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# Experimental Analysis of Quarry Dust and Metallic Dust as a Partial Replacement of Fine Aggregate in Concrete

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***Abstract*** **- Natural river sand is one of the key ingredient in concrete, now a days it is expensive due to over population and increasing infrastructure projects and also large scale of depletion of natural resources create environmental issues. To overcome these problems there is a need of alternate and economical resource in construction industry. Quarry dust is a waste obtained during quarrying process, it is an effective filler material. Metallic dust is a by-product of carbon steel which is obtained from industry. This paper analysis the use of quarry dust and metallic dust in concrete production. Design mix of M20 grade concrete with partial replacement of fine aggregate with 0%, 20%, 30%, 40%and 50% of quarry dust and 2% of metallic dust with all the fraction of quarry dust is used to increase its strength of concrete. Various tests like specific gravity, fineness, consistency, setting time, bulking of sand, water absorption, impact value, slump value, compaction factor and compressive strength of concrete is carried out. The result proves that there is an increase in compressive strength of concrete.**

***Keywords- M20 grade concrete, quarry dust, metallic dust***

## 1. INTRODUCTION

River sand has been the most popular choice for the fine aggregate component of concrete in the past, but over use of the material has led to environmental concerns. Therefore it is desirable to obtain cheap, environmental friendly substitutes for river sand. The world consumption of sand in concrete generation alone is around 1000 million tons per year, making it scarce and limited. The excessive and non-scientific methods of mining sand from the river beds has led to lowering of water table and sinking of bridge piers. Further, it has caused environmental degradation like removal of minerals from top-soil due to erosion and change in vegetative properties leading to soil infertility problems thereby affecting agricultural productivity, change in river-courses leading to floods, and alteration of river eco-system affecting flora and fauna. Hence, the current focus of construction industry should be partially or completely replace natural sand in concrete by waste material or a material that is obtained through recycling, without compromising the quality of the end product. In the recent years, the construction industries have identified some waste materials like fly ash, slag, limestone powder and siliceous stone powder use in traditional concrete. Quarry dust is a kind of waste material that is generated from the stone crushing industry which is abundantly available to the extent which has landfill disposal problems, health and environmental hazards. The present study is an attempt to experiment on use of quarry dust to replace river sand in concrete. The use of quarry dust in concrete is desirable because of its benefits such as useful disposal of by-products, reduction of river sand consumption as well as increasing the strength parameters and increasing the workability of concrete. Lathe metal scraps of cast iron from the lathe industry are introduced in the concrete mix to check whether the strength increases than the conventional concrete. Lathe waste is crimped fibre form is a waste from lathes. Various studies conducted on lathe waste shows increase in compressive strength. It increases the strength in tension of concrete.

## 2. REVIEW OF LITERATURE

2.1 Kothai et al worked relate the use of steel slag, a waste cheap material used as fine aggregate in M20 grade of concrete and recommends the approval of the material for use in concrete as a replacement material for fine aggregates. The partial substitution of natural aggregates permits a gain of compressive, tensile and flexural strength and modulus of elasticity of concrete up to 30% replacements.

2.2 Cheten khajuria et al reviewed adding 10% iron slag in concrete mix, there is an increase of 26% after 7 days, 43 % increase after 28 days and 50% increase after 56 days as compared to the control mix. If adding more than 30% there is decrease in compressive strength of concrete.

2.3 Iyyappan et al studied the compressive strength of concrete it shows an increase of 6.34% & 8.68% with the addition of lathe metal scrap into concrete by adding of lathe metal scrap into concrete by 2% & 3% respectively, when compared with the plain concrete after 28 days of curing. But with addition of lathe metal scrap with the concrete above 4% the compressive strength is reduced by 7.21% respectively.

## 3. MATERIALS STUDY

3.1 Cement: Portland Slag Cement (PSC) is conforming to IS12089:1987. It is created with a combination of 45-50% slag, 45-50% clinker, and 3-5% gypsum. Grade 33 conforming IS 455-1989 is used.

Table 1: Test on cement

| Description | Values |
|---|---|
| Specific gravity | 3.07 |
| Fineness | 7.06 |
| consistency | 33% |
| Initial setting time | 32 min |
| Final setting time | 605 min |

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3.2 Fine aggregate: Fine aggregate are basically sands own from the land or the marine environment. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 4.5mm sieve.

Table 2 Test on Fine aggregate

| Description | Values |
|---|---|
| Specific gravity | 2.55 |
| Bulking of sand | 16.2% |

3.3 Coarse aggregate: Coarse aggregates are particles greater than 4.75mm, but generally 20 mm angular aggregate are used in this study.

