Original Article
International Journal of Scientific Research in Civil Engineering
OPEN ACCESS
Available online at : www.ijsrce.com
© 2023 | IJSRCE | Volume 7 | Issue 5 | ISSN : 2456-6667

Seismic Analysis Of Tall Multistorey Structure Considering Variable Column Condition Using ETABS : A Review

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ARTICLEINFO

Article History:

Accepted: 01 Sep 2023
Published: 10 Sep 2023

Publication Issue
Volume 7, Issue 4
September-October-2023

Page Number
20-26

ABSTRACT

One important factor that affects the project's or building's economy is the distance between columns. Because of this relationship between column spacing and panel size, the cost of raw materials can vary in reinforced concrete buildings. When column spacing is smaller, panels are smaller, and when column spacing is larger, panels are larger.
In this paper presenting review of literature related to analysis of structures using analysis tools.
Keywords: Aspect Ratio, Optimum Column size, E – TABS, Multi – Storey Building, Quantity Modelling

I. INTRODUCTION

The population and land requirement for residential and commercial purposes is continuously increasing in urban areas, multistoried buildings are becoming common in construction industry. The low rise, high – rise buildings, apartments and multistorey buildings can be compared on the basis of required area for people but it also compared on the basis of required material for construction or cost. The cost is analyzed for sub – structure and super – structures. In this research, the cost is analyzed only for super – structural components. These components are column, beam and slab. The quantity of steel, concrete and shuttering is determined for each component. For multi-storey building, there are various forms of structure configuration possible. Depending upon the height of building, the form of structure is decided. The economy of such a structure is governed by many factors like, form of structure, selection of material, construction technique, time required for different work to execute. Spacing of column in a Reinforced concrete building is an important factor to determine the dimensions of columns itself, beams, slab etc. Therefore, cost of the material is also influenced by span length. In multi-story buildings, it has been discovered that the column spacing can be a significant factor in determining how economically efficient the structure is. The goal of the current study is to determine how column spacing affects building costs. Based on those crucial findings, the right column spacing for multi-story buildings will be chosen.

II. LITERATURE SURVEY

Himanshu Krishna and Prince Yadav (2022) An analysis of the seismic performance of multistory G+4 buildings with rectangular columns and buildings with unique shaped columns was the goal of the research work. The proposed buildings are examined using comparable static analysis for zone III in soil condition in accordance with IS Code 1893 (part 1):2016. The models were analysed using ETABs.

According to the findings, buildings with unique columns exhibit the fewest deflections, drifts, and shear forces when compared to buildings with standard columns. Buildings with unique columns displayed more rigidity than buildings with standard columns. Even using customised columns when construction is safer than using conventional ones.

Mohammed Rady and Sameh Youssef Mahfouz (2022) The goal of the study article was to examine how concrete grades and column spacings affect reinforced concrete (RC) building design. For buildings with three alternative floor systems—flat plates (FS), flat slabs with drop panels (FSDP), and solid slabs—cost design optimization was carried out with this goal in mind (SS). Because the evolutionary method offered by the Excel solver can handle the complexity of structural design issues, it was chosen as the optimization process. The goal was to reduce the building's overall construction costs while still adhering to the requirements of the Egyptian Code of Practice, which included charges for labour, formwork, reinforcement bars, and concrete (ECP-18). In terms of direct construction costs for low-rise RC residential buildings, the results showed that low concrete grades (i.e., characteristic strength up to 40 MPa) and column spacings up to 5 m are recommended.

Manazir Hussain et.al (2020) Finding the ideal column spacing in a tube frame without sacrificing structural response was the main goal of the study article. In four tubular structures with a building height of 600 feet, the columns are placed at heights of 7.5 feet, 10 feet, 15 feet, and 30 feet, respectively. The flat plate technology was used, and its impact on the structure's cost was noted. A straightforward linear static analysis was performed, seismic loading was applied to each model, and the base shear and drifts were adjusted by modifying the column cross-section to get the lowest steel ratio.

Conclusion: Lateral sway is significantly influenced by a structure's height, which is why the columns in the tube's periphery are spaced closely. Due to the observation that the use of flat plate slabs accounts for 50% of the overall cost, such slab framings are not recommended for high rise structures in order to make the construction more affordable. The base shear will decrease with increasing column spacing, but the cost will increase since thick sections must be used in the design. Therefore, a tubular construction with 10 ft column spacing was recommended as the most cost-effective frame for a 60 storey skyscraper.

Paolo Foraboschi (2020) The research paper focused on the strong column–weak beam rule (also referred to as “minimum flexural strength of columns” or “column–beam moment ratio”) and addresses the issue of satisfying this rule with the minimum impact on the architectural design. A simple method was presented that provides the minimum cross-sectional dimensions that satisfy the strong column–weak beam rule with a reasonable amount of steel reinforcement. Cross-sectional dimensions less than those furnished by this method require an amount of reinforcement that not only is very large but also makes it difficult to pour the concrete and to achieve good consolidation. Actually, the optimal cross-section allows a small reduction to be performed, but only if special column cages and concrete are used (which drastically affects the cost), while a greater reduction in any case would lead to poor quality constructional work.

