

APPLICATION OF ZYCOSOIL IN BITUMINOUS MIX

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Abstract

Rapid increase of urban population in India with rapid rise in industrialization needs high demand of vehicles. Road sectors are very important for the growth of economy, employments and empowerment of a country. India's road network with nearly 55 lakh Km road length is second largest road network in the world. About 98% roads are flexible in nature and rest 2% are rigid pavements. Approximately 40% roads are unpaved of total road lengths. The natural bitumen shows failure and serious problems during rainy seasons. The treatment and strengthening of bitumen is required to keep the pavement surface serviceable. So Zycosoil a nano material recently used as an additive to strengthen the pavement surface and to improve the properties like penetration, ductility and moisture damage of pavement.

In the paper, the engineering properties of the aggregates, filler and VG-30 grade bitumen are investigated for mix design. The optimum bitumen content is finding out by using Marshall Mix design method for bituminous concrete of grading-2. The OBC is considered for modified Marshall Mix design by adding 0.03%, 0.04% and 0.05% Zycosoil chemical and changes in the different properties are recorded, which shows better results as compared to conventional mix. Hence it is suggested to use it in the flexible pavement construction.

Keywords: Bituminous Concrete, Marshall Mix Design, Moisture damage, Optimum Bitumen Content, Penetration, Zycosoil,

I. INTRODUCTION

As per National Highway Authority of India there are 55 lakh km road lengths in India which is second largest road network in the world coming after USA. Out of which approximately 61% roads paved and rest 39% are unpaved. Road networks are the main element of transportation system which acts as a key element of economy of the country. Roads should be capable to take heavy loads and meets the demand of road user with enhanced performance of pavement. Researchers are continuously trying to improve the pavement with appropriate quality, better life time and stability. Bituminous mixes are most commonly used all over world in the construction of pavement. Because of rapid increase in population, modernization, urbanization and industrial revolution the number of vehicle with higher axle load which are responsible for putting high stresses over limiting available roads causes greater distress resulting in decreasing serviceability and it directly increases the resource consumption and maintenance cost.

In order to overcome these problems the modification of binder is a choice to meet the increasing traffic demand with appropriate pavement quality. The material used as modifier is capable to resist the variation in temperature. The road industries are therefore looking forward for a modifier which is helpful to design a suitable Marshall mix for flexible pavement as per MoRTH guideline to meet the requirement of long life pavement with less

distress and should be ecofriendly. In order to meet the above requirement the VG30 bitumen is used for the construction of bituminous concrete pavement with and without Zycosoil as per the standard specified in MoRTH and the impact of Zycosoil over various properties is investigated.

II. LITERATURE REVIEW

Zycosoil is a complete package of ecofriendly and water proofing nanotechnology. This is an anti-stripping agent used to reduce the moisture damage of the aggregate because of water intrusion in between them. Addition of Zycosoil in bituminous mix converts it to the hydrophilic silanol group to hydrophobic siloxane bond which is strongest bond of the nature. De bonding of the asphalt mixes because of inadequate and incomplete coating is eliminated resulting in the enhancement of the durability of the pavements by using the Zycosoil. The addition of Zycosoil in bituminous mixes increases its tensile strength ratio resulting increase its fatigue life.

Sarkar et al., (2014) stated that the weak materials like over burnt bricks are used as a coarse aggregate in bituminous concrete pavement construction when it is treated with Zycosoil. The optimum bitumen content is high in case of over burnt brick as compared to conventional mix because of higher porosity and roughness of over burnt brick. Stability value is increased by 30% in case of over burnt brick aggregates when it is treated by Zycosoil.

Bala Raju tepla (2014) concluded that the polymer modified bitumen (PMB40) is used in DBM construction with 4.2% is used with 0.04 % shows 100% coating and stability value also increased.

Tirthankar Dam et.al.,(2015) examined the bitumen and bituminous mix of bituminous concrete made by VG-10 grade bitumen and concluded that with 5.1% of OBC and 0.03% Zycosoil can be used in cold region to avoid the moisture damage.

III. MATERIALS AND METHODOLOGY

Coarse aggregate, fine aggregate, filler and bituminous binder are the material used in the bituminous concrete mix. In this study crushed stone is used as coarse aggregate and fine aggregate, stone dust as filler and VG-30 grade bitumen is used as binder. Bituminous concrete mix is prepared by using the ingredients mentioned above. The properties of materials and bituminous concrete mix are evaluated as specified in MoRTH (2013).

