



# Management of Manpower, Materials and Machinery while Planning and Construction of Road Projects in Tribal area

SHYAMKANT S. BORSE  
Civil engineering Consultant, Dhule 424002  
Maharashtra (India)

## Abstract:

*Highway maintenance can be defined as preserving and keeping each component of highway such as roadway, structure, and other components as far as possible in their original condition and provide such additional work which is necessary to keep the traffic moving safely. Thus maintenance of highway comprises of the following maintenance works.*

- (a) Maintenance of road surface*
- (b) Maintenance of shoulders*
- (c) Maintenance of roadway drainage*
- (d) Maintenance of bridges and other structures*
- (e) Maintenance of road sides etc.*

*The location, design and construction of a highway have direct bearing on its maintenance cost and condition. It is essential to know during the design and construction stage the possibility of developing various defects. At the time of alignment the drainage problems, stream crossings, land slide conditions, suitability of soils, and directness of route etc. must be investigated in detail. Insufficient thickness of pavement or base or improper construction results in serious damages very soon, which entails expensive repair and maintenance.*

---

**Keywords:** 3 M's, Construction, Highway maintenance, Pavements, Planning

---

## 1. Introduction

At places where narrow lanes or small roadway width force the heavy traffic to travel on shoulders, the shoulder maintenance becomes a serious problem. Therefore, proper design and quality control at the time of construction is very essential for proper and economical maintenance of highway system. Actually before discussing the methods of maintenance of highways, it is essential to discuss the causes of failures of highways. The subject of pavement failure is a complex problem as several factors contribute to the deterioration and failure of pavements. The factors will be discussed in detail under their sub-heads.

## 2. Causes of failures of road pavements

### 2.1 Failures of fixable pavements

The failure of the flexible pavement is defined as the localized depression and heaving up in its vicinity. The sequence of depression and heaving up develops a wavy surface of the pavement. The failure or settlement of any of the component layer of the flexible pavement develops waves and corrugations or longitudinal ruts and shoving on the pavement surface. The excessive unevenness of the pavement surface may itself be considered as a failure. Thus to make a pavement durable and maintain its stability, each layer should be stable. Fig illustrates the above concept of failure in flexible pavement. Fig. A shows the failure due to sub grade soil; Fig.B shows failure due to base course and Fig. C failure due to wearing course. The failure of surfaced pavement may be attributed due to the following two causes.

- A). Inadequate stability
- B). Excessive stress application.

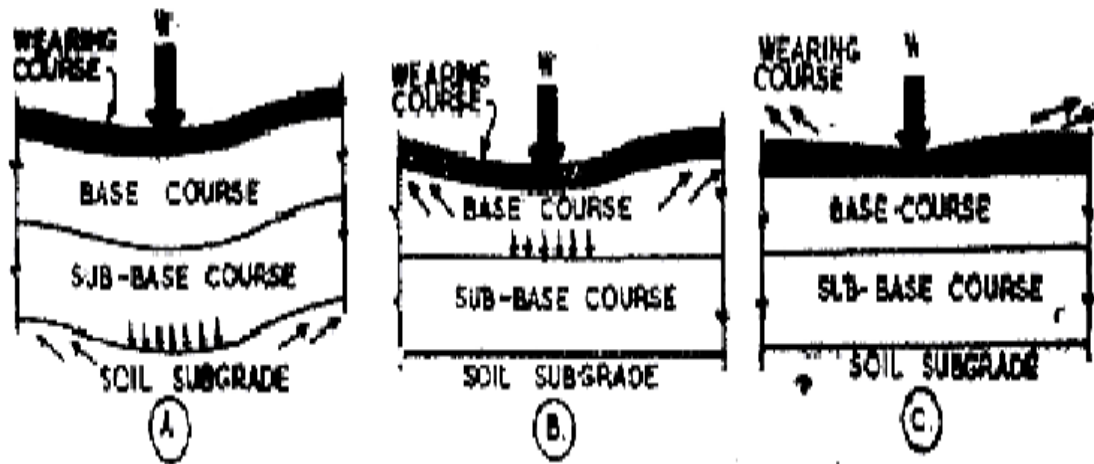


Fig. 2.1 Failures of flexible pavements

**(A) Inadequate stability**

The inadequate stability of the sub grade may be attributed due to the following factors:

- Inherent weakness of the soil itself.
- Excessive moisture in the sub grade.
- Inadequate compaction of the sub grade.

