

Evaluation of Properties of Concrete using Quartz Sand and Polypropylene Fiber “An Experimental Study”

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ABSTRACT: The use of quartz sand as replacement for sand is an economical solution for making the concrete resistant to weathering. The paper presents a concrete mix design procedure for partial replacement of sand with quartz sand. Present method was performed to evaluate the additional compressive, flexural strength with higher slump over conventional concrete in which sand is replaced with 0%, 20%, 40%, 60%, 80% and 100% of quartz sand by weight with 1% of Polypropylene Fiber. The research also revealed that there is possibility of replacing fine aggregate with quartz sand in the production of structural concrete. The mix proportion adopted was 1:1.5:3. Compressive, split tensile and flexural strength tests were carried out to evaluate the strength properties of concrete at the age of 28 days. RCPT tests were carried out at the age of 28 days.

KEYWORDS: Quartz sand, Polypropylene fiber, Compressive test, split tensile test, flexural strength test, Rapid Chloride Permeability Test.

I. INTRODUCTION

Sand becomes a scarce material, alternative for sand is needed all over, and also providing good strength than conventional concrete and some additional advantages, this experiment is done. This study gives a new alternative for fine aggregate. Resistant nature to weathering is very useful for buildings in future. Quartz sands are used for traction in the railroad and mining industries. These sands are also used in recreation on golf courses, volleyball courts, baseball fields, children's sand boxes and beaches.

It is also used in glass manufacturing, petroleum industry, as an abrasive. Quartz sand is used as filler in the manufacture of rubber, paint and putty. Quartz is very resistant to both chemicals and heat. It is used as a foundry sand with a melting temperature higher than most metals. Refractory brick is often made of quartz sand because of its high heat resistance.

Concrete is not normally designed to resist direct tension. Principal tensile stresses may also result from multi-axial states of stress. Concrete without any fibers will develop cracks due to plastic shrinkage, drying shrinkage and changes in volume of concrete. Normally cracking in concrete occurs when tensile strength exceeds its limiting value.

II. OBJECTIVES

1. Sand becomes a scarce material, alternative for sand is needed all over, and also providing good strength than conventional concrete and some additional advantages, this experiment is done.
2. Compare the strength properties of conventional concrete mix M20 with the properties of concrete with quartz sand partially replacing conventional sand. To observe the effect of vehicle composition on saturation flow.
3. Find the optimum percentage of quartz sand that can be replaced for sand.

III. SCOPE OF THE STUDY

1. Make use of the quartz sand available from Quartz quarry and industries as fine aggregate in concrete.
2. Evaluate the properties of fresh concrete and strength properties of hardened concrete.
3. This study gives a new alternative for fine aggregate. Resistant nature to weathering is very useful for buildings in future.

