To Examine Concrete's Mechanical Characteristics Using Demolished Waste and Waste Foundry Sand

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Abstract

This paper deals with the experimentation process of the concrete prepared by the waste materials like waste foundry sand and demolition waste. This waste is increasing in day-to-day life and creates problems in disposal in the form of land pollution. this study shows that the Demolition waste can easily be utilized in the concrete by replacing the coarse aggregate which gives a strength increment of 8.74% in compression. 9..90% in the split and 4.87% in flexural. On the same, hand the waste foundry sand also makes an increment in the strength of the concrete and an average of 3.3% in aspects of all strength. Using waste material in the place of key materials can decrease the cost of concrete also. A reduction of approximately 600INR is seen in the Replacement of Coarse aggregate with Recycled coarse aggregate and 300INR when the replacement of Finer sand is done with Waste foundry sand in the proposed Concrete.

Keywords: Alccofine, Concrete, Demolition waste, foundry sand

1. Introduction

1.1. Reinforced Cement Concrete

Reinforced Cement Concrete is a mixture of Cement, finer aggregate and coarser aggregate bonded to Water which hardens over time. Concrete is the second most used substance in the world after water, is the mostly and commonly used building material. Concrete is a close mixture of binders, fine aggregates, coarse aggregates, and water. It can be easily molded to the desired shape and size before it loses its plasticity and hardens.[1] The reason for the Capacity of concrete is mainly due to the mixture of water and cement. The reason concrete is preferred is that it is a non-flammable material, is refractory and can withstand high temperatures. It is also wind, water-resistant, making it an ideal choice as concrete is used for storm cellars.[2] Cement contains many ingredients for a variety of purposes. The most important and widely available raw material for cement is limestone, which is provided as CaO after heat treatment in a cement plant. The other components are clay and shale, which provide SiO2 and Al2O3. In addition, the Fe2O3 composition also contains a very small amount of iron. Concrete is a type of artificial rock. When mixed with water, cement reacts by hydration to persist over time.

1.2. Waste Foundry Sand (WFS)

Casting sand or Waste foundry sand is a clear, clean, uniform size, enriched in high-quality quartz or sea glass, mainly bonded to form iron (iron and steel) and non-iron composed of copper, aluminum, and brass like metal casting molds. These sands are clean before use, but after casting they may contain the iron (steel) industry, accounting for about 95% of the foundry sand used for casting [3]. The auto business and its providers are the biggest makers of foundry sand. The most usually involved projecting cycle in the projecting business is the sand projecting interaction.[4]. The kind of metal to be projected decides the added substances and sand grains utilized. The crude sand involved represents over 90% of the trim material utilized. Casting sand makes up about 97 percent of this mixture[5]. Chemical bond systems are most commonly used for "cores" (used to create cavities that cannot be created by normal molding operations) and molds for non-ferrous casting. Annual production of foundry waste (including dust and used foundry sand) in the United States is believed to range from 9 million to 13.6 million tonnes (10 million to 15 million tonnes) [6]. Normally, about 1 ton of cast sand is required for each ton of cast iron or steel producedThe sand is combined to form a mold or model used for casting iron (iron and steel) and non-ferrous metals (copper, aluminum, brass). The EPA supports the use of used silica-based cast sand for these casting grades in theapplicationslike As a component of soil-free medium (potting soil); As a road base course, (base course) Foundry is a factory that manufactures castings from metal. [7]Metal is cast into a mold by dissolving it in a liquid, pouring the metal into a mold, allowing the metal to cool and solidify, and then removing the material from the mold. This risk assessment only evaluates silicate-cast sand from iron, steel, and aluminum foundries. In contrast, used foundry sand from lead brass and bronze foundries is often regulated as hazardous waste. The metal casting industry produces used foundry sand as waste. [8]The foundry buys new, unused sand to make the mold, and the sand is reused many times in the foundry. Most of the Waste foundry sand can be safely and economically reused.

