The Experimental Analysis on Utilization of Waste Foundry Sand for Fine Aggregates Replacement and Debris for Cement Replacement for Sustainable and Economical Concrete Using Master Glenium 51

Raman Salgotra and Prince Sharma

February 24, 2023

The Experimental analysis on Utilization of waste foundry sand for fine aggregates Replacement and Debris for cement replacement for sustainable and economical concrete using Master Glenium 51

RAMAN SALGOTRA[a], PRINCE SHARMA[b]

[a]M.E Scholar, Department of Civil Engg. Chandigarh University, Mohali

[b]Asst. Professor, Chandigarh University, Mohali

ABSTRACT Waste foundry sand stays a derivative of metal casting of ferrous besides nonferrous metals and it has high silica content which can be castoff in construction material to gain high strength Concrete debris is a problem for the environment as its disposal is tedious. Thus an attempt is made to contribute to reduce the total environmental impact of the construction area by recycling it. This experimental study contributes towards the replacement of debris with cement at 10%, 20%, 30%, 40% and waste foundry sand as a fractional alternative with fine aggregates at 5%, 10%, 15% and 20%. Master Glennium 51 is adopted as a superplasticizer to augment the quality of concrete. The final test results indicates that 10% foundry sand and 30% of debris indicates better results with 1% use of master glennium 51. This study is done in order to utilise the waste product in concrete to save the environment.

KEYWORDS. Master glenium 51, Economical Concrete, Waste Foundry Sand,Debris

1 Introduction

1.1 Waste Foundry Sand

There are mainly two sorts of foundry sand available namely Greensand and Waste silica sand. The properties of Waste silica sand or Waste foundry are nearly equal to sand so it can be the better option for replacement. In the industrial sector waste foundry sand stays a chief waste as metal moulding is a primary process. [1] studies the consequence of Waste Foundry Sand on cement concrete and the test

Figure 1 Waste foundry Sand

results reveals that use of WFS is economical as target strength is achieved at low cost. [2]. studies the impact of WFS on concrete. The test results indicate that 40% of WFS replacement is optimal as it enhances the compressive as well as tensile strength of concrete. [3]**.** studies the impact of industrial waste and impact of WFS on concrete, the test results reveals that there is a substantial increase in mechanical properties of concrete. The flexural strength increase up to 15% when WFS is used in concrete[4]. [5]studies the concrete with debris and WFS, test results reveal that there is a decrease in the compressive force of concrete after a particular replacement percentage.

1.2 Master glennium

Master Glennium 51 is the best superplasticizer as it provides high early strength, high workability, and high plasticity without triggering bleeding by reducing water demand. It is basically an innovative admixture based on the modified polycarboxylic ether. Provided by BASF.

Figure 2 Master Glennium

1.3 Debris

Concrete debris is the waste generated when any structure is demolished like flyovers, buildings, bridges, subways, etc. Concrete could even be a versatile artifact yet it's a shortcoming that it's a brittle material with a rather poor modulus of rigidity and has low crack endurance failing at low strain[6]. But can be reutilized in various ways in the Concrete like by replacing sand and Coarse aggregate. Using Debris Can make a good saving in the constituent material of the concrete because it is cable to replace all the material due to its pozzolanic action[7]. Due to the lack of land in urban areas highrise are constructed which results in the Production of demolition waste which is increasing at rapid rate.

Figure 3 Uncrushed C&D Waste

2 Methodology

The materials adopted for the investigation are OPC cement as a binder, fine aggregates, coarse aggregates, Debris for fractional substitute of cement in the concrete and for same at optimum percentage of Strength waste foundry sand as a fractional substitute of concrete, and Master Glennium is chosen as a superplasticizer to achieve targeted strength of concrete. The investigation is done on M50 grade of concrete as an objective to achieve optimal strength on high grades of concrete.

