Need for Management of Recycled Aggregates – An Overview

Gyanendra Kumar Chaturvedy[1] Yogendra Singh Patel[2] Anil Pandey[3] Dr. Sanjay Bhandari[4]
[1,2,3]Research scholar [4]H.O.D
[1,2,3]Department of Civil Engineering [4]Department of Applied Mechanics & Structural Engineering
[1,2,3,4]Samrat Ashok Technological Institute; Vidisha; M.P.(India)

Abstract— In view of need for environmental protection, use of recycled aggregates in concrete can be very beneficial. In future, it seems to an increasing trend not only for meeting of increased need but also due to low material cost. In several countries of E.U., U.S.A., & Asian countries, the application of recycled aggregates has been started. For this, these countries have started several infrastructural laws relaxation to promote the recycled aggregates' use. This paper deals with the basic properties of recycled aggregates along with their comparison with natural aggregates. The changes in properties like compressive strength, flexural strength, workability, water absorption etc. are determined & their effects on concrete work are discussed here. In general, current status & trend in India with its upcoming needs & also successful utilization are discussed. Future recommendations relating to recycled aggregates are also included.

Key words: Recycled concrete aggregates (RCA), Natural aggregates (NA), concrete & Construction & Demolition (C & D)

I. INTRODUCTION

Throughout the world, concrete is the main construction material without which no one can imagine the fulfillment of construction requirement. India's present growth rate is about 9%. To meet this high growth rate, rapid infrastructural development is needed, which in turn require a large quantity of construction material. Concrete is the primary need for large construction work. As aggregates constitute about 70-80% of concrete components, so to fulfill the demand, we need a huge quantity of aggregates.

Since our natural resources are depleted fastly, so a giant problem is arising in front of fulfillment of demand. The scientists & the scholars all over the world are searching for the solution. One of the solutions of this problem lies in the reuse of aggregates obtained from demolition works. The process involves the recycling of obtained aggregates followed by crushing into suitable sizes and shapes & removing the deleterious compounds from aggregates' surfaces. The aggregates so obtained are known as recycled concrete aggregates.

As per report of THE HINDU of March 2007, India generates about 23.75 MT demolition waste annually. A report of Central Pollution Control Board, Delhi stated that 48 MT solid wastes was produced in year 2014 out of which 14.5 MT wastes was produced from construction sector, out of which embankment use was only 3%. The management of C & D waste is a problem due to huge quantity of demolition rubble, continuing shortage of dumping sites, increase in cost of disposal & bigger of all is the environmental degradation.

From economic point of view, cost of recycled aggregates is very less (20-30% of NA) thus saves a huge amount of money being spended in construction works. Also it saves time & labor thus presents an economic foundation for its use. From environmental point of view, about 0.0046 MT of carbon is produced during production of 1 ton of NA whereas only 0.0024 MT of carbon is produced during same amount of recycled aggregates. Considering the global consumption of 10 billion tones/year of aggregates for concrete production, the carbon footprint can be easily find out.

II. INDIAN SCENARIO ON RCA

In India, the work on RCA has been started to reuse the increasing C&D waste. According to Ministry of Urban Development circular on June 28, 2012 states are directed to set up recycling plants in all cities with a population over 10 lakh. Such a plant was first established in 2009 at Burari, New Delhi. It has saved the already polluted Yamuna & the overflowing landfills of Delhi from 15.4 lakh tonnes of debris. Its present capacity is 1200 tonnes per day. According to a techno – market survey on "Utilization of Waste from Construction Industry" conducted by TIFAC, an autonomous body under the Department of Science & Technology (Govt. of India), the total quantum of waste from construction industry was estimated to about 12 to 14.7 MT out of which 7.8 MT are concrete & bricks waste. The survey also stated the response of Indians towards use of RCA. According to the survey, 70% of respondent has given the reason for not adopting recycling of waste from construction industry is 'Not aware of the recycling techniques' while remaining 30% have indicated that they are not even aware of recycling possibilities. Further the user agencies / industries pointed out that presently the IS & other codal provisions don't provide the specifications for use of recycled products in the construction activities.

