

Behaviour of Superthermolay Atactic Polypropylene Polymer with Hydrated Lime in Bituminous Pavement

*C.Neeladharan¹, A.Muralidharan²

¹Head of the Department, Department of Civil Engineering, C. Abdul Hakeem College of Engineering and Technology, India

²Assistant Professor, Department of Civil Engineering, C. Abdul Hakeem College of Engineering and Technology, India

Abstract— Bituminous pavements are in common use in India and abroad. The composite materials used in the bituminous concrete are bitumen, aggregate, binders and additives which are mixed together and laid down in layers then compacted. The bituminous concrete is the highest quality of construction in the group of black top surfaces. Being of high cost specifications, the bituminous mixes are properly designed to satisfy the design requirements of the stability and durability. Now days, the roads are seriously damaged due to the seasonal temperature, flood etc., In order to reduce, some necessary modifications are made to improve the pavement strength and stability. Main aim of our paper is to improve the performance of bitumen pavement by using superthermolay atactic propylene polymer and hydrated lime and determine the improvement of it to reduce the economic loss. STP and hydrated lime results in gain of stability and bearing capacity of bitumen pavement.

Index Terms—Bituminous Concrete, superthermolay atactic propylene polymer, hydrated lime.

I. INTRODUCTION

Bitumen is a mixture of organic liquids that are highly viscous, black, sticky, entirely soluble in carbon disulphide, and composed primarily of highly condensed polycyclic aromatic hydrocarbons. The terms asphalt and bitumen are often used interchangeably to mean both natural and manufactured forms of the substance. Natural bitumen's contain sulphur and several heavy metals such as nickel, vanadium, lead, chromium, mercury and also arsenic, selenium, and other toxic elements. Bitumen can provide good preservation of plants and animal fossils. In the past, bitumen was used to waterproof boats, and even as a coating for buildings with some additives. Bitumen is primarily used, when mixed with mineral aggregates, to produce paving materials. Its other main uses are for bituminous waterproofing products, roofing felt and for sealing flat roofs. Bitumen pavement is the glue that holds the components together. Polymers when added, modifies natural viscoelastic behaviours of the bitumen pavement. In addition to improving pavement performance at locations with extreme hot – cold temperature variations, there are other benefits of using SuperThermoLay polymer in the bituminous pavement. Polymers may add to the cost of binder, but the use of SuperThermoLay polymer in bituminous pavement is quite economical. Hydrated lime is added to the bitumen, which reacts with aggregates, strengthening bond between bitumen and stone. It blocks the formation of water-soluble soaps which may cause moisture damage. It also reduces the aging of pavements. Unlike most mineral fillers, hydrated lime is chemically active rather than inert and makes the pavement more flexible. Pavements designed and constructed

for heavy duty traffic and extreme weather conditions require specially designed engineered Bitumen Grades. By changing the characteristics of normal bitumen with the addition of SuperThermoLay polymer and Hydratedlime, either they are of elastomeric nature or elastomeric, we succeed to obtain bitumen that allows the mixture to be more cohesive, with more strength and significant higher resistance to parameters like fatigue and permanent deformations for road pavements. Thus this innovative technology not only strengthens the road construction but also increases the road life as well as help to improve environment and create a source of income.

II. MATERIALS

A. Bitumen:

Asphalt binder 60/70 is used in this research. The bitumen used should have the following properties. Grade of bitumen used in the pavements should be selected on the basis of climatic conditions and their performance in past. It is recommended that the bitumen should be accepted on certification by the supplier (along with the testing results) and the State project, verification samples. The procedures for acceptance should provide information, on the physical properties of the bitumen in timely manner.

B. SuperThermoLay APP Polymer:

SuperThermoLay atactic polymer is a uniquely formulated pre – fabricated plastomeric water proofing membrane with spun bonded polyester mat as its core. The polymer modification of bitumen with Atactic Polypropylene (APP) and special resins results in an excellent resistance to hot and cold temperatures

C. Hydrated Lime:

Calcium hydroxide, $(Ca(OH)_2)$ is a colourless crystal or white powder and is obtained when calcium oxide (quicklime) is mixed or slaked with water.



