"ഭരണഭാഷ - മാതൃഭാഷ"

ചീഫ് എൻജിനീയറുടെ കാര്യാലയം
തദ്ദേശസ്വയംഭരണ വകുപ്പ്
റവന്യൂ കോംപ്ലക്സ്, മൂന്നാം നില
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തീയതി : 18.05.2016

സർക്കുലർ

20/04/2016 ൽ നടന്ന സംസ്ഥാനതല വികേന്ദ്രീകൃതാസൂത്രണ കോ-ഓർഡിനേഷൻ സമിതിയുടെ 2.3 നമ്പർ തീരുമാന പ്രകാരം തദ്ദേശ സ്വയംഭരണ സ്ഥാപനങ്ങളിൽ പ്ലാൻ ഫണ്ട്/മെയിന്റനൻസ് ഗ്രാന്റ് ഉപയോഗപ്പെടുത്തി നടപ്പിലാക്കുന്ന റോഡു പ്രവൃത്തികൾക്കുള്ള ആകെ വാർഷിക പദ്ധതി അടങ്കൽ തുകയുടെ 10% തുക പ്രത്യേകമായി മാറ്റിവച്ച് ഷ്രഡഡ് പ്ലാസ്റ്റിക് ഉപയോഗപ്പെടുത്തി റോഡുകൾ ടാറു ചെയ്യുന്നതിനുള്ള പദ്ധതികൾ ആവിഷ്കരിക്കണമെന്ന് ശുപാർശ ചെയ്തിട്ടുണ്ട്. IRC-SP-98-2013 പ്രകാരം waste plastic റോഡ് പ്രവൃത്തികൾക്ക് ഉപയോഗിക്കുന്നതിന്റെ നടപടിക്രമങ്ങൾ IRC പ്രസിദ്ധപ്പെടുത്തിയിട്ടുണ്ട്.

IRC specification അവലംബിച്ച്, VG-10, VG-30 എന്നീ ബിറ്റുമിൻ ഉപയോഗിച്ചുള്ള chipping carpet – ന്റെ Data, MoRD/CPWD specifications ഉപയോഗിച്ച് തയ്യാർ ചെയ്ത നിരക്കുകൾ ഇതോടൊപ്പം പ്രസിദ്ധപ്പെടുത്തുന്നു.

മേൽ റേറ്റുകൾ എസ്റ്റിമേറ്റിൽ ഉപയോഗിക്കുന്നതിനായി "PRICE" Software –ന്റെ LSGD approved observed Data –ൽ ഉൾക്കൊള്ളിക്കുന്നതാണ്.

ചീഫ് എൻജിനീയർ

ഉള്ളടക്കം:- 1) IRC-SP-98-2013
2) Approved Observed Data.

S738

Approved Data for Roads using Shredded Plastic

MoRD Data

5.9 508 20mm thick Open-Graded Premix Carpet using Bituminous (penetration grade/modified bitumen) Binder

Providing, laying and rolling of open-graded premix carpet of 20 mm thickness composed of 13.2 mm to 5.6 mm aggregates either using penetration grade bitumen or emulsion to required line, grade and level to serve as wearing course on a previously prepared base, including mixing in a suitable plant, laying and rolling with a three wheel 80-100 kN static roller capacity, finished to required level and grades to be followed by seal coat of either Type A or Type B or Type C as per Technical Specification Clause 508 (with 7% of bitumen replaced by shredded waste plastic)

Case - I By Manual Means

(I) Bitumen (S-90) (VG - 10)

Unit = sqm

Taking output = 500 sqm (10 cum)

a)	**Labour**					
	Mate	day	1.08	363.00	392.04
	Mazdoor (Unskilled)	day	21.00	329.00	6,909.00
	Mazdoor (Semi-Skilled)	day	6.00	329.00	1,974.00
b)	**Machinery**				
	Mixall 6/10 t capacity	hour	4.00	500.00	2,000.00
	Bitumen boiler oil fired 1000 litre capacity fitted with spray	hour	4.00	103.75	415.00
	Three wheel 80-100 kN static roller	hour	2.00	450.00	900.00
c)	**Material**				
	Bitumen (S-90) @ 14.60 kg per 10 sqm incl carriage	t	0.6789	50,706.49	34,424.64
MR	Shredded plastic incl carriage @ 7% of bitumen in the Original Data (0.1022 kg/m2)	t	0.0511	22,000.00	1,124.20
	Crushed stone chipping, 13.2 mm to 5.6 mm @ 0.27 cum	cum	13.50	1,356.49	18,312.62
	Cost of 500 sqm = a+b+c				**66,451.49**
	Rate per sqm = (a+b+c)/500				66,451.49
					132.90

