STRENGTH ASSESSMENT OF AXIALLY LOADED RC COLUMN STRENGTHENED BY STEEL CAGES

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Master of Engineering in Structural Engineering Design

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Thesis submitted in partial fulfilment of the requirement for the degree Master of Engineering

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DECLARATION

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ABSTRACT

In reinforced concrete buildings the columns are the main vertical elements, which sustain and carry the entire weight. Hence they should be capable to withstand the loads transferring from the beams and slabs without any failure. Any deficiency of the column may cause total collapse of the structure and it may lead to destruction of human life and also physical damages to other structures. But due to reasons such as change in use, design, number of floors, addition of other installations or deterioration, it is often necessary to strengthen RC columns in buildings during construction or post construction.

Three main methods; concrete jacketing, steel jacketing and composite jacketing are used to strengthen RC columns. Concrete jacketing is popular in Sri Lanka but it is worth to implement steel jacketing in the construction industry due to the easiness of the usage. The composite jacketing cannot be implemented due to high cost. Hence the aim of the present study is to encourage the use of steel jacketing in Sri Lanka.

To have economical use of steel, angles and strips can be used to strengthened RC columns. The objective of the present study is to check whether EUROCODE 4 (2004) or BS 5400-5 (1979) can be used to evaluate the load carrying capacity in compression for RC columns strengthened with steel angles and strips. The experimental results from foreign and local researches were gathered and compared with the calculated theoretical values.

The ratio between gross capacity without safety factor and experimental value is ranging 0.95 to 1.05 based on EC4 and 0.96 to 1.06 based on BS 5400 5 in the experiment II of Ester G with five strips and it is 0.84 based on EC4 and 0.85 based on BS 5400 5 in the experiment I of Ester G. with seven strips. But, for the experiment of Kumaranjan A. the ratio between gross capacity without safety factor and experimental value is ranging 0.97 to 1.03 for seven and five strips. The ratios between theoretical ultimate values of BS 5400 5 and EC4 are varying from 0.87 to 0.88 in experiment done by Ester G. and 0.84 in the experiment done by Kumaranjan A. The experimental values are higher than the theoretical ultimate values and the safety factor of 1.1 to 1.6 is for EC 4 and 1.36 to 1.85 is for BS 5400 5. It is confirmed that the safety factor of the both codes have sufficient provisions for the capacity of strengthen RC columns using steel cages. Also, when using seven strips the capacity has increased but it is not quantified using the codes calculations.

It is recommended to test the real size columns with several L angles sizes with load on it while strengthening to simulate a constructed column in a building. Also, an experimental study by varying the number of strips connected to the cage would lead to identify the limits of the enhancement of strength capacity.

ACKNOWLEDGMENT

I would like to give my gratitude to the staff of the Civil Department of the Faculty of Engineering and also the fellow students who helped me in my research study to collect data and preparation of the thesis report.

Also, I would like to thank to Mr. Kumaranjan Ashokrajbabu who provided his experimental data and results for the calculation of the theoretical values.

A very special gratitude should be offered to Dr. K. Baskaran who guided me throughout the research work and advised to obtain a valuable output from the thesis as the research supervisor.

At finally, my heartfelt gratitude is for my family members who help me anytime and my friends who encourage me always.

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LIST OF ABBREVIATIONS

Abbreviation	Description
FRP	Fibre Reinforced Polymer
CFRP	Carbon Fibre Reinforced Polymer
FEM	Finite Element Model
A_c	Cross-sectional area of concrete
A_a	Cross-sectional area of the structural steel section
A_s	Cross-sectional area of reinforcement
$N_{pl,Rd}$	Design value of the plastic resistance of the composite section
f_{yd}	Design value of the yield strength of structural steel
f_{cd}	Design value of the cylinder compressive strength of concrete
f_{sd}	Design value of the yield strength of reinforcing steel
$(EI)_{effk}$	Effective flexural stiffness of the cross- section
K_e	Correction factor for cracking of concrete that should be taken as 0.6
I_a,I_c and I_s	Respective second moment of area for the bending plane considered of the steel section, the uncracked concrete section and the reinforcement
E_a and E_s	Respective elastic moduli of the steel of the structural section and the reinforcement
E_{cm}	Elastic second modulus of the concrete
$N_{pl,Rk}$	Value of the plastic resistance $N_{pl,Rd}$ is calculated using material partial safety factors γ_a, γ_c and γ_y are set equal to 1.0 (using the characteristic material strength)
N_{cr}	Elastic critical normal force for the relevant buckling mode
$\bar{\lambda}$	Non-dimensional slenderness

N_{ed}	Total design normal force
χ	Reduction factor for the relevant buckling mode
α	Imperfection factor according to the buckling curve
α_c	Concrete contribution factor
N_u	squash load
A_s	Cross-sectional area of the rolled or fabricated structural steel section
A_r	Cross-sectional area of reinforcement
A_c	Area of concrete in the cross section
f_y	Nominal yield strength of the structural steel
f_{ry}	Characteristic yield strength of the reinforcement
f_{cu}	Characteristic 28 day cube strength of the concrete
l_E	Length of column for which the Euler Load equals the squash load
l_e	Effective length of the actual column in the plane of bending considered
E_c	Modulus of elasticity of concrete
E_s, E_r	Young's moduli of elasticity for the structural steel and reinforcement respectively
I_c, I_s, I_r	Second moments of area of the uncracked concrete cross section, the steel section, and the reinforcement respectively
λ_x	Slenderness function
l_x,l_y	Length of the column
N_{ay}	Axial failure load

K_{1y}	Determined from **C.1** using the parameters appropriate to the minor axis
h and *b*	Greatest and least lateral dimensions of concrete in the cross section of the composite column
0.85	Reduction factor to allow for the moments due to construction tolerances
N_{exp}	Experimental value
N_{th}	Theoretical ultimate value based on standards
N_g	Sum of the gross capacities of materials without safety factor
EG	Ester G.
KA	Kumaranjan A.