IQRA National
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Subject : Pavement Material Engineering

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Q . N O . (01) ANSWER (BELOW)

PART .(A)

- **THE PHNOMENA IS STRSS-STRAIN BEHAVIOUR/DISTRIBUTION OF FLEXIBLE PAVEMENT.**
- **At the point of contact of tire load the pavement surface is under compression & due to much higher elastic Elasticity/Elastic modulus of layer 1 as compared to layer 2 will cause to dessipate the stresses to lower layers & reduces w.r.t to depth.At a certain point in in layer 2 there is neutral axis with no compression & tension.**

PART .(B)

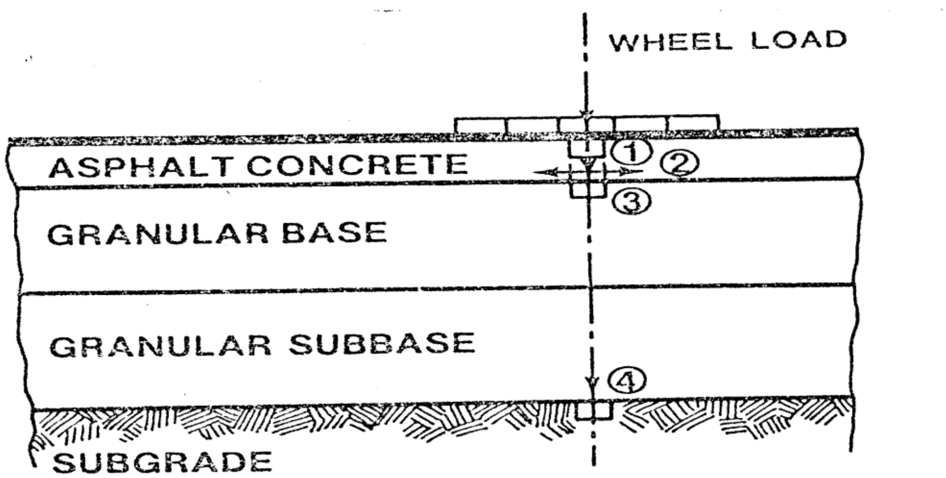
Behaviour of Flexible Pavement

- The simplest way to characterize the behaviour of flexible pavement under wheel load is to consider it as a homogenous half-space .A half space a infinitely large area & an infinite depth with a top plane on which loads are applied.

➢ Pavement Response Generally of interest "With Granular Base"

- The flexible Pavement with a granular base under wheel load causes stresses/strain in horizontal & vertical directions .

(1) Surface Deflecion represent surface Rutting.
(2) Horizontal Tensile Strain at bottom of AC layer (Control bottom up fatigue cracking)
(3) Vertical compressive strain on top of intermediate layer (base or sub-base rutting)
(4) Vertical compressive strain on top of subgrade layer (control sub-grade rutting)



TYPICAL FLEXIBLE PAVEMENT WITH GRANULAR BASE

Figure 3-1.3. Typical Asphalt Pavement with a Granular Base Showinng the Critical Stress/Strain Locations.

1. Compressive Strain - Rutting.
2. Tensile Strain - Fatigue or Alligator Cracking.
3. Compressive Strain - Rutting.
4. Compressive Strain - Rutting, Depressions.

➢ Pavement Response Generally of interest "With Granular Base"

- The flexible Pavement with a stabilized base under wheel load causes stresses/strain in horizontal & vertical direction.

(1) Surface Deflecion represent surface Rutting.
(2) Horizontal Tensile Strain at bottom of stabilized base layer (Control bottom up fatigue cracking/transverse reflective cracking)
(3) Vertical compressive strain on top of intermediate layer (base or sub-base rutting)
(4) Vertical compressive strain on top of sub grade layer (control sub-grade rutting)

