Pavement Material Engineering

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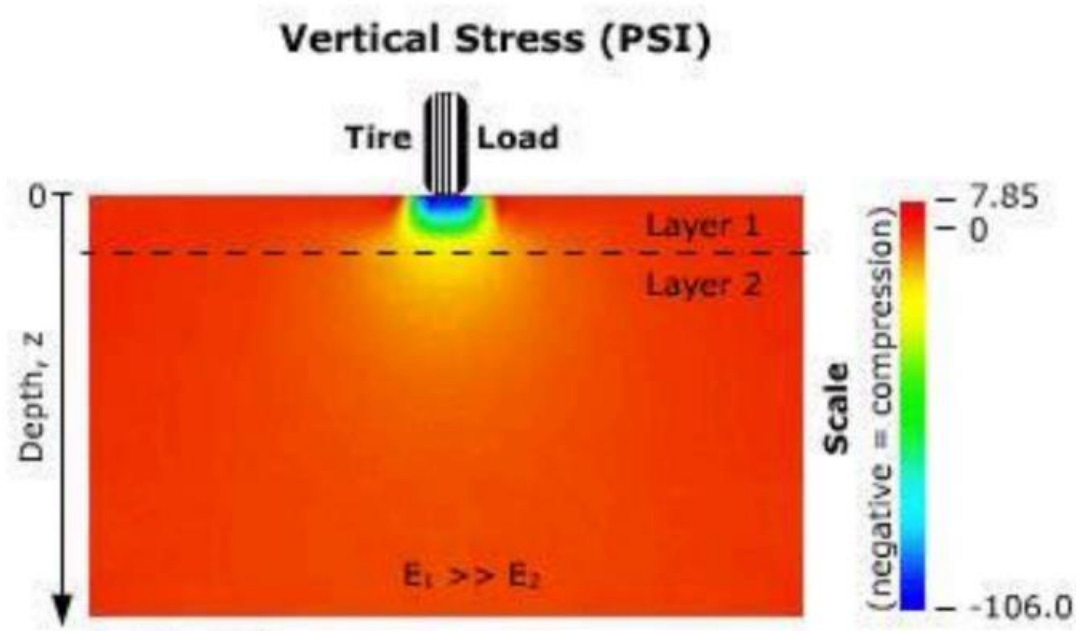
Answer No. 01



Part 01:

The figure 1 above shows the stress-strain phenomena in flexible pavement.

Part 02:

The vertical load applied by tyre shows maximum intensity of compression on Top layer of the road structure while load transfer on Layer 2 shows variations in compression values with depth and lower down on subgrade layer. The blue area in the figure is the most compressed zone while the green /yellow /sky area shows the moderate zone of compression and the red area shows the less effected (unaffected) zone by compression.

- The vertical stress applied by wheel on the stabilized base and granular base shows same compression strain and distresses while the behavior of granular and stabilized base is different in tensile strain.
- The effect of the tensile strain on stabilized and granular base has different point of impact.

Answer No. 02

Site investigation:

a) It is process of collecting information of a specific site and surrounded area which are proposed for a project.
b) Geologic and geotechnical assessment of site is one of the most important aspects of safety evaluation for both an existing and a new project
a) Insufficient investigations are harmful, which results in huge loss of life and property.

Part 01:

Site investigation steps for preparation of Geotechnical report:

1. Desk Study
2. Site Reconnaissance
3. Initial Design Investigations
4. Final Design Investigations
5. Geotechnical Investigation Report
6. Observation Made During Construction

Part 02:

Site investigation steps explanation:

1. Desk study:

- Very first phase of investigation process which is aimed at gathering maximum available information about the proposed sites
- Available information i.e. map studies, prior investigations is collected and reviewed.
- All gathered information is carefully analyzed to determine the following:
  a) Basic soil and rock types and their distribution in the site area along with their engineering properties.
  b) Estimation of seismicity in the site area and identify Faults.
  c) Geological and geomorphic history of the area and most importantly water table.

