EXPERIMENTAL STUDY OF E WASTE IN VIRGIN BITUMINOUS MIXES

Amit Ranjan[1], Prof. Charan Singh Thakur[2]
[1]Research Scholar, [2]Professor & Head
Shriram Group of Institutions, Jabalpur (M.P)

Abstract: Bituminous mixes are most commonly used all over the world in flexible pavement construction. It consists of asphalt or bitumen (used as a binder) and mineral aggregate which are mixed together, laid down in layers, and then compacted. Under normal circumstances, conventional bituminous pavements if designed and executed properly perform quite satisfactorily but the performance of bituminous mixes is very poor under various situations. Today's asphaltic concrete pavements are expected to perform better as they are experiencing an increased volume of traffic, increased loads, and increased variations in daily or seasonal temperature over what has been experienced in the past. In addition, the performance of bituminous pavements is found to be very poor in moisture-induced situations. Considering this a lot of work has been done on the use of additives in bituminous mixtures and as well as on the modification of bitumen. Research has indicated that the addition of mobile chips and waste LPDE plastic to asphalt binders helps to increase the interfacial cohesiveness of the bond between the aggregate and the binder which can enhance many properties of the asphalt pavements to help meet these increased demands. However, the additive that is to be used for modification of mix or binder should satisfy both the strength requirements as well as economical aspects.

In this research work, we will add LPDE plastic waste 4% by weight and mobile chips as an aggregate replacement as 10%, 15%, 20% and 25% by weight. To determine the best suitable and stable replacement of bitumen in construction industry.

I. INTRODUCTION

E-waste is growing exponentially in recent years because the markets for these products are also growing rapidly. The US-EPAhas estimated an increase of 5 to 10% in the generation of e-waste each year globally of which only 5% is being recovered. There by the amount of e-waste that needs to be disposed of in an environmental friendly manner is increasing day by day. The fraction including iron, copper, aluminum, gold and other metals in e-waste is over 60%, while plastics account for about30% and the hazardous pollutants comprise only about 2.70% [2]. The e-waste inventory based on this obsolescence rate and installed base in India for the year2005 has been estimated to be 146180.00 tones. This is expected to exceed 8,00,000 tone by 2012. In India, e-waste is mostly generated in large cities like Delhi, Mumbai and Bangalore. In these cities a complex e-waste handling infrastructure has developed mainly based on a long tradition of waste recycling. Sixty five cities in India generate more than 60% of the total waste generated in India. There is no large scale organized e-waste are cycling facility in India and the entire recycling exists in unorganized sector.

In this study work we will add LPDE plastic waste 4% by weight and mobile chips as an aggregate replacements 10%, 15%, 20% and 25% by weight. To determine the best suitable and stable replacement of bitumen in construction industry.

ELECTRONIC WASTE

In the race of technological advancements in the country it is not surprising for computers and other electronic equipments to become obsolete within few years. The e-Waste has been mounting rapidly with the rise of the information society. It is the fastest growing segment of the municipal solid waste stream because of increased affordability of new products and technological achievements which make it easy to purchase of new electronics rather than repairing or upgrading old products. The growth of end of life electronic products depends on economic growth of the country, population growth, market penetration, technology upgradation and obsolescence rate.

The waste from electrical and electronic equipment (WEEE) – also known as e-Waste typically consists of electronic products coming to the end of their useful life such as computers, televisions, mobile phones, VCRs, CD players, DVD players, refrigerators, air conditioners, microwave ovens, tube lights and other consumer electric and electronic components. The huge range and complexity of component materials in the electronic products makes it difficult and expensive to dispose of or recycle them safely with profit making business. Some of the materials used in electronic devices are of high value and highly recyclable - such as gold and platinum while many others are non-renewable - such as plastics which are currently either discarded or recycled to form lower grade material. The biggest concern with e-Waste is the presence of toxic materials such as lead, cadmium, beryllium, mercury and arsenic, toxic flameretardants, PVC containing plastics, printer cartridge inks and toners that pose significant health and environmental risks when WEEE is disposed of.

