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ADVANCING HIGH-STRENGTH CONCRETE: EXPERIMENTAL INVESTIGATION WITH CEMENT PARTIAL REPLACEMENT BY FLY ASH AND SAND SUBSTITUTION WITH STONE DUST

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ABSTRACT

The proper ratios of cement, sand, and aggregate coupled with a strong bond increase the compressive strength of the concrete. As a byproduct of stone crushing operations, stone dust filler has a variety of applications. The W.B.M. road is built using stone dust to ensure that the coarse aggregate is correctly connected to one another. One of the waste products produced in significant amounts by thermal power plants is fly ash. Fly ash mixed with cement produces a material that has the same properties as cement. For much of the investigation, fly ash was used in place of cement in the different trials. In an experiment to learn more about the behavior of concrete, fly ash and stone dust are mixed together and added to the mix. The main goal of building using fly ash and stone dust is to create a construction that is reasonably priced and of a specific strength. In this experiment, portions of the sand and cement are substituted with stone dust and fly ash, respectively. These two materials are mixed together. Fly ash is anticipated to comprise zero, five, and ten percent of the cement, while stone dust will replace fifty percent of the project's sand. The "slump test," which establishes the concrete's workability, is conducted by pouring concrete into an angle. The concrete is compared to regular concrete of grade M40 after its modulus of elasticity, split tensile strength, flexural strength, and other characteristics have been determined. This makes the concrete more suitable for the intended use for which it was intended. Every single genuine test that is conducted complies with the guidelines set out by the IS code.

I.INTRODUCTION

1.1. General

Since the majority of Indian households spend their whole life earnings on building a magnificent home, sustainable development is the most crucial policy for the nation. To do this, we need to focus on producing high-quality, reasonably priced construction materials, especially concrete. In this field, further research is required. I investigated the area of rock waste produced by the product as a material substitute in the concrete.

The amount of construction going on is growing quickly, and there is a growing shortage of natural sand resources. The only way out of this situation is to look for substitute materials that can either completely or partly replace naturally occurring building supplies like cement and stone dust. In certain concrete applications, fly ash—a byproduct of burning coal—is used in lieu of some of the cement. This method is less expensive and increases the performance of concrete.

In this project, we attempted to replace some of the fly ash with cement and some of the fine aggregate in a concrete mix with stone dust. We also discussed the various mechanical properties of concrete, such as compressive strength, tensile strength, flexural strength, and flexural strength.

1.2. Pozzolanic Materials

To put it simply, pozzolanas, also referred to as pozzolans, are materials that, although not cementitious in and of themselves, contain components that, when combined with lime at room temperature and with water, provide cementing properties. or Pozzolanic materials, in general, are aluminous and siliceous materials that have been finely split and have little to no cementitious value. They chemically react with the calcium hydroxide generated during hydration to create compounds having cementitious characteristics when exposed to moisture at room temperature. Improved resistance to thermal cracking due to reduced heat of hydration, increased ultimate strength and impermeability due to pore refinement, and enhanced durability against chemical attacks such as acid, sulphate water, and alkali-aggregate expansion are just a few of the engineering benefits that may result from the use of pozzolanas in concrete.

Pozzolana: The lime produced during the hydration of C3S and C2S is transformed into calcium silicate hydrate when the pozzolana reaction takes place. In the Portland cement hydration product chain, this might be considered the weakest link due to its low mechanical strength and lack of durability. The hydration process of pozzolan and mixed cement yields C-S-H gel and sulfoaluminates. Refer to Figure 1. On the other hand, a pozzolanic reaction proceeds much more slowly than Portland cement hydration at room temperature; however, water-cured concrete

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containing a pozzolan becomes stronger with time and loses permeability. Artificial and natural pozzolanas are the two categories into which pozzolanas fall. Volcanic ashes, volcanic tiffs, trass, and zeolites make up the natural group, whereas fly ashes, silica fume, calcined clays and shales, metakaolin, and rice-husk ash make up the artificial group. Metakaolin, rice-husk ash, and calcined clays and shales are also found in the natural category. Natural pozzolans become more reactive when heated to temperatures between 500 and 8000 degrees Celsius (Malhotra and Malhotra, 1996). The minerals used as pozzolaonas are described in this document's Sections 2 and 3, respectively.

