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Study on Performance of Concrete by Partially Replacement of Fine Aggregate with Demolition Waste and Cement with Cement Kiln Dust

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ABSTRACT

Concrete has inhabited a significant role in the construction industry and it is utilized widely in all types of constructions ranging from small structures to massive structures such as dams etc.. The substitute of natural resources in the manufacture of cement and sand is the existing issue in the present construction scenario.

Cement kiln dust (CKD) is a fine, powdery material, which contains some reactive calcium oxide, depending on the location within the dust collection system, the type of operation, the dust collection facility, and the type of fuel used. CKD consists of four major components unreacted raw feed, partially calcined feed and clinker dust, free lime, and enriched salts of alkali sulfates, halides, and other volatile compounds.When using CKD with high alkali content, fly ash or blast furnace slag should be incorporated to prevent alkali-silica reaction problems.

The recycled aggregates obtained from waste concrete are more angular and have higher absorption and specific gravity than natural coarse aggregates and it resulted in increased strength and improved load carrying capacity.

Hence in the current experimental study is conducted to evaluate the workability and strength characteristics of fresh concrete and hard concrete, properties of concrete have been assessed by partially replacing cement with Cement kiln dust, and aggregates with Recycled aggregates. The cement has been replaced by CKD accordingly in the range of 0% (without CKD), 5%, 10%, 15%, and 20% by weight of cement for M25 mix. The fine aggregates have been replaced by demolition waste accordingly in the range of 0% (without demolition waste), 10%, 20%, 30%, and 40% by weight of fine aggregate for M25 mix. Concrete mixtures were produced, tested and compared in terms of slump, compressive, and split tensile strength of the concrete.

Keywords: Fly ash, GGBS, SDA, RHA, Ceramic waste, Sewage sludge, CTM

1. INTRODUCTION

Concrete is one of the world's most widely used material. It consists of cement, coarse aggregate, fine aggregate and water. Cement acts as a binding material to bind fine and coarse aggregate in concrete but during the manufacturing of cement different harmful gasses are produced like Nitrogen Oxide, Sulphur Dioxide, Carbon Dioxide and the dust. Environmental pollution is caused due to the release of dust to air from cement industries. Cement dust created adverse effects on plants, ecosystems and human health.

The current cement production rate of the world is approximately 1.2 billion tons per year. This is expected to grow to about 3.5 billion tons per year by 2015.India is the second largest cement producer in the world and accounts for 6.7 percent of world's cement output.It was gathered that the production of every ton of cement emits carbon dioxide (CO2) to the tune of about one ton. When expressing it in another way, it can be concluded that 7% of the world's carbon dioxide emission is attributable to Portland cement industry. And also cement remains the most expensive ingredient in making concrete because the price of cement is increasing day by day, it is therefore important to find means of economizing the use of cement.

Because of the significant contribution to the environmental pollution, to the high consumption of natural resources like limestone and the high cost of Portland cement etc. So, we cannot go on producing more and more cement. Keeping in view the worst effects of binding material related to the cement manufacturing on the environment it requires to develop alternative binding materials for making concrete.

By utilizing different supplementary cementitious materials such as waste materials like Fly Ash (FA) ,Ground Granulated Blast-furnace Slag (GGBS) ,Silica-fume , saw dust ash (SDA) , Rice Husk Ash (RHA) ,Phosphogypsum (PG) ,Ceramic Wastes (CW) ,Sewage Sludge (SS) and corn cob ash (CDA) are used in replacement of cement and reduce the environmental pollution and cost of concrete production by making use of locally available materials. And it's leading to better compressive strength, heat of hydration, permeability, workability and chemical resistance is positively improved. Cement replaced by minerals has the ability to improve its early strength, which ultimately results in the reduction of the quantity of the cement.

And also Now, there are critical shortages of natural resources in the present scenario. Production of concrete and utilization of concrete has rapidly increased, which results in increased consumption of natural aggregate as the largest concrete component. In the modern evaluation of buildings and technologies, people tend to move to development through modernized buildings. Hence, the refreshment of the building is done either demolishing or renovating the structures for ten years at once. Advanced concrete technology can reduce the consumption of natural resources thereby lessen the burden of pollutants on the environment. By keeping the economic cost in mind, and also in order to avoid the wastage of materials recycled aggregate concrete is introduced. In the developing world, the number of high rise buildings is also increasing and the regular method of renovation of multi storey buildings is done by demolishing it.

