A STUDY ON MECHANICAL PROPERTIES OF CONCRETE WHEN FELDSPAR IS PARTIALLY REPLACED WITH CEMENT & QUARTZ SAND AS FINE AGGREGATE

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ABSTRACT : There are a lot of carbon emissions from cement which demands the usage of other alternatives as its replacement. Research is being carried out on the utilization of waste products in concrete as a replacement of natural sand. Due to the excessive usage of river sand as fine aggregate, the availability of the fine aggregate has become scanty. So, it demands for the search of other alternatives replacements for fine aggregates and cement additives which enhances the properties of fresh and hardened concrete like durability, strength, etc. In our study, we are going to experiment on the effects on mechanical properties of concrete by partially replacing cement with feldspar. Since Quartz is one of the most abundant materials available on the earth's crust and being highly siliceous these materials are being employed as the additives for cement and fine aggregate. This study mainly concentrates on the properties of hardened concrete properties which is the compressive strength of concrete. Here, cement is partially replaced using feldspar up to 25% at regular intervals of 5%. In addition to that, the river sand is completely replaced with quartz sand as fine aggregate. The above materials are being tested for M_{40} grade of concrete .

Key words – Feldspar, Quartz sand , Compressive strength, Quartz, Durability

1.Introduction

Concrete is one of the most versatile and durable construction materials that has been in used for centuries now in one form or the other. It is one of the widely accepted due to various properties such as fire resistance, plasticity, chemical resistance etc.

Cement is the chief compound in the concrete which is used as a binder. Albeit, cement may be one of the most viable and versatile binders that is available and being used, it has many harmful environmental impacts when concrete is directly being exposed and has sabotaging effects on the environment. It produces a lot of pollution releasing carbon dioxide and greenhouse gases in bulk amounts which harms the environment.

Cement industry produces about 10% of global manmade carbon dioxide emissions, of which 60% is from the chemical process. A Chatham house study from 2018 estimates that the 4 billion tonnes of cement which is produced annually accounts for 8% of worldwide carbon dioxide emissions. Due to the excessive use of river sand as fine aggregate, the availability of the fine aggregate has become scanty. Hence other materials can be used instead of river sand for construction purposes. So, it demands for the search of other alternatives for replacements of fine aggregates and cement additives which enhances the mechanical properties of concrete such as durability, workability, strength, etc.

Researches proved that mineral powders such as feldspar powder, glass powder, rice husk, etc., have proved that these powders when partially replaced with cement, increases the compressive strength and reduces the carbon emissions. One such material is the quartz sand which is used as an alternative for conventional river sand. These sands are used in recreation on golf courses, volleyball courts, baseball fields, children's sand boxes and beaches. Quartz sand can be found in Florida and passive continental margins. The researches proved that usage of quartz sand as replacement for sand is an economical solution for making the concrete resistant to weathering.

2. Experimental Methodology

2.1 Materials

2.1.1 Cement

53 grade Ordinary Portland cement of grade is used in the study. The properties of cement were tabulated below.

Properties	Magnitude
Specific gravity	2.3
Standard consistency	35%
Initial setting time	30 minutes
Final setting time	600 minutes

Table 1- Properties of Cement

2.1.2 Fine Aggregate

Quartz sand is used as fine aggregate in this study. Quartz sand is the most abundant silica mineral. The researches proved that usage of quartz sand as replacement for sand is an economical solution for making the concrete resistant to weathering.

The test procedure are taken from code IS 2720: 1980 part 3.

Properties	Magnitude
Specific gravity	2.53
Bulk density,kg/m^3	1830
Porosity%	29.67
Grading zone	Zone II
Fineness modulus	3.13
Water absorption	1.02%

Table 2 - Properties of Fine aggregate

2.1.3. Coarse Aggregate

The well graded round shaped crushed aggregates of size 20mm as per ***IS 2386: 1963-part-3*** is used as coarse aggregate.

Properties	Coarse aggregate
Particle shape	round
Particle size	20mm
Specific gravity	2.75
Bulk density	1340 kg / m^3
Fineness modulus	3.01%

Table 3 – Properties of coarse aggregate

2.1.4 Feldspar

Feldspar is the most important single group of rock forming silicate minerals. It is one of the second most abundant mineral available on the earths and makes up about 41% of the earth crust. In this present study feldspar is partially replaced with cement up to 25% at regular intervals of 5%.

Fig -1 Feldspar Powder

Oxide	Chemical composition (%)
Magnesium oxide	0.006
Ferrous oxide	0.215
Calcium oxide	0.010
Aluminum hydroxide	0.769
Silicon dioxide	99.02
Titanium oxide	0.078
Water	0.020

Table-4 Chemical composition of quartz sand

Oxide	Chemical composition (%)
Silicon dioxide	64.57
Aluminum hydroxide	18.28
Sodium oxide	0.09
Potassium oxide	16.01
Calcium oxide	-
Barium oxide	0.04

Titanium oxide	0.01

Table-5 Chemical composition of feldspar

2.5 Mix Design

Mix design leads to the development of a concrete specification. In the present investigations a mix of M40 grade concrete was used and designed as per relevant Indian Standard specification.

