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An Experimental Study on Concrete Containing Sandstone and Quarry Dust

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Abstract: *This research paper study to overcome dumping of sandstone waste and quarry dust and to lessen the use of natural aggregate in concrete. The effective waste management can contribute towards saving of our environment. M20 grade of concrete proportion a study carried to find out effective use of sandstone waste and quarry dust in concrete. The experimental study to investigate the fresh and hardened properties of M20 grade of concrete with W/C is kept 0.55. The sandstones might be utilised as a partial replacement of coarse aggregates with 0%, 10%, 20%, 30%, 40%, and 50%. The quarry dust might be utilised as a partial replacement of fine aggregate with 0%, 10%, 20%, 30%, and 40%. The test results show that the sandstone and quarry dust can be effectively use in concrete. In this study it is found to increase the hardened strength properties like compressive strength, flexural strength and split tensile strength.*

Keywords: *Concrete, Sandstone, Quarry Dust, Coarse Aggregate, Fine Aggregate, Compressive Strength, Flexural Strength, Split Tensile Strength.*

I. INTRODUCTION

Each year thousands of tons of wastes are disposed of in landfills which results in the occupation and degradation of valuable land. Currently waste handling & utilization are ecological problems. So reuse of wastes as inputs to other processes would alleviate disposal concern & reduce the need for virgin resources. Use of hazardous waste in concrete making will lead to green environment & sustainable concrete technology.

So use of sandstone waste in making concrete serves the meaning of "Green Concrete".

Sandstone is a classic sedimentary rock comprising an aggregate of sand sized (0.06 - 2.0 mm) fragments of minerals, rocks of fossils held together by a mineral cement. During burial the sand is compacted and a binding agent such as quartz, calcite or iron oxide is precipitated from ground water which moves through passage ways between grains to crete sand stone. The sandstone are of an irregular shape and white colour. Sand stone are used as aggregate because sand stone have compacted structure and they are stronger than good compressive strength.

In such a situation the quarry rock dust can be an economic alternative to the river sand. Quarry rock dust can be defined as residue, tailing or other non-volatile waste material after the extraction and processing of rocks to form fine particles less than 4.75mm. Usually, quarry rock dust is used in large scale in the highways as a surface finishing material and also used for manufacturing of hollow blocks and lightweight concrete prefabricated elements. In highways department the quarry dust is used to sprinkle over the newly laid bituminous road as a binding material between the bitumen and coarse aggregate. The fine powder from quarry dust is mixed with cement and used in grouting works. The quarry dust is used in the manufacturing of hollow blocks. Some mosaic companies use quarry dust partly for sand. In telecommunication department the quarry dust is used to refill the excavated pits after laying the telephone cables.

II. OBJECTIVE

To evaluate the fresh properties of concrete (slump test, compacting factor test) with the use of partial replacement of sandstone as (0%,10%, 20%, 30%, 40%, 50%) for coarse aggregate and quarry dust as (0%,10%,20%,30%,40%) as for fine aggregate.

Develop a new class of engineering material specifically suiting strength criteria for general and structural applications by incorporating sandstone waste in concrete making.

To achieve the hardened properties (Compressive strength, flexural strength, Split tensile Strength) of concrete with use of partial replacement of sandstone by 0%, 10%, 20%, 30% , 40%,50 % as coarse aggregate and Quarry dust replacement with 0%, 10%, 20%, 30% , 40% as fine aggregate.

III.MATERIAL USED IN CONCRETE

A. Cement

The Ordinary Portland Cement 53 grade was used for all concrete mixes. The properties of cement are fine, greenish, and grey powder. Cement is mixing with water, sand and aggregate to make standard concrete. The cement and water form a paste that binds the other materials together as the concrete harden state. A material having adhesive and cohesive properties which make it capable of bonding material fragment into compact mass. Cement is very important ingredient in concrete.

B. Water

The Water used for mixing and curing shall be clean and free from injurious amount of salts, oils, acids, alkalis, organic materials or other deleterious materials.

C. Fine Aggregate

The fine aggregate (sand), which is used in the investigation is clean river sand and conforming to zone II as per IS: 383-2016. The sand was first sieved through 4.75 mm sieve to remove any particles greater than 4.75 m.

D. Coarse Aggregate

The coarse aggregate use as the crushed stone aggregate used which is passed through the 20 mm IS sieve and retained from the 4.75 mm IS sieve.

