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Q NO 1.

Comparison of Flexible vs Rigid Pavements.

Flexible Pavement	Rigid pavement
1. Bitumen is used as a binder in Flexible pavements.	1. Cement is used as a binder in rigid pavements.
2. Deformation in the subgrade is transferred to the upper layers.	2. Deformation in sub grade is not transferred to subsequent layers.
3. Load is transferred by grain to grain contact.	No such phenomenon of grain to grain load transfer exists.
4. Flexible pavement have low initial	4. Rigid Pavements have low maintenance cost

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Construction costs but have high maintenance cost but have high initial construction costs.

5. Have low life span usually 10-15 years.

5. Life span is more as compare to flexible usually 30+ years.

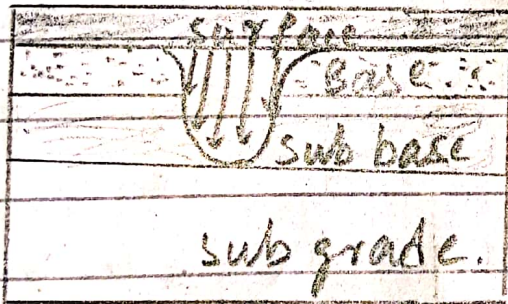
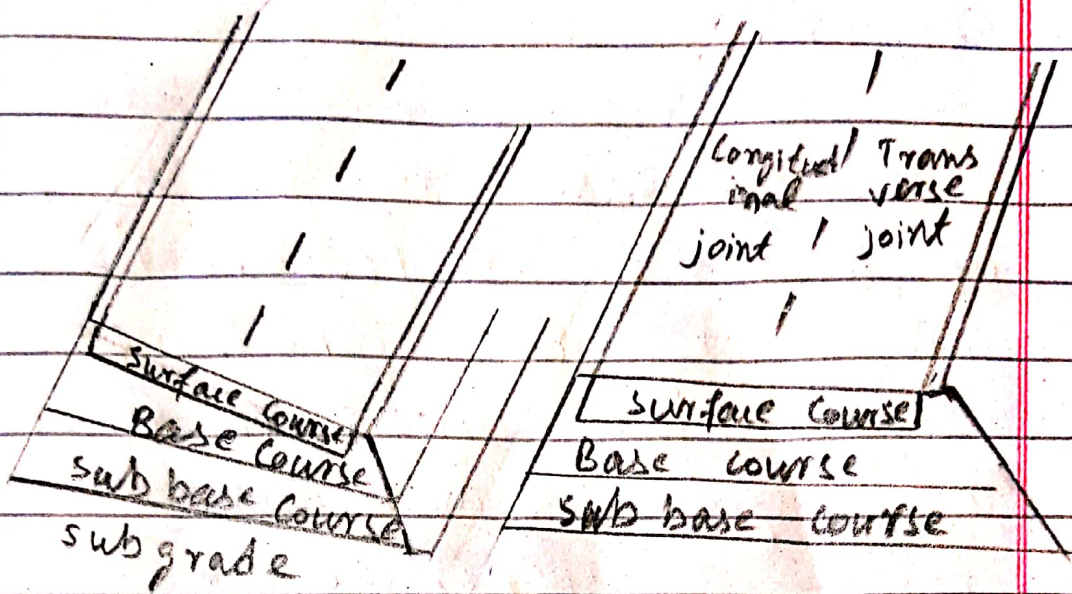
6. Surfacing cannot be laid directly on the sub grade but a sub base is needed.

6. Surfacing can be directly laid on the sub grade.

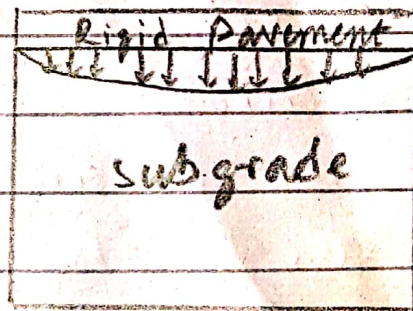
7. In flexible pavements strength of road highly dependent on strength of sub grade.

