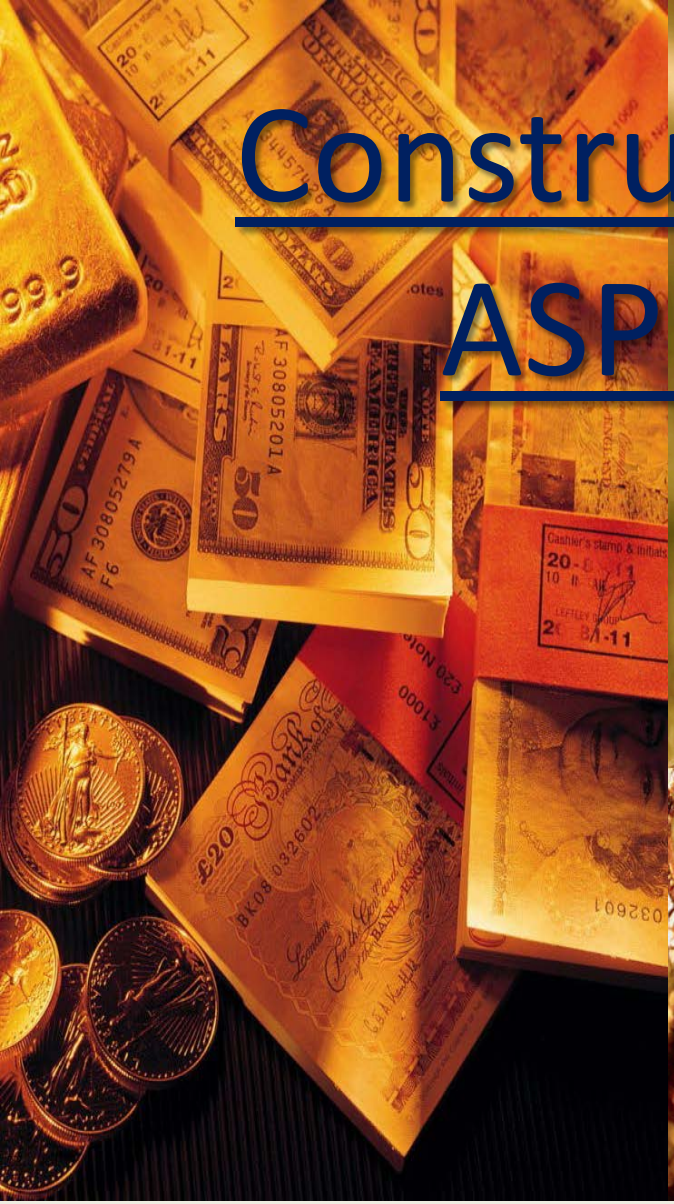
Construction Technology

ASPHALTIC MIXES



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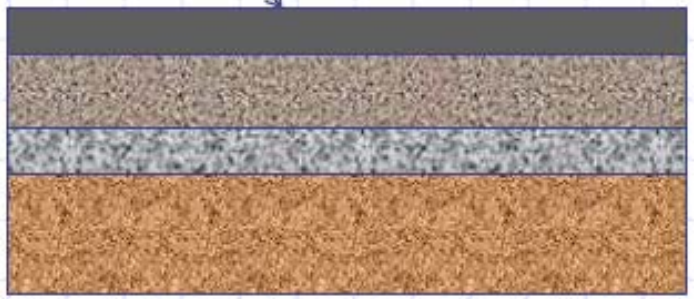
Typical Pavement Layers

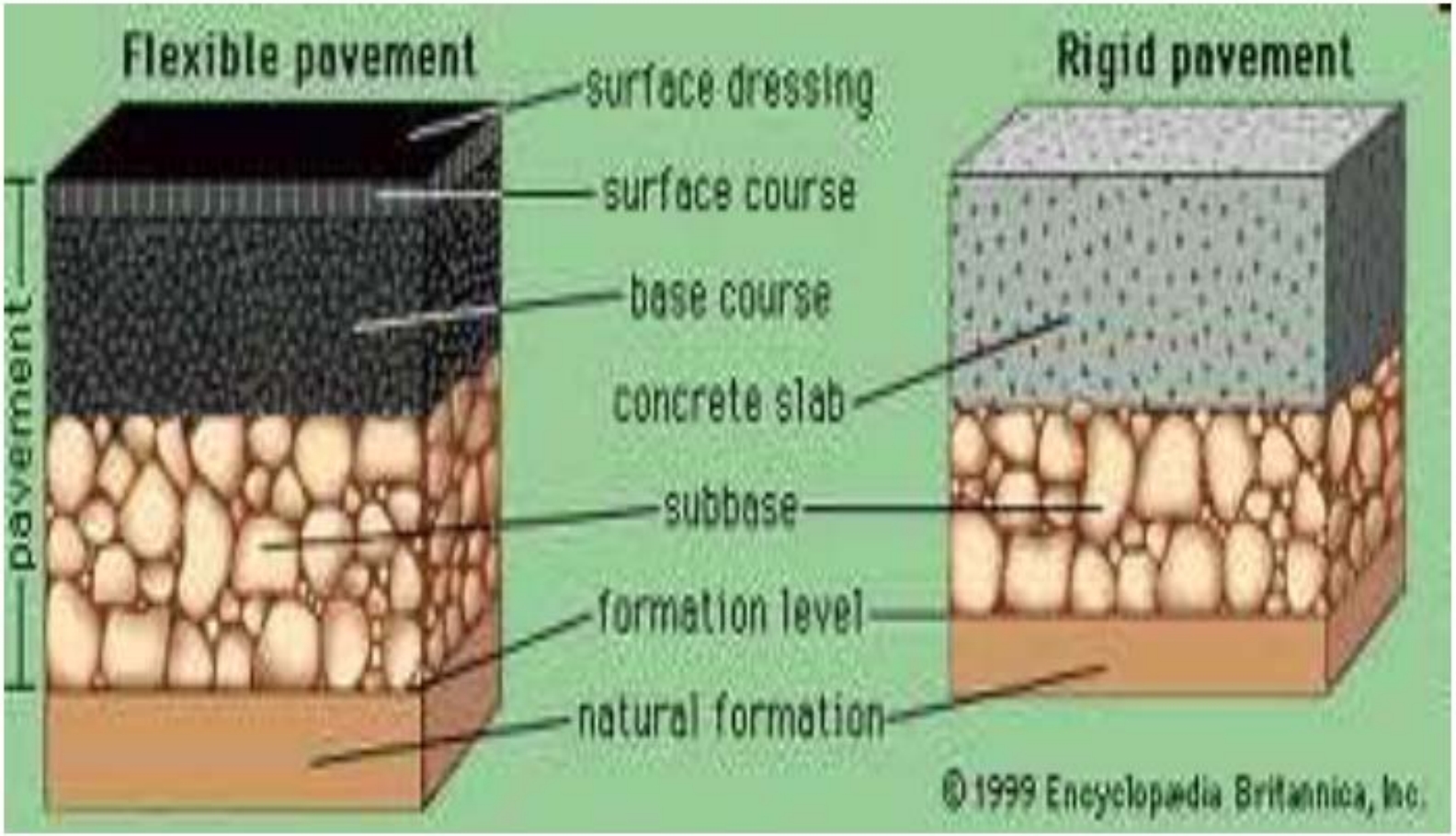
Typical Pavement Layers

- **Wearing course or surface**
- Base course
- Subbase
- **Subgrade**
  - Compacted or Stabilized
  - Natural



Types of Pavement

Types of Pavements



Why Flexible Pavement (Asphalt):

- Flexible pavements consist of a series of layers, with the highest quality materials at or near the surface. The strength of a flexible pavement is a result of building up thick layers and thereby distributing the load over the sub grade.
- There are many reasons that highway engineers and motorists prefer asphalt.
- Simply stated, asphalt pavements are designed and built to last.
- Most roads are constructed in layers, with each layer playing its part in delivering the best infrastructure possible.
- When it's all put together, asphalt pavements can handle the toughest traffic load.

