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Effective Utilization of Waste P.E.T(Plastic) and Steel Slag to Enhance Performance of Bitumen Based Pavements.

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ABSTRACT: This work includes experimental investigation of the use of waste P.E.T (plastic) and steel slag in construction of roads. It is our moral responsibility to have concern about some of the frequent problems faced in India regarding roads and environmental safety such as formation of potholes, rutting, decreased durability of the pavements are of major concern in Indian villages as well as in metropolitan cities; this study also states an evergreen solution to it. This study investigates use of plastic waste with bitumen to replace it to a limited extent and also the steel slag of a particular type in the form of aggregates along with conventional stone aggregates, its effects and an economical method for its implementation. Marshall Specimens were prepared at bitumen contents of 4.0, 4.5, 5.0% by weight to find optimum bitumen content, with P.E.T content of 0%, 4%, 6%, 8%, 10% by weight of bitumen and with steel slag aggregate content of 5%, 10%, 15% and 20% to find out respective limits and their properties. Marshall Stability, Flow values etc. were further determined and observed.

KEYWORDS: Plastic waste, Bitumen, steel slag, P.E.T(Polyethylene Terephthalate).

I. INTRODUCTION

India is a progressive country which is under development and its chase to be quoted as a “developed country” is ongoing. The fulfilment of this motive demands rapid industrialization and vast infrastructure as a need of hour. In addition to this the fact of being hugely populated country also exists. As a result of which India generates 150 million tons of waste on daily basis which is equivalent to 3 million truck loads as per the report from International Solid Waste Association (ISWA). This calls for a serious demand of municipal waste management. Particularly plastic wastes have many problems in its disposal. Although attempts have been made to cut down the use of plastics, yet no major changes have occurred.

Plastics are common man’s friend and people are widely dependent on plastics specifically those of use and throw culture like cups, carry bags. Some of the factors like ease of availability of plastics, economically beneficial, corrosion resistant, light weight and more importantly a versatile element for packaging have given it immense popularity and a remarkable place in domestic and in industrial sectors. But these plastics pose a serious threat to environment and human health when not taken care of; most of them are non-biodegradable in nature. Even if attempts for incineration are made, they create other problems like global warming, pollution etc. Hence they should be properly managed following the three R’s i.e. reduce, reuse and recycle.

By many researchers the use of plastic wastes like polyethylene, polypropylene, poly vinyl chloride in construction of pavement is suggested. These plastics have softening a softening point between 110°-140° and have a tendency to

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improve adhesion, reduce water permeability etc. These plastics are mixed at a temperature of 160° with hot aggregates and bitumen to form a modified mix. This modified mix has unique properties and enhanced quality.

As suggested, use of steel slag of a particular type is also a good alternative for conventional stone aggregates, it can be added to a limited extent with these stone aggregates in a bituminous mix to increase the parameters like strength, bearing capacity and tensile reinforcement. The investigation is also directed towards finding out the optimum contents of steel slag and P.E.T that can be added to this modified mix.

- Advantages of steel slag when used in bituminous pavements-(<http://www.wsdot.wa.gov/publications>)
 1. Higher resistance to skid.
 2. Resistant to wear
 3. Increased Stability.
 4. Resistant to stripping in presence of moisture
 5. Resistant to rutting effect
 6. Higher stiffness
 7. Resistant to fatigue.
 8. Resistant to permanent deformation
 9. High cohesive strength
 10. Compatible with typical asphalt binders

- Disadvantages of steel slag when used in bituminous pavements-
 1. High volume expansion potential in the presence of moisture
 2. High specific gravity results in lower volumes of pavement mix and higher transportation costs

II. LITERATURE REVIEW

In the construction of flexible pavements using asphalt, hot bitumen is coated over the heated stone aggregate and rolled up in which bitumen acts as a binder element. Though when water is stagnated over road during rainy season it penetrates and results in formation of potholes, as defect in the pavement. It leads to the discomfort for the traveler passing by and many other problems like accidents. Remedial measures of filling potholes by concrete or asphalt do not prove to be long lasting. Literature review related to the modified bituminous mix has been done. The specific objective was to know the guidelines regarding the performance of different modifiers used in the bituminous mix. It has been noticed that many researchers, academician and consultant have work on various mixes of bituminous using modifiers. Theoretically as well as practically the focus is made on the study of properties of BM using modifier. However, very little literature is available related to re-used plastic bottles as modifier. ***There is no or rather sufficient literature available on use of steel slag (chips) in bituminous pavement. Hence papers mentioning use of steel slag in concrete have been referred for an overview.***

