INFLUENCE OF COMBINED FLAKINESS AND ELONGATION INDICES OF COARSE AGGREGATES ON THE BITUMINOUS CONCRETE MIXTURE WITH NMAS OF 12.5MM

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Abstract

In India, approximately 98% roads are flexible types, probably because of economy. There are two million miles of paved roadways in India. The hot mix asphalt (HMA) is used on approximately 98% of all paved surfaces. Increasing traffic volumes, tire pressure, and Loading in recent time has place more demand on engineering roads. Technically, a well-designed and constructed road will not only support regional and national development of a country, but also assist in sustaining the life span of the infrastructure. To achieve this, an adequate mix design is essential. Aggregates are one of the key materials used in the construction of the Flexible pavements which they constitute about 95 % in the bituminous mixtures. Aggregate are the largest amount of material that can be found in HMA. Aggregates make up between 80% to 90% of total volume or 94% to 95% of the mass of hot mix asphalt (HMA). Therefore, aggregate properties are very important in HMA because it will affect the performances of the HMA.

The influence of combined flakiness and elongation indices on Marshall properties of coarse aggregate with NMAS 12.5mm was studied in this paper. Coarse aggregate were manually tested for combined flakiness and elongation indices and were separated under four different percentages(CFIEI 30-35%, 35-40%, 40-45% and 45-50%). Gradation was fixed as per MoRTH specifications(Upper, middle and lower limit).Optimum bitumen content(OBC) was determined for middle limit gradation with combined flakiness and elongation indices of 30-35%.workability(torque) values were determined at temperatures 90^0C, 110^0C and 130^0C for three gradation limits with different combined flakiness and elongation indices and graphs were plotted to validate effect of combined flakiness and elongation indices.

Keywords: *NMAS, Gradation, Optimum bitumen content, Workability.*

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1. INTRODUCTION

Bituminous concrete is a pavement specification composed of a thoroughly controlled hot mixed material having as ingredients i) Graded mineral aggregates, ii)filler and iii)bitumen. It is hot mixed and hot laid and is a superior type of asphaltic pavement. Hence the increasing traffic volume and loading is stressing need to achieve reliability in measuring workability values of bituminous concrete in rational and convenient manner. A new workability device was developed based on previous instruments used to measure workability in concrete and HMA industry. workability with different mixes with different combinations of nominal maximum aggregate size(12.5mm and 19mm), gradation shape(fine and coarse graded) was tested in temperature range of 120^0C to 170^0C. Device developed could differentiate mixes based on workability[1]. Three types of paddles code A, B and C were used to validate best suitable paddle for measuring workability. Paddles were tested for seven different mixes. First three mixes(upper, mid and lower graded) with penetration graded 80/100 bitumen and other three with bitumen of penetration grade 60/70 and last one was RAP. Each mix was tested at different speeds 5, 10, 15, 20 and 25 RPM. Paddle B was conclude best based on statistical analysis[2]. Mineral aggregates constitutes approximately 95% of Hot mix asphalt(HMA) by weight. Cubical particles possessed best rutting resistance over rod, disk and blade shaped aggregates. Flaky and Elongated aggregates in the mixture results in lower resistance to shear deformation[3]. Properties of mineral aggregates have a direct influence on performance of asphaltic pavements. The performance and serviceability of hot mix asphalt pavements are influenced by aggregates particle size, shape and texture[4]. Physical and mechanical properties of asphalt mixtures have a significant impact on pavement stability and reliability during its entire period of its operation. These properties mainly depends on geometric and physical properties of aggregates. The analysis of correlation dependence between geometric and strength indexes of different rock samples shows significant decline of particle strength with increase in number of flat and ablong particles[5]. Flaky aggregates in asphalt mixture influence its marshall properties, including optimum bitumen content. The stability and workability decreases while VMA and asphalt content increases with increase in flaky aggregate content[6]. Three

different aggregate gradations upper mid and lower limit were adopted and their effect on indirect tensile strength shear strength and rutting parameters on DBM and BC was evaluated[7]. The geometrical cubical shape of aggregate possesses high degree of homogeneity with visible edges and corner faces compared to normal shaped aggregates. Substitution of normal shaped aggregates with geometrically cubical shaped aggregates also produced significant improvement of 22%to 35% in aggregate toughness. Dense packing and fewer voids content can also be achieved. Asphalt content will also be lower[8].