2. Site Reconnaissance :

- Required to verify the information obtained during desk study to gain maximum possible information without involving field explorations.
- The reconnaissance should include a thorough inspection of key features like landslides, faults, area subsidence etc.
- A regional geological model is developed which contains all the information gathered also describes the missing details and information that may need further careful consideration during subsequent investigation phases.

3. **<u>Initial site investigation:</u>**

- investigations should include geophysical surveys and subsurface exploration (on a limited scale) to identify:

a) Distribution of subsurface material, ground water & Potential structure sites etc.
b) Material testing to get information on foundation characteristics.

4. **<u>Final design investigations:</u>**

- Final design investigations are an extension of geophysical surveys and subsurface explorations through cross-hole surveys
- Borehole photography is carried out to obtain information on fracture frequency and orientation etc.
- Complete Material testing are carried out.
- Necessary information is obtained to:

a) Design project
b) Estimate quantities
c) Develop cost estimates, rates of construction, prepare plans and specifications

5. **<u>Geotechnical investigation report:</u>**

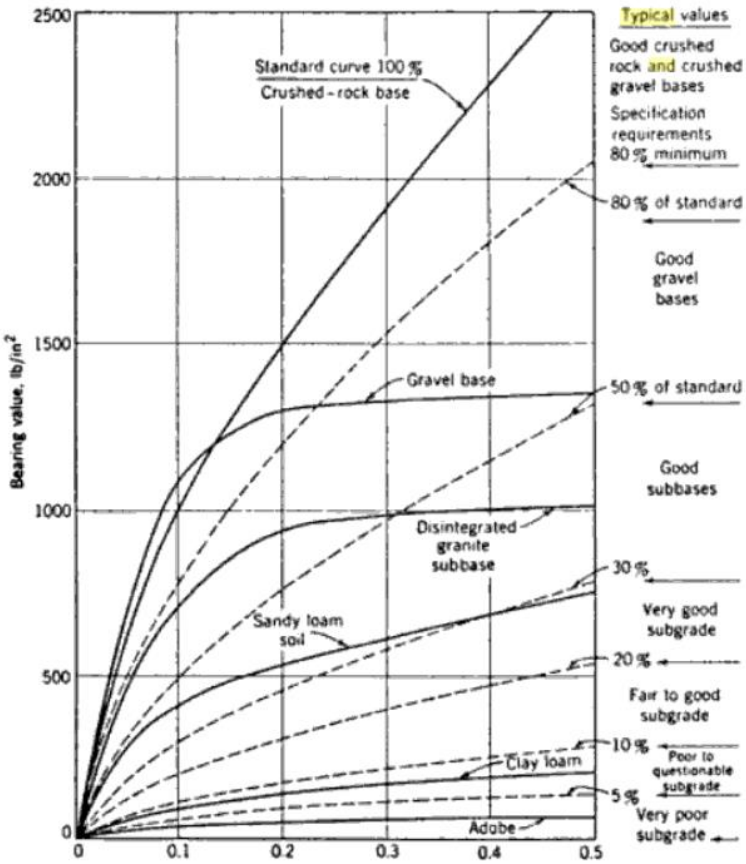
- A comprehensive report including a detailed description of observations, findings, and opinions etc., should be prepared.
- The Geotechnical Report will contain as follows:

a) Description & geology of site with plan/map
b) Description of borings with logs
c) Field and laboratory tests
d) Discussion & conclusions
e) Appendices, tables and figures

6. **<u>Observation Made During Construction:</u>**

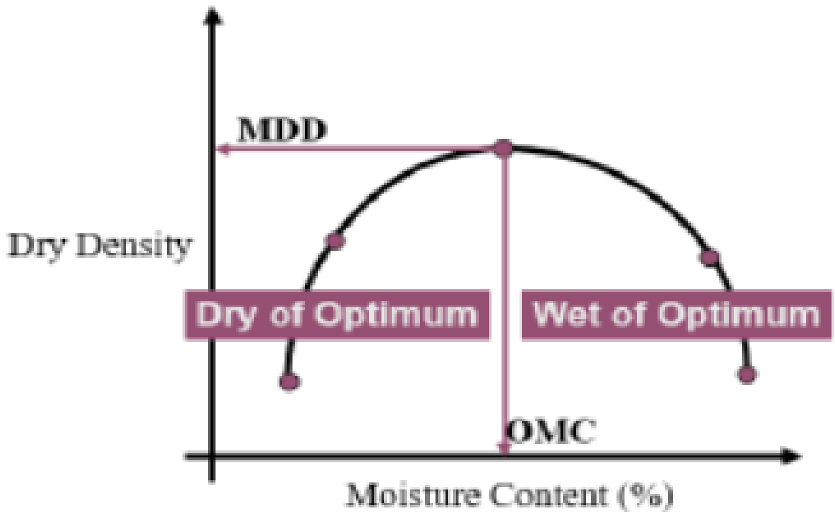
This is one of the most important parts of investigations and allows modification to design in case an unforeseen situation is encountered.

