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Parametric Study on Analysis and Design of Turbo Generator Foundation

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Abstract: *Machines are the most important equipment in the industry. The load produced within the machine is dynamic in nature caused due to vibratory motion, impact of hammer, earthquake or wind, pile driving, etc. Repetitively acting load over a long period of time the performance, safety and stability of machine is very important and are largely depends on its foundation which makes foundation one of the important component of that machine. Machine foundation is designed for static and dynamic loading generated by machine supported on top of the foundation. The object of the project is to Study of vibration and dynamic analysis of machine foundation in ANSYS for deferent geometry of footing having same volume.*

Keywords: Dynamic Analysis, ANSYS, Machine foundation

I. INTRODUCTION

Machines are the most important equipment in the industry. The load produced within the machine is dynamic in nature caused due to vibratory motion, impact of hammer, earthquake or wind, pile driving, etc. Repetitively acting load over a long period of time the performance, safety and stability of machine is very important and are largely depends on its foundation which makes foundation one of the important component of that machine. Machine foundation is designed for static and dynamic loading generated by machine supported on top of the foundation.

Design of machine foundation has been associated with the civil engineering discipline as soil mechanics specialist or structural design specialist gives the knowledge of the structural behaviour and design soil parameters but at the same time it is associated with the mechanical engineering discipline as to know data about the forces which are generating within the machine and how they are transferring to the foundation. To get the machine to desired performance level, it required the better interaction amongst all the concerned disciplines which are usually foundation designer and machine manufacturer from the planning stage till the installation of the machinery on the foundation.

The design of machine foundation is very complex than that of normal foundation which only supports static load. Bhatia says that machine foundations should be designed such that the dynamic forces of machines are transmitted to the soil through the foundation in such a way that all kinds of harmful effects are eliminated. The various types of heavy machinery require a much heavier support of foundation that can resist dynamic forces and vibrations. Those vibrations of machine may create harmful deformation and Resonance. Hence the design of machine foundation required to avoid the resonance and foundation will be safe.

A. Frame Foundation

Machine is supported on the deck slab which in tum is supported on base raft through columns and base raft rests directly over soil or on group of piles shown in Fig 1 4. In this case machine is treated as non-elastic inertia body whereas deck slab, and columns are considered as elastic inertia bodies and soil is considered as elastic media. In certain specific cases, base raft is also considered as elastic inertia body.

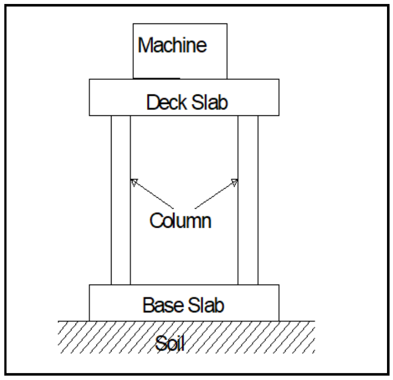

Fig 1 Typical Frame type Foundation

B. Necessity of Design of TG Foundation

TG foundation is very important structure and need special consideration while analysis and designing because of following reasons.

a) Superimposed load coming on the TG foundation is very huge and can cause shear or crushing failure.

b) Huge mass can cause settlement more than permissible limits.

c) Torsion (or Twisting) may occur if centre of gravity of machine and foundation is not in the same vertical line.

d) There are chances of resonance when machine operating frequency matches with natural frequency of the foundation and can cause premature fatigue of machine parts and damage of engine.

e) Amplitude of foundation may exceed permissible amplitude value and can cause huge cracks in the foundation or can damage adjacent structure.

f) There is possibility of losing of machine parts while operating and can cause unbalance force or moment on the foundation.

g) There are stream or hot air pipes, embedded in the foundation must be properly isolated otherwise can cause temperature effect on the foundation.

h) Foundation need to be coated with acid-resisting coating or suitable chemical treatment to avoid from machine oil and other chemical reactions

II. METHODOLOGY

The finite element method (FEM) is a widely used method for numerically solving differential equations arising in engineering and mathematical modelling.

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A. Problem Statement

Study of vibration and dynamic analysis of machine foundation is carried out in ansys for deferent geometry of footing having same volume, the geometry details of the models are as follow.

