4.3 EVALUATION BASED ON SURFACE APPERANCE

Causes of Failures in Flexible Pavements

This may be due to settlement of any one of the components of the pavement.

Causes of Failure in subgrade soil:

- Excessive settlement of the subgrade of soil in the form of excessive undulations or waves or corrugations on the pavement surface.
- Inadequate stability is due to excessive moisture, improper compaction and inherent weakness of the soil
- Excessive stress application causes the deformation of the subgrade to be plastic and unrecoverable resulting in subsidence of the subgrade

Causes of Failure of sub-base or base course:

- Settlement of layers due to internal readjustment of aggregates and movement of wheel loads which results in loosening of compacted layer.
- Lack of stability due to inadequate thickness or poor mix of base or sub-base course.
- Loss of base course materials

Causes of Failure of wearing course:

- Inferior or improper mix design
- Inadequate binder cement and Inferior quality of binder

TYPES OF FLEXIBLE PAVEMENT FAILURES

Alligator cracking or Map cracking (Fatigue)

This is a common type of failure of flexible pavements. This is also known as fatigue failure. Followings are the primary causes of this type of failure.

- Relative movement of pavement layer material
- Repeated application of heavy wheel loads
- Swelling or shrinkage of subgrade or other layers due to moisture variation

Alligators on Road surface

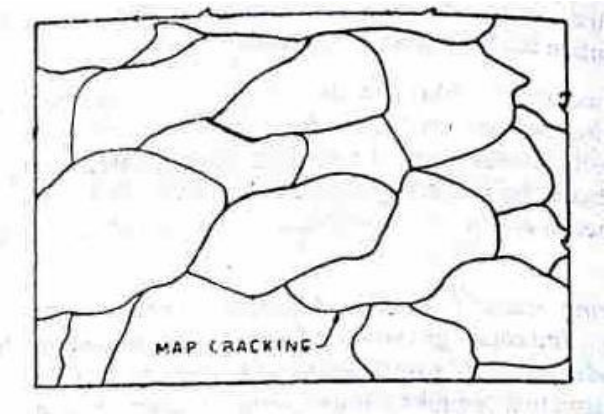

Figure 5.1.1 Map cracking

[Source: "Highway Engineering" by S.K.Khanna,C.E.G.Justo, Page: 494]

Consolidation of Pavement layers (Rutting)

Formation of ruts falls in this type of failure. A rut is a depression or groove worn into a road by the travel of wheels.

This type of failure is caused due to following reasons.

- Repeated application of load along the same wheel path resulting longitudinal ruts.
- Wearing of the surface course along the wheel path resulting shallow ruts.

Rutting on Road Surface

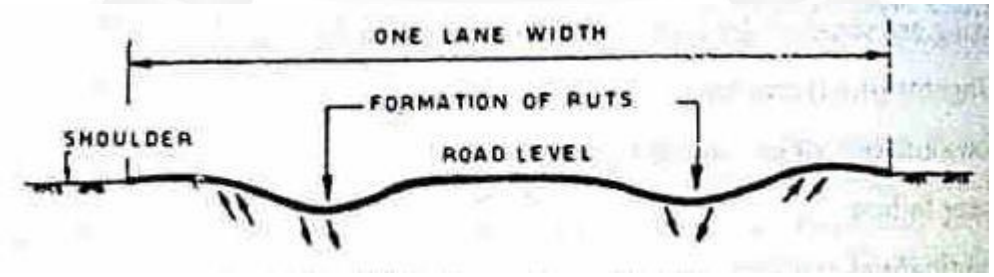

Figure 5.1.2 Formation of Ruts

[Source: "Highway Engineering" by S.K.Khanna,C.E.G.Justo, Page: 494]

Shear Failure Cracking

Shear failure causes upheaval of pavement material by forming a fracture or cracking. Followings are the primary causes of shear failure cracking.

- Excessive wheel loading
- Low shearing resistance of pavement mixture

Shear Fail on Road Surface

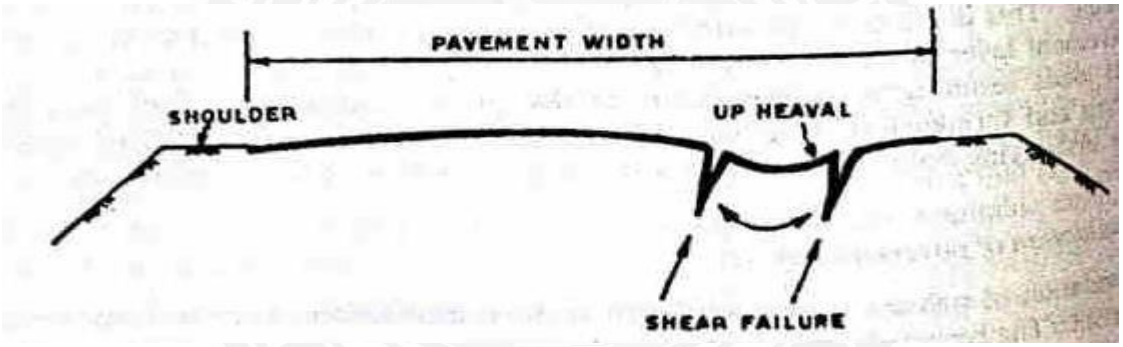

Figure 5.1.3 Shear Failure Cracking

[Source: "Highway Engineering" by S.K.Khanna,C.E.G.Justo, Page: 494]

Longitudinal cracking

This types of cracks extents to the full thickness of pavement. The following are the primary causes of longitudinal cracking.

