ABSTRACT

The development of any country depends on accessibility and interconnectivity to different places through well connected transportation network. Road transportation is the most adaptable mode of transport under varied conditions of topography and hence top priority is given by the governments to improve road transportation facilities throughout the world by allocating huge capital investments. About 40% of total land in India is covered by clayey soils and inevitably the roads have to pass through such subgrades. Generally flexible pavements are preferred to rigid pavements due to less initial cost, smooth riding surface and easy maintenance. The design pavement thickness over clay subgrades is more due to their low soaked CBR values and so the construction cost is high. In spite of providing large pavement thickness, common failures noticeable in flexible pavements over clayey soils are excessive rutting, wavy surface, longitudinal cracking along wheel track and shear failure in edge region.

Further, expansive clays pose serious problems to construction of pavements due to their shrink-swell behavior with moisture fluctuations and also make pavement construction expensive due to their very low strength in saturated condition resulting from swelling. Efforts are being made by researchers (Katti, 1979; Natarajan and Shanmukha Rao, 1979, Steinberg, 1992, Ramana Murthy, Prasada Raju) from time to time to improve the strength and stability of the clay subgrades in general and expansive soils in particular by stabilisation, reinforcing, moisture control and soil replacement techniques. The advent of geosynthetics has drawn the attention of highway engineers to consider them for use in pavement construction to enhance performance. Particularly, synthetic geotextile due to its multi functional behavior has been used in the control of reflection cracking in overlays, as separator- filter - drain at clay subgrades during the last two decades. Also, geotextiles held in position at subgrade not only stiffen the base layer but also reduce normal stress on subgrade due to membrane action. However reinforcing function of geotextiles due to membrane effect is not explored much.

Reinforced flexible pavement design given by Giroud & Noiray (1981) for unpaved roads and subsequent modified method by Satyanarayana Reddy and Murthy (2005) for pavements over expansive clay subgrade are based on deriving reinforcing action of subgrade placed at subgrade. The other methods developed by Bender & Barenberg and
Koerner are empirical. Hence, the present research is focused on developing design methodologies for expansive and non-expansive clay subgrades and validating the same through test track studies.

As existing design methodology of reinforced flexible pavements over expansive subgrades (Satyanarayana Reddy and Rama Moorthy, 2005; Satyanarayana Reddy and Chinnapa Reddy, 2011) is without much practical evidence, in the present study, a design methodology has been formulated ensuring safety against shear and settlement failures besides controlling swelling of clay subgrade. After verifying the stresses at subgrade from three layer elastic theory, based on the developed design methodology, test track has been laid over expansive clay subgrade which forms part of NH-18 passing through Kurnool town. The woven geotextile is placed at the interface of subgrade and sub base course layer and held in position by anchorage in longitudinal trenches. The subgrade at the test track area is black expansive clay with a soaked CBR of 2.0 percent. The test track is laid in October 2011 and is monitored under traffic and varied seasonal effects. A control section (unreinforced) is also laid based on CBR method of design for performance appraisal of reinforced flexible pavement section. The surface levels are recorded every month at three locations across the width of the test track and control section. The reinforced flexible pavement section is observed to offer better stiffness under traffic and swell control over the control section.

The flexible pavement failures over non-expansive clay subgrades can be avoided by spreading the wheel loads over a larger area at subgrade level to avoid punching of sub base material into subgrade. The undulating pavement surface and shear failures in shoulder regions can be avoided by stiffening the layers of pavement so that it transmits wheel loads on to subgrade by slab action. So, in the present work, reinforced soil mattress concept (Jones, 1983) is applied to stiffen the sub base layer using high tensile strength geogrid reinforcement. CBR method of design is adopted for non-expansive clay subgrade of intermediate compressibility (CI) and sub base has been designed as reinforced mattress with geogrid reinforcement. The proposed design helps in maintaining the pavement thickness, uniform distribution of load at subgrade level and thus enables construction of pavement with improved performance.
Based on the proposed reinforced foundation (sub base) mattress methodology, test track has been laid over clay subgrade of intermediate compressibility, which forms part of main road, near Government General Hospital, Kurnool city. The subgrade soil has a soaked CBR of 3.8 percent. The design of reinforced flexible pavement is done using membrane action of woven geotextile by anchoring in longitudinal trenches and test track is laid based on the methodology. Unreinforced test track section is laid based on CBR method of design for performance appraisal of reinforced flexible pavement sections. The test tracks are laid in October 2011 and are monitored under traffic and varied seasonal effects. The reinforced flexible pavement section with reinforced mattress approach is observed to show better stiffness under traffic and experienced lesser settlement over the geotextile reinforced test track and unreinforced (control section) test track.