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[ijirset@gmail.com](mailto:ijirset@gmail.com)

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# Mechanical Properties of Concrete by Using Fly Ash and Cow Dung Ash

D. Sree Lakshmi<sup>1</sup>, M. Mallikarjuna<sup>2</sup>, K. Shammad Basha<sup>3</sup>

Post Graduate Student, Department of Civil Engineering, SVR Engineering College, Nandyal, Kurnool (DT),

A.P, India<sup>1</sup>

Assistant Professor, Department of Civil Engineering, SVR Engineering College, Nandyal, Kurnool (DT),

A.P, India<sup>2</sup>

Assistant Professor, Department of Civil Engineering, SVR Engineering College, Nandyal, Kurnool (DT),

A.P, India<sup>3</sup>

**ABSTRACT:** Concrete is the most popularly used building material in the world. Consequently, the consumption of cement in concrete industries has been increasing day by day to fulfil the pressing needs of infrastructure due to growing population, industrialization and urbanization. The production of cement poses environmental problems due to emission of gaseous pollutants, because the production of one ton of Portland cement emits approximately 0.9 tons of CO<sub>2</sub> into the atmosphere. Therefore, there is a need to search for supplementary cementitious materials like cow dung ash, fly ash etc., for utilization as partial substitute for cement. In many parts of the developing world, caked and dried cow dung is used as fuel. Dung can be used to produce biogas to generate electricity and heat, in which 34% of cow dung become ash when it is burned. The Rayalaseema Thermal Power Plant (RTPP) located at Dharmal in Kadapa district produces about one million ton of fly ash every year. The use of these waste materials in cement makes the concrete greener.

In the present investigation, an attempt is made to find out the mechanical properties of concrete using cow dung ash and fly ash. The use of partial replacement of OPC by wastes favoured concrete production due to their advantages in improving some of the properties of concrete. The investigation was carried out for M<sub>25</sub> grade concrete maintaining the water/cement ratio 0.55 throughout the project. The study investigates the influence of cow dung ash and fly ash on properties of concrete. The experiment consists of partially replaced cement with cow dung ash as well as fly ash in concrete. Using 0%, 5%, 10%, 15%, 20%, 25% and 30% replacement of cement with fly ash and cow dung ash. All these mixtures were prepared, conducted the experimental investigation and then the subsequent analysis of test results and the following conclusions are drawn. The mechanical properties like compressive strength, split tensile strength and flexural strength were to be conducted on M<sub>25</sub> grade concrete.

**KEYWORDS:** Cement, Cow Dung Ash, Fly Ash, Compressive Strength, Split Tensile Strength, Flexural Strength

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## IINTRODUCTION

The concrete of its flexibility, durability, sustainability, and economy have made it the world's most widely used building material. The manufacture of one tone of cement of lime stone consumes 80 Units of electric power apart from releases one tone of CO<sub>2</sub> at large into the atmosphere. Out of the total CO<sub>2</sub> emission (from a variety of resource) worldwide, even industries contribute about 7% of CO<sub>2</sub> emissions. Annual cement manufacture rate of the world is increasing very much year by year. The manufacture can be reduced if demand is reduced. Demand can be condensed by using supplementary cementitious materials and other materials which can decrease cement content in concrete. Our country stands the first place among the other countries in cows farming and this cow dung as burning at 800oC and it produces the cow dung ash.



The fly ash is majorly used in the manufacture of cement. For efficient consumption of ashes in cement in India, using cow dung ash and fly ash in the form as partial replacements of cement is very important than other using complementary cementitious materials. There are both technical advantages and communal benefits in using cow dung ash and fly ash in concrete. In order to make the concrete more ecological friendly and greener there is a dreadful need to use CDA and FA in concrete. Here the study is based on partial replacement of OPC with Fly Ash and OPC with Cow Dung Ash. The durability and mechanical properties of concrete are examined by the replacement of fly ash and cow dung ash in cement.

