Pavement Failures And Its Rehabilitation

N.Naveen
Assistant Professor: Auroras Engineering College
Hyderabad, India

B.Govardhan
B.Tech: Auroras Engineering College
Hyderabad, India

M.Madhuvaran
B.Tech: Auroras Engineering College
Hyderabad, India

M.Anil
B.Tech: Auroras Engineering College
Hyderabad, India

Abstract— *Now-a-days roads are destructed due to weather conditions, traffic volume and heavy good vehicles. So, we have planned to do project on road rehabilitation and maintenance. We have selected a road to do project which is damaged with potholes, raveling etc. We will found the causes of failures on the road, and conduct lab tests on materials which were used for constructing that existing road to know the quality of the materials. we have conducted traffic survey which will help to know some more causes of the pavement failures.*

By the tests, we can justify the defect of the chosen pavement and we can repair the damaged path. We can also explain about preventive measures when constructing and designing pavement. Bitumen course is a surface layer which should be smooth, and the friction between the tire and road is good. Bitumen surface plays an important role in transportation, several tests on bitumen like ductility, softening point test, penetration test, flash and fire point test were conducted.

Repairing of roads is a type of treating the damage of a pavement. Generally various defects are alligator cracking, block cracking, pot holes, raveling, bleeding, etc. Finally we will show some preventive measures to protect the pavement from various failures.

Keywords— Bitumen; destructing; maintenance; raveling; rehabilitation; repairing

I. INTRODUCTION

Repairing of roads is a type of treating the damaged roads. Generally various defects are there like alligator cracking, block cracking, pot holes, ravelling, bleeding, etc.

The main causes for these cracks are weak sub base, sub grade and poor drainage and more traffic volume, weather conditions and defaults in mix design of the materials and laying thin coat of surface course. So that the reason of poor material use, we had conducted several lab tests among the materials samples collected from selected road which is fully effected.

Following tests were conducted for the materials,

1) Aggregate impact value test
2) Aggregate crushing value test
3) Los Angeles abrasion test
4) Permeability of soil test
5) Compaction test
6) CBR test
7) Bitumen ductility test
8) Penetration test
9) Softening point test.

Some of the types of failures are:

Fig 1: Alligator cracking

Alligator cracking is a load associated structural failure. It often starts in the wheel path as longitudinal cracking and ends up as alligator cracking after severe distress.

Fig 2: Block Cracking

Generally this type of cracking occurs due to Using of old (or) dried out mix, Mix was placed too dry, Fine aggregates mix with low penetration asphalt and absorptive aggregates.

Fig 3: Pot Holes

It Causes Poor drainage, Weak sub base or sub grade. It is very dangerous for two-wheeler vehicles and other vehicles too.

II. STUDY AREA

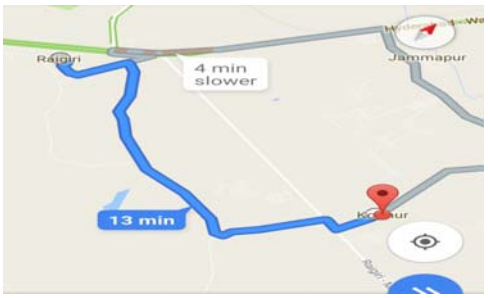

Fig 4: location map of the study area.

The area selected is from Raigiri to Kunoor which is in Yadadri distsrict in Telangana. It is of 2 Kms distance between the two points. The pavement is totally damaged to the various reasons like less stability in the subgrade.

III. ROAD EXAMINATION FOR THE DEFECTS

A. Causes And Types Of Deterioration

Pavement deterioration generally takes place due to combined action of traffic, weather, drainage, environmental factors, etc. Flexible pavements generally deteriorate at a more rapid rate when compared to rigid pavements due to the above factors. However flexible pavements are continue to deteriorate at slow rate even without the traffic movement on the surface, due to climatic and environmental factors.

Two types of deterioration take place in pavements they are

1) Functional Deterioration
2) Structural Deterioration

B. Functional deterioration

This deterioration of pavement is due to combined action of traffic, climate and environmental factors, predominantly on surfacing course of the pavement.

The physical form of functional deterioration of flexible pavements include, Formation of potholes, raveling and cracks at some locations, Formation of undulations or unevenness including depression along the longitudinal profile of the pavement surface.

