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ASSESSMENT OF STRENGTH CHARACTERISTICS OF WARM MIX BC MODIFIED USING NATURAL ZEOLITE

Rekhraj[1]*, Anil Kumar Suman[2]

[1]*M. Tech, Civil Engineering Department, Shri Shankaracharya technical Campus, Bhilai-490020 Chhattisgarh, India,*

[2]*Assistant Professor, Civil Engineering Department, Shri Shankaracharya technical Campus, Bhilai-490020 Chhattisgarh, India.*

Abstract

Bituminous concrete is composite material made by mixing aggregates and bitumen in fixed proportions used for con-struction of bituminous pavement. Bituminous pavement transfer wheel load to sub grade by grain to grain transfer mechanism and to transfer loads by this mechanism, the bituminous concrete should have high stability value. Conven-tional bituminous concrete works efficiently under normal loading and environmental conditions but nowadays vehicular traffic is increasing exponentially and environmental conditions are deteriorating fast. Humongous increase in traffic load cause many types of problems to bituminous concrete pavements, some of them are shear failure of pavements, rutting, alligator cracking etc. To overcome the problems imposed by in-creased traffic load and deteriorated environmental condi-tions different type of modifiers are being used in bitu-minous concrete. The failures of the bituminous pavements are not only due to increase in traffic but also due to extreme climatic conditions prevailing in our country The Warm Mix As-phalt (WMA) technologies are very popular in recent years because of its property to the reduction in compaction and mixing temperature of Hot Mix Asphalt (HMA) mixtures without compromising the quality. On the other hand, the utili-zation of Natural Zeolite in modified bituminous mixtures are that these increase the durability the pavement. Also use of Polymer Modified Bitumen can enhance fatigue life of bituminous mixes. These also help in reducing the cracking and rutting po-tential of the pavement. However bituminous concrete modified using Natural Zeolite requires a low mixing and compaction temperature as compared to conventional Hot Mix Asphalt because of lower melting point of Natural Ze-olite (110^{o}C). Therefore, in this study an investigation of the strength characteristics of bituminous concrete (using VG 30 and PMB 40 bitumen) modified with Natural Zeolite using Sasobit as an additive was initiated.

In present study Natural Zeolite is used as modifiers in bituminous concrete while Sasobit used as a warm mix additive in bitumen. Tests were carried out to access the physical properties of bitumen (VG 30 and PMB 40) and to access the strength characteristics of bituminous concrete having without any modifier and having modifiers as Natural Zeolite and Warm mix additive as Sasobit. Marshall tests were performed on VG 30 bituminous concrete and PMB 40 bituminous concrete without using Natural Zeolite to obtain the optimum bitumen content for in

further analysis of study. The amount of bitumen for preparing bituminous concrete using VG 30 was varied from 4.8% to 5.8% and bituminous concrete using PMB 40 was varied from 5.0% to 6.0%. The physical properties of bitumen blended with Natural Zeolite were accessed by conducting softening point test, ductility value test, dynamic viscosity test, flash & fire point test. After accessing physical properties of modified bitumen, warm mix bituminous concrete specimens were casted by using warm mix pro-cess and then Marshall tests were performed to find strength characteristics of warm mix bituminous concrete modified using Natural Zeolite. The amount of Natural Zeolite taken in the study was varied 4%, 5% and 6% by weight of binder content for VG 30 and PMB 40 both the grade of Bituminous concrete. Result of the study revealed that addition of Natu-ral Zeolite into VG 30 and PMB 40 grade bitumen enhances its physical properties. It increases the softening point value, flash & fire point and dynamic viscosity at lower temperature while it reduces the viscosity of binder at higher tempera-ture, so mixing and compaction of bituminous concrete was done at lower temperature than require in Hot Mix Asphalt. The optimum dose of Sasobit for blended in bitumen was found 2.0% by weight of bitumen from the research done ear-lier. The Marshall Stability of warm bituminous concrete (VG 30) modified using Natural Zeolite maximum at 5% after that it reduces and before also reduces and after this content flow values increases considerably, so the optimum content of Natural Zeolite were found to be 5% by weight of binder for VG 30 grade Bitumen. Similarly, Marshall Stability of warm bituminous concrete (PMB 40) modified using Natural Zeolitemaximumat5.0% content of Natural Zeolite and then reduces so the optimum content of Natural Zeolite were found to be 5.0% by weight of binder for PMB 40 grade Bitu-men The increase in Marshall Stability value is because of the fact that Natural Zeolite is mixed, they get mix thoroughly with bitumen and form homogeneous mixture when blended with aggregates. Reduction was observed in percent air voids with increment of Natural Zeolite content for both VG 30 PMB 40 grade bituminous concrete. Increased stability value accounts for more number repetitions of axels and safely transfer high traffic load to sub grade. Hence, increases life of pavement and it becomes more durable as compared to conventionally constructed pavement. The strength of VG 30 grade bituminous concrete was observed to increase by 34.82% in case of modification by Natural Zeolite. Moreover, the strength of polymer modified bituminous concrete is 45% more than the plain bituminous concrete. The bituminous pavements constructed using VG 30 and PMB 40 modified with Natural Zeolite can withstand higher wheel loads and more number of repetitions of wheel loads and thus will also reduce the maintenance cost.

