A study for characteristic strength of construction demolished waste materials

1- Dr.Umesh Chand,Ph.D.,(MNNIT, Allahabad)
Lecturer, Civil Engg. Department,
Pusa Institute of Technology, New Delhi.
Email: ucs_2chand@yahoo.co.in

2- Dr.S.K.Duggal, Professor,
Civil Engg. Depatrment,
Moti Lal Nehru National Institute of Technology,
Allahabad (Uttar Pradesh)
Email: shashikantduggal@gmail.com

Abstruct :-

In the civil engineering construction field concrete is the prime material of construction which provides durability, easy maintenance, wide range of properties and adaptability to any shape and size to the structure. Concrete, in general have two type ingredients namely active and inactive. The active part of the cement is water and cement where as inactive part contains the coarse aggregate and sand. In the aggressive environment condition the waste materials after dismantling a structure is a problem to decompose but this problem can be minimized by using recycle material in construction. In the present research waste concrete of a building was crushed to desired size and basic properties of this crushed waste concrete was compared with natural concrete. It is really surprising to know that the compressive strength as well as flexural strength of the crushed recycle concrete was at par with the natural concrete. In fact, mechanical strength is influenced by the grade of the original concrete. Workability was noticed to be reducing in the waste concrete but can be of higher value by adding admixture in it.

Key Words: Recycle concrete, Characteristic strength, aggregate,

Introduction:

Construction industries are witnessed to be large infrastructural development in last few decades. In any type of civil engineering construction specially in buildings concrete has been the leading building material since it was discovered and found viable for future due to its durability, easy maintenance, wide range of properties and adaptability to any shape and size. Concrete is the composite mix of cement, aggregates, sand and water. Concrete gets hardened like stone on mixing water with cement and aggregates. Concrete have two type ingredients namely active and inactive. The active group consists of water and cement. The inactive part consists of sand and coarse aggregates. Concrete have high compressive strength and low tensile strength. To overcome this shortcoming, steel reinforcements are used along with the concrete. This type of concrete is called reinforced cement concrete (RCC). Concrete structures that are designed to have service lives of at least 50 years have to be demolished after 20 or 30 years because of deterioration caused by many agents. Old buildings require maintenance for better and higher economics gains. The rate of demolition has increased and there is a shortage in dumping space and also increase in cost of dumping. Instead of dumping this demolished concrete, use of demolished as recycled concrete would not only reduce the cost but also will conserve the non renewable energy sources. The use of demolished concrete will further result in reduction in use of natural aggregates. The usage of natural aggregates is causing damage to natural resources resulting in imbalance in environment. Recycled aggregates consist of crushed, graded inorganic particles obtained from the materials that have been used in constructions. Recycled aggregates are generally obtained from buildings, roads and bridges which are demolished due to completion of life, wars and earthquake. Concrete is no longer made of aggregates, Portland cement and water only. Often, if not always it has to incorporate at least one of the additional ingredients such as admixtures, supplementary cementious material or fibers to enhance its strength and durability. During last few decades requirement of high performance and highly durable 2 concrete has been on rise. The use of mineral admixture in combination with chemical admixture has allowed the concrete technologists to tailor the concrete for many specific requirements. Amongst the mineral admixture, silica fume, because of its finely divided state and very high percentage of amorphous silica, proved to be most useful, if not essential for the development of very high strength concretes and concrete of very high durability i.e. high performance concrete. Therefore it is being used on a worldwide scale in concrete, for the making of high performance concrete. In spite of its numerous advantages silica fume suffers from one major disadvantage that it is imported therefore, very costly. In this work an attempt has made to find a suitable alternate of rice husk ash. Concrete has continuously posed challenges to architects, engineers, researchers and constructors all these years. While trying to improve certain properties of concrete, the other properties have suffered, hence maintaining a perfect balance between the various requirements of concrete happens to be the key to successfully use this wonderful material in emerging India. India is fastest growing economy among all developing nation. So replacement of ordinary Portland cement by pozzolana Portland cement is more efficient in terms of economy in mass construction. Replacement of pozzolana Portland cement by mineral admixtures (slag, silica fume) shows more efficiency in terms of both economy & strength. The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required strength, durability and workability as economical as possible, is termed as concrete mix design. The proportioning of ingredients of concrete is governed by the required performance of concrete in two states namely the plastic and the hardened state. If plastic concrete is not workable, it cannot be properly placed and compacted. The property of workability, therefore, becomes of vital importance. Industrialization in developing countries has resulted in an increase in agricultural output and consequent accumulation of unmanageable agro wastes. Pollution arising from wastes is a cause of concern for many developing nations such as India, Nigeria. Recycling of such waste into new building materials could be a viable solution not only to the pollution problem, but also to the problem of the high cost of building.

