DEPARTMENT OF CIVIL ENGINEERING
Mid Assignment / Quiz (Spring 2020)

Submitted By: **MUHAMMAD ASIF**

ID **15267**

Subject: **Pavement Material Engineering (CE-577)**

Instructor: **Engr.Shabir Ahmad**

Dept & Semester: **MS (CEM) Final semester**

Q No. (01)

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

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

Ans NO (1)

PART (1)

The figure given represent stress and strain phenomenon for flexible pavement.There are various modes in which the pavement fails. Cracking of the surface layer and permanent deformation of the pavement system which manifests as rutting on the pavement surface. Larger and more conc entrated loads produce larger stresses and strains, with thicker layer carrying higher flexural stresses than thinner layers. In pavement analysis, loads on the surface of the pavement produce two strains which are believed to be critical for design purposes. These are the horizontal tensile strain; at the bottom of the asphalt layer and the vertical compressive strain; at the top of the subgrade layer. The design criteria will be used for an analytical approach of pavement design

Ans NO (1)

PART NO (2)

The phenomenon of Burmister two layer theory is adopted in the present diagram.Burmister proposed a method for design of a two layer flexible pavement by the Simplifying assumption that the subgrade is the bottom layer and the surfacing, base and Sub base combine to form the top layer .Burmister further assumed that the op layer can be treated as an elastic slab infinite in the horizontal plane . The top layer is supposed to be resting on the bottom the bottom layer (in the case of subgrade) which is assumed to be semi infinite solid of lower modulus of elasticity compared to that of the top layer.

The diagram show deflection of road at the center of wheel

The figure show the deflection of flexible pavement under the center of wheel load when the load applied on it

It is generally accepted that pavements are best modeled as a layered system, consisting of layers of various materials (concrete, asphalt, granular base, sub-base etc.) resting on the natural subgrade. The behavior of such a system can be analyzed using the classical theory of elasticity (Burmister, 1945).

The Layered Elastic Analysis (LEA) is a mechanistic procedure capable of determining pavement responses (stress and strain) in asphalt pavement. The major assumptions in the use of layered elastic analysis are that;

The pavement structure is regarded as a linear elastic multilayered system in which the stress-strain solution of the material are characterized by the Young's modulus of Elasticity E and poison's ratio μ.

ii) Each layer has a finite thickness h except the lower layer, and all are infinite in the horizontal direction.

iii) The surface loading P can be represented vertically by a uniformly distributed vertical stress over a circular area.

Flexible Pavement

Flexible pavements are most commonly used for low to medium volume roads with significant usage also found in high volume interstate highways and airfieldrunways, taxiways and aprons subjected to heavy aircraft gear/wheel loads. As the demand for applied wheel loads and number of load applications increases, it becomes very important to properly characterize the behavior of subgrade soils and unbound aggregate layers as the foundations of the layered pavement structure.

Flexible pavements will transmit wheel load stresses to the lower layers by grain-to-grain transfer through the points of contact in the granular structure. The wheel load acting on the pavement will be distributed to a wider area, and the stress decreases with the depth.

Contour plot through plane that show different plot results, maximum, minimum, mean and their graphics are presented in diagram, to incorporate the material properties of the pavement layers and the moving traffic load, in the analysis of the flexible pavement, using the finite element method.

As observed above analysis from laboratory test result and standard specification result, the vertical deflection reduces as the modulus increases at all values of E.

Q. No. (02)

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

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

ANS No (02)

Soil reports also called "geotechnical soil reports" are usually prepared by experience licensed engineer the report gives understanding .of earth conditions effecting a structure and required where the foundation will be supported by fill, project on steep slop on where alot of .grading will be done, location with high ground water may also required a soil investigation report prior to construction . activitiies being a material design expert ,the following step should be included by the soil engineer in charge .

1) completely familiar .with the kind of information required from the investigation .
2) knowledge of type. size and importance of the project.

2) preparation of layout plan of that project .
4) preparation borehole layout plan which include number and spacing of boreholes , deepth .and frequency of sampling .

