ECONOMICAL DESIGN OF RCC BUILDING USING MODIFIED APPROACH

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ABSTRACT

The aim of study is to design a structure so that it fulfils three criteria namely safety including strength, stability and structural integrity. For the analysis purpose, modular ratio concept makes it possible to transform the composite section into an equivalent homogeneous section made up entirely of one material. The stress can be computed with transformed section by applying the flexure formula. In this case the second moment of area of the transformed section has to be considered. Continuous research by designers in modified approaches to understand, improve, and develop a property of economical design in a new type of modulus of elasticity for reinforced cement concrete known as ERCC for reinforced cement concrete. This paper deals with the results of conventional design and of G+5, G+10, G+15, G+20, G+25 &G+32 storey building. The basic aim of this research work is to use an equation for ERCC so as to arrive at economical design of RCC multi-storeyed building. The equation proposed for ERCC of beam as well as column can be very effective in case of RCC building. The analysis and design of various portal frames has been undertaken to illustrate the use of proposed equation of ERCC. The analysis of these frames is carried out through ETABS software.

Keyword : - Indeterminate Structures, Elastic Properties.

1. INTRODUCTION

In structural analysis, especially in indeterminate structures, it become essential to know material and geometrical properties of member. The codal provision recommends elastic properties of concrete and steel and these are fairly accurate enough. As two important material properties such as AE &EI play important role in analysis of high rise RCC building idealized as plane frame. The modulus of elasticity most commonly used for concrete is scant modulus. The modulus of elasticity of steel is obtained by performing a tension test of steel bar. But modulus of elasticity for reinforced cement concrete is obtained by experimental and analytical programs with percentage of reinforcement variations, cross area of plain concrete is taken into consideration whereas effect of reinforcement bars and concrete confined by stirrups are neglected. The IS codal provision recommend elastic properties of concrete and steel which are fairly accurate enough. These elastic properties are known independently for concrete and steel. While performing analysis by any software for high rise building, cross area of concrete plane section is taken into consideration whereas effects of reinforcement bars and concrete confined by stirrups are neglected, hence an empirical relation is used for evaluation of material property of RCC members. Modulus of elasticity for reinforced cement concrete (ERCC) has Significance in practical design. The basic aim of this project work is to assess the behavior of multi-storeyed RCC frames. The equation proposed for ERCC of beam as well as column can be very effective in case of RCC building. The analysis and design of various portal frames has been undertaken in this work.

$$\mathrm{ERCC} = (3774.23 * \mathrm{Pt}^2 + 2789.67 * \mathrm{Pt} + 5000 * (\mathrm{fck})^{0.5}$$

All columns are to be treated as being subjected to axial compression combined with biaxial bending as the design must account for possible eccentricities in loading (emin at least) with respect to both major and minor principle axis of the column section. Uniaxial loading is an idealized approximation which can be made when the e/D ratio with respect to one of the two principle axes can be considered as negligible. If the e/D ratios are negligible with respect to both principle axes, conditions of axial loading may be assumed, as a further approximation. The basic aim of this research work is to use an equation for ERCC so as to arrive at economical design of Rcc multi-storeyed building.

2. LITERATURE STUDY

Kulkarni S. et.al. [1] analyzed elastic property of RCC under flexural loading. The author experimentally investigated RCC models under flexural loading. Possible combinations of reinforcement for flexure test for M20, M25, and M30 grade of concrete were considered. Also the authors carried out FE analysis for realistic behavior of RC material with lot of combinations required in modelling by ANSYS. Various parameters were considered which oversee the highly accurate nonlinear behavior of RC beams.

Pulmano V., Shin Y. [2] presented a simpler finite element method for predicting the instantaneous and long term deflection of statically determinate or indeterminate ordinary reinforced and partially / fully prestressed beams.

Espion B., Halleux P. [3] carried out a series of tests on rectangular reinforced concrete beam subjected to bending and constant compressive normal force. The moment curvature relationships were evaluated and compared with prediction of two theoretical modules. The first model was CEB model proposed by Favre and Koprna. It was a simplified model which refers to the un-cracked and fully cracked stiffness in pure bending only. The second model was a proposition made by the author which takes into account the tensioning effect, the variation in the position of natural axis as a function of eccentricity of normal force and the non-linear behavior of concrete in compression.

