HIGHWAY ENGINEERING - III

CHAPTER 0*

Over-view of Pavement Materials

Lecture – 1

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Introduction

- Highway pavements are constructed of either asphalt or concrete and ultimately rest on native soil.
- The engineer must be familiar with the properties and structural characteristics of materials that are used in constructing or rehabilitating a roadway segment.
- The engineer must also be familiar with methods and theories for the design of heavy-duty asphaltic and concrete pavements, as well as various treatment strategies for low-volume roads.

Types of roads

- General 3 types of roadway pavements are common
  1. Flexible,
  2. Rigid, and
  3. Composite
- Flexible pavements typically consist of Asphalt Concrete (AC) placed over granular base/subbase layers supported by the compacted soil, referred to as the subgrade.

Types …

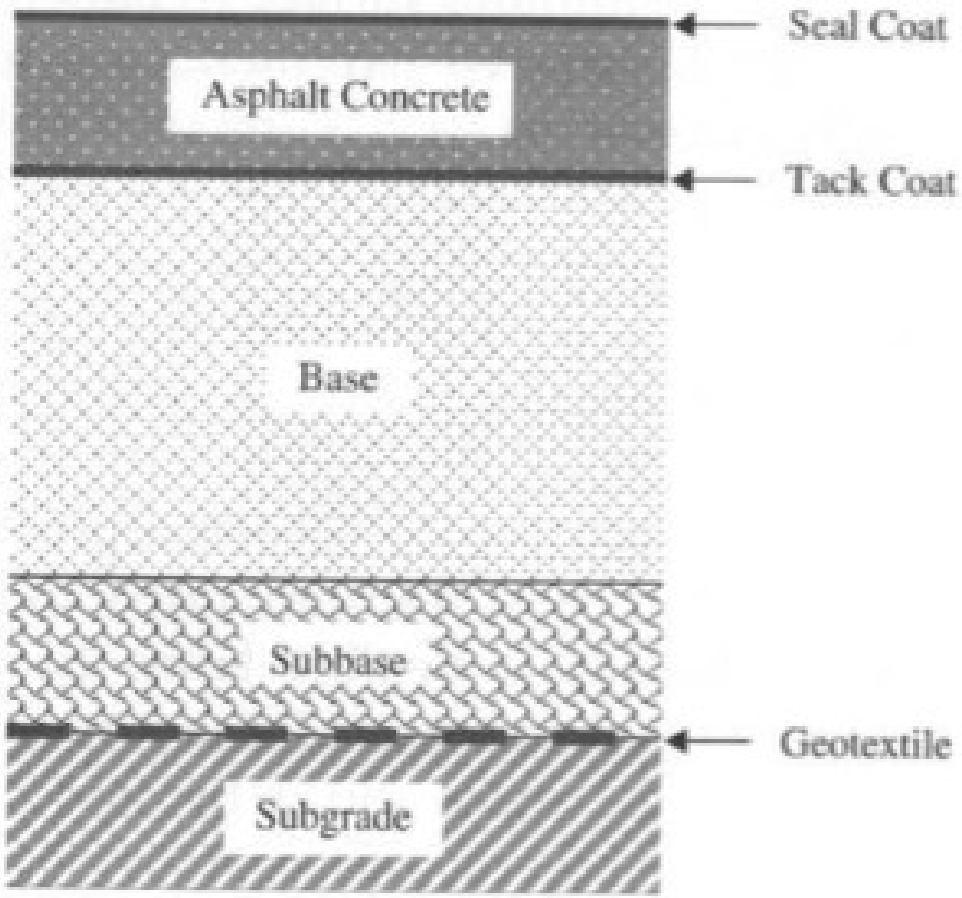
- Some asphalt-paved surfaces consist of a simple Bituminous Surface Treatment (BST),
- Rigid pavements typically consist of a Portland Concrete (PC) layer placed over the subgrade with or without a middle base layer.
- Composite pavements are typically the result of pavement rehabilitation, whereby PC is used to cover damaged AC or vice versa.

