

7.1. Introduction

Road maintenance is essential in order to (1) preserve the road in its originally constructed condition, (2) protect adjacent resources and user safety, and (3) provide efficient, convenient travel along the route. Unfortunately, maintenance is often neglected or improperly performed resulting in rapid deterioration of the road and eventual failure from both climatic and vehicle use impacts. It follows that it is impossible to build and use a road that requires no maintenance.

In order to plan for road maintenance needs, it is important to keep a complete set of "as built" plans and records of all maintenance operations and observations. The as built plan should contain the following:

1. Complete job index
2. Complete history of project from planning stage to construction
3. Photographic records
4. Exact location and observations of any unstable conditions in relation to the road location
5. Exact location of culverts and other drainage features
6. Wet areas that may have required additional excavation and replacement with more suitable ballast backfield materials
7. All major changes made to the original plan

Probably the most valuable tool for any maintenance program is the knowledge and experience gained by individuals performing the maintenance. Every effort should be made to retain competent, knowledgeable, and experienced individuals in these positions not only from the standpoint of instituting and executing a good maintenance program, but for future road planning needs as well.



Components of Road Maintenance



Definition of Road Maintenance:

Preserving and keeping each type of roadway, roadside, structures as nearly as possible in its original condition as constructed or as subsequently improved and the operation of highway facilities and services to provide satisfactory and safe transportation, is called **Road Maintenance** or **maintenance of highways**.



Roads Maintenance / Highways Maintenance
Definition

Road Maintenance Components

The various road maintenance function includes:

1. [Surface maintenance](#)
2. Roadside and drainage maintenance
3. Shoulder and approaches maintenance
4. Snow and ice control
5. Bridges maintenance
6. [Traffic service](#)

Highway maintenance is closely related to the quality of construction of original road.



Insufficient pavement or base thickness or improper construction of these elements soon results in expensive patching or surface repair. Shoulder care becomes a serious problem where narrow lanes force heavy vehicle to travel with one set of wheels off the pavement.

Improperly designed drainage facilities, mean erosion or deposition of material and costly cleaning operation or other corrective measures. For regular highways maintenance and repair sharp ditches and steep slopes require manual maintenance as compare to cheap repair of flatter ditch and soil by machine.

In snowy country, improper location extremely low fills and narrow cuts leave no room for snow storage, creating extremely difficult snow removal problems.

1. Surface Maintenance of Roads

Pavement maintenance and rehabilitation programs restore the riding quality and maintain the structural integrity of the pavement over its full design life. Asphalt concrete pavements are subjected to various [types of pavement distress](#) or **Failure** these include:

a. Surface Distresses

i. Alligator Cracking:

A series of interconnecting or interlaced cracks caused by fatigue of the asphalt concrete surface under repeated traffic loading. [Cracking is due to foundation movement at [subgrade](#)]

ii. Block Cracking:

Cracks forming large interconnected polygon usually with sharp corners or angles. These cracks are generated by hardening or shrinking e.g. asphalt or reflection cracking for underlying layers such as cement treated base.

iii. Transverse Cracking:

Cracks approximately at right angle to the pavement center line. These may be caused by hardness and shrinkage of asphalt or differential thermal stresses of asphalt concrete or may be reflection cracking.

iv. Longitudinal Cracking:

Cracks approximately parallel to the pavement center line. These are caused by poorly constructed construction joints and shrinkage of the asphalt concrete surface. Longitudinal cracks may also be reflection cracks.



Sealzall Machine - Automated High Production Longitudinal and Manual In-Lane Crack Sealing

v. Raveling:

Wearing away the pavement surface caused by dislodging of aggregate particles and binders. This is usually a result of insufficient asphalt binder in the mix or stripping of asphalt from particles of aggregate.

vi. Drip Track Raveling:

Progressive disintegration of the surface between wheel paths caused by dripping of gasoline oil from vehicle.

vii. Bleeding or Flushing (Fattening Up):

The exuding of bitumen on to the pavement surface causing reduction in skid resistance. Bleeding is generally caused by excessive amount of asphalt in the mix or low air void content. It occurs in the mix in hot weather.

viii. Corrugations:

Due to instability of base or poor original riding surface (plastic movement of pavement)

^ **Methods of Surface Treatment for Road Maintenance**

The surface treatment may be single or multiple. Although the best type of surface course is pre-mix carpet for roads maintenance. The surface treatment methods are employed when:

1. Intensity of traffic is not very high.
2. the pre-mix mixers are not easily available due to long transportation or technical reasons.
3. when the cost is high.

