EVALUATION AND MAINTENANCE OF PAYEMENTS:

1. Highway Maintenance:

Preserving and keeping each type of road way, 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 Maintenance at highways. It includes both physical maintenance activities such as sealing, patching and traffic service activities.

Highway Maintenance is essential inorder to

* preserve the road in its originally constructed condition.
* protect adjacent resources & user safety.
* provide efficient, convenient travel along the route.
Types of highway Maintenance:

Under the type of routine maintenance following works are carried out:

1. Maintenance of side drains as clearing of silt & maintain proper slope.
2. Maintain of shoulders & subgrade
3. Periodic Maintenance
4. Special Repairs - strengthening of pavement structure or overlay construction, widening of roads etc.

Factors affecting road Maintenance:

The following factors affect the maintenance of pavements:

* Increase in the intensity of Traffic.
* Inadequate thickness of pavements
* Effect on number of lanes

Functions of Highway Maintenance:

* Shoulder care becomes a serious problem where narrow lanes force heavy vehicle to travel with one set of wheels.
Improper designed drainage facilities mean erosion or deposition of material & costly cleaning operation or other corrective measures.

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

The various maintenance function include:

1) Surface Maintenance
2) Roadside & Drainage Maintenance.
3) Shoulder & approach maintenance.
4) Snow & ice control.
5) Bridge Maintenance.
6) Traffic service.

Pavement maintenance & rehabilitation programs, restore riding quality & maintain the structural integrity of the pavement over its full design life.
* For maintenance of gravel roads, blading & occasional resurfacing is required.
  * For surface treatment of low type bituminous surface in maintenance of roads, patching, seal coating or possible loosening, oiling, remixing & relaying are involved.
  * Use same material and methods for road surface maintenance as far as possible.

Roadside and highway Drainage Maintenance:
  * If there is dry grass fire hazard burning, plowing must be done.
  * When back slope is covered with bush, trimming must be done to increase the sight distance & clearance of road.
  * Picking up litter, thrown or blown along roadside or wayside area a routine work.
Sho ulders:
* Shoulders must be moved and occasionally bladed down to the level of the road so that water is not trapped in the traveled way. Gravel must be kept in good condition.
* Shoulders protected by bituminous blankets or surface treatments, same as for roadway surface.

Snow & Ice Control:
Ice forming on the roadway reduces coefficient of friction b/w tires & surface which makes vehicle control almost impossible.
In highway maintenance we can apply abrasive to heavily traveled roadway & street.
Suitable materials that can be used are clean & sharp sand, cinders & washed stone screening.

Bridge Maintenance:
* Exposed steel work must be cleaned by sand blasting flame or other means followed by painting.
Deck joint may extrude or become filled with dirt so that cleaning & resealing is necessary.

* Out of control vehicle, causing damage to guard rail, must be repaired & strengthened.

* Remedial measures to correct serious scour around & under piers & abutments.

Traffic service:

Include stripping, sign repair & maintenance.

Distress in flexible & rigid pavements:

Surface distress:

It is any indication of poor or unfavourable pavement performance or signs of impending failure. Surface distress related to roughness. Broadly classified into three groups:

* Fracture
* Distortion
* Disintegration
Flexible Pavement distress:

15. Alligator (Fatigue) cracking

Description:
A series of interconnected cracks caused by fatigue failure of the hot mix asphalt surface under repeated traffic loading. As the magnitude of load becomes more, longitudinal cracks formed and connect forming many sided sharp angled pieces that develop into a pattern of an alligator or crocodile.

Problem:
Roughness, indicator of structural failure, cracks allow moisture infiltration into the base & subgrade, results in potholes & pavement disintegration.

Causes:
* Decrease in pavement load supporting characteristics.
* Loss of base, subbase or subgrade support from poor drainage.
* Inadequate structural design & poor construction.
Repair:

Small, localized failure cracking indicative of loss of subgrade support. Remove the cracked pavement area then dig the out & replace the area of poor subgrade & improve the drainage at the area if necessary. Patch over the repaired subgrade.

