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# Analysis of Pile Cap with Geo Textiles Fibre Using ANSYS

M. Anila[1], V. Anisha Mol[2]

[1]*Assistant Professor, Department of Civil Engineering, Bethlahem Institute of Engineering, Karungal, India*
[2]*Assistant Professor, Department of Civil Engineering, Lourdes Mount College of Engineering & Technology, Marthandam, India*

***Abstract*: The study of geotextile as under the pile cap supported by pile group embedded in cohesive soil. In this paper a flyover bridge is taken. For that flyover bridge pile foundation is provided. In that place the soil is cohesive so friction pile is adopted. For the stabilization purpose of soil a sheet of woven geotextile is provided as under the pile cap. Above the pile, pile cap, pier, pier cap and deck slab where constructed. The bridge is analysed by with geotextile and without geotextile fibre. The results have been obtained from nonlinear finite element analysis. The analysis carried out using ANSYS Structural software.**

***Keywords*: Pile cap, Geo textiles.**

## 1. Introduction

### A. General

soil settlement is a function of the flextural rigidity of the super structure. The influence caused by the settlement of the supporting ground on the response of framed structures was often ignored in structural design The structural stiffness can have a significant influence on the distribution of the column loads and moment transmitted to the foundation of the structure. However, it indicates that the effect of the interation between soil and structure can be quite and significant. This requires that the engineers not only understand the properties of the ground but they also need to know how the bridge responds to deformation and what the consequences of such deformation will be the function of the bridge.

### B. Bridge

Bridge is a structure corresponding to the heaviest responsibility in carrying a free flow of transport and is the most significant component of a transportation system. Alignment of the flyover is laid out and the pile, pier and abutment locations are located. The piles are excavated to the suitable depth depending upon the type of soil. After reaching the suitable depth concrete is placed. In this project beam bridge is used.

### C. Beam Bridge

Beam bridge or girder bridge is the simplest and oldest bridge type. It generally consists of one or more spans which are supported by an abutment or pier at each end.

### D. Components of beam bridge

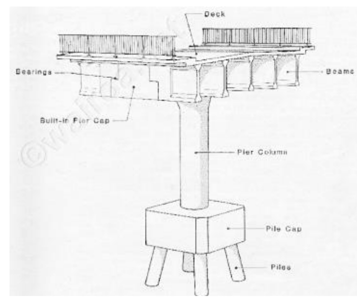



Fig. 1. Components of beam bridge

#### 1) Pile Foundation

A Pile is a long slender foundation member made either of timber, structural steel or concrete which might be cast-in-situ or diven and act as a structural member to transfer the load of the structure to a required depth in deep foundation carrying a load which may be vertical or lateral. we use the piles when the soil have low bearing capacity or in building in water like bridges and dams. Pile foundation is required when the soil bearing capacity is not sufficient for the structure to withstand. The pile foundations are generally preferred when heavy structural loads have to be transferred through weak subsoil to firm strata. In this project friction pile is used.

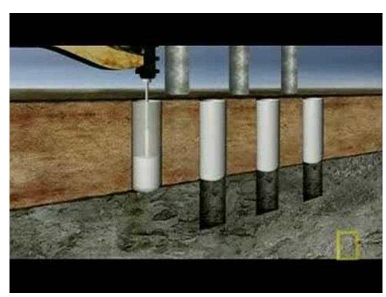


Fig. 2. Pile foundation

#### 2) Function of pile foundation

- To transmit the building loads to the foundations and the ground soil layers.
- To control the settlements, which can be accompanied by surface foundations.
- To increase the factor of safety for heavy loads buildings.

*3) Friction pile*

Friction piles are used to transfer loads to a depth of a friction load carrying material by means of skin friction along the length of pile. The pile transfers the load of the building to the soil across the full height of the pile, by friction. In other words, the entire surface of the pile, which is cylindrical in shape, works to transfer the forces to the soil. In a friction pile, the amount of load a pile can support is directly proportionate to its length.

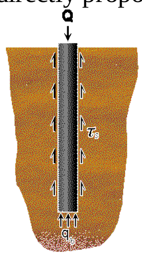


Fig. 3. Friction pile

*4) Pile cap*

A pile cap is a thick concrete mat that rests on concrete or timber piles that have been diven into soft unstable ground to provide a suitable stable foundation. A reinforced concrete mass cast around the head of a group of piles to ensure they act together and distribute the load among them is known as pile cap.

