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Experimental Investigation of Flexible Pavement Using Shingles

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Abstract: Huge volumes of Shingles are produced from building construction and Asbestos industries. Basically, waste Shingles Aggregates (WSA) are being produced by crushing Shingles during the process of transport and installation of roof, wall and floor. Present society are progressively moving forward to be more environment friendly. To meet up this purposes, recycling and reuse of this material can be the best alternatives than landfill disposal in respect of environment conservation and economy. To increase the usage of Shingles in pavement construction, different percentage of Shingles can be used with the natural aggregate. The technical flexibility of using waste Shingles aggregates as partial replacement of natural aggregates in bituminous mixes can be evaluated. This research work presents some of the laboratory investigation on the possible application of waste Shingles aggregates in bituminous mixes. The physical properties of coarse aggregates, fine aggregates, filler and bitumen are determined according to standard test. Marshall test specimens are prepared for testing to measure the Marshall properties. at optimum bitumen respectively are determined. According to AASHTO, Marshall stability test properties of mixes of waste shingles aggregates are satisfactory. investigated results indicate that the bituminous mixes with waste shingles aggregates give satisfactory results for construction of medium traffic road
Keywords: Waste Shingles Aggregates, Marshall Mix Design, Flexible Pavement Construction

I. INTRODUCTION

The recycling of waste aggregates has long been recognized to have the potential to conserve the natural resources and to reduce energy used in production. It is a standard alternative for both construction and maintenance, practically where there is a shortage of aggregate. Generally, the term 'waste aggregate' refers to aggregates that have been used previously in construction which comprise construction and demolition waste, deteriorated asphalt pavement material, used railway ballast and so on. Ceramic materials, which include shingle products, contribute one of the highest content of wastes in the construction and demolition wastes. Actually, ceramic tile, being one of the most widely used construction materials, having its consumption rising with the growth of population and urbanization in many countries. Not only for walls and flooring in the buildings but also in many kinds of industrial and commercial structures, we use them in decoration, protection, or other improvement applications. During the process of wide range of manufacturing, transport and installation, a large number of shingle wastes are generated in an increasing amount day by day. However, with the large number of wastes comprising asbestos shingle and assured increase of it in the future, land filling has alsobecome a major problem, particularly in countries where land is scarce. So apart from putting more effort in minimizing its generation and the setting up of temporary fill banks, recycle is one of the mosteffective means to alleviate the growing problem. On the other hand, many highway agencies, serviceproviders, private organizations and individuals have completed or are in the process of completing a wide variety of studies and research projects concerning the feasibility, environmental suitability and performance of using recycled products in highway construction. The ever-increasing economic cost and lack of availability of natural material have opened the opportunity to explore locally available waste materials like waste shingle. Thus, recycling has been gaining wider attention as a variable option for the handling of waste shingle. As per the studies, recycled aggregate utilization from the asbestos industry wastes was largely considered in road construction as: landfills, sub-base courses on low volume roads, concrete blocks and manufacture of concrete (Keyence H. *et al.,* 2004, Huang B. *et al.,* 2009). Kruger and Solas., (2008) investigated the use of asbestos shingle wastes as recycled aggregates for road surface courses. High whiteness and hardness of recycled aggregates from asbestos shingles waste improved sunlight reflection, avoiding heating during summer months and increased pavement stability, further improving the visual contrast in the roadway. Silvestre *et. al.,* (2013) reclaimed that recycled asbestos wastes are considered technically feasible to be incorporated as aggregates into asphalt concrete mixtures for open graded wearing courses.

The mixture with 30% of recycled asbestos aggregates by aggregates weight meet most of the mechanical and superficial characteristics to be usedas road surface layer for medium–low traffic volumes, with exception of water sensibility. In this study, investigation and experiments were performed to attain and compare the physical properties of stone aggregates and waste shingles aggregates primarily. Thus, the behavior of bituminous mixes with respect to stone aggregates and waste shingles aggregate was evaluated to suggest a design criterion for the construction of flexible pavements with waste shingles aggregate.

II. OBJECTIVES

1) To determine the optimum dosage or shingles to be added in the flexible pavement.
2) To ensure that the road pavement layers do not deteriorate to any serious extend within a specified period of time
3) To provide the road which can withstand the expected traffic loading.
4) To determine the cost-benefit ratio of flexible pavement using shingles with replacement of aggregates.

III. MATERIALS AND METHODOLOGY

A. Materials

Two types of coarse aggregates were used in this study which consist of aggregate chips to the size of 12.5 mm and less were collected from the construction site of Architecture Building of Nyati Wagholi,Pune. Waste shingles were obtained from different waste disposal sites of hadapsar. Shingles pieces were crushed manually to bring the size of 12.5 mm and down grade as coarse aggregates.

Figure 1: Appearance of Stone Aggregate

Figure 2: Appearance of Waste Shingle

Coarse sand, collected from Nyati, Wagholi, passing through 12.5 mm sieve and retained on 10 mmsieve was used as coarse aggregate. Particles of waste Shingles were obtained after collection of shingles pieces from different waste disposal sites of wagholi ,Pune. They were crushed manually to bring the size of 12.5 mm and retained on 10 mm sieve as fine aggregate.