Keywords: Hot Mix Asphalt (HMA); Warm Mix Asphalt (WMA); Dense mix concrete DMC Bitumen content BC.

** Corresponding author*

1. Introduction

Bituminous mix are wide use every flexible pavement constructions. It consist of hydrocarban and minerals aggregates which is mixe with it, and lay downs in layer and after that compressed. in normals situation, conservative bitumins pavement but design and execute correctly execute quites sufficiently except

presentation on bitumins mix are extremely poors below a variety of situation. Today asphaltics concretes pavement are likely to performs best as they is expectant improved load of traffics, improved traffics and increase variation in daily or serial heat over what has been skilled in the pasts (Murphy et al., 2001). This starting concept of WMA technology were impliment in Europeans to decrees green house gases release due to pollutions. Every country in Europeian Unions were facing withs green houses gases reductions target to the 1998 Kyoto agreement on climate changes. the majority WMA technology dones by lower the viscosity to the asphalts which allows to better coats aggregates surfaces and reduces the targetes temperature to reaches enough workability of the mixtures. This way it could be use in colder climate or for highway and throughway invention For the same cause, it can be ship long distance also. The WMA is produced by the addition of certain chemicals in the asphalt mixes. These substances help in the reduction in the viscosity of the mix. Reduced viscosity results in significantly lower mixing temperature than the hot mixes. Warm mix asphalt (WMA) technology enables an engineer to reduce energy consumptions and emissions in asphalt paving industry. Compare to hot mix asphalt (HMA) in which compacting and rolling is do neat higher temperatures here in WMA mixing, compacting and rolling is done at lower temperatures. The main ingredients of the warm asphalt mixes are the modifiers which are added in order to reduce the mix production and compaction temperatures. Apart from reducing temperatures, modifiers have been found to be immensely efficient owing to its economical and environment friendly attributes. Hence it is suggested that in arrange to progress the quality of bitumen certain admixtures should be added. Natural Zeolite has proven to be a promising modifier when it comes to incorporating pavement sustainability principles. Numerous studies have been done to determine the usage of warm-mix asphalt (WMA) technology in order to lower the mixing and compacting temperatures. WMA technology works on two principles, either it reduces the asphalt & aggregate interface friction or it lowers the viscosity of the bituminous mix. Various environmental benefits such as lower emissions of hazardous gases, decreased consumption of energy and better surrounding conditions for workers at the construction site can be achieved by incorporating WMA technology.

The WMA has certain distinct advantages over HMA as follows:

1) As the temperature level is moderately low, air-contamination caused because of emission and fumes is less. Also, the aging of asphalt binder during the heating process(called as short-term aging) is controlled considerably.
2) Less energy is spent while manufacturing.
3) Temperature drop during mix transportation is no longer a concern. The construction season expands and the haul distance increases.
4) Compacting effort is less so as to achieve a specified compaction level.

