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Dynamic load analysis of centrifugal machine foundation

Harpreet saroya[1, a)], Prof. Manoharan Rajalingam[2, b)]

Prabhdeep Singh[3, c)]

[1a)]M.Tech Structural Engineering, School of Civil Engineering, Lovely Professional University, (India)

[2b)]Associate Professor, School of Civil Engineering, Lovely Professional University, (India)

[3c)] M.Tech Structural Engineering, School of Civil Engineering, Lovely Professional University, (India)

ABSTRACT

The project is based on dynamic load analysis of centrifugal machine foundation used for measuring the vibrations produced by centrifugal rotating machine at foundation. Linear elastic theory and mass spring dashpot model methods are used for checking the dynamic analysis of machine foundation. Different design parameters are taken as per IS 2974(part 3) 1992 for doing manual calculation of machine foundation and results are compared. This project also involves the brief study of the assumed and detected action for this type of foundation.

Keywords: linear elastic theory, mass spring dashpot model, dynamic analysis

1. INTRODUCTION

Machine foundation is provided under the super structure of vibrating and rotating machine. Foundation are subject to the various force like dynamic and static caused by the machine. The dynamic forces that is produce by the machine is transferred to the foundation. Moving parts of the machine are balanced but there is always some unbalance in field due to eccentricity of rotating part occur. Foundations are subjected to combination of both static and dynamic loads. In addition to static loads, in some cases underlying soils are subjected to dynamic loads. Static loads produce no vibration and loads are imposed slowly. Dynamic loads produce vibration to foundation soil system. Foundations supporting machines such as reciprocating engines, radar tower, punch presses, turbines, large electric motors and generators etc. are subjected to vibration caused by unbalanced machine forces as well as static weight of machine.in this paper we take rotating type machine and suitable foundation is taken according to the dimensions of machine. Combined center of gravity of machine and foundation with the base of foundation will be checked. Machine frequency, natural frequency with the help of dashpot model and these values will be checked with permissible limits.

PROCEDURE

Parameter of soil and machine will be taken

Soil Parameter that will be consider

1. Soil Density
2. Poisson Ratio
3. Shear Wave Velocity / Dynamic Shear Modulus
4. Coefficient of Friction for Sliding
5. Allowable Bearing Pressure

Machine parameter

1. Machine and Foundation Dimensions and Orientations
2. Operating Frequency of Rotating Parts
3. Coordinates of CGs
4. Coordinates for Point of Application of Forces
5. Primary and Secondary Forces and Moments (for Reciprocating Machines)
6. Eccentricity of Unbalanced Forces for Rotating Parts
7. Critical Speeds
8. Rotor Weights
9. Unbalanced Forces at CGs
10. Grout Type and Extent in Plan
11. Levels
12. Base Plate and Anchor Bolt Details / Setting Details
13. Equipment Weights / Miscellaneous Details

Dynamic check

Dynamic Check shall be carried out for equipment heavier than 22kN

Frequency Checks

Amplitude and Velocity Checks

Acceleration

2 CALCULATION AND RESULT

A.Machine Parameters

Compressor Weight (W_C) = 3600 lbs.

Rotor Weight (W_R) = 2200 lbs.

Operating Speed (f) = 7000 rpm

(ω) = $2\pi f/60$

= 2 ×3.14 ×7000/60 =732.67 rad/sec

Critical Speed (f_C) = 1st ∽3500 rpm

2nd∽ 9850 rpm

e = 0.0015 (provided by manufacturer)

Dynamic eccentricity at operating speed

$e = e/ [1-(f/f_C)^2]$

$= 0.0015/[1-(7000/3500)^2] = 0.0005$ inch

Centrifugal force F_O

$F_O = (W_R/g) \times e \times \omega^2$

$= (2200/9.81 \times 3.28) \times 0.0005/12 \times 732.67^2 = 1530$ lbs.

Turbine Weight (W_T) = 17000 lbs.

Rotor Weight (W_R) =570 lbs.

Operating Speed (f) = 7000 rpm

(ω) = $2\pi f/60$

= 2×3.14×7000/60 =732.67 rad/sec

Critical Speed (f_C) = 1st ~ 2100 rpm

2nd ~ 9870 rpm

e = 0.0015 (provided by manufacturer)

$e = e/ [1-(f/f_C)^2]$

$= 0.0015/[1-(7000/2100)^2] = 0.0001483$ inch

Centrifugal force F_O

$F_O = (W_R/g) \times e \times \omega^2$

$= (570/9.81 \times 3.28) \times 0.0001483/12 \times 732.67^2 = 118$ lbs.

Total Centrifugal force F_O = 1530 + 118 =1648 lbs.