(II) Bitumen (S-65) (VG - 30)

Unit = sqm

Taking output = 500 sqm (10 cum)

a)	**Labour**				
	Mate	day	1.08	363.00	392.04
	Mazdoor (Unskilled)	day	21.00	329.00	6,909.00
	Mazdoor (Semi-Skilled)	day	6.00	329.00	1,974.00
b)	**Machinery**				
	Mixall 6/10 t capacity	hour	4.00	500.00	2,000.00
	Bitumen boiler oil fired1000 litre capacity fitted with spray	hour	4.00	103.75	415.00
	Three wheel 80-100 kN static roller	hour	2.00	450.00	900.00
c)	**Material**				
	Bitumen (S-65) @ 14.60 kg per 10 sqm incl carriage	t	0.6789	41,106.49	27,907.20
MR	Shredded plastic incl carriage @ 7% of bitumen in the Original Data (0.1022 kg/m2)	t	0.0511	22,000.00	1,124.20
	Crushed stone chipping, 13.2 mm to 5.6 mm @ 0.27 cum	cum	13.50	1,356.49	18,312.62
	Cost of 500 sqm = a+b+c				**59,934.05**
	Rate per sqm = (a+b+c)/500				59,934.05
					119.87

Case - II By Mechanical Means

(I) Bitumen (S-90) (VG - 10)

Unit = sqm

Taking output = 4000 sqm (80 cum)

a)	**Labour**				
	Mate	day	0.52	363.00	188.76
	Mazdoor (Unskilled)	day	10.00	329.00	3,290.00
	Mazdoor (Skilled)	day	3.00	363.00	1,089.00
b)	**Machinery**				
	HMP 30/40 t per hour	hour	6.00	7,400.00	44,400.00
	Electric generator set 125 KVA	hour	6.00	500.00	3,000.00
	Front end loader 1 cum bucket capacity	hour	6.00	900.00	5,400.00
	Tipper 5.5 10 t capacity	hour	3.64	212.50	773.50
	Paver finisher	hour	6.00	2,700.00	16,200.00
	Three wheel 80-100 kN static roller	hour	16.00	450.00	7,200.00
c)	**Material**				
	Bitumen (S-90) @ 14.60 kg per 10 sqm incl carriage	t	5.4312	50,706.49	2,75,397.09
MR	Shredded plastic incl carriage @ 7% of bitumen in the Original Data (0.1022 kg/m2)	t	0.4088	22,000.00	8,993.60
	Crushed stone chipping, 13.2 mm to 5.6 mm @ 0.27 cum	cum	108.00	1,356.49	1,46,500.92
	Cost of 4000 sqm = a+b+c				**5,12,432.87**
	Rate per sqm = (a+b+c)/4000				5,12,432.87
					128.11

(II) Bitumen (S-65) (VG - 30)

Unit = sqm

Taking output = 4000 sqm (80 cum)

a)	**Labour**				
	Mate	day	0.52	363.00	188.76
	Mazdoor (Unskilled)	day	10.00	329.00	3,290.00
	Mazdoor (Skilled)	day	3.00	363.00	1,089.00
b)	**Machinery**				
	HMP 30/40 t per hour	hour	6.00	7,400.00	44,400.00
	Electric generator set 125 KVA	hour	6.00	500.00	3,000.00
	Front end loader 1 cum bucket capacity	hour	6.00	900.00	5,400.00
	Tipper 5.5 10 t capacity	hour	3.64	212.50	773.50
	Paver finisher	hour	6.00	2,700.00	16,200.00
	Three wheel 80-100 kN static roller	hour	16.00	450.00	7,200.00
c)	**Material**				
	Bitumen (S-65) @ 14.60 kg per 10 sqm incl carriage	t	5.4312	41,106.49	2,23,257.57
MR	Shredded plastic incl carriage @ 7% of bitumen in the Original Data (0.1022 kg/m2)	t	0.4088	22,000.00	8,993.60
	Crushed stone chipping, 13.2 mm to 5.6 mm @ 0.27 cum	cum	108.00	1,356.49	1,46,500.92
	Cost of 4000 sqm = a+b+c				**4,60,293.35**
	Rate per sqm = (a+b+c)/4000				4,60,293.35
					115.07

DAR Data

16.32.1 2 cm premix carpet surfacing with 1.8 cum and 0.90 cum of stone chippings of 13.2 mm size and 11.2 mm size respectively, per 100 sqm and 52 kg and 56 kg of hot bitumen per cum of stone chippings of 13.2 mm and 11.2 mm size respectively including a tack coat with hot straight run bitumen, including consolidation with road roller of 6 to 9 tonne capacity etc. complete (tack coat to be paid for separately) (with 7% of bitumen replaced by shredded waste plastic)

With paving Asphalt grade VG - 10 heated and then mixed with solvent at the rate of 70 grams per kg of asphalt

Details of cost for 100 sqm

Asphalt 80/100

(i) Hot bitumen @ 52kg. per cum. of stone chippings 1.8 cum. of 13.2 mm nominal size chippings.

