

**A Review Paper on Use of Recycled Concrete Aggregates in Concrete  
Manufacturing Process***JavedPendhari<sup>1</sup>, Dr.D.N.Shinde<sup>2</sup>,**<sup>1</sup>M.E. (Structures),P.V.P.I.T., Budhgaon.**<sup>2</sup>Department of Civil Engg., P.V.P.I.T., Budhgaon*

---

**Abstract-** Construction industry generates large amount construction & demolition waste. This waste may be in the form of debris & building materials such as broken bricks, mortar, concrete, steel. At the same time foundry industry also generates large amount of waste sand. The foundry sand is sand used for the formation of moulds essential in the casting process. After the completion of its usefulness, it is dumped in open areas or low laying areas. The waste from construction & demolition are also dumped in open land & low laying areas. This process disturbs the environment & pollutes the ground water (SayeedJaved, 1992).

The reuse of this waste will not only reduce the cost of disposal along with land requirement but also be useful in environment by conserving the use of natural aggregate.

---

**Keywords-** Concrete, Natural sand, Natural Aggregates, Recycled Aggregates, Fly ash, Strength.

**“I. INTRODUCTION”**

Concrete is the world's second most consumed material after water, and its widespread use is the basis for urban development. It is estimated that 25 billion tonnes of concrete are manufactured each year. On the other hand over 1 billion tonnes of construction and demolition waste (C&DW) is generated every year worldwide. Crushed concrete is available nowadays in large quantities, which also results from the demolition of old structures and waste concrete from new structures. Every year, it is estimated that 2% to 10% (average of 5%) of the estimated ready mixed concrete produced is returned to the concrete plant which is also of great concern to dispose off.

The use of the recycled aggregates created from construction and demolition waste in new construction has become more important over the last two decades. Waste minimization and reducing the burden on landfills is a global issue. Extensive research has been carried out worldwide on the use of recycled aggregate in concrete. This includes substantial research reports by WRAP4, NRMCA5 and RILEM6. Globally the concrete construction industry has taken a responsible attitude to ensuring its natural resources are not overexploited.

The reuse of hardened concrete as aggregate is a proven technology - it can be crushed and reused as a partial replacement for natural aggregate in new concrete construction.

Recycling construction waste is vital both in order to reduce the amount of open land needed for land filling and to reduce depletion of raw materials. Recycling or recovering concrete materials has two main advantages - it conserves the use of natural aggregate and the associated environmental costs of exploitation and transportation, and it preserves the use of landfill for materials which cannot be recycled.

Many attempts to develop high-grade uses of construction waste, i.e., as aggregate for the manufacturing of new concrete, are made in last few decades. A decrease in the compressive strength was generally observed in all concretes in which the natural coarse aggregate was replaced with recycled aggregate prepared by the crushing of old concrete. In the current paper we are going to study the feasibility of Recycled Aggregate in concrete manufacturing when it is blended with different proportions of fly ash and admixtures. We are going to study strength characteristic of concrete made with optimum proportions of ingredients.

The study will give idea for the effective use of waste concrete which benefits sustainable development by reducing the necessity of land required for dumping waste concrete.

**“II. LITERATURE REVIEW”**

**2.1 Arundeb Gupta, Saroj Mandal and Somnath Ghosh (Department of Civil Engineering, Jadavpur University, India)**

They conducted an experimental investigation to study the mechanical as well as micro structural properties of recycled aggregate concrete (RAC) exposed to elevated temperature.

They found over all degradation of concrete after heating to an elevated temperature it was due to microstructure of concrete which becomes coarser due to high temperature and increase in total pore volume after heating, which leads to higher strain in concrete as well as lower compressive strength.

He concluded that in general RAC sample unheated and after heating at different elevated temperature shows an inferior behaviour compare to natural aggregate concrete (NAC); 10% replacement of cement with fly ash improves the micro structure of the concrete which improves the strength character of recycled aggregate concrete.

### **2.2 M C Limbachiya, A Koulouris, J J Roberts and A N Fried (Kingston University, UK)**

They explored a theme on the need for recycled aggregates and highlights its potential use as aggregate in new concrete construction. The results of an extensive experimental program aimed at examining the performance of Portland-cement concrete produced with natural and coarse recycled aggregates are reported in this paper. Also the effects of up to 100% coarse recycled concrete aggregate on a range of fresh, engineering and durability properties have been established and assessed its suitability for use in a series of designated applications.

Author further derived that it is important to determine density and water absorption of RCA carefully, prior to their use in concrete production. This must be done in order to avoid large variations in properties of hardened concrete as well as in achieving fresh concrete of adequate workability, stability and cohesiveness.