R. Vasudevan (2012) suggested use of plastics in the melted form to be used in the road construction along with the aggregates. The modified aggregates referred as polymer coated aggregates. Plastics having melting point at 110° can be coated over stone aggregates to show better performance and good durability. V.C. Renge (2012) reviewed that the quantum of plastic waste in municipal solid waste (MSW) is increasing due to increase in population, urbanization, development activities and changes in life style which leading widespread littering on the landscape. This waste plastic partially replaced the conventional material to improve desired mechanical characteristics for particular road mix. In the present paper developed techniques to use plastic waste for construction of flexible pavements has been reviewed. Mushtaq Ahmad (2015) reviewed that examines properties of waste plastic water bottles, polyethylene terephthalate (PET). The waste polymer was added to the normal bitumen penetration grade (80/100) prepared Marshall Samples using ACW-14 to investigate Marshall Parameters of polymer modified bitumen and compare with conventional bitumen. Thermal analysis of PET waste polymer was carried out using TGA and DSC to study decomposition and melting temperature of the waste polymer and also select suitable type of polymer because compatibility of the material is an essential. Study justified with the past Marshall Stability of the bitumen increase 50-60% by addition of waste polymer, study findings shows that by addition of 9.0% highest Marshall Stability in mix was achieved and likewise

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stiffness, flow and voids filled with bitumen properties of the Marshall Mix was improved Percentage of the void total mix found to decrease while increasing modified bitumen contents in the Marshall Mix.

Bhageerathy K. P (2014) stated that the main objective of the study was to investigate the performance of the bituminous mix modified with bio-medical plastic waste and to compare it with the normal mix. Medical plastic waste was collected from IMAGE (Indian Medical Association Goes Eco-friendly), Palakkad, Kerala, India. As part of the study, the properties of Plastic Coated Aggregates (PCA) were determined. The results showed improved properties for PCA when compared to normal aggregates. Johnson Kwabena Appiah (2017) discussed on the two main problems faced in Ghana; Firstly, management of municipal solid waste in regards with plastic; Secondly, the formation of the potholes on pavements in Ghana. He examined the effect of blending waste thermoplastics namely Low Density Polyethylene (LDPE) and High Density Polyethylene (HDPE) in conventional AC-20 graded bitumen. Sudha.P (2017) performed the experimental inspection to evaluate the characteristics of concrete using the steel slag as a coarse aggregate. Concrete is most commonly used material than any other material in the world so the use of concrete is necessary at the same time which leads to the scarcity of aggregate is also increased now a day. The industrial waste has been encouraged in construction industries because it reduces the usage of natural resources. Fly ash, silica fume and steel slag where considered as a common industrial waste material. These materials are successfully used in construction industries for the partial and full replacement in concrete. In this study of M20 grades of concrete with W/C ratio 0.45 respectively for the partial replacement of coarse aggregate 20%,40%,60%,80% and 100% by steel slag. Ravi Kumar(2016) carried out experimental investigation to evaluate the effects of concrete by replacing the normal coarse aggregate by steel slag on properties of concrete. Concrete is used, more than any other material in the world so the use of concrete is unavoidable at the same time scarcity of aggregate is also increased nowadays. The industrial waste has been encouraged in construction industries because it contributes to reduce the usage of natural resources for many years by product such as fly ash, silica fume and steel slag were considered as waste materials. They have been successfully used in the construction industry for the partial and full substitution in concrete. In this study concrete of M20, M30, M40, M50 grades were considered for a W/C ratio of 0.55, 0.45, 0.37, 0.32 respectively for the replacement of coarse aggregate 30% 60% and 100% by steel slag. This study revealed that there is improvement in compressive strength 5 to 10% for all the grades of concrete. There is 4 to 8% increase in split tensile strength in all grades of concrete. The Flexural strength of concrete is increase about 2 to 6% for all the grades steel slag can be use up to 60% replacement in all grades of concrete. Full replacement by steel slag decreases the strength considerably.