Formation of longitudinal ruts along the wheel path

1) Shoving of pavements or plastic movement within the layer resulting in the localized bulging of the surface
2) The pavement surface getting polished or very smooth, particularly along the wheel path and becoming slippery under wet condition
3) Formation of large waves along the longitudinal profile which affects high speed travel.

C. Structural deterioration

The main cause contributing to structural deterioration of pavement is due to repeated application of heavy traffic wheel loads; the rate of structural deterioration affects the service life of the pavement. The structural deterioration get accelerated due to entry of water into the pavement layers including the sub grade.

In case of flexible pavements, the structural deterioration is indicated by Increase in the magnitude of pavement deflection under a standard wheel load and Increase rut depth on the pavement surface which indicates the permanent deformation of the pavement layer including the sub grade along wheel path of heavy vehicles.

D. Stresses On Pavement

Generally, cracks generated from the surface are caused by fatigue from traffic especially HGVs.

1) Axle/wheel load
2) Traffic on pavement
3) Wear and tear
4) Temperature or environmental stresses

The stress (wheel load) acting on the pavement will be distributed to a wider area, and stress decreases with the depth. So layer form will be used in pavement construction.

E. Layers in pavement construction

TABLE I: DIFFERENT LAYERS IN THE PAVEMENT

Surface course
Base course
Sub base course
Sub grade

We have selected one road which is fully damaged and have conducted material tests to compare with normal materials and to find the material failures which are used for that road.

1) Aggregate tests
2) Soil tests
3) Bitumen tests

F. Aggregate crushing value test

Fig 5: Finding crushing value of the aggregates

The standard crushing value should be,

1) Surface - less than 30%

2) Base course – less than 40%

3) Sub base course – less than 50%

The mean of the crushing value obtained in the two tests is reported as the aggregate crushing value 0.98%.

G. Aggregate impact value test

Fig 6: Finding Impact value of the aggregates

Aggregate impact value is to classify the stones in respect of their toughness property as indicated below:

Aggregate impact values

< 10% -exceptionally strong;

10-20%-Strong

From the calculations, we got

Total aggregate weight (w1) = 360 grams

Aggregate weight passing through 2.36 mm sieve (w2) = 72 grams

Aggregate impact value (%) = w2 / w1 *100 = 20%

From the above results, we can say that the aggregates are enough strong.

H. Penetration Test

Fig 7: Finding penetration value of the bitumen

TABLE II: TABLE SHOWING THE PENETRATION VALUES

Sl. No	Reading
1	61
2	65
3	69

Penetration reading is 64

The difference between the initial and final penetration readings is taken as the penetration value. The mean value of three penetration measurements is reported as the penetration value.

Applications of Penetration Test

Penetration test is the most commonly adopted test on bitumen to grade the material in terms of its hardness. Depending up to the climatic condition and type of construction, bitumen of different penetration grades are used, 80/10 bitumen denotes that the penetration value ranges between 80 and 100. The penetration values of various types of bitumen used in pavement construction in this country range between 0 and 225. For bituminous macadam and penetration macadam Indian Roads Congress suggests bitumen grades 30/40, 60/70 and 80/100. In warmer regions lower penetration grades from preferred and in colder regions bitumen with higher penetration values are used.

The penetration test is not intended to estimate the consistency of softer materials like cutback or tar,

which are usually graded by a viscosity test in an orifice viscometer.

The India Standards Institution has classified paving bitumen available in this country into the following six categories depending on the penetration values. Grades designated 'A' (such as A 35) are from Assam Petroleum and those designated 'S' (such as S 35) are from other sources.

TABLE III: PENETRATION VALUES FOR DIFFERENT GRADE PAVEMENTS

Bitumen grade	Penetration
A 25	20 to30
A 35 & S 35	30 to40
A 45 & S 45	40 to 50
A 65 & S 65	60 to 70
A 90 & S 90	80 to 100
A 200 & S 200	175 to 225

I. Pothole terminator by mechanical concrete

Pothole terminator by mechanical concrete takes crushed stone and puts it inside a thin walled cylinder, which is a tire with its side walls removed, and then it is covered up.

So when we confine this aggregate, it is solid .it is not going anywhere . we can put asphalt, concrete or even more stone over it. Once installed, the now fixed road way is permeable, allowing water to run through it without causing damage.

Now it is like a structural French drain. A French drain is essentially a trench filled with gravel or rock or perforated pipe that redirects surface water and ground water away from an area. Much like the pothole terminator by mechanical concrete, French drain prevent ground and surface water from penetrating or damaging a foundation or in this case, the roadway base.

