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UTILIZATION OF LIGHT WEIGHT BUILDING STRUCTURE FOAM CONCRETE IN HIGH RISE BUILDING CONSIDERING LATERAL FORCE USING MIDAS GEN

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ABSTRACT

Multi-storied buildings are indispensable in urban areas due to the high cost of land, shortage of open space and scarcity of lands. Many times these multi-storey buildings are built with regular concrete, steel and other materials where the loads are high and require heavy structures and cost may not be effective. The use of lightweight foam concrete will reduce the dead load of a structure, which then allows the structural designer to reduce the size of the columns, footings, and other load-bearing elements. Structural lightweight concrete mixtures can be designed to achieve similar strengths as normal-weight concrete. We have considered a regular eight commercial building as part of the project. Then we developed the building frame model and analyzed and designed the structural elements such as columns, beams, slab and staircases by considering vertical loads.

Concrete structures are prone to earthquake due to the mass of the structures. the 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 a beam, column, and footings which results in a reduction of earthquake forces on the structure. This study is an attempt to predict the seismic response of a eight-storied reinforced concrete frame with the use of lightweight concrete. A well-designed eightstorey example is taken for study. The structure is modelled with MIDAS application, and analysis is carried out with traditional structure and structure using lightweight concrete. The main motive of our study is to assign a lightweight concrete in a high rise structure and results are compared against structure using traditional concrete, where we can check its positive and negative effect on the stability of the structure.

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

I. INTRODUCTION

The structures are always subjected to two kinds of load namely static and dynamic. Static loads are constant with time while dynamic loads are time varying. As a rule, most of the common structures are composed of the presumption that every single connected load is static. The impact of dynamic load isn't being viewed as in light of the fact that the structure is once in a while subjected to dynamic load, more the investigation makes the arrangement more entangled and monotonous.

In this research work light weight concrete blocks are casted with 65% of Fly ash and 35% of cement with preformed foam content 1.5% of total weight and to increase its strength quarry dust is added in its composition up-to 30% in an interval of 5% in different cubes to check properties of these Foam Concrete (FC) blocks test like compressive strength, density and water absorption is done in the laboratory to determine which sample is showing stable results to provide its properties and grade for analysis purpose.

In this work G+8 structure is considered for analysis with foam concrete as a replacement in RC concrete, to determine its beneficial effects on structure. For analysis and modelling midas Gen software is utilized.

Foam Concrete

Foam material is a versatile material which is made up of cement, fly ash and protein based foam. Basically it is a new material which is currently using in India for walling purpose. Improved insulating block form for use in the construction of concrete wall structures wherein the block form is formed from expandable polystyrene material to provide a lightweight, rigid, box-like structure having a pair of oppositely disposed side walls and end walls which together define a body cavity to receive concrete there in Foam material gives better sound insulation, thermal insulation, durable, lightweight, uniform size & shape, reduce permeability. It is non-load bearing structural element which has lower strength than conventional concrete. Cellular concrete is popular because of its light weight which reduces self-weight of structure.

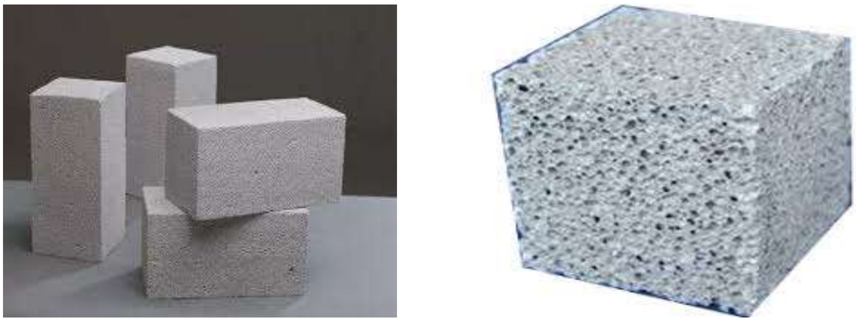

Fig 1: Light weight material

Objectives:

The objectives is to use light weight material (foam) blocks for wall panelling and also for structural purpose, generally hot clay bricks are used for wall panels, which is not eco-friendly, cost-effective, reduction in the dead load, non-uniformity in size & shape, less thermal insulation and fire resistance.

The main aim of this study is as follows:

1. To reduce the weight of building as well as material cost of structure.
2. To justify the introduction of light weight material in structure analysis.
3. To analyse the implementation of light weight concrete in tall structure using advance analysis programme MIDAS.
4. To justify the effect of lateral forces over a high rise structure built with light weight material.