Warm mix asphalt innovation is by all accounts very encouraging. It devours 30% less vitality, decreases carbon dioxide discharge by 30%, and lessens tidy outflow by 50-60% contrasted with hot mix asphalt.

2. EXPERIMENTAL PROGRAM

Materials

2.1 Aggregate

Aggregates are main component of bitumin concrete (BC) and they resist high magnitude of load stresses which transfer on the pavement. The physical properties of aggregates were assessed to determine their performance under normal condition according to Indian standards test meth-ods. Aggregate is use in production of a variety of pavements layer like in granular sub-base, base course and a variety of types of bituminou pavements layer in the binders and surfaces course. This impact value was found to check the toughness of aggregates, abrasion test was per-formed to check the hardness of aggregates, crushing value was found to check the strength of aggregates and shape test was performed to check the size of aggregates used in study. Test was performe on find out the stress propertie to find that how aggregates will act below vehical load. Shape test will give an idea about the compactness of the mix prepared by using these aggregate

Different test method of aggregate as per IS code is obtainable in Table 4.1.

Table 4.1: Test Methods of Aggregates as per IS Codes (Source: MORT&H, 2015)

S. No.	Name of Test	Test Methods
1	/Aggregate Impacts Values Test	IS: .2386-Part 4
2	/Specifics Gravity test	IS: .2386-Part 3
3	/Los Angeles abrasion Value test	IS: .2386-Part 4
4	/Aggregate Crushing Value test	IS: .2386-Part 4
5	/Combined flakiness and elongation Index test	IS: .2386-Part 1
6	/Water Absorption	IS: . 2386-Part 3

2.2 Bitumen

Bitumen is a petroleium products obtain by the cleansing of petroleium crude mostly use on the constructions of flexible pavement next to with minerals aggregate. this is wide use as binders of flexible pavements constructions since of it is binding property and vis-coelastic natures. Bituminous binders are very commonly used in surface course of pavements, they are also used in the base courses of flexible pavements to withstand relatively adverse conditions of traffic and climate. Bitumen have been use as binder for long times and it have been perfers fine of the pavements, it is materials which can be change and the strengths and further propertiy of the all bituminous concretes can be modified. The evaluation of physicals property of bitumens is very importants for the reasons it is very key components on the mix up and it affected the propertiy of mix and later on affected the presentation of pavements. Performance on pavements depend on the ductility and viscosity of bitumen, if bitumen used is not very ductile or is stiff than, when there is ex-pansion or contraction due to temperature change it shall not be able to performs adequately.

Table 4.2: Test Performe on .VG-30 Grads Bitumens and Test Methods (Source: Indian Standard Code 73, 2015)

S. No.	Name of Test	Test Method
1	Specific Gravity at 27°C	IS:1202
2	Ductility at 27°C	IS:1208
3	Softening Point	IS:1205
4	Penetration at 25°C	IS:1203
5	Flash Point	IS:1209
6	Fire Point	IS:1209

2.3 Polymer modified bitumen (PMB 40)

In India, flexible pavements with bituminous layers are extensively used. The high movement intensity regarding commercial vehicles, over-burdening of trucks and variations in temperature. Flexible pavements with bituminous surfacing are widely used in India. Distress like rutting, bleeding, cracking and potholes occurs due heavy vehicles loads and also due daily and seasonal temperature variations. The major concern in India, is extreme weather conditions in some parts of the country. Under these extreme conditions the bitumen tends to become soft in summer and brittle in winter. These failures can overcome by addition of certain additives known as modifiers and the bitumen mixed with these modifiers is known as "Modified Bitumen". Use of modified bitumen in the top layers of the pavement is expected to significantly enhance the life of the surfacing and extend the time of the maintenance of the pavement.

