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Development of Light Weight Material as Filler Element for High Rise Building Using ETABS Software

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ABSTRACT

Solid structures are inclined to tremor because of mass of the structures. essential utilization of auxiliary lightweight cement (SLWC) is to decrease the dead heap of a solid structure, which enables the basic fashioner to diminish the span of the basic individuals like pillar, segment, and footings which results in decrease of seismic tremor powers on the structure. This examination is an endeavor to anticipate the seismic reaction of a ten-storied fortified solid casing with the utilization of lightweight cement. A very much planned ten story precedent is taken for study. The structure is demonstrated with ETABS programming, and examination is completed with typical weight and lightweight cement. The fundamental rationale of our investigation is to allocate a light weight concrete in a tall building structure, where we can check its positive and negative impact on the strength of the structure. Likewise to legitimize the auxiliary cost decrease because of usage of light weight material.

Keywords : ETABS, Structural Analysis, Forces, Cost Analysis, Lateral Forces, Displacement.

I. INTRODUCTION

A tall building is a multi-story structure in which most tenants rely upon lifts [lifts] to achieve their goals. Presently a days because of development of the populace Housing has formed into an economy creating industry. Given this interest, while elevated structure structures have turned into an answer in the metropolitan urban areas.

The utilization of LWC (Lightweight cement) has been a component in the development business for quite a long time, yet like other material the desires for the execution have raised and now we are expecting a steady, solid material and unsurprising qualities. Basic LWC has an inplace thickness (unit weight) on the request of (1440 to 1940 kg/m³) contrasted with ordinary weight concrete a thickness in the scope of 140 to 150 lb/ft³ (2240 to 2400 kg/m³).

Froth material is an adaptable material which is comprised of bond, fly fiery remains and protein based froth. Essentially it is another material which is as of now utilizing in India for walling reason. improved protecting square structure for use in the development of solid divider structures wherein the square structure is framed from expandable polystyrene material to give a lightweight, inflexible, box-like structure having a couple of oppositely arranged side dividers and end dividers which together characterize a body pit to get concrete in that.

Froth material gives better solid protection, warm protection, tough, lightweight, uniform size and shape, decrease penetrability. It is non-load bearing basic component which has lower quality than customary cement. Cell concrete is well known in light of its light weight which diminishes self-weight of structure.

In this examination work light weight solid squares are threw with 65% of Fly fiery remains and 35% of bond with preformed froth content 1.5% of complete weight and to build its quality quarry dust is included its arrangement up-to 30% in an interim of 5% in various shapes to check properties of these Foam Concrete (FC) squares test like compressive quality, thickness and water retention is done in the research facility to figure out which test is indicating stable outcomes to give its properties and grade to investigation reason.

Figure 1: Tall Structure

Response Spectrum

The seismic forces strikes the foundation of a structure will move with the ground motion. It shows that structure movement is generally more than the ground motion. The movement of the structure as compared to the ground is refused as the dynamic amplification. It depends on the natural frequency of vibration, damping, type of foundation, method of detailing of the structure. The response "design acceleration spectrum" which refers to the max acceleration called spectral acceleration coefficient Sa/g, as a function of the structure for a specified damping ratio for earthquake excitation at the base for a single degree freedom system. The revised IS 1893-2002 uses the dynamic analysis by response spectrum. The fundamental natural period of vibration of the building (T in seconds), the damping properties of the structure, type of foundation provided for the building.

II. LITERATURE REVIEW

T. Subramani et. al. (2017) The computer aided analysis is done by using E-TABS to find out the effective lateral load system during dynamic loading in light weight concrete building. The performance of the building is evaluated in terms of Lateral Displacement and Storey Drifts. The study found that Response spectrum analysis reduced lateral displacement and storey drift due to dynamic loads compare to static analysis for all analyzed models. RCC constructions have more weight and larger cross sections for structural members. In our study about effective lateral load system during dynamic loading in light weight concrete building comparing to RCC member. The study also found; lateral displacement, storey drift with respect to dynamic loading in LWC section.