II. LITERATURE REVIEW

Yongliang He et al (2019) the research paper presented a innovative techniquefor using foam concrete as a typical building material for soft structures in underground coal mines subjected to dynamic loading. The experimental apparatus included 30 specimen in order to present the behavior of Foam concrete with a diameter of 50mm and height 50mm using 75mm diameter split Hopkinson pressure bar (SHPB) device.

The primary parameters included in the investigation were the type of form concrete (Fly-ash and Sand), Density of the Foam concrete (1,000, 1,200 and 1,400 kg/m3) and the impact velocity (3.0, 4.0, 5.0, 6.0 and 7.0 m/s). Six different specimen were compared to test the static loading. The developed stress-strain curve under impact loading presented three different phase which generally starts with a linear elastic stage, accompanied with yield phase and lastly ends with pore wall destruction phase.

The analytical results presented dynamic increases the factor, along with ultimate compressive strength, persistence and theirs sudden increase in the absorption of energy with strain rate on same density. Impact Velocity was the major factor to affect the failure model and the behavior of foam concrete.

The results concluded that the stress-strain curves of the foam concrete displayed a strain stage because of the retention of a lot of vitality in both static pressure and dynamic effect tests. In the static pressure test, the pressure of the foam concrete expanded with expanding thickness.

Under a similar thickness, the pressure of the foam concrete without fly ash was lower than that of the foam concrete with fly-ash. In the dynamic effect test, the pressure strain curve of foam concrete was separated into a direct flexible stage, a yield arranges, and a pore divider obliteration organizes. Under a similar effect speed, the level of the damage turned out to be progressively alarming with expanding density. At a similar thickness, the level of damage expanded with an expansion in the effect speed. In the dynamic stacking test, the dynamic compressive quality of foam concrete expanded with an expansion in the strain rate. The level of fracture likewise expanded, demonstrating a noteworthy connection with the strain rate. The connection between the DIF and important strain rate displayed critical damage relaxing the impact. Moreover, the effect sturdiness of foam concrete persistently expanded with an expansion in the normal strain rate

Pandule Ashok et al (2019) the research paper presented theanalysis of PSC Box Girder Deck Slab bridge using the analytical application Staad Pro. The project concentrated on the impact of seismic conduct of customary RCC bridge. Seismic conduct was analyzed for various parts of the flyover bridges in Staad Pro

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programming of PSC Box Girder Deck Slab bridge was the extension developed along a meeting expressway over an at-grade crossing point.

It permits two-bearing traffic to stream at free-stream speed on the extension. The was one of the strategies for taking care of traffic issues at-level intersections on expressways. The diminished the voyaging time of vehicles, decreased risk of accidents, efficient investment funds of fuel utilization, simple way move, The results demonstrated that 35%-40% of the complete traffic volume redirected by the Bridge, vehicle delays was decreased by 30.41% over a similar period. The strategy was utilized in Staad Pro examination exploring the seismic investigation of a flyover.

The results led to the conclusion that 37.7 m Length Bridge was considered for investigation of box girder deck Chunk Bridge, and for every one of the cases, deflection, and stresses are inside the permissible limits. So as to obtain the finest results the pre-stressed on concrete brace design deck chunk can be exposed to pre/post-tensioning. Pre-stressing on concrete girder setup gives us the greater part of the structure parameter inside admissible limits of functionality, deflection and shear contrast to deck slab design.

A. V. Bhansali and R. R. Sarode (2019) the research paper focused towards reducing the density of concrete with the use of optimum content of foam considering an examination study influencing various density of foam added to quarry dust based foam concrete. The scope of densities explored were 800kg/m3, 1000kg/m3, 1200 kg/m3, 1400 kg/m3, 1600 kg/m3, 1800 kg/m3.

The thickness of cement was changed by utilizing manufactured froth called sodium lauryl sulfate, for 30 litres of water 1 litre of foam was utilized independently and the equivalent was brought into the new concrete during its blending by controlling its focus to its ideal thickness of cement was accomplished.

The research paper concluded Foam concrete has one of a kind qualities that can be used in structural designing works. It requires no compaction yet will stream promptly from an outlet to fill limited and unpredictable cavities, and it very well may be siphoned over huge separations and statures. Accordingly, it could be thought of as a free-streaming, self-setting fill. This report provided a brief of foam solid covering its constituents, generation, designing properties and use.