IV.METHODOLOGY

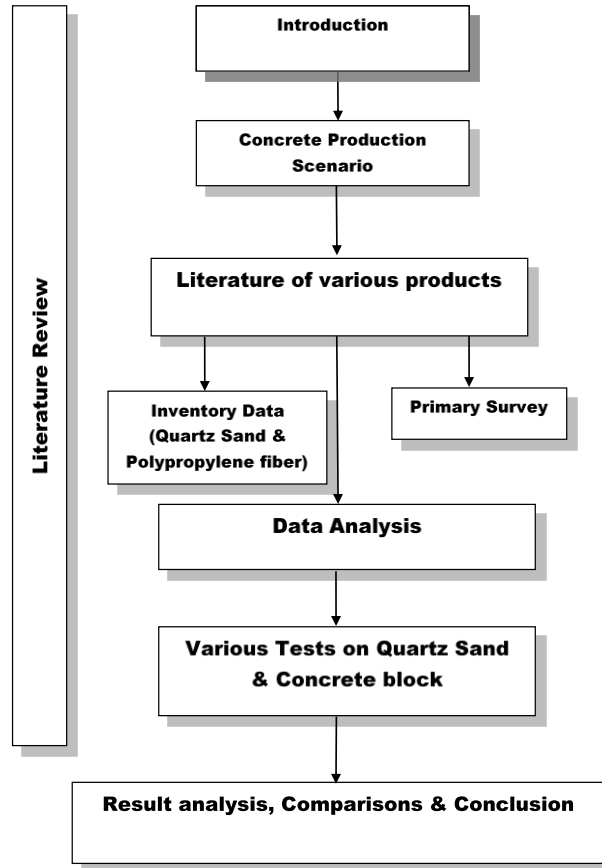


Fig 1. Flow chart showing methodology for the proposed work

V.PROPERTIES AND TESTS OF REPLACED MATERIALS

1. Quartz Sand

Quartz is the most important sand-forming mineral. Because it is resistant to both physical and chemical weathering and it is also physically hard. Quartz sand can be found in Florida and passive continental margins. Sand from Siesta Key beach is sometimes called the whitest in the world although it has competitors. Thus, we very often see it in sediments. Quartz is also the most important hydrothermal mineral, filling cracks in the crust with many other and often economically important minerals.

Chemical properties:

Table 1. Chemical Properties of Quartz Sand

Description	Percentage
LOI	29.28
SiO ₂	28.93
Al ₂ O ₃	2.00
Fe ₂ O ₃	0.76
CaO	37.33
MgO	0.53



Physical Properties:

Table 2. Physical Properties of Quartz Sand

Properties	Result
Specific gravity	2.45
Water absorption	2.1 %
Fineness modulus	2.2
Bulk density	1.6 gm/cm ³

2. Polypropylene Fiber

Polypropylene is available in two forms, monofilament fibers and film fibers. Monofilament fibers are produced by an extrusion process through the orifices in a spinneret and then cut to the desired length. The newer film process is similar except that the polypropylene is extruded through a die-that produces a tubular or Performance of Polypropylene Fiber flat film. This film is then slit into tapes and uniaxially stretched. These tapes are then stretched over carefully designed roller pin systems which generate longitudinal splits and these can be cut or twisted to form various types of fibrillated fibers. The fibrillated fibers have a net-like physical structure.

The tensile strength of the fibers is developed by the molecular orientation obtained during the extrusion process. The draw ratio (final length/initial length), a measure of the extension applied to the fiber during fabrication, of polypropylene fibers is generally about eight. Polypropylene has a melting point of 165 degrees C and can withstand temperatures of over 100 degrees C for short periods of time before softening'. It is chemically inert and any chemical that can harm these fibers will probably be much more detrimental to the concrete matrix'.

Monofilament fibers were the first type of polypropylene fiber introduced as an additive in PFRC. The majority of fiber manufacturers recommend the fibrillated type of fiber for use in paving applications. The exact chemical composition and method of manufacture may vary slightly among producers. The main types or geometry of fibers currently available from most producers are monofilament and fibrillated.

Table 3. Properties of polypropylene fiber

Properties	Result
Diameter	0.04 mm
Length	12 mm
Aspect Ratio	300
Tensile strength	4000-6000 kg/cm ²
Specific gravity	1.33
Elongation	50-70 %
Dispersion	3-4
Shape of fiber	Special triangle shape

VI. TESTS AND ANALYSIS OF RESULTS

1. TESTS ON CONCRETE

- A. Workability of Concrete
- B. Compressive Strength Test
- C. Tensile Strength Test
- D. Flexural Strength Test of Concrete (IS:516-1959)
- E. Rapid Chloride Permeability Test

