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STRENGTH CHARACTERISTICS OF COMPOSITE COLUMN

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Project Guide, Department of Civil Engineering, S.G. Balekundri Institute of Technology, Belagavi, Karnataka[1], India1 Student, Department of Civil Engineering, S.G. Balekundri Institute of Technology, Belagavi, Karnataka, India[2,3,4,5]

Abstract: Nowadays, developing safe structures with an eye toward the project's financial elements is the major priority. Regarding both residential and commercial purposes, typically, blocks, towers, high-rise buildings, and other tall constructions are built. They could also go by the name "vertical city." consist of the capacity to provide greater floor space and to house more people in a less area. Giving us advantages like a stunning skyline, significant landmarks, and optimal land use. The primary motivation behind them is the achievement of structural stability, strength, and stiffness, and fresh innovation was introduced to attain that goal. Called "composite construction." The column of size 230x300x600mm is casted with M25 Grade and one more composite column is casted with I section ISMB 250 is inserted to form a composite column. Both are tested under compression load and the load carrying capacity is observed, the results are expected to fall 50% more than the regular column.

I. INTRODUCTION

The primary motivation behind them is the achievement of structural stability, strength, and stiffness, and fresh innovation was introduced to attain that goal. called "composite construction."

Concrete is good in compression, while steel is good in tension, which explains why composite construction is frequently so good. by decreasing the forces in the elements sustaining them, particularly the foundations, it has a knock-on impact.

MATERIAL USED IN COMPOSITE COLUMN

Concrete, reinforcement, and structural steel are the materials that are most frequently utilised to cast composite columns. Due to the composite effect, composite columns have a far higher load carrying capacity than a typical reinforced concrete column. In the construction of high-rise buildings, composite columns are frequently used.

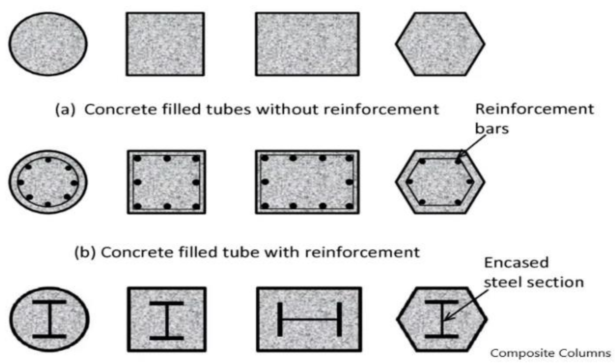

fig. 1 composite column sections

II. METHODOLOGY

1. LABORATORY TESTS ON MATERIALS

SL. No.	Materials	Test Properties	Result
1	**Cement**	Standard consistency	34%
		Initial setting time (in min)	30
		Final setting time (in min)	600
		Specific gravity	2.88
2	**Fine aggregate**	Specific gravity	2.62
		Water absorption	2%
3	**Coarse aggregate**	Shape Test on Aggregates.	2.75
		Water Absorption	0.99%
		Impact Test on Aggregates	23%

Table: 1 Laboratory Tests on Materials

2. MIX DESIGN

M25 concrete mix ratio is 1: 1: 2

Sand (fine aggregate), cement, and coarse aggregate are the main components of concrete. The process of determining the proper proportions of these components to achieve the desired compressive strength is known as concrete mix design. **Concrete mix design is the process of figuring out the right ratios of these components to obtain the desired compressive strength.**

Mix Proportion	1 m^3 of concrete	Ratio
Cement	480 kg	1:1.33:2.43
Fine Aggregate	624 kg	
Coarse Aggregate	1125 kg	
Water Cement Ratio	0.44	
Water Content	192 kg	

Table 3: Mix proportions

Mix proportion is = 1: 1.33 :2.43

3. MIXING AND PLACING OF CONCRETE AND I – SECTION INTO THE MOULDS.

Fig.2 Conctete Mixing proces

fig.3 Mould for column

fig.4 Pouring and tamping process

4. MATERIAL CALCULATION FOR MIX DESIGN M25 CONCRETE:

Cement = *(Volume of dry concrete/a+b+c) × a*

" = (1.54/a+b+c) × a"
= [(1.54/1+2+4)] × 1 = 0.22 cum
"Now density of cement = 1440 kg/cu.m"
Volume of cement = 0.22 × 1440 =316.8 kg.
" As we know, 1 bag of cement contains 50 kg of cement ."
" ∴ Cement bags required = 316.8/50 = 6.33 bags."

Calculation For Sand

Sand = *(Volume of dry concrete/a+b+c) × b*

- = (1.54/a+b+c) × b = (1.54/1+2+4) × 2 = 0.44 cu.m.

Calculation For Water Content

Let us assume the water cement ratio of concrete is 0.45.