Therefore, extensive research on the use of cement and aggregates replacement by industrial byproducts or any other waste materials. Usage of these by-products as binding materials is becoming popular all over the world because of the reduction of the evolution of many harmful gasses in the environment which have good effects on the environment.

1.2 CEMENT KILN DUST:

Cement kiln dust is a fine powdery material similar in appearance to Portland cement. It is composed of micron-sized particles collected from electrostatic precipitators during the production of cement clinker.Cement kiln dust generated is partly reused in cement plants and landfilled. Due to lack of landfilling space and ever increasing disposal cost, utilization of CKD in highway uses, waste treatment, soil stabilization, cement mortar/concrete, CLSM, etc. has become an attractive alternative to its disposal.

1.3.1. Advantages of Demolition waste:

Construction Waste is an Economic Boost

Although it may be simpler to haul the piles of waste off to a landfill and forget about them, the materials left after a demolition project can be quite valuable. Wood products are the most versatile of construction waste, as companies can recycle them into furniture and sell them, a trend that is quite popular with young homeowners. Metal and wood products can also be reused by construction companies as a cheaper material, lowering the building cost of new properties and welcoming more buyers.

Salvaging and recycling construction waste is big business, with over 230,000 jobs being created in 2007 alone to handle all of the recycled material, and many more for investment and expansion.

Building a Better Environment

The US produces a staggering amount of construction waste every year, and that waste hurts the environment in different ways over the course of its life.

The creation of construction materials, specifically steel and concrete, is an intensive process with large amounts of resources used and CO2 expelled. By leaving them in a landfill, that damaging process has been wasted and will be repeated to create replacement items.

Recycling construction waste benefits the environment by cutting down the extraction of virgin resources, as it returns the usable materials to the construction industry and limits the demand for newer products.

Landfills are also an environmentally precarious area, with many of them set to close due to overfilling. By reusing construction materials that would normally be abandoned, the burden for landfills to break down their contents is lessened and long-term environmental healing is made possible.

METHODOLOGY AND GENERAL INFORMATION

General:

In the present experimental work, recycled aggregates is used as partial replacement for sand and cement kiln dust is used as partial replacement for Cement in the concrete mix.

Concrete:

Concrete is an artificial material in which the aggregates both fine and coarse are bonded together by the cement when mixed with water. The concrete has become so popular and indispensable because of its inherent in concrete brought a revolution in applications of concrete. Concrete has unlimited opportunities for innovative applications, design and construction techniques. Its great versatility and relative economy in filling wide range of needs has made it is very competitive building material.

Cement:

Concrete is second only to water as the most consumed substance on earth, with nearly one ton of the material used annually for each person on the planet. Cement is the critical ingredient in concrete, locking together the sand and gravel constituents in an inert matrix. It is the 'glue' which holds together much of modern society's infrastructure. The word "cement" traces to the Romans, who used the term opus caementicium to describe masonry resembling modern concrete that was made from crushed rock with burnt lime as binder. The volcanic ash and pulverized brick additives that were added the burnt lime to obtain a hydraulic binder were later referred to to ascementum, cimentum, cäment, and cement.

Aggregates:

Aggregates are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. One of the most important factors for producing workable concrete is good gradation of aggregates. Good grading implies that a sample fractions of aggregates in required proportion such that the sample contains minimum voids. Samples of the well graded aggregate containing minimum voids require minimum paste to fill up the voids in the aggregates. Minimum paste will mean less quantity of cement and less water, which will further mean increased economy, higher strength, lower shrinkage and greater durability.

Coarse aggregate:

The properties of concrete such as strength, durability, workability and economy are mainly affected by the properties of aggregate. Originally aggregate was looked upon as an inert material for economic reasons. Since characteristics of concrete are directly related to the those of its constituent aggregate, aggregates for load bearing concrete should be hard, strong non porous elongated and laminated particles and should be suitable for the purpose required.

Fine aggregate:

The material which passes through BIS test sieve number 4 (4.75mm) is termed as fine aggregate, usually natural sand is used as a fine aggregate at places where natural sand is not available crushed stone is used as fine aggregates. The sand used for the experimental works was locally procured and confirmed to grading zone II, sieve analysis of the fine aggregate was carried out in the laboratory as per IS 383-1970 and results are provided. The sand was first sieved through 4.75mm sieve to remove any particle greater than 4.75 mm and then was washed to remove the dust. The results of testing carried out for fine aggregate is provided.