1.3. Demolition Waste

Demolition wastes are heterogeneous combinations of constructing substances consisting of aggregate, concrete, wood, paper, metallic, insulation, and glass which are generally infected with paints, fasteners, adhesives, wall coverings, insulation, and dirt. [9]The demolition waste can regularly be reclaimed and reused as aggregates, and potentially (if care is taken at some point of the demolition system) as complete substances - eg the reuse of reclaimed bricks. After a construction is demolished, "quite a good deal all metallic gets recycled," says Moe.[10] Metallic is the maximum recycled cloth withinside the world, with approximately ninety nine percent of structural metallic keeping off landfills. Actually, while construction is demolished a number of cloth may be recoverable a few or now no longer relies upon upon how powerful is demolishing. We can recycle bricks if they're in correct circumstance and may use it due to the fact brick have longer life[11]. The pipes also are recoverable if they're of solid iron. Now a days a extensive location of studies is being completed on recycling of concrete and its reuse. Many of the researchers used distinctive chemical substances to enhance the energy of used aggregates and cause them to capable of reuse.

2. Methodology..

For the experimental Study the Material are chosen on the basis of the properties listed in the Table 1.

Table 1 Properties of Material

Properties	Values
Cement (Specific Gravity)	3.13
Finer Aggregate (Specific Gravity)	2.65
Coarser Aggregate (Specific Gravity)	2.74
Admixture (Specific Gravity) (By Supplier)	1.08
Waste Foundry Sand (Specific Gravity)	2.4
Alccofine (Specific Gravity) (By Supplier)	2.9
Demolition Waste (Specific Gravity)	3.2
Cement (fineness)	99%
Finer Aggregate (fineness)Supplier	3.02
Coarser Aggregate (fineness)	8.01
Waste Foundry Sand (fineness)	93%
Cement (Setting Time)	30min, 680 min
Demolition Waste (fineness)	6.9
Maximum Size of Aggregate	20mm
Strength of Concrete Before Demolition (Demolition Waste)	35N/mm^2