Anastasios S. et al. [4] assessed the design charts for Rectangular RC columns under biaxial bending conducting review of the historical context. The authors critically assessed the evolution in time and provided a new series, compliant to the latest draft of British Codes. This study arised from the different assumptions and recommended values prescribed in the respective National Annexes. The charts presented by this paper were expected to provide a valuable tool for the professional community, facilitating the use of British Codes and minimize the epistemic uncertainty associated with the use of older or incompatible design charts in the design of reinforced concrete members.

3. STRUCTURAL DETAILS

For this present study analysis and design of multistory buildings RC frame structure is conforming to IS 456-2000 The structural systems considered for this study are typical symmetric-in-plan RC frame structures having ground + two storied configurations, intended for a regular office building in the seismic zone III as per IS 1893 . The RC design for this building is based on IS 456 guidelines. The study building is assumed to be located in zone III, The building frames have been analyzed using ERCC and without ERCC i.e. conventional design.

All study structures have the same arrangement. The floor to floor height is 3.0 m for all the storeys and the depth of foundation is 3.0 m. The RC frames are designed with M30 & M40 grade concrete (having 28 days characteristic cube strength of 30 MPa &40 MPa respectively) and Fe415 grade reinforcements (having characteristic yield strength of 415 MPa)

Table -1:. Building details

Structure Type	RCC
No. of story	G+5, G+10, G+15, G+20, G+25, G+32,
Typical story height	3m
Bottom Storey height	3m

Type of building use	Public Building
Seismic zone	III
Grade of concrete use	M-30, M-40
Young's modulus of concrete	25x102 kN/m2
Density of Reinforced concrete	25 kN/m2
Grade of steel	Fe 415
Poisson's ratio of reinforced concrete	0.20
Density of brick masonry	20 kN/m2
Thickness of floor	0.15
Beam size	230x600, 230x900
Column size	400x1500, 800x1500, 900x300, 1200x1500
Storey height	3m
Soil type	Medium
Programs used	ETABS 15
Location	Pune

