COMPRESSIVE STRENGTH OF M25 GRADE CONCRETE BY USING RECYCLING AGGREGATES

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ABSTRACT:

Concrete that contains recycled aggregate can help to safeguard the environment by controlling the depletion of natural aggregates [1]. The building materials of the future are recycled aggregates [2]. Many countries around the Globe, have started the usage of Recycled coarse aggregates (RCA) in place of naturally available aggregate. The basic characteristics of recycled fine aggregate and recycled coarse aggregate are reported in this work. All aggregate qualities undergo fundamental alterations, and their implications for concrete work are thoroughly have to be examined. The characteristics of concrete with recycled aggregate are also established. Compressive strength for various combinations of recycled aggregate with natural aggregate is studied. Workability for the various mixes used is also presented.

INTRODUCTION:

Concrete is the most frequently utilized man-made construction material in the world. It is made by combining water, fine aggregates, coarse aggregates, cement, and occasionally admixtures in the proper ratios. Fresh concrete, also known as plastic concrete, is a substance that has just been mixed and is capable of taking on any shape before hardening into what is known as concrete. A long-lasting chemical reaction between water and cement causes the hardening, which makes the cement stronger over time. The endurance and aesthetic appeal of concrete constructions made with regular Portland cement during the first half of the 20th century (OPC) Contempt has been fostered by the accessibility of the components of concrete, regardless of their characteristics, as well as the awareness that almost any combination of the components results in a mass of concrete. Without giving structures' longevity any regard, emphasis was placed on strength. The durability of concrete and concrete structures is declining as a result of the liberties taken; this decline appears to be gaining speed as it heads towards self-destruction. This is especially true of concrete structures built after 1970 or so, around the time that the next advancements began to occur. The use of high strength rebars with surface deformations (HSD) started becoming common. Significant changes in the constituents and properties of cement were initiated. Engineers are started using supplementary cementitious materials (SCM) and admixtures in concrete, often without adequate consideration. The Ordinary Portland Cement (OPC) is one of the main ingredients used for the production of concrete and has no alternative in the civil construction industry. Unfortunately, in the production of cement involves emission of large amounts of carbondioxide gas into the atmosphere, a major contribution for greenhouse effect and the global warming. To safeguard our environment, it is therefore necessary to either look for alternative materials or partially replace existing ones. The quest for any such cementitious material that can be utilized in place of or in addition to cement should result in the lowest possible environmental effect and worldwide sustainable development.

1. EXPERIMENTAL INVESTIGATION:

From the past research studies it is discovered that several pozzolanic materials, such as fly ash, ground granulated blast furnace slag (GGBS), rice husk ash, high reactive Metakaolin, and silica fume, can be used in concrete as a partial replacement for cement. Many studies investigating the effects of using these pozzolanic materials are ongoing both in India and overseas. These materials can be used in concrete as a partial replacement for cement because of their properties similar to cement. Studies on the effects of using these pozzolanic materials as cement substitutes are now being conducted both in India and overseas, and the findings are promising. The characteristics of the components, mix percentage, compaction technique, and other factors that are controlled during placement and curing determine the strength, durability, workability, and other characteristics of concrete. Several factors contribute to these demands, but as engineers, we must consider how durable the constructions made of these materials will be been able to meet the needs while putting long-term durability concerns to one side.

RCA is often used as a base material for roads, parking lots, and other construction projects. It can be used in place of gravel or other natural materials. RCA can be used in structural applications, such as concrete beams, columns, and walls. It can also be used to create precast concrete elements, such as pavers and blocks. RCA can be used as a decorative material in landscaping projects. It can be used to create retaining walls, garden beds, and other features. RCA can be used as a drainage material, helping to prevent water buildup in areas prone to flooding.