Prospects of recycle materials in India

India is an economic development country. Hence, the problem of demolished waste of civil structures is not so big as in developed countries. But it is not far off when India may have to face this problem. But it is evident that in the most populated areas like cities and town areas of the country concrete skyscrapers are replacing the old buildings causing production of demolished waste which needs to be hauled and dumped. It has been found that India is causing 10-15 million tons of building waste annually due to dismantling of bindings. Projections for building material requirement of the housing sector indicate a shortage of aggregates to the extent of about 55,000million m3 .An additional 750 million m3 aggregates would be required to achieve the targets of the planned road sector. To reduce the demand and supply gap the recycling of aggregate material from construction and demolition waste is highly needed.. Therefore, in India, the use of recycle construction material of demolished building waste could be of considerable to reduce the dumping space problem of concrete waste and to maintain a pollution free environment. As a result of researches in the connection of the pollution problem of demolished building waste, the cement companies provides an opinion of assessment of problems in liquidity and profitability analysis on their balance sheet and profit and loss a/c. The machinery as well as equipment used for analysis and interpretation have given method for useful and productive suggestions. The ratio analysis of the company is suitable. The suggestion in this regard to the company is that company should enhance its performance to meet the challenges and to exploit the chances in future and that will also help the management team in taking financial decisions. The movement and growth of the companies like Ultra Tech, ACC, Ambuja, Shree and Prism are favourable for the coming period.. This study has theoretical and practical significance and will help the academicians and researchers to develop new ideas for future study. The study focuses on the problems and prospects of cement industry, which may interest not only those who are interested in manufacturing cement or related products but also a matter of observing the process of change within the industry. This study will be useful to the management to take investment decisions and anticipate future conditions, identification of its areas of strength and weakness and to take appropriate decisions for the maximization of its intrinsic value. The study may also be useful to creditors and the financial institutions in their effective credit policy formulation. The study will act as a guide to investors for their investing decisions.

Impact on environment by waste material

Waste concrete has an adverse impact on environment. Transportation of waste concrete from site has bad impact on environment and the waste concrete filled valuable space in landfills. Construction and demolition waste makes up a large portion of all generated solid waste [Meyer 2008]. In 1980 the Environmental Resources Limited in the East European Communities (EEC) estimated that 80 million tones of demolition waste, mostly concrete, was produced each year. This number was expected to double by 2000, and triple by 2020 [Bairagi 1990]. Th big concerns of space and costing in dumping, traditional disposal of concrete waste in landfills was no longer an acceptable option [Meyer 2008]. The manufacturing and use of concrete is resulting in production of a wide range of environmental and social consequences like harmful, welcome, and both, depending on circumstances. As cement is known to be major component of concrete, which make an effort in environmental and social effects of the cement industry and is made of the three primary producers of carbon dioxide, a major greenhouse gas (the other two being the energy production and transportation industries). In 2001, the production of Portland cement contributed 7% to global anthropogenic CO2 emissions, largely due to the sintering of limestone and clay at 1,500 °C (2,730 °F). The research evident that Concrete is creating hard surfaces that contribute to surface runoff, which can cause heavy soil erosion, water pollution, and flooding, but conversely can be used to divert, dam, and control flooding. It is also evident that concrete is a contributor to the urban heat island effect, though less so than asphalt. The workers who cut, grind or polish concrete are at the pitfall of inhaling airborne silica, which can lead to silicosis The concrete dust as a by product in demolishing process of building and also of natural disasters like earthquakes can be a prime source of threatening air pollution. The presence of some hazardous matters in concrete, including useful and undesirable additives, are injurious to health due to toxicity and radioactivity. Fresh concrete (before curing is complete) is highly alkaline and must be handled with proper protective equipment.

