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Effect of Recycled Coarse Aggregate and Foundry Sand in Concrete Properties

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Abstract

Reducing the cost of manufacturing concrete, replacing fine sand with foundry sand may be a new trend, and waste foundry sand must be disposed of effectively as an engineering material and reduce pollution. Waste foundry is a by-product in which regular sand is likely to be finely aggregated in partial contracts and provided the opportunity for recycling. The rapid development of the construction trade consumes excessive resources and leads to environmental degradation, paradoxical to the sustainable development of the construction industry and hence the scarcity of resources can be exacerbated. At an equivalent time, a big amount of solid waste is produced within the method of construction of recent buildings every year. Today, the recycling of construction waste has become a standard concern issue and deserves deep researches. It is predicted that recycled aggregate concrete as a way of recycling and utilization of the construction waste can bring respectable economic and environmental edges. This paper identifies the opportunity of consuming waste from the manufacturing and construction industries for construction purposes and constitutes an experimental analysis of the use of foundry waste as a partial re-sand replacement by 10%, by 20%, by 30% and by recycled aggregates by 50%. Concrete mixtures were made, verified and related in terms of strength with the conventional concrete. These tests were dispensed to gauge the strength for 7, 14 and 28 days.

Keywords— *Waste foundry sand (WFS), Recycled aggregate (RA), Compressive strength, Split tensile strength, Flexural strength.*

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I. INTRODUCTION

Some of the key factors in this context are reducing consumption energy and the use of natural raw materials and waste materials. These are the topics significant consideration is being paid nowadays to sustainable development. Use to show the combined potential of reuse in construction as an alternative to primary (natural) waste from construction and demolition waste use. This protects natural resources and reduces the required landfill disposal space. The increasing rate of development and industrialization leads to higher exploitation of natural resources such as river sand and gravel, which sustain sustainability issues. It is now imperative to detect changes in component components of concrete. The waste foundry is a product of the sand molding, ferrous and non-ferrous metal industries. Such a promising material which can be used as an alternative to the natural solidification of sand. In the last few decades, several studies have been carried out to investigate this includes foundry sand as partial and regular replacement sand in concrete. It has been suitable for partial substitution of sand for structural concrete has been identified. The results indicate that most of the properties have been studied in the present paper. Various studies have shown some degree of restoration of foundry sand Increase durability as well as strength properties of concrete but at the same time, the falling value decreases with an increase in the replacement level of the foundry sand of the waste. Much emphasis needs to be placed on the use of waste and by-products in cement Concrete used for new construction. The use of a renewed community is particularly promising at 75 percent the concrete is made of aggregate. In such cases, the total groups considered are slag, power plant waste, recycled concrete, mining and excavation waste, glass, ingredients residues, red mud, burnt clay, sawdust, combustible ash and foundry sand. A large amount of poured concrete is available on various construction sites that are now causing serious disposal problems in urban areas. This can easily happen Use in recycling and concrete as aggregates. There are research and development activities it was taken worldwide to prove its feasibility, financial viability and price effectiveness.

