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Use of Building Waste Material in Low Service Pavement

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Abstract—*Road Construction events in India have undergone significant variations over the last two-three decades owing to the huge investments made and due to the implementation new construction technology and design principles. The use of waste and recycled materials in construction applications have much environmental welfare including cost saving in terms of their disposal, dumping and potential recyclability. Examples of such waste materials include recycled crushed brick, construction demolition materials (C&D), factory waste roof shingles, reclaimed asphalt pavement (RAP. The need to manage these materials has led to environment friendly actions that promote the reuse and recycling of this type of waste. This research work targets to investigate the reusability potential of the building waste materials as aggregates in the asphalt pavement by comparing the physical properties of the waste with the virgin material. For physical characterization of the material, test performed are basic characterization of aggregate and bitumen and for Marshall Stability test carried out to compare the physical performance of the asphalt mixture. It is expected that the building waste material can give reasonable performance in low service pavement with reduced cost of construction.*

Keywords*: Recycling Building Waste, Base layer, low service pavement, Marshall Stability of waste, Reclaimed, asphalt pavement, Recyclability, characterization of waste.*

1. INTRODUCTION

This study focuses on the recycling of building waste material for the construction of low service pavement which can result in conservation of materials and energy preservation of the environment [1]. For the fulfillment of the objectives of recycling the building waste materials in the pavement, its performance is characterized by different type of equipments. The samples prepared were bitumen mixture and cement bounded mixture. In this project it is observed that the recycled materials from the building waste have potential to perform reasonably with or without modification in the low service pavement and effectiveness of different components of the waste materials is needed to be evaluated in both the way physically as well as chemically for understanding its behavior in the pavement. Pavements are multilayered structures with an asphalt or concrete slab resting on a foundation system comprising layers of geomaterials such as the base, subbase, and subgrade. In rigid pavements structure deflects very little under loading due to the high modulus of elasticity of their surface course, this is the reason behind the naming of this structure. A rigid pavement structure is typically composed of a plain cement concrete (PCC) surface course built on top of either the subgrade or an underlying base course [2]. Because of its relative rigidity, the pavement structure distributes loads over a wide area with only one, or at most two, structural layers [3,4].

Fig. 1: Bitumen Sample

2. OBJECTIVES

The objective of this research project is to use those materials which are discarded as waste from site into open lands and to water bodies which lead to water pollution. So for not making then materials going waste we used those materials in low service pavement construction such that waste material gets recycled and village areas where there are no good pavements there pavements can be made by using building waste material.

Other objective of the project is to find an approach to construct village roads with lower cost and optimum performance.

3. METHODOLOGY

The test performed on the waste materials as well as on virgin materials are Specific gravity test (IS 2386 Part 3), Water Absorption Test (IS:2386 Part 3), Impact Test (IS: 2386 Part 4), Bulk density Test (IS:2386 Part 3), Loss Angeles Test (IS: 2386 Part 4), Crushing Test (IS:2386 Part 4), Flakiness Test and Elongation Test (IS: 2386 Part 1). All these tests were carried out to investigate the physical properties of virgin as well as the waste aggregate materials to understand its suitability in road pavements. After completion of the aggregate and bitumen characterization, the behavior of the bituminous mixture is evaluated by "Marshall Stability (ASTM D6927-06) Test. The Marshall Stability test is carried out on the 100% waste material following same procedure as followed for the virgin. The physical behavior of waste material is compared with virgin materials to achieve the reasonable performance in the pavement. The target of this research work is to check the usability of the waste materials collected from the building demolition to the surface layer of the low pavement which essentially needs better quality materials than the other layers spread under the top layer.

Selected aggregate gradation for preparing the Marshall specimen is shown in Table 1.

Table 1 Bitumen & aggregate gradation for prepairing the specimen

Sieve Size (mm)	Percentage passing (%)	Percentage Retained (%)	Weight (gm)
20	0	0	0
12.5	100	0	0
10	90	10	120
4.75	65	25	300
2.36	42	23	276
0.6	23	19	228
0.3	18	5	60
0.15	12	6	72
0.075	7	5	60
Binder		04-Jul	48-84

Note:- for binder material bitumen is mixed in 4 proportion of 4%,5%,6% & 7%.

The standard requirement for the Marshall Mix design is listed in the Table 2.

Table 2: IRC Recommendation for Marshall value and flow value.

S.No	Description	Requirement
1	Marshall Stability (ASTM Designation:D6927-06) determined on Marshall specimens compacted by 75 compactions blows on each faces of the sample.	820 Kg Minimum
2	Marshall flow(mm)	02-Apr
3	Percent void in mix	03-May

4. RESULT ANALYSIS

All the tests are performed to understand the individual behavior of the waste and the virgin materials. The test values are tabulated in the Table 3, 4, 5 and 6. The behavior the materials are compared by plotting the graph for each property as shown in Fig. 2, Fig. 3, and Fig. 4.

Table 3: Comparative analysis of aggregate waste & virgin

Physical properties	Waste	Virgin
Specific gravity	2.34	2.62
Aggregate crushing value (%)	19.14	10.71
Bulk Density (kg/m^3)	1465	1533
Water absorption (%)	2.84	1.35
Flakiness Index%	6.2	13
Elongation Index%	6.15	5.35
Impact Value %	19.72	14.58
LA Abrasion %	29.7	15.12

The basic characterization of the bitumen binder is carried out in the laboratory and mentioned in the table 4. The rheological properties of the materials mentioned in the following table validate its usability in the bituminous pavement.