Table 4.3: Tests Performed on PMB 40 Grade Bitumen and Test Methods (Source: Indian Standard Code Special publication 53, 2010)

S. No.	Name of Test	Test Method
1	Specific Gravity at 27°C	IS:1202
2	Ductility at 27°C	IS: .1206 (Part 2)
3	Softening.Points	IS: .1205
4	Penetrations at 25°C	IS: .1203
5	Flash Points	IS: .1209
6	Fire Points	IS: .1209

2.4 Cement

Portland Pozzolana cements confirm to IS 1489-1991 (Part-1) make ACC cements (OPC-43) is use in the presents experimental works. Cement is used as filler in bituminous construction to fill the voids of mineral aggregates and enhance the performance of pavements constructed using bituminous concrete. Cements use studies were check for it is packing, appear and colours, the specific gravity of the cement use was 3.15 as provided by the manufacturers.

2.5 Natural Geolite

The word "zeolites" comes from Greek words means "boiling stones", because when they release water vapour at elevated tempera-ture it seems to boil. The structure of the zeolites has large air voids where cations and even molecules or cation groups (such as wa-ter) can be hosted. Their ability to lose and absorb water without damaging the crystalline structure is the main characteristic of this silicate framework (Chowdhury and Button, 2008). The utilization of zeolites decreases the optimum bitumen content. Zeolites im-prove the repetitive loading strength of bituminous mixtures; improve permanent deformation ability and increases rigidity. Natural Zeolite is an acceptable alternative to commercial synthetic zeolite. Natural Zeolite not applicable its boiling and freezing temperature but its melting point is more than 1°C and flash point up to 600°C neg. and its bulk density is between 2.38-2.81.

Figure 1. Natural Geolite

2.6 Sasobit – Warm mix additive

Sasobit is made of a Wax called ―Sasol, which is mainly found in South Africa. Sasobit is used as modifier to improve the quality of bitumen. Sasobit are available in bags of 2kg, 5kg, 20kg and 600 kg. It is available either in flakes or in powdered form. Gasification of coal results in an aliphatic hydrocarbon, known as Sasobit. Sasobit is made by the pro-cess called Fischer-Tropsch (FT) process. In the FT process, carbon monoxide (CO) is converted into hydrocarbons mix-ture having molecular chain lengths of 1 to 100 carbon atoms. In this process, a mixture of carbon monoxide and hydro-gen (CO + H2) is produced by gasification of coal is synthesis gas. A process involving the treatment of coke with a blast of steam or white-hot hard coal. A vast quantities of gas is

manufactured for commercial use. The synthesis gas is reacted in the presence of cobalt or an iron catalyst; heat is created and products such as alcohols, synthetic waxes, gasoline and methane are made. The liquid products from the process are separated. The predominant chain length of the hydrocar-bons in Sasobit is in a range of 40 to 115 carbon atoms. Figure 4.3 showing warm mix additive Sasobit used in the study.

Figure 2. Sasobit

Warm Mix Asphalt Mix Design

The performances of WMA depend of the pavements designs factor consider of the designs phase and the existing or re-al factor including of the traffic load and their repetition, the weather and the drainage factor. This presen-tation plus a durability of flexible pavements depend of the availibilty of the pavements structures assembling the sub grade supports, property on the material use and the thickness of the a variety of pavements layer with situation to the traffic and wheater factors. The major purpose of this bituminou mix design are to based at a appropriate mix interwal which might complete the following necessities:

1. Sufficient stable or resistances of the warp in the mixes to resist deformation under predictable traffics loads.
2. Adequate bitumens binders contents to proper coats aggregates particle and to supply sufficient stability.
3. Adequate void is the compact mix to permit expand to the binders due to the temperatures increases and a slight extra compact under traffic load, with no cause bleed of bitumens.
4. contain the utmost void content to permeable and dampness induced damage.
5. Enough workable of the mixes through placements of the mix pavement and compact.