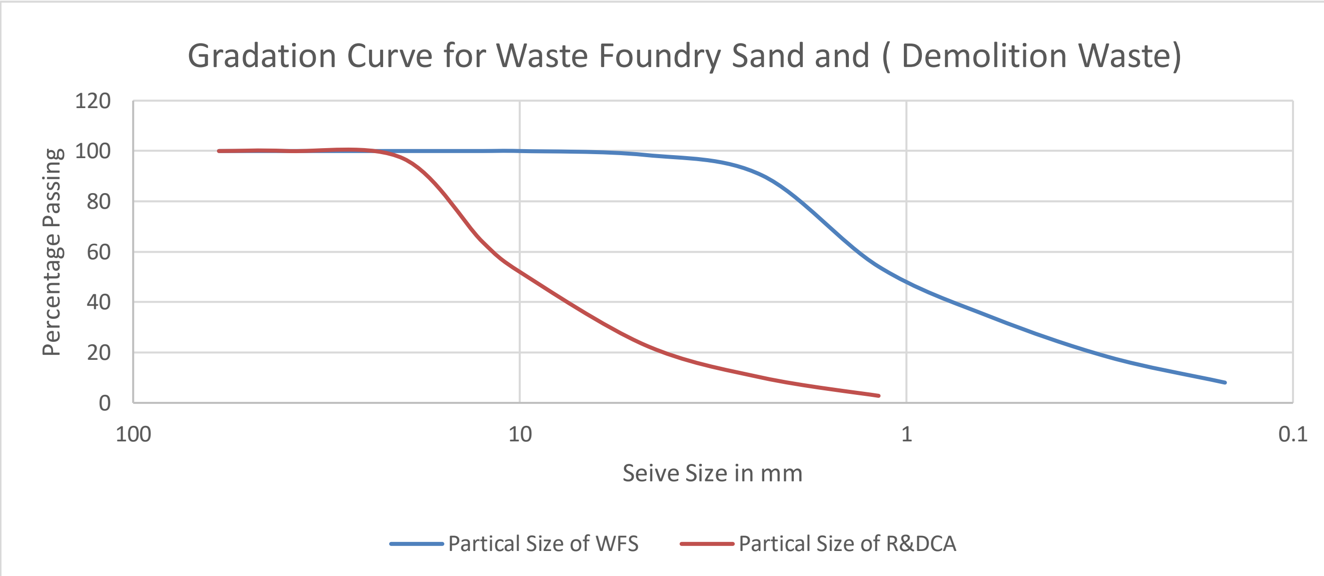

Figure 1 Gradation Chart for WFS and Demolition Waste

Gradation of the WFS and demolition waste is helpful in finding the replacing particle size i.e. WFS has the particle size similar to sand and Demolition waste aggregate has approximate size matching to Coarser aggregate. The concrete grade M50 is designed with Ratio 1:1.62:2.42 with a water-cement ratio as 0.36. Alccofine is used as 10% replacement to cement due to strength purposes. Alccofine helps in the increment in the Strength of Concrete[16].

Table 2 Mix Design M50

Ratio Designation	w/c	Cement	Alccofine	Water	admixture	Sand	Coarse aggregate
A.0	0.36	396	44	155	2.2	719	1069

*all values in Kg/m^3

The prices of the Constituent Materialswere taken from the Schedule of Rates given by the State Government of Punjab To the Public Works Department. The rates are also taken from local markets of the Mohali District. Only transportation cost is included for rates of Demolition waste and WFS. Rates are summarized in table 3.

Figure 2 a. Gradation of Demolition Waste b. Mix Sample

Table 3 Cost of Key Material

Cement	Water	Admixture	Sand	Coarse Aggregate	Demolition Waste	WFS	Alccofine
8	1	70	5	2.5	1	7	25

*Cost in Rs per Kg

For the experimental study, the coarser aggregate is being replaced by recycled and demolition coarse aggregate from 0% to 100%. Quantities for replacement are Shown in table 4 Studying the behavior of recycled and demolition coarse aggregate gives us the conclusion that water absorption is more than the normal coarser aggregate.

Table 4 Mix Design RCA Addition

Ratio Designation	Coarse aggregate		RCA	
A.R1	90%	962.1	10%	106.9
A.R2	80%	855.2	20%	213.8
A.R3	70%	748.3	30%	320.7
A.R4	60%	641.4	40%	427.6
A.R5	50%	534.5	50%	534.5
A.R6	40%	427.6	60%	641.4
A.R7	30%	320.7	70%	748.3
A. R8	20%	213.8	80%	855.2
A.R9	10%	106.9	90%	962.1
A.R10	0	0	100%	1069

*all values in Kg/m^3

Study of replacement of recycled and demolition coarse aggregate by Coarser aggregate gives us some percentage of optimum Strength on that optimum percentage the sand replacement is done by Waste Foundry Sand from 0% to 100% and the optimum percentage is taken from the Strength Parameters. Quantities are shown in table 5.

Table 5 Mix Design of MSF Addition

Ratio Nomenclature	Sand		Waste Foundry Sand	
A.W1	90%	647.1	10%	71.9
A.W2	80%	575.2	20%	143.8
A.W3	70%	503.3	30%	215.7
A.W4	60%	431.4	40%	287.6
A.W5	50%	359.5	50%	359.5
A.W6	40%	287.6	60%	431.4
A.W7	30%	215.7	70%	503.3
A.W8	20%	143.8	80%	575.2
A.W9	10%	71.9	90%	647.1
A.W10	0	0	100	719

*all values in Kg/m^3

3. Results

The achievement of Target mean strength from the mix design of Grade M50 is achieved with the nominal mix design. All the testing are done with the testing procedure given in the IS 516 and 5816 [17], [18]. Results are mentioned in the Table 6.

Table 6 Results of M50 Mix Design

Ratio Nomenclature	Compressive Strength Test Results	flexural Strength Test Results	Split tensile Strength Test Results	Cost
A.0	58	5.93	5.95	9953.56

*all Strength Values in MPa and Cost in rs per M^3

After getting the proper strength of the concrete is further analyzed replacement of Coarse aggregate and sand.