Pavement Smoothness

- Smooth roads conserve energy and extend the life of pavements.
- smoother surfaces can reduce fuel consumption in the neighborhood of 4.5 to 5 percent compared to fuel consumption on a rough pavement.
- A study in Sweden concluded that vehicles traveling on the smoothest roads in that country's network consumed up to 10 percent less fuel than vehicles on their roughest roads.
- Smoother pavements also result in longer pavement life by as much as 10 to 25 percent, resulting in lower maintenance costs.
- As a rule, asphalt pavements are smoother than concrete pavements.

Speed of Construction

- Paving with asphalt cuts construction project time significantly and eliminates the long curing times of concrete.
- As a result, traffic flows more smoothly, impact on commerce is minimized, and safety hazards are reduced.
- Asphalt paving projects can be planned and carried out to take advantage of low-traffic periods, like nights and weekends, minimizing the project's impact on motorists, residences and businesses.
- Asphalt work can be planned so that the crews work in off-peak periods only. This means that folks may drive home from work on a Tuesday night, then find a brand-new, smooth pavement when they drive to work Wednesday morning

Other Advantages of flexible paving

- **In addition to the previously mentioned advantages, flexible paving possess the following advantages:**

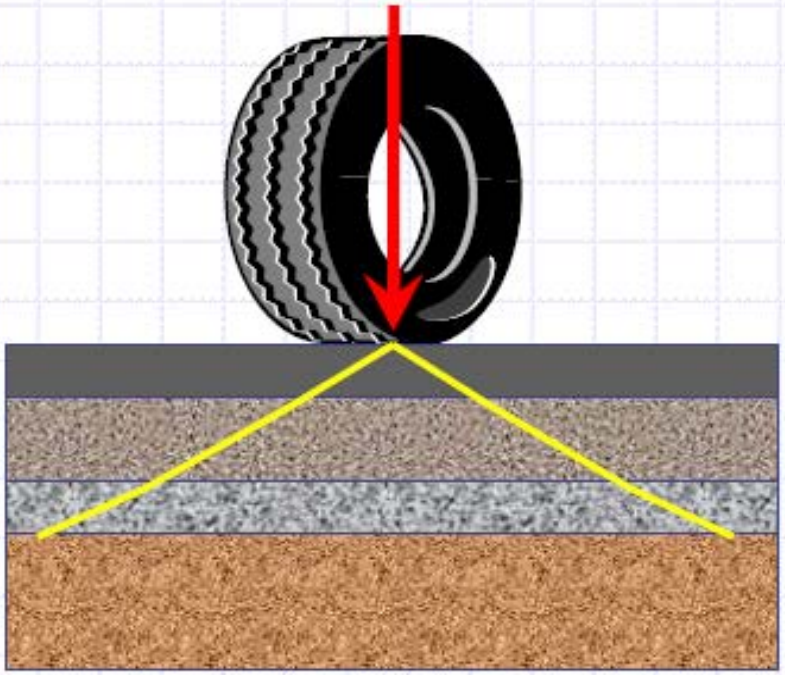
- Adaptability to stage construction
- Availability of low-cost types that can be easily built
- Ability to be easily opened and patched
- Easy to repair frost heave and settlement
- Resistance to the formation of ice glaze
- Adjusts to limited differential settlement
- Easily, quickly constructed and repaired
- Additional thickness can be added.
- Quieter and smoother (generally). More “forgiving”

Disadvantages of flexible paving

- ✓ Higher maintenance costs.
- ✓ Shorter life span under heavy use due to various cracks formation.
- ✓ Damage by oils and certain chemicals.
- ✓ Weak edges that may require curbs or edge devices.
- ✓ Properties may change over time as pavement ages.
- ✓ Generally shorter service life before first rehabilitation.
- ✓ May experience moisture problems.

Disadvantages of flexible paving

Flexible Pavement

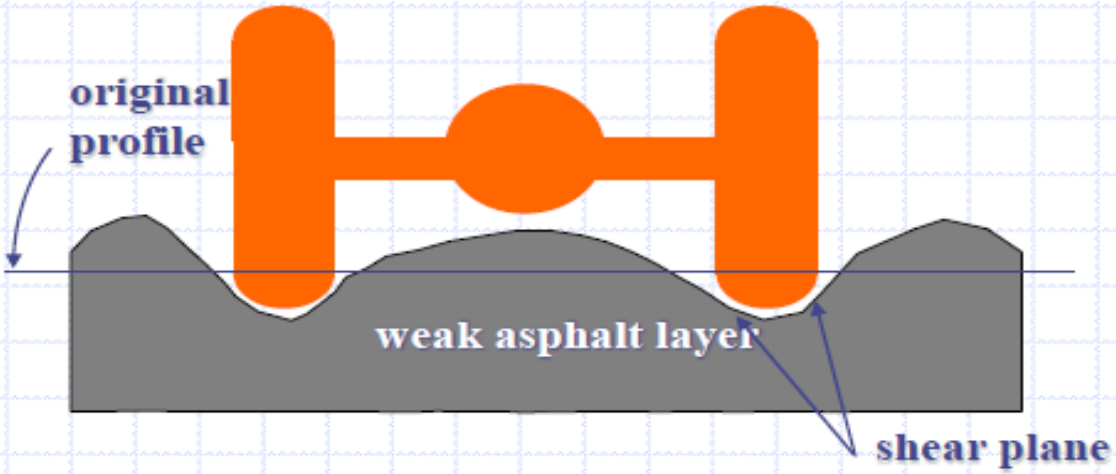


- Pavement layers bend
- Each layer spreads load to next layer
- Loads over a smaller area of subgrade

Disadvantages of flexible paving

Surface Course Distress

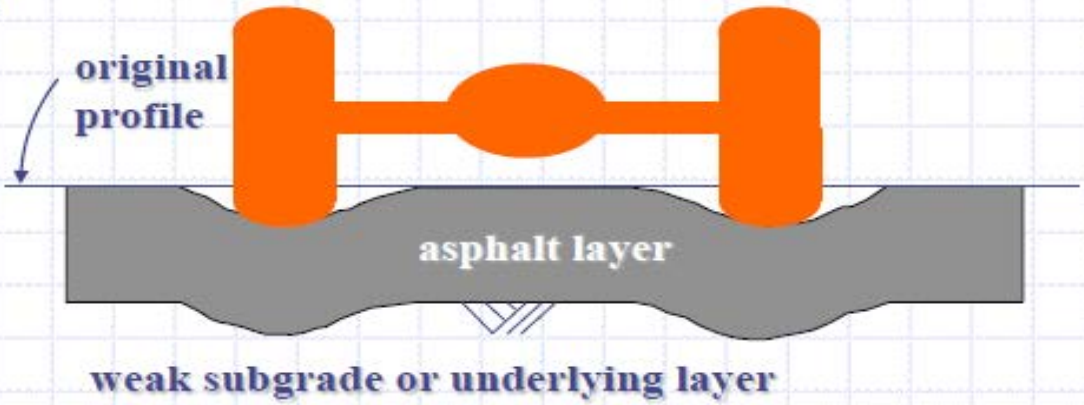
- Rutting mainly controlled by choice of materials and design of surface mixes
- Surfaces also must be resistant to cracking