(ii) Hot bitumen @ 56 kg. per cum. of stone chippings 0.90 cum. of 11.2 mm nominal size chippings.

Bitumen : 52xl.8+56x0.9 = 144 kg. or 0.144 tonne

2916	Paving Asphalt VG-10 of approved quality	tonne	0.134	50600.00	6776.35
2211	Carriage of Tar bitumen	tonne	0.134	106.49	14.27
MR	Shredded Plastic Incl Carriage @ 7% of bitumen in the Original Data (0.1 kg/m2)	tonne	0.010	22000.00	221.76
	Solvent 70gms/kg. for 0.144 t = 10.8 kg				
2914	Solvent	kg	10.08	25.00	252.00
2342	Carriage of Solvent/ Diesel	quintal	0.10	10.65	1.07
2910	Stone chippings/screenings 12.5/13.2 mm nominal size @ 1.80 cum. per 100 sqm	cum	1.80	1250.00	2250.00
2911	Stone Chippings/ screenings 10/ 11.2 mm nominal size @ 0.90 cum. per 100 sqm	cum	0.90	1250.00	1125.00
2202	Carriage of Stone aggregate below 40 mm nominal size	cum	2.70	106.49	287.52
	Steam coal for heating bitumen @ 2 quintals per tonne of bitumen = 2x0.144 = 0.288 q				
370	Coal (steam)	quintal	0.29	400.00	115.20
2200	Carriage of Steam coal	tonne	0.03	121.70	3.50
	LABOUR: for cleaning the road surface, heating and spraying bitumen and aggregate				
	(a) for cleaning:				
128	Mate	Day	0.08	363.00	29.04
114	Beldar	Day	1.40	329.00	460.60
115	Coolie	Day	1.40	329.00	460.60
	(b) for heating bitumen				
114	Beldar	Day	0.57	329.00	187.53
	(c) for screening and spreading aggregate:				
130	Mistry	Day	0.19	435.00	82.65
114	Beldar	Day	5.00	329.00	1645.00
	(d) consolidation charges:				
113	Chowkidar (at barrier for night watch and for road roller)	Day	0.27	329.00	88.83
101	Bhisti	Day	0.11	363.00	39.93
3	Hire charges of Diesel Road Roller- 8 to 10 tonne	Day	0.11	1500.00	165.00
1235	Diesel oil for road roller @ 18 litres per day	Litre	2.00	55.49	110.98
9999	Sundries-Carriage of diesel	L.S	2.73	1.78	4.86
1	Hire charges of Coaltar Boiler 900 to 1400 litres	Day	0.13	830.00	107.90
23	Hot Bitumen Mixer 0.5cum i/c hand cart	Day	0.04	4000.00	160.00
	(e) Misc: Brushes etc. for cleaning				
364	Wire brush (with thick wire)	each	0.11	20.00	2.20
365	Soft brush	each	0.32	18.00	5.76
9999	Sundries-Brooms and qunny bags	L.S	6.76	1.78	12.03
9999	Sundries-	L.S	9.49	1.78	16.89
	TOTAL				14626.48
	Add Water Charges @ 1%				146.26479
	TOTAL				14772.74

			Add CPOH @ 15%		2215.91157
			Cost of 100.00000 sqm		988.66
			Cost of 1 sqm		169.886554
			Say		169.65

16.32.1 2 cm premix carpet surfacing with 1.8 cum and 0.90 cum of stone chippings of 13.2 mm size and 11.2 mm size respectively, per 100 sqm and 52 kg and 56 kg of hot bitumen per cum of stone chippings of 13.2 mm and 11.2 mm size respectively including a tack coat with hot straight run bitumen, including consolidation with road roller of 6 to 9 tonne capacity etc. complete (tack coat to be paid for separately) (with 7% of bitumen replaced by shredded waste plastic)

With paving Asphalt grade VG - 30 with no solvent

Details of cost for 100 sqm

Asphalt 60/70

(i) Hot bitumen @52kg.per cum. of stone chippings 1.8cum. of 13.2mm nominal size chippings.

(ii) Hot bitumen @56kg. per cum. of stone chippings 0.90cum. of 11.2mm nominal size chippings.

