Construction and Building Materials 68 (2014) 501–516

Contents lists available at ScienceDirect

Construction and Building Materials

journal homepage: www.elsevier.com/locate/conbuildmat

Review

Recycled aggregate from C&D waste & its use in concrete – A breakthrough towards sustainability in construction sector: A review

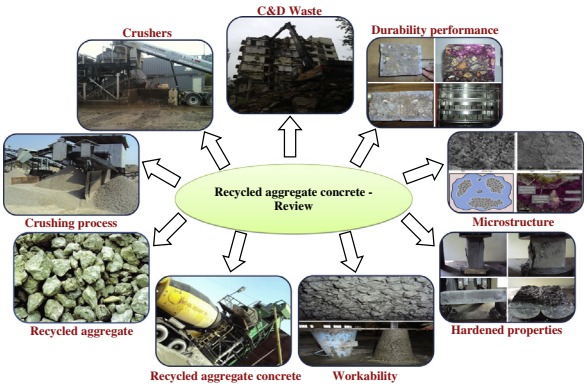
Monalisa Behera *, S.K. Bhattacharyya, A.K. Minocha, R. Deoliya, S. Maiti

CSIR-Central Building Research Institute, Roorkee 247667, India

HIGHLIGHTS

- Usage of RAC will possibly help the global community towards sustainable development.
- The strength and durability performance of RAC are comprehensively documented.
- ITZ of RAC is porous, presence of cracks and fissures are commonly found due to the residual mortar.
- The deficiencies observed in RAC can be significantly overcome by the incorporation of mineral additives to the concrete.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 24 March 2014
Received in revised form 27 June 2014
Accepted 2 July 2014

Keywords:
Construction and demolition waste
Recycled aggregate
Recycled aggregate concrete
Strength
Durability
Interfacial transition zone
Microstructure

ABSTRACT

The issues of sustainability are of prime concerns these days as we use large amount of natural resources for producing materials such as concrete. Depletion of natural resources is one of such sustainability issues which we need to address in an efficient manner. The recent trend in construction industry is to use the alternative source of construction materials which can substitute the use of virgin materials in order to reduce environmental impact in terms of energy consumption, pollution, waste disposal and global warming. On the other hand, the waste generated from the demolition of old structure and construction activity is a matter of concern all over the world. Thus, recycling and reuse of these wastes may reduce the usage of natural resources and it can also serve towards the demand of environment. The present paper gives a brief status of recycled aggregate concrete made out of recycled aggregate, summarizes and critically analyses some of the most important research findings over the past few years regarding the material aspects. It also attempts to elucidate the approaches for the better performances, identifies the gaps in the existing knowledge and underlines the reasons why this promising technology has not become widely accepted by the construction industry. The practical problems with application of recycled aggregate in concrete are also discussed.

* Corresponding author. Tel.: +91 1332283317, +91 9045379496.
E-mail address: monalisabehera7@gmail.com (M. Behera).

http://dx.doi.org/10.1016/j.conbuildmat.2014.07.003
0950-0618/

Contents

1. Introduction

Concrete is a composite material, basically consisting of different constituents such as binding materials, water, aggregates and admixtures. Among these ingredients, aggregate plays a very crucial role in concrete which occupy the largest volume of about 60–75% of total concrete volume [1]. It is indispensable for any construction work. The versatility of concrete as a construction material for large construction work lies in its high strength, low maintenance cost, resistant to weathering effect, economical over other construction materials and its excellent structural performance.

Moreover, the extensive increase in the rate of industrialization and urbanization due to the parallel growth in economy and population has made the use of concrete as the most non-sustainable material as it is consuming the maximum amount of natural resources. Concrete has a very important role in the economy development of a country due to its large volume utilization. It uses approximately 20 billion tons of raw materials (coarse aggregate) each year. According to Mehta and Meryman [2], the current usage of concrete is approximately 20 billion metric tons per annum. However, from the forecast of the research group of Fredonia, it was mentioned that the global consumption of aggregate used in construction may exceed 26 billion tons by 2012 [3]. With this increase in rate of consumption, it is expected that the demand of aggregates will be doubled in the next two to three decades [4]. Amongst different countries, India has occupied a place in the top ten users of the leading countries to use natural resources.

Thus, the concrete industry consumes a large amount of natural resources that cause substantial environmental, energy and economic losses as it exploits 50% raw material, 40% of total energy, as well as generates 50% of total waste [5]. So, minimizing the environmental impact, energy consumption and the increase in CO_2 intensity for the concrete to be used for construction have become more evident for construction industry which can lead towards sustainable development.

The present review paper accounts for the state-of the art report on the usage of recycled aggregate (RA) as construction material in developing new concrete. This paper includes a brief information regarding the properties of RA and its effects on different properties of fresh and hardened concrete (mechanical, durability etc.). It also emphasizes on different processing techniques of RA.

1.1. Essence of recycling of Construction & Demolition (C&D) wastes

In recent years, the large investment in construction sector and the increasing requirement of habitats in urban areas due to the growth in economy and the high growth rate in population have created a large demand of conventional building materials. Again, the depletion of good quality aggregates along with the increase in aggregate requirement makes the availability of raw materials scarcer. In addition to this, the materials tend to become more expensive due to the increase in transportation costs accompanied with the increasing haulage in some regions. As a result, there is an increase in the cost of construction materials. Further, rapid rate of modernization and industrialization have also led to the generation of sheer amounts of debris from construction and demolition (C&D) wastes. Major volume of these wastes emerges from demolition of old construction work. New construction works also generates waste almost to a smaller volume from the left over concrete of ready mix concrete plants, precast concrete plants, shot crete operations and the tested samples in compliance to laboratory applications. These C&D wastes are the largest waste streams of solid waste in many countries all over the world. In addition to these, large amounts of industrial and mining by-products such as fly ash, slag, and limestone powder are being generated annually. These large quanta of debris or by-product materials from industry are simply used as back filling material for low laying areas or illegally dumping material for vacant lands and their quantity has been increasing with time. All these have led to an increasing dearth of landfill areas; useful lands becoming dumping yard, increase in the price of land in recent years and highly increased dumping costs at landfill sites. So, handling of such debris has become one of the important issues in developed countries and it has become a global concern that requires sustainable solution. Moreover, the global concern about the reduction of carbon