The evolution in the construction industry introduces several concerns regarding availability of natural aggregate resources, as they are being rapidly depleted. Recent statistics showed the increasing demand of construction aggregate to reach 48.3 billion metric tons by the year 2015 with the highest consumption being in Asia and Pacific. This increasing demand is accompanied by an increase of construction waste. For example, construction waste from European Union countries represents about 31 % of the total waste generation per year (Marinkovic et al. 2010; Ministry of Natural Resources 2010). Similarly, in Hong Kong, the waste production was nearly 20 million tons in the year 2011, which constitutes about 50 % of the global waste generation (Tam and Tam 2007; Lu and Tam2013; Ann et al. 2013). Disposal in landfills is the common method to manage the construction waste, which creates large deposits of construction and demolition waste sites (Marinkovic et al.2010; Tam and Tam 2007; Naik and Moriconi 2005). Efforts to limit this practice and to encourage recycling of construction and demolition waste in different construction applications led to utilizing up to 10 % of the recycled aggregate in different construction applications (Marinkovic et al. 2010; Ministry of Natural Resources 2010; Naik and Moriconi 2005; European Aggregate Association 2010; Cement, Concrete, and Aggregates 2008; Tepordei1999). Therefore, recycling has the potential to reduce the amount of waste materials disposed of in landfills and to preserve natural resources.

The biggest barrier to using recycled concrete has been the variability and uncertainty in the quality and properties of the recycled material and how this variability affects the strength, stiffness and durability of reinforced concrete structures. Kurama's team is trying to develop an understanding of how using recycled concrete affects the behavior of reinforced concrete structures so that buildings using large amounts of recycled material can be designed for safety and to serve their intended purpose without undesirable consequences in performance. "Our initial research studied the variability from 16 recycled aggregate sources in the Midwest and quantified ways to pre-qualify the material for structural applications," Kurama said. "Through a partnership with the University of Texas at Tyler and New Mexico State 11 University, we are now expanding this study to many more sources from the eastern, southern, and southwestern U.S. We are also looking at durability and life-cycle cost, in comparison with natural aggregates, and effects of recycled concrete aggregates in prestressed concrete. Because of the knowledge gap to date, the use of recycled aggregates in the U.S. has been limited mostly to non-structural applications such as sidewalks and roadways, even though the quality of the material is generally significantly higher than is required in these applications. Our ultimate goal is to develop the necessary engineering background and methods for the wider utilization of recycled concrete aggregates in structural concrete, such as in buildings."

Test Result for Compressive Strength

Table A gives the test results of compressive strength at 7, 28 and 56 days. Water cement ratio was kept as 0.37 for all mixes. Super plasticizer used was 0.5% of cement.

Table b gives the percentage reduction in compressive strength for all mixes at different number of days.

Table A Test Results for Compressive Strength

Serial No.	Mix Proportion	W/C ratio	Compressive Strenth in N//mm^2		
			7 Days	28 Days	56 Days
1	M1	0.37	42.12	50.09	51.61
2	M2	0.37	42.42	50.42	51.24
3	M3	0.37	41.78	50.32	51.01
4	M4	0.37	42.50	48.99	50.12
5	M5	0.37	41.01	52.18	53.12

Table B Percentage reduction in compressive strength at different ages

Serial No.	Mix Proportion	Age (in days)	Percentage reduction in compressive strength				
			M1	M2	M3	M4	M5
1	1:1.23:2.52	7	Nil	10	15	22	25
2	1:1.23:2.52	28	0.2	12	10	15	20
3	1:1.23:2.52	56	0.5	14	18	16	18

Conclusions:

The compressive strength of all mixes exceeded at the age of 28 days. Compressive strength of control mix i.e. of m0 is 50.05 N/mm^2 which is greater than the target strength of 48.25 for M40 concrete. Compressive strength of M1 is slightly increased to 50.36. So the compressive strength increases by 0.5%. For M2, compressive strength is increased to 50.20 N/mm^2; it also showed an increase in compressive strength by 0.3%. Compressive strength of m3 is decreased to 49.11N/mm^{2}hat showed a decrease in compressive strength by 1.9%. But in case of m4, there is sudden increase in compressive strength that raises the compressive strength to 52.36 . Compressive strength is increased by 4.5%. So the results of test show that compressive strength does not follow a regular trend from M1 to M5. But from the results it is also concluded that compressive strength never went below the target strength for 28 days. This indicates that RCA can be used as replacement aggregates for compressive strength. From above conclusions it can be said that it is eco-friendly and creative to use demolished concrete in construction of concrete buildings.

