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Design And Analysis Of Light Weight Concrete Building Using ETAB With Respect To Dynamic Loading

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Abstract

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.

Keywords: Design, Analysis, Light Weight Concrete Building, ETAB, Dynamic Loading

1.INTRODUCTION

A Earthquake resistent Commercial Buildings, a form of grocery store, is a self-service store offering a wide variety of food and household merchandise, organized into departments. It is larger in size and has a wider selection than a traditional grocery store, also selling items typically found in a convenience store, but is smaller and more limited in the range of merchandise than a hypermarket or big-box store. The Earthquake resistent Commercial Building typically comprises meat, fresh produce dairy, and baked goods departments, along with shelf space reserved for canned and packaged goods as well as for various non-food items such as household cleaners, pharmacy products and pet supplies. Most shopping complex also sell a variety of other household products that are consumed regularly, clothes, and some stores sell a much wider range of non-food products.

The use of LWC (Lightweight concrete) has been a feature in the construction industry for centuries, but like other material the expectations of the performance have raised and now we are expecting a consistent, reliable material and predictable characteristics. Structural LWC has an in-place density (unit weight) on the order of 90 to 115 lb / ft^3 (1440 to 1840 kg/m^3) compared to normal weight concrete a density in the range of 140 to 150 lb/ft^3 (2240 to 2400 kg/m^3). For structural applications the concrete strength should be greater than 2500 psi (17.0 MPa). The concrete mixture is made with a lightweight coarse aggregate. In some cases a partion or the entire fine aggregates may be a lightweight product. Lightweight aggregates used in structural lightweight concrete are typically expanded shale, clay or slate materials that have been fired in a rotary kiln to develop a porous structure. Other products such as air-cooled blast furnace slag are also used. There are other classes of non-structural LWC with lower density made with other aggregate materials and higher air voids in the cement paste matrix, such as in cellular concrete. Consideration of earthquake force in structural design has become a serious issue to building owners, engineers, architects and developers in Bangladesh as it lies in a seismically active region. Analysis methods specified in BNBC (equivalent static method and dynamic response spectrum method) have limitation since they are linear methods. On the other hand performance based analysis or pushover analysis is now considered most reliable and effective inelastic analysis method to find actual behavior of the structure in earthquake.

Some medium rise (6 storied) frame structures are modeled and designed with the help of finite element software ETABS. Earthquake load is calculated automatically by the program. Wind load is calculated according to Bangladesh National Building Code by developing an excel sheet. Standard load combinations are taken according to BNBC.

For non-linear analysis ATC -40 is reviewed thoroughly. Hinge property is chosen from the provided experimental data. Allowable hinge deformation at different performance level for beams and columns is established. Hinges are assigned to each element. Structure are then subjected to push over analysis which include progressive damage of elements with plastic deformation of the hinge assigned on the element of the structure as the structure is laterally pushed through. In addition to the traditional concrete made with normal weight aggregate (NWC), an increasing interest is currently shown, both in our country and worldwide, for good quality lightweight concrete types such as the one made of lightweight aggregate (LWC). Because of their proven advantages, LWC structures are now used in the construction of low-rise and high-rise buildings, bridges, industrial facilities, sea vessels, and coastal systems. A growing interest for LWC structures is unfortunately not followed by appropriate regulations.

1.1. Equivalent Static Analysis

It is one of the methods for calculating the seismic loads. The high rise structures are not considered for the design simple static method. In practical as it does not take into account all the factors that are the importance of the foundation condition. The equivalent static analysis is used to design only for the small structures. In this method only one mode is considered for each direction. The earthquake resistant designing for the low rise structures the equivalent static method is enough. Tall structures are needed more than two modes and mass weight of each story to design earthquake resistant loads. This is not suitable to design those structures and dynamic analysis method to be used for high rise structures.

1.2. Responsespectrum Analysis

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. In this method takes into account all the five important engineering properties of the structures. 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.