II. LITERATURE REVIEW

Vema Reddy, S. Sridhar [8] has checked the performance of fresh and hard concrete materials that contain foundry sand discarded in place of fine aggregates. They have replaced foundry sand on squares and cylinders with 20% -100%. They conclude that concrete shrinkage decreases with% increase of foundry sand and compaction factor increases with% increase of foundry sand. The compressive strength of concrete has been increased by 13.42% in place of 20% foundry sand as compared to normal sand. They conclude that replacing foundry sand by up to 60% increases the compressive strength of concrete. Filament sand split tensile increases by up to 60% then decreases to 100%. The compressive strength of concrete has been measured instead of sand, replaced by foundry powder, by PranitaBhandari Dr. K.M. Tajne[7]. Up to 100% substitution of foundry sand has been tested. Through this study, they concluded that the compression strength of the concrete on the 28th day gives the maximum force when the sand is changed to 10 % to 20%. Eknath p. Salokhe, DB Desal [10] conducted an experimental study to evaluate the performance of foundry sand in concrete. They conclude that this fall is minimized with the help of foundry waste sand. The density of mixtures with FWS was found to be lower than with FWS. They have tested the compressive strength of ferrous FWS and non-ferrous FWS. They conclude that a 20% penalty combined with a ferrous FWS yields 28 days more power than a non-ferrous FWS. So 0% ferrous FWS is just as powerful as ordinary concrete and both ferrous and non-ferrous FWS have 20% bonding. RafatSiddique [2] presented the results of an experimental test to evaluate the mechanical properties of a concrete mixture in which the fines were partially replaced by the foundry sand used together. Three percent (10%, 20%, and 30%) of the fine community were weighed down by UFS. Tested for the properties of fresh concrete, the tensile strength, elastic strength and modulus of elasticity were determined at 28, 56, 91 and 365 days. Test results have shown a slight increase in the strength properties of plain concrete by including UFS as a partial replacement of micro-aggregate sand and can be used effectively to produce good quality concrete and construction materials. Khatib and Beg [2] inspected fresh and hardened concrete properties containing waste foundry sand (WFS). Instead of 0 to 100% penalty aggregated. Cement to water was kept constant for all mixtures. Testing on hardened assets was mainly conducted at 14, 28 and 56 days. The results show that mixing waste foundry sand into concrete systematically decreases efficiency, ultrasonic pulse speed and strength, and increases water absorption and shrinkage of concrete. Yongja Kim [1]; (i) The ratio of total recycled to total reuse increased The increased efficiency of concrete may be due to the increased proportion of fine particles From the recycling process; (ii) replaced with aggregate recycling aggregate, The compressive strength decreased. The amount of the recycled penalty increased the likelihood of additional replacement Micro total power reduction; (iii) When we replace more than 60% of the micro total, Strength reduction became more significant. VR Ramkumar [9] gives the results show that the elastic strength of concrete with natural aggregate is more than recycled aggregate concrete. However, water and Acid treatment can improve the strength of recycled aggregate concrete. Ayed Ahmed Zuhud; (i) Recycled total weight loss and poor compaction.Due to the nature of the recycled aggregate and its structure, the density of the recyclable aggregate concrete is less than 5.5% of the natural total; (ii) Abuse recycling capacity The total aggregation rate is more than two times; This makes renewable functionality The concrete is low; (iii) Recycled aggregate concrete, using the same amount of cement Provide almost equivalent strength of concrete relative to natural aggregates.

III. Materials and Methodology

Materials

A. Cement

Cement is a binder, a substance that sets and hardens and can bind other materials together. It plays an important role in the construction sector. In this study, the Ordinary Portland Cement (OPC) of 53 grades (Ultratech Cement) is used. The cement used was fresh and without any lumps.

TABLE I. **PHYSICAL PROPERTIES OF PORTLAND POZZOLANA CEMENT**

Properties	Values
Grade of cement	53 (OPC)
Fineness of cement	7.5%
Specific gravity	3.15
Initial setting time	30min
Final setting time	600min
Consistency	28%

B. Aggregate

Aggregation is a natural reserve of sand and gravel and also gives structure to concrete. It occupies about 75% to 80% volume in concrete and therefore has an impact on various properties such as efficiency, strength, durability and economy of concrete. Concrete is often

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used in different sizes to increase the density of the aggregate. Acts as reinforcement and strength for total aggregate content. Taken together, it is well used as a road, railroad and infrastructure.

C. *Fine Aggregate*

In the present investigation, locally available river sand was used as a micro aggregate. The sand was free from clay, silt, and organic impurities. The sieve is collected and without more than one percent rough material is obtained, it is well used as roads, railways and infrastructure. The main function of the micro aggregate is to fill the voids in the coarse particles and also help to create uniformity inefficiency and mixing. Taken together, it is well used as a road, railway and infrastructure.

TABLE II. **PHYSICAL PROPERTIES OF FINE AGGREGATE**

Properties	Values
Silt content	4.76%
Fineness modulus	2.752
Bulking of sand	2.21%

D. *Coarse Aggregate*

Total aggregates with a size greater than 4.75 mm are called rocks. The rugged community is described by its nominal size i.e. 40 mm, 20 mm, 16 mm, and 12.5 mm, etc. 80mm size is the maximum size that can be conveniently used to make concrete. These can be in the form of small broken blocks or gravel that occurs naturally.