Bitumen :52xl.8+56x0.9=144kg. or 0.144 tonne

7309	Paving Asphalt VG-30 of approved quality	tonne	0.134	41000.00	5490.72
2211	Carriage of Tar bitumen	tonne	0.134	106.49	14.27
MR	Shredded Plastic Incl Carriage @ 7% of bitumen in the Original Data (0.1 kg/m2)	tonne	0.010	22000.00	221.76
2910	Stone chippings/screenings 12.5/13.2 mm nominal size @ 1.80 cum. per 100 sqm	cum	1.80	1250.00	2250.00
2911	Stone Chippings/ screenings 10/ 11.2 mm nominal size @ 0.90 cum. per 100 sqm	cum	0.90	1250.00	1125.00
2202	Carriage of Stone aggregate below 40 mm nominal size	cum	2.70	106.49	287.52
	Steam coal for heating bitumen @ 2 quintals per tonne of bitumen = 2x0.144 = 0.288 q				
370	Coal (steam)	quintal	0.29	400.00	115.20
2200	Carriage of Steam coal	tonne	0.03	121.70	3.50
	LABOUR: for cleaning the road surface, heating and spraying bitumen and aggregate				
	(a) for cleaning:				
128	Mate	Day	0.08	363.00	29.04
114	Beldar	Day	1.40	329.00	460.60
115	Coolie	Day	1.40	329.00	460.60
	(b) for heating bitumen				
114	Beldar	Day	0.57	329.00	187.53
	(c) for screening and spreading aggregate:				
130	Mistry	Day	0.19	435.00	82.65
114	Beldar	Day	5.00	329.00	1645.00
	(d) consolidation charges:				
113	Chowkidar (at barrier for night watch and for road roller)	Day	0.27	329.00	88.83
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3	Hire charges of Diesel Road Roller- 8 to 10 tonne	Day	0.11	1500.00	165.00
1235	Diesel oil for road roller @ 18 litres per day	Litre	2.00	55.49	110.98
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1	Hire charges of Coaltar Boiler 900 to 1400 litres	Day	0.13	830.00	107.90
23	Hot Bitumen Mixer 0.5cum i/c hand cart	Day	0.04	4000.00	160.00
	(e) Misc:				
	Brushes etc. for cleaning				

364	Wire brush (with thick wire)	each	0.11	20.00	2.20
365	Soft brush	each	0.32	18.00	5.76
9999	Sundries-Brooms and qunny bags	L.S	6.76	1.78	12.03
9999	Sundries-	L.S	9.49	1.78	16.89
	TOTAL				13087.78
	Add Water Charges @ 1%				130.87782
	TOTAL				13218.66
	Add CPOH @ 15%				1982.79898
	Cost of 100.00000 sqm				15201.46
	Cost of 1 sqm				152.014588
	Say				151.78

CHIEF ENGINEER 18/4/16

DB3 13/05/16

IRC:SP:98-2013

GUIDELINES FOR THE USE OF WASTE PLASTIC IN HOT BITUMINOUS MIXES (DRY PROCESS) IN WEARING COURSES

INDIAN ROADS CONGRESS
2013

GUIDELINES FOR THE USE OF WASTE PLASTIC IN HOT BITUMINOUS MIXES (DRY PROCESS) IN WEARING COURSES

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Contents

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GUIDELINES FOR THE USE OF WASTE PLASTIC IN HOT BITUMINOUS MIXES (DRY PROCESS) IN WEARING COURSES

1 INTRODUCTION

1.1 The H-2 Committee in its meeting held on 15th June, 2012 decided to formulate guidelines for waste plastic Bitumen and entrusted this task to Dr. Sunil Bose. Accordingly, Dr. Sunil Bose prepared the initial draft and submitted to H-2 Committee in March, 2013. Thereafter, H-2 Committee deliberated on this draft in a series of meetings. The H-2 Committee finally, approved the draft document in its meeting held on 17th June 2013. The Highways Specifications & Standards Committee (HSS) approved the draft document in its meeting held on 19th July, 2013. The Council in its 200th meeting held at New Delhi on 11th and 12th August, 2013 approved the draft "Guidelines for the Use of Waste Plastic in Hot Bituminous Mixes (Dry Process) in Wearing Courses" after taking on board the comments offered by the members.