In **Highway Maintenance**, for good surface treatment it is necessary that:

- Base course is well prepared to its profile and is made more free from pot holes and ruts.
- Excellence of surface dressing depends upon the correct proportion of binder aggregate.

In all bituminous construction it is necessary that the newly surface possess a bond with the existing base at the interface. It is also necessary that the base is nearly impervious.

- For maintenance of gravel roads blading and occasional resurfacing is required.
- For surface treatments of low type bituminous surface in maintenance of roads; Patching, seal coating or possible loosening oiling, re mixing and relaying are involved.
- For high type bituminous concrete and Portland cement concrete, the Removal and replacement of failure areas and resurfacing are approximate treatment methods for highway maintenance.
- Use same material and methods for road surface maintenance as far as possible.
- Maintenance and repairs of roads must be planned for rapid performance and to cause least possible disruption or hazard to traffic.

2. Roadside and Highway Drainage maintenance

Depends on the characters of road side where the roadside is grassy it must be mowed; cutting, ploughing or spraying with weed killer must be done.

If there is dry grass fire hazard burning, plowing must be done in road maintenance. To improve visibility and increase the sight distance and clearance of road trimming should also be done. Its important to note that side slope erosion by mulching, seeding etc should be checked and controlled as and where required to ensure slope and shoulder stability. Furthermore, picking up litter, thrown or blown along roadside or wayside area should be a routine work.

Drainage of Highways: Keeping ditch, culvert and other drainage structure, clean and ready to carry next flow water. Sediments deposited during period of heavy flow must be removed badly eroded channel and dikes properly protected to prevent recurrence.

3. Shoulders Maintenance:

The maintenance of shoulders depend on the surface character of the area where the maintenance and repair is performed.

SOD shoulders (Sod shoulders are earth shoulders on which a solid turf has been established. Normally they require very little maintenance and holes, ruts, and settlements should be repaired with sod or stabilized material.) must be moved and occasionally bladed down to the level of the roadway so that water is not trapped in the traveled way. Grass must be kept in good condition. In maintenance of roads shoulders protected by bituminous blankets have surface treatments same as for roadway surface.

Gravel and earth shoulders that leaves a drop off at the pavement edges creates a serious accident hazard, hence, should be corrected by reconstruction, resurfacing or other appropriate means. Due to continuous wetting and drying of shoulder, edge joints result between lane and shoulder which may cause settlement of pavement due to entrance of water to sub grade soil. It can be repaired by filling the joint with sand and asphalt concrete

Factor Affecting Roads

Maintenance:

Generally following factors affect the maintenance of pavements:

Increase in the intensity of traffic.

Since we know that there is increase in road transport per year about 8%. Hence this is the most important factor, which affects the maintenance of roads.

Inadequate Thickness of Pavement.

As already discussed adequate thickness of pavement is essential. If the adequate thickness is not provided, it will result frequent pavement failure, unevenness and heavy patches.

Basic objectives of highway maintenance.

The basic objectives of carrying out highway maintenance from time to time are to ensure to provide the following facilities:

(a) Continue to provide safe and convenient travel facilities to the road users.

(b) Avoid detour, speed changes, etc. due to failures in roadway facilities and to minimize the increase in road transportation cost.

(c) Preserve the asset and investments made on the road infrastructure by taking appropriate maintenance measures at the right time.

(d) Avoid rapid deterioration of the pavement structure leading to huge maintenance cost by carrying out timely 'preventive maintenance' works.

Classification of Highway Maintenance Works.

