



Pavement Materials II



Natural Ground

- Natural ground surface on which a pavement is constructed
- Consists of unbound materials
- Mostly simply classified as subgrade
- No binder or similar binding agent
- No tensile strength
- Resilient modulus/modulus of resilience

Pavement Materials

- General Practice
 - High volume
 - Low cost
 - Can be produced easily and cheaply
- Mostly Include
 - Earth, rock, sand and clay
- Relatively sparingly used materials
 - Cement, bitumen, additives, modifiers

Road Construction

- Many kilometers of road construction
- Resurfacing and rehabilitation of existing pavements
- Increase in demand because of population growth and increased use of road transport vehicles
- Natural resources are depleting but the demand is increasing

Expectations from Engineers

Pavement engineers are required to;

- Maximize the potential of available materials
- Low cost construction
- Easy to handle materials
- Longer pavement life
- Innovative construction and rehabilitation techniques

Expectations from Engineers

- Reuse of natural resources and conservation of energy
 - Bitumen
 - Aggregate
 - Asphalt
 - Concrete

Expensive Materials

- Cement
 - Concrete
 - Steel/reinforcement
 - Bitumen
 - Polymers/bitumen modifiers
 - Additives for aggregates
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- Pavement construction involves large quantities of materials

Road Construction in Pakistan

Assignment # 1

- Road Infrastructure
 - Types
 - Lengths
 - Construction techniques
- Pavement Materials
 - Quarries map for aggregates & mineralogy
 - Sources and suppliers (Bitumen & modifiers)
 - Chemical Nature (Bitumen & modifiers)

Soil

- Foundation of a Pavement Structure
- Underlying soil should be adequately protected from applied loads
- Soils **vary from** heavy clays, through silts and sands to high-strength rocky materials.
- Soils are **not usually consistent** along the length of a road or across any pavement site.
- Soils are **sensitive to water** content to differing degrees
- **Water contents vary** during the life of a pavement, sometimes over quite short timescales
- Some soils are highly **permeable**; some clays are virtually impermeable but **porous**

Soil

- It is necessary to **categorize** each soil type encountered
- There are **two fundamental areas** in which soil behavior affects pavement performance
- These are:
 - **stiffness** under moving **load**;
 - **resistance to deformation** under **repeated load**, likely to be related to **shear strength**

Granular Materials

- **Unbound** Materials
- includes natural gravel, crushed rock and granulated industrial byproducts (slag from steel production)
- Soil is also a granular material but it is utilized in its available form
- Granular materials are however **selected** and **different sizes are blended** together according to the requirement of the engineer

Granular Materials

- Granular materials are therefore more **predictable** in comparison to soils
- More controlled material but uncertainty still lies because they are;
 - Natural materials
 - Different aggregate types used in the blend will have different properties and behavior
- However, performance related properties are still **stiffness and shear strength**

Hydraulically Bound Material

- Materials that are produced by using **hydraulic binders**
- **Examples** of hydraulic binders
 - Portland cement
 - Substitutes of cement such as fly ash or ground granulated blast-furnace slag
- They are used to **strengthen** granular materials
- The term 'hydraulic' means they require the presence of **water** for the **cementing action** to take place

Hydraulically Bound Material

- Concrete is one of the best hydraulically bound material and very different from soil as it can withstand **tension**
- Their main properties include
 - **Stiffness**
 - **Tensile strength**
 - **Fatigue resistance**
 - Curing rate (affects construction & economy)
 - Thermal expansion

Bitumen Bound Materials

- Asphalts
- Around 90% of the highways around the world are covered or surfaced by using this material
- Different from hydraulically bound materials because;
 - Hydraulic binders produce a rigid material
 - Rigid material cannot deform and is susceptible to cracking

Bitumen Bound Materials

- Bitumen is however viscous and has ability to flow
- Flow may leads to rutting
- Bitumen can accommodate expansion and contraction due to thermal changes
- Similarly it can accommodate moderate deformation (differential settlement) in the foundation. Hydraulically bound material will exhibit cracking under these conditions
- Key properties are **stiffness and fatigue characteristics**

Other Materials

- **Block Paving**
 - Hydraulically bound materials if produced by using concrete
 - Can be cut from natural stones or bricks can also be used directly
- **Use of steel for reinforced concrete**
 - Reinforcement of hydraulically bound materials

Other Materials

- **Grouted Macadam**
 - Combination of hydraulic and bitumen bound materials
 - Expensive and only used for specific heavy duty applications
 - Examples are;
 - Bus lanes
 - Industrial pavements

Other Materials

Reinforced granular materials

- Geosynthetics
 - Geogrids
 - Use of specially made grids for stabilization of roads over soft grounds
 - Geotextiles
 - Can have a reinforcing function but their most common usage is simply as a separator, ensuring that fine soil particles do not migrate up into the pavement and that stones from a granular layer do not lose themselves in the soil.

Construction of a Highway

- A case study
 - See the attached file “Road construction; Case Study” for reference