Investigation of the Effects of Urban Iron Ore Tailing in Bituminous Mix

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Abstract: ***The mechanical dynamic modulus test was used to determine the dynamic moduli of hot-mix asphalt (HMA) with and without different types of fibers, and master curves were developed. The ultrasonic pulse velocity (UPV) test was then conducted on the same specimens to estimate the dynamic moduli across multiple temperatures, and master curves were developed. The Poisson's ratios required for UPV modulus prediction were estimated for different reduced frequencies, and a sensitivity analysis on their effect on the modulus values was performed. The master curves developed using the UPV moduli were superimposed on the mechanical test master curves and matched closely. Witczak's predictive equation and the Hirsch model were also used to predict the dynamic modulus master curves. The UPV moduli closely matched the mechanical dynamic moduli better than those predicted from the Witczak or Hirsch models at intermediate and high reduced frequencies. An attempt was made to combine the UPV modulus prediction with the Witczak and Hirsch models to improve moduli estimation at low reduced frequencies. Typical mechanical test methods are time consuming and require an expensive load frame and instrumentation setup. The UPV test requires less time, and the equipment needed is relatively inexpensive. Using the UPV test in combination with either the Witczak or Hirsch model is recommended as a lower-cost alternative to develop the master curves of the HMA dynamic moduli..***

Keywords: Ultrasonic pulse velocity (UPV) Hot Mix Asphalt (HMA), Witczak's

1. Introduction

It's been several years in the in site conditions generally in the road construction has revealed considerable reduction in the compaction temperature as well as mixing which leads failure of pavement like cracking, rutting and stripping. Compaction characteristics depends by the air void of the mix and it not fall below 8% according to the Ministry of Road Transport and Highway .It is necessary to build strong and durable roads with better performance to its design life. A road should design should sustain heavy axle loads without causing rutting to the pavements. In India most of the roads were construction by black toping with the bituminous surface. It should also observed intensity of traffic is more in the highway with overloading of axles which results in structural deterioration of flexible pavements which indicates shear failure cracks and longitudinal cracks and also cause increase in the rut depth. It is required to design the durable bituminous mix for the flexible pavements to perform for heavy axle loads with high traffic intensity. The properties and quality of the bituminous mix mainly depends on the materials coarse aggregates, fine aggregates, filler and binder. The change in the physical properties that lead improvement in the bituminous mixes in the flexible pavement which causes reduction in the structural failure in the pavements.

Use of Iron ore tailing (IOT) as filler a replace use of silica sand and restore the natural resource. IOT is available in the Hospete, in the large quantity. It is necessary to use Industrial wastes in the constructions of roads to its better performance and mainly to turn this industrial waste into valuable resources which causes reduction uses natural river bed sand. IOT are ultra- fines which are having 150 µm in diameter which is not useful any purpose and hence it is disposed

Figure 1: Iron ore tailings

1.2 Scope and Objective of the Study

The following are the Need for study, scope and objective of the study. The objective of this study is to investigate the effect of using iron ore tailings in bituminous mix and also to evaluate the performance characteristics of the bituminous concrete (BC) mix using IOT.

1.2.1 Scope of the Present Study

The following are the scope of the present study
1) The marshal stability test was conducted on bituminous mixes containing various amount of bitumen, at various temperatures, and with various stabilizer rates.
2) It was utilised in the study to determine the best binder content (OBC).
3) To find co-relation in the bituminous mix properties

between laboratory compaction methods.

4) In Marshall Stability method the specimens are subjected to rolling compaction. To develop realistic approach to specimens.
5) By conducting ultrasonic pulse velocity test the depth of penetration for flaw detection or measurement is superior to other NDT tests

1.2.2 Objectives

The aim of this study is to evaluate the performance characteristics of the bituminous concrete (BC) mix using IOT of varying percentage of 0% to100%.