Water

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quality and quantity of water is required to be looked into very carefully. Portable water is generally considered satisfactory. In the present investigation tap magnetized water is used for mixing and portable water used for curing purposes.

Admixtures:

Admixtures are those ingredients in concrete other than Portland cement, water, and aggregates that are added to the mixture immediately before or during mixing. About 80% of concrete produced in North America have one or more admixtures. About 40% of ready-mix producers use fly ash. About 70% of concrete produced contains a water-reducer admixture. One or more admixtures can be added to a mix to achieve the desired results.

Concrete mix design:

The concrete mix design is a process of selecting the suitable ingredients of concrete and determining their most optimum proportion which would produce, has economically as possible, concrete that satisfies a certain compressive strength and desired workability.

The concrete mix design is based on the principles of Workability

Desired strength and durability of hardened concrete

Conditions in site, which helps in deciding workability, strength and durability.

Workability:

Workability is the ability of a fresh (plastic) concrete mix to fill the form/mould properly with the desired work (vibration) and without reducing the concrete's quality. Workability depends on water content, aggregate (shape and size distribution), cementitious content and age (level of hydration) and can be modified by adding chemical admixtures, like super plasticizer. Raising the water content or adding chemical admixtures will increase concrete workability. Excessive water will lead to increase bleeding (surface water) and segregation of aggregates (when the cement and aggregates start to separate), with the resulting concrete having reduced quality. Workability of fresh concrete is determined by following methods:

1. Slump Test

2. Vee-Bee Test

3. Compacting factor test

Slump test is used to determine the workability of fresh concrete. The slump test result is a measure of the behavior of a self-compacted inverted cone of concrete under the action of gravity. It is a measure of the concrete's workability or the dampness of concrete. Slump test as per IS: 1199-1959 is followed. The apparatus used for doing slump test are Slump cone and tamping rod.

Procedure to determine workability of fresh concrete by slump test:

The internal surface of the mould is thoroughly cleaned and applied with a light coat of oil.

The mould is placed on a smooth, horizontal, rigid and non absorbent surface. The mould is then filled in four layers with freshly mixed concrete, each approximately to one-fourth of the height of the mould.

Each layer is tamped 25 times by the rounded end of the tamping rod (strokes are distributed evenly over the cross section.

After the top layer is rodded, the concrete is struck off the level with a trowel. The mould is removed from the concrete immediately by raising it slowly in the vertical direction.

The difference in level between the height of the mould and that of the highest point of the subsided concrete is measured.

This difference in height in mm is the slump of the concrete.

Compacting factor:

Compacting factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test as per IS: 1199-1959. The apparatus used is Compacting factor apparatus.

Physical Properties of Cement (OPC 53 GRADE) (IS 8112-1989)

S. No	Property		Values
1	Specific Gravity the		3.16
2	fineness of Cement by sieving		4.5%
3	Normal Consistency		31.8%
4	Setting Time, a) Initial setting time		64 minutes
	b) final setting time		540 minutes
5	Compressive Strength.	a) 3 days	29 N/mm2
		b) 7days	42.9 N/mm2
		c) 28 days	52.6 N/mm2

Fine aggregate:

Aggregates which pass through 4.75mm sieve are considered as fine aggregate.

The details of test conducted on fine aggregate are described below:

Specific gravity according to IS:2386 (Part-III)

The specific gravity of an aggregate is considered to be a measure of strength or quality of the material. The specific gravity test helps in the identification of stone.

Specific gravity of fine aggregate: 2.56

Fineness modulus:

The standard definition of fineness modulus is as follows: "An empirical factor obtained by adding the total percentages of a sample of the aggregate retained on each of a specified series of sieves, and dividing the sum by 100."

Sieve analysis helps to determine the particle size distribution of the course and fine aggregates. This is done by sieving the aggregates as per IS: 2386(Partl)-1963.

A set of IS Sieves of sizes- 80mm, 40mm, 20mm, 16mm, 10mm, 4.75mm, 2.36mm, 1.18mm, 600µm, 300µm, 150 µm.

From 80mm to 4.75mm IS sieves were used for coarse aggregate analysis and from 4.75mm to 150 µm IS sieves were used for analysis of fine aggregates.

