DYNAMIC RESPONSE FOR DIFFERENT GEOMETRICAL SHAPE OF RCC SLABS

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Abstract— Over the years, building slabs have been designed on the basis of equivalent static loading condition. It is assumed that the factor of safety taken during design process will take care of the variation that arises due to dynamic loading conditions. This process is appropriate for buildings with simple structural configuration – both in terms of geometry and material usage. The objective of this study is to carry out an analytical investigation to determine the realistic representation of modal properties of RCC slab (Different geometrical shape) and there by determine the best suited geometrical shape towards dynamic response.

Keywords— Modal Analysis, Dynamic Response, Finite Element Method, Rayleigh frequency, STAAD.PRO and Different Geometrical Shape.

INTRODUCTION:

Finite Element Method is universally accepted as a technique for numerical modelling to understand various structural behaviours, e.g. vibration characteristics, etc. To study an individual floor dynamics of a multi-storeyed building, modelling of the entire structure is not warranted. Therefore certain assumptions are to be taken for dynamic modelling of a floor slab.

Uncertainties to the shape of the slab also exist along with material property. The variation in stiffness of the floors due to improper assumption of shape of slab leads to variation in natural frequencies. Although a very realistic shape of slab selection depends entirely on the intuitiveness of the selector, no matter how good a selector may be, there always exist uncertainties in the results.

To resolve these uncertainties in selection of shape of slab, a Finite Element Analysis results is always necessary between the vibration parameters like natural frequencies, mode shapes etc.

METHODOLOGY:

To determine the shape of RCC slab towards dynamic response, Modal Analysis is performed to obtain the Rayleigh frequencies of the slab in different modes using STAAD.PRO software. These frequencies were obtained for all shapes (Circular, Regular Hexagonal, Regular Pentagonal, Regular Rectangular and Regular Triangular) of slab. In all of the cases, the frequencies are computed for keeping all the parameter constant. After obtaining these data, shape of slab v/s frequency graphs are plotted. The maximum frequency will give the familiar shape of slab towards dynamic response.

ANALYSIS OF RCC SLAB:

Dynamic force exerted on RCC slabs. In the current work Rayleigh frequency in fundamental mode is used to study the dynamic behavior of RCC slabs.

Following EBCS code are used for the analysis of RCC slabs.

d) EBCS-1:1995 , “Basis of design and actions on structures”.

e) EBCS-2:1995, “Structural use of concrete”.

f) EBCS-8:1995, “Design of structures for earthquake resistance”.

PROBLEM – FOEMULATION:

Analyze the dynamic response for different geometrical shape of RCC slabs as per Ethiopian code of practice.

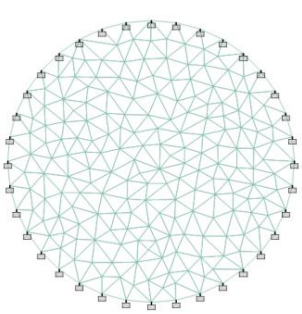
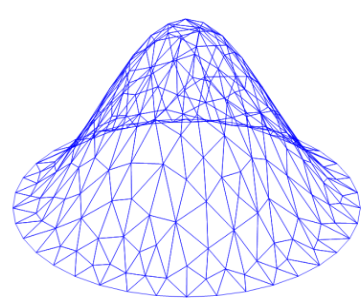
A. Detail of SLAB

- Type = RCC Slab with fixed Boundary condition.
- Surface area = 225m^2.
- Shape: Circular, Regular Hexagonal, Regular Pentagonal, Regular Rectangular and Regular Triangular.
- Thickness: 200 mm.
- Grade of Concrete: C30
- Material = Homogeneous and Isotropic.
- Young’s Modulus of elasticity(E) = 3.2×10^{10} Pa
- Poisson’s Ratio = 0.17
- Weight Density = 24kN/m^3
- No of division on Periphery = 36
- Meshing = Triangular

RESULT:

Fundamental mode shape and frequency in basic mode are tabulated in table-1 and table-2. Fig-1 shows the graphical representation of fundamental frequency for different geometrical shape of RCC slabs.

Table 1: Fundamental mode shape and frequency in basic mode for different geometrical shape of RCC slabs.

