Comparative Study on Effects of Quartz Powder and Textile Sludge on Strength of Concrete

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ABSTRACT

The growth of concrete technology during the last decade has been mainly based on finding a suitable and eco-friendly substituent for cement. This project is synonymous to the same perception of finding an eco-friendly and feasible cementitious material. The reason trend is to incorporate industrial waste into concrete. Textile sludge is such a kind of industrial waste which is currently disposed by land filling that leads to ground water pollution and poor productivity of soil. In this study an attempt has been made to compare the mechanical strength of concrete of M30 grade by replacing cement by quartz powder and textile sludge respectively. Specimen were cast by replacing cement by quartz powder at 5,10 and 15 percentage by weight of cement and by textile sludge 5,10 and 15 percentage by weight of cement. An effort is also taken to investigate the combined effect of quartz powder and textile sludge on concrete by replacing quartz powder and textile sludge in equal proportion of 5, 10 and 15 percentage by weight of cement. Strength parameters such as compressive strength and split tensile strength were investigated. It was observed that the quartz powder of 10 % by weight of cement proved to be the optimum whereas on addition of textile sludge a decreasing trend was observed with 5% as the optimum.

Keywords: *mechanical strength of concrete, textile sludge, quartz powder, partial replacement.*

1. INTRODUCTION

Cement is a binder substance used in construction that sets and hardens and can bind other materials together. The most important types of cement are used as a component in the production of mortar in masonry, and of concrete, which is a combination of cement and an aggregate to form a strong building material. The total production of cement world-wide is of the order of 2000 MT. India is the second largest cement producer in the world. The installed production capacity at present is nearly 165 million tonnes (MT) annually. Cement is becoming a scarce resource all over the world because of its increasing demands day by day. The construction activities have increased in almost all the developing countries of the world. There always has been great effort in improving the quality and standards of the properties of concrete as a construction material. Traditionally fly ash is added to concrete as a pozzolana material to enhance the properties of concrete. The use of quartz powder as a pozzolana material has increased in recent years because when mixed in certain proportions it enhances the properties of both fresh and hard concrete like durability, strength, permeability and compressive strength, flexural strength and tensile strength. Quartz powder is a very fine crystalline material.

The textile industry is one of the oldest and largest sectors in India. At present it is among the top foreign exchange earning industries for India. The textile industry involves processing or converting raw material into finished cloth employing various operations. It consumes large quantities of water and produces polluting waste effluents. About 200 tonnes/day of textile sludge are generated in Tirupur. Although some of the sludge is disposed in an engineered landfill, much of the sludge is openly dumped, which leads to soil, surface water and groundwater contamination. Waste can be used to produce new products or can be used as admixtures so that natural resources are used more efficiently and the environment is protected from waste deposits. During the production of cement Co2 is produced which cause global warming. By reducing cement consumption environment can be protected. An attempt was made to partially replace the cement with Quartz powder and waste material Textile sludge with an aim to attain a strength far from original concrete mix.

1. EXPERIMENTAL INVESTIGATION

1.1. Materials

Cement: The Bureau of Indian Standards (BIS) has classified OPC in three different grades. The classification is mainly based on the compressive strength of cement-sand mortar cubes of face area 50 cm^2 composed of 1 part of cement to 3 parts of standard sand by weight with a water-cement ratio arrived at by a specified procedure. The grades are (i) 33 grade (ii) 43 grade (iii) 53 grade. The grade number indicates the minimum compressive strength of cement sand mortar in N/mm^2 at 28 days, as tested by above mentioned procedure. In this project, Chettinad 53 Grade Ordinary Portland Cement was used conforming IS 12269:1987.

Fine Aggregate: Aggregate which passed through 4.75 mm IS Sieve and retained on 75 micron (0.075 mm) IS Sieve is termed as fine aggregate. Fine aggregate is added to concrete to assist workability and to bring uniformity in mixture. Usually, the natural river sand is used as fine aggregate. Ordinary river sand conforming IS 383-1970 was used in this project.

