

Dense Bituminous Macadam Preparation by Utilizing Waste Plastic

Yogesh choudhary⁽¹⁾, Nandeshwar lata⁽²⁾, Bharat nagar⁽³⁾

¹M.tech scholar, ²Assistant Professor, ²Professor,

Department of Civil Engineering, Jagannath University Chaksu, Rajasthan, India

ABSTRACT

Plastic is cheaper material and it is used for mass industrial productions and also it is a effective raw material that is used in industrial mass production of started goods with plastic. Now, The various sectors of growing economy of country like information technology, automobile, construction, agriculture, communication is been exponentially and virtually transformed with the utilization of plastics. It has been widely seen that non-biodegradable items are in very much use now-a-days and it is also raising a great issue that how to manage plastic-squander. The various studies have connected the diverse ill-advised removal of plastic. The studies have been done to observe issues as far off as skin issues in people, malignant growth, genital variations from the norm and also ill effects on creatures. Various past investigations show that polymer waste can be use as asphalt development material by joining it with bitumen. Polymer changed bitumen is utilized rather than characteristic bitumen since it diminish weakness and perpetual harm in black-top asphalt. Bitumen is blended in with squander polymers in various forms. Ldpe and Polypropylene and various times Hdpe and so on are used in the blends. Their certain add up is used in blend to improve bitumen properties. Polymer changed bitumen are created by utilizing waste polymers, and by doing so, we lessen substance of normal bitumen and when it is achieved that less amount of bitumen is used by substituting than it becomes eco well disposed. Such innovation of development bring about equivalent better then the virgin blend and increment the anticipation against disappointment due to rutting and weakness along these lines diminishing the asphalt thickness. In this examination squander polymer is supplanted by bitumen in variety from 2 to 10% at time frame in thick Bituminous Macadam layer of adaptable asphalt. Marshall Stability test is performed to look at the quality and stream parameter to get the ideal portions squander polymer. It has been seen that 4 and 6 % of waste plastic in blend shows better outcomes as contrast with regular blend.

Key Words: Stability-Flow Test, DBM, Polymer Waste etc.

Date of Submission: 13-06-2020

Date of Acceptance: 29-06-2020

I. INTRODUCTION

When we talk about any of versatile material than plastic is considered one of them. From the times of industrial revolutions, there is always a need of cheap material for production of goods, and plastic than seems to be very cheap material that can be used as a raw material for production of goods. The various sectors of growing economy of country like information technology, automobile, construction, agriculture, communication is been exponentially and virtually transformed with the utilization of plastics. An estimated life of more than four thousand years has been researched by scientist for plastic and it makes this material a non-biodegradable material. There is a lot of improper removal/disposal of this material has been found by various studies and this action leads to severe hazards to health, this has also been studied in researches. Genital and hormonal

abnormalities have been found to be a great hazard for humans and other creatures and it has been also studied in some researches. Due to the heavy use of plastic as a raw material, the waste creation has taken a form of evil for present society and for its future also, but due to its increased demand a complete boycott or prohibition cannot be implemented. Instead of prohibition to use we can reuse waste generated in form of plastic.

Plastic waste

From the year 2000 the versatile development of roads constructed with waste plastic has initiated. To provide the binding amid the aggregates the use of bitumen is obliged in black-top pavement since it cover to aggregate to bond them together. The life and road attributes will also be improved. But it has been observed that water resistance of this is inferior. The quality of bitumen

can be enhanced in means of rheological properties when it is substituted or altered with elastic-plastic polymers. Addition or utilization of plastic in bitumen termed as polymer adjusted bitumen. There

is no requirement of any new development in the conventional workplace when reused LDPE is going to be blended with dark top mixes.



Fig. 1 Generated Waste of Plastic

Objectives

Main objectives of the study.

- Polymer modified bitumen will be compared with properties of virgin bitumen in wide scope.
- To analyze the effect on Dense Bituminous Macadam of Polymer bitumen and to analysis the Stability parameter and Strength by standard test of different mix at by keeping Polymer bitumen content maximum in Dense Bituminous Macadam.
- Economy of construction by using waste plastic so reduces the requirement of new road material.
- To make more eco friendly and to use waste material dumped in land.

