

DETERMINE THE DURABILITY PROPERTIES OF CONCRETE BY USING DIFFERENT SIZE OF AGGREGATES

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ABSTRACT-Concrete is a mixture of various materials coarse aggregate, fine aggregate, cement and water, each of them is mixed in various proportions to achieve specific strength. Durability of concrete is defined as its ability to resist weathering action, chemical attack, abrasion or any other process of deterioration. It also includes the effects of quality and serviceability of concrete when exposed to sulphate and chloride attacks. Not only this, Environmental pollution can also be decreased to some extent because the emission of harmful gases like carbon monoxide & carbon dioxide are very limited in concrete. In this project 20 mm coarse aggregate has been partially replaced with 6 mm, 12 mm aggregates in different proportions 0%, 5%, 10%, 15%, 20% of cubes casted for "M20" grade mix proportions (1:1.5:3) with water cement ratio 0.5. Hence coarse aggregate sizes 6 mm, 12 mm, 20 mm aggregates are chosen mainly based on criteria of cost and their durable quantities. The conventional concrete made by 20 mm coarse aggregate only, hence the partial replacement of 5% of 12 mm aggregate is constant and 5%, 10%, 15%, 20% of 6 mm aggregates are changed, similarly 10%, 15%, 20% of 12 mm aggregates are constant and 6 mm aggregates are changed at various proportions. The effect of 1% of H_2SO_4 and sea water on these concrete mixes are determined by immersing these cubes for 90 days in above solution and respective changes in compressive strength is observed and up to a major extent we can conclude concretes made by that the maximum results at partial replacement of coarse aggregate by 10% of 12 mm aggregate and 5% of 6 mm aggregates had good strength and durable properties comparison to conventional aggregate in severe Environment.

Keywords; Different size of aggregates, H_2SO_4 solution, Durability, Compressive strength test.

I. INTRODUCTION

Concrete is a widely used construction material for various types of structures due to its structural stability and strength. The usage, behavior as well as the durability of concrete structures, built during the last first half of the century with Ordinary Portland Cement (OPC) and plain round bars of mild steel, the ease of procuring the constituent materials (whatever may be their qualities) of concrete and the knowledge that almost any combination of the constituents leads to a mass of concrete have bred contempt.

Acidic attack is one of the world's wide problems that may cause gradual but severe damages to concrete structures. Concrete can be attacked by the sulphate present in the soil or in the sea water, and by sulfuric acid produced from present in the atmosphere of industrial cities. Most acid attacks concrete by a process of dissolution and leaching, converting the constituents of the cement paste into readily soluble salts. The scale of harass depends on the properties of the belligerent agent and its meditation. Damage is to be estimated if the pH of the acidic result is lower than six.

It is well recognized that coarse aggregate plays an important role in concrete. Coarse aggregate typically occupies over one-third of the volume of concrete, and research indicates that changes in coarse aggregate can change the strength and fracture properties of concrete.

The effects of aggregate type, size, and content on the behavior of normal and high-strength concrete, and the relationships between compressive strength, split tensile strength are discussed. The concrete mixtures incorporate, partial replacement of 20 mm coarse aggregate with aggregate sizes of 12 mm, 6 mm and coarse aggregate. Water-to-cementitious material ratio 0.50. Compressive strengths of concrete will increase by partial replacement of 20 mm coarse aggregate by sizes 12 mm, 6 mm compared with normal concrete compressive strength.

II. LITERATURE REVIEW

Deepak et. al (2018): Found that the Experimental study on partial replacement of coarse aggregate by coconut shell and lathe scrap in concrete. Coarse aggregate is replaced by 3%, 6%, 9% of coconut shell in conventional aggregate. cement have been replaced with lathe waste by 0.5% & 1%. Tests were carried out to find the compressive strength, split tensile strength and flexural strength using cube, cylinder and beam specimens respectively. The results show that a new possible exists for the usage of coconut shells as replacement of regular aggregate in the conventional concrete and light-weight RC construction.

