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Dynamic Analysis of Machine Foundation for Reinforced Soil Bed

Shruti S. Marjive[1], Shraddha W. Meshram[2], Vidhi C. Maske[3], Rudraprasad T.Chatterjee[4], Nikunj Y. Bhelave[5]

Student [1, 2,3,4,5]

Department of Civil Engineering

KDK College of Engineering Nandanwan Nagpur 440009

***Corresponding Authors' Email: -** shrutimarjive8999@gmail.com[1],*

shraddhameshram2020@gmil.com[2], vidhimaske5@gmail.com[3]

Abstract

Dynamic analysis of a machine foundation involves identifying loads, determining natural frequencies and mode shapes, and evaluating the foundation's response to dynamic loads using numerical simulation techniques like FEA or BEM. Results help optimize foundation design, support machine performance requirements, and prevent failure or damage. Environmental factors such as soil properties, temperature, and humidity are also considered. Regular maintenance and monitoring of the foundation system can prevent costly repairs or replacements in the future. The analysis should comply with relevant codes and standards to ensure safety and reliability. Overall, a dynamic analysis is critical for the design and maintenance of machine foundations to prevent excessive vibrations, deformations, or failures that can impact machine performance and longevity.

Keywords: GTS NX MIDAS, *Dynamic analysis, Materialproperties*

INTRODUCTION

Machine foundation is an essential component that transmits dynamic forces generated by machines to the soil. Compared to static loads, dynamic loads are more critical for the foundation design as they can cause vibration and other dangerous effects. The foundation's primary function is to absorb and dissipate the dynamic loads, thereby preventing any adverse impact on the machine and its surroundings.

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Vibration is a common parameter generated due to dynamic loads in machines, and it can have severe consequences if not managed correctly. Therefore, vibration isolation techniques are often used to reduce the vibration levels in the machine and minimize the risk of machine failure.

The dynamic load generated by the machine foundation produces vibration that can settle within limits, preventing any damage to the machine or its surroundings. On the other hand, static loads are slowly imposed and do not produce any vibration.

The foundation design must consider the dynamic loads generated by the machine and ensure that they do not exceed the soil's bearing capacity. The foundation's depth and width must be adequate to ensure stability under dynamic loads. The foundation's design must also consider the soil's properties, including its stiffness, damping, and natural frequency, as they play a crucial role in the foundation's response to dynamic loads.

The use of proper materials and construction techniques is also critical in ensuring that the foundation can withstand the dynamic loads without failing. In conclusion, machine foundation design must consider the dynamic loads generated by the machine, which can cause vibration and other dangerous effects. Proper foundation design and vibration isolation techniques can help reduce the vibration levels and minimize the risk of machine failure.

GTS NX MIDAS

GTS NX MIDAS is a software designed for geotechnical, civil, and mining engineers for the modeling and analysis of various components and assemblies of any system. It is capable of performing a wide range of geotechnical analyses, including linear static analysis, seepage, soil structure interaction, SRM slope stability analysis, and dynamic analysis applications. Its intuitive interface allows for easy integration into the work process, and its ability to perform multiple analysis types on a single model file greatly increases efficiency.

The software also supports a powerful post-processing engine for displaying key results and offers a wide array of display options to satisfy different project styles and preferences. Overall, GTS NX MIDAS provides an advanced level of geotechnical design with its fast analysis speed, outstanding graphics, and output capabilities.

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Methodology and procedure

The method used in GTS NX MIDAS is based on finite element analysis (FEA). The software uses a mesh-based approach to discretize the soil and reinforcement layers, allowing for the calculation of stresses and strains at discrete points within the model. To model the settlement of adjacent machine foundations on a reinforced soil bed with a single layer of reinforcement, the following steps are typically taken:

1. **Geometry Definition:** The geometry of the model, including the size and shape of the machine foundations and the reinforced soil bed, is defined in the software.

2. **Material Properties:** The material properties of the soil, reinforcement, and machine foundations are defined in the software. These include parameters such as elastic modulus, Poisson's ratio, and unit weight.

3. **Mesh Generation:** The software automatically generates a mesh of nodes and elements to discretize the model geometry.

4. **Boundary Conditions:** Boundary conditions, such as fixed or free edges, are applied to the model to simulate the real-world conditions of the problem being analyzed.

5. **Load Application:** Loads are applied to the model to simulate the weight of the machine foundations and any other applied loads.

6. **Analysis:** The model is analyzed using finite element analysis to calculate stresses and strains at discrete points within the model.

7. **Results and Interpretation:** The software provides graphical and numerical outputs of the analysis results, including settlement, stress distribution, and deformation of the soil and reinforcement layers.

In summary, GTS NX MIDAS uses a mesh-based FEA approach to model the settlement of adjacent machine foundations on a reinforced soil bed with a single layer of reinforcement.