Highway maintenance works.

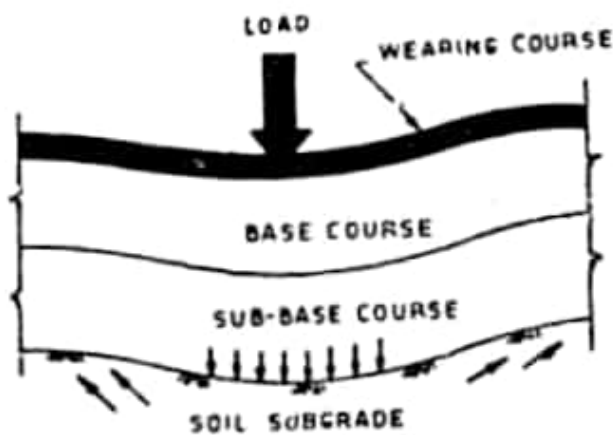
Various highway maintenance works that are generally carried out may be divided into the following types:

[1] Routine maintenance.

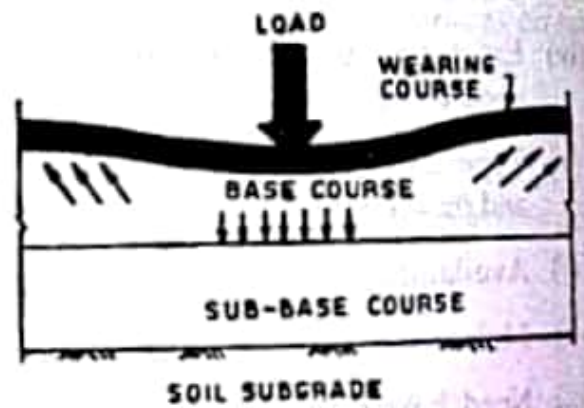
[2] Preventive maintenance.

10.2.2 Failures in Flexible Pavements

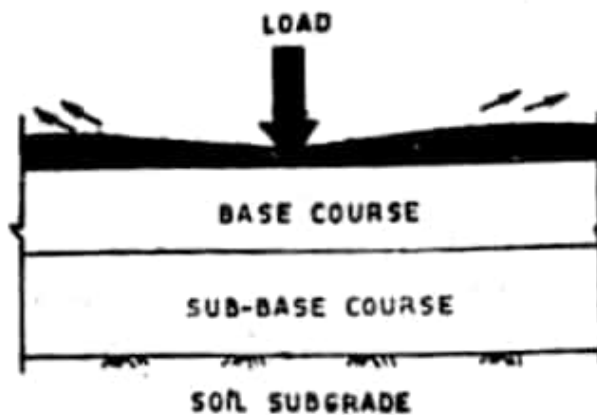
As stated above, the localized settlement of any one component layer of the flexible pavement structure could be enough to cause pavement failure. This demands that each one of the layers should be carefully designed and laid. Thus to maintain the stability of the pavement structure as a whole, each layer should be stable within itself and thereby make the total pavement maintain its stability. Figure 10.1 illustrates the above concept. Figure 10.1-a, b and c illustrate the failures in the soil subgrade, base course and the surface or wearing course. It may be seen that ultimately there is surface deformation when failure takes place either in subgrade or base or surface.



(a) Failure in Subgrade



(b) Failure in Base Course



(c) Failure in Wearing Course

Arrows indicate the direction of up heaval due to the movement of material from the layer

Fig. 10.1 Failure in Flexible Pavement

10.2.3 Typical Flexible Pavement Failures

Following are some of the typical flexible pavement failures :

- (i) Alligator (map) cracking
- (ii) Consolidation of pavement layers
- (iii) Shear failure
- (iv) Longitudinal cracking
- (v) Frost heaving
- (vi) Lack of binding (keying) to the lower course.
- (vii) Reflection cracking
- (viii) Formation of waves and corrugation.

Alligator (Map) Cracking

Figure 10.4 shows the general pattern of alligator or map cracking of the bituminous surfacing. 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. Localized weakness in the underlying base course would also cause a cracking of the surface course in this pattern.

