Design of TG Foundation on Different Type of Soils

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ABSTRACT

Turbo generator is the most dynamic and expensive equipment of a power plant complex and generally kept inside a turbo-generator building. Present paper discusses the natural frequency of Turbo Generator (TG) Foundation and find out which mode frequency is not matching to operating mode frequency and critical speed. The frequency will compare with different types of soils like Rock, Medium, soft and find out the natural frequency with mat footing and without mat footing and the mat will be compared by different depths. The model and analysis was done in structural analysis program (STRAP).

Keywords: turbo generator, natural frequency, soils, mats.

1. INTRODUCTION

The turbo-generator forms the heart of a power plant. It is the most vital and expensive equipment of a power plant complex and is generally housed inside a turbo-generator building. A turbo-generator consists of a turbine, generator and other auxiliaries like condenser, pipelines carrying superheated steam etc. Turbo-generator falls under high speed rotary type machines and its capacity varies from 2 MW to 2000MW. The turbo-generator foundation consists of turbo-generator and its auxiliaries mounted on a table top foundation. The foundation can be either made of steel or RCC. The top deck, column and bottom raft together constitute the turbo-generator foundation.

Machine foundations require a special consideration because they transmit dynamic loads to soil in addition to static loads due to weight of foundation, machine and accessories. The dynamic load due to operation of the machine is generally small compared to the static weight of machine and the supporting foundation. In a machine foundation the dynamic load is applied repetitively over a very long period of time but its magnitude is small and therefore the soil behavior is essentially elastic, or else deformation will increase with each cycle of loading and may become unacceptable

Based upon structural form, different types of machine foundations are available; generally they are classified as fallows

1. Block foundation
2. Box or caisson foundation
3. Wall foundation
4. Framed foundation

Generally turbo machinery requires framed type of foundations which accommodate the necessary auxiliary equipment between two columns.

Architect plan

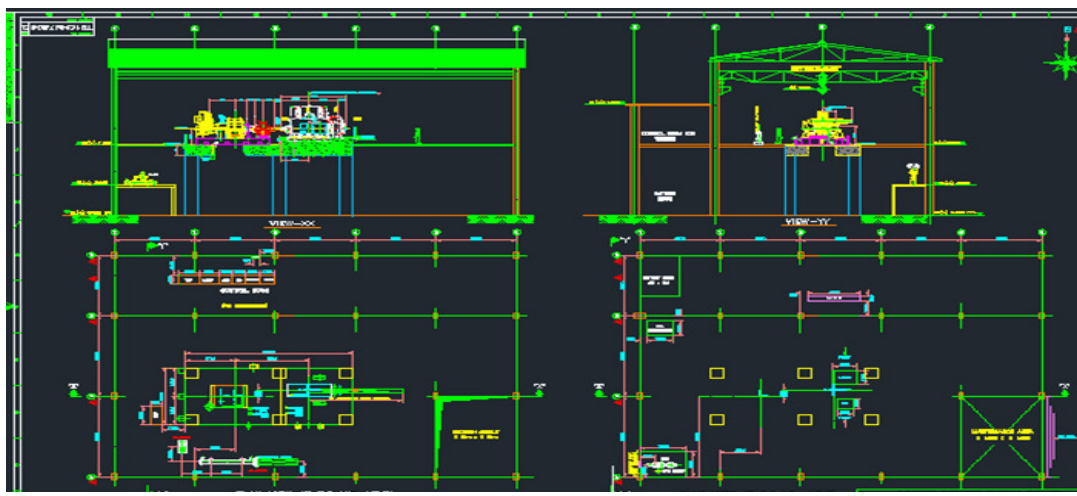


Fig1: Architect plan for turbo generator foundation.

The above figure shows the architect plan for turbo generator framed foundation in different views.

Dimensions and properties

Plan of TG foundation without mat	= 12500×5600mm
Grade of concrete	=M20
Size of column	= 1000×1000mm
Height of the column	=6.78M
No of columns	= 6 No's
Top deck height for turbine	= 950mm
Top deck height for gear box	= 1670mm

Load cases

The load under the turbine

1. The Self-weight of foundation
2. Turbine static parts weight(X2)
3. Rotating parts(X2)
4. Turbine dynamic force in vertical (+ X2)
5. Turbine dynamic force in vertical (- X2)
6. Turbine dynamic force in transverse (+ X3)
7. Turbine dynamic force in transverse (- X3)
8. Turbine Vacuum pull

Load cases under gear box

9. Alternator static weight
10. Vertical downward (+X2)
11. Vertical downward (-X2)
12. Alternator dynamic loads horizontal (+X3)
13. Alternator dynamic loads horizontal (-X3)
14. Alternator axial loading (+X1)
15. Alternator axial loading (-X1)
16. Short circuit (+X3)
17. Short circuit (-X3)

Load combinations

There are totally 22 load combinations are taken from As per IS 279:1992 part 3.