**2.1 Excessive stress application**

The excessive stress application is due to application of more load than designed or provision of inadequate thickness of pavement. The deformation of sub grade soil increases with increase in number of load repetitions

**2.1.1 Failure of sub base or base course**

Failure of sub base or base course takes place due to the following reasons:

- Inadequate strength or stability.
- Loss of cohesion or binding action.
- Loss of material.
- Inadequate thickness of wearing course.
- Use of improper or inferior material.
- Crushing of base course.
- Lack of lateral support for the base course.

**(A) Inadequate strength**

Following are the main reasons for the inadequate strength or stability of sub base courses

- Improper mix proportion.
- Inadequate thickness of sub base or base course.
- Use of soft variety of stone aggregates.
- Poor quality control during construction period.

**(B) Loss of cohesion or binding action.**

Under the repeated application of load or stress the internal movement of the aggregates in the sub base or base course takes place, which disturbs the composite structure of the layers. The disturbance in the structure of the layers results in loosening of total mass. Thus the loss in cohesion results in low stability and poor load distributing property of the pavement layer.

**(C) Loss of base course material.**

Now days due to the fast moving vehicles on the road, Suction is caused between the exposed base course material and the pneumatic tires. This suction causes removal of binding material in WBM base leaving the stone aggregates in loose state.

The exposed aggregates of the base course also form dust due to abrasion. The repeated use of such pavements results in loss- of stone aggregates forming pot holes. The removal of materials is- called releveling.

**(D) Inadequate thickness of wearing course.**

Inadequate thickness of wearing course or its absence exposes the base course to the ill effect of climatic variations due to rains, frost action and traffic action as well. Depending upon the intensity, type and volume of traffic suitable thickness of wearing course must be provided.

**(E) Use of inferior material.**

Due to the use of inferior materials in the highway construction many structural failures have been observed. The characteristics of many materials deteriorate due to their exposure to continuous cycles of weather changes. Hence highway materials should be tested fully as per I.S. before use.

**2.1.2 Failure of bituminous wearing course**

The failure of wearing course may be attributed due to the following factors:

- a) Improper mix design,
- b) Inadequate binder material.
- c) Inferior quality of binder material.
- d) Poor quality control during construction.
- e) Oxidation of bituminous binders.
- f) Oxidations and volatilization of binders make the bituminous surface brittle and causes its cracking. These cracks allow rain water to seep downward which damage underlying layers

**3 Maintenance and drainage of road pavements**

**3.1 General**

after studying the various defects that may cause the failures of pavements, it is necessary to know the different measures that can be adopted to maintain and up keep the pavements in excellent condition, As a basic principle, it may be assumed that any pavement designed and constructed on scientific basis should need the minimum maintenance.

**3.2 Factors affect the maintenance**

Generally following four factors affect the maintenance of pavements:

- Increase in the intensity of traffic.
- Inadequate thickness of pavement.
- No. of lanes or width of the pavement.

- Increase in labour as well as material cost.
- Increase in the intensity of traffic.

Since independence the increase in road transport in India is about 8 % per year, which is more than even from U.S.A. or U.K. Further to cope with the transport demand, Govt. of India has allowed a 25% increase in the axle load. It has been established by the highway research Board of U.S.A. that 25% increase in the axle load has twice the destructive effect on the pavement.

- **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.