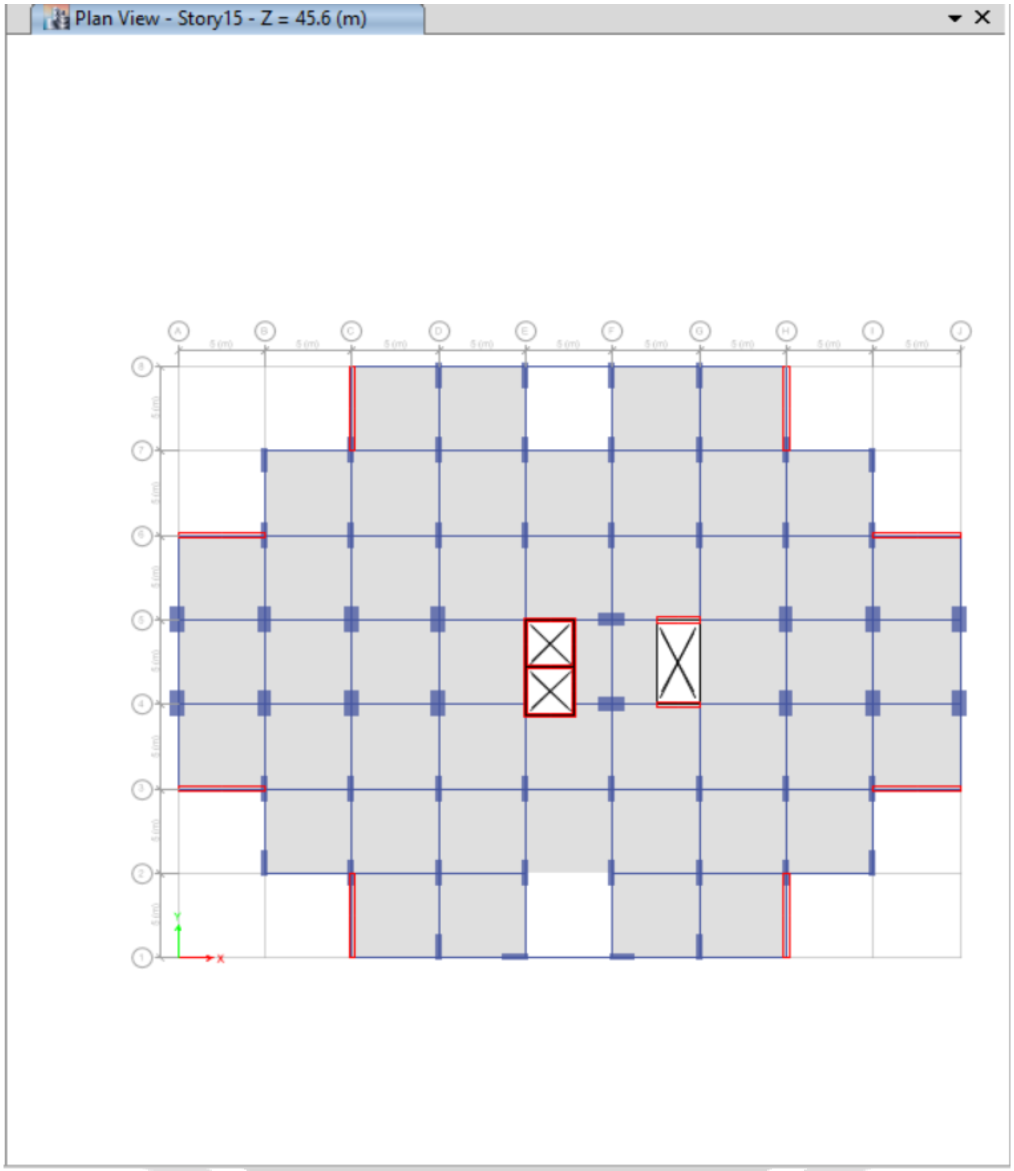

Fig. 1. Floor area Plan for multi-storey building

3.1 Calculations for Ercc value

For 15 story building at story 1, column label C81 percentage of steel required is 3.43% hence calculating the Ercc value for that column.