TABLE III. **PHYSICAL PROPERTIES OF COARSE AGGREGATE**

Properties	Values
Specific gravity	2.705
Size of aggregate	20mm
Water absorption	1.58%
Impact test	14.54%

E. *Waste Foundry Sand*

Foundry sand is clean, uniformly shaped, high-quality silica sand, used in the foundry casting process. Sand is bound to form molds or patterns used for casting of ferrous (iron and steel) and non-ferrous (copper, aluminum, brass) metals. Shack-out sand from finished metal castings is often retrieved back into the foundry sand process. Foundry sand is uniformly shaped, high-quality silica sand will form a mold for casting of ferrous and nonferrous metals. This sand is thinner than fine sand. Burn foundry sand is often used in the processing of casting metals, waste is collected as foundry sand when it is no longer needed. Such waste foundry sand is useful to solve the problem of demand for fine sand. Replacing fine sand in the building industry can result in low cost, environmentally friendly, low weight and high-resistance concrete results.

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TABLE IV. **PROPERTIES OF FOUNDRY SAND**

PROPERTIES	
State Amorphous	Sub-micron powder
Colour	Black powder
Specific Gravity	2.39 to2.55
Absorption (%)	0.45
Bulk Density	2590kg/m3
Coefficient of permeability (cm/sec)	0.001 to 0.000001

TABLE V. **SPECIFICATIONS OF FOUNDRY SAND**

Mechanical properties	Results
Micro-Deval abrasion loss	<2%
Magnesium sulphate soundness loss	5-15%
Friction angle (deg)	33-40 deg.
California bearing ratio %	4-20

TABLE VI. **CHEMICAL PROPERTIES OF FOUNDRY SAND**

Constituent	Value (%)
$Si0_2$	83.93
Al_20_3	0.021
Fe_20_3	0.950
Ca0	1.03
Mgo	1.77
$S0_3$	0.057
LOI	2.19

F. *Recycled Aggregate*

Recycling is the recycling of materials used to create a new product for use. With the development of advanced infrastructure, the use of natural integration is becoming more and more intensive. Recycled aggregates can be used as replacement products to reduce the use of existing aggregates. Crush and labeled inorganic parts obtained from materials used in buildings or demolition debris contain recycled aggregate materials. Recycled aggregate materials are a reusable way to keep waste away. It is much cheaper than usual.

G. *Water*

Water plays an important as it contributes to the chemical reaction with cement. Water is used for mixing as well as for curing purposes also it should be clean and free from salts, acids, alkalis and other harmful materials. Generally, ordinary water is used for mixing concrete.

H. *Mix design*

Mix design is a process in which the right concrete materials are selected and their proportions are calculated which will create a block of concrete that will meet the needs of the work in the most economical way available. Selection of components is the first step

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behind the goal of obtaining concrete with the desired performance characteristics, the next step is a method called mix design by which material comes in the right combination. The mix proportion was modified by replacing fine aggregate with waste foundry sand (WFS) by 0%, 10%, 20% and 30% and coarse aggregate by 50% of recycled coarse aggregate (RCA) in the range of both. Mix design was carried out manually conforming to IS10262:2009. The mix proportion obtained is as shown in the table.

TABLE VII. MIX PROPORTION

Mix No.	Cement Kg	WFS Kg	CA Kg	RCA Kg	FA Kg	Super Plasticizer
M_0	46.8	0	133.61	0	93.6	0.468
M_1	46.8	9.36	63.29	84.24	84.24	0.468
M_2	46.8	18.72	63.29	84.24	84.24	0.468
M_3	46.8	28.08	63.29	84.24	84.24	0.468

I. The casting of specimens and testing procedure

Cement, sand and aggregate were taken in mix proportion 1:2:2.85 which corresponds to M30 grade of concrete. 0%, 10%, 20% & 30% fine aggregate & 50% of coarse aggregate was replaced by waste foundry sand and recycled aggregate in all the mixes. All ingredients were dry mixed. The required amount of water was added to this dry mixture (W / C = 0.38) and again the whole mixture was made uniform. It is poured into a wet concrete mold that is compacted in both layers by hand and by a vibrator. Samples were easily finished and removed from the vibrator table. Then, a smooth finish was given to create the patterns and then bags were covered.

IV. EXPERIMENTAL TEST RESULT

The study was conducted to find out the influence of waste foundry sand and recycled aggregate on the strength properties of normal concrete. The effects of the following parameters were studied. Compressive strength, Split tensile strength and flexural strength at various percentage replacement of fine aggregate with waste foundry sand and coarse aggregate with recycled aggregate on some of the normal concrete. These samples were removed after 24 hours and transferred to tanks for a period of 7, 14, and 28 days for curing.