Cement(kg)	Fine aggregate(kg)	Coarse aggregate(kg)	w/c ratio
534.21	508.88	949.67	0.38

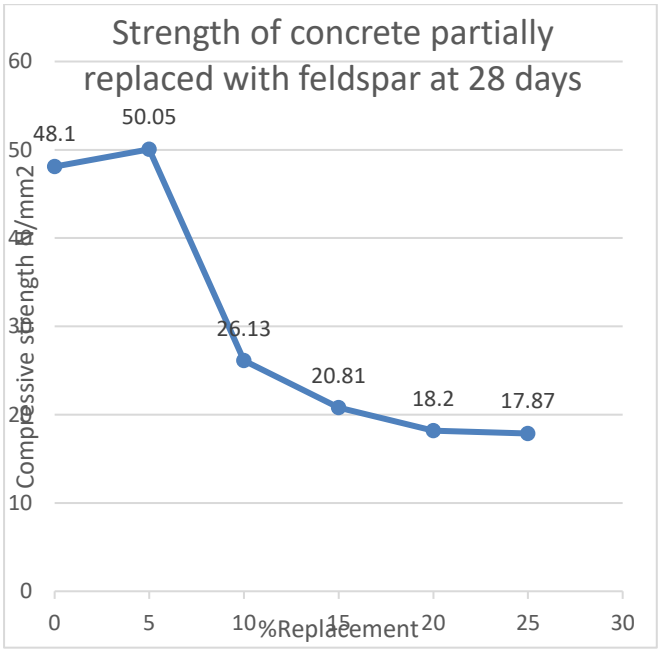
Table-6 mix design for M40 concrete

3. EXPERIMENTAL RESULTS

3.1 Compressive Test

The compressive test was performed when cement was partially replaced with feldspar with different percentages (5, 10, 15, 20, 25%) respectively for M40 grade of concrete at different ages such as 7,28 and 60 days respectively.

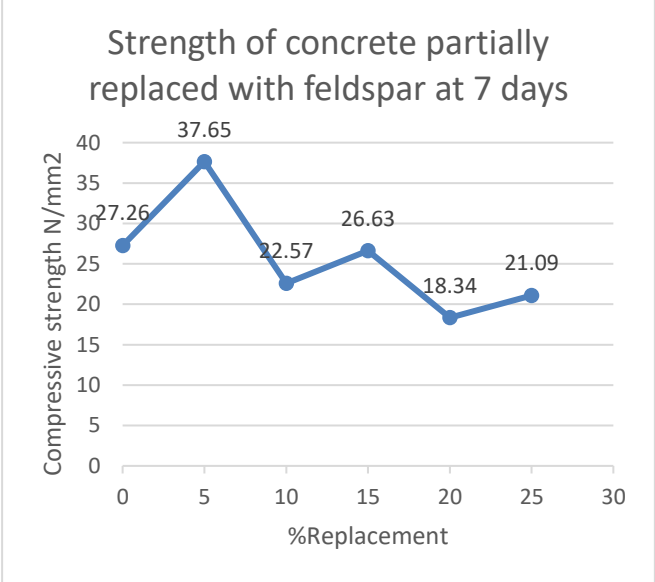
It was observed that the compressive strength of concrete decreased with the increase in percentage of feldspar



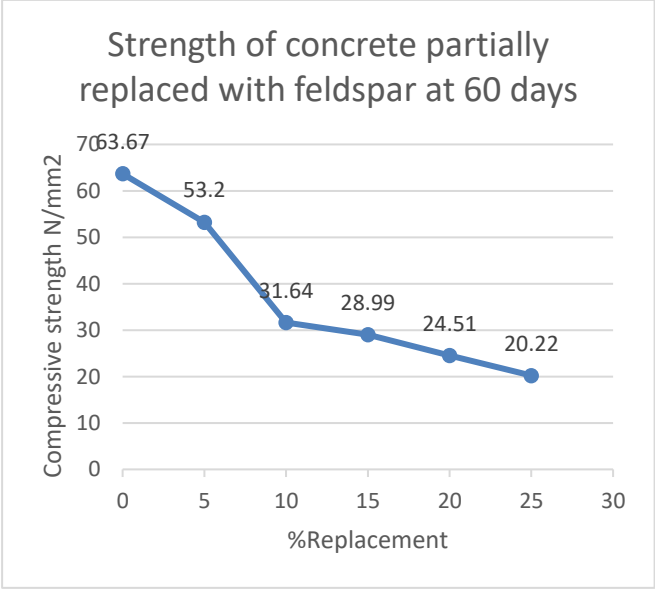
Graph 1 – Strength of concrete partially replaced with feldspar at 28 days

4. RESULTS AND DISCUSSIONS

- The experimental results showed that the mean compressive strength of concrete decreased with the increase in percentage of feldspar after 7 days and the maximum strength was achieved at 5%
- The mean compressive strength of concrete at 28 days is maximum when cement is partially replaced with 5% feldspar. It has then decreased steadily.
- The mean compressive strength of feldspar at 60 days is maximum when cement is partially replaced with 5% feldspar. It has then decreased steadily.



Graph 2 – Strength of concrete at 7 days



Graph 3 – Strength of concrete partially replaced with feldspar after 60 days

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