III. METHODOLOGY

In present work with the end goal to contrast fortified solid structure and lightweight strengthened solid structure considering tremor inclined region G+8 multi-story building having plan measurement 24.5 m, x 42.5 m is displayed and dissected in Etab adaptation coordinated building outline programming. Proportionate static investigation and dynamic reaction range examination are performed on the structure. Following two kinds of structures are displayed:

1. Modelling of RCC Structure and Light weight reinforced concrete structure using MIDAS

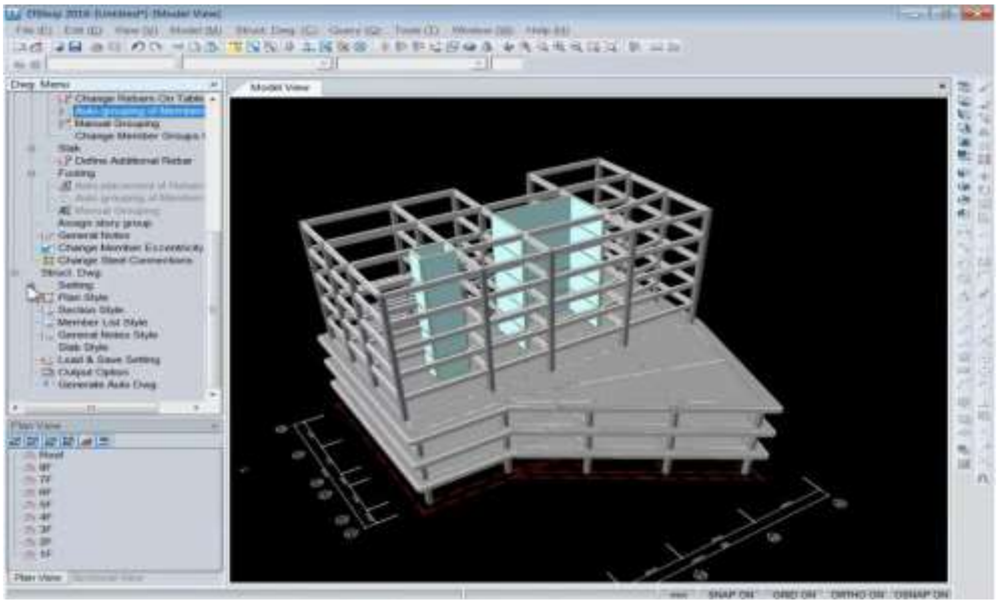

Fig 2: Making of structure using MIDAS

Modelling of Building Frame

MIDAS is a multipurpose program for investigation of structure. The accompanying three exercises must be performed to accomplish that objective.

- Modelling of the diverse cases in MIDAS
- Calculation and Provisions according to Indian gauges can be connected.
- Analysis of structure to decide forces, dislodging and moment producing in a casing.

For this research work following steps should be followed:

Step-1 Firstly literature survey should be done to determine the past research and

Need of study. DXF file Import.

