Strength Analysis on Concrete with Full Replacement of River Sand

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Abstract: Our nation is enhanced with many natural resources. Because of industrial development, natural resources are being looted. One of the natural resources is sand used in the construction of buildings and road pavements which is quarried from the river bed causes depletion of bed, lowering the water table, and bed coarsening. So, the emerging need is to find an alternative material equivalence to sand and confirming an economical and environmental indebted solution. Simultaneously, squander from ventures makes hurt nature. To manage both the issues, the waste is prescribed to supplant the fine total really taking shape of cement. From the past studies, it is confirmed that the replacement of river sand with other fine materials increases the compressive strength of concrete. This project manages the supplanting of waterway sand with other waste, which is gathered from the business and dump yard which are liberated from harmful materials. The inclusion of this waste in the concrete showed better performance in terms of compressive strength. Among all the waste, the iron slag gives more strength compares to the others. In this way, in the development field, the iron slag will be proposed as a brilliant material regarding cost-effectiveness, accessibility, the productivity of the material, and so on.,

Key words: River sand, plastic, compressive strength, replacement

1. Introduction:
The significant job in the financial advancement of the nation is the development business. Service of Statistics and Program Implementation Planning Commission, Government of India has been reported that the portion of the development business is around 9.47% in the year 2017. In any case, presently a day the interest for sand is expanded. It is a scourge that sand is being utilized as a fine total in concrete. As indicated by the specialist Fredonia Group, the interest of totals for development is around 51.7 billion tons in 2019. The expense of development materials expanded consistently in light of popularity, shortage of crude materials, and significant expense for vitality. To preserve the normal assets, it is exceptionally basic to locate an elective material for the development material. Inferable from this, exploration and augmentation exercises will be needed to create an eco-accommodating, practical and financial development material.

The starting point of each sort of sand starts with the making of mountains or natural life forms. When mountains are shaped, they gradually start to dissolve into progressively littler parts because of the powers of nature. The hard tissue parts which are getting after the life form, for example, shells, corals, wipes, ocean imps, marine plants and bryozoans passed on, began to debase into grains of sand regularly known as Biogenic sand. Exploration is being completed in the use of waste item as a substitution to sand.

Numerous analysts examined the impacts of waste materials in concrete. The test on the substitution of waterway sand by Iron slag (I sand) presumed that the ideal substitution of 30% stream sand by I sand gives the better outcomes without trading off the nature of cement [1]. The pre-owned
quarry dust as fractional substitution of common waterway sand was explored and the outcome clarifies that the flexural quality of cement expanded about 4.3% than the regular stream sand concrete [2]. Another significant examination carried on compressive quality of cement with 5 sorts of reused plastic waste as a substitution of waterway sand [3]. The parametric examination uncovered that the utilization of Polyethylene terephthalate (PET) delivers the financial and powerful exhibition of cement contrasted with other plastic squanders, for example, High-Density Polyethylene, Polypropylene Strips, Polypropylene multifilament strands and High Density Polypropylene Pellets. The spent garnet in concrete gives better execution as a result of its particular gravity (3), fineness (zone II), iron substance, alumina and high silica content [4]. The arranged Cathode Ray Tube (CRT) pipe glass was adequately utilized in the planning of cement by supplanting the fine total [5]. The ideal substitution of Used Foundry Sand (UFS) with fine total ought not to surpass 20% by weight [6]. Fake sand supplanted by stream sand shows higher compressive quality, higher flexure quality and decrease in cost of cement [7].

