PERFORMANCE ENHANCEMENT OF MASTIC ASPHALT MIX USING PLASTIC MODIFIER

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Abstract: Stone mastic asphalt is a gap graded asphalt mixture which can be used in the surface layer of high volume pavements, wearing surface for bridge decks, etc…. Due to recent problem of pavement failure at the intersection, bridge deck, rotary, etc, the use of mastic asphalt is increasing exponentially. The mastic asphalt is a void-less bitumen pavement where the voids are filled with bitumen up to 16%, but the optimum bitumen content is very high up to 16% in Indian condition and hence it causes bleeding. This study aims to reduce the OBC content by using modified bitumen. Modified bitumen can decrease the onsite cooking time as well as OBC. Hardness number test has been conducted according to MORTH 5th Revision for finding out the hardness number for modified bitumen & conventional bitumen. In these test 105 molds has been prepared for modified and conventional bitumen. From the test, optimum bitumen content and optimum plastic content has been extracted. On-site mixing time has been reduced by 20 min using plastic as a modifier. A result of the Comparison between modified bitumen and conventional bitumen shows that OBC content of modified bitumen is slightly less than the conventional bitumen VG 30.

*IndexTerms–**Pitch mastic asphalt, bridge deck, hardness no, shredded plastic, pavement surface***

1. INTRODUCTION

Construction of new road and strengthening bridge are major thrust area in India in the area of infrastructure development. To construct the bridge wearing course with strength, sustainability mastic asphalt is material which gives all properties for wearing course. The bitumen mastic is composed of suitably graded mineral filler and coarse aggregates, fine aggregates and hard grade of bitumen as to form a coherent, void less, impermeable mass, solid or semi-solid under normal temperature conditions, but sufficiently fluid when brought to a suitable temperature to be spread by means of a float in manual construction and by paverin mechanized construction.

Mastic asphalt is a thick mixture consists of coarse aggregate, sand, limestone fine aggregate, filler, bitumen, which may contain additives like polymers, waxes. The mixture is designed to be of minimum void content. The binder content is adjusted like that the voids are completely filled with the bitumen and that even a slight excess of the binder may occur. Pitch Mastic asphalt is easily spread in its working temperature condition. It is no requires compaction on site. Pitch Mastic asphalt is widely used for bridge surfacing. Pitch mastic asphalt has been known as a durable & deformation resistant surfacing however, a significant rise in traffic loading and requirements for an application under more critical environmental conditions warrant increase performance. It is a gap-graded mix, characterized by high coarse aggregates, asphalt contents. It provides a more resistant to rutting & provides enough friction to pavement surface even it is reveal to repeated loads. It has a greater proportion of coarse aggregate, the lower proportion of middle size aggregate & greater proportion of mineral filler. Pith mastic asphalt is used at a very huge scale in most of the countries like in bridge deck, rotary where the wearing and load of the heavy vehicle is more. The main problem in mastic asphalt is drained down of the binder during mixture, transportation due to a high percentage of bitumen content (5)

2. DIFFERENT FORMS OF MASTIC

2.1 Mastic asphalt for bridge deck and roads

This types of mastic asphalt are used for the flooring of warehouses, godowns, railway platforms, etc. colored mastic of brown and red color can also be produced for decorative flooring. Mastic asphalt can be laid by spreading colored grits over the mastic surface when it is hot and pressed gently. Mastic asphalt is graded in four grades according to their usages such as **Grade I – special flooring, Grade II – light duty flooring, Grade III – Medium duty flooring and Grade IV – Heavy duty flooring** (industrial factory flooring) and accordingly their thickness requirement id decided as per specified limit for each grade.(1)

2.2 Mastic asphalt for bridge deck and roads

In the case of flexible road pavement, the traffic load (stresses) are transmitted to the lower layer and ultimately dissipated into the sub grade. But in the case of bridge pavements, the steel deck performs the function of a base which is rigid and as such all the stresses transmitted through the different pavements layers, are either to be taken by the steel deck(or rigid pavement in case of cement concrete pavements) or they are to be absorbed by the flexible pavements layers. Mastic asphalt is one such material which satisfies such demands.