- **No. of lanes or width of the pavement.**

The road research laboratory U.K has established by experiments that concentration of load is almost 4 times larger on a single lane pavement than a double lane pavement sections. Thus the pavement distress and maintenance requirements on single lane pavements are higher than double lane pavements. In India more than 70% National highways and 80% to 95%. State and Major district roads are single lane, therefore, our highways need greater care and maintenance.

- **Increase in labour and material cost.**

Paucity of funds and. increase in prices of materials and labour has further aggregated this problem.

### ***3.3 Types of maintenance***

Generally following types of maintenance operations are adopted:

- Routine or periodic maintenance.
- Special repairs.
- Resurfacing.
- Periodic maintenance.

Since all types of highways are exposed to the adverse climatic conditions and moving traffic, they would positively wear out. Thus for economy, they need maintenance before further deterioration. Under this category of maintenance generally following works are carried out:

- Up keep of carriage way.
- Maintenance of shoulders and sub grade.
- Maintenance of side drains as clearing of silt and main taming proper slope.
- Maintenance of other ancillary works such as bridges etc.
- Improvement of highway geometrics and traffic controls etc.

#### **Special repairs**

Special repairs are carried out for special problems as and when occur due to failure of pavements. Sometimes special repairs are needed for some subsurface drainage system and cross drainage structures.

#### **Resurfacing**

After the useful life of the pavement or due to its surface being badly damaged, resurfacing is done.

### **3.4 Maintenance Operations**

The schedule of maintenance operations indicates the month in which different maintenance operations should be carried out; generally these schedules are drawn to suit the local conditions. A typical schedule of highway maintenance is given below.

#### **April to June**

In this period generally following works are carried out:

- Renewal of wearing coat, as per plan.
- Repairs of broken edges, bleeding and patch work repairs etc.
- Collection of material such as gravel, kanker etc. needed for stabilization of beams.
- Wherever possible, improvement of beams by mechanical stabilization.
- Detailed inspections of culverts, bridges and their repairs where ever necessary.
- Removal of sand from the carriage way and beams.
- Silt clearance etc. of side drains and construction of new drains where ever necessary.
- Maintenance of road side trees.

#### **July to September**

- Attending to patch repairs.
- Attending to cuts developed by rains.
- Draining of water from road where ever necessary by cutting the beams.
- Stabilization of beams.
- Attending to drains and other damages caused by rain.

#### **October to December**

- Patch work repair.
- Renewal of coats.
- Repairs of damages caused by rains.
- Attending kilometer stones, Road sign hoards, village name boards, direction boards etc.
- Repair of scours in culverts and bridges, and clearing of silt etc.

#### **January to March**

- Patch work repair.
- Repairs and Inspection of Bungalows and Gang huts etc.
- Renewal and improvement works.

Now we shall discuss the maintenance techniques of different types of highways.

### **3.5 Maintenance earth roads**

In earth roads usually following damages need maintenance:

- Formation of dust during dry weather.
- Formation of longitudinal ruts along wheel path of the vehicles.
- Formation of cross ruts due to rain water.
- Formation of gullies in side slopes.
- Growing of vegetation inside drains and their silting up etc.

#### **Remedies**

- The dust nuisance may be remedied either by frequent sprinkling of water or by treating the surface with certain chemicals such as calcium chloride.
- Formation of ruts may be maintained by spreading moist soil along the ruts and compacting it properly. If need be, the camber may be reshaped.
- Cross ruts may either be repaired after monsoon or stabilized layer may be provided.
- Formation of gullies in side slopes may be treated by dressing the side slopes.

- Side drains may be maintained by silt clearance and removing vegetation from them.

### ***3.6 Maintenance of gravel roads***

Maintenance of gravel roads should be done on the same lines as that of earth roads, but in no case local soil should be spread over the gravel surface. Only gravel should be used. For this reason additional material should be stacked along the road on the berms before the onset of monsoon. The volume of gravel stacked should be sufficient to be spread over the full width of the road in a thickness of 5 cms.