2. MATERIALS USED

Cement

In the construction industry, Ordinary Portland Cement has been used as a binder material. The Ordinary port land cement of Grade-43 confirming to IS 8112: 2013 [8] standards was used in this project. The normal consistency, specific gravity and initial and final setting times has been carried out and the results are presented in Table 1.

| Test                  | Suggested Value as per IS 8112:2013 | Obtained value |
|-----------------------|---------------------------------------|----------------|
| Initial Setting time  | 30 mins (max)                        | 22 mins        |
| Final Setting time    | 600 mins (max)                       | 498 mins       |
| Specific gravity      |                                       | 3.14           |
| Normal Consistency (%)|                                       | 32             |

Coarse Aggregate

The locally available 20mm aggregate has been used as a coarse aggregate in this investigation. For the proper mix design of normal concrete it is essential to calculate the properties of materials such as sieve analysis, specific gravity and water absorption. The test results of coarse aggregate are presented in Table 2 & Table 3.

| S.No | IS Designation | Sieve designation (gms.) | Weight retained (gms.) | % weight retained | cumulative % of weight retained | % of passing |
|------|----------------|--------------------------|------------------------|------------------|---------------------------------|---------------|
| 1.   | 40 mm          | 0                        | 0                      | 0                | 0                               | 100           |
| 2.   | 25 mm          | 0                        | 0                      | 0                | 0                               | 100           |
| 3.   | 20 mm          | 534                      | 26.71                  | 26.71            | 73.29                           |               |
| 4.   | 12.5 mm        | 1411                     | 70.59                  | 97.3             | 2.7                             |               |
| 5.   | 10 mm          | 43                       | 2.15                   | 99.45            | 0.55                            |               |
| 6.   | 4.75 mm        | 11                       | 0.55                   | 0                | 100                             | 0             |
| 7.   | 2.36 mm        | 0                        | 0                      | 0                | 100                             | 0             |
| 8.   | 1.18 mm        | 0                        | 0                      | 0                | 100                             | 0             |
| 9.   | 600micron      | 0                        | 0                      | 0                | 100                             | 0             |
Water
Potable water is used to produce the desired properties of concrete achieved by the chemical reaction with cement.

Fine Aggregate
Due to shortage of river sand, some of the industrial waste has been replaced for river sand. Before replacing the fine aggregate, the properties of wastes were calculated to meet the requirements of river sand and it is given below.

M-Sand
The manufactured sand (M sand) has the similar properties of river sand such as gradation of fines, shape and smooth surface textures. This physical property of sand provides greater strength and the results of this sand is listed in Table 4.

Waste Marble Dust
Marble waste is a by-product which is generated from the marble industry during the process of sawing and polishing of marble blocks. Many researchers investigated the effect of marble dust in concrete and presented the positive result. In this investigation the river sand is partially and fully replaced by marble powder and the properties of marble powder is listed in Table 4.

Iron Slag
Iron slag is a by-product obtained in the manufacture of pig iron in the blast furnace and is produced by the blend of down-to-earth constituents of iron ore with limestone flux. Mostly, the slag consists of, magnesium, aluminium silicates, calcium and manganese in various arrangements. The properties of Iron slag are listed in Table 4.

Foundry Sand
The annual generation of foundry sand in India is about 2 million tons. In this investigation, the river sand is replaced by foundry sand because of its clean, uniformly sized, high quality silica sand content. The properties of foundry sand are tabulated in Table 4.

Coal ash
Coal ash produced from the burning of coal fired in electric power plants. The particle size of coal ash is comparable to that of river sand because it depends upon the non-combustible matter present in the coal. The property of coal ash is tabulated in Table 4.

Table 3: Physical properties of coarse aggregate

| S.No | Property          | Value |
|------|------------------|-------|
| 1.   | Specific gravity | 2.72  |
| 2.   | Water absorption | 1.00  |

Table 4: Test results of fine aggregate

| Type of fine aggregate | Fineness | Specific gravity |
|------------------------|----------|------------------|
| River sand             | 2.71     | 2.63             |
| M-sand                 | 2.55     | 2.59             |
| Waste marble dust      | 2.353    | 2.12             |
| Iron slag              | 2.353    | 2.12             |
| Foundry sand           | 1.667    | 2.5              |
| Coal ash               | 2.75     | 1.75             |
3. Experimental Program

3.1 Slump test

Concrete slump test has been carried out to confirm the uniform quality of concrete or to determine the workability or consistency of concrete mix. The tests were conducted to find the effects of different wastes on slump value. Fig 1 shows the slump value of M sand replaced by river sand. Results from the tests have been tabulated in Table 5 and confirmed to 1199-1959[9].

