Q#01

Ans (a) The given figure is stress and strain phenomena. Complex dynamic loading phenomena is caused by moving traffic load on road. Main effects considered are

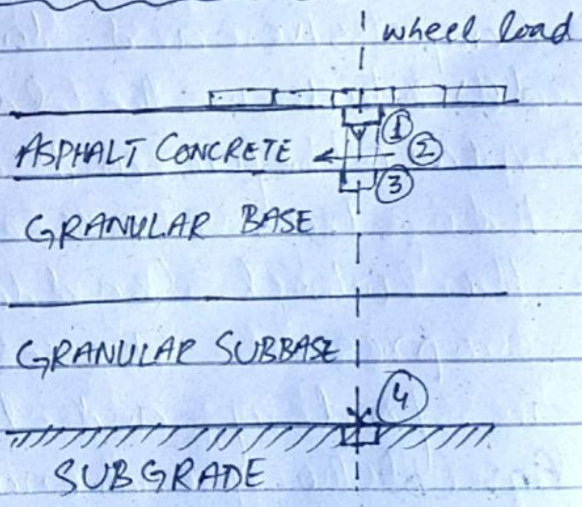
1) wheel load causing stress
2) Time dependent response of the road material
3) Stress induced by impact load.

Figure provides various stresses such as vertical stress, horizontal stress and shear stresses in the top of the layers. Compressive and tensile stresses are also described in the layers. The principle stresses rotate before and after the wheel load. the stresses are mainly tensile under the wheel load while there are compressive stresses in the bound layers in front of and behind the wheel load.

Ans (b) The phenomenon produced under traffic traffic loading refers to stress strain relationship in the pavement layers, which is further categories into vertical and horizontal stress and strains. vertical stress Refers to the direct critical load which is transferred to each layer under the axis of the wheel load line of action. the vertical strain is responsible for the compression of the below layers. This compression is transferred to the

sub layers with respect to the above existing layer. if the bearing capacity of the soil is low more strain will be transferred to the below layers and vice versa.
The horizontal strain is caused due to the effect of vertical strain which is transferred through compact contact of grains. It may also be caused due to contact effect of the wheels or due to the slipping effect of the bracks of vehicle.

Typical Flexible Pavement with Granular Base:



Typical Flexible Pavement with Granular Base.

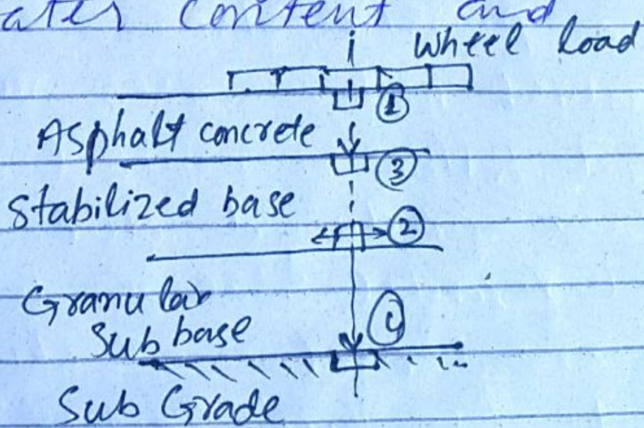
Four type of stresses are created by the wheel under the layer. the four stresses are described as under

⇒ In asphalt concrete layer due to wheel load compression is produced which produces compressive strains which in turn cases rutting.
At bottom of asphalt layer tensile stresses are produced due to effects of horizontal stresses which causes fatigue or aligator cracking
In the third layer compressive stresses and their strains are produced

at the top which causes rutting.
In the fourth layer of granular base compressive stresses and their strains are produced which subsequently cause rutting and produces depression in the subgrade mainly due to its position of being the last layer.