Consolidation of pavement Layers

Formation of ruts are mainly attributed to the consolidation of one or more layers of pavement. The repeated application of loads along the same wheel path cause cumulative

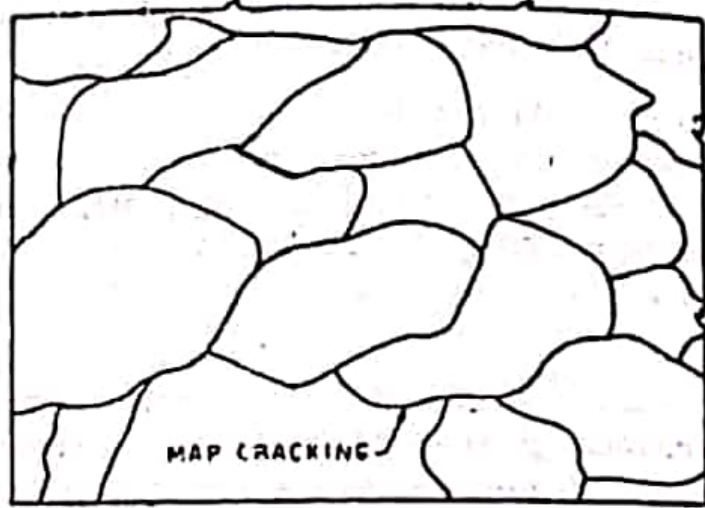


Fig. 10.4 Map Cracking

deformation resulting in *consolidation deformation* or longitudinal ruts. Shallow ruts on the surfacing course can also be due to wearing along the wheel path. Depending upon the depth and width of ruts, it can be estimated whether the consolidation deformation has been caused in the subgrade or in subsequent layers. A typical section of the pavement surface showing such failure is given in Fig. 10.5.

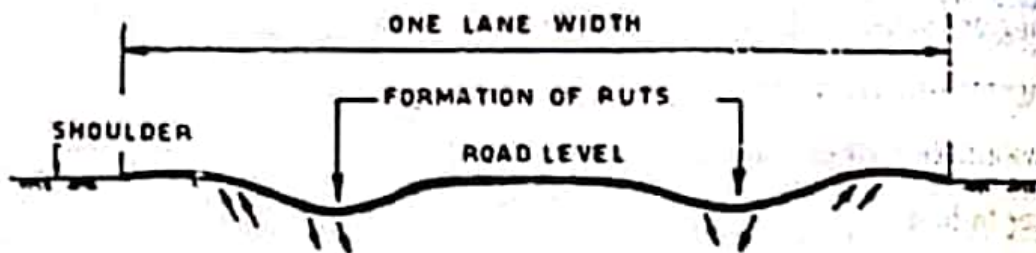


Fig. 10.5 Formation of Ruts

Shear Failure & Cracking

Shear failures are 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. Figure 10.6 is a typical section showing this type of failure.