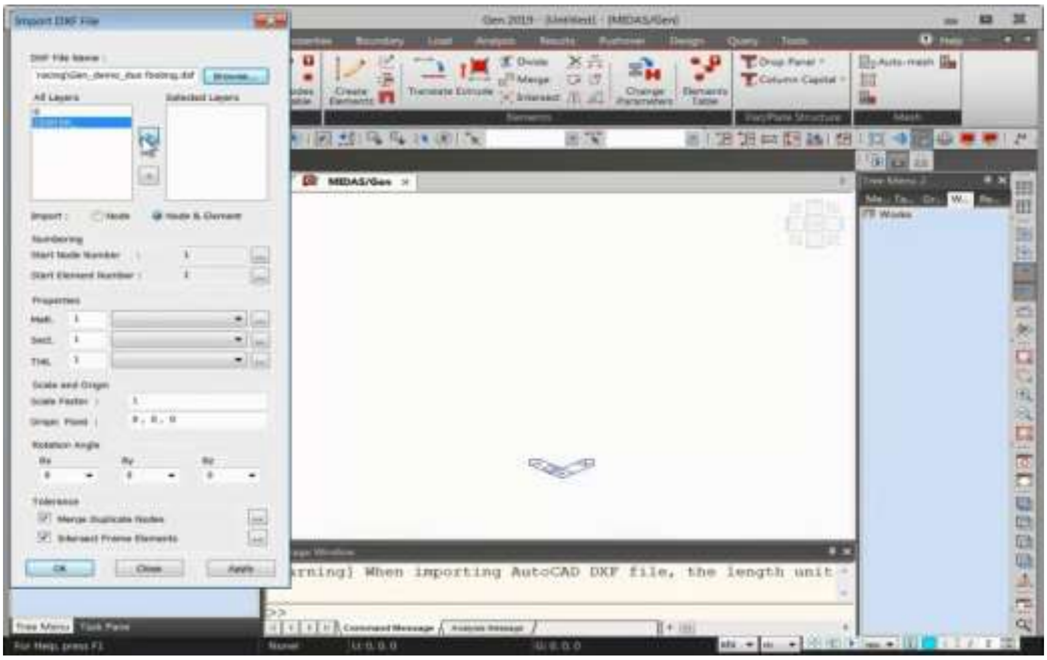

Fig 3: Importing DXF file

Step-2 defining nodes and elements in MIDAS.

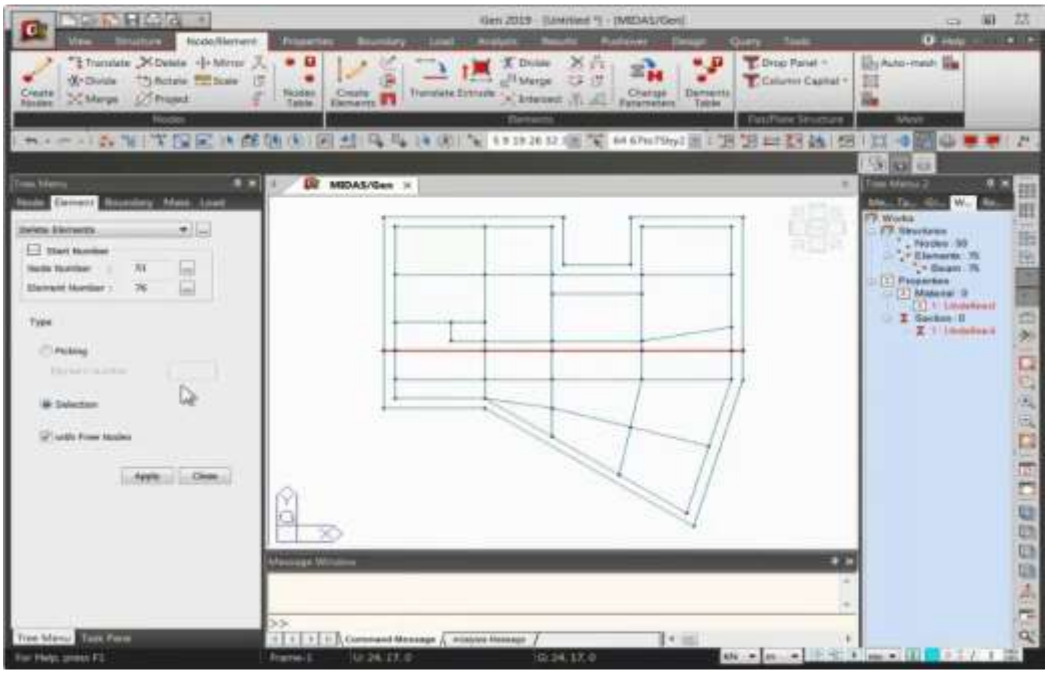

Fig 4: Plan of structure

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Step-3 To prepare modelling of a unsymmetrical building frame (G+8) using MIDAS.