Typical Flexible Pavement with Stabalized Base:

The main purpose of a stabilized base or sub base is to provide a transitional load bearing strata between the pavement layer which receives directly the wheel loadings of vehicular traffic and the underlying subgrade soil.
The position of the four types of stresses being created by the wheel depends upon the layers and their respective properties such as compressive strength, bearing capacity, tensile strength, water content and permeability etc.



In the first layer of asphalt concrete compressive stresses are produced due to wheel load which subsequently

produces compressive strains
In the second layer of stabilized base tensile strains are produced which cause transverse reflective cracking while the compressive strain produced cause rutting.
In the fourth layer of granular subbase rutting and depression are caused due to the compressive strains induction in the subgrade

Q#02

Ans Geotechnical soil reports are usually prepared by experienced engineer. The report gives understanding of earth conditions affecting a structure and required where the foundation will be supported by fill, projects on steep slopes or where a lot of grading will be done, location with high ground water may also require a soil investigation report prior to construction activities.

Being a material design expert, the following steps 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

3) Preparation of layout plan of project.

4) Preparation of bore hole layout plan which includes number and spacing of boreholes, depth and frequency of sampling.

5) Selection of proper drilling and sampling equipment

6) Selection of personnel to supervise the field investigation

7) Marking on the layout plan any additional types of soil investigation.
8) Preparation of guidelines for laboratory testing of collected samples.

the following phases 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 DESK STUDY
This is the phase where all the information that are available are collected. the information which needs to be collected are
→ Site plan
→ Type, size and importance of the structure
→ Loading conditions.
→ Previous geo-tech reports
→ Topographical maps
→ Still photographs etc
Phase-02 PRELIMINARY RECONNAISSANCE:-
In this phase a site 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 current conditions of the site.

The following things are required to be noted.

→ Photographs of the site and its neighborhood

→ Access to the site for workers and equipments

→ Sketch of all fences, utility post, walkways, drainage etc.

→ Available utility services such as water and electricity.

→ Sketched of topography.

→ Exterior and interior cracks on existing buildings or any tilt.

→ Geological features from any exposed area such as road cut or excavated portions.

Phase-03 DETAILED EXPLORATION:

The objectives of a 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 tests.

→ To conduct in situ tests

Phase-04. LABORATORY TESTING

The objectives of laboratory tests are

→ To classify the soils

→ To determine soil strength, failure stresses and strains, stress-strain response, permeability, compaction properties and settlement parameters.

Phase-05 REPORT WRITING:

the report must contain a clear description of the soils at the site methods of exploration, Soil statography. In situ and laboratory test methods and results and the location of the ground water, recommendation regarding construction operation.

Q#03

Solution: ~~the absssa~~

The abscissa of the given graph shows values of the penetration of the plunger in inches while the ordinate gives values of the bearing in pound per square inch.

The bold line in the graph is representing the standard curve having a value of 100%.

Starting from the bottom, the first line shows a very poor subgrade as the penetration value of it has reached its maximum value of 0.5 inch by applying a very small fraction of load. It is less than 2% of the standard curve.

The first bold curve from the bottom that indicates 5% of the standard curve is of a clay loam. The graph is clearly showing the looseness of the soil as it is poor in holding the stress i.e the full penetration (0.5 inch) in reached by merely holding 5% of the standard load which 125 lb/inch. It is also reffered as poor to questionable subgrade.