Stress and deflection

- The terms ***flexible*** and ***rigid*** relate to the way asphalt and portland concrete pavements, respectively, transmit stress and deflection to the underlying layers.
- Ideally, a flexible layer transmits **uniform stresses** and non-uniform deflections, while the

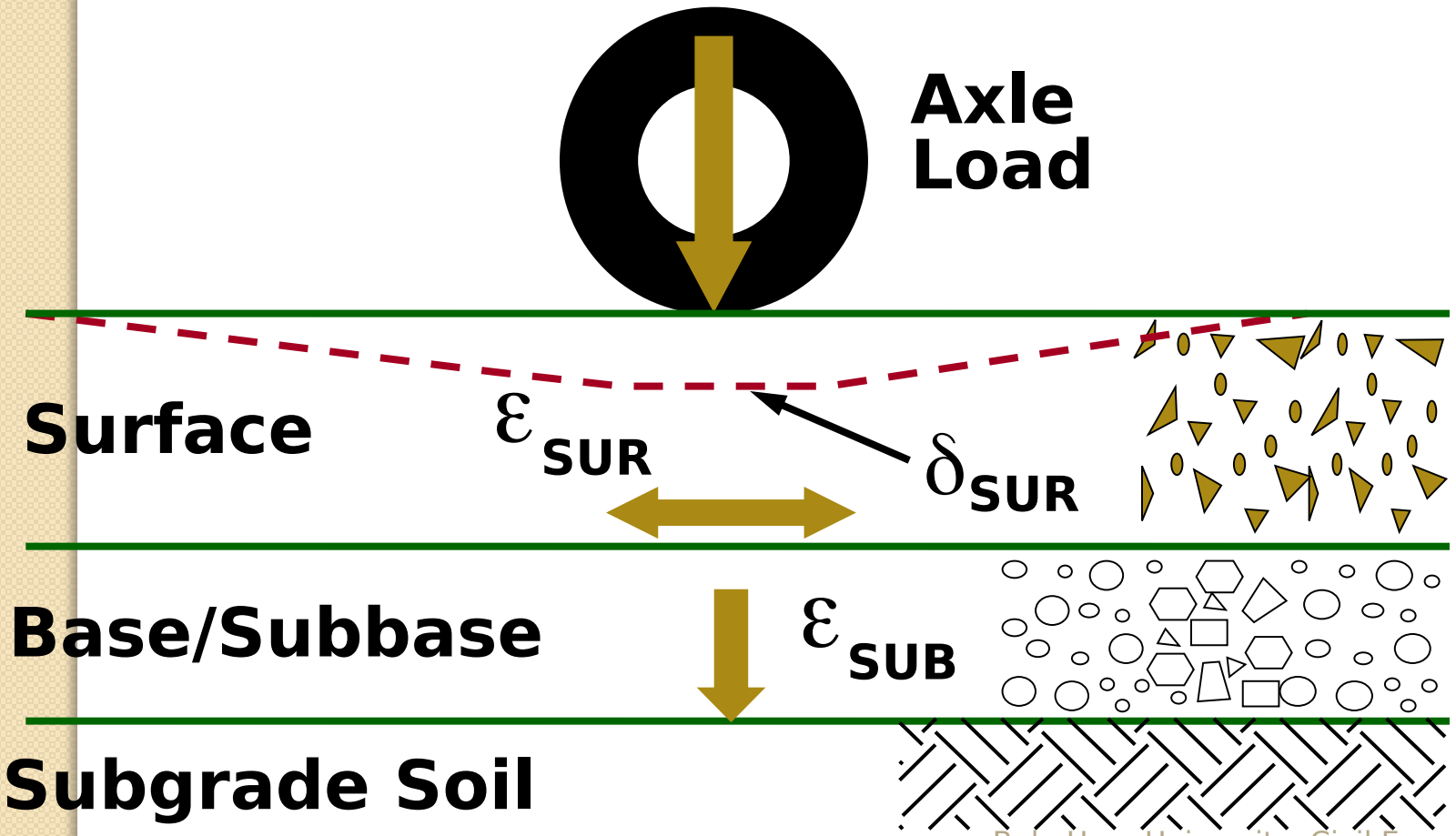
Stress …

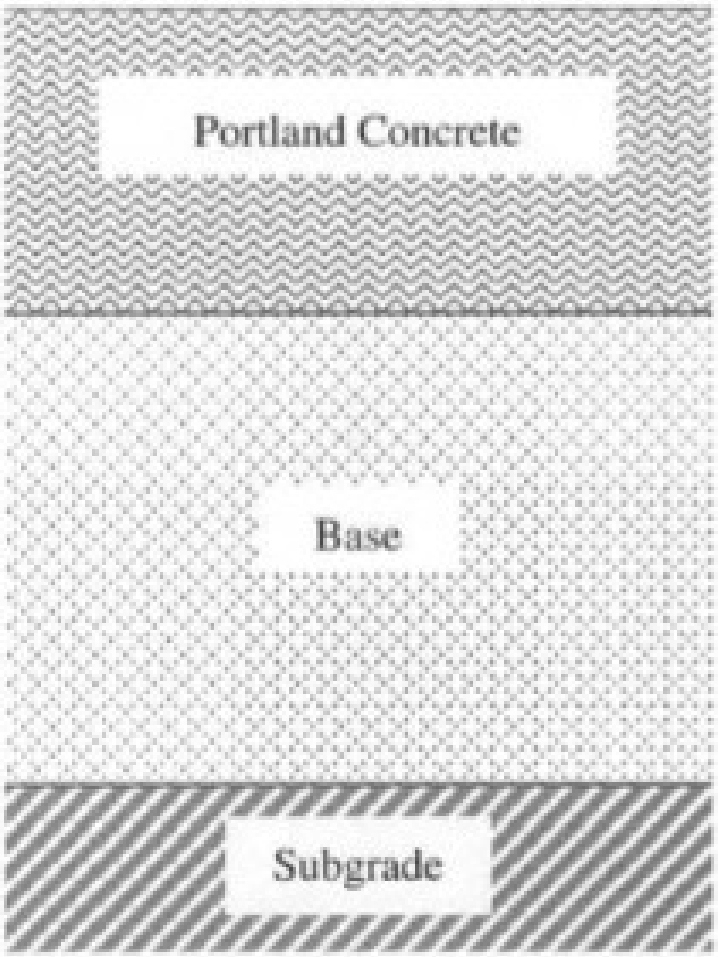
- In practice, the stress and deflection distributions in AC and PC pavements depend on the relative stiffness of these layers with respect to those of the under-lying granular layers.
- This ratio is much lower for AC than PC, which justifies their generic designation as *flexible* and *rigid*, respectively.
- This affects significantly the way these two pavement types are analyzed and designed.



Typical Section of AC Pavement

Pavement Responses Under Load





Typical Section of a PC Pavement

Flexible pavement layers

- The AC layer, which may consist of two or more sublayers, or lifts, is placed on top of the granular base/subbase layers, which are placed on top of the subgrade.
- A tack coat layer may be applied to provide adhesion between layers, while a seal coat may provide a pavement surface barrier.

Flexible …

- A fabric or other geotextile placed between the base and the subgrade **prevents migration of fines** between them, and maintains their integrity.
- The base layers can be either compacted gravel, referred to as, simply, granular, or incorporate cement, referred to as *stabilized*.

