

CIVIL ENGINEERING TECHNOLOGY 2

1.2 ROAD PAVEMENTS

TYPES OF PAVEMENT



ROAD PAVEMENTS

Durable surface material laid down on an area intended to sustain vehicular or foot traffic, such as a road or walkway

Main materials

Asphalt
Concrete

Others

Gravel
Cobblestone
Granite setts

Exercise 1

Read the text given and in groups prepare a small presentation of the part assigned by your lecturer.



The Design Manual for Roads and Bridges (DMRB)

Introduced in 1992 in England and Wales

Contains information about current standards, advice notes and other published documents relating to the design, assessment and operation of trunk roads - including motorways.

Gathered together in a consistent series of 15 volumes

Volume 7 - Pavement Design & Maintenance



The Manual of Contract Documents for Highway Works (MCHW)

First published in 1992

Contains information for contract administrative process and the project Contract documents

- Specification for Highway works
- Method of measurement
- Site supervision

Gathered together in a consistent series of 6 volumes

Volume 1 – Specification for Highway Works
Volume 3 – Highway Construction details



Types of pavements (DMRB HD 26/06)

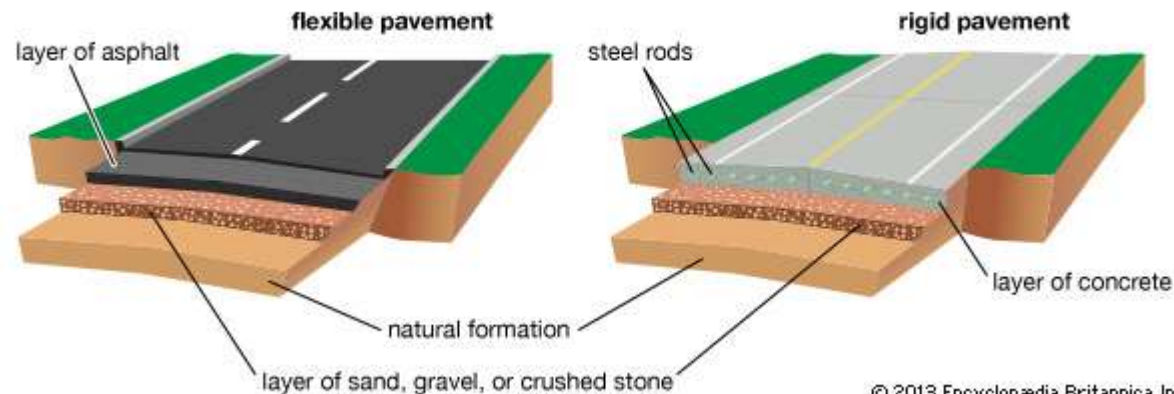
Flexible pavements

- Use of bituminous products

Rigid pavements

- Concrete (reinforced or not)

