RECYCLING OF CONCRETE AGGREGATE MATERIALS IN CIVIL ENGINEERING

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Abstract-*Recycling of concrete debris can make a contribution to reducing the total environmental impact of the building sector. To increase the scope for recycling in the future, aspects of recycling have to be included in the design phase. Besides, aggregate sources near Metro Manila are almost depleted, so aggregates have to be brought from far quarries. Consequently, reclaiming aggregates from concrete debris would lead to environmental and economic benefits. This experimental study aimed to use crushed concrete debris as alternative fine aggregate in a mortar mixture. A conventional mortar mixture will be compared to concrete debris mixture of the same proportions. The common definition of solid waste is everyday household waste, which is collected by municipalities and disposed of in a landfill or incinerator.*

Keywords- Sand mining, river sand, mine dust structure analysis

Introduction-

Recycling as part of environmental considerations has become a common feature in the construction industry. Construction and demolition (C&D) debris is the waste material that results from the construction, renovation, or demolition of any structure, including buildings, roads, and bridges. Typical waste components include Portland cement concrete, asphalt concrete, wood, drywall, asphalt shingles, metal, cardboard, plastic, and soil. This waste material has only recently gained attention as concerns about its environmental impact have developed. One of the things builders, developers and contractors must consider during construction, renovation or demolition is where to put all the debris. As what most people do in the preservation of the environment and for economic purposes, studies, researches and experiments are being done to discover new ways on how to find solution considering where else to put these debris and what can be done to lessen its disposal to landfills and since there is an increasing environmental problem regarding the waste disposal to landfills, it is necessary to think of possible ways on how to avoid these problems and at the same time secure safety and convenience, and that is, to recycle.

To fully understand the environmental implications of C&D debris, it is important to understand the size of the C&D debris stream. The exact quantity of C&D debris generated in the US is currently unknown. Many states do not track the amount of C&D debris disposed of or recycled. Some states do collect this data from landfills and recycling facilities, but some facilities do not have scales and report only converted volume estimates . Methodologies have been developed to estimate how much C&D debris is generated, generally applying average waste generation per unit area amounts to total area of construction, renovation, or demolition activity. Few other types of national C&D debris estimations have been performed to find a better method or to contrast against the current estimations.

Recycling of materials

"The materials recycling" denotes the generation, collection, storage, transport, source separation, processing, treatment, systematic control of the disposal of recovery and solid waste. Waste transportation manages all processes and resources, from the maintenance and dumping facilities of trucks to the collection, transport and disposal of waste, sewage, and other waste to comply with health codes and environmental regulations. Municipal (residential, institutional, and commercial), agricultural and special (health care, household hazardous waste, sewage solid waste of various kinds, including sludge).

The term is usually related to materials produced by human activity, and to use this process usually health; reduce their impact on the environment or aesthetics. Waste management may not have much impact globally, but it can certainly spread diseases like plague, dengue, etc., so humans must learn to develop proper recycling of materials techniques. Understanding the existing system of waste management and the problems associated with it is very important for proper waste management. A few decades ago, there was no problem of waste management for the production of waste as it was either used in fields or was imbibed by nature. This was due to the fact that most of the waste generated by humans was recycled. The problem mainly started after industrialization and population boom and wastes were produced in an amount that could not be assimilated by nature and waste like plastics etc. could not be recycled by nature.

Recycling Process

A recycling plant crushing the same plant that produces natural aggregates. As illustrated in the closed system, FIG. 1, which is the layout, is recommended for the production of normally recycled aggregates (Hanson et al. 1985). Open system, which is shown in FIG. 2, more capacity but reduce the maximum particle size is well defined and it can be large variations in the size of the final product. As clean concrete should always be provided in the recycling plant is not available, extraction of contaminants from the material. The layout of a stable recycling plant, which makes a high-quality product, as shown in FIG. 3.

