IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

MASTERING IN BITUMEN

[1]Vishwajeet Singh, [2]Shivam Pandey, [3]Rahul Kumar, [4]Vikrant Yadav,

[5]Harivash Chaudhary

[1234]B.Tech Students, [5]Assistant Professor,
[1234]School of Civil Engineering
[1234]Galgotias University, Greater Noida, Uttar Pradesh, India

Abstract: This review examines the current state of expertise and experience in the field of modified bitumens. The data for this thesis came from a comprehensive analysis of the most recent articles in the literature on updated bituminous materials, processes, and advancements. The paper is divided into two main parts for this reason. The bitumen itself is studied change in physical and chemical properties in terms of modified and unmodified bitumens in the first section. The paper's second section is on bitumen field investigation and standard deviation in some properties of modified and unmodified bitumen. In conclusion, the findings of this analysis have shown the significance of bitumen properties before and after modification. Although some polymers and binders can enhance one or more aspects of unmodified bitumen properties, they can also cause consistency issues when it comes to storage and temperature. In this regard, several experiments have shown the effectiveness of polymers in enhancing bitumen compatibility as well as several advantages related to binder mix into bitumen.

Index Terms – Binder, Chemical properties.

1. Introduction

Bituminous mixes are commonly used for paving in India and around the world. In India, road projects are currently undertaken on a Design, Construct, Operate, and Transfer (DBOT) basis. To satisfy contractual commitments, the highway contractor and the agency must ensure that the pavement performs satisfactorily during its construction existence. The serviceability of bituminous pavements during the design life is determined by the collection of suitable paving binders when taking into account climatic and loading requirements, as well as the scientific design of the thicknesses of different pavement layers. The form, consistency, and quantity of binder used have a significant impact on the mechanical properties of bituminous mixes. Rutting, crack formation, and proliferation in flexible pavements are caused not only by traffic loads, but also by the thermal resistance of bituminous binders.
Bitumen is a petroleum liquid or semi-solid that is sticky, black, and extremely viscous. It is a pitch-like material that can be contained in natural deposits or as a refined product. The word bitumen was still used until the twentieth century. The word is derived from the ancient Greek word bitumenous, which was derived from a word from the East.

The primary application of bitumen (70 percent) is in road construction, where it is used as a glue or binder in combination with aggregate particles to form asphalt concrete. Its other key applications include bituminous waterproofing products, such as roofing felt and flat roof sealing.

In India, an ambitious road plan is in the works, mainly involving bituminous pavements. MORTH specification for road and bridge work, 2001 Version is currently being used for the construction of all highways, including the National Highway. Nearly every year, advancements in bitumen construction technology are made around the world. This report discusses bitumen's history, field applications, processing, bitumen tests, types of bitumen, composition of bitumen, and how to treat bitumen, among other topics.

2. Objectives

- Checking the properties of different modified bituminous binders in the lab.
- Laboratory experiments on a standard bituminous mix using different modifiers, as well as an analysis of the mix's properties.
- Research bituminous mix rutting efficiency in the lab and build performance prediction.
- Build performance prediction for use in pavement construction by studying the field performance of a thin bituminous overlay with various bituminous binders.

3. Literature

Bitumen emulsion is a combination of fine bitumen droplets and vapour. However, since bitumen is a petroleum oil, it does not blend with water and is sticky, it is difficult to disintegrate into fine droplets. An emulsifier is used to solve this problem. A surface-active agent is what an emulsifier is. By preventing the bitumen from mixing with other droplets, the emulsifier holds it in its fine droplet form. Since the droplets are so thin, they float in water.