Fig. 1: Recycled Aggregates

After visualizing the above matters, there is a urgent requirement to take the following steps-:

1) Increasing awareness about the use of RCA
2) Preparation & implementation of techno-legal arrangements including legislation, guidelines etc. for disposal of C&D waste
3) Establishment & implementation of research and its set up on national level
4) Establishment of recycling plants & provide technical supports to the users
5) Preparation of database on utilization of RCA

6) Making codal provisions & relaxation of rules for use of RCA in different works
7) Tax exemptions & incentives to promote use of RCA in construction works

III. METHODOLOGY

Plain cement concrete (PCC) blocks & RCC blocks are collected from sites (viz. Samrat Ashok Technological Institute, Vidisha). These materials are crushed with the help of hand operated hammer to separate the aggregates & to bring them into small pieces with required shapes & sizes suitable for further tests. These aggregates are sieved according to IS 23186 (part V)-1963 and IS: 383- 1970 as per requirements needed. Along with these materials, sand, water & admixtures are mixed to make test blocks confirming to IS 10262: 2009 and IS 456: 2000. Following the above stated IS codal provisions, various tests are carried out & their results are compared with NA.

Fig. 2: Screening Plant

IV. PROPERTIES OF RECYCLED CONCRETE AGGREGATES

The significant findings of the tests carried out are

1) Shape & texture-: Both coarse & fine aggregates turn into very angular & rough caused by the effect of crushing & also due to sticky cement particles on the surfaces of aggregates.
2) Water absorption capacity-: Cement particles adhered to the aggregate surfaces increases water absorption capacity up to double to that of NA. This is so because cling cement particles has more tendency to absorb water.
3) Specific gravity-: Sp. gravity of RCA was found from 2.54 to 2.62 which are less than that of NA. This lower sp. gravity is due to the lower denseness of RCA due to crushed mortar present which is porous & has some air entrained.
4) Bulk density-: Bulk density comes lower by 12.5% to 14% as compared to NA.
5) Crushing & Impact values-: RCA is relatively weaker in both crushing & impact values as compared to NA. From crushing & impact test, it is concluded that RCA can be used beneficially for applications other than wearing courses in roads.
6) Compression strength-: Compression strength comes around 70-80% of that of NA. Hence it provides a satisfactory option for use

Properties	Natural Aggregates	Recycled Concrete Aggregates
Shape & texture	Well rounded, smooth to angular & rough	Angular & rough surface
Water absorption	1% - 2%	2% – 6.5%
Specific gravity	2.7 – 2.8	2.54 – 2.6
Loss abrasion test mass loss	15% - 30%	20% - 45%
Chloride content	0% - 1 kg/m3	0.6 – 7 kg/m3

Table 1: Comparisons between NA & RCA

V. CONCLUSION

1) After reduction of w/c ratio in RCA, tensile strength & elastic modulus are improved.
2) Energy, money & time can be considerably saved by using RCA.
3) Use of RCA up to 25% - 30% does not affect the functional need of the structure.
4) Sp. gravity, shape & texture & other properties are in much similarity to that of NA.
5) RCA mix has greater water absorption & porosity as compared to NA but it is under tolerance limit.
6) From past studies, it is found that 10% extra water & 5% extra cement should be used to produce a good mix by using RCA.
7) It is strongly recommended to build new standard & provisional codes to enhance the use of RCA satisfactorily.
8) The deleterious chloride compound may harm the concrete, so proper steps must be taken to overcome the bad effect.

VI. FUTURE RECOMMENDATIONS

From current & past studies & tests, it is strongly advised to make codal provisions to use of RCA as it can provide the solution for many problems.

1) Making codes of practices for use of RCA in no. of construction activities
2) To increase the awareness & promote the uses of RCA
3) Nationwide research should be done to take more advantages of RCA

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