A Technical Study of Recycled Fine Aggregates Used in Mortar

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***Abstract*—Recycled Debri Sand is procured by crushing the discarded concrete cubes of the testing laboratory and Ready mix plant. The purpose of the study is to replace the sand by Recycled Concrete Debris (RDS) in mortar as in future there will be depletion of sand. Discarded concrete cubes were crushed to the required grain size distribution and is termed as Recycled Debris sand (RDS). Hence, it is necessary to study the different aspects of the material which is related to Recycled Debri Sand (RDS).**

***Keywords*—Demolition Debris, Natural Fine Aggregates, Compressive Strength, Flexural Tensile Strength**

I. INTRODUCTION

A mortar is a material in a plastic state which can be trowelled into place and sets in situ. It consists of a binder (lime, Ordinary Portland Cement (OPC)), clay, an aggregate (sand or gravel),Water Types Of Mortar like Type N, Type S, Type M, Glass block mortar, Refractory mortar. Each mortar has its own importance according to the requirements of construction industry. The first mortars were made of mud and clay. Because of a lack of stone and an abundance of clay, Babylonian constructions were of baked brick, using lime or pitch for mortar. Gypsum mortar was essentially a mixture of plaster and sand and was quite soft. In the Indian subcontinent, multiple cement types have been observed in the sites of the Indus Valley Civilization, such as the Mohenjo-Daro city-settlement. Gypsum cement that was "light grey and contained sand, clay, traces of calcium carbonate, and a high percentage of lime" was used in the construction of wells, drains and on the exteriors of important looking buildings. Cured lime mortar can be degraded by contact with water, many structures suffered from windblown rain over the centuries.

II. LITERATURE REVIEW

Christian Meyer (1987-2000) [1]: Concrete is by far the most widely used construction material worldwide. Its huge popularity is the result of a number of well-known advantages, such as low cost, general availability, and wide applicability. But this popularity of concrete also carries with it a great environmental cost. Most damaging are the enormous amounts of energy required to produce Portland cement as well as the large quantities of CO2 released into the atmosphere in the process. This paper summarizes the various efforts underway to improve the environmental friendliness of concrete to make it suitable as a ―Green Building material. Foremost and most successful in this regard is the use suitable substitutes for Portland cement, especially those that are by products of industrial processes, like fly ash, ground granulated blast furnace slag, and silica fume. Also efforts to use suitable recycled materials as substitutes for concrete aggregate are gaining in importance, such as recycled concrete aggregate, post-consumer glass, tires, etc. The paper discusses some of the economic drivers which determine the degree of commercial success. Simply deposing of waste materials in concrete products is unlikely to succeed except in unusual situations. But by identifying and exploiting specific properties inherent in various waste materials or by products, it is possible to add value to such materials and increase their chances of success in a market-driven economy of supply and demand. Also, the emergence of the Green Building movement in North America is already changing the economic landscape and the factors that influence resource utilization. In this paper he has to use a many tools and strategies and workout on totally environmental impact corresponding sustainable development and finally concluded: The economic feasibility of recycling depends largely on the application. In general, virgin materials have a quality control advantage over recycled materials. But the economic feasibility of recycling will increase in time, as virgin materials become increasingly scarce and the disposal costs of construction debris and other waste materials keep increasing. More important, we will see a proliferation of Green Building and sustainability development principles, which will modify the economic picture in favor of the environment. We all agree that we cannot keep wasting our natural resources. Eventually they all will run out. It is basically up to governmental authorities to level the playing field by holding producers responsible for the costs associated with disposal of their products, whether these are associated with reuse, recycling, or land filling. In many European countries, this is already the law and forces manufacturers to design their products with those disposal costs in mind. In other words: let him who pollutes pay for the cleanup. The principles of sustainable development are self-evident. It is difficult to disagree with the goal of passing on to future generations a world no worse than the one we were given. The political differences appear when it becomes necessary to balance the needs of environmental preservation against those of development to raise the living standard. The World Summits of Rio and Kyoto

were serious attempts to balance the needs of the ―haves‖ and the ―have-nots‖. While the developed, industrialized countries are called upon to reduce pollution of the environment and their share of the usage of the world's resources, including energy, the developing countries need to avoid the mistakes of the past. The American concrete industry has not been a leader in this transition. But let us now all work together to keep our planet liveable.

