PAVEMENT MATERIAL ENGINEERING

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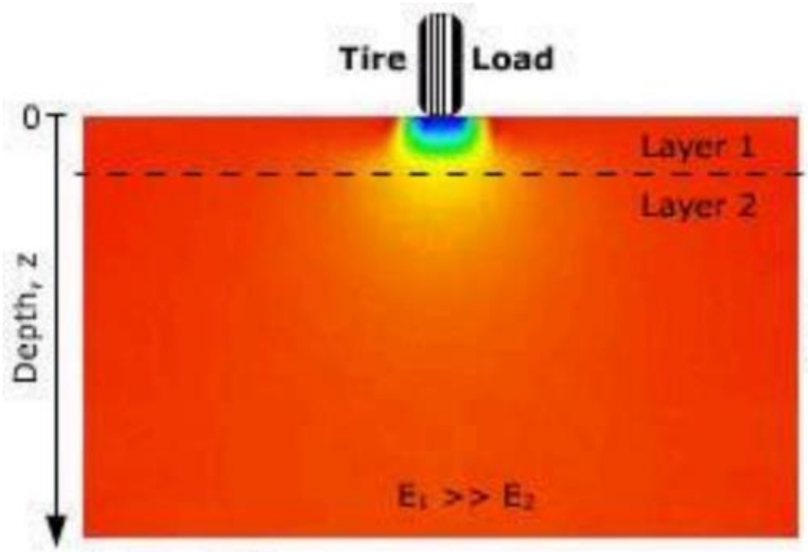
Q.No. (01)



1)

Stress-strain(Compression) phenomina are shown in the diagram.

2)

Blue: Most Compressed
Sky: Compressed
Green: Less Compressed
Orange: Not Compresssed

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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 of Geotechnical Report? ?

Ans.1)

Site Investigation is the gathering of the information about the proposed location of a project e.g highway or buildings. Being a material design expert, if awarded the consultancy services by the client, for preparation of the geotechnical report for the upcoming road project the following steps (General Procedure) would be considered while soil investigation and preparation of Geotechnical Report;

GENERAL PROCEDURE OF SOIL INVESTIGATION FOR PREPARATION OF GEOTECHNICAL REPORT

- Desk Study
- Site Reconnaissance
- Preliminary Investigations
- Main Investigations
- Geotechnical Report

Desk Study:

Desk studies are an essential part of the site investigation process, irrespective of whether they have been developed or not. These reports are invaluable in assessing the requirements of a ground investigation not only from an environmental perspective, but also for geotechnical purposes. A well-executed desk study can help to formulate investigation work, targeting specific areas of contamination or geotechnical parameters, culminating in a cost effective and targeted investigation.

Benefits of a Desk Study

- Mitigate/minimize risk
- Understanding of potential variations in ground conditions
- Can lead to economical design of foundations / geotechnical structures
- Reduce likelihood of unforeseen ground conditions
- Reduce chances of delays on site
- Quantify / qualify risk
- Accurate forecast of budgets

Site Reconnaissance:

The objective of the site reconnaissance is to visually and physically observe the property and any structure(s) located on the property in order to determine the likelihood of environmental impact to the property. The entire site must be observed, both inside and outside. If there are any areas that are not accessed, they must be specifically identified in the report.

Preliminary Investigations:

A preliminary investigation is a historical search of the past uses of the site and on-site activities. The purpose of a preliminary investigation is to collect and review existing information to determine the possibility of contamination or pollution. It is primarily a document review activity, and while the site is visited, no sampling occurs. A Preliminary investigation is usually performed by an environmental consultant but it is not required by law. The historical search can include:

- identifying past owners and the property uses during time of ownership
- reviewing of governmental records to identify past use and the use or disposal of hazardous substances at the site
- reviewing of state and federal databases that list regulated environmental activities (e.g., CERCLIS, RCRA, CAA and NPDES records and state records of emergency removal)
- interviewing of past property owners and employees
- reviewing of aerial photographs of the site
- visiting the site, adjoining properties, buildings and infrastructure

Main Investigations:

Main investigation must be undertaken to determine the bearing capacity of the soil, its settlement rate and the position of the water table. One of the easiest methods is to dig trial pits and visual inspections carried out then samples with minimum disturbance are collected for subsequent laboratory testing. Where possible, drilling should be undertaken as this enables one to obtain undisturbed samples from which settlement rate and bearing capacity may be obtained. For soils that loosen, such as sand and gravel, a plate-bearing test can be used to determine the bearing capacity of the soil insitu and designing of the static loads on spread footings. If the strength of the soil is not adequate for the increased loading, it is necessary to improve on the foundations by introducing piles or enlarging the footing and reinforcing it betters to sustain the increased loading.

GEOTECHNICAL REPORT:

All the findings are then presented in the form of Geotechnical report upon the completion of a soil investigation programme. The geotechnical report is the tool used to communicate the site consitions and design and construction recommendations to the proposed project.

This report should include the scope of investigation, description of the proposed structure, and general site conditions. The report should present the general description of soil strata, position of ground water table and other information pertinent to the site.The detail of field exploration should include the number of borings, lay-out and depth of boring, type of boring and other specifications of field test conducted during the exploration.