Table 4.2 Sieve Analysis of Fine Aggregate

S. No	Sieve size	Weight retained (gm)	Cumulative weight retained (gm)	Cumulative weight retained	% Weight passing
1	10	0	0	00.00	100
2	4.75 mm	1	1	00.08	99.92
3	2.36 mm	639	640	32.00	68.00
4	1.18 mm	450	1090	54.50	45.50
5	600 µm	124	1214	60.70	39.30
6	300 µm	386	1600	80.00	20.00
7	150 µm	95	1695	84.75	15.25
8	Pan	305	2000	100	00.00
			Total	311.35	

Fineness modulus = 311.35/100 = 3.1135

According to IS 383-1970 this sand confirms to Zone -II

Coarse Aggregate:

Aggregates greater than 4.75mm are considered as coarse aggregate.

Specific gravity according to IS:2386 (Part-III)

The specific gravity of an aggregate is considered to be a measure of strength or quality of the material. The specific gravity test helps in the identification of stone.

The specific gravity of coarse aggregate is 2.81

Crushing value according to IS: 2386 (Part-IV)

The aggregate crushing value provides a relative measure of resistance to crushing under a gradually applied compressive load. To achieve a high quality of pavement. aggregate possessing low aggregate crushing value should be preferred.

Sieve analysis according to IS: 383-1970

A sieve analysis (or gradation test) is a practice or procedure used (commonly used in civil engineering) to assess the particle size distribution (also called gradation) of a granular material. The size distribution is often of critical importance to the way the material performs in use. A sieve analysis can be performed on any type of non-organic or organic granular materials including sands, crushed rock, clays, granite, feldspars, coal, and soil, a wide range of manufactured powders, grain and seeds, down to a minimum size depending on the exact method. Being such a simple technique of particle sizing, it is probably the most common.

Sieve analysis of coarse aggregate

S. No	Sieve size	Weight retained (gm)	Cumulative weight retained (gm)	% Weight retained
1	20 mm	00.00	00.00	00.00
2	16 mm	48.00	48.00	9.6
3	12.5 mm	47.7	95.7	19.14
4	10 mm	320.3	416	83.2
5	4.75 mm	77	493	98.6
6	Pan	6.0	499	99.8

Sieve analysis of recycled aggregates

S. No	Sieve size	Weight retained (gm)	Cumulative weight retained (gm)	% Weight retained
1	20 mm	00.00	00.00	00.00
2	16 mm	47.5	47.5	9.5
3	12.5 mm	50.00	97.5	19.5
4	10 mm	319.8	417.3	83.46
5	4.75 mm	78	495.3	99.06
6	Pan	3.0	498.3	99.66

Fineness modulus = 442.48/100 = 4.4248

Water absorption of coarse aggregate according to IS: 2386 (Part-III)

Water absorption gives an idea of the strength of aggregate. Aggregates having more water absorption are more porous in nature and are generally considered unsuitable unless they are found to be acceptable based on strength, impact and hardness tests.

Water absorption = 0.15%

Demolition waste:

(a) Physical properties of Demolition waste

The slag is a black glassy and granular in nature and has a similar particle size range like sand. The specific gravity of slag lies between 3.4 and 3.98. The bulk density of granulated copper slag is varying between 1.9 to 2.15 kg/m3, which is almost similar to the bulk density of conventional fine aggregate. It is also found that the copper slag has less moisture content so it has less heat of hydration.

Physical properties of cement kiln dust **Chemical properties of cement kiln dust**

S. No	Property	Cement kiln dust	S. No	Property	Cement kiln dust
1	Specific gravity	3.02	1	Specific gravity	3.02
2	Percentage of voids %		2	Percentage of voids %	
3	Bulk density g/cc	1453 kg/m2	3	Bulk density g/cc	1453 kg/m2
4	Fineness modulus of Cement kiln dust	7.40	4	Fineness modulus of Cement kiln dust	7.40
5	Water absorption %	28.8	5	Water absorption %	28.8
6	Moisture content	4.3	6	Moisture content	4.3

Physical properties of Demolition waste (AS PER SUPPLIER) Chemical properties of cement kiln dust (AS PER SUPPLIER)