Disadvantages of flexible paving

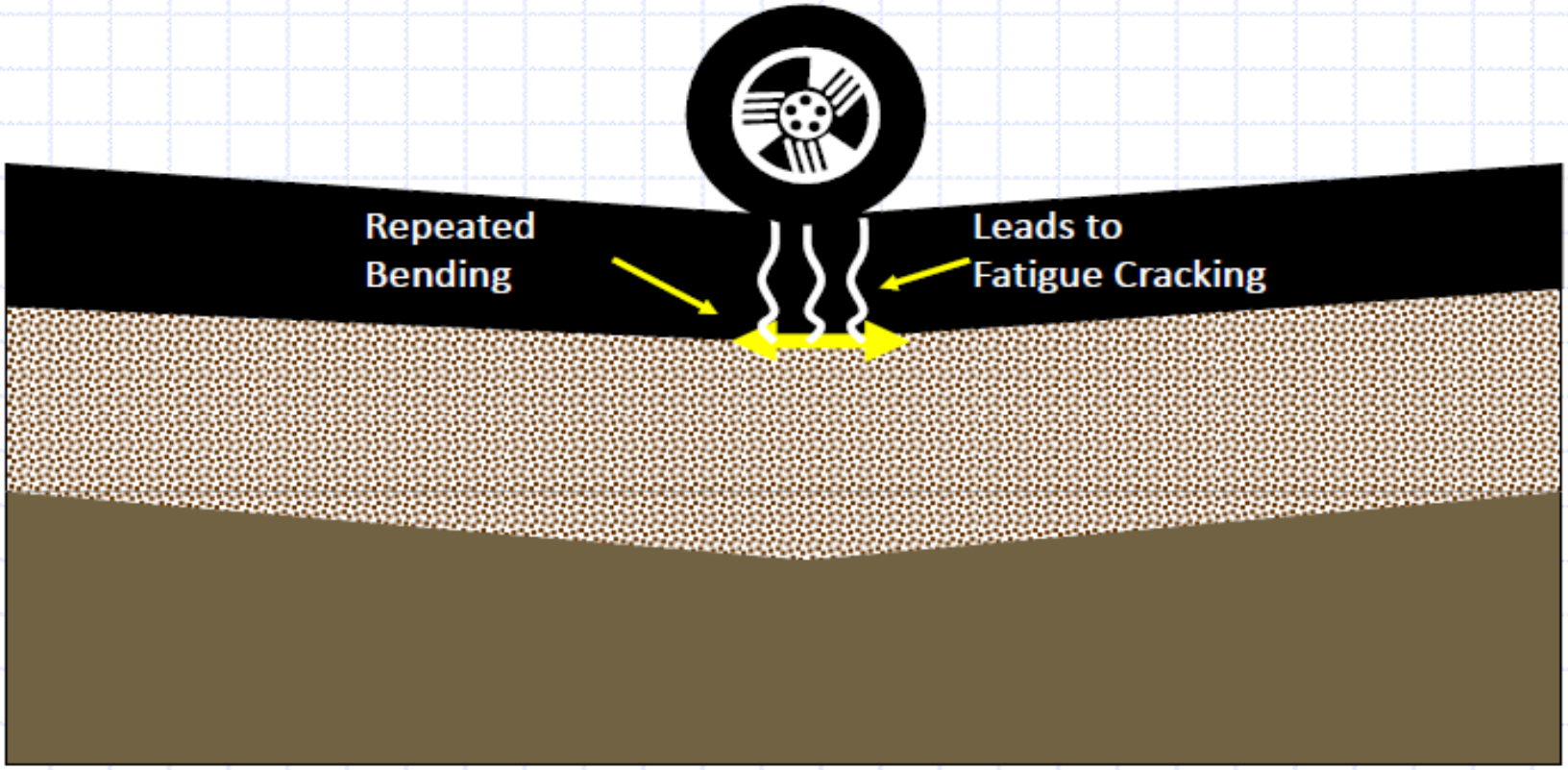
Foundation Distresses

- Poor subgrade support can cause rutting.
  - Drainage
  - Frost penetration?
  - Stabilization



Disadvantages of flexible paving

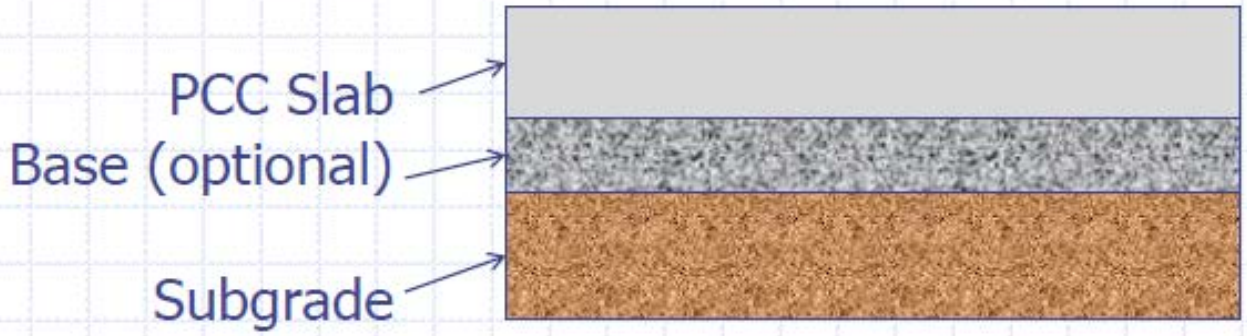
Fatigue Cracking



Rigid pavement layers

Typical Applications – Rigid Pavement

- High volume traffic lanes
- Freeway to freeway connections
- Exit ramps with heavy traffic

