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# Use of Polymer Modified Bitumen in Road Construction

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**Abstract –** *Due to the heavy traffic on the streets, over-burdening of vehicles and temperature variance of pavements because of climatic changes stimulates development of a variety distresses to the bituminous surfacing. Because of high temperature, bitumen becomes very soft in summer and fragile in winter. Additionally, in a developing nation like India, roadway development is occurring at a high pace which require substantial request of development material that too eco-accommodating and sparing. A few Investigations have uncovered that properties of bitumen and bituminous blends can be enhanced/adjusted with expansion of specific added substances and the bitumen premixed with these added substances/modifiers is known as modified bitumen. This paper includes detailed specifications of the types and properties of Polymer Modified Bitumen. It also explains its advantages and disadvantages as per its applications in a developing country like India.*

***Key Words***: **MODIFIED BITUMEN, POLYMER, MARSHALL STABILITY**

## I. Introduction

A rising quality of life, and high rates of resource utilization patterns have had an unintended and adverse effect on the urban condition - generation of wastes far beyond the handling capacities of urban governments and agencies. Urban cities are presently thinking about the issues of high volumes of waste, the costs included, the transfer advances and philosophies, and the impact of wastes on the local and global environment. In any case, these issues have additionally given a window of chance to urban areas to discover arrangements - including the group and the private part; including creative advances and transfer techniques; and including conduct changes and awareness raising. These issues have been abundantly shown by great practices from numerous urban cities around the globe. Developing enterprises and populace together has resulted in generation of different sorts of waste materials. The creation and transfer of non-rotting waste materials, for example, Fly-ash, Steel Slag, Scrap Tires, Plastics and so on have been posturing troublesome issues. Extensive work has been done in different nations for the transfer of some of these waste items and use of some different products.

## Polymer: Definition

Any of numerous natural and synthetic compounds of usually high molecular weight consisting of up to millions of repeated linked units, each a relatively light and simple molecule.

## II. Polymer Modified Bitumen

Improvements in the assembling procedure of Polymer Altered Bitumen (PMB) are continually expanding the end execution of street and asphalt surfaces. Modified Bitumen has been utilized for more than 30 years and was presented in the 80's. Manufacturers are ceaselessly endeavoring to enhance the execution through more tightly quality controls and advanced manufacturing processes employed. Numerous experts now prescribe the utilization of at least 10% adjusted bitumen which brings about longer enduring streets with better execution.

Through research and ascertained insights of expanded general movement volumes, tire weights, overwhelming hub loadings, speed of activity, ecological and atmosphere changes and concerns, have requested inventive street development outlines and materials to be used.

Polymers were acquainted with bitumen to alter its unique conduct. They compose and amount of polymer included, the based bitumen cover utilized and the production technique utilized will extraordinarily impact the end execution attributes of the changed bitumen delivered. A harmony between the consistency and elastics properties of a cover, can be discovered, controlled and accomplished by utilizing the right base bitumen and polymer.

## Types of Polymer Modified Bitumen (PMB)

1) Plastomeric Thermo Plastic Based Type-A (PMB 120, 70, 40) – Penetration Based Polymer used PE, EVA, EBA, EMA etc.

| S.NO | Characteristic | Requirements | | | ASTM Standards |
|---|---|---|---|---|---|
| | | PMB(P)-120 | PMB(P)-70 | PMB(P)-40 | |
| 1 | Penetration at 25°C, 1/10mm, 100g, 5 sec | 90-150 | 50-90 | 30-50 | D 5 |
| 2 | Softening Point, (R&B),°C, Min | 50 | 55 | 60 | D 36 |
| 3 | Fraass Breaking Point # °C, Min | -20 | -16 | -12 | - |
| 4 | Elastic Recovery at 15°C, %, Min or | 50 | 40 | 30 | D 6084 |
| | G*/sin?, min1.0 kpa, 25 mm plate, 10rad/s at a temp °C | 52 | 58 | 72 | |
| 5 | Flash Point, COC, °C, Min | 220 | 220 | 220 | D 92 |
| 6 | Separation, Difference in Softening Point, (R&B),°C, Max | 3 | 3 | 3 | - |
| 7 | Viscosity at 150°C, Poises | 1-3 | 2-6 | 3-9 | D 2170/D4402 |
| 8 | Thin Film Oven Test & Tests on Residue | - | - | - | D 2872 |
| 8a | Loss in Mass, %, Max | 1.0 | 1.0 | 1.0 | D 6 |
| 8b | Reduction in Penetration of residue at 25°C, 1/10mm, 100g, 5 sec, %, Max | 35 | 35 | 35 | - |
| 8c | Increase in Softening Point, °C, Max | 7 | 6 | 5 | - |
| 8d | Elastic Recovery at 25°C, %, Min or | 35 | 30 | 20 | D 6085 |