2. ANALYSIS OF RESULT

A. WORKABILITY OF CONCRETE

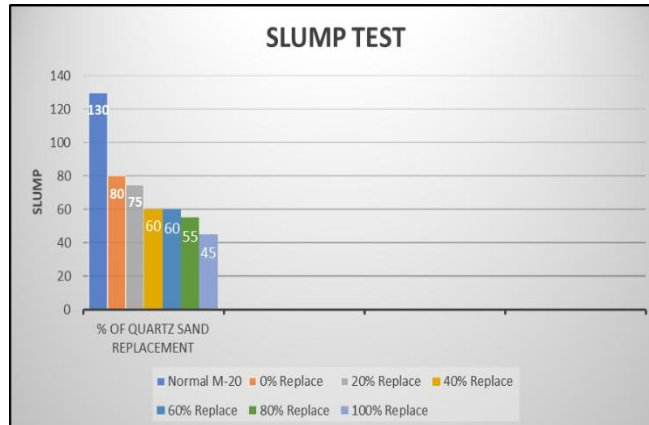


Fig 2. Slump Test Chart

B. COMPRESSIVE STRENGTH OF CONCRETE CUBE

The cube compressive strength of concrete was determined by conducting test on 150mm x 150mm x 150mm cube specimens after 28 days of curing. After curing the cube specimens were tested on compression testing machine.

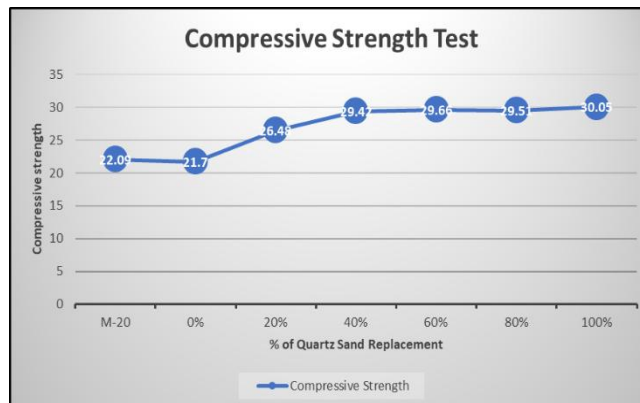


Fig 3. Compressive strength After 28 Days Graph

C. SPLIT TENSILE STRENGTH OF CONCRETE CYLINDER

The tensile strength of concrete was determined by conducting test on cylinder of diameter 150mm and height of 300 mm after 28 days of curing. After curing the specimens were tested on compression testing machine.

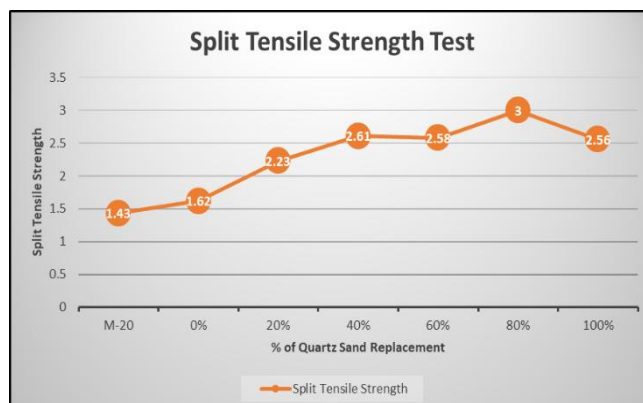


Fig 4. Split Tensile strength After 28 Days Graph



D. FLEXURAL STRENGTH OF CONCRETE BEAM

The flexural strength of concrete was determined by conducting test on beam of size 150mm x 150mm x 700mm after 28 days of curing. After curing the specimens were tested on Flexural test machine.

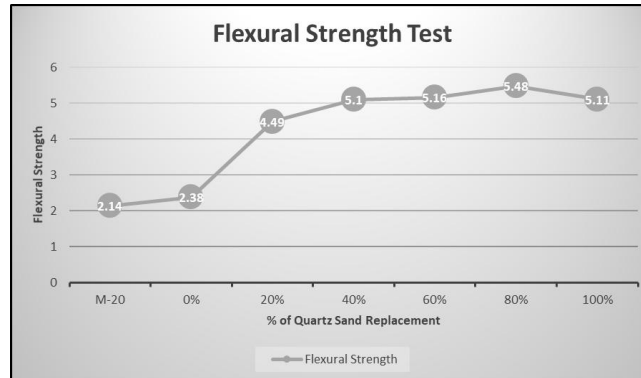


Fig 5. Flexural strength After 28 Days Graph

E. RAPID CHLORIDE PERMEABILITY TEST

We have performed Rapid Chloride Permeability Test (RCPT) on two hardened concrete specimens having different proportion of quartz sand as a replacement and compared the test results of both of them in Unique Engineering Testing and Advisory Services. One specimen was a normal M-20 concrete mix and the other had 80% replacement of river sand with quartz sand. Polypropylene fibers weighing 1% of the weight of cement were added in concrete having 80% replacement. The sample having 80% replacement was selected because it has shown maximum compressive, split tensile and flexural strength in our previous tests.