2.3 Mastic asphalt for damp proofing and tanking

It is used suitably in basements of multi-storied building and industries building as a damp proofing layer over a cement concrete platform in 25 mm thickness. The sidewall of the basements van also be coated with mastic asphalt as damp proofing layer. It is used in strips of one-meter width. The joints are overlapped and in no way, the joints should be allowed to leak. In comparison to other waterproofing treatment adopted, mastic asphalt is the most effective and durable solution. It may be applied also on sloping per vertical walls.

On the ground – supported and suspended concrete bases, where wet process is to be used, mastic asphalt should be laid in two coats, the first coat being an underlay or waterproofing mastic asphalt. This system should be used in toilet and shower compartment on suspended concrete slabs over accommodation areas, wet process area and in breweries and food factories(5).

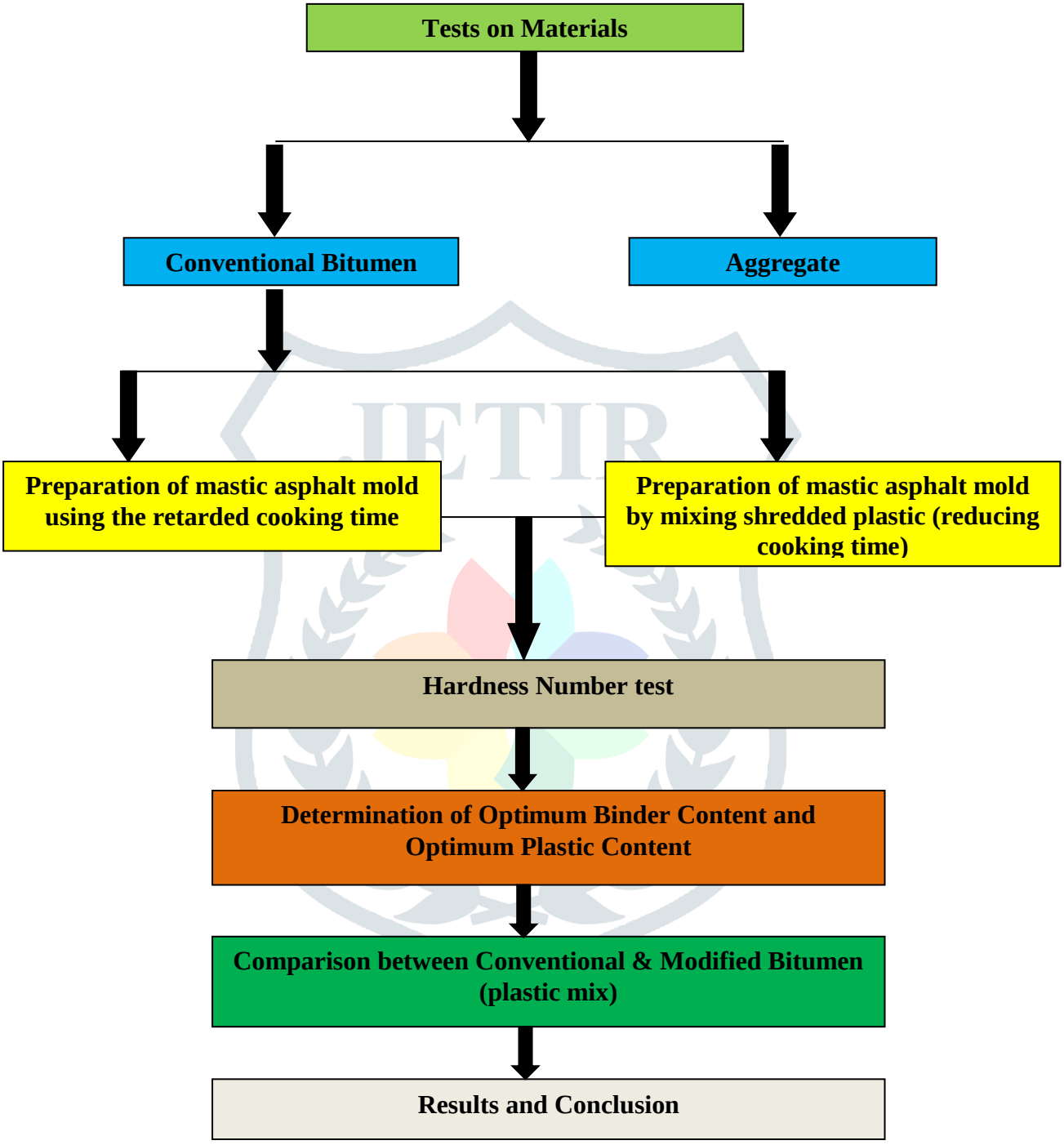
3. Manufacture of mastic asphalt

The manufacture of pitch-mastic consists of two stages. The first stage shall be mixing of filler and fine aggregates and then heating the mixture to a temperature of 170 to 205" C. Required quantity of bitumen shall be heated to 170 to 180°C and added to the aggregate. They shall be mixed and cooked in mechanically agitated mixer called mastic cooker for 2 to 3 h until the materials are thoroughly mixed. During mixing, care shall be taken to ensure that the contents in the cooker are at no time heated to a temperature exceeding 205"C.

The second stage shall consist of the incorporation of the coarse aggregates. When the pitch-mastic is to be transported directly to the site of work, a quantity of coarse aggregate 6 to 20 mm normal size to form not less than 30 percent and not more than 50 percent by mass of the final mixture shall be added and thoroughly incorporated with the mastic in the cooker. The actual percentage of the coarse aggregates to be added shall be specified according to design requirements. When the material has been cast into blocks, these shall be reheated in the cooker to a temperature of not less than 170" C and not more than 205°C and the coarse aggregate as mentioned before shall be thoroughly incorporated in the mastic. Hardness number test is conducted by using hardness number equipment given in fig 1.