4. DATA COLLECTION

NHAI, ASPT, NCHRP, and EVA datasets were used in this research. As seen in the table, data is aggregated into a single set by integrating and averaging set of datas connected to different perimeters of physical properties of bitumen. The focus of the research is on comparing the properties of modified and unmodified bitumen. In addition, it can be compared to a field investigation. So the dataset of Field Investigation is taken from Kuduvathi to Kodalagurkhi on National Highway NH104, Karnataka. The data is chosen in table format

Table 1: Physical properties of modified and unmodified binders

Properties	Binder Type				
	VG30	**PMB70**	**CRMB55**	**NRMB70**	**WPMB70**
Penetration at 25 °C 0.1mm, 100g, 5s	60 to70 (60 to 70)	50 to 60 (50 to 90)	30 to 40 (< 60)	50 to 60 (50 to 90)	30 to 40 (30 to 50)
Softening point (R&B), oC	46 (45-55)	60 (55 min)	56 (55 min)	50 (50 min)	62 (60 min)
Flash Point, °C	> 220 (175 min)	> 220 (220 min)	> 220 (220 min)	> 220 (220 min)	220 (220 min)
Ductility at 27 °C cm	80 (75 min)	100 +	57.7	78.5	34
Specific gravity, gm/cc	1 (0.99 min)	1.03	1.03	1	1.045
Elastic recovery at 15 °C (%)	71	77 (70 min)	68 (50 min)	55 (40 min)	23.67 (50 min)
Viscosity at 150 °C, (@ 135 °C for VG30), Poise	5.29 (3 min)	7.29 (2-6)	7.87 (2-6)	2.97 (2-6)	5.33 (3-9)
Separation, Difference in softening Point, °C	---	1 (3)	2 (3)	2 (3)	3 (3)
After subjecting to aging in thin film oven					
Loss in weight (%)	0.42 (1 max)	0.19 (1 max)	0.35 (1 max)	0.3 (1 max)	1.01 (1 max)
Reduction in penetration of residue at 25 °C (%)	18.23 (48 max)	12.72 (35 max)	28.57 (40 max)	11.67 (40 max)	26.67 (35 max)
Increase in softening Point, °C	4	2 (6 max)	4 (6 max)	3 (6 max)	7 (6 max)
Elastic recovery at 25 °C (%)	---	60 (50 min)	48 (35 min)	32 (25 min)	23 (35 min)

Table 2: Deflection studies on test before construction (July 2010)

Chainage	**Bitumen type**	**Corrected Charact. Defl., in mm**	**Chainage**	**Bitumen type**	**Corrected Charact. Defl., in mm**
84 to 85	VG30	0.269	94 to 95	PMB70	0.323
85 to 86		0.217	95 to 96		0.326
86 to 87		0.215	96 to 97	NRMB70	0.272
87 to 88		0.220	97 to 98		0.253
88 to 89	CRMB55	0.194	98 to 99		0.219
89 to 90		0.259	99 to 100		0.413
90 to 91		0.282	100 to 101	WPMB70	0.213
91 to 92		0.267	101 to 102		0.222

92 to 93	PMB70	0.223	102 to 103		0.359
93 to 94		0.286	103 to 104		0.507

5. METHODOLOGY

First we had learnt about the property about the bitumen which include the history of bitumen, its manufacturing process, characteristic properties which includes physical and chemical of bitumen. Bitumen Emulsion is one of the important form of bitumen and it has various positive aspects but also have some negative sides, we had come to know about it. Then we had collected the laboratory data of physical characteristics of modified as well as unmodified bitumen and compare it in tabular form using software. We will learnt about some modified and unmodified binders that are used in PCC construction of Highways. Then we had done a field investigation where they had done the renovation of road by modified bitumen(initial construction had been done with unmodified bitumen) NH104 in Karnataka, where we had collected the dataset and transform it in simplest form. We had taken the set of data of various test before construction and test after construction of that field. We compare both the data and then, we finally conclude it.

The software in use is non-automated analytics software. They'll need to know a lot about data and how to work in the industry. As a result, we are able to engage, discover, and be introduced to different factors that must be addressed when doing such study and testing. Advanced software can provide you with fast and accurate results, but it has its own limitations. They will only act to that degree and do not encourage us to conduct further study. Therefore, we use softwares like Tableau, Smart draw, MS excel, etc in making the project.

