Effect of Natural Rubber on the Properties of Bitumen and Bituminious Mixes

Rohitash Kumar, Deepak Juneja

Abstract: ***In India the leftovers of results of regular elastic latex are stored each year frequently wild causing disjoin natural and other financial negative effects. The ecological strong waste like elastic, swim tops, gloves and so on can be reused betterly so it is useful for what's to come. Numerous investigations have been done to discover other elective material to use as modifiers in bitumen blends on the improvement of its properties and expressway quality. Concentrates still today for the most part centered around mechanical and physical attributes of rubber treated blends in which swell elastic is utilized either as option in contrast to characteristic totals or as added substance. In this exploration Natural Rubber latex (as inflatable's) has been utilized as bitumen modifier. Common elastic changed bitumen is utilized for the prolongation of life of state streets. The need to receive elastic for the utilization of development of the streets is predominantly that it lessens the expense of development and furthermore reused elastic is utilized as it limits the natural contamination. In this examination Natural Rubber latex (as inflatable's) has been utilized as bitumen modifier. Bitumen when contrasted with the rubber treated bitumen is bit delicate when presented to traffic burden and temperature. The Rubberized bitumen shaped decreases perpetual distortions because of over-burden out and about and in this way unaffected by the progressions in environmental temperature and improves slide obstruction. Elastic expands protection from stream of bitumen at higher temperature and improves the protection from fragile break at low temperature. The upper surface layer of the asphalt has been made of rubber treated bituminous blends. Rheological attributes of rubber treated bitumen just as fundamental properties of the actualized, rubber treated bituminous blend are exhibited. The practices of the two modifiers were examined by far reaching research facility testing and assessment. It was seen that the expansion of normal elastic gave better by and large execution in the bituminous blends. Subsequently, this shows characteristic elastic may contribute toward better adaptable streets later on. The above properties increment the administration life of rubber treated streets much of the time to in excess of hundred percent when contrasted with that of bituminous streets. Accordingly changed elastic bitumen of streets will join reserve funds with security.***

Keywords: ***Inflatable Rubber, Remnants of Environment, Natural Rubber Latex, Pavement, Traffic, Rubberized Bituminous Mixture.***

I. INTRODUCTION

Normal elastic changed bitumen is utilized for the prolongation of life of state streets. The need to receive elastic for the utilization of development of the streets is principally that it diminishes the expense of development and furthermore reused elastic is utilized as it limits nature contamination. The use of reused elastic in asphalt development segment can be an exceptionally encouraging and naturally amicable what to take out the countries supply of scrap. A constant flow of gigantic volume of waste remainder or characteristic elastic is created because of the persistent increment in the creation of waste produced by the populace. The accessibility of the Natural Rubber (Latex) is huge, as the elastic is an item gotten from Latex (e.g., sleeping cushions, gloves, swim tops, inflatable's) has progressed toward becoming piece of day by day life. On the off chance that it isn't reused, its present transfer is either via land filling or by burning. Both the procedures have certain effect on the earth. Different investigations are being done to improve the nature of bitumen utilized in bituminous street development. One of the aftereffects of such examinations is to utilize polymer-altered bitumen. Polymer adjusted bitumen is developing as one of the critical development materials for adaptable asphalts. Utilization of polymers in the development of adaptable asphalt is picking up significance as a result of the few reasons. The polymer altered bitumen show better properties for street development and plastics squander, generally viewed as a contamination hazard, can discover its utilization in this procedure and this can help taking care of the issue of contamination. Bitumen is a valuable cover for street development. Distinctive evaluations of bitumen like 30/40, 60/70 and 80/100 are accessible based on their entrance esteems. The relentless increment in high rush hour gridlock power regarding business vehicles and the noteworthy variety in day by day and regular temperature request improved street qualities. The investigations on the warm conduct and restricting property of the Natural Rubber advanced an examination on the arrangement of Natural Rubber-bitumen mix and its properties to discover the reasonableness of the mix for street development. "The underlying expense is higher by around 20 percent, yet life-cycle cost is impressively lesser than streets surfaced utilizing altered bitumen".

.