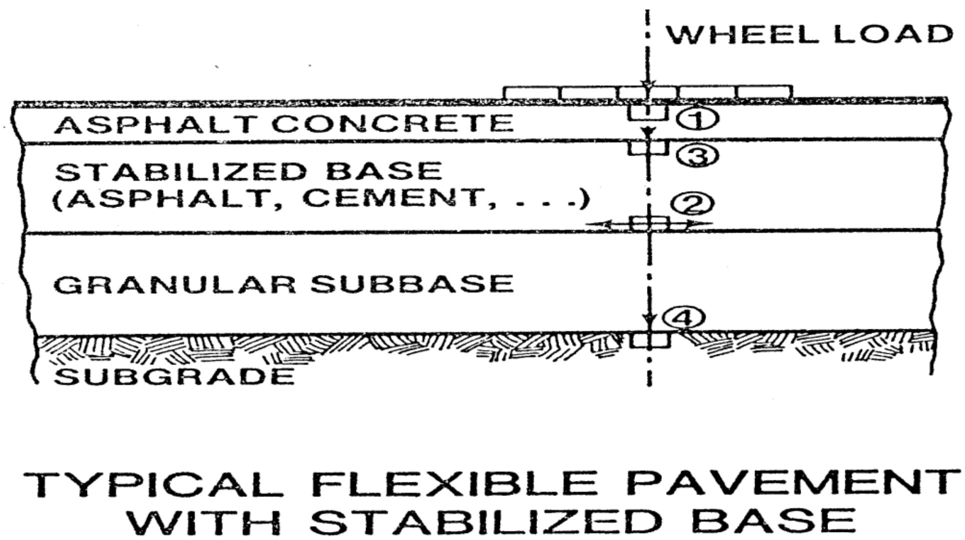


Figure 3-1.4. Typical Asphalt Pavement with a Stabilized Base Showing the Critical Stress/Strain Locations.

1. Compressive Strain - Rutting.
2. Tensile Strain - Transverse Reflective Cracking or Fatigue Cracking
3. Compressive Strain - Rutting.
4. Compressive Strain - Rutting, Depressions.

➢ CONCLUSION/REMARK

In case of flexible pavement in either case load is transfer through grain size distribution. The stresses at the point of contact load/tire on pavement surface is high & due to elastic behaviour dissipate load to lower layers.

Q . N O . (02) ANSWER (BELOW)

General Procedure/Steps to be consider in Soil Investigation & Geo-Technical Report.

(1) **Desk Study** : All possible information about all candidate/requisite sites are gathered .

(2) **Site Reconnaissance** :In this step Site is visited to gather /confirm initial data.

(3) **Preliminary Investigation** : It Include prelim BHs & prelim tests.

(4) **Main investigation** : Detailed investigation ,insitu tests, sampling, laboratory test.

(5) **Geotechnical report** : (a) All findings are presented
(b) Recommendations are made

1. DESK STUDY / COLLECTION OF PRELIMINARY DATA

- **This** is essentially the collection of a wide variety of information relating to the **General geology** of the site, **history of the site**, **pavement details**.

- **Other information include** : **Maps**, drawings, **local authority information**, geological maps, **memoir**s, records, details of utilities

2. SITE RECONNAISSANCE

- **In this step**, an early examination of the site by appropriate experts is most desirable e,g. Geologist, land surveyor, soils engineer, hydrologist etc.

- **Information** should be collected on the **overall site layout**, topography, General ground slope, Property in proposed ROW, basic geology, details of access, entry and height restrictions.

- **Local conditions** should be examined, such as climate, presence of Water courses, Soil Stratification from deep cuts, stream flows, ground water conditions, site utilization related to weather and time of year.

- **Any Local problems** like Floods , cracks , Subsidence etc

- **Where possible** , photographic records should be kept.

3. PRELIMINARY INVESTIGATION/SITE EXPLORATION

- Investigation of detailed geology and sub**-surface soil conditions using surface surveys, trial pits, headings, boreholes, sounding, geophysical methods, as appropriate.**

- **Survey** of groundwater conditions over a signification period of time

- **Examination** of existing and adjacent structures or cavities, buried pipes, services, etc.; provision of **samples** for further examination and laboratory testing.

4. MAIN INVESTIGATION

(a) FIELD TEST / INSITU TEST

- Tests carried out on the site either prior to or during the construction process.
- Ground test such as :
- shear-vane, standard penetration (SPT), cone penetration(CPT), Insitu density moisture, plate bearing, pressure meter; structure loading test, such as test on piles, proof loading; displacement observation.

(b) . LABORATORY TESTING

- **Tests** on soil like **classification** test (**Sieve analysis, Atterberg Limits),** disturbed and undisturbed samples submitted from the site team.
- Test on soils (as specified) for classification, quality, permeability, shear strength, compressibility/Settlement/Expansion, etc.
- T**est on rock cores** and samples for strength and durability.
- Test on constructional materials, such as **California Bearing Ratio**(CBR).
- Test on groundwater, **chemical** and petro graphic analysis**.**

5. GEO TECHNICAL REPORT WRITING

- **Details of geological study, including structures, stratigraphy and mapping; results of borings, etc., including log, references for samples and stratigraphy interpretations as requested.**
- **The geo technical engineer must provide recommendations for all earth work, rock, slopes, retaining wall, foundation , geo-technical problems.**
- **Provide recommendation for embankment construction, slope recommendations, foundation recommendations.**
- **Comments and recommendations relating to the design and construction of the proposed works; recommendations relating to further investigating or testing, and to ongoing or post-completion monitoring.**

THE STEPS TO BE CONDUCTED IN GEOTECHNICAL REPORT:

As the steps discussed earlier in part one, I as a geotechnical expert will conduct and accomplish my geotechnical investigation of a road project in following steps.