Shape of the Slabs (top view)	Detail of the RCC Slabs	Mode Shape (Fundamental mode)	Frequency (Hz) (Basic mode)
	1. Circular Slab 2. Surface area = 225m^2 3. Diameter = 16.92m 4. No of Division on Periphery = 36 5. Thickness = 200mm 6. Grade of Concrete = C30 7. Poisson’s Ratio = 0.17		**4.787**

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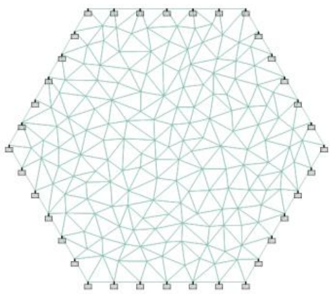
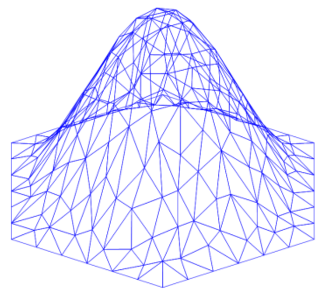
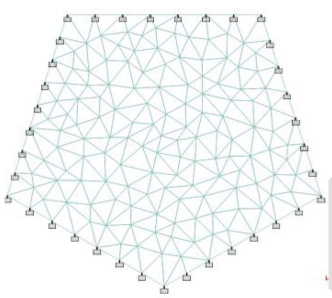
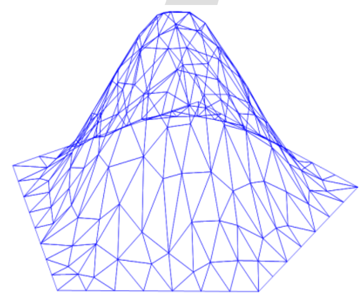
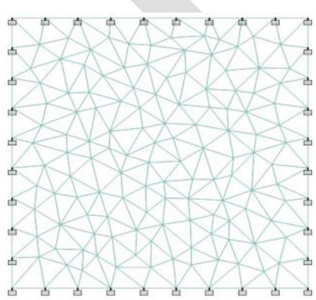
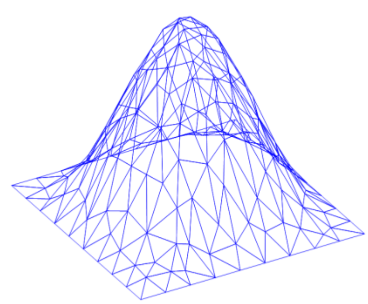
	8. Weight Density = 24kN/m^3 9. E = 3.2 x 10^{10} Pa		
	1. Regular Hexagonal Slab 2. Surface Area = 225m^2 3. Side = 9.309m 4. No of Division on Periphery = 36 5. Thickness = 200mm 6. Grade of Concrete = C30 7. Poisson's Ratio = 0.17 8. Weight Density = 24kN/m^3 9. E = 3.2 x 10^{10} Pa		**4.933**
	1. Regular Pentagonal Slab 2. Surface Area = 225m^2 3. Side = 11.4358m 4. No of Division on Periphery = 36 5. Thickness = 200mm 6. Grade of Concrete = C30 7. Poisson's Ratio = 0.17 8. Weight Density = 24kN/m^3 9. E = 3.2 x 10^{10} Pa		**5.343**
	1. Regular Rectangular Slab 2. Surface Area = 225m^2 3. Side = 15m 4. No of Division on Periphery = 36 5. Thickness = 200mm 6. Grade of Concrete = C30 7. Poisson's Ratio = 0.17 8. Weight Density = 24kN/m^3 9. E = 3.2 x 10^{10} Pa		**5.315**
	1. Regular Triangular Slab		**6.319**