Figure 4 Prepared Specimens

2.1 Material testing and analysis

Numerous tests conforming to IS 456:2000 and IS 10262:2019 were conducted to prepare mix design of concrete before examining the mechanical and physical properties of concrete. The preliminary test result indicates that setting time of cement is **31 min** initial and **568 min** final. Consistency test of cement shows the value of **27.5%** and fineness of **98%**. This values are taken from experiments done on cement in references of IS8112 [8]Le chatlier apparatus is used to test the soundness of cement which shows a value of **1mm**. Specific gravity test results indicates that the specific gravity of cement is **3.13** and that of debris is **2.70**, whereas coarser aggregates and finer aggregates shows the value of **2.72** and **2.64** and **2.36** for waste foundry sand. The sieve analysis is done and as per IS 383[9], the sand is classified as zone 2 based on test results. The water absorption of coarse aggregate and fine aggregate is **0.5%** and **1%** and **0.7%** for waste foundry sand. Specific Gravity of the RCA is found to be 2.35 and fineness modulus was found to be 6.9. but the debris particle which is used in the analysis is by passing by 90 micron sieve.

The water cement ratio for nominal mix is adopted as **0.33** which is less than the maximum allowable as per IS 10262:2019 as **0.45.** The method of mixing adopted was hand mixing. Master glennium as a superplasticizer used having specific gravity of **1.1**(Mentioned By BASF). brown liquid. Gives slump incrementation of **120** to **160mm** in **1%** addition depending upon the properties of other materials. The fineness modulus of natural fine aggregates is **2.58** and **1.03** for waste foundry sand. The test for WFS are done are of Sand due to matching particle size.

2.2 Preparation of M50 Grade Concrete

The Concrete Grade of M50 is prepared in accordance with IS10262 and IS 456 [10], [11]. The following quantities are finalized by multiple iterations. The Ratio Of designed Concrete is 1:1.75:2.72:0.33 in the Form of Cement:Sand:Aggregate:water.

Table 1 M50 Mix Design

Material	Quantity in kg per metric cube
Cement	435
Sand	765
Aggregate 20 mm and less in equal proportion	1187
Water (w/c=.33)	144
Admixture 1%	4.35

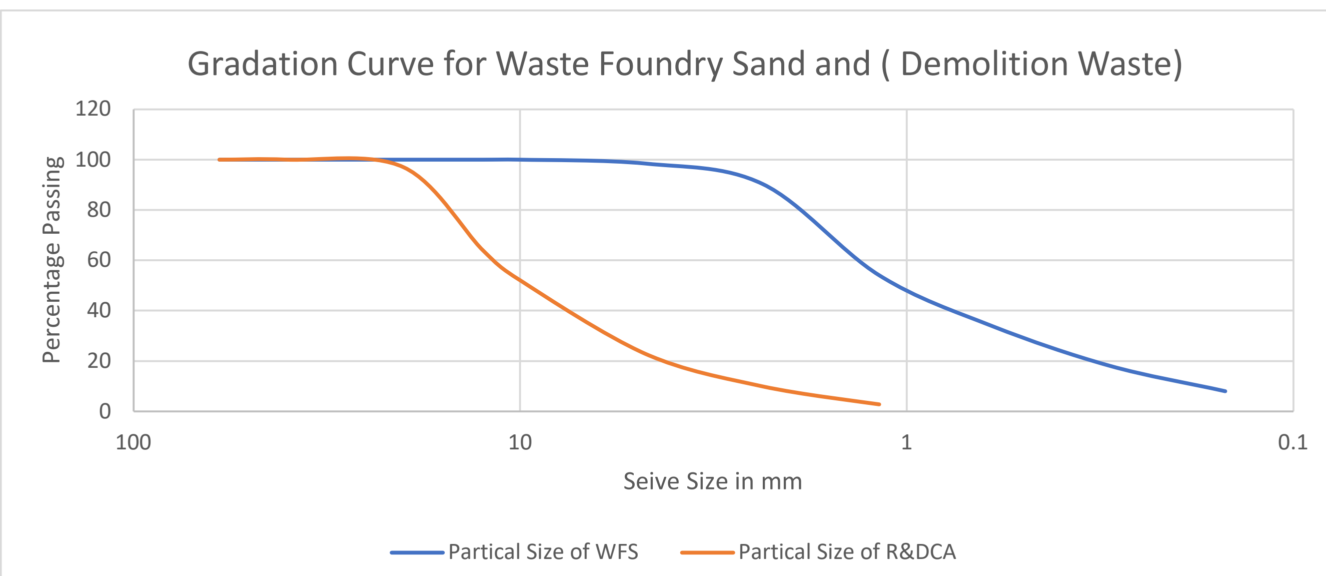

Figure 3 Gradation for WFS and RCA

Gradation of the materials Shows Different Size of WFS and RCA By which they can be Selected and used for the Replacement of key materials depending on the particle size .For Debris the replacement ratios are taken from 0% to 20% in the gap of 5%. Shown in table 2 The debris normally used in concrete is in the replacement of Coarse aggregate. Previous studies show that debirs may be a good replacement of Cement.