II. REVIEW OF LITERATURE

Zhen Leng et.al. (2018) has conducted studies to explore the attainability of utilizing the waste PET added substances, determined through an aminolysis procedure, to improve the capacity security and rheological execution of scrap elastic changed black-top (CRMA). Both the capacity dependability, and rheological and concoction properties of the black-top covers all things

considered altered with PET added substances and CR were examined. It was discovered that the fuse of PET based added substances to CRMA improved the capacity soundness, rutting and weakness protections, and expanded the rotational thickness (RV) of the adjusted folios.

Shubham Bansal et.al. (2017) study endeavors to use these waste materials. In their studied they have adjusted fastener by substituting of bitumen in halfway to prepare a solid blend of asphalt bitumen. To reenact with the actual and practical field conditions the various examination have been performed and 'Marshall Stability Analysis' was also performed on the examples arranged. They have taken the supplanting in different percentages varying from four percent to ten percent and taken the interval of supplanting as two percent. And further more the supplanting with squander plastic is taken in range of 5 to 15 percent and they have taken interval of five percent in it. Test results show extra ordinary results as sixteen percent of additional quality has been observed while there is addition of fifty percent of squander plastic in the specimen with elastic material, and all these quality were augmented with standard blend. Research center testing results shows very

ecofriendly results as it targets to utilize less conventional material and by utilizing the said material the same conventional thickness and quality can be achieved in asphalt by utilizing such waste material. Along with this it also provides a logical solution to the disposal of waste.

Johnson Kwabena Appiaha et.al. (2017) have studied about thermoplastic polymers and they also analyzed impacts of its mixing. The impacts were studied about Polypropylene and high thicknes polythene by mixing them in different mixes of polymers of thermoplastic. TO observe the bitumen composite functionality the FTIR spectroscopy has been additionally utilized to over look the composite. The polymer adjusted bitumen has shown extraordinary progression in rheological **Materials**

properties when it has been compared with unmodified bitumen. The HDPE adjusted bitumen has shown good properties when modified with polypropylene polymer. The augmented consistency, impaction on homogeneity along with good penetration and impact value softening and viscosity values has been observed. The visco-elastic nature of conventional bitumen can be modified by supplanting of thermoplastic polymers. PP and HDPE were used in their studies to study different rheological properties of black-top. They have taken different percentages of supplanting the said waste and found good results for rheological properties of bitumen. Decreased value of penetration, increased value of softening, enhancement in dynamic and viscosity values has been observed in their study.

Table1 Bitumen Physical Properties

Properties	Raw Bitumen	Polymer Waste Bitumen	IS 73:2007 limits
Penetration	68	62	60-70
Ductility (cm)	79	72	Min.-40
SG	1.3	1.4	1.13
Softening Point (°c)	52	57	60
Viscosity (Poise)	1220	1380	--