1) Detailed examination on the properties of iron ore tailings
2) To study the use of Iron Ore Tailings in preparation of specimen by replacing fine aggregates in various proportions and performing laboratory tests.
3) Four different percentages (25%, 50%, 75%, and 100%) of IOT are being used, and the proposed mix designs for bituminous mix are prepared in accordance with Marshall Mix design and conduct the experiment to check for various improvements on the properties of bituminous mix.
4) By conducting ultra sonic pulse velocity test the strength and quality of the material is assessed by measuring the velocity by using an ultra sonic pulse velocity device in which transducers and receivers can be used to get the readings.
5) To Evaluate flow value by using bitumen content 5.5%.
6) To evaluate the optimum bitumen content for bituminous mix

2. Materials and Methodology

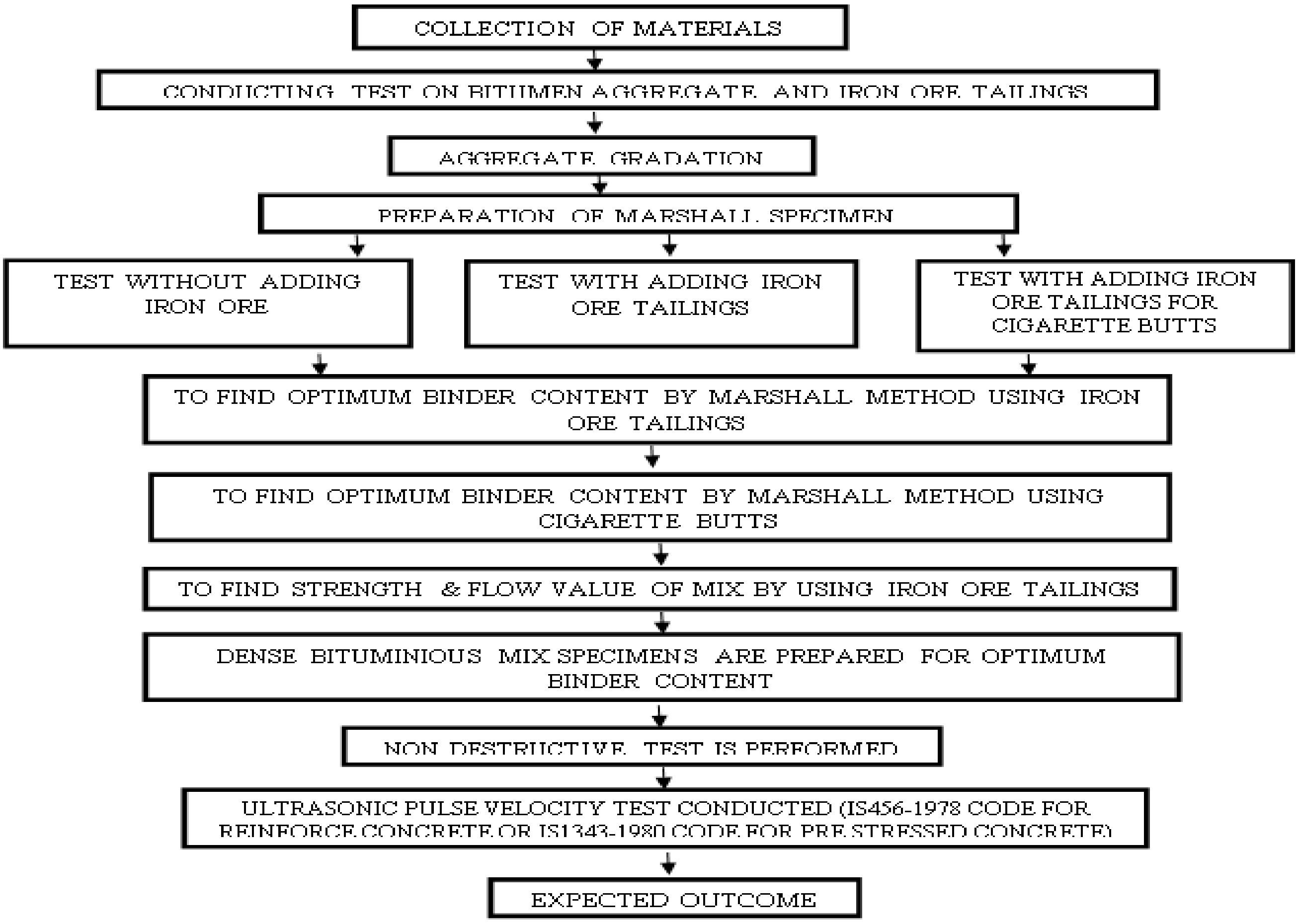

Figure 2: Flow Diagram

2.2 Test Conducted in Present Investigation

Table 1: Flow Diagram

Property	Value	Specification (ASTM C33 LIMIT)
Specific Gravity	2.41	2.4 – 2.9
Unit Weight (Bulk Density)	1513.2	1200 – 1750 kg/m3
Water Absorption	2.81%	< 4%
Voids in aggregates	36.25%	30 – 45%
Silt contents	4.87%	< 5%
Moisture Content	3.62%	0-4%
Fitness Modules	2.40	-