Vandanapu and Krishnamurthy (2018) Studied that Concrete structures are prone to earthquake due to mass of the structures. ,e primary use of structural lightweight concrete (SLWC) is to reduce the dead load of a concrete structure, which allows the structural designer to reduce the size of the structural members like beam, column, and footings which results in reduction of earthquake forces on the structure. This paper attempts to predict the seismic response of a six-storied reinforced concrete frame with the use of lightweight concrete. A well-designed sixstorey example is taken for study. The structure is modelled with standard software, and analysis is carried out with normal weight and lightweight concrete. Bending moments and shear forces are considered for both NWC and LWC, and it is observed that bending moments and shear forces are reduced to 15 and 20 percent, respectively, in LWC. ,e density difference observed was 28% lower when compared NWC to LWC. Assuming that the section and reinforcements are not revised due to use of LWC, one can expect large margin over and above MCE (maximum considered earthquake; IS 1893-2016), which is a desirable seismic resistance feature in important structures.

Grethel (2015) Potential market to use structural lightweight concrete is increasing in Mexico due to high rise building construction, tilt-up and precast industry. Structural Lightweight Concrete can be designed to get similar performance to normal weight concrete and to offer a weight-strength ratio more efficient in structural elements. Most of the cases, the marginal cost of lightweight concrete is compensated by size reduction of structural elements, decrease of reinforced steel, reduce dead load of structures, which means global costs reduction of the project. There are no several sources of lightweight aggregates in Mexico to design this type of structural concretes. This report validates different types of normal aggregates of five regions of Mexico (Mexico City, Tijuana, Guadalajara, Monterrey and Cancun) using lightweight synthetic particles to design lightweight concrete with structural performance including fresh concrete properties (slump, pumping, equilibrium and dry density) and hardened concrete properties (compressive strength, elasticity modulus and thermal conductivity). Structural lightweight concretes are validated in three levels of equilibrium density: 1500 kg/m3 , 1700 kg/m3 and 1900 kg/m3 with different dosages of lightweight synthetic particles.

Vanissorn et. al. (2012) In structural design, an ideal situation in material saving is to reduce the weight of the structure without having to compromise on its strength and serviceability. A new lightweight sandwich reinforced concrete section has been developed with a novel use of lightweight concrete as infill material. The section, namely LSRC section, is suitable for use as beam or slab members. Experimental investigations into the strength of beams with LSRC section shows promising results under both flexural and shear tests. Based on the test results, the flexural capacity of LSRC beams was found to be almost identical to the capacity of the equivalent solid beam. The shear capacity of the LSRC beams was expectedly reduced due to the low compressive strength of the lightweight concrete infill material. ANSYS 12.1 was employed to develop three dimensional nonlinear finite element models of LSRC beams and was verified against the experimental results.

Zulkarnain et al.(2013) investigated that compressive strength of foamed concrete is mainly a function of dry density and is only slightly affected by the percentage of cement replaced by silica fume. Large proportion of silica fume did not significantly affect the long-term compressive strength. The compressive strength of foam concrete with silica fume is higher than the foam concrete without silica fume and the difference of strength between foam concrete with silica and control samples is approximately same for all age.

Siram (2015) on her study he concluded that Foams formed from protein based surfactants have smaller bubble size, are more stable and have a stronger closed bubble structure compared to the foam produced using synthetic surfactants. Hence, they are high strength foam concretes. The density of foam concrete is the function of volume of foam that is added to the cement paste. The compressive strength of foamed concrete is an inverse function of the density of the material.

Aim of the study:

a. To reduce the cost of construction
b. To decrease the self-weight of the structure and also give a better material for wall panelling which can withstand to better sound insulation, thermal insulation, durable, lightweight, uniform size & shape, reduce permeability.
c. To analyse the implementation of light weight concrete in tall structure using ETABS"17.

d. To determine the variation in stability of the structure under lateral forces considering light weight concrete.

