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Use of Slim Columns for Cost Effective and Aesthetic Construction

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Abstrat :Day by day cost of construction is increasing rapidly because cost of materials required for construction like bricks, masonry, cement, aggregate, reinforcement, formwork, plastering etc. is increasing. Generally column width is more than width of brick wall in RCC frame structure, as main load carrying member is column, whereas wall just act as partition media. This results in offsets inside the room. This plastering of uneven faces requires comparatively more time and also requires more quantity of material which ultimately leads to increase the cost of construction. If we consider the practical aspect, the formwork that is plywood/wood comparatively at low rates. Hence, if we construct column of same width as that of wall it will not only reduce the offsets and plastering time, but will also provide uniform surface finishing which will be pleasing aesthetically. It will also be cost effective from shuttering point of view and reducing labour cost.

KeyWords -- Column, wall, plastering, shuttering, aesthetic, economy

1. Introduction

A column forms a very important component of a structure. Columns support beams which in turn support walls and slabs. It should be realized that the failure of a column results in the collapse of the structure. The design of a column should therefore receive importance. Supporting the slabs is the main function of the columns. Such slabs are called Simply Supported Slabs. Simply supported slabs could be either one way slab or a two-way slab. It depends on the dimensions of the slab.A column may be classified based on different criteria such as:

(1) Based on shape – rectangle, square, circular, polygon

(2) Based on slenderness ratio – short or long column

(3) Based on type of loading – axially loaded column, column subjected to axial load and uniaxial bending, column subjected to axial load and biaxial bending

(4) Based on pattern of lateral reinforcement – tied columns, spiral columns.

1.1 Positioning Of Columns

Columns should be preferably located at the corner of the building and at the intersections of beams. Basic function of column is to support beams placed under the walls. Position of columns must be such as, which reduces the bending moment in beam. The Column position decides span of the beam, therefore column must not be placed at greater distance. In case the columns are positioned at greater distance, ultimately it led to higher bending moment demand for large cross section of beam with high steel. On the other hand, in case of column, the increase in total load due to increase in length is negligible as long as the column is short. Therefore the cost of the beam per unit length increases rapidly with the span as compared to column on the basis of unit cost. Therefore as possible as the large span of the beams should be avoided for economy purpose. Sometimes it also leads to formation of strong beam and weak column joint, which is not preferred for the structure due to varying displacement.

1.2 Orientation Of Columns

Projections of column must be avoided outside the wall, which not only give bad aesthetic but also obstruct the use of floor space and create problems in furniture flush with the wall. Orientation of column should be such that the depth of the column is contained in the major plane of bending or perpendicular to major axis of bending. When the column is rigidly connected to right angles, it is subjected to moments of addition to the axial load. In such cases, the column should be so oriented that the depth of the column is perpendicular to major axis of bending so as to get larger moment of inertia and hence greater moment resisting capacity. It will also reduce Leff/D ratio resulting in increased the load carrying capacity of column [4]. It must be noted that increasing the depth in the plane of bending not only increases the moment carrying capacity but also increases its stiffness, there by more moment is transferred to the column at the beam column junction. However, if the difference in bending moment in two mutually perpendicular directions is not large the depth of the column may be taken along the wall provided column has sufficient strength in the plane of large moment. This will avoid offsets in the rooms.

1.3 Formwork For Column

Resin bonded plywood sheets are attached to timber frames to make up panels of required sizes. The cost of plywood formwork compares favorably with that of timber shuttering and it may even prove cheaper in certain cases in view of the considerations: (1) it is possible to have smooth finish in which case on cost in surface finishing is there. (2) By use of large size panels it is possible to effect saving in the labour cost of fixing and dismantling. (3) Number of reuse is more as compared with timber shuttering. For estimation purpose, number of reuses can be taken as 20 to 25 [3].For

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surviving economy criteria, the plan of the building should imply minimum number of variations in the size of rooms, floor area etc. so as to permit reuse of the formwork repeatedly. Design should be perfect to use slender sections only in a most economical way. Minimum sawing and cutting of wooden pieces should be made to enable reuse of the material a number of times. The quantity of surface finish depends on the quality of the formwork.

1.4 Column Stiffness

Stiffness of structural members of a building strongly influences response of the building to ground shaking. For linear analysis, the member stiffness control predictions of the period of the structure, the distribution of loads within the structure and the deformation demands [2].For nonlinear analysis, an accurate estimate of the member stiffness is required to reliably estimate the yield displacement, which in turn, affects the displacement ductility demands.

2. Materials and Methods

ETABS is the ultimate integrated software package for the structural analysis and design of buildings. It offers 3D object based modeling and visualization tools, blazingly fast linear and nonlinear analytical power, sophisticated and comprehensive design capabilities for a wide-range of materials, and insightful graphic displays, reports, and schematic drawings that allow users to quickly and understand analysis and design results. CAD drawings can be converted directly into ETABS models or used as templates onto which ETABS objects may be overlaid. The integrated modules include: Drafting module for model generation. Seismic and wind load generation module. Gravity load distribution module for the distribution of vertical loads to columns and beams. Output display and report generation module. Steel frame design module and concrete frame design module. Hence ETAB software is used for calculating the stiffness of the RCC structure. Following procedure is adopted for calculating and then comparing the stiffness of the stories.