III.MATERIALS

The basic materials used in construction of any flexible pavements are as follows-

1. Stone Aggregates of varying sizes. (6mm,10mm,12mm,20mm etc.)
2. Bitumen (VG-30 grade in Maharashtra)
3. Mineral Filler

The materials which are to be added to above materials to replace them to a limited extent to enhance properties are-

4. Waste P.E.T plastic. (processed)
5. Steel Slag of a particular form. (chips or having aggregate like structure)

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Fig 1(a): Stone Aggregates of various sizes

The above Fig 1(a) shows the conventional stone aggregates of varying sizes used in construction of flexible pavements. Same are to be used to prepare bituminous mix specimens for carrying this work. The aggregates were properly sieved under I.S sieves of varying sizes before use to achieve accuracy.



Fig 1(b): Bitumen of VG-30 grade (binder)

The above Fig 1(b) shows the bitumen of grade VG-30 which was used as per the suitability for Maharashtra state. Bitumen is the main binder element and its function is to hold the ingredients together. In above figure heating of bitumen is shown, for achieving its temperature and making it viscous/soft for further use.

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Fig 1(c): Mineral filler

The above Fig 1(c) shows the mineral filler. The mineral filler used may be simple Ordinary Portland Cement, fly ash or crushed sand powder.



Fig 1(d): Waste P.E.T plastic (processed)

The above Fig 1(d) shows the waste P.E.T plastic. P.E.T stands for Polyethylene Terephthalate, in simple manner it is nothing but the plastic from which plastic bottles for storing water, detergents, phenyl etc. is made. The waste form of such plastic is collected from Municipal Plants and after a number of processes like cleaning, drying, shredding and cutting it is used as an modifier to bitumen or to replace bitumen content up to certain extent. It is also a binding element.

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Fig 1(e): Steel slag of a particular form.(from en.wikipedia.org/wiki/Construction)

The above Fig 1(e) shows the steel slag of a particular form having aggregate like structure or a chip form. This type of steel slag is incorporated as a replacement to a conventional stone aggregates up to a certain limit to enhance properties like bearing capacity etc.

IV.METHODOLOGY

A. Preparation of raw materials-

- Collection of Waste P.E.T plastic from scrap center/ Municipal treatment units.
- Cleaning of plastic.
- Shredding and cutting into fine pieces.
- Collection of bitumen, stone aggregates and steel slag from the supplier.

B. Ingredient Testing and characterization of steel slag used-

Following tests were carried out on ingredient materials before their use-

1. Tests on Aggregates-
 - i. Sieve Analysis
 - ii. Aggregate Impact Value
 - iii. Aggregate Crushing Value
 - iv. Water Absorption Test
2. Tests on Bitumen-
 - i. Penetration Test
 - ii. Softening Point Test
 - iii. Ductility Test
 - iv. Flash and Fire Point Test
 - v. Specific Gravity Test

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3. Test on Plastic-
 - i. Softening Point of P.E.T plastic
 - ii. Binding Property
4. Tests on Steel Slag-
 - i. Impact value of steel slag
 - ii. Specific Gravity of steel slag
 - iii. Study about its chemical composition
5. Test on Conventional and Modified molds-
 - i. Marshall Stability
 - ii. Marshall Flow

Characterization of steel slag-(en.wikipedia.org)

1. History of steel slag

The use of iron and steel slag dates back a long way in history. European Slag Association (2006) has reported about the earliest reports on the use of slag, it is mentioned that Aristotle used slag as a medicament as early as 350 B.C. All form history use of slag has ranges from the novel to the usual including: cast cannon balls in Germany (1589), wharf buildings in England (1652), slag cement in Germany (1852), slag wool in Wales (1840) armoured concrete in Germany (1892) slag bricks made from granulated slag and lime in Japan (1901) according to Iron and Steel (2007). In the past, use of steel slag was not noticeable because enormous volumes of blast furnace slag were available. Through environmental considerations and awareness more recently the concept of sustainable development, extensive research has transformed slag into modern industrial product which is effective and beneficial. The American Society of Testing and Materials (ASTM) (1999) define blast furnace slag as “the non-metallic product consisting essentially of calcium silicates and other bases that is developed in a molten condition at the same time with iron in a blast furnace.” Slag was considered to be essential in the production of iron, but if once it served its purpose in refining the metal, it was strictly a nuisance with little or no use. The usefulness of slag was realized with the first ore smelting process. The use of slag became a common practice in Europe at the turn of the 19th century, where the incentive to make all possible use of industrial by-products was strong and storage space for by-products was lacking. Shortly, many markets for slag were opened in Europe, the United States, and elsewhere in the world.

