A REVIEW ON POTENTIAL USE OF RECYCLED CONCRETE AGGREGATE IN BITUMINOUS CONCRETE

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Abstract: The paper discusses the RCA characteristics, the impact of RCA use on concrete material properties, and the wide impact of RCA on structural components. The use, as partial and complete replacement for natural coarse aggregate (NA), of Recycled Concrete Aggregate (RCA) is increasingly interested in the building sector since it decreases requirement for pure aggregates. The use of RCA also contributes to a feasible alternative to the issue of the environment created by cement waste and decreases the adverse economic effects of aggregate removal from natural assets. This paper discusses the most significant physical, mechanical and chemical characteristics of RCA. The indirect tensile strength ratio of moisture sensitivity has an effect on the durability of asphalt pavement is also discussed. Full replacement of coarse aggregates is giving better result or 10,20, 30...et % replacement of RCA giving better result also discussed in this paper. I main aim is to right this paper is how bonding between NA and RCA is we can and which one giving better results compare to NA and RCA.

***Keywords* – Recycled Concrete Aggregate (RCA), Hot Mix Asphalt (HMA), Natural Aggregates (NA).**

I. INTRODUCTION

Roughly 90% of India's roads are paved with asphalt. Building and maintaining these streets demand large volumes of aggregates, which typically represent more than 90% of the asphalt mixture by weight. The India produced approximately 26 million tons (Mt) of hot asphalt (HMA) in 1999, which may lead to the supposition that some 20 Mt of aggregates were consumed, it is estimated. On its managed roads and motorways in India, the Highway Agency alone uses around 15 tons of aggregates annually. A significant percentage (industrial: 47 percent; commercial: 66 percent; local: 83 percent) of waste was sent to sites of site waste across India, with approximately 48 Mt industrial waste, 30 Mt commercial waste and 28 Mt municipal waste produced. The environment in the cement industry plays a major role, mainly in the following aspects: large amounts of cement must be consumed in large quantities. 1tone CO_2 gas for every 1st production for air discharge, 7% of CO_2 emissions. A large amount of water is required for production of cement. Down and built a concrete waste road building poses environmental challenges. Public infrastructure demand is aligned with growth. It is estimated that the international demand for asphalt is growing at 122,5 million tons by 2019 by 2.8 percent per year. The population growth, urbanization and economic growth will continue to increase. A great number of aggregates are necessary for the construction of asphalt pavements. The need for sustainable asphalt design and construction within asphalt industry is becoming a priority with regard to resource conservation and the protection of the environment. As the aggregate however plays an important role in the final performance of the asphalt mix, it is crucial for the development of the asphalt mix to understand its properties. Furthermore, it will depend on the properties of the recycled aggregates, its market availability, the performance criteria for a mix, the product's entire durability and the economic viability of its incorporation to achieve the level of RCA substitution. The results are highly significant when these materials are used. These advantages include conservation of natural resources, improved landfill use, savings of waste dumping charges, reduction of emissions and energy conservation. The use of RCA in hot mix asphalt mixtures provides an efficient and cost-effective waste solution. In order to ensure that recycling materials can fulfill relevant requirements at reasonable costs through the uses of available technologies and equipment, property requirements of these applications must also be understood.

Fig. 1 Recycled concrete aggregates (RCA).

II. PROPERTY REQUIREMENTS FOR MATERIALS IN ASPHALT PAVEMENTS

The properties of the RCA compared with NA are discussed in this section. An understanding of how the aggregate changes after concrete is used can improve the ability to explain why RCA can function differently in new concrete than NA. The main aggregate characteristics presenting the aggregate are density, porosity, and water absorption, the form and gradation of the aggregate as well as the overall crushing and abrasion resistance.

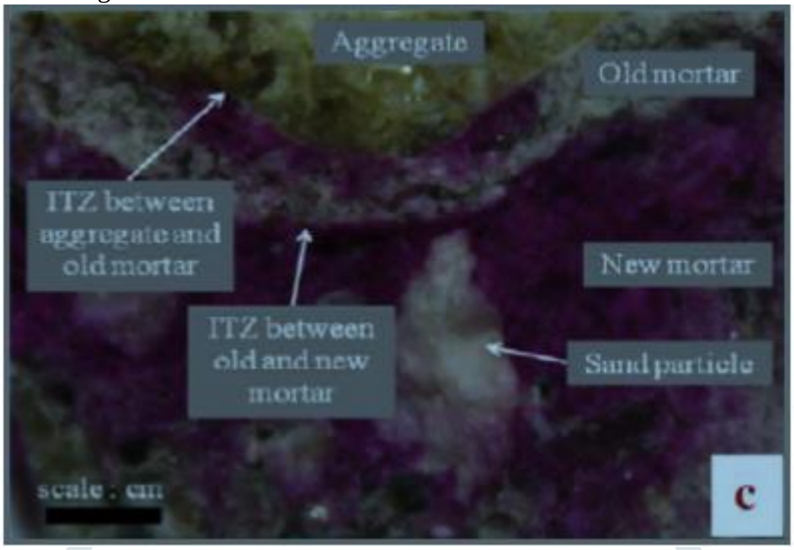

Figure. 2 Sectional view of RCA [10].