- "w/c = 0.45"
- "Required water for 1 bag cement = 0.45 × 0.0353 = 0.0159 cu.m.

Where volume of 50 kg cement = 0.0353 cu.m"

- 1 m^3 water = 1000 Liter
- "Required water for 1 bag cement=0.0159 × 1000 = 15.9 Liter"

" Required water for 6.33 bags cement = 6.33 × 15.9 = 101 Liter."

concrete curing:

Normally, concrete needs 24 to 48 hours to dry completely before you may drive or walk on it. However, concrete drying is a continual and dynamic process that typically takes 28 days to acquire its maximum effective strength. Here are some fundamental details on the issue of concrete drying time.

Steel calculation :

No of stirrups $= \frac{500}{120} + 1 = 5$
No of bars = 4 no of12 mm dia
No of stirrups = 5 no of 8 mm dia
Volume = 0.15 × 0.2 × 0.6 =0.018M^3
12mm dia bars = $4 \times \frac{\pi}{4} \times 0.6 \times 7850 \times ((0.012)^2) = 2.13kg$
8mm dia bars = $5 \times \frac{\pi}{4} \times (0.008)^2 \times 0.6 \times 7850 = 1.18kg$
Total steel load =2.13+1.18=3.31 kg
% of steel is $= \frac{3.31 \times 100}{7850 \times 0.018} = 2.34\%$ of steel
Volume of steel $= \pi/4 \times (8 \times 8) \times 550$
$= 27646.0mm^3$
ast $= \pi/4 \times 8^2 = 50.26mm^2$
Ast $=4 \times 50.26mm^2 = 201.6mm^2$

I-section area calculation

Area of flange = $0.7 \times 0.6 \times 2 = 8.9\ cm^2$
Area of web = 11.3×0.45 $= 5.085\ cm^2$
Total = $13.485\ cm^2$
Volume = $0.07 \times 0.006 \times 2 \times 0.5 = 0.00042$
Volume $= 0.0045 \times 0.113 \times 0.5 = 0.00025$
Total volume $= 0.00067425\ m^3$

Area of I section :

$$70\times 7 + 114\times 6 + 70\times 7 = 1664mm^2$$

fig.5 I section sample

Curing of casted concrete column :

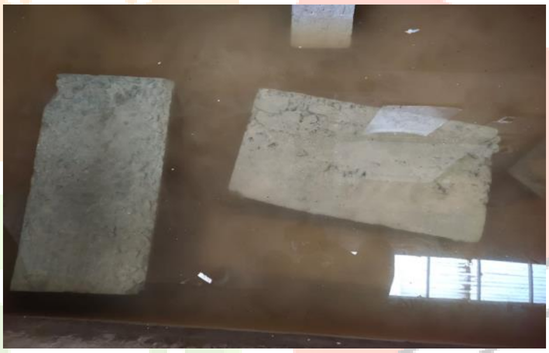

Fig. 6 Curing of column

Fig. 6A Cured column

5. **SPECIMENS TESTING:**

Testing machine: UTM (universal testing machine**)**

Column testing procedure in UTM

1) Measure all the dimensions of the column and note down its weight

2) Place the composite column in UTM such that it's shorter side should be parallel to the plates.

3) make sure that the column is placed properly, and plates will touch the ends of the column.

4) Start applying the loads and note the reading up to column failure.