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The software provides an efficient and accurate method for analyzing this type of problem, with graphical and numerical outputs for interpretation and design purposes.

MATERIAL PROPERTIES

In the present investigation, locally available silty sand was considered as foundation soil. The unit weight and shear strength properties of the foundation soil was obtained from the laboratory studies. The Young's modulus and Poisson's ratio of the soil were adopted from Bowles (1996).

The dilatancy parameter was considered, ψ=m diameter was assumed to be made with M20 grade concrete. The weight of the machine was selected as per the guidelines given by Leonard (1962). As per the guidelines, the ratio between the weight of the foundation to the weight of the machine was maintained equal to 2.1, resulting the weight of the machine equal to 10kN. A similar procedure was adopted by Fattah et al. (2015) for the selection of weight of the machine. In this study, concrete foundation was modelled as a linear elastic material.

Table 1.1 Properties of soil

Material	**Soil**	**Concrete**
Property	3D	3D
Model Type	Solid	Solid
Material	Silty sand	Concrete

Table 1.2 Properties of different material used in numerical modeling

Material	**Parameter**	**Value**
Foundation soil(silty sand)	Unit weight, (kN/m3)	19
	Young's modulus, E (kN/m2	20,000
	Poisson's ratio, u	0.35
	Angle of internal friction, φ (0)	32
	Cohesion, C (kN/m2)	0
	Dilatancy angle, ψ (0)	2

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Foundation	Young's modulus, E (MPa) Poisson's ratio, μ	275 0.35
	Poisson's ratio, μ	0.35

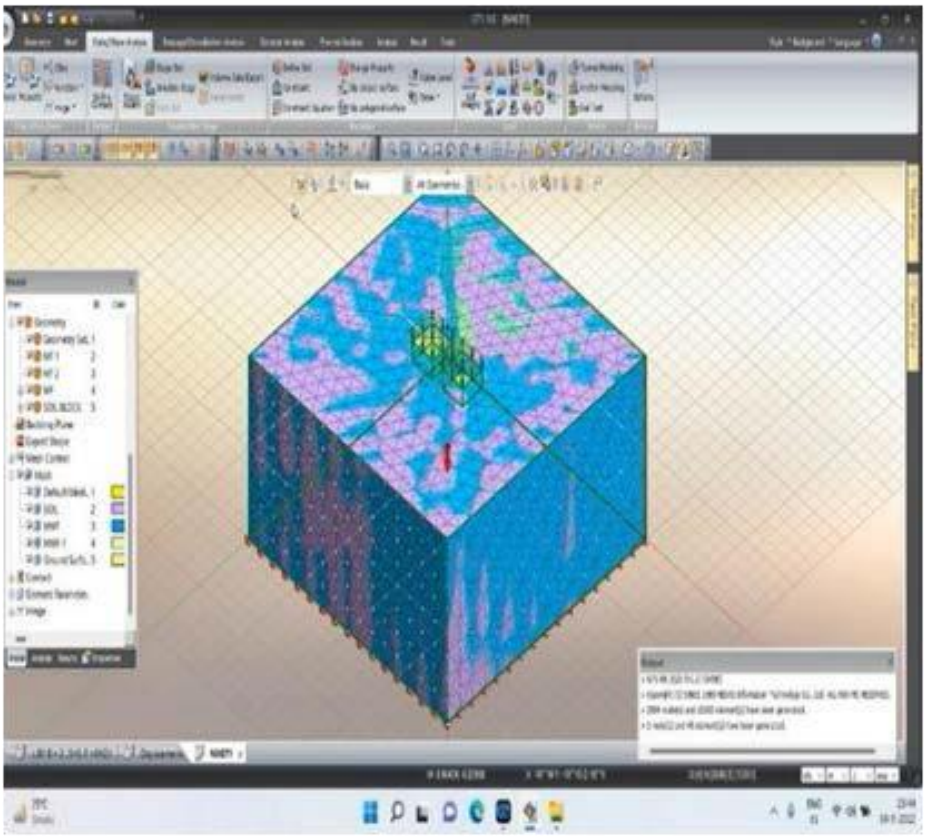


Figure 1

RESULTS

Values of displacements after placement of single layer of geo grid for various frequencies of dynamic loading are presented in the Table.

