Subject Pavement material

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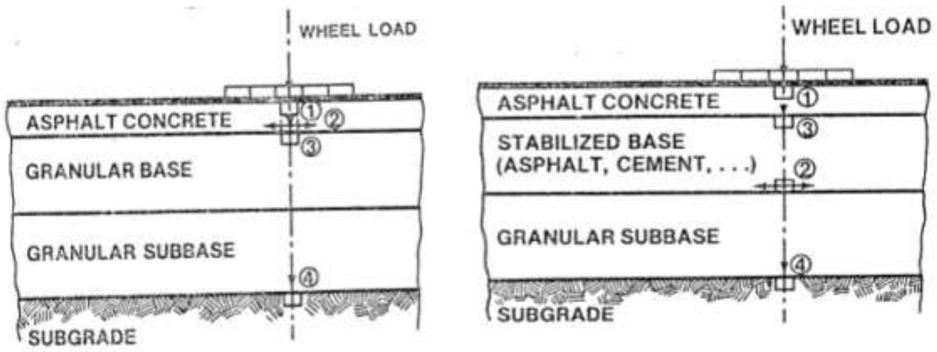
Q1) Vertical stress under wheel load The phenomena shown in figure 1 is Vertical stress under wheel load

The pavement directly under the load is under compression, while most of the surrounding pavement is under very little stress.

Q1 B



TYPICAL FLEXIBLE PAVEMENT WITH GRANULAR BASE

TYPICAL FLEXIBLE PAVEMENT WITH STABILIZED BASE

Q 2

3.1 Field Reconnaissance Survey

For most site investigations access and environmental constraints have major influences on cost. It is therefore necessary for a field reconnaissance survey to be conducted as the first stage of a geotechnical investigation. This may be undertaken by Main Roads Western Australia (MRWA) or by a Consultant specifically engaged for this survey. Information on the following should be obtained

Legal and physical aspects of access to site, for example, access for drilling rigs.

Availability of any services or supplies of water, electricity, earthworks plant.

Buried or overhead services etc.

3.2 Desk Top Study

Every site investigation should commence with a desk study directed towards collecting, collating and reviewing the following:

• Design drawings from any previous structure at the site.

• Previous site investigation reports, borehole logs, penetrometer results and construction experience.

• Geological maps, survey data and records.

• Hydrological data. MAIN ROADS Western Australia Guidelines for Geotechnical Investigation Page 3 of 18 R: 2006-21 M of Road Widening and Reconstruction Issue August 2006

• Aerial photographs.

• Local knowledge and resources. Where possible, collection and collation of the above information should be undertaken during the field reconnaissance survey stage. However, further work to fully explore the extent of information available may be required

3.3 Site Investigation

A comprehensive geotechnical investigation of the project site should be carried out in order to characterise the materials and conditions which will be encountered during the construction and operation of the project, their nature, variability, extent and any special requirements to be observed. The investigation should be undertaken in a systematic manner to minimise the likelihood of contract variations arising from unexpected conditions. The detail of the investigation should be commensurate with the potential risks, hazards and complexity of the project.

3.3.1 Embankment Foundation

The embankment foundation investigation should as a minimum consider the following issues:

• the range of materials in the embankment foundations and where appropriate the pavement subgrade (including subgrade strength)

• settlement potentia

l • stability

• hydrogeology, moisture regime and drainage requirements

• special construction requirements

3.3.2 Cuttings in Soil

The cutting investigation should as a minimum consider the following issues:

• the range of materials in the cuttings and in the pavement subgrade

• slope stability

• subgrade strength

• suitability of cut materials for basecourse, sub-base and embankment fill

• excavation conditions

• hydrogeology, moisture regime and drainage requirements

• the extent of any problems which may be encountered during and after construction.

3.3.3 Cuttings in “Rock Excavation Materials”

For road construction specification purposes and for the purposes of this Guideline, MRWA defines “rock excavation materials” as “all materials to be excavated to achieve the road design cross section including table drains which cannot be ripped and excavated with a tracked dozer in good condition with matching hydraulic single shank ripper of combined mass not less than 52 tonnes (this refers to a Caterpillar D10R or its equivalent) at a rate in excess of 90 cubic metres (solid) per hour. Isolated boulders greater than 0.8 cubic metres in volume may be included in this definition"

3.3.4 Soft/Wet Areas

Where soft/wet soils are found, particularly in the vicinity of low embankments, or in shallow cuttings, additional investigation, sampling and testing should be carried out to determine the in situ CBR of the proposed subgrade.

