

PAVEMENT MATERIALS

Fall 2020

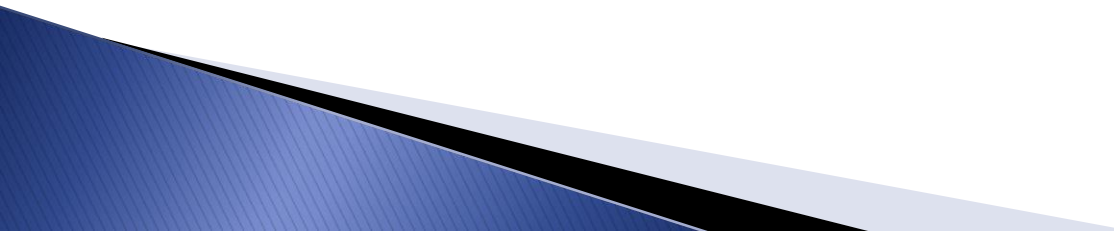
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Lecturer CED, INU

PAVEMENT MATERIALS

Lecture 1

Sequence

- ▶ Pavement
 - Loads
 - Purpose
 - ▶ History of Pavements
 - Old and Modern
 - ▶ Pavement Layers
 - Purposes
 - ▶ Stresses and Strains in Pavements
 - ▶ Pavement Materials
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What is Road?

What is Pavement?

Pavement

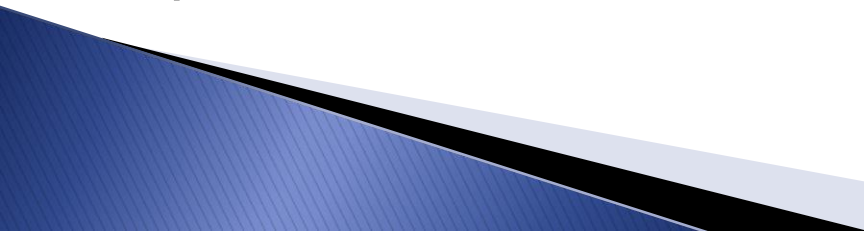
- ▶ Road
Public way for the passage of Vehicles.
- ▶ Pavement
Hard and Smooth surface of the road

Loads on Pavements

- ▶ Traffic
 - Wheel Load (stresses and strains)
 - Impact (Imperfections, Joints)
 - Repetition of Load (Plastic and Elastic Deformation)
 - Position of Wheel Load (concentration of load)
- ▶ Climate
 - Moisture
 - Rainfall
 - Ground Water
 - Temperature
 - Frost
- ▶ Road Geometry
 - Curvature
 - Vertical Profile

Purpose of Pavement

For satisfactorily performing the above functions, the pavement should have many desirable characteristics:

- ▶ 1. It should be structurally sound enough to withstand stresses imposed on it.
 - ▶ 2. It should be sufficiently thick to distribute the loads and stresses to a safe value on the subgrade soil.
 - ▶ 3. It should provide a reasonably hard wearing surface, that the abrading action of wheels does not damage the surface.
 - ▶ 4. It should be dust-proof so that traffic safety is not impaired.
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Purpose of Pavement

- ▶ 5. Its riding quality should be good. It should be smooth enough to provide comfort to the road users at the high speeds at which modern vehicles are driven.
- ▶ 6. The surface of the pavement should develop as low friction with the tires as possible. This will enable the energy consumption of the vehicles to be low.
- ▶ 7. The surface of the pavement should have a texture and adequate roughness to prevent skidding of vehicles.
- ▶ 8. The surface should not produce excessive levels of noise when travelling.
- ▶ 9. The surface should be impervious so that water does not get into the lower layers of the pavement and the subgrade and cause deterioration.
- ▶ 10. The pavement should have long life and the cost of maintaining it annually should be low.

Pavement History

Romans

- ▶ The first and most famous great **Roman** road was the Via Appia (or Appian Way).
- ▶ Constructed from 312 BCE and covering 196 km.
- ▶ It linked **Rome** to Capua in as straight a line as possible and was known to the **Romans** as the Regina viarum or '**Queen of Roads**'