TABLEAU is a platform that allows users to quickly and interactively view and visualise results. Previously, it was only intended for the management of business intelligence and sales force results. It is now regarded as the best choice for data management. Later on, people began to use it for relational analysis and database discovery, as well as simulation techniques. It can extract, retrieve, and store data in a variety of formats to create graph visualisations.

In this project we use Smartdraw, which is one of the best know software that anyone who wants to draw a picture, from contractors and architects to corporate leaders and project managers, should use SmartDraw. The resources in SmartDraw can help every professional become more productive. This is economically also best and very easy to work with it which help beginers to work comfortably with it.

6. RESULTS

A. Quality Control

Density, gradation, and bitumen content measurements were taken before and immediately after the installation of the test stretches to ensure that the strength of the bituminous overlay construction matched the specifications. As seen in Table, the use of different bitumens has no significant impact on the density values for a given aggregate gradation. On the other hand, the production temperature range, storage, and placement all play a major role. Variations in the density of bituminous waste + ingredient blends have also been observed, which may be due to production process variations.

Figure 1: Quality control test

Table 3: Density control during construction (March-April 2010)

Chainage	Bitumen type	Bulk Density		
		No of samples	Mean	Std Dev
84 to 88	VG30	8	2.28	0.02
88 to 92	CRMB55	8	2.28	0.03
92 to 96	PMB70	8	2.30	0.03
96 to 100	NRMB70	8	2.28	0.03
100 to 104	WPMB70	8	2.30	0.10

B. *Periodic Pavement Performance Evaluation*

In the pavement performance appraisal measures, the evolution of pain such as rutting, cracking, roughness, and overall condition was studied. Calculating rebound deflection on a regular basis was used to determine structural adequacy. For the entire test stretch, the table displays the differences in deflection values of different bituminous blends.

Table 4: Deflection studies after construction

Chainage	Bitumen type	Characteristic deflection, mm			
		First cycle after construction	Second cycle after construction	Third cycle after construction	Fourth cycle after construction
84 to 85	VG30	0.82	1.11	1.25	1.29
85 to 86		1.06	1.39	1.61	2.01
86 to 87		0.72	0.98	1.19	1.22
87 to 88		0.45	0.65	0.82	0.91
88 to 89	CRMB55	0.55	0.77	0.88	1.18
89 to 90		0.67	0.92	1.14	1.30
90 to 91		0.37	0.54	0.9	1.31
91 to 92		0.7	0.96	1.25	1.45
92 to 93	PMB70	1.11	1.44	1.74	1.82
93 to 94		1.02	1.36	1.48	1.55
94 to 95		0.39	0.58	0.73	0.81
95 to 96		0.73	0.99	1.32	1.35
96 to 97		0.98	1.48	1.56	1.61
97 to 98		0.94	1.26	1.36	1.46
	NRMB70				
98 to 99		1.19	1.86	2.10	2.22
99 to 100		0.63	0.86	0.99	1.07
100 to 101	WPMB70	0.46	0.66	0.85	0.97
101 to 102		0.59	0.82	0.98	1.24

The diagrams below illustrate how deflection varies over time with different binders in different wearing courses. Power law models with similarities greater than 0.9 in all situations capture the trend in deflection progression (Table given below). The established models used normalised deflections to account for variations in the structural adequacy of the pavement system prior to overlaying.