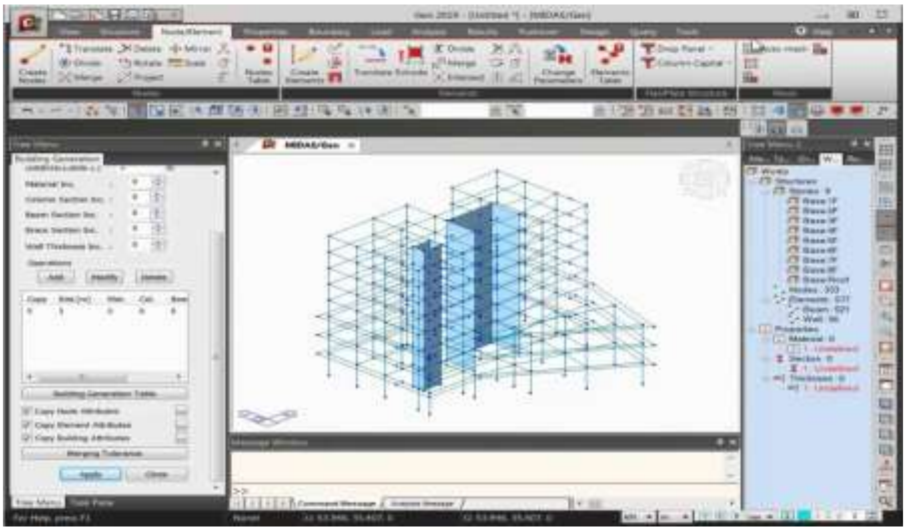

Fig 5: Translating plan in Z direction

Step 4- Assigning Material properties

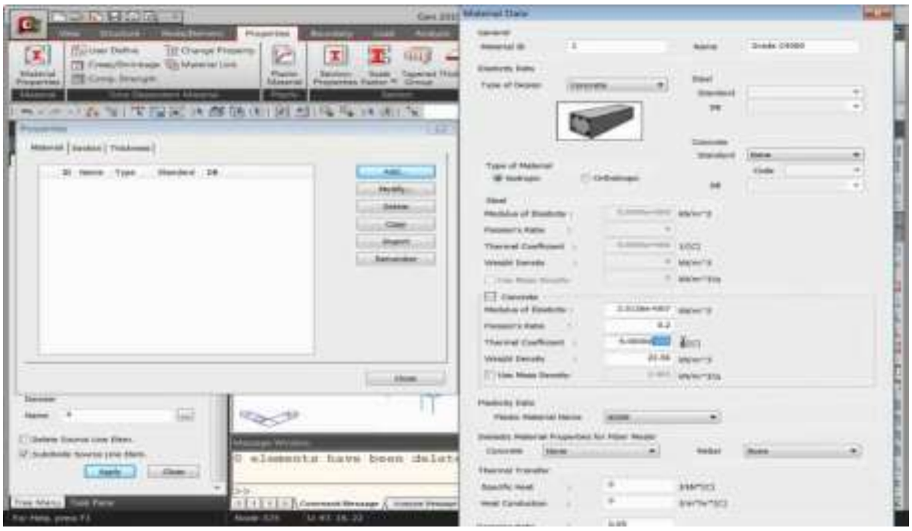

Fig 6: Assigning Material Properties

Step-5 To assign Section data and support conditions.