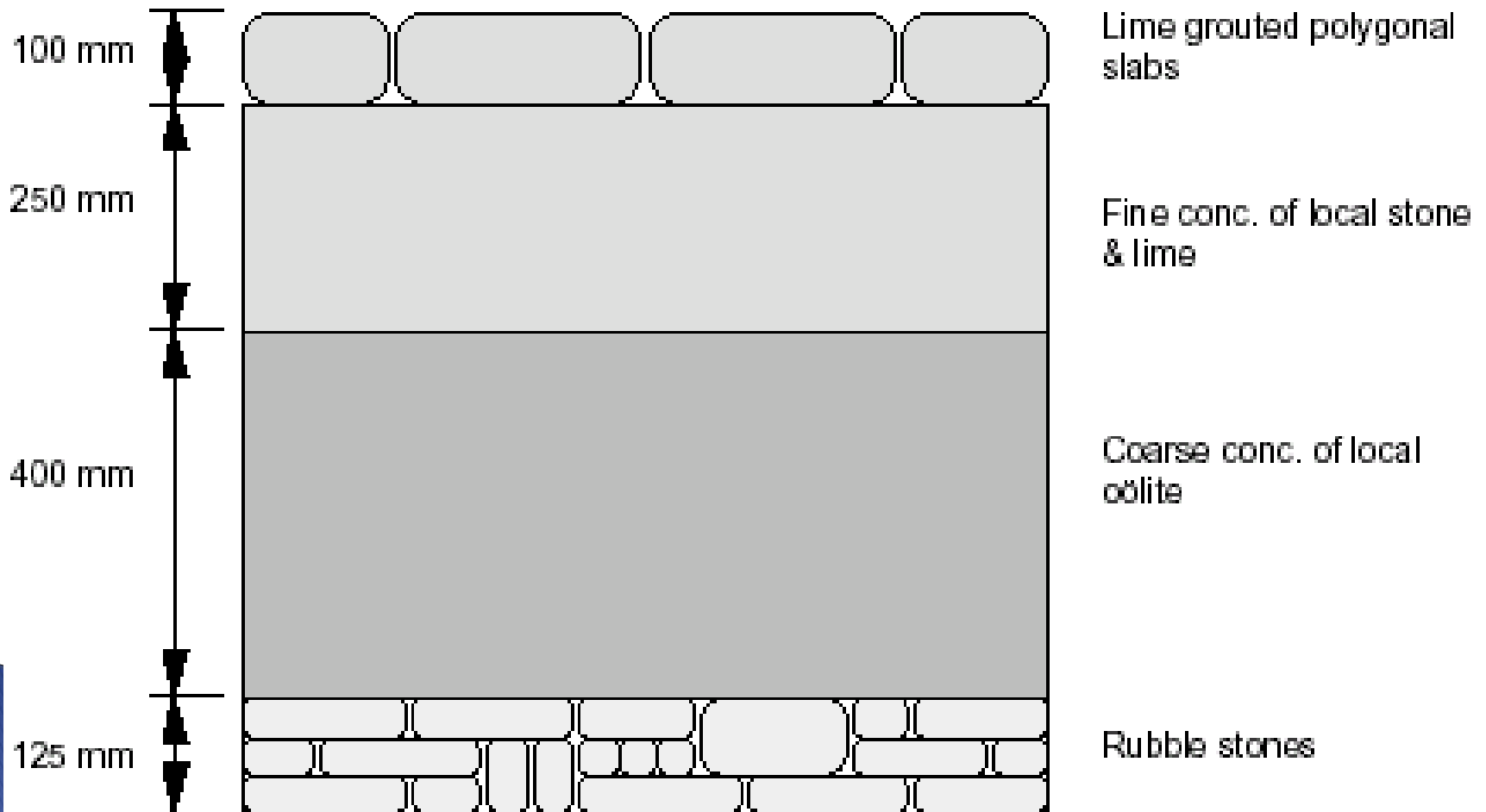
Pavement History

Romans



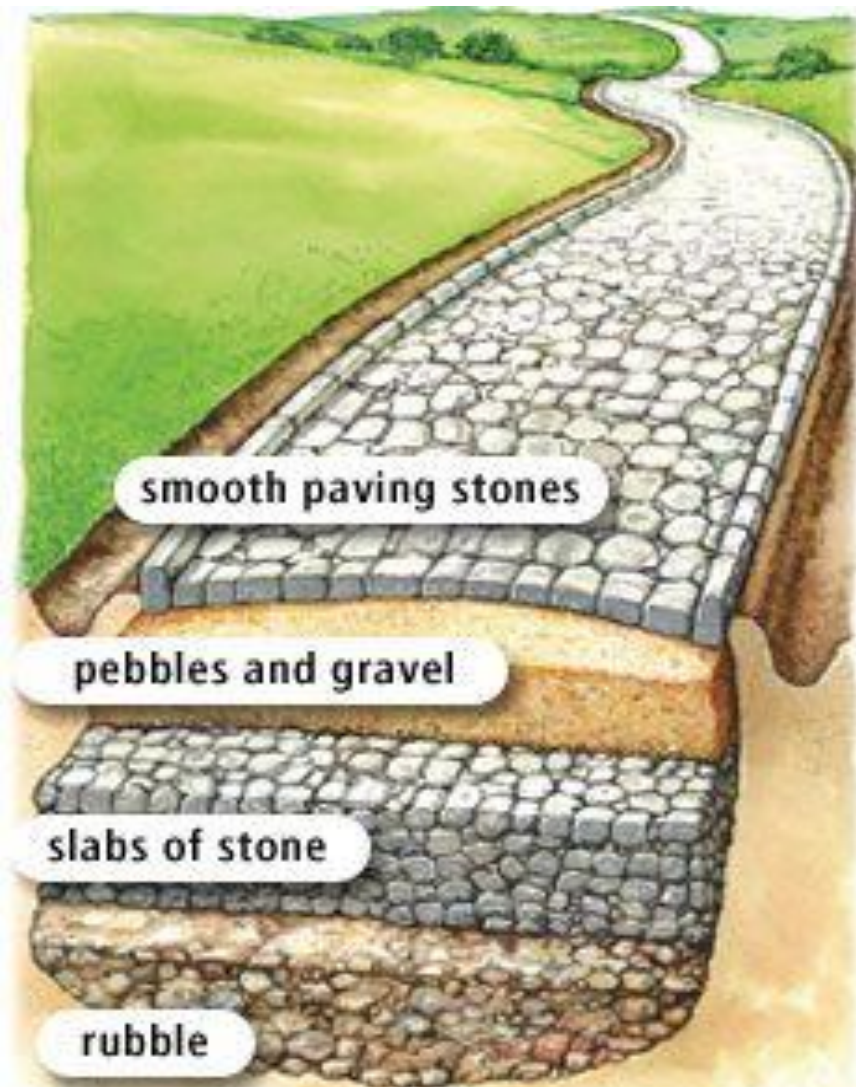
Pavement History

- ▶ Romans
- ▶ Via Appia 312 B.C.