1.3 Importance Factor Of The Building

The ductility of the structure represented by response reduction factor

1.3.1 Zone Factors For Different Zones In India

Zone	Seismic coefficient of 1984	Seismic zone factor (z of 2002)
V	0.08	0.36
IV	0.05	0.24
III	0.04	0.16
II	0.02	0.1

1.4 Design Sets Of Buildings

RCC Frame system: The structural analysis and design has been based on the prevailing codes that are in practice in Nepal, the Nepal National Building Code and the IS codes at places. Considering Architectural, Economic and strength demands reinforced cement concrete (RCC) is used as the major structural material. The selected material also confirms the availability and ease in construction. The concrete grade used is M20 as per Indian Standard Specification. This material provides minimum grade of structural concrete and favourable for easy production and quality control as well. Fe415 is provided as longitudinal and shear reinforcing in Beams, Columns, foundations, and slabs wherever RCC is used.

The loads distributed over the area are imposed on area element and that distributed over length are imposed on line element whenever possible. Where such facility is not feasible, equivalent conversion to different loading distribution is carried to load the Model near the real case as far as possible. For lateral load, necessary calculations were performed using NBC 105: 1994 for seismic coefficient method. Different load combinations based on Nepal National Codes are developed and used for design purposes.

2.REPORT WRITING

2.1 Name Of The Project

Light weight concrete building in Salem Dt.

2.2 Necessity & Scope Of The Project

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.

2.3 Availability Of Labours & Materials

Experienced and skilled labours such as Mason, Carpenters and Painters etc., are available at 5 roads in Salem District and all the materials are available locally here.

2.4 Administartive Approvals

The administrative approval should be obtained from the concerned authority of Government of Tamilnadu.

2.5 Schedule Of Rates

The rates of adapted as per the current P.W.D schedule of rates 2016-2017 of Salem district and prevailing current market rates locally available.

2.6 List Of Notations

The following letter symbols have the meaning indicated against each
Which is used in this project book.
B=Breadth of the beam or slab.
D=Overall depth of beam or slab.
d=Effective depth of beam or slab.
F_{ck}=Characteristic strength of the concrete.
F_y= Characteristic strength of the steel.
K=Constant of co-efficient of factor.
L_{ex}=Effective length of shorter side of slab.
L_{ey}= Effective length of longer side of slab.
SV=Spacing of stirrups.
V=Shear force.
Vu=Design Shear force.
W=total load.

Wu=Factored load.
σ_{cbc}=Compressive bending stress in concrete.
σ_{max}=Maximum shear stress in concrete with shear.
B_V=Basic value.
Mf=Modification factor.
F_U=Factored live load.
Le=Effective length.
A_{st}=Area of tension steel
A_{sc}=Area of compression steel
A_{CC}=Area of concrete
A_{SV}=Total cross sectional area of stripes
F.F.L = Floor finish load
D.L = Dead load
C.C = Cement concrete
C.M = Cement mortar
R.C.C = Reinforced cement concrete
P = Axial load
L = clear span
M.R = Moment of resistance
C/C = Centre to centre distance
S.F = Shear force
M = Modular ratio
MBM = Maximum bending moment
C.C = Clear cover
W.S = Width of support
N.C = Nominal cover
τ_v = Actual shear stress
$\tau_{c\,max}$= Maximum shear stress
τ_c = Permissible shear stress
Q_U= Moment of resistance co-efficient
Ag= Gross sectional area of column
Ast_{req}= Area of tension steel required
Ast_{prov}= Area of tension steel provided
= Diameter of bars
S_C= Stress in concrete
S_s = Stress in steel

2.7 STAAD Symbols

M_z = Bending moment
F_y = Shear force
F_x = Axial shear force
M_{30} = Grade of concrete
Fe_{500} = Grade of steel
V_Y = Shear strength
L_D = Length of beam
P_{UZ} = Strength of column
IR = Interaction ratio

3.SPECIFICATIONS

3.1. Materials:
All materials shall be as per standard specifications. Coarse aggregate shall be of hard, well-burnt brick ballast of 40 mm gauge. It shall be clean, free from dust, dirt, and other foreign matters. Brick ballast shall pass through square mesh of 52.5 mm and not more than 20 per cent shall pass through a mesh of 25 mm.