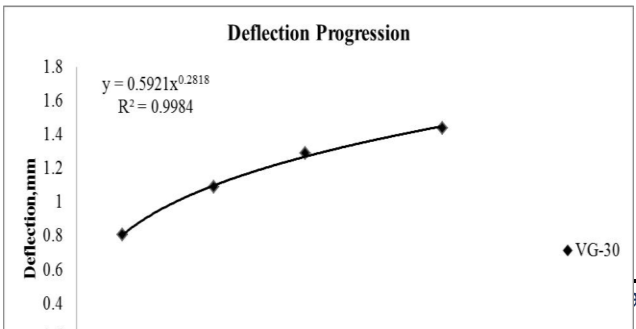
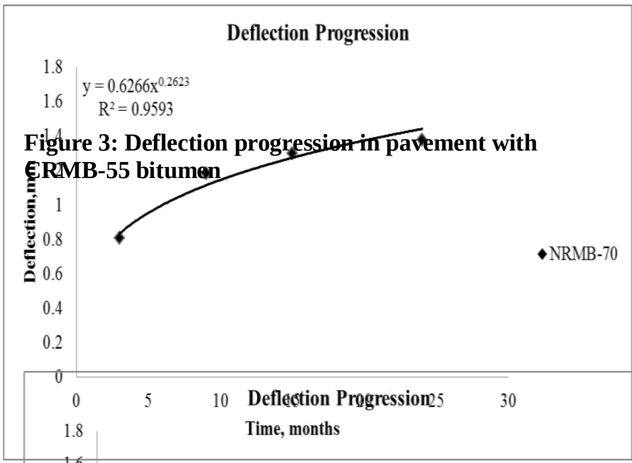
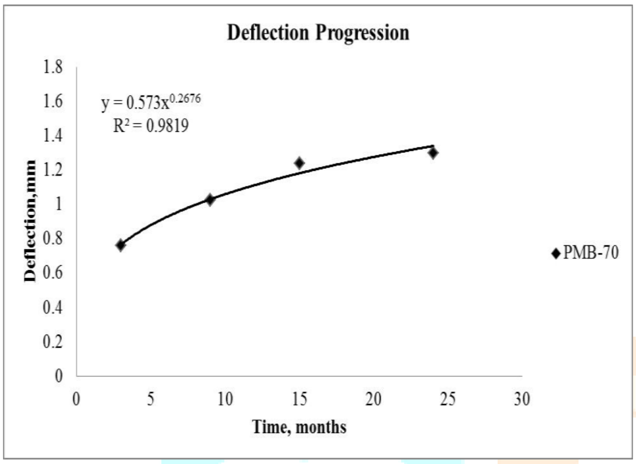


