Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 12, Issue 6, June 2021: 1336-1339

Evaluation Of Impact Toughness Behavior Of Concrete Replacing Ingredients With Admixtures

M.Soundararajan[a], K.Prakash[b], S.Thirumurugan[c]

[a,b,c]Assistant professor, Department of Civil Engineering, Sona College of Technology, Salem, India

***Corresponding author:** soundarcivil@gmail.com

Abstract

Utilization of artificial aggregates and waste products are more prevalent nowadays. Many attempts and researches were made to justify the use of byproducts will be a viable solution than using natural resource in buildings. In the present study, aiming high performance concrete mix with ferro slag aggregates were replaced partially with coarse aggregate by 50% and 100% and its impact strength is evaluated systematically. The test results shows that replacement of ferro slag aggregate records a better value than normal aggregates. 100% replacement of aggregates shows comparatively higher value than control concrete mix.

Keywords: coarse, impact strength, aggregates, high strength, ferro slag

1. Introduction

In general, concrete is a heterogeneous mixture of binder, fine aggregate, coarse aggregate and water in a definite proportion. High performance concrete is generally provides high strength. In such case the normal material used for concreting should be revised or altered such that the performance of concrete can be increased. By using alternative material, the utilization of natural resource can be reduced. The use of industrial by-products as a partial substitute for aggregates would increase concrete efficiency. Even though high strength concrete provides good strength to the concrete, specifically when such concrete are subjected to adverse condition like impact loading (1) or chemical attacks their performance is lowered. In order to address such conditions, alternative materials such as byproducts of industrial waste (ferro slag) will be a viable solution. In the present study, ferro slag is blasted into 12.5mm aggregates and it is partially replaced by 50% and 100% in the total volume of coarse aggregate. Evaluations of the impact strength of these concrete mixes were experimentally assessed and toughness values are evaluated systematically (5,6&7). The test result shows that introducing ferro aggregates into the concrete will enhance its impact strength than conventional materials.

2. Material used

The following materials are used for experimentations and evaluation for the entire study.

2.1. Cement

Ordinary 53 grade Portland cement is used and its properties are set out in Table 1.

Table 1: Properties of cement

S. No	Description	Values
1	Initial setting time	110 minutes

2	Consistency	29%
3	Specific gravity	3.15
4	Fineness (by sieve analysis)	4.60 %

2.2. Aggregates

Aggregates are used from the local available resources. Particles of size lesser than 4.75mm are used as fine aggregate (river sand available in the market). Gravel, which is more than 4.75 mm in size, is similarly used as coarse aggregates. Table 2 and Table 3 list the properties of fine and coarse aggregates. Ferro slag is a byproduct of industrial waste during the manufacture of iron. This slag is gathered and blasted into 12.5mm in the molten state, which is used in this analysis as a partial substitute for coarse aggregate(8-9).

Table 2: Properties of coarse aggregate

S. No	Description	Values
1	Abrasion Value	26.5
2	Bulk Density	1653.06 kg/m³
3	Fineness modulus	6.98
4	Cushing Value	26.5
5	Specific gravity	2.73
6	Water absorption	1.00%
7	Impact Value	25.3
8	Surface moisture	0.086%

Table 3: Properties of fine aggregate

S. No	Description	Values
1	Fineness modulus	2.93
2	Bulk Density	1.67 g/cc
3	Water absorption	0.5%
4	Specific gravity	2.65

2.3. Water

Laboratory available portable water is used.

3. Concrete Mix Details

Theoretically a mix design is arrived targeting strength of M60 grade of concrete. In the total quantity of coarse aggregate, ferro slag is replaced by 50% and 100% and its impact strength is systematically evaluated.

4. Testing Details

Concrete circular slabs of 0.4 m diameter, 0.04 m thickness were cast with 50 percent and 100 percent replacement of coarse aggregate with ferro slag aggregate for control concrete and concrete for control concrete. A weight of 4.75kg is made to free fall from a height of 1m over the slab. The slab sample is mounted in a metallic base that holds the sample in a restrained position such that the specimen itself can fully absorb the energy exerted on the sample (2).

