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APPLICATION OF WASTE GLASS AND RAP IN GSB

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ABSTRACT

The topic has been selected to check the suitability of waste materials in road construction. This will help in getting the economy in road construction as well as saving the environment degradation in terms of reduction in mining and less air pollution. Construction of roads and highways involve huge amount of money and materials mainly aggregates.

As millions tones of fresh aggregates are used in road construction and considering their scarcity, replacement of part of the fresh aggregate with waste glass and reclaimed asphalt pavement (RAP) is considered in the present study. The present study discusses the suitability and applicability of waste glass and RAP when used in blends with fresh aggregates for road construction. Performance of these blend are measured by performing various laboratory tests such compaction test and California Bearing Ratio (CBR) test. Granular Sub Base (GSB), grading-3 from the latest MORTH specification has been selected.

The test results indicate that virgin aggregate can be replaced by waste glass and RAP up to 25% and 30% by weight respectively and provided satisfactory geotechnical results to be used in GSB.

Keywords- Reclaimed asphalt pavement, granular sub base, California bearing ratio, aggregate

1. INTRODUCTION

Waste material has been defined as any type of material by-product of human and industrial activity that has negligible value. The recycling of glass and aggregate is a process in which used glass and aggregate is reused for new construction. Reckless growth in the quantities and type of waste materials, scarcity of landfill spaces and the likelihood of less availability of fresh aggregate materials in future impose pressure and urgency on finding innovative ways of recycling and reusing waste materials. The recycling and later reuse of waste materials will also reduce the demand for fresh natural resources which leads to less usage of energy, reduction in emission of greenhouse gases and finally a more sustainable environment.

Different types of construction material used in the pavement construction consist of different grades of aggregates and binding material. The main function of the pavement is to transfer the wheel load to the soil below subgrade. Pavement are generally classified into two categories flexible and rigid pavements. A typical flexible pavement consist of subgrade, subbase, base coarse and wearing coarse layers from bottom to top and as we move from top to bottom the stresses on the layer gets on decreasing. Depending upon the requirement of pavement different mixes are used in different layers such as bituminous macadam, dense bituminous macadam, semi dense bituminous macadam and bituminous concrete.

In this load transfer mechanism aggregates have to bear the wheel load and resist wear due to abrasive action of the traffic. Therefore for pavement engineers the properties of aggregates is of great significance so, the aggregates are categorized on the basis of their shape, size, texture and gradation.

Therefore different agencies like A.S.T.M. , B.S.I, I.S.I and IRC specify separate gradation for different pavement mixes.In India a study (Ranjth, 2012) was conducted in 366 Indian cities constituting 70% of India's urban population. This study states that the total amount of municipal solid waste materials is 68.8 million ton per year or 188,500 tons per day. The urban waste mainly consists of organic waste (47%), paper (6%), glass (0.7%), rag (3.2%), plastic (1%) and rest is moisture content.

The present study checks the suitability of the waste glass (WG) and reclaimed asphalt pavement (RAP) in the granular sub base (GSB) where WG is a mixture of different colored glass particles which comprises of different types of adulterations such as paper. plastic, gravel, metals and organic waste and RAP is generated when asphalt pavements are removed for reconstruction, resurfacing of the previous asphalt pavement.

2. LITERATURE REVIEW

Taha et al. (2002) studied about blended mixes of natural aggregates and RAP aggregates and states that maximum dry density, CBR are decreased and there is no change in optimum moisture content whereas permeability increases with increasing content RAP aggregates. The CBR value for a 100% RAP mix was

reported as 11% but when RAP content reduced to 80% in the mix, the CBR value increased to 26%.

Grubb et al. (2006) prepared three crushed glass and dredged material blends and evaluated them in field to explore the feasibility of using crushed glass and dredged material in embankment and structural fill. The mix proportions are prepared of crushed glass/dredged material as 20/80, 50/50 and 80/20 with a tolerance of 5% of the dry unit weight. The construction 20/80 blend embankment was compacted to a minimum of 90% modified proctor compaction, whereas the 50/50 and 80/20 blend embankment was compacted to a minimum of 95% modified proctor compaction. The results states that as the percentage of crushed glass vary from 20, 50, 80 the respective maximum dry density are 15.1, 16.6. 18.2kN/m3 and optimum water content are 11, 15 and 10 respectively. Ali et al. (2011) checks the suitability of using recycled glass and crushed rock blends for pavement subbase. The results of the laboratory tests show that adding up to 50% of recycled glass has low to minimal effect on the physical and mechanical properties of crushed rock. The mix varying proportion of recycled glass/crushed rocks are 50/50, 40/60, 30/70, 20/80, 15/85. 10/90 meets the VicRoads requirements. All recycled glass and crushed concrete blends tested for CBR and Los Angle's abrasion values passed VicRoads requirements for pavement subbase material. Initial laboratory repeated load triaxial testing on the blends indicate that permanent strains are sensitive to moisture content and a higher content of glass additive could potentially produce higher permanent strains. However, the resilient modulus was not sensitive to either changes in moisture or glass additive content. The permanent deformation and resilient modulus of the recycled glass and crushed concrete blend, with up to 30% recycled glass content, is comparable to those of natural granular subbase.