Table 4. Value of current passed

Date	Time	CURRENT (mA)			
		80 % quartz sand + 1% PP fiber		Normal M-20	
		Sample 1	Sample 2	Sample 1	Sample 2
03-05-2020	12:34	96.9	97	97.2	97.5
03-05-2020	13:04	106.4	107.1	112.4	112.6
03-05-2020	13:34	113.2	115.7	121.6	123.2
03-05-2020	14:04	123.6	125.8	129.1	131.3
03-05-2020	14:34	128.7	131.5	138.3	142.8
03-05-2020	15:04	136.2	139.2	147.1	153
03-05-2020	15:34	147.5	149.8	159	165.5
03-05-2020	16:04	159.8	162.4	171.3	178.5
03-05-2020	16:34	172.6	176.3	183.6	190.8
03-05-2020	17:04	181.4	184.6	195.3	201.8
03-05-2020	17:34	193.7	197.2	206.4	212
03-05-2020	18:04	204.6	208.4	219.1	223
Coulombs		3108.6	3167.6	3297.2	3389.8

The RCPT result for concrete sample of 80% replacement has shown slight improvement in durability over sample of normal M-20 concrete.

F. COMPARISON OF STRENGTHS (COMPRESSIVE, SPLIT TENSILE AND FLEXURAL STRENGTHS)

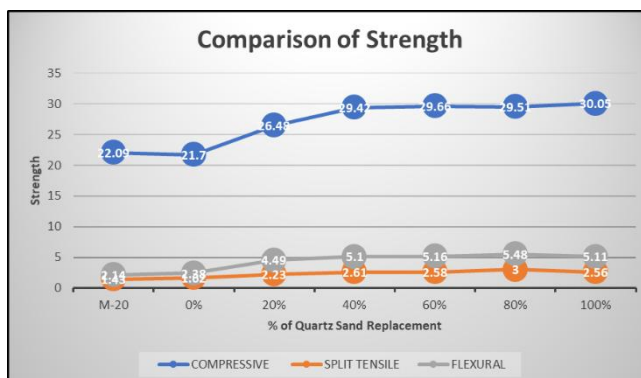


Fig 6. Comparison of strengths After 28 Days Graph

VII.APPLICATIONS

1. Due to its increased fire resistance, it can be used in construction of chimneys, cooling towers, etc.
2. Improved resistance to cracking makes it suitable to be used for construction of structures subjected to vibration like power looms industries.
3. More durable nature of hardened concrete gives it an upper hand to be used for construction of marine structures.

VIII.CONCLUSION

- We used Quartz sand as 20%, 40%, 60%, 80% and 100% replacement of river sand and also added constant proportion of 1% of polypropylene fiber by weight of cement. We have performed many practical's and got good results.
- We found that compressive strength, split tensile strength and flexural strength is better than normal M-20 concrete.
- We found out the maximum Compressive, split tensile and flexural strength with 80% replacement of river sand with Quartz sand in M-20 concrete.
- The RCPT for concrete containing maximum strength i.e., 80% replacement has shown slight improvement in durability over normal M-20 concrete.
- After comparison, we can conclude that all the test results which we gained for quartz sand and polypropylene fiber is better than normal sand.
- Concrete containing quartz sand as a replacement shows higher resistance to fire due to high percentage of silica content as compared to conventional river sand.
- Concrete containing quartz sand as a replacement yields higher strength possibly due to small grain size of quartz sand which result in less voids in concrete specimens.

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