**Chart 1:** Specifications of Plastomeric Thermo Plastic Based Type-A Bitumen

2) Elastomeric Thermoplastic Based Type-B (PMB 120, 70, 40)– Penetration Based Polymer used SIS, SBS, ETP etc.

| S. NO | Characteristic | Requirement PMB(E)120 | PMB(E)70 | PMB(E)40 | ASTM Standards |
|---|---|---|---|---|---|
| 1 | Penetration at 25°C, 1/10mm, 100g, 5 sec | 90-150 | 50-90 | 30-50 | D5 |
| 2 | Softening Point, (R&B),°C, Min | 50 | 55 | 60 | D36 |
| 3 | Fraass Breaking Point # °C, Min | -20 | -16 | -12 | - |
| 4 | Elastic Recovery at 15°C, %, Min | 70 | 70 | 70 | D6084 |
| 5 | Flash Point, COC, °C, Min | 220 | 220 | 220 | D92 |
| 6 | Separation, Difference in Softening Point, (R&B),°C, Max | 3 | 3 | 3 | - |
| 7 | Viscosity at 150°C, Poises | 1-3 | 2-6 | 3-9 | D2176 D2872 |
| 8 | Thin Film Oven Test & Tests on Residue | - | - | - | |
| 8a | Loss in Mass, %, Max | 1.0 | 1.0 | 1.0 | D6 |
| 8b | Reduction in Penetration of residue at 25°C, 100g, 5 s, %, Max | 35 | 35 | 35 | - |
| 8c | Increase in Softening Point, °C, Max | 7 | 6 | 5 | - |
| 8d | Elastic Recovery at 25°C, %, Min | 50 | 50 | 50 | D6085 |

**Chart 2:** Specifications of Elastomeric Thermoplastic Plastic Based Type-A Bitumen

3. Natural Rubber Based Type-C (NRMB 120, 70, 40) – Penetration Based Latex or Rubber powder

| S.NO | Characteristic | Requirement NRMB 120 | NRMB 70 | NRMB40 | ASTM Standards |
|---|---|---|---|---|---|
| 1 | Penetration at 25°C, 1/10mm, 100g, 5 sec | 90-150 | 50-90 | 30-50 | D 5 |
| 2 | Softening Point, (R&B),°C, Min | 45 | 50 | 55 | D 36 |
| 3 | Fraass Breaking Point # °C, Min | -20 | -16 | -12 | - |
| 4 | Elastic Recovery at 15°C, %, Min | 50 | 40 | 30 | D 6084 |
| 5 | Flash Point, COC, °C, Min | 220 | 220 | 220 | D 92 |
| 6 | Separation, Difference in Softening Point, (R&B),°C, Max | 3 | 3 | 3 | - |
| 7 | Viscosity at 150°C, Poises | 1-3 | 2-6 | 3-9 | D 2170/D4402 D 2872 |
| 8 | Thin Film Oven Test & Tests on Residue | - | - | - | |
| 8a | Loss in Mass, %, Max | 1.0 | 1.0 | 1.0 | D 6 |
| 8b | Reduction in Penetration of residue at 25°C, 100g, 5 s, %, Max | 35 | 35 | 35 | - |
| 8c | Increase in Softening Point, °C, Max | 7 | 6 | 5 | - |
| 8d | Elastic Recovery at 25°C, %, Min | 35 | 25 | 20 | D 6085 |

**Chart 3:** Specifications of Natural Rubber Based Type-C Bitumen

4. Crumb Rubber Based Type-D (CRMB 50, 55, 60) – Softening Point Based Crumb Rubber powder from discarded truck tires

| S.NO | PROPERTIES | CRMB 50 | CRMB 55 | CRMB 60 | ASTM STANDARDS |
|---|---|---|---|---|---|
| 1 | Penetration at 25°C, 1/10mm, 100g, 5 sec | < 70 | < 60 | < 50 | D5 |
| 2 | Softening Point, (R&B),°C, Min | 50 | 55 | 60 | D36 |
| 3 | Elastic Recovery at 15°C, %, Min | 50 | 50 | 50 | D6084 |
| 4 | Flash Point, COC, °C, Min | 220 | 220 | 220 | D92 |
| 5 | Separation, Difference in Softening Point, (R&B),°C, Max | 4 | 4 | 4 | - |
| 6 | Viscosity at 150°C, Poises | 1-3 | 2-6 | 3-9 | D2170/D4402 |
| 7 | Thin Film Oven Test & Tests on Residue | - | - | - | D2872 |
| 7a | Loss in Mass, %, Max | 1.0 | 1.0 | 1.0 | D6 |
| 7b | Reduction in Penetration of residue at 25°C, 100g, 5s, %,Max | 40 | 40 | 40 | - |
| 7c | Increase in Softening Point, °C, Max | 7 | 6 | 5 | - |
| 7d | Elastic Recovery at 25°C, %, Min | 35 | 35 | 35 | D6085 |

