ETI ENGINEERING AND TECHNOLOGY IN INDIA
Volume 3 | Issue (1) | April, 2012 | 55-58

A CASE STUDY

The study of rigid and flexible pavement in transportation engineering with special reference to N.H.-1

ARVIND DEWANGAN AND D.P. GUPTA

ABSTRACT : Rigid pavements are those which posses note worthy flexural strength or flexural rigidity. The stresses are not transferred from grain to grain to the lower layers as in the ease of flexible pavements layers the rigid pavements are made of Portland cement concrete-either plain, reinforced or prestressed concrete. The plain cement concrete slabs are expected to take up about 40 kg/cm^2 flexural stress. As the rigid pavements slab has tensile strength, tensile stresses are developed due to the bending of the slab under wheel load and temperature variations thus the type of stress develop and their distribution within the cement concrete slab are quit different. The rigid pavement does not get deformed to the shape of the lower surface as it can bridge the minor variation of lower layer.

Key words : Soil engineering, Soil mechanics, Flexible pavement, Geotechnical, Construction, Structure

How to cite this Article : Dewangan, Arvind and Gupta, D.P. (2012). The study of rigid and flexible pavement in transportation engineering with special reference to N.H.-1. *Engg. & Tech. in India,* **3**(1&2) : 55-58.

Article Chronicle : Received : *12.12.2011;* **Revised :** *01.01.2011;* **Accepted :** *18.02.2012*

Geotechnical engineering is an area of civil engineering concerned with the rock and soil that civil engineering systems are supported by knowledge from the fields of geology, material science and testing, mechanics, and hydraulics what are applied by geotechnical engineers to safely and economically design foundations, retaining walls, and similar structures (Subhas Chander, 2007 and Singh and Chowdhary, 2009). Environmental concerns in relation to groundwater and waste disposal have spawned a new area of study called geo environmental engineering where biology and chemistry are important.

Some of the unique difficulties of geotechnical engineering are the result of the variability and properties of soil. Boundary conditions are often well defined in other branches of civil engineering, but with soil, clearly defining these conditions can be impossible. The material properties and behaviour of soil are also difficult to predict due to the variability of soil and limited investigation. This contrasts with the relatively well defined material properties of steel and concrete used in other areas of civil engineering. Soil mechanics, which define the behaviour of soil, is complex due to stress-dependent material properties such as volume change, stress–strain relationship, and strength.

MEMBERS OF RESEARCH FORUM
Address for correspondence :
ARVIND DEWANGAN, Department of Civil Engineering, Haryana College of Technology and Management, KAITHAL (HARYANA) INDIA
Email: arvinddewangan237@gmail.com

Coopted Authors :
GEETA KAUSHIK, Haryana College of Technology and Management, KAITHAL (HARYANA) INDIA
Email: dpgupta22@gmail.com

Types of pavement structure:

Based on the structural behavior, pavement are generally classified into two categories

- Flexible pavement
- Rigid pavement

The cement concrete pavement slab can very well serve as a wearing surface as well an effective base course. Therefore, usually the rigid pavement structure consists of a cement concrete slab, below which a granular base or subbase course may be provided. Providing a good base or subbase course layer under the cement concrete slab, increases the pavement life considerable and, therefore, works out more economical in the long run. The rigid pavements are usually designed and the stresses are analysis using the elastic theory, assuming the pavements as an elastic plate resting over an elastic or a viscous foundation.

Flexible pavements:

Flexible pavements are those having negligible flexural strength and are flexible in structural actions under the loads. The term flexible is associated with those pavements which reflect the formation of sub grade and of subsequent layers on to the surface. The design of flexible pavement is based on load distributing characteristics of the component layers. Flexible pavements do possess some flexural strength which is, however, negligible.

The load spreading ability of this layer, therefore, depends on the type of material and the mix design factor. Bituminous concrete is one o the best flexible pavement layer materials. Other materials which fall under the group are, all granular materials with or without bituminous binder, granular base and subbase course materials like the water bound macadam, crushed aggregate, gravel, soil aggregates mixes etc.

A typical flexible pavement consists of four components namely:

– Soil sub-grade
– Sub base
– Base course

Surface course:

The maximum vertical compressive stresses on pavement surface is directly under the wheel load and are equal to the contact pressure under wheels (Fig. 1). Due to ability to distribute the stresses to a larger area in space in shape of a truncated cone, the stresses get decreased at the lower layers. Therefore, "layer system concept" was developed. According to this, the flexible pavements may be constructed in a number of layers and the top layer has to be strongest as the highest compressive stresses are to be sustained by this layer, in addition to wear and tear due to the traffic. The lowest layer is prepared surface consisting of the local soil itself, called the sub grade.

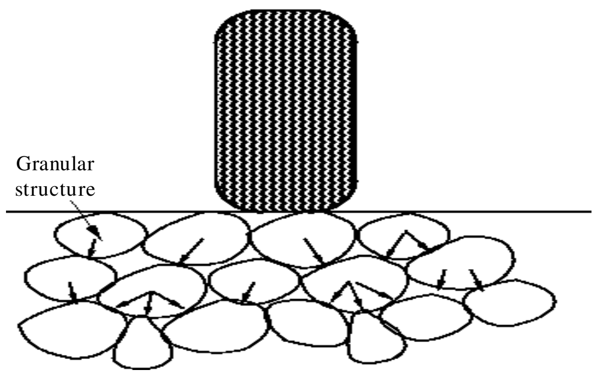

Fig. 1 : Vertical compressive stresses on pavement surface under the wheel load

Specification to be followed:

Grade of bitumen: 60/70, Binder content used: 3 – 4.5 per cent by weight of mix.Amount of aggregates required for 10 meter: 0.60-0.75 meter cube and 0.90-1.10 meter cube for 50 and 75, respectively.

