Section - C

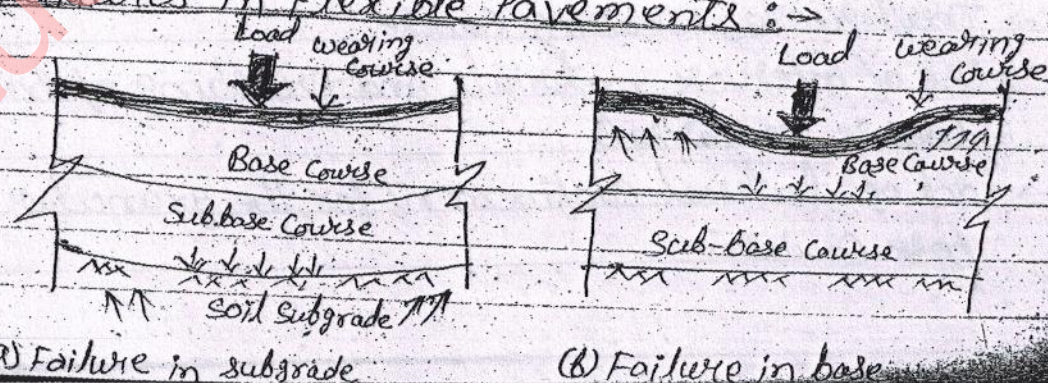
Unit-V (Highway Maintenance)

☒ Pavement Failures :->

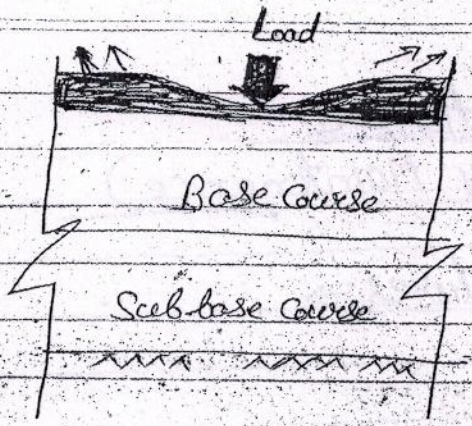
General Causes :-

(a) Defects in the quality of materials used
(b) Defects in construction method and quality control during construction.
(c) Inadequate surface or subsurface drainage in the locality resulting in the stagnation of water in the subgrade or in any of the layers.
(d) Increase in the magnitude of wheel loads and the number of load repetitions due to increase in traffic volume.
(e) Settlement of foundation of embankment of the fill material itself.
(f) Environmental factors including heavy rainfall, soil erosion, high water table, snow fall, etc.

☒ Failures in Flexible Pavements :->



(a) Failure in subgrade (b) Failure in base



(c.) Failure in wearing Course

Note:-
Arrows indicates direction of up heaval due to the movement of material from the layer

Failures of subgrade may be due to
→ Inadequate Stability
→ Excessive Stress application

Failure in Sub-base or Base Courses may be due to
→ Inadequate stability or Strength
→ loss of binding action
→ loss of base course material
→ Inadequate wearing Course
→ Use of inferior materials and crushing of base course materials.
→ Lack of lateral confinement for the granular base course.

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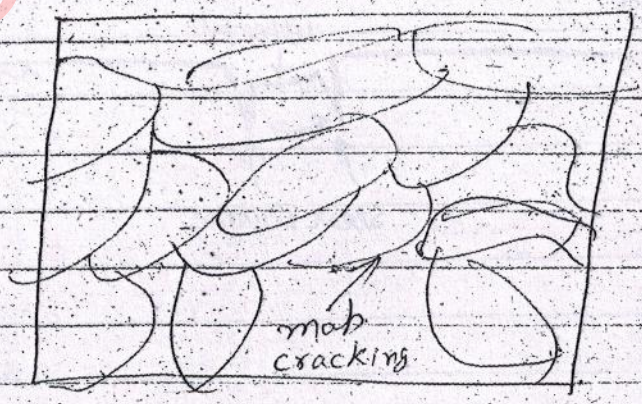
Typical Flexible Pavement Failures:-

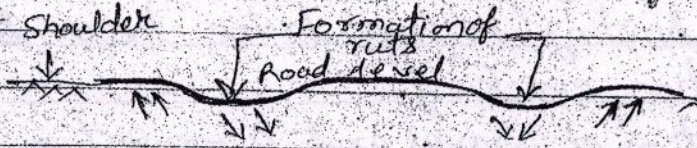
(i) Aligator (map) cracking
(ii) Consolidation of pavement layers
(iii) Shear Failure
(iv) Longitudinal cracking
(v) Frost heaving
(vi) Lack of binding (keying) to the lower surface
(vii) Reflection cracking
(viii) Formation of waves and corrugation