## II. LITERATURE REVIEW

This chapter presents the literature on a small review of the terminology and also the past studies on cow dung ash (CDA) and fly ash (FA). O. Kayali et al. (2008) made a research on fly ash mild weight aggregates in high performance concrete. mild weight aggregates had been synthetic by sintering fly ash and crushing the product into suitable sizes. these aggregates own unique traits that make them suitable for excessive strength and high-performance concrete. The importance of the brand-new aggregates lies mainly inside the fact that superior qualities are performed without having to growth the cement content material. for this reason, it is viable to lessen the quantity of cement by means of as much as 20% without affecting the required strength. eventually, making use of fly ash to provide quality aggregates ought to yield sizeable environmental benefits.

T. Omoniyi et al. (2014) work reports on an investigation into the use of cow dung ash (CDA) as Supplementary Cementitious Material in concrete. Cement was replaced with cow dung ash up to 30% at 5% interval. The slump cone test and initial and final Setting time was carried out on the fresh cement with cow dung ash in different proportion. The result of setting times indicates that as the percentage of cow dung ash increases, the initial and final setting time increases respectively. It indicates the Cow dung ash acts as a set retarder in concrete. The workability of concrete decreases as the cow dung ash content in cement of concrete increases.

O. Y. Ojedokun et al. (2014) had to study the use of cow dung ash as partial replacement in cement of concrete. The experiments were intended to study the effects of concrete by the adding of Cow Dung Ash in various proportions by weight of cement in concrete respectively. It also involves determining the initial and final setting time, Bulk Density and Workability of concrete using Cow Dung Ash in various proportions. The Compressive strength test results show the 10% cow dung ash replacement exhibits nearly better results compared to normal concrete.

K.S.Ramesh et al. (2015) has done an experimental study on replacement of cement with fly ash and also replacement of sand with m sand. Based on the research, the fly ash can be used as supplementary cementitious construction material but decisions are to be taken by engineers. The entire experimental data shows that the addition of the industrial wastes improves the physical and mechanical properties. These results are of great importance because this kind of innovative concrete requires large number of fine particles. Due to its high fines of fly ash provides very effective in assuring very good cohesiveness of concrete.

P. Thej Kumar et al. (2015) study presents the possibility of utilizing Cow dung ash (CDA) as a supplementary cementing material in cement mortar and concrete. Cement was partially replaced with four percentages (5%, 10%, 15%, and 16%) of cow dung ash by weight. Test results indicated that the consistency limits increased up to an optimum content and decreased further with the increase in the % of CDA in cement. The compressive strength is increased when the cement is replaced by 5% of CDA and decreased with the increase in the cow dung ash content.

Swapnil Samrit et al. (2016) made an investigation about the use of fly ash as replacement material of cement in concrete pavements. The Research is to investigate the behaviour of concrete in Pavements while replacing the fly ash in cement. The replacement accordingly in the range of 0%, 10%, 15%, & 20% by weight in concrete. Concrete with 15% replacement of cement with fly ash shows good compressive strength and split tensile strength for 28 days of curing as compared to 10% and 20% of replacement but for 15% of replacement, Flexural strength reduces as compared to 10% and 20% of replacement.

R. D. Padhye et al. (2016) studied the Cement Replacement by Fly Ash in Concrete. Different grades of concrete mixes with varying percentage of fly ash content were prepared and the effects of fly ash on mechanical properties of fresh and hardened concrete have been investigated. The compressive strength of concrete was measured for 7, 28 and 45 days and compaction factor is taken as a measure of workability. Compressive strength of concrete at different proportions of cement being replaced by fly ash has been checked and results have been found effective and applicable. Hence, a comparative study is done and use of fly ash as a cement replacement in concrete can be analysed and compared.