7. Strength of road less dependent on strength of sub grade in rigid pavements.

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Flexible
Pavements



Rigid
Pavements

Q No 2.

Base and sub base.

→ A sub base is a layer of material between base and subgrade. Sometimes a granular material under a rigid pavement is called a sub base.

→ sub base may consist of select material, such as natural gravels, that are stable but that have characteristics which make them not completely suitable as base course. They may also be of stabilized soil/borrow material.

→ The purpose of sub base is to permit the building of relatively thick pavement at low cost. Thus, the quality of sub base can vary within wide limits

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as long as the thickness design criteria are fulfilled.

Base Course:

A base course is defined as a layer of granular material which lies immediately below the wearing surface of a pavement.

→ Purpose of base and subbase:-

→ Base and sub base courses under flexible pavements are primarily to increase the load supporting capacity by distributing the load through a finite thickness of pavements this will reduce shear and consolidation deformation in the sub grade.

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Water bound Macadam:

→

Water bound macadam may be defined as a dense and compact course of a road pavement composed of stone aggregates bound together by a thin film of ~~cement~~ cementing medium consisting of fine mineral filler (such as stone screenings or gravel) with cementitious properties and containing a minimum laden moisture to impart to the necessary cohesive and adhesive properties to enable it to bind the aggregate together.

→ The strength of water-bound macadam course is thus

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- Primarily due to the thorough mechanical interlock in the aggregate particles.
- Cohesion between the aggregate particles due to the cementitious of soil-moisture binder.

→ The water bound macadam is constructed by spreading loose metal which gives a consolidated thickness of 75 mm - 100 mm.

Wet mix Macadam::

→ Wet-Mix Macadam is a specification in which a well-graded aggregate is mixed with water in a mechanical mixer and the resultant mixture is laid by pavers and compacted.

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→ The aggregate is generally crusher-run, and includes fines also. Because of the close grading, the course will have good interlock with excellent density.

Dry-Bound Macadam:-

The voids in a layer of almost single-sized stone (usually 53 mm nominal size of recent projects) are filled with a dry, cohesionless fine aggregate filler. Hot tar is poured over the course aggregate layer and flows into the voids, coating the large aggregate in the process.

“ If the aggregate are held together by mechanical interlock only.

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Penetration Macadam:-

If a bituminous material is sprayed over the stones and allowed to penetrate into the course and by "premix" macadam if the bituminous material is mixed with the aggregates prior to laying.

Q NO. 3.

Bitumen:-

A class of black or dark-colored (solid, semi-solid or viscous) cementitious substances, natural or manufactured, composed principally of high molecular weight hydrocarbons found in Asphalts, Tars, Pitches and Asphaltites are typical.

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Asphalt :-

A dark brown to black cementitious material in which the predominating constituents are bitumens which occur in nature or are obtained in fractional distillation of petroleum (crud oil) along with certain mineral matter.

- In American Terminology.
- Both asphalt and bitumen are same and are " ASPHALT "

Asphalt vs Bitumen.

→ In some literature Bitumen is actually the liquid binder that holds asphalt together.

→ Asphalt is generally used as a term to refer to the combination of

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bitumen and gravel specifically for road construction.

Asphalt Cement:

A fluxed or unfluxed asphalt specially prepared as to quality and consistency for direct use in the manufacture of bituminous pavements, and having a penetration between 5 and 300.

Bituminous Emulsions:

→ A suspension of minute globules of bituminous material in water or in an aqueous solution.

→ A suspension of minute globules of water or of an aqueous solution in a

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Liquid bituminous material.

Cut-Back Products:

Petroleum or Tar residue
m which have been
blended with distillates.

Asphalt Composition:-

Some generalizations can be made, however, with regard to the chemical composition of the semi-solid materials.

According to Simpson they generally consist of

- Carbon (70-85%)
- Hydrogen (7-12%)
- Nitrogen (0-1%)
- Sulfur (1-7%)
- Oxygen (0-5%)

→ and small amounts of metals either dispersed in the form of oxides

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and salts or in metal containing organic compounds.

