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Study of Bituminous Concrete under Different Mix Conditions by Using Epoxy Resin as Modifier

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ABSTRACT

The use of bitumen in road construction has increased many-fold throughout the world due to its compatibility, the ease in road construction and above all the advantage of allowing traffic immediately after construction. The most common binder used for road surfacing is bitumen obtained from petroleum However; Petroleum is nowadays becoming scarce due to depletion of its source. Even though bitumen is widely used in road construction, there are some drawbacks in bituminous mix like high susceptibility to temperature variation, tendency to crack, lesser effective service life etc. Therefore, bituminous pavements fail to give the expected service life under adverse climatic, environmental and traffic condition. In an attempt to enhance the service life of bituminous surfacing under adverse prevailing conditions, research is going on throughout the world in the area of additives in search of improved, durable and cost effective bituminous binders. The main objective of this study is to evaluate the properties of bituminous mixes that can be made by use of different grading of modified bitumen like VG10 VG30 by using epoxy resin and different grading of aggregate with using of code references.

Keywords: VG 10 and VG 30 grade Bitumen, Marshall Stability and Flow, Epoxy Resin

I. INTRODUCTION

In India, the National Highways span about 67,000 km, of which about 200 km are expressways. National highways constitute approximately 2% of the total road network of India but carry nearly 40% of the total traffic. About 65% of freight and 80% passenger traffic is carried by the roads.

Indian road network of 33 lakh km is second largest in the world and consist of Expressways, National Highway, State Highway, Major district roads and Rural and other roads. Number of vehicles has been growing at an average pace of 10.16% per annum over the last five years .The most common binder used for road surfacing is bitumen obtained from petroleum. However, petroleum is nowadays becoming scarce due to depletion of its sources. In addition to this, bituminous pavements have some drawbacks such as high temperature susceptibility, low temperature cracking etc which demand frequent maintenance and hence increase in life cycle cost of the pavement. Roads are mainly constructed now to use the mineral aggregate and bitumen. Even though the amount of bitumen used is very small as compared to that of mineral aggregates, the performance of the road pavement is mostly determined by the properties of the bitumen, as bitumen is the continuous phase and the only deformable component. On the other end, the increasing of traffic load continuously on the road pavements has to require maximum mechanical stability of the pavement to the good performance with conventional pure bitumen. For the achievement of the improvement, so it is very necessary for the road construction to use modified mix. There is two mains considerations of flexible pavement are the design of pavement and mix design for the pavement. The present study is related to the mix design considerations. A good design of bituminous concrete is expected to result of the mix which has adequately durable, resistance to fatigue, strong, and environment friendly and economically. A mix designer has to try for the achievement of these requirements through a number

of tests on the mix with varied proportions of aggregate and bitumen and finalizes with the best one. This present research has to identify some of the issues which are involved in the bituminous concrete mix design.

Scope and Objective of Study

Scope

Bituminous concrete mix consists of a mixture of aggregates which has maximum size less than 25 mm, and the fine filler has size is less than 0.075 mm. Optimum bitumen is added to the mix so that the compacted mix is effectively impervious, good compressive strength and elastic properties. The bituminous mix design aims to determine the proportion of coarse aggregate, fine aggregate, filler and bitumen to produce a mix which is strong, durable, workable, and economical.

Objective of Study

- To study Bituminous Concrete Mix with using the aggregate grading with different proportion of coarse aggregate and fine aggregate.
- To study BC Mix with using the different Modified grading of bitumen like VG10, VG30.
- To study the strength of mix using Marshall Method.
- In this method calculate the Stability Value, flow value, voids in the mix, Unit weight of the mix, voids filled with bitumen etc.
- Comparison of different mixes.

II. METHODS AND MATERIAL

Test of Aggregate

Table-1: Test of aggregate

TEST	Maximum value for BC Mix	Observed value
Crushing test	30 %	15.2%
Abrasion test	30%	17.4%
Impact test	30%	20.8%
Flakiness index	15%	9%
Elongation index	15%	11%
Water absorption	2%	0.8%

Specific gravity (course aggregate)		2.71
Fine aggregate		2.65
Filler (sand)		2.28

Test of Bitumen

Bitumen is available in a variety of types and grades. To judge the suitability of these binders various physical tests have been specified by agencies like ASTM, Asphalt Institute, British Standards Institution and the ISI. These tests include penetration test, ductility tests, softening point test and viscosity test.