### ***3.7 Maintenance of W.B.M. roads***

W.B.M. is the basic stage of the planned improvement of road surfacing. W.B.M. roads are damaged rapidly due to the heavy mixed traffic and adverse climatic conditions. The steel tyred bullock carts cause severe wear and tear to the W.B.M. surfaces. In dry weather dust and in rainy season mud is formed.

The fast moving vehicles suck up the fine particles from the road surface resulting in loss of binding particles in the surface. In rainy season the rain is soaked by the surface which makes the surface soft. In such conditions the movement of vehicles makes the layer of surface loose. In this situation some aggregate get displaced from their position causing ruts and pot holes on the surface.

#### **Remedies**

- To prevent aggregate from getting loose from the surface course a thin layer of moist soil should be spread over the surface periodically particularly after the rainy season.
- The dust nuisance can be effectively eliminated by providing a surface dressing of bituminous material.

#### **Ruts**

These are longitudinal depressions in the surfacing. Ruts are formed due to the following reasons:

- If iron tyred bullock carts use the track again and again.
- Depressions are formed. In such cases depressions over the surface are seen, a layer of murrum should be spread over the surface.
- Ruts are also formed if the sub grade is of inadequate supporting power. In such cases either sub grade should be strengthened. or thickness of road crust should be increased.
- If the camber in the pavement is excessive, the tendency of traffic remains to use the central part of the pavement forming a pairs of ruts in the middle half of the pavement. In such cases the ruts should be repaired as soon as possible and camber also should be rectified.
- Ruts can also be developed due to insufficient compaction. In such cases it can be rectified by scarifying and recompacting the surface.

#### **Pot holes**

These are isolated depressions in a road surface. Pot holes may develop due to the following reasons:

- Sinking of aggregates in relatively soft patches in the sub- grade.
- Surface irregularities are covered without proper compaction.
- By metalling over uneven stone soling.

## Remedies

- Pot holes should be cut in rectangular or square shape up to the defective depth and the excavated material removed. Then coarse aggregate of the same size is filled up in the pot hole or the Patch work and compacted well by ramming. The level of patched area is kept 1 cm above the general surface of the pavement. This allows further compaction of the patched area under traffic. The soil binder is applied to this, patched area to fill up the interstices and the surface is rammed again.
- In such cases the recompaction should be done providing proper grade and section. A little additional material should be left for future compaction.
- In such conditions the uneven soling should be completely removed, repacked and compacted conforming to the normal line of grade and section and pot hole patched up.

## Corrugation.

Corrugations are longitudinal waving in the road surface. Corrugations are formed under following conditions.

- Due to initial waving produced while rolling. While compacting the renewal coat the surface should be finished to required line and grade.
- Due to the use of very sandy murrum at the time of remetalling better quality murrum should be used.
- Due to the provision of very thin crust. Proper crust should be built up by successive renewal coats.

### 3.7.1 Raveling

The removal of material is called raveling. It is generally caused by

- use of too sandy binder
- Insufficient compaction.

In early stages of pavement construction raveling can be detected by the presence of hair cracks along the interstices.

At this stage it can be arrested by blinding the surface with good murrum. If the defect progressed too far, all floating metal should be removed and a good blinding with better quality murrum should be given.

### 3.7.2 Fraying of edges

Damage to edges is known as fraying. Fraying of edges is caused by lack of shoulder support which may result by wearing down by traffic or gullying by rain water.

First of all, the shoulder support should be improved and then frayed edges patched up. Where shoulders are maintained in a good and stable condition, smooth and flush with the pavement throughout the year, the chances of breaking pavement edges are very remote.