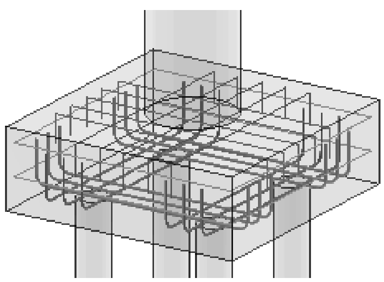


Fig. 4. Pile cap

*5) Textile fibre*

Textile fiber can be spun into yarn or made into a fabric by various methods including weaving, knitting, braiding, felting and twisting. The essential requirements for fibers to be spun into yarn include a length of at least 5mm, flexibility, cohesiveness and sufficient strength. Other important properties include elasticity, fineness, uniformity, durability and luster.

*E. Geotextile*

Geotextile is a synthetic manmade fibre which is manufactured from polyprolene, polyester, polyethylene, nylon and polyvinyl chloride. The thickness of geotextile is 10 to 300mil(1mil=1/100inch) and width is 30ft. The roll length of geotextile is 2000ft. Geotextile is used to prevent erosion and stabilize the loose soil. It is used in highways, dams and retaining walls.

*Types of Geotextile:*

1) Woven geotextile
2) Non-woven geotextile

*F. ANSYS structural software*

ANSYS Structural software is used to determine deformations, strains, stresses and reaction force

Key benefits

- Achieve innovative, reliable and high quality products and processes
- A more flexible and responsive information based development process, enabling modifications of design at later stages
- A seamless working exchange of data, regardless of location, industry, CAD environment etc.

*G. Objectives of the project*

a) To investigate the soil interaction analysis of flyover bridge with geotextile under the pile cap.
b) To evaluate the effect of displacement and moment in the flyover bridge
c) To calculate soil integration effect on the response of the building frame in terms of displacements, rotations, shears and bending moment through the analytical results.

*H. Scope of the present study*

In the present study, a flyover bridge with geotextile under the pile cap is analyzed using ANSYS structural software for nonlinear static and dynamic analysis. This study is used for flyover bridge with pile foundation to know the analytical results of bridges.

## 2. Methodology

According to the literature review to select the optimum method for analysis of pile cap with geotextile fibre using ANSYS.

*A. Modelling*

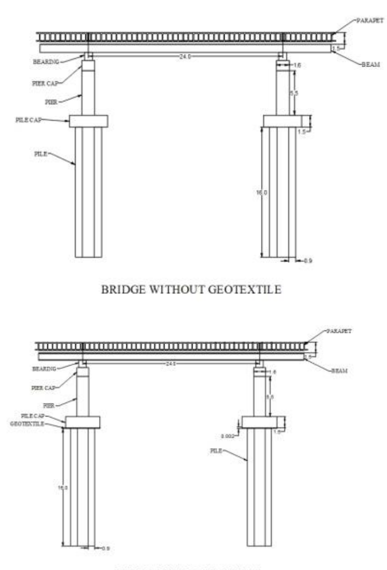



Fig. 5. Modelling of bridge

*Dead load calculations:*

Table 1
Total Dead load

| **Components** | **Dead load** |
|---|---|
| Crash Barrier | 216 KN/m |
| Wearing Coarse | 3088 KN/m |
| Deck slab | 1350 KN/m |
| Beam | 1500 KN/m |
| Pier cap | 510 KN/m |
| Pier | 137.5 KN/m |
| Pile cap | 828 KN/m |
| Pile | 360 KN/m |
| Total Dead loads | 7989.5 KN/m |

*Live load calculations:*

Maxmium Reaction Case: $R_1$ $R_2$
Reaction due to 70R =442 422
Vertical Reaction = 864 KN
$R_1$ $R_2$
Due to 2 class A = 441 424
Vertical Reaction = 868 KN
Total vertical Reaction = 864+868
= 1734 KN

*Wind load calculations:*

AS PER CLAUSE 209 OF IRC:6 – 2014
Height of structure above mean retarding surface,
H = 5.976 m
Basic wind speed as per location = 39 m/sec
Terrain category of the structure = Plain
Design hourly mean wind speed = 32.85 m/sec
Horizontal wind pressure corresponding to above velocity
(Pz) = 647.65 N/m$^2$
span length (c/c of expansion gap) = 24.000
overall plan width of deck = 10 m
Drag coefficeint of girder ($C_D$) = 2.211538
Lift coefficient ($C_L$) = 0.75
Drag coefficeint for live load ($C_D$) = 1.2
Gust factor (G) = 2

