A Report on Concrete Replacement Materials And Waste Management

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Abstract- *The construction industry has grown day to day, as well as the quantity of availability of raw materials to prepare concrete is going to decrease. This problem can be solved by an alternative to concrete materials, which is called replacement of concrete materials. In this present report, the majorly available concrete replacement materials are discussed along with the waste management. The technical improvement of concrete, and its impacts caused by replacements were also discussed in detail. This study was limited to replacement of concrete by, demolished Construction waste, broken glass waste, e-waste, brick waste, tyres and rubber waste, fly ash, saw dust, sanitary ceramics and agriculture waste. Some researchers has proven that the concrete prepared by replacement materials will also give equal compressive strength than that of conventional concrete.*

Keywords- Concrete, Fly Ash, Saw Dust, Glass Powder, E-Waste, Coarse Aggregate, Fine Aggregate and Cement

I. INTRODUCTION

Building Construction Waste Management

In general, for any construction project, plans for recycling of waste materials should be developed prior to the commencement of work. These plans should identify the types of waste to be generated and the method of handling, and the recycling and disposal procedures. In addition, areas for the temporary accumulation or storage of the construction waste materials should be clearly designated. It shows that 20% of the total quantity of waste of 1721.8 tons consists of glass, plastic, and concrete. The weights of these materials are estimated to be: 35 tons of glass, 52 tons of plastic, and 240 tons of concrete. Hence, this waste should be incorporated in a waste management plan. The development of an action plan for waste management in every construction case is the responsibility of the owner or his agent. This is to ensure that all waste products generated by a construction project on a property are surveyed, handled and disposed of in a legal manner for the protection of the environment. A waste management plan directs the construction activities towards an environmentally friendly process by reducing the amount of waste materials and their discard in landfills. The environmental and economic advantages that occur when waste materials are diverted from landfill include conservation of raw materials, reduction in the cost of waste disposal and efficient use of the materials.

Waste materials must be kept clean and in separate batches in order to be used or recycled in an efficient manner. Although separation can take place after the mixed waste is removed from the construction site, separation at the site increases the efficiency of recycling or reuse of that waste. The reduction of waste construction materials can be achieved by starting with studying the design details of the building to ensure efficient use of materials, in addition, careful cutting and measuring should be applied accurately. The use of materials that are made from recycled materials and are recyclable should be included in the initial design of the structure. Storage methods should be investigated to prevent dam-age from mishandling and weather conditions. In addition, the ordering of materials should be made just before thework commences. To complete the waste management plan, there should be an estimation of the amount and type of recyclable and non-recyclable waste materials that are expected to be generated on site. Listing of all the expected quantities of each type of waste gives an indication of what type of management activities are appropriate for the specified waste. At each stage of construction, there should bespecific ways to reduce, reuse or recycle the wastes.

II. TECHNICAL IMPROVEMENT OF CONCRETE

When concrete shows high fluidity, in addition to good cohesiveness, it is said to be self-compacting. This recent achievement of concrete technology, which has lead to several advantages, is in fact a development of the well-known rheo-plastic concrete achieved with super plasticizers, in which segregation and bleeding are suppressed by a filler addition and the use of a viscosity-modifying agent. However, these additions may not be sufficient, if the maximum volume of coarse aggregate and minimum volume of fine particles (including cement, fly ash, ground limestone, and other similar materials) are not complied with. Furthermore, from rheological tests on cement pastes, it has been observed that, for maximum segregation resistance, the yield stress of the paste should be high and the difference in density between the aggregate and the paste should be low. This would mean that segregation will be particularly reduced when lighter aggregate, such as recycled aggregate, is used. Moreover, this behavior seems to be enhanced when concrete-rubble powder, that is the fine fraction produced during the recycling process of concrete-rubble to make aggregates, is reused as filler. In this condition, the segregation resistance appears so high that the coarse recycled aggregate can float on a highly viscous cement paste, and an adjustment could be attempted by adding fly ash which, when used alone as a filler, confers reduced flow-segregation resistance and increased flowability to concrete.