Pavement History

Romans



Pavement History

Grand Trunk Road (Sher Shah Suri)

- ▶ 1440–1450
- ▶ *Kankar (impure limestone) was used as Surface Course
- ▶ *a surface layer of soil encrusted with calcium carbonate

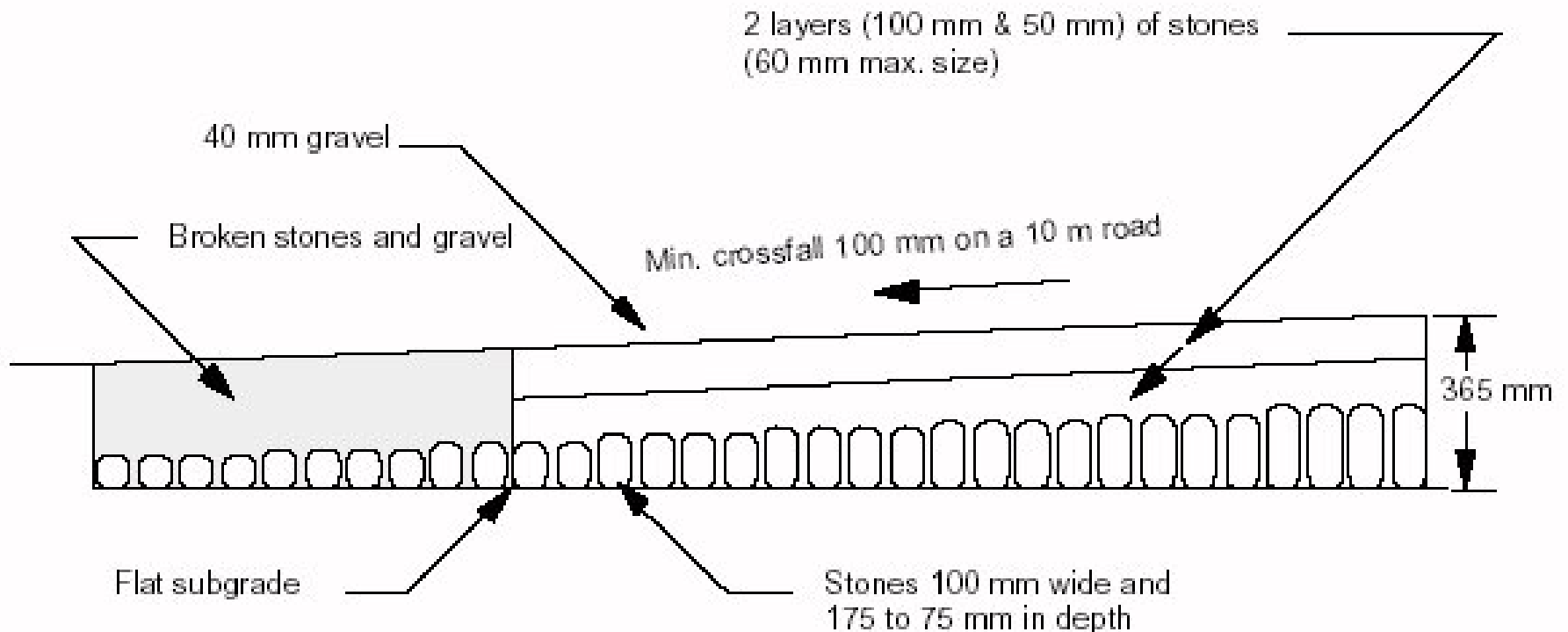
Pavement History

Grand Trunk Road (Sher Shah Suri)