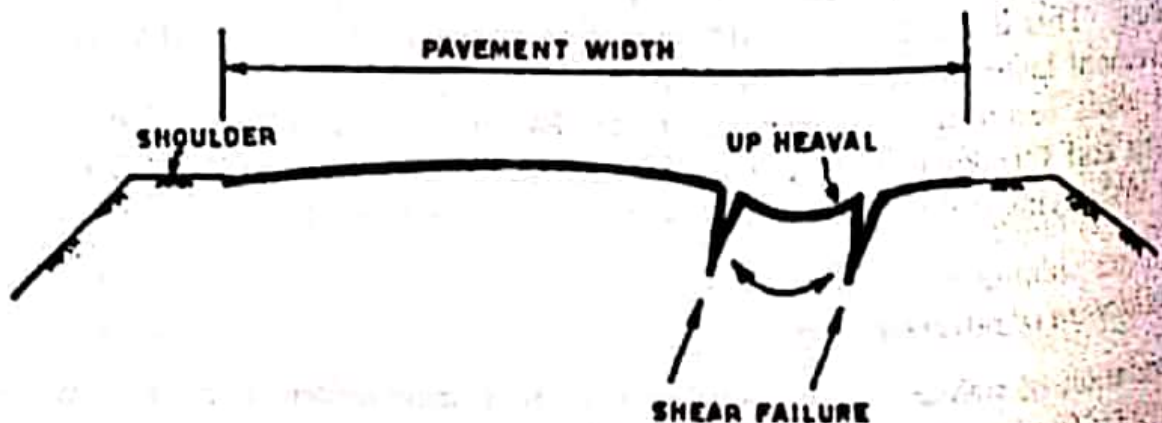


Fig. 10.6 Shear Failure Cracking

Longitudinal Cracking

Due to frost action and differential volume changes in subgrade longitudinal cracking is caused in pavement traversing through the full pavement thickness. Settlement of fill and sliding of side slopes also would cause this type of failure.

Frost Heaving

Frost heaving are often misunderstood for shear or other types of failures. In shear failure, the upheaval of portion of pavement is followed with a depression. In the case of frost heaving, there is mostly a localized heaving-up pavement portion depending upon the ground water and climatic conditions. See Fig. 10.7.

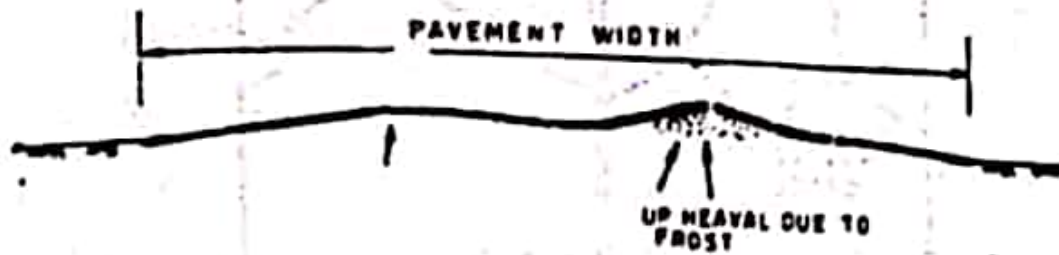


Fig. 10.7 Failure due to Frost Heave

Lack of Binding with Lower Layer

Slipping occurs when the surface course is not keyed/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. This condition is more pronounced when the prime/tack coat in between two layers is lacking. The typical failure is shown in Fig. 10.8.

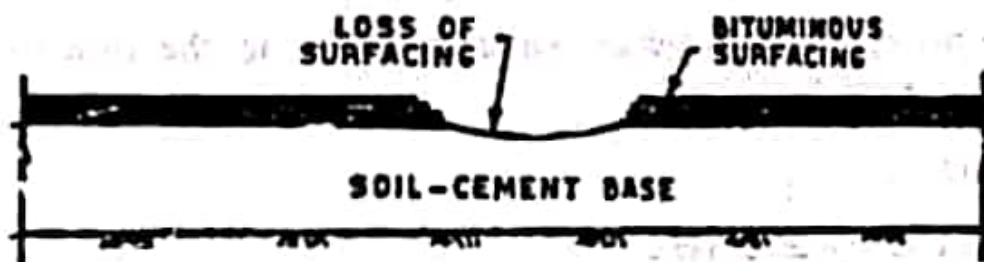


Fig. 10.8 Failure due to Lack of Binding

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 bituminous surfacing in the same pattern. Structural action of the total pavement section is not much influenced by the presence of reflection cracks but since the cracks appear at the surface, these allow surface water to seep through and cause damage to the soil subgrade or result in *mud pumping*. See Fig. 10.9.