III. ECONOMICAL EVALUATION

As in most common structural applications, if a strength class value of 30 MPa is required, recycled aggregate concrete without any mineral addition may not perform satisfactorily, where as recycled aggregate concrete with high-volume fly ash would have excellent performance. For this reason an economical comparison should be made for comparable performances between natural-aggregate concrete and recycled-aggregate concrete with high-volume fly ash of the same strength class. Only negative eco-costs, deriving from waste disposal, are taken into account. Expenses related to the environmental impact caused by the extraction of natural aggregates from quarries should be added to the eco balanced cost of natural-aggregate concrete. On the basis of current costs of the individual constituents, traditional costs evaluation can be carried out leading to the cost of high-volume fly ash recycled-aggregate concrete being slightly higher (about 5%) than natural-aggregate concrete. This result is nearly obvious since both types of concrete belong to the same strength class. However, besides the traditional cost of aggregates, it would be important to take into account their environmental cost. The eco-costs, which are the expenses necessary to eliminate the environmental impact caused by the extraction of natural aggregates from quarries, should be considered as well as the negative eco-costs, that are the expenses to eliminate the environmental load if rubble from building demolition, and also fly ash from thermal plants, are not utilized to produce concrete. By considering the environmental costs of aggregates, though not yet easily determinable and changeable with social and political factors, it can be predicted that high-volume fly ash recycled-aggregate concrete in the future could be remarkably cheaper than the natural-aggregate concrete.

IV. IMPACTS ON ENVIRONMENT

During land filling, hazardous compounds may spread to the surrounding environment and nearby surface water, ground water, and reservoirs and also evaporate to the atmosphere. Exposure to e-waste might occur environment degrades and pollution. There might be a lot of influences on the environment due to e-waste, like contamination of air, water and food supplies. Burning of e-waste creates air pollution containing poisonous gases and heavy metal. E-waste also creates soil pollution and then the ground become infertile to produce crops. Bangladesh is blessed with many rivers, surface water and rainwater reaches underground sources and if the e-waste dumped in land, contaminating ingredients are seeping into the soil, the groundwater will be contaminated. A large proportion of e-waste dumping systems create blockage in water runoff channels.

V. REPLACEMENT MATERIALS OF CONCRETE

Some of the abundantly used materials in the place of coarse aggregate, fine aggregate and cement either by complete replacement or partial replacement are discussed below,

E-waste

E-waste is the waste generated form the discarded electronic devices it is an emerging issue causing serious environmental problems as it is very difficult to efficiently dispose the e-waste without causing any harm to the environment. We use Printed Circuits Boards (PCB) as e-waste. We collect the e-waste from local electronic shops. The size of the aggregate is between 1.18mm to 2.36mm. All the metals attached on the PCB were removed by hand.

Saw Dust

Saw dust has been used in conc rete for at least 30 ye a r s, but not widely. Although seriously limited by its low compressive strength, saw dust concrete can be made to perform well in certain floor and wall applications. When low structural strength is not a problem this light weight material may answer the contractor’s need for concrete with good insulation value and sati s factory resiliency. When dry, most sawdust concrete weighs only 30 percent as much as normal weight concrete, its insulating properties approximate those of wood. It can be sawed and drilled as easily as wood and it will hold nails and screw s. With proper cement-tosawdust ratios it is not flammable. However, the strength of sawd u s t concrete when made in the most commonly used pro portion of 1:3 is only 10 to 20 percent of that of normal concrete. It is not usable where high structural strength is required or where it would be subjected to heavy traffic and severe abrasive action. Its wood content also prohibits installation of lean mixes in environments of excessive moisture. Cement - to - sawdust ratios in standard sawdust concrete mixes are usually from 1:2 to 1:6. However, strength is drastically reduced as the percentage of sawdust is increased. For example, tests made by the Common wealth Scientific and Industrial Research Organization show that a mix of cement sawdust develops an ultimate compressive strength of 1,100 psi after 7 days of curing, but the strength of a 1:3 mix is only 500 psi, and that of a 1:6 mix 110 psi. The strength of sawdust concrete can be increased substantially by adding sand to the mix.