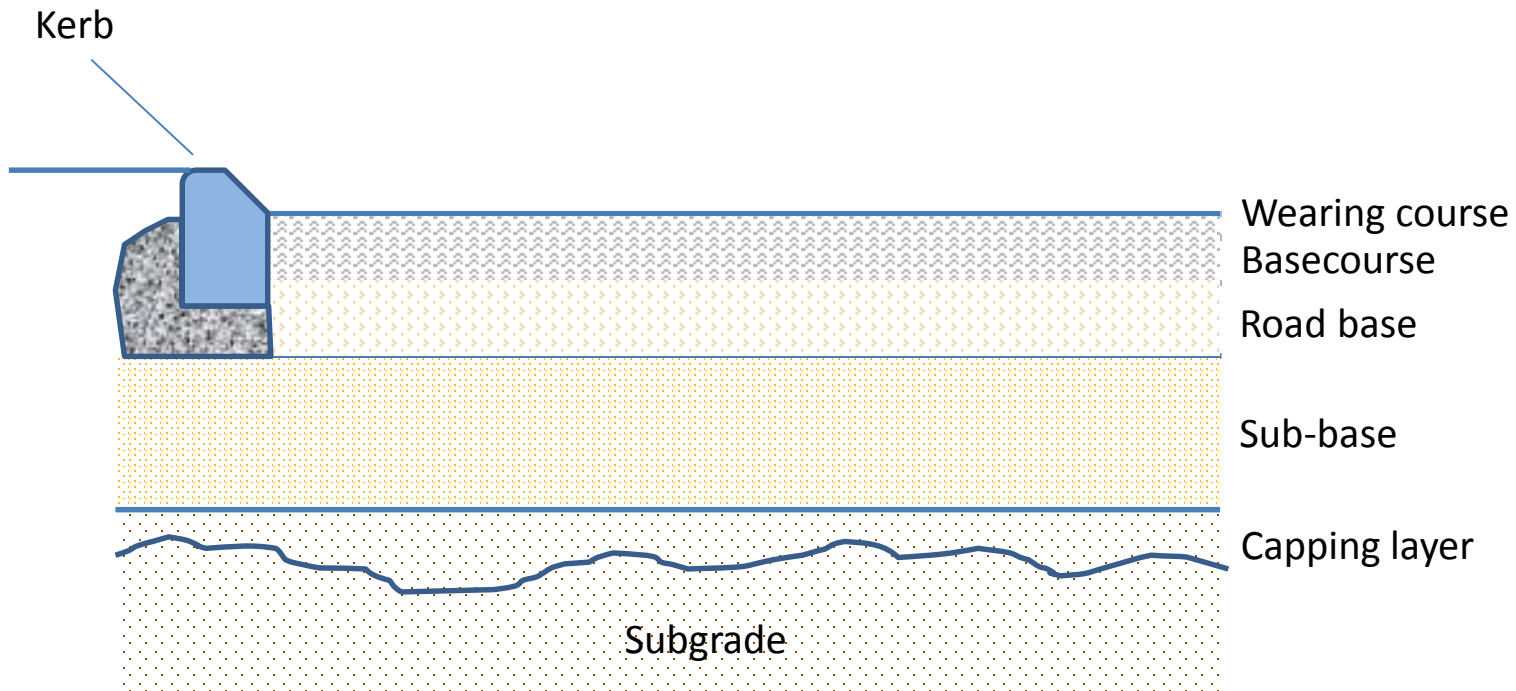
Types of road construction



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Typical section of road pavement





Capping layer

Built only for weak subgrades

Necessity of larger sub-bases –cheaper to build

Working platform for sub-bases construction

Protects subgrade from wet weather

Use of crashed gravels and rockfill (up to 125 mm) obtained locally

Indefinite thickness – according to necessities

Geotextiles to inhibit penetration of material



Sub-base

Laid as soon as possible to prevent damage from rain

- Rain damage or sun baking
- Avoid the entrance of water

Layers of small thickness to be compacted (not more than 250 mm)

Most common materials: Type 1. Unbound material (crushed rock, crushed slag, crushed concrete, recycled aggregates, burnt non-plastic shale)

Up to 10% may be natural sand

Predefined range of material size (can be mixed) to obtain good resistance when compacted

Lean mix can also be used



Road base

Main bearing layer for distribution of loads

Thickness depending on transport load and materials used

For flexible pavement

Well graded aggregates

Sometimes a lean mix with a binder is used

Permitted hydraulically bound materials (HBM) (HD 26/06):

- CBGM, cement bound granular material;
- FABM, fly ash bound material;
- SBM, slag bound material.

For rigid pavement

Road base not necessary



Surfacing layers

For flexible pavement

Basecourse

Wearing course

For rigid pavement

Concrete slab



Road base for flexible pavement

Basecourse

Helps distribute the loads of traffic onto the base road

Provides a flat surface for a thinner final layer

Thickness variable

Flexible pavement types permitted (HD 26/06)

Penetration
Index

- Dense Bitumen Macadam (DBM50 or DBM125) or Heavy Duty Macadam (HDM50);
- Stone Mastic Asphalt (SMA), for use as a binder course only, not as a base;
- Hot Rolled Asphalt (HRA50) (it must comply with Clause 943)
- High modulus (stiff) dense bitumen macadam (EME2 - Enrobé à Module Élevé), but only on a Class 3 or 4 Foundation (see pavement design), subject to a “Departure from Standard” being granted by the Overseeing Organisation.