1. Desk study:

- The very first step to start a geotechnical investigation is to conduct a desk study which require to collect , collate and review different information such as
    - We will collect the design drawing of any previous structures
    - Previous investigation report if any is available bore hole logs, hydrological data of site from concerned sources
    - Geological data etc.
    - All data as discussed in part one of general procedure will be collected and will forward for further work.

2. Site reconnaissance survey:

- To know the exact condition of site and to conform the data obtain during desk study.we must gather a site visit.to estimate the exact cost and consider real site condition a site survey is necessary.The team of expert will attained the site survey.
- We will collect information about different site feature as discussed in part one about the real picture of site to confirm the initial data and to know about the environmental social or any other constrains .

3- Field investigation and Sampling:

- To start field investigation, we have to prepare a work plan for the manpower and equipment's with respect to the program.
- Mobilization of geotechnical team supervision and other personnel
- Survey will be started and setting out bore holes' coordinates
- We will collect samples in a proper way and will transport to geotechnical laboratory.

4- Laboratory investigation/Main investigation

The samples collected from site will be tested in laboratory for classification and geotechnical requirement of the project, followings are the tests which will be conducted.

Index property tests (determining of soil classification)

- Moisture content - determination of the moisture content of a soil as a percentage of its oven-dried weight.
- Unit weight - determining the total/moist and dry densities - unit weights - of soil specimens.
- Specific gravity -.

- Atterberg limits - determination of the liquid limit, plastic limit, and the plasticity index of soils.
- Particle size distribution -
- Engineering properties tests (determining of strength and deformation parameters)
- Unconfined compression strength - determination of the unconfined compressive strength of cohesive soil of the axial load.
- Consolidation test (one-dimensional consolidation properties) –
- Consolidated undrained triaxial compression test
  Rock Strength Properties Tests
- Point load test - determining the point load strength index of rock. This is an index test and is intended to be used to classify rock strength.

Chemical Analysis of Groundwater

- pH value, sulphate content and chloride content tests – determining the aggressiveness of groundwater to concrete and steel structures.

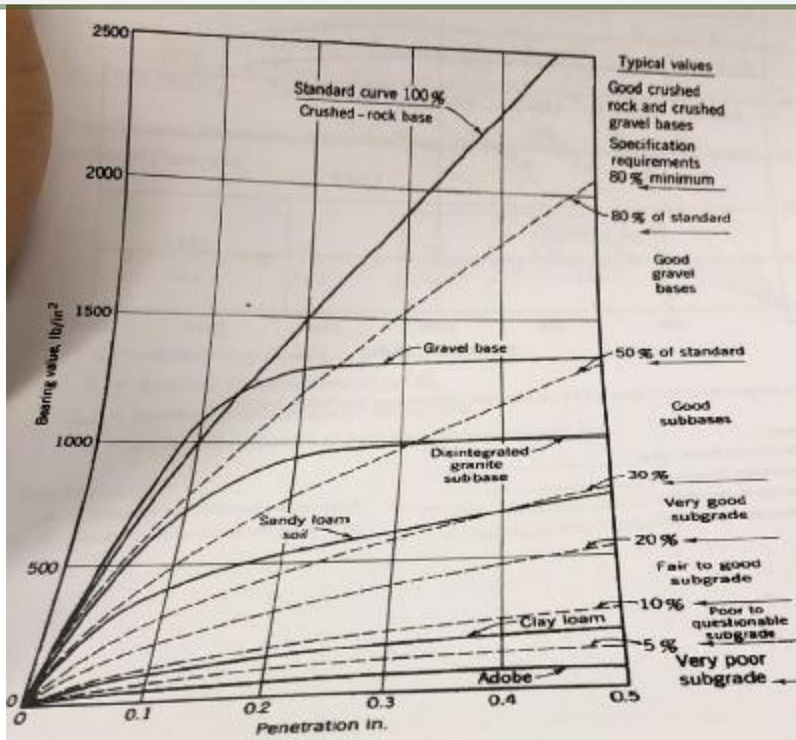
5- Geotechnical report:

The final step of geotechnical investigation is to prepare the report which will consist to main parts

- presentation of Information for Tenderers: first part of report will contain preliminary information for tenderer such as alignment, location sampling and results
    - Photographs of surface condition there will be many more details included in this section of report which are discussed in part one.
- In this part we will prepare a presentation of evaluation we have done and what are the conclusion and findings obtained from site and what instruction and technical guidance recommended for tenderers.

