**Application of Cast Iron Waste (CIW) in Concrete Enhancing the Thermal Insulating (TI) Property**

Mohammad Irshad Ansari1 Piyush das2 Meghal Dewangan3 Bhumika Chandrakar4

Dept of Civil Engg. Dept of Civil Engg. Dept of Civil Engg. Dept of Civil Engg.

Kalinga University Kalinga University RCET GEC

Naya Raipur CG Naya Raipur CG Bhilai CG Raipur CG

[Irshad.ansari@kalingauniversity.ac.in](mailto:Irshad.ansari@kalingauniversity.ac.in) [Piyush.das@kalingauniversity.ac.in](mailto:Piyush.das@kalingauniversity.ac.in) [Meghal.dewangan@rungta.ac.in](mailto:Meghal.dewangan@rungta.ac.in) [14bhumika@gmail.com](mailto:14bhumika@gmail.com)

**ABSTRACT**

Concrete is a mixture material of cement, sand and aggregate (fine aggregate and coarse aggregate) with water content in a definite proportion. There are some admixture material who are enhance the property of concrete, such types of concrete is name as modified concrete. Cupola blast furnace slag is used in this experiment in the percentage of 1%, 3% and 5% with partially replacement of cement (OPC). For making M25 concrete used the ratio 1:1:2 mix proportion. After the adding CIW in cupola cement concrete the slump value is gradually reduced 2.64%, 9.22% and 16.79% resp. after adding the 1% to 5% of CIW the water holding capacity is also reduced by 12.65%, 16.66% and 27.02%. and the compressive strength is reduced after 1% adding of Cupola slag is 3.40% and increased 10.68% and 11.61% after adding the 3% and 5% of CIW resp. thermal conductivity is gradually reduced by 12.89%, 13.12% and 19.12% after adding the 1%, 3% and 5% of cupola slag. The thermal performance may be more good after adding the more percentage of CIW.

**KEYWORDS**: ***Cast iron Waste, Normal cement concrete, cupola cement concrete, thermal conductivity, Ordinary Portland cement.***

1. **INTRODUCTION**

Slag can be used in various building construction material for changing there physical and chemical properties for the easy comfort of living. There are many waste are use in building construction material (BCM) like fly ash , slag, agricultural waste, industrial waste, domestic waste etc. these all waste contains different types of properties and basis of there property we can use these waste in building.

Slag can be produced from many metallurgical waste like –iron, steel, nickel, managnese, copper etc. [1] In construction industry many types of waste or slag can be used but mostaly blast furnace slag are used due to its friendly property with cement but now a day a new material is introduced from industry waste “Cupola slag” it is byproduct of metals .from one tonns of metal 50-60 kg of CS is generated.

The chemical properties of CS is similar to the blast furnace slag ,which is depend on Sio2 ,Al2O3 ,CaO , MgO ,FeO , and other oxides and sulphides [2]. The physical property of CS is huge similar to natural fine aggregate and coarse aggregate used in concrete. Cupola slag can be used in concrete for gaining satisfactory strength. Economic analysis shows a saving of 19% of cement replacement and 1, 7 and 0.53 % for FA and CA resp.

1. **LITERETURE REVIEW**

The presence of alkalis in cement, particularly portland cement, such as potassium oxide (K2O) and sodium oxide (Na2O), may be of concern, according to Willie et al. For instance, if the cementitious materials are mixed with aggregates that include Silicon Oxide (SiO), the expanding alkali Silica gel that results from the reaction between the cementitious materials' alkalis and the SiO2 may cause the concrete structure to fracture and crumble.

The use of cementitious materials with low alkali concentration is often preferred since it is challenging to identify reactive SiO2 in aggregates. As a result, the ASTM C150 specification includes an optional restriction of a maximum equivalent NaO of about 0.6 percent. With SiO2 reactive aggregates, it is feasible to utilise cement that contains more than 0.60 percent equivalent Na2O while preventing excessive expansion and lowering the total energy required to make the cement. Cement, ideally portland cement, and latently hydraulic materials like granulated blast furnace slag are one example.

However, because portland cement reacts more quickly, the latently hydraulic elements actually add to the strength of the later-developed cement rather of the earlier. Lower temperatures of hydration due to the early activity decline result in the creation of thermal cracks. Blast furnace slag is added, yet thermal fracture development still persists. Granulated slag (GS) has been successfully used in concrete in previous research as a cement substitute. The recycling of slag will undoubtedly become an important measure for the preservation of the environment and, as a result, will be of great relevance, according to Sun and Zhu's 2007 research. According to Dubey et al. (2012), GS concrete requires a longer curing time than normal concrete. Khan and Usman (2004) came to the conclusion that because GS concrete is more workable, the water-to-cement ratio may be decreased, increasing compressive strength. According to Shariq and Ahuja (2008), using GS in place of Ordinary Portland Cement (OPC) in concrete results in the strongest concrete at 40% after 56 days of curing. Geopolymer concrete with GS was the subject of a study by Naidu et al. (2012), who discovered that the concrete's strength had increased. The early strength development of composites including GS is significantly reliant on temperature under conventional curing conditions, and the GS mortar build strength more slowly than mortars with Ordinary Portland Cement, according to studies by Barnett et al.

