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Micro surfacing: A Proactive Maintenance for Rigid Pavement

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Abstract - *India resides in the tropical region where the climatic conditions vary, day to day, concrete is the material which due to variation in the temperature develops high stresses and deforms. In this research work the various causes of distresses occurred on rigid pavements are analyzed. Micro Surfacing is an eco-friendly surface treatment, applied over an existing road which is structurally sound. It is a solution for resurfacing as a wearing course. The material and laboratory mix design is developed for micro surfacing on rigid pavement to Increase the service life of pavement. The average life of microsurfacing is 4 year as per IRC: SP: 81:2008.*

***Key Words*: Micro surfacing, Distresses on pavement Proactive maintenance**

1. INTRODUCTION

India has an extensive road network of 4.24 million km– the second largest in the world [1]. The National Highways have a total length of 70,934 km and serve as the arterial road network of the country. It is estimated that more than 70 percent of freight and 85 percent of passenger traffic in the country is being handled by roads [1]. Micro Surfacing is an eco-friendly surface treatment used to restore and preserve the surface characteristics of the road. It is of two types (i) 4 mm to 6 mm thick (Type II) (ii) 6 mm to 8 mm thick (Type III). It is a mix of polymer modified asphalt emulsion, graded aggregate, cement, water and additives. This mixture is applied in a semi-liquid condition with specialized paving equipment.

Micro surfacing is to be applied over an existing pavement surface which is structurally sound, but the surface is showing signs of premature ageing, aggregate loss, and high degree of polishing, oxidation surface etc. Micro surfacing is a solution for resurfacing as a wearing course. It is cost effective as compared to hot mix treatment. It gives smooth surface without disturbing existing profile. Though microsurfacing has been in use worldwide for a very long time as a routine form of maintenance in preference to the conventional overlays of the hot mix, yet it was introduced only in 1999-2000[11] in India under the brand name of Macroseal by Yala construction and Elsamex SA, Spain. In India, the guidelines related to the use of micro surfacing is given in Indian Road Congress (IRC), IRC: SP:81-2008 - Tentative Specifications for Slurry Seal and Microsurfacing.

2. Analysis of Causes of Distresses through Literature

Rigid pavement distress is a serious issue all over the world, the distresses causes some serious problems at wide range. Prevention of rigid pavement distresses is a challenge to the Engineers. Maintenance and Rehabilitation is to be properly done to prevent the distresses in rigid pavement.

The common distresses occurred on pavement is as shown in following table

Table -1: Common Distresses Occurred on Pavement

Sr. No.	Distresses occurred on site	Description
1	Blowups	Blowups occur from mid-morning to mid-day due to change in temp. All blowups need repair in an emergency due to safety concerns.
2	Bumps, Settlements and Heaves	Bumps, settlements and heaves in concrete pavement are caused due to frost heaving, soil swelling or consolidation.
3	Corner breaks	Corner breaking in a concrete pavement are caused due to repeated wheel load at corners which cause corner deflections and stress in pavement resulting in fatigue damage.
4	Curling/Warping Roughness	Roughness in joined concrete pavements is cause due to upward deformation of the slab which is cause due to 3 different mechanisms of temp. And moisture either alone or in combination.
5	D Cracking	"D" cracking is not caused by traffic loads, it diminishes the concrete's structural integrity, particularly on the outer edges of the pavement, along the centerline, and on the wheel-paths near joints and cracks.
6	Faulting	Faulting in JPCP and JRCP is a major contributor to roughness, but it is not a major problem for CRCP. Normally, faulting is not a major problem for low-volume roads and streets.
7	Joint seal damage	Joint seal damage may be caused by the use of an inappropriate sealant type, improper joint sealant installation, or simply aging of the sealant.
8	Joint Spalling	Joint spalling may occur primarily in

		the top few inches of the slab, or may occur below the surface at a higher depth, depending on the conditions of the construction.
9	Linear Cracking	It crosses slabs at an angle other than perpendicular to the bottom of the slab, diagonal cracking is similar to transverse cracking.
10	Map Cracking, Crazing, and Scaling	Crazing or map cracking is usually caused by over-finishing, but may also be indicative of alkali-aggregate reaction.
11	Polishing	Polishing causes a substantial reduction in surface friction and increased risk of skidding accidents.
12	Pop outs	Pop outs detract from the appearance of a pavement but are not considered worth repairing, as they do not generally affect the ride quality, durability, or structural capacity of a concrete pavement.
13	Punch-outs	Punch outs and working transverse cracks are the two major structural distresses in CRCP (Continuously Reinforced Concrete Pavement).
14	Settlement Cracks	Settlement of the subgrade and sub-base can cause the cracking of the concrete pavement.