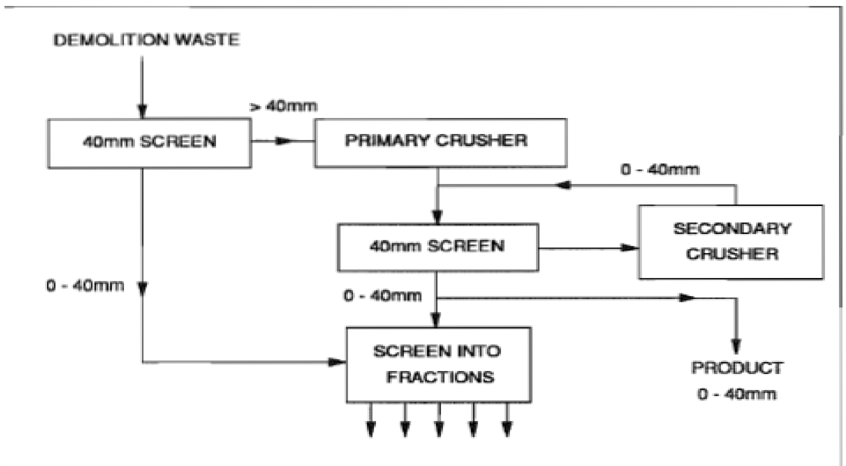

Fig. 1 closed system recycling plant

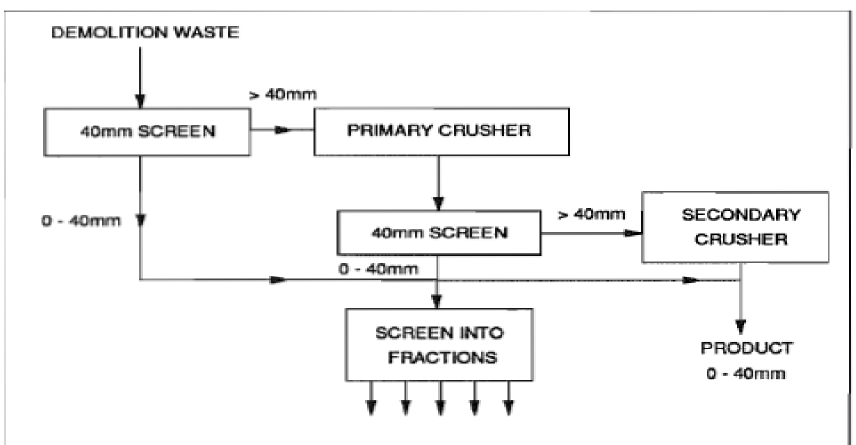

Fig. 2 open system recycling plant

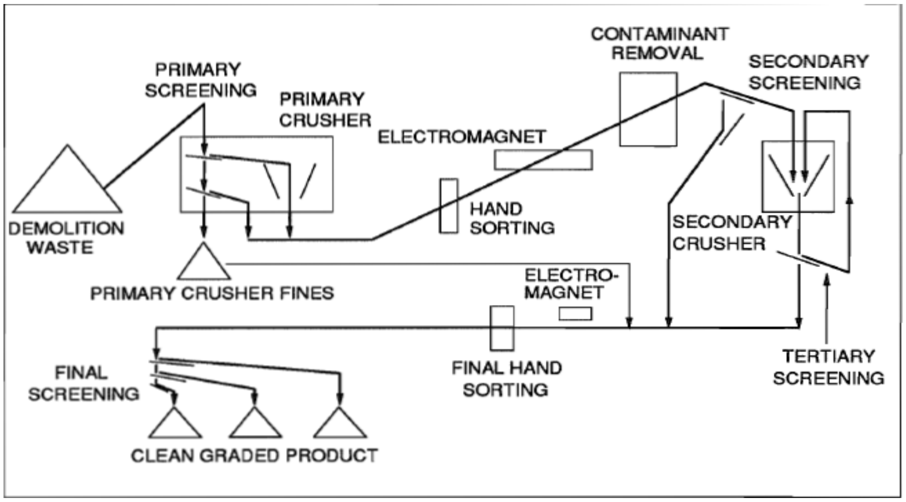

Fig. 3.3 layout of a stationary recycling plant

Recycling plant can be mobile or stationary. Usually consists of a crushing and screening equipment in a mobile plant. Work to remove the contaminants and steel is mainly used by sorting by hand and self-cleaning electromagnets. Some cases involve two crushers in mobile plant, as was demonstrated by Somerest County Council on the repair of the Taunton Bypass in1989.

Literature Review

A recycling plant crushing the same plant that produces natural aggregates. As illustrated in the closed system, is recommended for the production of normally recycled aggregates (Hanson et al. 1985). Open system, which is more capacity but reduce the maximum particle size is well defined and it can be large variations in the size of the final product. As clean concrete should always be provided in the recycling plant is not available, extraction of contaminants from the material. Usually consists of crushing and screening equipment in a mobile plant. Work to remove the contaminants and steel is mainly used by sorting by hand and self-cleaning electromagnets. Some cases involve two crushers in mobile plant, as was demonstrated by Somerest County Council on the repair of the Taunton Bypass in1989.