1.3. Types of Pozzolanas:

1.3.1. Natural pozzolans

The name "pozzolana" comes from the Roman town of Pozzuoli, which was a source of zeolitic tuff and was situated on the slopes of Mount Vesuvius. Natural pozzolanas are mostly made of volcanic dust and ash. Natural pozzolans, such diatomaceous earth, clay and shale, and other like minerals, are processed by pulverizing, grinding, and size preparation; if necessary, they are also heated to activate the material. More active pozzolans have been available to customers, which has led to a reduction in the popularity of natural pozzolans.

1.3.2. Artificial pozzolanas (pozzolanas made of clay)

Artificial pozzolanas are made from a range of industrial by-products, including metakaoline, grounded granulated blast furnace slag, burnt diatomaceous earth, and nano and micro silica. Burned clay and shale (with some brick) constitute artificial pozzolanas.

1.4. Fly ash (also known as pyroclastic flow):

Because fly ash has shown significant advances in material performance over the last several decades, its application in construction has been growing rapidly. The role of fly ash in the cementitious matrix has been better understood thanks to a number of recent studies. This includes the cement's hydration, the concrete's mechanical properties, and its microstructural makeup. On the other hand, some of these effects are yet not fully known. This study also includes the examination of the cementitious matrix's nanostructure using advanced characterisation techniques to determine how it affects concrete performance. Fly ash was given for this experiment by Trimukth MinChem (Hyderabad). In a scientific environment, this fly ash's specific gravity and bulk density were measured. Trimukth MinChem was contacted for the remaining information, excluding the chemical and physical features (Hyderabad).

Fig 1.1 : Fly ash

1.5. Stone Dust

Stone dust is generated by crusher facilities as a byproduct of the crushing process. A fraction of it may be used in concrete in place of natural river sand to some extent. Because quarry dust may provide strength at a 50% replacement rate for natural river sand, it can be a viable alternative for natural river sand in concrete mixtures. This helps preserve natural river sand for next generations in addition to enhancing the quality of the concrete (Balamurgan et al., 2013). It has been shown that the compressive, flexural, and tensile strengths of concrete are all much boosted when crushed stone dust is utilized as fine aggregate (Nagpal et al., 2013). Franklin et al. (2014) have shown that stone dust may be substituted for fine aggregate at a 40 percent to 60 percent ratio. When crusher dust was used in place of natural sand, concrete's compressive strength increased by 5 to 22 percent. Additionally, it was found that, of all the mixes, the one with the greatest compressive strength was the one in which crusher dust was used to replace 40% of the natural sand (i.e., 40% of the sand was replaced with 40% of the crusher dust) (Quadri et al., 2013). Using natural sand in combination with the mix design specifications was insufficient to create the required slump. However, a highly workable mix with the required mix design parameter was created by employing manufactured sand with the right shape, surface roughness, and necessary grading to lessen the quantity of void content present (M S Shetty, 2013). According to Mahzuz et al. (2011), the compressive strength of concrete made from stone powder was found to be 14.76 percent higher than that of concrete made from regular sand. Research has shown that concrete made from quarry rock dust has compressive and flexural strengths that are almost 10% more than those of ordinary concrete (Suribabu et al., 2015). The present study recommends investigating the best way to substitute stone dust for river sand in concrete in order to maximize compressive strength performance at 7 and 28 days after installation.

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1.6. The purpose of the current research

In order to determine the compressive strength, tensile strength, and flexural strength of concrete that has 50% of its fine aggregate replaced with stone dust, this study compares the M40 grade of concrete that has partially replaced fly ash with cement and partially replaced fine aggregate with stone dust.