They concluded that RCA concrete mixes possess bulk engineering and durability properties similar to the corresponding natural aggregate concretes, providing they were design to have equal strength.

### **2.3 Nelson, Shing Chai NGO. (University of Southern Queensland)**

He carried out this project to determine and compare the high strength concrete by using different percentage of recycled aggregates. The investigation was carried out using workability test, compressive test, indirect tensile test and modulus of elasticity test. For strength characteristics, the results found a gradually decreasing in compressive strength, tensile strength and modulus of elasticity as the percentage of recycled aggregate used in the specimens increased.

They recommended for further studies, more trials with different particle sizes of recycled aggregate and percentage of replacement of recycled aggregate to get different outcomes and higher strength characteristics in the recycled aggregate concrete.

### **2.4 T.R. Naik, G. Moriconi**

They have advocated the use of sustainable materials and techniques in concrete manufacturing, to reduce the adverse environmental impact created due to the exploitation of natural resources. They say that recycling not only helps in reducing disposal costs, but also helps to conserve natural resources, providing technical and economic benefits. This is sustainability to eliminate waste and take life cycle responsibility /ownership.

Nike et al have recommended that foundry sand can be used as a replacement of regular sand up to 45% by weight, to meet various requirements of structural-grade concrete.

### **2.5 Karthik Obla1, Haejin Kim, and Colin Lobo**

In their project work they advised that use of crushed concrete aggregate (CCA) significantly benefits sustainable development by reducing the necessity of land filling returned concrete and conserves the use of increasingly scarce good quality virgin aggregate. Further they concluded that the compressive strength and elastic modulus of concrete containing CCA is lower than that of the control concrete. However, the decrease in strength is not substantial and the strength drop can be compensated for by normal mixture adjustments to achieve the desired strength.

Author's cost calculations suggest that the concrete producer can achieve considerable savings by using CCA from reduced use of virgin materials and reduced disposal costs. The concrete producer should test the concrete containing CCA for a wide range of properties that are important for the application. If CCA will be used the producer should adopt quality control measures while producing the CCA. They recommend that CCA pile should be kept moist as the CCA should ideally be maintained at a level greater than the saturated surface dry condition.

### **2.6 P. Saravana Kumar1 and G. Dhinakaranin**

In his work he concluded that maximum reduction of 15% in compressive strength in RAC compared with FAC, which is very much acceptable in practice. However, it proved possible, with the help of SP and FA, to produce good quality RAC capable of satisfying the strength requirements for concrete and the SP is a major component in producing good quality RAC.

### **2.7 CCANZ Technical Report**

It is the Best Practice Guide intended to raise the awareness of the need for concrete recycling in New Zealand and to present the technical guidelines to specifiers, contractors, aggregate suppliers, and concrete manufacturers on the use of recycled aggregate in concrete, and on the recovery of concrete aggregate and fines from leftover fresh concrete.

## **2.8 Brett Tempest; Tara Cavalline; Janos Gergely; David Weggel.**

They carried out the study to show that use of recycled aggregates in concrete is both economically viable and technically feasible. In order to elucidate the inhibiting factors, the supply and demand for recycled aggregates were studied in a growing south-eastern metropolitan area.

The study shows that a shortage of field experience with, specifications for, and demonstration of recycled aggregate concrete in North Carolina has delayed acceptance and interest in the material by engineers, contractors and suppliers. Since much of the research and guidance has been centered on RA originating from returned concrete, further research should be conducted to verify the similar performance of demolition waste sourced aggregates.

### **“III. INGRADIENTS”**

**3.1 Cement:** A 43 grade ordinary Portland cement (Brand- Chettinad) confirming to IS: 8112-1989

**3.2 Fine Aggregates:** Locally available natural river sand passing through 4.75 mm IS sieve.

**3.3 Coarse aggregates:-**

**3.3.1 FCA:** Crushed basalt from crushers at Jaysingpur as Fresh coarse aggregates having 20 mm MSA. The coarse aggregate should have maximum fraction of angular shaped stone fragments for concrete manufacturing, are proposed for the experimental testing work.

**3.3.2 RCA:** Break down concrete from cube tests of civil lab of PVPIT, Budhgaon and hardened waste concrete from RMC plant at Jaysingpur crushed, thoroughly washed and sun-dried for two weeks as recycled coarse aggregate for concrete manufacturing.

