Finite Element Analysis of Vibration For Flat Slab System Using Ansys Workbench

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Abstract- *Human footfalls are the main source of vibration in office building and it could affect the structure of the building as well as causing discomfort and annoyance to the occupants of the building when the vibration level inside the building exceeds the recommended level. The objectives of study is to determine vibration level in flat slab & to check their values such as stress, strain.*

Keywords- Floor vibration criteria ,vibrational frequency, footfall.

I. INTRODUCTION

Annoying vibrations caused by occupant walking is an important serviceability problem for long-span floors. At the design stage the floor's structural arrangement may frequently change to cater for the owner's varying requirements. An efficient and accurate approach for predicting a floor's acceleration response is thus of great significance. Consequently, the probability distribution of the floor response is determined with good agreement between the predicted and measured floor responses. However, response levels can be translated inconsistently in terms of human comfort by various acceptance criteria.

Human footfalls are the main source of vibration in office building and it could affect the structure of the building as well as causing discomfort and annoyance to the occupants of the building when the vibration level inside the building exceeds the recommended level.

Typically, floor vibration is regarded as a serviceability issue because of the negative psychological effects it has on. In addition, vibration may also adversely impact the performance of sensitive equipment. Rarely do such vibrations compromise structural capacity; however, there is the potential for floor vibration to cause overload and fatigue (Allen, 1990a). The International Standards Organization, ISO 10137, has distinguished three primary components of vibration serviceability assessment (ISO10137, 2007):

The Receiver **-** A receiver may be a person or an object that is experiencing the vibration disturbance. Objects may range from components of the structure itself to items placed on or fastened to the structure. The level of vibration that the receiver is subjected to must meet the appropriate acceptability criteria. This research is concerned with the human receiver, which is always located on the floor.

The source of floor vibration in buildings is usually the result of occupant-imposed, dynamic loading. These occupant imposed dynamic loads may originate from people walking, running, jumping and group activities such as exercise or dancing on floors. In the case of multi-story parking garages, vehicular traffic can also produce undesirable and excessive vibration. In addition to internal dynamic actions, external sources of vibration due to human activities may come from traffic or heavy construction.

For example one cannot simply strike the object or displace it from equilibrium, since not only the one mode liable to be excited in this way. The shape of the vibration will thus be very complicated and will change from one instant to the next.

However, one can use resonance to discover both the frequency and shape of the mode. If the mode has a relatively high Q and if the frequencies of the modes are different from each other, then we know that if we jiggle the body very near the resonant frequency of one of the modes, that mode will respond a lot. The other modes, with different resonant frequencies will not respond very much. Thus the resonant motion of the body at the resonant frequency of one of the modes will be dominated by that single mode.

Doing this with strings under tension, we find that the string has a variety of modes of vibration with different frequencies.

The lowest frequency is a mode where the whole string just oscillates back and forth as one with the greatest motion in the center of the string.

A. Objectives

- To determine mode shapes and time period for different footfall rate.
- To compare results of Flat slab with single column and flat slab with four columns model for normal stress, normal strain, shear stress and shear strain for frequency (1.5–1.8, 1.8–2.0, 2.0–2.4) using ANSYS.
- To compare natural frequency between flat slab with four columns & R.C.C.

II. METHODOLOGY

a. Finite Element Modeling

The finite element method (FEM) is the most popular simulation method to predict the physical behavior of systems and structures. Since analytical solutions are in general not available for most daily problems in engineering sciences numerical methods like FEM have been evolved to find a solution for the governing equations of the individual problem. Much research work has been done in the field of numerical modeling during the last thirty years which enables engineers today to perform simulations close to reality. Nonlinear phenomena in structural mechanics such as nonlinear material behavior, large deformations or contact problems have become standard modeling tasks. Because of a rapid development in the hardware sector resulting in more and more powerful processors together with decreasing costs of memory it is nowadays possible to perform simulations even for models with millions of degrees of freedom. In a mathematical sense the finite element solution always just gives one an approximate numerical solution of the considered problem. Sometimes it is not always an easy task for an engineer to decide whether the obtained solution is a good or a bad one. If experimental or analytical results are available it is easily possible to verify any finite element result.

b. Materials properties:

Sr.No	Material	Property	Value
1	Structural steel	Yield stress f_{SY} (MPa)	265
		Ultimate strength f_{su}(MPa)	410
		Young's modulus Es(MPa)	205×10^3
		Poisson's ratio μ	0.3
		Ultimate tensile strain e_t	0.25
		Young's modulus (MPa)	1.21x10^5
		Poisson's ratio μ	0.27
2	Concrete	Compressive strength f_{sc}(MPa)	42.5
		Tensile strength f_{SY}(MPa)	3.553
		Young's modulus E_c(MPa)	32920
		Poisson's ratio μ	0.15
		Ultimate compressive strain e_s	0.045

c. Material modeling

The definition of the proposed numerical model was made by using finite elements available in the ANSYS code default library. SOLID186 is a higher order 3-D 20-node solid element that exhibits quadratic displacement behavior. The element is defined by 20 nodes having three degrees of freedom per node: translations in the nodal x, y, and z directions. The element supports plasticity, hyper elasticity, creep, stress stiffening, large deflection, and large strain capabilities. It also has mixed formulation capability for simulating deformations of nearly in compressible elasto-plastic materials, and fully incompressible hyper-elastic materials. The geometrical representation of is show in SOLID186.

This SOLID186 3-D 20-node homogeneous/layered structural solid were adopted to discretize the concrete slab, which are also able to simulate cracking behavior of the concrete under tension (in three orthogonal directions) and crushing in compression, to evaluate the material non-linearity and also to enable the inclusion of reinforcement (reinforcement bars scattered in the concrete region).Contact pairs couple general axisymmetric elements with standard 3-D elements. A node-to-surface contact element represents contact between two surfaces by specifying one surface as a group of nodes.

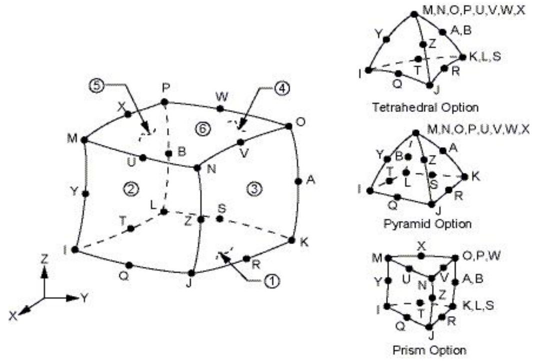


Fig.1 SOLID186

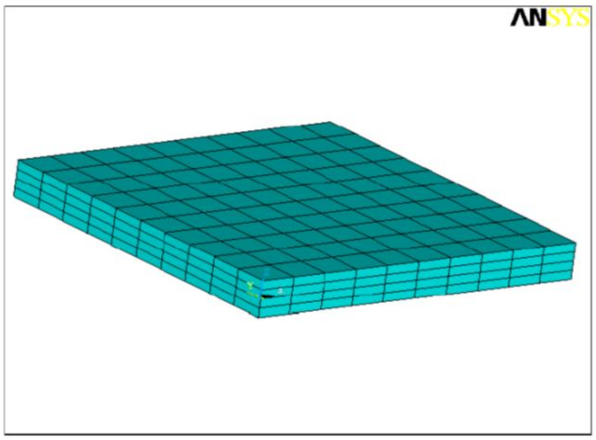


Fig.2 Laminated composite plate with meshing

III. PROBLEM STATEMENT

The typical floor system of 5m X 7m is adopted for vibration analysis of structures and following data is adopted

Size: 5m x 7m
Thickness: 200mm
Grade of Concrete: M25
Vibrational frequency: 2.4 Hz

Model 1: Vibrating model of flat slab with single supporting column.

Model 2:Vibrating model of Flat slab with four columns.