Kanchidurai et.al (2017): Found that the paper presents the partial and complete replacement of over burnt brick bat (OBB) 20-30mm as coarse aggregate in the concrete. Strength and durability studies on concrete with partial replacement over burnt brick bat waste. The Experimental results found 25-50% of over burnt brick bat wastes can be replaced with the normal and mass concrete without quality compression.

Mufeesuddin Ali et. al (2017): Found that the Partially Replacement of Coarse Aggregate with Soda Lime Bottles and Polyethylene Terephthalate. The mix proportions 5 %, 10 %, 15 %, 20 % variation of M30 grade concrete. The concrete cubes tested for compression and Split tensile strength of concrete for 3days, 7days, and 28days. Hence 5 % of Compressive strength gives good strength compare than normal concrete.

Prafulla Kumar Tiwari, Dr. Raman Nateria (2016); Found that the Replacement of recycled coarse aggregates with natural coarse aggregates in concrete. Here we are trying to see a pattern of how the strength decrease once we replace natural coarse aggregate (NCA) with recycled coarse aggregates (RCA). The percentages of replacement will be 0%, 50% and 100%. The test and design is as per Indian standard codes. The concrete cubes are designed for M30 as per Indian standard codes.

Salau et. al (2015): Found that the Effect of Different Coarse Aggregate Sizes on the Strength Characteristics of Latinized Concrete. As the percentage of laterite increases, there was a reduction in all these characteristics even with the particle size of coarse aggregate reduction due to loss from the aggregate-paste interface zone. Also, when sand was replaced by 25% of laterite, the 19.5mm and 12.5mm coarse aggregate particle sizes gave satisfactory results in terms of workability and compressive strength respectively at 28 days of curing age, compared to normal concrete. However, in case of 50% up to 100% laterite contents, the workability and compressive strength values were very low.

Swroop et. al (2013): Found that the Durability Studies On Concrete With Fly Ash & GGBS The effect of 1% of H₂SO₄ and sea water on these concrete mixes are determined by immersing these cubes for 7days, 28days, 60days in above solutions and the respective changes in both compressive strength and weight reduction had observed and up to a major extent we can conclude concretes made by that Fly Ash and GGBS had good strength and durable properties comparison to conventional aggregate in severe Environment.

Bloem and Gayer (1963); Studied the effects of size and other coarse aggregate properties on the water requirements and strength of concrete. Their results confirm that increasing the maximum aggregate size reduces the total surface area the aggregates, thus reducing the water requirements; however even with the reduction in water, the larger size aggregate still produce the lower compressive strengths in concrete compare to concretes containing smaller aggregate. Generally lower strength concrete reduction in mixing water is sufficient to offsets the detrimental effects of aggregate sizes. However, in high strength concretes the effect size dominates and smaller strength produce the higher strength.

III. MATERIALS AND METHODS

The various materials used in the experimental investigation include:

- Ordinary Portland Cement (OPC) s
- Coarse aggregate
- Fine Aggregate (Natural River Sand)
- Water

Different experiments conducted on cement, fine aggregate and coarse aggregate are

Cement:

- Normal Consistency
- Initial setting time
- Final setting time
- Specific Gravity
- Fineness Modulus

Fine aggregate:

- Specific Gravity of Fine aggregate
- Bulk density of fine aggregate
- Sieve analysis of fine aggregate

Coarse aggregate:

- Specific Gravity of Coarse aggregate
- Sieve analysis of Coarse aggregate
- Flakiness Index and Elongation Index

Ordinary Portland Cement (53 grade)

Cement used in experimental work was Ordinary Portland Cement (OPC) of 53 grade from ZUARI brand. Cement used was fresh, of uniform color, free from any lumps and foreign matter, and from the same batch.

TABLE 1. PROPERTIES OF CEMENT

S.No.	Property	Test Value	Standard values (IS 8112:1989)
1	Specific gravity	3.13	3.15
2	Normal consistency	33%	Not Specified
3	Initial setting time(min)	42	>30
4	Final setting time(min)	350	<600
5	Fineness	6	10

Fine Aggregate

The sand used throughout the experimental work was obtained from Putter, Chittoor district, Andhra Pradesh. The specific particle size composition of the sand was prepared as per the IS 650:1966 and IS 383:1970. Sand was thoroughly washed with tap water to remove impurities like decayed vegetable matter, humus, organic matter and deleterious materials like clay, fine silt and fine dust and was oven dried for 24 hours and cooled to room temperature.