Table 2: Flow Diagram

Sl No	Test	Requirement as per MORTH	Test method	Control binder (CB)
1	Penetration	50-70	IS:1203-1925	61
2	Ductility Test	Min 75	IS:1208-1978	77
3	Specific gravity	-	IS :1202	1.01
4	Softening point	Min 47	IS:1205-1978	54
5	Flash point	Min 220	IS :1209-1978	302

Table 3: Flow Diagram

S. No	Test	Obtained value	Test Method
1	Specific gravity	3.45	IS 383-1970
2	Aggregate impact test	27.89%	IS: 2386 part 4-1963
3	Crushing test	28.4%	IS: 2386 part-4-1963
4	Los Angeles abrasion test	27.8%	IS:2386 part 4-1963
5	Water absorption 20mm down 12.5mm down	0.24%	
6	Flakiness and elongation index (combined)	25%	

Figure 2: Flow Diagram

Figure 3: Flow Diagram

Figure 4: Flow Diagram

Figure 5: Flow Diagram

Figure 6: Flow Diagram

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Figure 7: Flow Diagram

Figure 8: Flow Diagram

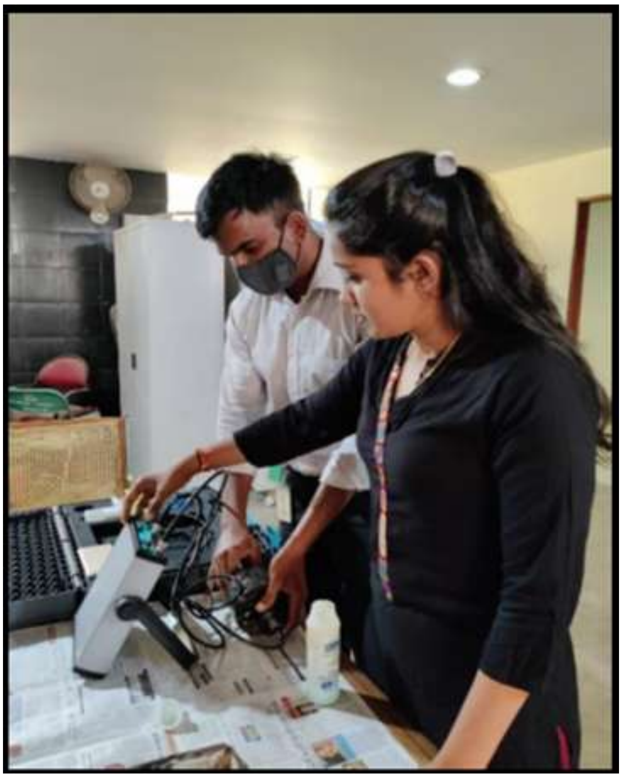
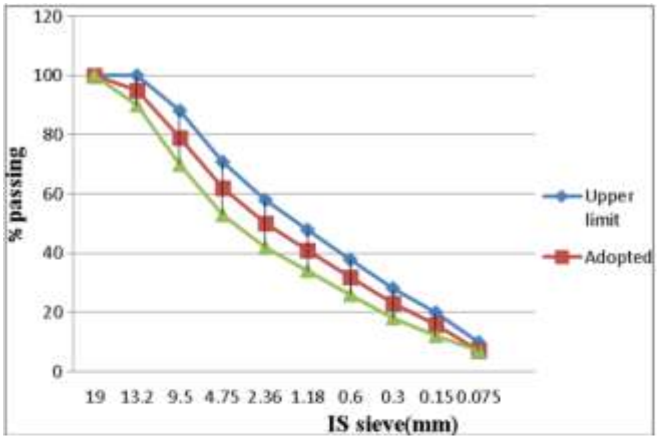