Step1. Selection of Plan

Architectural plan is selected as such having proportionate length and breadth ratio, also known as aspect ratio of the building.

Step2. Loading

Loading analysis is done for beam and slabs all the different types of all the stories, for assigning the loads to the model.

Step3. Modeling by using Software ETABS 2015

First step for making model in software is defining grid for drawing structural elements, assigning material properties (steel and concrete), assigning frame and area sections (beams, columns and slabs respectively), modeling (includes drawing beam, column and slabs as per drawing), assigning loads, assigning load combinations, assigning supports, check, analysis and finally design.

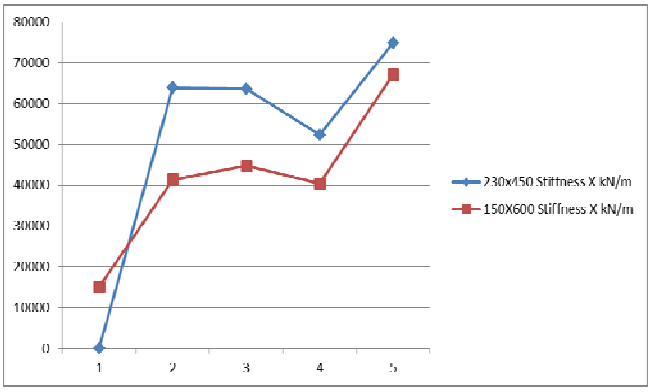
Step4. Comparing the stiffness of Model 1 and Model 2

Making two models (G+3) using ETABS with same dimensions, load combinations and loadings but only assigning different column sizes, but keeping the same column orientation.

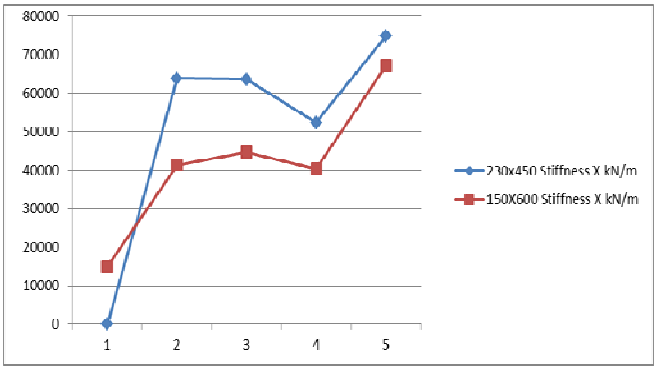
Model 1 Column size 230x450 -- Generally adopted column

Model 2 Column size 150x600 -- Slim Column

After modeling is completed of both, analysis and design is done, and then checked for failure. Results obtained where Model 1 – Safe and Model 2 – Safe. After comparing the stiffness of Model 1 and Model 2 in X and Y direction respectively,



Graph No. 1 Stiffness Comparison between **Model 1** and **Model 2** in **X -direction**



Graph No. 2 Stiffness Comparison between **Model 1** and **Model 2** in **Y -direction**

The above graphs shows similar pattern of stiffness with small reduction in the model having 150x600 size columns.

Step8. Comparing the stiffness by increasing number of stories in Model 2:

After observing the stiffness graph pattern of Model 1 and Model 2 shows similar pattern, only Model 2 is concentrated by increasing number of stories, so as to study the stiffness pattern by increasing number of stories.

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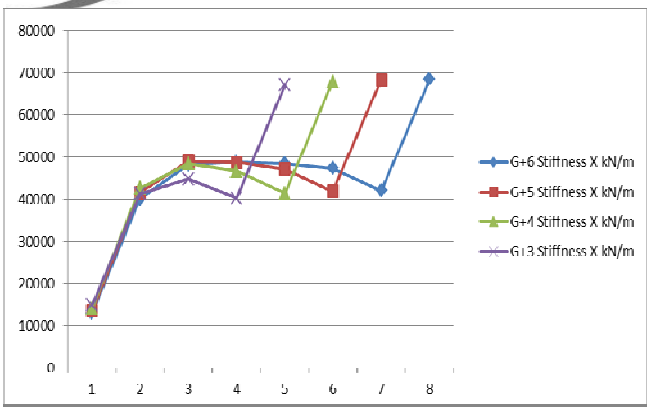

Graph No. 3 Stiffness comparison in **Model 2** by increasing number of stories

The above graphs shows similar type of pattern of stiffness in G+3, G+4, G+5 and G+6 structure, after that structure failure was checked from design point of view it resulted, G+3 – Passed, G+4 – Passed, G+5 – Passed and G+6 – Failed for the load combination of 1.5(D.L +L.L).

3. Conclusion

Hence conclusion can be made as follows,

1. Column sizes 150mm x 600mm can be recommended in structure but only up to four stories and also only for those structures which do not lie in seismic Zone III and Zone VI.
2. Thus we can construct the column of same width as those of wall it will not only reduce the offsets and plastering time, but will also provide uniform surface finishing. It will also be cost effective from shuttering point of view as well as it will look better aesthetically.
3. But an extra supervision efforts and attention is required so as avoid eccentricity, while execution.

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