Fly Ash

In power plants that are fuelled by coal, there are spherical particles in the gas that come from burning coal with a diameter of 0.1 to 0.15 mm; the particles are made up of about 85% of silicon, aluminium, iron, magnesium and calcium. Investigating the effects of fly ash started in 1999, and it was observed that the creep and shrinkage level of fly ash samples can be less than those of materials that do not use fly ash. Also, if the curing temperature increases, the fly ash reaction will increase in the cement paste. This is not limited to only the amount of cement hydration but has effects on the type, characteristics, stability and the production process of hydration. According to ASTM C618, fly ash has two classes, Class F and Class C. The main difference between the two is on the levels of calcium, aluminum, silicon and iron content in the ash. In 1987 and 1989, studies explored the incorporation of large quantities of fly ash in concrete. The method was about aerated and non-aerated concrete with 55% weight of fly ash substituted for cement in three strength levels of 21, 28 and 35 MPa. The results showed that the initial and final settings were not significantly influenced by replacing fly ash with cement by up to 55%. In addition, concrete containing 40 to 60% of fly ash showed lower compressive strength at an early curing age. However, it showed higher compressive strength compared to similar concrete without fly ash in 28 days. Generally, Class F fly ash with good pozzolanic activities causes good mechanical properties, durability and low chloride permeability. By using a super plasticizer, poor abrasion resistance was generated compared to concrete without fly ash. By using 50% fly ash in Class F, an appropriate concrete was obtained for the construction of reinforced concrete structures, showed that in fly ash concrete, setting time and air percentage increased with enhancement of fly ash dose. Due to the fact that a high amount of fly ash and good pozzolanic activity reacts with CH of cement, the porosity of concrete decreases. Moreover, compressive and flexural strength of concrete shows an ongoing trend in 91 days and 365 days. Concrete mixtures containing fly ash with low loss of ignition had higher mechanical properties compared to concrete mixtures containing fly ash with high loss of ignition; in addition, increasing fly ash in concrete caused higher shrinkage due to drying at different ages.

Brick

Fired bricks are burnt in a kiln and most of them contain silica, alumina, lime, iron oxide and magnesia. Because of this chemical structure, the use of bricks in concrete production seems to be practical. Researchers have suggested different mixtures to create this type of concrete. One study showed that the compressive strength of this concrete has a downward trend. This reduction was equal to 10% to 35% for coarse aggregates and 30% to 40% for fine aggregates. Using clay bricks as sand in concrete increased water absorption and this may affect the durability of concrete parameters, so this subject needs more investigation. In terms of durability, the concrete containing clay brick waste was no different from the control sample. Nevertheless, the brick aggregates had a negative effect on the durability of the reinforced concrete. A high amount of clay brick aggregate can reduce the corrosion time of bars, although this concrete has better performance in freezing and thawing. As the amount of bricks increase, the stability against the chloride ion penetration reduces. This reduction can be due to the higher absorption of the bricks because of their porosity. The 28-day compressive strength of concrete with brick coarse aggregates was slightly greater than that of the control sample and workability was also improved by increasing the amount of the brick coarse aggregates in the concrete. In general, the results showed that using this type of waste was economical and practical. In addition there were no significant negative effects on the concrete. However, bricks are not suitable for use in reinforced concrete because they cause corrosion of bars.