2.1 Analysis of Distresses Observed on Site (Phase 2 of Miraj-Solapur National Highway)

Various pavement distresses were observed by visual inspection on the roads. The road is open for the traffic in mid-November 2019.The cracks developed on road is described and the condition of road is analyzed. The different distresses considered on concrete pavements are described below

Spalling

This can be described by cracking, breaking or chipping of joint/crack edges, it usually occurs within about 0.6 m of joint/crack edge. Due to spalling, the problems generated on the road are loose debris on the pavement, roughness, etc. This is generally an indicator of advanced joint/crack deterioration.

Polished Aggregate

These are areas of pavement where the section of the aggregate that stretches above the cement paste is either very small or the aggregate particles are not rough or angular. It leads to reduced skid resistance.

Fig -1: spalling on pavement

Shrinkage Cracking

This may be described by hairline cracks formed during PCC setting and curing hat is not located at joints. We do not typically spread through the entire width of the slab. Shrinkage cracks are considered a pain if uncontrolled phenomenon.

Linear Cracking

These are linear cracks not associated with corner breaks or blowups that extend across the entire slab. Such cracks usually divide a single slab into two to four parts. This creates roughness, allows moisture infiltration leading to erosion of base/sub base support, and also these cracks will eventually spall and disintegrate if not sealed.

Corner Break

This is a crack that intersects the PCC slab joints near the corner. A corner break covers a wide surface, and is caused by high corner tension. Problems associated with the corner break are roughness, moisture infiltration, severe corner breaks will fault, spall and disintegrate.

Pop outs

Pop outs are the pieces of PCC that split free from the surface that left the pocket with small marks. Pop outs range from 25 to 100 mm in diameter, and 25 to 50 mm in depth. Pop outs related issue is roughness, which is typically a sign

Fig -2: Corner Break

Sr. No.	Stresses	Defected Area	Total Area (Sq.M)	% Loss = $\frac{DA}{TA}$ X100
1	Shrinkage Cracking	2.5*2.1	3.5*4.5	33.33 %
2	Linear Cracking	2*2.5	3.5*4.5	31.74 %
3	Corner break	2.5*2.7	3.5*4.5	42.857 %
4	Transverse Crack	1*5	7*4.5	15.873 %
	Near the Joint	4.1	3.5*4.5	9.52 %
	Over the width of pavement	1*7	7*4.5	22.22 %

3. Microsurfacing as a proactive maintenance strategy

Proactive maintenance is a maintenance strategy for stabilizing the reliability of equipment. In this maintenance a situation is controlled by making things happen rather than waiting for things to happen and then reacting to them. It is a preventive maintenance strategy that works to correct the root cause of failure and avoid breakdowns. Microsurfacing is used as a maintenance tool for rigid pavement to extend the service life of the pavement and minimize the overall cost of maintenance. Figure 3 shows the relationship that a treatment has when applied at the optimal time to the overall pavement condition. Pavement restoration is the sum of all operations, including corrective and preventive maintenance, as well as minor maintenance, to provide and maintain serviceable roadways. New pavements or pavements that need substantial restoration or reconstruction are not included in the plan. The goal of a pavement preservation program is to maintain pavement network investment, extend pavement life, increase pavement durability, ensure cost-effectiveness, and minimize user delays. In short, the purpose is to fulfil customer needs.