S. No	Property	% of component	S. No	Property	% of component
1	Particle shape	Spherical	1	Silicon dioxide	85
2	Appearance	Grey	2	Aluminium oxide	1.13
3	Specific Surface area cm2/gm	160000	3	Iron oxide	1.47
4	Specific gravity	2.21	4	Calcium oxide	0.5
5	Bulk density kg/m3	240	5	Magnesium oxide	0.85
6	Fineness modulus of demolition waste	20000	6	Sodium oxide	0.6
7	Moisture content %	0	7	Potassium oxide	1.0
			8	Loss on ignition	5

IS Code Method of Mix design (IS 10262-2009):

This method was developed as per IS 10262-2009. This Indian standard (first revision) was adopted by the bureau of Indian standards, after the draft finalized by the cement and concrete sectional committee has been approved by civil engineering division council. Indian standard institution has brought out mix design procedure mainly based on work done in national laboratories. This method can be adapted to both medium strength and high strength concrete. The basic assumption made in the mix design is that the compressive strength of workable concrete is by and large, governed by the water-cement ratio. Another most convenient relationship applicable to normal concrete is that for a given type, shape, size and grading of aggregates, the amount determines its workability and the other factors which affecting the properties of concrete are quality of cement, water and aggregates, batching, transporting, placing, compacting and curing etc.

Casting:

The cubes were cast in steel moulds of inner dimensions of 150 x 150 x 150mm for testing the compressive strength of the specimens, the cylinders were cast in steel moulds of inner dimensions as 150mm diameter and 300mm height for testing the split tensile strength and finally, the flexural beams were cast in steel moulds with inner of 500 x 100 x 100 mm for flexural strength of the specimens.

The cement, sand, coarse aggregate and copper slag mixed thoroughly. Approximately 25% of water required is added and mixed thoroughly with a view to obtain uniform mix. After that, the balance of 75% of water was added and mixed thoroughly with a view to obtain uniform mix. Care has to be taken in mixing to avoid balling effect.

For all test specimens, moulds were kept on table vibrator and the concrete was poured into the moulds in three layers by tamping with a tamping rod and the vibration was effected by table vibrator after filling up moulds. The concrete filled moulds are shown in plate. The specimens were taken after twentyfour hours and were kept immersed in clean water tank upto the specified period of curing. Before testing the specimens were taken out dried under shade and weight of the specimens were noted.

9 cubes, 9 cylinders and 9 flexural beams were cast for each percentage of replacement. In this test total 45 cubes, 45 cylinders and 45 prisms were casted and tested for sand and cement replacement of M25 mix design.

4.5. Strength Studies on Concrete:

4.5.1. Compressive strength test according to IS: 516-1959:

The test set up for conducting cube compressive strength test is depicted in Plate No. Compression test on the cubes is conducted on the 300T compression testing machine. The cube was placed in the compression testing machine and the load on the cube is applied at a constant rate up to the failure of the specimen and the ultimate load is noted. The cube compressive strength of the concrete mix is then computed. A sample calculation for determination of cube compressive strength is presented in Appendix-II (A). This test has been carried out on cube specimens at 7,14 and 28 days age. The values are presented in tables above for M25 grade concrete

Compressive strength = P/A

Where,

p=maximum load in kg applied to the specimen

A = cross sectional area of the cube on which load is applied (150 X 150 mm)

Split tensile strength test according to IS: 5816-1999:

This test is conducted on 300T compression testing machine as shown in plate no. The cylinders prepared for testing are 150 mm in diameter and 300 mm height. After noting the weight of the cylinder, diametrical lines are drawn on the two ends, such that they are in the same axial plane. Then the cylinder is placed on the bottom compression plate of the testing machine and is aligned such that the lines marked on the ends of the specimen are vertical. Then the top compression plate is brought into contact at the top of the cylinder. The load is applied at uniform rate, until the cylinder fails and the load is recorded. From this load, the splitting tensile strength is calculated for each specimen. A sample calculation for computation of split tensile strength is presented in Appendix-II (B). In the present work, this test has been conducted on cylinder specimens after 7, 14 and 28 days of curing. The values are tabulated in above tables for M25 grade concrete.