Coarse Aggregate: The coarse aggregate for the works should be river gravel or crushed stone. Angular shape aggregate of size is 20 mm and below. The aggregate which passes through 75 mm sieve and retain on 4.75 mm are known as coarse aggregate.It should be hard, strong, dense, durable, clean, and free from clay or loamy admixtures or quarry refuse or vegetable matter. The pieces of aggregate should be cubical, or rounded shaped and should have granular or crystalline or smooth (but not glossy) non-powdery surfaces. Aggregate should be properly screened and if necessary washed clean before use. Coarse aggregate containing flat, elongated or flaky pieces or mica should be rejected. The grading of coarse aggregate should be as per specifications of IS 383-1970.In this project, maximum normal size of coarse aggregate was 20 mm for controlled concrete.

Water: The water should be fit for mixing. The water should not have high concentrations of sodium and potassium and there is a danger of alkali-aggregate reaction. Natural waters that are slightly acidic are harmless, but water containing organic acids may adversely affect the hardening of concrete. Such water as well as highly alkaline water should be tested. The water should conform to IS 456-2000 standards. Generally, water satisfactory for mixing is also suitable for curing purposes. However, it is essential that curing water should be free from substances that attack hardened concrete like free CO_2 etc.

Textile sludge: The textile sludge was obtained from the Veerapandi common effluent treatment plant (CETP), Tirupur, Tamil nadu, India. The sludge was collected from the sludge drying beds and land filling areas by Systematic sampling procedure. The sludge had a roughly 30% moisture content. The collected sludge was sundried to remove the moisture content present and was crushed and then sieved through 90 micron sieve. The fig 1, and 2 shows the sludge collected from CETPs

Fig 1 Dried sludge

Fig 2 Sieving of sludge sample

Quartz powder: Pozzolanic materials are generally able to combine with the hydrated calcium hydroxide (Ca(OH)2) forming the hydrated calcium silicate (C–S–H), which is the principal responsible for the strength of hydrated cement pastes. Also, increases in the bulk density of concrete results as the mixture voids are filled with very small admixture particles. It can produce both chemical and physical effects, which cause meaningful changes in the microstructure of concrete, diminishing its permeability and improving strength. The most important region in the microstructure of the concrete is around the aggregate. The addition of quartz powder in concrete leads to reduction in porosity of the transition zone between matrix and aggregate in the fresh concrete and provides the microstructure needed for a strong transition zone.

Hence, quartz powder is added with textile sludge to improve the strength of the concrete. Quartz powder is replaced by 5, 10 and 15 percent by the weight of cement. The fineness of the quartz powder is 200 Mesh which is equivalent to 74 microns which is finer than cement. It is a very reactive due to its fine size and high purity of silica content. The quartz powder particle is shown in fig 3.

Fig 3 Quartz powder

2.2 Mix Proportion

General:

As per IS method, mix design for M30 grade concrete was carried out using the test data for cement, coarse aggregate, and fine aggregate obtained by preliminary investigations.

Table 1 – Mix Proportion For M30 Concrete

	Cement	**Water**	**F.A.**	**C.A**
kg/m^3	442	186	671.814	1145.715
Ratio	1	0.42	1.395	2.586

3. RESULTS AND DISCUSSIONS

3.1. COMPRESSIVE STRENGTH TEST

Compression test has been carried out on concrete cubes with standards confirming to IS 516-1999. All the samples were tested in a 1000KN capacity universal testing machine. After 28 days of curing, the cubes were permitted to turn into dry condition before testing. Plane surfaces of the specimen were between platens of compression testing machine and subjective to loading.

Table 2 – Characteristic Compressive Strength of concrete (N\mm^2)

SL.NO	MIX COMBINATIONS	CHARACTERESTIC COMPRESSIVE STRENGTH (N/mm^2)	
		7-DAYS	28-DAYS
1	S0 Q0	18.66	29.83
2	S0 Q5	13.33	28.89

3	S0 Q10	16.89	32
4	S0 Q15	12.89	26.68
5	S5 Q0	18.22	30.67
6	S10 Q0	10	15.56
7	S15Q0	5.0	8.22
8	S5Q10	11.22	26.12
90	S10Q10	10.20	24.28
10	S15Q10	10.0	19.59