Sruthy B et al. (2017) has made an experimental investigation on strength of Concrete made with cow dung ash and glass Fibre. This paper presents the study on the use of Cow Dung Ash (CDA) as partial replacement of cement in the production of concrete. This replacement was designed to study the effects of adding Cow Dung Ash (CDA) in various percentages by weight (6%, 8%, 10%, 12% and 14%) of cement. To strengthen the CDA concrete and making it more durable 0.5% glass fibre is being added, as it is an economically strong material, have excellent flexural strength, crack resistance and can also be used as an alternate material for concrete Construction. The M25 mix design for the proposed concrete mix is calculated. Results showed that up to 8% replacement of cement by cow dung ash there was an increase in compressive strength.

### III. MATERIALS

**A. Cement:** Cement is a binder material, which is used to binds the other material together. Ordinary Portland cement of 53 grade manufactured via. Ultratech company confirming to IS 12269-1987 is used. The main benefit is the faster rate of development of strength. The specific gravity of cement is 3.15&fineness modulus of cement is 225m<sup>2</sup> /kg.

**B. Aggregate:** After cement, the aggregate is the basic material used in any concrete to comprise the body of concrete for increasing the strength to the material quantity, and to minimize the consequential volume change of concrete. The fine and coarse aggregates generally occupy 60% to 75% of concrete volume and strongly influence the concrete's freshly mixed and hardened properties, mixture proportions and economy. The natural sand with specific gravity is 2.65 and fineness modulus is 2.89 and the crushed aggregates of 20mm size with specific gravity is 2.75 were used.

**C. Fly Ash:** Fly ash confirming to the requirements of IS 1727 (1967) obtained from RTPP with specific gravity of 2.2 and Fineness of 320m<sup>2</sup> /kg was used as supplementary cementitious material in concrete mixtures

**D. Cow Dung Ash:** The cow dung ash used in the present investigation. It is the by-product of cow dung cakes which was used in biogas. The cow dung ash is grey in colour. The specific gravity is 2.55.

### IV. EXPERIMENTAL RESULTS

#### A. Mix Proportions:

In this investigation M25 grade concrete is used with a constant water/cement ratio of 0.55. Concrete specimens were prepared by varying the percentage of replacement of cement in concrete with cow dung ash (5%, 10%, 15%, 20%, 25% and 30%). Similarly, in the same way the cement was replaced with fly ash (5%, 10%, 15%, 20%, 25% and 30%).

**B. Casting of Specimens:** Specimens have been casted out of which 170 were cubes, 156 were cylinders and 24 beams. For each test 3 specimens were tested and average value is calculated. 150mm × 150mm × 150mm size cubes, standard cylinders of 300mm height × 150mm diameter and flexure test strength. The compressive strength, split tensile strength and flexural strength were done for the specimens at 7 days, 14 days, 28 days, 56 days and 90 days.

#### C. Compressive Strength of concrete on Fly Ash:

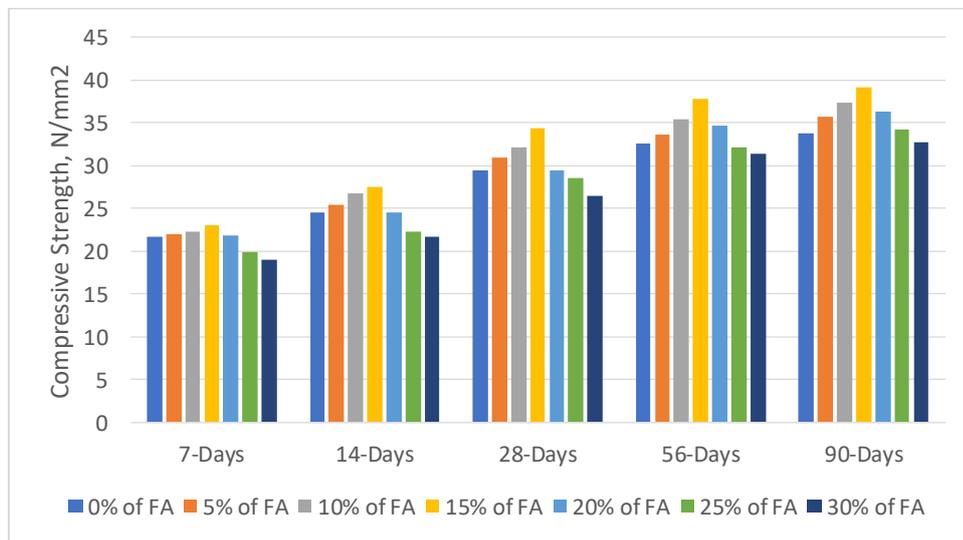
The compressive strength of M<sub>25</sub> grade concrete mixes by replacing OPC with Fly Ash at 5%, 10%, 15%, 20%, 25% and 30% is investigated. The results of compressive strength for these concrete mixtures tested at 7 days, 14 days, 28days, 56 days and 90 days are presented in table no - 4.1.1. The Graphical representation between compressive strength versus curing age of concrete is represented in Fig.4.1.1