Comparison of Flexible and Rigid Pavement

Flexible Pavements

- Deformation in the sub grade is transferred to the upper layers
- Have low flexural strength
- Load is transferred by grain to grain contact
- Have low completion cost but repairing cost is high
- Have low life span (High Maintenance Cost)
- Surfacing cannot be laid directly on the sub grade but a sub base is needed
- No thermal stresses are induced as the pavement have the ability to contract and expand freely
- expansion joints are not needed
- Strength of the road is highly dependent on the strength of the sub grade
- Rolling of the surfacing is needed
- Road can be used for traffic within 24 hours
- Damaged by Oils and Certain Chemicals

Rigid Pavements

- Deformation in the subgrade is not transferred to subsequent layers
- Have high flexural strength
- No such phenomenon of grain to grain load transfer exists
- Have low repairing cost but completion cost is high
- Life span is more as compare to flexible (Low Maintenance Cost)
- Surfacing can be directly laid on the sub grade
- expansion joints are needed
- Strength of the road is less dependent on the strength of the sub grade
- Rolling of the surfacing in not needed
- Road cannot be used until 14 days of curing

Load distribution

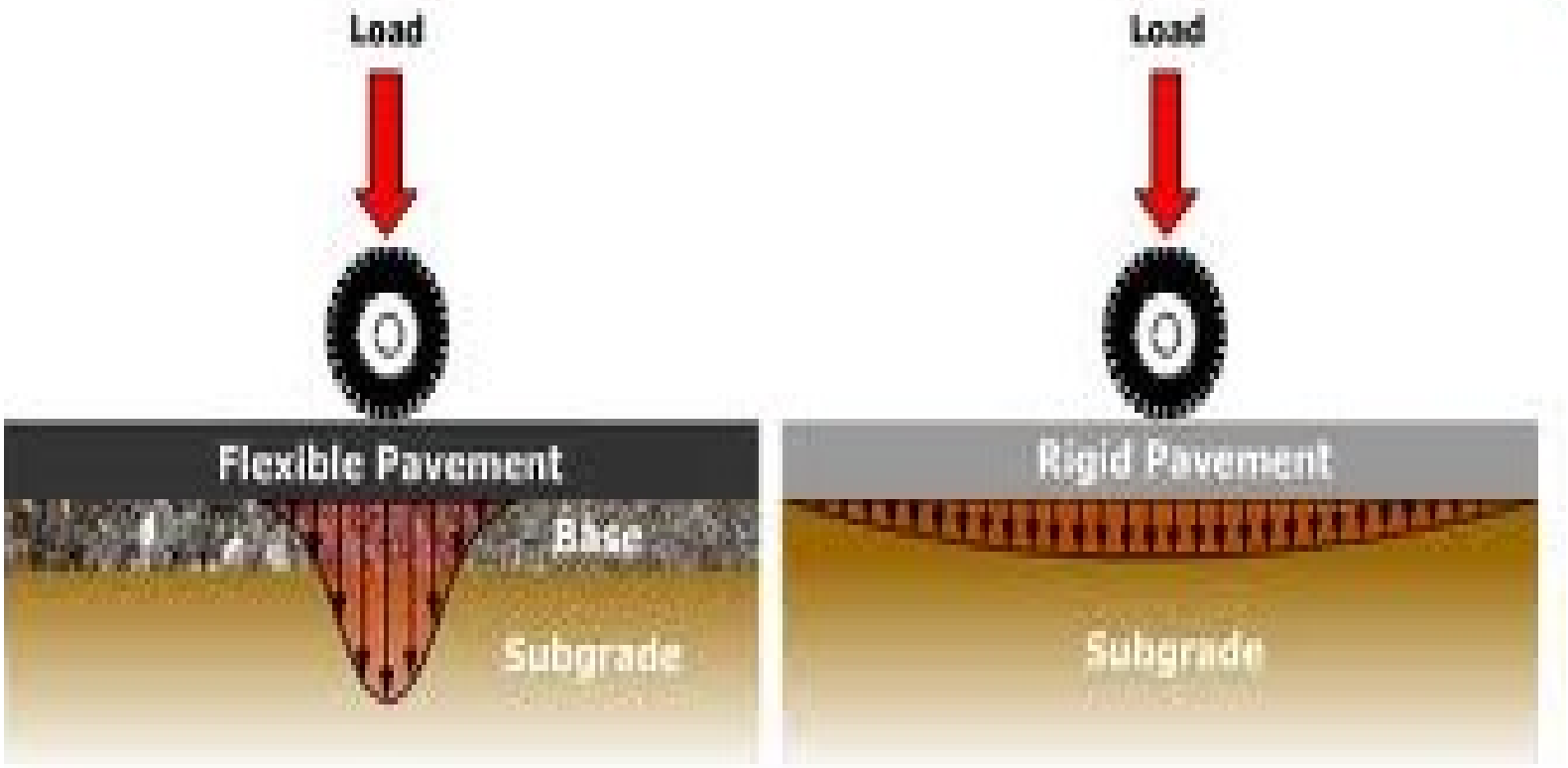
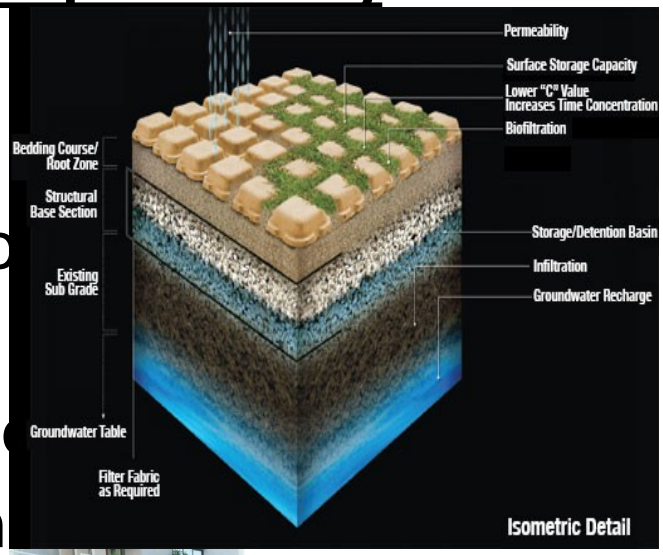