Table 2 Quantities for Debris Treatment

Percentage of Debris	Quantity of Cement Per metric Cube	Quantity of Debris per metric Cube
0	435	0
5	413.25	21.75
10	391.5	43.5
15	369.75	65.25
20	348	87

This trend is also followed for the sand replacement with fine aggregate. Quantities are given in table 3 Because waste foundry sand has been a good replacement in the previous studies [12].

Table 3 Quantities for WFS Treatment

Percentage of WFS	Quantity of Sand Per metric Cube	Quantity of WFS per metric Cube
0	765	0
5	726.75	38.25
10	688.5	76.5
15	650.25	114.75
20	612	153

3 Experimental Investigation and Results

The experimental investigation encompasses four segments. In the initial phase, optimal percentage of master glennium is achieved with suitable proportions. In the second phase, debris is replaced with cement in multiple proportions discussed below. The third phase consists of a fractional substitute of natural fine aggregates substituted with WFS. The detailed investigation stays discussed below:

3.1 Addition of Master Glennium 51

The mix design is adopted as per IS 10262:2019 and IS 456:2000 provisions were followed wherever required. Initially, to obtain the optimal value of master glennium, it is used in three proportions 0.8%, 1%, and 1.2% in addition to the weight of cement. Furthermore, compressive strength for different admixture content test results are Discussed in Table 4

Table 4 Results of Addition of Admixture

Master Glennium 51 proportion	Compressive Strength achieved (28 days)
0.8%	52.62 MPa
1%	57.36 MPa
1.2%	59.26 MPa

From the above table, it clearly indicated that 1% of master glennium addition is optimal and the target mean strength as per IS 10262:2019 is 58.25 MPa when Designed for M50 and experimentally the achievable value is 57.36 MPa which is in the range as per code. Thus, 1% master glennium value is optimal and it is adopted for further investigations.