Table no -4.1.1 – Compressive strength test results for Fly Ash

% Replacement in Cement	Compressive Strength, N/mm <sup>2</sup>				
	7-Days	14-Days	28-Days	56-Days	90-Days
0	21.7	24.6	29.4	32.6	33.8
5	22.03	25.5	30.9	33.7	35.7
10	22.3	26.8	32.2	35.5	37.4
15	23.1	27.5	34.4	37.8	39.17
20	21.8	24.5	29.5	34.7	36.4
25	19.9	22.3	28.6	32.1	34.2
30	19.0	21.7	26.4	31.4	32.8

Fig.4.1.1 Compressive Strength of Concrete on Fly ash



#### 4.1.2 Compressive Strength of Concrete on Cow Dung Ash:

The compressive strength of M<sub>25</sub> grade concrete mixes by replacing OPC with Cow Dung Ash at 5%, 10%, 15%, 20%, 25% and 30% is investigated. The results of compressive strength of concrete mixtures tested at 7 days, 14 days, 28 days, 56 days and 90 days are presented in table no - 4.1.2. Graphical representation between compressive strength versus curing age of concrete is represented in Fig.4.1.2

Table no -4.1.2 – Compressive strength test results for Cow Dung Ash

% replacement in cement	Compressive strength N/mm <sup>2</sup>				
	7-Days	14-Days	28-Days	56-Days	90-Days
0	21.7	24.6	29.4	32.6	34.5
5	21.9	24.9	30.1	34.1	36.1
10	22.6	26.5	32.8	35.9	38.7
15	20.8	22.8	26.9	31.1	34.8
20	18.6	19.2	24.6	29.6	32.5



