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Effect of Zeolite on Marshall Properties of SDBC Mix

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Asphalt is used in bituminous layer. In this study an experimental investigation has been carried out using a chemical additive which can be easily available. The chemical additive used is Zeolite, which is the minerals of aluminosilicate group, the crystalline structure of which contain water bound in a specific way. The Beneficial properties of Zeolite include a controlled release of moisture with hot mix which aid mixture workability and the ability of the asphalt to effectively coat the aggregate particles, due to which homogeneous mixture form. In this experimental study Zeolite is mixed in SDBC (semi dense bituminous concrete) mix. Mix is prepared at different percentage of zeolite (by total weight of aggregate) that is (0.3, 0.6, 0.9, 1.2%). It has been found that Marshall Stability value is maximum when 0.6% zeolite is added to the mix.
Keywords: Zeolite, Bitumen, Aggregate, Lime.

I. INTRODUCTION

Semi Dense bituminous Concrete (SDBC) is the upper bituminous layer of road subjected to moderate traffic load. So it is important for wearing course to be strengthened enough to bear this traffic load. In recent, some technologies are used to improve the Marshall properties of Hot Mix SDBC by using Plastic waste, Emulsion etc. Using zeolite as an additive with hot mix along with improving the Marshall Properties, it also decreases the bitumen viscosity and improving its adhesion to aggregate. An additional benefit is that it is possible to transport the mix over longer distance and this, in turn, increases the area of operation for companies with stationary asphalt mixing plants.

This paper envisages the use of zeolite in different proportion (0.3 to 1.2% by total weight of aggregate) with hot mix SDBC and consider the change in various Marshall Properties.

II. LITERATURE REVIEW

A. Zeolite in Asphalt concrete

During the last few decades research work on the analysis of asphalt mixes with zeolite carried out by various researchers.

1) *Huley and Prowell, 2005:* evaluated three different Hot mix Asphalt additives; Aspha-Min(synthetic zeolite), Sasobit(Wax) and Evotherm (emulsion) and conclude that all the three technologies improved the asphalt mixture compatibility and resulted in reduction of air voids.
2) *Goh et al, 2007:* evaluated the properties of HMA with the addition of Aspha-Min(Synthetic zeolite) based on the Mechanistic-Empirical Pavement Design Guide (MEPDG). They found that the addition of Aspha-min did not have any effect on dynamic modulus values for any of asphalt mixture examined. The Rut depths predicted from the MEPDG simulations showed that Rutting decrease in HMA
3) *Hodo et al,2009:* stated that the foamed asphalt mixtures presented better workability at lower temperatures which showed greater ease in placing and compacting it and the moisture susceptibility tests showed marginal results and they suggested that if anti-stripping agents were added to the HMA mixture. The moisture damage resistance would be improved.

III. SYNTHETIC ZEOLITE

Zeolite are crystalline, micro porous and hydrated aluminosilicates that are built from an infinitely extending three dimensional network of (SiO_4) and (AlO_4) tetrahedral linked to each other by the sharing of oxygen atoms. Usually, their structure can be considered as inorganic polymer built from tetrahedral TO4 unit, where T is Si4+ or Al3+ ion. Each O atom is shared in between two T atoms. Zeolite are silicate frameworks with structure having large empty spaces, that can include large cations such as calcium and sodium. These empty spaces may also allow the large cation groups such as water molecules. Zeolite have property to lose or absorb water without any change in crystal structure. Heat releases the water present in zeolite. When zeolite is added to the mix as the binder, water gets released. This released water creates an expansion of binder that results in foaming of asphalt and

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increase in workability. This also helps in coating of aggregate at lower temperature. Synthetic Zeolite with Clinoptilolite type structure is used with chemical composition $[Si_{29.84}Al_{6.16}O_{72}]21.36H_2O$

IV. MATERIAL AND METHODOLOGY

In this study VG30 grade bitumen is used. Coarse aggregates of size 10mm, 6mm and fine aggregate(dust) is used in different proportion to satisfy MORTH specification as shown in table(1). The apparent specific gravity are found to

Specific Gravity				
Bitumen	Coarse aggregate (10mm)	Coarse aggregate (6mm)	Fine aggregate (DUST)	Zeolite
1	2.92	2.87	2.74	2.33

The normal mix specimens was prepared with bitumen contents of 4.5, 5, 5.5, 6% by total weight of aggregate. The optimum bitumen content and different Marshall Properties was found out using Marshall test. Modified specimens using zeolite at different percentage (0.3, 0.6, 0.9, 1.2%) by weight of total aggregate are prepared. Marshall Properties of Normal mix and Modified Mix are compared.