III. EXPERIMENTAL WORK

A. Marshall Sampling Mould

The specifications of the Marshall sampling mould and hammer are given in table1.

TABLE – 1: Dimensions of Marshall Sampling mould & hammer

Apparatus	Value	Working tolerance
Mould		
Average internal Diameter ,mm	100.5	± 0.5
Hammer		
Mass,kg	4.500	±0.02
Drop height,mm	450	±1.0
Foot diameter,mm	98.5	±0.5

B. Calculation involved

Sample calculation:

- Empty weight of the mould = 1143 g

- Total weight of the aggregates = 1035 g
- 4.5% of bitumen is used = $\frac{4.5}{100} * 1035 = 46.57$ g.
- 10 % of hydrated lime = $\frac{10}{100} * 46.57 = 4.657$ g.
- 5 % of STP = $\frac{5}{100} * 46.57 = 2.328$ g.
- Weight of the sample = 1088.55 g.
- 6 moulds are prepared with different ratios of hydrated lime and STP.

Table. No:2: Quantities of materials

S.No	% of hydrated lime	% of STP	Weight of hydrated lime 'g'	Weight of STP 'g'	Weight of aggregate 'g'
1.	0	0	0	0	1035
2.	0	0	0	0	1035
3.	0	0	0	0	1035
4.	10	0	4.6	0	1010
5.	10	0	4.6	0	1010
6.	10	0	4.6	0	1010
7.	20	0	9.2	0	992
8.	20	0	9.2	0	992
9.	20	0	9.2	0	992
10.	30	0	13.8	0	983
11.	30	0	13.8	0	983
12.	30	0	13.8	0	983
13.	10	5	4.6	2.3	975
14.	10	5	4.6	2.3	975
15.	10	5	4.6	2.3	975
16.	20	10	9.2	4.6	960
17.	20	10	9.2	4.6	960
18.	20	10	9.2	4.6	960
19.	30	15	13.8	6.9	945
20.	30	15	13.8	6.9	945
21.	30	15	13.8	6.9	945

C. Marshall Stability and Flow test:

Stability:

It is defined as the maximum load at which the specimen fails under the application of the vertical load. It is the maximum load supported by the test specimen at a loading rate of 50.8mm/minute (2 inches/minute). Generally, the load was increased until it reached the maximum & then when the load just began to reduce, the loading was stopped and the maximum load was recorded by the proving ring.

Flow:

It is defined as the deformation undergone by the specimen at the maximum load where the failure occurs. During the loading, an attached dial gauge measures the specimen's plastic flow as a result of the loading. The flow value was recorded in 0.25 mm (0.01 inch) increments at the same time when the maximum load was recorded.