The Composition of H-2 Committee is as given below:

A.V. Sinha	--------	Convenor
Dr. Sunil Bose	--------	Co-convenor
S.K. Nirmal	--------	Member Secretary

Members

Arun Kumar Sharma	K. Sitaramanjaneyulu
B.R. Tyagi	N.S. Jain
B.S. Singla	P.L. Bongirwar
Chaman Lal	Prabhat Krishna
Chandan Basu	R.K. Jain
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1.2 Safe disposal of waste plastic is a serious environmental problem. Being a non-biodegradable material it does not decay over time and even if dumped in landfills, finds its way back in the environment through air and water erosion, can choke the drains and drainage channels, can be eaten by unsuspecting grazing animals causing them illness and death, can contaminate the construction fill, etc. The best way of disposal of waste plastic is its recycling to the maximum extent and many developed countries have recycled waste plastics to manufacture various products, including some used in heavy construction, e.g. railway sleepers.

1.3 Studies have revealed that waste plastics have great potential for use in bituminous construction as its addition in small doses, about 5-10%, by weight of bitumen helps in substantially improving the Marshall stability, strength, fatigue life and other desirable properties of bituminous mix, leading to improved longevity and pavement performance. The use of waste plastic thus contributes to construction of green roads.

1.4 Depending on their physical properties, they may be classified as thermoplastic and thermosetting materials. Thermoplastic materials can be formed into desired shapes under heat and pressure and become solids on cooling. On subjected to the same conditions of heat and pressure, they can be remolded. Thermosetting materials which once shaped cannot be softened/remolded by the application of heat. The examples of some typical Thermoplastic and Thermosetting materials are tabulated in **Table 1**. Thermosetting materials are not used in pavement construction.

Table 1 Typical Thermoplastic and Thermosetting Resins

Thermoplastic	Thermosetting
Polyethylene Teryphthalate (PET)	Bakelite
Polypropylene (PP)	Epoxy
Poly Vinyl Acetate (PVA)	Melamine
Poly Vinyl Chloride (PVC)	Polyester
Polystyrene (PS)	Urea - Formaldehyde
Low Density Polyethylene (LDPE)	Alkyd
High Density Polyethylene (HDPE)	

1.5 Plastics can also be classified according to their chemical sources. According to sources of plastic, there are six general groups: Cellulose Plastics, Synthetic Resin Plastics, Protein Plastics, Natural Resins, Elastomers and Fibers. **Table 2** gives the source of waste

plastic generation. Only plastic conforming to Low Density Polyethylene (LDPE), High Density Polyethylene (HDPE), PET and Polyurethane shall only be used in pavement construction.

Table 2 Waste Plastic & its Source

Waste Plastic	Origin
Low Density Polyethylene (LDPE)	Carry bags, sacks, milk pouches, bin lining, cosmetic and detergent bottles.
High Density Polyethylene (HDPE)	Carry bags, bottle caps, house hold articles etc.
Polyethylene Teryphthalate (PET)	Drinking water bottles etc.
Polypropylene (PP)	Bottle caps and closures, wrappers of detergent, biscuit, wafer packets, microwave trays for readymade meal etc.,
Polystyrene (PS)	Yoghurt pots, clear egg packs, bottle caps. Foamed Polystyrene: food trays, egg boxes, disposable cups, protective packagine etc.
Polyvinyl Chloride (PVC)	Mineral water bottles, credit cards, toys, pipes and gutters; electrical fittings, fumiture, folders and pens, medical disposables; etc.

1.6 There are two processes namely dry process and wet process for manufacturing bituminous mixes using waste plastic. In the dry process, processed waste plastic is added after shredding in hot aggregates where as in the wet process, processed waste plastic in the form of powder is added in the hot bitumen.

2 SCOPE

These guidelines deal with the specifications and use of waste plastic in wearing course using dry process, their advantages, application, manufacturing, transportation, storages, and quality testing requirements.

3 ADVANTAGES AND LIMITATION OF USING WASTE PLASTIC AS MODIFIER AND BINDER

Laboratory as well as field performance studies/investigations carried out in India (**Appendix-1**) identifies following advantages in using waste plastic in bituminous mixes.

- Higher resistance to deformation.
- Higher resistance to water induced damages.
- Increased durability and improved fatigue life.
- Improved stability and strength.
- Disposal of waste plastic and thereby environment friendly.

However following need to be ensured in order to achieve the advantages of these specifications;

- The material shall consist of only low density polyethylene (LDPE) or high density polyethylene (HDPE), PU (available in limited quantity as waste) and PET.
- Black coloured plastic waste is a result of repeated recycling and should not be used.
- PVC shall not be used since they release lethal levels of dioxines.
- The Thermo Gravimetric Analysis (TGA) of thermoplastics has revealed gas evolution and thermal degradation may occur beyond 180ºC. Thus misuse or wrong implementation of this technology may result in release of harmful gases, premature degradation, if the temperatures are not maintained during construction.