Table 7 Results RCA Addition

Ratio Nomenclature	Compressive Strength Test Results	flexural Strength Test Results	Split tensile Strength Test Results	Cost
A.R1	59.40	6.07	6.09	9793.21
A.R2	60.52	6.18	6.21	9632.86
A.R3	62.74	6.41	6.44	9472.51
A.R4	61.50	6.28	6.31	9312.16
A.R5	60.64	6.19	6.22	9151.81
A.R6	59.90	6.12	6.14	8991.46
A.R7	58.05	5.93	5.95	8831.11
A.R8	57.43	5.87	5.89	8670.76
A.R9	55.82	5.70	5.73	8510.41
A.R10	54.34	5.55	5.57	8350.06

*all Strength Values in MPa and Cost in rs per M^3

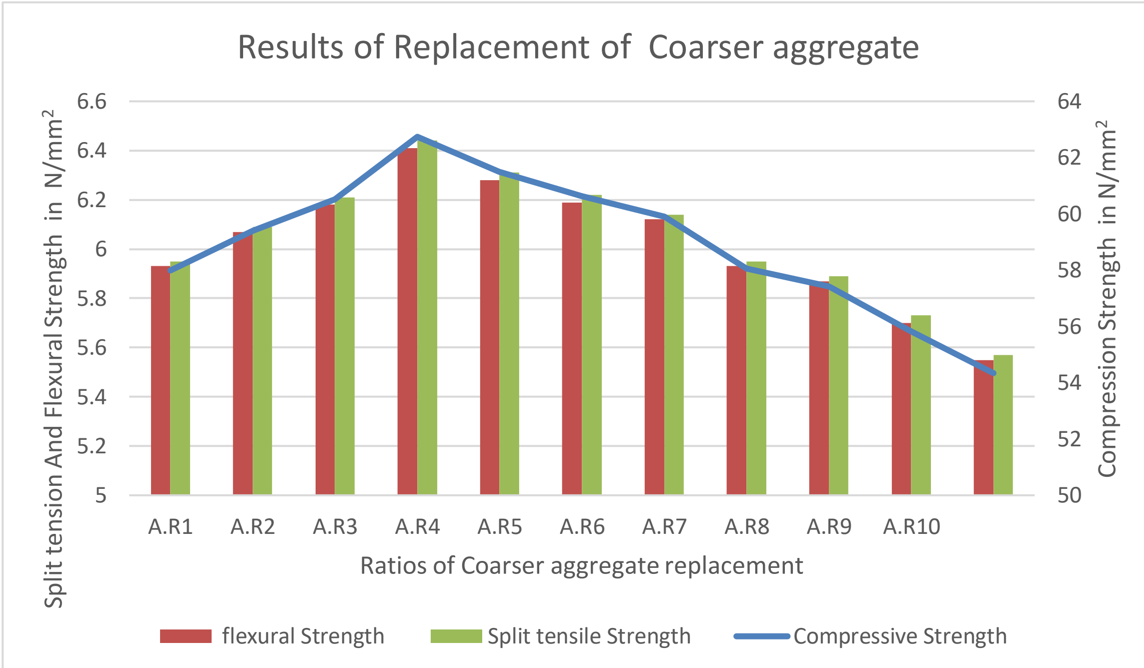

Figure 3 Results RCA Addition

The addition of coarse aggregate makes a good and satisfactory increment. Due to the presence of debris particles attached to the surface of the aggregates fills the voids of concrete. The debris particles are generally a bond mix ofcement and sand which absorbs water and decreases the strength of concrete. It is seen that after 30% replacement of Coarse aggregate the strength starts decreasing. The increment of 8.17 % in compression is seen at 30% replacement. 4.87 % in flexural and 10% in split tension strength increment of the concrete is analyzed at the same percentage shown in Figure4 and table 7.