Bleeding:

Description:

A film of asphalt binder on the pavement surface. It usually creates a shiny, glassy-like reflecting surface that can become sticky when dry & slippery when wet.

Problem: Loss of skid resistance when wet, unsightly.

Causes:

* Excessively asphalt binder in the HMA.
* Excessive application of asphalt binder during BST application.
* Low HMA air void content.
Repair:

Minor bleeding can often be corrected by applying coarse sand to blot up the excess asphalt binder.

Major bleeding can be corrected by cutting off excess asphalt with a motor grader or removing it with a heater planner. If the resulting surface is excessively rough, resurfacing may be necessary.

Block cracking:

Description:

Pavement distress in flexible & rigid pavement

Introduction:

The maintenance operations involve the assessment of road condition, diagnosis of the problem and adopting the most appropriate maintenance. Even if the highways are well designed, constructed, they may require maintenance, the extent of which will depend on several factors including the pavement type.
General causes of pavement failures

1. Defects in the quality of materials used.
2. Defects in construction method & quality control during construction.
3. Inadequate surface or sub-surface drainage in the locality resulting in the stagnation of water in the subgrade or in any of the pavement layers.
4. Increase in the magnitude of wheel loads & no. of load repetitions due to increase in traffic volumes.
5. Settlement of foundation of embankment & the fill material itself.
6. Environmental Factors including heavy rainfall, soil erosion, high water table, snowfall, frost action etc.

Pavement Failures:

Failure in cement concrete pavement:

Failure of cement concrete pavements are recognized by the formation of structural cracking. The failures are mainly due to:

i) Deficiency of pavement materials.
ii) Structural inadequacy of the pavement system.
Following are the chief causes of which would rise to the different defects or failures of c.c pavement.

1) soft aggregates 11) Poor workmanship in joint construction
2) Poor joint Fillers & sealers
3) Poor Surface finish 12) Improper & insufficient curing.

The various defects that creep in due to the above are

a) Disintegration of cement concrete.
b) Formation of cracking
a) Poor riding surface.
a) Spalling of joint.
a) Formation of shrinkage cracks.
a) Slippery surface.
g) Ingress of surface water & further progressive failures.

Structural inadequacy of pavement

Inadequate subgrade support pavement thickness would be a major cause of developing structural cracking pavements.

Types of failure which develops.
i) Inadequate base ment thickness
ii) Inadequate sub-grade support & poor subgrade soil
iii) Incorrect spacing of joints.

Above leads to the following failures.

i) Cracking at slab corners.

ii) " " pavement longitudinally

iii) Settlement of slabs.

iv) Widening of joints.

v) Mud pumping.

Failure in Flexible Pavement

i) Failures in subgrade.

ii) Failures in base course

iii) Failures in wearing course.

Failure in Subgrade, wearing course,

Load

Base course

Sub base course

Soil subgrade

Arrows indicate the direction of upward movement due to movement of material from the layer.
Failure

1) Inadequate Stability - Inherent weakness of soil, excessive moisture.

2) Excessive Stress application - Improper compaction, more no. at repetitions, loads to change in bearing of unmodulation waves & corrugations.

Failures in sub-base (or) base course.

1) Inadequate stability or strength.
2) Inadequate wearing course.
3) Lack of lateral confinement for the granular base course.
Failure

1. Loss of binding action - Poor mix of proportioning, inadequate thickness, soft stone aggregates, loss of binding action.

2. Formation of alligator - Internal movement of aggregates under repeated stress application.

3. Loss of base course material - Non provision of w.c over base course or complete wearing out the w.c exposes the base course to the damaging effects of climate variation.

4. W.B.M base & stone aggregates being left in a loose state - Suction causes blow the pneumatic tires & exposed base course materials.