![Fig 1 Slump value for M sand](image)

| S.No | Type of Fine Aggregate used | Slump value (mm) |
|------|-----------------------------|------------------|
| 1    | River sand                  | 100              |
| 2    | M-Sand                      | 135              |
| 3    | Waste Marble Dust           | 95               |
| 4    | Iron slag                   | 120              |
| 5    | Foundry sand                | 125              |
| 6    | Coal ash                    | 80               |

3.2. Compressive strength (include photos)

The compressive strength was tested for different specimens of concrete manufactured with different replacement of river sand. Testing was carried out after 28 days of cube casting in compression testing machine shown in Fig.2. The results are tabulated in Table 6

![Fig 2. Compressive strength of waste marble dust](image)
Table 6: Compressive strength values for different alternative materials

| S.No | Materials            | Compressive strength (N/mm²) |
|------|----------------------|------------------------------|
| 1    | River sand           | 18.9                         |
| 2    | M-sand               | 32                           |
| 3    | Waste marble dust    | 15.7                         |
| 4    | Iron slag            | 40.5                         |
| 5    | Foundry sand         | 12.2                         |
| 6    | Coal ash             | 7.8                          |

4. Result Analysis and Conclusion
From the experimental study it is revealed that some of the industrial wastes used as a potential replacement of fine aggregate. The properties of river sand concrete and various alternatives have been compared in terms of compressive strength and slump and it is shown in Fig 3 & Fig 4.
• The accompanying ends have been produced using the tests done on quality attributes of cement.
• The compressive quality of solid utilizing iron slag is 2.14 occasions the stream sand and the compressive quality of M sand is 1.69 occasions the waterway sand.
• The iron slag with roughly comparable droop stream to that of waterway sand.
• It obviously shows that 100% substitution of characteristic sand by iron slag and M sand invigorates more than the others.

References:
[1] Rahmathulla Noufal E and Unnikrishnan Manju., 2016, I-sand: “An environment friendly alternative to river sand in reinforced cement concrete constructions”, Journal of Construction and Building Materials, 125, pp.1152-1157.
[2] Bismarck K. Meisuh, Charles K. Kankam and Thomas K. Buabin., 2018, “Effect of quarry rock dust on the flexural strength of concrete”, Journal of Construction Materials, 8, pp.16-22.
[3] J.Thorneycroft, J.Orr, P.Savoikar and R.J. Ball., 2018, “Performance of structural concrete with recycled plastic waste as a partial replacement for sand”, Journal of Construction and Building Materials, 161, pp 63-69.
[4] Habeeb Lateef Muttashar, Nazri Bin Ali, Mohd Azreen Mohd Ariffin and Mohd Warid Hussin., 2018, “Microstructures and physical properties of waste garnets as a promising construction materials”, case studies in construction materials, 8, pp. 87-96.
[5] Liu.T., Song.W.,Zou.D and Li.L., 2018, “Dynamic mechanical analysis of cement mortar prepared with recycled cathode ray tube glass as fine aggregate”, Journal of Cleaner Production,174, pp. 1436 – 1443.
[6] Thiruvenkitam Manoharan.T, Dhamothiran Lakshmanan, Kaliyannan Mylsamy, Pandian Sivakumar and Anirbid Sircar., 2018, “Engineering properties of concrete with partial utilization of used foundry sand”, Journal of Waste Management, 71, pp.454-460.
[7] BajadmM.N and Sakhare, S., 2018, “Influence of artificial sand on the properties of concrete and mortar”, International Journal of Civil Engineering and Technology, 9, Issue 1, pp. 447 – 454.
[8] IS: 8112-1989, “Specifications for 43-Grade Portland Cement”, Bureau of Indian Standards, New Delhi, India.
[9] IS 1199 – 1959, “Methods of sampling and Analysis of Concrete”, Bureau of Indian Standards, New Delhi, India.