2. MATERIAL CHARACTERIZATION AND METHOOLOGY

2.1 Aggregates

Aggregates used in project work was collected at quarry in Yellapura , Tumkur district. Three aggregate gradations for each type of mix was selected as per MORTH specifications.

- Upper limit of gradation range: The nominal maximum size of this gradation is 9.5mm for BC.
- Middle limit of gradation range: The nominal maximum size of this gradation is 13.2mm for BC.
- Lower limit of gradation range: The nominal maximum size for this gradation is 13.2mm for BC.

Table-1: Proportion of coarse and fine aggregate in each gradation range

Aggregate Gradation	Upper Limit	Mid limit	Lower Limit
Coarse %	29	38	47
Fine %	71	62	53

Aggregate gradation curve for three gradation ranges is plotted as below:

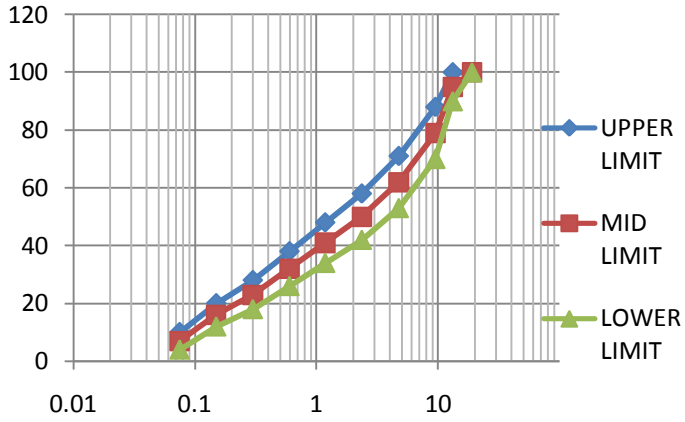

Chart-1: Gradation adopted

Basic properties of aggregates were determined in laboratory and are within the specification in accordance with MORTH.

Table-2: Basic properties of aggregates:

SI. No	Test	Result	MORTH specification Limits
1	Aggregate Impact value	23.12%	24% max
2	Los Angeles Abrasion value	26.49%	30 %max
3	Aggregate Crushing value	26.76%	30% max
4	Specific gravity		
	20mm down	2.69	-
	12.5mm down	2.7	-
	Dust	2.66	-
5	Water absorption (%)		
	20mm down	0.2	-
	12.5mm down	0.5	-
	dust	0.85	-

2.2 Bitumen

The type of binder used for preparation of bituminous mixture is VG-30 and this was tested for its physical properties and it satisfies all requirements as per MoRTH specification.

Table-3: Properties of VG – 30 grade bitumen

Sl NO	Test	Code	Results	Requirements as per MORTH
1	Penetration at 25°c (mm)	IS 73:2006	62	50-70
2	Ductility at 25°c (cm)	IS 73:2006	95	Min 75
3	Softening point (°c)	IS 73:2006	52	Min 47 °c
4	Specific gravity at 25 °c	IS 73:2006	1.01	0.97 – 1.02
5	Flash & Fire point (°c)	IS 73:2006	285 °c 310 °c	Min 220°c Min 270°c

3. COMBINED FLAKINESS AND ELONGATION INDICES

Aggregate samples were collected from crusher on different days and shape test was carried out. Based on test results they were sorted under four different percentages of Combined Flakiness and Elongation Indices 30-35%, 35-40%, 40-45% and 45-50%.

