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Theoretical Analysis of Factors Affecting Ultimate Nominal Load of Reinforced Concrete Axially Loaded Short Squire Columns (Pu) Comparing use Prokon Program

A B S T R A C T

One of this theoretical study, parameters that affecting the ultimate load capacity of the axially loaded column are studied. The parameters such as compressive strength of concrete and steel reinforcement ratio. Throughout study a different value of each factor will be assumed. Then the nominal load-carrying capacity of axially loaded column was calculated for these different factors parameters according using the simplified methods provided in (ACI-318- 14) building code requirement for structural concrete and Prokon Program. It is observed that increasing the compressive strength of concrete result in improving the ultimate load capacity. Using compressive strength of concrete more than 40MPa which results in increasing of (Pu) from (2362kN) to(5918KN) . On other hand The total area of longitudinal reinforcement bars (AST), and the gross area of concrete section (Ag) have a significant effects also on increasing of (Pu) value but not as (Fc').

Introduction

In general, reinforced concrete columns rectangular or circular cross-section have steel mesh to offer reinforcement. The cross-sectional dimensions of a column are normally considerably less than its height. Columns support vertical loads from super-structures to the foundations. The ultimate strength of axial loaded columns is governed by the crushing resistance of concrete, assuming that reinforcing bars are ductile enough to deform at constant yield stress until concrete crushes in compression [3,4].

A combination of all of the mentioned requirements and an inter-relationship between these criteria creates column design as a complex problem.

Nominal Load-Carrying Capacity of Axially Loaded Short Columns

Axial strength φ Pn: For compression members shall not be taken greater than φ (Pn,max) computed by ;

1- ***For non-prestressed members with spiral reinforcement***;

$$Pu = \emptyset Pn, max = 0.85 * \emptyset[0.85\, f'c * (Ag - Ast) + Ast * fy] \quad (1)$$

2- For non-prestressed members with tie reinforcement;

$$Pu = \emptyset Pn, max = 0.8 * \emptyset[0.85\, f'c * (Ag - Ast) + Ast * fy] \quad (2)$$

$$\mathrm{Pu} = \emptyset \mathrm{Pn}, \mathrm{max} \quad (3)$$

$$\emptyset = 0.65\ for\ tied\ Columns$$

$$\emptyset = 0.75\ for\ Spirally\ reinforced\ Columns$$

The Behavior of Reinforced Concrete Short Column

Reinforced concrete columns, have to the complex nature of the governing design relationships, are highly multidimensional optimization issues. Therefor a reinforced concrete column can be subjected to axial load or a combination of axial load and bending moment. The bending moment acting on the column may be uniaxial or biaxial [1,2]. In this study only, the action of column with axial load is taken. Generally column can be classified as short columns or slender column depend on slender ratio. The ratio of effective length of the column to its lateral dimension is defined as slenderness ratio [3,4]. In order to study the effect of the ultimate nominal load carrying capacity of axially loaded short squire columns (Pu) theoretically, square column with (400mm*400mm) dimension is assumed.

2.1 Methodology

In this theoretical study, different values of concrete compressive strength and steel ratio are taken to illustrate the performance of reinforced concrete axially loaded columns.

The columns dimension, is (400 mmx400 mm and length 3 m). Three group of samples can be constructed as shown in Table 1.

According to ACI- 318 specification the ultimate load capacity of axial columns are calculated and compared with Prokon program results.

Table 1. R.C. Columns Samples with Different Variables

Item	Sample	f_{cu}, (MPa)	ρ_g,(%)
Set 1	C11	30	2
	C12	40	2
	C13	60	2
Set 2	C21	30	4
	C22	40	4
	C23	60	4
Set 3	C31	30	8
	C32	40	8
	C33	60	8

Load Capacity Output by American of Concrete Institute Code (ACI-318)

The analysis results of the ultimate load based on ACI318-14 procedures are presented in Table z

Table 2. Analysis results of ultimate load based on ACI 318M-2011 procedures

Set No.	*Sample*	*f_{cu}, (MPa)*	*ρ_g,(%)*	*P_u (KN)*	*Increased P_u(%)*
Set 1	*C11*	*30*	*2*	*2362*	*-*
	C12	*40*	*2*	*2916*	*23*
	C13	*60*	*2*	*4025*	*70*
Set 2	*C21*	*30*	*4*	*3026*	*-*
	C22	*40*	*4*	*3570*	*18*
	C23	*60*	*4*	*3841*	*27*
Set 3	*C31*	*30*	*8*	*4357*	*-*
	C32	*40*	*8*	*4877*	*12*
	C33	*60*	*8*	*5918*	*35*

