ID: 14397
Subject: Pavement Material Engineering
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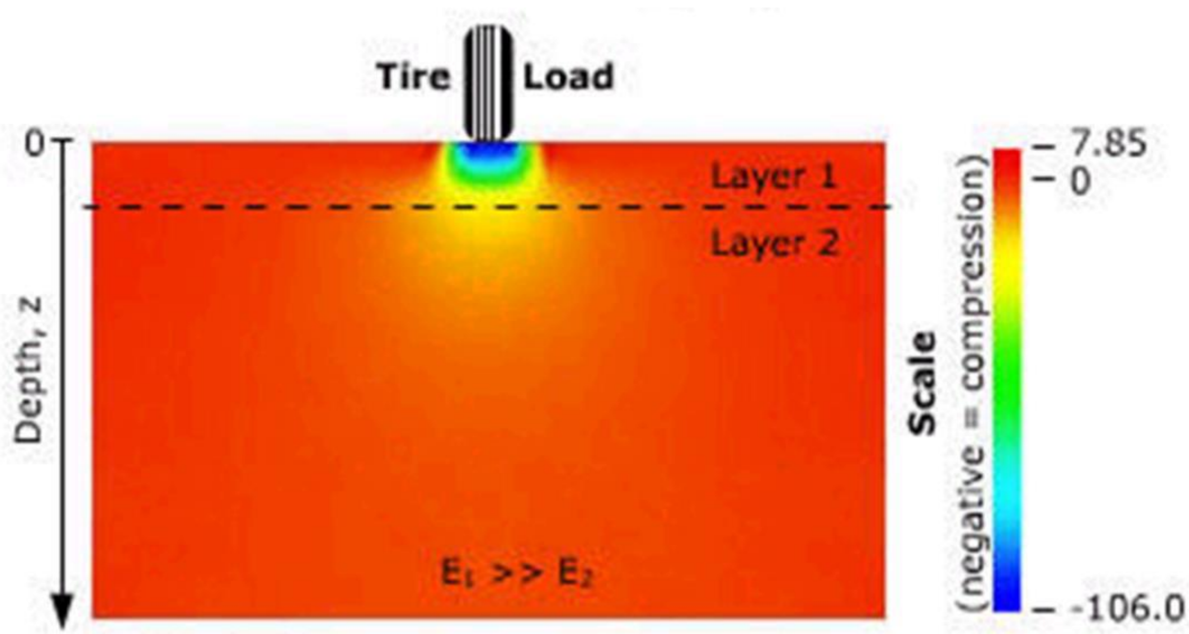
Semester: M.S (Civil Engineering)

QUESTION 1



1. Given Figure. 1 refers to which phenomena of the pavement conditions?

Figure 1 refers to the Stress-Strain phenomenon of the pavement condition. Phenomenon discussed in figure is the load distribution requirement for flexible pavement for which it is compulsory that the material property (elastic modulus/Mr) of upper layer should be higher than lower one, otherwise load transfer to subgrade will not be possible as clear from the figure E1 is greater than E2 thus compression forces reduces to higher extent at the bottom of layer 2. The pavement directly under the load is under compression while most of the surrounding pavement is under little stress. The vertical stress reduces as it goes down to subgrade and it is high at the top surface layer.

2. Find the phenomena and discus that phenomena / behaviour for flexible pavement with granular base and stabilized base.

If we use **stabilized base** in which we mostly add cement or lime to granular base we will enhance its material property i-e MR value than that of granular base. Thus enhancing MR value of base course we will need a superior material with much higher value of E in top layer.
Like for **granular base** E value of surface layer requirement will be lower to fulfil the phenomenon of load transfer than that of using stabilized base.

QUESTION 2

Being a material design expert, if client department award you the consultancy for preparation of the geotechnical report for the upcoming road project.