MATERIALS FOR ROAD LAYERS

Asphalt Concrete (BS EN 13108-1)

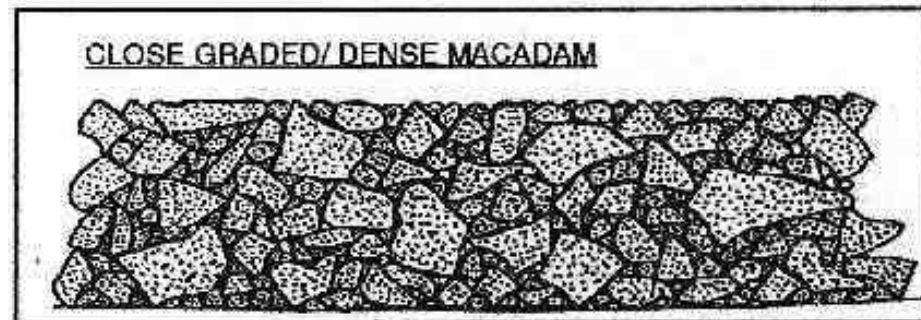
Known too as close graded macadam/dense bitumen macadam

Well-graded aggregate (coarse aggregates)

The particles knot together to produce a tight aggregate mass held together by the bitumen binder

100-150 mm thick and compacted with heavy rollers

Excellent load carrying and durable base within the road pavement



MATERIALS FOR ROAD LAYERS

Hot Rolled Asphalt

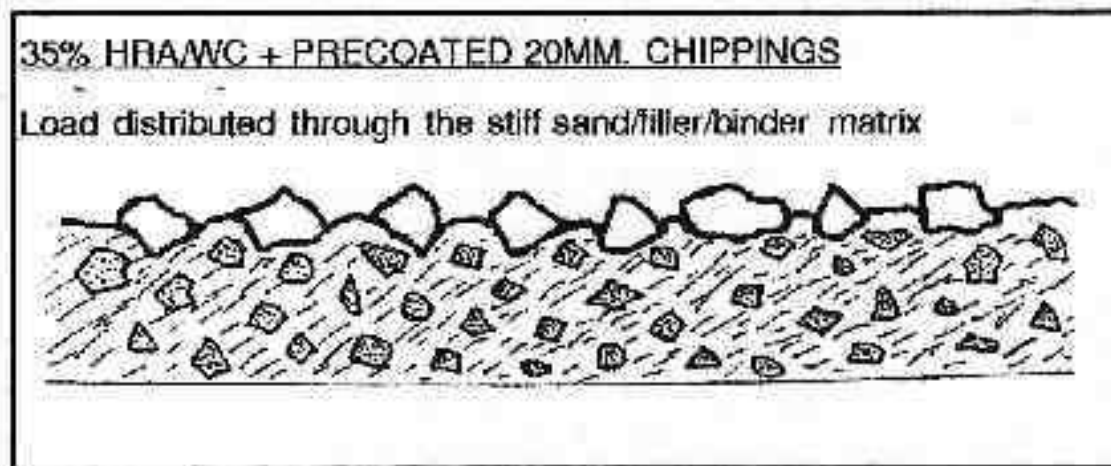
With or without chipping

Chipping provide adherence and durability

It is spread when the asphalt is hot, and rolled again over it. As the asphalt melts, chipping is adhered.

40-50 mm width

Hot rolled asphalt with applied high polished stone value precoated chippings – Premium highway surfacing material