V. RESULT AND DISCUSSION

Marshall specimen were prepared without adding Zeolite and with adding Zeolite 0.3% to 0.6% by weight of total aggregate. The marshall parameter obtained are summarized in table(2). The variation of Flow value, Stability, Bulk Density, Voids filled with Bitumen (VFB) and Voids Mineral Aggregate (VMA) shown in Fig.

TABL1

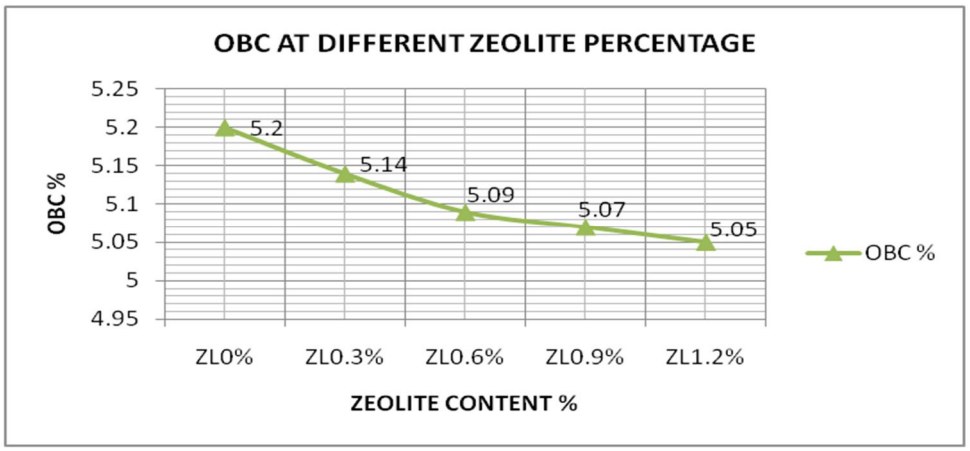
SDBC JOB MIX FORMULA						
Sieve Size	% Passing by weight				Combined Grading (.28A+.30B+.40C+.02D)	MORTH Specification TABLE NO 500-18
	10mm	6mm	Dust	Filler		
	A	B	C	D		
13.2	100	100	100	100	100	100
9.5	82	100	100	100	94.96	90-100
4.75	20	56.5	100	100	64.55	60-80
2.36	2	16.5	80	100	39.51	35-65
0.3	0	3.5	21	100	11.45	6-25
0.075	0	0	4	95	3.5	2-10

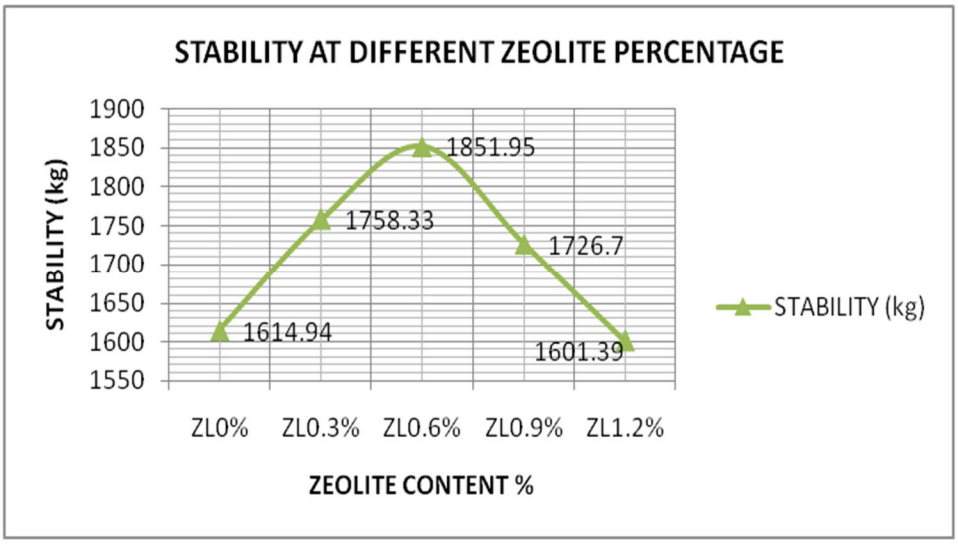
TABLE-2
Marshall Parameter for SDBC Using Zeolite at different proportion