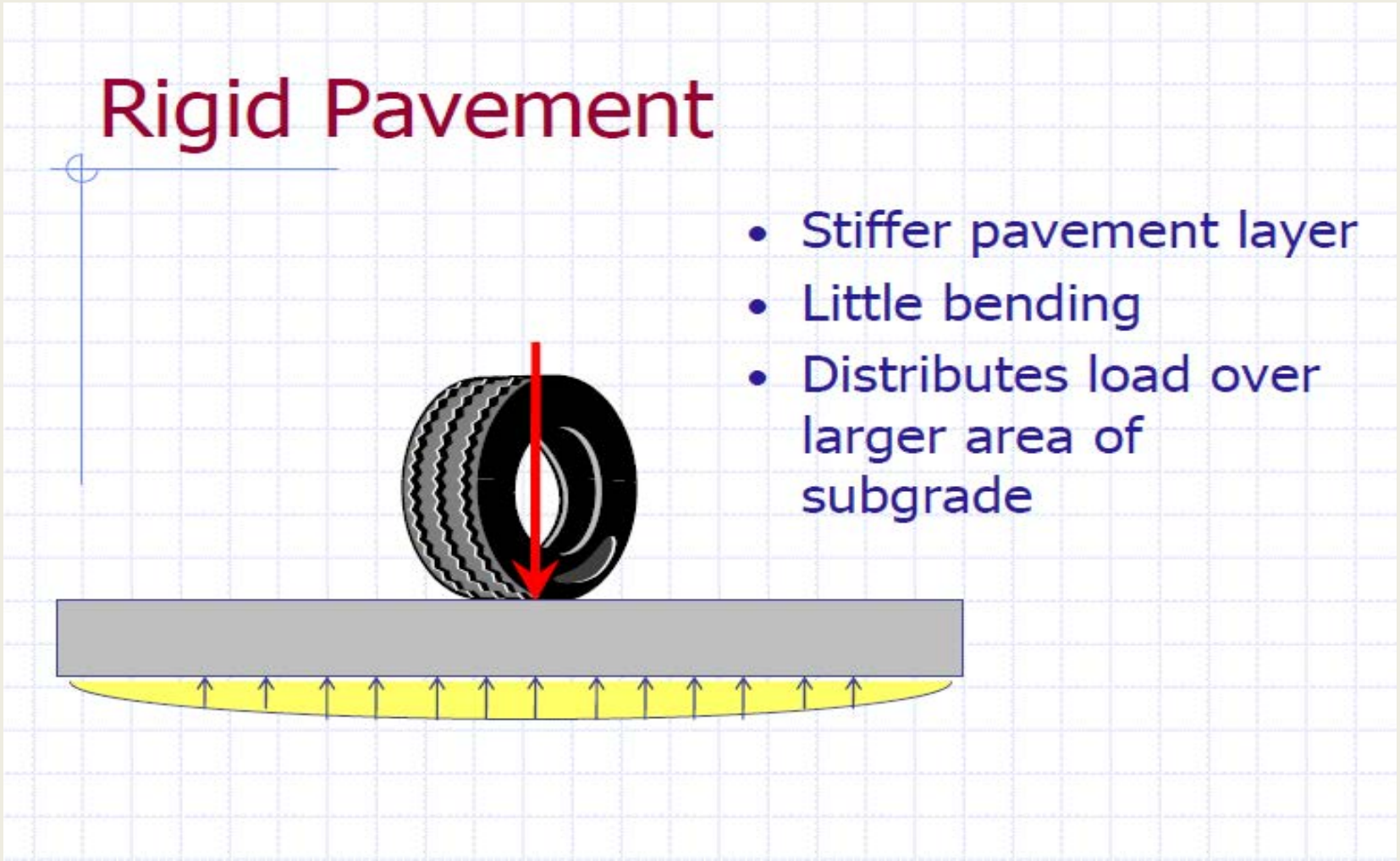


Advantages of Rigid paving

Rigid pavements have a high compressive strength, which tends to distribute the load over a relatively wide area of soil. There are several advantages of properly constructed rigid pavements -

- ✓ Low maintenance costs
- ✓ Long life with extreme durability
- ✓ High value as a base for future resurfacing with asphalt
- ✓ Load distribution over a wide area, decreasing base and sub grade requirements
- ✓ Ability to be placed directly on poor soils
- ✓ No damage from oils and greases.
- ✓ Strong edge
- ✓ Withstand repeated flooding and subsurface water without deterioration.

Advantages of Rigid paving



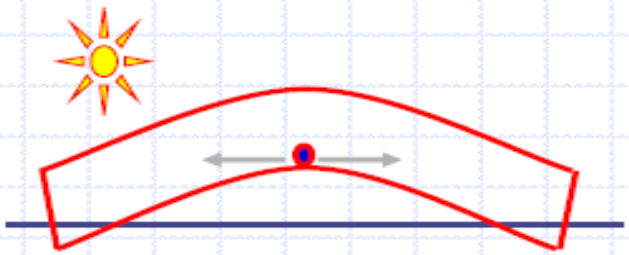
Disadvantages of Rigid paving

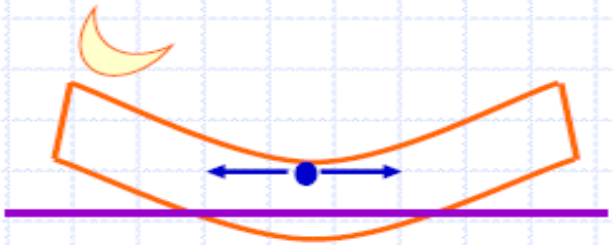
- ✓ High initial costs.
- ✓ Joints are required for both contraction and expansion.
- ✓ Generally rough riding quality.
- ✓ High repair costs when required.
- ✓ Distresses may be harder/more expensive to repair
- ✓ May polish (lose frictional properties) over time
- ✓ Needs even subgrade support

Disadvantages of Rigid paving

Concrete Slab Temperature and Moisture Gradients

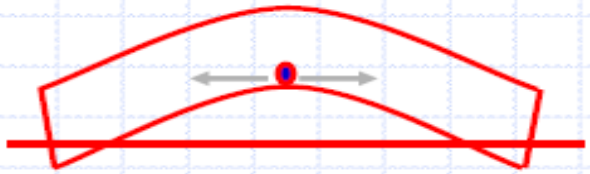
Curling



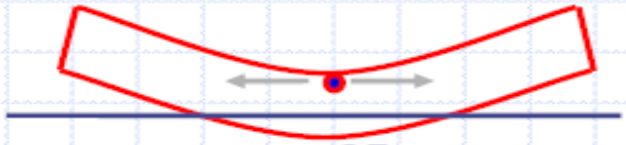


Warping

Slab wetter on top



Slab dryer on top



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HIGHWAY CONSTRUCTIONS

Pavement Design

Pavement means surfacing layer only.

- ✓ In terms of highway design, it means the total thickness of road including, surfacing , base & sub-base, if any.
- ✓ Thus pavement includes all the structural layers of road structure lying.

Design of pavements mainly consists of two aspects.

1. Design mix of materials
2. pavement thickness on subgrade of the road

Factors affecting Road Design

1. **Climate:** rainfall, Temp, Frost action
2. **Environment:** Height of embankment, foundation cutting
3. **Geometry:**
4. **Available Pavement materials:** they have to resist climatic conditions, durable and low maintenance cost.
5. **Characteristics of Subgrade Soil:** it decides and determine the thickness of pavement
6. **Traffic:** Repetitions, Speed, Wheel Loads, contact pressure, volume of traffic, no of vehicles/day .