The e-Waste is disposed of in one of the four ways landfilling, incineration, recycling or exportation. Each process has an environmental impact as well as affects the health and safety of the worker. Disposal in landfills is a common practice but eventually it results in leaching of toxic metals in soil and subsoil aquifers thus many countries (especially European countries) have undertaken legal measures to check the disposal in municipal landfills. The incineration process release heavy metals and other toxicants contained in electronic subassemblies and components as air emissions. Recycling process is considered the best way for disposing of electronic components only if the process employs environmentally sound recycling. It is considered that the developed nations usually have technological resources and infrastructure for environmentally sound recycling whereas developing nations lack the regulations as well infrastructure for proper recycling. The obsolete electronics are exported to developing countries like India, China, Pakistan and Africa due to cost benefits. This exportation is creating ecological footprints in developing and underdeveloped countries of the technological advancements in industrialized nations. It is cheap to export the obsolete electronics in developing nations rather than recycling these products in developed nations The imported obsolete electronics in developing nations creates e-Waste trade chain employing several informal workers, collectors, segregators, middlemen, scrap dealers and recyclers who manage to take components apart, reuse the functional components and recycle the non-functional components by burning, acid dipping and other unprofessional techniques. The spent acids and other chemicals, solid wastes after burning and other wastes are disposed of in open drains which eventually end up in rivers.

Figure 1.1 Mobile Waste

CONVENTIONAL BITUMINOUS MIXES

The Bituminous Mixes which were been in practice in early days before SMA mix. It was not much effective compared to Stone Matrix Asphalt (SMA).Thus it is now completely replaced by the use of SMA. SMA is better in all respect. SMA provides greater resistance to fatigue, better rutting resistance, increased durability, resist high deformation in high temperature region. SMA has reduced sensitivity and resistance to moisture, resists crack at low temperature. It gives better resistance in plastic deformation than that of conventional Bituminous Mixes. In assessment of all these SMA has been proven better compared to the conventional Bituminous Mixes.

The resistance of the mix against the external weathering and abrasive actions can be called as the durability property. The wheel loads with high abrasion action on the pavement result in the formation of tensile strains. Lack of durability of the pavement result in the following failures:

- Pot Holes
- Stripping

Pot holes is the local deterioration and stripping is the failure that expose all the aggregates. Higher binder content help in reducing the chances of disintegration to some extend.

Figure 1.2 Bitumen mix

The workability of the mix depends on the following factors:

- The aggregate type – angular, flaky and elongates
- The content of bitumen
- The gradation of aggregates
- Shape and texture of the aggregates
- Type of bitumen

OBJECTIVE

Main objectives of bituminous mix design are to find;

1. To determine Optimum content of mobile chips in a suitable proportion of bitumen.
2. To determine Sufficient strength to resist shear deformation under traffic.
3. To determine the enhancement in tensility and ductility of sample using plastic waste.
4. To determine the use of non-biodegradable waste in construction industry.
5. To determine sufficient flexibility to avoid cracking due to repeated traffic load.

II. AIM OF STUDY

A comparative study has been made in this investigation in SMA mixes with plastic content (4%) and mobile waste chips in different sample as 10%, 15%, 20% and 25%.

The objectives of this investigation are to observe the followings;

- Study of Marshall properties of mixes using both
  - o mobile chips as aggregate replacement.
  - o plastic waste as an bitumen replacement.
- The effect of polyethylene as admixture on the strength of bituminous mix with different filler and replacing some percentage of fine aggregate by mobile chips.

III. SMA METHODOLOGY

Stone Matrix asphalt is a gap graded mixture extensively differs in its result according to the different methods, procedures, apparatus and Materials to be used for the Mix preparation and so the effects also is valid only to the specific region and environments . This subject for the most part incorporates the choice of material sorts which incorporates Coarse and Fine Aggregate, Filler, Binder and Stabilizer. In this examination Coarse Aggregates are utilized i.e. Stone total. Cover is Bitumen of review 60-70 as it is the for the most part favored by the architects because of its reasonableness in Indian condition. Stabilizers utilized are Mobile chips and plastic waste of mobile.