In this study, trial castings were done to arrive at water content and desired workability. So it was advisable to carry out trial castings with demolished concrete aggregate proposed to be used in order to arrive at the water content and its proportion to match the workability levels and strengths requirements respectively

REFERNENCES

1. Abou-Zeid, M.N., Shenouda, M.N., McCabe, S.L., and El-Tawil, F.A. (2005). "Reincarnation of Concrete," Concrete International, V. 27, No.2, February 2005, pp. 53-59.
2. Ajdukiewicz, A., and Kliszczewica, A. (2002). "Influence of Recycled Aggregates on Mechanical Properties of HS/HPS," Cement and Concrete Composites, V. 24, No. 2, 2002, pp. 269-279.
3. Bairagi, N. K., Vidyadhara, H. S., and Ravande, K. (1990). "Mix Design Procedure for Recycled Aggregate Concrete," Construction and Building Materials, V. 4, No. 4, December 1990, pp. 188-193.
4. Buyle-Bodin, F., "Influence of industrially produced recycled aggregates on flow of properties of concrete." Materials and structures/ Mate'riaux ET. Construction, Vol. no. 35, September-October 2002,pp 504-509.
5. Chen, H.J., Yen, T., and Chen, K.H. (2003). "Use of Building Rubbles as Recycled Aggregate, "Cement and Concrete Research, V.33, No.1, pp. 125-132.
6. FHWA. (2004). "Transportation Applications of Recycled Concrete Aggregate: FHWA State of the Practice National Review September 2004," U.S. Department of Transportation, Federal Highways Administration, Washington, DC.
7. GTAA. (2007). "Reducing, Reusing and Recycling Terminal 2," Toronto Pearson Today: Terminal 2, Terminal 2 Commemorative Issue, Greater Toronto Airports Authority, and Toronto, ON.
8. Hansen, T.C., and Hedegard, S.E. (1984). "Properties of Recycled Aggregate Concretes as Affected by Admixtures in Original Concretes," ACI Journal, JanuaryFebruary 1984, pp. 21-26.
9. Hendricks, Ch. F., "Use of Recycled materials in constructions", Materials and structures/ Mate'riaux ET. Construction, Vol. no. 36, November 2003,pp 604-608.
10. IS: 456-2000, "Indian Standard Code of practice for plain and reinforced concrete", (second revision), Bureau of Indian Standard, New Delhi. 74
11. IS: 383-1963, "Indian Standard Specifications for Coarse and Fine Aggregate from Natural Sources for Concrete", Bureau of Indian Standard, New Delhi.
12. IS: 516-1959, "Methods of Tests for Strength of Concrete", Bureau of Indian Standard, New Delhi.
13. IS: 10262-1982, "Recommended Guidelines for Concrete Mix design", Bureau of Indian Standard, New Delhi.
14. IS: 2386(Part-1)-1963, "Methods of Test for Aggregate for Concrete (Part-1 Particle Size and Shape)", Bureau of Indian Standard, New Delhi.
15. IS: 8112-1989, "Specification for 43 Grade Ordinary Portland Cement", Bureau of Indian Standard, New Delhi.
16. IS: 4031-1968, "Indian Standard Definitions And Terminology Relating To Hydraulic Cement", Bureau of Indian Standard, New Delhi.
17. Katz, A. (2003). "Properties of Concrete Made with Recycled Aggregate from Partially Hydrated Old Concrete," Cement and Concrete Research, V. 343 No. 5, pp. 703-711.
18. Kumar, Satish (2002), "Design of concrete mix using aggregate from Demolished Concrete", M.Tech Thesis.
19. Lin, Y.H., Tyan, Y.Y., Chang, T.P., and Chang, C.Y. (2004). "An Assessment of Optimal Mixture for Concrete Made With Recycled Concrete Aggregates," Cement and Concrete Research, V. 34, No. 8, pp. 1373-1380.
20. Mehta, P.K. (2001). "Reducing the Environmental Impact of Concrete," Concrete International, V. 23, No.10, October 2001, pp. 61-66.
21. Meyer, C. (2008). "The Greening of the Concrete Industry," 2nd Canadian Conference on Effective Design of Structures, paper #97, McMaster University, Hamilton, ON, 2008.
22. Naik, T.R., and Moriconi, G. (2005). "Environmental-Friendly Durable Concrete Made with Recycled Materials for Sustainable Concrete Construction," International Symposium on Sustainable Development of Cement, Concrete and Concrete Structures, Toronto, Ontario, October 5-7, pp. 277-298.