1. Which steps (General Procedure) you would consider while soil investigation and preparation of Geotechnical Report?

The steps (General Procedure) considered for soil investigation and preparation of Geotechnical report are

a) Desk study
b) Site Reconnaissance
c) Preliminary Investigation
d) Main investigation
e) Geotechnical report

2. Elaborate the steps briefly in your own words.

a) Desk study

Relevant information about all the sites are collected and studied. History of site, general geology of site and other relevant information are studied without visiting the site

b) Site Reconnaissance

Site visit is conducted to check general topography, to check its terrain (plain, or hilly), general views of the site, presence of water courses and other local problems. The initial data is also confirmed in site visit.

c) Preliminary Investigation

It includes preliminary BHs and preliminary tests.

d) Main Investigation

In this step detailed investigation is done. At field, sampling, test pits, In-situ tests, boring , SPT etc are carried out. The samples are brought to the laboratory and further lab tests are conducted i-e Atterberg limits, CBR test, direct shear test, sieve analysis, resilient modulus, permeability etc.

e) Technical Report.

After above steps and analysis of test results, a geotechnical report is prepared in which conclusion and recommendations are made in light of the results of geotechnical investigation.

QUESTION 3

The below Figure. 2-1.7 refers to the CBR results showing penetration of the piston in X-axis and bearing value on Y-axis. At y-axis right side of the graph, it shows ranges in percentage from 5% to 100% referring to different degrees of the subgrade (any material) quality in reference to CBR test.

1. Please elaborate the Figure in your own words in detail.

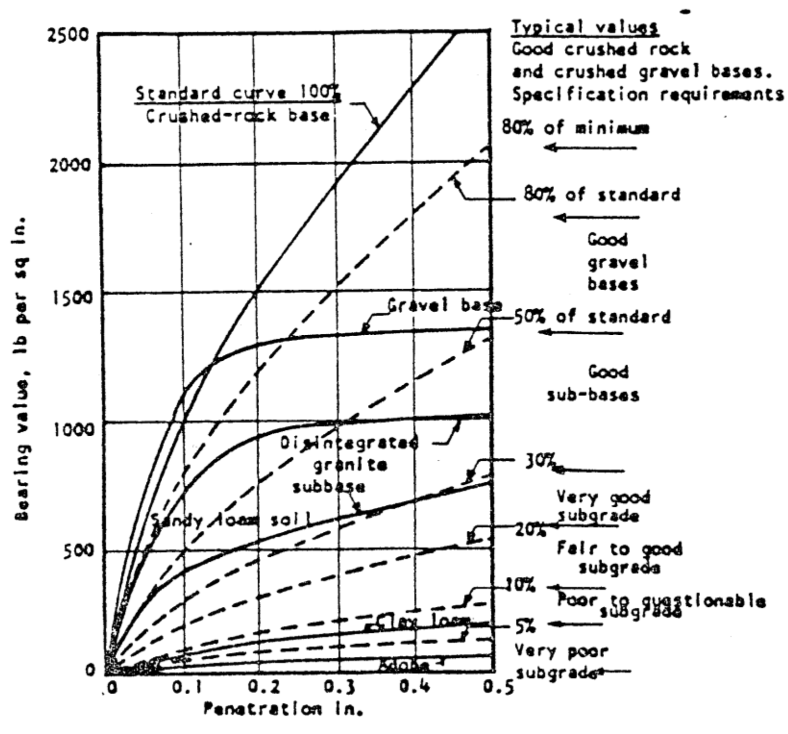


Figure 2-1.7. CBR Testing Procedure and Load-Penetration Curves for Typical Soils.

The graph shows the relationship between penetration values taken from CBR test and bearing value in lb per sq inch. It shows recommended values of CBR test in percentage of different type of soil on right side of Y-Axis .The different load penetration curves are plotted and it gives the bearing values for different penetration values.

The dotted lines shows the percentage values of CBR .

