# Non Linear Dynamic and Static Analysis Of Laterally Loaded Pile

**Junaid Maste**[1]
P.G student, MGMCET,Navi Mumbai
Assistant Professor,AIKTC
New Panvel (India)

**Dr. V. A. Patil**[2]
Principal,B.R.Harne C.E.T.,Karav, Ambernath

**Ravi Jain**[3]
P.G student, MGMCET, Navi Mumbai

**Prof.P J Salunke**[4]
Assistant Professor,MGMCET
Navi Mumbai (India)

**Abstract:** Response of a pile subjected to lateral load is carried out which is embedded in two layered soil considering soil pile interaction using finite element method. Soil is modeled as 3D element further the corresponding deflections are determined with varying modulus of elasticity. Both static and dynamic conditions are taken into account.

**Key words:** Pile soil interaction, finite element analysis, Pile deformation, Dynamic analysis.



## INTRODUCTION:

The soil–structure interaction (SSI) has increasingly attracted the interest of researchers and engineers in the fields of, wave mechanics, and soil dynamics. Piles are generally used to carry the vertical loads from the super structure but sometimes to withstand the effect of lateral load e.g. offshore structure, retaining structure etc. Various research work has performed in regards with soil pile interaction in which some researcher they have assumed elastic nature of soil, elastoplastic & nonlinear behavior of soil. Over the past decades the soil–structure interaction (SSI) has increasingly attracted the interest of researchers and engineers in the fields of, wave mechanics, and soil dynamics.

For this case a general finite element method is developed, pile which is embedded in soil modeled as two nodded beam element. A simple & sophisticated computer based analysis for laterally loaded pile is required for laterally loaded pile. Piles are particularly difficult to analyze mainly because of the complex soil-pile interaction nature. Both the dynamic and static analysis is taken into consideration.

**Model Description:**

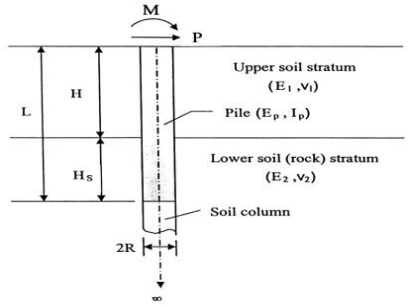


Fig.1 model description

A laterally loaded pile embedded in a two layered soil represents the soil structure interaction problem. An attempt is made in this work to take into account non-linearity of soil for the use of finite element method. For the two layers, poisons ratio and modulus of elastically are varied. The embedded length of pile & pile head is considered as variable for analysis and the deflections are worked out. Obtained results are compared with different cases and after validation of the same dynamic analysis are carried out taking different sectional properties.

**Procedure for computation:**

- A new 3D model is made with the use of FB-multipier software
- In the pile model edit tab window, pile section, length, geometry and properties are defined
- Pile is descritized into no. of nodes
- Soil is modeled by assigning different layers with different engineering properties for each layer
- In analysis command non-linear static case is selected
- Analysis is done for different cases.



**Illustrative example (static):** A Steel pile 0.305 m in diameter in embedded in two layered soil with top layer soil thickness 0.915m & 6.71m bottom layer soil. Pile is subjected to lateral load of 66.75KN at top. Pile deformation is calculated, considering engineering properties of pile &soil (Es& Poisson's ratio) as variable & results are obtained.