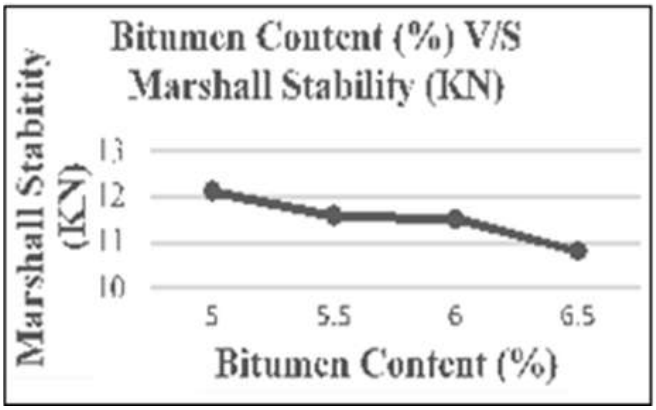
Figure 9: Flow Diagram

3. Present Investigations

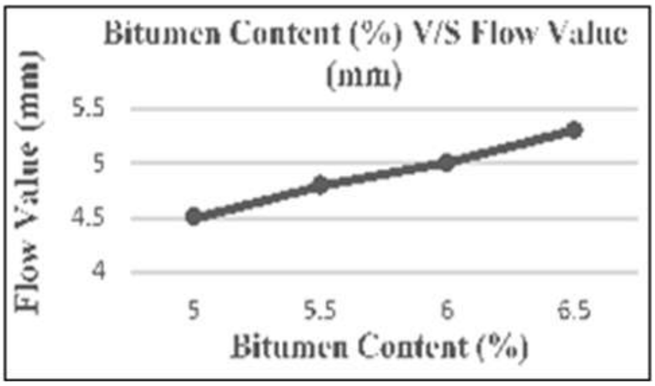
Figure 10: Flow Diagram



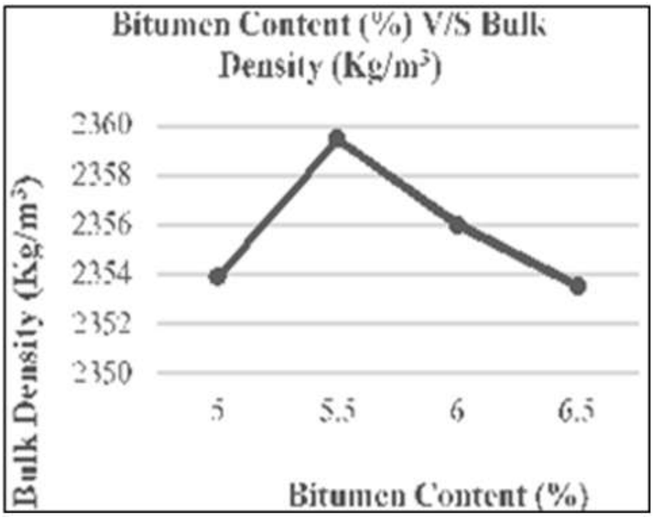
Graph 1: Flow Diagram



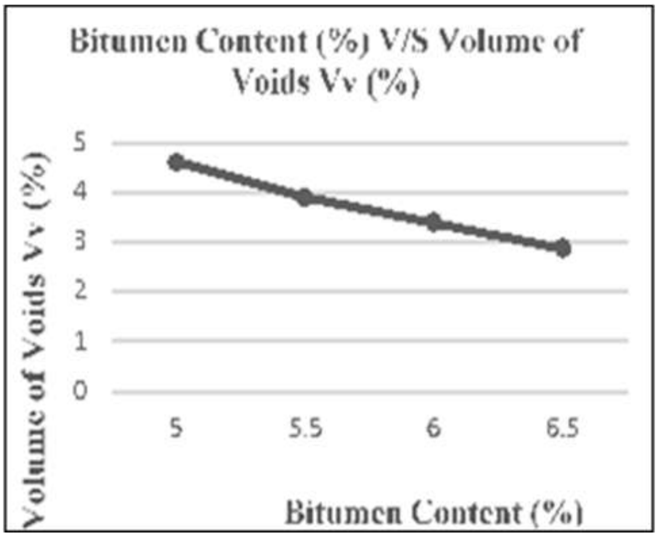
Graph 2: Bitumen Content v/s Marshal Stability