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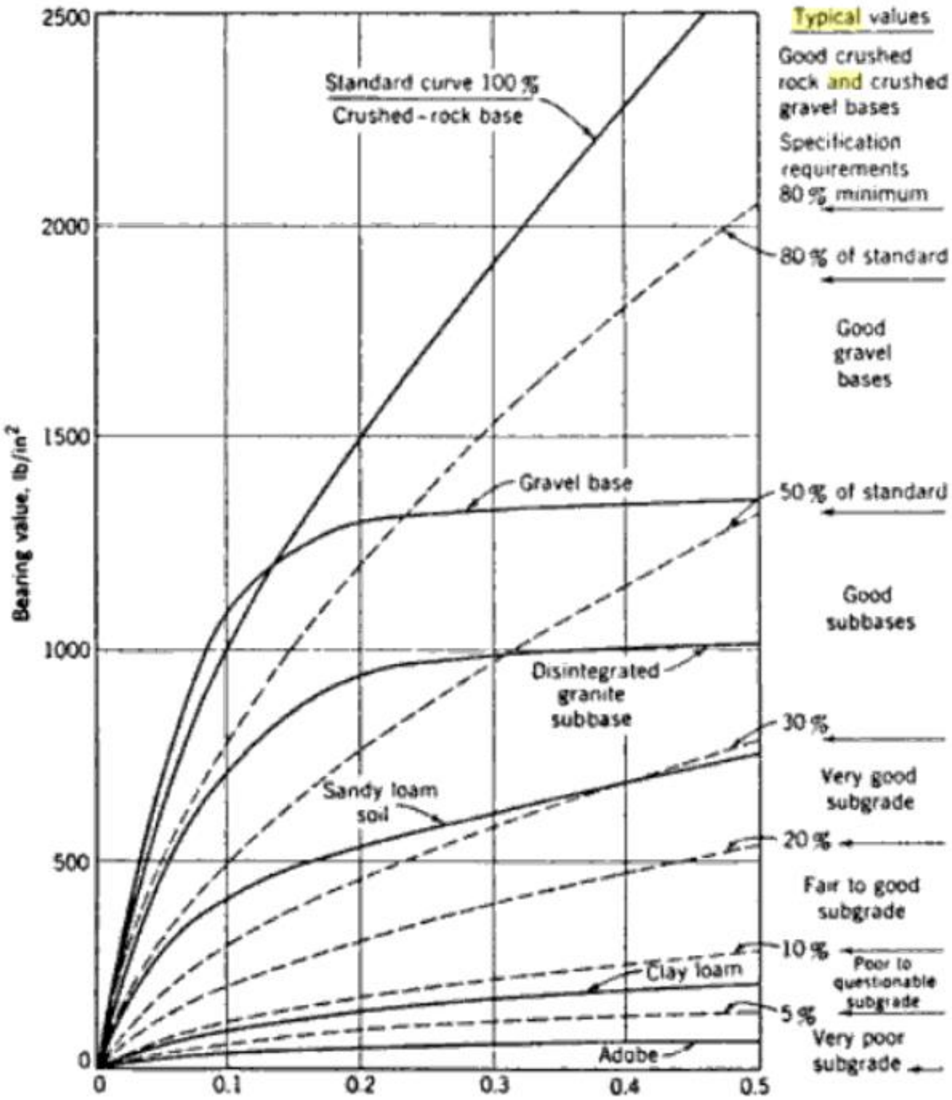
Q. No. (03)



2500
2000
1500
1000
500
0
Bearing value, lb/in^2
0
0.1
0.2
0.3
0.4
0.5
Standard curve 100 %
Crushed - rock base
Gravel base
Disintegrated granite subbase
Sandy loam soil
Clay loam
Adobe
Typical values
Good crushed rock and crushed gravel bases
Specification requirements 80 % minimum
80 % of standard
Good gravel bases
50 % of standard
Good subbases
30 %
Very good subgrade
20 %
Fair to good subgrade
10 %
Poor to questionable subgrade
5 %
Very poor subgrade

4.1 CBR

The CBR (California Bearing Ratio) test measures the resistance of the soil to penetration. A piston with an end area of 3 in² is pressed into a 6-in diameter, 5-in tall soil specimen in a steel compaction mold at a standard rate of 0.05 in per minute. The load required to force the piston into

the soil is measured at given penetration intervals. The resulting penetrations are plotted to obtain a load-penetration curve. The value of the unit load corresponding to a 0.1 in penetration is determined and compared with a standard value of 1,000 lb for a high quality crushed stone. The CBR may then be expressed as:

$$CBR(\%) = \frac{\text{UNIT LOAD AT 0.1-IN PEN}}{1000} \times 100$$

CBR curves for a wide range of soils are pictured in figure 2-1.7.

Because this test is arbitrary in nature, it has many limitations. An advantage is the relatively simple equipment needed and the large amount of historical data available for correlating results with field performance. A major disadvantage is that the test method is very sensitive to the method of specimen preparation. There have been significant modifications to the original CBR method to improve its applicability.

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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.

Answer:

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).

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.

Effects of compaction on engineering properties of soil:

Compaction is the process of expulsion of air from the voids present in the soil. In the construction field, it is an important process as it improves the engineering properties of soil to a great magnitude. Effects of compaction on different engineering properties are described as under;

1. 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.

2. 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.

3. 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.

4. Soil Structure

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

5. 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.
- When 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.

6. 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.

7. 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.

8. Stress-strain Behavior of Soil

- Soils compacted to dry side of optimum will take more stress for little strain hence, stress-strain curve of this type of soil is much steeper and elastic modulus is more. Brittle failure occurs in this case.
- Similarly, soils compacted to wet of optimum will produce more stress even for smaller stress. Hence, Stress-Strain curve, in this case, is much flatter and plastic-type failure occurs at a larger strain. These type of soils have low elastic modulus.