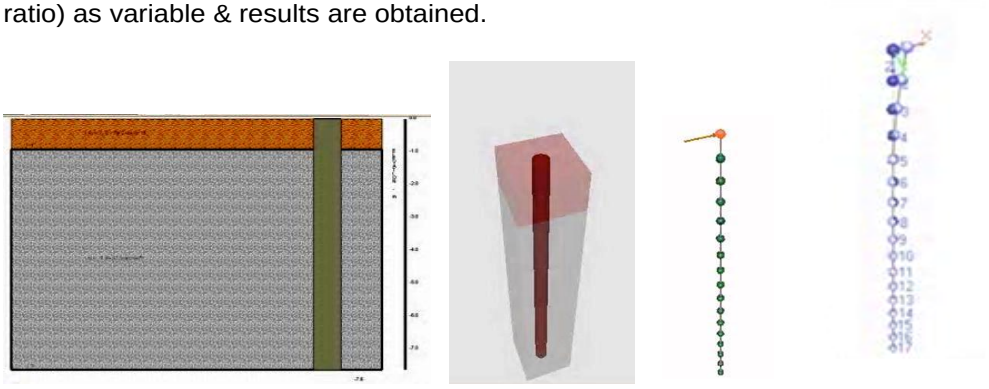

Fig2. Showing geometry and elevation, 3D model, loading and deformation.

**Observation & Results:**

The deformations of the pile considering soil pile structure interaction are observed and compared with other results.

| Cases | E1/E2 | Deflection(mm) |
|---|---|---|
| 1 | 0.5 | 16.5 |
| 2 | 1 | 9.498 |
| 3 | 2 | 6.2 |

The above mentioned case was studied by Pise (1982) ,to compute the maximum moments and ground deflection for a free headed steel pile. Deflection is calculated for E1/E2 0.5,1,2,10 with top layer thickness of 0.915m. A result obtained by Pise (1982), San Shayan (2006) & Ashish Mehta (2010) for above case is compared with our model.

**Illustrative example (Dynamic):**

Further the dynamic analysis is carried out considering a pile which is subjected to a blast loading with stiffness of 110k/in and damping of 20%.The corresponding loading and displacement are shown below.

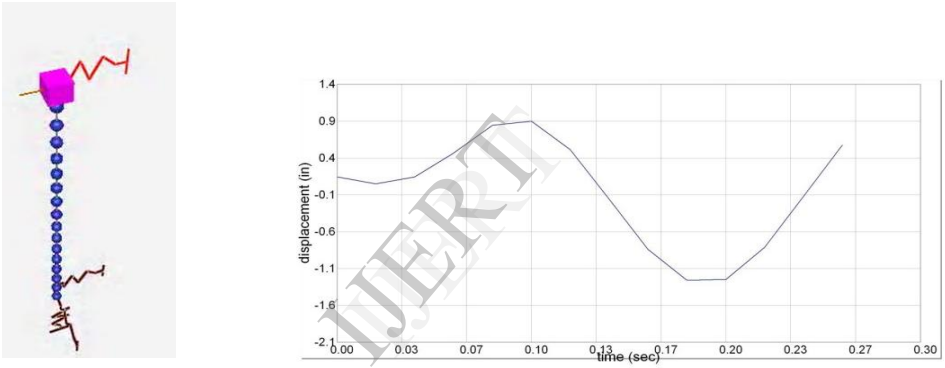


Fig.3 application of load, displacement

The above case was studied by poz(2002) and results are compared with our case.

**Conclusions:**

Results as shown below are found in good agreement with Pise (1982), San Shayan (2006) & Ashish Mehta (2010) & poz(2002).Hence predicted model can be used to obtain deflection with various soil and pile data.

**Static case:** Table no.1

| Cases | E1/E2 | Deflection (pise method) (mm) | Deflection By San shyan (mm) | Deflection(mm) Ashish Mehta (2010) | Deflection(mm) |
|---|---|---|---|---|---|
| 1 | 0.5 | 17 | 17 | 17 | 16.5 |
| 2 | 1 | 12 | 10.5 | 9.68 | 9.498 |
| 3 | 2 | 7.2 | 6.8 | 5.38 | 6.2 |

**Dynamic case:** Table no.2

| Time | Deflection poz(mm) | Deflection(mm) |
|---|---|---|
| 0.00 | 0.00 | 0.00 |
| 0.02 | 0.069 | 0.071 |
| 0.04 | 0.399 | 0.368 |

**References:**

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