Disfani et al. (2011) conducted a comprehensive suite of geotechnical laboratory tests on samples of recycled glass produced in Victoria, Australia. Depending upon the size of recycled glass they are classified in three categories as coarse, medium and fine sized glass. Laboratory test result indicate that medium and fine sized recycled glass sources exhibit geotechnical behavior similar to natural aggregates however coarse recycled glass was found to be unsuitable for geotechnical engineering applications. Shear strength tests indicate that the fine and medium glass shows shear strength parameters similar to that of natural sand and gravel mixture comprising of angular particles.

Ali and Arulrajah (2012) studied about the use of recycled crushed concrete and recycled glass blends in pavement subbase. The laboratory work in this research work has incorporated 50% of recycled glass into recycled crushed concrete which shows minimal effect on the physical and mechanical properties of the original materials. The recycled glass and recycled crushed concrete blends with maximum percentage of 30% of recycled glass were found to satisfactorily meet the VicRoads requirements. Vyas and Khara (2013) computed specific gravity, water absorption and aggregate impact value (AIV) besides conducting gradation test and flakiness and elongation test for RAP aggregates as per MORTH. They concluded that specific gravity ranges from 2.8 to 3. water absorption ranges from 0.3% to 2%, aggregate impact value is 15.28% (max. 30%) and combined flakiness and elongation index value is 27.64% (max.30%). However, large size of aggregates were deficient in the mix because of crushing and aging action and so the recycled aggregates could not satisfy the gradation requirements as per MORTH.

Arulrajah et al. (2014) perform the laboratory and field evaluation on the use of blends of fine recycled glass, recycled concrete aggregate and waste rock as pavement base or subbase materials. The field and laboratory testing results indicates that fine recycled aggregate blends are suitable in pavement subbase applications. The field testing results indicate variation in each recycled blend within each pavement sections which can be attributed to the nature of mixing of the recycled blends used. Blends of 20% fine recycled glass with coarse size recycled concrete aggregate and waste rock met the requirements as a subbase material.

Berwal et al. (2014) conducted water absorption test, specific gravity test, aggregate impact value test and modified proctor test for compaction and CBR test and finally concluded that Values of Maximum dry density and Optimum moisture content of RAP mixes are nearly equal to values for virgin aggregates. Maximum dry density for Granular sub base is found to be 2.06 and 2.04g/ce in case of virgin aggregates and recycled aggregates respectively. Aggregate impact value and water absorption values are within the permissible limits. Permeability results show that the permeability of recycled aggregates is more than the fresh aggregates. Finally they reported that we can use RAP aggregates of 50% in GSB. Herbert et al. (2015) studied about the use of reclaimed asphalt pavement aggregate in Granular sub base (GSB), Wet mix macadam (WMM) by replacing of RAP aggregates with altering percentage of 0, 15, 30, 45, 60 and 75% with natural aggregates and concluded that the value of maximum dry density obtained with addition of 45% of RAP which is less than 0.01g/cc for GSB, 0.09g/ce more for WMM when compared with referral mix and the value of California bearing ratio with the addition of 45% RAP aggregate is 0.5% less than that of referral mix in the both the cases i.e. GSB and WMM.

Ali and Kushwaha (2015) studied about partial replacement of recycled aggregates with natural aggregates of varying percentages of recycled aggregates of 0. 20, 30, 40, 50 and 60%. They carried out modified proctor test and California bearing ratio test on granular sub-base (GSB) and wet mix macadam (WMM) with RAP-natural aggregate mixes and found that the values of maximum dry density and CBR are obtained with addition of 40% of RAP are less than 0.01g/ce and 0.5-0.6% respectively as compared to no addition of RAP to the natural aggregates. The aggregate impact value and Los Angeles abrasion value for recycled aggregates are 28,69% and 38.5% respectively which are within permissible limits: whereas maximum permissible Los Angeles abrasion value and aggregate impact value for bituminous macadam are 50% and 35% respectively as per MORTH specifications.

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