Aggregates- The aggregates should have sufficient strength, toughness, hardness, specific gravity and desired shape. The limiting values of different test result for properties of coarse aggregate used for the preparation of bituminous concrete is specified by MoRTH. The aggregate should have superior mechanical and engineering properties to fulfill the requirement of long life pavement and to sustain the heavy traffic loads. As per MoRTH (2013) specification, the maximum Impact value, Los-Angeles abrasion value and water absorption value of aggregates for bituminous concrete should not exceed 30%, 40% and 2% respectively. Range of specific gravity should be 2.5 to 3.

Table 1: Properties of Coarse Aggregates

Test performed	Values
Aggregate impact value	17.345 %
Los Angeles abrasion value	23.58 %
Water absorption	0.71 %
Bulk specific gravity	2.655
Apparent specific gravity	2.71

Filler- Stone dust, slag dust, hydraulic cement, hydrated lime, fly ash and some other mineral materials can be used as filler. Filler should passing 100% through 0.06 mm sieve, 95-100 % through 0.30 mm, 70% through 0.075 mm sieve size. It should be sufficiently dried to flow freely at the time of sample preparation. Here in this study stone dust is used as mineral filler.

VG-30 Bitumen Binder- Now days VG-30 viscous grade bitumen is used as binder in place of 60/70 penetration grade bitumen to take care of heavy traffic load of bituminous concrete pavement. It has excellent bonding and adhesion properties with aggregates. It resists moisture to a greater extent.

Zycosoil as modifier- The chemical additive used as modifier in this study is zycosoil. It is a nano material (size 50-100 nm) water soluble organosilicon fragment. As it has the property to function amine and hydrated lime to give Mother Nature's strongest bond which can't be uproot by water. It eliminates the de-bonding of bituminous mix and enhances the durability of bituminous pavement.

Table 2: Gradation of Aggregates for Bituminous Concrete Grade-2

Sieve in mm	% passing by weight of specimen	Cumulative % retained	% of aggregate and mineral filler
19	100	0.00	Coarse aggregate 36 %
13.2	79-100	10.5	
9.5	70-88	20	Fine aggregate 61 %
4.75	53-71	36	
2.36	42-58	48	
1.18	34-48	58	

0.60	26-38	67	
0.30	18-28	77	
0.15	12-20	83	
0.075	4-10	97	

Mineral filler 3 %

Table 3: Result of Vg-30 Grade Bitumen with and Without Zycosoil

Characteristics of test	VG-30	VG-30 + 0.03% zycosoil	VG-30 + 0.04% zycosoil	VG-30 + 0.05% zycosoil
Penetration (mm)	67.8	62.3	59.2	56.67
Softening point (°C)	50.2	51.2	51.9	52.1
Ductility (cm)	86.67	80.26	82.9	85.46

IV. EVALUATION OF BITUMINOUS CONCRETE MIX (GRADING-2)

Bituminous concrete mix is designed by Marshall Method. This test provides the strength of mix in term of strength and stiffness of mix. This test is done to determine the optimum bitumen content. Various properties like stability value, bulk density, air voids are mainly depends on aggregate gradation, bitumen content and its type, compaction types and temperature. The gradation of aggregate for Bituminous Concrete grade-2 is carried out as per MoRTH specification and the Marshall specimen are prepared by adding 4,4.5,5,5.5 and 6% of bitumen by weight of aggregates. 75 no's of blows are provided on both side of specimen to simulate the heavily trafficked condition. Here in this study the optimum bitumen content is found to be 5.5 %.

Table 4: MoRTH Specification for Bituminous Concrete Mix Design

Description	Requirements
Stability Value (Kg or KN)	Min 820 Kg (or 8.2 KN)
Flow Value (mm)	2-4
% Air Void (Va)	3-5