Table 8 Results WFS Addition

Ratio Nomenclature	Compressive Strength Test Results	flexural Strength Test Results	Split tensile Strength Test Results	Cost
A.R3	62.74	6.41	6.44	9472.51
A.W1	63.20	6.46	6.48	9366.12
A.W2	64.00	6.54	6.57	9259.74
A.W3	64.80	6.62	6.65	9153.35
A0W4	65.20	6.66	6.69	9046.97
A.W5	64.50	6.59	6.62	8940.58
A.W6	63.20	6.46	6.48	8834.2
A.W7	62.60	6.40	6.42	8727.81
A.W8	61.50	6.28	6.31	8621.43
A.W9	61.10	6.24	6.27	8515.04
A.W10	60.70	6.20	6.23	8408.66

*all Strength Values in MPa and Cost in rsper M^3

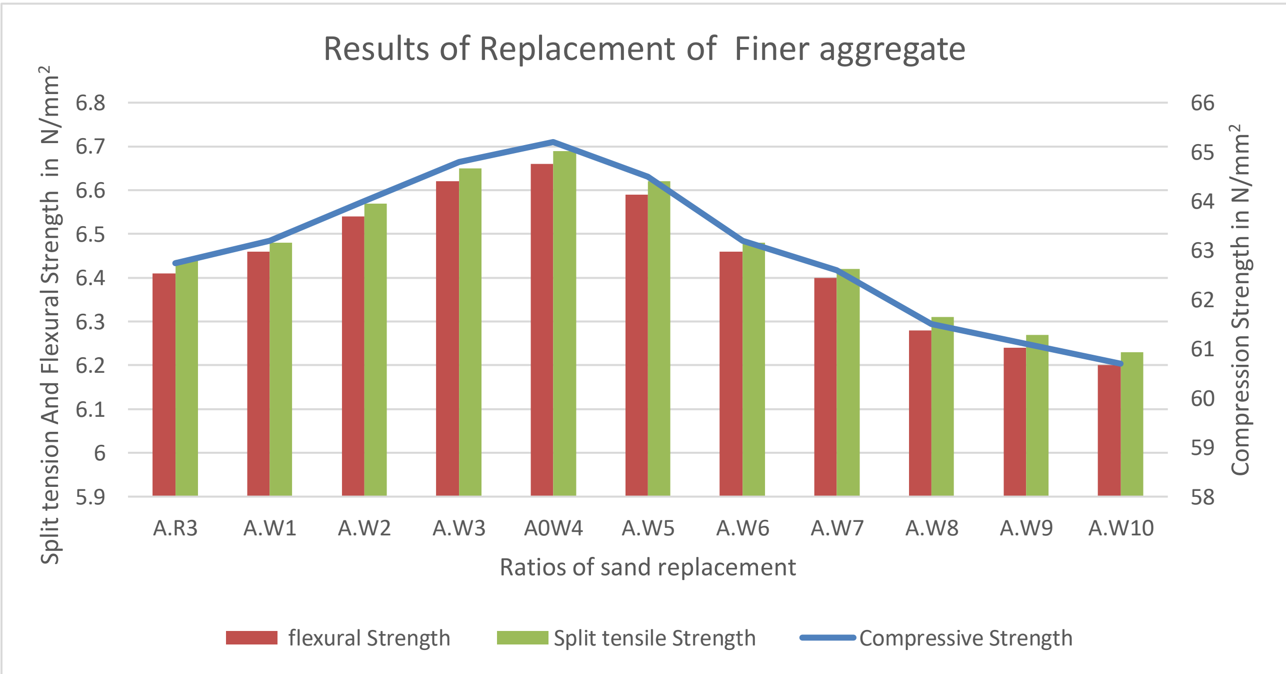

Figure 4 Results replacement of Fine Aggregates

The additionof waste Foundry sand in the place of Finer aggregate in M50 Grade of Concrete makes a good increment up to 40% Shown in Table 8 and Figure 5after that the strength of the concrete decreases due the towaterabsorptiondemand in the waste foundry sand.The fineness and metallic structure of WFS provides help in making good bonds between the Concrete materials.

4. Conclusions

- 30% addition of RCA gives a good increment of 9% in compression 7% in Flexural and 10% in Split tension strength. RCA Decreases the strength after 30% due to water absorption behavior.
- 40% addition of waste foundry sand gives an approximateincrement of 4% in the overall strength of the concrete. Due to the water absorption capacity of the waste foundry sandstrength starts decreasing after 40% replacement.
- Use of WFS and RCA makes a total increment of 12 % in Compression 11% in flexural and 15% in spilt tension.
- Use of WFS and RCA contributes to the reduction of environmental pollution

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