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Effective Use of Recycled Material in Concrete

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Abstract: ***The waste minimization strategy is developed within a framework in which resource recovery including re-use, reprocessing, recycling and energy recovery are being encouraged. Construction and demolition materials, which is conservatively estimated to constitute about 16% of total waste produced. It is an important target group of waste materials for which recycling is a priority. Most of the construction and demolition waste not recycled ended up in the landfills occupying valuable land not to mention the cost incurred in land filling. Here, it describes an overview of the waste minimization approach taken, the policies and programs that are put in place to bring about successful outcomes. Use of Recycle aggregate in concrete can be useful for environmental protection. Recycled aggregates are the materials for the future. The application of recycled aggregates has been started in a large number of construction projects of many European, American, and Asian countries.***
Keywords: Construction and Demolition Waste, Recycle Aggregate, Re-use, Reprocessing.

I. INTRODUCTION

The promotion of environmental management and the mission of sustainable development have exerted the pressure demanding for the adoption of proper methods to protect the environment across all industries including construction. Construction by nature is not an eco-friendly activity. Construction, renovation and demolition activities lead to the formation of the waste. Recycling comprises the recovery of recyclable waste, its processing into new materials or products, and the marketing of these new products. Recycling prevents the emission of many greenhouse gases and water pollutants, saves energy, supplies valuable raw materials to industry, creates jobs, stimulates the development of more environmentally-friendly technologies, conserves resources for our children's future, and reduces the need for new landfills and incinerators. Recycling of waste concrete is beneficial and necessary from the viewpoint of environmental preservation and effective utilization of resources. For the effective utilization of waste concrete, it is necessary to use waste concrete as recycled aggregates for new concrete. To make this technology feasible, a significant amount of experimental works has been carried out. Various investigations mainly engaged in the processing of demolished concrete, the mixture design, the physical and the mechanical properties as well as the durability aspects.

Construction and demolition (C&D) waste means non-hazardous waste resulting from the construction, remoulding, repair and demolition of structures. Structures include both residential and non-residential buildings, public works projects such as roads, bridges, piers and dams. It also results from natural disasters such as earthquakes and tornadoes. C&D waste includes but is not limited to concrete, bricks, masonry, ceramics, metals, plastic, paper, cardboard, gypsum drywall, timber, insulation, asphalt, glass, carpeting, roofing, site clearance, excavation material and site sweepings. Some wastes are not included in the definition of C&D waste because of their nature. These include paints and other liquid wastes, asbestos and other hazardous wastes, putrescible waste, tires, appliances and containers with residue. The more things we produce and consume the more waste.

We have to dispose of. There is growing recognition that waste elimination at source, through combined minimisation and recycling, is the only long-term solution to our waste disposal problems.

Currently, the level of recycling of solid waste is very low and only very limited activities for recycling of scrap metal, waste lead–acid batteries, textile waste, aluminium cans, glass, paper, bagasse, coal ash, construction & demolition waste, used oil and plastics are carried out. The existing recycling activities are operated entirely on a commercial basis by the private sector.

II. NEED FOR RECYCLED AGGREGATE

Urbanization growth rate in India is very high due to industrialization. Growth rate of India is reaching 9% of GDP. Rapid infrastructure development requires a large quantity of construction materials, land requirements & the site. For large construction, concrete is preferred as it has longer life, low maintenance cost & better performance. For achieving GDP rate, smaller structures are demolished & new towers are constructed. Protection of environment is a basic factor which is directly connected with the survival of the human race. Parameters like environmental consciousness, protection of natural resources, sustainable development, play an important role in modern requirements of construction works. Due to modernization, demolished materials are dumped on land & not used for any purpose. Such situations affect the fertility of land. As per report of Hindu online of March 2007, India