4 MATERIALS

4.1 Bitumen

The bitumen for bituminous mixes for wearing course with waste plastic shall comply with the Indian Standard Specifications for viscosity graded paving bitumen IS 73. Guidelines for selection for grade of viscosity graded paving bitumen shall be in accordance with the IRC:111-2009.

4.2 Aggregates

The aggregates shall comply to IRC:111-2009, for dense graded mixes and IRC:14-2004, IRC:SP:78-2008 and IRC:110-2005 for open graded mixes respectively.

4.3 Filler

The filler for dense graded mixes shall comply with IRC:111-2009.

4.4 Waste Plastic

- The waste plastic shall conform to the size passing 2.36 mm sieve and retained on 600 micron sieve.
- Dust and other impurities shall not be more than 1 percent. The process is indicated in **Appendix-2**. An easy method to determine the quantity of impurity is to determine the ash content at 600ºC.
- To ascertain the ability of plastic to mix with the binder, the melt–flow value shall be tested as per ASTM D 1238-2010, for which the range shall be as follows:

  For LDPE: 0.14-58 gm/10 min

  For HDPE: 0.02-9.0 gm/10 min

5 DESIGN OF MIX

The requirements for waste plastic modified design and open graded mixes are as follows:

5.1 Dense Graded Mixes

The properties for dense graded mixes are indicated in **Table 3**.

Table 3 Requirements for Waste Plastic Modified Dense Graded Bituminous Pavement Layers

Minimum stability (kN at 60°C)	12.0
Minimum flow (mm)	2
Maximum flow (mm)	4
Marshall Quotient (kN/mm)	2.5-5
Compaction level (Number of blows)	75 blows on each of the two faces of the specimen
Per cent air voids	3 – 5
Retained Stability (%)	98
ITS (min) MPa	0.9
VMA	16
VFB	65-75
Quantity of Waste Plastic % by weight of bitumen	6 to 8 depending on low rainfall or high rainfall areas

5.2 Open Graded Mixes

Waste Plastic @ 6 to 8 percent of the weight of the bitumen can be used for Open-Grade Premix Surfacing and Mix Seal surfacing mix. Quantity of bitumen can be reduced correspondingly.

6 MANUFACTURING OF BITUMINOUS MIX USING WASTE PLASTIC

The scope of the present guidelines is restricted to dry process only for the following reasons;

- Plastic is coated over stones - improving surface property of aggregates.
- Coating is easy & temperature required is same as road laying temp.
- Use waste should be 6-8 percent by weight of bitumen depending on the climatic conditions of high and low rainfall areas.
- Flexible films of all types of plastics can be used.
- Doubles the binding property of aggregates.
- No new equipment is required.

- Bitumen bonding is stronger than normal.
- The coated aggregates show increased Stability of the mixes.
- Better performance after construction based on the experience gained for medium level city traffic.
- No evolution of any toxic gases as maximum temperature is 180ºC.

6.1 Dry Process

In order to ensure that the quality of the finished waste plastic product is consistent the following process (**Appendix-1**) must be adhered to before considering its use in bituminous construction:

a) Collection of waste plastic

b) Cleaning and shredding of waste plastic

c) Shredding Machine

d) Mixing of shredded waste plastic, aggregate and bitumen in central mixing plant

7 CONSTRUCTION

Construction operation shall be in accordance with the IRC:111-2009, IRC:14-2004, IRC:110-2005 and IRC:SP:78-2008 for dense graded and open graded mixes respectively.

8 CONTROLS

Controls shall be in accordance with the IRC:111-2009, IRC:14-2004 and IRC:110-2005 and IRC:SP:78-2008 for dense graded and open graded mixes respectively. Besides, plastic shall be tested for impurity and melt flow value. Three sample be tested for each day work or when there is change in the source of plastic.

REFERENCES

1) Punith, V.S. and Veeraraghavan, A., "Laboratory Fatigue Studies on Bituminous Concrete Mixed Utilizing Waster Shredded Plastic Modifier", Proceedings of 21st ARRB Transport Research (ARRB) and 11th Road Engineering Association and Australia (REAAA) Conference, Caims, Australia, May 19-23, 2003.

2) Punith, V.S., and Veeraragavan, A., "Behaviour of Asphalt Concrete Mixtures with Reclaimed Polyethylene as Additive", Journal of Materials in Civil Engineering, American Society of Civil Engineers, USA Volume 19 Number 6 June 2007 pp. 500-507.

3) Verma. S.S. "Roads from Plastic Waste", The Indian Concrete Journal, pp. 43-44. November 2008.

4) FHWA, User Guidelines for Waste and By-product Materials in Pavement Construction; 1997.