Fig.7 Placing of coloun on UTM

fig. 8 Crack found on column

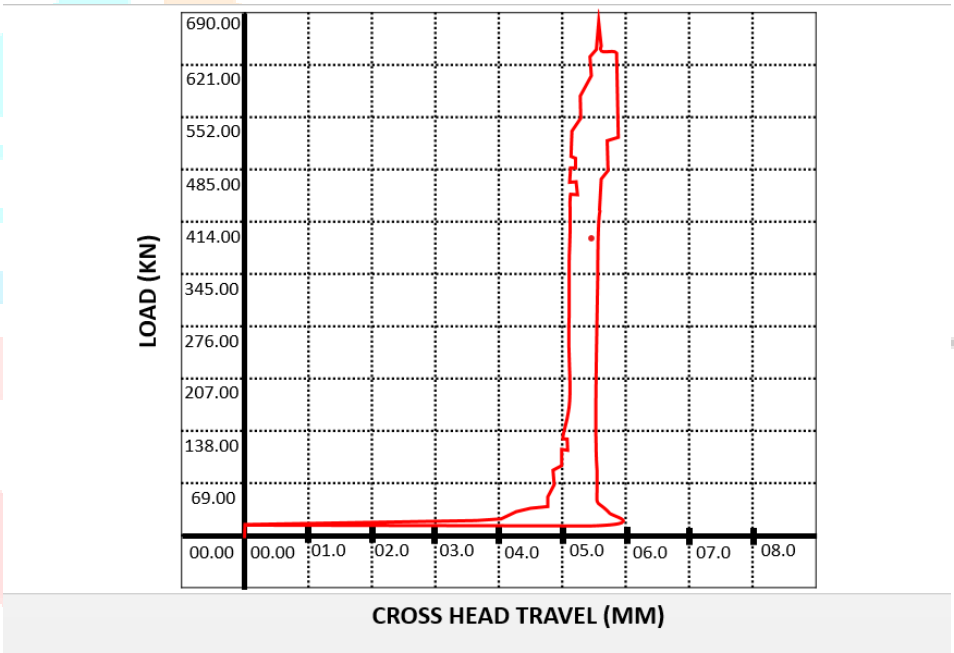

Fig.9 sample Failure Graph under compression test

6. CALCULATION:

"an ISHB 300 is to be used as a shon column carrying axial load. Its compressive strength likely to be affected by local buckling assuming (a) Fe 410 steel with f=250 MPa (b) Fe 540 steel with a design strength $f_{y} = 410$MPa ".

From section tables,

$b_{f} = 250$mm , $t_{f} = 10.6$mm , D = 300mm, R = 11.0mm, $t_{w} = 7.6$mm ,

A = 7480mm^2

(a) $f_{y} = 250$MPa from Table 2 of the code, IS ,800/2007, (bit) allowable E = 15

Actual (b/t) for flange = (250/2)/10.6 = 11.79 <15.7

d/t for web = [300-2 (10.6+11)]/7.6=33.79

From Table 2 of code, (d/t) max = 42

Thus full cross section is effective and design strength = 250 x 7480/(1.1 x 1000) 1700 kN

B) For f_{y} = 410MPa Flange limit is 15.7

Sqrt (250/410) = 12.26 > 5.9

Neb limit = 42 sqrt(250/410) = 32.79 < 33.79 Therefore, cross section is slender on account of proportions of the web.

Effective cross section

d = 300 - 2(10.6 + 11) = 256.8

A_{eff}=7480-\ 256.8-7.6×32.79\ 7.6

=7480 - (256.8 - 249.2) ×7.6 =7480 - 57.76 = 7422.24mm^2

= Design strength = 7422.24 x410/(1.1 x 1000) = 2766.5 kN

Manual calculation of regular column :

Size of column =600× 230 × 300

Compression load : 4.96 N/mm^2

Cross section area : 230×300=69000mm^2

Experimental load : 685.10kN

Cross section steel $=\frac{\pi}{4} \times 12^2 = 452.3$$mm^2$

COMPRESION.

$pu = 0.4 \times fck \times Ac + 0.67 \times fy \times ASC$ from IS 456-2000 clause no 39.3

“Pu =axial loads on the member “

“Fck=characteristic compressive strength of the concrete.”

“Ac= area of the concrete .”

“Fy =characteristic strength of the compression reinforcement.”

Asc =area of longitudinal reinforcement.”

Manual calculation of regular section :

$$= 0.4 \times fck \times Ac + 0.67 \times fy \times ASC$$

$=0.4 \times 25 \times 69000 + 0.67 \times 500 \times 452.3 = 841.52kN$

Manual calculation of composite section:

$= 0.4 \times fck \times Ac + 0.67 \times fy \times ASC$

$= 0.4 \times 25 \times 69000 + 0.67 \times 500 \times 2116.3 = 1550\ kN$

7. RESULT:

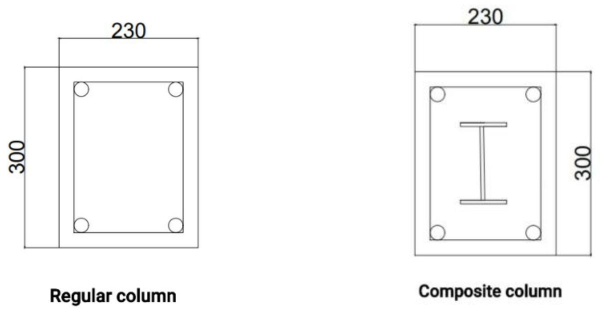

Fig. 4.15 Cross section of regular Column and Composite column

Summary of result,

- Analytical result of compressive strength for a regular column As per IS 456: 2000 Clause no 39.3, is 841 kN (Axial compression)
- Experimental result of the regular column is 685 kN (Axial compression)
- Analytical result of compressive strength for a composite column is 1550 kN (Axial compression)
- Experimental result of compressive strength for a composite column is 1260 kN

8. CONCLUSION:

- The load taken by regular column is 685kN and the load carried by the composite column of same dimensions is 1260 kN by the experimental result.
- Here we can conclude that the % of load carrying capacity of composite column is 54% more than the regular column.

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