5. Pot holes - Abrasion & attrition.

6. Structural Failure - Iron tires cause damaging effect to surface course. Use of inferior materials, inadequate pavement thickness, lack of proper mix.
Failure in wearing course

Observed due to lack of mix design
Improper gradation of aggregate
Inadequate binder content & incorrect type of binder result in a poor bituminous surfacing

Failure causes

i) Cracking of pavement - Inadequate gradation of aggregates

ii) Inadequate binder - Inadequate binder content

iii) Inferior type of binder - Volatilization & oxidation of binder make the bituminous surfacing brittle

Lack of high degree of quality control, over or under estimated binder content
Rigid Pavement Failures:

Following are some typical & basic types of failures in rigid pavements which are dealt here in detail.

1) Scaling of cement concrete:
   a) Scaling is observed in cement concrete pavement showing overall deterioration of concrete.
   b) The scaling is mostly attributed due to the deficiency in the mix or presence of some chemical impurities which damages the mix.
   c) Further due to excessive vibration given to mix, the cement mortar comes to the top during construction & thus with use, the cement mortar gets abraded exposing the aggregate of the mix.

2) Shrinkage cracks:
   a) During the curing operation of cement concrete pavement, immediately after the construction, the shrinkage cracks normally develop.
   b) The placement of cracks are in longitudinal as well as in transverse direction.
3) Spalling of joints

Sometimes when preformed filler materials are placed during casting of pavement slab, the pavement is somehow delocated & 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 topside & the joint later on shows excessive cracking & subsidence.

4) Warping cracks,

If the joints are not well designed to accomodate the warping of slabs @ edges, this results in development of excessive stresses due to warping & the slab develops cracking @ the edges in an irregular pattern.

Hinge joints are generally provided for relieving the slabs of warping stresses.

5) Mud Pumping

Mud Pumping is recognized when the soil slurry ejects out through the joints & cracks of cement concrete slab under
the heavy wheel loads.

Following are the factors which cause mud pumping are

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

Pavement Management System:

iv) Minimum acceptable serviceability standards for the maintenance at different categories of roads.

v) Field surveys for the evaluation of maintenance requirements.

vi) Various factors influencing the maintenance needs such as subgrade soil, drainage, climate, traffic, environmental condition etc.

vii) Estimation of rate of deterioration of the pavement under the prevailing set of conditions.

viii) Type & extent of maintenance requirements and various possible alternatives & their economic evaluation

ix) Availability of Funds.
vii) Maintenance cost, availability of materials, manpower & equipment.

viii) Need based allocation for optimum utilization of inputs & fixing maintenance properties.

Pavement Evaluation:

The primary objective of pavement condition evaluation is to assess as to whether & to what extent the pavement fulfills the intended requirements so that the maintenance & strengthening jobs could be planned in time.

Various approaches for pavement evaluation

i) Structural evaluation of pavements.

ii) Evaluation of pavement surface condition.

Structural Evaluation of Pavements:

* The structural evaluation of both flexible & rigid pavement may be carried out by plate bearing test.

* The structural capacity of pavement may be assessed by the load carried @ a specified deflection of the plate.
* Measurement of transit deflection
  pavement under design wheel loads serve as an index of the pavement to carry traffic loads under prevailing condition.

* of the various equipment used for the purpose, Benkelman beam is most commonly used, as the measurements are simple & easy.

* There are no other non-destructive testing techniques for assessing the load carrying capacity of the pavements.

Evaluation of pavement surface conditions

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

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

Unevenness:

The pavement unevenness may be measured by using unevenness indicator, profilograph, profilometer or roughometer.
Bump Integrator: Integrate the unevenness of pavement surface to a cumulative scale that gives the unevenness index of the surface in cm/km, length of road.

Present Serviceability Index (P.S.I).

This is correlated with the physical measurements such as longitudinal & transverse profile of pavement, degree of cracking & patching etc., affecting pavement serviceability.

Skid Resistance:

Skid resistance property of pavement surface is essential requirement for highway safety.

The skid resistance or friction of the pavement surface may be measured by using anyone of the devices such as the pendulum type friction recorder or the skid testing device attached to test vehicle or the instrument mounted dynamic skid resistance tester by another vehicle.
Skidding has been contributing to the large no. of accidents on highways. 40% of accidents are due to the poor skid resistance.