Split tensile strength Fct = $2P/(\pi \times d \times l)$

Where,

p=Maximum load in Newton's applied to the specimen

d=Cross sectional dimension of the specimen in mm (150 mm)

I = 1 Length of the specimen in mm

4.5.3. Flexural strength test according to IS: 516-1959:

This test is conducted on 10T Universal Testing machine. The loading arrangement to test the concrete beam specimens for flexure is shown in Plate No. The beam element is simply supported on two steel rollers of 38mm in diameter d these rollers should be so mounted that the distance from centre to centre is 400 mm for 10.0 cm specimens. The load is applied through two similar rollers mounted at the third points of the supporting span, which is spaced 13.3cm center to centre. The load is divided equally between the two loading rollers, and all rollers are mounted in such a manner that the load is applied axially and without subjecting specimen to any torsional stresses. The specimen is placed in the machine in such a manner that the load is applied to the uppermost surface as cast in the mould, along two lines spaced 13.3 cm apart. The axis of the specimen is carefully aligned with the axis of the loading device. No packing is used between the bearing surfaces of the specimen and the rollers. The load is applied without shock and increasing continuously at a rate such that the extreme fibre stress increases at a rate of 180 kg/min for the 10.0 cm specimens. The load is increased until the specimen fails, and the maximum load applied to the specimen during the test is recorded. Also the distance between the line of fracture and the nearer support is measured. The sample calculation for computing flexural strength is presented in Appendix-II (C). In the investigation, this test has been conducted on beam specimens after 7,14 and 28 days of curing. The values are presented in above tables for M25 grade concrete.

Flexural strength Fb = $(P \times l)/(b \times d \times d)$

Where,

FbFlexural strength

p = maximum load in kg applied to the specimen

1 = length in cm of the span on which the specimen was supported

b= Measured width in cm of the specimen

d = Measured depth in cm of the specimen at the point of failure

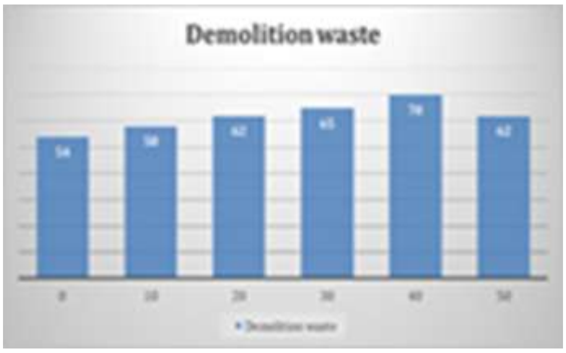
RESULTS AND DISCUSSION

Partial Replacement of Fine aggregate with Demolition waste:

Workability in terms of Slump Cone test

Grade of concrete	Percentage of Demolition waste	Slump (mm
M25	10	58
	20	62
	30	65
	40	70
	50	62

VARIATION OF SLUMP



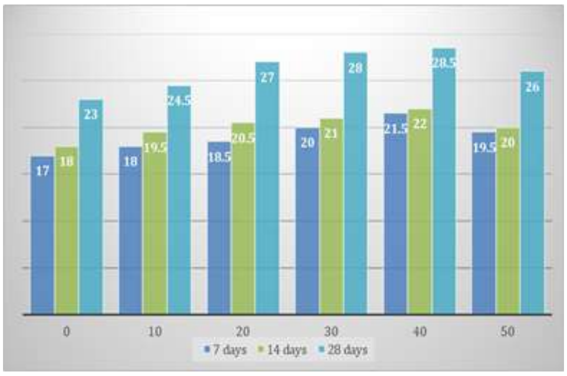
Slump cone test results and Graphs

Compressive strength Results and Graphs (IS 516-1959):

Compressive strength with different replacement percentages of Demolition waste

% of recycled aggregates waste replacement.	7 days	14 days	28 days
0	17	18	26.4
10	18	19.5	27.5
20	18.5	20.5	28
30	20	21	29.2
40	21.5	22	30.5
50	19.5	20	27

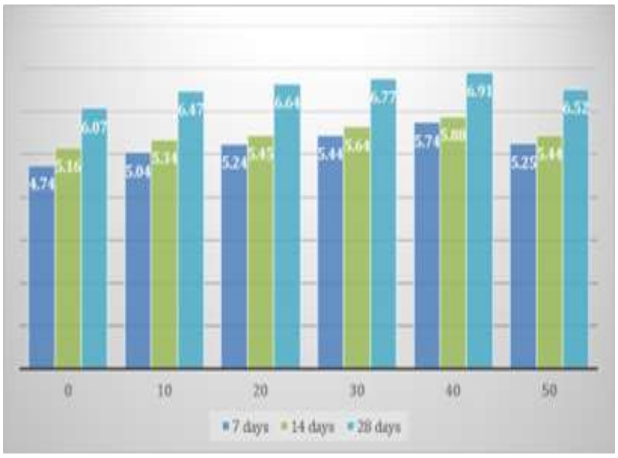
COMPRESSIVE STRENGTH OF CONCRETE BY PARTIAL REPLACING SAND WITH DEMOLITION WASTE



