Modelling of Geosynthetic-Reinforced unpaved Roads by Finite Element Method

Dr. EVR RAO 1*, Dr. R. P. DAS 2 *

Prof. of Civil Engineering, 1. NALLAMALA REDDY ENGINEERING COLLEGE, TELENAGANA, India, 2. Director R & D NSRIT, A.P, India.

ABSTRACT

Geosynthetics are used for mechanical stabilization of soil. Unpaved roads have granular bases. Geosynthetics improve the performance of such roads by reducing permanent vertical deformation such that service life can be extended. Finite Element Method enhances the analysis of unpaved roads with and without Geosynthetics considerably repeated wheel traffic and uneven wheel load.

INTRODUCTION

The main advantage of using geogrid in the flexible pavement is reduced rutting and minimal lateral displacement of granular material. The stiffness is increased and reflection is reduced due to the reflected wheel loads.

Generally, geosynthetics cover geotextiles, geogrids, geo nets, geo strips & geo membranes. Geo synthetics are eminently suitable for the flexible pavement as reinforcement material. Being composed as polymers there are designed to give flexible solution. The additional adhesive sheet resistance results in better load carrying capacity. Moreover, geotextiles react to the applied wheel loads due to increase in elastic module reflective cracking in the pavements can be prevented by geo synthesis. Lateral drainage is also improved [] A pattern of geogrid as shown in fig1.

For the source of analysis, flexible pavement section has 4 types of surface layer is of asphalt concrete. The sub-base layer is of sand. The surface layer is clay. The pavement section is subjected to static loading as per IRC: 37-2010. The thickness of pavement layer is also determined by this. PLAXIS 2D finite element is used for studying the effect of different. Axial stiffness of the geogrid on vertical deformation subgrade is 500mm, sub-base is 300mm, base is 250mm & surface layer is 150mm. geogrid layer is placed at the interface of sub-base & base course. A 600K P load is applied on single lane bases. A triangular pattern of nodes is selected for analysis. Geogirds of different type was used for studying the stiffness factor.

METHODOLOGY

The steps of finite element are:

a) Selection of suitable field variables and elements.

b) Discretization of continua

c) Selection of interpolation points.

d) Element properties.

e) Assembling element properties to obtain global properties

f) Implementation of boundary condition.

g) Solution of the system to get nodal unknows.

h) Additional calculations to get the required vales.

The basic equation

$$[K]_e\{\delta\}_e = \{F\}_e$$

$[K]_e$ is the element stiffness matrix $\{\delta\}_e$ is the nodal displacement vector, $\{F\}_e$ is the nodal force vector.

The element of stiffness K_{ij} gives course in direction 'I' due to unit displacement in coordinate 'j'. there are four methods to formulate the element properties.

a) Direct approach

b) Variational approach.

c) Weighted residual approach

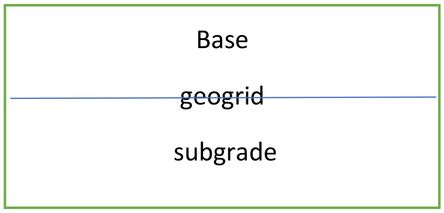
d) Energy balanced approach.

Variational approach is employed to assemble stiffness matrix and nodal force factor for consistent load.

Element properties are used to assemble global properties / structural properties to get system equation. The boundary conditions are imposed. The solution of simultaneous equation gives the nodal unknows. Utilizing the nodal values additional calculations are made to get the required values like stresses, strains and movements.

PRINCIPLES: Shell elements were selected for the base course and subgrade layers .

The reinforcement element are base-subgrade interface can be considered as a truss element having thickness of 0.003meter.



1) The model is constrainedat the bottom . displacement in X direction & rotation in y and z are prevented on 2 vertical faces.

2) To have heavy vehicular traffic, a cyclic load of triangular type with cyclic repetition equal 1000 was applied over a circular area having radius of 0.152m. amplitude 40KN (pavement pressure of 550kpa) frequency =0.5Hz. this amplitude is one half of an axle load from equivalent single axle load.