2. Types of Slag

Slag is by-product formed in smelting, and other metallurgical and combustion processes from impurities in the metals or ores being treated. During smelting or refining slag floats on the surface of the molten metal, protecting it from oxidation or reduction by the atmosphere and keeping it clean. In iron and steel production slag phases are generated, formed mainly from the addition of mixture of oxides and fluxes and are also composed of reaction products like those resulting from the oxidation of charge materials and the dissolution of refractories. Primary purpose is to refine the liquid metal by removing impurities.

- Air-cooled blast furnace slag
- Granulated blast furnace slag
- Steelmaking slag (Electric Arc Furnace Slag)

C. Procedure-

- Adopting the Marshall method of mix design and weighing all ingredients according to proportions.
- A mold is to be prepared for testing not exceeding weight of 1200 gm as far as possible.
- Take into consideration mix proportions for preparing conventional bituminous mix i.e. weights as follows 20mm aggregate- 504 gm, 10mm, 6mm aggregate- 96 gm, crushed sand up to 480 gm, filler- 24 gm and vary bitumen % from 4%, 4.5%, 5.0% and find out optimum bitumen content for conventional mix.
- Heat the weighed aggregates and bitumen, steel slag (in oven) separately up to a temperature of 163°C and 170°C respectively. Note that steel slag should be heated up to 130°C and with proper inspection.

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- For first specimen take conventional materials and proportions.
- For modified specimens take 4% P.E.T and by weight of bitumen and 5% steel slag by weight of aggregates. Further take these materials in the increasing proportions like 6% P.E.T and 10% steel slag, 8% and 15% steel slag so on.
- Mix the plastic, steel slag, stone aggregates also thoroughly after heating, transfer the mixed material to the compaction mold
- Give 75 blows on the top side of the specimen mix with a standard rammer (45 cm, 4.86 kg) or under compaction machine, now do similar on other side and take out the mold for cooling of few minutes.
- Now take out the specimen from the mold by gentle pushing. Mark it and keep it for overnight.
- A series of specimens are prepared in a similar manner with varying material contents in an increasing order.
- Before testing of molds keep them in water bath for half an hour.
- Test the molds under Marshall Apparatus and note down the results of the test for comparison



Fig 2(a): Mix prepared after mixing all the ingredient materials and the moulds in which it is to be filled

The above Fig 2(a) shows the bituminous mix prepared after thoroughly mixing all the ingredient materials and while filling the specimen moulds to be prepared for further testing.



Fig 2(b): Specimen mould

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The above Fig 2(b) shows the finished specimen mould which is to be tested under Marshall apparatus.



Fig 2(c): Series of specimen moulds prepared by varying P.E.T and steel slag content.

The above Fig 2(c) shows the clear picture of moulds prepared for testing. Such specimens are to be prepared by using both, the conventional mix and the modified mix.



Fig 2(d): Specimen mould testing under Marshall Stability Apparatus.

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The above Fig 2(d) shows the testing of specimen moulds prepared by using both conventional and modified mixes for their analysis.

V. RESULTS AND DISCUSSION

Marshall Stability Test results:

Table 1.1 and Table 1.2 shows the volumetric properties of various bituminous mix specimens prepared and the graphical representation of the same is shown in figures (f) to (j). Results are discussed below

The results of Stability of mixes shown in Table 1.14. From results it is clearly observed that stability of mixes is a function Plastic Modifier and Steel Slag content. One can observe that stability for mix modified with waste plastic is maximum for sample having bitumen content 4.5% by weight of aggregate and 8% waste plastic by weight of bitumen and 15% of steel slag content.