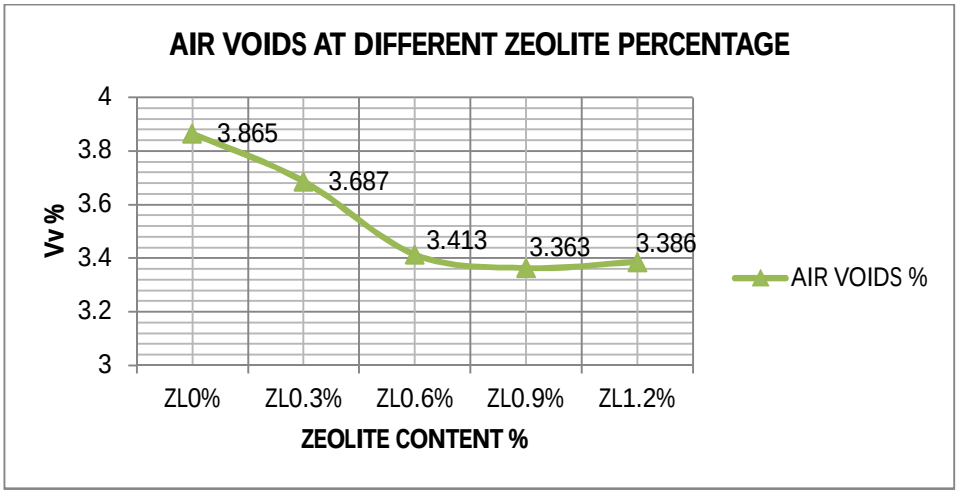
OPTIMUM PROPERTIES OF SDBC MIX					
OPTIMUM MARSHALL PROPERTIES	ZL0%	ZL0.3%	ZL0.6%	ZL0.9%	ZL1.2%
OBC %	5.2	5.14	5.09	5.07	5.05
Flow mm	3.98	3.71	3.57	3.54	3.46
Marshall Stability kg	1614.94	1758.33	1851.95	1726.70	1601.39
Bulk Density gm/cc	2.479	2.486	2.493	2.495	2.485
Vv %	3.865	3.687	3.413	3.363	3.386
VFB %	76.636	77.565	78.634	79.044	78.836
VMA %	16.8160	16.459	16.147	16.01	15.890

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ZL0 – Bitumen Content with 0% zeolite
ZL0.3% - Bitumen Content with 0.3% Zeolite by weight of total Aggregate
ZL0.6% - Bitumen Content with 0.6% Zeolite by weight of total Aggregate
ZL0.9% - Bitumen Content with 0.9% Zeolite by weight of total Aggregate
ZL1.2% - Bitumen Content with 1.2% Zeolite by weight of total Aggregate