1. **MATERIAL AND METHODOLOGY**

For the designing of concrete cement (OPC), aggregate (fine aggregate and coarse aggregate) and sand is required in a sufficient percentage of water As per IS code. In this experiment we have to use Cupola blast furnace slag (CBFS) to increased the property of concrete (M20). The ration of M20 concrete is 1:2:4 As per IS code.

* 1. **INGREDIENT OF CONCRETE**

Cement, sand and aggregate is mixed in a definite proportion for the desining concrete. Aggregate is a material which is responsible for the strength of the concrete, and the cement is responsible for the binding and the sand is work in concrete is to increased the crushing strength and prevent the shrinkage and cracking of the concrete. Figure 3.1 shows the material used in the experimental work. Figure 3.2 shows the admixture material which is used in the replacement material with cement. i.e.Cupola Blast furnace slag is used with the replacement of Cement in the concrete.

  

Figure 3.1: Cement (OPC), Sand, Aggregate



Figure 3.2: Cast Iron Waste (CIW)

* 1. **EXPERIMENTAL PROCEDURE**

To analyse the thermal property of concrete, in this experiment we were used the CBFS in the percentage of 1%, 3% and 5% respectively with the cement. Collect the raw material from the source and garding these material as per IS 456:2000. In this analysis experimental work composite material is prepared which is shown in table 3.1. to know the correct proportion of material in percentage.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name/Material | Cement (OPC) in % | Sand in % | Aggregate in % | Cupola Blast Furnace Slag in % |
| Normal Cement concrete (C0) | 100 | 100 | 100 | 0 |
| Cupola cement Concrete (C1) | 99 | 100 | 100 | 1 |
| Cupola cement Concrete (C2) | 97 | 100 | 100 | 3 |
| Cupola cement Concrete (C3) | 95 | 100 | 100 | 5 |

Table 3.1: Percentage of material used in experiment

* 1. **TEST ON CONCRETE**

Mainly Four test were conducted in this research work i.e. workability test, water absorption test, Comprssive strength test and thermal conductivity test respectively. These test are conducted 7 days and and after 28 days. For the workability test slump cone test is used in the different proportion of water content but here we take 50% of water content. For the water absoption test cube (150 mm\*150mm\*150mm) is casted and test done after the 7 and 28 days. After that compressive strength test were conducted with the compressive testing machine after 7days and 28 days. The main test were performed the Thermal conductivity test (TC) with the help of KD2 pro analyser after 28 days.

The test result were discussed further point. The thermal conductivity test are performed of concrete bricks which have diamension 150mm\*75mm\*75mm. the needle of Anlyzer is insert in the bricks in a fixed time interval of 10 min.

1. **RESULT AND DISCUSSION**

The test conducted in previous poits are discussed here to analyse the result of concrete:

* 1. **WORKABILITY OF CONCRETE**

The workability on Normal cement concrete of M25 is recorded 76 mm. and the after adding the CBFS in the percentage of 1%, 3% and 5% the slump value is gradually decreased with increasing CBFS. The figure 4.1 shows the workability property of NCC and CCC.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name/Material** | **Concrete code** | **OPC in %** | **Replacement with CBFS** | **Water content** | **Slump value in MM** |
| **Normal cement Concrete** | C0 | 100 | 0 | 0.50 | 76 |
| **Cupola cement Concrete** | C1 | 99 | 1 | 0.50 | 74 |
| C2 | 97 | 3 | 0.50 | 69 |
| C3 | 95 | 5 | 0.50 | 64 |

Table 4.1: workability of Concrete and CCC

* 1. **WATER ABSORPTION OF CONCRETE**

The water absoption capacity is recoded of Normal cement concrete and cupola cement concrete after the 7 days and 28 days. It is observed the when we add the CBFS in the increasing order the water holding capacity in reduced gradually. The figure 4.2 shows the performance of CBFS for the water holding capacity.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name/Material** | **Concrete code** | **OPC in %** | **Replacement with CBFS** | **Water absorption in %** | |
| **7 Days** | **28 Days** |
| **Normal cement Concrete** | C0 | 100 | 0 | 29.5 | 17.4 |
| **Cupola cement Concrete** | C1 | 99 | 1 | 26.0 | 15.2 |
| C2 | 97 | 3 | 23.7 | 14.5 |
| C3 | 95 | 5 | 22.8 | 12.7 |