Pavithra S M and Geetha K (2019) research paper aimed to evaluate and compare the seismic performance of G+15 structural model with composite frame and a R.C Frame model having spacing between columns as 5m and 10m is considered for the building models, these models were subjected to seismic zone IV, their corresponding behaviors and results are extracted and interpreted. Various parameters such as displacements, storey drifts, storey acceleration, storey force, storey stiffness, and base shear were gathered. ETABS software was used and the results were compared.
Results stated that The storey displacement in composite building models with 5m spacing between columns is found to be comparatively little higher than that of the R.C Frame model. Whereas in the case of 10m spacing between columns it was found to be lesser in composite model than for R.C frame model. Base shear for RCC frame is more than structural Steel-concrete composite because the weight of the RCC frame is more than the composite frame. Structural steel-concrete composite is light in weight as compared RCC which gives economical foundation design. Self-weight of composite structures reduces as compared to RCC which in turn reduces the foundation cost. Due to the reduction of self-weight of composite structures, it induces fewer amounts of lateral forces.

Sourabh Dhiman et.al (2019) research paper presented the comparison between conventional steel sectional columns and tubular steel section column. Total 6 number of models of 12-Storey Building were analyzed in staad.pro (designing tool) having different conventional and tubular steel section as a column. The performance of all the models was investiagted by performing dynamic seismic analysis in zone IV and evaluated in terms of structural parameters of columns i.e. axial force, bending moment, displacement
It was concluded that the ratio of maximum displacement and total steel quantity comes out to be 1.16 and 0.74 for the buildings without bracing (i.e. Type B to Type A) respectively. Ratio of maximum displacement and total steel quantity is 0.98 and 0.78 for the buildings having cross-bracing (i.e. Type D to Type C) respectively. Ratio of maximum displacement and total steel quantity is 1.05 and 0.80 for the buildings having cross-bracing (i.e. Type F to Type E) respectively. Tubular sections proved to be more economical than conventional sections as it saves 20% to 30% material cost.

Sumit Udakhe and K.R. Ghadge (2019) Analysis of the G+10 RCC Framed Structure is done in the research article, and several column shapes are used. Using ETAB software, a 3D space frame model of this building was created with six degrees of freedom at each node to simulate its behaviour when subjected to seismic loading. The support issue has been entirely resolved. The model is only designed in three different ways by altering the cross sections of the columns. For base shear, displacement, and joint reactions, all three models are created and examined using the ETABS software.
Results stated that Model I with L-shaped column has maximum base shear along both X & Y-direction and Model III with rectangular columns has minimum base shear along X & Y-direction and the Model III with Rectangular columns has more joint displacement as compared to other two Models and Model I with L-shaped columns has least joint displacement along X, Y & Z-direction.

Kuldeep Kumar Chaudhary et.al (2018) in the research paper, an industrial G+9 space frame building was analyzed for earthquake using STAAD-PRO V8I. Earthquake & wind analysis was done for Delhi Region (zone -IV) for both steel as well as RCC

building. Keeping the loading conditions, span of beams same applying Indian code provisions for (G+ 9) industrial buildings. The plan configuration of structure has significant impact on the seismic impact on the seismic response of structure in terms of displacement, storey drift, storey shear.
It was observed that the seismic forces are maximum on the regular structure because of higher plan area. Minimum displacement was observed in the Triangular steel building. It indicates that building with safe irregularity shows average displacement and storey drift. As the number of storey increases in the building, the lateral displacement, natural frequency, base reaction and storey drift also increases. The natural period decreases with the increases number of stores in the building for regular space frame comparison to irregular space frame. The value of lateral displacement, storey drift and base reaction (base shear) of RCC frame with irregular building with soil continued is more compare to the irregular space fixed base and spring model.

Laxman Lal Kumawat et.al (2018) The moment resisting frame determined the impact of column spacing on economy in a comparative study of G+10 and G+20 R.C. Three examples (2m, 4m, and 6m case) of column spacing were taken into consideration to determine the impact of column spacing on economy. ETABS was used to model, analyse, and design the structure in accordance with IS 456:2000. To determine the relation for the ideal column spacing for the various building heights, these models were analysed. The building's aspect ratio is set at 1.5, and the most economical building is determined by adding up the costs of the shuttering, steel, and concrete.
The quantity of shuttering increases with increasing the number of storey and decreases with increasing the spacing between the columns. As per cost analysis, it was observed that the overall cost reduced 16.60% for 6m case and 24.65% for 4m case by 2m case cost. Hence, in 10 storey building the 6m case and in 20 storey building the 4m case is most economical case. When the height of a building increases the most economical case is obtained for minimum spaced column model or building.