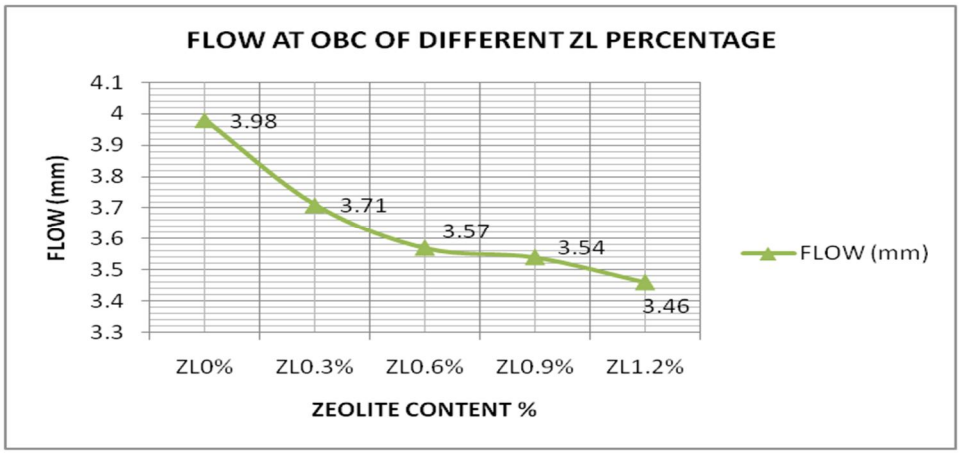


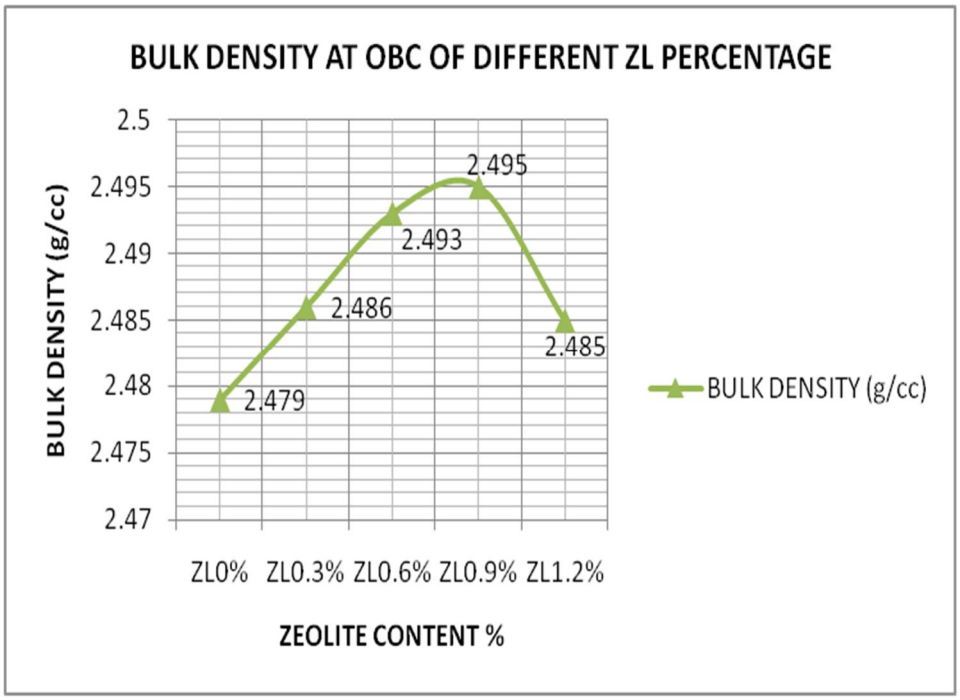


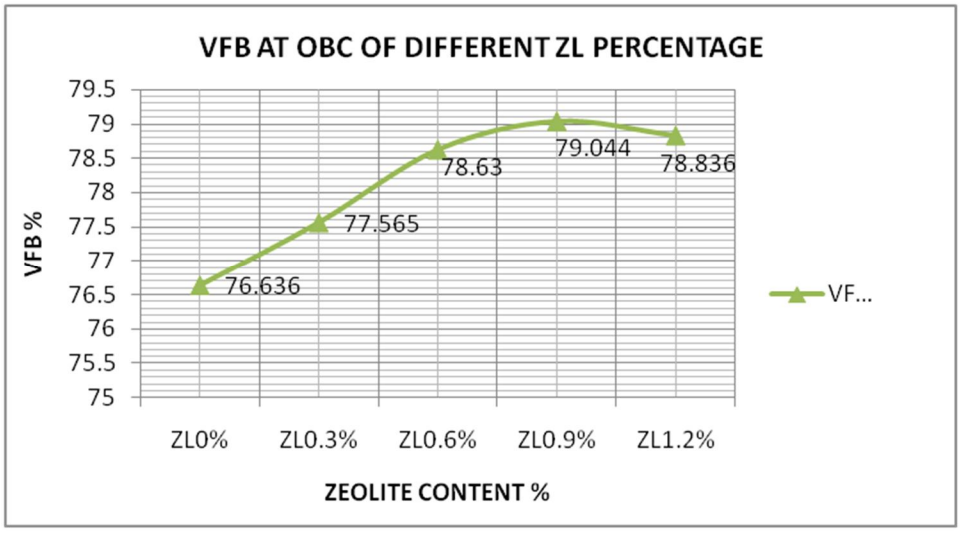


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VI. CONCLUSION

A. Based Upon Result obtained From Laboratory test On SDBC containing DIFFERENT Proportion of Zeolite The Following Conclusion Are Drawn

1) By increasing the percentage of Zeolite into the mix the Marshall Stability values are increased and maximum stability is found for the mix containing 0.6% zeolite by weight of total aggregate. At 0.9% zeolite the Stability value has decreased. Therefore the optimum zeolite is found as 0.6%.