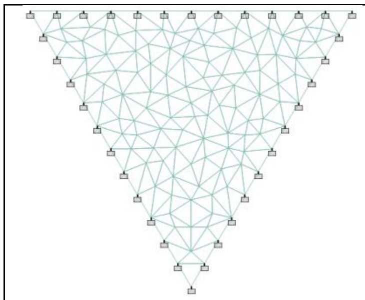
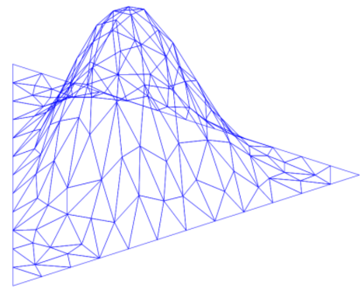
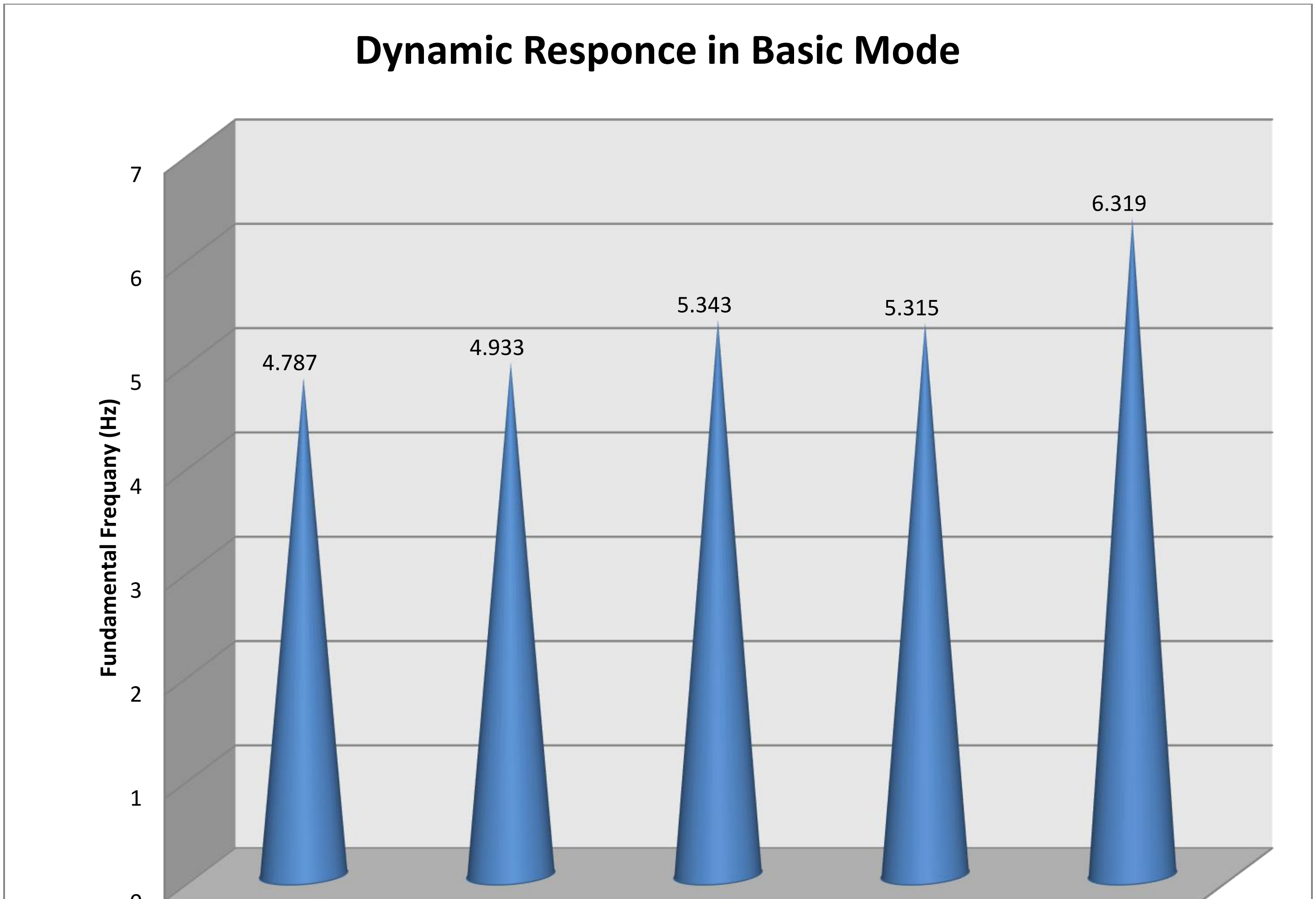
	2. Surface Area = 225m^2 3. Side = 22.795m 4. No of Division on Periphery = 36 5. Thickness = 200mm 6. Grade of Concrete = C30 7. Poisson's Ratio = 0.17 8. Weight Density = 24kN/m^3 9. E = 3.2 x 10^{10} Pa		

Table 2: Frequency in basic mode for different geometrical shape of RCC slabs

Sr. No.	Shape of the Slab	Frequency (Hz) (Basic mode)
1	Circular	4.787
2	Hexagonal	4.933
3	Pentagonal	5.343
4	Rectangular	5.315
5	Triangular	6.319



	Circular	Hexagonal	Pentagonal	Rectangular	Triangular
Mode 1	4.787	4.933	5.343	5.315	6.319

Fig-1 Fundamental frequancy for diferrent geomerical shape of slabs

CONCLUSION:

Following conclusions are obtained from all above graphical representations:

5. Fundamental frequency of Regular Triangular slab is 6.319 Hz which is highest among the entire slab.
6. Fundamental frequency of Circular slab is 4.787 Hz which is lowest among the entire slab.
7. Fundamental frequency of Regular Triangular slab is 32% more than Circular slab, 28.09% more than Regular Hexagonal slab, 18.26% more than Regular Pentagonal slab and 18.88% more than Regular Rectangular Slab.
8. Regular Triangular slab is best suited geometrical shape towards dynamic response among the entire slab.
9. Fundamental frequency of slab are decreasing if we are moving from Regular triangular slab to Circular Slab. But Fundamental frequency of Regular Pentagonal Slab (5.343 Hz) is more than Regular Rectangular slab (5.315Hz).
10. Regular Pentagonal Slab is better geometrical shape towards dynamic response than Regular Rectangular slab.

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