VMA (%)	11-13
VFB (%)	65-75
Optimum Bitumen Content (OBC)	Minimum 4.5 %

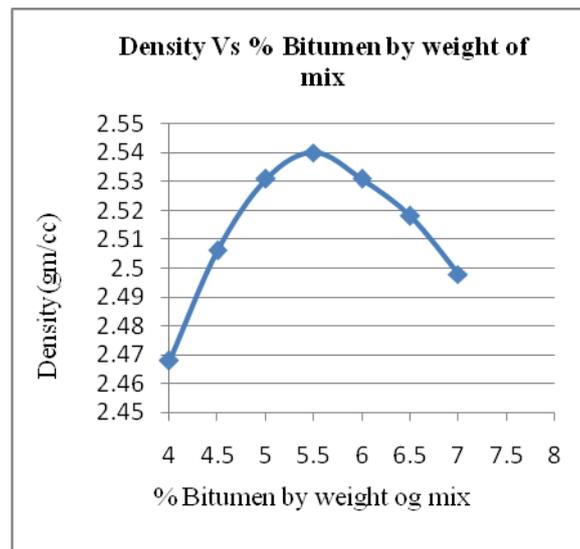


Fig.1: Density Vs % Bitumen by weight of mix

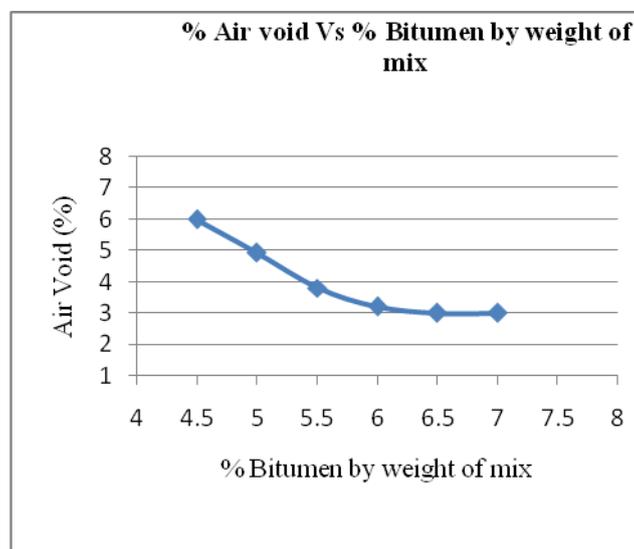


Fig.2: % Air void Vs % Bitumen by weight of mix

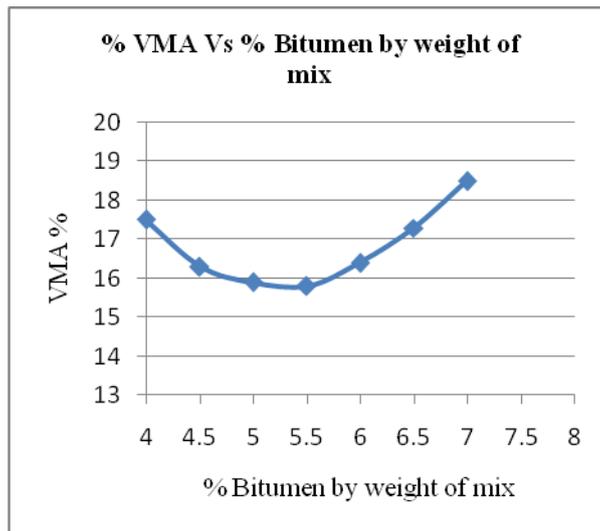


Fig.3: % VMA Vs % Bitumen by weight of mix

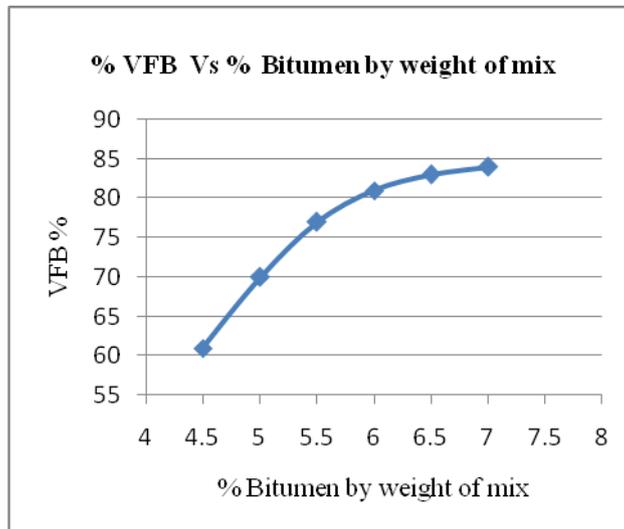


Fig.4: % VFB Vs % Bitumen by weight of mix

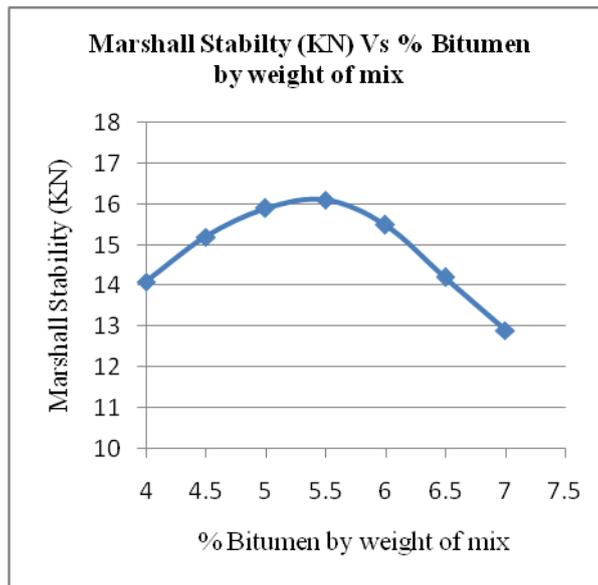


Fig.5: Marshall Stability (KN) Vs % Bitumen by weight of mix

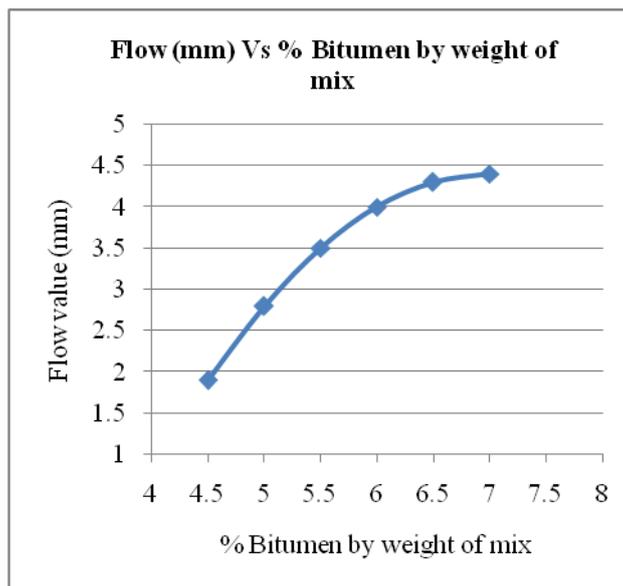


Fig.6: Flow (mm) Vs % Bitumen by weight of mix

The bituminous mix with required standard specified by MoRTH (2013) specification is considered to find out the optimum bitumen content which is 5.5 % in this case to ensure the durable mix and maximum stability along with the consideration of specified percent of air voids. This OBC is further considered for modified Marshall mix without and with the addition 0.03%, 0.04% and 0.05% of Zycosoil additive at 175°C and various parameters are compared.

Table.5: Different Parameters of Marshall Mix Modified with Zycosoil

Bitumen % by weight of total mix	Bulk density (gm/cc)	Air void in % (Va)	VMA (%)	VFB (%)	Stability (KN)	Flow (mm)
5.5%	2.540	3.80	15.80	77.00	16.10	3.5
0.03% Zycosoil	2.534	3.78	15.78	77.20	16.50	3.7
0.04% Zycosoil	2.536	4.02	15.84	77.12	17.20	4.1
0.05% Zycosoil	2.535	4.01	15.79	77.18	16.80	4.3

V. DISCUSSION AND CONCLUSION

The use of zycosoil as an additives improves the tensile strength and flexibility of asphalt mixture to take care of the heavily traffic load. As heavy loads are responsible for many type of pavement distresses like rutting, fatigue, pot hole, stripping. The addition of zycosoil as an additive with VG-30 grade bitumen shows there is decrease in penetration value. It shows that stiffness is increased therefore enhance the condition of temperature susceptibility resulting in increase of workability of bituminous mix. The softening point increases with the increment of zycosoil percentage shows increase of resistance of bitumen to the heat and it shows the decrease in tendency to soften in hot weather hence increases the rutting resistance, load taking capacity, stability and durability. It is concluded that modified bituminous concrete (grading-2) mixed with 0.04 % zycosoil shows better results as compared to conventional mix hence it is suggested to use it for the construction of flexible pavement of heavily traffic load with long life pavement.

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