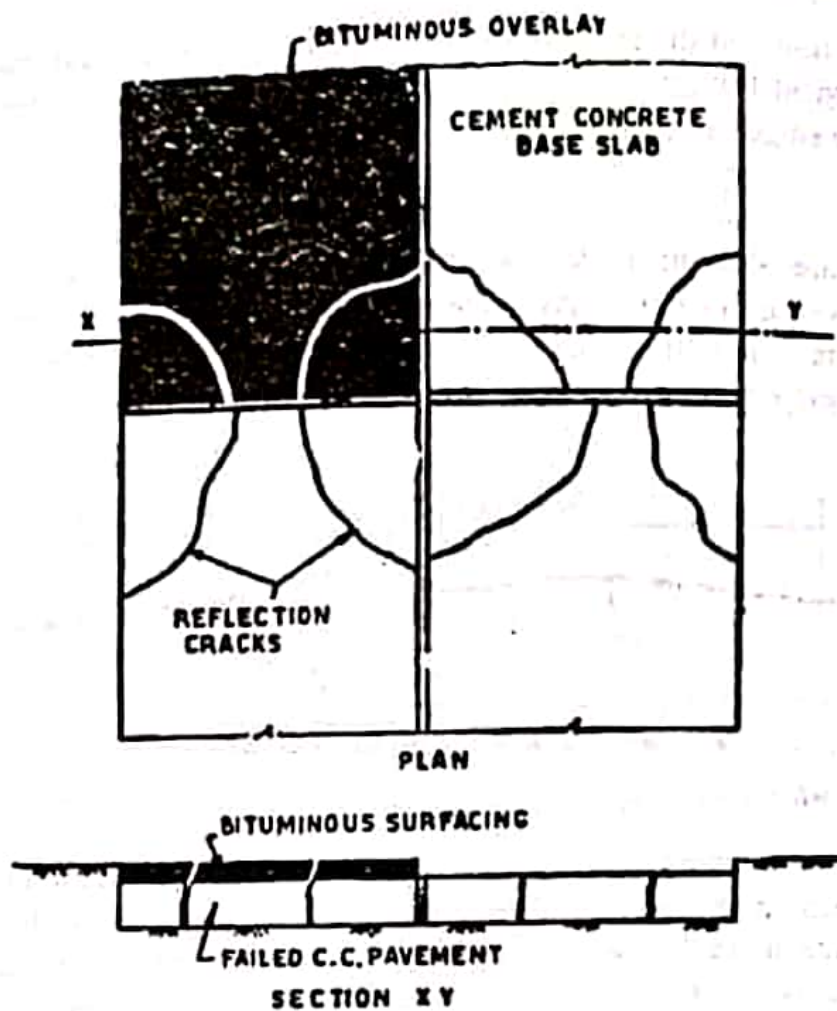


Fig. 10.9 Formation of Reflection Cracks

Deficiency of Pavement Materials

Following are the chief causes which would give rise to the different defects or failures of cement concrete pavement :

- (i) Soft aggregates
- (ii) Poor workmanship in joint construction
- (iii) Poor joint filler and sealer material
- (iv) Poor surface finish
- (v) Improper and insufficient curing

The various defects that creep in due to the above are

- (i) Disintegration of cement concrete
- (ii) Formation of cracking
- (iii) Spalling of joints
- (iv) Poor riding surface
- (v) Slippery surface
- (vi) Formation of shrinkage cracks
- (vii) Ingress of surface water and further progressive failures

10.2.5 Typical Rigid Pavement Failures

Following are some typical and basic types of failures in rigid pavements which are dealt here in detail :

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

Scaling of Cement Concrete

Scaling is observed in cement concrete pavement showing overall deterioration of the concrete. The scaling is mainly attributed due to the deficiency in the mix or presence of some chemical impurities which damage the mix. Further due to excessive vibration given to mix, the cement mortar comes to the top during construction and thus with use, the cement mortar gets abraded exposing the aggregate of the mix. This makes the pavement surface rough and shabby in appearance.

Shrinkage Cracks

During the curing operation of cement concrete pavements immediately after the construction, the shrinkage cracks normally develop. The placement of cracks are in longitudinal as well as in transverse direction.

Spalling of Joint

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 faulty alignment of the filler material. Thus this forms an overhang of a concrete layer on the top side and the joint later on shows excessive cracking and subsidence.