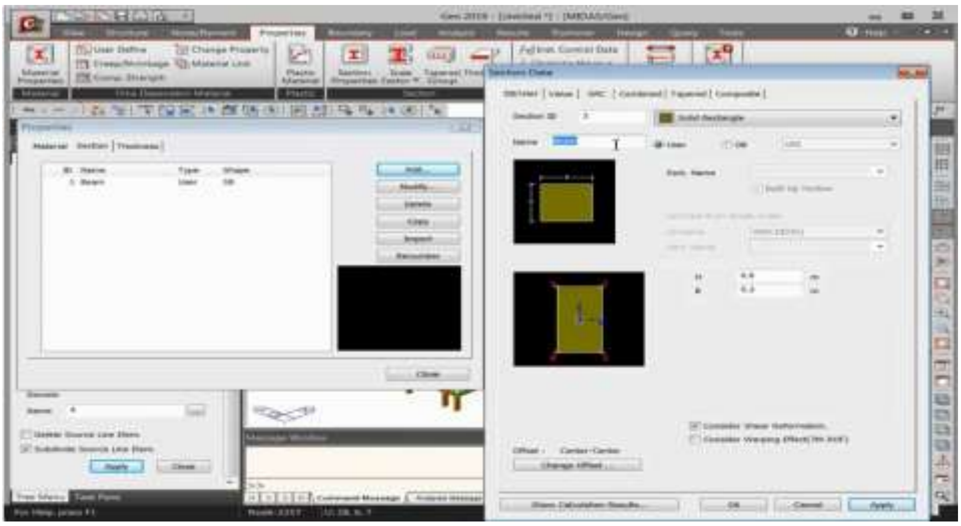

Fig 7: Section data for beam

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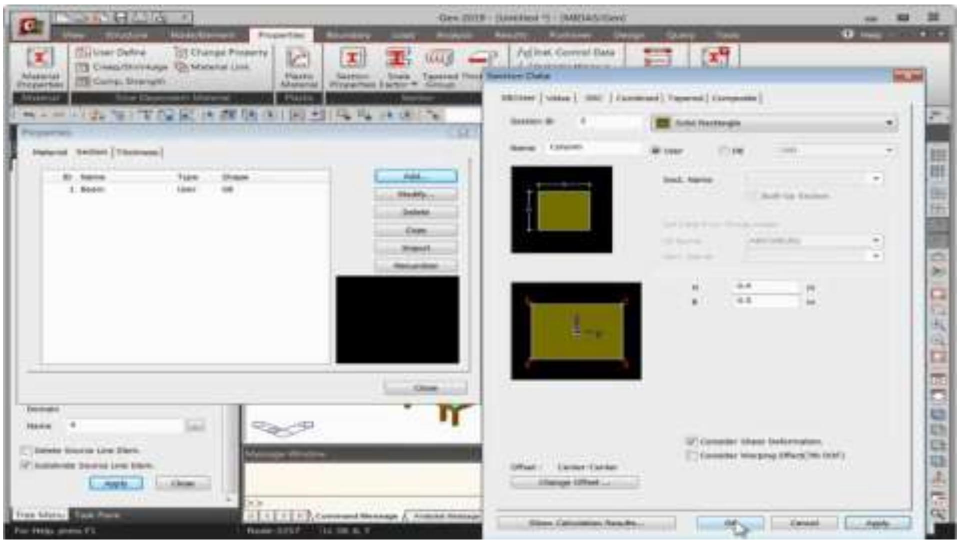

Fig 8: Section Data for column

Step 6 Defining Thickness data for the Slab

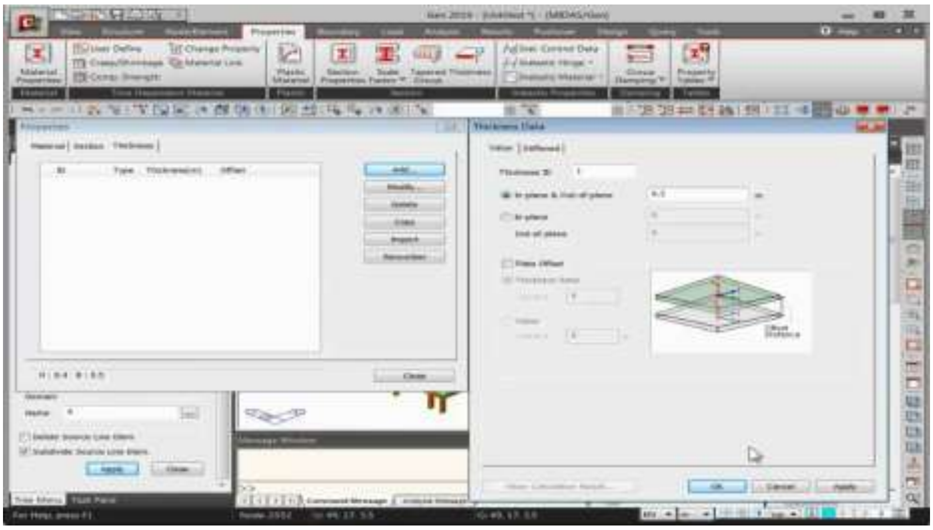

Fig 9: Assigning Slab Thickness

Step 7 Mesh Structure using interior nodes, Interior lines and boundary connectivity

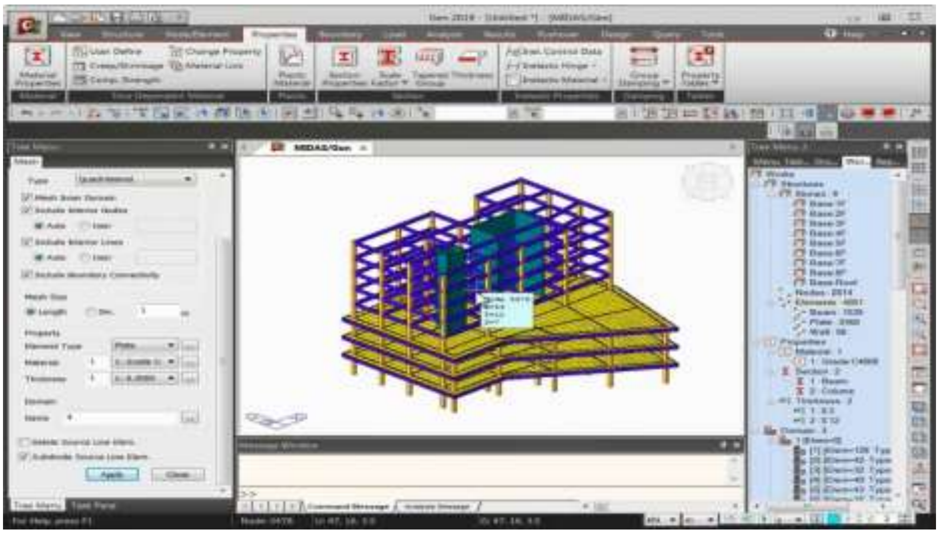

Fig 10: Mesh Structure

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Step 8 Assigning Wind load profile