OBJECTIVE OF THE STUDY

To study the various mechanical properties of concrete, such as its flexural, tensile, and compressive strengths, by substituting stone dust for fine aggregate and cement for fly ash in half of the mixture.

II.EXPERIMENTAL INVESTIGATION

2.1 INTRODUCTION

In this study, the mechanical properties of concrete with concrete grade M40 that contains fly ash (0, 5, 10, 15, and 20% by weight of cement), stone dust (half by weight of fine aggregate), and fine aggregate (half by weight of fine aggregate) are examined.

Targeted mix design M40		
Mix	Fly Ash percentage (by weight of cement)	Fine aggregate
Mix 1	0 %	River sand
Mix 2	0%	River sand replaced with Stone Dust 50%
Mix 3	5%	
Mix 4	10%	
Mix 5	15%	

Table No. 2.1 Mix Proportion percentages

2.2 Materials

2.2.1.Cement

All of the project's cement was bought in one shipment and stored in a safe place. The building was constructed using regular Portland cement (53 grade), in compliance with IS:12269. The properties of the cement (IS: 12269, 1987) that was utilized in the investigation are shown in the table below.

s.no	property	Test results
1	Fineness	96%
2	Normal consistency	30%
3	Initial setting time	38 min
4	Final setting time	600 min
5	Specific gravity of cement	3.14
6	Compressive strength at	
	7 days	34.1 N/mm2
	28 days	55.2 N/mm2

Table: 2.2.1 Physical properties of ordinary Portland cement (OPC 53 grade)

2.2.2. Properties of fly ash:

Compared to other fly ashes, Indian fly ashes have a more varied chemical makeup and physical attributes. Below is a more detailed description of certain fly ash properties that affect the strength and caliber of concrete:

a) Fineness:

Among all the physical characteristics of fly ash, its fineness is one of the most important and influences its activity more than any other. The air permeability approach is often used to compute specific surface area, which is then expressed as a percentage of the total surface area. The range of its cm2/gram is 2194–6842. It seems that the Indian fly ashes produced in our country are excellent and comparable to those produced outside.

Sieve study shows that the Indian fly ashes have a coarser texture when compared to foreign fly ashes. For instance, just three Indian fly ashes were found to fit into this category, despite the fact that most American fly ashes and more than 80% of the material passing the 45-micron IS sieve were found to do so. The fact that fly ash is removed by mechanical collectors in most Indian thermal power plants and that even this fraction gets mixed up with the corner fractions collected in the middle or bottom hoppers of the plants may be one of the reasons of this.

b) Particle Size :

Ashes from flying insects have been discovered to include black particles that are angular as well as spherical, as well as spheroidal glass and minute quartz grains.

The fractions that passed through the 45-micron filter included some rounded block particles as well as a significant amount of spheroidal glass. Particles are black (rounded) and quartz grains in ashes that have been maintained at a size greater than 150 microns or 75 microns. When compared

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to American fly ashes, the quantities of spheroidal glass (8-38 percent) in Indian fly ashes are much lower (50-90 percent).

c) Pozzolonic Activity :

The lime reactivity test is used to ascertain this value. In order for fly ash to be deemed acceptable for use as a pozzolon, it must demonstrate in the test that its lime reactivity test strength is more than 40 kg/cm2 on the basis of the test. The pozzolonaic activity of Indian fly ashes was shown to be very high. However, as compared to American fly ashes, Indian fly ashes are much less reactive. For example, when the bulk of American fly ashes were utilised as a 20 percent substitution of cement by weight, the compressive strength of the cement motor was 100 percent or more than the compressive strength of the equivalent aircraft motoris after just 90 days. When compared to this, none of the Indian fly ashes employed as a 20 percent substitution of cement by weight were found to be comparable to the compressive strength of the matching plane cement motor (1:3 cement-sand) even after one year of operation. Because Indian fly ashes respond less aggressively than foreign fly ashes

2.2.3. Use of fly ash in Concrete:

The most common application of fly ash is in the production of Portland pozzolona cement or in the partial replacement of cement.