Results for Settlement of Adjacent Machine Foundations for Reinforced Soil Bed

Table 1.3 Settlements of adjacent machine foundation on soil bed reinforced with single layer of geogrid for f = 5 Hz

Spacing ratio between adjacent machinefoundations 'S/B'(m)	**Settlement 'Stf' (mm)**	
	L/B = 1	L/B = 2

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1.5	2.16	1.72
2.0	2.05	1.69
2.5	1.74	1.51
3.0	1.48	1.38

Table 1.4 Settlements of adjacent machine foundations on soil bed reinforced withsingle layer of geogrid for f = 10 Hz

Spacing ratio between adjacent machine foundations 'S/B' (m)	Settlement 'Stf' (mm)	
	L/B = 1	L/B= 2
1.5	2.52	1.95
2.0	2.36	1.77
2.5	1.89	1.64
3.0	1.57	1.49

Table 1.5 Settlements of adjacent machine foundation on soil bed reinforced with single layer of geogrid for f = 15 Hz

Spacing ratio between adjacent machine foundations 'S/B' (m)	Settlement 'Stf' (mm)	
	L/B = 1	L/B= 2
1.5	2.68	2.13
2.0	2.42	2.09
2.5	2.23	1.79
3.0	1.94	1.62

Table1.6 Settlements of adjacent machine foundation on soil bed reinforced with single layer of geogrid for f = 20 Hz

Spacing ratio between adjacent machine foundations 'S/B' (m)	Settlement 'Stf' (mm)	
	L/B = 1	L/B = 2
1.5	3.62	2.20

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2.0	3.46	2.13
2.5	3.28	2.01
3.0	2.81	1.83

Table 1.7 Settlements of adjacent machine foundation on soil bed reinforced with single layer of geogrid for f = 25 Hz

Spacing ratio between adjacent machine foundations 'S/B'(m)	Settlement 'Stf' (mm)	
	L/B = 1	L/B = 2
1.5	1.96	1.59
2.0	1.74	1.47
2.5	1.49	1.36
3.0	1.40	1.27

Figure shows graphs of settlements of adjacent machine foundations on soil bedreinforced with single layer of geogrid for different frequencies for Aspect ratio 1 and2.

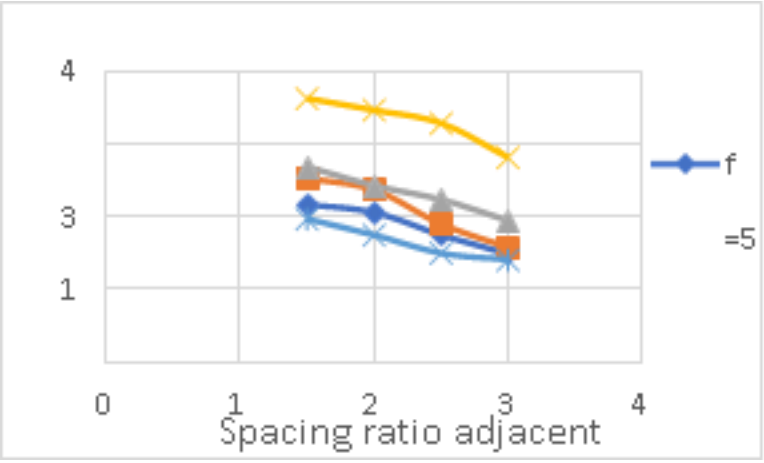


Figure 2 Settlements of adjacent machine foundations on soil bed reinforced with single layer of geogrid for aspect ratio =1

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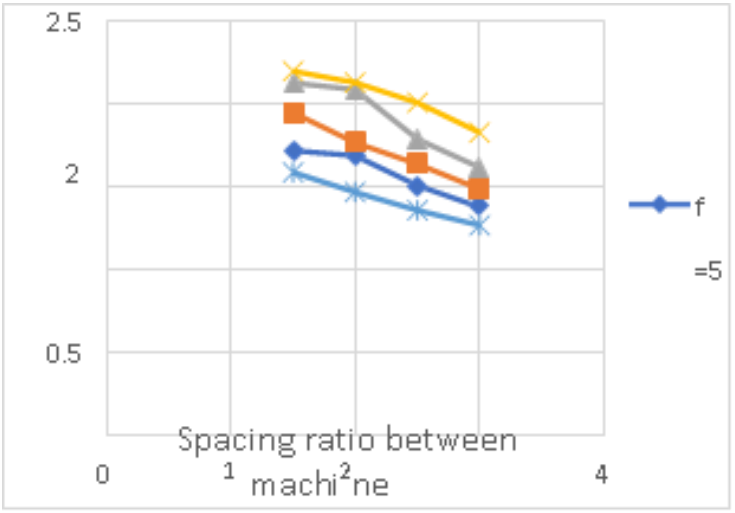


Figure 3 Settlements of adjacent machine foundations on soil bed reinforced withsingle layer of geogrid for aspect ratio =2

CONCLUSION

In conclusion, the method used in GTS NX MIDAS for analyzing the settlement of adjacent machine foundations on a reinforced soil bed with a single layer of reinforcement is based on finite element analysis. It involves defining the geometry and material properties of the model, generating a mesh of nodes and elements, applying boundary conditions and loads, and analyzing the model to calculate stresses and strains. The software provides graphical and numerical outputs of the analysis results, which can be used for interpretation and design purposes. Overall, the use of GTS NX MIDAS provides an efficient and accurate method for analyzing this type of problem

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