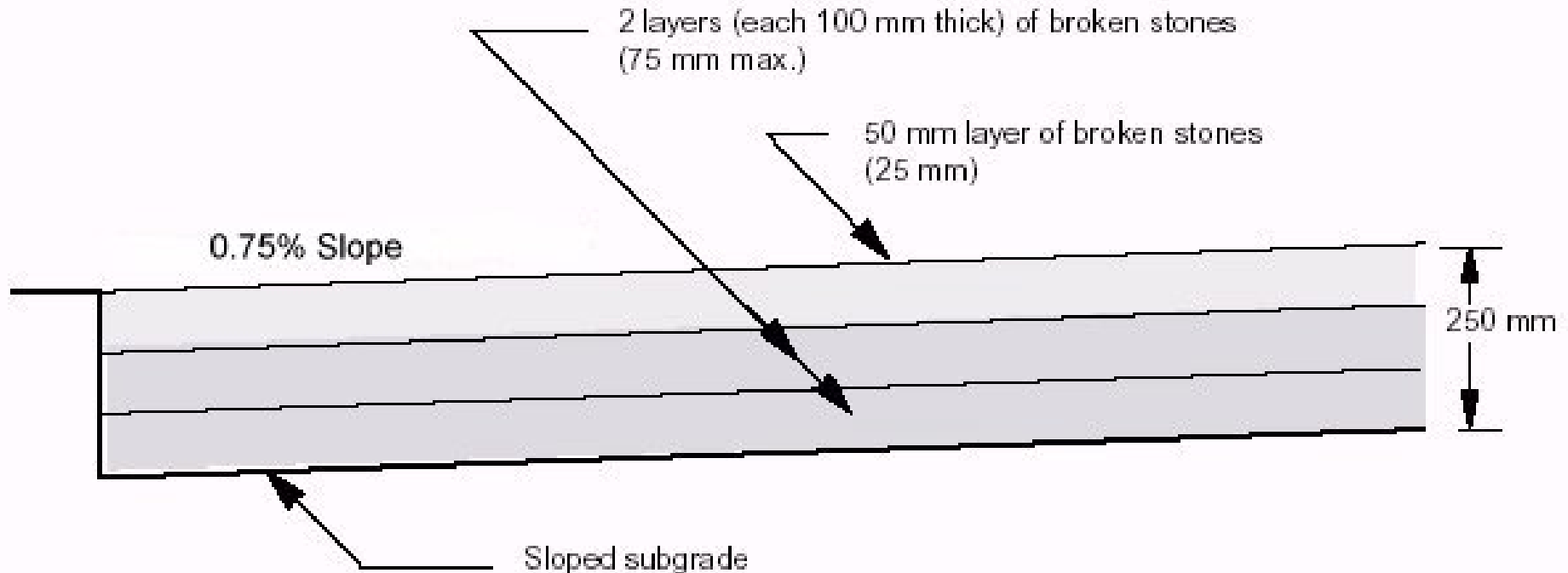
Pavement History

- ▶ Telford
- ▶ 1780



Pavement History

- ▶ Macadam
- ▶ 1823



Pavement History

◆ Macadam

The original system involved a triple layer of stone.

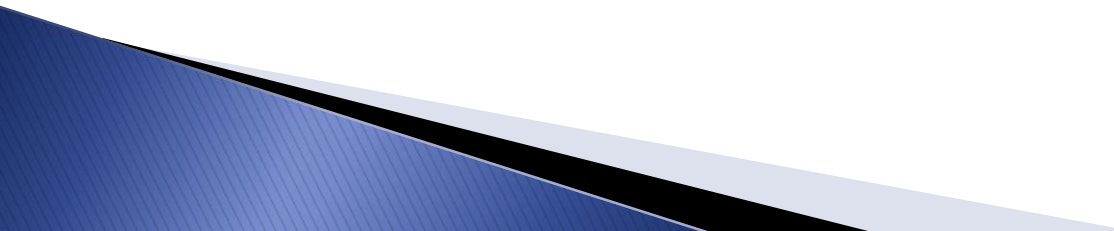
The bottom two layers were comprised of hand-broken rocks laid to a depth of 8 in (20.3 cm) over a formation level called a subgrade.

The top layer was much smaller rocks, made to be no more than 2 in (5 cm) thick.

The entire road was then compacted and crushed together by use of an enormous roller. In addition, macadamized roads had a slightly convex shape, so that water would run off into drains on either side, rather than collecting on the road

Macadam is a type of road construction pioneered by Scottish engineer John Loudon Macadam around 1820.

The method simplified what had been considered state of the art at that point. Single-sized aggregates layers of small stones, with a coating of binder as a cementing agent, are mixed in an open-structured roadway