$$\mathrm{ERCC} = (3774.23 * 3.43^2 + 2789.67 * 3.43 + 5000 * (30)^{0.5}$$

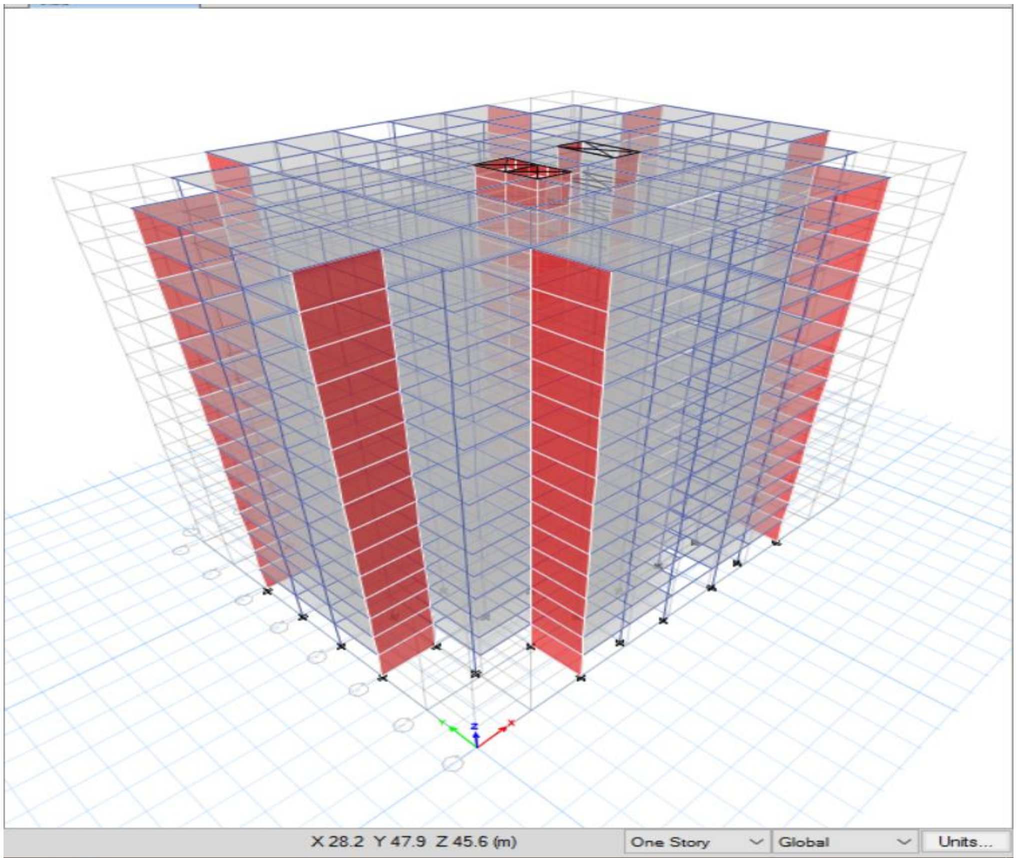

Fig. 2. 3D view after analysis and design of G+15 building

3.2 Results

Table 2: Comparitive study of Conventional and Non-Conventional building using E_{RCC}

Storey	Ercc	RCC	Ercc (MT)	RCC (MT)	RCC (COST)	Ercc (COST)	% reduction
0	0	0					
5	6.14	6.51	144.597	153.3105	6506865	6898973	5.68
10	15.3	18.96	360.315	446.508	16214175	20092860	19.30
15	53.57	69.4	1261.574	1634.37	56770807.5	73546650	22.81
20	71.34	93.45	1680.057	2200.748	75602565	99033638	23.66
25	80.92	109.77	1905.666	2585.084	85754970	116328758	26.28
32	92.25	125.8	2172.488	2962.59	97761937.5	133316550	26.67

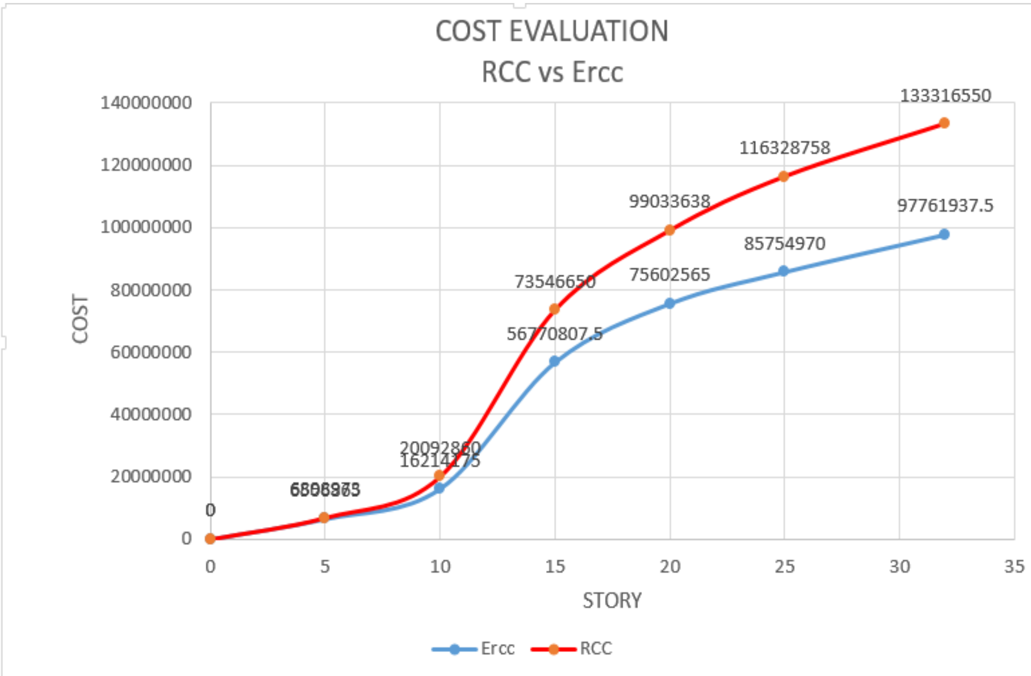

Chart-1 Graphical representation of cost comparison study after analysis and design multi-stoery buildings

4. CONCLUSIONS

1. Using E_{RCC} equation for multi-story buildings results shows reduction in percentage of steel increases with increase in height of building.
2. As the structure become economical in designing, the reduction in column size also possible.
3. Cost comparison also shows the considerable difference in high-rise structure as compare to low rise buildings.

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