Fig, 1 Hardness number equipment for mastic asphalt

4. RESEARCH METHODOLOGY



4.1 Selection of Material

- There are three types of material that I have to select and, the materials are Aggregate, Bitumen, and Filler.
- Aggregate is collect from sewaliya.
- I will use bitumen of grade VG 30 collect from the local company of Vadodara karjan area.
- I used limestone as a filler less than 80% $CACO_3$ as per MORTH 5th Revision

4.2 Physical test of material

- To carry out all the physical properties of the material as per specification in MORTH 5thRevision (Bitumen, Aggregate, Filler)

4.3 Selection criteria for mix design

- Criteria's are selected as per MORTH 5th Revision.

4.4 Selection of bitumen & plastic content

- Bitumen content is selected between 14% to 16% with varying plastic content from 2.5% to 4% for preparation of mould to find optimum bitumen content & plastic content purpose.

5. RESULTS AND DECISION

5.1 Results of the physical test of aggregate

Table 5.1 Physical test of aggregate

SR NO	Property tested	Test value	Requirement as per MORTH specification
1	Loss Angeles Abrasion Value	5.95	40% maximum
2	Aggregate Impact Value	5.35	30% maximum
3	Flakiness And Elongated Indices(Total)	7.9	30% maximum
5	Soundness Loss With Magnesium Sulphate-5 Cycles	2.50	18% maximum
6	Water Absorption	0.79	2% maximum

5.2 Result of physical test of bitumen

Table 5.2 Physical test of bitumen

Test name	Test Result	Specified limit as per MORTH 5th revision
Penetration at 25ºC	12	10 to 20
Softening point (R&B), min	59	55 to 75
Loss of heating at 163ºC, by mass min	0.99	Max 1 %
Solubility in CS_2	98.5	Min 99%
Ductility at 25ºC, cm, min	2.5	3 cm

5.3 Result of mastic asphalt for conventional VG 30& modified bitumen

Table 5.3 hardness number calculation for VG 30 bitumen

Bitumen content (%)	Hardness number	Cooking time(min)
14	12	180
14.5	13	180
15	14	180
15.5	15	180

Plastic content (%)	For 14% B.C	For14.5%B.C	For15%B.C	For 15.5%B.C
	H.N	H.N	H.N	H.N
2.5	8	9	10	11
3.0	6	7	8	9
3.5	4	5.2	6.5	7.2
4.0	3	4	5	6

Table 5.4 Hardness number calculation for modified bitumen

Table 5.4 shows that hardness number calculation for modified bitumen with very different bitumen content from 14% to 15.5% and plastic content from 2.5 % to 4 %. From table we show that with plastic content increase hardness number decrease with fixed cooking time **160 min**