When the oxides in the raw materials are exposed to high clinkering temperatures, they mix to create complex compounds in the cement manufacturing process. The following are the four main compounds:

I) Calcium silicate tricalcium (3CaOSiO2)

(ii) Dicalcium Silicate (2CaOSiO2)

(iii) Tricalcium Aluminate (3CaOAl2O3)

(iv) Tetra Calcium Alumino Ferrite (Tetra Calcium Alumino Ferrite) (4CaOAl2O3Fe2O3)

The most significant compounds responsible for strength are C3S and C2S. They make up 70 to 80 percent of cement when combined. Calcium silicate hydrate and calcium hydroxide are produced when C3S and C2S react with water.

$$2(3CaO.SiO_2) + 6H_2O \quad 3Ca\,O.2SiO_2.3H_2O + 3Ca\,(OH)_2$$

$$2(2CaO.SiO_2) + 4H_2O \quad 3Ca\,O.2SiO_2.3H_2O + Ca\,(OH)_2$$

The calcium hydroxide that is so released has no effect on the strength. Furthermore, it is water soluble and is leached away, making the concentrate porous. As a result, this is a bad product. At usual temperatures, finely split fly ash reacts chemically with Ca (OH) 2 to produce compounds with cementitious characteristics, decreasing the detrimental effects of Ca (OH) 2. As a result, fly ash, which is a waste product with a significant disposal issue, is put to good use.

2.3. Aggregates

The aggregate size, shape, and gradation all play a part in producing appropriate concrete. The aggregate size will be determined by the rebar spacing.

The coarse aggregate selected has an angular form, is highly graded, and has a maximum size that is lower than that required for traditional concrete. The aggregate size in ordinary conventional concrete should not exceed 20mm. When selecting a coarse aggregate, grading is a crucial consideration.

2.3.1. Fine aggregate

In this study, the fine aggregate is made using locally accessible sand. Clayey materials, salts, and organic contaminants are absent from the sand. Sand has a specific gravity of 2.72 and has a fineness modulus of 2.56.

S.No.	Property	Test results
1	Specific gravity	2.62
2	Fineness modulus	3.64

Table: 2.3.1. Properties of Fine aggregate

Sieve Analysis is carried out for Fine aggregate as per IS:2386(part-III)-1963

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s.no	Sieve size	Weight retained	% retained	% cumulative retained	% fineness
1	4.75mm	2.310	0.46	0.462	99.543
2	2.36mm	7.521	15.254	1.964	98.054
3	1.18mm	128.111	25.626	27.585	72.423
4	600 microns	153.312	30.666	58.249	41.765
5	300 microns	183.965	36.784	95.028	4.983
6	180 microns	23.424	4.685	99.775	0.325
7	150 microns	0.332	0.0614	99.762	0.244
8	75 microns	0.321	0.0644	99.829	0.187
9	Pan	0.201	0.0412	99.864	0.143

Table: 2.3.2 sieve analysis of sand

2.3.2. Stone dust

A nearby crushing mill provided the stone dust utilised in the laboratory experiments. Stone dust has a specific gravity of 2.5.

Stone dust is subjected to sieve analysis in accordance with IS:2386(part-III)-1963.

IS sieve size	Weight retained (kg)	Cumulative weight retained (kg)	Cumulative percentage retained	Cumulative percentage passing
4.75mm	0.16	0.16	16	84
2.36mm	0.174	0.334	33.4	66.6
1.18mm	0.201	0.53	53.5	46.5
600 micron	0.151	0.68	68.6	31.4
300 micron	0.189	0.87	87.5	12.5
150 micron	0.102	0.97	97.7	2.3
75 micron	0.02	0.99	99.7	0.3
pan	0.003	1	100	0