(Tiruse Ayushim Abistu and Amare Sennett Minal, 2013) GIS and went to discuss remote sensing techniques are important tools for solid waste site selection. Therefore, the ability to use a suitable solid waste dumping GIS and remote sensing technology to effectively identify the site will reduce the environmental risk and human health problems. (Sundar Rajan et al., 2014) Studied remote sensing and GIS technologies to Hosur municipality. Selection of suitable sites for waste disposal is based on several factors. Using weighted overlay analysis with GIS technology is used to select the appropriate solid waste disposal sites and it is classified into three categories, namely, good, moderate and poor. Accordingly, suitable sites which may be suitable for the environment, transport and economic outlook (Monavari et al, 2014). In his studies, went to using regional ration's capital city, reviewed the suitability of solid waste landfill in ration City. Screening Method (RSM), Geographic Information Systems (GIS) and Analytical Hierarchy Process (AHP). (Rinsitha et al., 2014) Discussion went that easy to use sites for the disposal of solid waste. These locations were planted in the analysis away from any water source and other variables. They are located in the city's south and southeast, and have dry agriculture, bare land and grass land. (Imtiaz Ahmed Chandio, Abd Nasir bin Matori, 2011) studied land suitability analysis considering the accessibility of hill development using the integrated GISbased multi-criteria decision analysis method. If hill development can be protected from environmental hazards, it will be more attractive to the people and may contribute to the country's economy. GIS-based MCDA methods serve a more realistic, attainable objective on a nonpartisan basis for decision-making on site selection.

Recycling in Civil Engineering

Considering the amount of repairs carried out on road every year, the design and construction of road pavements using natural aggregate in the unbound layers could be improved. Although road pavement deterioration cannot always be attributed to a weakened sub-base, it has been found, even when natural aggregate is used, that a sub-base can be damaged by frost heave or can be subjected to excessive deformations by construction traffic at an early age. The data from this research suggest that a road constructed using recycled aggregate in the sub-base layer would not be unlike a structure containing a natural aggregate sub base. These observations could only be confirmed by conducting field trials using accelerated traffic loading or by placing recycled aggregate in the sub base of a lower class road and monitoring its performance under normal traffic loading.

In recent years, demolition contractors have been forced to recycled construction waste due to high dumping costs, particularly in large cities. Some contractors have purchased basic mobile crushing and screening plant to recycle construction waste and use the recycled product either on the same site or locally. This is worthwhile but in a sense demolition contractors have been forced to bypass a step in what might be referred to as the ideal progression of recycling in the construction industry. The setting up of recycling plants by individual contractors, without some standard guidance on the production of high quality recycled material, could result in the production of many recycled products variable contents and quality. The most efficient way of promoting recycling in the civil engineering industry would have been to produce a standard to which recycled aggregates should comply. This might have had the effect of reducing the number of mobile recycling plants being installed. Alternatively, it could have encouraged demolition contractors to unite their efforts by setting up sophisticated, stationary recycling plants around large cities to which all construction waste could be brought for recycling.

These recycling plants would be capable of recycling all grades of contaminated material with the guarantee of producing a good quality aggregate. The producer of recycled aggregate at a recycling plant should ensure that the aggregate complies with any existing specification for the purpose for which the aggregate is required. The situations are likely to arise for a demolition contractor-

- The rubble from a structure under demolition is not to be reused as a high quality aggregate on the same site.
- A structure is demolished and the rubble is needed for reuse on the same site but in the form of a high quality aggregate. The client could only be guaranteed of a high quality product if the rubble was recycled in a plant with good cleaning systems, particularly if the structure was made up of several types of materials.
- The situation involves the recycling of relatively clean rubble e.g. a concrete slab in a road pavement.

Uses of Recycled Materials

Some possible uses of recycled materials were stated previously, both crushed concrete and demolition debris could be used as road sub-base material but the frost susceptibility of any recycled material to be used in a particular job would need to be determined. If the sulphate content of recycled aggregate was found to be below 1.9g of SO_3 per liter then it could be used as the aggregate in lower grade, cement bound material for use in roads, as defined in clauses 1035, 1036 and 1037 of the specification for highway works. The particle grading of material to be used as pipe bedding is different to the well graded aggregate required for sub-base. Depending on the grade of pipe bedding required, the particle size of the material should be in the ranges of 20mm-5mm,14mm-5mm or 40mm-5mm. to obtain these grading, some screening would be necessary to remove large particles and fines. The recycled material would also have to be tested to ensure that its sulphate content was less than 1.9g/litre. Material to be used as backfilling to pipe bays should not have more than 3% of its particles passing the 0.075mm sieve and the maximum particle size should be 20mm.