Table 2 Properties of Aggregates

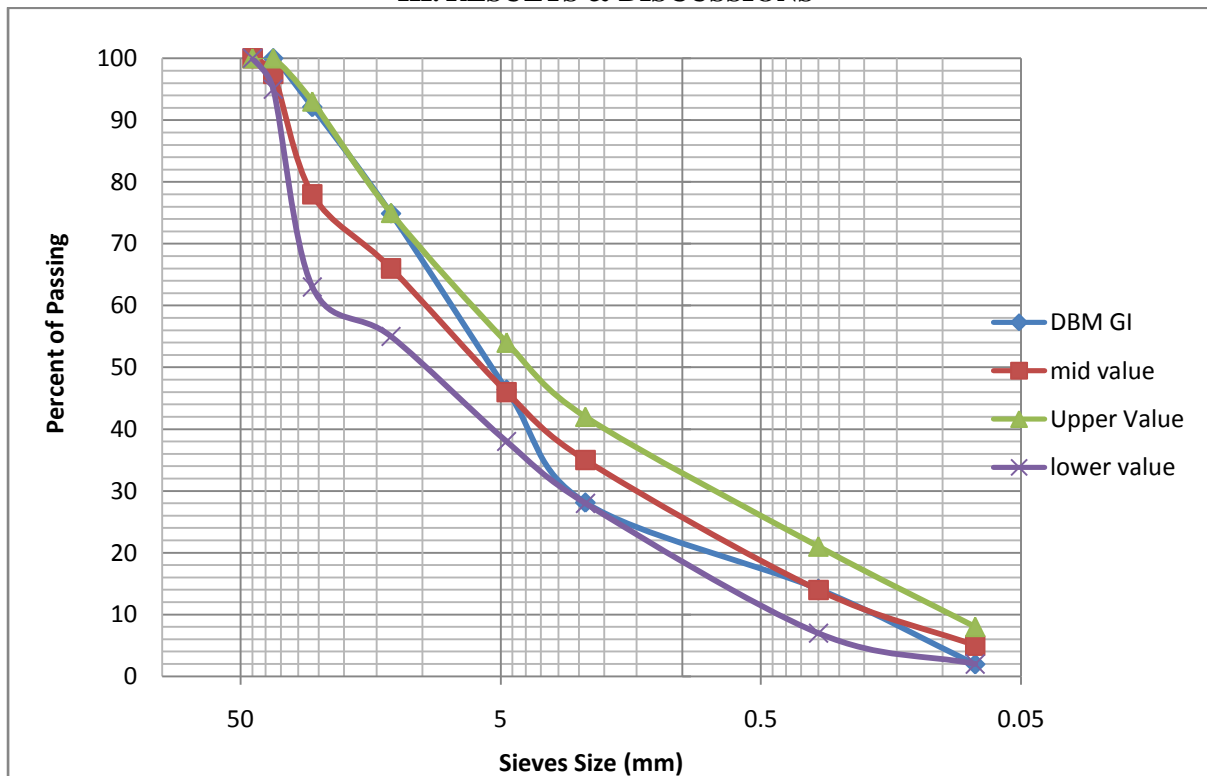
S. No.	Properties	IS Code(IS:2386)	Aggregates %
1	Flakiness and Elongation Indices	Part I	25.6%
2	Abrasion Value	Part IV	16.7%
3	SG	Part III	2.72
4	Crushing Value	Part IV	14.50%
5	Impact Value	Part IV	15.5%
6	Absorption Value	Part III	0.25%

A. Polymers Waste (PET)

Major problem for the world is plastic because of its nature. The reviews of various studies concluded that by the properties of bitumen and its strength can be enhanced by adding some

part of plastic that is in waste form. Polymer bitumen gives good resistance to water and temperature etc. Our study aims to utilize waste plastic bottle in crushed formed and is used with various percentage in bitumen