**Chart 4:** Specifications of Crumb Rubber Based Type-D Bitumen

## III. Selection Criteria for Grades of Modified Bitumen

| Lowest Mean Air Temperature °C | Highest Air Mean Temperature °C | | |
|---|---|---|---|
| | Less than 20°C | 20°C to 30°C | More than 30°C |
| More than -10°C | PMB / NRMB 55 | PMB / NRMB 45 | PMB / NRMB 50 |
| | CRMB 50 | CRMB 55 | CRMB 60 |
| -10°C or lower | PMB / NRMB 55 | PMB / NRMB 120 | PMB / NRMB 45 |
| | CRMB 50 | CRMB 50 | CRMB 55 |

**Chart 5:** Selection Criteria

## IV. Working Temperature Required for Modified Bitumen

| STAGE OF WORK | INDICATED TEMPERATURE °C |
|---|---|
| BITUMEN AT MIXING TEMPERATURE | 165 - 185 |
| AGGREGATE AT MIXING | 165 - 185 |
| MIX AT MIXING PLANT | 150 - 170 |
| MIX AT LAYING | 130 - 160 |
| ROLLING AT LAYING SITE | 115 - 145 |

**Chart 6:** Working Temperature

## V. Advantages of PMB

- Stronger road with increased Marshall Stability Value.
- Better resistance towards rain water and water stagnation.
- No stripping and no potholes.
- Increase binding and better bonding of the mix.

- Reduction in pores in aggregate and hence less rutting and ravelling.
- Generate jobs for rag pickers.
- The strength of the road is increased by 100%. For 1km X 3.75m road, 1 ton of plastic (10 lakh carry bags) is used and 1 ton of bitumen is saved.
- Value addition to the waste plastics (cost per kilogram increases from Rs 4 to Rs12).
- Reduce the cost to around Rs. 5000/Km. of single lane road.
- The maintenance cost of road is almost nil. Disposal of waste plastic will no longer be a problem

## VI. Disadvantages of PMB

- Cleaning process -: Toxics present in the co-mingled plastic waste would start leaching.
- During the road laying process -: In the presence of chlorine will definitely release noxious HCL gas.
- After the road laying -: It is opined that the first rain will trigger leaching. As the plastics will merely form a sticky layer, (mechanical abrasion). The components of the road, once it has been laid, are not inert.

## VII. Conclusion

- Plastic will increase the melting point of the bitumen.
- Help to improve the environment.
- Plastic roads would be a boon for India's hot and extremely humid climate, leaving most of the roads with big potholes.
- Waste plastics when mixed with binder is found to give higher strength, higher resistance to water and better performance.
- The High Cost of Polymers is still a cause for concern.
- Bitumen prices are on the rise.
- Natural Disasters like flooding which erode roads is another factor taken into consideration.
- CRMB AND NRMB should be more actively specified.
- Advance Economies are still the major users of PMB. Local Road Authorities in Developing Countries should be better informed of the benefits of using Modified Bitumen over standard grades.
- Increased traffic conditions will and are reducing the life span of roads. Modified bitumen is a means of prevention, and ultimately will be the cure. It will save millions of dollars in the future and reduce the amount of the resources used for construction.
- Using recycled Polymers and Rubber to make Modified Bitumen helps to Save the Earth and benefit the Environment.

## REFERENCES

[1] Bindu, C.S. Beena, K.S. (2010). "Waste plastics as stabilizing additive in Stone Matrix Asphalt", International Journal of Engineering and Technology, Vol.2(6), 379-387

[2] IRC SP-53:2010, "Guidelines on use of modified bitumen in road construction"

[3] IRC SP: 53-2002, 2004, 2010 "Guidelines on use of Polymer and Crumb Rubber Modified binders

[4] Ministry of Road Transport and High Ways, Manual for construction and supervision of Bituminous works, New Delhi, November 2001.

[5] Ministry of Road Transport and Highways Specification (2010)

[6] R. Vasudevan, S. K. Nigam, R. Velkennedy, A. Ramalinga Chandra Sekar and B. Sundarakannan, 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, Chennai, India, September (2007) pp. 105-111

[7] Rokade S "Use of Waste Plastic and Waste Rubber Tyres in Flexible Highway Pavements" (2012) International Conference on Future Environment and Energy IPCBEE vol.28, IACSIT Press, Singapore (2012)

[8] Sabina, Khan Tabrez A, Sangita, Sharma D.K., Sharma B.M, Performance Evalution. of Waste Plastic/ Polymers Modified Bituminious Concrete Mixes, Journal of Scientific and Industrial Research Vol.68,2009.