Table: 2.3.3 Sieve Analysis of Stone Dust

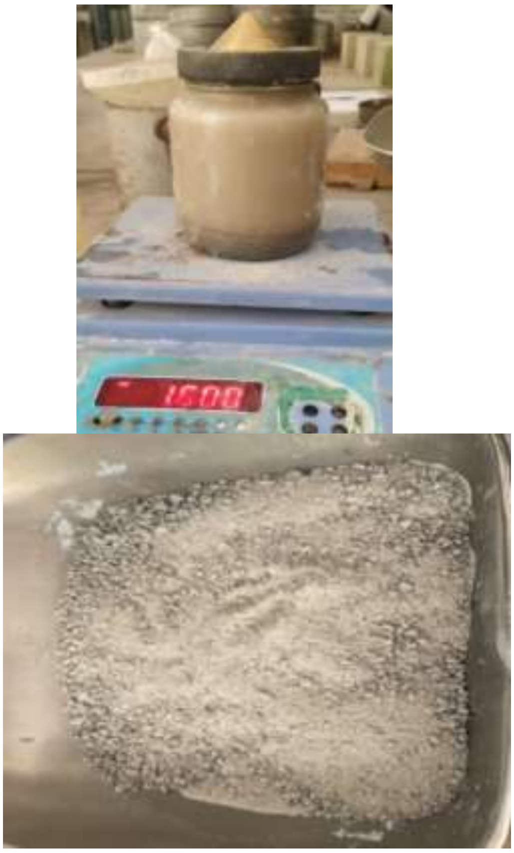

Fig. 2.3.4 Pycnometer with wet Stone Dust and Stone Dust in a try

2.4. Water

The concrete was made and cured using the tap water available in the concrete laboratory.

2.5 Superplasticizer

FORSOC chemical India ltd utilised and produced the superplasticizer CONPLASTSP430. Cement concrete contains this chemical additive. The increased workability has no effect on any strength or microstructure properties, but it does improve workability.

2.6.Mix proportions In the laboratory,

The quantities used in the mix preparation are determined according to the requirements of IS:10262: 2009.

Design specifications for concrete of the M40 grade

2.7. Grade Designation: M40

Type of cement: OPC-53 grade

Fine Aggregate: zone-2

2.8. Specific gravities:

Material	Cement	FA	CA(20mm)	Stone Dust
Specific gravities	3.14	2.62	2.64	2.5

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Table 2.4: Specific gravities of different materials used

2.9. Summary of Mix proportions for M40 grade concrete

S.NO	Material	By Weight/m^3
1	Cement	420.01 kg/m^3
2	fine aggregate	714.1 kg/m^3
	River sand	357 kg /m^3
	Stone dust	357 kg/m^3
3	coarse aggregate	1162.6 kg/m^3
4	Water	174 kg/m^3
5	super plasticizer (CONPLASTSP430)	1% (by weight of cement)
	Water cement ratio	0.41

Table 2.5.: Mix proportions for M40 grade concrete

2.10. Preparing of test specimens

Quantities of material required per 1m3 of M40 grade concrete as required

Test specimen	cement in kg	Fly ash kg	F.A in kg	River sand (50%) in kg	Stone dust (50%) in kg	C.A in kg	Water in kg	Super plasticiser in kg
M1	420.01	0	714.1	0	0	1162.6	174	4.2
M2	420.01	0	0	357	357	1162.6	174	4.2
M3	411.6	21	0	357	357	1162.6	174	4.11
M4	407.4	42	0	357	357	1162.6	174	4.07
M5	403.2	63	0	357	357	1162.6	174	4.03

Table 2.6 : Quantities of material required per 1m3 of M40 grade concrete

2.11. Mixing

The materials are mixed in a revolving drum. Trowels are used to thoroughly mix the ingredients by hand. Wet mixing continues until a consistent colour and consistency is obtained, at which point the specimens may be cast.

2.12 Adaptability

With the use of superplasticizer, a slump of 10mm to 20mm is achieved for concrete workability..

Fig. 2.7 True Slump

2.13. Compaction

Compaction is the process of releasing trapped air from newly laid concrete and compacting the aggregate particles to improve the density of the concrete. Concrete compaction is an essential part of the concrete laying process. If compaction is not done properly, a succession of flaws may appear, and the concrete will lose a considerable amount of strength. In this experiment, an immersion vibration, also known as a needle vibrator, is utilised to achieve complete compaction and maximum density.