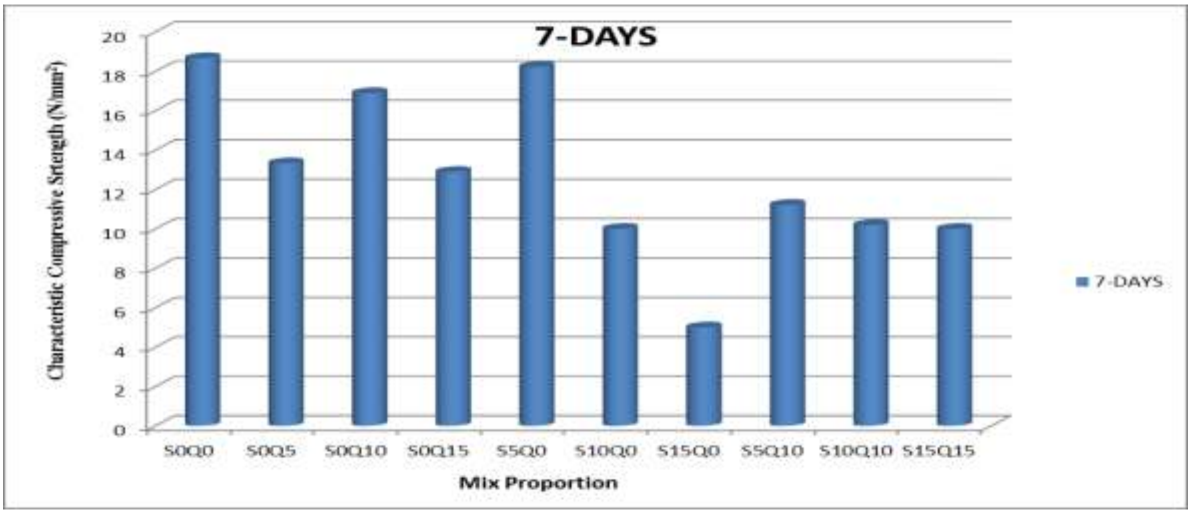

Figure 4 Compressive strength 7 Days (N/mm^2)

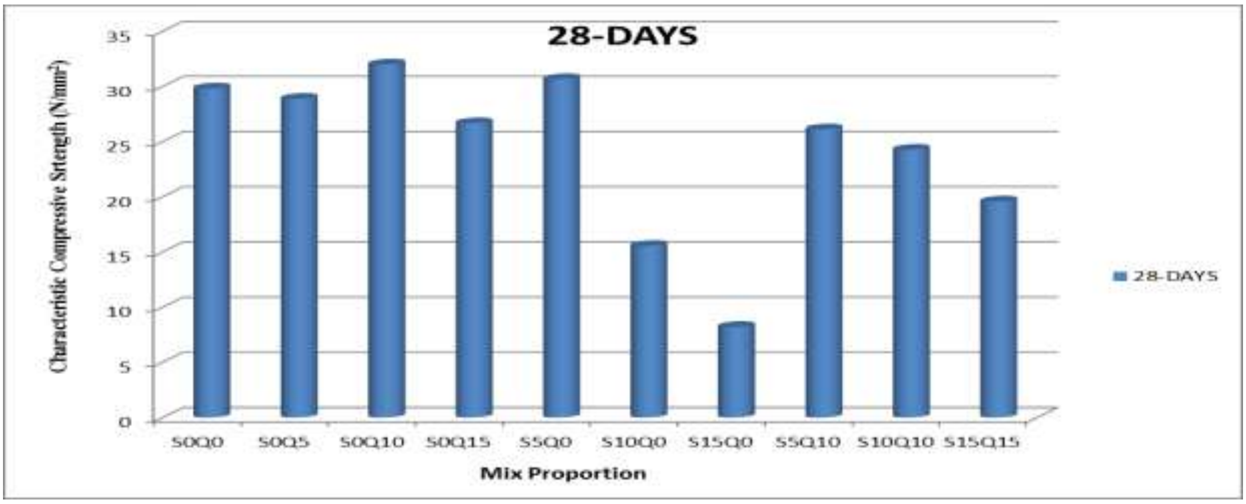

Figure 5 Compressive strength 28 Days (N/mm^2)

3.2 Tensile Splitting Test

The split tensile strength of a concrete is carried on cylindrical specimen of diameter 150mm and length 300mm.Two wooden-bearing strips are placed. The specimen was loaded until it fails. The test is done at the age of 7, and 28 days. The machine used was the same UTM that used for compression test.