5.4 Graphical representation of hardness number

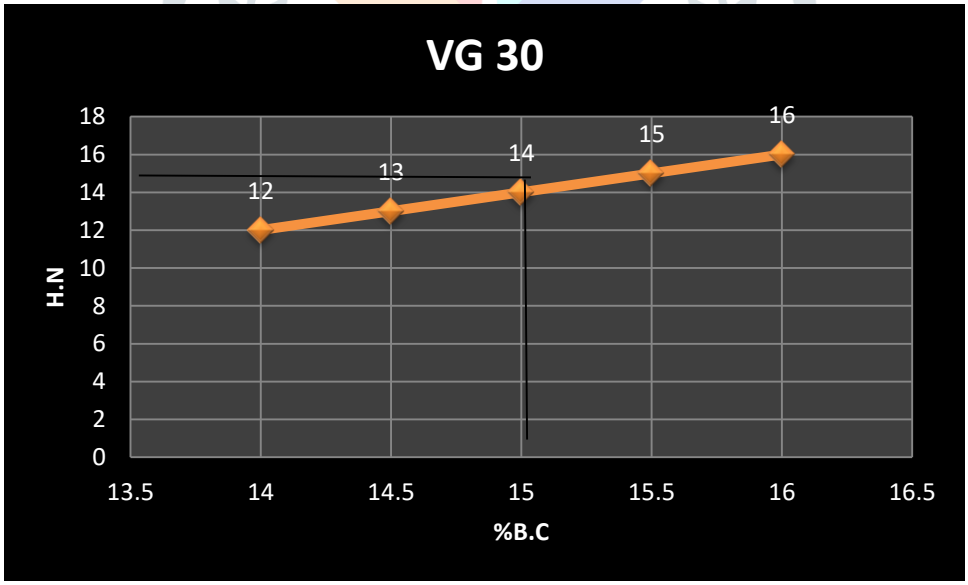


Fig 5.1 B.C V/S H.N

- From graph 5.1 hardness number increase with bitumen content increase and obtain avg bitumen content 15 % for VG 30 bitumen