River sand conforming to Zone-II as per IS 383-1970 was used. The fine aggregate was clean, inert and free from organic matter, silt & clay. The fine aggregate was dried before use. The most common constituent of sand is silica, usually in the form of quartz, which is chemical inert and hard. The size of sand is that passing through 4.75mm and retained on 150 microns IS sieve. The specific gravity of Sand is taken as 2.67.

TABLE 2: PROPERTIES OF FINE AGGREGATES

S.no	Properties	Results
1	Specific gravity	2.62
2	Bulking of sand	3%
3	Fineness modulus	3.12
4	Grading zone	II

TABLE 3 SIEVE ANALYSIS TEST FOR FINE AGGREGATE

IS Sieve Size	Weight Retained (grams)	Percentage of total weight retained	Cumulative % of total weight retained	Percentage Passing	Permissible Values as per IS 383-1970 (Percentage)
4.75mm	15	1.5	1.5	98.5	90-100
2.36mm	30	3	4.5	97	75-100
1.18mm	355	35.5	40	64.5	55-90
600μ	325	32.5	72.5	79	35-59
300μ	210	21	93.5	93.5	80-30
150μ	65	6.5	100	0	0-10

Fineness Modulus of Fine Aggregate = $312/100 = 3.12$

Coarse Aggregate (20 mm)

Conventional coarse aggregate from an established quarry was used. For most of building constructions, the coarse aggregate consists of gravel or crushed stone up to 20mm size. However, in massive structures, such as dams, the coarse aggregate may include natural stones or rock. The coarse aggregate is free from clayey matter, silt and organic impurities etc. The coarse aggregates used were of size 20mm. The coarse aggregates were tested in accordance to IS 383-1970.

The Coarse aggregate is obtained from a local quarry is used. The coarse aggregate with a maximum size 20 mm having a specific gravity 2.55 and fineness modulus of 7.85 have been used in the present study.

TABLE 5 GRAIN SIZE DISTRIBUTION OF COARSE AGGREGATE (20 MM)

Table 4 Properties of Coarse aggregate (20 mm)

S. No.	Properties	Results
1	Specific gravity	2.55
2	Water Absorption	0.37%
3	Elongation Index	21.20%
4	Flakiness Index	23.20%
5	Fineness modulus	7.28
6	Bulk density	1541 kg/m ³

IS sieve size	Weight of aggregate retained (kg)	% of total weight retained	Cumulative % of total weight retained	% of passing	Permissible values as per IS 383-1970
80mm	0	0	0	100	----
40mm	0	0	0	100	100
20mm	1.875	1.875	26.6	73.4	85-100
10mm	3.075	4.95	99	1.0	0-20
4.75mm	0.005	5	100	0	0-5
2.36mm	0	0	100	0	----
1.18mm	0	0	100	0	----
600μ	0	0	100	0	----
300μ	0	0	100	0	----
150μ	0	0	100	0	----
		TOTAL	725.6		

Fineness modeless=725.9/100=7.25

Coarse Aggregate (12mm)

Conventional coarse aggregate from an established quarry was used. For most of building constructions, the coarse aggregate consists of gravel or crushed stone up to 12 mm size. However, in massive structures, such as dams, the coarse aggregate may include natural stones or rock. The coarse aggregates used were of size 12 mm. The coarse aggregates were tested in accordance to IS 383-1970.

The Coarse aggregate is obtained from a local quarry is used. The coarse aggregate with a maximum size 12 mm having a specific gravity 2.69 and fineness modulus of 7.10 have been used in the present study.