- Differential volume changes in subgrade soil
- Settlement of fill materials
- Sliding of side slopes

Longitudinal Crack on Road Surface

Frost heaving

Frost heaving causes upheaval of localized portion of a pavement. The extent of frost heaving depends upon the ground water table and climatic condition.

Frost Crack on Road Surface

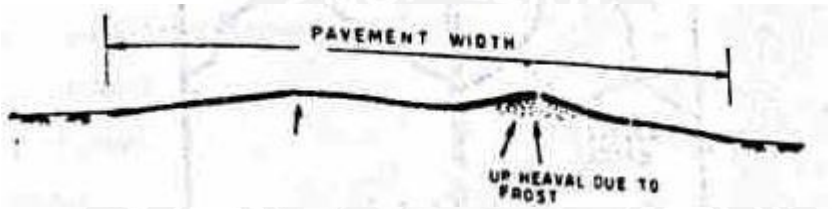

Figure 5.1.2 Failure due to Frost heaving

[Source: "Highway Engineering" by S.K.Khanna,C.E.G.Justo, Page: 495]

Lack of binding to the lower course

When there is lack of binding between surface course and underlying layer, some portion of surface course looses up materials creating patches and potholes. Slippage cracking is one form of this type of failure. Lack of prime coat or tack coat in between two layers is the primary reason behind this type of failure.

Road Failure due to Lack of Binding

Reflection cracking

This type of failure occurs, when bituminous surface course is laid over the existing cement concrete pavement with some cracks. This crack is reflected in the same pattern on bituminous surface.

Reflection Crack on Road Surface

Formation of waves and corrugation

Transverse undulations appear at regular intervals due to the unstable surface course caused by stop- and-go traffic.

Wave Failure on Road Surface

Bleeding

Excess bituminous binder occurring on the pavement surface causes bleeding. Bleeding causes a shiny, glass-like, reflective surface that may be tacky to the touch. Usually found in the wheel paths.

Bleeding Failure on Road Surface

Pumping

Seeping or ejection of water and fines from beneath the pavement through cracks is called pumping.

Mud Pumping on Road Surface

CAUSES OF FAILURES OF RIGID PAVEMENTS

- Deficiencies in Pavement materials
- Structural Inadequacy
- Improper Construction and Maintenance

Deficiencies in Pavement materials

Causes are;

- Soft aggregates
- Dirty aggregates with silt and clay
- Low quality joint filler
- Poor sealer material
- Poor quality steel
- Improper use of cement for the specific region

Structural Inadequacy

Causes are;

- Poor subgrade soil and improper assessment of its strength
- Improper mix design approach
- Inadequate pavement thickness
- Incorrect spacing of joints
- Incorrect design of load transfer devices
- Absence of longitudinal hinge joints
- Long length of slab
- Non-existence of temperature steel

- Deep foundation movements

Improper Construction and Maintenance

Causes:

- Poor workmanship in pavement and joint construction
- Poor surface finish
- Improper and insufficient curing
- Use of concrete mixes which are wet

TYPICAL RIGID PAVEMENT FAILURES

- Scaling of Cement Concrete
- Shrinkage Cracks
- Warping Cracks
- Spalling of Joints

Scaling of cement concrete

Scaling of rigid pavement simply means, peeling off or flaking off of the top layer or skin of the concrete surface. This may be due to the following reasons

- Improper mix design
- Excessive vibration during compaction of concrete
- Performing finishing operation while bleed water is on surface

Shrinkage cracks

Shrinkage Crack on Road Surface (a)

Formation of hairline shallow cracks on concrete slab is the indication of shrinkage cracks. Shrinkage cracks develop on concrete surface during the setting & curing operation. These cracks may form in longitudinal as well as in transverse direction.


Shrinkage Crack on Road Surface (b)

Joint spalling

Joint spalling is the breakdown of the slab near edge of the joint. Normally it occurs within 0.5 m of the joints. The common reasons for this defect are

- Faulty alignment of incompressible material below concrete slab
- Insufficient strength of concrete slab near joints
- Freeze-thaw cycle
- Excessive stress at joint due to wheel load


Joint Spalling Crack on Road Surface

Warping cracks

In hot weather, concrete slab tends to expand. Therefore the joints should be so designed to accommodate this expansion. When joints are not designed properly, it prevents expansion of concrete slab and therefore results in development of excessive stress. This stress cause formation of warping cracks of the concrete slab near the joint edge. This type of crack can be prevented by providing proper reinforcement at the longitudinal and transverse joints. Hinge joints are generally used to relieve the stress due to warping.


Warping Crack on Road Surface

Pumping

When material present below the road slab ejects out through the joints or cracks, it is called pumping. When soil slurry comes out it is called mud pumping.

The common reasons for this defect are

- Infiltration of water through the joints, cracks or edge of the pavement forms soil slurry. Movement of heavy vehicles on pavement forces this soil slurry to come out causing mud pumping.
- When there is void space between slab and the underlying base of sub-grade layer
- Poor joint sealer allowing infiltration of water
- Repeated wheel loading causing erosion of underlying material

Pumping can also lead to formation of cracks. This is because; ejection of sub-grade material below the slab causes loss of sub-grade support. When traffic movement occurs at these locations, it fails to resist the wheel load due to reduction of sub-grade support and develops cracks.

This type of defect can be identified when there is presence of base or sub-grade material on the pavement surface close to joints or cracks.


Joint Soil Spillage on Road Surface