Mixing of Natural Zeolite in Bitumen

Mixing of Natural Zeolite in to the bitumen is very important parameter as far as the proper modification of bitumen is concerned because im-proper mixing will lead to the false results and the analysis will go wrong so, it's very important to mix the Natural Zeolite in bitumen properly and carefully. Mixing was done by firstly heating the bitumen up to 80^{o}C - 90^{o}C and making it sufficiently fluid to make mixing easy then Natu-ral Zeolite was slowly added in to the hot bitumen continuous stirring was done for proper mixing. Stirring was done until a uniform solution of bitumen and Natural Zeolite was obtained. This process applied for both the grade of bitumen

Test on Bitumens Modifiey Used Natural Zeolite

Tests was performe on the bitumens (VG 30 and PMB 40 grade) modifiey by used Natural Zeolite to review the physicals property since physi-cals property on binders use for bitumins creation is as specific by IS: 73 after that could be secure this bitumins concretes is construct by use that bitumens which has best physicals property

Table 4.6 Tests Performed Modified Using Natural Zeolite on Bitumen (VG 30 grade) and Tests Metjods (Source: IS - 73, 2015)

S. No.	Name of Test	Test Method
1	/Specifics Gravity at 27°C.	IS: 1202
2	/Ductility at 27°C	IS: 1208
3	/Softenings Points	IS: 1205
4	/Viscosity	IS: 1206
5	/Flash and Fire Point	IS: 1209

Table 4.7 Tests Performed on PMB 40 Grade Bitumen Modified Using Natural Zeolite and Test Methods (Source: IRC: SP-16)

S. No.	Name of Test	Test Method
1	Specific Gravity at 27°C	IS:1202
2	Ductility at 27°C	IS: 1206 (Part 2)
3	Softenings Point	IS: 1205
4	/Penetrations at 25°C	IS: 1203
5	/Flash Points	IS: 1209
6	/Fire Points	IS: 1209

Marshalls Method on Bitumin Mixs Design

This Marshalls methods on mixs designs are a design values whichs use to plan the size of differents constituent on bitumin mix. Here is a lot of method accessible of mixs designs unstable of compactions, sizes of the tests example and further tests disclaimer. Marshall Methods of mixes designs is the mainly populars single out them, the Marshalls Stabilityes and flows worth provide an idea abouts the presentation of Marshalls mixes designs. The constancy of tests compute the highest loads support at collapse with the tests specimens at a load rate of 50.8 mm /minute. Loads are apply of the case till collapse and greatest loads in KN is design as constancy. A attach dials gauges measure the real specimen plas-tics flows warp due to loading the flows values are recorded in 0.25 mm (0.01inch) increment of the same point while the utmost loads are rec-ord. Figure 4.7 shows Marshall test being performed in the laboratory.

3. TESTING, RESULT AND BRIEF DISCUSSION

Table 5.4: Results of Tests Performed of VG 30 Grade Bitumen Modified Using Natural Zeolite

S. No.	Name of Test	Test Results			IRC SP-53, 2010 Specifications
		4% Natural Zeolite	5% Natural Zeolite	6% Natural Zeolite	
1	Ductility at 27°C (cm)	98	96	94	Min. 75
2	Softening Point (°C)	62	63	68	Min. 60°C
3	Viscosity at 60°C (Poises)	3642	4621	2050	-
4	/Flash Point (°C)	280	290	294	Minimum. 175°C
5	/Fire Point (°C)	300	315	325	Minimum. 220°C

Table 5.5: Results of Tests Performed of PMB 40 Grade Bitumen Modified Using Natural Zeolite

S. No.	Name of Test	Test Results			IRC SP-53, 2010 Specifications
		4% Natural Zeolite	5% Natural Zeolite	6% Natural Zeolite	
1	Ductility at 27°C (cm)	100	100	100	Min. 75
2	Softening Point (°C)	70	72	69	Min. 60°C
3	Viscosity at 60°C (Poises)	8250	11290	8662	-
4	Flash Point (°C)	280	285	292	Min. 220°C
5	Fire Point (°C)	312	317	322	Min. 220°C

Design of Warm Mix Bituminous Concrete Modified Using Natural Zeolite

Table 5.6: Proportion of Aggregates Used for Study

Sieve Size (mm)	Percentage Passing				Achieved Grading	MoRT&H 2013 Specification
	13 mm	4.75 mm	Dust	Filler		
Proportion %	**30%**	**20%**	**48%**	**2%**	-	-
13.2	95.2	100	100	100	98.56	90-100
9.5	67.5	94.80	100	100	87.58	70-88
4.75	0	56.90	96.4	100	54.832	53-71