Table 4: Bitumen Characterization

Physical properties	values
Ductility Test	63 at 25˚C
Penetration Test	65 at 25˚C 100gm, 5sec1/10mm
Viscosity Test	3.8 at 60˚C

The marshal stability values for fresh materials are mentioned in the table 5. The flow, bulk density and air void content is the significant property of the bituminous mixture evaluated in the laboratory and enlisted in the table 5.

Table 5: Marshall Stability result of virgin material

SN.	% Bitumen	MS Value (Virgin)	Flow value	Bulk density (gm/cm3)	Air void %(Vv)
1	4%	620	3.24	1.93	5.12
2	5%	830	3.8	2.01	3.07
3	6%	540	4.3	2.02	1.53
4	7%	450	5.1	1.98	1.61

Similarly the physical properties of the waste materials recycled are mentioned in the table6.

Table 6: Marshall Stability result of waste material

S.N.	Bitumen (%)	MS Value (Kg)	Flow value (mm)	Bulk density (gm/cm3)	Air void %(Vv)
1	4%	590	3.7	1.87	3.58
2	5%	770	4.6	1.96	3
3	6%	490	5.2	1.99	1.31
4	7%	400	5.8	1.94	1.16

Graph obtained by following date between percentage bitumen and Marshall Stability of virgin and waste material.

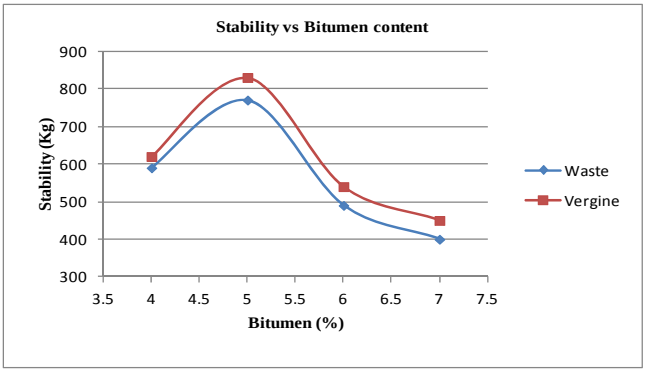

Fig. 2: Bitumen content v/s Stability

The data obtained from the Marshall testing of bituminous mixture are listed in the tables 5 and 6 the comparative analysis of mixture of virgin material and the waste material is done by plotting a graphs Stability v/s bitumen content, Flow v/s bitumen content and Density v/s bitumen content.

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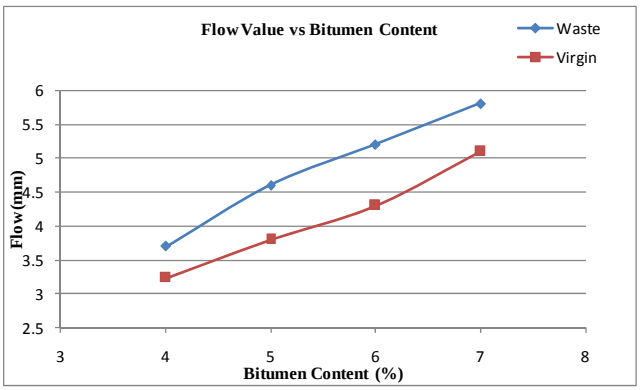

Fig. 3: Flow value v/s bitumen content

It is seen in this research work that the building waste material mixed with bitumen follows the same pattern of physical properties variation on addition of bitumen as the mixture of virgin material with compromised performance. The recycled materials lose significant physical properties however they retain reasonable usability potential in different forms.

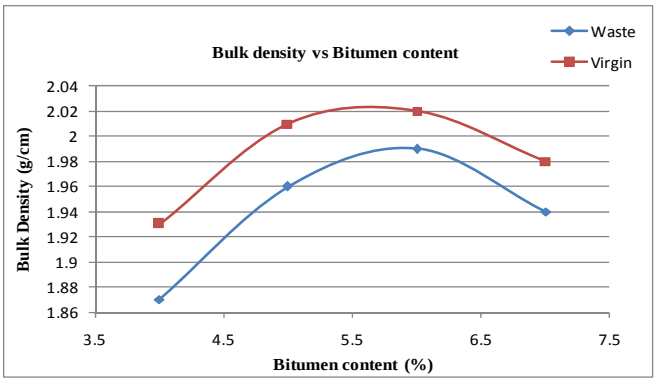

Fig. 4: Bulk Density v/s bitumen content

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The flow value of the mixed mixture of waste material is found to be better then the mixture of virgin material. The bulk density obtained for the waste material is needed more bitumen content than the virgin material and the graph plotted density v/s bitumen content follows the same pattern as the virgin material (Fig 4).

5. CONCLUSION

It is seen from the result of comparative analysis of building waste materials with virgin aggregate that the waste materials have retained usable properties and these properties can be utilized in different forms. As per flow value comparison it is

concluded that the waste material needs lesser energy than the virgin mixture in compaction on the site because of better workability. Optimum binder requirement for achieving full performance of recycled asphalt pavement depends on the nature of the reclaimed materials. The building waste material can be used as aggregate portion for the low service pavement in village roads which can serve better than the earthen roads.

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