**3.4 Water:** Potable water available at concrete technology lab at JJMCOE, Jaysingpur.

**3.5 Admixture:** Admixtures are those ingredients in concrete other than portland cement, water, and aggregates that are added to the mixture immediately before or during mixing. Admixtures can be classified by function as follows:

- A. Air-entraining admixtures
- B. Water-reducing admixtures
- C. Plasticizers
- D. Accelerating admixtures
- E. Retarding admixtures
- F. Hydration-control admixtures
- G. Corrosion inhibitors
- H. Shrinkage reducers
- I. Alkali-silica reactivity inhibitors
- J. Colouring admixtures
- K. Miscellaneous admixtures

The major reasons for using admixtures are:

- A. To achieve certain properties in concrete more effectively than by other means.
- B. To maintain the quality of concrete during the stages of mixing, transporting, placing, and curing in adverse weather conditions.
- C. To overcome certain emergencies during concreting operations.
- D. To reduce the cost of concrete construction.

Here in this work the admixtures are proposed to maintain the required slump for the Fly ash blended concrete mixes & to get homogeneous samples.

### **“IV. EXPERIMENTAL SET UP”**

Recycling not only helps in reducing disposal costs, but also helps to conserve natural resources, providing technical and economic benefits. This is sustainability to eliminate waste and take life cycle responsibility or ownership. It is possible to produce good quality RAC capable of satisfying the strength requirements for concrete.

In order to check feasibility of replacing RCA with FCA following test procedures are proposed in the current study.

#### **4.1 Phase I testing:**

A reference sample mix design was prepared for M30 grade concrete.

This sample was checked with replacing Fresh Coarse Aggregates by 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100% of Recycled Coarse Aggregates. 28 day compressive strengths of all mixes are compared with reference concrete and a limitation of replacement of natural aggregate is worked out.

#### **4.2 Phase II testing:**

By using the limitation of replacement of natural aggregate a test sample with RCA is to be prepared and its various properties were tested and compared with Mix designed concrete.

Again samples were corrected with various % (10, 20, 30, 40 ) of fly ash along with admixture if required to maintain constant slump.

The results obtained are to be compared with FCA & RCA concrete.

### **“V. TEST RESULTS”**

**5.1 Phase I Test Results:** Table shows the results of compressive strength of reference sample mix design for M30 grade concrete.

Mix	3 day Strength in MPa	7 day Strength in MPa	14 day Strength in MPa	28 day Strength in MPa
M30	16.07	26.57	32.65	39.88

### **“VI. CONCLUSION”**

Experimental test results show that 28 day strength of design mix M30 is 39.88MPa which is greater than target mean strength of 36.60 MPa.

### **REFERENCES**

- [1] Bureau Of Indian Standards, IS : 2386 ( Part I) – 1963, 11<sup>th</sup> Reprint AUGUST 1997, “Methods Of Test For Aggregates For Concrete Part I Particle Size And Shape.”
- [2] Bureau Of Indian Standards, IS : 2386 ( Part III) – 1963, 11<sup>th</sup> Reprint August 1997, Part I, Specific Gravity, Density, Voids, Absorption And Bulking (Eighth Reprint March 1997 )
- [3] Cement Concrete & Aggregates Australia, “Use of Recycled Aggregates in Construction”, May 2008 : 1-25
- [4] Charles E. Pierce, Larry R. Brown and Samuel Foster. “Engineering Properties of Recycled Organic Aggregate for Controlled Low-Strength Materials”. The university of Wisconsin Milwaukee Centre for By-products Utilization, Second International Conference on Sustainable construction materials and technologies, June 28- June 30, 2010.
- [5] Federal Highway Administration. User Guidelines for Waste and Byproduct Materials in Pavement Construction
- [6] Foundry Industry Recycling Starts Today (FIRST). “Foundry Sand Facts for Civil Engineers”, report for Federal Highway
- [7] Gurpreet Singh, Rafat Siddique. “Abrasion resistance and strength properties of concrete containing waste foundry sand (WFS)”, Construction and Building Materials 28 (2012) 421–426
- [8] H. Merve Basar, Nuran Deveci Aksoy. “The effect of waste foundry sand (WFS) as partial replacement of sand on the mechanical, leaching and micro-structural characteristics of ready-mixed concrete”, Construction and Building Materials 35 (2012) 508–515
- [9] Moulding Sand Mines of M/s. Kedareshwara Associates. “Kedareshwara EIA & EMP report: March 2008, 1-45”.
- [10] Neelam Pathak, Rafat Siddique. “Effects of elevated temperatures on properties of self-compacting-concrete”, Construction and Building Materials 34: (2012) 512–521
- [11] Paul J. Tikaisky Department of Civil Engineering, The Pennsylvania State University, “Proportioning fine foundry aggregates in controlled-low strength materials” Report : F2-2-1 - F2-2-10
- [12] Priyanka A. Jadhav and Dilip K. Kulkarni “an experimental investigation on the properties of concrete containing manufactured sand”. International Journal of Advanced Engineering Technology, IJAET/Vol.III/ Issue II/April-June, 2012/101-104.