3.3.5 Embankment Materials

The suitability of materials encountered within the cuttings should be assessed for embankment or pavement construction. Recommendations should be made as to the use of selected fill materials within one metre of pavement subgrade level and the placement of inferior quality materials in the lower parts of the fills.

3.3.6 Road Reconstruction and Widening

Investigation and testing for reconstruction of an existing pavement should involve the following:

- Benkelman Beam or Falling Weight Deflectometer (FWD) testing for assessing the structural adequacy of existing pavement
- Sampling and testing of existing pavement materials (pavement dippings)
- In-situ tests on the subgrade using Perth Sand Penetrometer or Dynamic Cone Penetrometer
- Subgrade sampling for moisture content determinations

3.3.7 Groundwater

Groundwater must be investigated to determine:

- the level of the permanent groundwater table at the time of the investigation and seasonal variation
- occurrence of a perched water table condition and its level
- the presence of sub-artesian conditions
- potential aggressiveness of the soil and groundwater, for example SO4, Cl, pH and Total Dissolved Solids (TDS) to buried concrete and steel. For some cases it will be necessary to install standpipes in selected boreholes to enable sampling and observations of water level to be made.

3.4 Field Logging and Sampling

Standards Logging of soils shall be carried out in general accordance with Appendix A, Section A2 of AS 1726 - 1993 "Geotechnical Site Investigations" except as varied below. Logging of rock shall be carried out in general accordance with Appendix A, Section A3 of AS 1726 - 1993 "Geotechnical Site Investigations". Where boulders occur in a soil, the log shall include the maximum size of boulder (eg. boulders to 800mm).

3.5 Laboratory Testing

All testing shall be performed in accordance with the MRWA “Materials Testing Manual”. Where no MRWA Test Method exists, Australian Standards should be utilised. If no Australian Standard is appropriate other standards may be utilised with the approval of the Project Manager. Laboratory testing shall only be carried out in NATA accredited laboratories for the particular tests in question. All test results shall be presented as NATA endorsed reports.

Q 3 : please elaborate the figure .

This figure shows typical bearing values (psi) verses penetration (inch) for various materials ranging from very poor subgrade (cbr upto 5) to good crushed rock basis (cbr of 100) .

The cbrs are in term of percentages since the bearing value is divided by 100 psi (.1 % penetration) are 1500 psi (.2 inch penetration) which represent the bearing value of a crush rock material (refer to standard curve 100 %) .

It also shows the thickness design curves from 12 years of cbr test with both failed and good performance pavements on the California highway system. Curves A and B show the minimum pavement thickness for light and medium heavy traffic the additional curves were added us army corps of engineer for the design of air field pavements during ww2.

The tyre infiltration pressure for the traffic was 400 kpa the design curves also embody the assumption of the pavement structure lying on compacted soils atleat (300mm of compacted subgrade).

Q 4 (1)

Effects of Compaction on Soil Properties

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 properties of the soil are explained in this article.

It is known that the soil becomes dense when it undergoes compaction. To facilitate easy compaction, some amount of water is added to the soil and the water content at

which the maximum dry density of soil can be obtained is known as optimum moisture content. It can be seen in the compaction curve(fig-1). So, 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. Effects of compaction on engineering properties of the soil are briefly discussed below.

Fig 1: Compaction Curve

Q4 (2)

Effects of Compaction on Soil Properties Following are the properties of soil which get affected by compaction:

1. Permeability

2. Compressibility

3. Shear strength

4. Soil structure

5. Swelling of soil

6. Shrinkage of soil

7. Pore water pressure

8. Stress-strain behavior of soil 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.

Fig 2: Compaction of

Soil using Sheep-foot Roller 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.

Fig 3: Effect of

Compaction on Soil Structure 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.

Fig 4: Shrinkage

Cracks in Wet Compacted Soil 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.

Fig 5: Stress – Strain Behavior of

Compacted Soil