TABLE 6 PROPERTIES OF COARSE AGGREGATE(12 MM)

S. No.	Properties	Results
1	Specific gravity	2.69
2	Water Absorption	0.39%
3	Elongation Index	19.20%
4	Flakiness Index	22.10%
5	Fineness modulus	6.72
6	Bulk density	1541 kg/m ³

TABLE7 GRAIN SIZE DISTRIBUTION OF COARSE AGGREGATE (12 MM)

IS sieve size	Weight of aggregate retained (grams)	% of total weight retained	Cumulative % of total weight retained	% of passing	Permissible values as per IS 383-1970
80mm	0	0	0	100	----
40mm	0	0	0	100	---
20mm	0	0	0	100	---
10mm	2.46	2.46	82	18	0-20
4.75mm	0.35	2.81	93.6	6.4	0-5
2.36mm	0.1	2.91	97	3	----
1.18mm	0.09	3	100	0	----
600 μ	0	3	100	0	----
300 μ	0	3	100	0	----
150 μ	0	3	100	0	----
		TOTAL	672.6		

Coarse Aggregate (6 mm)

Conventional coarse aggregate from an established quarry was used. For most of building constructions, the coarse aggregate consists of gravel or crushed stone up to 6 mm size. However, in massive structures, such as dams, the coarse aggregate may include natural stones or rock. The coarse aggregates used were of size 6 mm. The coarse aggregates were tested in accordance to IS 383-1970.

The Coarse aggregate is obtained from a local quarry is used. The coarse aggregate with a maximum size 6 mm having a specific gravity 2.76 and fineness modulus of 7.36 have been used in the present study.

TABLE 8 PROPERTIES OF COARSE AGGREGATE(6 MM)

S. No.	Properties	Results
1	Specific gravity	2.76
2	Water Absorption	0.41%
3	Elongation Index	20.20%
4	Flakiness Index	21.40%
5	Fineness modulus	5.57
6	Bulk density	1541 kg/m ³

TABLE 9 GRAIN SIZE DISTRIBUTION OF COARSE AGGREGATE (6 MM)

IS sieve size	Weight of aggregate retained (grams)	% of total weight retained	Cumulative % of total weight retained	% of passing	Permissible values as per IS 383-1970
80mm	0	0	0	100	----
40mm	0	0	0	100	---
20mm	0	0	0	100	---
10mm	0	0	0	100	---
4.75mm	1.45	1.45	72.5	27.5	---
2.36mm	0.3	1.75	87.5	22.5	----
1.18mm	0.2	1.95	97.5	0.025557	----
600 μ	0.05	2	100	0	----
300 μ	0	2	100	0	----
150 μ	0	2	100	0	----
	TOTAL		557.5		

Fineness modulus = $557.5/100=5.57$

Water

Water is an important ingredient of concrete as it initiates the chemical reaction with cement, and the mix water was completely free from chlorides and sulphates. The water used for the study was free of acids, organic matter, suspended solids, alkalis and impurities which when present may have adverse effect on the strength of concrete. The two principal functions of water in a concrete mix are to effect hydration and improve workability.

Workability Test

Workability is carried out by conducting the slump test and compaction factor test as per IS 1199-1959 on ordinary concrete and fiber reinforced concrete.

Compressive Strength Test

Compression test is the most common test conducted on hardened concrete, partly because it is easy test to perform and partly because most of desirable characteristic properties of concrete are qualitatively related to its compressive strength. Compression test is carried out on specimens of cubical shape. The size of specimen is 15×15×15 comes were cast for M30 grade of concrete. After curing, these cubes were tested on compression testing machine AS per I.S. 516- 1959. The failure load was noted. In each category two cubes were tested and their average value is reported. The compressive strength was calculated as fallows, compressive strength (Map) = failure load/ cross sectional area



Fig 1: Compressive strength

IV. RESULTS AND DICUSSIONS

These results on strength & durability studies give a clear conclusion that 6 mm ,12mm ,20 mm size of aggregates can be used as viable replacements are Coarse Aggregate respectively with Superior properties of Durability & Mechanical Properties compared to Control Concrete, saving in cost of concrete and reducing the environmental pollution without affecting the Quality and Strength Properties.

TABLE 10: COMPARISON OF COMPRESSIVE STRENGTH OF CONCRETE CURRIED IN H₂SO₄ SOLUTION WITH CONVENTIONAL CONCRETE AFTER 90 DAYS.