1. Results and Discussion

3.1 Analysis of High-Performance Strength Reinforced Concrete Columns by Program Prokon

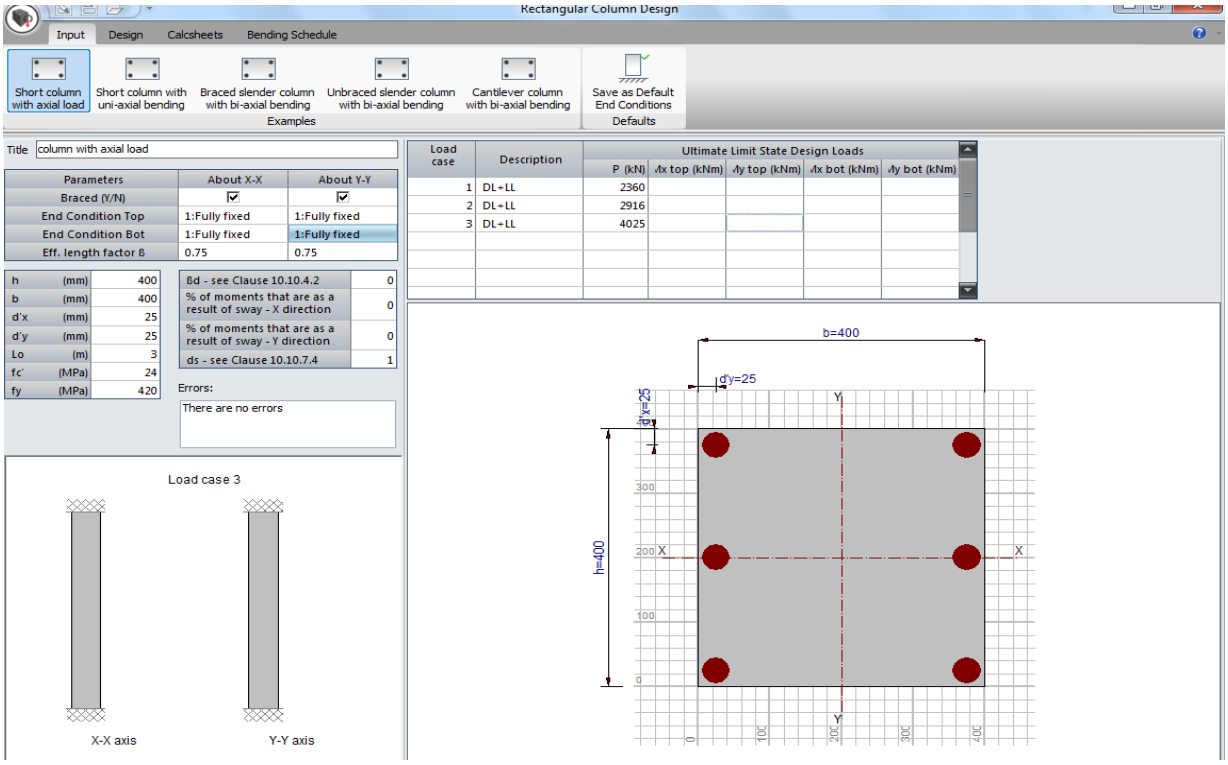
PROKON established and supported by a team of professional is engineers and intended for use by structural engineers and technicians. It is design and detailing programs to simplify the Structural Analysis and Design process and provides reliable output design data for reinforced concrete members and steel design member as well.

Load Type

The variety of load combination are applied gradually on columns according to code specification. See table 3

Table 3. Effect of loads cases & fcu on behavior response of R.C. columns.

Item		Fcu 30 (MPa)		(A_{sc}/Ac) (%)
Load Case	**Load (KN)**	**M $_{min}$ (KN.m)**	**A_{sc}(mm²)**	
1	2362	63.7	3188	1.99
2	2916	78.7	5862	3.66
3	4025	108.7	11199	7 *
Item		**Fcu 40 (MPa)**		**(A_{sc}/Ac) (%)**
Load Case	**Load (KN)**	**M $_{min}$ (KN.m)**	**A_{sc}(mm²)**	
1	3026	81.7	3733	2.33
2	3570	96.4	**6396**	4
3	3841	103.7	**7722**	4.8
Item		**Fcu 40 (MPa)**		**(A_{sc}/Ac) (%)**
Load Case	**Load (KN)**	**M $_{min}$ (KN.m)**	**A_{sc}(mm²)**	
1	4357	117.7	**4878**	3
2	4877	131.7	**7513**	4.7
3	5918	159.8	**12794**	8 *