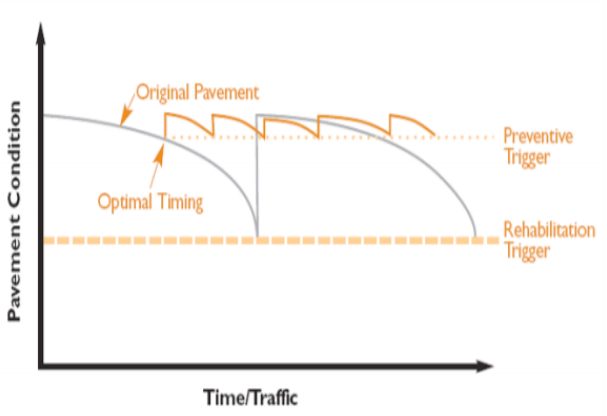

Fig -3: Pavement Preservation Concept

3.1 Materials used for Micro surfacing

1. Emulsion

Bitumen shall be a modified confirming to requirements, as specified in IRC:SP:81. It may also be required to be specifically designed bitumen emulsion for a particular with regard to the quantity and grading of aggregates. The emulsion is collected from SMB enterprises Pune.

2. Aggregate

The aggregate used shall be the type specified for the particular application requirements of the micro surfacing. The gradation of aggregate is as per IRC: SP:81. The aggregate is collected from the local crusher.

3. Filler

Mineral filler shall be ordinary Portland cement. The quantity of filler shall be preferably in the range of 0.5 to 2.

4. Water

Water shall be potable, free from harmful salts and contaminants. The pH value of water shall be in the range of 6 to 7.

5. Bitumen

For the microsurfacing the residual bitumen is added by percentage of weight of aggregate.

6. Additives

Additives may be used to accelerate or retard the break/set of the micro surfacing. Appropriate additives, and their applicable use range, should be as per the mix design.

3.2 Design and Proportioning of Microsurfacing Mix

International Slurry Surface Association (ISSA) gives the guidelines related to Micro surfacing and design method for micro surfacing in ISSA A143.In India, the Indian Road Congress published a tentative specification for slurry seal and micro surfacing in IRC:SP:81:2008.

ISSA Design Method for Micro surfacing (2010 b) ISSA A143

ASTM Design Method for Micro surfacing (ASTM 2007 b): ASTM 6372-99a

These two are the basic design methods from which every agency worldwide bases there designs.

The basic design steps for microsurfacing are as follows:

Selection and characterization of road

Material selection: emulsion, aggregate, filler, additives and water.

Developing a mix design for microsurfacing as per road condition.

Evaluation of micro surfacing trough laboratory tests.

Determination of rate of application

Applying suitable Mix design for construction

Mix Design for Microsurfacing

Sample preparation

Materials	Quantity and Percentage
Aggregate	100%
Cement	2.5% by weight of dry aggregate
Water	8% by weight of dry aggregate
Emulsion	13% by weight of dry aggregate

Weight of Aggregate 500 gm

Weight of Cement =2.5% of Aggregate

= 500*2.5/100 = 12.5 gm

Weight of Water = 8% of Aggregate

= 500*8/100 = 40 gm

Weight of Emulsion = 13% of Aggregate

=500*13/100 = 65 gm

3.3 Construction Practices

Construction practices and procedures vary from country to country and are generally associated with the climatic conditions in which the microsurfacing will be applied. The Most agencies will find the following types of equipment on a typical microsurfacing project:

• Microsurfacing mixing (also called a placement) machine,

• Mobile support units (also called nurse or feeder trucks) to replenish the materials in the mixing machine,

• Broom sweepers—rotary or suction, and

• Rollers, if required—pneumatic or static.

The machine shall be specially designed and manufactured to microsurfacing. It shall be self-propelled equipment, truck mounted, consisting of the following sub-assemblies used to manufacture and simultaneously spread these mixes on the surface.

1. Aggregate bin
2. Filler bin
3. Water and emulsion tanks
4. Additive tanks
5. Aggregates and filler conveyors to supply the mixer box
6. Pump or compresses air system to supply the emulsion or water
7. Mixer box
8. Spreader box to place the mixed slurry on the job

4. CONCLUSIONS

From pavement preservation concept it is clear that for the preservation of pavements it is necessary that at optimal timing the required preventive maintenance is to be done to restore the serviceability and durability of pavement. The microsurfacing gives the smooth surface and good riding quality after applying it on the pavement with the life of minimum 4 years.

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