From the results obtained, we can say that the flow values for Bituminous mixes modified with waste plastic and steel slag are within the limit i.e. 2mm to 4mm at optimum bitumen content.

Figure 3(b) shows the stability value with varying P.E.T and steel slag content, thereby it is seen that maximum value of stability is achieved at 8% of P.E.T and 15% Steel slag therefore this shows the extent up to which this modifier can replace the bitumen and aggregates. Increment above this leads to negative results.

Similarly, Figure 3(c) shows the Flow value with varying P.E.T and steel slag content and Figure 3(d) & 3(e) show VMA and VBF respectively.

Table 1.1: Properties of conventional Bituminous mixes with different Percentages of Bitumen

Sr.No	Properties	4.0%	4.5%	5.0%
		1	Marshall Stability, kN	11.2
2	Flow Value, mm	4.9	3.8	4.4
3	Marshall Quotient, kN/mm	2.28	3.63	2.81
4	Theoretical Max Density (Gt), gm/cc	2.48	2.45	2.45
5	Average height of specimen, cm	6.8	6.8	6.8
6	Weight of sample in air, gm	1254	1257	1266
7	Volume of sample, cc	534.004	534.004	534.004
8	Bulk Density (Gb), gm/cc	2.348	2.353	2.370
9	Volume of air voids (Vv), %	5.645	4.081	3673
10	Volume of bitumen (Vb), %	12.425	13.587	14.824
11	Voids in mineral aggregate (VMA), %	18.070	17.668	18.498
12	Voids filled with bitumen (VFB), %	68.759	76.898	80.141

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The above table shows the results of various properties like Flow value, Stability value, Marshall quotient, VFB, VMA etc. for the specimens of conventional bituminous mix with varying percentages of bitumen like 4%, 4.5% and 5.0%. Also the optimum bitumen content is found out from above. Optimum bitumen content is the bitumen content at which properties like stability and flow show the most better results.

Table 1.2: Properties of 4.5% bituminous mix with various plastic and steel slag %

Sr.No	Properties	4 and 5%	6 and 10%	8 and 15%	10 and 20%
		1	Marshall Stability, kN	14.1	15.4
2	Flow Value, mm	2.6	2.7	2.5	2.38
3	Marshall Quotient, kN/mm	5.42	5.70	6.72	6.17
4	Theoretical Max Density (Gt), gm/cc	2.48	2.47	2.47	2.47
5	Average height of specimen, cm	6.8	6.8	6.8	6.8
6	Weight of sample in air, gm	1258	1260	1259	1263
7	Volume of sample, cc	534.004	534.004	534.004	534.004
8	Bulk Density (Gb), gm/cc	2.355	2.359	2.357	2.365
9	Volume of air voids (Vv), %	5.241	4.453	4.858	4.453
10	Volume of bitumen (Vb), %	12.124	12.686	13.364	12.390
11	Voids in mineral aggregate (VMA), %	17.622	16.840	17.223	16.844
12	Voids filled with bitumen (VFB), %	70.252	71.554	72.791	73.559

The above table shows the results of various properties like Flow value, Stability value, Marshall quotient, VFB, VMA etc. for the specimens of modified bituminous mix with percentage of bitumen being constant i.e. 4.5% (optimum bitumen content) and varying percentages of plastic and steel slag. For example- 4% P.E.T and 5% steel slag, 6% P.E.T and 10% steel slag and so on.

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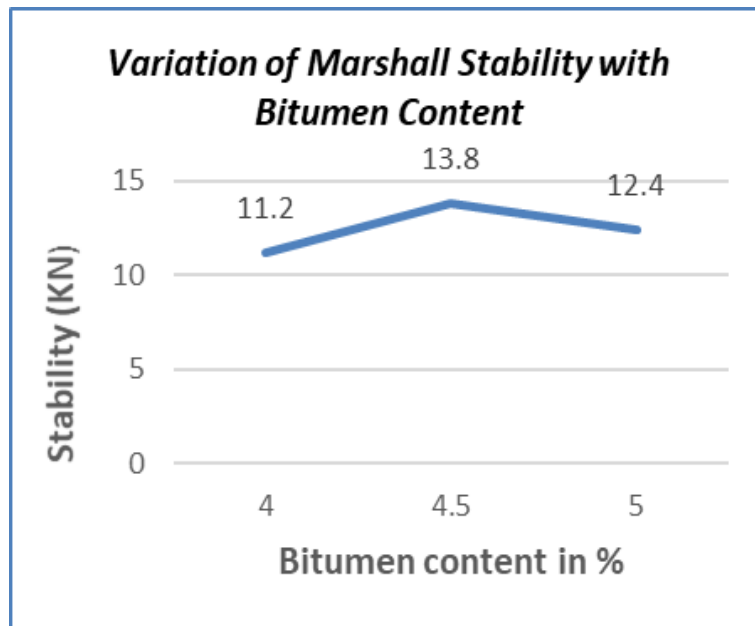