Hir Otak (2000)[2]: This paper outlines the state of reuse of by- products in concrete in Japan and outlines the problems related to reuse. It also summarizes the JIS Technical Report, TR A 0006 ―Recycled Concrete Using Recycled Aggregate‖ published in 2000. Research has been conducted on the reuse of many kinds of by-products in concrete and many papers have been published every year. However, although large quantities of several kinds of by-product materials are used in concrete today, the reuse of many kinds of by-products has not grown in spite of intensive research and development. He has worked in three categories and relevant brief explanation given below:

- Category 1: Use of by-products, from non-construction industries to concrete

- Category 2: Use of by-products, from concrete to concrete

- Category 3: Use of by-products, from concrete to other materials

The ultimate purpose of recycling materials is to minimize the impact of human activities on the environment and the planet. From this viewpoint, the first priority of concrete engineers is to maximize the lifespan of concrete structures, at least concerning Category 2, because buildings and infrastructures must be used for a very long time and, generally speaking, reuse of concrete and/or recycling of concrete materials is not easy technically or economically. Furthermore, he showed that if the use of by-products from industries other than construction, degrades the quality, especially durability, we must carefully consider how to properly use those materials. Recently, it has become necessary to accept large volumes of many kinds of by-products for use in concrete, with reuse sometimes taking priority over concrete quality. Many concrete engineers are concerned that concrete is being thought of as a dustbin. And he had found out what it react, how to influence on making new concrete about brief representation. However, this issue influences and is influenced by many conditions and circumstances in a complex manner. Therefore, we must take a broad perspective when evaluating the relevant technologies for reusing and recycling concrete materials.

Nelson, Shing Chai NGO (2004)[3]: Nelson has worked on Recycled aggregates which comprises of crushed, graded inorganic particles processed from the materials that have been used in the constructions and demolition debris. The results showed that a gradually decreasing in compressive strength, tensile strength and modulus of elasticity as the percentage of recycled aggregate used in the specimens increased. The aim for this project is to determine the strength characteristic of recycled aggregates for application in high strength structural concrete, which will give a better understanding on the properties of concrete with recycled aggregates, as an alternative material to coarse aggregate in structural concrete. The scope of this project is to determine and compare the high strength concrete by using different percentage of recycled aggregates. The investigation was carried out using workability test, compressive test, indirect tensile test and modulus of elasticity test. There were total of eight batches of concrete mixes, consists of every 20% increment of recycled aggregate replacement from 0% to 100%. Moreover, 100% of recycled aggregate mix batches included fly ash, water/cement ratio of 0.36 and 0.43. The workability of concrete considerably reduced as the amount of recycled aggregate increased. He has tested many specimens in laboratory and considered the all types of mechanical properties found out of concrete specimen. The study shows that when the water/cement ratio was decreased, the compressive strength can reach 48MPa. This is classified as high strength concrete and they can be applied in the infrastructures, which need compressive strength up to 40MPa. Another result found in this research is that when reducing the water amount used in recycled aggregate mixes, tensile strength and modulus of elasticity are also improved. This will give an improvement in general strength characteristics of structural building. Although recycled aggregate can be applied in the high strength structure, but one issue must not be neglected as recycled aggregate with reduce water content would have low workability. Whenever recycled aggregate is applied, water content in the concrete mix has to be monitored carefully due to the water absorption capacity of recycled aggregate will vary. This type of concrete can only be used under the condition that does not involve a lot of handling works.

Kingston University *(2004-2005)[4]:* Researchers have worked on Waste arising from construction and demolition (C & D) constitutes one of the largest waste streams within the European Union (EU) and many other developed countries. The study shows that plain as well as reinforced concrete can be crushed using primary and secondary crushers to provide crushed aggregate with an acceptable quality to current BS 882 requirements. Of this a large proportion of potentially useful material disposed of as landfill. The environmental and economic implications of this are no longer considered sustainable and, as a result, the construction industry is experiencing more pressure than ever before to overcome this practice. The results of an extensive experimental programme aimed at examining the performance of Portland-cement concrete produced with natural and coarse recycled aggregates are reported in this paper. The effects of up to 100% coarse recycled concrete aggregate on a range of fresh, engineering and durability properties have been established and assessed its suitability for use in a series of designated applications. And they have suggested some conclusion: Because of the attached cement paste in the RCAs, the density of these materials is about 3-10% lower and water absorption is about 3-5 times higher than the corresponding natural aggregates. It is therefore important that density and water absorption of RCA are determined carefully, prior to their use in concrete production. This must be done in order to avoid large variations in properties of hardened concrete as well as in achieving fresh concrete of

adequate workability, stability and cohesiveness. The results also indicate that for RCA samples obtained from four different sources, there was no significant variation in strength of concrete at a given RCA content, indicating no significant effect if adequate provisions for RCA characteristics are made. The RCA concrete mixes were found to possess bulk engineering and durability properties similar to the corresponding natural aggregate concretes, providing they were design to have equal strength. He stated that, if the construction industry as a whole question need for aggregates and review alternatives on a case by case basis then it is possible that the result may give both economic and environmental benefits.

