DEPARTMENT OF CIVIL ENGINEERING

Mid Assignment / Quiz (Spring 2020)
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Semester: M.S CEM

Subject: Pavement Material Engineering
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Q.No.1.

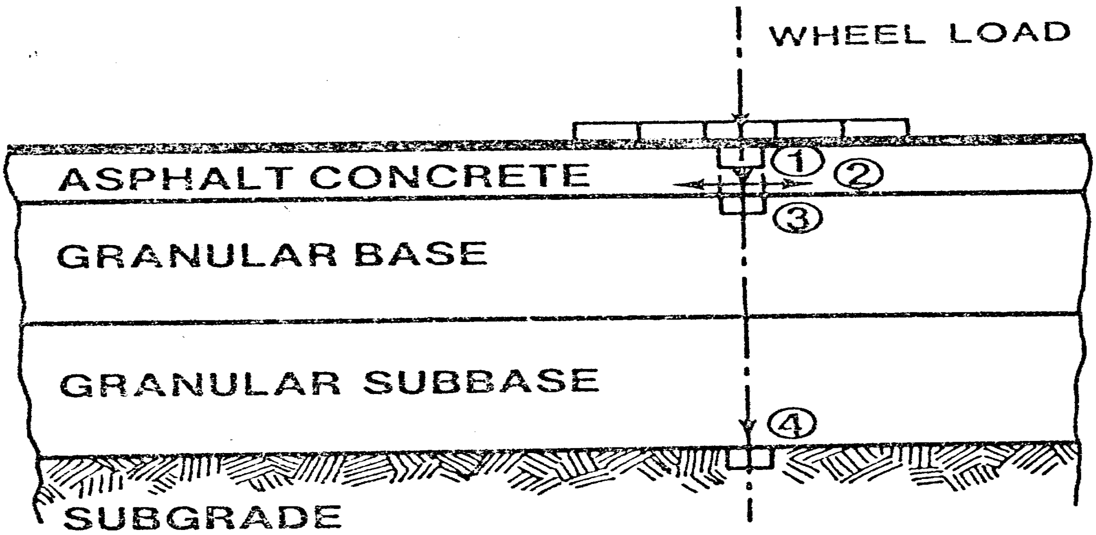
1. **Given Figure. 1 refers to which phenomena of the pavement conditions?**

Answer: The given figure refers to **Vertical Stress phenomenon** for flexible pavements, where a wheel load is applied over a flexible pavement.

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

Answer: According to this phenomenon, the pavement directly under the wheel load is under compression, while most of the surrounding area is under very little stress. The elastic modulus, or modulus of elasticity, describes the stiffness of a material, i.e. its capacity to bear and spread load. In an ideal road structure the modulus of the materials in the pavement layers should decrease from top to bottom. This is because the closer the material is to the surface, the greater will be the stress caused by the wheel load. A stiffer material will spread the load better over the layer below. Behavior for flexible pavement with granular base and stabilized base are as follows.

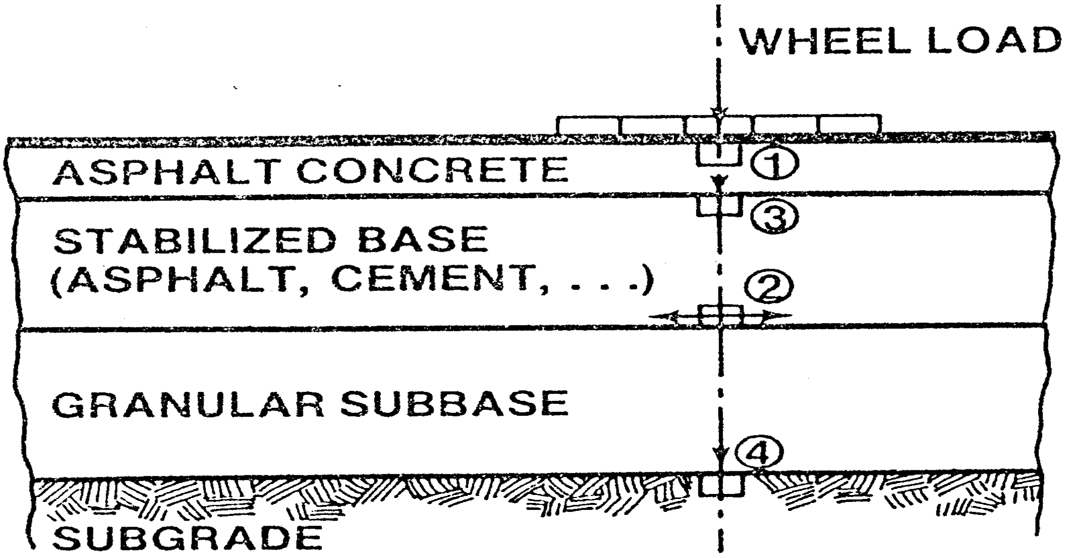
A) **For Granular Base:**



Typical Asphalt flexible Pavement with Granular Base shows the critical stress/strain locations.

1. Compressive Strain and it can possibly cause Rutting.
2. Tensile Strain and it can cause Fatigue or alligator cracking.
3. Compressive Strain which can cause Rutting.
4. Compressive Strain which can cause Rutting and depression.

B) **For Stabilized Base:**



Typical Asphalt Flexible Pavement with Stabilized Base showing the critical stress/strain locations.