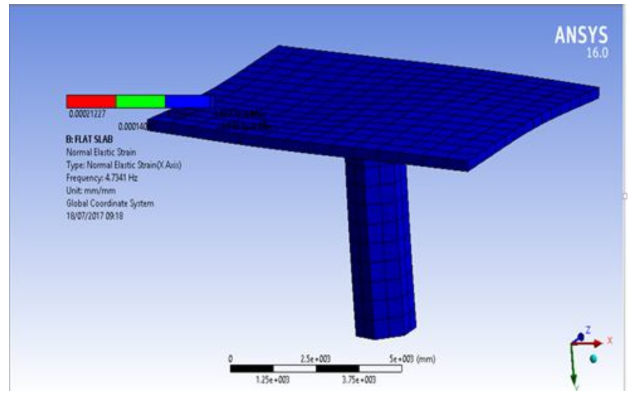


Fig.3 Normal strain

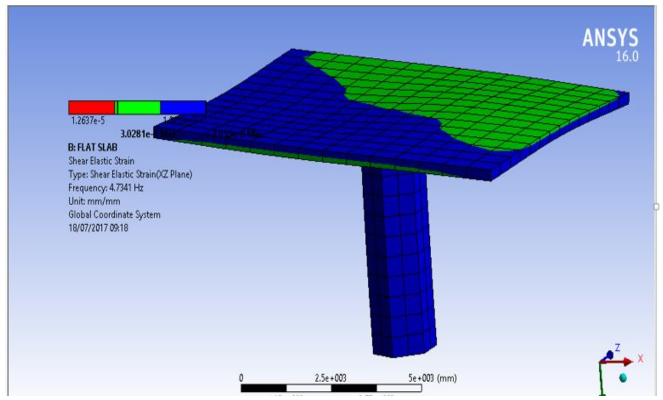


Fig.4 Shear strain

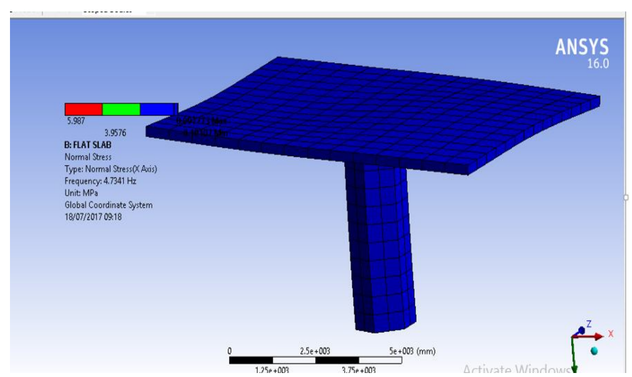


Fig.5 Normal stress

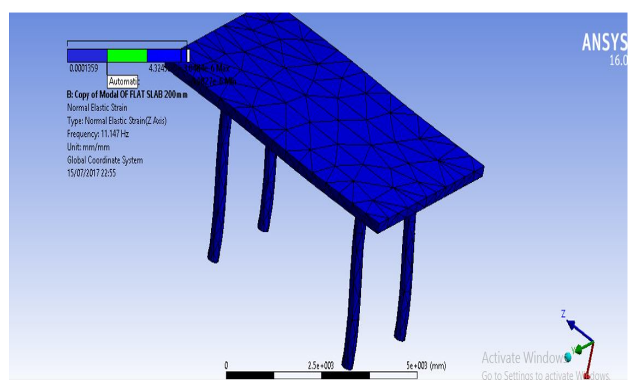


Fig.6 Normal strain

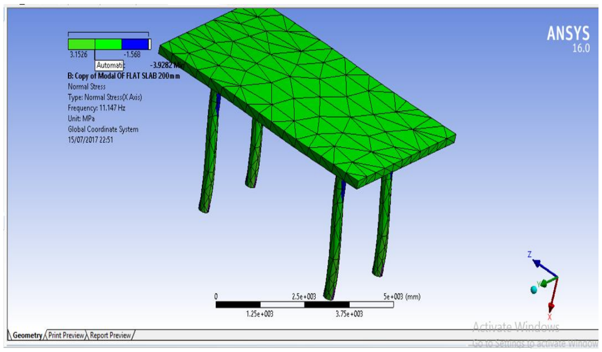


Fig.7 Normal stress

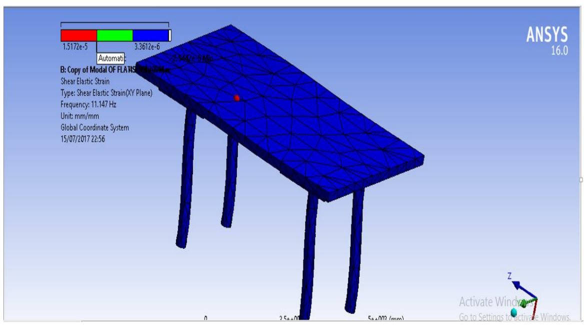


Fig.8 Shear strain

IV. RESULTS & DISCUSSION

Table 1 Flat slab with four column

Normal strain	Shear strain	Normal stress	Shear stress
1.359x10[illegible]	1.5172×10^{-5}	3.1526	0.16