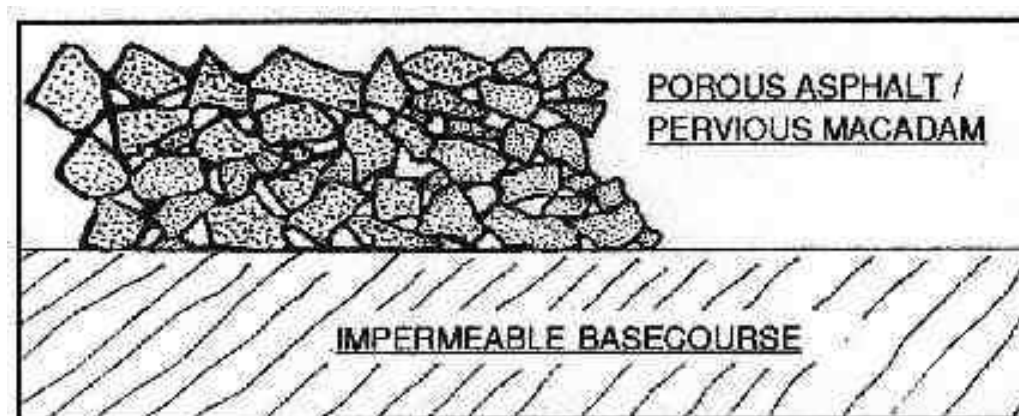
MATERIALS FOR ROAD LAYERS

Porous Asphalt/Pervious macadam

Gap-graded or uniformly-graded aggregates, with few fines

We obtain a drainage surface

Used for parking, road pavement (sustainable urban drainage)



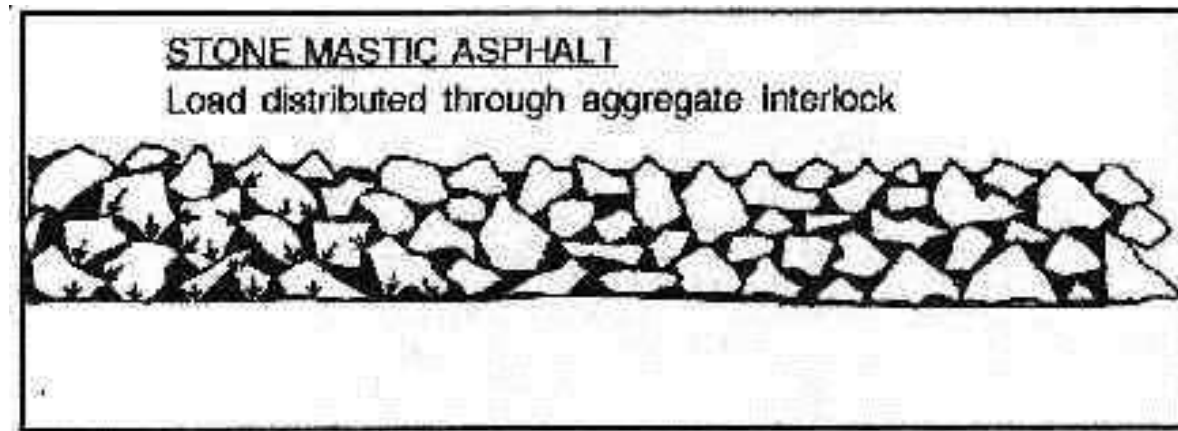


MATERIALS FOR ROAD LAYERS

Stone Mastic Asphalt (SMA)

Gap-graded or uniformly-grades aggregate

The quantity of asphalt concrete is much more and fill the voids left





Bituminous macadam



Hot rolled asphalt



**Stone Matrix
Asphalt
SMA**



**Conventional
Hot Mix Asphalt
HMA**



Road base for flexible pavement

Wearing course

Provides water drainage and skid resistance

Reduce surface noise

Laid in a wide range of bituminous materials

Selection of material depending on traffic density

The most common in the UK:

- Hot rolled asphalt (HRA). High fines and asphaltic cement content with crushed rock, slag or gravel.

Trunk roads: HRA or porous asphalt (PA) for water drainage



Road base for rigid pavement

Concrete slab

Distributes loads very well

Low loads to sub-base

Thickness variable depending on loads to distribute

Types (HD 25/06)

- Continuously reinforced concrete pavement (CRCP) (normally with an asphalt overlay of minimum thickness 30 mm)
- Continuously reinforced concrete base (CRCB) with an asphalt overlay of 100 mm.

For limited use:

- Unreinforced jointed concrete (URC)
- Jointed reinforced concrete (JRC)



Specifications for road pavement materials (previous BS 594 and BS 4987)

BS EN 13108-1 : 2006:Bituminous mixtures. Material specifications. Asphalt Concrete
BS EN 13108-2 : 2006:Bituminous mixtures. Material specifications. Asphalt Concrete for very thin layers
BS EN 13108-3 : 2006:Bituminous mixtures. Material specifications. Soft asphalt
BS EN 13108-4 : 2006:Bituminous mixtures. Material specifications. Hot rolled asphalt
BS EN 13108-5 : 2006:Bituminous mixtures. Material specifications. Stone mastic asphalt
BS EN 13108-6 : 2006:Bituminous mixtures. Material specifications. Mastic asphalt
BS EN 13108-7 : 2006:Bituminous mixtures. Material specifications. Porous asphalt
BS EN 13108-8 : 2005:Bituminous mixtures. Material specifications. Reclaimed asphalt
BS EN 13108-20 : 2006:Bituminous mixtures. Material specifications. Type testing
BS EN 13108-21 : 2006:Bituminous mixtures. Material specifications. Factory production control