Revised Manuscript Received on July 05, 2019

Rohitash Kumar, M.Tech Student, Department of Civil Engineering, Chandigarh University, Gharuan, India

Deepak Juneja, Assistant Professor, Department of Civil Engineering, Chandigarh University, Gharuan, India

II. MATERIAL USED

a) Natural Rubber (Latex)

Characteristic elastic is an elastomer that was initially gotten from smooth latex found in the sap of certain plants. The cleaned type of regular elastic is the substance polyisoprene, which can likewise be created artificially. Characteristic elastic is utilized broadly in numerous applications and items, as is engineered elastic. To accomplish the particular properties required for a given item, crude common elastic must be exacerbated utilizing fixings, for example, carbon dark, hostile to degradants, conditioners and a vulcanization framework.

b) Poly Isoprene

A standout amongst the most outstanding normal polymers is polyisoprene, or regular elastic. Polyisoprene is diene polymer, which is a polymer produced using a monomer containing two carbon-carbon twofold bonds. Like most diene polymers, it has a carbon-carbon twofold bond in its spine chain.

c) Environmental Concerns

Because of it being non-biodegradable elastic is exceptionally deadly to the earth. It is one of the primary commitments to arrive contamination. Other than plastic, glass, containers, jars and different types of litter. Elastic discharge a ton of poisons that have even lead to extreme skin illnesses, contamination of drinking water and fish being hurtful to devour. In the event that Rubber is singed it radiates synthetic substances into the encompassing air and display poisonous quality in the earth which has a few impacts throughout everyday life.

d) Bitumen

Bitumen is a typical fastener utilized in street development. it is mainly gotten as a leftover item in oil refineries after higher portions like gas, petroleum , lamp oil and diesel ,and so forth are evacuated. Indian Standard Institution (ISI) characterizes bitumen as a dark or dull darker non-crystalline soil or thick material having cement properties gotten from oil unrefined either by or by refinery process.

III. TESTING PROCEDURE

3.1 Tests on Bitumen

The various tests that have to be conducted of bitumen are

- Penetration test
- Softening point test
- Viscosity test Ductility test

Flash & fire point

3.2TESTS ON BITUMINOUS MIXES

- **Marshalls Method of Mix Design**

There are two major features of the Marshall method of designing mixes namely,

Density-voids analysis

Stability-flow test

- **Gradation of Aggregates for Bituminous Macadam Mix**

Sieve analysis is conducted on the supplied samples of 20mm, 10mm, 6mm and stone dust.

The specifications given by morth for bituminous macadam are presented in table 1.

TABLE 3.1: GRADATION OF AGGREGATES

S.NO	SIEVE SIZE (mm)	RECOMMENDED GRADATION AS PER %FINER (MORTH SPECIFICATION)
1	26.5	100
2	19.0	90-100
3	13.2	56-88
4	4.75	16-36
5	2.36	4-19
6	300µ	2-10
7	75µ	0-8

The optimum content for the mix design is found by taking the average value of the following bitumen contents found from the graphs of the test results.

- Bitumen content corresponding to maximum stability
- Bitumen content corresponding to maximum unit weight

TABLE 3.2: SPECIFICATIONS FOR MARSHALL STABILITY TEST

Test Property	Specified value
Marshall tability, kg	340(minimum)
Flow value, 0.25mm units	8 to 16

IV.TESTS RESULTS AND DISCUSSIONS

The results of the above tests are presented in the following tables and figures.

4.1 PENETRATION TEST RESULTS:

Table 4.1 shows the penetration values of ordinary bitumen (O.B) and bitumen mixed with natural rubber(N.R)

TABLE 4.1: PENETRATION VALUES OF O.B AND POLYMER MODIFIED BITUMEN

TEST PROPERTY	O.B	O.B+ 1%N.R	O.B+ 2%N.R	O.B+ 3%N.R	O.B+ 4%N.R	O.B+ 5%N.R	O.B+ 5.5%N.R	O.B+ 6%N.R	O.B+ 7%N.R
Penetration	69	78	74	75	81	82	80	83	74