The need for concrete with a high strength is now unavoidable due to the building industry's shift to pre-cast parts and the demand for post-tensioning. Engineers had to find a way to get around these challenges, which we have largely succeeded in doing. But today's construction sector aims to save money through both concrete and financial factors. Used in the building of kerbs, sat gutters, and precast concrete. Saving money: Concrete is unaffected, and it is anticipated that the cheaper price of recycled concrete aggregate will more than make up for the higher cost of cement (RCA). Alkali silica reaction is discovered to be controlled by 20% fly ash replacement of cement (ASR).It is environmentally friendly and there is less travelling and no resource extraction. Hence, less land is needed. About saving time there is no need to wait for the availability of the material. Less crushing results in lower carbon emissions. For all concrete with a typical strength of 65MPa or less, up to 20% of natural aggregate can be replaced with RCA or recycled mixed aggregates (RMA) without the requirement for extra testing., as per Dutch standard VBT 1995, is permitted.

1.2 Materials:

1.2.1 Cement: Cement is a material that has cohesive and adhesive in the properties in the presence of water.

Table:1 Properties of ordinary Portland cement

Fineness	$340 m^2$ /Kg
Specific gravity	3.10
Initial setting time(min)	42
Final setting time (min)	190

Table:2 Chemical properties of cement:

S.NO	Characteristics	Result(0% by mass)
1	Loss of ignition	3.15
2	Silica (sio_2)	2.27
3	Alumina (al_2O_3)	4.42
4	Iron (fe_2O_3)	11.38
5	Calcium (cao)	58.51

1.2.2 Fine aggregate:

Fine aggregates are materials passing through an IS sieve that is less than 4.75mm gauge.

Table:3 Properties of fine aggregates:

Properties	Results obtained
Specific gravity	2.74
Water absorption	0.8%
Fineness modulus	2.47

Table:4 Sieve analysis of fine aggregate (weight of sample 1000g)

S. L N O	IS Sieve size	Weight retained (g)	Cumulative weight retained	Cumulative % weight retained (g)	Cumulative % passing
1	10mm	0.00	0.00	0.00	100.00
2	4.75mm	10.00	10.00	1.00	99.00
3	2.36mm	46.50	56.50	5.65	94.35
4	1.18mm	188.00	24.50	24.45	75.55
5	600mm	288.00	532.50	53.25	46.75
6	300mm	358.00	890.50	89.005	10.95
7	150mm	109.00	1000.00	100.00	0.00

Fineness modulus of sand = (273.35/100) =2.73

1.2.3 Coarse aggregate: Coarse aggregates are materials which retains on an IS sieve 4.75mm gauge.

Recycled coarse aggregate (RCA) is a type of construction material that is made by crushing and recycling concrete waste. It is an environmentally friendly alternative to traditional coarse aggregates that are typically made from natural resources such as rocks and gravel. Recycled coarse aggregate refers to the processed and reused construction waste that consists of crushed concrete, bricks, tiles, and other demolition debris. The process of recycling coarse aggregate involves breaking down and crushing the waste materials into smaller pieces that meet specific size and quality requirements for use in new construction projects. Recycled coarse aggregate has several benefits, including reducing the amount of waste sent to landfills, conserving natural resources, and reducing the carbon footprint of construction projects. Additionally, it is often more affordable than using virgin materials, making it an economical choice for construction projects.

Table:5 Properties of coarse aggregate:

Specific gravity	2.74
Water absorption	0.4%
Fineness modulus	4.01

Table:6 Sieve analysis of coarse aggregate(weight of sample 5000g)

S.L. NO	IS Sieve size	Weight retained(g)	Cumulative weight retained	Cumulative % weight retained (g)	Cumulative % passing
1	80mm	0.00	0.00	0.00	100.00
2	40mm	0.00	0.00	0.00	100.00
3	20mm	3376.50	3376.50	67.52	32.487
4	10mm	1358.00	4761.00	95.22	4.78
5	4.8mm	169.00	4930.00	98.60	1.40
6	2.4mm	70.00	5000.00	100.00	0.00
7	1.18mm	0.00	5000.00	0.00	0.00
8	600mm	0.00	5000.00	0.00	0.00
9	300mm	0.00	5000.00	0.00	0.00
10	150mm	0.00	5000.00	0.00	0.00

Fineness modulus of coarse aggregate = $\sum g/100$ =36.1/100 =3.61

2. CASTING AND COMPACTION OF TEST SPECIMENS:

The cube moulds shall be 150mm x 150mm x 150mm size confirming to IS 10086-1982 are cleaned and all care was taken to avoid any irregular dimensions. The joints between the sections of moulds were coated with mould oil and a similar coating to prevent water from escaping during filling, mould oil was placed between the contact surfaces of the base plate and the bottom of the moulds. Mold oil was lightly applied to the inside surfaces of the moulds to avoid concrete adherence and to facilitate simple mould removal following casting. The moulds are then set up on the plain casting platform.