Pavement History

- ▶ Macadam
- ▶ 1823



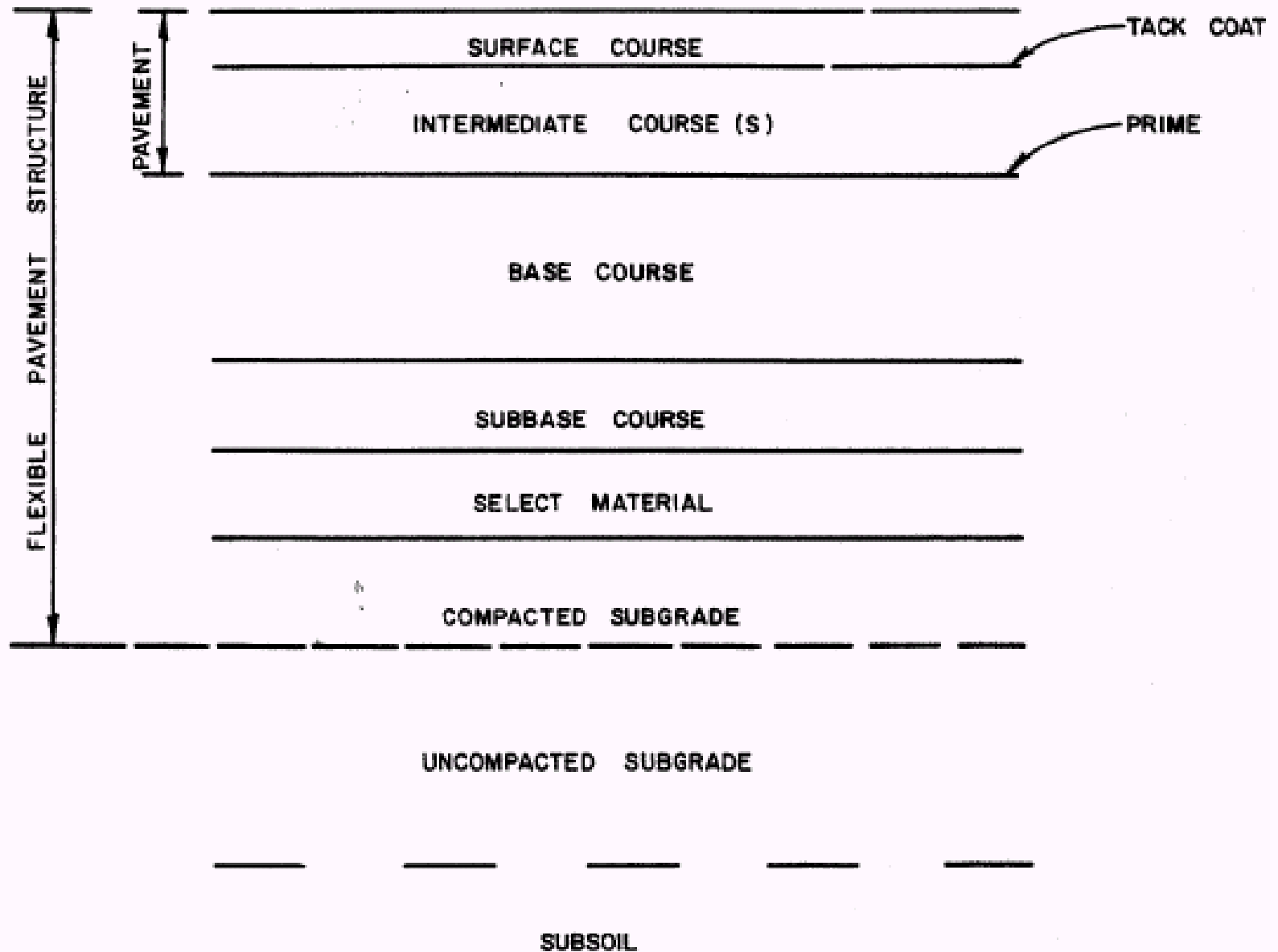
Pavement History

- ▶ Modern Pavements
- ▶ Sheet Asphalt 1876
- ▶ Bitulithic Pavements
- ▶ 1901–1903
- ▶ *First step towards HMA*
- ▶ <http://www.pavementinteractive.org/article/pavement-history/>
- ▶ *Evolution of Pavement Layers*

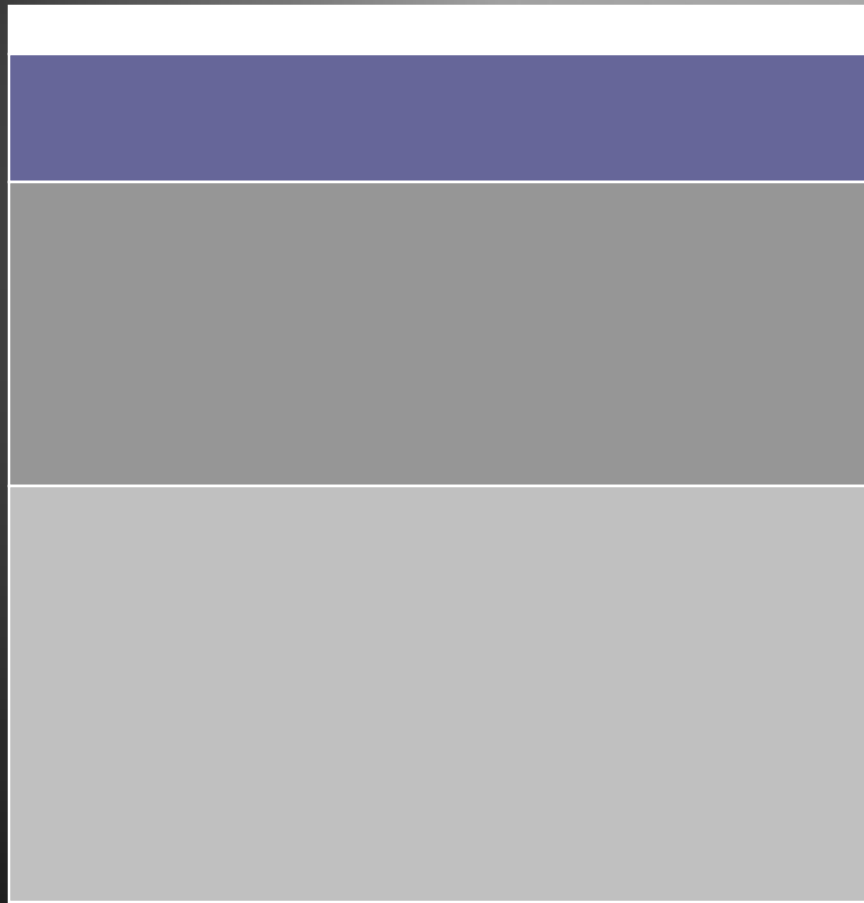
Pavement Types

- ▶ Flexible
 - ▶ Rigid
 - ▶ Flexible Composite
 - ▶ Composites
-
- ▶ *Flexibility of bituminous pavement permits slight adjustments in the pavement structure, owing to consolidation of base course or effect of load, without detrimental effect .*