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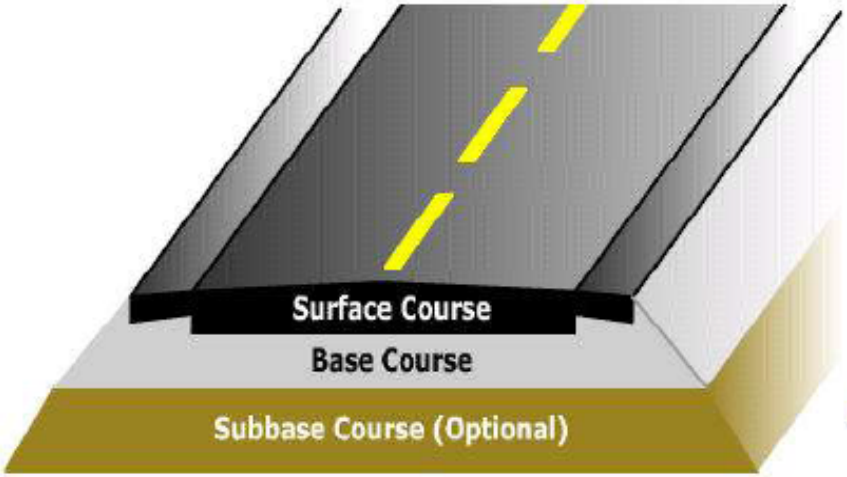
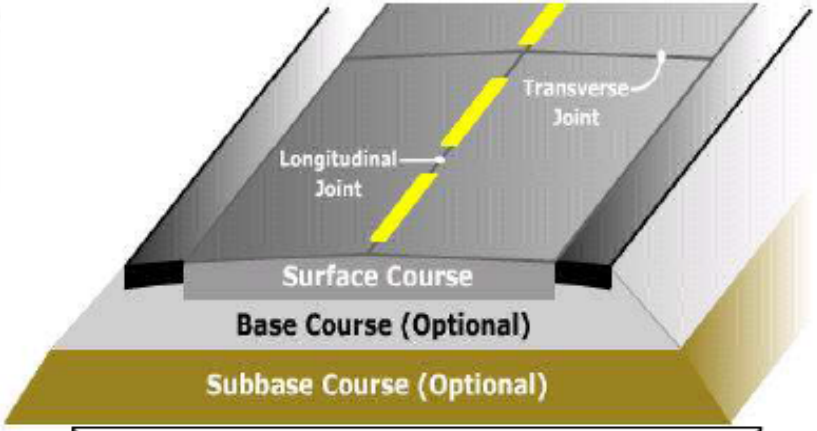
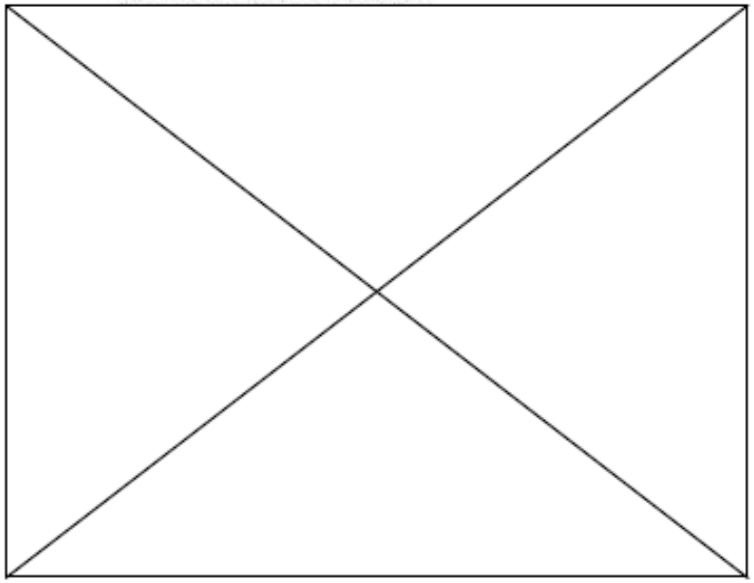
Design Approach for rigid Pavements

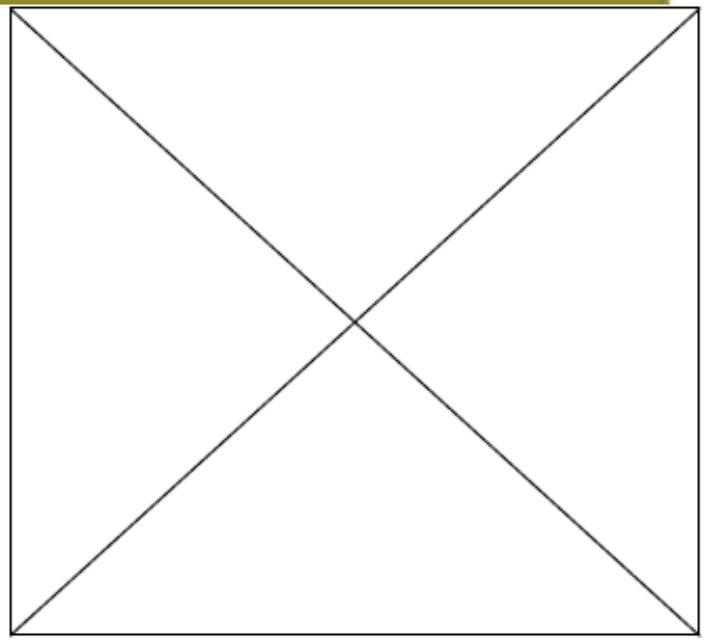
Variables affecting the rigid pavement design