Table 1 Parameters to be consider for rectangular geometry analysis

Square	
Top Slab size	6 x 6 m
Top Slab Thickness	0.2 m
Height of Column	1.5 m
Size of column	0.5 x 0.5 m
Size of footing	6 x 6 m
Thickness of footing	0.2 m
Volume of footing	7.2 M^3
Rectangular	
Top Slab size	6 x 6 m
Top Slab Thickness	0.2 m
Height of Column	1.5 m
Size of column	0.5 x 0.5 m
Size of footing	6 x 8 m
Thickness of footing	0.15 m
Volume of footing	7.2 M^3
Circular	
Top Slab size	6 x 6 m
Top Slab Thickness	0.2 m
Height of Column	1.5 m
Size of column	0.5 x 0.5 m
Diameter of footing	8.48 m
Thickness of footing	0.127 m
Volume of footing	7.2 M^3
Oval	
Top Slab size	6 x 6 m
Top Slab Thickness	0.2 m
Height of Column	1.5 m
Size of column	0.5 x 0.5 m
Size of footing	2.8 x 9.6 m
Thickness of footing	0.29 m
Volume of footing	7.2 M^3

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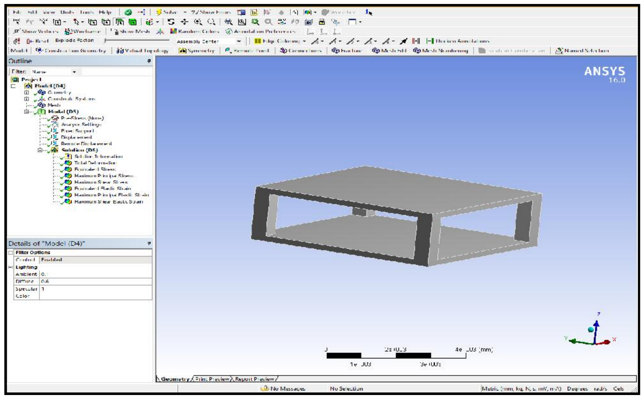

Fig 1 Square Model

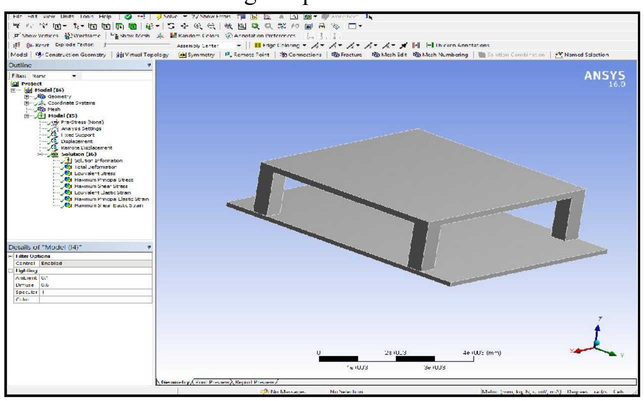

Fig 2 Rectangular Model

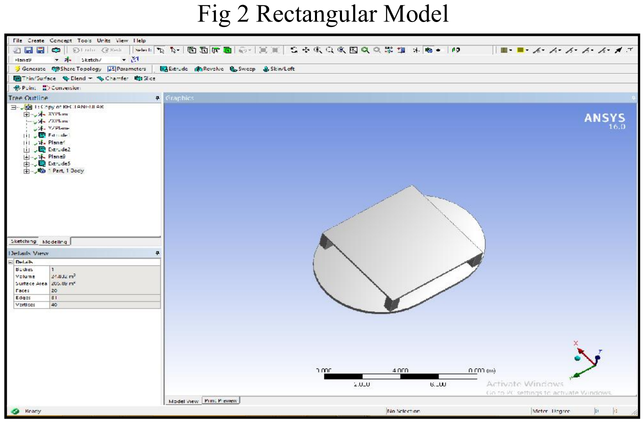

Fig 3 Circular Model

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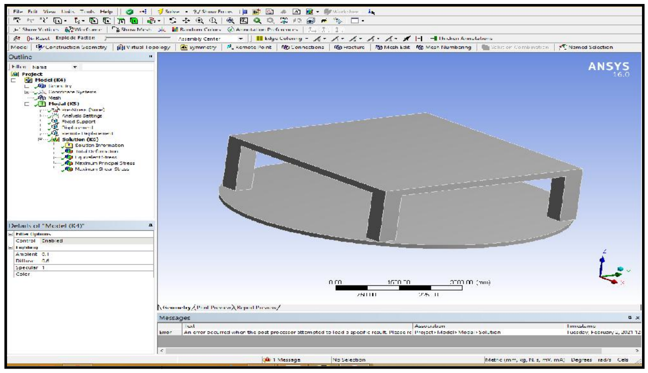