Table 1
Properties Of Coarse And Fine Aggregate

Physical Properties	Coarse Aggregate	Fine Aggregate
Specific gravity	2.75	2.70
Fineness modulus	7.10	2.64
Free surface moisture (%)	Nil	0.60 %
Water absorption (%)	0.45 %	0.53 %

E. Sandstone

The Sandstone is also known as silica, calcium carbonate, or iron oxide. It can be used in concrete and materials. Micro silica, when used in concrete, it can improve concrete's properties such as compressive strength, bond strength and abrasion resistance, reduces permeability. It Is Usually A White Coloured Sand Stone. From These Sites I Have Collected the Sandstone Waste from Dhagadhara taluka which Is Located in Tejas sand stone Pvt. Ltd. Kuda village, Surendranagar Dist.

TABLE 2 PHYSICAL PROPERTIES OF SANDSTONE

Physical properties	Crushed Sandstone
Specific gravity	2.50
Fineness modulus	7.05
Free surface moisture (%)	Nil
Water absorption (%)	0.60 %

TABLE 3CHEMICAL PROPERTIES OF SANDSTONE

Chemical Composition	Unit	Obtained Results
Silica as SiO ₂	%	85.00
Alumina as Al ₂ O ₃	%	10.37
Iron as Fe ₂ O ₃	%	0.54
Lime as Cao	%	2.84
Magnesium as MgO	%	0.0086
Soda(Na ₂ O)	%	1.0
Loss On Ignition (LOI)	%	1.0 to 1.2
Potash (Kro)	%	1.2

Source: Reliable Testing Laboratory Rajkot

F. Quarry Dust

The Quarry dust is similar to fine aggregate angular to round in shape. It is directly replaced fully or partially by fine aggregate in concrete. Stone dusts are grey in color and dry in condition. From These Sites I Have Collected the quarry dusts from local crusher mix Rajkot.

TABLE 3
PHYSICAL PROPERTIES OF QUARRY DUST

Physical properties	Quarry dust
Specific gravity	2.57
Fineness modulus	2.43
Free surface moisture (%)	Nil
Water absorption (%)	0.40 %

TABLE 4
CHEMICAL PROPERTIES OF QUARRY DUST

Chemical Composition	Unit	Obtained Results
Silica as SiO ₂	%	50.00
Alumina as Al ₂ O ₃	%	26.31
Iron as Fe ₂ O ₃	%	7.65
Lime as Cao	%	9.11
Magnesium as MgO	%	1.04
Soda(Na ₂ O)	%	1.0
Loss On Ignition (LOI)	%	0.48
Potash (Kro)	%	3.18

Source: Reliable Testing Laboratory Rajkot

IV. EXPERIMENTAL PLAN

A. Procedure

- 1) Assessment of mix design methods.
- 2) Selection of mixing procedure and test methods.
- 3) Selection of the target properties of normal concrete made with also sand stone & quarry dust for the subsequent tests.
- 4) Selection of constituent's materials

B. Mix Proportions

The coarse aggregate is partially replaced with sandstone by 0%,10%,20%,30%,40%,50% and fine aggregate replaced with quarry dust 0%, 10%,20%,30%,40%.test was carried out for M-20 grade of concrete.

TABLE 5
DESIGN MIX PROPORTIONS

Volume of concrete	By weight (kg/m ³)	By volume
Cement	348.33	1.00
Water	191.58	0.55
Fine aggregate	745.77	2.10
Coarse Aggregate	1166.36	3.35

