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THEORETICAL STUDY OF LONGITUDINAL COLUMNS (BI-AXIALLY LOADED) WITH REFERENCES TO VARIOUS CODES AND RESEARCHER'S COMPARATIVE ANALYSIS.

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ABSTRACT

Due to high complexity of common procedures, practical design of slender bi-axially loaded RC columns uses simplified approach, usually related to many concern and inconsistencies. Since such columns are unavoidable in building structures, more right design action is still of present interest. Beams and girders transfer their end moments into the corner columns of a structure frame in two perpendicular planes. Interior columns may also have biaxial moment if the layout of the column is uneven .For that reason such columns are designed consider axial load with biaxial bending. The biaxial bending moment may be resulted from the space action of the entire frame system or from an axial compressive load bi-axially located with respect to the major axes of the column cross section. On the other hand the long column is not something but the column so slender that it will fail under longitudinal load by bending rather than by crushing and have a length of 20 to 30 times the diameter also having the ratio of useful length to least lateral measurement is greater than 12.

Key words: Bi-axially, design, column, slender, compressive load.

1. INTRODUCTION

Modeling the presentation of compressed slender reinforced concrete columns in final limit state is numerically very not easy Problem and dependent on great number of parameter. Non-linear constitutive relatives for concrete and reinforcement make the analysis materially non-linear, while element structural deformation may considerably influence the level of stress and may not be neglected. Therefore, such essentials should be analyzed in the way that their geometrically non-linear performance and second order effects are accounted. When columns are subjected to biaxial bending, which is the most common case in practice, the problem becomes much more multifaceted and demanding. RC elements' design actions are, in practice, still base on first order effects, where the equilibrium corresponds to non-deformed element and where effects of material nonlinearity are introduce at the dimensioning stage, locally, and do not affect stress supply. In practice, such approach is highly justified for members not responsive to deformational effects. Though, when slender columns are worried, design process has to be upgraded in the way to account, not only second order effects, but other deformational phenomena, such as defect or creep deformation, as well.

Multi-storey building are classically considered as being parallel braced. Beside serviceability necessities, such perform is essential in order to keep the next order result low sufficient. Thus, organization in most cases may be classified as non-sway agreement, with alternative to completely neglect horizontal displacement of its joints. Criterion classify such estimate, although rough, are essential concerning much more complex option, not expedient for practical use. Now, moment at the column's ends are not reliant on second order structural

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Performance which allows separate analysis of isolated columns: only local analysis of second order effects. Also, for bi-axially bended columns, supplies of mechanical codes mainly stay unsaid and suggested design procedures are characterized with inconsistency and nonappearance of clear physical background. Since the application of general measures, which time after time use basic design supposition, is still highly limited with growth of computers, approximate procedures come as an only alternative and their formulation – a necessity.

2. TYPICAL CAUSES AND CONSEQUENCES OF COLUMN FAILURE DURING EARTHQUAKES

The earthquake show of RC building has been well recognized from the study of past seismic events. The fall down of a RC building is cause, in the collection of cases, by the collapse of the perpendicular member. The seismic behaviour deficiency of RC buildings can be connected with design, detail and building lack, as well as fall and structural modification. Points out the ten most common causes of failure or damage in RC buildings:

- ✓ Lack of stirrups/hoops, confinement and ductility.
- ✓ Bond/anchorage/lap-splices slipping and bond splitting
- ✓ Inadequate shear capacity
- ✓ Inadequate flexural capacity
- ✓ Inadequate shear strength of the joints
- ✓ Influence of the infill masonry on the seismic behaviour of frames
- ✓ Vertical and horizontal irregularities, abrupt change in structural and/or element properties
- ✓ Higher modes' effects
- ✓ Strong-beam weak-column mechanisms.
- ✓ Structural deficiencies due to architectural requirements.

BI-axially loaded columns

The study and design of columns under eccentric loading was discuss, in view of a uniaxial case. This means that the load Pn was acting along the, causing a combination of axial load Pn and a moment about X - axis the equal to $M_{nx} = P_n e_y$

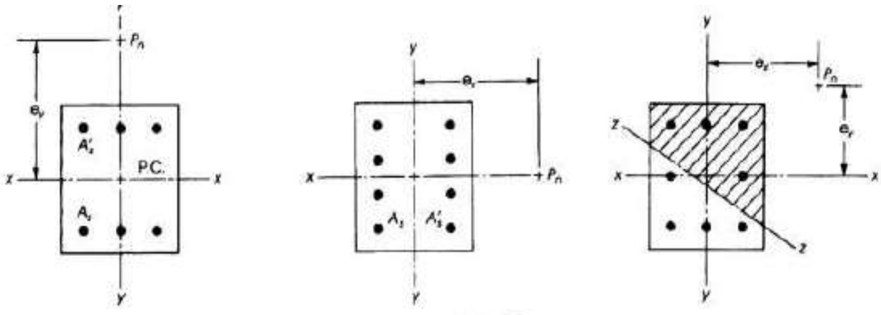

Figure No - 1.1: ***Bi- Axially Loaded Column***

Square or rectangular columns with uneven bending moments about their main axes will require a dissimilar amount of reinforcement in each direction. An estimated method of study of such section was developed by Boris Bresler and is called the Bresler reciprocal method. According to this method, the load ability of the column under biaxial bending can be determined by using the following expression

$$\frac{1}{P_u} = \frac{1}{P_{ux}} + \frac{1}{P_{uy}} - \frac{1}{P_{uo}}$$

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Where:

P_u = Factored Load under Biaxial Bending.
P_{ux} = Factored uniaxially load when the load acts at an eccentricity e_y and $e_x = 0$
P_{uy} = Factored uniaxially load when the load acts at an eccentricity e_x and $e_y = 0$
P_{uo} = Factored axial load When $e_x = e_y = 0$

3. OBJECTIVES

- Theoretical study of behavior of long columns under uniaxial and bi-axial loading.
- Standard methods of design of long column under bi-axial bending by various codes and researches.
- Comparative study of design of long column.
- Evaluation of merits and demerits of IS codes.