3.2. Proportions:
The concrete shall consist of 1 m^3 of brick ballast, 0.32 $m^3$of surkhi (sand and cinder) and 0.16 $m^3$of white lime in the proportion of 100: 32: 16 by volume.

3.3 Mixing:
Mixing shall be done on clean water tight, masonry platform of sufficient size. Brick ballast shall be stacked in a rectangular of uniform thickness usually 30 cm high and well soaked with clean water for a period of at least three hours.Lime and surkhi shall be measured with wooden box in the proportion in 1: 2 and mixed thoroughly dry to have uniform colour.

3.4 Foundation And Plinth:
Foundation and plinth shall be used Ist class brickwork in 1: 6cement mortar over 1: 1: 8 cement concrete.

3.5 Sand Filling In Basement:-
The basement filled up with clean sand to a depth of 450mm and it should be compacted with water as per standard specifications.

3.6 Damp Proof Course:
Damp proof course shall 700mm thick cement concrete 1: $1^{1/2}$: 3, mixed with standard water proofing materials as specified and painted with two coats of bitumen.

3.7 Super Structure:
Super structure shall be of I stclass brickwork with 1: 6 cement mortar. The height of all walls will be 4000 mm above floor level. Parapet walls 300 mm thick and 1200 mm high will be provided all around. The beams sizes as 300 mm x 300 mm and columns sizes as 500 mm x 500 mm will be provided all around.

3.8. Roofing:
Roof shall be of R.C.C. slab with an insulation layer and lime concrete terracing above, supported over R.C.C. beams as required. Height of all rooms will be 4 m.

3.9 Flooring:
Floors of all rooms shall be of mosaic. Bath rooms and rest rooms shall be coloured and polished of cement concrete over lime concrete.

3.10 Finishing:
Inside and outside walls shall be of 12 mm cement lime plastered 1: 1: 6. Bath rooms and rest rooms are inside white washed 3 coats.

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4. ETABS REPORT

Figure.1 shows 3d Structure. Figure.2 shows Whole Structure - Slab Stress

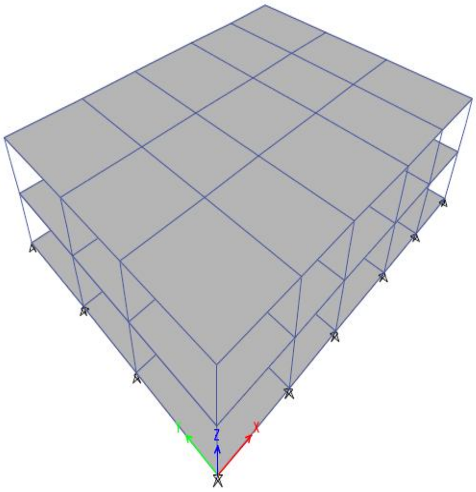

Figure.1 3d Structure

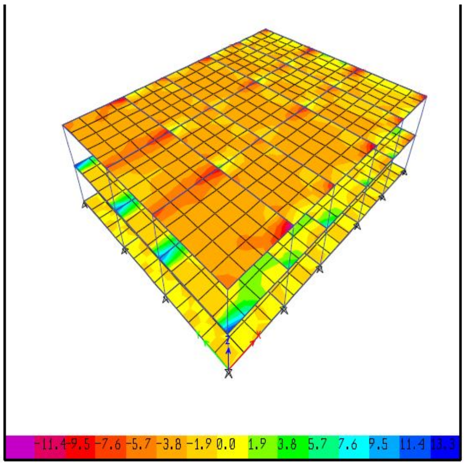

Figure.2 Whole Structure - Slab Stress

4.1 Properties

This chapter provides property information for materials, frame sections, shell sections, and links.