Figure 2: Deflection progression in pavement with VG-30 bitumen

Figure 3: Deflection progression in pavement with CRMB-55 bitumen





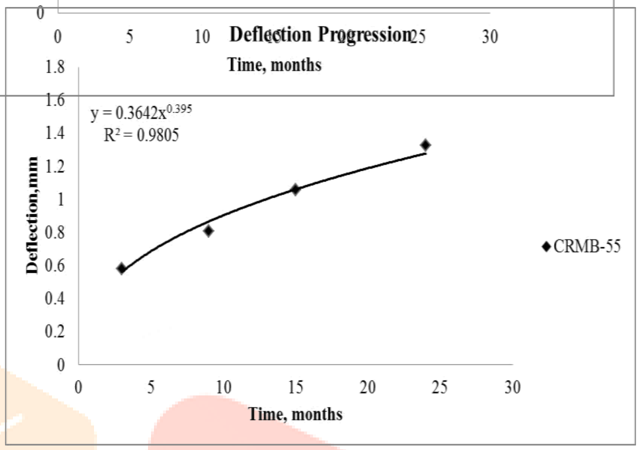


Figure 4: Deflection progression in pavement with PMB-70 bitumen

Figure 5: Deflection progression in pavement with NRMB-70 bitumen

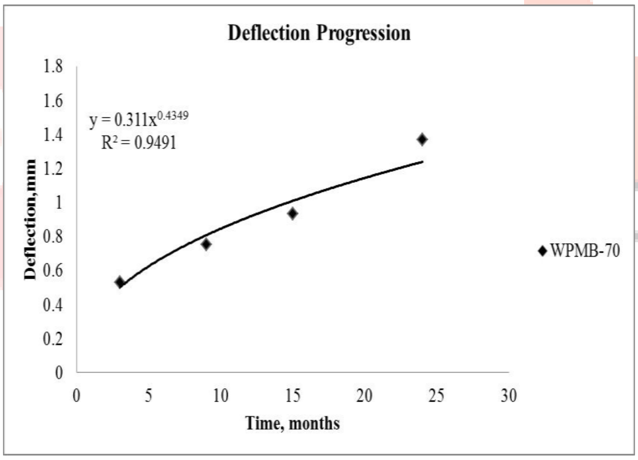


Figure 6: Deflection progression in pavement with WPMB-70 bitumen

Table: Deflection Progression with different binders

Bitumen type	Statistical Model	Correlation Coefficient
VG30	$0.5921(t)^{0.2818}$	0.9984
CRMB55	$0.3642(t)^{0.3950}$	0.9805
PMB70	$0.5731(t)^{0.2680}$	0.9819
NRMB70	$0.6266(t)^{0.2623}$	0.9593
WPMB70	$0.3110(t)^{0.4349}$	0.9491
*where ***t*** is the	time in months	

7. Conclusion

To enhance the riding standard, the test track was designed with a 25 mm thick semi-dense bituminous concrete resurfacing with numerous changed and unmodified bituminous binders. Until renovation, the deflection values indicated that the pavement segment was structurally defective, necessitating a reinforcing overlay rather than thin resurfacing. The rapid degradation in pavement quality was caused by a delay in selecting a test segment, construction delays, a higher-than-expected rise in traffic volume, and sudden overloading in the chosen test stretch due to quarrying.

1. After ageing checks, modified bitumen viscosity levels improved 1.5 times in rubber and waste plastic modified binders relative to unmodified binders. The physical properties revealed that after ageing, waste plastic transformed bitumen does not meet the elastic recovery properties.
2. By matching bituminous mixes of unmodified bitumen to mixes with modified asphalt binders, it was discovered that unmodified bitumen was more vulnerable to rutting at high temperatures.
3. A mathematical model for deflection progression indicated that using polymer modified bitumen enhanced the structural state of the pavement system slightly.
4. According to the findings of this report, the relative efficiency of semi-dense bituminous concrete mixes with various binders is as follows: (best performing binder first):

a. SBS Modified Binder

b. Crumb Rubber Modified Binder

c. Waste Plastics Modified Binder

d. Natural Rubber Modified Binder

e. Unmodified Binder

8. Refrences

- McDaniel, R. S., and Bahia, H. U. (2003) Field evaluation of asphalt additives to control rutting and cracking. Proceedings of 86th Annual Meeting of Transportation Research Board, National Research Council, Washington D.C.
- Ministry of Road Transports and Highways. (2001) Specifications of roads and bridge work. The Indian Roads of Congress (MORT& H), 4thRevision, New Delhi, India.
- Molenaar, A. .A. .A., and Nirmala, S. K. (2001) Use of sealoflex modified mixtures for a heavy duty pavement in India. Seloflex World Conference, Rome.
- Morales, G. M., Partal, P., Navarro, F. J., Boza, F. M., Gallegos, C., Gonzalez, N.,Gonzalez, O., and Munoz, M. E. (2004) Viscous properties and microstructure for recycled EVA advanced bitumen. Fuel, 83, 31U˝ 38.
- Morales, M. G., Partal, P., Navarro, P. J., and Gallegos, C. (2006) Effect of wastage of polymer on addition on the rheology of modified bitumen. Fuel, 85, 936-943.
- NCHRP 1-37 A. (2002) Mechanistic-empirical design for the New & rehabilitated pavement structures. National Cooperative Highway Research Program, (NCHRP), 2002.
- NCHRP 465. (2002) Simple performance testor for Superpave mix design. National Cooperative Highway Research Program, (NCHRP), 2002.
- NHAI. (2012) Indian Road Net National Highway work In National Highways Authority of India. http://www.nhai.org/nhairoadnetwork.htm, Accessed on 10th October 2010.
- Nicholas, K. N., Bartdet, J., Eckmann, D., and Donal, F. S. (1988) Polymer advanced bitumen for high performance hot mixer binders. Proceedings of the Association of Bitumen Paving Technologists, 5, 509-
- 525Oliver, S. W. H., and Tredrea, P. F. (1997) The change in properties of polymer modified binders with simulated field exposure. Proceedings of the Association of Asphalt Paving Technologists, 66, 570-592.