5) Gupta, Dr. Y.P. and Pandey, J.K. "Utilisation Plastic Waste in Construction of Bituminous Roads", NBM & CW March 2010, pp. 92.

6) Schroceder, L.R. "The Use of Recycled Materials in Highway construction', Public Roads, Vol 58 (Issue 2), 1994.

7) Bose, Sunil, Raju R. "Utilization of Waste Plasticsaste Plastic Bituminous Concrete Mixes", Roads and Pavements, 2004.

8) S.E. Zoorob, L.B. Suparma "Laboratory Design and Investigation of the Properties of Continuously Graded Asphaltic Concrete Containing Recycled Plastics Aggregates Replacement (Plastiphalt)". Cement Concrete Composites 2000; 22:233-42.

9) Little D.N., "Enhancement of Asphalt Concrete Mixtures to meet Structural Requirements Through the Addition of Recycled Polythene, Use of Waste Materials in Hot Mix Asphalt", ASTM Special Tech Publication, 1193(1993).

10) Flynn L., "Recycled Plastic finds it home in Asphalt Binder", Roads and Bridges, (1993).

11) Qadir A, Imam M., "Use of Recycled Plastic Waste Aggregate as a Partial Substitution Material in Pavement Structure". In: Proceedings of the International Symposium on Pavement Recycling; 2005.

12) Kumar S., and Gaikwad S.A., "Municipal Solid Waste Management in Indian Urban Centres: an Approach for Betterment", in Gupta K.R. (Ed): Urban Development Debates in the New Millennium, Atlantic Publishers and Distributors, New Delhi, pp. 100-111, (2004).

13) Manual on Municipal Solid Waste Management, Government of India (2000).

14) Narayan, Priya, 2001, "Analyzing Plastic Waste Management in India: Case study of Polybags and PET Bottles" published by IIIEE, Lund University, Sweden, pp 24-25 accessed at library/publications/reports/2001/Priya-Narayan.pdf

15) CPCB report on 'Assessment of Plastic Waste and its Management at Airport and Railway Station in Delhi' p.8, December 2009.

16) The Report of the National Plastic Waste Management Task Force, Ministry of Environment and Forests, Government of India, 1997.

17) Plastics for Environment and Sustainable Development, ICPE, Vol. 8, Issue 1, Jan-March 2007.

18) Vasudevan R., Nigam S.K., Velkennedy R., Ramalinga Chandra Sekar A and Sundarakannan B., "Utilization of Waste Polymers for Flexible Pavement and Easy Disposal of Waste Polymers", Proceedings of the International Conference on Sustainable Solid Waste Management, 5-7 September 2007, Chennai, India. pp.105-111.

19) Huang Yue, Roger N. Bird, Oliver Heidrich, "A Review of the Use of Recycled Solid Waste Materials in Asphalt Pavements Resources", Conservation and Recycling 52 (2007) 58–73.

20) Gawande Amit., Zamare G., Renge V.C., Tayde Saurabh, Bharsakale G. "An Overview on Waste Plastic Utilization in Asphalting of Roads", Journal of Engineering Research and Studies, Volume III, Issue II, April-June, 2012/01-05.

21) Utilization of Waste Plastic Bags in Bituminous Mixes (November 2002). CRRI Report submitted to M/s KK Plastic Waste Management Ltd (Bangalore).

22) Sridhar R., Bose Sunil., Kumar Gajendra and Sharma Girish., "Performance Characteristics of Bituminous Mixes Modified by Waste Plastic Bags", IRC-HRB, Volume 71, December, 2004.

23) Bose Sunil., Sridhar Raju., "Utilization of Waste Plastic in Bituminous Concrete Mixes", New Building Materials & Construction World, Vol. 9 Issue-8, February 2004, pp 8-13.

Appendix-1

(Refer Clause 3)

Case studies in India

- In Tamil Nadu, length of roads around 1000 m in various stretches were constructed using waste plastic as an additive in bituminous mix under the scheme "1000 km Plastic Road", and found that, the performance of all the road stretches are satisfactory.
- The performance of the road stretches constructed using waste plastic in Bangalore (Karnataka) are also found to be satisfactory. More than 2000 km have been laid so far.
- In Delhi a number of test sections about 50 km were laid and most of them are performing well.

Appendix-2

(Refer Clause 4.4)

Processing details:-

i) collection of waste plastic

ii) cleaning and shredding of waste plastic

iii) mixing of shredded waste plastic, aggregate and bitumen in central mixing plant

iv) laying of bituminous mix

a) **Collection of waste plastic:**

Waste plastic is collected from roads, garbage trucks, dumpsites or compost plants, or from school collection programmes, or by purchase from rag-pickers or waste-buyers

Fig. 1 Collection of Waste Plastic

b) **Cleaning and shredding of waste plastic:**

Waste plastic litter in the form of thin-film carry-bags, use-and-throw cups, PET bottles, etc. these are sorted, de-dusted, washed if necessary.