4. OPTIMUM BITUMEN CONTENT (OBC)

Optimum Bitumen content was determined for Middle limit gradation with Combined Flakiness and Elongation Indices of 30-35% and results are tabulated:

Table-4: OBC results

Optimum Bitumen Content	5.5
Percent Air Voids(%)	4.09
Density, g/cc	2.36
Stability, KN	22.67
Voids In Mineral Aggregates(VMA)	16.94
Percent Voids Filled with Bitumen(VFB)	75.85
Flow, mm	2.75

5. WORKABILITY

Workability of bituminous mix is ease with which it can be mixed, laid and compacted at workable temperature. Workability of Hot Mix Asphalt(HMA) is critical element in getting desired density of bituminous pavements. Temperature as well as constituents in the mix influences workability of Hot Mix Asphalt. Workability was measured in terms of torque using workability testing machine. This consists of a metallic drum cup shaped at bottom, a shaft attached with blades at bottom edge at different angles, a motor with gearbox, digital ammeter and voltmeter to measure the power required to rotate the mix . Shaft rotation is set to 20rpm . Ammeter and voltmeter readings are noted at different temperatures and torque value is calculated using the equation below:

$$T = \frac{60 \times OUTPUT\ POWER}{2 \times \pi \times N}$$

OUTPUT POWER=1.73×V×I×PF
Where,
T=Torque(N-m)
N=Speed
V=voltmeter value
I=ammeter value
PF=power factor(0.77)

Workability values calculated for three gradation limits at different temperatures with different Combined Flakiness and Elongation Indices are tabulated and graphs are plotted:

Table-5: Workability results

CFEI	Temperature Degree	upper limit Torque N-M	middle limit Torque N-M	lower limit Torque N-M
30-35%	140	31.09	38.87	46.64
	130	35.76	48.20	54.42
	120	46.64	57.53	63.74
	110	55.97	65.30	77.74
	100	62.19	82.40	83.96
	90	77.74	88.62	99.50
	80	90.18	93.28	107.28
35-40%	Temperature	upper limit	middle limit	lower limit
	140	35.75	46.64	54.41
	130	43.53	51.31	60.63
	120	49.75	57.53	66.85
	110	59.08	66.85	80.85
	100	71.52	79.29	91.73
	90	87.07	97.95	105.72
	80	94.84	107.28	121.27
40-45%	Temperature	upper limit	middle limit	lower limit
	140	46.64	55.97	63.74
	130	57.53	65.30	76.18
	120	69.96	82.40	93.28
	110	77.74	91.73	107.27
	100	94.84	110.38	124.38
	90	105.72	121.27	138.37
	80	116.61	136.82	157.03
45-50%	Temperature	upper limit	middle limit	lower limit
	140	69.96	80.85	93.28
	130	79.29	90.18	107.28
	120	90.18	97.95	118.16

	110	99.50	119.72	127.48
	100	108.83	130.60	144.59
	90	113.50	138.37	153.92
	80	127.49	147.70	169.47