A. Compressive strength

Compressive strength tests were performed on cube samples of size 150mm X 150mm X 150mm using a compression testing machine. Three samples per batch were tested with the average strength values reported in the table.

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TABLE VIII. COMPRESSIVE STRENGTH TEST RESULTS

Fig. 1. **Representation of Compressive Strength Values**

B. Splitting Tensile strength

Splitting tensile strength tests were performed on a compression testing machine (CTM) using cylindrical samples of size 150 mm X 300 mm. Three samples per batch were tested with the average strength values reported in the table.

TABLE IX. SPLIT TENSILE STRENGTH TEST RESULTS

Sr. No.	Replacement	Average Split Tensile Strength		
		At 7days (N/mm^2)	At 14 days (N/mm^2)	At 28days (N/mm^2)
1	0%	2.46	3.36	3.75
2	10%	1.19	2.26	3
3	20%	1.1	2.16	2.57
4	30%	1.35	2.16	2.65

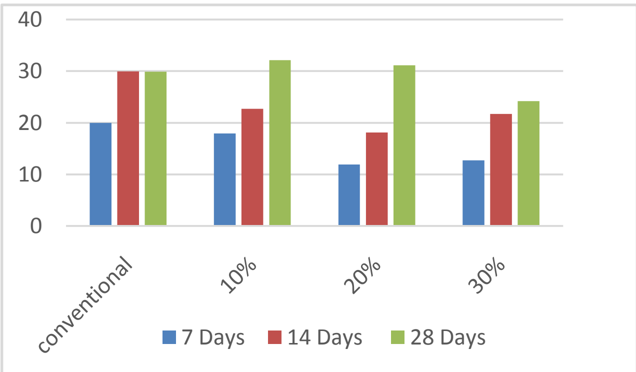

Fig. 2. **Representation of Split tensile Strength Values**

C. Flexural strength

Flexural strength tests were performed on a compression testing machine (CTM) using beam samples of size 150mmx150mmx750mm. Two samples per batch were tested with the average strength values reported in the table.

Sr. No.	Replacement	Average Split Tensile Strength		
		At 7days (N/mm^2)	At 14days (N/mm^2)	At 28days (N/mm^2)
1	0%	5.20		6.34
2	10%	7.06	7.39	7.92
3	20%	6.71	7.13	7.50
4	30%	6.69	7.13	7.60

TABLE X. **FLEXURAL STRENGTH TEST RESULTS**

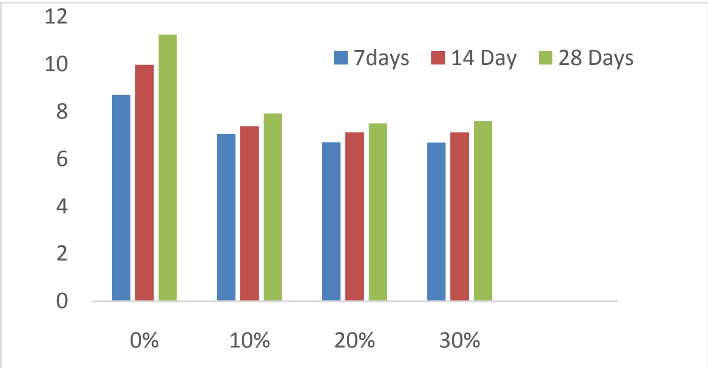

Fig. 3. **Representation of flexural Strength**

Sr. No.	Replacement	Average Compressive Strength		
		At 7days (N/mm^2)	At 14days (N/mm^2)	At 28days (N/mm^2)
1	0%	19.98	29.94	29.88
2	10%	17.9	22.71	32.12
3	20%	11.9	18.12	31.15
4	30%	12.71	21.71	24.18

V. CONCLUSIONS

Waste foundry sand and Recycled aggregates can be effectively used as fine aggregates and coarse aggregates in concrete. Replacement of fine aggregates with foundry sand with a 10% replacement gives maximum strength. The mechanical properties also get negatively influenced if foundry sand is used above 10% along with 50% of recycled aggregates. It gives environment-friendly concrete & helps in preparing green concrete. Using recycled aggregates we can reduce the demolition waste.