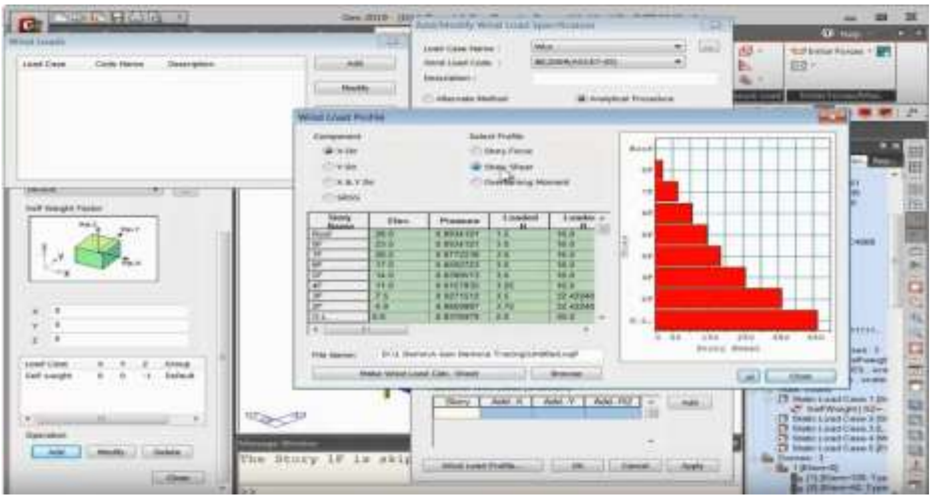

Fig 11: Assigning of wind load

Step-9To Assign Seismic Load as per I.S. 1893-Part-I: 2016.

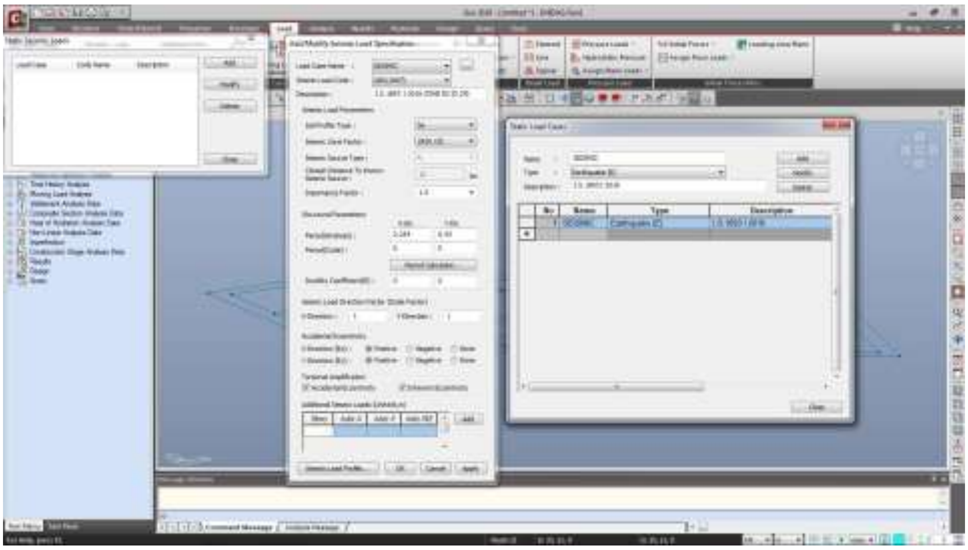

Fig 12: Assign Seismic Load as per I.S. 1893-Part-I: 2016

Step-10To compare the results with bare frame structure against structure with foam concrete.

MIDAS software is exclusively made for modeling, analysis and design of buildings. Various features in the MIDAS are listed below

- MIDAS provide object based modelling. It takes slab as area object, column, beam, brace as a line object and support, mass, loads as point objects.
- MIDAS has feature known as similar story. By which similar stories can be edited and modelled simultaneously. Due to which building is modelled very speedily.
- MIDAS can perform various P-delta, Response Spectrum, Static Non-linear, Time history, Construction sequence and many more analysis with good graphics.
- MIDAS automates templates for typical structures like steel deck, waffle slab, flat stab, Ribbed Slab etc.
- MIDAS can do optimization of steel section.
- MIDAS has a facility to design composite beam. Also composite deck can be modelled in MIDAS.
- MIDAS has forceful facility of Section designer. By which different types of composite sections can be made easily.