Table 4.2: Water absorption of Concrete

* 1. **COMPRESSIVE STRENGTH OF CONCRETE**

After the adding cupola blast furnace slag in the percentage of 1%, 3% and 5% the compressive strength is decreased in early stage and after adding 3% and 5% it is recorded the CS is increased in 7 days and 28 days.

|  |  |  |  |
| --- | --- | --- | --- |
| **Name/Material** | **Concrete code** | **Compressive strength in N/mm2** | |
| **7 days** | **28 days** |
| **Normal cement concrete** | C0 | 11.2 | 33.4 |
| **Cupola cement concrete** | C1 | 10.1 | 32.6 |
| C2 | 12.7 | 35.7 |
| C3 | 14.9 | 38.8 |

Table 4.3:Analysis of Compressive strength of concrete and modified concrete

* 1. **THERMAL CONDUCTIVITY OF CONCRETE**

The thermal conductivity of concrete and modified concrete is recorded with partially replacement of cement 1%, 3% and 5% respectively. It is observed that after adding CBFS the the thermal conductivity were decreased gradually. Figure 4.4 shows the performance of CBFS in concrete.

|  |  |  |
| --- | --- | --- |
| **Name/ Material** | **Concrete code** | **Thermal conductivity in W/mK** |
| **Normal cement concrete** | C0 | 2.25 |
| **Cupola cement concrete** | C1 | 1.96 |
| C2 | 1.91 |
| C3 | 1.82 |

Table 4.4: Thermal performance of Concrete and Modified concrete

Figure 4.1:Workability of concrete

Figure 4.2: water absorption of concrete and modified concrete

Figure 4.3: Compressive strength of NCC and CCC

Figure 4.4: Thermal conductivity of concrete

1. **CONCLUSION**

Concrete is a most importance building construction material used in all types of construction. It is have some main property like strength, durability, safety etc. But there is one more property to feel comfort to the people that is thermal conductivity. The tc of concrete is 2.25 to 2.30 w/mk as per experiment. After the adding 1% of cupola blast furnace slag the slump value is reduced by 2.64%**,** water absorption capacity is reduced by 12.65% and compressive strength and thermal conductivity is reduced 3.40% and 12.89% respectively. After adding the 3% and 5% of cbfs the slump value, water absorption, compressive strength and thermal conductivity is 9.22%, 16.79% (reduced), 16.66%, 27.02% ( reduced), 10.68%, 11.61% (increased), 13.12%, 19.12% (redueced) respectively. The percentage of cupola blast furnace slag is increased more the performance of concrete is enhance more. After the adding cbfs the thermal performance of concrete is reduced.

**REFERENCE**

[1] Carlos Thomas ,José Sainz-Aja, Israel Sosa, Jesús Setién, Juan A. Polanco and Ana Cimentada Physical-Mechanical Properties of Cupola Slag Cement Paste ; 2021.

[2] S. Chakravarty , P. Haldar  ,T. Nandi , G. Sutradhar Cupola slag reutilization for sustainable waste management ; 2021.

[3] Experimental thermal assessment of bio-based materials (AleppoPine wood, cork, and their composites) for building insulation by Limam A, Zerizer A, Quenard D, Sallee H, and Chenak A (2016) Build. 116 89-95

[4] Li H-g, Lu C-l, Zhou X-y, and Zheng F 2010 An eco-friendly material made of cotton stalk fibres for thermal insulation Build. 42 1070-4

[5] Benchabane A, Agoudjil B, Boudenne A, Ibos L, and Fois M 2011 Characterization of date palm wood as a renewable resource to mitigate heat loss from buildings Energy Build. 43 491-7

[6] Mohammad irshad Ansari, Meghal Dewangan;2023;[Medical Waste Management and Treatment in India: A Review](https://scholar.google.com/citations?view_op=view_citation&hl=en&user=yhXwYxIAAAAJ&citation_for_view=yhXwYxIAAAAJ:ufrVoPGSRksC)

[7] Pooja sikdar, Mohammad Irshad Ansari;2023;[Road Accidents in India-Hypothesis :review](https://scholar.google.com/citations?view_op=view_citation&hl=en&user=yhXwYxIAAAAJ&citation_for_view=yhXwYxIAAAAJ:WF5omc3nYNoC)

[8] Mohammad irshad Ansari, Priyanshu pandey; 2023;[Construction of Pavement with Iron Waste: A review](https://scholar.google.com/citations?view_op=view_citation&hl=en&user=yhXwYxIAAAAJ&citation_for_view=yhXwYxIAAAAJ:eQOLeE2rZwMC)