Others

PD 6691:2007:Guidance on the use of BS EN 13108 Bituminous mixtures. Materials specifications,
BS 594987:2007:Asphalts for roads and other paved areas -
Specifications for transport, laying and compaction and type testing protocols,



EXERCISE 2

Design the section of a road, first with a flexible pavement and secondly with a rigid pavement. Draw and define the characteristics of every layer.



PLANT & CONSTRUCTION





Road reclaimers, mixers

It pulverizes the asphalt layer and mix it with the underlaying base to stabilise deteriorated roads.





Cold planer, pavement recycler or milling machine

It removes bituminous pavement and prepares it to be used as new aggregates. It is usually used to replace the previous asphalt.





Water truck

Spreads water to control dust and compaction





Grader

It is a machine with a long blade used to create a flat surface.





Rollers or Compactors. Padfoot

It breaks the natural bonds of cohesive soil and has better results with compaction





Rollers or compactors. Steel Drum

Vibratory compactors

In the static mode, also used for rolling asphalt finishing





Rollers or compactors. Combination

For compaction of asphalt base and sub-base courses. It can combine the roller, pneumatics and vibration.

Pneumatics introduce less water in the layer (impermeability)





Oil distributor

It is used to apply prime or tack coats on a surface in preparation of paving.





Concrete mixing plant

Produce concrete





Ready-mix truck

Transport concrete





Asphalt plant

Manufacture of asphalt, macadam or other forms of coated road stone.





Paver

Used to lay pavement on the roadway.





Chip spreader

It lays down the aggregate on top of a bituminous binder which is then rolled.





CONSTRUCTION OF FLEXIBLE PAVEMENT. VIDEO

DYNAPAC COMPACTASPHALT. VIDEO

CONSTRUCTION OF RIGID PAVEMENT. VIDEO



EXERCISE 3

With the information given (equipment list, videos and text), make a summary of the different stages needed for the construction of a road pavement, from the subgrade to the pavement finish.

- Divide the process in different stages
- Explain the activities developed at every stage
- Name all equipment required
- Explain how to organise the plant

Make 2 groups. One group will work with flexible pavements and the other with rigid pavements. At the end, you will make a presentation of your work to the other group.



FLEXIBLE VS RIGID PAVEMENT

EXERCISE 4

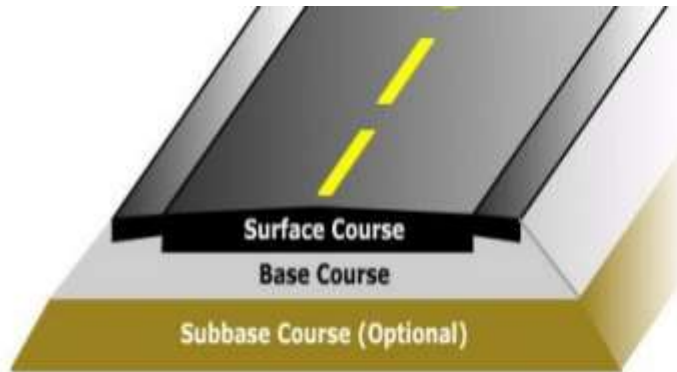
Think about the differences between flexible and rigid pavements in the following aspects:

- Deformation
- Transmission of loads to lower layers
- Flexural strength
- Cost
- Life span
- Thermal stress
- Friction
- Construction