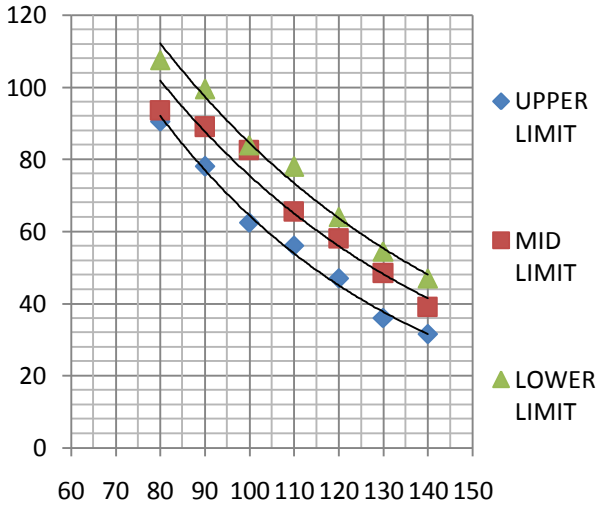

Chart-2: Torque v/s Temperature 30-35% CFIEI

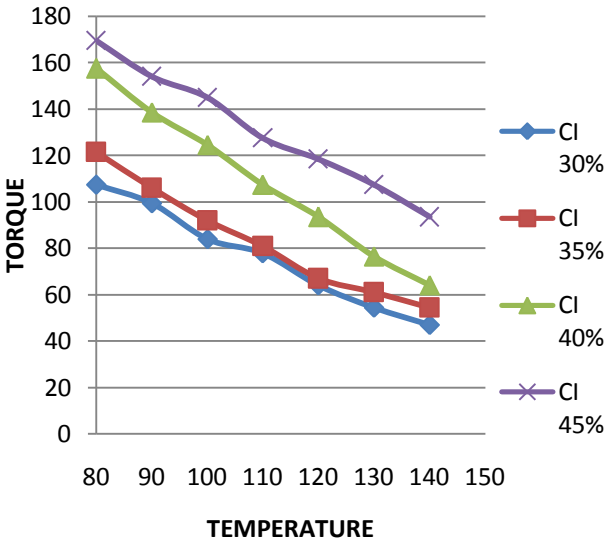

Chart-3: Torque v/s Temperature Lower Limit

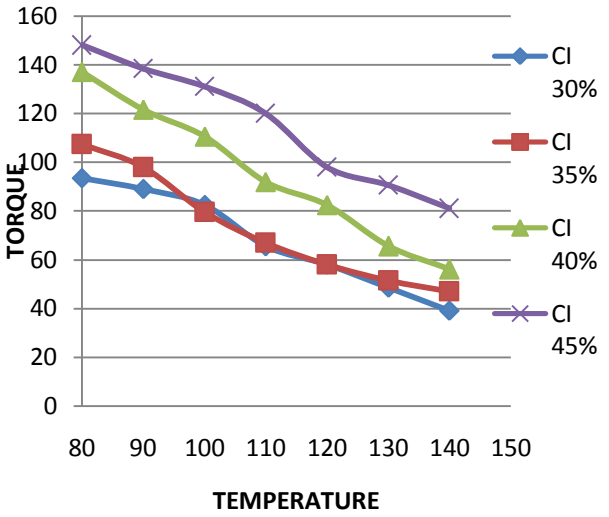

Chart-4: Torque v/s Temperature Mid limit

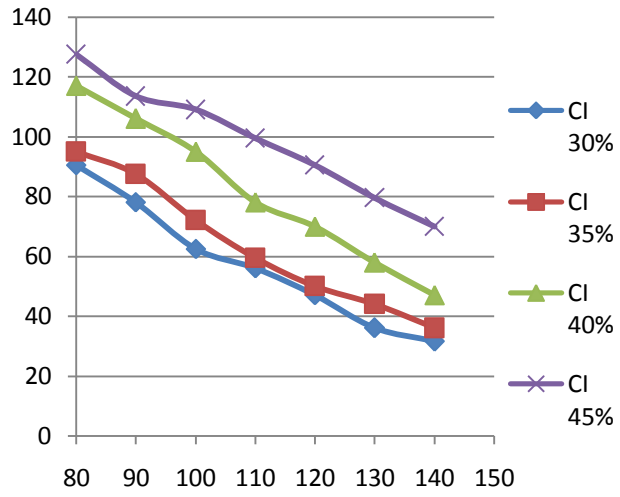

Chart-5: Torque v/s Temperature Upper limit

6. CONCLUSION

- Workability values increases with increase in temperature.
- Workability values increases with decrease in Combined Flakiness and Elongation Indices.
- Workability is inversely proportional to Torque values.

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BIOGRAPHIES

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