Fig. 2 Cleaning Process

c) **Shredding machine**

Plastic waste which is cleaned is cut into a size between 2.36 mm and 600 microns and of maximum size 2.36 mm length and 2.00 mm width using a shredding machine.

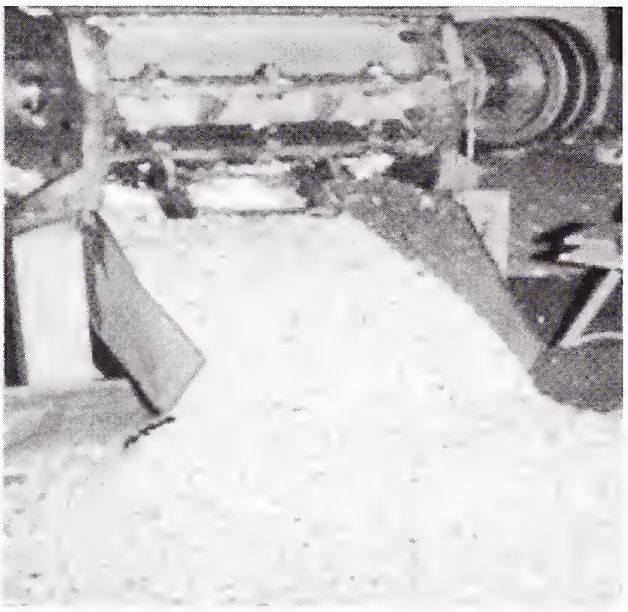

Fig. 3 Shredding Machine

d) **Mixing of shredded waste plastic, aggregate and Bitumen in Central mixing Plant:**

The aggregate mix is heated to 140-175°C in Central mixing plant. The requisite percentage of waste plastic to the weight of bitumen is injected with a pipe under compressed air in the drum of a drum mix plant through a pipe at 2/3 length of the drum or through an opening over the pugmill in the case of a batch mix plant. The waste plastic initially coats the heated aggregates. In the next stage bitumen is added to the aggregates, the temperature of the binder shall conform to the temperature depending on the grade of binder and the type of mix. The plastics waste coated aggregate is mixed with hot bitumen for 15 secs and the resulting mix transported for road construction.

Central mixing plant helps to have better control of temperature and better mixing of this material thus helping to have a uniform coating and heated bitumen is also sprayed.

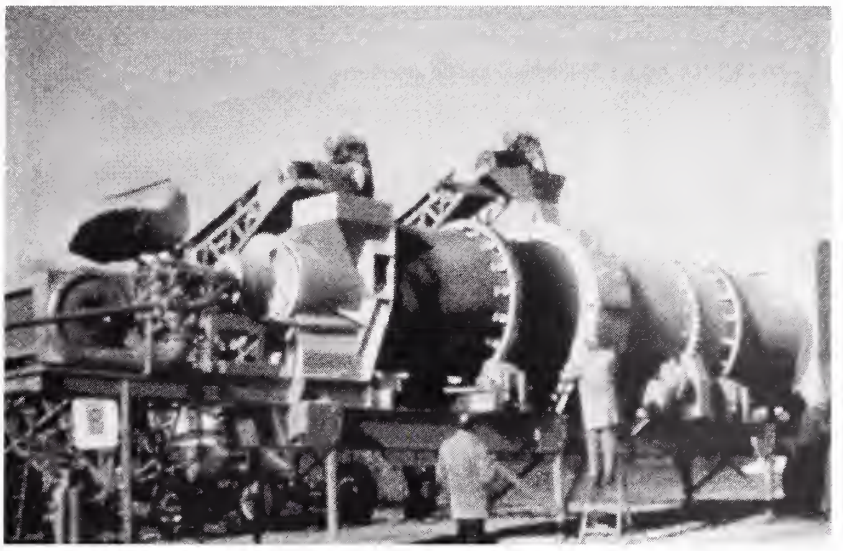

Fig. 4 Central Mixing Plant

e) **Laying of bituminous mix:**

The road laying temperature is between 110ºC to 120ºC for waste plastic bituminous mix . The roller used can be of any specified capacity.

(The Official amendments to this document would be published by the IRC in its periodical, 'Indian Highways' which shall be considered as effective and as part of the code/guidelines/manual, etc. from the date specified therein)