The specimens of Standard cube moulds (150mm x 150mm x 150mm) placed in trays and the mixed concrete poured in to specimen moulds in three layers and compacted with a tampered rod thoroughly to reach required shape and compaction. By this way we have casted 360 no. of cubes. These prepared cubes and prisms were placed at plain leveled surface for 24 hours.

Table: 7 Impact test tabular form:

SL.NO	Type of aggregate	Weight of aggregate with mould	Weight of aggregate	Passing throughout 2.36mm	Retained in pan
1	10mm	2193gms	650gms	73gms	577gms
2	10mm	2157gms	614gms	80gms	534gms
3	10mm	2182gms	639gms	104gms	535gms

Table: 8 Crushing test tabular form:

SL.NO	Type of aggregate	Weight of aggregate with mould	Weight of aggregate	Passing through out 2.36mm	Retained
1	10mm	13.5kgs	4.5kgs	1.2kgs	3.4kgs
2	10mm	13kgs	4kgs	0.8kgs	3.2kgs
3	10mm	13kgs	3.7kgs	1.2kgs	2.5kgs

Table: 9 Slump cone test tabular form:

Degree of workability	Slump		Compacting factor	Use for which concrete is suitable
	Mm	In		
Very low	0-25	0-1	0.78	Very dry mixes; used in road making.
Low	25-50	1-2	0.85	Low workability mixes; used for foundations with light reinforcement.
Medium	50-100	2-4	0.92	Medium workability mixes; normal reinforced concrete manually compacted and heavily reinforced sections with vibrations.
High	100-175	4-7	0.95	High workability concrete; for sections with congested reinforcement

3. WORKABILITY OF VARIOUS CONCRETE MIXES:

MIX ID	SLUMP (mm)
C100	90
C80	85
C70	90
C60	80
C50	80

4. TEST FOR COMPRESSIVE STRENGTH OF CONCRETE:

On the date of testing i.e., after 7,14,21 days casting of the cube specimens were removed from the water sump and placed on flat surface for 15 to 20 minutes to wipe off the surface water and grit, and also remove the projecting fineness on the surface of the cured cubes. Before placing the cubes in compression testing machine the bearing surfaces (top and bottom of the compression testing machine was wiped clean with a piece of cotton or fine brush, and the cube specimens also cleaned. The cube specimen was placed in the compression testing machine (CTM) of 2000KN capacity. The load was applied approximately 150kg to 200k/sq.cm/min until the resistance of the cube. The applied load is gradually increased until the cube is failed. The maximum load is recorded when the cube was collapsed. By dividing the greatest load applied to the specimen during the test by the cross sectional area of the specimen, the compressive strength of the cube was computed average of three values of three cubes and the individual variation is more than 15% of the average was observed. The test results are presented in Table.

Compressive strength (C) = P/A.
Compressive strength(C) = Load/Area
Where, P = maximum applied load in Newton's

A= area of cross section of cube in mm^2 (150mm×150mm)

Table: 10 Compressive strength of concrete for different percentages by recycled aggregate M25 grade

MIX ID	Natural aggregates	Recycled aggregates	7 Days	14 Days	21 Days
C100	0	100	32.68	46.8	54.87
C70	30	70	34.2	46.98	56.8
C60	40	60	36.5	50.2	60.3
C50	50	50	31.8	44.3	54.2
C40	60	40	25.44	39.8	48.2
C30	70	30	22	35.4	42.13