25	15.7	18.4	23.7	27.9	31.6
30	13.4	16.8	21.9	25.3	30.2

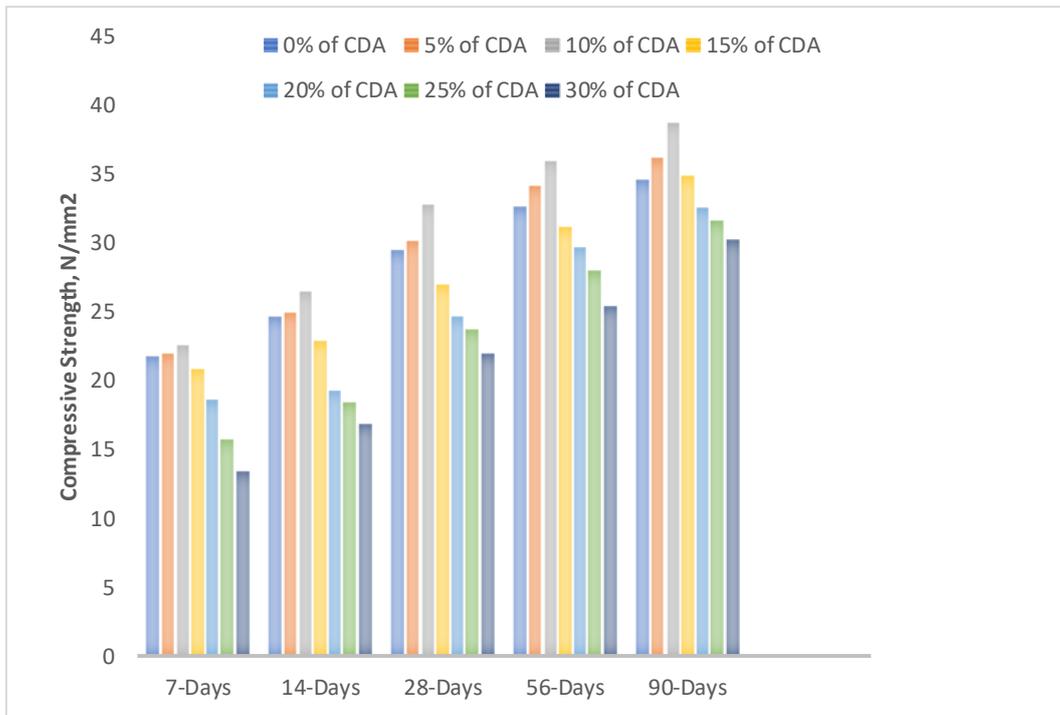


Fig.5.1.2. Compressive Strength of Cow Dung Ash

**4.2 Split Tensile Strength:**

The test results for 7days, 14days, 28days, 56days and 90 days of split tensile strength with various percentages replacement of cement by Fly Ash and Cow Dung Ash are presented in tables and then discussed. From the results it may be observed that increment and decrement of results by replacing various percentages of materials with cement.

**4.2.1 Tensile Strength of Concrete on Fly Ash:**

The Split tensile strength of M<sub>25</sub> grade concrete mixes replacing OPC by Fly Ash at 5%, 10%, 15%, 20%, 25% and 30% is investigated. The results of split tensile strength of concrete mixtures tested at 7days, 14 days, 28 days, 56days and 90 days are represented in table-4.2.1. A graphical representation age versus Split tensile strength is represented in Fig.4.2.

Table no4.2.1– Split tensile strength test results for using Fly Ash

% replacement in cement	Split Tensile strength N/mm <sup>2</sup>				
	7-Days	14-Days	28-Days	56-Days	90-Days
0	2.3	2.5	3.3	3.8	3.8
5	2.84	2.95	3.43	3.91	4.12
10	2.91	3.03	3.6	4.12	4.25
15	3.03	3.12	3.8	4.2	4.17
20	2.54	2.78	3.5	4.01	4.08
25	2.41	2.61	3.36	3.86	3.97
30	2.39	2.28	3.18	3.6	3.82

