

CONSTRUCTION OF INTERACTION DIAGRAM FOR COMPOSITE COLUMN

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Abstract-Composite framing system consisting of steel girder acting monolithically with concrete has been as a viable alternative to the conventional steel or reinforced concrete system in the high-rise construction.

The manual calculation for interaction diagram is too laborious and time-consuming. The purpose of our project is to develop a design aid for more simplified & effective design of column subjected to compressive force & uniaxial bending.

The recommended programming is focused on solving the problem with the aid of the load vs moment diagram. Whose construction is time consuming. This makes economical design difficult .therefor a user friendly application (a simple excel program) is develop for the everyday used.

Finally charts is develop for composite column is developed by varying reinforcement percentage to 1%,2%,3%,4%,5% and 6% for a steel section available in SP-6(1) which is used in our composite section design.

Keyword- Composite framing system,interaction diagram,steel girder,uniaxial bending.

I. INTRODUCTION

A composite column is a structural member that uses a combination of structural steel shapes, pipes or tubes with or without reinforcing steel bars and reinforced concrete to provide adequate load carrying capacity to sustain either axial compressive loads alone or a combination of axial loads and bending moments. The interactive and integral behavior of concrete and the structural steel elements makes the composite column a very cost effective and structural efficient member among the wide range of structural elements in building and bridge constructions. as shown in Fig. 1.1. We could also find those columns subjected to bending moments in combination with axial tensile loads, in which case it would be necessary to have a design method that includes the overall range of combinations of axial load and bending moments.

1.1 General Concept of Composite Columns

Composite columns may be of two kinds : (1)Concrete-filled pipe and tubular steel columns, and (2) concrete-encased steel columns, as shown in Figs. 1.1(A),(B) ,Fig 1.2(A),(B) shows a composite column in which the steel pipe and tube serve both as form and reinforcement.

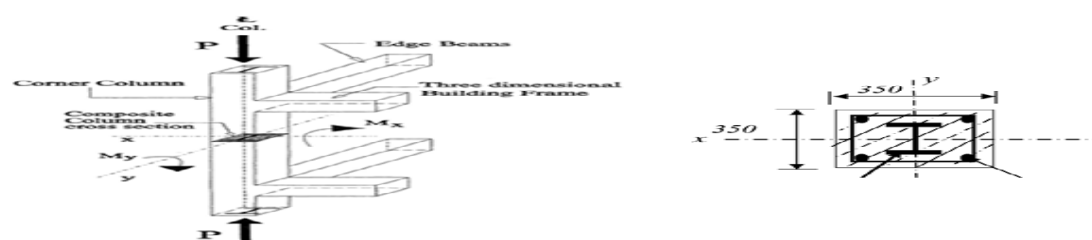


Figure 1.1 (A) Typical three-dimensional structural building frame , (B) Cross-Section of composite encased section.

II. LITERATURE REVIEW

B. M. Broderick [1] Attempt has been made to find The behavior of partially encased composite beam-columns under the combined effects of earthquake and axial loads investigated in a series of cyclic and pseudo-dynamic tests. The results confirm the excellent performance of this type of construction and reaffirm the viability, indeed the desirability, of using composite beam-columns for seismic design applications in multi-story structures.

N.E. Shanmugam , B. Lakshmi[2] The objective of research work is that to carried out to date accounting for the effects of local buckling, bond strength, seismic loading, confinement of concrete and secondary stresses on the behavior of steel–concrete composite columns. Author conclude that Intensive research is required on the interaction between steel and concrete, the effect of concrete restraining local buckling of steel plate elements, effect of steel section, confining concrete, etc.

Shosuke Morino , Keigo Tsuda[3] It examine the structural system and discusses advantages, research findings, and recent construction trends of the CFT column system. The paper also describes design recommendations for the design of compression members, beam-columns, and beam-to-column connections in the CFT column system. The results confirm A design method for a CFT beam-column using higher strength material formulas to evaluate deformation capacity of both short and slender CFT beam-columns, the restoring force characteristic of a CFT beam-column and connection.

Ahmed Abdullah [4] It Examine a complete non-linear finite element model that could represent the behavior of the composite columns tested under axial compression in the laboratory was developed. The study was confined on the composite columns that have been simulated by using finite element theory. The structure stability observations on the composite columns showed that buckling phenomena is associated with long columns, while short columns will squashed under axial compression.

Chao Liu[5] Investigates the load - deflection curves of new high strength steel encased concrete composite beams. Calculation formula of load which changes with depth of section and flexural strength is given The simplified plasticity theory can be adopted to calculate the flexural capacity, the cross-sectional form of thick steel plate at the bottom has good flexural capacity and ductility the stress factor can be appropriately improved in the calculation. New high-strength steel and high-strength concrete composite beams have high flexural capacity and high ductility, but blindly increase the strength of the material is not reasonable and economical method.