2.14 Casting of specimens

Before concrete is poured into the cast iron moulds, dust particles are removed and mineral oil is applied to all surfaces. The cubes are 150mm x 150mm x 150mm, the cylinder is 150mm x 300mm, and the beams are 100mm x 100mm x 500mm. The moulds are set on a flat surface. Vibrations using a needle vibrator fill the moulds with well-mixed concrete. With a trowel, excess concrete was removed, and the top surface was levelled and smoothed.

Fig. 2.8. Split Tensile test Specimen

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2.15. Curing of the specimen

After casting, the specimens are kept undisturbed at room temperature for approximately 24 hours.
After that, the specimens are taken from the moulds and placed in a curing pond with clean and fresh water for 28 days.

2.16 Specimen analysis

After 7 days and 28 days of cure, the cast specimens are tested. The test findings are meticulously tabulated.

Tests conducted

2.16.1 Compression Test

The most significant property of hardened cement is its compressive strength. As a result, it's not unexpected that the strength of cement is usually evaluated in a laboratory before it's utilised in major projects. Concrete's main function in most structural applications is to withstand compressive stress. After 7 and 28 days of curing, a series of standard concrete cubes 150mm*150mm*150mm are evaluated in a compressive testing machine. At least three specimens, preferably from separate batches, must be produced for testing. The test is carried out in accordance with IS: 516-1959. The compressive strength of a specimen is determined by dividing the load by the area of the specimen, and the results are shown below.

$$Fc = P/A mm^2$$

Where,

P = cube compressive load affecting failure

A = cross section area of cube in mm^2

Fig. 2.9. Compressive Strength Test

2.16.2 Split Tensile Strength

One of the most fundamental and essential characteristics of concrete is its tensile strength. The design of concrete structural components requires an understanding of their importance. Concrete's direct tensile strength is difficult to establish. It is an indirect technique of determining concrete ensile strength. The specimen's length must be no less than the diameter and no more than twice the diameter. The specimen must be a cylinder with a diameter of 150mm and a length of 300mm. For testing, at least three specimens must be produced, preferably from separate batches. The test is carried out in accordance with IS: 516-1959. The base plate must be 6.5mm thick so that it does not protrude more than 0.02mm from the plant surface. The load is delivered to a cylinder that is positioned horizontally between the compressive testing machine's two plates. After 7 days of curing and 28 days of cure.

$$Fst = 2P/PI\ LD\ mm^2$$ Where,

Fst = Split tensile strength N/mm^2 , P = maximum load in N , L = length of specimen

D = cross section diameter

Fig. 2.10. Split tensile strength Test

2.16.3 Flexural strength test

The flexural test is used to determine the tensile strength of concrete. It examines the capacity of an unreinforced concrete beam to resist bending failure. It's worth noting that the two-point load test yielded the modulus of rupture value. The specimen was casted and will be 100mm * 100mm * 500mm to investigate the bending movement of concrete under two-point stress. The modulus of rupture is the highest tensile stress measured at the failure of a beam and is calculated. The modulus of rupture is used to represent the specimen's flexural strength (Fb). It's also calculated after 7 and 28 days of cure. For testing, at least three specimens must be produced, preferably from separate batches. The test is carried out according to IS: 516 – 1959, which states that if the distance between the line of action and the closer support is

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equivalent, it must be computed to the closest 0.5 kg/sq mm on the tensile side of the specimen.
$Fb = PL/aD^2$ N/mm^2

When a is greater than 200mm for 150 mm specimen or greater than 133 mm for a 100mm specimen, or
$Fb = 3Pa / bd^2$

When a is less than 200mm but greater tha 170mm for 150mm specimen, or less than 133mm but greater than 110mm for 100mm specimen
Where,
Fb = modulus of rupture
B = measured width of specimen
D= measured depth of specimen at the point of failure
L= length of the span on which the soecimen was supported
P = maximum load applied to the specimen

Fig.2.11. Flexural Test

III.EXPERIMENTAL RESULTS

For M40 concrete of various specimens for 7 and 28 days of curing The purpose of this research is to determine the mechanical characteristics of concrete including Nano silica (2%, 3%, and 4% by weight of cement), stone dust (50%) and marble powder (50%) by weight of fine aggregate.