MATERIAL USED

Materials taken for the SMA blend for the specimen and for tests and to analyze the venture work are filler stabilizer, coarse total and fine total, Coarse total are taken are Stone total. Stone clean is taken as fine total. Stabilizers taken are Mobile chips and plastic cover. The Bitumen of review 60-70 is taken as folio as it is most great in Indian condition. Properties of the fixings utilized are given underneath:

Table 3.1- Various properties (physical) of Stone Aggregate

Testdescription	Coarseaggregates	Fineaggregates	Standardvalues
Combinedflakines & elongationindex(inpercentage)	29	-	<31
Specificgravity	2.75	2.65	2.60-2.95
LosAngelesabrasion Value(inpercentage)	28	-	<31
Impactvalue(inpercentage)	21.5	-	<20
AggregateCrushing value (inpercentage)	28	-	<31
Angularitynumber	09	-	0-10

Table 3.2 -Various properties (Physical) of Bitumen

Testdescription	Results	Standard values
Penetrationat25ºC(1/10 mm)	66	50to 90
SofteningpointºC	64.6	>48 oC
Ductilitycm	>80	>50
Specificgravity	1.02	-

APPARATUS REQUIRED

Code IRC:SP – 79 give the gradation of the materials needed. Therefore the IS Sieve size of the same is required for the gradation for sieving. After the Sieving, the sample is heated to 155°C -160°C for which Oven is required. Then the sample is mixed in the mixing apparatus using Bitumen as binder. The Moulds are required for casting using the hammer of specific weight and fixed falling. For testing hot water bath is used for water bath of the sample at 60°C for 30 minutes. At last in Marshall Testing Apparatus, the testing is done and stability and flow value readings are obtain

Table 3.3 - IRC : SP - 79 gradation chart for 13mm Mix

ISSieve	Cumulative Percentage	Mean	percentage retained
26.5	-	-	-
19	95-100	95-100	0
13.2	91-100	96	5
9.5	55-75	69.0	34.5
4.75	18-30	25	40.0
2.36	15-25	75	5
1.18	15-24	18	4
0.6	11-17	14	3
0.3	11-21	16	4
0.75	9-12	11	3

Figure 3.1- Sample Prepared

Figure 3.2- Water Bath

Figure 3.3- Marshall testing machine

IV. PREPARATION OF TEST SPECIMEN

Material Selection

In SMA mix, Bitumen is profoundly wanted by the specialists contrast with different fasteners, in light of its properties like Water evidence, Durability, Resistant to solid corrosive and Good establishing properties. For the balancing out material Mobile chips and plastic cover whose reasonableness is to be resolved in the terms of dependability and stream esteem. Plastic utilized in light of properties like solid strength, great solidness, level of fineness, Tenacity and simple accessibility and sparing contrast with other regular fibers.

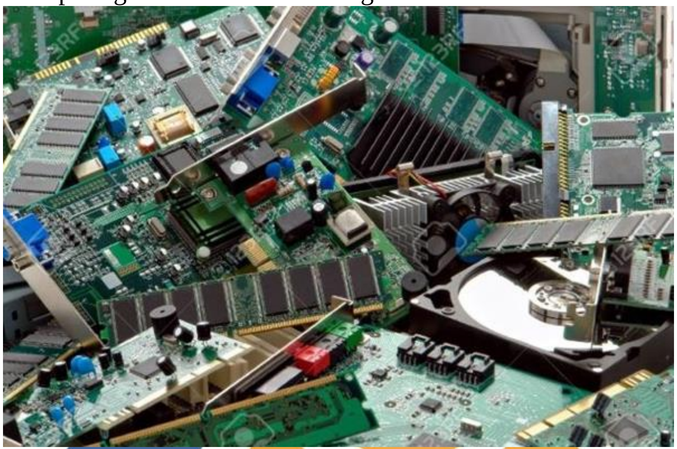

Figure 4.1- Mobile Chips

Preparation of Sample

The Methods followed during the preparation of SMA sample and all the other practice followed before taking it to the Marshall testing Machine to test for Stability and flow values are-