Factors causing: water, clay, dust, dry sand, oil & grease leads to reduction in grip btw tyre & pavement surface.

Types of skidding:

a) Straight skidding: occurs in the direction of travel when the sudden brakes are applied

b) Impending skidding: encountered when the braking is gradual & wheel continues to revolve.

c) Sideway skidding: occurs on curves where sufficient superelevation is not provided or coeff. of friction is inadequate.

Remedial measure to skidding is renewal of the wearing course surface.
Evaluation by Benkelman deflection method:

A well compacted pavement section or one which has been well conditioned by traffic deforms elastically under each wheel load application. When the load moves away, there is an elastic recovery or rebound deflection of the deformed pavement surface. This is the basic principle of deflection method pavement evaluation (or) overlay design.

Procedure:

The stretch of road length to be evaluated is first surveyed to assess the general condition of pavement with respect to ruts, cracks or undulation.

A minimum of 10 deflection observations may be taken on each of the selected stretch of pavement. The deflection observation points may also be staggered, if necessary, & taken along the wheel paths on both the edges of pavement.

After making the deflection observation point, study is carried out in following steps.
1) The truck is driven slowly 11° to the edge is stopped such that the left side rear dual wheel is centrally placed over the first point for deflection measurement.

2) The probe end of the Benkelman beam is inserted below the gap of dual wheel & is placed exactly over the deflection observation point.

3) When the dial gauge reading is stationary or when the ratio of change of pavement deflection is less than 0.025 mm/minute, the initial dial gauge reading $D_0$ is noted.

4) The truck is moved forward slowly through a distance of 0.7 m from the point & stopped. The intermediate dial gauge reading $D_1$ is noted when the rate of recovery of pavement is less than 0.025 mm/minute.

5) The truck is then driven forward through a further distance of 9.0 m & final dial gauge reading $D_f$ is recorded as before.
The strengthening deflection dial reading $D_0, D_f$ form a set of readings at one deflection point under consideration. Similarly, the truck is moved forward to the next deflection point, the probe of the truck beam inserted and the procedure of noting the set of three dial observations is repeated. The deflection observation is also to be continued at all desired points.

Temperature at surface is recorded periodically. Tyre pressure, moisture content in subgrade soil is determined at suitable intervals.

Rebound deflection value $D'$ at any point is given by one of the following two conditions:

i) If $D_i - D_f \leq 2.5$ divisions of dial gauge,

$$D = 2(D_0 - D_f).$$

ii) If $D_i - D_f \geq 2.5$ divisions, correction needed for vertical movement at front leg.

$$D = \Delta (D_0 - D_f) + 2K(D_i - D_f)$$

$$K = \frac{3d - 2e}{f}.$$
where
\[ d = \text{Distance blw the bearing of beam & rear adjusting leg.} \]
\[ e = \text{Distance blw dial gauge & rear adjust leg.} \]
\[ f = \text{Distance blw the front & rear legs.} \]

Deflection value, \( D \) with leg correction is given by

\[ D = 0.02 (D_0 - D_f) + 0.0582 (D_1 - D_f) \text{ mm} \]

STRENGTHENING OF EXISTING PAVEMENTS

Strengthening may be done by providing additional thickness of pavement at adequate thickness in one or more layers over the existing pavement, which is called overlay.

If the existing pavement have completely deteriorated, an overlay wouldn't serve the purpose and the solution would be to remove the existing damages pavement structure & to rebuild the same.
In particularly damaged pavement sections, patch repair works are carried out before constructing the overlay.

The maintenance engineer should therefore take the decision in time for providing an overlay as and when needed.

**Types of overlays:**

The overlay combinations are divided into four categories based on the type of existing pavement & overlay.

i) Flexible overlay over flexible pavement.
ii) Cement concrete or rigid overlay over flexible pavement.
iii) Flexible overlay over cement concrete or rigid pavements.
iv) Cement concrete or rigid overlay over rigid pavements.