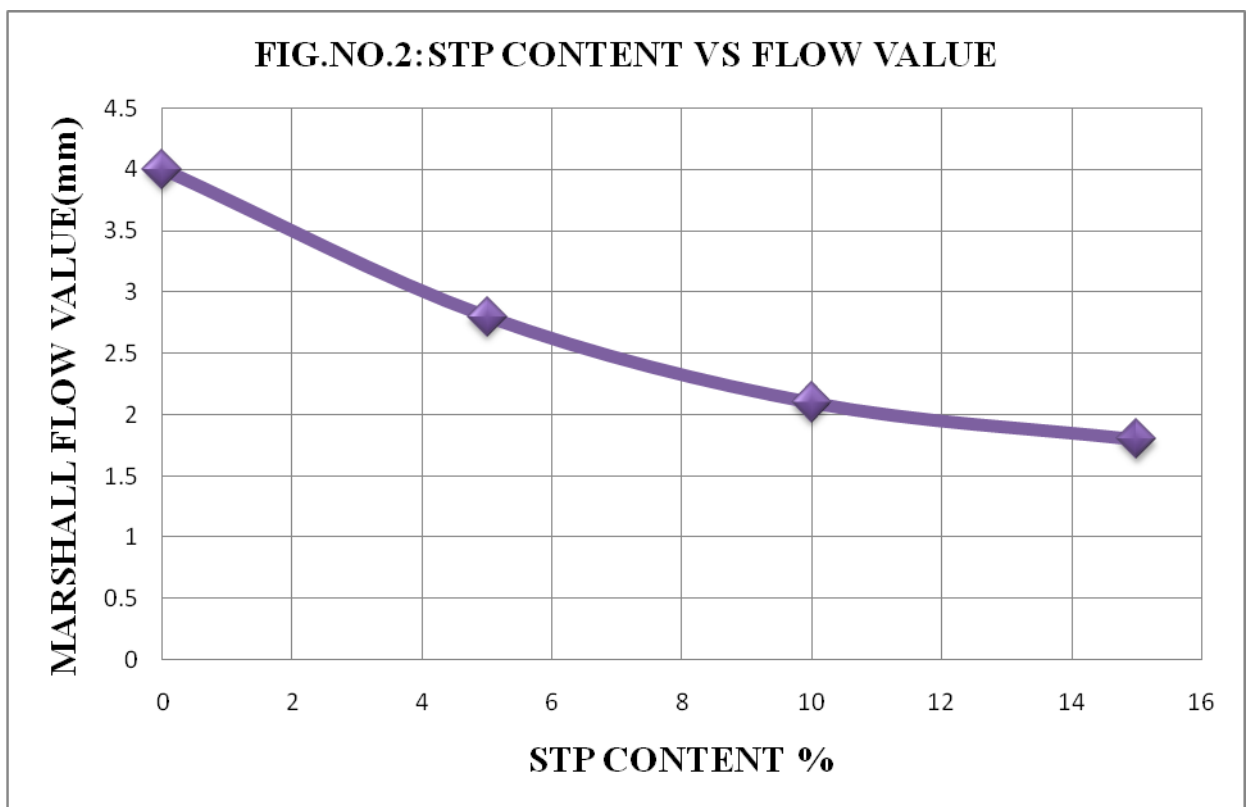
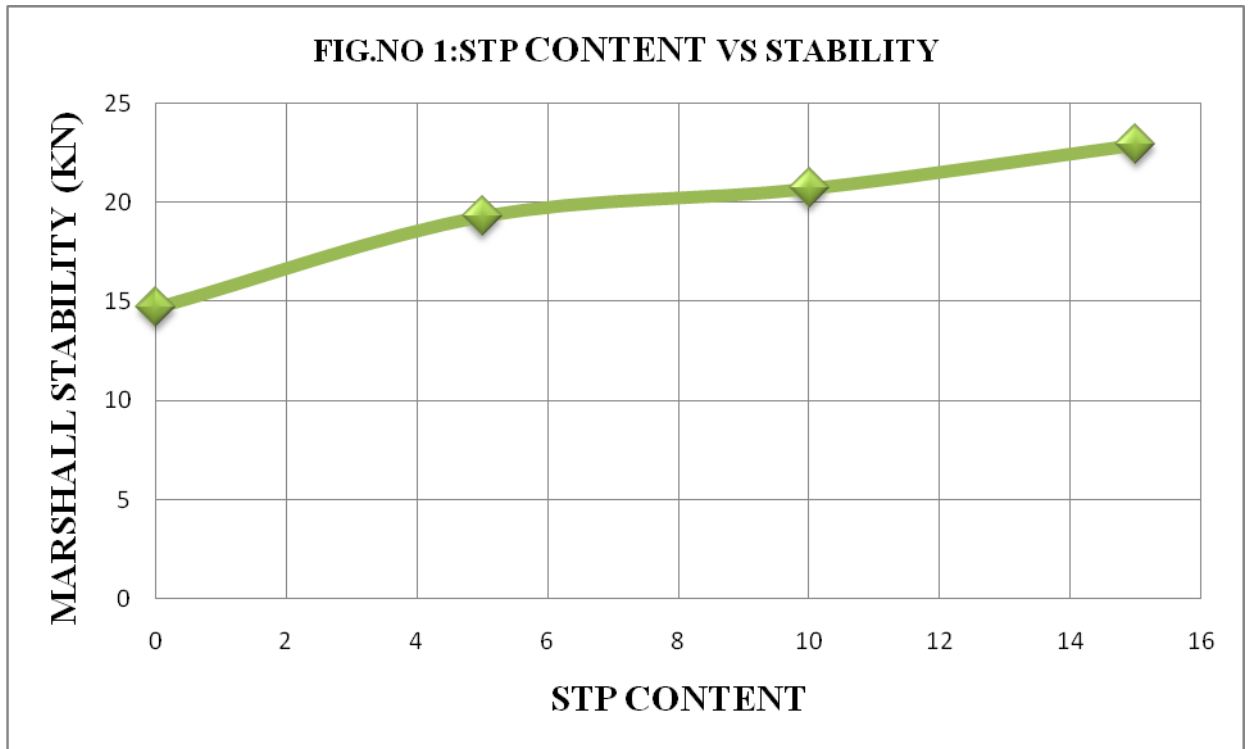
Marshall Mix Design:

The mix design should aim at an economical blend, with proper gradation of aggregates, adequate proportion of bitumen and the additives (Hydrated lime and the STP) so as to fulfill the desired properties of mix.

Table.No:3. Stability Value and Flow Value

S.No	% of hydrated lime	% of STP	Stability (KN)	Flow (mm)
1.	0	0	14.7	4.0
2.	0	0	14.2	4.2
3.	0	0	14.4	4.3
4.	10	0	15.0	3.6
5.	10	0	15.3	3.5
6.	10	0	15.2	3.3
7.	20	0	16.4	3.3
8.	20	0	16.3	3.2
9.	20	0	16.0	3.1
10.	30	0	16.4	3.0
11.	30	0	16.6	3.1
12.	30	0	16.5	2.9
13.	10	5	18.6	2.8
14.	10	5	19.0	2.6
15.	10	5	19.3	2.4
16.	20	10	20.3	2.3
17.	20	10	20.6	2.1
18.	20	10	20.7	2.0
19.	30	15	22.7	2.1
20.	30	15	22.9	1.9
21.	30	15	22.5	1.8

IV. ANALYSIS AND GRAPH



V. CONCLUSION

Bitumen is useful in road making and road maintenance and because of its basic thermoplastic nature, whereas modified bituminous pavement are also thermoplastic in nature. The addition of polymers to bitumen allows the modification of certain physical properties, such as softening point, brittleness & ductility, of the bitumen. They have been in use around 30 years or more. Altering the characteristics decreases stiffness of binder & increases the workability of bituminous mixtures @ low temperatures, (e.g. Hand-lay work). The cost reductions have made modified bituminous polymer pavement attractive for use in market. It gives longevity. When compare to normal bituminous pavement, polymer modified bituminous pavement adds to 25% increase in durability, contributing low maintenance& being economical. Super Thermolay Polymer (STP) is adaptable to both hot & cold temperatures. It is impermeable & proves to be flexible without showing any deterioration & serves for a prolonged period of time. More than 50 years, Hydrated Lime has been proved to be world-wide reference among bituminous pavement to mitigate moisture damage. The values VMA, VA, VFB are with in required specifications; the polymer coating reduces void spaces & withstands heavy traffic showing better service life. It is also environment friendly. Thus considering all this criteria transportation authorities need not face public inconvenience that results from repair & maintenance of pavements that fail prematurely. They have proved to be a reliable solution for all criteria.

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