Experimental Study on Strength Characteristics of Concrete with Gold Ore Tailings as Fine Aggregates

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***Abstract* - Global consumption of natural sand is very high due to extensive use of concrete. In particular, the demand for natural sand is quite high in developing countries owing to rapid infrastructural growth. Because of scarcity, construction industries are in stress to identify alternative materials to lesser or eliminate the demand for natural sand. Some alternative materials have already been used as a part of natural sand. For example; fly ash, slag, iron ore tailings and limestone and siliceous stone powder were used in concrete mixtures as a partial replacement of natural sand. Gold ore tailings are a common type of solid waste in KGF and have caused serious problems as landfill. If tailings are not disposed properly, it can damage human health and disrupt agriculture. As a result, an attempt has been made to study the strength characteristics of M20 grade concrete with different percentages of replacement of natural sand by gold ore tailings varying from 0 to 100%.**

***keywords* - Ordinary Portland Cement; Gold Ore Tailings; Compressive strength; Split tensile strength.**

1. Introduction

Concrete is widely used material in the world. Based on the global usage, it is placed at second position after water. Fine aggregate is the essential component of concrete. The most commonly used fine aggregate is natural sand or pit sand. The global consumption of natural sand is very high due to extensive use of concrete. In particular, the demand for natural sand is quite high in developing countries owing to rapid infrastructural growth. India has taken a major initiative in developing the infrastructure such as express highways, power projects, and industrial structures etc., to meet the requirements of globalized world. Therefore, the construction industries are in stress to identify alternative materials to lesser or eliminate the demand for natural sand. Some alternative materials have already been used as a part of natural sand. For example, fly ash, slag, iron ore tailings and limestone and siliceous stone powder were used in concrete mixtures as a partial replacement of natural sand.

Tailings were not utilized it will cause harm. When tailings waste are in dry state, can fly everywhere as tailings grain is very fine. It can damage human health and disrupt agriculture. Gold ore tailings are discharged into the tailings pond after a chemical treatment to remove free cyanide and other heavy metals. When tailings are disposed in the form of mud into the reservoir, treatment costs are huge. We have to build dam to accommodate the tailings slurry, environmental pollution due to seepage and dam maintenance after the mine is closed. Tailings disposal in the deep sea can pollute the environment due to the control that is not easy. Disposal of gold ore is one of the major problems in mining industry. Gold ore tailings are a common type of solid waste in KGF and have caused serious problems as landfill.

It is often predominantly silty in nature and does not have Pozzolanic properties the Kolar gold fields of Karnataka have 33 million tons of such waste. Bharat Gold Mines Limited at Kolar Gold Fields (KGF) has created 33 × 10^6 tons of tailings (which are non-toxic) heaped into 13 hillocks. There is a large scope for utilizing mine wastes for the manufacture of building materials and products. Being a hot spot of public concern gold ore tailings with a wide involvement in comprehensive utilization not only matters survival and development of enterprise and industry, but also influences environment and safety. 33 × 10^6tons of gold mine tailings at KGF can be converted into Concrete, which can satisfy the demand for Concrete at Bangalore city for the next 30 years or more.

Fig 1: Google map of Deposition of gold ore tailing at KGF.

Fig2: Deposition of gold ore tailing at KGF **Fig3:** Collection of gold ore tailing at KGF

SEPARATION OF ORE AND TAILINGS

Ore separation may be done using physical or chemical separation methods. The end product of ore separation is an ore concentrate. After separation, some ore concentrates are sent for further processing, such as smelting, to produce pure metal for sale. A by-product of ore separation is tailings, which are a mixture of water and finely ground rock from which most of the minerals of value have been removed. Tailings may still contain metal-bearing minerals, and the mixture may also contain residues of reagents used in ore processing.

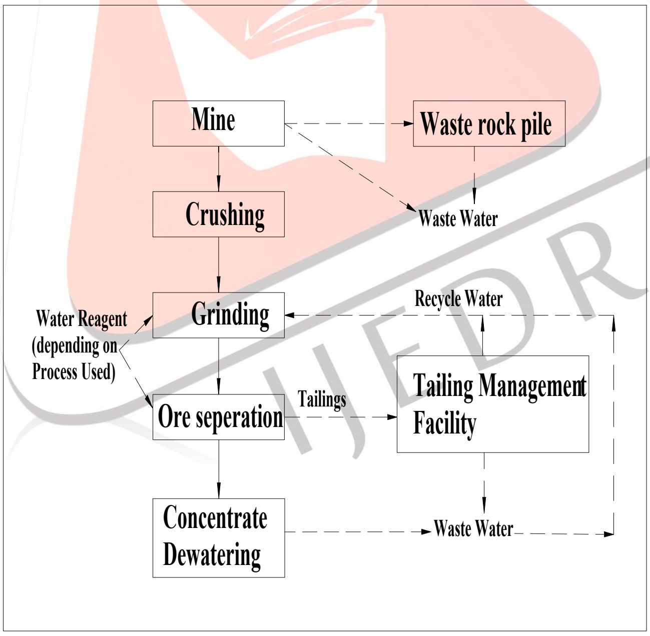


Fig4: Typical Layout of Separation of Tailings

2. MATERIALS AND METHODS

Materials

Portland cement is the most common type of cement in general usage. It is a basic ingredient of concrete, mortar and plaster. In the present work, OPC 53 grade cement with a specific gravity of 3.12; fineness of 9.22%; standard consistency of 36%; initial setting time of 40min; final setting time of 285min.