2.36	0	25.80	92.6	100	46.97	42-58
1.18	0	6.60	71.1	100	37.44	34-48
0.60	0	3.30	51.3	100	27.29	26-38
0.30	0	0.04	9.6	100	6.17	18-28
0.15	0	0	3.5	100	3.68	12-20
0.075	0	0	0	100	2.88	4-10

Table 5.7: Results of Marshall Tests on Bituminous Concrete Using VG 30 Grade of Bitumen

S. No.	Properties	Bitumen Content (%)					
		4.8	**5.0**	**5.2**	**5.4**	**5.6**	**5.8**
1	/Bulk Density (gm/cc)	2.291	2.310	2.315	2.321	2.309	2.21
2	/Stability Value (KN)	7.27	10.38	11.80	11.32	10.89	9.53
3	Flow Value (mm)	2.65	2.95	3.10	3.20	3.35	3.45
4	Air Voids (%)	4.49	4.37	4.21	4.12	4.02	3.81
5	VMA (%)	15.25	14.95	14.20	13.93	13.81	13.06
6	VFB (%)	69.50	71.23	73.23	74.01	74.98	75.06
7	Marshall Quotient	2.74	3.51	3.81	3.53	3.25	2.76

Table 5.8: Results of Marshall Tests on Bitumin Concretes Use PMB 40 Grade of Bitumen

S. No.	Properties	Bitumen Content (%)				
		5.0	**5.2**	**5.4**	**5.6**	**5.8**
1	/Bulk density (gm/cc)	2.24	2.25	2.30	2.42	2.39
2	/Stability Value (KN)	13.81	13.92	14.09	14.40	14.05
3	/Flow Value (mm)	2.80	2.85	3.10	3.25	3.40
4	/Air Voids (%)	4.45	4.32	4.15	4.07	4.01
5	/VMA (%)	15.12	14.62	14.13	13.61	13.54
6	/VFB (%)	70.01	72.30	73.26	74.92	75.02
7	Marshall Quotient	4.91	4.88	4.55	4.43	4.13

Table 5.9: Results of Marshall Tests on BC (VG 30 Grade Bitumen) Modified Using Natural Zeolite

S. No.	Properties	Natural Zeolite			
		0%	**4%**	**5%**	**6%**
1	/Bulk Density (gm/cc)	2.39	2.26	2.34	2.31
2	/Stability Value (KN)	11.01	11.69	16.51	12.54

3	Flow Value (mm)	3.30	3.69	4.07	3.21
4	Air Voids (%)	4.05	3.96	3.72	3.38
5	VMA (%)	13.86	14.27	13.83	13.69
6	VFB (%)	74.54	74.83	75.22	75.66
7	Marshall Quotient	3.33	3.18	4.07	3.92

Table 5.10: Results of Marshall Tests on BC (PMB 40 Grade Bitumen) Modified Using Natural Zeolite

S. No.	Properties	Natural Zeolite			
		0%	4%	5%	6%
1	/Bulk Density (gm/cc)	2.41	2.33	2.39	2.37
2	/Stability Value (KN)	14.46	14.92	17.76	15.03
3	/Flow Value (mm)	3.35	3.52	4.04	4.25
4	/Air Voids (%)	4.03	4.18	4.06	3.92
5	/VMA (%)	13.59	15.51	15.29	14.64
6	VFB (%)	74.99	73.03	73.34	74.18
7	Marshall Quotient	4.31	4.26	4.42	3.55

IS that clears froms the result that change of bitumen use Natural Zeolite improve physical property of bitumens, strengths character of warm mix bitumins concretes too gets enhanced by modify warm mix bituminous concrete using Natural Zeolite. It is also clear that using polymer modified bitumen results in increased quality of bituminous concrete mix. Further its properties were enhanced by using Natural Zeolite. It is also clear from the results that there is optimum dose of Natural Zeolite to which strengths character improves, if Natural Zeolite is adde further than that contents there is decrements in the stability value and specifics gravity.

