AN APPROPRIATE LATEX-BITUMEN EMULSION BLEND FOR ROAD SURFACING

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ABSTRACT

Natural rubber modified bitumen is a valuable material for road surfacing. It enhances the strength and durability of the road surface better than the bituminous material alone. It can be produced by incorporating natural rubber in the form of powder in to hot bitumen or by mixing latex into bitumen emulsion. The latter process is most beneficial to road engineers as the blend is a water based liquid which can be applied on road surfaces directly, by spraying. The process of blending natural rubber latex with bitumen emulsion has been investigated in this work. From the studies, suitable formulations for preparing bitumen emulsion and blend of latex bitumen emulsion for road surfacing have been identified.

Introduction

It is widely recognized that natural rubber blended bitumen is superior to bitumen alone, for road surfacing. The roads surfaced with the blend have been found to be better in strength properties and more durable. For its production, generally a small proportion of natural rubber ca. 2 to 4 w/w %, is incorporated into bitumen.

The mixing of these two materials may be accomplished by incorporating natural rubber in the form of powder into hot bitumen melt or latex with cold bitumen emulsion. The latter process is more advantageous as the blend is a water based liquid, which requires no heating prior to its application and can be used directly for road surfacing. However the process has not hitherto been successfully carried out locally, due to problems of producing latex-compatible bitumen emulsion.

Thus the objective of this work is to identify a suitable bitumen emulsion for mixing with natural rubber latex and to investigate the quality of the resulting blend for road surfacing.

Method of approach

Since natural rubber latex is locally available as an anionic latex, attempts are made in this work to produce bitumen also, in the form of anionic emulsion, with a view to enhance the miscibility of two components. Thus anionic bitumen emulsions of various formulations having different proportions of their contents are prepared and their suitability for mixing with natural rubber latex and for spraying is examined. Following the choice, latex-bitumen emulsion blends are made with the suitable ones and then evaluated for their technical performance. From this investigation, the most appropriate bitumen emulsion and blend of latex-bitumen emulsion for road surfacing are identified.

Materials Used

Bitumen : 80/100 penetration grade bitumen is chosen, as the grade is commonly used for road surfacing in this country.

Emulsifier: Emulsifier based on locally available vegetable oil is considered for low cost production. For the production of the emulsifier, rubber seed oil is saponified with potassium hydroxide. The choice of the oil is made, because of its higher proportion of unsaturated fatty acid components (Table 1). These components are believed to give more stable lathers in emulsifying system, in comparison to saturated fatty acid components.

For saponification, potassium hydroxide is preferred to other alkalis because of its higher solubility.

Stabilizer: Casein is chosen, to enhance the stability and bonding property of the bitumen emulsion.

Latex: Ammoniated 60% centrifuged natural rubber latex is selected as it is accessible in adequate quantity in the plantation industries of the country.

Table 1
Fatty acid composition of rubber seed oil

	Weight %
Plamitic acid $C_{15}H_{31}COOH$	10.6
Stearic acid $C_{17}H_{35}COOH$ Saturated acids	11.5
Arachidic acid $C_{19}H_{39}COOH$	1.0
Oleic acid $[CH_3(CH_2)_7CH=CH(CH_2)_7COOH]$	17.2
Linoleic acid $[CH_3(CH_2)_4CH=CHCH_2CH=CH(CH_2)_7]$	35.8
Linolenic acid $[CH_3CH_2CH=CHCH_2CH=CH(CH_2)_7COOH]$	23.9

Experimental

Preparation of the components of bitumen emulsifying system

The following formulations were used to prepare the components, emulsifier and stabilizer of the emulsifying system.

Emulsifier (30%)

	Pwt
Rubber seed oil	250
Potassium Hydroxide	50
Water	560

Stabilizer (5%)

	Pwt
Casein	5
Borax	10
Water	85

Preparation of bitumen Emulsions

Bitumen emulsions according to formulations as shown in the table 2, were prepared by means of a laboratory colloid mill. Bitumen content in the mix formulations were varied from 50 % to 60 % (w/w) in the emulsions with a view to produce stable emulsions.

For the preparation of emulsion, a mix containing the emulsifier, stabilizer and water at temperature ca. 40°C and kerosene added bitumen at temperature ca. 130-140 °C were fed separately, in required proportions, into the chamber of the colloid mill, and the mixing temperature was maintained around 85°C-95°C.

Blending Latex with Bitumen Emulsions

Required quantity of ammoniated centrifuged natural rubber latex (60%) was added into each of the most suitable ones of the above emulsions, to about 3-4 % w/w rubber in bitumen.(see Table 3)

Characterisation tests for bitumen emulsions

The following tests were carried out to characterise the bitumen emulsions prepared in this work.
Viscosity test (ASTM D88-79)
Storage Stability test (ASTM D244 -77)
Sieve test (ASTM D244 – 77)
pH determination

The test results are presented in table 2

Characterisation and Technical performance Tests for Blends of Latex-bitumen emulsions

In addition to above characterisation tests, the following tests were carried out to evaluate the quality of the blends.