1. Wheel Loads
2. Traffic
3. Climate
4. Terrain
5. Subgrade conditions
6. Properties of Cement









Flexible

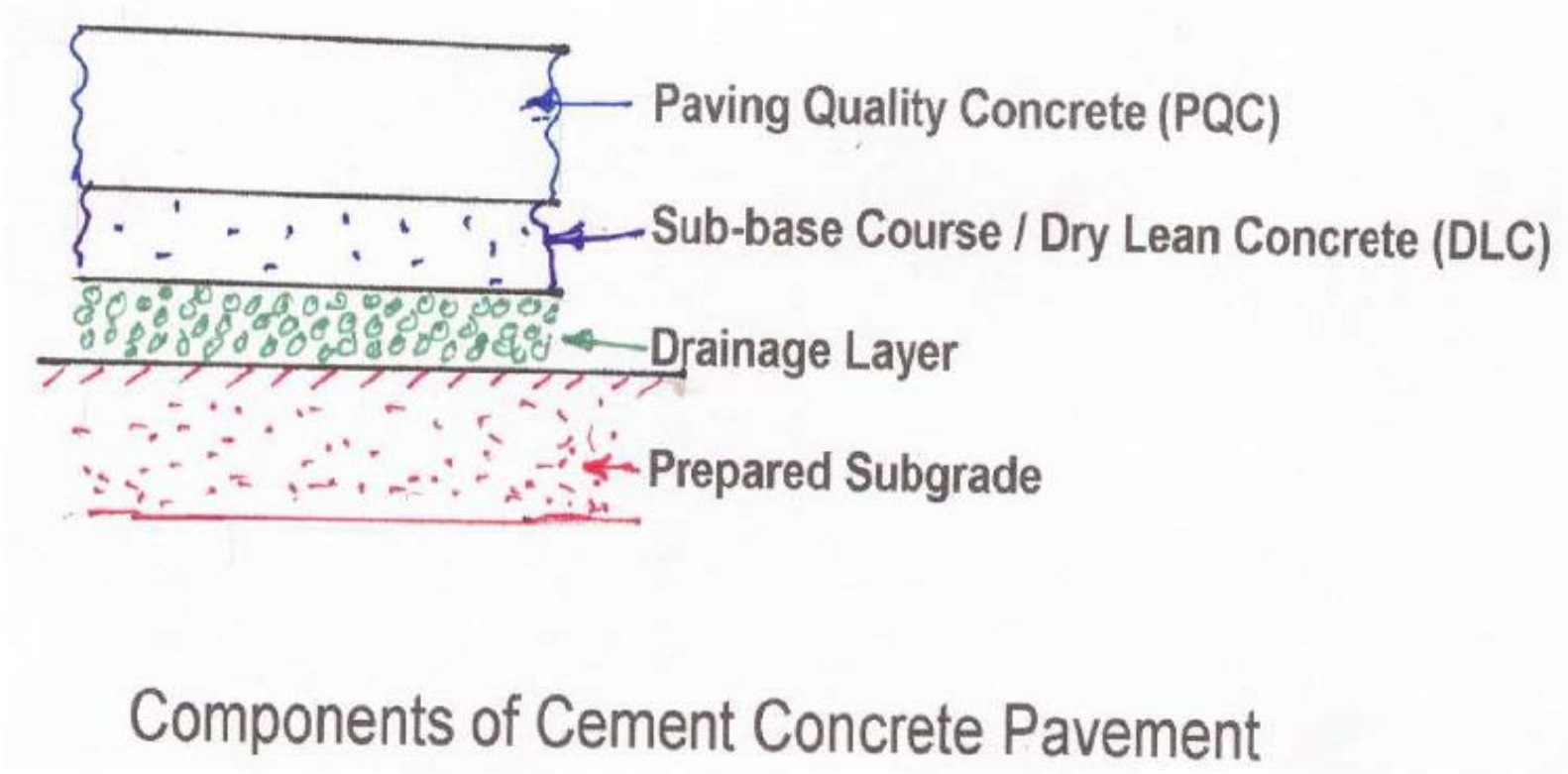
Rigid

Comparison between Flexible and Rigid Pavements

Properties	Flexible Pavement	Rigid Pavement
Design Principle	Empirical method based on load distribution characteristics of the components.	Designed and analyzed by using the elastic theory
Material	Granular material	Made of Cement Concrete either plain, reinforced or pre-stressed concrete.
Flexural Strength	Low or negligible flexible strength	Associated with rigidity or flexural strength or slab action so the load is distributed over a wide range of subgrade soil.
Normal loading	Elastic deformation	Act as a beam on elastic foundation.
Excessive loading	Local depression	Causes cracks
Stress	Transmits vertical and Compressive stresses to the lower layers	Tensile Stress and Temperature Increases
Design practice	Constructed in number of layers	Laid in slabs with or without steel reinforcement.
Temperature	No stress is produced	Stress is produced
Opening to Traffic	Road can be used for traffic within 24 Hours.	Road cannot be used until 14 days of curing
Surfacing	Rolling of the surfacing is necessary	Rolling of the surfacing in not needed.

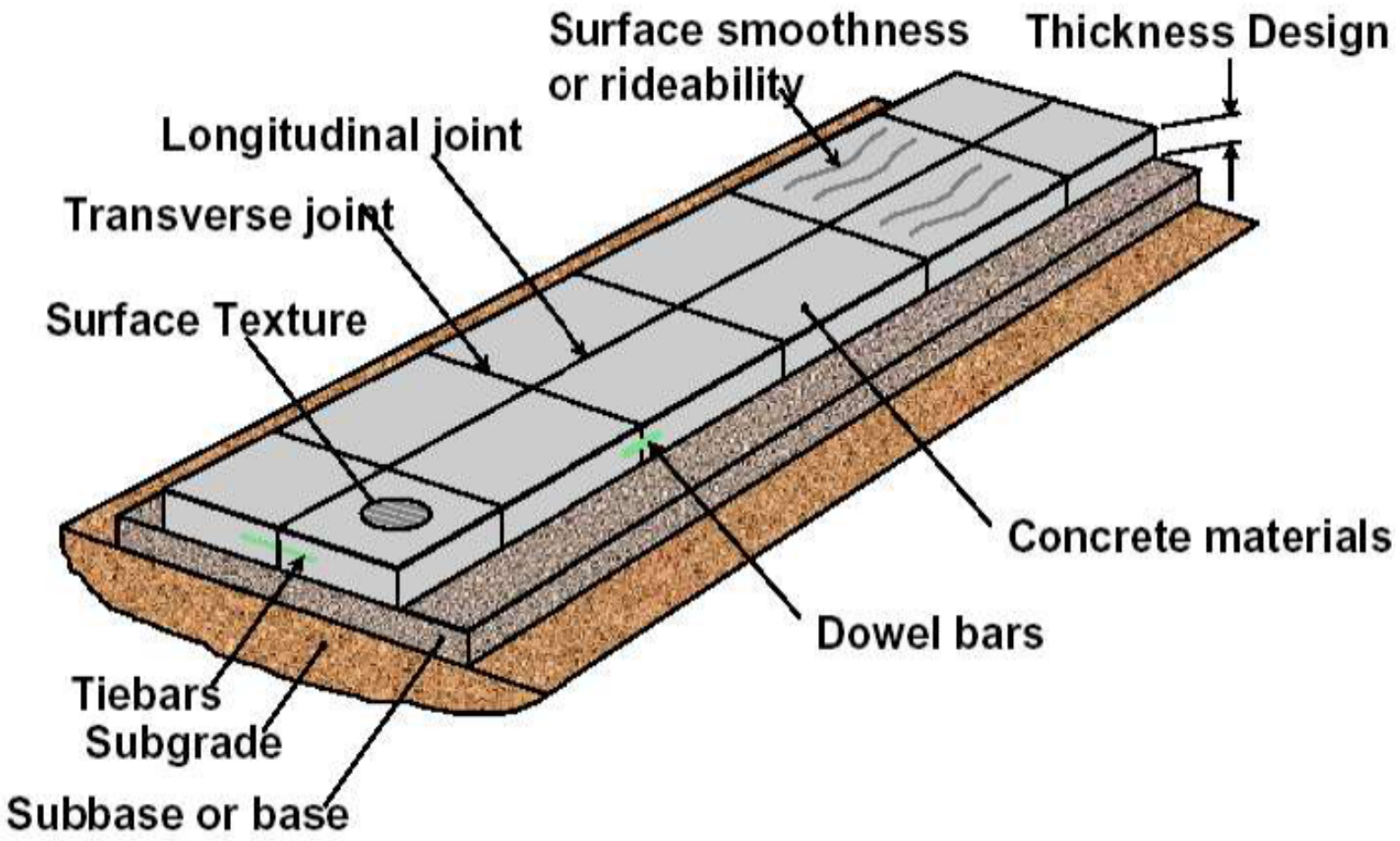
Component of cement Concrete Pavement

Components of CC pavement



Components of Cement Concrete Pavement

Longitudinal section in Cement Concrete Pavement



Types of Rigid Pavements

1. **Jointed Plain Concrete Pavement (JPCP)**

No temperature steel

2. **Jointed Reinforced Concrete Pavement (JRCP)**

Temperature steel placed at mid height and discontinued at the joints.

3. **Continuously Reinforced Concrete Pavement (CRCP)**

Not popular and– very costly

4. **Pre-stressed Concrete Pavement (PCP)**

Not popular and very coasty

Design Approach for rigid Pavements

Cement Concrete roads provides a highly rigid surface and hence for the success of such roads, following two conditions should be satisfied:

1. They should rest on non- rigid surface having uniform bearing capacity.

2. The total thickness or depth of the concrete pavement & the non rigid base should be sufficient to distribute the wheel load on a sufficient area of sub-base so that the pressure on unit area remains with the permissible SBC of the soil.