V. RESULTS AND DISCUSSION

TABLE 6
FRESH AND HARDENED PROPERTIES OF CONCRETE

Concrete Mix	Identification Mark	Slump (mm)	Compacting Factor	Compressive Strength (N/mm ²)		Flexural Strength (N/mm ²)	Split Tensile Strength (N/mm ²)
				7 Days	28 Days	28 Days	28 Days
M1	FA 100 % + CA 100% + QD 0 % + SS 0 %	72	0.92	18.41	27.72	3.06	2.89
M2	QD 10 % + SS 10 %	69	0.91	18.84	28.40	3.11	2.92
M3	QD 20 % + SS 10 %	63	0.87	19.33	29.23	3.28	2.99
M4	QD 30 % + SS 10 %	59	0.84	19.44	29.29	3.68	3.14
M5	QD 40 % + SS 10 %	54	0.81	19.00	29.00	3.13	2.93
M6	QD 10 % + SS 20 %	67	0.88	18.89	28.46	3.17	2.98
M7	QD 20 % + SS 20 %	61	0.85	19.44	29.30	3.32	3.07
M8	QD 30 % + SS 20 %	57	0.82	19.61	29.60	3.75	3.21
M9	QD 40 % + SS 20 %	52	0.79	19.24	29.02	3.15	3.03
M10	QD 10 % + SS 30 %	65	0.86	18.93	28.52	3.22	3.06
M11	QD 20 % + SS 30 %	59	0.83	20.47	30.84	3.4	3.15
M12	QD 30 % + SS 30 %	55	0.8	20.77	31.32	3.85	3.3
M13	QD 40 % + SS 30 %	50	0.77	20.07	30.25	3.27	3.11
M14	QD 10 % + SS 40 %	63	0.84	19.47	29.35	3.38	3.12
M15	QD 20 % + SS 40 %	57	0.81	20.61	31.08	3.47	3.19
M16	QD 30% + SS 40 %	53	0.78	20.99	31.70	3.92	3.37
M17	QD 40 % + SS 40 %	48	0.75	20.22	30.52	3.35	3.15
M18	QD 10 % + SS 50 %	61	0.82	19.42	29.27	3.18	3.07
M19	QD 20 % + SS 50%	55	0.79	21.61	32.58	3.22	3.13
M20	QD 30 % + SS 50%	51	0.76	22.13	33.41	3.8	3.25
M21	QD 40 % + SS 50%	46	0.75	20.99	31.07	3.2	3.05

A. Slump Test

The workability of concrete consistency is measured by slump test. In M-20 grade concrete with the increment of sand stone and quarry dust as partial replacement of coarse aggregate and fine aggregate there is decrease in slump in the rate of percentage as 72, 69, 67,63,61 in M-20 grade of concrete.

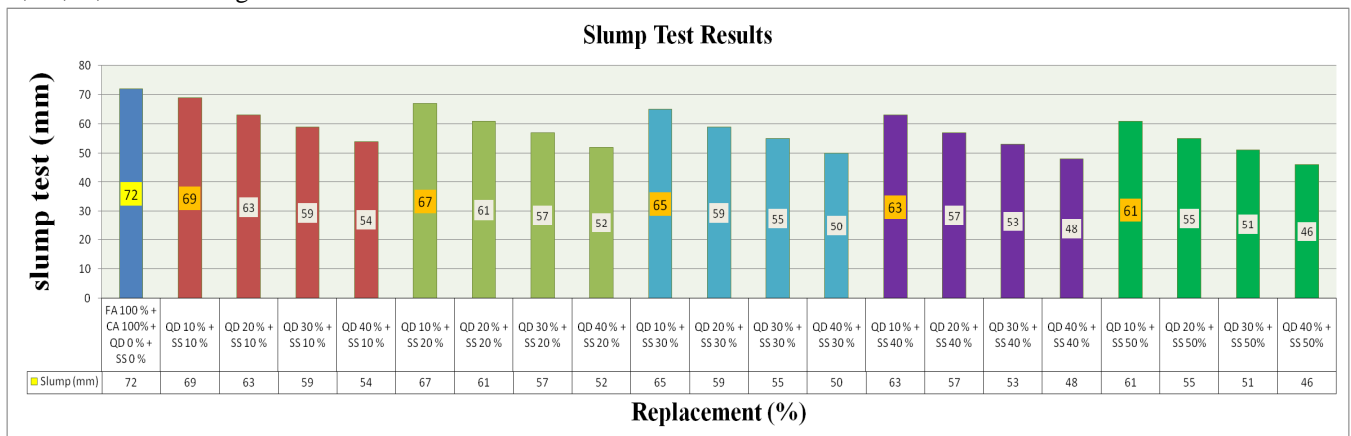


Fig. 1 Slump Test Results

B. Compacting Factor Test

The workability of concrete mix of is measured by Compacting Factor test. In M-20 grade concrete with the increment of sand stone and quarry dust as partial replacement of coarse aggregate and fine aggregate there is decrease in slump in the rate of percentage as 0.92,0.91,0.88,0.86,0.84,0.82 in M-20 grade of concrete.

