International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Pavement Proactive Maintenance Utilizing Micro - Surfacing

Revatee G. Boralkar[1], S. P. Nirkhe[2]

[1]PG Student Department of Civil Engineering, Deogiri Institute of Engineering & Management Studies, Aurangabad, Maharashtra, India
[2]Assistant Professor, Department of Civil Engineering, Deogiri Institute of Engineering & Management Studies, Aurangabad, Maharashtra, India

Abstract: ***Because India is located in a tropical location with varying climatic conditions from day to day, concrete is a material that generates high strains and deformities as a result of temperature variations. The many sources of distresses on inflexible pavements are investigated in this study. Micro Surfacing is an environmentally friendly surface treatment that is put over a structurally sound existing road. It is a resurfacing option as a wearing course. The material and laboratory mix design are being developed for micro surfacing on stiff pavement to increase pavement service life. According to IRC: SP: 81: 2008, the typical life of micro surfacing is four years.***

Keywords: Micro surfacing, Distresses on pavement Proactive maintenance

1. Introduction

India has the world's second largest road network, with 4.24 million kilometers [1]. The National Highways span 70, 934 kilometers and serve as the country's arterial road network. Roads are anticipated to carry more than 70% of freight traffic and 85% of passenger traffic in the country [1]. Micro Surfacing is an environmentally friendly surface treatment used to restore and preserve the road's surface properties. It is available in two thicknesses:

(i) 4 mm to 6 mm thick (Type II) and (ii) 6 mm to 8 mm thick (Type III). Polymer modified asphalt emulsion, graded aggregate, cement, water, and additives are used to make it. This mixture is used in a semi - liquid state. Micro surfacing is to be applied over an existing structurally sound pavement surface that is displaying signs of premature ageing, aggregate loss, and a high degree of polishing, oxidation surface, and so on. Micro surfacing is a resurfacing solution used as a wearing course. It is less expensive than hot mix treatment. It provides a smooth surface without disrupting the existing profile. Though micro surfacing has been used as a routine type of maintenance in place of hot mix overlays for a long time, it was only introduced in India in 1999 - 2000 [11] under the brand name Macroseal by Yala construction and Elsamex SA, Spain.

2. Literature Review

Rigid pavement discomfort is a severe issue all throughout the world, causing a variety of serious consequences. Engineers face a hurdle in preventing inflexible pavement distresses. To avoid distresses in stiff pavement, proper maintenance and rehabilitation must be performed. The following table lists the most prevalent pavement distresses.

Table 1: Common Distresses Occurred on Pavement

Sr. No.	Distresses occurred onsite	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 nota 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.

1) Analysis of Distresses Observed on Site (Dhulia - Solapur National Highway)

Visual investigation of the roads revealed a variety of surface distresses. The route will reopen to traffic in mid - November 2019. The road cracks are described, and the road's condition is assessed. The various distresses evaluated on concrete pavements are discussed further below.

Spalling: This is characterized by cracking, breaking, or chipping of joint/crack edges, and it often occurs within 0.6 m of the joint/crack edge. The problems caused by spalling on the road include loose material on the pavement, roughness, and so on. This is generally an indicator of advanced joint/crack deterioration.

Polished Aggregate: These are pavement regions where the aggregate section that extends above the cement paste is either very little or the aggregate particles are neither rough or angular. It results in decreased skid resistance.

Figure 1: Spalling on Pavement

Shrinkage Cracking: This is characterized by hairline fractures that emerge during PCC setting and curing but are not seen at joints. We rarely stretch throughout the entire width of the slab. Shrinkage cracks are considered painful if unchecked.

Linear Cracking: These are linear cracks that run the length of the slab and are not related with corner breaks or blowups. These fissures typically separate a single slab into two to four sections. This causes roughness, permits moisture infiltration, and causes degradation of the base/subbase support. If not sealed, these fissures will eventually spall and collapse.

Corner Break: This is a crack in the corner that intersects the PCC slab joints. A corner break is generated by strong corner strain and covers a large surface area. Roughness, moisture infiltration, and severe corner breaks will fault, spall, and disintegrate are all issues related with corner breaks.

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.