Scope of study:

The main motive of this research is to study the effect of Foam Concrete blocks on a tall structure. light weight cellular concrete blocks are casted with 40% of Fly ash and 40% of cement with foam content 1.5% of total weight and to increase its strength quarry dust is added in its composition upto 35% increasing 5% in each case. Structural performance of light weight Material on high rise building using ETABS software. By constructing the modern Light weight concrete building with all facilities and it is very useful the peoples including time saving, purchased to all things in single place, and also energy saving.

III. METHODS AND MATERIAL

Method following in this project:

1. Casting light weight material.

For this investigation, a pre formed method was adopted to provide polyurethane foamed concrete. The readymade foam was added to the base mix through the nozzle of the foam can according to the calculated amount by trial & error. The density of the foamed concrete produced was then checked against the target density.

Test on material:

Water absorption tested

Density and compression strength.

Table 1: Test results

COMPRESSIVE STRENGTH IN MPa		
S.NO	% of Quarry dust	M-20
1	0%	17.4
2	5%	17.52
3	10%	17.67
4	15%	18.43
5	20%	20.13
6	25%	19.23
7	30%	18.98

As per compressive testing machine results 20% quarry dust sample will be studied

For further implementation in software:

For this research work following steps should be followed:

Step-1 Review of literature survey done in past related to our .

Step-2 To determine the properties of light weight material to be use in this study.

Step-3 To Analyze the structure using light weight material properties using analysis tool.

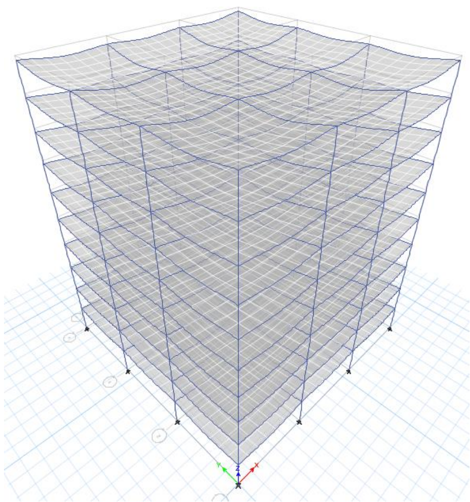
Step-4 To Define sectional details and end conditions.

Step-5 To perform dynamic loading as per Standard criterias.

Step-6 To determine the analysis results

Step-7 To perform comparative analysis using M.S. Excel.

Step-8 To estimate the cost of material as per Schedule of rates..



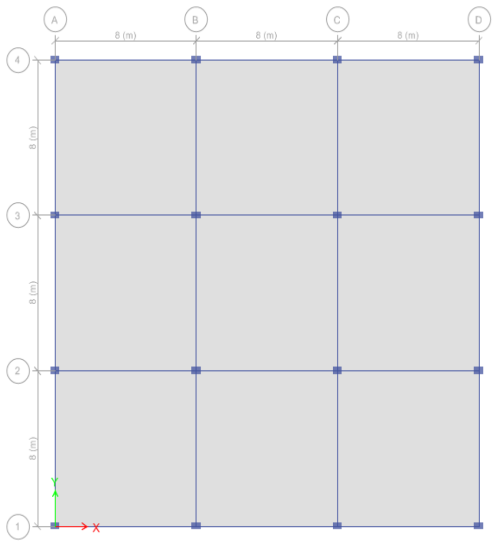


Figure 2 : Plan & 3-D of Selected Building Frame

Conventional Analysis and design:

Data given, (m)
Clear span (or Room size) = 7mX3m
L.L = 1.5 KN/m^2 , support thickness = 200mm
Surface finishing = 1 KN/m^2
Using M20 & Fe 415

Point 1 :- Design constant for M20 concrete & Fe415 steel

Fck =20 N/mm^2 , Fy = 415 N/mm^2
Mulimit = 0.138 fck bd^2
Xu = 0.479 d

Point 2 :- Type of Slab- ly/lx = 7/3 = 2.33 > 2
therefore design One way slab,
considering shorter span.