Figure 1: Rigid and Flexible Pavement Load Distribution

Soft paving

- **<u>Turfgrass</u> soft paving**
- Colourful
- Relatively low installation co
- Dust free
- Good drainage characteristi
- Difficult and expensive to m
- **<u>Turf blocks soft paving</u>**
- Same as turf alone but has a stability to withstand light ve loads
- Requires high level of maint





Subgrade soil

- Soil is an accumulation or deposit of earth material, derived naturally from the disintegration of rocks or decay of vegetation, that can be excavated readily with power equipment in the field or disintegrated by gentle mechanical means in the

Subgrade …

- The supporting soil beneath pavement and its special under courses is called subgrade.
- Undisturbed soil beneath the pavement is called natural sub grade.
- Compacted subgrade is the soil compacted by controlled

Subgrade soil



Subgrade soil



Soil Types

- The wide range of soil types available as highway construction materials have made it obligatory on the part of the highway engineer to identify and classify different soils.
- Broadly, the soil types can be categorized as Laterite soil,

Aggregates

- Aggregate is a collective term for the mineral materials such as sand, gravel, and crushed stone that are used with a binding medium (such as water, bitumen, Portland cement, lime, etc.) to form compound materials (such as AC and PC concrete).
- By volume, aggregate generally accounts for 92 to 96% of AC and about 70 to 80% of PC concrete.
- Aggregate is also used for base and sub-base courses for both flexible and

Aggregates



Asphalt/Bitumen

- Bituminous materials or asphalts are extensively used for roadway construction, primarily because of their excellent binding characteristics and water proofing properties and relatively low cost.
- Bituminous materials consists of bitumen which is a black or dark coloured solid or viscous cementations substances consists chiefly high molecular weight hydrocarbons derived from **distillation of petroleum** or natural asphalt, has adhesive properties, and is soluble in carbon disulphide.

Asphalt/Bitumen

- Tars are residues from the destructive distillation of organic substances such as coal, wood, or petroleum and are temperature sensitive than bitumen.
- Bitumen dissolves in petroleum oils where as tar not.

END

THANK YOU!