Generates 23.75 million tons demolition waste annually. As per report of Central Pollution Control Board (CPCB) Delhi, in India, 48million tons solid waste is produced out of which 14.5 million ton waste is produced from the construction waste sector, out of which only 3% waste is used for embankment. Out of the total construction demolition waste, 40% is of concrete, 30% ceramic's, 5% plastics, 10% wood, 5%metal, & 10% other mixtures. As reported by global insight, growth in global construction sector predicts an increase in construction spending of 4800 billion US dollars in 2013. These figures indicate a tremendous growth in the construction sector, almost 1.5 times in 5 Years. For production of concrete, 70-75% aggregates are required. Out of this 60-67% is of coarse aggregate & 33-40% is of fine aggregate. As per recent research by the Fredonia group, it is forecast that the global demand for construction aggregates may exceed 26 billion tons by 2012. Leading this demand is the maximum user China 25%, Europe 12% & USA 10%, India is also in top 10 users. From environmental point of view, for production of natural aggregates of 1 ton, emissions of 0.0046 million ton of carbon exist where as for 1ton recycled aggregate produced only 0.0024 million ton carbon is produced. Considering the global consumption of 10 billion tons/year of aggregate for concrete production, the carbon footprint can be determined for the natural aggregate as well as for the recycled aggregate.

The use of recycled aggregate generally increases the drying shrinkage creep & porosity to water & decreases the compression strength of concrete compared to that of natural aggregate concrete. It is nearly 10-30% as per replacement of aggregate. Recycling reduces the cost (LCC) by about 34-41% & CO2 emission (LCCO2) by about 23-28% for dumping at public / private disposal facilities.

III. ADVANTAGES OF RECYCLING OF CONSTRUCTION MATERIALS

A. Used for construction of precast & cast in situ gutters & kerbs.
B. Cost saving: - There are no detrimental effects on concrete & it is expected that the increase in the cost of cement could be offset by the lower cost of Recycled Concrete Aggregate (RCA).
C. 20% cement replaced by fly ash is found to control alkali silica reaction (ASR).
D. Save environment: - There is no excavation of natural resources & less transportation. Also less land is required.
E. Save time: - There is no waiting for material availability.
F. Less emission of carbon due to less crushing.

Up to 20% replacement of natural aggregate with RCA or recycled mixed aggregates (RMA) without a need for additional testing for all concrete up to a characteristic strength of 65 MPa, as per Dutch standard VBT 1995, is permitted.

IV. PERFORMANCE OF RECYCLED AGGREGATE CONCRETE

The following problems exist with the recycled concrete which uses a conventional recycled aggregate of low quality.

A. Strength is low.
B. Drying shrinkage is large, and cracks occur easily.
C. Durability such as resistance to freezing and thawing and carbonation inferior.

These are the reasons why the recycled aggregate with low quality cannot be applied to vital structures. Properties of the recycled concrete which used high quality recycled coarse and fine aggregate were examined.

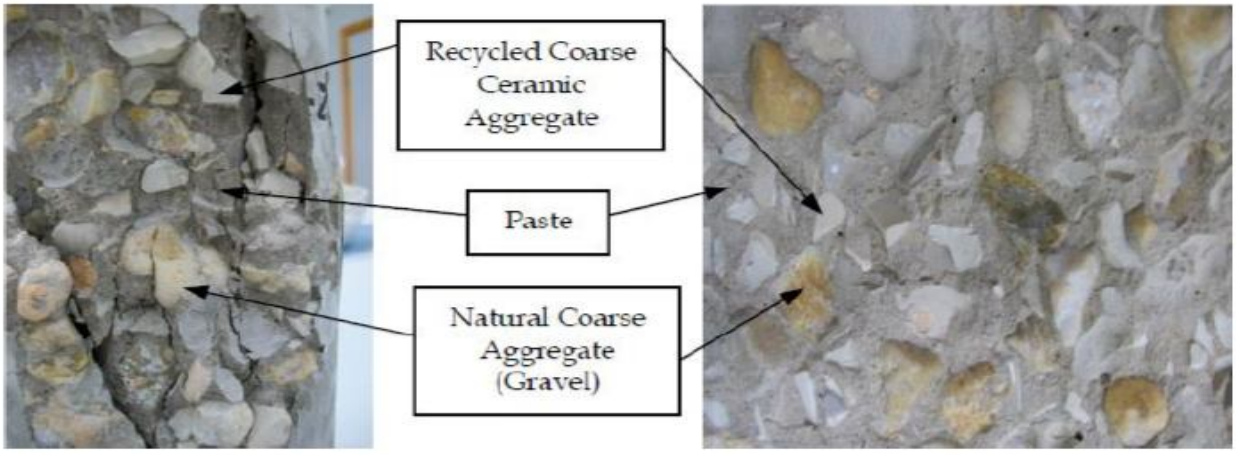

Fig.1 Specimens of natural and ceramic recycled coarse aggregates and cement paste.