III. RESULTS & DISCUSSIONS



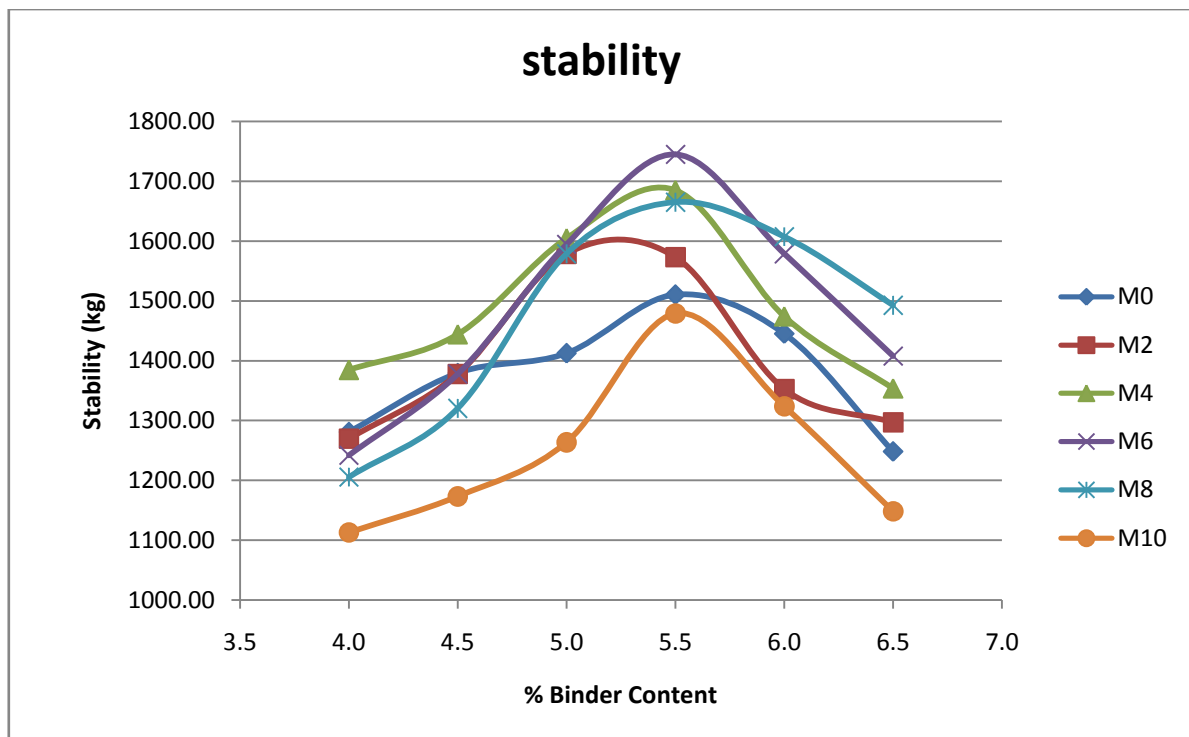
Graph 1 Job Mix Gradation for Dense Bituminous Macadam Grade I

Marshall Mix Test

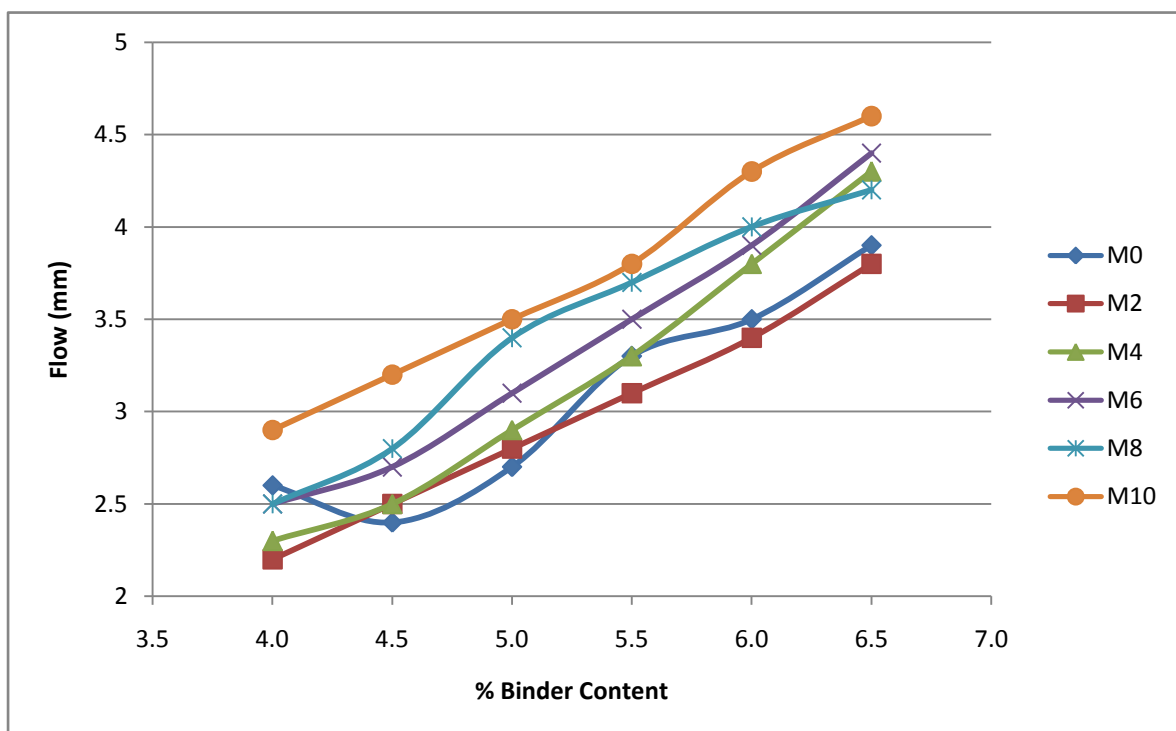
Featuring has been done on dominant mixes with the Marshall test to examine out the binder content value that is optimum and at which achievement of maximum stability cognized. For both the DBM Layers at different mixes, Marshall Test is performed on gradation.