III. OBJECTIVE AND SCOPE

Our prime objective is to development interaction diagram for uniaxial loaded composite column. Develop a program for considerable simplification of time consuming evaluation process and elimination of manual derivation of characteristics of the cross section shapes. Using program we can quickly and efficiently design composite column of the usual types. The manual calculation for interactive diagram is too laborious and time-consuming. The purpose of our project is to develop a design aid for more simplified & effective design of column subjected to compressive force & uniaxial bending. The recommended programming is focused on solving the problem with the aid of the load vs moment diagram. Whose construction is time consuming. This makes economical design difficult .therefor a user friendly application (a simple excel program) is develop for the everyday used.

IV. METHEDOLOGY

Method of Design

At present, there is no Indian Standard covering Composite Columns. The method of design suggested in EC4 (euro code, EN 1994-1-1:2004 (E)) which incorporates the latest research on composite construction. This method also adopts the basis of column design. It is formulated in such a way that only hand calculation is required in practical design.

Steps In Design

Design Steps for columns with axial load and uni-axial bending

List the composite column specifications and the design values of forces and moments.

List material properties such as f_y , f_{sk} , $(f_{ck})_{cy}$, E_a , E_s , E_c

List section properties **Aa** , **As** , **Ac** , **Ia** , **Is** , **Ic** of the selected section

Design checks

- (1) Evaluate plastic resistance, P_p of the cross-section from equation,

$$P_p = A_a f_y / \gamma_a + a_c A_c (f_{ck})_{cy} / \gamma_c + A_s f_{sk} / \gamma_s$$

- (2) Evaluate effective flexural stiffness, $(EI)_e$ of the cross-section for short term loading

in x and y direction using equation,

$$(EI)_e = E_a I_a + 0.8 E_{cd} I_c + E_s I_s$$

- (3) Evaluate non-dimensional slenderness, λ_x and λ_y in x and y directions from equation,

$$\lambda = (P_{pu} / P_{cr})^{(1/2)}$$

where

$$P_{pu} = A_a f_y + a_c A_c (f_{ck})_{cy} + A_s f_{sk}$$

Note: P_{pu} is the plastic resistance of the section with $\gamma_a = \gamma_c = \gamma_s = 1.0$

And

$$P_{cr} = \pi^2 (EI)_e / l^2$$

- (4) Check for long-term loading

The effect of long term loading can be neglected if following conditions are satisfied:

Eccentricity, e given by

$e = M/P \geq 2$ times the cross section dimension in the plane of bending considered λ the non-dimensional slenderness in the plane of bending being considered exceed the limits given in Table 6.

- (5) Check the resistance of the section under axial compression for both x and y axes. Design against axial compression is satisfied if following condition is satisfied for both the axes:

$$P < \chi P_p$$

where

χ = reduction factor due to column buckling.

$$= 1 / [\Phi + \{\Phi^2 - \lambda^2\}^{(1/2)}]$$

And

$$\Phi = 0.5[1 + \alpha(\lambda - 0.2) + \lambda^2]$$

- (6) Check for second order effects

Isolated non – sway columns need not be checked for second order effects if following conditions are satisfied for the plane of bending under consideration:

$$P / P_{cr} \leq 0.1$$

$$\lambda \leq 0.2$$

- (7) Evaluate plastic moment resistance of the composite column about the plane of bending under consideration.

$$M_p = P_y (Z_{pa} - Z_{pan}) + 0.5 p_{ck} (Z_{pc} - Z_{pcn}) + p_{sk} (Z_{ps} - Z_{psn})$$

where

Z_{ps} , Z_{pa} , and Z_{pc} are plastic section modulus of the reinforcement, steel section, and concrete about their own axes respectively.

Z_{psn} , Z_{pan} , and Z_{pcn} are plastic section modulus of the reinforcement, steel section, and concrete about neutral axis respectively.

- (8) Check the resistance of the composite column under combined axial compression and uni-axial bending

The design against combined compression and uni-axial bending is adequate if following condition is satisfied:

$$M \leq 0.9 \mu M_p$$

where

M = design bending moment

M_p = plastic moment resistance

μ = moment resistance ratio

V.CONCLUSION

This thesis introduces a program for automated efficient evaluation and design of composite column of usual cross section shapes in compliance with currently applicable Indian standard. The main contribution is considerable simplification of time consuming evaluation process and elimination of manual derivation of characteristic of the cross section shapes. Using the program we can quickly and efficiently design composite column of usual type. In addition to this interaction chart of P_u - M_u diagram considering all I section of SP-6 are developed to ready reference. Moment capacity and axial force carrying capacity can directly be interpolated from these charts for % of reinforced steel.

VI. REFERENCES

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