- Sampling of coarse aggregates and fine aggregates is done for 13mm STONE MATRIX ASPHALT composition as specified by IRC:SP-79.
- The aggregates are graded according to IRC:SP-79 then dried and about 1200 gm is weighed to obtain height of 63.5 + 1.3 mm when compacted in the mould.
- The aggregate is heated in the oven to a temperature of 150-160 °C temperature for 1 hour.
- The necessary quantity of bitumen is weighted and heated separately to temperature of 170-190 °C.
- Then aggregate contained is taken out and heated in a mixing bowl. The binder is then poured in it and manual mixing is done to obtain properly coated aggregate. The mixing temperature should be within the limit for the binder temperature.
- A washed mould of 101.6 mm diameter and 76.2 mm height is taken with base plate and an extension collar.
- A piece of filter paper is fixed in the bottom of the mould then the whole mix is poured into mould.
- The whole assembly of mould is then placed on the compaction pedestal and hammered 75 blows for no fibre and 50 blows for fiber with the help of 2500 g compacting hammer having falling height of 80 mm. The same treatment is given on the reversed side of the specimen by reversing the mould
- The specimen is then transferred from the mould to a smooth flat surface and allowed to cool to room temperature for 24 hours.
- Then the specimen is measured and weighed in air and then after paraffin wax coating weighed in water. After marking the specimen is stored for stability and flow measurements.
- Before performing the test on Marshall testing machine, each sample is kept in hot water bath for 30 min at temperature of 600C.

Figure 4.2- Mould Setting

Fig 4.3- Bitumen Addition

Fig 4.4- Mixing of Sample

Fig 4.5 Casting of sample

Fig 4.6- Sample after Paraffin wax Coating

V. RESULTS AND DISCUSSION

The Results obtained from the tests in laboratory, using different types of gradation according to the IS code for different SMA Mix and analyzed to obtain the required results. The Results are analyzed and then compare with one another and when all comparisons are done, the results are properly tabulated as well as graphs are plotted. The Stabilized value is mainly calculated by using the co-relation method and all other required values like Volume of sample and bulk volume ,Gmb, Gmm, Ps value to calculate and find out GSB, VA and VMA value to plot the graphs

MARSHALL STABILITY TEST

From this study the following results are obtained which is shown in following Tables Marshall Properties of various Bituminous Mixes and marshal curves for this design mix shown from the below figures are as follows:

In all cases 4% plastic obtained from mobile case is utilized as a bitumen replacement whereas 10%, 15%, 20% and 25% mobile chip is utilized for replacing aggregate in a stone mix asphalt sample

Table 5.1: Marshall Properties of various Bituminous Mix

Sr. No.	TypeofMix	FlowValue	Va(%)	VMA(%)	VFB(%)	MarshallStabilityvalue(kg)
1.	SMA mixwith 10 %chips as aaggregate replacement	3.5	4.4	7.75	70.3	1560
2.	SMA mixwith 15 %chipsas a aggregaterepla cement	3.8	2.43	8.28	69.80	1640
3.	SMAmix with 20 %chipsasa aggregate replacement	4.1	3.0	9.48	68.3	1700
4.	SMA mixwith 25 %chips as aaggregate replacement	4.0	2.8	8.85	68.9	1686

PENETRATION TEST

Penetration of a bituminous material is the distance in tenths of millimeter that standard needle will penetrate vertically into a sample under standard conditions of temperature, load and time. As per I.S. Code IS: 1203 – 1978