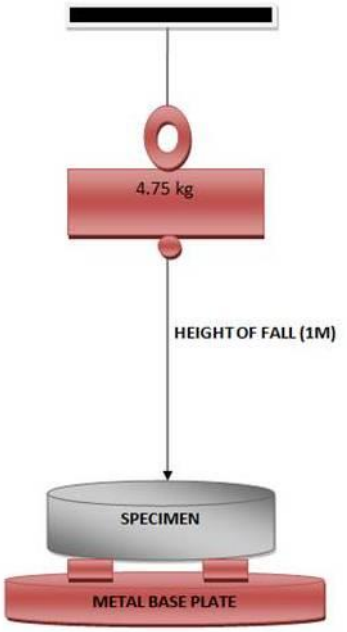


Figure 1: Experimental test set up for impact strength evaluation

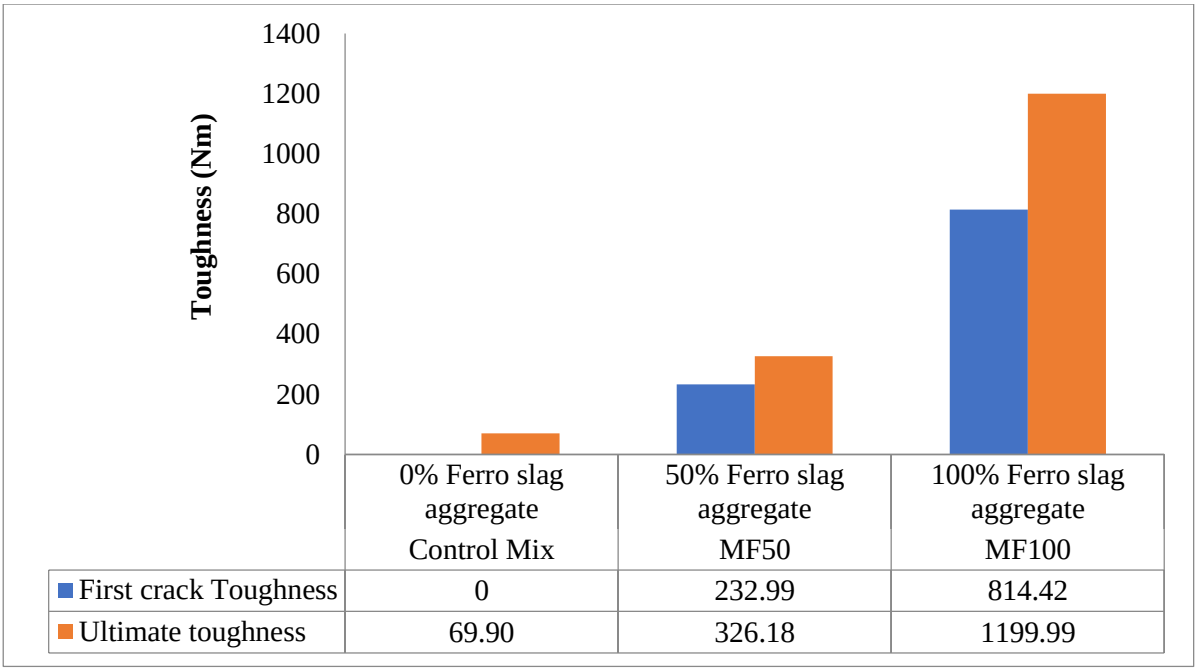
5. Results & Discussion

The impact durability assessment is carried out by documenting the number of blows needed for the first crack and the ultimate crack to occur (2&3). The effect intensity values of all the blends are shown in Table 4.

Table 4: Impact Toughness values

Mix ID	Percentage of ferro slag	First crack Toughness (Nm)	Ultimate toughness (Nm)
Control Mix	0% Ferro slag aggregate	-	69.90
MF50	50% Ferro slag aggregate	232.99	326.18
MF100	100% Ferro slag aggregate	814.42	1199.99

The test results are graphically represented in Figure 2. From the result it can be concluded that control concrete fails suddenly and records a lesser toughness value. Whereas concrete replaced with ferro slag aggregates were able to absorb more energy than control concrete. In specific, replacement of ferro slag by 100% records a comparatively higher value than 50% replacement.



	0% Ferro slag aggregate Control Mix	50% Ferro slag aggregate MF50	100% Ferro slag aggregate MF100
First crack Toughness	0	232.99	814.42
Ultimate toughness	69.90	326.18	1199.99

Figure 2: Impact toughness evaluation

6. Conclusions

The following findings have been taken from the systematic assessment. The use of ferro slag aggregate as a partial substitute for coarse aggregate is proposed to be a feasible alternative to prevent natural resource destruction. From the test results, the energy absorption capacity of ferro slag replaced concrete shows a better performance than control concrete. Ferro slag aggregate consist of comparatively higher silica content and hence the energy absorption capacity is considerable more than normal aggregate. Hence ferro slag aggregate can be used as a replacement material for conventional aggregates.

References

[1] Abbas, H., N. K. Gupta, and M. Alam. "Nonlinear response of concrete beams and plates under impact loading." *International Journal of Impact Engineering* 30.8-9 (2004): 1039-1053.

[2] Badr, Atef, and Ashraf F. Ashour. "Modified ACI Drop-Weight Impact Test for Concrete." (2005).

[3] Balasubramanian, K., "Flexural behaviour of Steel Fibre Reinforced Concrete Beams under Static Load." (1998).

[4] Bindiganavile, V., and N. Banthia. "Polymer and steel fiber-reinforced cementitious composites under impact loading—Part 1: Bond-slip response." *Materials Journal* 98.1 (2001): 10-16.

[5] Nirmalkumar, K., and V. Sivakumar. "Corrosion studies on concrete using treated and untreated textile effluent and impact of corrosion inhibitor." *Journal of Sustainable Development* 1.3 (2008): 68 - 74.

[6] Nirmalkumar, K., and V. Sivakumar. "A study on the durability impact of concrete by using recycled waste water." *Journal of industrial pollution control* 24.1 (2008): 1-8.

[7] Soundararajan, M., and NirmalKumar K. "Experimental Study on mechanical and durability properties of High Performance Concrete replacing coarse aggregate by Ferro Slag Aggregates." *Journal of advances in chemistry*, 13.8, (2016): 6413-6420.

[8] Guo, Yongchang, et al. "Effects of steel slag as fine aggregate on static and impact behaviours of concrete." *Construction and Building Materials* 192 (2018): 194-201.

[9] Zhu, Xue-Chao, Han Zhu, and Hao-Ran Li. "Drop-weight impact test on U-shape concrete specimens with statistical and regression analyses." *Materials* 8.9 (2015): 5877-5890.