Machine loading data

Weight of main generator stator = 200 KN

Weight of complete rotor = 90 KN

Weight of exciter stator = 15 KN

Cooler = 40 KN

Modeling and analysis

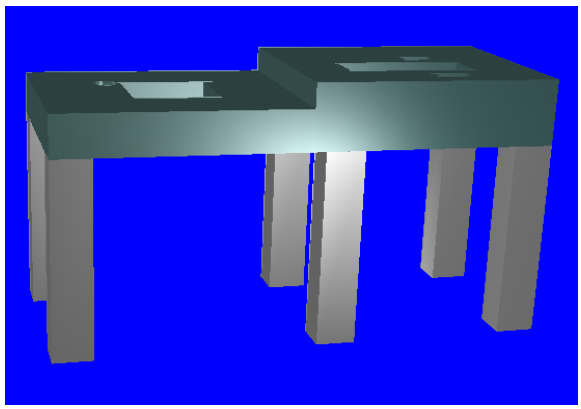


Fig 2: render view of TG foundation

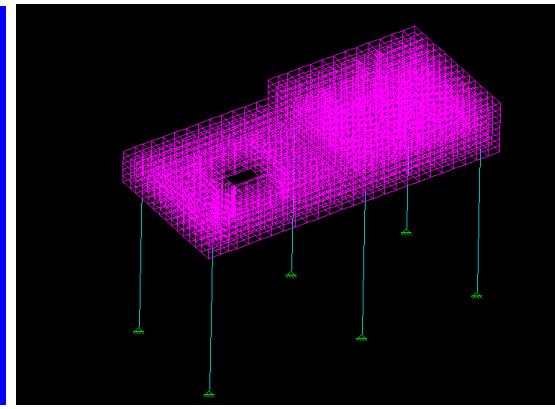


Fig 3: Solid view of Tg founation

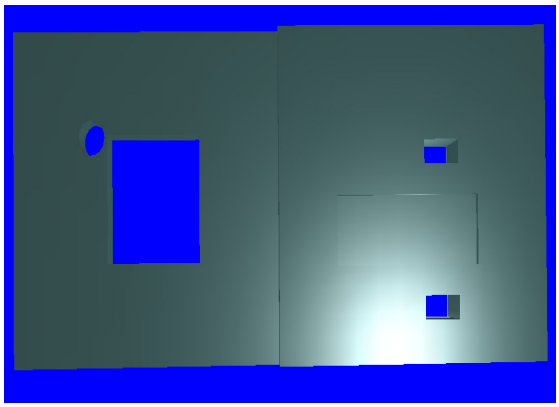


Fig 4: Top view of turbo generator foundation

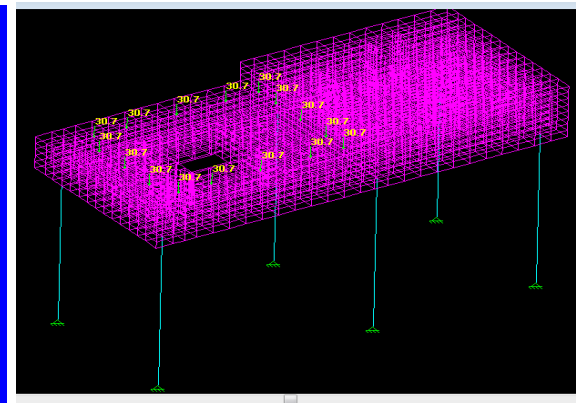


Fig 5: After assigning the load on foundation

The above figures show the render view (fig2), solid view (fig3), top view (fig4), after assigning the load (fig5) of framed foundation. In top view left side hole is for steam inlet, left side turbo generator and right side alternator has been placed. Fig 5 shows one of the examples for framed foundation after assigning the load; like that static and dynamic loads are applied individually on framed foundation.

Result

Machinery data

Frequency of turbine	= 113.73 HZ
Frequency of gear box output	=25 HZ
Critical speed	= 36HZ

Table1: Frequency of foundation

Mode no	frequency(HZ)
1	3.4
2	4.7
3	5.9
4	30.1

As per IS 279 part 3 the fundamental natural frequency shall be at minimum 20% away from the machine operating speed. The frequency of foundation compared with machine frequency. In 4th mode frequency will match so there is a chance to resonance to be happening.

1M DEPTH MAT IN DIFFERENT TYPE OF SOILS

The framed foundation has been analyzed with different types of soils at different depth of mat. In this case the framed foundation is analyzed with 1meter depth of mat for rock, medium, soft soils.

