Review Paper on Application of Stone Cutting Waste in Construction Industry

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Abstract : Rapid growth in urban population has led to increase in construction activities. Rise in construction activities leads to increase use of raw materials such as Natural river sand, aggregates, Cement, top fertile soil. The procurement/manufacturing of the mentioned materials involves depletion of huge quantities of virgin and scarce materials; secondly the process is energy intensive. The other industry growing by leaps and bounds is Stone cutting/quarrying/mining industry. The latter generates heaps of stone chips, powdered material or dust, which has great potential of use in construction industry. These discarded materials from such industries can replace and reduce the use of virgin materials such as sand, aggregates and top soil in construction sector. The present paper includes the review of research papers on application of these wastes in different sectors of construction industry. The major components of construction industry consist of RCC construction with masonry units as infill walls. There has been great development in construction sector but it has also caused several environmental issues as these activities uses cement as their primary raw material which is the source of CO_2 emissions. The other industry that is growing is mining and cutting of stones which generates large amount of waste which causes problem due to improper disposal. The present paper includes the review of research papers on application of these wastes in different sectors of construction industry.

***IndexTerms* - concrete, stone waste, sustainable construction.**

I. INTRODUCTION

Use of concrete has increased due to growth in construction sector but high usage of cement and aggregates has led to depletion of natural resources and environmental imbalance. Cement is also the primary source for emission of greenhouse gases. Excessive use of natural resources which may lead to its scarcity in the near future it has become important to find alternative material that can replace these natural resources. Due to its limited availability the cost of natural resources is increasing at regular interval and thus the cost of construction.

There are many industries which generate a huge amount of waste which is disposed in the form of landfills. Land nowadays are extremely costly so it is better to recycle and reuse these wastes. One of such growing industries is of mining and cutting of stones. The waste generation from stone mining and cutting industries is in tons. The landfill of these wastes covers the large area of soil and also could the waste could be carried by wind and cause respiratory disease to near residents. In few cases these wastes are dumped in water bodies which causes contamination of water.

Due to this environmental issues a significant amount of research work is being done in recycling and reusing these wastes as alternative material to cement or natural aggregate in construction sector. This paper consists of review of application of wastes obtained from mining and cutting of stones such as limestone, sandstone and marble. Sandstone cutting waste is siliceous in nature while limestone and marble cutting waste is calcareous in nature. Though it a fact that the properties of these stone wastes changes depending on the source location but its chemical and mineralogical composition can be studied and based on that their replacement has to be decided.

II. LITERATURE REVIEW

Torkaram et al. [1] in this study, represents parametric experimental study in which an investigation on replacement of cement by rice husk ash, wood fiber waste and limestone powder waste is carried out. The wood fiber waste used in this research was obtained from fiberboard. The rice husk ash was obtained from by burning ground rice husk in suspension at 700°C temperature and sieving it through 150 micron sieve. Limestone powder waste was obtained from nearby quarry site. CaCl2 at the dosage of 5% weight was used as accelerator for hydration process. Specimen with six different mixes were prepared with different replacement ratios by weight of cement. These specimens were tested for compressive strength, water absorption and bulk density. From the results of this experimental study the authors concluded that the composites having limestone waste powder had shown higher compressive strength while addition of rice husk ash reduced water absorption and bulk density and addition of wood fiber waste increased water absorption. Addition of 25 wt% limestone powder waste and 25 wt% wood fiber waste produced about 30% lighter than the conventional concrete block.

Kumar et al. [2] in this study, evaluated the effect of utilization of sandstone as partial replacement of coarse aggregate in cement concrete. The mix designs comprised of M30 grade concrete. Quartz sandstone were utilized to partially replace natural coarse aggregate for 0%, 20%, 40%, 60%, 80% and 100%. Nine cubes of 100mm sides were casted for measuring compressive strength and beams of sizes 100mm × 100mm × 500mm were casted for measuring flexural strength. These specimens were tested for compression, flexure, pull off strength, water absorption, external sulphate attack and carbonation. From this research work authors concluded that when strength is concerned quartz can be utilized to partially replace natural coarse aggregate by 40 %. The strength

more than target strength was achieved in replacement levels of mixes with water- cement ratios 0.35 and 0.40. Further it was concluded that partial replacement of natural coarse aggregates by quartz sandstone can solve the environmental problems of depleting natural resources and land filling with reasonable strength results.

Zhen He et al. [3] in this study, investigated the use of sandstone powder as an additive to replace cement in concrete. The sandstone powder taken in this study was obtained as the by-product of coarse aggregate production. It consisted of 63% silica and 3.83 % alkali content. The sandstone powder was utilized to partially replace cement by 20%, 25%, 30% and 50% by weight and 5 % silica fume was added to promote the chemical reaction of sandstone powder. The water to binder ratio was kept 0.4 and the cube specimens with size 100 mm × 100mm × 100mm were casted. These specimens were tested for compressive strength and alkali silica reaction. From the study the authors concluded that maximum reduction in strength by 35% was observed when sandstone powder was utilized to replace 50% cement by weight. Addition of 5 % silica fume with sandstone powder enhanced the performance of concrete. Utilization of sandstone powder in concrete showed better resistance to alkali silica reaction due to its pozzolanic nature. Further they finally concluded that sandstone powder could be utilized as partial replacement of cement to enhance durability performance of concrete.