3.2 Replacement of debris with cement

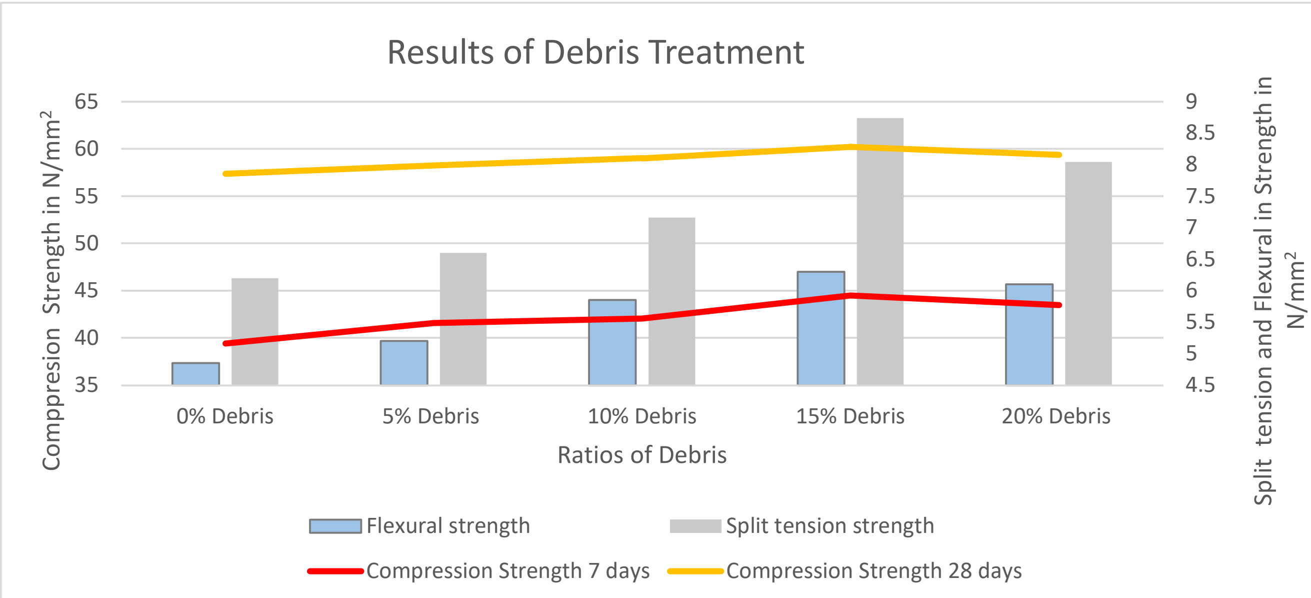

Figure 4 Results of Debris treatment after 28 Days Curing

The debris obtained is first screened through fine sieve analysis and then the particle passing 90-micron sieve is used for replacement with cement. To obtain the best results, recycled crushed cement debris is replaced with OPC at 5%, 10%,15%, and 20%, replacement . results in Figure 4 Compression, tensile and flexural tests were conducted, and test results indicate that 15% replacement is an optimal contrasting upsurge in flexural strength and less decrement in compressive strength. The increase in the Strength is due to the presence of high pozzolanic action in the debris[13]. This debris particle may be not finer but posses high pozzolanic action which gives a good Strength increment at 15% but due to water absorption in the Debris particle which is higher than the other key materials the strength starts decreasing. Debris doesn't make much change in strength but it can save the quantity of Cement used in mix design.

3.3 Replacement of Waste foundry sand with Fine aggregates

From section 3.2. it is found that 15% replacement is optimal. The same concrete is further adapted for partial substitution of waste foundry sand to enhance the compressive properties of concrete. The various proportions adopted for replacement are 5%, 10%, 15%, and 20% of fine aggregates. The analysis results are shown in the figure 5. after the successful investigation and achievement of the test results, it can be concluded that 10% waste foundry sand shows optimal results as there is a surge in mechanical properties of concrete viz. compressive, flexural, and tensile. The replacement of 10% WFS makes water scarcity in the concrete because of its water-absorbing nature which creates the workability problem in the proposed concrete.

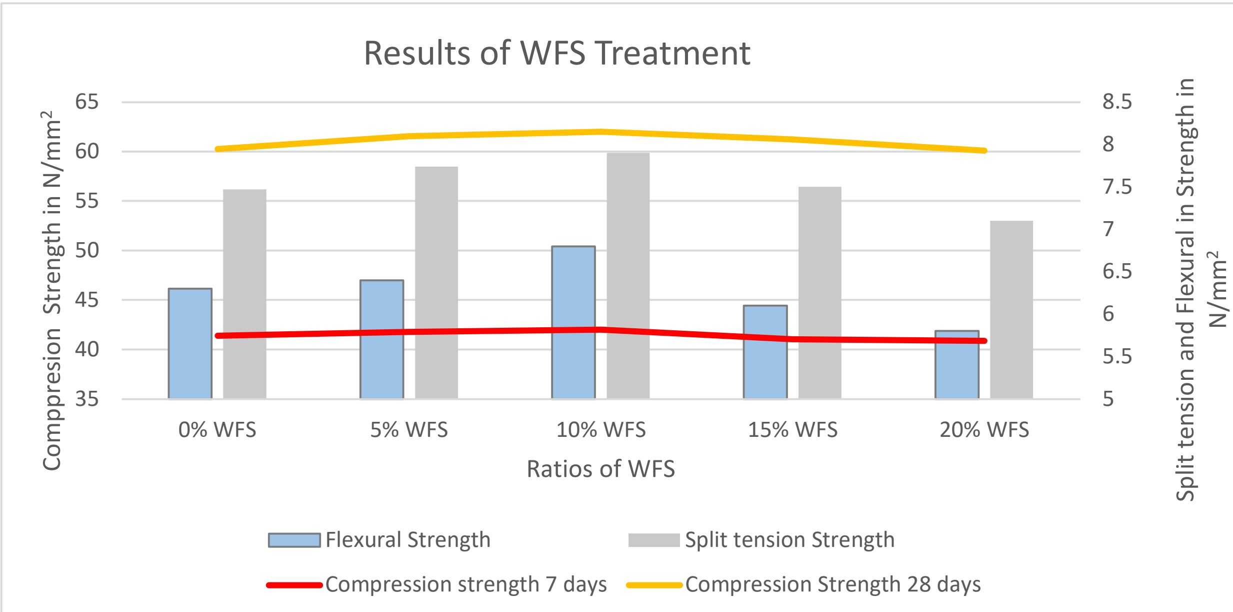

Figure 6 Results of WFS treatment

4 Conclusion

From the investigation conclusion can be drawn are:

1) Master glennium 51 can be used optimally at 1% addition by weight of cement which helps us to reduce W/C ratio and Increase the Workability of the Concrete.
2) Debris shows better results when partially replaced with cement by 15% only After that due to water absorption capacity and lack of Binding capacity strength decreases but helps to achieve economical construction practice.
3) The 10% substitution of WFS with natural aggregates shows optimal results. After that strength Starts decreasing Due to Water absorption Capacity. Water requirement of the WFS is more than the Sand for same Quantity so it cannot be used beyond 10% when already 15% Debris is used in the place of cement.
4) Use of waste product in the concrete can make a good contribution towards saving and preserving environment.

REFERENCES

[1] A. Abasaheb Bandal ., "Utilization Of Waste Foundry Sand In Conventional Concrete," 2020, [Online]. *Journal of Materials in Civil Engineering*, vol. 32, no. 4, , Apr. 2020, doi: 10.1321/(asce)mt.1943-574.02543.

[2] T. Sravani, , "Experimental Study on Partial Replacement of Fine Aggregate with Waste Foundry Sand in Concrete." May2020 , *Procedia Engineering. Vol 34*

[3] S. S. Amritkar, S. N. Chandak, S. S. Patil, and R. A. Jadhav, "Effect of Waste Foundry Sand (WFS) on the Mechanical properties of concrete with artificial sand as Fine Aggregate." *IOP Conference*

Series: Earth and Environmental Science, Dec. 2020, vol. 789, no. 10 doi: 10.1098/255-13689/889/1/01250.

[4] A. Bolshakov, "Characterization of foundry sand waste Laser Ablation Molecular Isotopic Spectrometry (LAMIS) View project," 2019 International Journal of Current Engineering and Technology," 2015. [Online]. Available: http://inpressco.com/category/ijcet

[5] V. Srivastava, P. Pandey, and A. Harison, "Utilization of Waste Foundry Sand as Partial Replacement of Fine Aggregate for Low Cost Concrete International Journal of Current Engineering and Technology," 2015. Vol 12 [Online]. Available: http://inpressco.com/category/ijcet

[6] H. Vani and S. Arora, "Experimental Study Of High Strength Concrete Prepared By Bagasse Ash, Debris, And Polypropylene Fiber," *International Journal of Advance Science and Technology*, vol. 29, no. 10S, pp. 5231–5242, 2020.

[7] H. Vani and S. Arora, "Experimental study of concrete prepared by kota stone dust, bagasse ash, and recycled concrete," in *IOP Conference Series: Earth and Environmental Science*, Dec. 2021, vol. 889, no. 1. doi: 10.1088/1755-1315/889/1/012040.

[8] IS: 8112- 2013, "Ordinary Portland Cement, 43 Grade," *Indian Standard*, no. March, 2013.

[9] IS 383: 2016, "Coarse and fine aggregate for concrete - specification (third revision)," *Indian Standard*, vol. third edit, no. January, 2016.

[10] IS 10262:2019, "Concrete Mix Proportioning — Guidelines," *Indian Standard*, no. January, 2019.

[11] IS 456:2000, "Plain And Reinforced Concrete - Code Of Practice," *Indian Standard*, no. July, 2000.

[12] G. Anusha, and D. Mallika, "Experimental Study on Partial Replacement of Fine Aggregate with Waste Foundry Sand in Concrete." *Journal of Materials in Civil Engineering*, vol. 30, no. 4, p. 04018046, Apr. 2018, doi: 10.1061/(asce)mt.1943-5533.0002233.

[13] T. U. J. Ganiron, "Recycling Concrete Debris from Construction and Demolition Waste," *International Journal of Advanced Science and Technology*, vol. 77, pp. 7–24, Apr. 2015, doi: 10.14257/ijast.2015.77.02.