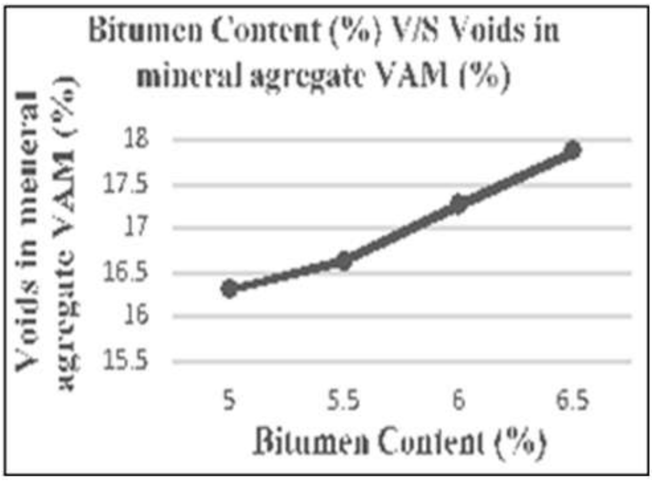
Graph 3: Bitumen Content v/s flow value



Graph 4: Bitumen Content v/s bulk density

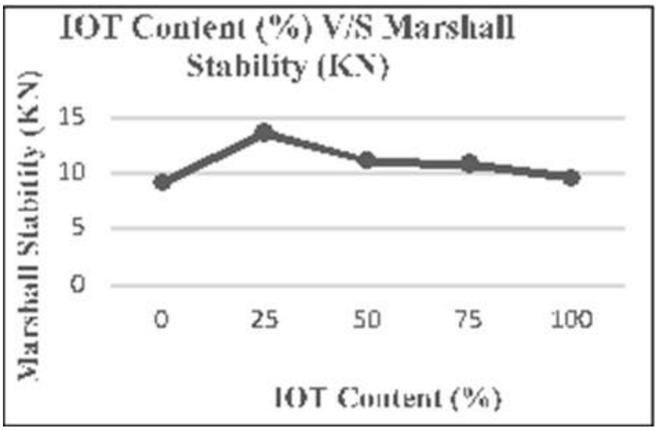


Graph 5: Bitumen Content v/s volume of voids

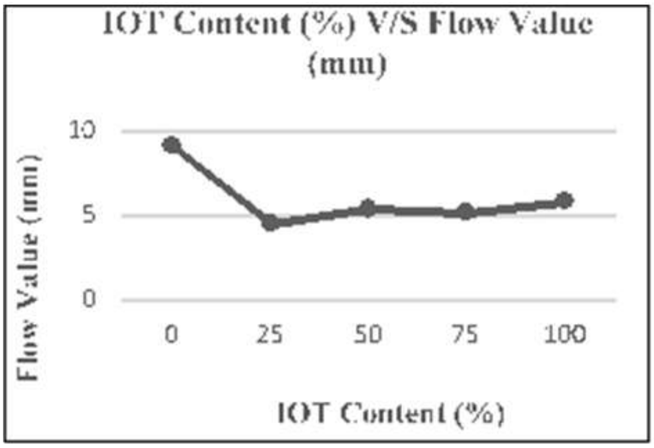


Graph 6: Bitumen Content v/s VMA Content v/s Marshal

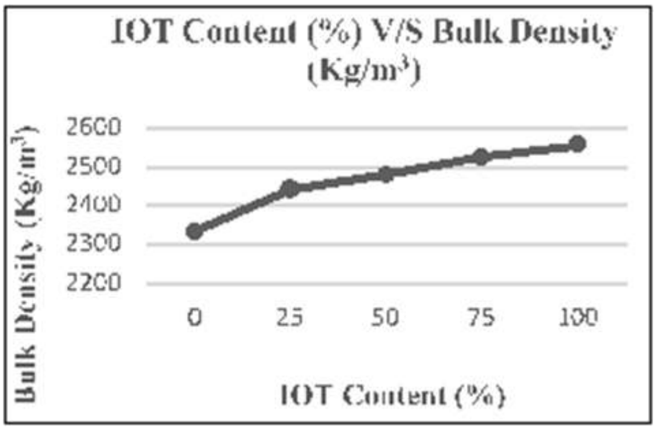
The following graphs shows the Marshall stability with respect to IOT Content in different %, IOT content with respect to flow value, Bulk density, volume of voids ,Voids in Mineral Aggregate VMA (%),IOT content v/s VFB