Mix. No.	20 mm aggregates (%)	12 mm aggregates (%)	6 mm aggregates (%)	Compressive strength (N/mm ²)	Compressive strength – H ₂ SO ₄ (N/mm ²)
MS0	100%	0%	0%	31.85	22.60
MS1	90%	5%	5%	32.77	22.30
MS2	85%	5%	10%	33.05	22.01
MS3	80%	5%	15%	35.12	22.15
MS4	75%	5%	20%	37.09	22.30
MS5	85%	10%	5%	38.80	25.30
MS6	80%	10%	10%	39.61	25.61
MS7	75%	10%	15%	43.50	26.75
MS8	70%	10%	20%	45.29	26.93
MS9	80%	15%	5%	48.65	31.60
MS10	75%	15%	10%	46.33	30.75
MS11	70%	15%	15%	44.26	26.33
MS12	65%	15%	20%	41.71	25.33
MS13	75%	20%	5%	39.00	25.17
MS14	70%	20%	10%	35.65	23.97
MS15	65%	20%	15%	34.44	23.66
MS16	60%	20%	20%	32.03	20.68

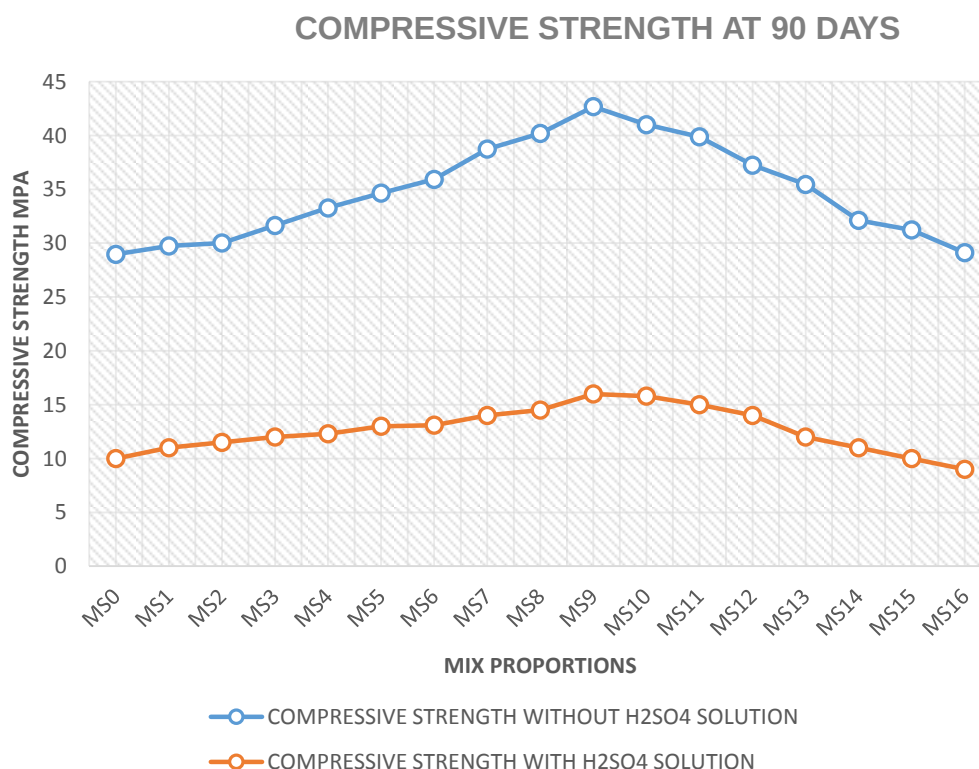


Fig 1: Compressive strength after 90 days curing

CONCLUSION

- The compressive strength blended concrete was conducted for the OPC as source materials, 20 mm coarse aggregate has been replaced by 12 mm and 6 mm of aggregates with 5%, 10%, 15%, 20% and mix proportion specimens tested at the age of 28 days.
- The results observed that 20 mm coarse aggregate has been partially replaced by 12 mm and 6 mm aggregates, strength goes on increasing up to certain limits compare to normal concrete
- 20 mm coarse aggregate replaced by 15% of 12 mm aggregates, 5% of 6 mm aggregates gives the higher Compressive strengths at 28 days.

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