2.1 Particle shape and texture

Because of the shredding of old concrete, RCA tends to be very angular and rough and because of the existence of hardened concrete paste / mortar attached to the original coarse surfaces. RCA particles typically contain, depending on their aggregate size, 30 to 60 percent old concrete paste / mortar. The smaller sized fractions of coarse aggregate are connected with a greater amount of old cement paste / mortar. RCA is similar to crushed particle rock, but crusher equipment type influences the gradation of crushed concrete and other characteristics [8].

2.2 Specific gravity

The specific gravity of the RCA is less when compare to NA because RCA having attached with mortar [1]. Bulk density is depending on specific gravity of coarse aggregate because it is the major part of the mix [9].

2.3 Absorption

The aggregate abrasion value (AAV) is a measure of the wear resistance of the aggregate. When material is lost most by wear, a higher AAV is obtained. The RCA AAV is generally larger than the NA AAV. RCA values range between 20 and 45% in typical Los Angeles abrasion, higher than NA values [8]. A related total characteristic, also attributed to residual mortar, are porosity and water absorption. NA is generally low because of low porosity, but the bonded RCA mortar is more porous, allowing the aggregate to contain more water in its pores than NA [6]. Recycled concrete aggregates have different physical, chemical or mechanical properties than natural aggregates, because of the presence of cement paste on the surface of the natural aggregates. The concrete paste reduces density and increases the capacity for water absorption [13].

2.4 Crushing and L.A. Abrasion

Abrasion tests are measurements for the durability of the aggregate material on their own in Crushing and Los Angeles (LA). The overall trend is that RCA has higher crushing and L.A values. Abrasion rather than Na, if the aggregate is contained in steel balls and crushed or affected by L.A. RCA test for abrasion has finer break-out particles than NA. Crushing tests resulted in basalt (NA) at RCA values of 23,1% vs. 15,7% and RCA vs. 24%. [6]. Only lighter heavy traffic categories are suitable for the RCA. The LA was, through contrast, suitable for all heavy traffic categories for natural aggregates [12].

2.5 Property requirements for asphalt

The paving surface layers contain the most strong and costly material in road construction to resist tyre and climate. Features such as friction, strength, noise and surface-water drainage are vital to the safety and quality of vehicles [4].

III. PERFORMANCE OF ASPHALT PAVEMENTS CONTAINING RECYCLED CONCRETE AGGREGATES

3.1 Marshall stability and flow test

The stability ratio (kN) to flow rate (mm), as defined by the Marshall quotient (MQ), is an indicator of the mixture's rigidity. In addition, the MQ measures shear stress, constant deformation and routing resistance to materials. The optimum asphalt binder content was determined through the maximum volume specific gravity, maximum stability, 4 percent air vacations in the whole mixture and 80 percent asphalt vacuums [18]. Fatigue is usually caused by repeated loading in asphalt mixtures. In 1945 Miners offered to control the process of cumulative failures, based on liner rule, with the mathematical equations. Assumption by Miner that the failure is evaluated because of load repeated stress load in I [13]. The criteria used to assess asphalt mix performance in the design of Marshall mixes are voids in Total Mix (VTM), mineral aggregates voids (VMA), asphalt filled vessels (VFA) and stability. Considering the measured variability, it has been concluded that, while for RCA mixture, the values are apparently outside limits, RCA falls within and below these criteria (i. e. VTM, VMA, VFA, and stability). The measured values for VMA and stability do not fulfill the criteria [9]. Generally, concrete is less than NA concrete. That's because some of the old mortars rub RCA away and produce extra fines in the concrete mixture. This is because the fines adsorb some of the mixed water and thus reduce concrete bleeding. The greater the fines, the more the concrete mix cohesive at a lower free water content. The higher corner and surface roughness at a higher RCA content also contribute to the cohesiveness of concrete [9].

Figure 3: Test set up for Marshal Method [5].

These samples have been made from a combination of recycled and natural aggregates. A collapsed bridge in Karachi produced the recycled aggregates. Three levels were taken into account when adding RA with natural aggregates. Increased 0.5%, the asphalt content ranged from 3% to 6%. As control specimens, samples made of natural aggregates were used. A decrease in the volume of void is the addition of asphalt content that fills the gap between the aggregates. Because they are porous, recycled aggregates absorb more asphalt than CSA, leaving fewer asphalt binder to fill voids. Thus, with the RA addition in the mix, air vacuum rises [5]. From the above journals RCA giving higher stability values when compare to NA because RCA having rough surface so bonding between two aggregates is high.