5) selection of proper drilling and sampling equipments .
6) selection of personnel to supervise the field investigation .
7) marking on the layout plan any additional type of soil investigation.

8)preparation of guidelines for laboratory testing of collected samples.

The following phase are involved in soil investigation.
Phase - 1) desk study.

Phase - 2) preliminary reconnaissance.

phase - 3) detailed soil exploration.

Phase - 4) laboratory test.

Phase -5) report writing.

Phase -1) DEST STUDY .

This is the phase where all the information that is available are . collected. The information which need to be collected are

- site plane.
- type , size and importance of the structure.
- loading conditions.
- previous geo tech reports.
- topographical maps.
- still paragraphs etc .

Phase 2) PRELIMINARY RECONNAISSANCE .

In this phase absite visit is made to get a general idea of the topography and geology of the site . All the information gathered in phase 1 are taken to compare with the site . The following things are required to be noted.
> photograph of the site and its neighbourhood .

> access to the site for workers and equipment.

> sketches of all the fences, utility post, walkway , drainage etc .

> available utility services such as water and electricity .
> sketches of topography.

> exterior and interior cracks on existing building or any tilt .
> geological features from any exposed area such as road cut or excavated portions.

PHASE -3) DETAILED EXPLORATION.

The objectives of the detailed soil exploration are.

> to determine the geological structure which should include the thickness, sequence and extent of the soil strata.

> To determine the ground water condition.
> To obtain disturbed and undisturbed samples for laboratory test .
> To conduit in sites test.

PHASE _4) LABORATORY TESTING .

The objective of laboratory test are

> to classify the soil.

> to determine soil strength and failure stresses and strains , Stress-strain response , permeability, compactions properties and settlement parameters.

PHASE -5) REPORT WRITING .

The report must contain a clear descriptions of the soil at the site , method of exploations, soil statigraphy in sites and laboratory test methods and result and the location of the ground water , recommendation regarding construction operation .

Q. No. (03)

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

AnsN0 (3)

In this graph the X-axis shows the penetration resistance offered by subgrade materials to the standar piston of CBR apparatus while Y-Axis shows the corresponded strength of the materials in pound per square inch.

The graph cure represent the 100% value of CBR as per applied load and given penetration.

From the figure it shows that

At the bottom the value of CBR 5% indicate very poor subgrade.

According to the graph when the penetration value reach to his maximum value 0.5in under very little load less than 200lbs.

The 1st bold curve at the bottom which indicate 5% value of CBR represent clay loam. The graph shows poor condition of soil as it reached to his highest penetration value at the load of above 250lbs,its refereed to be poor to questionable subgrade.

The next cure which represent 10% of the standard penetration value give a fair to good subgrade, its show the diff between 5% and 10%. Its means the penetration value of this cure is more than the previous curve and the same it bearing load which is more than the previous layer.

The next cure give us CBR value of 20% under the bearing load of more than 500lbs at the maximum penetration rate which represent very good subgrade. The main diff b/w this curved and the previous curve is that its slope slightly increased as compared to the previous one which represent high bearing load and same high penetration value

The next curve are plotted bold at 30% CBR value which represent very good subgrade, and show sandy loam soil. The curve drops at the end which shows that their must happening shear failure under high stresses.

The third bold line the graph represent disintegrated granite sub base have a linear start up to approximately 700lbs, after that graph slopes started deceasing and get flattened which represent that the materials is good at handling the lighter stresses but weaker at higher point, the graph if interpolated we get up to 70% of the strength but it declined after 700lbs

The fourth bold curve indicate that the gravel base is same as the standard graph up tp approximately1300lbs stress but than a rapid declination is observed and then reached to the point of 50% of the standard strength. This graph also indicate the behaviors of gravel base same as that of disintegrated granite subcase which is that it is weaker at higher loads