4. METHODOLOGY

- To collect data related to slender column subjected to biaxial loading.
- To study the behavior long column and the concept of biaxial bending from collected data and researches.
- Design the column by using various codes.

5. LITERATURE REVIEW

Sr.No	Year	Author	Topic	Methodology	Conclusion
1	2015	Zoran Brujic and Radomir Folic	Approximates Design Of Slender Bi-Axially Loaded Rc Columns	Derived from such investigation, a suggestion of approximate ultimate limit design of bi-axially loaded slender RC columns is formulated.	The results of voluminous numerical experiment, based on the most general design approach, the most influential parameters affecting the behavior of slender columns are recognized and their effects are quantified.
2	2017	Cristoforo Demartino, Jiguang Wu and Yan Xiao,	Experimental And Numerical Study On The Behavior Of Circular Rc Columns Under Impact Loading	Brittle shear-type damage was observed characterized by one main diagonal crack located from the rear base of the column to the base of the impact point.	The experimental results including time history of impact force and development of damage were analyzed and discussed to investigate the dynamic behavior of column under impact loading.
3	2019	H. Sezen , M.S. Lodhi , E. Setzler , and T. Chowdhury	Simulation Of Behavior Of Reinforced Concrete Column Subjected To Cyclic Lateral Loads	The proposed monotonic and cyclic response models are tested against a database of test specimens. The comparison of monotonic response model with the test data shows	the proposed models can accurately predict the lateral force-displacement response of well designed columns as well

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				reasonable agreement in predicting the maximum strength of the columns and their failure mode.	
4	2016	N. Dahiya, V.K. Sehgal and B. Saini,	Analysis And Design Of Rectangular And L-Shaped Columns Subjected To Axial Load And Biaxial Bending	The analysis and design of L-shaped column under biaxial bending and axial compression are cumbersome and time consuming	The results of this investigation can be used to develop the interaction curves for a given reinforcement layout.
5	2013	Hugo Rodrigues, Humberto Varum, Antonio Arêde and Aníbal G Costa	Behaviour Of Reinforced Concrete Column Under Biaxial Cyclic Loading—State Of The Art	Experimental research on the inelastic response of RC members under compression axial force and biaxial lateral cyclic bending loading conditions is currently very limited.	The experimental results show that the RC columns' response is highly dependent on the loading pattern, and the biaxial loading induces a decrease in the maximum strength and anticipates each damage state.
6	2019	Md Intaf Alam, Baburaj Kanagarajan and Prasun Jana	Optimal Design Of Thin-Walled Open Cross-Section Column For Maximum Buckling Load	A inite element based optimization methodology is developed to obtain the optimal designs of thin walled open cross-section columns for maximum buckling load.	The optimization of the cross-sections results in remarkable enhancement, up to as high as 236%, in the maximum buckling load capacity compared to the base model.
7	2016	Christelle Combescure, Pierre Henry and RyanS. Elliott	Post-Bifurcation And Stability Of A Finitely Strained Hexagonal Honeycomb Subjected To Equi-Biaxial In-Plane Loading	a systematic branch-following and bifurcation technique for the perfect structure, complemented by analytical group theory results to identify and compute the bifurcation and post-bifurcation behavior of a perfect hexagonal honeycomb structure	The post-bifurcation behavior is extremely sensitive to the applied loading device, in spite of a common principal solution.
8	2016	Wei Don, Zhimin Wu, Xiangming Zhou and Hui Huang	Experimental Study Of Equal Biaxial-To-Uniaxial Compressive Strength Ratio Of Concrete At Early Ages	Uniaxial and equal biaxial compressive tests were carried out on the early age concrete to investigate the variation of equal biaxial-to-uniaxial compressive strength ratio b with respect to age.	The failure of the concrete younger than 7 days resulted from the weak bond between mortar and coarse aggregate.
9	2018	Hong Gao, Jianhai	Uniaxial And Biaxial Ratcheting Behavior	The effects of different loading paths on biaxial	The ratcheting strain accumulative model

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		Wang, Fan Li, Lilan Ga and Zhe Zhang	Of Ultra-High Molecular Weight Polyethylene	ratcheting behavior of UHMWPE were studied. Both ratcheting strain and ratcheting strain rate are strongly influenced by the loading path.	was constructed to predict the uniaxial ratcheting behavior of UHMWPE with different stress amplitudes, stress rates and hydroxyapatite contents.
10	2016	T.A. Sebaey and E. Mahdi	Behavior of pyramidal lattice core sandwich CFRP composites under biaxial compression loading	A numerical study was performed to check the damage mechanism and the Whole sensitivity of CFRP pyramidal truss core sandwich composites.	The results showed the capabilities of the pyramidal truss core sandwich composites as compared to the conventional composite plates, in terms of the notch sensitivity.

6. CONCLUSION

It is noted that as of history study the correctness of the aforesaid design measures for strength of slender columns depends on how the slenderness effect and the outcome of sustained loads are accounted for in the calculation of the member displacements. The second-order effect for the design of biaxial loaded slender columns can be better by further explanation from physical tests. Although future procedure only roughly simulates ultimate resistance of slender column, accuracy analysis shows almost acceptable deviations. However, parameter used within individual approximation are not totally physically differentiate, while only moment resistance is concerned.

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