Pavement Layers



Pavement Layers – UK, PAK



Wearing Course

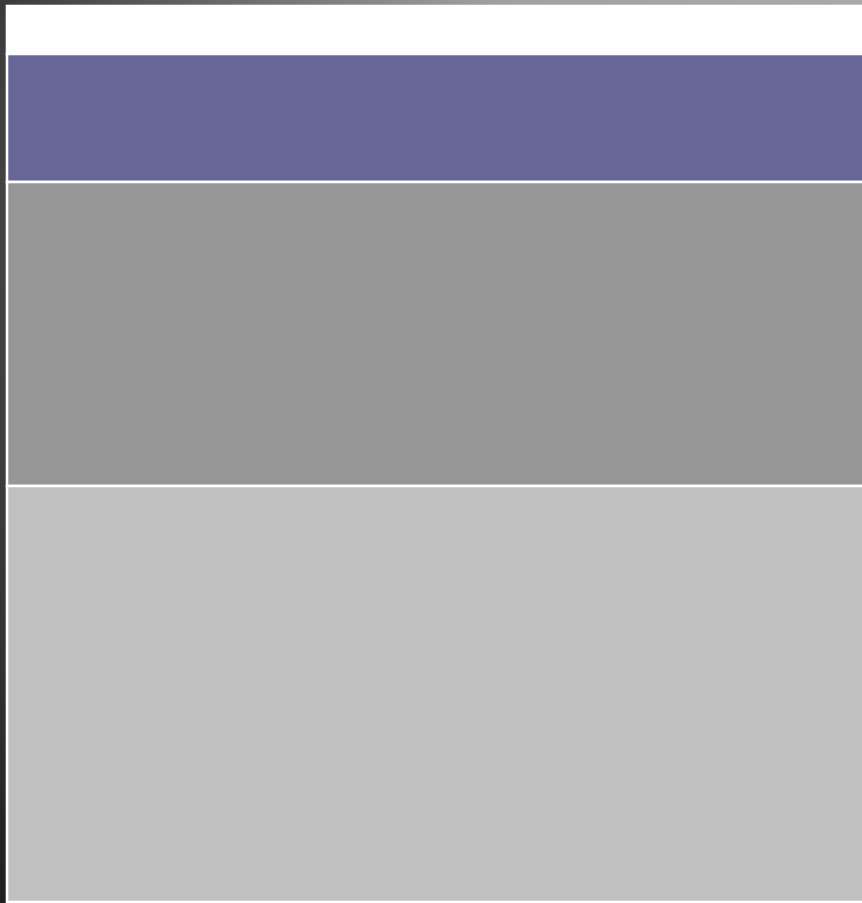
Bituminous Base Course

Road Base (Granular)

Subbase

Subgrade

Pavement Layers-USA



Surface Course

Binder Course

Base Course (Granular)

Subbase

Subgrade

Purpose of Pavement Layers

- ▶ SUBGRADE

- ▶ Foundation of Pavement

- ▶ SUB-BASE COURSE

- ▶ 1. To provide additional help to the base and surface courses in distributing the loads
- ▶ 2. To prevent intrusion of the fines from the roadbed soils into the base course
- ▶ 3. To minimize the damaging effect of frost heave
- ▶ 4. To facilitate drainage of free water that might get accumulated below the pavement

Purpose of Pavement Layers

▶ BASE COURSE

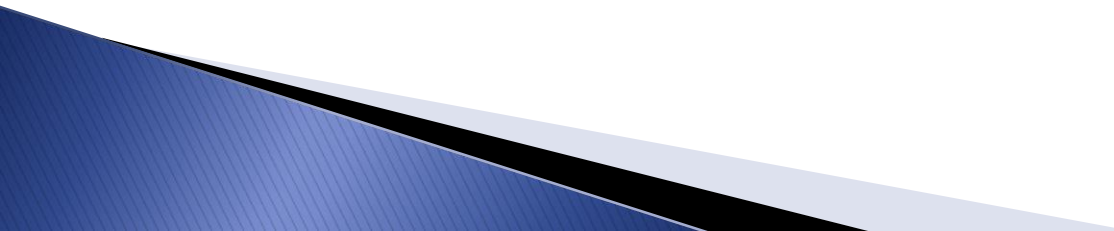
- ▶ 1. To act as structural portion of the pavement and thus distribute the loads
- ▶ 2. Can be constructed directly over the subgrade, to prevent intrusion of the subgrade soils into the pavement.