4.2 Materials

Table.2 shows Materials property – Summary

Table.2 Materials property - Summary

Name	Type	E MPa	ν	Unit Weight kN/m³	Design Strengths
4000Psi	Concrete	24855.58	0.2	23.5631	Fc=27.58 MPa
A615Gr60	Rebar	199947.98	0.3	76.9729	Fy=413.69 MPa Fu=620.53 MPa

4.3 Frame sections

Table.3 shows Frame sections – Summary

Table.3 Frame sections – Summary

Name	Material	Shape
BEAM	4000Psi	Concrete Rectangular
COLUMN	4000Psi	Concrete Rectangular

4.4 Shell sections

Table .4 Shell sections - Summary

Table .4 Shell sections - Summary

Name	Design Type	Element Type	Material	Total Thickness mm
Slab1	Slab	Shell-Thin	4000Psi	200

4.5 Loads

User Coefficient Auto Seismic Load Calculation

This calculation presents the automatically generated lateral
seismic loads for load pattern SEISMIC using the user input coefficients, as calculated by ETABS.

Direction and Eccentricity

Direction = Multiple
Eccentricity Ratio = 5% for all diaphragms
Figure.3 shows Overall Bending Moment

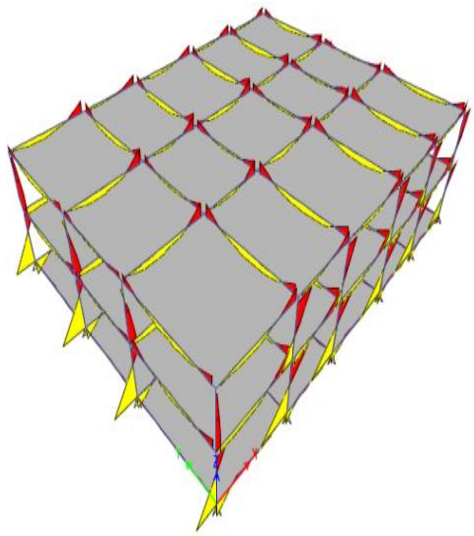

Figure.3 Overall Bending Moment

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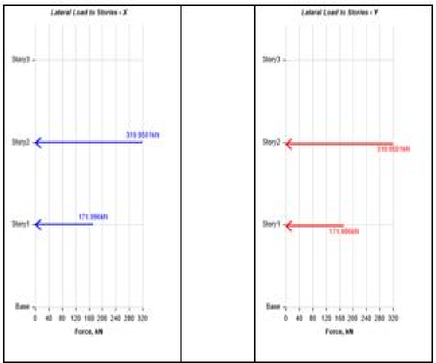
Factors and Coefficients
Equivalent Lateral Forces
Table.5 shows Base shear

Table.5 Base shear

Calculated Base Shear

Direction	Period Used (sec)	C	W (kN)	V (kN)
X	0	0	4919.4613	491.9461
Y	0	0	4919.4613	491.9461
X+Ecc. Y	0	0	4919.4613	491.9461
Y+Ecc. X	0	0	4919.4613	491.9461
X-Ecc. Y	0	0	4919.4613	491.9461
Y-Ecc. X	0	0	4919.4613	491.9461

Applied Story Forces



Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
Story3	10.5	0	0
Story2	7	319.9501	0
Story1	3.5	171.996	0

Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
Story3	10.5	0	0
Story2	7	0	319.9501
Story1	3.5	0	171.996

Figure.4 shows Story Drift and Figure.5 shows Overall Shear Force. Figure.6. shows Beam and Column layout. Table.6. shows Eigen solutions and Spectral acceleration