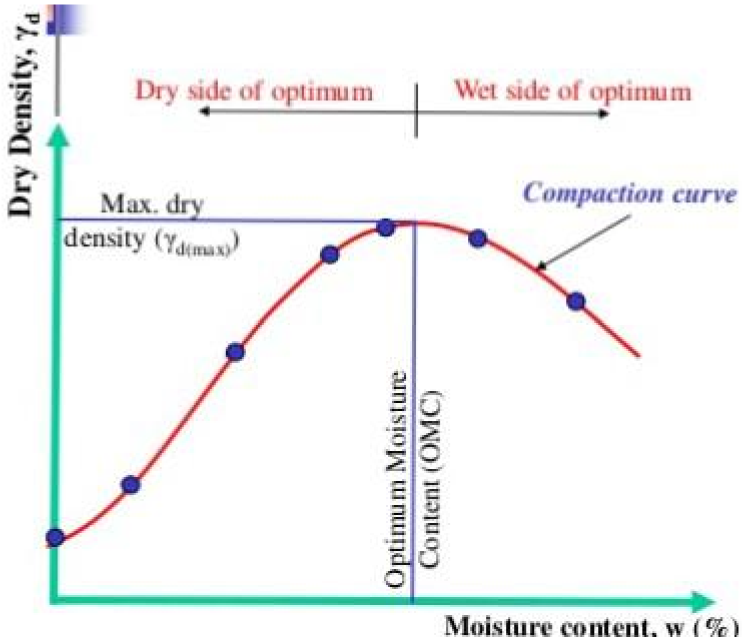
The summary of the graphic representation is that at the soil material up to 20% of the standard materials shows consistency in the graph progression, I.e. the week materials remain weaker till the full application of load, while if considered above the 20% we can see that the graphs loses their consistency I.e. the graph start a very steep progression or they are linear at the start but after some points they losses their consistency and almost get flattened at the end.

Q. No. (04)

1. In the Figure given below what is Dry of optimum and Wet of optimum? Explain? 2. What are effects of compaction on Engineering properties of soil? Details.

Dry of Optimum:

Optimum moisture content of the soil to the dry side of OMC is called dry of optimum.
Water as a lubricant here and so become easy for particles to rearrange and orient.
Wet of optimum:
Optimum moisture content of the soil to the wet side of the OMC is called wet of Optimum.
Here the water are too much and replaces the soil particles.



The water content of a compacted soil is expressed with reference to the OMC. Thus, soils are said to be compacted dry of optimum or wet of optimum (i.e. on the dry side or wet side of OMC). The structure of a compacted soil is not similar on both sides even when the dry density is the same, and this difference has a strong influence on the engineering characteristics.

Soil Structure

For a given compactive effort, soils have a flocculated structure on the dry side (i.e. soil particles are oriented randomly), whereas they have a dispersed structure on the wet side (i.e. particles are more oriented in a parallel arrangement perpendicular to the direction of applied stress). This is due to the well-developed adsorbed water layer (water film) surrounding each particle on the wet side.

Swelling

Due to a higher water deficiency and partially developed water films in the dry side, when given access to water, the soil will soak in much more water and then swell more.

Shrinkage

During drying, soils compacted in the wet side tend to show more shrinkage than those compacted in the dry side. In the wet side, the more orderly orientation of particles allows them to pack more efficiently.

Construction Pore Water Pressure

The compaction of man-made deposits proceeds layer by layer, and pore water pressures are induced in the previous layers. Soils compacted wet of optimum will have higher pore water pressures compared to soils compacted dry of optimum, which have initially negative pore water pressure.

Permeability
The randomly oriented soil in the dry side exhibits the same permeability in all directions, whereas the dispersed soil in the wet side is more permeable along particle orientation than across particle orientation.
Compressibility

At low applied stresses, the dry compacted soil is less compressible on account of its truss-like arrangement of particles whereas the wet compacted soil is more compressible.

2. effects of compaction on the engineering properties of soil.

Now we will discuss about effects of compaction on the properties of soil. The following properties are effected... 1) Soil structure 2) Permeability 3) Swelling 4) Pore Water Pressure5) Shrinkage 6) Compressibility 7) Stress-Strain Relationship 8) Shear Strength a) Shear strength at moulded water content b) Shear strength after saturation.

1. Effect on 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.

THE END

THANK YOU SIR