Case 1

Type of soil =Rock (SBC =200KN/m^2 with 1m depth of mat)

Mat plan =14500 ×7600

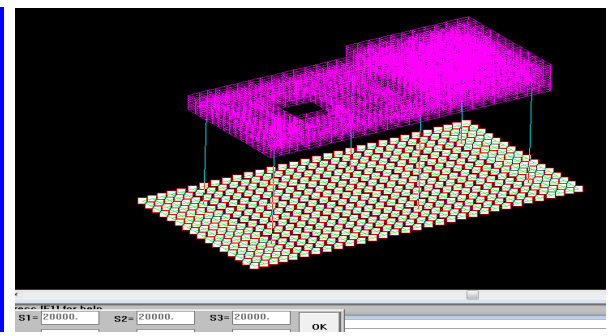


Fig 6: Render view of TG foundation **Fig 7: After assigning the soil to the foundation**

The above figure shows the framed foundation with mat and assigning spring to the mat and applies the static and dynamic load to the foundation and analyzed.

Result

Machinery data

Frequency of turbine = 113.73 HZ

Frequency of gear box output =25 HZ

Critical speed = 36HZ

Table2: Frequency of foundation

Mode no	frequency(HZ)
1	2.1
2	2.2
3	2.9
4	20.13

The frequency of foundation compared with machine frequency. In this case the foundation frequencies are mismatch to the machine frequency so there is no chance to happen the resonance, the foundation was safe.

Case 2

Type of soil =Medium (SBC =60 KN/m^2 with 1m depth of mat)

Table3: Frequency of foundation

Mode no	frequency(HZ)
1	1.8546
2	2.0741
3	2.7802
4	11.612

In this case the foundation frequencies are mismatch to the machine frequency so there is no chance to happen the resonance, the foundation was safe.

Case 3

Type of soil = soft (SBC =10 KN/m^2 with 1m depth of mat)

Table4: Frequency of foundation

Mode no	frequency(HZ)
1	1.1731
2	1.5935
3	2.35
4	4.6791

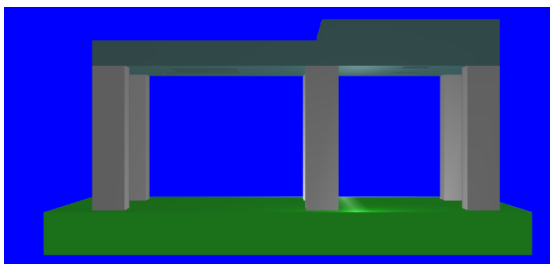
In this case the foundation frequencies are mismatch to the machine frequency so there is no chance to happen the resonance, the foundation was safe.

1.5M DEPTH WITH MAT IN DIFFERENT TYPE OF SOILS

In this case the framed foundation is analyzed with 1.5meter depth of mat for rock, medium, soft soils.

Case 1

Type of soil = Rock (SBC= 200KN/m^2 with 1.5m depth of mat)



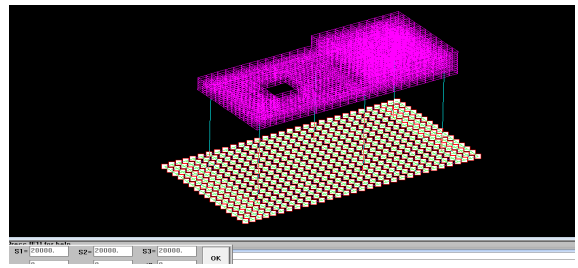


Fig 8: Render view of framed foundation with mat Fig 9: After assigning the soil to the mat

The above figure shows the framed foundation with mat and assigning springs to the mat and applies the static and dynamic load to the foundation and analyzed.

Table 5: Frequency of foundation

Mode no	frequency(HZ)
1	1.6446
2	1.7422
3	2.356
4	16.8574

In this case the foundation frequencies are mismatch to the machine frequency so there is no chance to happen the resonance, the foundation was safe.

Case 2

Type of soil = Medium (SBC= 60KN/m^2 with 1.5m depth of mat)

Table 6: Frequency of foundation

Mode no	frequency(HZ)
1	1.9215
2	2.1895
3	2.9523
4	9.419

In this case the foundation frequencies are mismatch to the machine frequency so there is no chance to happen the resonance, the foundation was safe.

Case 3

Type of soil = Soft (SBC= 10KN/m^2 with 1.5m depth of mat)

Table 7: Frequency of foundation

Mode no	frequency(HZ)
1	0.8347
2	1.1644
3	1.7847
4	3.2287

2. CONCLUSION

This paper finds the natural frequency of Turbo generator foundation capacity of 18 MW using structural analysis program (STRAP software) and found where the resonances will happened. This paper compares the framed foundation with mat and without mat. The foundation with mat condition analyzed with different type of soils (Rock, medium, soft) and different mat depths (1m, 1.5m). From the above discussions the 1m depth mat is economical compare with 1.5m for this foundation. Generally medium and hard soils are preferred to the framed foundation.

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