Table no 1: Physical Properties of Aggregates

Sr. No.	Description of Test	Test Method	Test Result Observed	Specification as per MORTH Table 500-18
1	Aggregate Crushing Value (%)	IS:2386-IV	18.12%	Max 10-25%
2	Aggregate Impact Value (%)	IS:2386 P-IV	20.0%	Max 24 %
3	Los Angle Abrasion Value (%)	IS-2386 (P-IV)	18.29%	Max 30%
4	Flakiness and Elongation Index (%)	IS:2386 (P-I)	20.17%	Max 30 %
5	Water Absorption (%)	IS:2386(P-III)	0.87%	Max 2%

Table no 2: Physical Property of shingles Aggregate

Sr. No.	Description of Test	Test Method	Test Result Observed	Specification as per MORTH Table 500-18
1	Aggregate Crushing Value (%)	IS:2386-IV	18.06%	Max 10-25%
2	Aggregate Impact Value (%)	IS:2386 P-IV	3.30%	Max 24 %
3	Los Angle Abrasion Value (%)	IS-2386 (P-IV)	21.87%	Max 30%
4	Flakiness and Elongation Index (%)	IS:2386 (P-I)	25.06%	Max 30 %
5	Water Absorption (%)	IS:2386(P-III)	1.29%	Max 2%

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Table-3: Asbestos Sheet Compositions

Constituent	Composition (%)
SiO2	25-40
CaO2	30-55
Al2O3	10-25
SO3	1-3
K2O	0-5
Na2O	0-5
MgO	1-5
MnO	0-2
OTHER OXIDES	BALANCE

IV. METHODOLOGY

In order to meet the objectives, the following research methodology was adopted:

A. *Material*

1) Natural Aggregate
2) Shingles (asbestos Sheet)

B. *Experimental Investigation*

Test on Aggregates (Natural + Shingles)

1) Elongation Index and Flakiness Index
2) Impact
3) Los Angeles Abrasion
4) Water absorption
5) Specific gravity

C. *Result Analysis*

Comparative analysis

V. BITUMINOUS MIX DESIGN

In order to study the effect of aggregates on the behavior of bituminous mixes, Marshall Test specimens were prepared with 50 blows for medium traffic road according to the standard procedure specified byAASHTO.

VI. MARSHALL MIX PROPERTIES

The maximum load carried by a compacted specimen at a standard test temperature of 60°C can be defined as Marshall Stability of a mix. The deformation of the Marshall Test specimen that undergoesduring the loading up to the maximum load in 0.25 mm units is called the flow value. Marshall properties like stability, flow value, unit weight, total voids in a mix, voids in mineral aggregates and voids filledwith bitumen were determined for three mix types.

Table No. 4 Marshall Stability test for Aggregates

Sr. No.	% Bitumen By total mixed	Special height mm	Wt of specimen			Volume Of specimen	Bulk sp. Gr. Of specimen	Stability				Flow in (mm)
			In air (A)	In water (B)	SSD Iin air (C)	D = C-B)	Gmb =(A/D)	Proving ring	Marshall stability	Correction factor for ht	Corrected stability (KN)	
1	5.42	63.60	1203	728	1209	481	2.501	200	11.40	1.00	11.40	3.2
2		63.75	1201	725	1205	480	2.502	215	12.45	0.96	11.76	3.3
3		63.79	1210	728	1209	481	2.499	210	12.97	1.00	11.97	3.00
AVG =											11.76	3.2

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Table No. 5 Marshall Stability test for Shingles

Sr. No.	% Bitumen By total mixed	Special height mm	Wt of specimen			Volume Of specimen	Bulk sp. Gr. Of specimen	Stability				Flow In (mm)
			In air (A)	In water (B)	SSD in air (C)	D = C-B)	Gmb =(A/D)	Proving ring	Marshall stability	Correction factor for ht	Corrected stability (KN)	
1	5.42	63.63	1103	805	1225	420	2.62	215	12.25	1.00	12.25	3.2
2		63.80	1276	845	1219	374	3.411	220	12.52	0.96	12.01	3.3
3		63.87	1196	796	1222	426	2.80	205	11.60	1.00	11.60	3.00
AVG =											11.97	3.17

VII. ANALYSIS OF RESULTS

As determination and comparison of the physical properties of natural aggregates and waste tiles aggregates are one of the main objectives of this study, Table 1 and Table 2 represents the experimental test results of physical properties of both types of aggregates. The experimental result shows that both types of aggregates satisfied the respective limiting value. Marshall Stability at optimum bitumen content are 12.25 kN, 12.01KN and 11.06 kN respectively. These three stability values satisfy the limiting value. The flow values are 3.2 mm, 3.3mm, 3 mm respectively. These values satisfy the limiting value3-5 according to design criteria for medium traffic.

VIII. CONCLUSION

On the basis of experimental results of this study, the following conclusions are drawn:

1) Aggregates which are obtained by crushing asbestos sheets are suitable for the bituminous mixes from the consideration of aggregate strength properties.
2) Asbestos sheets aggregate as a partial replacement of black stone aggregates, in proportion of 60 – 40% .60 % of aggregates and 40% of shingles.
3) Laboratory tests were performed for defining the physical properties of asbestos sheets aggregate and found to be within acceptable limits as per the Indian standards which show that asbestos sheets aggregate is feasible to utilize as aggregate material in flexible pavement.
4) Total materials cost of the project it reduces by 9.98%.

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