### 3.7.3 Renewal of surface

After the useful life of the pavement or when the surface falls extensively to such an extent, that it can no longer be maintained by routine maintenance operations, then renewal of surface is adopted. Normally a good W.B.M. surface will require renewal after every 3 to 5 years depending upon the traffic and weather conditions. Generally 8 cm thickness in loose state of the renewal layer is sufficient. If the thickness of the W.B.M. is adjudged to be less, then it can be increased at the time of renewal or resurfacing.

### **3.8 Maintenance of bituminous surfaces**

In bituminous surfaces generally following repairs are carried out:

- Patch repairs.
- Pot holes and their repairs.
- Surface treatment.
- Resurfacing.

#### **(A) Patch repairs**

Patch repairs may be carried out on the damaged or improper portion of the road surface. Localized depressions cause pot holes formation in the road surface. Inadequate or defective binding material causes removal of aggregates from the road surface during rainy season. Thus patching may be done on affected localized areas or sections for removing inequalities in shape and surface and also removing waviness in order to have a smooth riding surface.

#### **(B) Pot holes and their repairs.**

Pot holes are generally formed due to the following causes

- Non-uniform distribution of asphalt, resulting in lack of asphalt in small pockets.
- Movement of base due to inadequate thickness.
- Yielding of sub grade.
- Lack of proper maintenance of the surface.

#### **Remedies**

Pot holes may be rectified by following methods:

**1. Paint patching.** This method can be adopted to hold up the pot hole formation in its material stage i.e. when the surface starts revealing.

#### **2. Penetration patching**

Pre mix Patching In this method, the pot holes are cut in a square or rectangular shape and excavated up to the depth until the sound materials are encountered. The affected material is removed. The excavated holes are cleaned of all loose aggregate, Dust, foreign matter and water etc. The sides and bottom of the cut portion slightly primed with a primer. When the hole is ready, a pre mixed material or patching mixture is placed in it as soon as possible and compacted well by ramming. Patching mixture generally consists of cut back emulsion as a binder and well graded mineral aggregate of max size 20 to 125 mm.

If the depth of the hole is less than 8 cm, the whole depth may be filled in one operation and compacted well. While filling

Depression an allowance of 20% compaction should be made. For this allowance generally compacted material is kept 1 cm higher

Than existing surface of the pavement. If the depth is more than 8 cm then patch material should be laid in layers. Generally the thickness of one layer should not be more than 6 cms.

#### **(C) Surface treatment**

If the binding material or binder such as bitumen is in excess in the surface, it will come upon the surface during summer. The process of coming up to surface of bitumen is known as Due to the bleeding of the bitumen, the pavement surface becomes patchy and slippery causing corrugations or ruts or shoving in the surface. In such circumstances it is customary to spread coarse sand or aggregate chips of maximum size of 1.25 cm during summer. After



spreading sand or aggregate light rolling is done to develop bond between the existing surface and the material spread,

Due to constant contact with the atmospheric changes, the binder of the black surface gets oxidized. In this process, the binder becomes stiff, forming minute cracks on the pavement surface, In such circumstances a new seal coat or renewal coat is applied on the pavement surface. If the surface gets damaged seriously due to oxidation or volatilization of binder materials, the surface may be provided with more than one layer of surface treatment.

#### (a) Waves and Corrugation

Following factors contribute to the formation of Corrugation and waves:

**1. Defective rolling.** During Construction stage if rolling is defective it will cause formation of waves, and it will indefinitely. This will further be aggravated by the traffic movement if the rolling is improper during construction stage. In this case small aggregates together with an excess of bitumen or asphalt build up a mat.

**2. Poor sub grade.** If the sub grade is consisted of poor soils. Such as organic soils or highly plastic soils and high water table exists close to the sub grade then it may cause the sub grade surface non uniform and of inadequate stability. If boulders are used as soling course in such sub grades, a differential settlement of stones will take place. It will also contribute to the formation of corrugation and waves.

**3. Inadequate surface course.** Inadequate surface course

To take the Intensity of the traffic will cause waves and corrugation of the pavement.

