CE-392 B.Tech Project
Design Optimisation
of pile foundations

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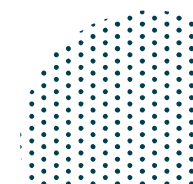
INTRODUCTION

What is a Foundation?

Foundation is the main supporting component of any building structure. It is the lowest part of the building which is in contact with soil and transfers all structural load to soil safely. The purpose of a foundation is to hold up and hold together the structure above it.

Types of Foundation

(i)Shallow foundations - Those that transfer loads in bearing close to the surface. They either form individual spread footings or mat foundations, which combine the individual footings to support an entire building or part of it.In shallow foundation the below criteria is satisfied.

$$Df \leq Bf$$

(ii) Deep foundations - A deep foundation is a type of foundation that transfers building loads to the earth farther down from the surface than a shallow foundation does to a subsurface layer or a range of depths.

$$Df > Bf$$

Pile Foundation

- ❖ Pile foundations are deep foundations. They are formed by long, slender, columnar elements typically made from steel or reinforced concrete, or sometimes timber.
- ❖ The main function of a pile is to transmit loads to lower levels of ground by a combination of friction along their sides and end bearing at the pile point or base as show in the figure below

Pile Footing
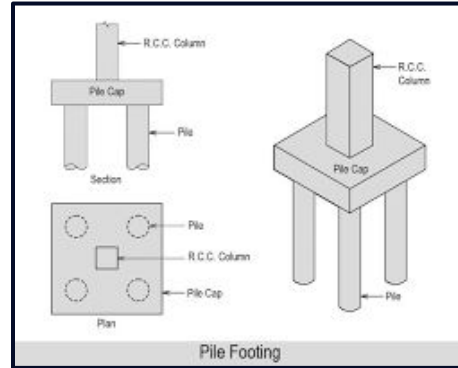
- ❖ Pile foundations are used when there is a layer of weak soil at the surface or the building has very heavy, concentrated loads, such as in a high rise structure, building, or water tank.
- ❖ The design of pile foundations has a lot of aspects. We are mainly going to see the structural design aspects of pile foundation of concrete piles. The structural design of the pile typically involves determining the required cross-sectional dimensions, area and spacing of lateral and longitudinal reinforcement require to ensure that the pile can resist the applied loads.

1. **Structural Design of pile by doing manual calculations**

❖ The structural design of a pile foundation treating it as a column involves several steps, including determining the required diameter of pile, area of reinforcement provided, diameter of main bar, number of main bar, diameter and pitch of spiral reinforcement to resist the applied loads and moments.

❖ Manual calculations can be time-consuming and prone to errors, but they are still used in some cases where the design is relatively simple or when there is limited access to computer software.

❖ The design of precast concrete pile foundation is done by referring the code book IS456-2000 (plain and reinforced concrete), design aids for reinforced concrete to IS: 456- 1978.

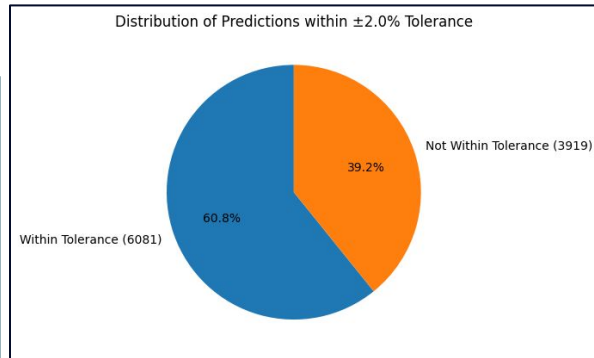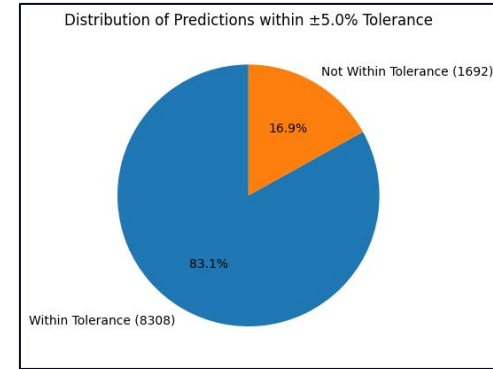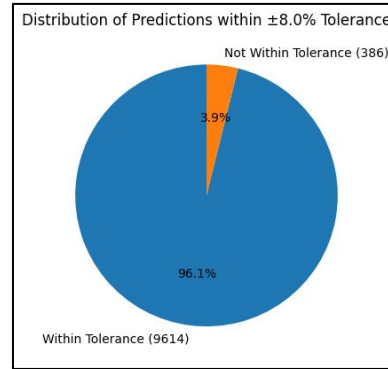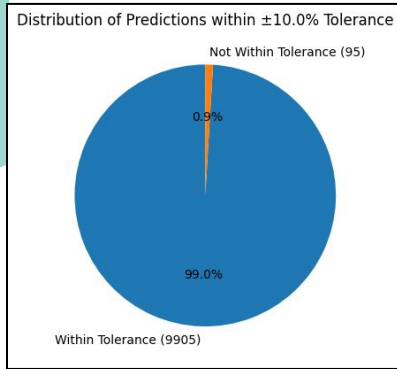## 2. Structural design of pile by program and dataset generation

❖ In the design process of a pile foundation, accurate and efficient calculations are essential to ensure that the foundation system can safely and effectively support the applied loads and moments.

❖ Digitization of interaction curve of columns for chart of SP-16 should be done.

❖ C++ code to generate 2 lakh as per IS code - 456 - 2000.

❖ Once the test cases have been generated, the dataset is used to test the design criteria under various conditions. The test results is used to do the analysis.

❖ This dataset is used to perform statistical analysis, such as regression analysis, to determine the sensitivity of the design criteria to the input parameters.

3. Training of ML model

❖ The ML model is Artificial Neural Network (ANN) model which uses the TensorFlow and Keras libraries to optimize the design of concrete pile foundations.

❖ The objective is to predict key parameters crucial for pile design, including the diameter of the pile, area of steel reinforcement, and pitch.

❖ This analysis will delve into the various components of the code, from data preprocessing to model evaluation.

❖ The neural network is constructed using Keras Sequential API. It consists of an input layer, a hidden layer with 32 neurons and ReLU activation, a dropout layer for regularization, an additional hidden layer with 64 neurons, another dropout layer, a third hidden layer with 16 neurons, and a final output layer.

❖ The model is trained using the training set and validated on the cross-validation set for 500 epochs with a batch size of 32.

Results and Conclusions :

Distribution of Predictions within ±10.0% Tolerance
Not Within Tolerance (95)
0.9%
99.0%
Within Tolerance (9905)

Distribution of Predictions within ±8.0% Tolerance
Not Within Tolerance (386)
3.9%
96.1%
Within Tolerance (9614)

Distribution of Predictions within ±5.0% Tolerance
Not Within Tolerance (1692)
16.9%
83.1%
Within Tolerance (8308)

Distribution of Predictions within ±2.0% Tolerance
Not Within Tolerance (3919)
39.2%
60.8%
Within Tolerance (6081)

❖ The accuracy with +-10% is very good but it decreases as we decrease the tolerance to +-2%.

❖ I would like to thank Dr. Vishwajit Anand for giving me the Design Optimization of Pile Foundation Project. I would like to extend my sincere gratitude towards you for giving such an opportunity to work on such an innovative and explorative project. It was a pleasure to work in your guidance and your advice helped me a lot to learn new things.

Thank You