Split Tensile Strength Results And Graphs:

Split tensile strength with different replacement percentages of copper slag (IS 516-1959

% of Demolition waste replacement.	7 days	14 days	28 days
0	1.74	2.16	3.24
10	2.03	2.34	3.60
20	2.27	2.45	3.504
30	2.46	2.64	3.36
40	2.71	2.88	3.3
50	2.25	2.44	3.168

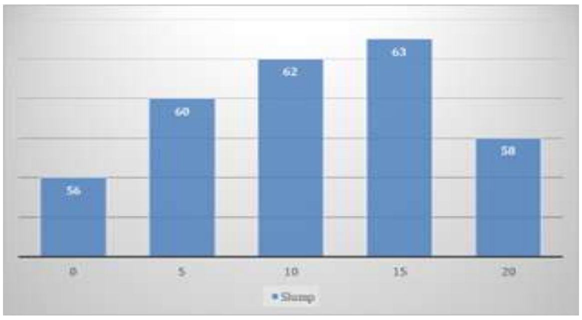


Split tensile strength of concrete by partial replacing sand with recycled aggregates.

Partial Replacement of cement kiln dust with Cement: Slump cone test results and Graphs

Workability in terms of Slump Cone test

Grade of concrete	Percentage of recycled aggregates waste	Slump (mm)
	0	56
	5	60
M25	10	62
	15	63
	20	58

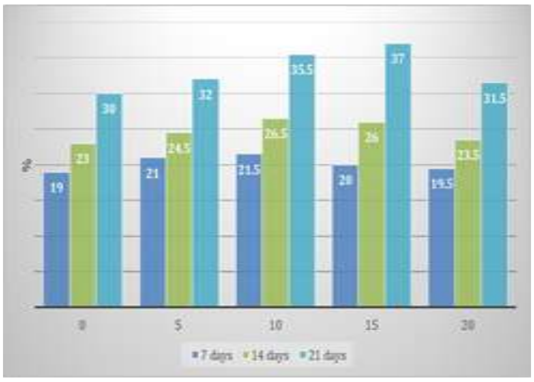


Variation of Slump

Compressive strength Results and Graphs:

Compressive strength with different replacement percentages of CKD (IS 516-1959)

% of cement kiln dust replacement	7 days	14 days	28 days
0	19	23	30.23
5	21	24.5	32.56
10	21.5	26.5	35.5
15	20	26	37.01
20	19.5	23.5	31.5



Compressive strength of concrete by partial replacing cement with cement kiln dust.

Split Tensile Strength Results And Graphs:

Split tensile strength with different replacement percentages of CKD (IS 516-1959) cement kiln dust.

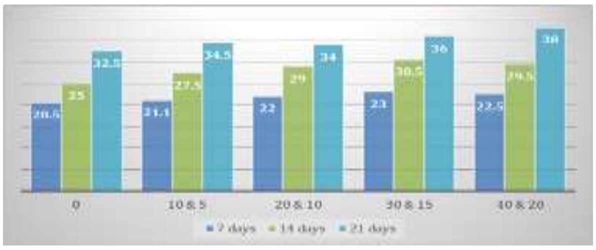
% of cement kiln dust replacement	7 days	14 days	28 days
0	1.65	2.28	3.62
5	1.45	2.73	3.90
10	2.10	2.41	4.26
15	2.23	2.87	4.44
20	2.09	2.46	3.78

Split tensile strength of concrete by Demolition waste with cement kiln dust

Workability in terms of Slump Cone test

% of Demolition waste& cement kiln dust replacement	7 days	14 days	28 days
0	20.5	25	32.5

10 & 5	21.10	27.5	34.4
20 & 10	22	29	35.67
30 & 15	23	30.5	38.12
40 & 20	22.5	29.5	36.88



Compaction factor test Result and Graph

Variation of Compaction factor

Compressive strength Results and Graphs

Compressive strength with different replacement percentages of Demolition waste and cement kiln dust (IS 516-1959).