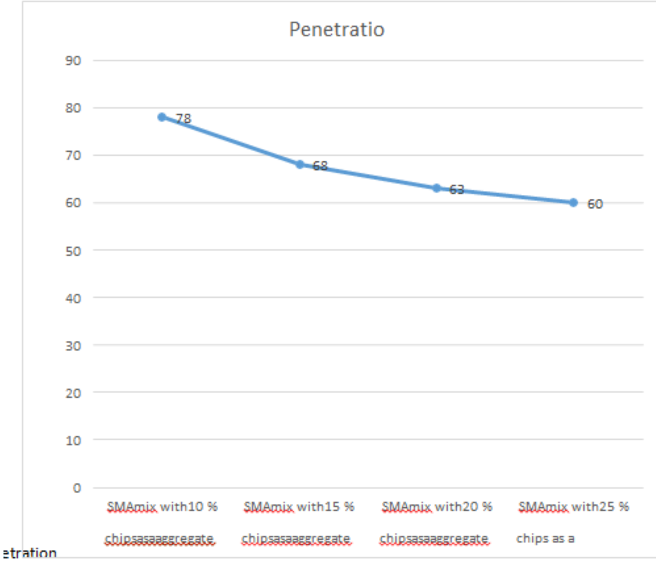

Figure 5.1 – Penetration

Table 5.2 Penetration Test

PENETRATIONTEST		
S.No.	Standardvalue	Testresult
SMA mix with 10 % chipsasaaggregatereplacement	60-70(0.1) mm	78
SMA mix with 15 % chipsasaaggregatereplacement		68
SMA mix with 20 % chipsasaaggregatereplacement		63
SMA mix with 25 % chipsasaaggregatereplacement		60

DUCTILITY TEST

This test is done to determine the ductility of distillation residue of cutback bitumen, blown type bitumen and other bituminous products as per IS: 1208 – 1978. The principle is : The ductility of a bituminous material is measured by the distance in cm to which it will elongate before breaking when a standard briquette specimen of the material is pulled apart at a specified speed and a specified temperature. As the chips percentage increases, the tensile strength of the sample and ductility increase with increase ratio of sample.

Table 5.3 Ductility test

DUCTILITYTEST		
S.No.	Standardvalue	Testresult
SMA mix with 10 % chipsasaaggregatereplacement	75cm(min.)	100
SMA mix with 15 % chipsasaaggregatereplacement		101.5
SMA mix with 20 % chipsasaaggregatereplacement		103.43
SMA mix with 25 % chipsasaaggregatereplacement		104.3

Table 5.4 Following results were obtained from the other tests conducted on bitumen

Sr. No.	Property	Specification ofIS:73	TestResult
1.	SpecificGravity	0.99(min)	1.025
2.	Softening Point	45-55°C	50

Table 5.5 Overall results

Sr.No.	TypeofMix	Flow Value	Ductility test	PENETRATION TEST	Marshall Stabilityvalue(kg)
1.	SMA mixwith 10 %chipsas a aggregatereplacement	3.5	100	78	1560
2.	SMA mixwith 15 %chips as aaggregate replacement	3.8	101.5	68	1640
3.	SMA mixwith 20 %chips as aaggregate replacement	4.1	103.43	63	1700
4.	SMA mixwith 25 %chips as aaggregate replacement	4.0	104.3	60	1686

VI. CONCLUSION

- Marshall Test conducted on bituminous mix with combination 20% mobile chips and have higher value of stability 1700 kg correspondingly the values of flow is 4.1,percentage air voids is3.0 %, VMA is 9.48% & VFB is 68.30%.
- It is observed that by addition of mobile chips to the mixture, the resistance to moisture susceptibility of mix also increases. BC with polyethylene results in highest tensile strength ratio in SMA mix.
- From the study it is concluded that mobile case increases the binding property of the mix in a natural way.
- The ductility of the sample increases with increase in mobile chips as it provides good tensile strength to the sample.
- As per the cost cutting in construction this method is very valuable and as it is very helpful in cost cutting of bitumen in a mix

VII. FUTURE SCOPE

- This study has been limited to the design procedures for SMA. So, other suitable procedures should be developed for different mixes.
- The performance study of stone mix is primarily based on analysis of Marshall Stability and air void content in the compacted hot mix. The mix performance characteristics in terms of many other engineering properties need to be considered.