Table 1: Chemical analysis of OPC 53grade Cement

Ingredients	**%by volume**
Lime (CaO)	62
Silica(SiO_2)	22
Alumina (AL_2O_3)	05

CalciumSulphate ($CaSO_4$)	04
Iron Oxide (Fe_2O_3)	03
Magnesia (MgO)	02
Sulphur (S)	01
Alkalies(K_2O, Na_2O)	01

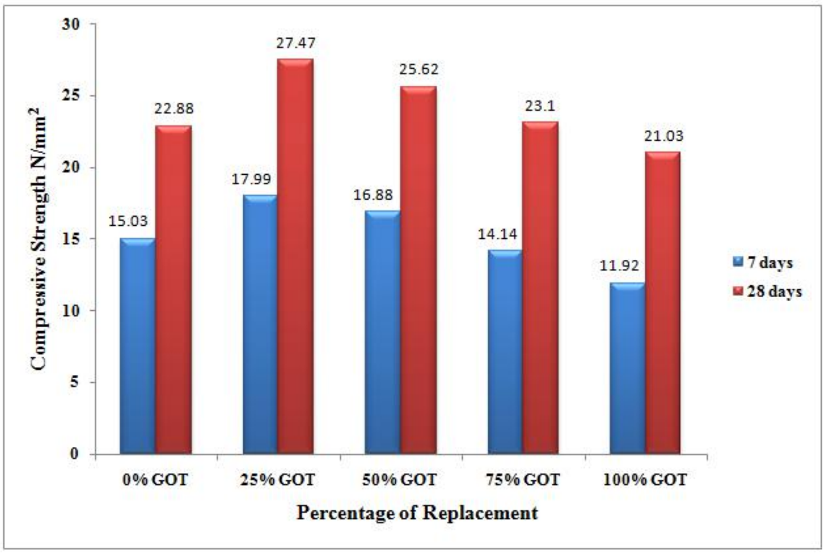
Table 2: Chemical composition of Gold Ore Tailings.

Constituent	**% by weight**
SiO2	40.5
Al2O4	0.5
P2O5	0.09
K2O4	16.1
Cu	2.55ppm
Pb	0.04
As	<0.01
CN	Nil
SO3	0.05
SO4	0.5
CaO	14.96
MgO	6.97

Methods

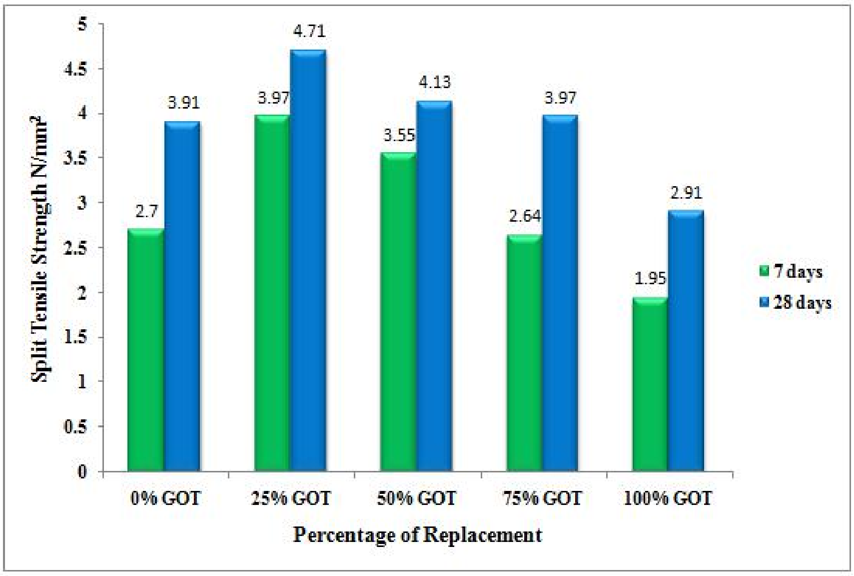
Concrete mix proportion is calculated for mixes with different percentages of replacement of natural sand by Gold Ore Tailings varying from 0 to 100% based on IS 10262:2009. For each mix, concrete is casted into 9 cubes and 9 cylindrical moulds. The cubes and cylinders are tested to determine the compressive and split tensile strength after 7 and 28 days of curing.

3. Results and Discussion



Graph 1: Compressive strength of concrete mixes with varying percentages of replacement of natural sand by Gold Ore Tailings after 7 and 28 days of curing.

The above graph indicates the compressive strength of concrete for concrete mixes with varying percentages of replacement of natural sand by Gold Ore Tailings after 7 and 28 days of curing. It was observed that compressive strength of concrete mix with 25% replacement of natural sand by Gold Ore Tailing is more than compared to that of concrete mix with zero replacement.



Graph 1: Split Tensile strength of concrete mixes with varying percentages of replacement of natural sand by Gold Ore Tailings after 7 and 28 days of curing.

The above graph indicates the split tensile strength of concrete for concrete mixes with varying percentages of replacement of natural sand by Gold Ore Tailings after 7 and 28 days of curing. It was observed that split tensile strength of concrete mix with 25% replacement of natural sand by Gold Ore Tailing is more than compared to that of concrete mix with zero replacement.

Conclusions

1. From the above results 25 % replacement of GOT gives high Compressive and Split Tensile Strength.
2. By using these wastes instead of conventional materials, we would not only be preserving the natural precious resources, but also solving the problems of disposal of waste, which has become a problem.
3. GOTs are the finer materials which can reduce the voids in concrete.
4. Construction of buildings from mine waste is eco-friendly as it utilizes waste and reduces air, land and water pollution. It is energy efficient and also cost effective.
5. There is large scope for utilizing mine wastes for the manufacture of building materials and products. This mine wastes are used as fine aggregate in concrete can meet the demand for next few decades.

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