Targeted mix design M40 Test Specimens		
Fly Ash replacement percentage (by weight of cement)		
M1	0	
M2	0 (with F.A 50%+50%)	
M3	5%	
M4	10%	
M5	15%	
Fine aggregate	River Sand	50%
	Stone Dust	50%

Table 3.1 : Targeted mix design M40 Test Specimens

MIX/TEST SPECMN	CEMENT	Fly Ash	F.A	RIVER SAND (50%)	STONE DUST (50%)	C.A
M1	1.0	0	1.70	0	0	2.77
M2	1.0	0	0	0.5	0.5	2.77
M3	0.98	5%	0	0.5	0.5	2.77
M4	0.97	10%	0	0.5	0.5	2.77
M5	0.96	15%	0	0.5	0.5	2.77

Table 3.2: Mix proportions for M40 grade concrete

3.1.COMPRESSIVE STRENGTH OF CONCRETE

Concrete compressive strength tests are performed seven and twenty-eight days after casting and curing for M1, M2, M3, M4, and M5 mix fractions. The Compressive Strength of Concrete for 7 and 28 days after casting is shown in the table below M1,M2,M3,M4 and M5.

Compressive strength of concrete N/mm^2					
Test Specimen	M1	M2	M3	M4	M5
7 days	31.2	34.81	42.34	45.1	44.01
28 days	52.2	53.9	57.30	58.9	56.9

Table 3.3: Compressive strength of concrete N/mm^2

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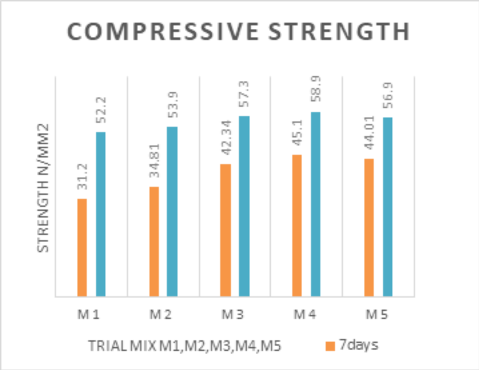


Graph 3.1 : Compressive Strength of Concrete at 7 and 28 day

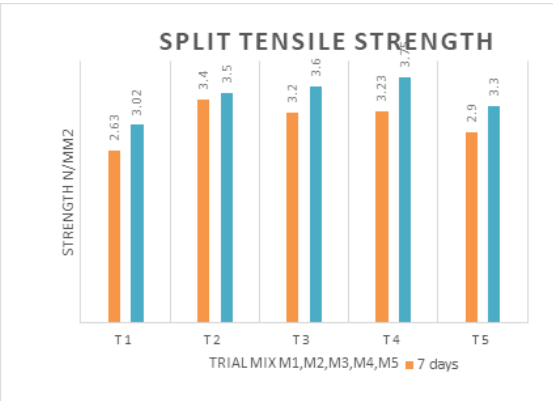
Table 3.3 and Graph 1 show that the Compressive Strength of M4 at the 28th day rose by 9% compared to M2 and 12% compared to M1. When compared to M4, M5 strength has been reduced by 3%.

3.2. SPLIT TENSILE STRENTH TEST

The split tensile strength of concrete for 7 and 28 days after casting is shown in the table below M1,M2,M3,M4 and M5.