Binder content shouldn't be less than 4.5 % of total mass as per the specification of

MoRT&H. For flexible pavement the BM is considered as surface coarse. Binder percentage is taken at different intervals initially it is taken 4 and on a broader state 6.5 percentis taken and the interval kept between various blend of mixes is 0.5 percent in order to evaluate optimum binder content value with taking help of Marshall Test. Under mentioned gives the values of binder content as outcome of test for different mix:



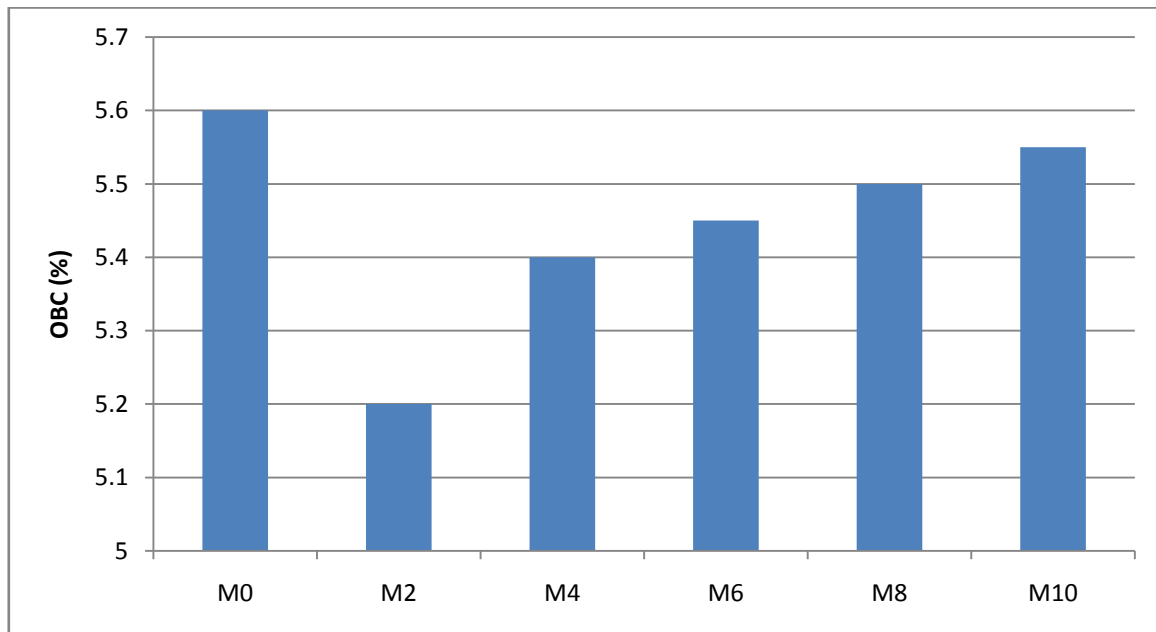
Graph 2 Comparative Graph of various mixes for DBM layer at different binder