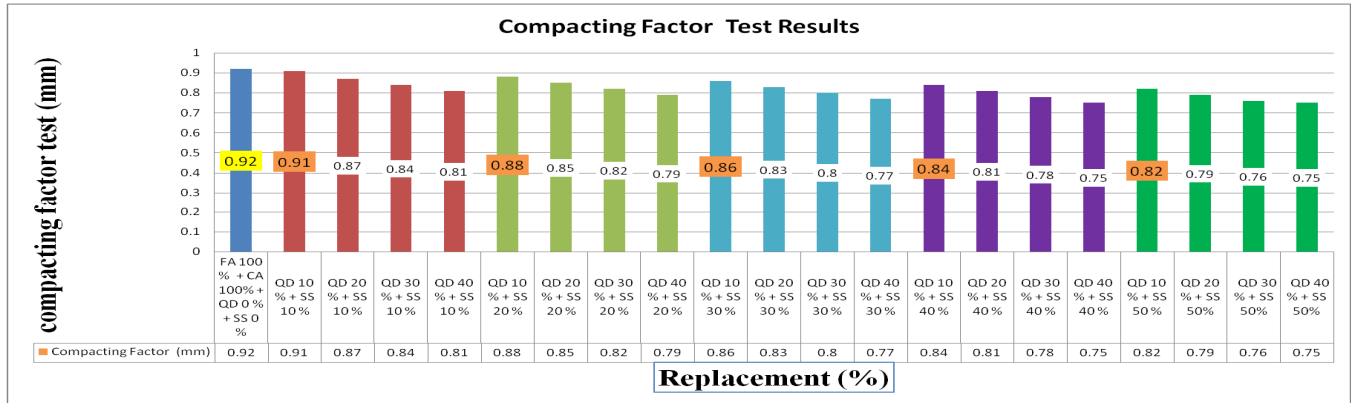


Fig. 2 Compacting Factor Test Results

C. Compressive Strength Test

The Results of Compressive Strength of grades M-20 of partial replacement of sand stone and quarry dust as partial replacement of coarse aggregate and fine aggregate.

In M-20 grade concrete the value of 50 % sandstone and 30 % of quarry dust partial replacement gives 7 days & 28 days maximum 22.13 MPa& 33.41 MPa compressive strength.

Compressive Strength of concrete In M-20 grade concrete with the increment of sand stone and quarry dust as partial replacement of coarse aggregate and fine aggregate there in the rate of percentage as for 7 days results 18.41,19.44,19.61, 20.77, 20.99, 22.13 and 28 days results 27.72,29.29,29.60,31.32,31.70,33.41 .