Fig 3(a) Marshall Stability Vs Bit. Content (Optimum bitumen content found out to be 4.5%)

The graph in above Fig 3(a) shows the variation of Marshall Stability for varying bitumen content. From above the Optimum Bitumen Content for conventional mix was found out. It is the content of bitumen in percentage for which maximum stability is achieved.

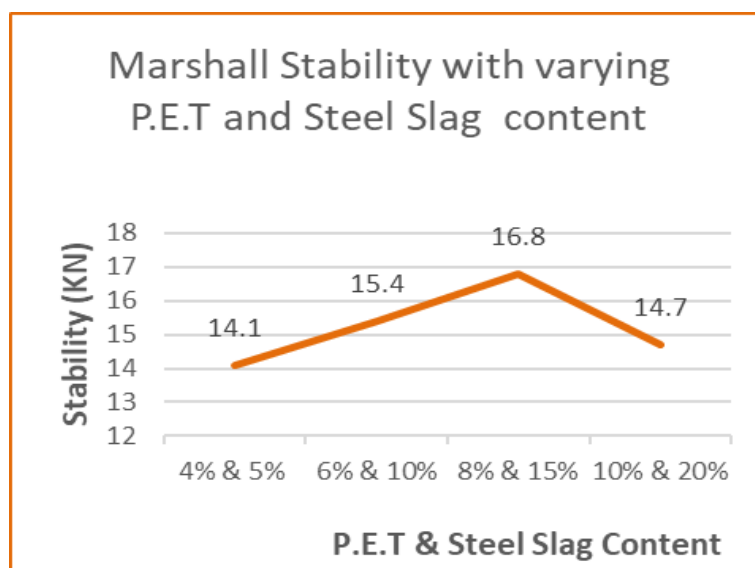


Fig 3(b) Marshall Stability variation for various P.E.T and steel slag contents.

The above Fig 3(b) shows the Marshall Stability values in KN for various P.E.T and steel slag combinations. For example- 4% P.E.T as a replacement to bitumen and 8% steel slag as a replacement to aggregates by total weights.

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As per IRC minimum stability value of 9 KN is suggested

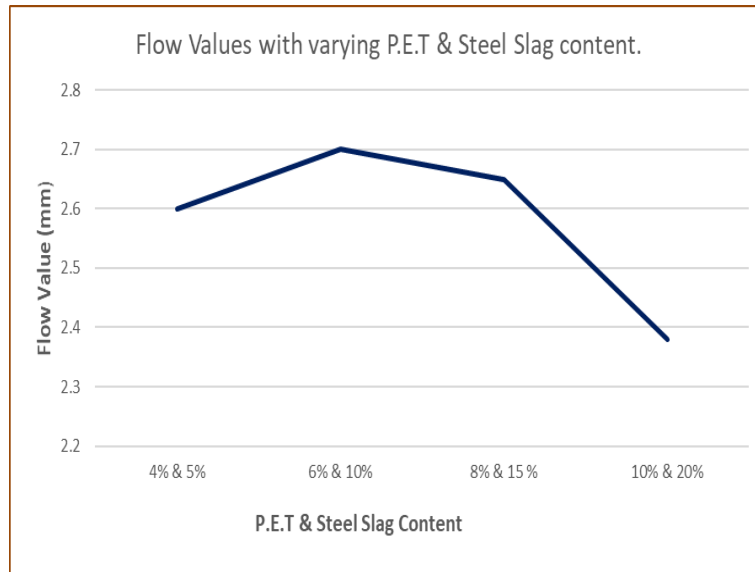


Fig 3(c) Marshall Flow in mm for various P.E.T and steel slag contents

The above Fig 3(c) shows the Marshall Flow values in mm for various P.E.T and steel slag combinations. It is observed that result starts falling down (negative) after point of 8% P.E.T and 15% steel slag addition. IRC specification for Marshall Flow ranges between 2mm-5mm.