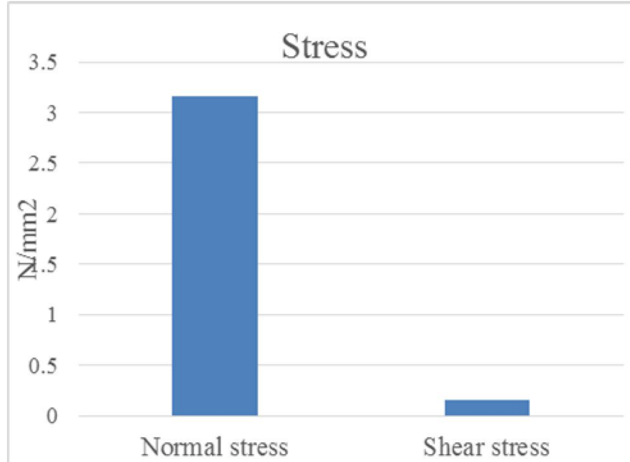
Table 2 Flat slab with single column

Normal strain	Shear strain	Normal stress	Shear stress
2.122x10[illegible]	1.26x10[illegible]	5.98	0.14

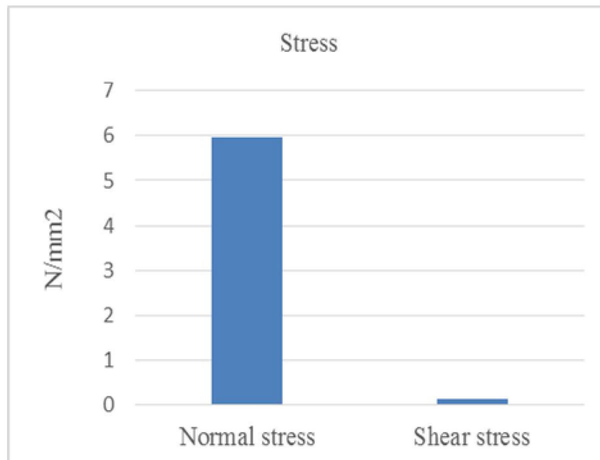
Table 3 Natural frequency of flat slab

Natural Frequency (*f*)	*f1*	*f2*	*f3*	*f4*	*f5*	*f6*
Flat slab with four columns	0.37581	0.41872	0.81344	1.8818	3.0465	8.6874
Flat slab with single column	5.8759	5.8778	6.465	21.336	21.362	26.861

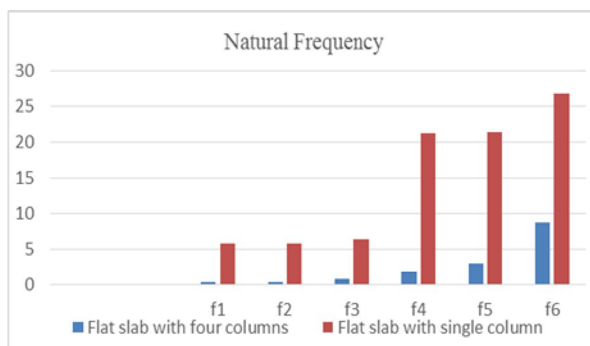
Natural frequency of flat slab with four columns is observed less than natural frequency of flat slab with single column by 67.68%.



Graph1 Normal stress of flat slab with four columns



Graph 2 Normal stress of flat slab with single column



Graph 3 Natural frequency of flat slab

V. CONCLUSION

Following observations are obtained

1. Natural frequency of flat slab with four columns is observed less than natural frequency of flat slab with single column shows that frequency goes on increases with increase in stiffness.

2. Normal stress is greater in flat slab with single column than the flat slab with four column by 47.28%.
3. Normal strain observed larger in flat slab with single column than the flat slab with four column.
4. Shear stress is greater in flat slab with four column than the flat slab with single column by 12.5%.

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