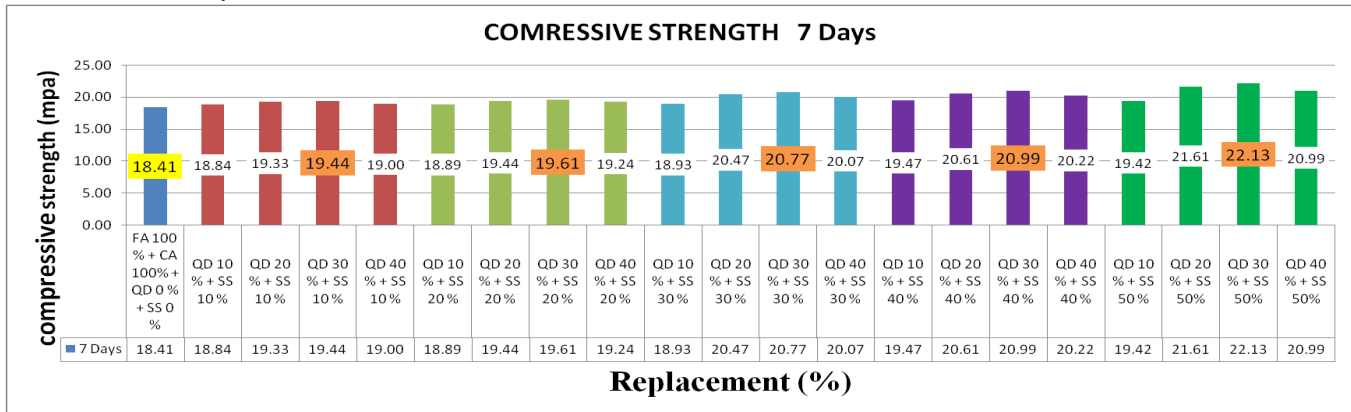


Fig. 3 Compressive Strength Test Results @ 7 Days

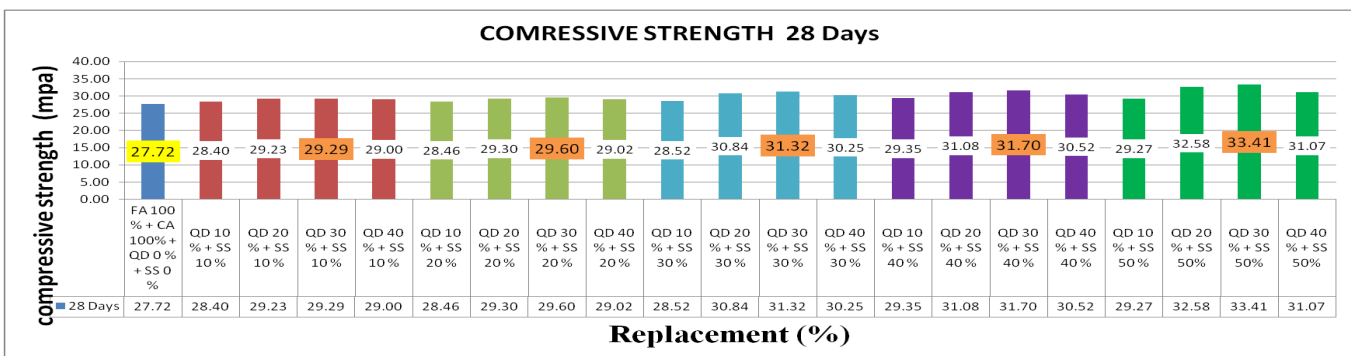


Fig. 4 Compressive Strength Test Results @ 7 Days

D. Flexural Strength Test

In M-20 grade concrete the value of 40 % sand stone and 30 % quarry dust partial replacement of coarse aggregate and fine aggregate gives maximum 3.92 MPa flexural strength. flexural Strength of concrete In M-20 grade concrete with the increment of sand stone and quarry dust as partial replacement of coarse aggregate and fine aggregate 28 days results 3.06,3.68,3.75,3.85,3.92,3.80 .

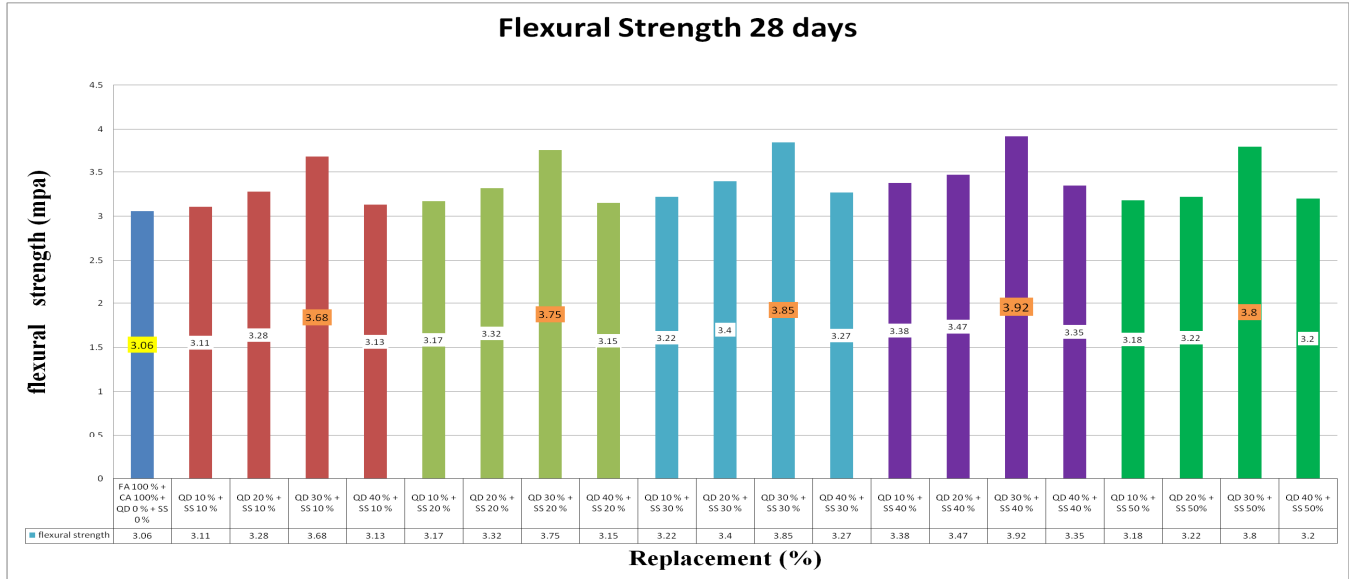


Fig. 5 Flexural Strength Test Results @ 28 Days

E. Split Tensile Strength Test

In M-20 grade concrete the value of 40 % sand stone and 30 % quarry dust partial replacement of coarse aggregate and fine aggregate gives maximum 3.37 MPa strength Split Tensile strength. Split Tensile strength of concrete In M-20 grade concrete with the increment of sand stone and quarry dust as partial replacement of coarse aggregate and fine aggregate 28 days results 2.89,3.14,3.21,3.30,3.37,3.25 .