2) The flow value goes continuous decreasing with the addition of zeolite in the mix.

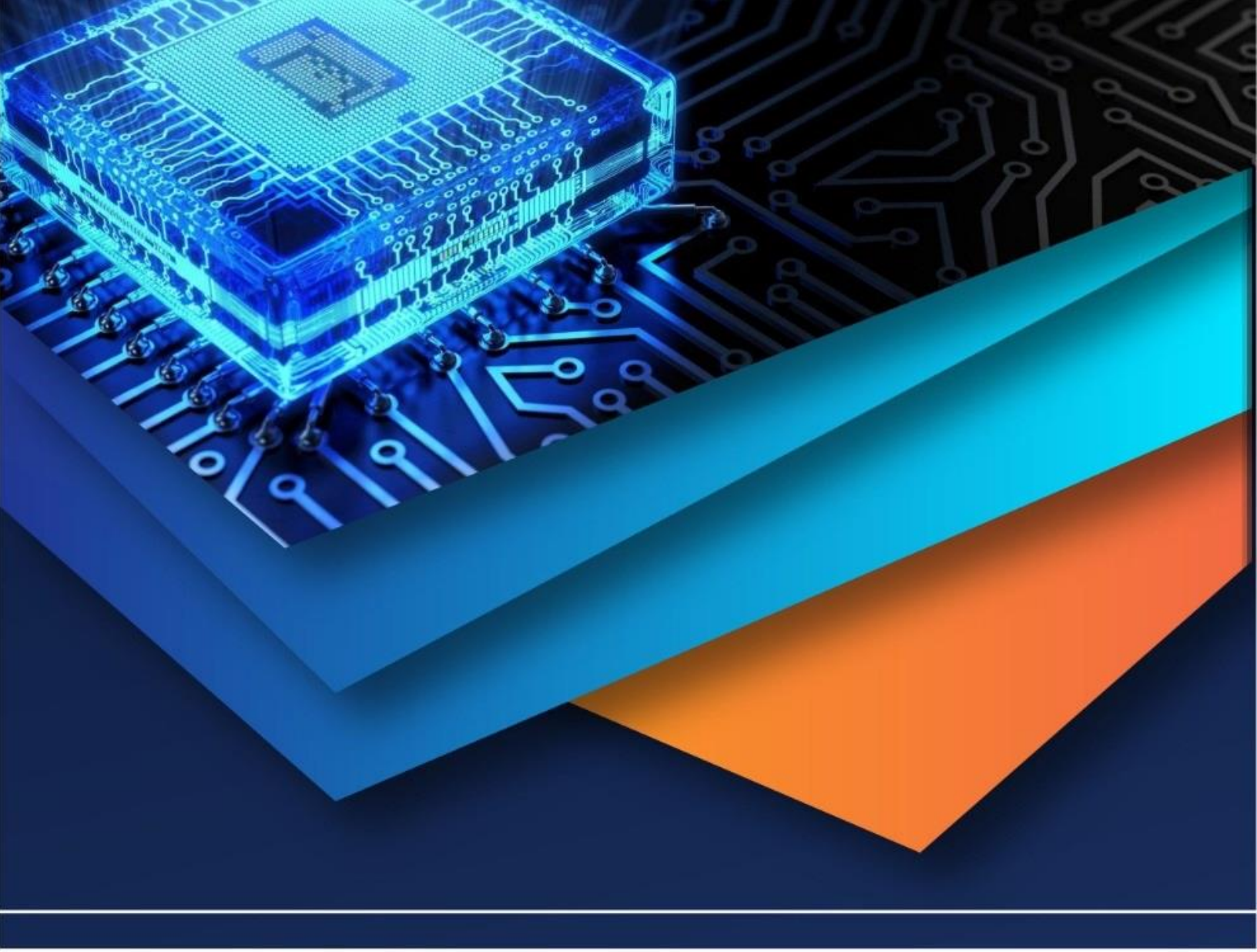
3) Bulk density increases with increases in zeolite content upto 0.9% zeolite then start decreasing beyond 0.9% zeolite.

4) The percentage air voids in the mix decreases continuously and VFB continuously increasing with the addition of zeolite in the mix. From the above test results it can be concluded that addition of zeolite to the Semi Dense Bituminous concrete mix significantly improves the performance in the mix. The strength and voids parameter also satisfied the requirement of MORTH specification. So the optimum zeolite content was obtained at 0.6% by weight of total aggregate.

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