The performance of the concrete which used a high-quality recycle daggregate was similar to concrete which used natural aggregate. Hardened cement paste bonded to aggregate deteriorates the performance of the recycled concrete. Only a little, hardened cement pastes is bonded to high-quality recycled aggregate. Therefore, high-quality recycled aggregate obtains a similar performance to the natural aggregate for concrete.

V. PROPERTIES OF RECYCLED OF AGGREGATE

Generally the properties of R.A mostly depend on original concrete. The brief description of properties of R.A is as discussed below.

A. Shape and Texture

1) The R.A is generally angular in shape.
2) It has fairly low flakiness index.

B. Grading

1) The grading of R.A is similar to that of natural rock.
2) It consists of about 80% course aggregate and 20% fine aggregate.

C. Specific Gravity and Water Absorption

1) Specific gravity was found to be decreased by 5-14% to that of natural rock.
2) Water absorption is 2.3 to 4.7 times of natural rock.
3) In W.A 70% of 24 hours absorption capacity is attended in first 30 min of soaking period and after 4 hour, value is 95%.

D. Mechanical Properties

1) Loss Angles abrasion test was found to be 22.4 o 41.4%.
2) Crushing value lies between 23-24.6%
3) Impact value 26 to 31 %.

E. Workability: Not Affected.

VI. TESTS ON RECYCLED AGGREGATE

Sieve analysis is carried out as per IS 2386 for crushed recycled concrete aggregate and natural aggregates. It is found that recycled coarse aggregate are reduced to various sizes during the process of crushing and sieving, which gives the best particle size distribution. The amounts of fine particles less than 4.75mm after recycling of demolished waste were in the order of 5-20% depending upon the original grade of demolished concrete. The best quality natural aggregate can be obtained by primary, secondary & tertiary crushing, whereas the same can be obtained after primary & secondary crushing incase of recycled aggregate. The single crushing process is also effective in the case of recycled aggregate. 20 mm of coarse recycle aggregates are used for overall experiments. The particle shape analysis of recycled aggregate indicates similar particle shape of natural aggregate obtained from crushed rock. The recycled aggregate generally meets all the standard requirements of aggregate used in concrete

Table no.1 Expected values of test

SR.NO.	PARTICULARS	VALUES	
		Natural Aggregate	Recycled Aggregate
1	Specific Gravity	2.4-3.0	2.35-2.58
2	Water Absorption	0.29%-0.3%	0.3-0.32%
3	Bulk Density	1678.2KN/m^3	1469.8KN/m^3
4	Crushing Values	18.4%	36.3%
5	Impact Values	17.65%	35.2%

Table no. 2 observed values

Sr. No.	TEST	Natural Aggregate	Recycle Aggregate
1	Specific gravity	2.45	2.41
2	Water absorption	1.67	3.38
3	Impact value (%)	17.65	35.2
4	Crushing value (%)	18.4	36.3
5	Bulk density	1678.2KN/m^3	1469.8KN/m^3

VII. CONCLUSIONS

In order to reduce the construction waste, during the time of construction order only the correct amount of raw materials. Proper care should be taken to ensure the protection of materials being delivered and stored in the site. When a structure is being demolished, salvage as much of the more valuable fittings and materials as possible. Any suitable substitute for aggregate should be considered during the construction. It is the duty of an engineer to revaluate technical specification for materials where strength and safety do not have to be compromised to permit the use of recycled materials. As sorting and recycling facilities become more wide spread and better developed it will be easier to redirect our construction waste from the landfill. The nurturing of a reprocessing and recycling industry in particular is necessary to sustain waste reductions and none is more critical than the construction and demolition waste recycling. The subject of use of RCA in construction works in India should be given impetus, because of big infrastructural projects are being commissioned in the coming years.

A. Use of recycled aggregate up to 30% does not affect the functional requirements of the structure as per the findings of the test results.

B. Various tests conducted on recycled aggregates and results compared with natural aggregates are satisfactory as per IS 2386.