Table 3 Test on Coarse aggregate

| Description | Values |
|---|---|
| Specific gravity | 2.73 |
| Impact value | 22.6 |

3.4 Quarry dust: Quarry dust a by-product from the crushing process during quarrying activities. It has very recently gained good attention to be used as an effective filler material instead of fine aggregate. Quarry dust is defined as the non-valuable waste material obtained after the extraction and processing of rocks due to quarrying to form fine particles of size less than 4.75mm.

Table 4: Comparison Table

| Material | Specific gravity |
|---|---|
| Sand | 2.55 |
| Quarry dust | 2.82 |
| Metallic dust | 2.76 |

Fig 1: Quarry dust

3.5 Metallic dust: Metal scraps of cast iron from the lathe industry are introduced in the concrete mix to check whether the strength increases than the conventional concrete. An alloy of iron that contains 2 to 4 percent carbon along with varying amounts of silica and manganese present in the metal. Cast iron tends to be brittle in nature and gives good compressive strength than other metals.

Fig 2 Metallic dust

Table 5: Chemical composition of metallic dust

| Chemical properties | Percentage (%) |
|---|---|
| Carbon | 2.5-4% |
| Silicon | 1-3% |
| Iron | 90-93% |

## 4. DESIGN MIX

4.1Mix Proportions: Design mix for M20 grade concrete as per IS 10692-2009

Cement = 413 kg/$m^3$
Water = 180 kg/$m^3$
Fine aggregate = 680 kg
Coarse aggregate = 1199 kg

Mix proportion 1:1.6:2.9 with water cement ratio of 0.45

Table 6: Mix Proportion

| Fine aggregate (kg) | Metallic dust (kg) | Quarry dust (kg) |
|---|---|---|
| 680 | - | |
| 775.71 | 21.528 | 219.96 |
| 676.26 | 21.528 | 329.94 |
| 576.81 | 21.528 | 439.92 |
| 477.36 | 21.528 | 549.9 |

## 5. TEST ON CONCRETE

5.1 Slump test: Slump test for different fractions of quarry dust and metallic dust was carried out to find the workability of fresh concrete

Table 7: Slump value

| Quarry Dust & Metallic Dust | Slump Value (mm) |
|---|---|
| 0 % | 170 |
| 20 + 2% | 155 |
| 30 + 2% | 110 |
| 40 + 2% | 90 |
| 50 + 2% | 55 |

5.2 Compressive Test on Concrete: Compressive strength was carried out by 150 x 150 x 150 mm cubes and the test results for 7, 14, 28 days are graphed in N/$mm^2$

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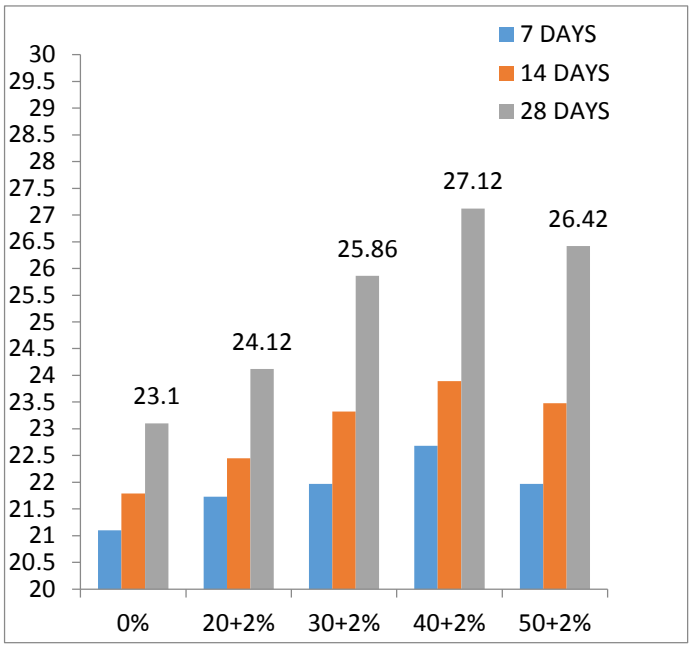


Fig 3: variation of compressive strength of conventional concrete with quarry dust and metallic dust

## 6. CONCLUSION:

One of the ways to improving sustainability is to reduce the human consumption of natural resources. In order to protect the natural resources such as river sand, this study has identified quarry dust and metallic dust; is a waste products from stone crushing industry and lathe industry is available almost free of cost, as partial replacement of river sand.

- This study has brought out positive results that compressive strength is increased than the quarry dust concrete.
- Concrete acquires maximum increase in compressive strength at 40% replacement of river sand in M20 concrete.
- If the workability of concrete is decreased by adding % of quarry dust. But it is compensate by adding metallic dust, because it increase workability.
- The further increasing the percentage of replacement can be made useful by adding the fly ash along with the quarry dust so that 100% replacement of can be achieved.

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