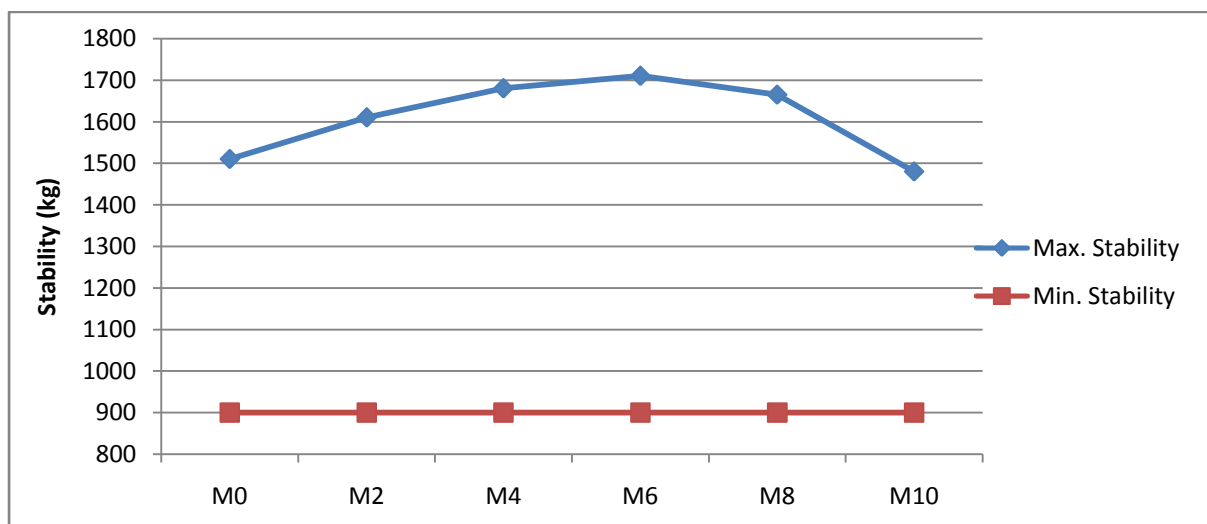
Graph 3 Comparative Graph of various mixes for DBM layer at different binder

Table3 DBM layer Analysis Marshall Test of Different mixes

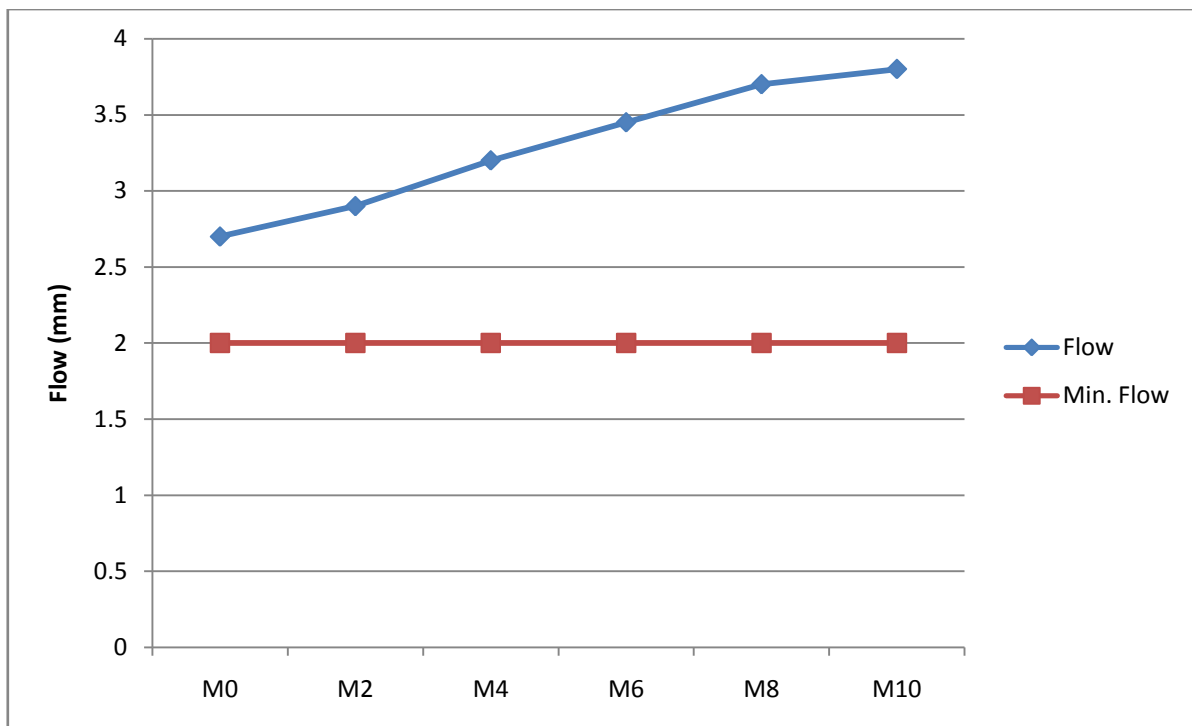
MIXES	OBC (%)	Ultimate Stability (KG)	Flow rate (mm)	Quotient (KN/mm)
M-0	5.6	1510	2.7	5.59
M-2	5.2	1610	2.9	5.55
M-4	5.4	1680	3.2	5.25
M-6	5.45	1710	3.45	4.96
M-8	5.5	1665	3.7	4.50
M-10	5.55	1480	3.8	3.89