▶ BITUMINOUS BASE COURSE

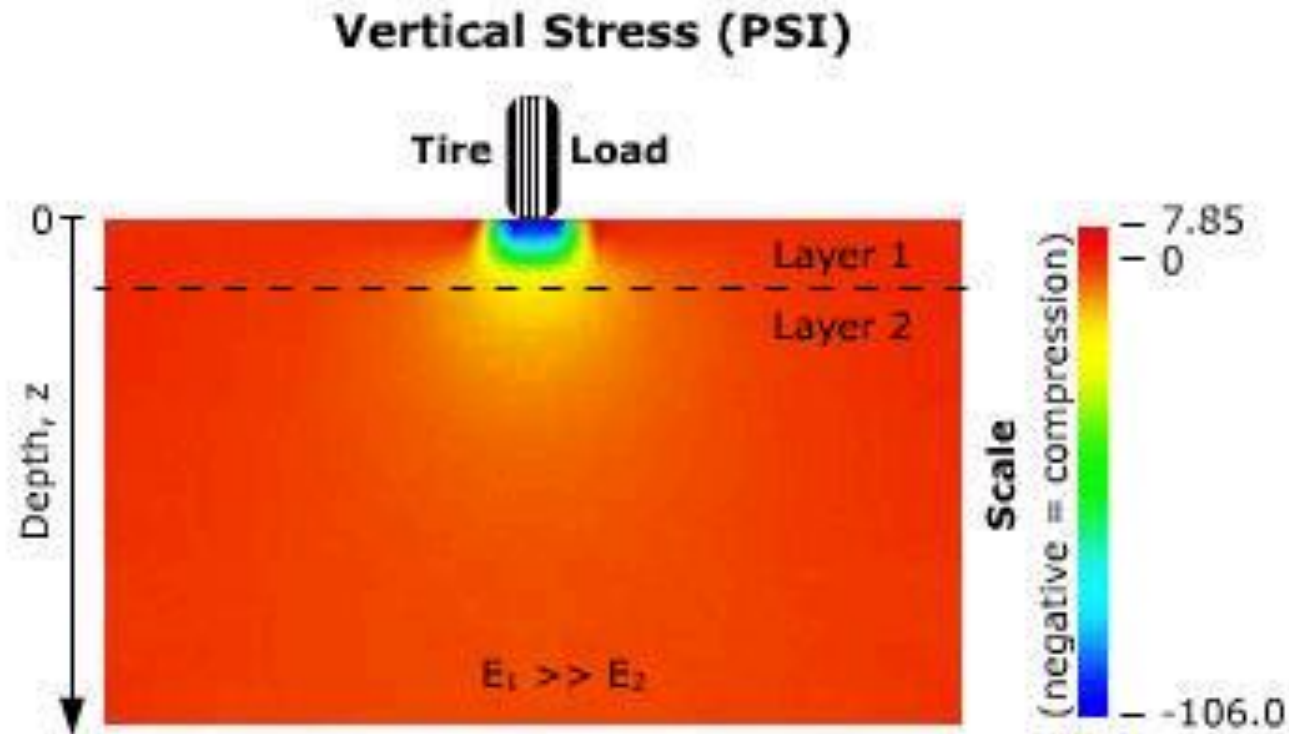
- ▶ 1. To perform as structural portion of the pavement
- ▶ 2. To provide resilient behavior of the flexible pavements
- ▶ 3. To prevent the surface water penetrating the pavement

Purpose of Pavement Layers

▶ WEARING COURSE

- ▶ 1. To perform as structural portion of the pavement
 - ▶ 2. To provide resilient behavior of the flexible pavements
 - ▶ 3. To resist the abrasive forces of the traffic
 - ▶ 4. To reduce the amount of the surface water penetrating the pavement
 - ▶ 5. To provide the skid-resistant surface
 - ▶ 6. To provide a smooth and uniform riding surface
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Stresses and Strains



Vertical Stress

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

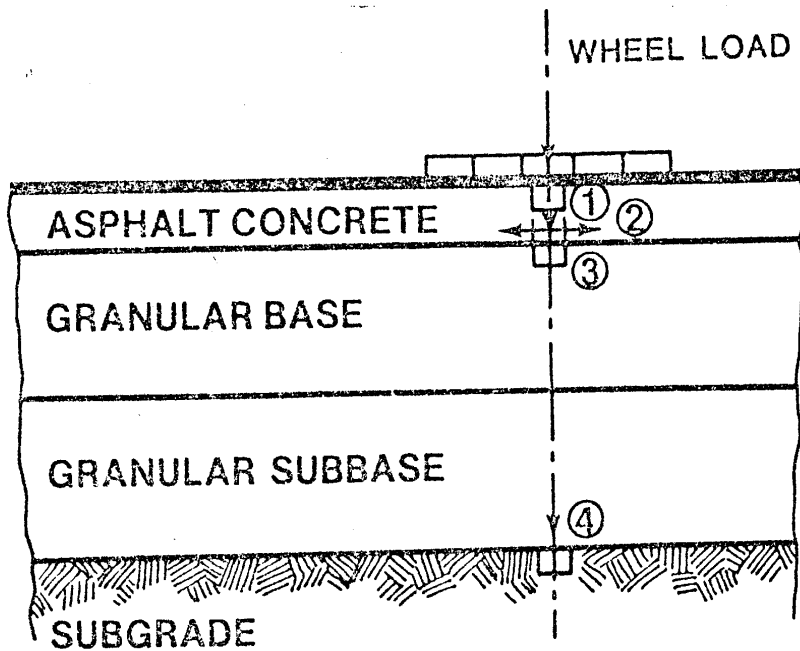
[View Vertical Stress](#)

[View Horizontal Stress](#)

[View Vertical Strain](#)

[View Horizontal Strain](#)