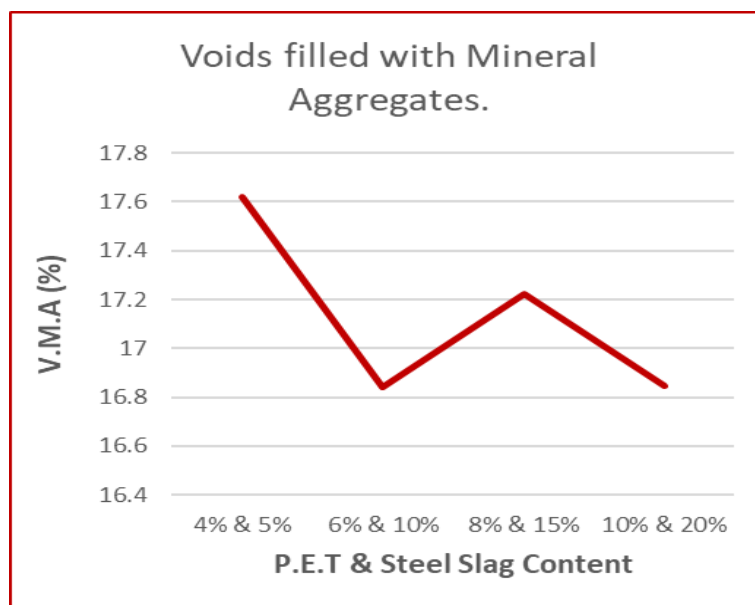


Fig 3(d) A graph of Voids in Mineral Aggregates Vs P.E.T and steel slag content

The above Fig 3(d) shows the graph representing Voids in Mineral Aggregates (VMA) in percentages.

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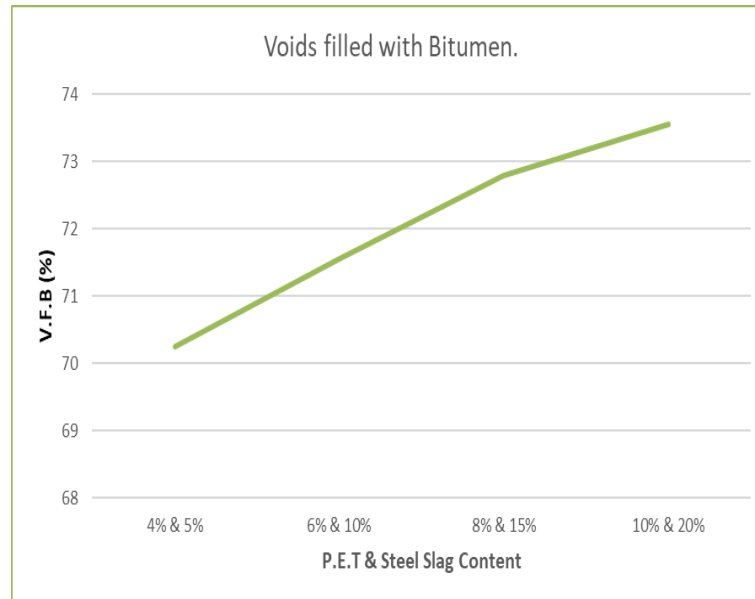


Fig 3(e) A graph of Voids Filled with Bitumen (VBF) Vs P.E.T and steel slag content

The above Fig 3(e) shows the graph representing Voids Filled with Bitumen (VBF) in percentages.