Broken Glass

Colored glass may be used as an exposed aggregate to impart deep hues with brilliance. Special colored glasses are manufactured for the purpose but waste glass is also available from member companies of the Glass Container Manufacturers Institute, who now operate 90 glass container redemption centers. Exposed aggregate surfaces made with colored glass aggregate have permanent color and gloss. They are most effective in mixes made with white Portland cement. Aggregate should pass the 3⁄4- or 3⁄8- inch sieve depending on the effect desired. Pleasing combinations can be obtained by using a blend of more than one color. A number of techniques are useful. One is to embed the dry aggregate into a freshly troweled surface, spray it with a retarder and later expose the aggregate by scrubbing and washing with water. Another is to make a special facing mix containing the aggregate and place it in the mold for a precast panel, the bottom face of which has previously been painted with a retarder. The facing mix is immediately backed up with a mix containing an ordinary structural aggregate. After stripping, the face is scrubbed and washed to expose the aggregate. A more complicated but sometimes useful method permits vertical casting of panels. The interior of one vertical surface is painted with a retarder. Aggregate is prepacked in the form but a vertical separator near the painted face, and parallel to it, makes it possible to use only a thin layer of glass and to fill most of the mold with another aggregate. The separator is pulled upward little by little as the aggregates are added so that by the time the form is full the separator has been completely removed. Grout is pumped into the f o rm from the bottom to fill all the voids. After the concrete has hardened the form is stripped and the aggregate is exposed by scrubbing the retarded surface. Before using any glass as an aggregate, assurance should be obtained from the supplier that it will meet the requirements of ASTMC 33 with respect to alkali-aggregate reaction when tested according to ASTMC 227. If it does not meet the specification by it the supplier should be able to provide the corrective material such as opal or other pozzolan that will prevent disruptive expansion and he should give information about the amounts of these materials required, based on laboratory evidence. In many cases it may be sufficient simply to use a portland cement whose alkali content (when expressed as Na_2O) is 0.60 percent or less but this should be substantiated by laboratory data. The use of glass as ordinary aggregate for structural applications has not become common although the pressure to find new applications for waste materials might at first seem to make it attractive. Any glass aggregate to be used for conc rete must certainly be required to meet the ASTM requirements just cited, either by itself or in combination with some other material. Even after meeting these requirements it is likely that it will contribute less to the desirable properties of concrete than the aggregates now in common use. A comparison has been made of the effect of replacing a normal weight aggregate with glass cullet obtained from broken bottles. The bottles had been roughly hand sorted according to color before breaking and crushing so that the aggregate was almost free of brown glass but contained perhaps 20 percent or more of green glass; there is a index was clear. Particles were midway in shape between flat plates and cubes, with most sharp edges worn away. Maximum size of particles was 3⁄4 inch. Some large particles were convex - concave. In one mix the normal weight sand was replaced by glass of the same size, in another the coarse aggregate was replaced by coarse glass and in another both the sand and coarse aggregate were replaced. Starting with an 8,000-psi concrete mix of normal weight sand and g ra vel the strength was reduced to less than 50 percent of the original when the sand was replaced, to less than 40 percent when the coarseaggregate was replaced and to less than 30 percent when both were replaced. The resistances to salt scalingcement pipe and aggregates have been formed into brick. Costs of the aggregates are currently $2.50 per ton or less. Mix proportions for the use of such materials in making pressed b rick have required 4 to 10 percent Portland cement by weight of total solids. An accelerator is commonly used. Brick or block is pressed in a machine that turns out 3,000 to 3,600 bricks per hour. The brick are cured in stockpiles. It is anticipated that the brick and block will meet the specifications in ASTM C 55 and C 90, respectively, for grades suitable for use in exterior walls.

Sanitary Ceramics

The first studies on chemical properties of waste ceramic tiles were done in 2000. The results showed that waste tile has pozzolanic properties and the ability to be used in concrete construction. Some studies investigated the use of clay brick waste from demolished buildings as a pozzolanic material. The results showed that this material could be replaced in cement. 20% of the samples of ceramic waste as a pozzolan. The experimental results showed that strength equal to 91% of the control sample can be reached by using these materials. It also reduced the permeability of concrete and increased its efficiency. Waste ceramic tile concrete with silica fume to determine the effects of pozzolanic tile waste and confirmed pozzolan activity. Tile powder was used in different amounts in the concrete and its properties were measured. The results showed that increasing ceramic tile reduces compressive strength. However, if silica fume is added, the good effects will be doubled and the concrete defects will be covered. In these experiments the highest compressive strength was observed in the for 20% ceramic tile and 15% silica fume, while the lowest compressive strength was related to the 25% ceramic tile and 5% silica fume.