Q . N O . (03) ANSWER (BELOW)

➢ Discussion on Grapgh/Elaboration



- The graph represent typical soil california Bearing ratio values.
- The graph is used to find out the bearing pressure for different type of soils at a given penetration.
- For crushed rock it takes 1000psi to be penetrated 0.1 inch, 1500psi for o.2 inch, 2000psi for 0.3 inch, & so on .
- Curves for different soils (given in graph) can be used to find out bearing capacity/pressure at given penetration rate which is given in inches.
- Highly Crushed Stone has a CBR of 100%.
- Keeping this information we can find how much pressure is needed to penetrate In term of inches for a given soil.
- 2500psi Typical values Standard curve 100% Good crushed rock and crushed gravel bases Specification requirements 80 % minimurm Crushed - rock base 2000psi of standard 80 % Good gravel bases 1500psi Gravel base 50 % of standard Good sub-bases 1000psi Disintegrated- granite sub-base 30 % Very good sub-grade Sandy loam soil 20% - Fair to good sub-grade 500psi 10% Poor to questionable Sub grade Very poor sub-grade clay loam Adobe 0.5 0.4 0.3 0.2 0.1 Penetration (inch).

CONCLUSION/REMARK (ANS.03)

Using this graph we can find out bearing values in lb/in2, for different sub grade soils by knowig penetration values in inches.

Q . N O . (04) ANSWER (BELOW)

- The water content at which the soils compacted play an important role In soil structure.

DRY OF OPTIMUM : Optimum moisture content of a soil is also called dry of optimum on the dry side.

- **Soils compacted at moisture content less than optimum water content & having flocculated structure, refer to dry of optimum**.

WET OF OPTIMUM : Optimum moisture content of a soil is also called wet of optimum on the wet side.

- **Soils compacted at moisture content more than optimum water content & having dispersed/oriented structure, refer to wet of optimum**.

EFFECTS OF COMPACTION ON ENGINEERIC PROPERTIES OF SOIL

(1) Strength
(2) Compressibility
(3) STABILITY; (a) Swelling (b) Permeability
(4) Shrinkage
(5) Pore water pressure
(6) Strain stress curve

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 broke & ultimate strength will be equal for both dry & wet sides.
- The strength wet of optimum also depends somewhat to the type of compaction because of differences In soil structure.

COMPRESSIBILITY

- The flocculated structure on dry side of optimum offers greater resistance to compression than the dispersed structure on side.

- Compressibility of compacted clays is a function of stress level imposed on the soil mass. At relatively low stress levels clays compacted wet of optimum are more compressible.
- **Conclude:** So, the soils compacted dry of optimum are more compressible.

STABILITY

(A) **Swelling**

- Swelling of a compacted clays is greater for those compacted dry of optimum.
- They have a relatively greater difficiency of water & therefore have a greater tendency to adsorb water & thus swell more.
- Soils dry of optimum are I general more sensitive to environmetal changes such as changes in water content.

Conclude :

The effect of compaction is to reduce void space & hence swelling is enormously reduced.

(B) **Permeability**

- It depends on void size as water content increases there is an improved orientation of particles resulting to reduction of void size & permeability.
- Above optimum water content permeability slightly increases.
- If compacted effort is increased , the permeability decreases due to increased Dry density.

Conclude :

Permeability at constant compactive effort decreases with increasing water content & reaches a minimum at about the optimum . if the compactive effort is increased the coefficient of permeability decreases because the void ratio decreases.

SHRINKAGE

- Soils compacted dry of optimum shrink less when compared to compacted wet of optimum.
- The soils compacted wet of optimum shrink more because of soil particles in dispersed structure can packed more efficiently.

PORE WATER PRESSURE

- The pore water pressure for soil compacted dry of optimum is less than for same soil compacted wet of optimum.

➢ STRAIN STRESS CURVE

- The soils compacted dry of optimum have steeper stress strain curve than those o wet side
- The strength & modulus of elasticity of soil on dry side of optimum will be high.
- Soils compacted dry of optimum shows brittle behavior while on wet side experienced increased strain.

SUMMARY/CONCLUSION
(Q . No. 4 ANSWER)

STRUCTURE PROPERTIES	DRY SIDE (MORE RANDOM)	WET SIDE MORE ORIENTED
permeability	more permeable	less permeable
compressibility	more compressible in high pressure rage	more compressible in low pressure rage
swelling	swell more	shrink more
strength	higher	Lesser

THE END