Point 3 :- Effective depth of span
for continuous slab one way
deff = l/(26 X M.F)
assume Modification factor
M.F =1.3 (IS456:2000 Page - 38)
= 3000/(26 X 1.3)
provide depth = 88.75 ≈ 90 mm ,
Take deff = 125 mm

Overall depth D = d +(c.c+Ø/2) = 125 +(20+10/2) = 125+25 =150 mm	assume dia. of bar 10mm c.c= 20mm

Point 4 :- Effective Span (leff)-
(1) L+ b = 3000 + 200 = 3200 mm
(2) L+ b = 3000 + 125 = 3125 mm (which ever is less)
thus leff = 3.125 m

Point 5 :- Load Calculation-
(1) Dead load of slab = 1x1x(d/1000) ρrcc
= (150/1000)x25 =3.75KN/m^2
(2) Live load = 1.5 KN/m^2
(3) Finishing load = 1 KN/m^2
Working load w = 6.25 KN/m^2
Factored load wu = 1.5w = 1.5x6.25
= 9.375 KN/m^2

Point 6 :- Factored Bending Moment (Mu)-
Mu = coeff. x wu x $leff^2$
From :
IS 456:2000
Page 36 Tabel no.12
[BM coefficients of Continuous slab at the mid of interior
span for dead load & imposed load (fixed) + 1/16]
Mu = (9.375x3.125^2)/16
Mu = 5.722 KNm per meter width of slab

Point 7 :- Check for depth (dreq.)-
Effective depth required dreq. = √(Mu/0.138fck b
= √(5.722x10^6)/(0.138x20x1000)
dreq. = 45.53 mm
dreq. < dprovided
OK-SAFE

Point 8 :- Main Steel –
Ast = 0.5 fck/fy [1-√1-(4.6 Mu/fck bd^2)] bd
Ast = 0.5x20/415[1- √1-(4.6 x 5.722 x 10^6 / 20 x 1000
x 125^2)] 1000 x 125
Ast = 129.638 ≈ 130 mm^2
and Astmin = 0.0012 bD

= 0.0012 x 1000 x 150
= 180 mm²
here, Astmin > Ast
therefore use Astmin i.e. 180 mm²

Point 9 :- Spacing Of Main Bar –
(1) (1000 x Ast) / Astmin = (1000 x π/4 x 10²) / 180
= 437 mm
(2) 3d = 3x125 = 375 mm
(3) 300 mm = 300 mm
(which ever is less)
provide (δ = 300 mm)
Ø = 10 mm @ 300 mm c/c spacing along shorter span.
Length of rod = 3000 – (2 x clear cover)
= 3000 – (2 x 20) = 2960 mm
provide 10 Ø @ 200 mm c/c & extra at top upto l/4 i.e.
0.8 m both supports
Point 10 :- Spacing Of Distribution steel –
here Astmin = 180 mm²
(assuming dia. Of bar 8 mm)
(1) (1000x π/4 x 8²)/180 = 279.25 ≈ 280 mm
(2) 5d = 5x125 = 625 mm
(3) 450 mm
(which ever is less)
provide 8 mm dia. Of distribution bar @ 280 mm c/c
spacing across main bar

Step-6 Design of Beam:

Data :
Clear span(L) = 4.75 m, fck = 20
Depth of flange (Df) = 150 mm, fy = 415
Depth of web (bw) = 200 mm
Imposed Load = 112 KN/m,

Step-1 Effective Depth (d):

Adopt D = 320 + 20 + 25 = 360 mm

Step-2 Effective Span (leff):