Value(1/10th)mm	72	68	65	82	79	82	78	74	67
	65	66	83	71	77	78	81	72	73
	61	73	74	72	78	77	79	80	72
	62	64	73	78	75	83	81	77	79
	69	70	74	68	77	84	77	70	78
	63	74	78	83	78	83	84	78	80
	66	72	69	79	71	81	86	72	76
	68	72	78	65	80	79	77	83	77
	69	78	67	72	78	82	79	77	65
	72	63	76	83	74	82	74	78	80
	66	76	79	74	77	72	76	68	71
	67	77	68	76	80	81	78	80	73
	66	78	77	81	82	78	71	82	77
	67	76	78	80	82	78	80	76	70
	62	78	74	84	81	81	79	79	64
	69	72	84	80	75	77	74	73	75
	65	72	77	78	76	81	77	65	65
	61	65	79	72	80	83	80	81	70
	66	73	78	84	80	75	81	71	79
Average Value(1/10th)mm	67	72	75	77	78	80	78.6	76	73

Subsequent to directing the infiltration esteem test it is seen that there is progressive increment in entrance esteem upto 5% and the esteem continuously diminished. This shows at first the bitumen got mollified upto 5% and after that it got solidified. Consequently bitumen with 1-4% cover substance is appropriate in colder locales and from 4-7% it is reasonable in hotter areas.

4.2 SOFETENING POINT AND VISCOSITY RESULTS:

TABLE 4.2: SOFTENING POINT RESULTS OF ORDINARY & POLYMER MODIFIED BITUMEN

TYPE OF SAMPLE	SOFTENING POINT VALUE(°C)	VISCOSITY POINT VALUE(°C)
Ordinary Bitumen	52	292
Ordinary Bitumen + 1% (N.R)	49	221
Ordinary Bitumen + 2% (N.R)	49	341
Ordinary Bitumen + 3% (N.R)	51	417
Ordinary Bitumen + 4% (N.R)	52	527
Ordinary Bitumen + 5% (N.R)	54	624
Ordinary Bitumen + 5.5% (N.R)	56	647
Ordinary Bitumen + 6% (N.R)	58	711
Ordinary Bitumen + 7% (N.R)	59	792

In the wake of leading the conditioning point test it is seen that the base bitumen relaxing point esteem is 52°C and diminishes at 1% of bitumen modifier to 48°C which isn't helpful. Maybe 1% Binder substance esteems can be discounted. As there is consistent increment from 2% we can confine our examination to 2-7% of Binder content.

4.3 Ductility and Flash & Fire Test Results

Table 4.3 shows the ductility value and flash & fire point results of ordinary bitumen (O.B) and bitumen mixed with natural rubber (N.R).

TABLE 4.3: DUCTILITY RESULTS OF ORDINARY & POLYMER MODIFIED BITUMEN

TYPE OF SAMPLE	DUCTILITY VALUE (CM)	FLASH POINT(°C)	FIRE POINT(°C)
Ordinary Bitumen	111	250	260
Bitumen + 1% natural rubber latex	111	220	230
Bitumen + 2% natural rubber latex	111	230	240
Bitumen + 3% natural rubber latex	57	240	250
Bitumen + 4% natural rubber latex	55	260	270
Bitumen + 5% natural rubber latex	51	270	290
Bitumen + 5.5% natural rubber latex	55	270	300
Bitumen + 6% natural rubber latex	49	290	310
Bitumen + 7% natural rubber latex	46	320	230

In the wake of directing malleability esteem test it is seen that the base bitumen flexibility esteem is 110cm. There is unexpected abatement in pliability esteem from 2 to 3%. At that point it step by step diminishes and goes under 50 cm at 6% and proceeds upto 7%. As indicated by ISI details flexibility esteems underneath 50 cm are not reasonable for street development. Streak and flame point test is directed on 60/70 bitumen evaluation blended with Natural Rubber (Latex) and diagram is drawn between % of bitumen modifier included x-hub and temperature in degrees on y-hub. In Flash point from 1-3% we can see consistent chart and after 3% it is expanding. Despite the fact that from 1-3% it is diminishing it isn't much lower so it is reasonable for working conditions without causing fire risks from security perspective. The base estimation of blaze point determined by ISI is 175°C for all evaluations of bitumen.