Warping Cracks

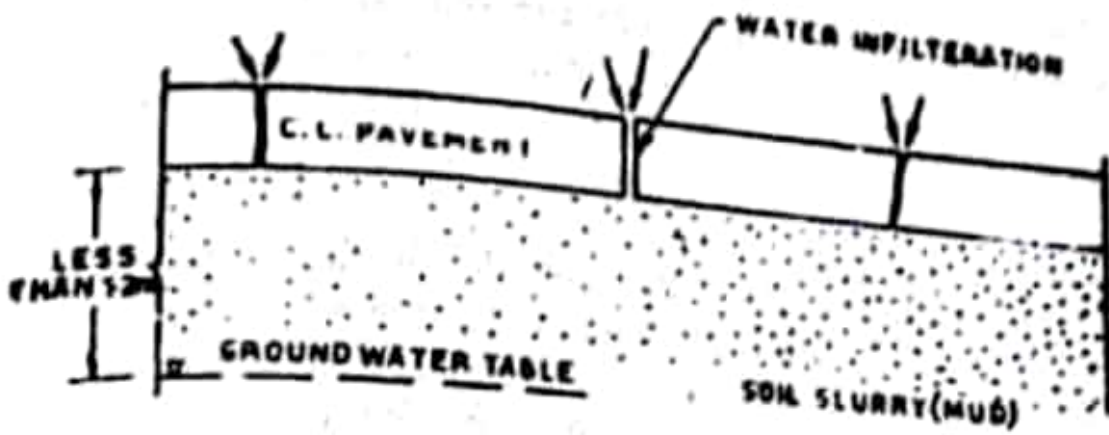
If the joints are not well designed to accommodate the warping of slabs at edges, this results in development of excessive stresses due to warping and the slab develops cracking at the edges in an irregular pattern. Hinge joints are generally provided for relieving the slabs of warping stresses. There is no structural defect due to the warping cracks if proper reinforcement is provided at the longitudinal and transverse joints as it takes care of the structural adequacy.

Mud Pumping

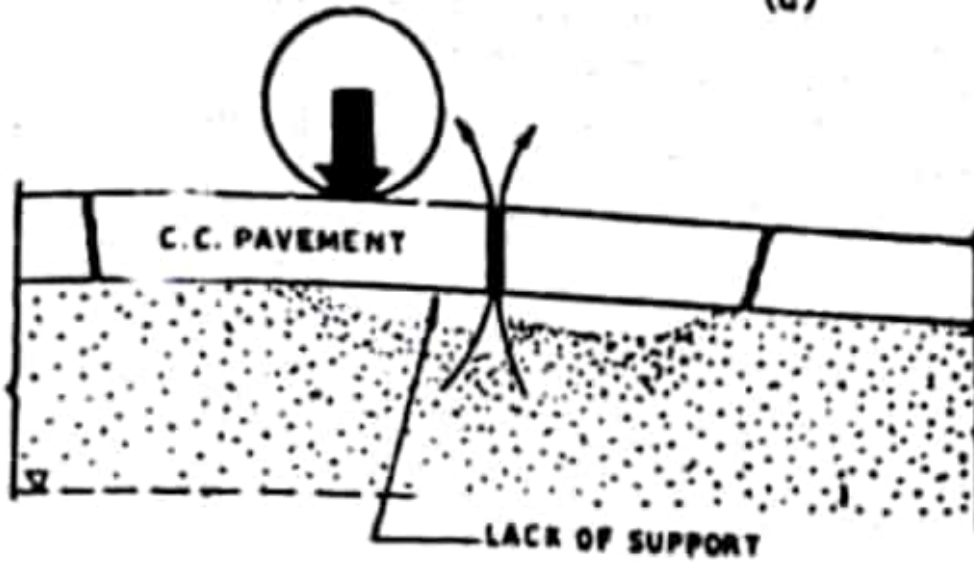
Mud pumping is recognised when the soil slurry ejects out through the joints and cracks of cement concrete pavement caused during the downward movement of slab under the heavy wheel loads. Following are the factors which cause the mud pumping:-