Tensile strength of concrete N/mm^2					
Test Specimen	M1	M2	M3	M4	M5
7 days	2.63	3.4	3.2	3.23	2.9
28 days	3.02	3.5	3.6	3.75	3.3

Table 3.4: Tensile strength of concrete



Graph 3.2 : Split Tensile Strength of Concrete at 7 and 28 day

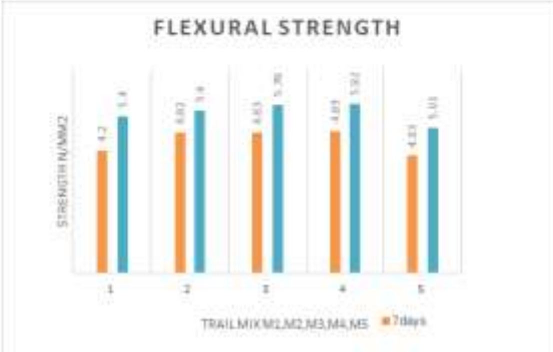
Table 3.4 and Graph 2 show that the Split Tensile Strength of M4 at the 28th day increased by 7% when compared to M2 and by 24% when compared to M1. When compared to M4, M5 strength has been reduced by 13%.

3.3.FLEXTURAL STRENGTH TEST

The split tensile strength of concrete for 7 and 28 days after casting is shown in the table below M1,M2,M3,M4 and M5.

Flexural strength test N/mm2					
Test Specimen	M1	M2	M3	M4	M5
7 days	4.2	4.82	4.83	4.89	4.03
28 days	5.40	5.6	5.78	5.82	5.01

Table 3.5: Flexural Strength of Concrete



Graph 3.3 : Flexural Strength of Concrete at 7 and 28 day

According to Table 3.5 and Graph 3.3, the Flexural Strength of M4 at the 28th day rose by 3.9 percent when compared to M2 and 7.7% when compared to M1. When compared to M4, M5 strength has been reduced by 16%.

5.4. MODULUS OF SPECIMENS:

The values for modulus of elasticity of specimen are tabulated in Below Table

Test Specimen No.	Modulus of Elasticity E (N/mm2)
M1	8295.075
M2	8976.702
M3	9865.21
M4	10138.37
M5	8373.526

Table 3.6: Modulus of Elasticity of Specimens

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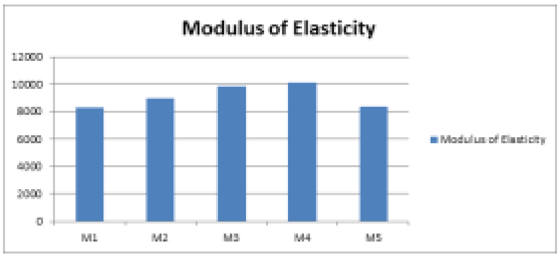

Graph 3.4: Initial Tangent Modulus Elasticity of Specimen

According to Table 3.6 and Graph 3.4, the Flexural Strength of M4 at the 28th day rose by 12% compared to M2 and 21% compared to M1. When compared to M4, M5 strength has been reduced by 19%.

IV.CONCLUSIONS

The results of this experimental study are as follows.

1. From M1 to M4, the compressive strength increased by 12%. From M4 to M5, it started to decline by 3%.

2. From M1 to M4, Split Tensile Strength increased by 24%; however, from M4 to M5, it decreased by 13%.

3. Flexural strength decreased to a value of 16 from M4 to M5, after rising 7.7% from M1 to M4.

4. From M1 to M4, the elasticity modulus rose by 21%; however, from M4 to M5, it decreased by 19%.

5. In general, the M4 mix yields the best results in the tests of modulus of elasticity, flexural strength, split tensile strength, and compressive strength.

SCOPE FOR FURTHER INVESTIGATION

In the future, there is a lot of potential to improve mix proportions by substituting different percentages of cement with fly ash and stone dust. Research is also needed to find out more about the use of concrete in RCC structures and to look into other properties of concrete, like

2. It is necessary to determine the long-term properties of concrete, such as creep, shrinkage, sulphate attack, acid resistance, and durability.
3. The mechanical properties of structural elements like beams and columns may be studied using concrete.
4. To assess the Nano structure of the concrete, further Nano research may be carried out.

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