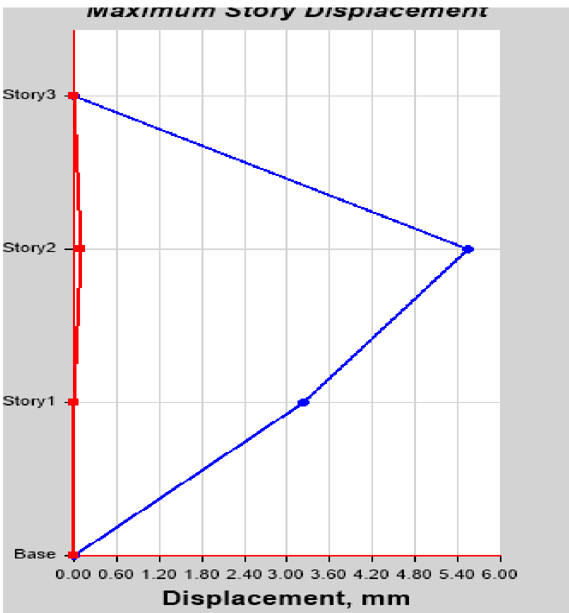


Figure.4 Story Drift

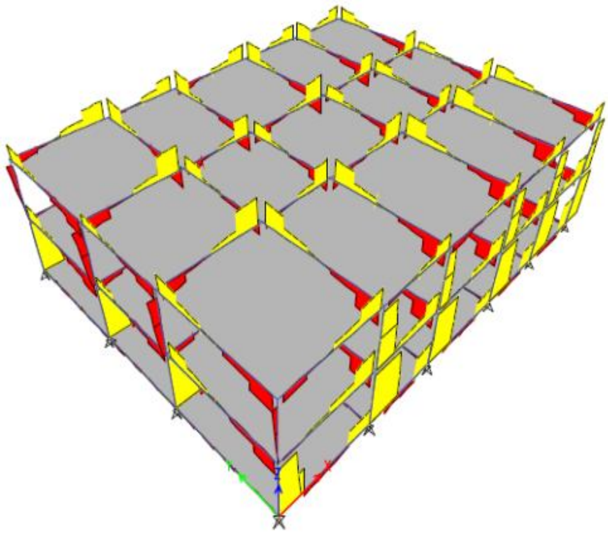


Figure.5 Overall Shear Force

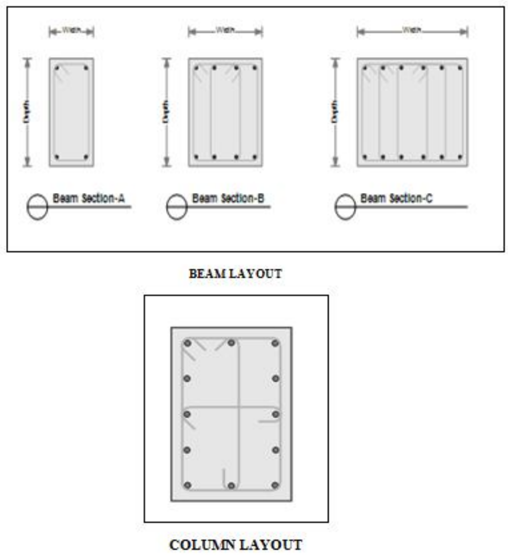


Figure.6. Beam and Column layout

Table.6. Eigen solutions and Spectral acceleration

EIGEN SOLUTIONS

MODE	FREQUENCY(CYCLES/SEC)	PERIOD(SEC)	ACCURACY
1	1.871	0.53442	5.286E-13
2	2.021	0.49491	9.139E-12
3	2.192	0.45625	3.852E-11
4	2.675	0.37388	7.211E-09
5	3.046	0.32832	8.046E-09
6	3.119	0.32061	2.881E-08

SPECTRAL ACCELERATION

MODE	SPECTRAL ACCELERATION	SEISMIC COEFFICIENT(X)
1	1.87120	0.0936
2	2.02058	0.1010
3	2.19177	0.1096
4	2.50000	0.1250
5	2.50000	0.1250
6	2.50000	0.1250

5.CONCLUSION

Advantages of using light weight concrete it reduces dead load of wet concrete allows longer span to be poured unpropped. This save both labour and circle time for each floor. Faster building rates and lower haulage and handling costs. A less obvious but important characteristics of light weight concrete is its relatively low thermal conductivity a property which improves with decreasing density. Through our project we conclude that application of software in civil industry plays an important role in our study. In our project Earthquake resistent Commercial Building we adopt planning in Autocad and limit state method for analysis and design of our structure E-tabs .In our project we are show the results of using dynamic loads in a light weight building and concluding that light weight concrete is more effective compared to conventional concrete.

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