Base Plate weight (W_B) = 6000 lbs.

Total Machine weight (W_M) = $W_C+W_T+W_B$

=36000 + 17000 + 6000= 59000 lbs.

Soil Parameter (from geotechnical field)

Soil Density (γ) = 125Pcf

Shear Modulus (G) = 6500 Psi

Poisson's Ratio = 0.45

Concrete Footing Trial outline

Weight of the footing (W_F) = 118000 lbs.

Weight of footing / weight of machine = 118000/59000 = 2

Total static load (W) = Machine weight + weight of footing

= 59000 + 118000 =177000 lbs.

Actual Soil Pressure = 177000/14(22) = 632 PS

3 Dynamic analysis

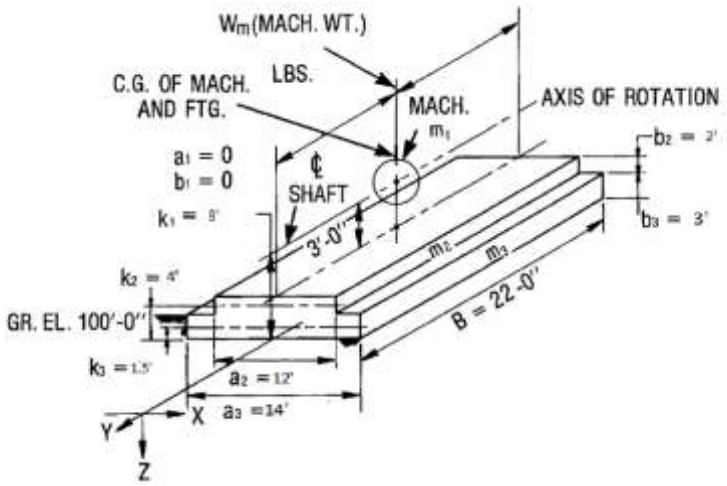

Fig 3

FREQUENCY CALCULATION AND CHECK					
S.NO	Natural Frequency		Operating Speed	Ratio	Resonance
1.	Vertical Excitation	1030 rpm	7000 rpm	O.P >1.2 N.F	No Resonance
2.	Horizontal Excitation	864 rpm	7000 rpm	O.P >1.2 N.F	No Resonance
3.	Rocking Excitation	1254 rpm	7000 rpm	O.P >1.2 N.F	No Resonance
4.	Torsional Excitation	944 rpm	7000 rpm	O.P >1.2 N.F	No Resonance
5.	Pitching excitation	1295 rpm	7000 rpm	O.P >1.2 N.F	No Resonance
6.	Longitudinal excitation	864 rpm	7000 rpm	O.P >1.2 N.F	No Resonance

AMPLITUDE CALCULATION AND CHECK			
S No.	Vibration Amplitude		Permissible limit
1.	Vertical Excitation	0.0007 mm	Less than 0.002 mm
2.	Horizontal Excitation	0.000015 mm	Less than 0.002 mm
3.	Rocking Excitation	0.000004 mm	Less than 0.002 mm
4.	Torsional Excitation	0.0000016 mm	Less than 0.002 mm
5.	Pitching excitation	0.000003 mm	Less than 0.002 mm
6.	Longitudinal excitation	0.00016 mm	Less than 0.002 mm

CENTER OF GRAVITY CALCULATION AND CHECKS			
S.no	Base	Foundation	Difference
1.	Z = 7 ft.	Z = 66 ft.	< 5%
2.	X = 11 ft.	X = 10.9 ft.	< 5%

4 CONCLUSION

The manual calculation is done for the machine and foundation and the result were check with permissible or required value from code IS 2974(part 3) .we seen the manual calculation take so much time and the software for the calculation is very costly for a normal. So that by the analytic model is made on the basis of manual calculation for the dynamic analysis and static analysis for the various cross section of foundation. Comparison of dynamic and static analysis machine foundation will also be done for the various cross section of foundation.

REFERENCES

[1]. George Gazetas (1983) Analysis of machine foundation vibration, 0261-7277/83/010002-41

[2]. Jayarajan P.,Kouzer K.M (2014) Dynamic analysis of turbo generator machin foundation Volume 1, Number 4; August, 2014,

[3]. Manoj sao,Gulab chand sahu (2017) Analysis of static and dynamic loads on equipment foundation in modular design of cold rolling mill, ISSN: 2350-0328

[4]. Porto B.thiago,Mendoca (2012) Basic design requirement for structure subjected to dynamic action,13-16 Noviembre 2012

[5]. Shamsher Prakash,vijay k.Puri (2006) Foundation for vibrating machin April-May 2006,