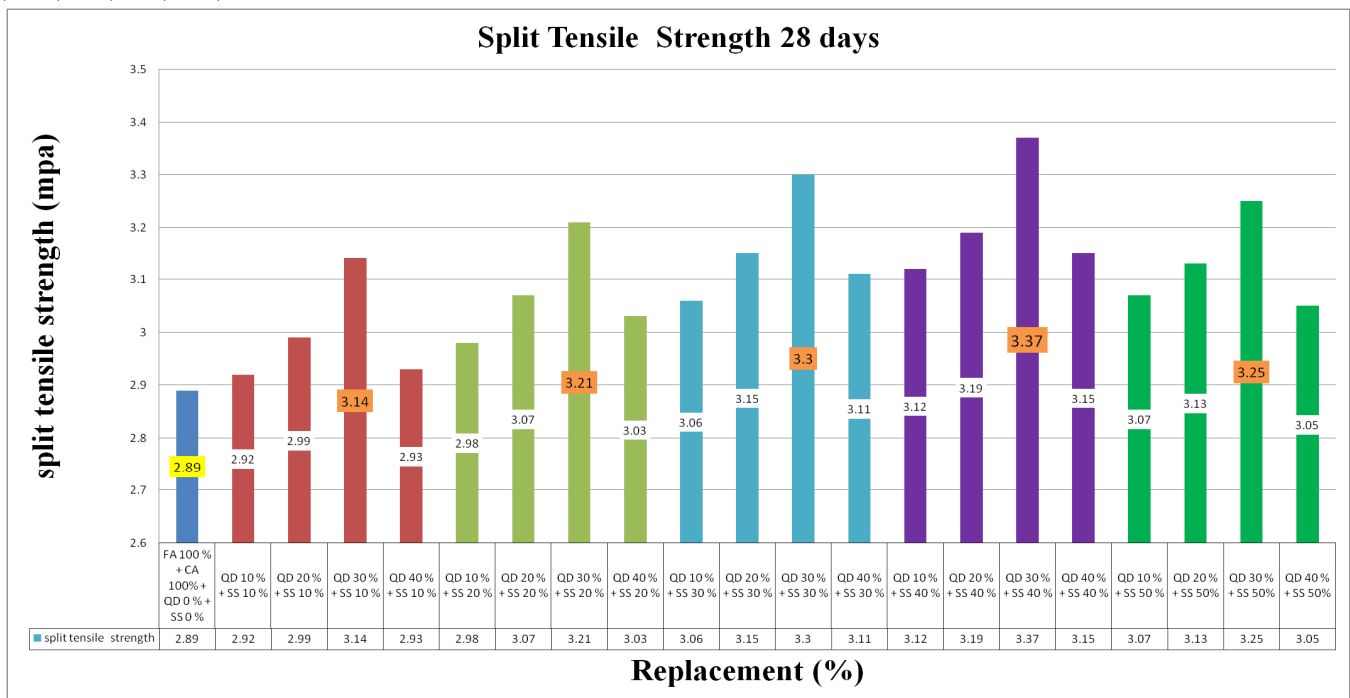


Fig. 6 Split Tensile Strength Test Results @ 28 Days

VI. CONCLUSIONS

Based on experimental investigation, following observations are made on the fresh property, hardened properties and durability of M-20 grade of concrete:

- A. Workability of concrete is measured by slump and compacting factor test. The percentage of sandstone and quarry dust was increases than workability of M20 grade of concrete is decreases constantly.
- B. In M-20 grade concrete the value of 50% sandstone with coarse aggregate and 30% of quarry dust with fine aggregate replacement gives maximum compressive strength. The maximum increase in strength was 20.52% compare to normal concrete mix.
- C. In M-20 grade concrete the value of 40% sandstone with coarse aggregate and 30% quarry dust with fine aggregate gives maximum flexural strength. The maximum increase in strength was 28.10% compare to normal concrete mix.
- D. In M-20 grade concrete the value of 40% sand stone with coarse aggregate and 30% quarry dust with fine aggregate gives maximum Split Tensile strength. The maximum increase in strength was 16.61% compare to normal concrete mix.
- E. Fine aggregate are effectively replaced by quarry dust and coarse aggregate are effectively replaced by sandstone increases the strength of M20 grade concrete.

VII. ACKNOWLEDGMENT

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