Transverse wind force $F_T$ for Dead load (as per clause 209.3.3 OF IRC:6-2014)
$A_1$ (solid area) = 57.624 m$^2$
$F_T = P_Z$ x $A_1$ x G x $C_D$ = 165.1 kN
C.G of load wrt bearing level = 1.20 m

Longitudinal wind force $F_L$ for Dead load (as per clause 209.3.4 OF IRC:6-2014)
$F_L$ = 0.25 x $F_T$ = 41.2673 kN
C.G of load wrt bearing level = 1.20 m

Upward/Downward Vertical Wind forces $F_V$ (as per clause 209.3.5 OF IRC:6-2014)
$A_3$ (area in plan) = 240 m$^2$
$F_V = P_Z$ x $A_3$ x G x $C_L$ = 233.2 kN

Transverse wind force $F_{T,L}$ for Live load (as per clause 209.3.6 OF IRC:6-2014)
$A_1$ (solid area) = 48 m$^2$
$F_{T,L} = P_Z$ x $A_1$ x G x $C_D$ = 74.6 kN
C.G of load wrt bearing level = 3.50 m

Longitudinal wind force $F_{L,L}$ for Live load (as per clause 209.3.6 OF IRC:6-2014)
$F_L$ = 0.25 x $F_{T,L}$ = 18.65 kN
C.G of load wrt bearing level = 3.50 m

## 3. Finite element analysis

### A. *General*

The finite element method is a numerical method of solving systems of differential equations. They are used extensively in many fields of engineering because they require very little knowledge of mathematics beyond basic algebra to use. It belongs to the methods of weighted residuals in that the problem is formulated such that some conditions are satisfied exactly, while others are satisfied only approximately or numerically (i.e. the "residual" being the difference between the exact solution and the approximate solution is weighted and minimized to get the best approximation)

While the case of setting up a problem using finite elements and getting a solution is the reason for its popularity, it is also the cause of its frequent misuse and distrust of the answer obtained. Usually you have to check your results with an experiment before your model is acceptable for use. It is the authors observation that the use of finite element in structural analysis is in particular poorly managed. Engineers typically begin working with FE having very little knowledge of numerical methods or knowledge of finite element behavior. There are no standards and guidelines for modeling and few managers who understand well enough to regulate modeling. It has led to mistrust of the method, its arrested development, and some very bad analysis being performed that is copied by others. Much aircraft structural design is analyzed using FE. The goal of modal analysis in structural mechanics is to determine the natural mode shapes and frequencies of an object or structure during free vibration. It is common to use the finite element method (FEM) to perform this analysis because, like other calculations using the FEM, the object being analysed can have arbitrary shape and the results of the calculations are acceptable. The types of equations which arise from modal analysis are those seen in Eigen systems.

### B. *Steps of FEA*

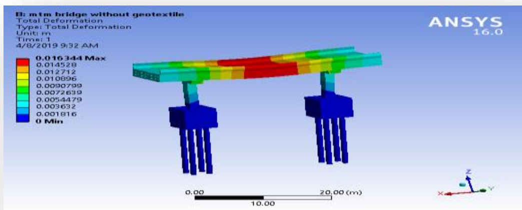
The analysis of a structure by the finite element method can be divided into several distinctive steps. These steps are to a large extent similar to the steps defined for the matrix method. Here we give a theoretical approach to the method, and its different steps.

*Input data*
*Modelling Procedure*
*Design parameters of bridge:*

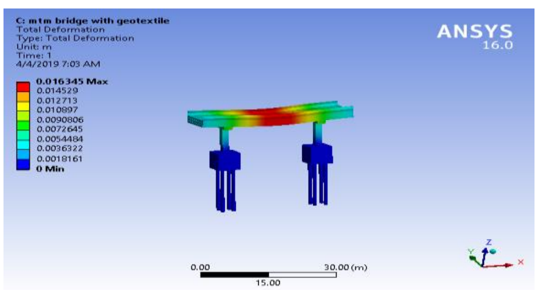
Length of pile = 16m
Diameter of pile = 0.9m
Size of pile cap = 4.7X4.7X1.5m
Size of pier = 5.5X1m
Size of pier cap = 8.5X1.6X1.5m

| | |
|---|---|
| Size of Beam | = 24X0.625X1m |
| Width of Carriage way | = 9m |
| Kerb | = 0.5m |
| Parapet | = 1.5m |
| Type of Bearing | = Spherical |