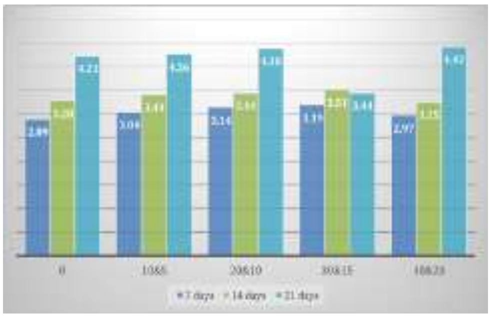
% of Demolition waste and cement kiln dust replacement	7days	14days	28days
0	19	25	32
10&5	19.5	27	34.5
20&10	21	29.5	36
30&15	22.5	31	36.10
40&20	20	26	34

Compressive strength of concrete by partial replacing sand and cement Recycled aggregates and cement kiln dust.

Split Tensile Strength Results And Graphs

Split tensile strength of M25 grade concrete with different replacement percentages of cement kiln dust and Demolition waste

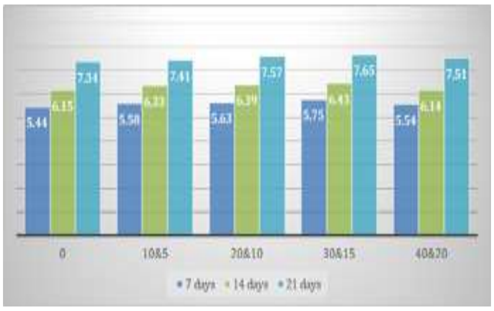
% Of Demolition waste and cement kiln dust replacement	7days	14days	28days
0	2.89	3.28	3.90
10&5	3.04	3.41	4.128
20&10	3.14	3.44	4.28
30&15	3.19	3.51	4.57
40&20	2.97	3.25	4.42



Flexural Strength Results and Graphs:

Flexural strength of M25 grade concrete with different replacement percentages of cement kiln dust and Demolition waste.

% of Demolition waste and cement kiln dust replacement	7days	14days	28days
0	5.44	6.15	7.34
10&5	5.58	6.33	7.41
20&10	5.63	6.39	7.57
30&15	5.75	6.43	7.65
40&20	5.54	6.14	7.51



CONCLUSIONS:

Results are analyzed to derive useful conclusions regarding the strength characteristics of concrete on partial replacement of cement with CKD and sand with Demolition waste for M25 grade concrete.

Conclusions:

1. The compressive strength for partial replacement of fine aggregate with Demolition waste increased in the order of 3.42%, 5.93%, 9.93%, 13.9% and 2.36% for 10%, 20%, 30%, 40% and 50% partial replacements respectively.
2. The split tensile strength for partial replacement of fine aggregate with recycled aggregates increased in the order of 6.18%,8.58%,10.34%,12.16%, and 6.90% for 10%, 20%, 30%, 40% and 50% partial replacements respectively.
3. The compressive strength for partial replacement of cement with CKD decreased in the order of 1.4%, 2.13%, 1.18% & 2% for 5%, 10%, 15% & 20% partial replacements respectively with respect to control specimen.
4. The split tensile strength for partial replacement of cement with CKD decreased in the order of 1.42%, 4.05%, 3.9% & 2.9% for 5%, 10%, 15% & 20% partial replacements respectively with respect to control specimen.
5. The compressive strength for partial replacement of fine aggregate with recycled aggregates & cement with CKD increased in the order of 3.59%, 6.10% and 8.65% for 10%RA & 5%CKD, 20%DW& 10% CKD and 30%RA& 15% CKD partial replacements respectively and decreased by 2% for 40%DW& 20% CKD partial replacement with respect to control specimen.
6. The split tensile strength for partial replacement of fine aggregate with recycled aggregates & cement with CKD increased in the order of 1.52%, 4.47% and 5.75% for 10%RA& 5%CKD, 20%RA& 10%CKD and 30%DW& 15% CKD partial replacements respectively and decreased by 0.8% for 40%DW& 20%CKD partial replacement with respect to control specimen.
7. The flexural strength for partial replacement of fine aggregate with Demolition waste& cement with CKD increased in the order of 2%, 3.9% and 5.10% for 10%DW& 5%CKD, 20%DW& 10%CKD and 30%DW& 15% CKD partial replacements respectively and decreased by 3.28% for 40%DW& 20% CKD partial replacement with respect to control specimen.

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