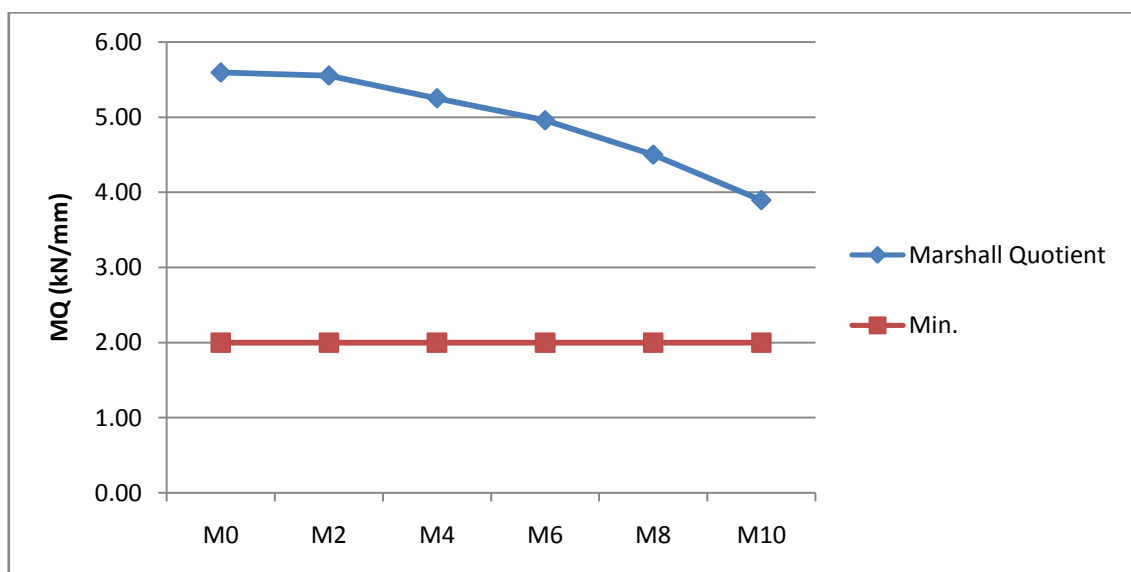
Graph 4 Comparison of various mixes Optimum Binder Content



Graph 5 Comparison of various mixes for maximum Stability at OBC



Graph 6 Flow comparison of various mixes



Graph 7 Marshall Quotient comparison of various mixes for layer

Properties of Polymer waste Bitumen

Various experiments has been done on the waste polymer bitumen and the standards of tests has been taken from IS 73:2007. Physical properties of waste Bitumen that is prepared with blend of polymer are observed with these test and

the values of properties of raw bitumen has been compared with the same. Various properties of Polymer waste Bitumen contains for pavement work. Experimental are followed as code of IS73:2007.