(a) Tests on residue of the blend after distillation
Penetration (ASTM D5-78)
Softening point (ASTM D36-76)

(b) Performance tests (see appendix 1)
Sand sealing
Cold mixing
Coating and Stripping

The test results are presented in table 3

Results

Table 2
Anionic Bitumen Emulsions

Formulations

	A	B	C	D	E	F
Components	Pwt.	Pwt.	Pwt.	Pwt.	pwt	pwt
Bitumen	50	55	55	55	55	60
Kerosene	2	2	2	2	2	2
Emulsifier (k-soap Of Rubber seed oil)-30%	20	20	20	20	10	5
Stabiliser (5%)	-	10	7.5	5	2.5	1
Water	28	13	15.5	18	30.5	32

Characterisation test results

	A	B	C	D	E	F
Viscosity (Saybolt Furol at 25°C, S)	15	102	94	38	35	34
Storage stability (24 hrs) %	0.0	0.1	0.1	0.0	0.0	0.1
Sieve test %	0.0	0.02	0.01	0.0	0.0	0.0
pH	11	10.5	10.5	10.5	11	10.5

Table 3
Latex – Bitumen emulsion Blends

Formulation

Components	Formulation I Pwt	Formulation I pwt	Formulation I pwt
Ammoniated NR-Latex (60%)	3	3	3
Bitumen Emulsion D	100	-	-
Bitumen Emulsion E	-	100	-
Bitumen Emulsion F	-	-	100

Characterization test results:

Viscosity (Saybolt, Furol at 25oC,S	31	33	32
Storage Stability (24 Hours, %	0.0	0.0	0.1
Sieve test %	0.0	0.02	0.04
pH	10.5	10	10

Performance test results

Sand Sealing	Good	Good	Good

Cold mixing:

a) Metal aggregate	Not Satisfactory	Not Satisfactory	Not Satisfactory
b) Lime stone aggregates	Not Satisfactory	Good	Good
c) Metal aggregates + 5% w/w lime	Not Satisfactory	Good	Good

Coating and stripping:

a) Metal aggregates	<95%	<95%	<95%
b) Lime stone aggregates	<95%	>95%	>95%
Metal aggregates + 5% w/w lime	<95%	>95%	>95%

Test results on residue, after distillation

a) Softening point oC	56	60	61
b) Penetration (ASTM D5-78)	55	52	50

Discussion And Conclusion

Choice of Bitumen Mix for Blending with Latex

The results of the study reveal that among all mixes (A, B, D, E & F) used for the preparation of bitumen emulsions, the mixes D, E & F have been found to be most suitable (Table 2). The emulsions produced from these mixes have desirable viscosity values, in addition to other favorable characteristics such as storage stability and sieve test results, that required for road emulsions. Mix A is unsuitable for it gives too low viscosity emulsion (15 Saybolt, Furol, S), which if used, may drain off road, during spraying. Mixes B & C could not also be considered befitting, because the emulsions produced have shown very high viscosity values (>90 Saybolt, Furol, S.) The spraying this emulsion may cause problems through the conventional jets.

Choice of Latex – Bitumen Emulsion Blend

The test results of the latex – bitumen emulsion blends (table 3) indicate that all these blends I, II & II have required values of viscosity, storage stability and sieve test results, for them to be used as road surfacing bituminous emulsions .The blends have also proved to be suitable ones for sand sealing, and for producing rubberized bitumen with higher softening point (= 60°C) and better resistance for deformation (penetration = 52). However, on investigating, the performance test results of cold mixing and coating and stripping, it has been found that, **a)** All three blends I, II & III have failed to give satisfactory results with normal aggregates (metal aggregate) and, **b)** the blends II & III (compared to blend I) show promising results if only the normal aggregates are replaced with lime stone aggregates or the aggregates are partially mixed (5% w/w) with lime powder.

The failure of obtaining good results with blend I, with all type of aggregates (Normal, aggregates) could be attributed to its higher content of emulsifier (20 pwt).

Thus the following conclusions can be made from this work:

a). Bitumen emulsions, similar in contents and compositions to mix E or Mix F could be successfully used to produce natural rubber latex – bitumen emulsion blend for road surfacing , and

b). For better performance of such blend, the roads must be constructed with either lime stone aggregates or 5% w/w lime mixed normal (metal) aggregates.

References

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Appendix 1

Sand Sealing test

In this test, the latex-bitumen emulsion blend is applied on a sand surface and visually inspected for its bonding property.

Cold mixing test

The road surfacing aggregates are spreaded on a surface and wet with water spray. Then the latex-bitumen emulsion blend (6% w/w on the aggregates) is applied on the aggregates and visually inspected for its coating property.

Coating and Stripping

100g of the surfacing aggregates of size 9.5mm is mixed with 8g of the latex-bitumen emulsion blend and the resulting mix is kept under water for 24 hours. Following this treatment, the surface area coated with the bitumen is determined and expressed as a percentage of the total surface area of the aggregates.