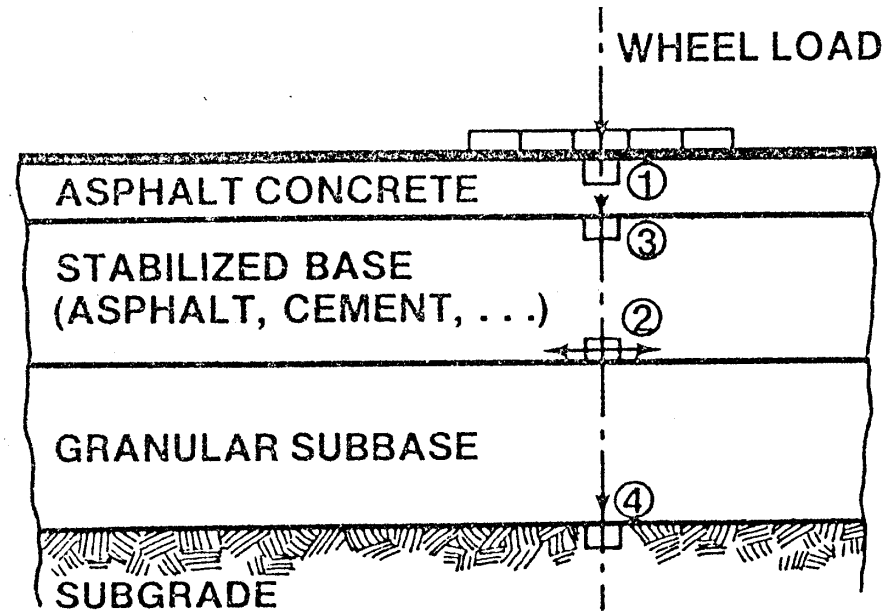
Stresses and Strains



**TYPICAL FLEXIBLE PAVEMENT
WITH GRANULAR BASE**

Figure 3-1.3. Typical Asphalt Pavement with a Granular Base Showing 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.



**TYPICAL FLEXIBLE PAVEMENT
WITH STABILIZED BASE**

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.

Pavement Materials

- ▶ Pavements are a conglomeration of materials. These materials, their associated properties, and their interactions determine the properties of the resultant pavement.
- ▶ Thus, a good understanding of these materials, how they are characterized and how they perform, is fundamental to understanding pavement.
- ▶ Pavement Materials
- ▶ Soils/Rocks
- ▶ Aggregate
- ▶ Asphalt
- ▶ Combination/Mixtures of *the above*

Pavement Materials

▶ Aggregate

- ▶ Aggregate is a collective term for the mineral materials such as sand, gravel and crushed stone
- ▶ Aggregates are used with a binding medium (such as water, bitumen, Portland cement, lime, etc.) to form compound materials (such as asphalt concrete and Portland Cement Concrete).
- ▶ By volume, aggregate generally accounts for 92 to 96 percent of HMA and about 70 to 80 percent of Portland cement concrete.
- ▶ Aggregate is also used for base and Sub-base courses for both flexible and rigid pavements.

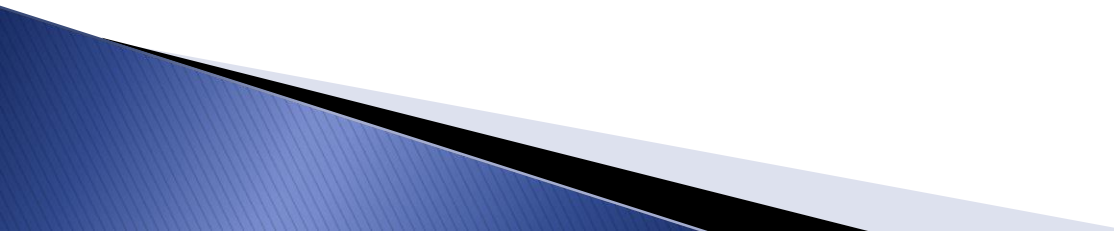
Pavement Materials

- ▶ Asphalt/Bitumen
- ▶ Natural or artificial semi-liquid to solid gluing and water-proofing substance.

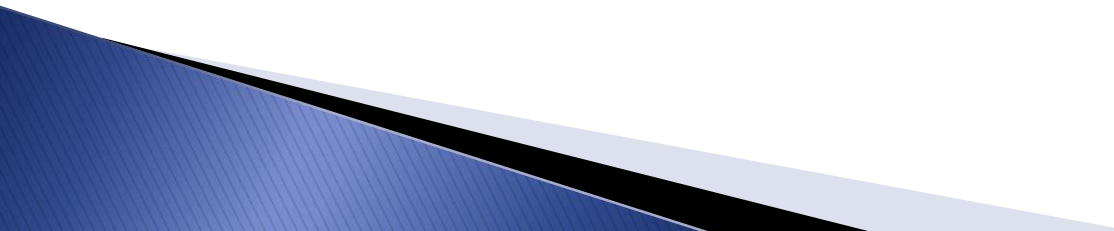
Pavement Materials

- Hot mix asphalt (HMA).
- A combination of aggregate and asphalt binder mixed together at elevated temperatures that forms a hard, strong construction material when cooled to ambient temperatures. HMA is known by many names such as "asphalt concrete" (AC or ACP), "asphalt", "blacktop" or "bitumen".
- Portland cement concrete (PCC).
- A combination of aggregate, water and Portland cement to form a hard, strong construction material when set. PCC is known by several names including "cement" and "concrete".
- Concrete.
- Term often used to describe Portland cement concrete. However, in its more generic form "concrete" refers to any conglomeration of materials usually held together by a binding substance. Thus, asphalt concrete and Portland cement concrete are two types of concrete with the "asphalt" and "Portland cement" referring to the binding material.

Course Heads

- ▶ Subgrade
 - Natural
 - Stabilized
 - ▶ Subbase
 - ▶ Base Course
 - Unbound
 - Bound
 - ▶ Surface Courses
- 

Course Agenda

- ▶ Material Identification
 - ▶ Material Evaluation
 - ▶ Material Selection
 - ▶ Material Compaction/Construction
 - ▶ Quality Evaluation During Construction
 - ▶ Quality Evaluation After Construction
- 

Semester Papers / Projects

- ▶ Mid Term
- ▶ Final Term
- ▶ Sessional Marks

THANK YOU