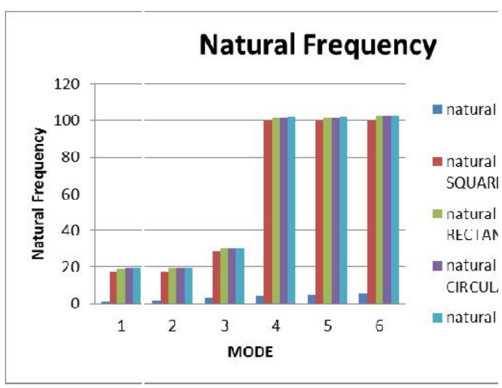
Fig 4 Oval Model

III. RESULTS OF ANALYSIS

A. Natural frequency

Table 2 Natural Frequency

Natural Frequency				
Step	Square	Rectangular	Circular	Oval
1	17.207	19.137	19.323	19.494
2	17.218	19.509	19.349	19.528
3	28.448	29.72	29.715	29.922
4	99.914	101.29	101.33	101.6
5	99.937	101.52	101.45	101.74
6	99.955	102.66	102.61	102.81



Graph 1 Natural Frequency

In above graph shows the results of natural frequency of all models in ANSYS, the result conclude that natural frequency of the oval shape footing is greater than other shape of footings by 10-15%.

B. Total Deformation

Table 3 Total Deformation mm

Total Deformation mm				
Step	Square	Rectangular	Circular	Oval
1	0	0	0	0
2	0.03945	0.039	0.0351	0.0361
3	0.077	0.077	0.0734	0.0746

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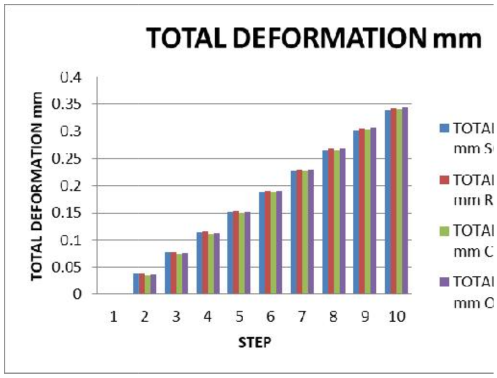
4	0.11455	0.115	0.1117	0.1131
5	0.1521	0.153	0.15	0.1516
6	0.18965	0.191	0.1883	0.1901
7	0.2272	0.229	0.2266	0.2286
8	0.2649	0.267	0.265	0.267
9	0.302	0.305	0.303	0.3058
10	0.34	0.343	0.3416	0.344



Graph 2 Total Deformation mm

In above graph shows the results of Total Deformation of all models in ANSYS, the result conclude that Total Deformation of the Rectangular shape footing is greater than other shape of footings by 15-20%.

C. Equivalent Stress

Table 4 Equivalent Stress

Equivalent Stress Mpa				
Step	Square	Rectangular	Circular	Oval
1	0	0	0	0
2	0.0368433	0.03783333	0.04483333	0.09
3	0.077393	0.07603333	0.09033333	0.07
4	0.1179433	0.11423333	0.13583333	0.17
5	0.15849333	0.152433333	0.181333333	0.156
6	0.1990433	0.190633333	0.226833333	0.195
7	0.23959333	0.228833	0.27233333	0.234
8	0.28	0.267	0.318	0.273
9	0.32098	0.3053	0.363	0.312
10	0.3611	0.3434	0.409	0.351

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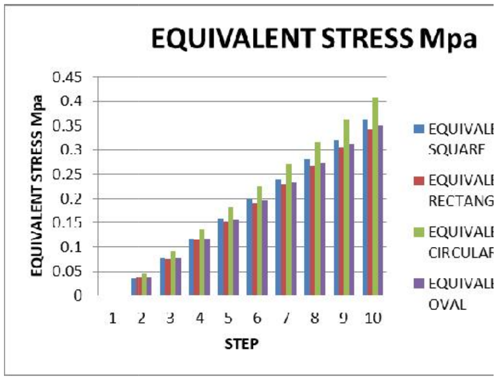

Graph 3 Equivalent Stress

In above graph shows the results of Equivalent Stress of all models in ANSYS, the result conclude that of Equivalent Stress the Circular shape footing is greater than other shape of footings by 10-20%

VI. CONCLUSION

In the above study analysis square, rectangular, circular and oval footing having same volume and from analysis its conclude that the footing shape of rectangular and square having economic results and can suggest for that footing shape for machine footing than oval and circular , the above results conclude from following statement

- The results of natural frequency of all models in ANSYS, the result conclude that natural frequency of the oval shape footing is greater than other shape of footings by 10-15%
- The results of Total Deformation of all models in ANSYS, the result conclude that Total Deformation of the Rectangular shape footing is greater than other shape of footings by 15-20%
- The results of Equivalent Stress of all models in ANSYS, the result conclude that of Equivalent Stress the Circular shape footing is greater than other shape of footings by 10-20%

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