Table 2 Optimum Dose Modifier of VG 10 and VG 30

Designation	VG 10	VG 10 + 3% of ER	Permissible Limit (min.)	VG 30	VG 30 + 2% of ER	Permissible Limit (min.)
Penetration (dmm)	75	67	30	59	55	30
Softening Point (°C)	49	56.1	47	56	62	47
Viscosity (Poise)	823	1121.6	800	2411	3078	2400
Ductility (cm)	80	89	50	85	87.8	50
Elastic Recovery (%)	22	26.6	35	23.5	26.4	35

Gradation of Aggregates

Table 3 Gradation of Aggregate for BC (grade 2)

Sr. No	Seive size in mm	Aggregate		Stone Dust	Aggregate		Stone Dust	Obtained Gradation	Desired Gradation
		12mm	**4.75mm**		**28%**	**27%**	**45%**	**1.00**	
1	19	100	100	100	28.00	27.00	45.00	100.00	100
2	13.2	98.5	100	100	27.58	27.00	45.00	99.58	90-100
3	9.5	35.3	100	100	9.88	27.00	45.00	81.88	70-88
4	4.75	0	78.6	100	0.00	21.22	45.00	66.22	53-71
5	2.36	0	30.5	88.4	0.00	8.24	39.78	48.02	42-58
6	1.18	0	12.5	78.3	0.00	3.38	35.24	38.61	34-48
7	0.6	0	0	66.4	0.00	0.00	29.88	29.88	26-38
8	0.3	0	0	45	0.00	0.00	20.25	20.25	18-28
9	0.15	0	0	29.6	0.00	0.00	13.32	13.32	12-20
10	0.075	0	0	9.5	0.00	0.00	4.28	4.28	4-10

Aggregate Blend

Aggregate Type I 28 %
Aggregate Type II 27 %
Stone Dust 45 %

III. RESULTS AND DISCUSSION

Table 4 Values of VG 30 Conventional Bitumen Mix

% Bitumen	Marshall Stability kg	Flow mm	Gmb gm/cm3	Va %	VMA %	VFB %
4.50	1436.18	2.98	2.32	6.28	16.24	61.34
4.75	1460.48	2.99	2.35	5.12	15.68	65.74
5.00	1490.55	3.16	2.37	4.51	15.65	68.76
5.25	1408.16	3.25	2.37	4.17	16.05	78.54
5.50	1390.12	4.19	2.35	3.88	16.30	79.82

Table 5 Values of VG 10 Conventional Bitumen Mix

% Bitumen	Marshall Stability kg	Flow mm	Gmb gm/cm3	Va %	VMA %	VFB %
5.2	1023.1	2.47	2.98	5.16	16.94	78.13
5.6	1403.2	2.71	3.00	4.70	17.72	82.22
6.0	1650.6	3.26	3.03	3.82	16.84	85.13
6.4	1418.3	3.68	3.04	3.52	17.24	91.37
6.8	1390.2	3.81	3.01	3.17	17.07	95.06

Optimum Binder Content of VG30 is 5.05 % and for VG 10 is 6%.

Table 6 Comparison of Marshall Value of Neat and Modified Bitumen

Type of Bitumen	%Bitumen	% Epoxy Resin	Marshall Stability kg	Flow mm
VG 30	5.05	0	1490.55	3.16
		2	1684.9	3.01
VG 10	6.0	0	1650.6	3.26
		3	1655.2	3.10

IV. CONCLUSION

- The optimum bitumen content for VG 10, and VG 30 are 6.0%, and 5.05% respectively.
- Stability of VG 30 at Bitumen content 5.05% of 2 % Epoxy Resin is higher than VG 10 at Bitumen content 6.0% of 3% Epoxy Resin and Flow is decreased.
- As we increase the grade of bitumen, the flow value will be decreased

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