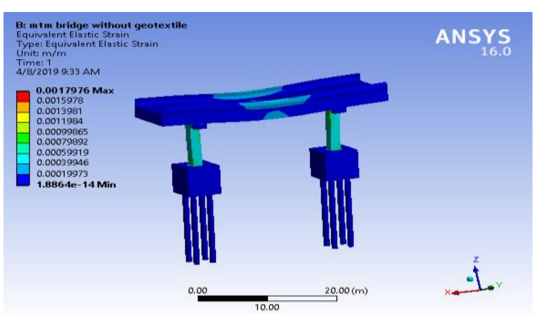
*Total Deformation*
*Bridge without Geotextile*



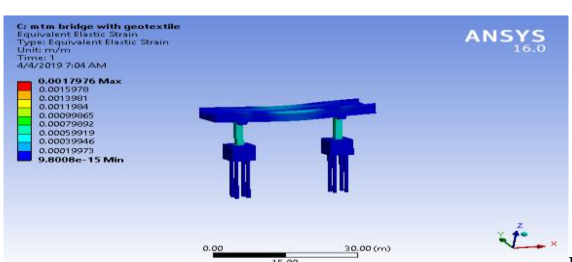

*Bridge with Geotextile*




*Equivalent Elastic Strain*
*Bridge without Geotextile*




*Bridge with Geotextiles*

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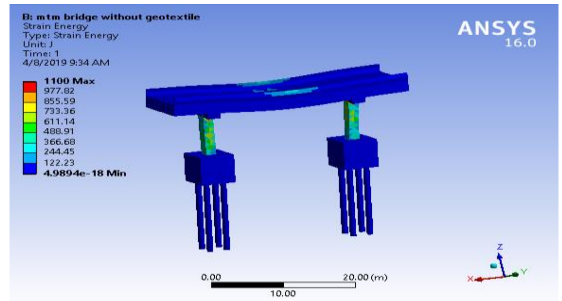
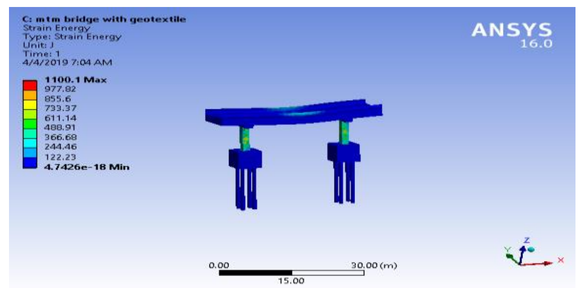
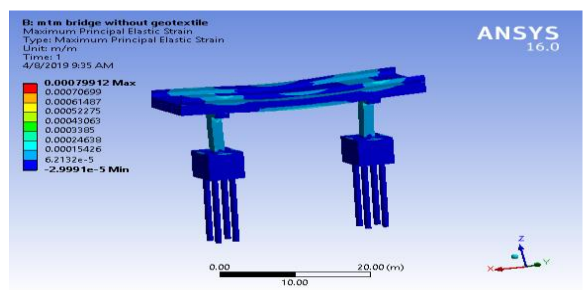
*Strain Energy*
*Bridge without Geotextile*



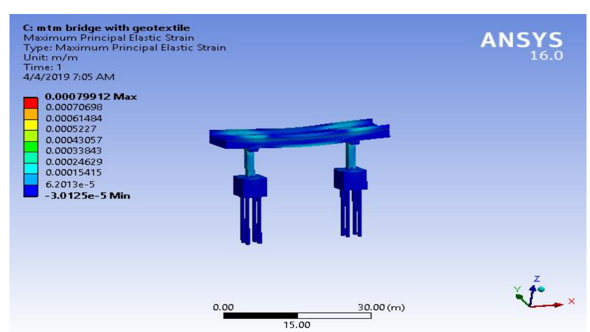

*Bridge with Geotextile*




*Maximum Principal Elastic strain*
*Bridge without Geotextile*




*Bridge with Geotextile*




## 4. Conclusion

- Woven geotextile have high tensile strength and load bearing capacity, it stabilize the cohesive soil and support it

- A layer of woven Geotextile is used under the pile cap of cohesive soil, it stabilizes the cohesive soil and it avoid the cohesive of water from upper and lower layers.
- By using Woven geotextile, the excess water will be drained off from the site
- 2mm of woven geotextile sheet is provided for the stabilization purpose of cohesive soil to resist the penetration of water into the concrete
- By analyzing in ANSYS software the woven geotextile gives enough support to the cohesive soil with 0.0163mm of deformation compare to the results of bridge without woven geotextile

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