Tyres and Rubbers

Tyres are rubber pieces that are mounted on vehicle wheels. Tyres are made of natural rubber, styrene-butadiene, polybutadiene, carbon black and silica, which are used in high-performances tyres. The main idea of using this elastomeric material in cementitious matrix is to reduce the stiffness of concrete in order to make it more flexible and to improve its resistance to fire. The use of tyre scrap as a substitute for aggregates and cement in concrete is new. The grading tyre that can be used in concrete. Some are used rubber waste as fibre. The results showed that by increasing the amount of rubber, the performance of concrete decreased. A flexural strength test showed that the concrete samples containing rubber tyre as fibre were stronger by up to 20% compared with the strength of the control samples. This could have been due to the conversion of the concrete to a more flexible material through the addition of rubber fibre. The control samples showed fractures caused by brittleness, and immediately split after cracking, while the samples containing plastic fibre became deformed but did not collapse. Showed that using silica fume with increased adhesion between the cement paste and rubber particles improved the filling of the pores and increased the compressive strength. The density of this type of concrete is also 13% less than that of the control samples. The increase of waste tyres can influence the carbonation depth, especially if the tyres are used as coarse-grained rubber. Workability is also reduced by keeping the ratio of water to cement and increasing the amount of the ash of rubber. By increasing the percentage of rubber ash for water-to-cement ratios of 0.35 and 0.45, compressive strength was decreased. The 90-day compressive strength of cement with various ratios of water-to-cement and rubber ash. In freezing-thawing resistance, the experiments showed that replacing or adding fine crumb rubber improved this property. It would seem that the use of tyre waste as an alternative in concrete still needs to be studied and further explored to determine the durability and strength of this material on concrete.

Agriculture Waste

From agricultural waste, rice husk ash is the most applicable. The heating value of 1 ton of rice husk is equal to the thermal value of 0.48 tons of coal or 0.36 tons of fuel oil. If rice husk is used for fuel, it burns uncontrolled and many particles change to crystalline, which dramaticallyreduces pozzolanic activity. Therefore, if rice husk is going to be used in concrete, it must be burnt under controlled conditions and milled in the long run so that its pozzolanic properties increase. In a study, by calcining rice husk in 500 and using microsilica in high-performance concrete, the researchers obtained porosity decreased by development of the hydration of cement. Using these two materials improve the compressive strength and water absorption of concrete and it was proved that rice husk ash has high pozzolanic potential. It can also improve resistance to chloride attack, compressive strength and other mechanical properties. Adding a superplasticiser can also increase slump and decrease viscosity. Using rice husk ash can reduce the filling ability of concrete; however, paste viscosity and segregation rose sharply. By combining rice husk ash and fly ash the self-compacting and compressive strength properties of concrete improved. Finally, studies have showed that in countries with limited production, rice husk ash can be a valuable additive in concrete products such as high-strength concrete and reconstructive mortars. Corncob has also been used in some studies. Corncob ash consists of more than 65% silicon dioxide and more than 70% combination of aluminium oxide and silicon dioxide. This reflects that the material is cemented and may have a viscous role in concrete. Therefore, the use of these materials in the construction of concrete is practical, but they should be used more carefully in order to preserve their pozzolanic property and to strengthen the microstructure of the concrete.

VI. CONCLUSION

The higher proportions of concrete materials like sand, gravel, cement and water were used by Construction sectors only and if it continues, there is a lack of availability of materials. This will overcome by the partial replacement of available waste materials which are disposed. With these replaced concrete, we can construct RCC pavement, small constructions, foot paths etc. according to some researchers, the compressive strength of concrete with the help of replaced materials will also give equal strength comparing with conventional concrete.

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