3) In unpaved structure, relativity large deformation occurs under traffic load due to elastic plastic behaviour of base and subgrade layer. Drucer-prager method gives hyperbolic yield criterion

   Let p be the initial hydro static tensile strength of the material.

   ψ= soil diltary angle, $\beta =$ slope.

4) For the geogrid, elastic model can be used

   For geographic, y(kpa)=3000

   From the table thickness=0.003, E=400Mpa

5) Two interfaces are: 1) between ABC & geogrid

   2) geogrid & subgrade

   One interface is between ABC & subgrade

   Compact surface is quite distributed.

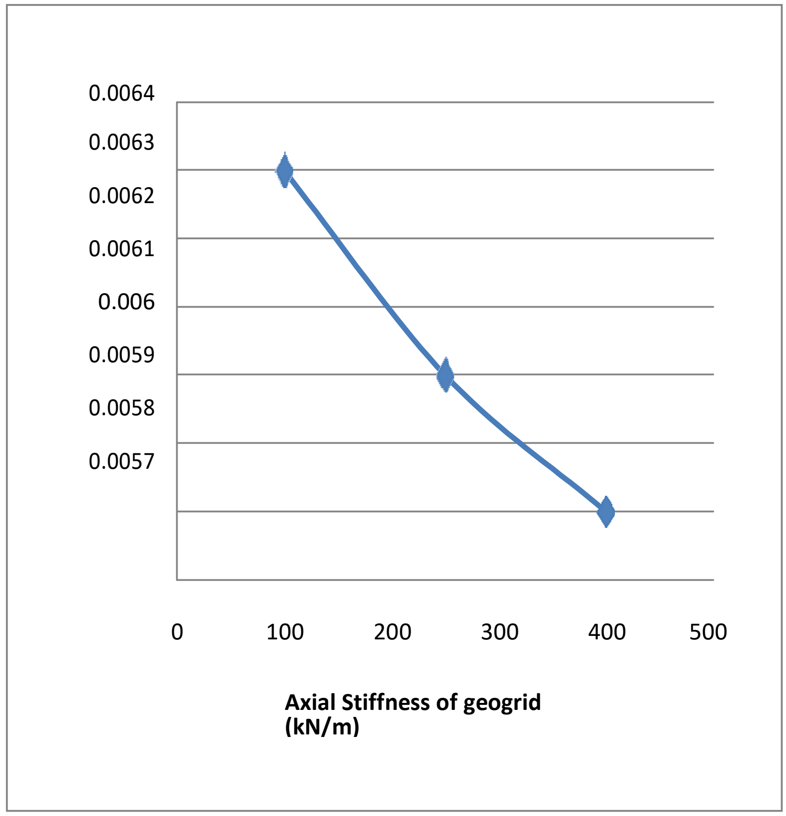
 ISSN No : 1006-7930

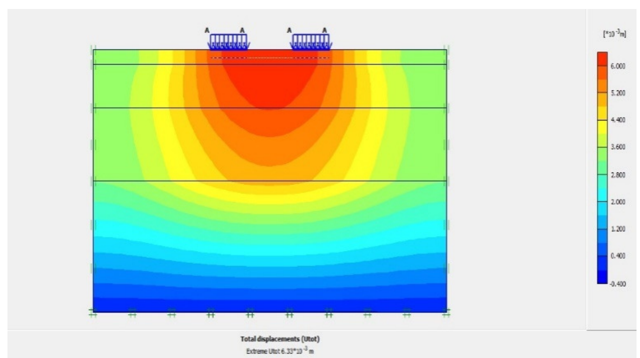
Material	Surface	Base Aggregates)	Subbase	Subgrade
Type of model	Linear Elastic	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Thickness (mm)	100	250	300	500
Dry unit weight (kN/m3)	23	22	15	14
Saturated unit weight (kN/m3)	-	24	16	16.2
Cohesion (kN/m2)	-	1	1	1200
Angle of internal friction	-	42	40	5

ASSUMPUTIONS

RESULTS

1) Reduction in vertical deformation is observed in increase in stiffness.
2) Vertical deformation in geogrid reinforcement is less.
3) Stiffness deformation is quite less for higher





Result show that this method is effective.

References:

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