- (i) Extent of slab deflection
- (ii) Type of subgrade soil
- (iii) Amount of free water

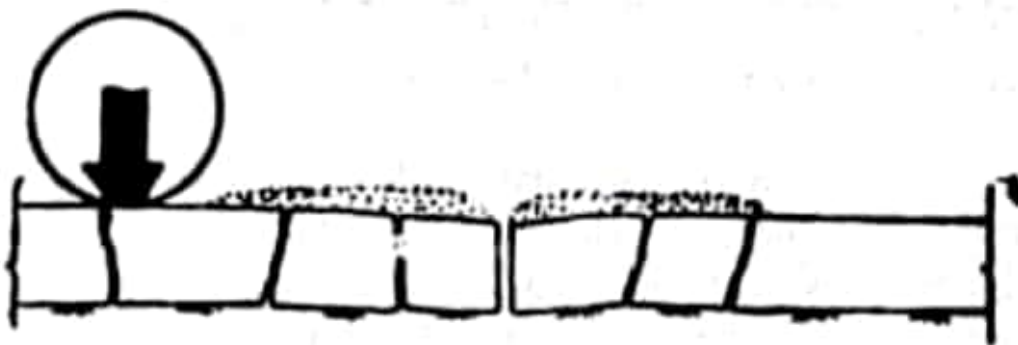
Pumping is noticed just after the rains in cement concrete pavements that are placed on clayey soil subgrade. Due to the applications of repeated loads, initial spaces are developed underneath the pavement slabs and water infiltrates into these spaces through joints, cracks and edges of the pavements as shown in Fig. 10.10a. Since the soil is also of fine grained type, it holds water and forms the soil slurry or soil suspension in water or the *mud*.



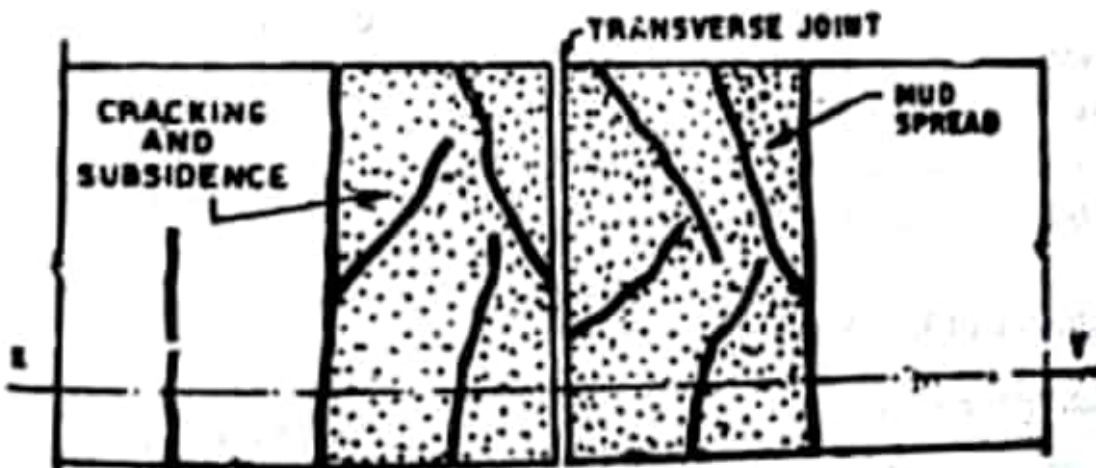
(a)



(b)



(c)



PLAN

(d)

References

- Book 'S.K Khanna & Justo'.
- abc-civil.org/maintenance-of-highways-roads.html.

Assignment Questions

- Discuss briefly the importance of highway maintenance!
- What are the general causes of pavement failures?
- What are the various types of failures in flexible pavement? Explain the causes.
- Write short notes on
 - (i) Reflecting cracking
 - (ii) Mud Pumping
 - (iii) Scaling of pavement surface
 - (iv) Spalling of joints.