3.2 Dynamic creep test

Dynamic creep tests can assess the resistance of HMA mixtures to permanent deformation. A cylindrical sample of 70 mm / 101 mm is repeatedly undergoing pulse uniaxial stress during a dynamic Creep test. Two linear variable differential transformers (LVDTs) were used for measuring the axial deformation of the sample at 180° [18].

3.3 Indirect tensile test

In ITS tests, an indirect tensile method is used to assess the sample's fatigue life. This process involves the loading of a vertical compressive compression specimen which generates a relatively uniform tensile stress along the vertical diametric plane. The load type in this method causes vertical axis two-axis stress [13]. The gyratory compactor compacted the specimens used in this test. The rank of this test did not match the stability, and there was no statistically significant trend in the air vacuum content [9]. An important characteristic of the paving is the most popular indicator of stress-strain of asphalt mixtures measurable in indirect tensile mode. The rigidity modulus provides a measure of the ability of the bituminous layers to dispose of the load and, thus, controls the traffic-induced strain of the material on the base of the road, which causes fatigue cracking and compressive strain in the sub-degree that can lead to permanent distortion [18]. Generally, for all three temperatures, resilient modulus increased with lowered RCA. The resilient aspect is highest at the lowest test temperature of 5 ° C, showing that under recoverable deformation, the stiffest material condition is present. The ANOVA test at 5 percent significance level was performed to evaluate the effect of RCA on the resilient module. The analysis showed that more than the percentage of RCA in a mix, 5, 25, and 40° C, respectively, were responsible for results differences [15].

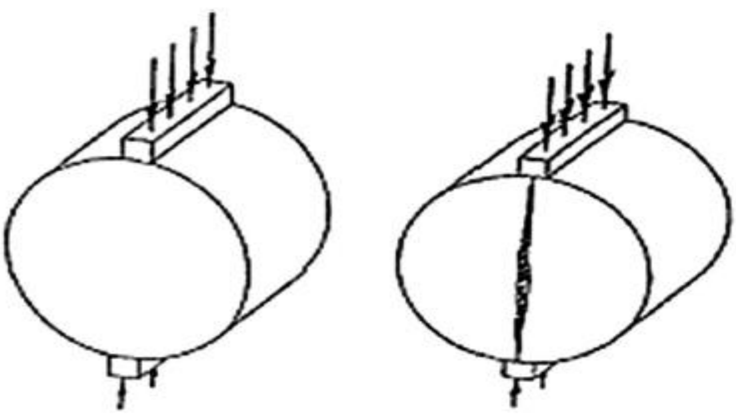

Figure. 4. Position of loading and failure of sample in indirect tensile method [13]

3.4 Indirect Tensile Strength Ratio

The indirect tensile ratio experiment was conducted to prevent asphalt mixtures from being susceptible to humidity harm, as indicated by ASTM D 4867 and KS F 2398. The charging and inspection speed of the ASTM D 4867 and KS F 2398 was 50 mm / minute and 25°C. In the indirect tensile strength of mixtures, the indirect tensile strength ratios of the original specimen were divided by moisture-conditioned specimens. Mixture has a minimum acceptable tensile resistance proportion of 0.7. Before and after training is the indirect tensile resistance proportion of the blend [2]. The minimum allowable tensile resistance percentage should be 80 percent, to ensure the combination of the cement is adequately resistant to humidity and water related damages, otherwise recognized as peeling, according to ASTM D 4867/D 4867-M04. At 25ºC, the sensitivity to humidity uses the mixture's indirect resistance test. The degree of humidity susceptibility to VA-RCA HMA is shown to be reduced with the increase of the RCA percentage [3].

IV CONCLUSION

RCA is helpful to create concrete with appropriate characteristics and durability as a replacement for NA. The primary issue with using RCA in fresh concrete, however, is its incompatible performance, especially when acquired by demolishing ancient constructions in concrete. The physical characteristics of RCA affect the new and hardy characteristics of concrete considerably. The combined values of abrasion, effect and decomposition of RCA influence the power of the concrete. In addition, the negative chemical characteristics of RCA can influence the durability and efficiency of RCA concrete during operation. RCA and NA are rounder and finer in form, although they have a comparable gradation. Tests for abrasion and abrasion. Replacing NA with RCA reduces the compressive force, but results in an equal or higher intensity of the dividing tensile. The RCA concrete rupture was lower than standard concrete, probable as the interface area was damaged from residual mortar. The elasticity modulus, caused by a ductile aggregate, is also less than expected. RCA-content beams of full-scale do not appear as impacted by testing small-scale products.

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