Fig 8: Process of Pot hole terminator

Most road surface failures are caused by water penetrating into the compacted base stone binder, causing it to fall apart. This causes road edge collapse, potholes, ruts and creates safety problems for drivers.

J. Self Repairing roads:

The materials used are Cement, Course Aggregate, Fly ash, Fine aggregate, Hydrophilic coated fibers

Procedure

The high strength concrete will be used to make the road is bolstered with fibre reinforcement using hydrophilic Nano-coating, which makes the concrete absorb the water while keeping the road hydrated. Hydrophilic means the nature of absorbing the water and keep hydrating the concrete.

When the cracks occurred on the road, the cracks will be covered automatically by displacement of silts by its hydrophilic nature. The concrete will have the more strength by using the fiber reinforcement. When cement is used to create roads, it generates the greenhouse gases which are negatively affect the environment. To prevent this, 60% of cement will be replaced with fly ash.

IV. RESULTS AND SUGGESTIONS

TABLE IV: THE EXPERIMENTAL VALUES OF VARIOUS TESTS WERE SHOWN

Sl. no	Experiments	Results
1	Aggregate crushing test	0.98 %
2	Aggregate impact test	20 %
3	Abrasion test	34.58 %
4	Permeability of soil	Semi permeable
5	CBR	4.09 %
6	Bitumen softening point test	50^0 c
7	Bitumen penetration test	64
8	Ductility test	94 cm
9	Compaction factor test	Max dry density = 2.77 OMC =15%

A. Specifications

1) Aggregate impact test: The maximum allowable aggregate impact value for sub base and base course as per the IRC pocket book 2006 = 30%

2) Aggregate crushing value test: The limit of aggregate crushing value according to IRC for base course is less than 40%

3) Los Angeles abrasion test: According to IRC pocket book 2006, the allowable limit of aggregate LA value is 40%

4) Permeability of soil: Semi permeable is ideal for sub grade layer

5) Aggregate impact test: The maximum allowable aggregate impact value for sub base and base course as per the IRC pocket book 2006 = 30%

6) Aggregate crushing value test: The limit of aggregate crushing value according to IRC for base course is less than 40%

7) Los Angeles abrasion test: According to IRC pocket book 2006, the allowable limit of aggregate LA value is 40%

8) Permeability of soil: Semi permeable is ideal for sub grade layer

9) CBR: The CBR value for sub grade should be more than 7% according to IRC pocket book 2006

10) Ductility test : According to Indian practice (IS:73-2006), the ductility value for the bitumen grades of VG10, VG20, VG30, VG40 are 75, 50, 40 and 25 cm length respectively.

11) Penetration test: According to IS:73-1992, the bitumen used for paving has been classified into 6 grades, Viz. S-35, S-45, S-55, S-65,S-90 and S-200 having penetration grade value 50/60, 60/70, 80/100 and 175/200 respectively (MORTH 2001)

12) According to IS: 73-1992 (MORTH 2001), the minimum required value of penetration for most of grades of bitumen is 35. We got 64 so it is 60/70 grade

13) Softening point test: According to IS:73-2006, the minimum temperature of the softening point for paving bitumen of grades VG 10, VG 20, VG 30, and VG 40 should be 40, 45, 47, 500c respectively.

V. CONCLUSION

After conducting lab tests of materials, the CBR value obtained is 4.09% but the value should be more than 7% for sub grade as per IRC pocket book 2006. So, this may be the cause of failures on pavement.

Generally, the failures take place on pavement surface due to traffic, poor drainage. So using following methods, we can overcome those problems.

1) The potholes, ravelling occurs mainly due to weak sub grade and base course. So, using of Pothole terminator by mechanical concrete method (explained above), we can decrease the potholes and ruts and drainage problem too. This is applicable for both bitumen and concrete road.

2) The cracks will be healed when the cracks are in minor stage on the self-healing roads and this is very useful in rainy season. These can reduce the pollution by using more fly ash with cement and this is the concrete road.

And we can say that placing of bitumen/concrete should be done immediately after the mixing to avoid ravelling. To prevent edge cracks, there should be no vegetation at edges of pavement. Bleeding occurs due to more bitumen with less aggregate. So, the mixing should be proper. Through and go, spray injection, though and roll, patching with hot or cold mix, seal coats are the methods which are to be used after cracking.

VI. AKNOWLEDGMENT

We like to thank my college who helped us to do all the laboratory tests.

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