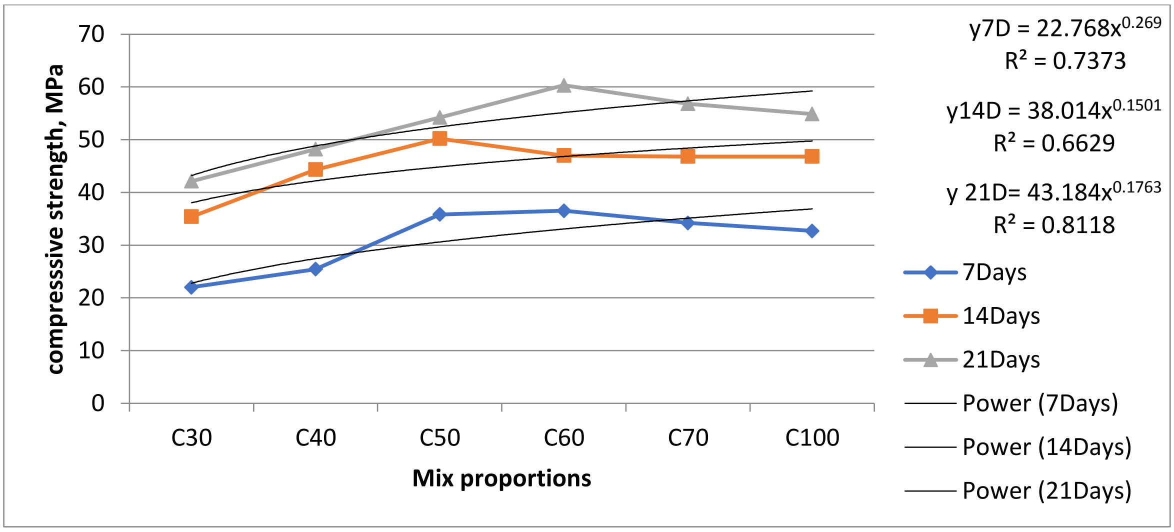

FIGURE 1: Compressive strength of concrete for different percentages by recycled aggregates

4. CONCLUSIONS:

Based on experimental investigations the following conclusions are drawn.

1. The use of recycled aggregate has been found to be better than that of natural aggregate.

2. When being broken down into smaller pieces, a significant amount of carbon dioxide is absorbed, lowering the atmospheric concentration of CO.

3. The physical properties of recycled aggregates make them ideally suited for road base and sub-base. This is due to their physical characteristics, which require less cement, making them suitable for use as sub-bases. In addition, developers often benefit financially from the process.

4. From the figure1, the variation of compressive strength with different coarse aggregates to RCA proportions is studied for 7days, 14days and 21days, and is presented below.

7 Days; $y = 22.768x^{0.269}$, , $R^2 = 0.7373$
14 Days; $y = 38.0.14x^{0.1501}$, $R^2 = 0.6629$
21 Days; $y = 43.184x^{0.1763}$, $R^2 = 0.8118$

5. REFERENCES:

1. https://doi.org/10.1016/j.cemconcomp.2018.03.008

2. https://doi.org/10.1016/B978-0-08-102616-8.00003-4

3. M. Collepardi, "Admixtures used to enhance placing characteristics of concrete" Cement & Concrete Composite, Vol. 20, 1998, 103-112

4. S. Bhanja, B. Sengupta, "Modified water cement ratio law for silica fume concretes", Cement and Concrete Research. Vol 33. 2003. 447-450.

5. IS 456: 2000, "Indian Standard Code of Practice for Plain and Reinforced Concrete", Bureau of Indian Standard, New Delhi.

6. IS 10262: 2009 "Recommended Guidelines for Concrete Mix Design", Bureau of Indian Standard, New Delhi.

7. IS 383: 1970, Specification for Coarse Aggregate and Fine Aggregate From Natural Sources for Concrete", Bureau of Indian Standard New Delhi.

8. IS 9103: 1999, Indian Standard Concrete Admixture Specification " Bureau of

Indian Standard, New Delhi.

IS Codes:

1) IS 456-2000 code of practice for plain & reinforced cement concrete.

2) IS 10262-2009 recommended guide line for concrete mix design.

3) IS 12269-1987 Specification for OPC 53 grades.

4) IS 3 83-1970 Specification for coarse aggregate and fine aggregate from natural sources.

5) IS 650-1966 Specification for standard sand for testing of cement.