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REFERENCES

[1] Han-Young Moon, Yun-Wang Choi, Yong-Kyu Song and Jung-Kyu Jeon, Fundamental properties of Mortar and Concrete using Waste Foundry Sand, Journal of the Korea Concrete Institute, Vol.17 No.1, February 2005, 141-147.
[2] RafatSiddique, Geert de Schutter, Albert Noumowe, "Effect of used-foundry sand on the mechanical properties of concrete", Elsevier, Construction and Building Materials 23 (2009) 976–980.
[3] J. M. Khatib, S. Baig, A Bougara, and C Booth, Foundry Sand Utilisation in Concrete Production, Second International Conference on Sustainable Construction Materials and Technologies, June 28-June 30, 2010.
[4] RafatSiddique and El-Hadj Kadri, (2011), "Effect of metakaolin and foundry sand on the near-surface characteristics of concrete", Construction and Building Materials, vol. 25, pp 3257–3266
[5] Gurpreet Singh and RafatSiddique, Effect of waste foundry sand (WFS) as partial replacement of sand on the strength, ultrasonic pulse velocity and permeability of concrete, Journal of Construction and Building Materials 26 (2012), 416-422.
[6] PathariyaSaraswati C, RanaJaykrushna, ShahaPalas, Mehta Jay, Patel Ankit, "Application Of Waste Foundry Sand For Evolution Of Low Cost Concrete," International Journal of Engineering Trends and Technology(IJETT)- Volume 4 Issue 10 Oct 2013, ISSN 2231-5381
[7] Pranita Bhandari, Dr.K. M. Tajne "Use of Foundry Sand in Conventional Concrete," Volume 2, No 1, 2011 International Refereed Journal of Engineering and Science Volume 2, Issue 2(February 2013), PP.45-53
[8] Vema Reddy Chevuri, S.Sridhar, "Usage of Waste Foundry Sand in Concrete," SSRG International Journal of Civil Engineering (SSRG-IJCE) – volume 2 Issue 12 December 2015.
[9] V.R Ramkumar G.Murali, Flexural behavior of recycled aggregate concrete- an experimental study, International Journal of emerging trends in engineering & development, ISSN 2249-6149, issue-2 volume 4, May 2012.
[10] Jayachandra, Shashikumar.A, Sanjith.J, DG.Narayana, " Strength Behaviour Of Foundry Sand On Modified High Strength Concrete," International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308
[11] Eknath P Salokhe, D. B .Desai "Application of Foundry Waste Sand In Manufacture of Concrete," IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) ISSN: 2278-1684, PP: 43-48
[12] Smit M. Kacha, Abhay V. Nakum, Ankur C. Bhogayata, "Use Of Used Foundry Sand In Concrete: A State Of Art Review," International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308
[13] Uysal Mucteba, Yilmaz Kemalettin, Ipek Metin, "The effect of mineral admixtures on mechanical properties, chloride ion permeability and impermeability of self-compacting concrete", Constr Build Mater 2012;27, pp 263–70.
[14] IS 2720(Part 3). Methods of test for aggregates for—specification. New Delhi: Bureau of Indian Standards.
[15] IS 2386(Part 3):1963. Methods of test for aggregates for concrete: Part 3 Specific gravity, density, voids, absorption and bulking. New Delhi: Bureau of Indian Standards.
[16] IS 2386(Part 1):1963. Methods of test for aggregates for concrete: Part 1 Particle size and shape. New Delhi: Bureau of Indian Standards.
[17] IS 1124:1974. Methods of test for determination of water absorption, apparent specific gravity and porosity of natural building stones. New Delhi: Bureau of Indian Standards.
[18] IS 4032:1985. Method of chemical analysis of hydraulic cement. New Delhi: Bureau of Indian Standards.
[19] IS 10262:2009. Guidelines for concrete mix proportioning. New Delhi: Bureau of Indian Standards.
[20] ACI 209.1 – Guide for Modeling and Calculating Shrinkage and Creep in Hardened Concrete.
[21] IS 13311(Part 1):1992. Methods of non-destructive testing of concrete: Part 1 Ultrasonic pulse velocity. New Delhi: Bureau of Indian Standards.
[22] IS 456:2000. Plain and reinforced concrete code of practice. New Delhi: Bureau of Indian Standards.
[23] CEB-FIP Model Code. Design Code. Comite euro-international du beton; 1990.

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