Answer No 03:



- The figure shows the relationship between bearing value and penetration value with respect to CBR values for quality of soil in percentages from 5% to 100% .The dotted line shows the standard value of CBR for different soils.
- The adobe soil shows a maximum of 0.5 "penetration at 75 lb per sq inch without showing any kind of resistance and thus its very poor subgrade soil.
- The clay loam shows a maximum of 0.5" penetration at 200 lb per sq inch, showing little resistance to bear load thus it is categorized as poor subgrade soil.
- The sandy loam shows a maximum of 0.5" penetration at 750 lb per sq inch, showing little more resistance to bear load thus it is categorized as good subgrade soil.
- The Disintegrated granite sub-base shows a maximum of 0.5" penetration at 1010 lb per sq inch, showing approximately 40% of standard CBR value thus it is categorized as good sub-base.
- The Gravel base shows a maximum of 0.5" penetration at 1350 lb per sq inch, showing more than 50% of standard CBR value thus it is categorized as good gravel-base.
- The crushed rock base shows a maximum of 0.45" penetration at 2500 lb per sq inch, showing more than 80% of standard CBR value thus it is categorized as very good quality crushed rock-base.

Answer No 04:



Optimum Moisture Content:

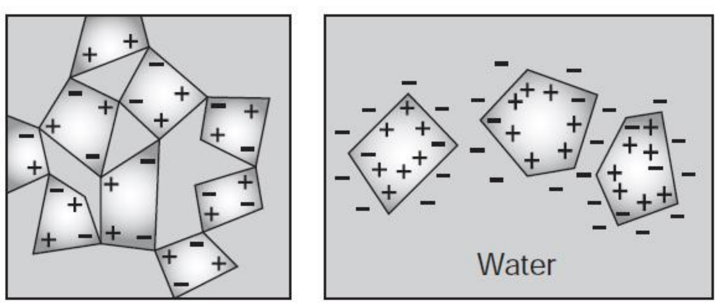
Optimum Moisture Content refers to the water content of a compacted soil. OMC of a soil is also called the compacted dry of optimum or wet of optimum on the dry side or wet side of OMC, respectively. The structure of a compacted soil is not similar on both sides even when the dry density is the same. This difference has a strong influence on the engineering characteristics of the soil.

Dry of optimum:

When the soil is drier than the optimum compaction of the soil, then it is called dry of compaction. These soil 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. These soil need lesser water supply and compaction.



Before After

- The Diagrammatic representation of flocs formation by soil particles before addition of water and dispersion of flocs after addition of water

- In view of the above figure the compactive effort of soil show flocculated structure on dry side (i.e. soil particles are oriented randomly) while it shows dispersed structure on wet side (i.e. particles are more oriented in a parallel arrangement perpendicular to the direction of applied stress).This whole process happens due to the well establish absorbed water layer where each particle is on the wet side.

2) Effects of compaction on engineering properties of soil:

The following properties are effected…

1) Soil structure
2) Permeability
3) Swelling
4) Pore Water Pressure
5) Shrinkage
6) Compressibility
7) Stress-Strain Relationship
8) Shear Strength
    a) Shear strength at molded water content
    b) Shear strength after saturation

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
- At Point A, the water content is low and attractive forces are predominant, so results in flocculated structure.
- As the water content is increased beyond optimum, the repulsive forces increase and particles get oriented into a 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.
- 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.

THE END