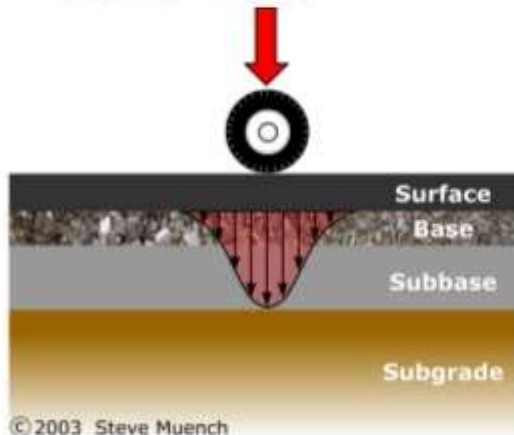


Flexible Pavements

Deformation in the sub grade transferred to the upper layers



Subgrade (Existing Soil)

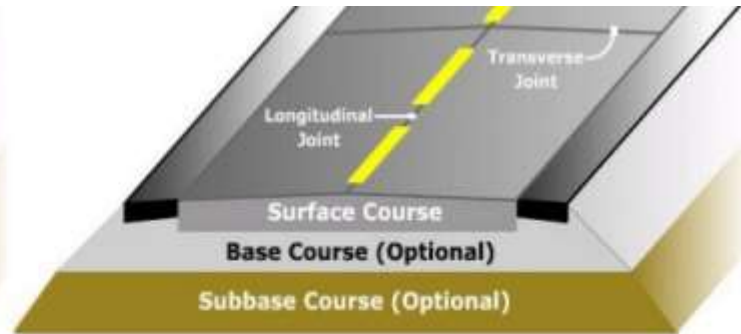


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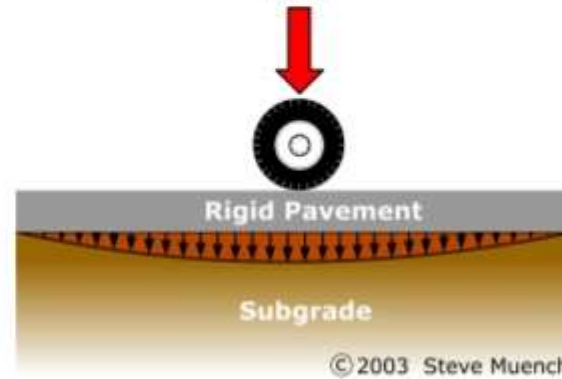
Flexible