Q NO. 4.

The factors considered in the AASHTO procedure for the design of flexible pavements as presented in the 1993 guide are:

1. Pavement Performance
2. Traffic
3. Road bed soils (sub grade material)
4. Materials of Construction
5. Environment
6. Drainage
7. Reliability.

Pavement Performance:

→ The primary factors considered under pavement performance are the structural

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and functional performance of the pavement.

→ Structural performance:

It is related to the physical condition of the pavement such as the capability of the pavement to carry the traffic load.

→ Factors which reduces the structural performance of the pavements includes cracking, faulting, raveling and so forth.

→ Functional performance:

It is an indication of how effectively the pavement serves the user. The main factor considered under functional performance is riding comfort.

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→ To quantify pavement performance, a concept known as the serviceability performance was developed and is measured using Pavement Serviceability Index (PSI).

→ The scale ranges from 0 to 5, where 0 is the lowest PSI and 5 is the highest.

Traffic Load:

→ The standard Axle loading is defined as an axle with dual tyres loaded to 80 kN (8.2 tonne) (18000 lb).

→ In the AASHTO design method, the traffic load determined in terms of the number of repetitions of an 18,000-lb (80 kilonewtons (kN)) single-axle load applied to the

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pavement on two sets of dual tires.

→ This is usually referred to as the equivalent single-axle load (ESAL).

8.2 tonne (80 kN) OR (18000 lb)



$$\left(\frac{\text{Load}}{18,000 \text{ lb}} \right)^4 = \text{relative damage factor.}$$

$$\left(\frac{\text{Load (tons)}}{8.2 \text{ tons}} \right)^4 = \text{relative damage factor.}$$

→ To determine the ESAL, the number of different types of vehicles such as cars, buses, single unit trucks, and multiple-unit trucks expected to use the facility during its lifetime must be known.

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→ The total ESAL applied on the highway during its design period can be determined only after the design period and traffic growth factors are known.

→ The design period is the number of years the pavement will effectively continue to carry the traffic load without requiring ~~an~~ on overlay. Flexible highway pavements are usually designed for 20-year period.

→ Since traffic volume does not remain constant over the design period of the pavement, it is essential that the rate of growth be determined and applied when calculating the total ESALs.

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→ The growth rate ranges between 3-6% and in some cases up to 10%.

→ The growth factors (G_m) for different growth rates and design periods can be obtained from equation.

$$G_m = \left[\frac{(1+r)^n - 1}{r} \right]$$

n = number of years

r = growth rate in decimals

~~The~~ Difference b/w structural and functional performance of pavement:

The functional evaluation of pavements is based on DGH and PCI method, which combines International Roughness Index (IRI) and pavement condition index (PCI) values, while structural pavement

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evaluation is performed by analyzing the deflection value of falling weight Deflectometer (FWD) measurement analyzed by AASHTO.

Q. NO. 5.

Alligator cracking:

- Alligator cracking may be considered a combination of fatigue and block cracking.
- It is a series of interconnected cracks of various stages of development.
- Alligator cracking develops into a many-sided pattern that resembles chicken wire or alligator skin.

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→ Occurs in areas subjected to repeated traffic loadings.

Block Cracking:

→ A pattern of cracks that divides the pavement into approximately rectangular pieces, with sides generally longer than one foot.

→ Rectangular blocks range in size from approximately 0.1 m^2 to 10 m^2 .

→ Possible cause: shrinkage of asphalt.

Longitudinal Cracking:

Description: Cracks predominantly parallel to pavement centerline.

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Location within the lane (wheel path versus non-wheel path) is significant.

Possible Causes: Expansion and contraction of pavement material, road bed settlement, poorly constructed paving joints.

Transverse Cracking:

Cracking across the center line, not due to reflection cracking.

→ Possible causes:

Expansion and contraction of pavement material, road bed settlement, poorly constructed paving joints.