[9] Sweta katre, Mohammad irshad ansari , Dr ravi raj gabbi, Dr J D Supe, Preety ;2023;[Construction of Pavement with Iron Waste: A review](https://scholar.google.com/citations?view_op=view_citation&hl=en&user=yhXwYxIAAAAJ&citation_for_view=yhXwYxIAAAAJ:eQOLeE2rZwMC)

[10] Sonila sonker Mohammad irshad ansari , piyush Das;2023;[Suitability Of Nano Silica Particles (NSP) & Silica Fume (SF) On Physical Property of Concrete](https://scholar.google.com/citations?view_op=view_citation&hl=en&user=yhXwYxIAAAAJ&citation_for_view=yhXwYxIAAAAJ:W7OEmFMy1HYC)

[11] meghal dewangan Mohammad irshad ansari , shweta katre, pooja sikdar, keshri ;2023;[Use Of Cupola Blast Furnace Slag (CBFS) In Concrete for Pavement Design](https://scholar.google.com/citations?view_op=view_citation&hl=en&user=yhXwYxIAAAAJ&citation_for_view=yhXwYxIAAAAJ:Y0pCki6q_DkC)

[12] Mohammad irshad ansari , piyush Das, deeksha chandrakar;2023;[Experimental analysis on cupola blast furnace slag (CBFS) in concrete for thermal performance (TP)](https://scholar.google.com/citations?view_op=view_citation&hl=en&user=yhXwYxIAAAAJ&citation_for_view=yhXwYxIAAAAJ:Tyk-4Ss8FVUC)

[13] Mohammad Irshad Ansari; 2023;[Management Of Waste Plastic (WP) In Flexible Pavement For Advanced Construction](https://scholar.google.com/citations?view_op=view_citation&hl=en&user=yhXwYxIAAAAJ&citation_for_view=yhXwYxIAAAAJ:zYLM7Y9cAGgC).

[14] Dr.farhan khan, mohammad irshad Ansari, himanshu, kaushal;2022;[analysis of alternate soil binder and thier effect on soil: A Review](https://scholar.google.com/citations?view_op=view_citation&hl=en&user=yhXwYxIAAAAJ&citation_for_view=yhXwYxIAAAAJ:IjCSPb-OGe4C)

[15] Dr.farhan khan, mohammad irshad Ansari, himanshu, kaushal;2022;[Impact of soil property in selection of stabilization technique:A review](https://scholar.google.com/citations?view_op=view_citation&hl=en&user=yhXwYxIAAAAJ&citation_for_view=yhXwYxIAAAAJ:UeHWp8X0CEIC)

[16] Mohammad irshad Ansari. Govinda gahine;2022;[Solid waste management of steel city: Bhilai](https://scholar.google.com/citations?view_op=view_citation&hl=en&user=yhXwYxIAAAAJ&citation_for_view=yhXwYxIAAAAJ:qjMakFHDy7sC)

[17] Mohammad Irshad Ansari, H Kumarwarte, K Dalapati, A Sahu, K Patel;2022;[Experimental Study On Properties Of Cement Mortar Using Chicken Featheres And Eggshell Powder](https://scholar.google.com/citations?view_op=view_citation&hl=en&user=yhXwYxIAAAAJ&citation_for_view=yhXwYxIAAAAJ:u5HHmVD_uO8C)

[18] Mohammad Irshad Ansari;2021;[Experimental analysis for the study of bamboo fibre and polypropylene fibre in concrete](https://scholar.google.com/citations?view_op=view_citation&hl=en&user=yhXwYxIAAAAJ&citation_for_view=yhXwYxIAAAAJ:9yKSN-GCB0IC)

[19] MI Ansari, R Agrawal;2021;[Study for the Development of Thermal Insulated Sustainable Green Material for Roof Top](https://scholar.google.com/citations?view_op=view_citation&hl=en&user=yhXwYxIAAAAJ&citation_for_view=yhXwYxIAAAAJ:u-x6o8ySG0sC)

[20] Characterization of hygrothermal characteristics of wood-based products - Effect of moisture content and temperature Vololonirina O, Coutand M, and Perrin B 2014 63 223-33 Constr. Build. Mater.

[21] Investigating sound insulation, thermal conductivity, and radioactivity of chipboards made with cotton waste, fly ash, and barite Binici H, Gemci R, Kucukonder A, andSolak HH 2012. 30 826-32 Constr. Build. Mater

[22] The 2016 study by Stapulionien R, Vaitkus S, Vjelis S, and Sankauskait examined the thermal conductivity of natural fibres treated using various mechanical techniques. Int. J. Pr. Engineering Man. 17 1371–81

[23] Laskowski and Murat 2017 Ecological Dom Murator 8

[24] 2015 Adamowski J, Rejment M How did the viewpoint on energy-efficient building materials change Itinerant Budownictwa

[25]https://www.rethinkwood.com/sites/default/files/Green-Building-Wood-Products-CEU-June