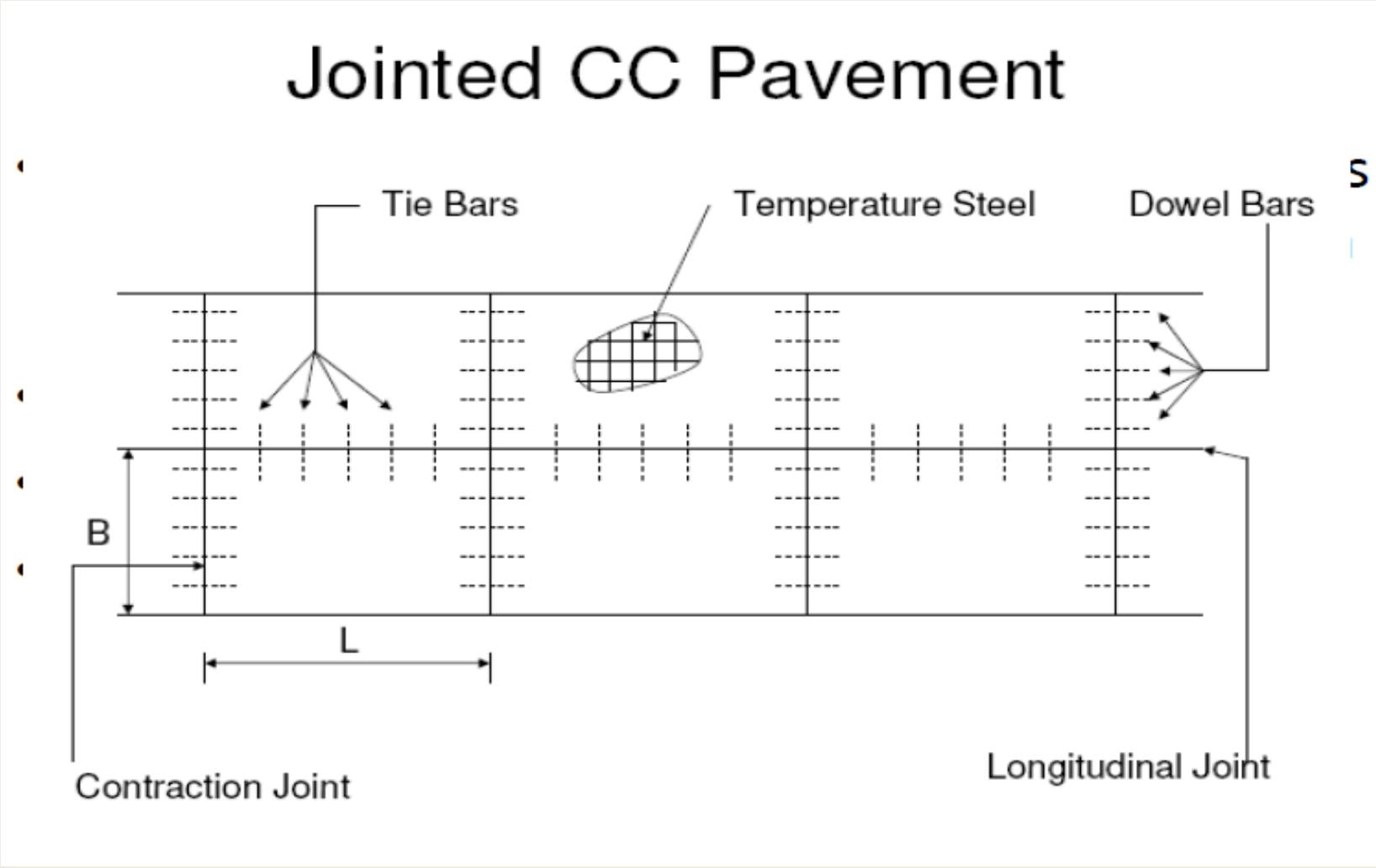
Purpose of joints in Concrete Roads

1. To absorb expansion & contraction due to variation in temperature. (horizontal movements of slabs).

2. To avoid warping of slab edges.

3. To grant facility in construction .They should rest on non- rigid surface having uniform bearing capacity.

Purpose of joints in Concrete Roads



CONTRACTION JOINTS (Control Joints)

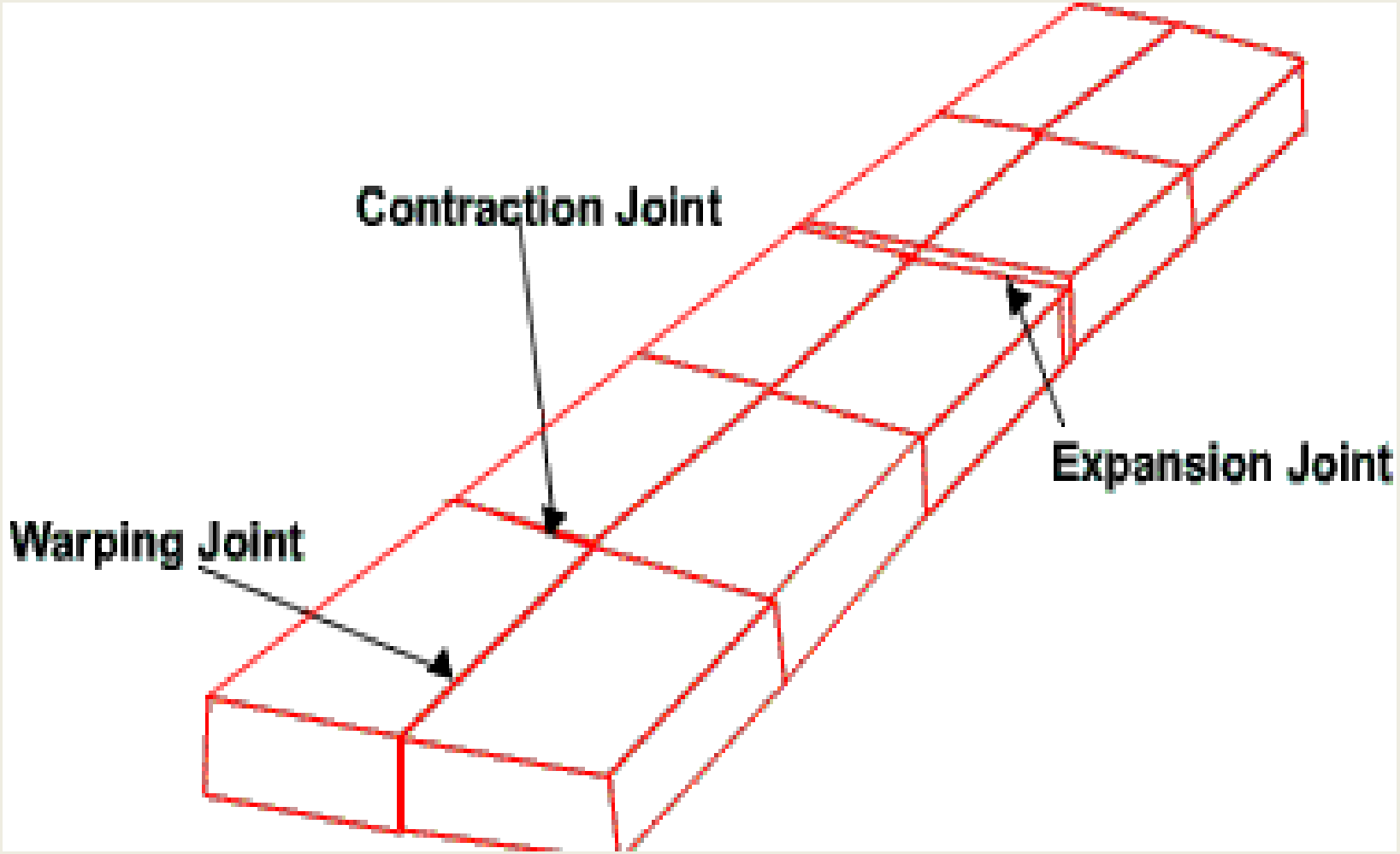
These are purposely made weakened planes which:

- ✓ Relieve the tensile stresses in the concrete, Caused due to changes in the moisture content (Drying shrinkage) and/or temperature and
- ✓ Prevent the formation of irregular cracks due to restraint in free contraction of concrete .

They are also provided to:

- ✓ Relieve stresses due to warping
- ✓ To permit the contraction of the slab
- ✓ To grant facility in construction .They should rest on non-rigid surface having uniform bearing capacity.