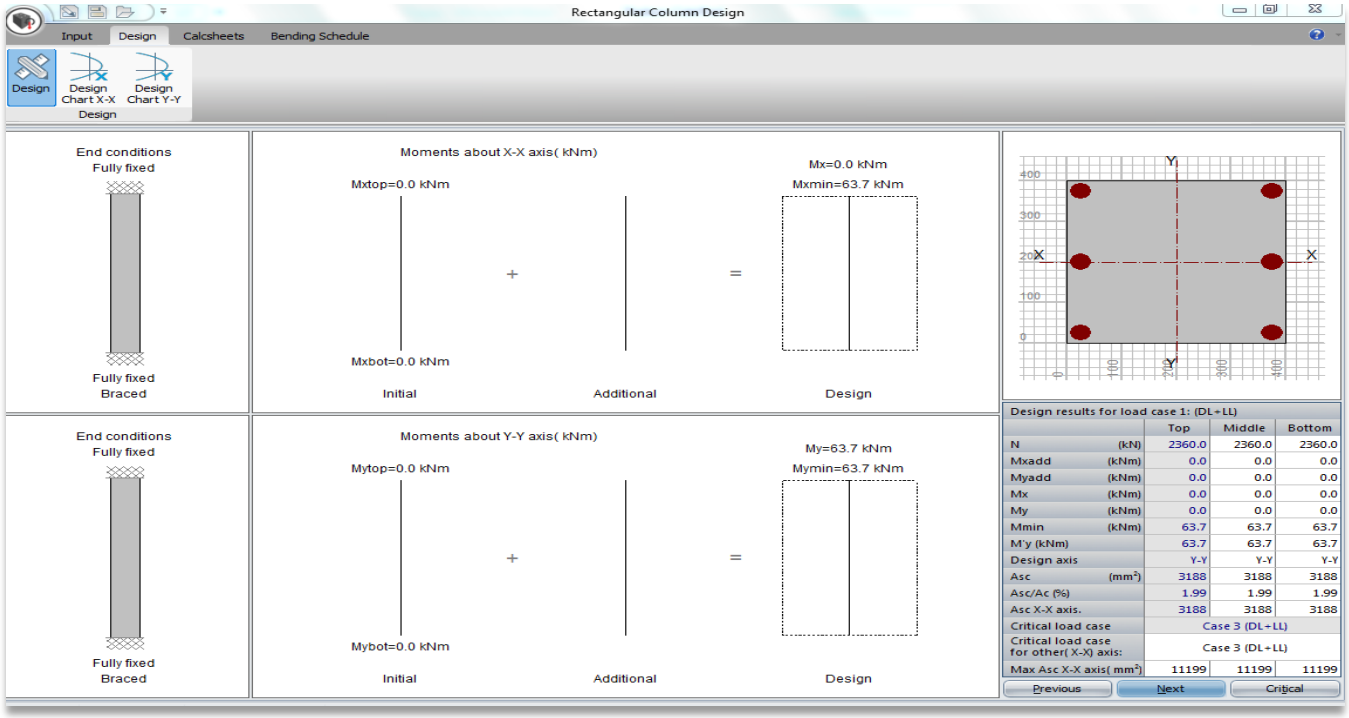


Figure.1,2. Input data details and output results in program Pokon v.3 of the column sample

Conclusion

Based on the theoretical results obtained by Prokon software program and ACI-318 specification the following conclusions may be drawn

- The increasing of compressive strength of concrete (fc) has the greatest effect in increasing the ultimate load capacity of the column.
- It's also demonstrated that the increase of (Ast) and increase of (Ag) has a significant effect in increasing the (Pu).
- Prokon software program has been used to design all columns as per ACI 318M-14 code requirements for axial loads as well as bending moments.
- Prokon software program is one of the most famous structural engineering software's used for 3D model generation, analysis and multi-material design.
- Prokon software program is very easy to learn and work, accurate for both analysis and design, and one of preferable software's used for the design of structures.

- Computer programs such Prokon software program is used to determine

- the ultimate load capacity of different short rectangular reinforced concrete columns designed under axial loads plus uniaxial bending.
- Further empirical study should be conducted on the effect of the (fc, fy, Ast, and Ag) on the ultimate strength of eccentrically loaded columns: axial load and bending (uniaxially and biaxially loaded columns) .

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