Michał Bołtryk, Dorota Małaszkiewicz and Edyta Pawluczuk (2005)[5]: Recycled aggregate (RA) obtained from crushed concrete rubble, instead of being stored, can be reused in building industry. Study on the possibility of reuse of concrete from demolition has been carried on in Poland. The paper reports experimental results of selected performance features of RAC. Recycled aggregate (2/4, 4/8, 8/16 mm) was obtained from crashed laboratory concrete specimens. Concrete mixtures were produced at recycled aggregate content equal: 0%, 25%, 50% and 75% of coarse aggregate. Compressive strength of recycled aggregate concrete (RAC) showed a decrease of up to 6% compared to natural aggregate concrete (NAC). RAC water absorption was higher compared to NAC because of remains of mortar on its rough surface. They have worked with Four series of concrete specimens with variable amount of coarse recycled aggregate (0%, 25%, 50% and 75%) were prepared. All mixtures used in this investigation were proportioned using the absolute Volume method. Consistencies of concrete mixtures were constant and classified as Veebee method. There were used four types of Compositions of concrete mixtures given below:

- Series NAC – concrete mixture with natural aggregate exclusively,
- Series RAC1 – concrete mixture with 25% of recycled aggregate,
- Series RAC2 – concrete mixture with 50% of recycled aggregate,
- Series RAC3 – concrete mixture with 75% of recycled aggregate.

Water absorption for the recycled aggregate was significantly higher than in the case of the natural aggregate due to the higher absorption of the old mortar attached to the recycled aggregate. Higher content of dust fractions (lower than 0.063 mm) in recycled aggregate causes higher water demand in concrete mixtures with this aggregate. For these reasons the amount of water was determined experimentally in order to obtain the same workability of the mixtures tested on Vebe apparatus. The paper proposes application of concrete rubble which after proper processing can be used as a substitute of natural gravel in the production of concrete mixtures. On the basis of analysis of experimental results it can be concluded: Procedure of preparing concrete mixture containing recycled aggregate resembles the one with natural aggregate; it is necessary however to adjust the amount of water in order to obtain the desired consistency of the mixture; Test results in the range of the recycled aggregate properties as well as the properties of recycled aggregate concrete allow stating that there is a possibility to produce RAC with properties comparable with properties of NAC; Compressive strength of recycled aggregate concrete in which natural gravel 2/16 was replaced by recycled aggregate in the range from 25% to 100 % is comparable with strength of NAC; Water absorbability of RAC is higher up to 24% compared with NAC; Compressive strength after 75 freezing/thawing cycles decreased insignificantly in two series; in the series where 25% of natural gravel was replaced by recycled aggregate it was even higher; mass loss after freezing/thawing cycles was lower for RAC and in all cases it did not exceed 0.5%; Test results proved that RAC can be a freezing resistant material. It can be stated that recycled aggregate obtained from crushed concrete of average strength can be used as a full-value component of new concrete. It is not recommended however to replace fine natural aggregate by fine recycled aggregate.

Akbari Yogesh Vallabhbhai (2011)[6]: Recycled aggregate concrete utilizes demolition material from concrete and masonry construction. Reuse of demolition waste concrete avoids the problem of waste disposal and is also helpful in reducing the gap between the demand and supply of crushed natural aggregate. Though several studies have been made in the reuse of concrete waste but limited work has been made with respect to unknown strength of demolished old concrete as an aggregate. The present study to assess the physical and mechanical properties of recycled aggregates for its suitability in concrete making and study the compressive strength and behavior of recycled aggregate concrete, using unknown strength of demolished concrete aggregate. The present study makes an effort to assess a safe and economic use of such a structural grade concrete, a supplementary material for housing industry. The investigation was carried out using workability test, compression test, flexural strength, split tensile strength and one of Non destructive ultrasonic pulse velocity test. There were total of forty eight batches of concrete mixes, consist of recycle aggregate replacement from 0 to 50% such as 0%, 15%, 30% and 50%. Moreover recycled aggregate mix batches included silica fume addition with different percentage, water/cement ratio of 0.60, 0.52 and 0.43. The workability of concrete considerably reduced as the amount of recycle aggregate increased. This was evaluated through standard slump test and compaction factor test. For strength characteristics, the results showed that a gradually decreasing in compressive strength, split tensile strength and flexural strength as percentage of recycled aggregate used in the specimens increased and it's a vice versa in addition of silica fume in the mix of concrete.

III. CONCLUSION

The various efforts underway to improve the environmental friendliness of concrete to make it suitable as a ―Green Building material. Foremost and most successful in this regard is the use suitable substitutes for Portland cement, especially those that are by products of industrial processes, like fly ash, ground granulated blast furnace slag, and silica fume. The investigation was carried out using workability test, compressive test, indirect tensile test and modulus of elasticity test. There were total of eight

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