1. Compressive Strain, which results in Rutting.
2. Tensile Strain, which results in transverse reflective cracking or fatigue cracking.
3. Compressive Strain, It Cause Rutting.
4. Compressive Strain, Causes Rutting and Depression.

Q.No.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.**

Answer:

In soil investigations, we need a complete picture of sub surface conditions. Following are the general steps/ procedure to be followed while soil investigation.

1. Collection of preliminary Data.
2. Reconnaissance
3. Site Works
4. Laboratory Tests.
5. Reports.

2. **Also elaborate the steps briefly in your own words.**

1. **Collection of Preliminary Data:**
   It is the first step for the preparation of geotechnical report. In this we check the general geology of the site, any existing reports about the site and pavement details.

2. **Reconnaissance:**
   In this step we organized a Site Visit and examine the General Topography General Ground Slope of the area. We also check the Property in Proposed ROW and Presence of Water Courses and Soil Stratification from Deep Cuts and Prospect Material Sources and assure if there is Any Local Problems (Floods, Cracks, Subsidence.)

3. **Site Works:**
   The third step is site works in which we make test pits and take samples from the area which is to be tested in the laboratory. And measure the in-situ moisture and density of the soil.

4. **Laboratory Tests:**
   In this step we made laboratory tests like classification analysis (sieve Analysis and Atterberg's limits) and strength tests, consolidation and settlement and chemical testing. Reports are prepared which are compiled with the field conditions and then take appropriate decisions based on these results.

5. **Reports:**
   The final stage are reports based on the testing and field evaluation.

Q.No.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.**

Answer:

Figure (from Porter's paper [1942]) shows typical bearing values (psi) versus penetration (in.) for various materials ranging from "very poor subgrade" (CBR up to 5) to "good crushed rock bases" (CBR of 100). The CBRs are in terms of percentages since the bearing value is divided by 1,000 psi (0.1 penetration) or 1,500 psi (0.2 in. penetration) which represents the bearing value of a crushed rock material (refer to "standard curve 100%" in Figure).

The figure shows that soils like clays and adobe have very low CBR values and hence are very poor subgrade materials, with low bearing values. As the CBR values increases like in sandy loam soils the bearing values of the soil also increases hence are very good for subgrade.

For a good sub-base material, the disintegrated granite shows good CBR value of 30-40%. And the hard rocks whose CBR values are maximum are used for the base and wearing courses.

The figure also shows that with the increase in penetration size, the CBR value percentage also increases.
We can say that a soil with CBR value 0 is the least suitable or very poor soil and with the increase in the CBR value percentage the suitability of soil also increases. Hence a CBR value more than 30 is good for subgrades and sub-bases and bases.

Q.No.4.

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

   Answer:

Starting at low water contents, as the water content increases, the particles develop larger and larger water films around them, which tend to "lubricate" the particles and make them easier to be moved about and reoriented into a denser configuration.
However, we eventually reach a water content where the density does not increase any further. At this point, water starts to replace soil particles in the mould, and the dry density curve starts to fall off.

Dry of Optimum: When the soil is drier than the **optimum compaction of the soil**, then it is called **dry of compaction**. Dry of optimum soils are always flocculated. These soils need more compaction.

Wet of Optimum: When the soil is wetter than the **optimum compaction of the soil,** then it is called **wet of compaction.** In Wet of optimum, fabric becomes more oriented or dispersed. These soils need lesser water supply and compaction.

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

   Answer:

Now we will discuss about effects of compaction on the properties of soil. The following properties are affected.
1) Soil structure
2) Permeability
3) Swelling
4) Pore Water Pressure
5) Shrinkage
6) Compressibility
7) Stress-Strain Relationship
8) Shear Strength

1. **Soil Structure:**
   The water content at which the soil is compacted plays an important role in soil structure. Soils compacted at water content less than optimum water content have flocculated structure. Soils compacted at water content more than optimum water content have dispersed structure.

2. **Permeability:**
   Permeability of soil depends on void size. As water content increases, there is an improved orientation of particles resulting in reduction of void size and permeability. Above optimum water content, the permeability slightly increases. If compactive effort is increased, the permeability decreases due to increased dry density.

3. **Swelling:**
   The effect of compaction is to reduce void space. Hence swelling is enormously reduced. Further soil compacted dry of optimum exhibits greater swell than compacted on wet side because of random orientation and deficiency of water.

4. **Pore Water Pressure:**
   It is defined as pressure of ground water held within a rock or soil, in gaps between particles (pores). The pore water pressure for soil compacted dry of optimum is therefore less than that for the same soil compacted wet of optimum.

5. **Shrinkage:**
   Soils compacted dry of optimum shrink less when compared to compacted wet of optimum. The soils compacted wet of optimum shrink more because the soil particles in dispersed structure can pack more efficiently.

6. **Compressibility:**
   The flocculated structure on the dry side of optimum offers greater resistance to compression than the dispersed structure on wet side. So, the soils compacted dry of optimum are less compressible.

7. **Stress-Strain Relationship:**
   The soil compacted dry of optimum have steeper stress-strain curve than those on wet side. The strength and modulus of elasticity of soil on dry side of optimum will be high. Soil compacted dry of optimum shows brittle failure. And soils compacted on wet side experience increased strain.

8. **Shear Strength:**
   In general, the soils compacted dry of optimum have a higher shear strength than wet of optimum at lower strains. However at large strains the flocculated structure of soil is broken, and ultimate strength will be equal for both dry and wet sides.