4.4 MARSHALL STABILITY TEST RESULTS:

TABLE 4.4: MARSHALL STABILITY RESULTS FOR BITUMINOUS MACADAM MIX

SAMPLE	MARSHALL STABILITY VALUE (kg)	FLOW VALUE (mm)
Sample with 3.3% Ordinary bitumen	601	2.91
Sample with 3% bitumen containing 3% natural rubber	591	2.82
Sample with 3% bitumen containing 4% natural rubber	618	2.89
Sample with 3.5% bitumen containing 3% natural rubber	543	3.09
Sample with 3.5% bitumen containing 4% natural rubber	528	3.29

For normal bitumen of 60/70 grade, most extreme quality is gotten at 3.3%. 3% and 4% common elastic is added to two rates of bitumen levels (3% and 3.5). 3.5% is chosen in light of the fact that for typical 60/70 bitumen the ideal folio content is acquired at 3.3%. From Marshall Stability test most extreme quality 616kgs is acquired for 4% normal elastic at 3% bitumen dimension. By including 4% bitumen modifier, the bitumen substance can be diminished significantly, in this way the expense of street development is decreased. As 1% and 5% above cover substance are discounted, 2%, 3% and 4% are taken as ideal fastener content for the figuring of Stability and stream tests.

4.1 & 4.2 Figures shows presentation of various tests

V. CONCLUSIONS

1. Huge measure of scrap elastic is created from surroundings which can absolutely be utilized for this reason by reusing it and taking care of the issue of transfer of elastic and its waste age.

2. Penetration test at 25°C

is the most ordinarily embraced test on bitumen to review the material as far as hardness. In this way, in hotter areas lower entrance grades are favored and in colder locales higher infiltration esteems are utilized. Since the acquired esteem is in the middle of 60mm (1/10thmm) and 80mm (1/10thmm), it tends to be utilized for the two locales in asphalt development.

3. Softening point test gives a thought of temperature at which the bituminous material accomplishes a specific consistency. So bitumen with higher mellowing point favored in hotter spot and it is likewise used to determine hard bitumen. Since the acquired esteem is somewhere in the range of 50°C and 55°C, it very well may be favored in hotter spots.

4. From the thickness esteems, it tends to be inferred that protection from stream increments with increment of % bitumen modifier. Along these lines, higher the length progressively gooey is the material. As thickness esteem is more, it very well may be utilized in asphalt development.

5. The least esteem indicated by Indian Standards Institution is 50cm, % of bitumen modifier more than 5.5 ought not be utilized in asphalt development. As it is under 50cm after 5.5% of bitumen modifier, because of its low malleability esteem, the asphalt may break particularly in chilly climate.

6. Flash and fire point has no noteworthiness about quality of bitumen. They are utilized to know the working temperatures of the bitumen. On the off chance that the working temperatures are more than blaze and fire point esteems, at that point fire risks may happen. Since Bitumen gets mellow at 1% it is precluded and rates above 5.5% are discounted in flexibility. Subsequently from 2-4% we can get the ideal cover content an incentive for deciding Marshall steadiness test.

VI. REFERENCES

1. Bituminous Road Construction, Barmah Shell.
2. Highway Engineering Materials by Khanna and Justo.
3. http://rubberboard.org.in/ManageTechnical.asp?Id=34.
4. International Journal of Engineering and Advanced Technology (IJEAT). ISSN: 2249-8958, Volume-2, Issue-3, February 2013 on Pavement Performance with Carbon Black and Natural Rubber (latex).
5. Indian Standard Methods for testing Tar and Bitumen, Determination of Penetration, IS: 1203 Indian Standards Institution.
6. Indian Standard Methods of Testing Tar and Bitumen: Determination of Softening Point, IS: 1205, Indian Standards Institution.
7. Indian Standard Methods for Testing Tar and Bitumen: Determination of Viscosity, IS: 1206, Indian standards institution.
8. Indian Standard Methods for Testing Tar and Bitumen; Determination of Ductility, IS: 1203, Indian standards Institution.
9. Indian Standard Methods of Testing Tar and Bitumen: Determination of Flash and Fire Point, IS: 1209 Indian Standards Institution.
10. Indian Standard Specifications for Paving Bitumen, IS:73-1961; Indian standards Institution.
11. Journal on "Bitumen Scrap Rubber Seals", Engineering Road Note No.7 (October 2003), Main Roads Government of Western Australia.
12. Manual for Construction and Supervision of Bituminous Works, Published by IRC on behalf of the Government of India; Ministry of Road Transport and Highways, New Delhi;2001.
13. Recommended Practice for Bituminous Penetration Macadam (Full Grout), IRC.
14. Rheology of Polymer Modified Bitumen: A Comparative study of three binders and three binder/filler materials.
15. SK khanna and CEG Justo, Highway Material Testing Laboratory Manual, Nem Chand Bros; Rourkee.