If a recycled aggregate fails the compliance tests, then there are several ways in which its performance may be improved. Alternating the particle grading at the recycling plant should not be difficult if screens are available and if the jaw crushers are set at the correct setting to produce the required grading. The susceptibility of recycled materials to frost might be found to be lower if frost heave tests were conducted three months after placement of the aggregates rather than immediately after compaction. If further research proved that frost susceptibility did not improve with time, the addition of cement to recycled aggregate could reduce frost heave and improve its bearing capacity and shear strength. The partial replacement of recycled material with natural aggregate is likely to improve its performance but this defeats the purpose of recycling i.e. slowing down, as much as possible, the depletion of natural aggregate. If sample of recycled material appears to be plastic then it is more than likely to have been contaminated with clay fines. This would have occurred if the fine material had not been removed before crushing. Again, in this case the recycling process would need to be altered if an acceptable material was to be obtained.

Discussion

In this study it became clear that India was well behind other countries in its attitude to recycling of construction waste. The construction industries of other countries have accepted recycling as a useful, alternative source of aggregate and have written standards to which recycled aggregates should comply. These standards mainly include allowable limits of contamination in the recycled materials. India is relatively rich in natural aggregate reserves and therefore the civil engineering industry did not seriously consider the recycling of construction waste until dumping became expensive and an increased awareness of the environment became evident in recent years. In comparison, the Netherlands has poor reserves of natural aggregate and has developed sophisticated recycling plant which incorporates several sorting and cleaning techniques to produce high quality recycled aggregate for use in construction. This confirms that the technology and equipment exist to produce reusable aggregate from demolition waste. Some of the standard compliance tests involve testing aggregate in cylindrical moulds. The CBR test is conducted on material less than 20mm in particle size which is compacted in a 152mm diameter mould. Aggregate to be tested in the 150mm diameter mould of the BS 5835 compaction test is required to contain particles less than 37.5mm in size whereas in the frost heave test, particles up to 37.5mm in size are tested in a 102mm diameter mould.

The three tests are conducted on aggregate which is to be used for the same purpose but the laboratory tests are conducted on different grading. These grading may also be unlike the grading of aggregate to be placed on site. This approach to aggregate testing is inconsistent and Dawson and Jones, in the conclusions of the symposium of unbound aggregates in roads, stated that some effort should be made to standardize the grading and the ratio of the mould diameter to the maximum particle size. In this study was found that limestone should be placed at peak dry density and optimum moisture content, as defined in the BS 5835 compaction test, to achieve high values of CBR, $\emptyset_{ds}$ and frost heave. The results from tests on demolition debris suggest that it could perform well when placed at a density slightly below peak and at moisture content below optimum. Crushed concrete should perform well if it is placed at peak density and optimum moisture content or slightly below. While this can be described as lightweight aggregates and recycled materials, but their shear strength went pie similar to limestone. Shear box test method, which was sub-base developed by Eerland and pike for the content as checking aggregates for use in, was held on limestone and recycled materials. The results of these tests it was concluded that the demolition debris and crushed concrete will be classified in the medium power range and limestone to the highest power range. The critical state angles of friction of the recycled materials and of limestone were in the range of 40^0 – 42^0 and were considerably higher than the 33^0 value which was obtained for Leighton Buzzard sand. The value of Q defined by Bolton that materials with particles grains softer than quartz or feldspar would have Q values less than 10. Results of this research show that Q may depend on particles of grading, sampling ratio of the maximum particle size of the box-shaped or angularity of particles. Accuracy of Cornforth loose heap test to determine the critical state angle of friction was found to be lower for well graded aggregates than for uniform, small grained sands.

Conclusions

The results from this research confirm that the requirement of a sub-base to be both a stiff and permeable layer is too demanding. More use should be made of a free draining capping layer which would reduce the risk of frost heave occurring in the sub base. Cannot be removed any definitive conclusions on the sensitivity of frost demolition debris crying and could not be held in the required tests, other laboratories by Webster. Crushed concrete was found to be susceptible to frost. Data indicates that the result of frost recycled content in most cases inconclusive or will fall susceptible boundaries of frost. However, there may be means of self Segmenting capacity of recycled aggregates that will reduce the sensitivity of these materials to frost. Problems concerning frost susceptibility are also evident for many natural aggregates and are not specific to recycled materials. It can be concluded for the recycled aggregate concrete, examined in study, that an increase in free water of 8% was too high to achieve workability similar to the natural aggregate concrete. Traditional concrete than the compressive strength and a slight difference in Young's modulus of recycled aggregate concrete.

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