VI. CONCLUSIONS

- The optimum bitumen content was found out to be 4.5% It is seen that up to 8% use of plastic and 15% of steel slag improved results can be achieved.
- This study suggests a reliable alternative to the conventional materials used in construction of bituminous roads. It is seen that use of plastic and steel slag as a modifier is a good choice which also enhances the performance of the roads. Since plastic is a hazardous waste which has difficulties in disposal, its utilization in construction of road proves as an approach in safeguarding the environment and this work provides a scope for further studies of steel slag as an ingredient in flexible pavements.
- Use of steel slag increases the strength parameters. It provides resistance to rutting, stripping, permanent deformation etc.
- Modified mixes shows low permeability and seepage of water which would prevent formation of potholes and also increase durability.
- Cost of steel slag is very less approximately Rs 600 per tonne and are as affordable as stone aggregates. (market survey)
- Marshall stability and flow values show improved results for modified mix.
- Mostly costly ingredient in road construction is bitumen or asphalt, Since P.E.T would replace this bitumen there would surely be cost saving up to some extent making the process economic.

REFERENCES

- [1] R. Vasudevan, A.Ramalinga Chandrasekar, B Sundarakannan and R.Velkennedy," A technique to dispose plastics in an eco-friendly Way- Application in construction of flexible pavements", Construction and Building Materials 28(2012),pp. 311-320, 20 October 2011
- [2] Bhageerathy K. P, Anu P. Alex, Manju V. S, Raji A. K (2014), "Use of Biomedical Plastic Waste in Bituminous Road Construction". International Journal of Engineering and Advanced Technology (IJEAT). ISSN: 2249 – 8958, Volume-3 Issue-6, pp.89-92, August 2016.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

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- [3] Mushtaq Ahmad, Mohamad Bin Ayob (2015), “*Improvement of Asphaltic Concrete by Using Waste Polyethylen Terephthalate (PET)*”. International Journal of Innovative Research in Science, Engineering and Technology. Volume-4 Issue-8, pp.6744-6753, August 2015.
- [4] Srinivasa Raju Penmetsa, Ashwin Kesiraju, Addepalli Dinesh Varma (2015), “*Productive Re-Use Of Municipal Plastic Waste To Improve Temperature Resistance And Reduce Rain Water Infiltration In Flexible Pavement*”. International Journal of Civil Engineering and Technology (IJCET), ISSN 0976 – 6308 Volume-6 Issue-3, pp.1-9, March 2015
- [5] Atul Ashok Idate, Sushma Shekhar Kulkarni (2014), “*Utilization of Industrial Waste in Pavement*”. Current Trends in Technology and Science, ISSN: 2279- 0535. Volume: 3, Issue: 4, pp.322-328, October 2016.
- [6] Johnson Kwabena Appiah.” *Use of Plastic Waste for Road Construction in Ghana*”, Case Studies in Construction Materials 6(2017), pp.1-7, 11 November 2016;
- [7] Mrs. Vidula Swami, Abhijeet Jirge, Karan Patil, Suhas Patil, Sushil Patil, Karan Salokhe, “*Use of waste plastic in construction of bituminous road*”. International Journal of Engineering Science and Technology (IJEST), ISSN: 0975-5462, Volume-4 Issue-5, pp.2351-2355, May 2012.
- [8] Sudha.P, Hadadi1, Lakshmi Medleri, Shilpa Nayak, “*Characteristic Strength of Concrete using Steel Slag as a Coarse Aggregate*”. International Journal of Engineering Science and Computing(IJESC), Volume-7 Issue-5,pp.11665-11666, May 2017.
- [9] Nandini Suri, Y Anandh Babu.” *Experimental Investigation on partial Replacement of Steel Slack as Coarse Aggregate and Eco Sand as Fine Aggregate*”. International Journal of Engineering Science and Computing(IJESC),ISSN Online: 0976-6316, Volume 7, Issue 5, pp.322-328, September 2016.
- [10] Ravi Kumar H, Dr. J.K. Dattatreya, Dr. K.P Shivananda.” *Experimental Investigation on Replacement of Steel Slag as Coarse Aggregate in Concrete*”. Journal of Civil Engineering and Environmental Technology, ISSN: 2349 – 8404 Volume 2 Number 11, pp.58-63, April 2015.
- [11] Amit Gawande, G. Zamare, V.C. Renge, Saurabh Tayde, G. Bharsakale, “*An Overview On Waste Plastic Utilization in Asphaltting of Roads*”. Journal of Engineering Research and Studies, ISSN 0976-7916, Volume-3 Issue-2, pp.01-05, April 2012.