Rigid Pavements

Deformation in the subgrade not transferred to subsequent layers



Load

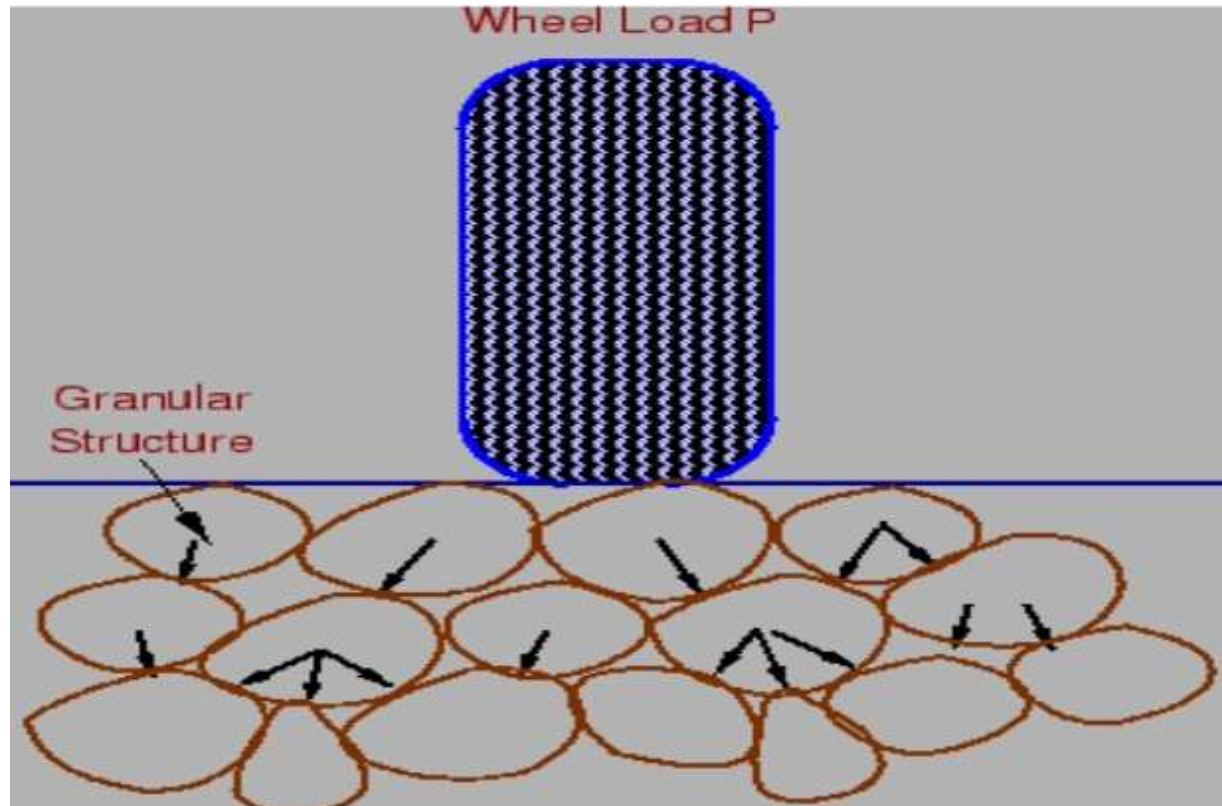


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Rigid



Flexible Pavements	Rigid Pavements
• Design based on load distributing • Have low flexural strength • Load is transferred by grain to grain contact	• Design based on flexural strength or slab action • Have high flexural strength • No such phenomenon of grain to grain load transfer exists



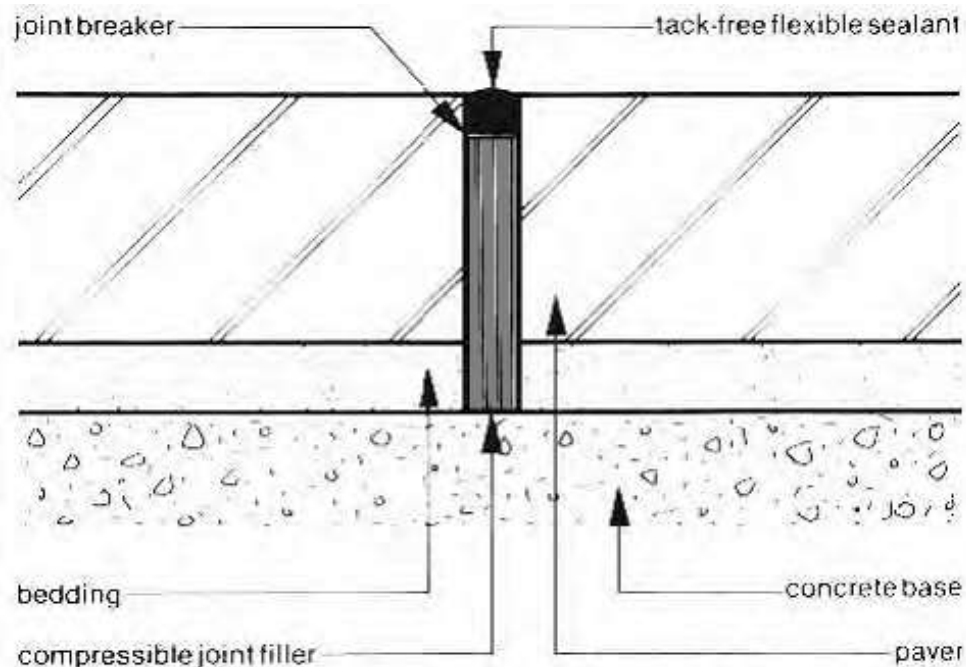


Flexible Pavements

- 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
- That's why expansion joints are **not** needed

Rigid Pavements

- 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
- Thermal stresses are more vulnerable to be induced as the ability to contract and expand is very less in concrete
- That's why expansion joints are needed



Expansion joint



ROAD PAVEMENTS

Flexible Pavements	Rigid Pavements
• Strength of the road highly dependent on the strength of the sub grade • Rolling of the surfacing needed • Road can be used for traffic within 24 hours • Force of friction is less • Damaged by Oils and Certain Chemicals	• Strength of the road less dependent on the strength of the sub grade • Rolling of the surfacing not needed • Road cannot be used until 14 days of curing • Force of friction is high • No Damage by Oils and Greases