G Sri Lakshmi and J D Chaitanya Kumar (2017) objective of the research paper was to analyze a safe G+11 commercial by obtain the ideal space parameters of varied columns. The research work was limited to plot frames of 50m X 50m (with aspect ratio of panel sizes varying from 1 to 4) for the first case and for second case the size of the panel are 50m x 50m, 50m x 30m, 50m x 25m and 50m x 20m (with an aspect ratio of 1, 0.6, 0.5, and 0.4 respectively). The structure was modeled, analyzed for gravity and lateral (seismic) loads then designed as per IS: 456-2000 and analyzed in STAAD. Pro. Failed members are again modulated until all the members are safe. By observations and calculations, the most economical panel size is suggested and its spacing is noted.
According to aspect ratio which panel shows more story drift and which is having more self-weighted respectively which leads to economical column spacing design further. The database is prepared for worst load combination and the structural elements are designs for the worst load.

Jingbo An (2017) Special-shaped column frame structure in has broad application prospects in multi-floor residential buildings, especially in non-aseismic areas and middle and low intensity areas. The special-shaped column frame structure provides a structural system for the structural design of multi-floor high residential buildings. Due to the special natures of special column section, the difference and complexity of forces and the uncertainty of earthquake action, special-shaped column frame structure design should be strictly controlled and structural design should take bearing capacity, stiffness, stability, ductility into consideration to carry out optimization design to make the structure safe, reliable and economical.

Mohammad Hossaina and Fayez Moutassem (2017) Through a parametric analysis that took column design inputs into account and the use of a Finite Element Method (FEM) modelling approach, the research report examined the impacts of reinforced concrete (RC) columns' slenderness in a frame structure. Using FEM software ETABS, three ten-story commercial structures were modelled. In the RC beam-column frame structures, a parametric research was carried out on three distinct square floor panels, five different column heights, and three different column positions.

As a result, Non-Sway Moment Magnification Factor (ns) was found to have a greater impact than Sway Moment Magnification Factor (s). Due to the larger value of ns, the column that is longer than or equal to 17.5' (5334 mm) is vulnerable. The variation in δns sometimes increases significantly when the column height is increased from 17.5' (5334 mm) to 20.0' (6096 mm). This sudden increment in δns value will affect the steel ratio of the column.

Vishal Yadav and Vivek Garg (2017) The study report used a G+1 storey, 5 bay by 5 bay frame in seismic zone II that is subjected to an induced load of 5 kN/m2, and STAAD Pro software was used for the analysis. To ascertain the necessity of pattern loading, the member forces of a building were compared under conventional loading (i.e. seismic and all span gravity loading) and pattern loading (i.e. conventional loading + 5 patterns of imposed load).

The outcome showed that all beam members' values for bending moment were much larger for pattern loading than for conventional loading. When compared to hogging moment, this moment rise is more prevalent in beam sagging moment. In comparison to the lower storey beams, the upper storey exterior beams are more affected by pattern loading. Insignificant increases in column axial force and beam shear force are brought on by pattern loading. The bending moment of column members is unaffected by pattern loading. This shows that the typical loading is suitable for designing column members.

Venkataraj. M and Helen Santhi. M (2015) research paper presented analysis of two flat slab systems with different column spacing designed using RAPT software. Analysis of flat slab systems was carried out using the direct design method as given in Indian code (IS 456- 2000).

The results show that there is a significant reduction in bending moment and shear force thereby reduction in reinforcement is achieved.

Ami A. Shah and B. A. Shah (2014) in the research paper, a series of pushover analysis was carried out by using ETABS V9.7.4. Software. The analysis was carried out on the RC space frame for G+15 storey buildings as per ATC-40 for the models having rectangular column and equivalent square columns with 31.5m x 13.5 m overall plan of building. In both the models, optimization of column sizes was done on the basis of percentage of steel not exceeding 4 percentage, as per IS 456:2000. A comparison of the influence of the shape of the column on the seismic response of a building was presented.

Results stated that the numbers of plastic hinges developed in rectangular column RC frame are more as compared to square column RC frame as in rectangular column one direction is weaker direction. There was a little difference in structural cost of rectangular column RC frame and Square column RC frame at immediate occupancy level. The behaviour of square column is better than rectangular column when the comparison is in terms of storey drift, base shear and roof displacement. The performance of square column RC frame is better than the rectangular column RC frame.

III. OUTCOME OF REVIEW

Here many authors has stated and performed study related to analysis of structures considering various conditions and justify the utilization of analysis tools and other conditions.

IV. RESULTS AND DISCUSSION

Arduino is a compu

V. CONCLUSION

In this monitoring and management for green environment.

Cite this article as :

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