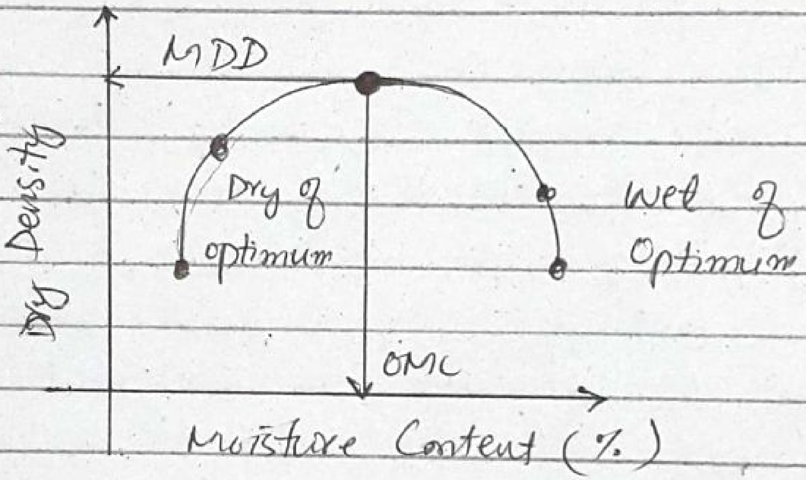
The adjacent curve to the clay loam is the one which holds 10% of the

standard penetration and is designated as fair to good subgrade. There is not much difference between it and the 5% curve.
The curve representing 20% of standard bearing value is designated as very good subgrade. The difference between this and the predecisive graphs is that its slope is bit increased. which is a sign of increase in bearing capacity.
The 3rd bold curve which indicates disintegrated granite subbase have a linear start upto approximately 700 lb/in, after that the graph slopes started decreasing and the got flat which shows that the material is good at handling the lighter stresses but weaker at higher points. The graph in the initial stages of interpolated would have reached upto 70% of the standard strength but it declined after 700 lb/inch.
the 4th bold curve which indicates the gravel base is same as the standard graph upto 1300 lb/inch stress but than a rapid declination is observed and than reached to the point of

50% of the standard strength.
the graph also shows the behavior of gravel base same as that of disintegrated granite subbase which is that it is not strong at higher loads.

Q#04 (01)

In the given below figure, what is dry of optimum and wet of optimum? Explain



Sol:

It is understood that when compaction of soil is done, it becomes dense. To carry out compaction smoothly and easily, some amount of water is added to the soil. The water content at which the maximum dry density of soil can be achieved is called optimum moisture content. If the amount of water added is less than the optimum moisture content then it is called as Dry of optimum compaction, if the amount of water added is more than the optimum moisture content then it is called as Wet of optimum compaction the determination of the maximum dry density and optimum moisture content of the soil is a measure of compaction level of soil this can be measured by mainly two methods

→ Standard Proctor Compaction Test

→ Modified Proctor Compaction Test.

Generally dry soil contains soil particles which are not in contact with each other and when it is tried to compact that type of soil without water it becomes stiff and cracks and gaps will be formed. When we add water to it, the water forms a thin film around the each soil particle and this film helps the particles to contact with each other. thereby the soil becomes denser under compaction.

If water is added beyond the optimum moisture content, the water will occupy the extra space since there is no air volume and dry density will reduce

Q#04 (02)

What are effects of compaction on Engineering properties of soil? Detail.

Ans: The process of expelling air from the voids present in the soil is known as compaction. Compaction has a vast impact on the engineering properties of soil and has important role in the field of construction.

Following are the properties of soil which get affected by compaction.

① Compaction reduces the voids present in the soil which reduces permeability as a result.

For the same soil sample, at a particular density, permeability is more for soils which are compacted to dry of optimum than those compacted to wet of optimum.

② 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.

③ 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.

④ Soils compacted to dry of optimum have flocculated structure due to the attraction between soil particles because of low water content. Soil compacted to wet of optimum have dispersed structure due to repulsive force between soil particles because of high water content.

⑤ When the soil is compacted to dry of optimum, the soil is in need of water and it swells easily when contacted with water. When water is compacted to wet of optimum, the soil particles are oriented in a dispersed manner and swelling doesn't occur, so to avoid swelling, soils should be compacted to wet of optimum.

⑥ 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.

⑦ 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 to dry of optimum.

⑧ Stress-strain behavior of soil has also impact as soil compacted to dry side of optimum will take more stress for little strain, similarly soil compacted to wet of optimum will produce more stress even for smaller strain.