this investigation suggest that brick powder or glass powder could be very conveniently used in structural concrete.

C. Marthong, T. P. Agrawal (2012)

The utilization of fly ash in concrete as partial replacement of cement is gaining immense importance today, mainly on account of the improvement in the long-term durability of concrete combined with ecological benefits. This paper reports a comparative study on effects of concrete properties when OPC of varying grades were partially replaced by fly ash. Figure 5 shown below the percentage of fly ash affecting the strength of different samples (C. Marthong et. al.)

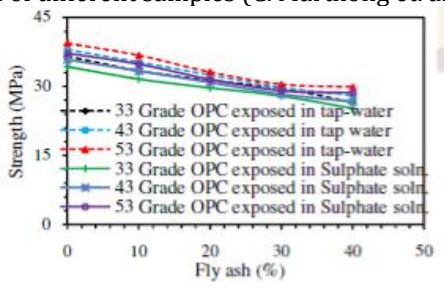

Fig. 5: Percentage of Fly ash affecting the strength of different samples (C. Marthong et. al.)

The main variable investigated in this study is variation of fly ash dosage of 10%, 20%, 30% and 40%. The compressive strength, durability and shrinkage of concrete were mainly studied. Test results shows that, inclusion of fly ash generally improves the concrete properties up to certain percent of replacement in all grades of OPC.

Akira Nishimura, Hiroshi Yamamoto & et .al. (2011)

The Island Tower Sky Club is a super high-rise RC apartment block constructed in Fukuoka City, Japan, which makes inventive use of the most advanced building technologies. The building is 145 m tall with 42 storeys and has composed of three similar, slender towers with three-fold rotational symmetry. The towers are connected at three different levels by aerial gardens and contain various vibration control devices to assure a high level of safety. The base of the building is isolated using a hybrid system of bearing supports and validity of the control system implemented is confirmed by human power vibration tests conducted at the aerial gardens.

T. Öztürk, Z. Öztür(2008)

This paper summarizes the analysis of load carrying systems and its effects on multi-storey RCC buildings during seismic loads. It is so important to determine all possible earthquake loadings and behavior of reinforced concrete Because of it helps to design the structure system and also to resist seismic effects. seismic load effects are also an important factor in all types of normal buildings including skyscrapers.

Q.S. Li, Y.Q. Xiao, J.R. Wu & et. al.(2007)

Detailed analysis of the field data was conducted to investigate the characteristics of typhoon-generated wind and wind-induced vibrations of these super-tall buildings under typhoon conditions. The dynamic characteristics of the tall buildings were determined from the field measurements and comparisons with those calculated from the finite element (FE) models of the structures were made. Furthermore, the full-scale measurements were compared with wind tunnel results to evaluate the accuracy of the model test results and the adequacy of the techniques used in the wind tunnel tests. The results presented in this paper are expected to be of considerable interest and of use to researchers and professionals involved in designing super-tall buildings.

Y. Zhou, T. Kijewski, and A. Kareem (2003):

Under the action of wind, tall buildings oscillate simultaneously in the along wind, across wind, and torsional directions. Accordingly, most current codes and standards provide little guidance for the across wind and torsional response. The database consists of high-frequency base balance measurements on a host of isolated tall building models. Combined with the analysis procedure provided, the non-dimensional aerodynamic loads can be used to compute the wind-induced response of tall buildings. The influence of key parameters, such as the side ratio, aspect ratio, and turbulence characteristics for rectangular sections, is also discussed. The database and analysis procedure are viable candidates for possible inclusion as a design guide in the next generation of codes and standards.

Wensheng LU, Xilin LU (2000)

The paper briefs about the tests of some scaled high-rise multi-tower structure models on the trembling table. By considering the effect of a flexible transfer floor in a new analytic model is shown. The test result considers the theoretical dynamic behavior comparison. The combination floors between towers at top levels, and the stiffness of foundation role to structural dynamic behavior is also described in this paper. Many suggestions and theoretical guidelines are also accomplished.

Conclusions

Following are the conclusions made based on the review of Literature are as follows:

1) The different research papers reveals that the usage of analytical methods formerly involves construction of high-rise structures like hospitals or any other structure in seismic and non-seismic parts with different size of columns.
2) By reviewing all the research papers, it can effortlessly recognize the importance of analytical methods.
3) It can simply compute the result of seismic loading for different size of columns at different levels of building by using software like staad pro and E-tabs before construction of high-rise buildings.
4) Calculation and modeling is the key resolution of the supposition, so the analysis of various models and concludes the result via graphical representation.
5) Reduction of axial force is getting structure lighter as its result concludes cost efficient building but have to maintain the strength and durability of the specific building.

Future Scope

Based on the study of past articles the following points are taken for the study in future work are as follows:

1) None of the papers have mentioned axial force reduction.
2) Condition should satisfy for seismic loading as per IS 1893:2016.
3) None of the researches have mentioned the size change of column is responsible for axial force as per civil engineering point of view.

4) Analysis of building for axial force should be done on various soil conditions.
5) Only some researchers have concluded various cases based on the location of the porch and none of them concluded its efficient location with the load bearing porch.

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