International Journal of Civil Engineering (IJCE)
ISSN 2278-9987
Vol.1, Issue 2 Nov 2012 1-6

International Academy of Science, Engineering and Technology
Connecting Researchers; Nurturing Innovations

APPLICATION OF COPPER SLAGAS OPTIONAL FILLER IN MICROSURFACING

[1]RAJESH S. GUJAR & [2]KRUPESH A. CHOHAN

[1]Research Scholar, SVNIT, Surat, Gujarat, India

[2]Associate Professor, Civil Engineering Department, SVNIT, Surat, India

ABSTRACT

Copper slag is generated during pyro metallurgical production of copper from copper ores contains materials like calcium oxide, iron, alumina, silica etc. for Pertonne of metal production about 2.2 ton of slag is generated. In this research experimental investigation is carried out to analyze suitability of copper slag as alternative filler for an option of cement in microsurfacing. Microsurfacing is a one of the preventive maintenance technique extensively used, in India. The present paper describes results of experimental investigation of microsurfacing mix obtained by using alternative filler as copper slag as a substitute of OPC. In this experimental investigation breaking time of the emulsion, the cohesion and the abrasion resistance of microsurfacing material with copper slag as filler is examined. The outcomes show that copper slag can be suitable alternative filler for microsurfacing technology as compare to OPC. The use copper slag as alternative filler, make microsurfacing technology cost-effective and environmental friendly.

KEYWORDS: Copper Slag, Slurry Seal, Micro Surfacing

INTRODUCTION

Dumping or disposal of such large quantities of slag affects environmental profile. In last past two decades attempts have been made by several researchers and copper producing units all over the world to explore the potential utilisation of copper slag. The copper slag is commonly utilised to make the products like cement, abrasive, fill, ballast, aggregate, roofing granules, glass, tiles etc.

Micro surfacing is a mixture of a polymer modified asphalt emulsion, medium to fine graded high quality aggregate, filler, additives, and water [TAC 97]. It is placed using special equipment in layers ranging in thickness from 8 to 10 mm. Microsurfacing can extend service life of the pavement up to 7 to 9 years at a high cost. However despite the price tag, microsurfacing is viewed as a cost effective maintenance treatment as long as the pavement deterioration (roughness and surface distress) are well above minimum thresholds.

An additional benefit is that it can help with other pavement surface issues such as rutting or other deficiencies in addition to providing a new riding surface and increased friction. The components are proportioned and blended at the rear end of a microsurfacing paver and distributed on the paver with a heavy duty "spreader box" equipped with augers and adjustable strike-off. The use of micro surfacing is rapidly growing for maintenance of highways, high traffic streets and airports. Microsurfacing is normally specified and designed according toIRC:SP:81-2008 or ISSA recommendations. In present scenario cement is used as mineral filler in mix design of microsurfacing.

It enhance the breaking time of the modified asphalt emulsion and also work as filler.In this paper out comes obtained by substituting OPC by copper slagis used to improve microsurfacing Technology.

MATERIALS

Aggregate

The coarse and fine aggregate (Type-II) used in mix design of microsurfacing. The Source of aggregates was Rajeshree Stone Crusher,Sevaliya,Gujarat. The requiredphysicalproperties of the aggregate are in table 1.

Table 1: Physical Properties of the Aggregate

Sample Type	Test Name		
	Water Absorption	Sand Equivalent Value	Soundness (with Sodium Sulphate Solution)
Stone Aggregate	1.4	67.5	*Not Required
Test Method	IS 2386 Part 3	IS 2720 Part 37	IS 2386 Part 5
Limit as per IRC: SP: 81:2008	Max. 2	Min. 50	Max. 12

The gradation of the aggregate mixture was within the specified limits as determined by IRC:SP:81-2008 for Type II mixture. The actual gradation of the aggregate mixture is as shown in Table 2.

Bitumen Emulsion

The bitumen emulsion used was a cationic bitumen emulsion modified with latex. The Source of Polymer Modified Emulsion is Tiki Tar Industries (Baroda) Limited Its characteristics, which meet the requirements IRC:SP:81-2008 specification, are shown in Table 3.

Mineral Fillers

The mineral fillers used were ordinary Portland cement (OPC) and copper slag. The composition of The ordinary Portland cement is shown in table 4.

copper slag were collected from Birla Copper Industries, Dahej. Chemical composition of copper slag is given in table 4.

Table 2: Gradation of Aggregates (Type II)

IS Sieve Size (mm)	Type II (4-6 mm)	IRC:SP:81-2008 Limits	
	Percentage (%) passing		
	Obtained Gradation	Higher Limits	Lower Limits
6.3	100	100	100
4.75	95.5	100	90
2.36	82.7	90	65
1.18	59.3	70	45
0.6	42.3	50	30
0.3	25.6	30	18

Table 2: Gradation of Aggregates (Type II) – Contd.