C. Due to use of recycled aggregate in construction, energy & cost of transportation of natural resources & excavation is significantly saved. This in turn directly reduces the impact of waste material on environment.

D. As we increases the percentage of recycled aggregate up to 50% then compressive strength reduces. So we conclude that we can only replace recycled coarse aggregate less than 50%.

E. The most important that cost of construction is minimized due to utilization of recycle aggregates. This is the cost effective and nature free solution for increasing concrete demand.

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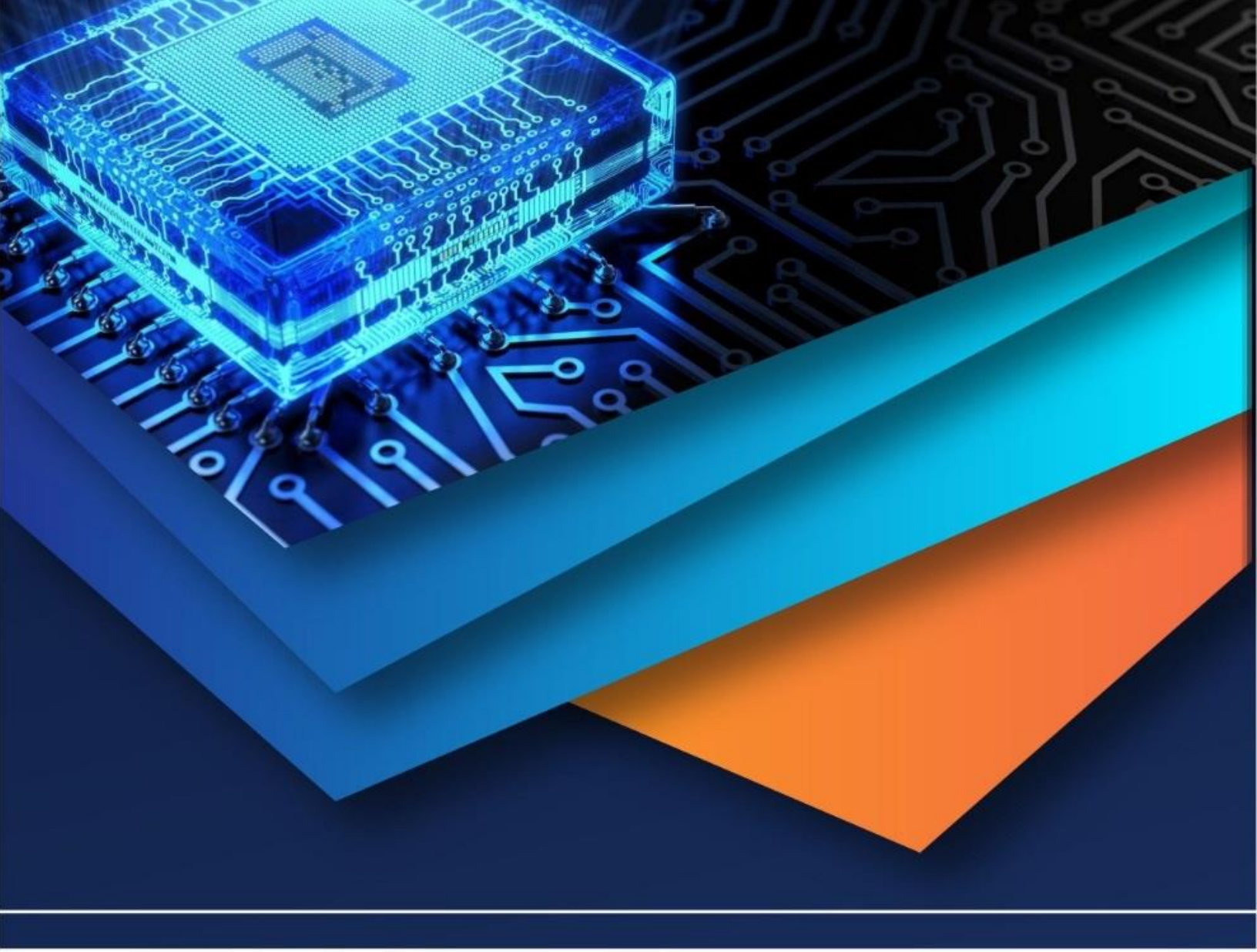

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