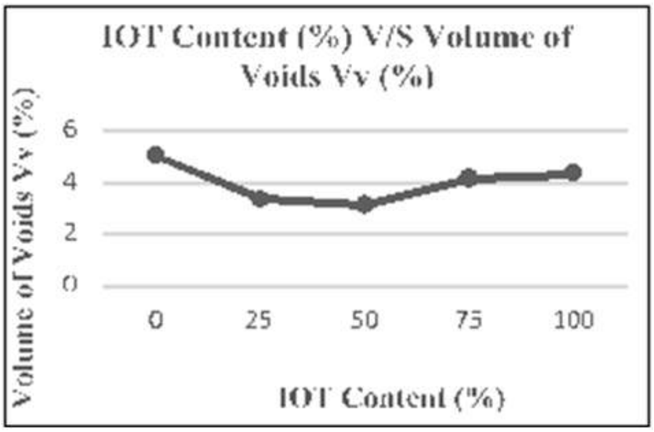
Graph 7: IOT content v/s Marshal Stability



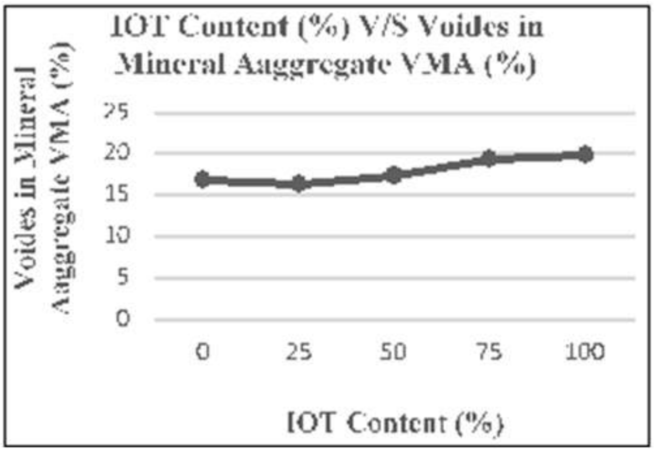
Graph 8: IOT content v/s Flow value



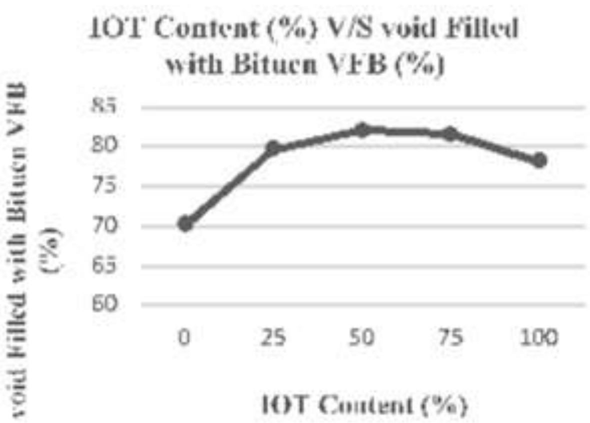
Graph 9: IOT content v/s bulk density



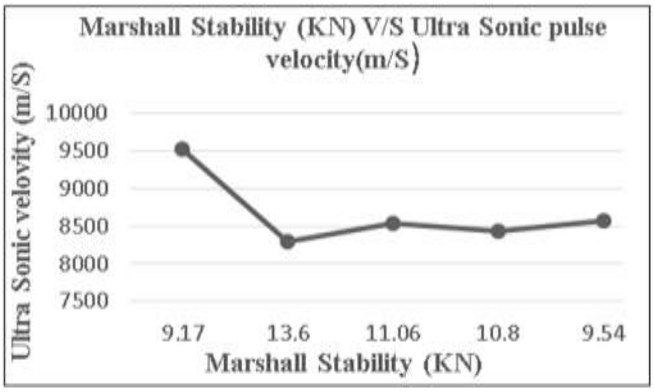
Graph 10: IOT content v/s VV



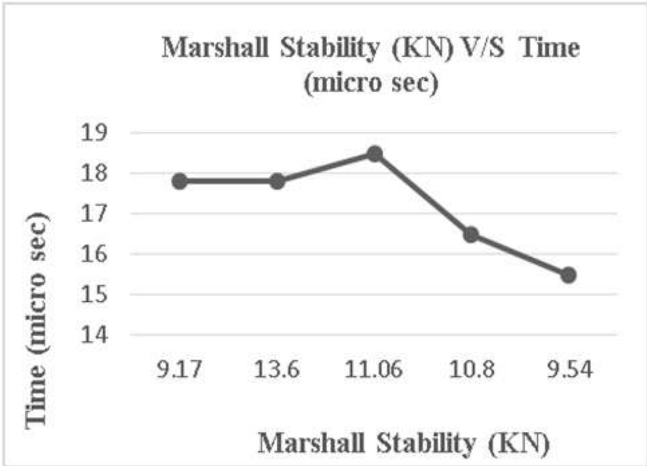
Graph 11: IOT content v/s VMA



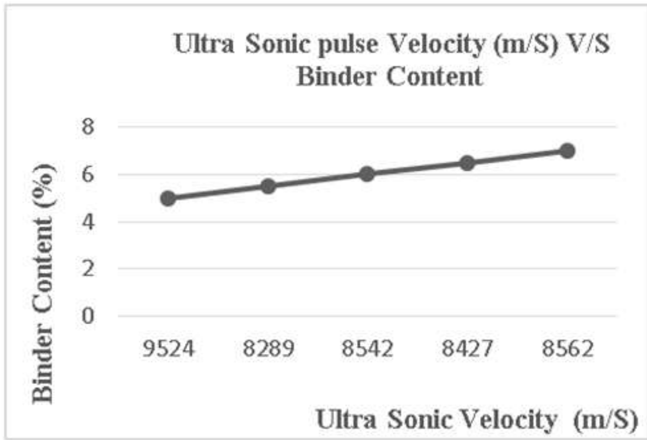
Graph 12: IOT content v/s VFB



Graph 13: Marshal Stability v/s UPV



Graph 14: Marshal Stability v/s Time



Graph 14: UPV v/s Binder content

4. Results and Discussion

Test conducted with IOT

1) The aggregates utilized in the existing research have physical characteristics that meet the MORT&H criteria.
2) The physical characteristics of the 60/70 (VG – 30) grade bitumen and warm mix binder employed in the current research were tested, and they met the MORT&H criteria.
3) In the current research, the Marshall property of HMA meets the MORT&H requirements.
4) At 1500°C, the optimal bitumen concentration for HMA mix was found to be 5.5 percent.
5) In a 25% substitution of IOT with natural aggregates,

the Marshall Stability values are shown to be higher. It's possible that the greatest stability is due to improved coating and bonding between the mixtures.

6) When 25% of IOT was replaced with natural aggregates, the proportion of air voids in the mix was found to be lower.
7) As the characteristics of IOTs improved, the bulk density of the mix rose as well, as did VMA.
8) Based on the results of the experiments and testing, a 25% substitution of aggregates with IOTs is better suited for road building and provides more strength and stability.

Test conducted with cigarette butts

1) For the SMA Mix without CBs, the Marshall Stability value is 5.67 kN.
2) The Marshall Stability values for SMA mixes with CBs of 2%, 4%, and 6% are determined to be 3.846 kN, 2.197 kN, and 1.154 kN, respectively.
3) As the proportion of CBs grows, the Marshall Stability values drop, but when the percentage of CBs is less than 2%, the marshal characteristics are similar to SMA mix without CBs.

Scope for further research

1) Other bitumen grades, modified bitumen, cuts, and emulsion can also be utilised to evaluate the overall performance of Iron ore Tailings in the future.
2) Use of IOT may also be tested not only for HMAs but also for different other WMAs and super pave.
3) In the laboratory, the biodegradability of HMA utilizing UV radiation may be studied.

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