(i) Aligator (map) Cracking:-

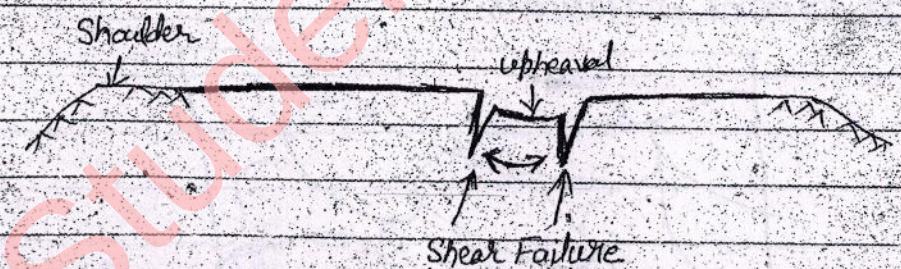
This is the most common type of failure and occurs due to relative movement of pavement layer materials. This may be caused by the repeated application of heavy wheel loads resulting in fatigue failure or due to the moisture variations resulting in swelling and shrinkage of subgrade and other pavement materials.



(ii) Consolidation of Pavement layers :-
Formation of ruts are mainly attribute to the Consolidation of one or more layers of pavement. The repeated application of loads along the same level wheel path cause cumulative deformation resulting in consolidation deformation or longitudinal ruts.



(iii) Shear Failure & Cracking :-
It is associated with the inherent weakness of the pavement mixtures, the shearing resistance being low due to inadequate stability or excessively heavy loading. The shear failure causes upheaval of pavement materials by forming a fracture or cracking.



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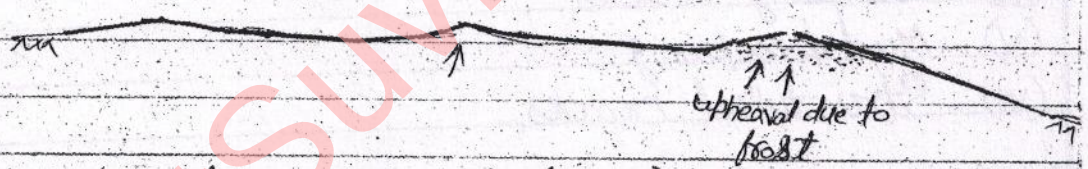
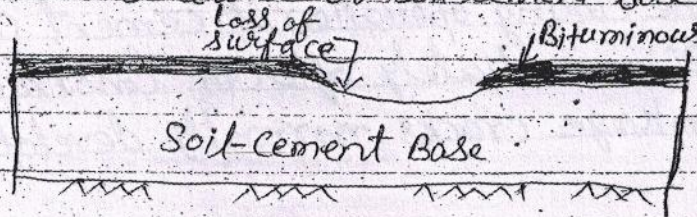
(iv) Longitudinal Cracking :→
Due to frost action and differential volume changes in subgrade longitudinal cracking is caused in pavement transversing through the full pavement thickness. Settlement of fill and sliding of side slopes also would cause this type of failure.

(v) Frost Heaving :-
These are often misunderstood for shear or other type of failures. In the this case, there is mostly a localized heaving-up pavement portion depending upon the groundwater and climatic conditions.



(vi) Lack of binding lower layer :-
Slipping occurs when the surface course in not bound with the underlying base. This results in opening up and loss of pavement materials forming patches or pot holes. Such conditions are more frequent in case when the bituminous surfacing is provided over the existing cement concrete base course or soil cement base course.



(vii) Reflection Cracking:-
This type of cracking is observed in bituminous overlays provided over existing cement concrete pavements. The crack pattern as existing in cement concrete pavements are mostly reflected on bituminious surfacing in the same pattern.

✳ Typical Rigid Pavement Failures :-

(i) Scaling of cement concrete
(ii) Shrinkage cracks
(iii) Spalling of joints
(iv) Warping cracks
(v) Mud pumping
(vi) Structural cracks.

(i) Scaling of cement concrete :-
It is mainly attributed due to efficiency in the mix or presence of some chemical impurities which damage the mix.

(ii) Shrinkage Cracks :-
During the curing operation of cement concrete pavements immediately after the construction, the shrinkage cracks normally develop. The

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placement of cracks are in longitudinal as well as in transverse direction.

(iii) Spalling of joints :-
Sometimes when pre-formed filler materials are placed during casting of pavement slabs, the placement is some how dislocated and filler is thus placed at an angle. The concreting is completed without noticing this fault alignment of the filter material.

(iv) Warping Cracks :-
If the joints are not well designed to accomodate the warping of slabs at the edges, this results in the development of excessive stresses due to warping and the slab develops cracking at the edges in an irregular pattern.

(v) Mud Pumping :-
It is recognised when the soil slury ~~gets~~ ejects out through the joints and cracks of cement pavement caused during the downward movement of slab under the heavy wheel loads. Factors which cause the mud pumping :- (i) Extent of slab deflection
(ii) Type of subgrade soil
(iii) Amount of free water

☒ Maintenance of Water Bound Mecadam Roads

WBM roads damaged rapidly due to heavy mixed traffic and adverse climatic conditions.
In dry weather dust is formed and during rains mud is formed. The steel tyre bullock carts cause wear and tear to the WBM surface.
The fast moving automobiles raises dust in dry weather and churn-up mud in wet condition.
Due to the combined effects of traffic and the rain water, the stone aggregates protrude out or get loose on the surface layer.