Table – 3. Split tensile strength for 7 & 28 days

S NO	MIX COMBINATION	SPLIT-TENSILE STRENGTH (N/mm^2)	
		7 DAYS	28 DAYS
1	NORMAL	2.108	3.137
2	S0 Q5	1.2	2.68
3	S0 Q10	1.84	3.81
4	S0 Q15	0.84	1.32
5	S5 Q0	1.25	2.1
6	S10 Q0	1.686	2.509
7	S15 Q0	1.44	1.52
8	S5Q10	1.23	1.84
9	S10Q10	1.17	2.1
10	S15Q10	1.1	1.8

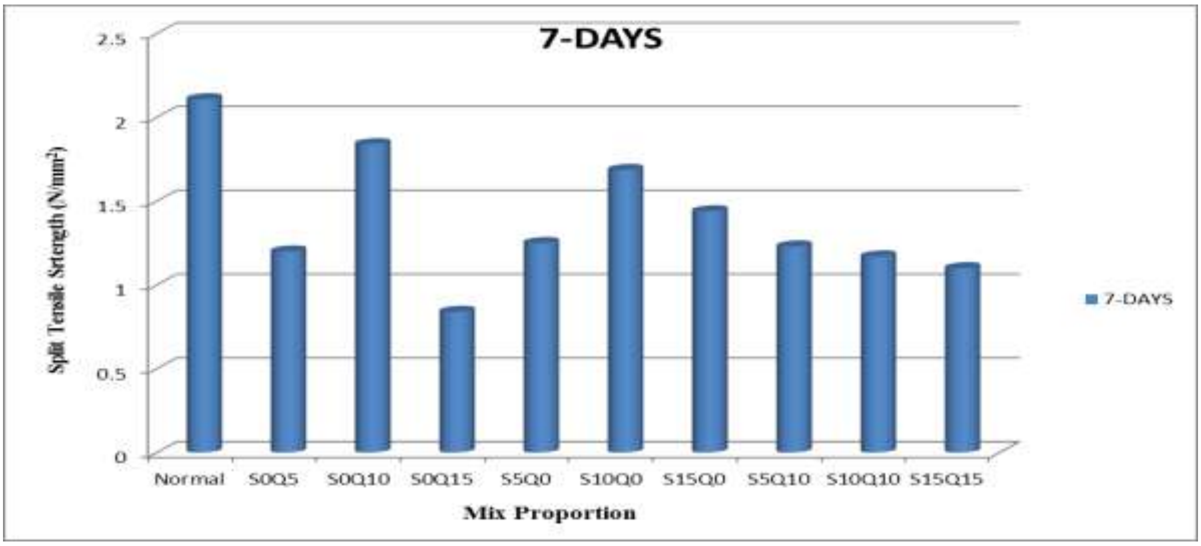

Figure 6 Split tensile strength 7 Days (N/mm^2)

Figure 7 Split tensile strength 28 Days (N/mm^2)

CONCLUSIONS

Extensive experimentation has been carried out to determine utilization of the textile sludge as cement replacement material in concrete and also to found out the effect of quartz powder as a partial replacement of cement in concrete. Based on the above results the following conclusions can be drawn.

1. From the compressive strength results it is seen that the strength of the concrete decreases on the addition of textile sludge as replacement of cement.
2. When the cement is replaced by textile sludge alone by 5, 10 and 15 percent, the maximum compressive strength is attained at 5% and the value decreases as the percentage increases.
3. When 5, 10 and 15 percentage of quartz powder is added, the compressive strength is increased by 9.6% at 10% than the normal concrete.
4. The increase in strength of the sludge based concrete was not greater than the control concrete might be due to the fact that the silica present in the quartz powder is either less reactive or non-reactive.
5. Other strength parameter like split tensile strength also decreases like the compressive strength with the increase in the percentage of replacement of cement with textile sludge
6. The cement can be replaced by quartz powder partially with 10% so that the required quantity for cement can be reduced by 134gms in 150*150*150 cube.

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