Table 4 Properties of Polymer Waste Bitumen compared to raw bitumen

Properties	Bitumen	Polymer Waste Bitumen	IS 73:2007 limits
Viscosity (Poise)	1250	1450	--
Ductility	80	89	minimum.40
Penetration	76	68	65-70
SG	1.3	1.4	1.15
Softening Point	60	75	60-65

IV. CONCLUSION

The waste plastic reduces the need of bitumen content around the 10-6%. It has been also observed that there is an increment found in performance of the road; also the strength parameters are increased. Plastic that is worthless and a total waste used in pavement reduces the cost bitumen used as binder. The melting point of bitumen also decreases with Using waste plastic and increase the penetration value which indicates that modified waste polymer bitumen can be used for high temperature zones. Use of the new and grateful technology not give strength the road pavement but also increases the life of pavement. Plastic decreases the

ductility, a higher softening point which directly indicates reduction of rutting and cold crack in flexible pavement.

Marshall Stability for various mixes at 0%, 2%, 4%, 6%, 8% and 10% replacing waste polymer by virgin bitumen in DBM mix are 1510, 1610, 1680, 1710, 1665 and 1480 kg. Stability is increase till 6% of replacement after than stability is in decreasing order. Flow values increased with aggregate % replacement. Filler content decreases with percent of replacement of bitumen. Waste polymer reduces the construction cost as it reduces the requirement of natural material which makes project economical. Utilization of waste polymer in dense bituminous macadam increases the strength and flow at certain amount of doses which reduces the waste and makes environment eco friendly.

REFERENCES

- [1]. Md Maniruzzaman A. Aziz, Md Tareq Rahman et.al., "An overview on alternative binders for flexible pavement", *Construction and Building Materials* 84 (2015) 315–319
- [2]. Zhen Leng, Rabindra Kumar Padhan, Anand Sreeram, "Production of a sustainable paving material through chemical recycling of waste PET into crumb rubber modified asphalt", *Journal of Cleaner Production* 180 (2018) 682e688
- [3]. Umadevi Rongali, Gagandeep Singh et.al. , "Laboratory investigation on use of fly ash plastic waste composite in bituminous concrete mixtures" *Procedia - Social and Behavioral Sciences* 104 (2013) 89 – 98
- [4]. Shubham Bansal, Anil Kumar Misra, Purnima Bajpai "Evaluation of modified bituminous concrete mix developed using rubber and plastic waste materials", *International Journal of Sustainable Built Environment* (2017) 6, 442–448
- [5]. Johnson Kwabena Appiah, Victor Nana Berko-Boateng, Trinity Ama Tagbor, "Use of waste plastic materials for road construction in Ghana", *Case Studies in Construction Materials* 6 (2017) 1–7
- [6]. D. Movilla-Quesada, A.C. Raposeiras et.al., "Use of plastic scrap in asphalt mixtures added by dry method as a partial substitute for bitumen", *Waste Management* 87 (2019) 751–760
- [7]. Sara Fernandes, Liliana Costa et.al. , "Effect of incorporating different waste materials in bitumen" *Ciência & Tecnologia dos Materiais* 29 (2017) e204–e209
- [8]. Bindu C. S,Dr. K.S. Beena," Waste plastic as a stabilizing additive in Stone Mastic Asphalt" *International Journal of Engineering and Technology* Vol.2 (6), 2010, 379-38
- [9]. IRC: SP: 98-2013. "Guideline for the Use of Waste Plastic in Hot Bituminous Mixes (Dry Process) in Wearing Courses". Indian Road Congress
- [10]. Specification for Road and Bridge Works-5th Revision, Ministry of Road Transport & Highways.
- [11]. L.R Schroeder, "The Use of Recycled Materials in Highway construction", *Public Roads*, Vol 58(Issue 2), 1994.
- [12]. Sunil Bose, Sridhar Raju , "Utilization of waste plastic in Bituminous Concrete mixes", *Roads and Pavements*, (2004), 49