CONTRACTION JOINTS (Control Joints)



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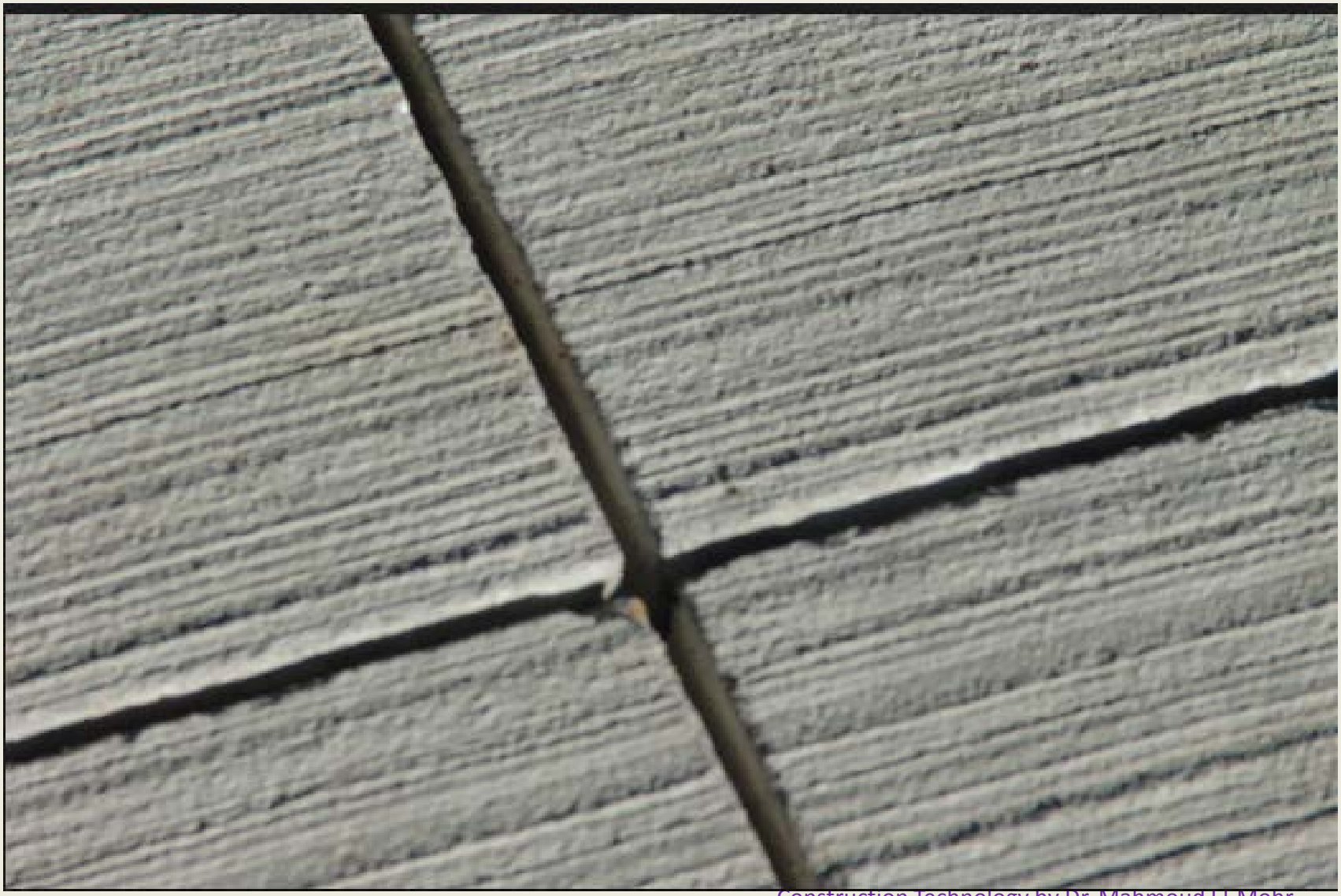


LONGITUDINAL JOINTS

Lanes are jointed together by joint known as Longitudinal joint. Longitudinal joints are provided in multilane pavements and also when the pavement is more than 4.5 m wide. They are provided normally at 3.5m c/c to:

- ✓ Relieve stresses due to warping.
- ✓ To allow differential shrinkage & swelling due to changes of sub grade moisture
- ✓ To prevent longitudinal cracking

Procedure of construction

Initially joint is cut to a depth 1/3rd slab thick ± 5mm. Tie bars are provided at the joints not for load transference but for keeping the adjoining slabs together..

The top 15-20 mm of the joint is sawn to a width of 6-8 mm for sealing.

Expansion JOINTS

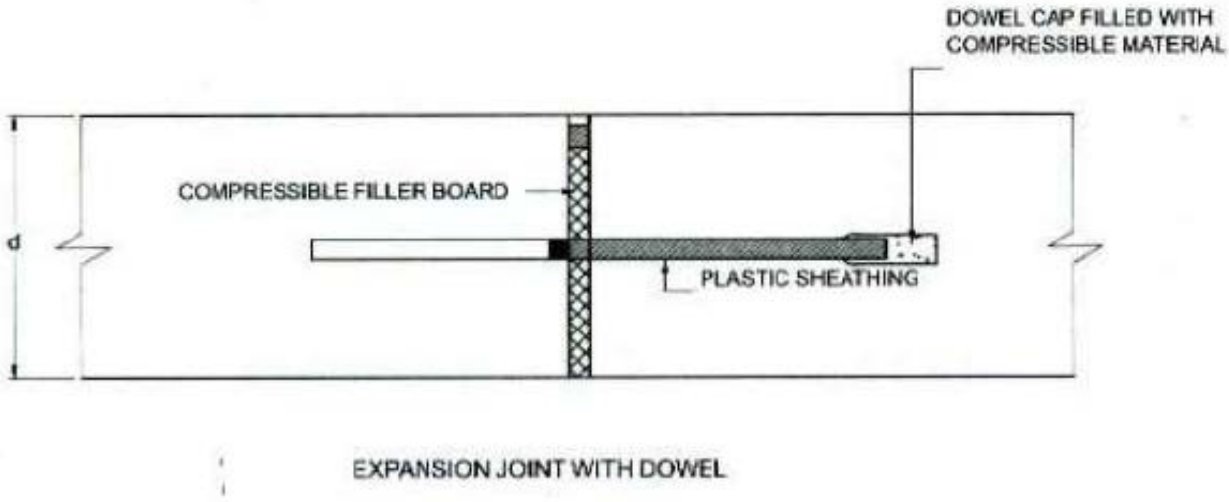
There are full-depth joints provided transversely into which pavement can expand, thus relieving compressive stresses due to expansion of concrete slabs, and preventing any tendency towards distortion, buckling, blow-up and stalling.

- ✓ They allow expansion of slabs due to temperature
- ✓ They permit contraction of slabs.
- ✓ They are about 20 mm in width
- ➢ A joint filler board of compressible material conforming to specification is used to fill the gap between the adjacent slabs at the joint.
- ➢ The height of the filler board is such that its top is 23-25mm below the surface of the pavement.
- ➢ The joint groove is filled by a sealant.

Expansion JOINTS

Expansion Joint

Dowels: 25mmdia., 500mm long and spaced at 250mmc/c



EXPANSION JOINT WITH DOWEL

Filler board: compressible Joint filler 20mm ± 1.5mm
Filler depth 25mm ± 3mm lower than slab thickness
Dowel bars (MS rounds) to be covered with plastic sheathing for ½ length +50mm

Choosing a Pavement Type

Many states have guidelines or policies to choose pavement type which are driven by:

- ✓ **Engineering and economic considerations (preferred)**
- ✓ **Sometimes influenced by other considerations**

SEE YOU NEXT LECTURE

THANK YOU!