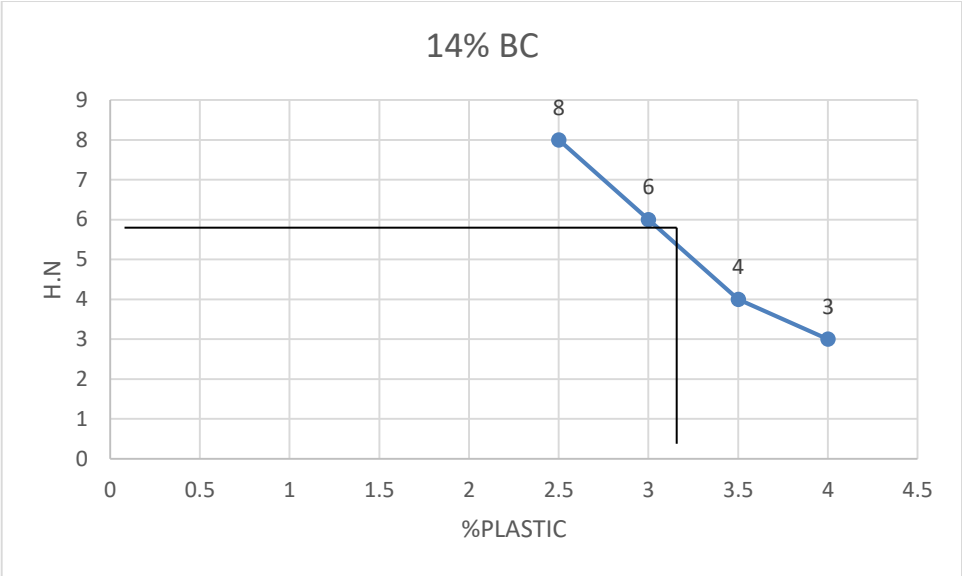


Fig 5.2 H.N V/S P.C

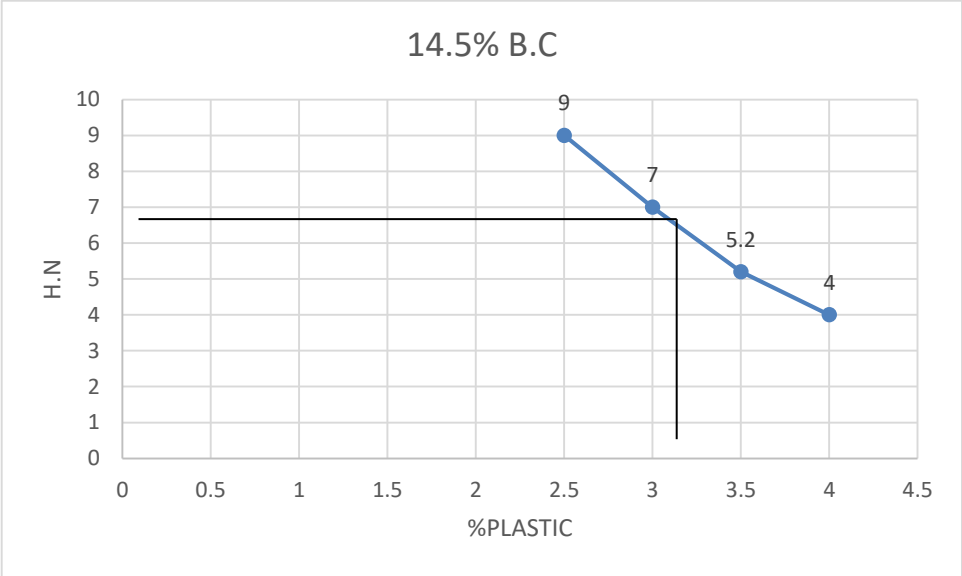


Fig 5.3 H.N V/S P.C

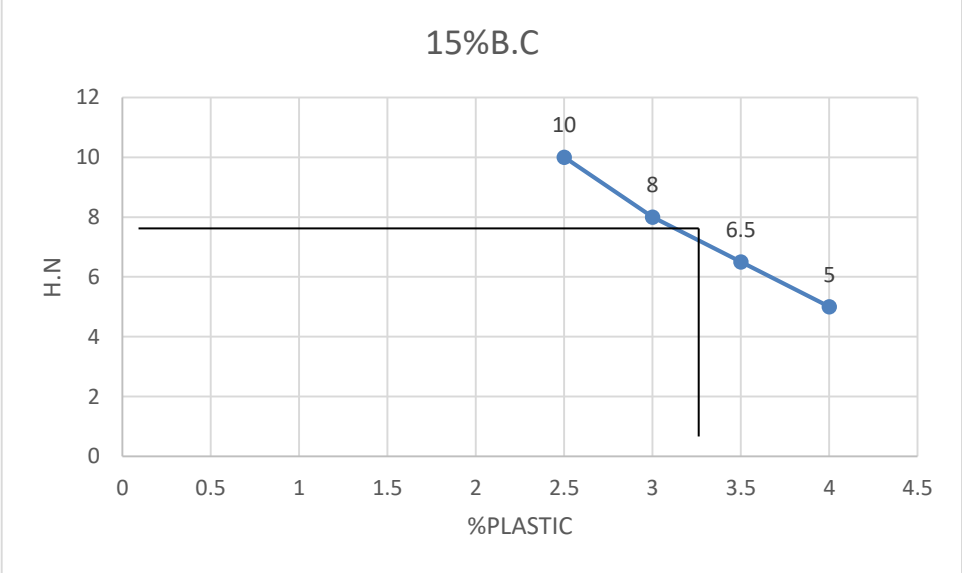


Fig 5.4 H.N V/S P.C

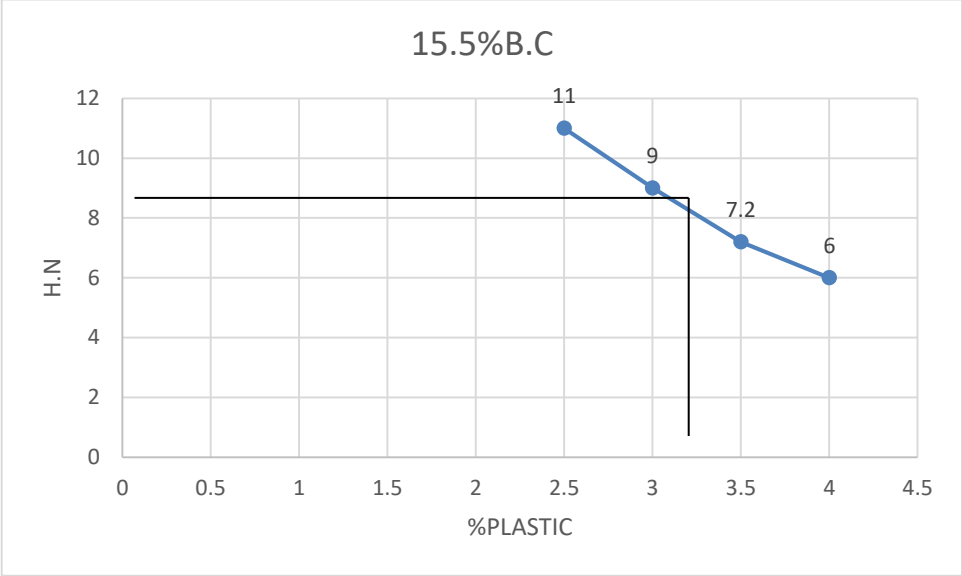


Fig 5.5 H.N V/S P.C

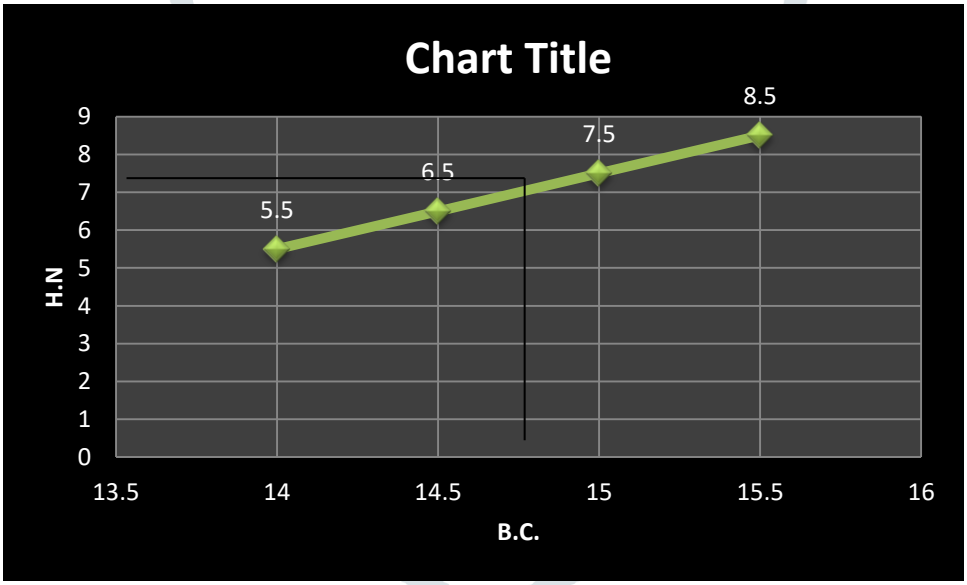


Fig 5.6 AVG H.N V/S B.C

- From graph 5.2 to 5.6, we can see that hardness number decrease with increase in plastic content, and obtain optimum plastic content from plot avg hardness number on the graph
- From graph 5.6 we get optimum bitumen content of modified bitumen 14.7 which is slightly less than conventional VG 30 bitumen.
- According to the above graphs for bitumen hardness number increase with % of bitumen content increase.
- In modified bitumen hardness number decrease with increase % plastic content.
- From the above graphs we can show that we get harder mastic with the addition of plastic content with a lower bitumen content
- And also we reduce cooking time by 20 min with the addition of plastic content and get harder mastic asphalt

VI Conclusion

From the present study, it can be seen that hardness number increase with bitumen content increase. As per objective and scope of the study all physical test of bitumen and aggregate has been carried out according to MORTH 5th Revision. The data collected for the VG 30 industrial bitumen and modified bitumen using plastic as a modifier and compare both modified and unmodified bitumen to find optimum bitumen content & optimum plastic content as per scope of the study. From the study it is found that optimum bitumen content is more in VG 30 industrial bitumen up to 15% & by using plastic as a modifier the modified bitumen has a optimum bitumen content is 14.7%. On site mixing time (cooking time) has been also reduce by 20min by using plastic in bitumen.

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