Figure 2: Corner Break

2) Micro surfacing as a proactive maintenance strategy:

Proactive maintenance is a maintenance technique for improving equipment reliability. A situation is handled in this maintenance by making things happen rather than waiting for things to happen and then reacting to them. It is a preventative maintenance method that aims to address the underlying cause of failure and avoid breakdowns. Micro surfacing is utilized as a stiff pavement maintenance method to increase the service life of the pavement and reduce overall maintenance costs. Figure 3 depicts the relationship between a treatment and the total pavement condition when administered at the ideal time. Pavement restoration is the sum of all operations to provide and maintain serviceable roadways, including corrective and preventative maintenance as well as minor repair.

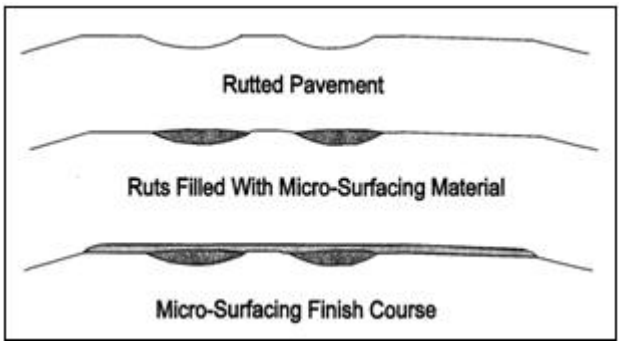

Figure 3: Typical Applications of Micro – Surfacing

3) Materials used for Micro surfacing:

Binder:

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 withregard to the quantity and grading of aggregates. The emulsion is collected from SMB enterprises Pune.

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 aggregateis collected from the local crusher.

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

Water:
Water shall be potable, free from harmful salts and contaminants. The pH value of water shall be in the range of 6 to7.

Bitumen:
For the micro surfacing the residual bitumen is added bypercentage of weight of aggregate.

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.

Mix Design for Micro surfacing:

Table 2: Mix Design Criteria for Micro Surfacing Mix (Table 500 - 33 of MoRTH Spec.)

Requirements	Specifications	Method of Test as given in IRC: SP: 81
Mix time, minimum	120s	Appendix - 1
Consistency, maximum	3 cm	Appendix - 3
Wet Cohesion, within 30 min, minimum.	12 kg cm	Appendix - 4
Wet Cohesion, within 60 min, minimum	20 kg cm	Appendix - 4
Wet stripping, pass %, minimum	90	Appendix - 5
Wet track abrasion loss (one hour soak), maximum	538 g/m2	Appendix - 6

Table 3: Micro - surfacing Sample Preparation

Particulars	Type II 4 - 6mm	Type III 6 - 8mm
Premium quality aggregate	8.4 to 10.8 kg per sqm	11.1 to 16.3 kg per sqm.
Binder (polymer modified emulsion)	13 – 15% by weight of Aggregate.	10 – 15% by weight of Aggregate.
Additive	Up to 2% by wt. of Aggregate.	Up to 2% by wt. of Aggregate.
Cement/Filler	0.5 – 2.0% by weight of Aggregate.	0.5 – 2.0% by weight of Aggregate.
Water	13 – 15% by weight of aggregate.	10 - 15 % by weight of aggregate

For Type II Micro surfacing: -
Weight of Aggregate 1000 gm
(6 mm Aggregates 30% + Crushed sand 70% =100%)

Weight of Emulsion	13% of Aggregate = 1000*13/100 = 130 gm
Weight of Cement	1% of Aggregate = 1000*1/100 = 10 gm
Weight of Water	15% of Aggregate 1000*15/100 = 150 gm
Weight of Additive	Depends on Ambient temperature at site.

For Type III Micro - surfacing:
Weight of Aggregate 1000 gm (6 mm Aggregates 30% + Crushed sand 70% =100%)

Weight of Emulsion	15% of Aggregate 1000*15/100=150
Weight of Cement	2% of Aggregate
Weight of Water	1000*2/100 = 20 gm= 15% of Aggregate 1000*15/100= 150 gm
Weight of Additive	Depends on Ambient temperature at site.

Construction Practices:

Construction practices and techniques differ by nation and are often related to the climatic conditions in which the micro surfacing will be performed. A typical micro surfacing job will include the following types of equipment:

- Micro surfacing 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 micro surfacing. 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

3. Conclusions

According to the pavement preservation concept, it is vital to do the necessary preventative maintenance at the ideal timing to restore the serviceability and durability of the pavement. After being applied to the pavement, micro surfacing provides a smooth surface and good riding quality for a minimum of four years.

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