IS Sieve Size (mm)	Type II (4-6 mm)	IRC:SP:81-2008 Limits	
	Percentage (%) passing		
	Obtained Gradation	Higher Limits	Lower Limits
0.15	17.1	21	10
0.075	9.2	15	5

Table 3: Characteristic Properties of Polymer Modified Bitumen Emulsion

Test Name	Test Value	Test Method	Limit as perIRC:SP:81:2008
Residue on 600micron IS Sieve (% by mass)	0.039	IS:8887	Maximum 0.05
Viscosity by Say Bolt Furol Viscometer, at 25^{o}C , in second	22	IS:8887	20 – 100 Second
Coagulation of emulsion at low temperature	Nil	IS:8887	NIL
Storage Ability after 24h , %	1.5	IS:8887	Maximum 2
Particle charge, +ve/-ve	Positive [+ve]	IS:8887	Positive [+ve]
Test on Residue			
Residue by evaporation, %	63.5	IS:8887	Minimum 60%
Penetration at 25^{o}C/100g/5s	47	IS:1203	40 – 100
Ductility at 27oC, cm	55	IS:1208	Minimum 50cm
Softening Point, in ^{o}C	58.5	IS:1205	Minimum 57 ^{o}C
Elastic Recovery	51.5	IS:15462	Minimum 50%
Solubility in trichloroethylene, %	98.5	IS:1216	Minimum 97%

Table 4a: Composition of Mineral Fillers

PARAMETER	UNIT	READING
SiO2	%	69.8
Al2O3	%	1.1
Fe2O3	%	0.8
Reactive Slice	%	41.5

Table 4a: Composition of Mineral Fillers – Contd.

PARAMETER	UNIT	READING
MgO	%	0.008
Cl2	%	0.002
Loss of Ing.	%	3.5
C4SO4	%	0.15
C4O	%	0.4

Table 4b: Chemical Composition of Ordinary Portland Cement

PARAMETER	UNIT	Test Method Standard	Results Obtained
SiO2	%	IS : 4032	18.2
Al2O3	%	IS : 4032	4.1
Fe2O3	%	IS : 4032	4.6
Reactive Slice	%	IS : 4032	
MgO	%	IS : 4032	2.9
SO3	%	IS : 4032	1.9
Cl2	%	IS : 4032	0.04
Loss of Ing.	%	IS : 4032	2.9
CaO	%	IS : 4032	54.2
2C3A+C4AF	%	IS : 4032	22.6
C3A	%	IS : 4032	4.2
C4AF	%	IS : 4032	14.2
INSOLUBLE RESIDUE	%	IS : 4032	2.1
Al2O3/ Fe2O3	%	IS : 4032	0.89

Mix Design

The mix design was performed according to IRC: SP: 81-2008 specifications. Based on the sieve analysis result and others recommended criteria mentioned in IRC: SP: 81-2008 the material should be mixed in the proportions shown in table 5.

Table 5: Mix Design of Microsurfacing

Material	Mix Proportions (%)
Aggregates	100
Cement	1.5
Water	10-14 as required
Polymer Modified Emulsion	13
Additive	(as required based on climate)

Testing

The different mixtures were tested for the determination of Mix Time, Consistency, Cohesion, Wet Stripping, Wet Track Abrasion loss, according to **IRC: SP: 81-2008** specifications. The mixing is done at temperature of 35^0C.

RESULTS AND DISCUSSIONS

The results obtained from the use of optional fillers in microsurfacing are showed in Table 6. As it can be seen that copper slag gave satisfactory results under IRC: SP: 81-2008. The results obtained from experimental investigation shows that copper slag gives relatively similar results as of OPC.Results shows that copper slag provide better cohesion than OPC. After this experimental analysis we can say use of copper slag as alternative mineral filler leads to not only reduce the Overall cost of microsurfacing technology but also reducing the amount of dump of copper slag from earth.

Table 6: Results Obtained from Experimental Investigation

Requirement/Test names	Cement	Copper Slag	Limits as per IRC:SP:81-2008	Test Methods [IRC:SP:81-2008]
Mix Time (seconds)	135	134	120s Minimum	Appendix – 1
Consistency (cm)	2.4	2.3	3cm, Max	Appendix – 3
Wet Cohesion, within 30min; (kg.cm)	14	16	12 kg.cm Min	Appendix - 4
Wet Cohesion, within 60min; (kg.cm)	22	24	20 kg.cm Min	Appendix - 4
Wet Stripping, Pass%	99.5	99.2	90 Min	Appendix – 5
Wet Track Abrasion loss,(one hour soak); g/m^2	267.5	360.2	538 g/m^2 Max	Appendix – 6

CONCLUSIONS

The use of Microsurfacing in India becomes famous in last few years in the field ofroad maintenance and surface improvement.Till now, OPC is used for making microsurfacing mix as filler due to its good mixing purposes and adhesion. In this paper copper slag is used as optional fillers in order to replace cement in the production of microsurfacing. The mixing time is somehow similar to as of OPC and wet cohesion of copper slag is more than OPC which shows that it can be suitable filler for microsurfacing mix. The use of copper slag makes microsurfacing technology cost-effectiveand ecofriendly.

REFERENCES

1. N. OIKONOMOU. (2007). ALTERNATIVE FILLERS FOR USE IN SLURRY SEAL. Global NEST Journal. 9 (2), 182-186.
2. IRC: SP: 81-2008 Tentative Specification for SlurrySeal and Microsurfacing
3. A. Nikolaides. (2000). The use of flyash as a substitute of cement in microsurfacing. WasteMaterials in Construction, p234-240.
4. ASTM D3910-90, Design, Testing and Construction of Slurry Seal, Annual Book of ASTM Standards, Section 4, Construction, Vol. 04.03, Road and Paving Material (1996)
5. International Slurry Surfacing Association, Recommended Performance Guidelines for Micro surfacing, ISSA, A143,, Washington D.C. (1991)

6. AASHTO M 316-96, Polymer Modified Cationic Emulsified Asphalt, Standard
7. Specifications for Transportation Materials and Methods of Sampling and Testing, Part I, Specifications (1998)
8. The Uses of Hydrated Lime | eHow.comhttp://www.ehow.com/info_8214675_uses-hydrated-lime.html#ixzz24UObCevn
9. BipraGorai. (2003). Characteristics and utilisation of copperslag—a review. Resources, Conservation and Recycling. 39 (4), P299-313.