The least of
(i) Centre to centre of support = 4.75+0.2 = 4.95 m
(ii) Clear span + effective depth = 4.75 + 0.32 = 5.1 m
Effective span = 4.95 m

Step-3 Loads

Imposed load = 112 KN/m
Ultimate load = 1.5 X 112 = 168 KN/m

Step-4 Ultimate BM and Shear force

$$M_u = \frac{wl^2}{8} = 0.125 \times 168 \times 4.95^2 = 514.55 KN - m$$

$$V_u = \frac{wl^2}{2} = 0.5 \times 168 \times 4.95 = 415.8 KN$$

Step-5 Effective width of flange (bf):

$$b_f = \left(\frac{l}{6} + b_w + 6D_f \right)$$

=[(4.95/6)+0.2+(6X0.15)
= 1925 mm

Step-6 Shear reinforcement:

τv = (Vu / bw d) = 415.8X10³/(200X320)
= 6.49 N/mm²
Pt = 100 Ast /bwd = 100X545.651/(200X320)
= 0.853 m
from IS 456:2000, page no.73,table-19,
Design shear strength of concrete (M20)
τc = 0.28 N/mm²

Step-7 Design of columns

Data

Axial load on column = 400 KN

Length (L)	= 3.3 KN
Column size = 200X300 Adopt M20 and Fe415	
Fck = 20 N/mm²	Fy = 415N/mm²

Step1:- Effective length of column

both end fixed l = 0.6 L
= 0.65 X 3.3 = 2.145 m
factored load Pu = 1.5 X 400 = 600 KN

Step2:-Slenderness ratio

unsupported length/least lateral dimension
{Leff/D} = 2145/200 =10.725 < 12
hence column is designed as short column

Step3:-Minimum Eccentricity

e-min = [(l/500)+(D/30)] or 20 mm

Step4:- Main steel design

Main steel (Longitudinal reinforcement)-

Pu = [(0.4XfckAc) + (0.67FyAsc)]
Ac = area of concrete
Asc = area of steel
Ag = gross area (200x300 = 60000 mm²)
600X10³ = 0.4X20X0.99Ag + 0.67X415X0.01Ag
Ag = 56072.15 mm²
Asc = 0.01 Ag = 561 mm²
Ascmin = 0.08 Ag = 448.57 mm² ≈ 449 mm²
provide 12Ø - 6Nos(Total Area of steel = 678.58 mm²)

Step5:- **Design of Lateral Ties-**

(1) Dia. of ties Øtie = Øtie / 4 =12/4 = 3 mm
Øtie = 8 mm (for Fe 415)
Spacinga) least lateral dimension = 200 mm
b) 16 X Ømain = 16X12= 192 mm
c) 300 mm
which ever is less
provide 8 Ø @ 200c/c

IV. RESULTS AND DISCUSSION

Analysis & Results:

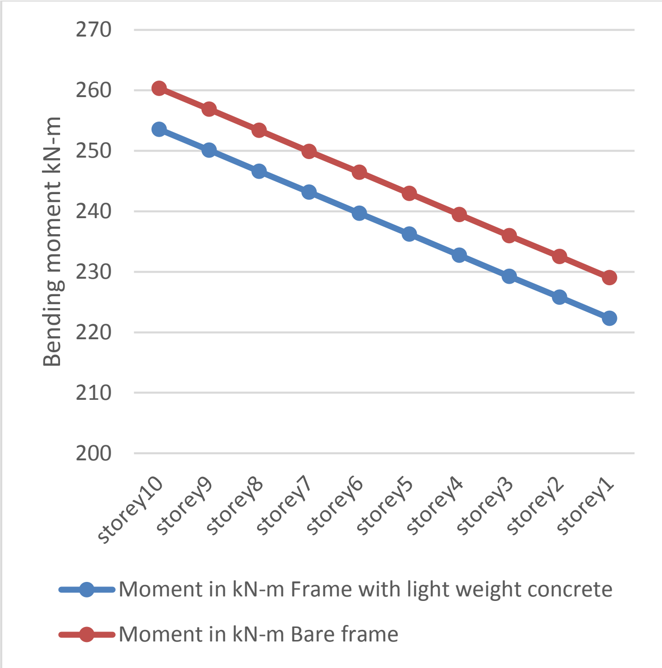


Figure 3 : Moment In Typical Storeys

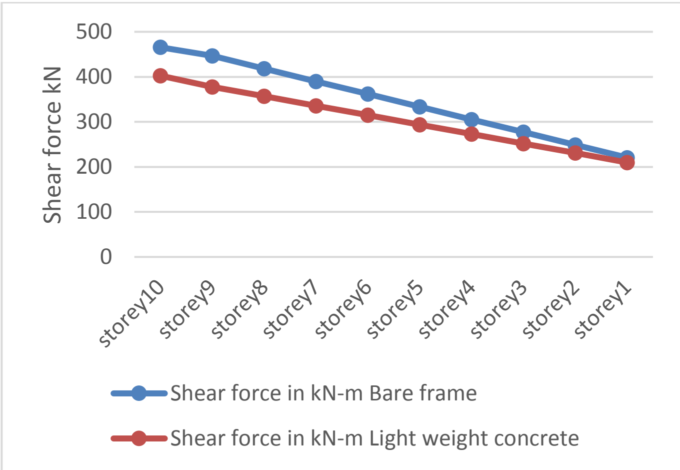


Figure 4 : Shear force

Cost Analysis:

Table 2: cost analysis

S.No.	Frame type	Concrete cu.m	Rate of concrete (m^3) as per S.O.R.	Cost of concrete in INR (Rupees)
1	Bare frame	110.98	5757	6,38,911.86
2	Frame with light weight concrete	96.98	5757	5,58,313.86

S.No.	Frame type	Reinforcement in kg	Rate of Rebar kg as per S.O.R.	Cost of Rebar in INR (Rupees)
1	Bare frame	9454.23	72.75	6,87,795.23
2	Frame with light weight concrete	9252.87	72.75	6,73,146.30

V. CONCLUSION

- ✓ It can be concluded that structure with light weight concrete as infill can be stable as results shows less bending moment which results in economical structure too.
- ✓ Performance of structure using light weight material (foam) a reduction in the risk of earthquake damage and increased thermal insulation and fire resistance using ETABS .
- ✓ The structure results in less lateral displacement due to lateral forces as observed in results.
- ✓ Structure is more economical in terms of material cost as per S.o.R.
- ✓ Capable of resisting lateral forces in severe seismic regions.

VI. REFERENCES

[1]. A. Kılıc, C. D. Atis¸, E. Yas¸ar, and F. Ozcan, “High strength ¨ lightweight concrete made with scoria aggregate containing mineral admixtures,” Cement and Concrete Research, vol. 33, no. 3, pp. 1595-1599, 2003.

[2]. ACI 211.2-98, “Standard practice for selecting proportions for structural lightweight concrete,” 1998.

[3]. A. Kan and R. Demirboga, “A novel material for lightweight concrete production,” Cement and Concrete Composites, vol. 31, no. 7, pp. 489-495, 2009.

[4]. Available Design Codes in STAAD Pro, pp. 1-14, Bentley Communities publisher, 2015.

[5]. ACI 318-14, Building Code Requirements for Reinforced Concrete, vol. 552, American Concrete Institute, IHS, 2014.

[6]. H. J. Shah, Design Example of a Six Storey Building. A Report by IIT Kharagpur—A Case Study.

[7]. ASTM C 567, “Standard test method for determining density of structural lightweight concrete,” 2014.

[8]. ACI Committe-213, Guide for Structural LightweightAggregate Concrete, pp. 1-38, American Concrete Institute, Farmington Hills, MI, USA, 2003

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