Soil subgrade and its construction:

The soil sub grade is a layer of natural soil prepared to receive the layers of pavements materials placed over it. The loads on the pavement are ultimately received by the soil subgrade for dispersion to the earth mass. It is essential that at no time the soil subgrade is overstressed.

It means that the pressure transmitted on top of sub grade is within the allowable limit,

Not to cause excessive stress condition or to deform the same beyond the elastic limit.

The sub-grade layer of a pavement is, essentially, the underlying ground. It is also known as the formation level, which can be defined as the level at which excavation ceases and construction starts: it's the lowest point of the pavement structure (Fig. 2)

Fig. 2 : Sub-grade of N.H. 1

Therefore, it is desirable that at least 50 cm layer of the sub grade soil is well compacted under controlled conditions of optimum moisture and maximum dry density.

CBR test:

The *California bearing ratio (CBR)* is a penetration test for evaluation of the mechanical strength of road sub-grades and base-courses. To determine the California bearing ratio by conducting a load penetration test in the laboratory. The California bearing ratio test is penetration test meant for the evaluation of subgrade strength of roads and pavements. The results obtained by these tests are used with the empirical curves (Fig. 3) to determine the thickness of pavement and its component layers. This is the most widely used method for the design of flexible pavement.

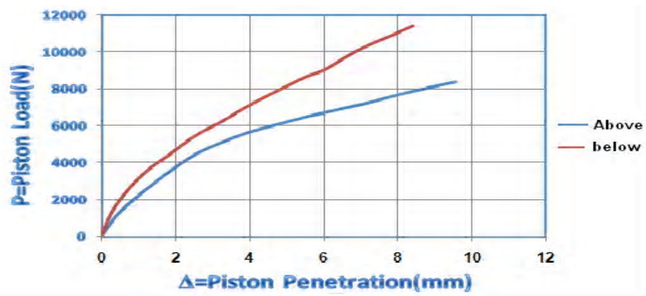

Fig. 3 : Azarshahr clay (1/5) + Urmieh lake water

The test procedure to determine R-value requires that the laboratory prepared samples are fabricated to a moisture and density condition representative of the worst possible in situ condition of a compacted subgrade. The R-value is calculated from the ratio of the applied vertical pressure to the developed lateral pressure and is essentially a measure of the material's resistance to plastic flow. The testing apparatus used in the R-value test is called a stabilometer .Values obtained from the stabilometer are inserted into the following equation to obtain an R-value:

$$R = 100 - \left\{ \frac{100}{\left(\frac{2.5}{D}\right)\left[\left(\frac{Pv}{pH} - 1\right)\right] + 1} \right\}$$

where, R = Resistance value

Pv = Applied vertical pressure (160 psi)

Ph = transmitted horizontal pressure at Pv = 160 psi

D =Ddisplacement of stabilometer fluid necessary to increase horizontal pressure from 5 to 100 psi.

Some typical R-values are:

– Well-graded (dense gradation) crushed stone base course: 80+

–MH silts: 15-30Standard R-Value test methods are:

AASHTO T 190 and ASTM D 2844: Resistance R-Value and Expansion Pressure of Compacted Soils

$$M_R = (\text{or } E_R) = \frac{\sigma_d}{\varepsilon_r}$$

where M_R (or E_R) = resilient modulus (or elastic modulus since resilient modulus is just an estimate of elastic modulus)

σ_d =stress (applied load / sample cross sectional area)

ε_r = recoverable axial strain = D L/L

L = gauge length over which the sample deformation is measured

D L = change in sample length due to applied load

For cohesive soil

q_u (Fl = q_u, For cohesionless soil where

q_u ~. = bearing capacity of footing

qu (p,) = bearing capacity of test plate

BF. = breadth of footing

Bp. = breadth of test plate

If the above method give too high bearing capacity, Engineer should use judgment to limit allowable pressure to be more reasonable for each type of soil condition.The prediction of settlement can also be done from the load-settlement curve from the test.

Roller:

The roller used are smooth wheeled rollers which are of two types: vibratory and tandem roller. The former gross weight is 8-18 tonnes and the latter has 1-14 tonnes.The comcting efficiency depends upon weight, width and diameter of the roller. The smooth wheeled rollers are suitable to roll a wide range of soils, preferably granular soils and pavement material.

– Optimum configuration of drum axle load, amplitudes and centrifugal forces resulting highest compaction performance.

– Superb all-round view and improved front - rear visibility due to new design, resulting in more security and easy handling in confined working areas.

– Imported micron filter for protection of expensive hydraulics. Close - loop hydrostatic drive and vibration system ensuring trouble free operation.

– Full opening steel engine hood (hinge type) ensuring best maintenance-service access. The unique design of engine installation, hydraulic pump at rear resulting easy workability.

– Fully imported hydraulic kit ensures longer life. Fully imported Planetary axle with disc brake.

Conclusion:

This paper shows the required to evaluate the strength characteristics of the soil subgrade, this helps the designer to adopt the suitable values of the strength parameter for design purposes and in case this supporting layer does not come upto the expectations, the same is treated or conditioned to suit the requirements. The flexible pavement layers transmit the vertical or the compressive stress to the lower layers by grain to grain transfer through the points of contact of the granular structure. A well compacted granular structure consisting of strong graded aggregate (interlocked aggregate structure with or without binder material) can transfer the compressive stress through a wider are and thus forms a good flexible pavement layer.

REFERENCES

Subhash Chander (2007). Geotechnical and foundation engineering.

Singh, Alam and Chowdhary, G.R. (2009). Soil engineering In theory and practice.

****