To prevent the agg. from getting loosened from the surface course, it is necessary to replace the soil binder periodically. This is done by spreading a thin layer of moist soil binder on the surface.

Dust nuissance can be efficiently prevented by providing bituminous surface dressing course over WBM pavement.
Pot holes and ruts should be patched up. The path repair work is carried out by first cutting out a rectangular shape of the defective area to remove the stone up to the affected depth. Then with coarse agg. of same size, the patch is filled up and compacted well.

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⊠ Maintenance of Bituminous surface :→
It Cosists of
(i) Patch repair (ii) Surface treatments
(iii) Resurfacing

(i) Patch Repairs:-
It is carried out on the damaged road surface. Inadequate or defective binding materials causes removal of agg. during monsoons. Patching may be done on affected localised areas or sections using a cold premix.

(ii) Surface Treatment:→
Excess of bitumen in the surface materials bleeds and the pavement becomes patchy and slippery. Corrugations or rutting or shoving develop in such pavement surfaces. Necessary rolling is done to develop permanent bond between the existing surface and the new materials, after heating the surface if necessary.

(iii) Resurfacing:-
In the case when the pavement surface is totally worn out and develops a poor riding surface, it may be more economical to provide an additional surface course on the existing surface. In case

of inadequate thickness, an overlay of adequate thickness should be designed and constructed.

☒ Maintence of Cement Concrete Roads

Treatment of cracks:

The cracks developed in cement concrete (CC) may be classified into two groups:

(i) Temperature cracks, which are initially fine cracks or hair-cracks formed across the slab, in between a pair of transverse or longitudinal joints, dividing the slab length into two or more equal parts due to temp. stresses in the slab.

(ii) Structural cracks formed near the edge and corner regions of the slabs due to combined wheel load and warping stresses in the slab.

The presence of fine cracks only as such are not harmful and do not call for immediate maintenance. The dirt, sand and other loose particles are at the cracks are throughly cleaned using a sharp tool, stiff brush and pressure blower.

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☒ Pavement Evaluation :->

Methods :-

(i) Structural pavement evaluation

(ii) Evaluation of pavement surface condition

(i) Structural Evaluation of Pavements :->

The structural evaluation of both flexible and rigid pavements may be carried out by plate bearing test.

Field investigations and tests carried out in various countries have shown that the performance of a flexible pavement is closely related to be elastic deflection under loads. Of the various equipment used for the purpose, Benkelman Beam is the most commonly used, as the measurements are simple and easy.

(ii) Evaluation of pavement surface Condition :-

The surface condition of flexible pavement may be evaluated by the unevenness, ruts, patches and cracks.

The surface condition of rigid pavements may be assessed by the cracks developed and by faulty joints affecting the ~~rigidity~~ riding quality of the pavement.

The pavement uneveness may be measured using Unevenness indicator, profilograph, profilometer or roughometer.

✱ Benkelman Beam :→ Pg. - 509

It is a device which can be conventially used to measure the rebound deflection of a pavement due to a dual wheel load assembly or the design wheel load. It consists of a slender beam of length 3.66 m which is pivoted to a datum frame at a distance 2.44 m from the probe end. The datum frame rests on a pair of front levelling legs and a rear leg with adjustable length. The probe end of the beam is inserted between the dual rear wheels of truck and rests on the pavement surface at the centre of the loaded area of the dual wheel load assembly.
A dial gauge is fixed on the datum frame with its spindle in contact with the other end of the beam.

Diagram

☒ Types of Overlay :→

(i) Flexible overlay over flexible pavements
(ii) Cement Concrete or rigid overlay over flexible pavements
(iii) Flexible overlays over cement concrete or rigid pavements
(iv) Cement Concrete or rigid overlay over rigid pavements

(i) Flexible overlay Design by Bal Benkelmen Beam Deflection Studies :-

⇒ Write about Benkelman Beam

(ii) Rigid Overlay Over Rigid Pavement :-

When a rigid or cc overlay is constructed over an existing rigid or cc pavement, the interface between the old and new concrete cannot have perfect bond such that two slabs can could acts as a monolithic one. Two typical types of interface are possible :

(i) providing maximum possible interface bond by making the old surface rough
(ii) Separating the two slabs at the interface by thin layer of bituminous material, or without interface bond

To calculate overlay thinkness, use equation

$$h_o = (h_d^a - X h_c^b)^n$$

Here, h_o = Rigid overlay thickness
h_d = design thickness
h_e = existing pavement thickness

(iii) Flexible Overlay Over Rigid Pavement:-
A flexible or bituminous overlay when provided over a rigid pavement, the wheel load is distributed through a larger area by the overlay, thus slightly reducing the wheel load stress on the old rigid pavement. $h_f = 2.5(Fh_d - h_e)$, F = Factor

(iv) Rigid Overlay over Flexible Pavement:-
The plate bearing test is conducted on the existing flexible pavement K value is thus obtained. The design is made for this K value and the design wheel load.