- If we take the **ADOBE SOIL** load penetration curve, the trend it shows, tells that it gives negligible resistance to the penetration so the bearing value is also negligible and the curve comes under the dotted line of 5% CBR so it is considered very poor subgrade.
- Similarly **CLAY LOAM** penetration curve indicates that it shows very less resistance to penetration and at bearing value of around 110 lb per sq inch it gives full penetration of 0.5 in. The curve comes between 5% and 10% CBR value so it is considered poor subgrade.
- **SANDY LOAM** Curve shows an increasing trend and at bearing value of around 750lb per sq inch it gives penetration of 0.5 in. Sandy loam subgrade is considered very good subgrade.
- If we take **DISINTEGRATED GRANITE** load penetration curve, the bearing value increases to a value of 1000 lb per sq inch and at this bearing value it gives penetration of 0.3 inch. From this onwards, there is no resistance to penetration and gives maximum penetration of 0.5 inch at the same bearing value of 1000 lb per sq inch. It comes between 30% and 50% CBR Value, considered fair quality subbase.
- **GRAVEL BASE** load penetration curve shows an increasing trend and at bearing value of around 1350lb per sq inch, it gives penetration of 0.2 inch. After that, it gives maximum penetration of 0.5 inch at the same bearing value of 1350lb per sq inch. It falls below 80% of recommended CBR value of base course, so considered poor quality base course.
- Now if we consider **CRUSH ROCK BASE** load penetration curve, it shows high resistance to penetration and at highest bearing value of 2500 lb per sq inch, it gives penetration of around 0.45 inch. This load penetration curve comes above 80% of dotted CBR, so it is considered very good quality base course material.

QUESTION 4

1. **In the Figure given below what is Dry of optimum and Wet of optimum? Explain?**

DRY OF OPTIMUM

From the figure, as the water content increases, the particles develop larger and larger water films around them which tends to lubricate the particles and make them easier to be moved about and reoriented into a denser configuration. The soils are always flocculated. Samples compacted dry of optimum have higher strengths than those compacted wet of optimum.

WET OF OPTIMUM

Eventually water content is reached where dry density does not increase any further and maximum dry density of soil is obtained. After this water starts to replace soil particles in the mold and since Pw<<Ps, the dry density starts to decrease. The amount of water added is more than OMC then it is called as wet of optimum.

2. What are effects of compaction on Engineering properties of soil? Details.

When a soil is compacted, it changes its engineering properties and behaves differently. Some of the engineering properties which changes on compaction are described below

a) Compressibility

The Compressibility of compacted soil varies according to the amount of pressure applied. For low-pressure range, compressibility is more for soils which are compacted to wet of optimum than soil compacted to dry of optimum. Similarly, for high-pressure ranges, compressibility is more for soils which are compacted to dry of optimum than soil compacted to wet of optimum.

b) Permeability

Compaction reduces the voids present in the soil hence permeability also reduces. At a particular density, for the same soil sample, permeability is more for soils which are compacted to dry of optimum than those compacted to wet of optimum.

c) Shear strength

Shear strength of soil compacted to dry of optimum is more than those compacted to wet of optimum at lower strains. At higher strain, soil compacted to wet of optimum will have more shear strength. Type of compaction, drainage conditions and type of soil also influence the shear strength of compacted soil.

d) Swelling of Soil

When the soil is compacted to dry of optimum, the soil is in need of water and it swells easily when contacted with water. water is compacted to wet of optimum, the soil particles are oriented in a dispersed manner and swelling does not occur.

So, to avoid swelling, soils should be compacted to wet of optimum.

e) Shrinkage of Soil

Shrinkage is more for the soil compacted to wet of optimum than dry of optimum.

In case of dry of optimum compaction, soil particles are in random orientation and they are in stable condition.

But in case of wet of optimum, soil particles are in parallel orientation and they are unstable which makes it easy for packing of particles causing shrinkage.

f) Pore Water Pressure

Pore water pressure is high for those soil whose water content is high. Hence, soils compacted to wet of optimum compaction will exhibit more pore water pressure than soil compacted dry of optimum.

g) Stress-strain Behavior of Soil

Samples compacted dry of optimum produce much steeper stress-strain curves with peaks at low strains, whereas samples compacted wet of optimum, having the same density, produce much flatter stress-strain curves with increase in stress even at high strains.