Step-11To determine cost analysis as per S.o.R. 2017.

Table 1: Quantity Estimation

Quantity estimate by MIDAS	
Total volume of Concrete	92.98 cu. M.
Bar Diameter in mm	weight (Newton)
8	19776
12	25131
16	31659
20	11402
25	5241
Total	93209

Table 2: Geometrical details

s. no	**Description**	**Values**
1	Number of storey	Eight
2	Number of bays in X direction	five
3	Number of bays in Z direction	Seven
4	Height of each storey	3.5 m
5	Bay width in X direction	4 m
6	Bay width in Z direction	5 m
7	Size of beam	300 x 200 mm
8	Size of column	450 x 450 mm
9	Thickness of R.C.C. slab	125 mm

IV. ANALYSIS RESULTS

Table 3: Bending Moment

Bending Moment in kN-m		
Storeys	Frame with light weight concrete	Bare frame
storey8	514.93	620.01
storey7	501.96	591.47
storey6	488.99	562.93
storey5	476.02	534.39
storey4	463.05	505.85
storey3	450.08	477.31
storey2	437.11	468
storey1	424.14	461.05

Table 4: Shear Force

Shear force in kN-m		
Storeys	Bare frame	Light weight concrete
storey8	867.45	734.19

storey7	848.85	707.63
storey6	830.25	681.07
storey5	811.65	654.51
storey4	793.05	627.95
storey3	774.45	601.39
storey2	755.85	574.83
storey1	737.25	548.27

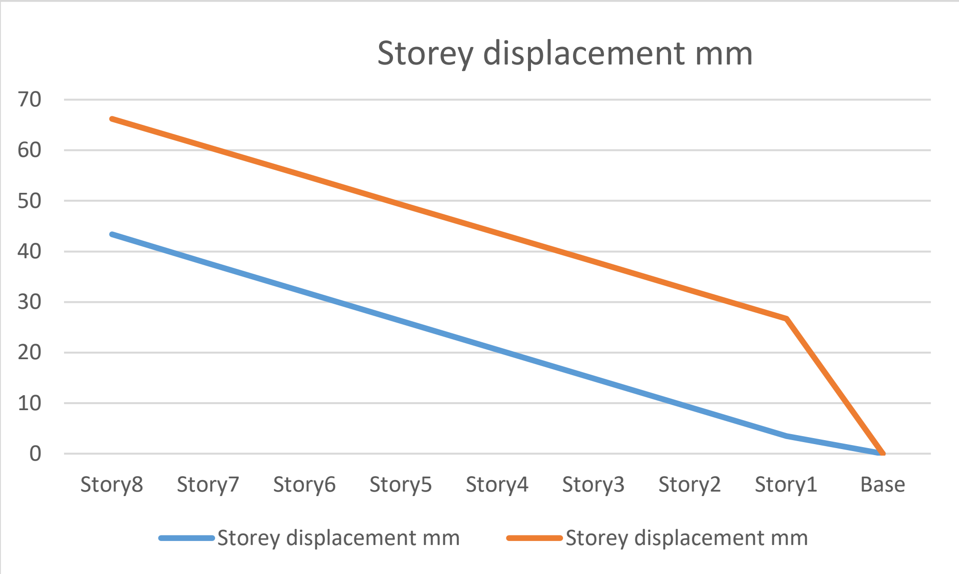

Fig 13: Displacement

Table 5: 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	92.98	5757	5,02,313.86
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	9052.87	72.75	5,73,146.30

V. CONCLUSION

Maximum Bending Moment:

In the chapter above, it is clearly observed that bending moment in bare frame is 743.35 kN-m whereas in case of light weight concrete frame it is reduced to 566.81 kN-m, thus light weight concrete case requires less reinforcement.

Maximum Shear force:

In above chapter it is observed that unbalance forces are maximum in bare frame case 941.85 kN whereas in light weight structure case these are reduced to 840.43 kN which shows stability of the structure.

Maximum storey displacement:

It is observed that lateral stability is comparatively increased in light weight concrete case comparing to bare frame case. In case of light weight structure displacement is minimised to 66.16 mm instead of 88.84 mm in bare frame.

Axial Force:

In the above chapter it is observed that there is very minute variation in axial force as it is considered for same loading condition in both the cases.

Cost comparison:

In the above chapter it is observed that cost of concrete in light weight concrete case is decreased by 18.78%, whereas cost of reinforcement is decreased by 23.20%.

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