Buruksagis et al. [4] in this study, investigated the effect of using marble waste powder in cement based mortar. In this research materials used are marble waste powder, dolomite and cement. The marble waste powder was obtained from single block of marble which was crushed in the crusher plant and then sieved from Iscehisar region. The specific gravity of marble powder was 2.72g/cm3. Raw dolomite of particle size ranging from 200-700 micron was obtained from Sivrihisar region. The specific gravity of dolomite was 2.86 g/cm3. The marble powder was used by displacing the cement mortar components by dolomite. During the preparation of mixture cement, marble powder, dolomite and chemicals were dry mixed for 3 minutes in the container then water was added and stirring was continued for another three minutes until it became homogenous. The tests that were carried out on the mortar are fresh mortar spreading test, initial setting time, bending strength test, compression strength test, tensile strength test and physical property test. From this research work authors concluded that marble waste powder can have application as bonding mortars like mantle, decorative plasters and tiles adhesive mortars. It was also found out that use of marble powder in mortars was economical and marble waste powder can be reused in mortars instead of landfilling.

Gupta et al. [5] in this study, evaluated the effect on mechanical properties of cement sand mortar containing waste granite powder. In this research work waste granite powder was used to partially replace natural fine aggregate in mortar. In this experimental study two series of mix proportion were used i.e. 1:4 and 1:6. For each series three types of mixes were prepared:(1) Control with fine sand, (2) Mix with ratio 70:30(Coarse sand : granite powder), (3) Mix with ratio 60:40(Coarse sand : granite powder). The tests conducted on mortars were flow table test, compressive strength test, Ultra Pulse Velocity test, tensile bond strength test, adhesion test, water absorption test and drying shrinkage test. From this research work authors concluded that partial replacement of natural fine aggregate by waste granite powder showed improvement in mechanical properties of mortar. Mortar with 30% replacement showed maximum bond strength which is significant for application in masonry. Water absorption and voids with mortars containing granite waste was lesser compared to control cement sand mortars.

Ballester et al. [6] in this study, evaluated the effect of utilization of limestone waste in mortars. In this experimental programme two types of mortar mixes were prepared along with control mix consisting of cement, sand and pure limestone powder. In one mix pure limestone was replaced by waste limestone powder obtained from mussel while in other some proportion of cement was also replaced by waste limestone powder. These mortar mixes were tested for compressive strength, flexural strength, adhesion test and thermal analysis test. From the results it was concluded that utilization of waste limestone powder enhanced mechanical performance of mortars and reduced cement content and hence cost.

Gritsada et al. [7] in this study, evaluated the effect of utilization of bagasse ash in increasing amount in addition with limestone powder in producing self-compacting concrete. In this research work, fine aggregate in concrete were replaced in proportion of 10, 20, 40, 60, 80, 100% by bagasse ash and limestone waste powder by volume. A 35 liter of mixture was prepared for each batch and superplasticizer was added to provide fluidity desired for self- compacting concrete. A slump of 70 ± 2.5 cm was maintained for the mixture. Various workability tests like V-funnel flow test, J- ring flow test and slump flow test were performed on it. From the results it was concluded that replacement of fine aggregate with bagasse ash and waste limestone powder in proportion of 20% by volume improved workability as well as hardened properties of self-compacting concrete.

Esra et al. [8] in this study, evaluated the effect of utilization of recycled marble waste as a replacement of aggregates on mechanical properties of concrete by conducting review of other research papers. The authors concluded that utilization of marble waste was 15 % more economical than conventional concrete and solved environmental problems. The papers suggested that application of marble waste as replacement of aggregates and cement gave favorable results. The optimal percentage of replacement for cement and aggregates with marble waste powder was found out to be 10% and 20% respectively. From this research work, non-linear equation were derived for estimation of compressive and split tensile strength of concrete containing marble waste.

III. CONCLUSIONS

Construction industry is the one which is using large amount of natural resources like river sand and cement is the primary raw material in RCC construction which emits greenhouse gases which has caused environmental imbalance. These natural resources are scarce which has increased the need to find out alternative materials. The above papers are a step toward utilization of stone mining and cutting waste in construction industry. These papers shows that these wastes are first to be evaluated for its chemical composition. Based on their chemical composition their application has to be decided. Stone cutting waste of stones like sandstone, granite are rich in silica content and therefore could be used as a partial replacement of cement and sand in concrete & mortars. The chips of such stone cutting waste can be reduced to size of the aggregates and can be used as a replacement to coarse and fine aggregates in concrete, mortar or as an ingredient in making of masonry units. Stone cutting waste of stones like limestone and marble are calcareous in nature which could be used as partial replacement of binder. The above research has shown that replacement of cement by limestone

powder and marble waste powder shows favorable results in concrete and mortar respectively while granite powder can be utilized as a partial replacement of natural fine aggregates and sandstone can be utilized as partial replacement of natural fine as well as coarse aggregate in construction units. More research work has to be done to further improve the applications of these stone cutting wastes in construction industry.

IV. ACKNOWLEDGMENT

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