**4. Poor gradation poor mix.** Defective gradation poor Mix used for the surface also is a cause for formation of corrugation and waves.

**5. Compaction temperature.** The viscous property of bitumen greatly depends upon temperature. High temperature, during mixing and compaction of bitumen mix would result in very low stable pavement surface.

Weak or unstable underlying layers. Weak underlying layers also cause formation of waves due to repeated plying of vehicles on them.

**Remedial measures.** Corrugations may be rectified up to design sections by cutting of the high ridges. The inequalities and waviness may be removed by filling the depressions with premixed material after applying tack coat over the cleaned surface.

#### (b) Base repairs

Structural failures of base course in flexible pavements may result due to the following factors

- Inadequate base thickness
- Inadequate sub-grade support
- Excess moisture in base or sub-grade
- A combination of two or more factors stated above.
- The failure may result due to consolidation or developing shear in sub grade or base course or surface. In case failure is due to consolidation of road layers, rut will not develop by any upheaval of the surface, where as sub grade shear failure will exhibit surface upheaval at some distance from the depressed rut.
- Shear failure of surface course will develop upheaval relatively close to tyre track. Hence proper investigations of the causes should be done before carrying out any repair work.
- If the failure is due to excessive moisture, then proper drainage should be provided.
- If the failure is total and it has been decided to increase the base thickness then old

surface and base should be loosened by scarifying to the full depth and sub grade removed up to the depth necessary to give the needed additional thickness to the new base. Now road is brought to the proper cross-section and compacted.

#### **(D) Resurfacing**

When the road base is structurally sound but the bituminous mats worn out resulting in poor riding surface, then to provide an additional mat on the existing surface is economical. After repairing the existing surface by suitable patch work, a light tack coat is applied and new surface is laid and finished.

#### **4. Conclusions**

Road and highways plays very important role in development of any nation, all types of goods and passengers are possible to move all around the world due to the well maintained network of road and highways systems. The efficiency of road ways and highways are depend upon its regular repair and maintenance , every road ways and high ways need regular repair and maintenance ,frequency of regular repair and maintenance is depend upon its quality of construction, geology of area , type of traffic loads , rainfall ,altitudes many factors are responsible for frequency of regular repair and maintenance of road way and highways, if roads are not repair and maintained its adversely affect the movements of traffic on it , this will reduce the efficiency of traffic movements and increase the fuel consumption ,pollution, traffic conjunction ,wear and tear of vehicles , accidents on road pavement ,therefore regular repair and maintenance will reduce the cost of repair and maintenance of vehicles , cost of fuel , air pollution, cost of accidents ,delays while travelling.

#### **References**

1. Agrawal, B. K. (2001). Introduction to Engineering Materials”, 4<sup>th</sup> edition, Tata Mc Grawhill Publishing company ltd, pp194-195
2. Amnon Katz, (2004). “Environmental impact of steel and FRP reinforced polymer”, Journal for composite for construction vol 8 no.6 pp 48-488
3. Gopal Krishna, (2007). ”Key role of chemical admixtures for pavement quality concrete”, NBM&BW vol 13, pp166-169.
4. Highway planning and design by Justo Khanna
5. Highway planning and design by S. C. Rangwala
6. Kenneth, G. Budhinski, Michel, K. Budhinski, (2004).” Engineering materials-Properties & selection”, 8<sup>th</sup> edition, Prentice Hall India, pp 194-195
7. Reis, J.M.L. (2006). “Fracture and flexure characterization of natural fibers-reinforced polymer concrete” Construction and Building Materials vol 20 pp 673-678
8. Seehra,S. S. (2007). “An Innovative concrete technological development of fully mechanized construction of cement concrete pavement”, NBM&BW vol 12 pp76-93
9. Soni, K.M. (2007). “Fiber Reinforced Concrete in Pavements”, NBM&CW vol 12, pp 178-181