4. Conclusions

Further following conclusions are drawn from the present study:

1. Ductility value of bitumens (VG 30) customized use Natural Zeolite decrease with increases in Natural Zeolite contents. That ductilitys value of bitumens depend upon the compositions of the bitumens and but some new materials mixes with bitumens form uniform mix it will affect ductility but not as much as when a modifier mixed forms heterogeneous mixes, but anything kind of modifier are mix it will certainly decreases the ductility as the particles of modifiers will break the continuity of the bitumen film which in turn will break on elongation and hence ductility value decreases with increase in Natural Zeolite. Viscosity of bitumen (VG 30 and PMB 40) modified using Natural Zeolite is more at 5% of

Natural Zeolite in both the grade of bitumen. Viscosity of bi-tumen (VG 30 & PMB 40) increased to 5% from previously found out 4%, with further decrease of 6%. Vis-cosity of the modified bitumen was found be maximum at 5% composition, thus, indicating better performance compared to conventional bitumen.

2. Softening point, Flash point and Fire point of Bitumen (VG 30 and PMB 40) modified using Natural Zeolite increased with increment in Natural Zeolite The Marshall stability of warm mix bitumin con-cretes customized use Natural Zeolite of VG 30 and PMB 40 grade bitumen both decreased at 4% & 6% but at 5% increased compare to conventional warm mix BC. This give the best dose of Natural Zeolite at 5% by the weights of the bitumens. Marshall Stability values of warm mix BC using Natural Zeolite in VG 30 grade of bitumen increased by 34.82% and in case of PMB 40 grade increased by 45% when compared with conventional warm mix BC. Percentag of air void (VV) decrease with addition of Nat-ural Zeo-lite. This tendency is mostly since of the fact that at first when Natural Zeolite are mixed with bitumen and bitumin con-cretes is ready by use this customized bitumens the voids are filled by these modifiers also which reduces the void con-tent of mix while in conventional bituminous concrete (for VG 30 and PMB 40) only bitumen fills the voids, this may be a reason to the observed trend. Marshalls Quotient (MQ) values are not direct measure of toughness of bitumin concrete. MQ initially increase then started decreasing with increment in Natural Zeolite content for both Natural Zeolite. Maximum Marshall Quotient (MQ) value was observed at 10% of Natural Zeolite for VG 30 and at 9% of Natural Zeolite by weight of bitumen for PMB 40.(Sengoz, Topal and Gorkem,2017)
3. Flows values improved with increments of Natural Zeolite content for VG 30 grade of bitumen. This trends can be explained by the fact that addition of Natural Zeolite decreaseses the inter-particles fric-tions in the mix, when loads is applied on specimen since the resistance has been compact the particle movement in the direc-tions of applied force and the magnitude of movement are more when compared with flow of conventionals warm mix BC. (Sengoz, Topal and Gorkem,2017)
4. Warm mix is successfully mixed at lower temperature (130 °C) as compared to conventional hot mix (160°C); hence the mixing temperature can be reduced up to 300C.

5. Recommendation for Future Works

In the present study, VG 30 and PMB 40 grade bitumen was used. Future studies may be carried out with other grades of bitumen like VG 10, VG 20, VG 40, PMB 70, and PMB 120.

In the present study, assessment of strength characteristics of wearing surface of Bituminous Concrete was done. Studies may also be carried out on other types of bituminous mixes like SDBC, DBM etc.

In present study, Natural Zeolite was additives in Warm Mix Bituminous Concrete. Future studies may be carried out on some other additive like Synthetic Zeolite, Chemical additives, Organic additives etc.

In the present study, Bituminous Concrete was prepared by using warm mix process in which Sasobit was used as a warm mix additive. Future studies may be done Half Warm Mix Asphalt (HWMA), Hot Mix Asphalt (HMA) and Cold Mix Asphalt (CMA).

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