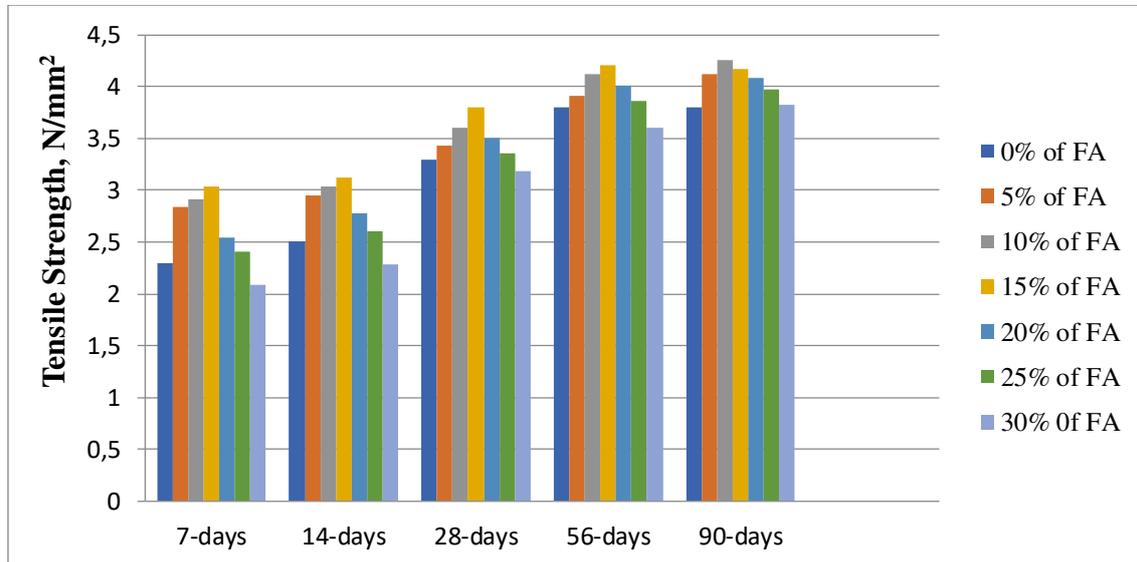


Fig.4.2.1. Tensile Strength of Fly Ash

4.2.2 Tensile Strength of Concrete on Cow Dung Ash:

Split tensile strength of M<sub>25</sub> grade concrete mix replacing OPC by Cow Dung ash at 5%, 10%, 15%, 20%, 25% and 30% are investigated. The results of split tensile strength of tested at 7, 14, 28, 56 and 90 days are shown in table-5.2.2. A graphical representation of tensile strength results as shown in fig.5.2.2

Table no4.2.2– Split tensile strength test results for Cow Dung Ash

% replacement in cement	Split Tensile Strength N/mm <sup>2</sup>				
	7-Days	14-Days	28-Days	56-Days	90-Days
0	2.3	2.5	3.3	3.8	3.96
5	2.35	2.59	3.61	3.96	4.13
10	2.44	2.7	3.74	4.27	4.97
15	2.09	2.24	3.04	3.84	4.04
20	1.92	2.11	2.92	3.52	3.84
25	1.74	1.93	2.74	3.21	3.62
30	1.68	1.70	2.21	2.93	3.41

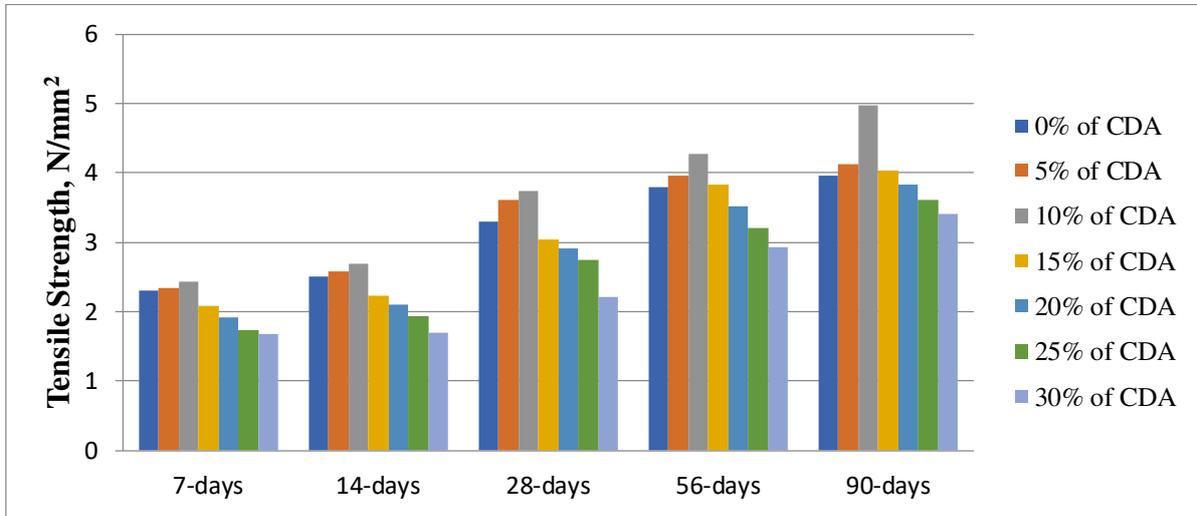


fig.4.2.2. Tensile Strength of Cow Dung Ash

**4.3 Flexural Strength:**

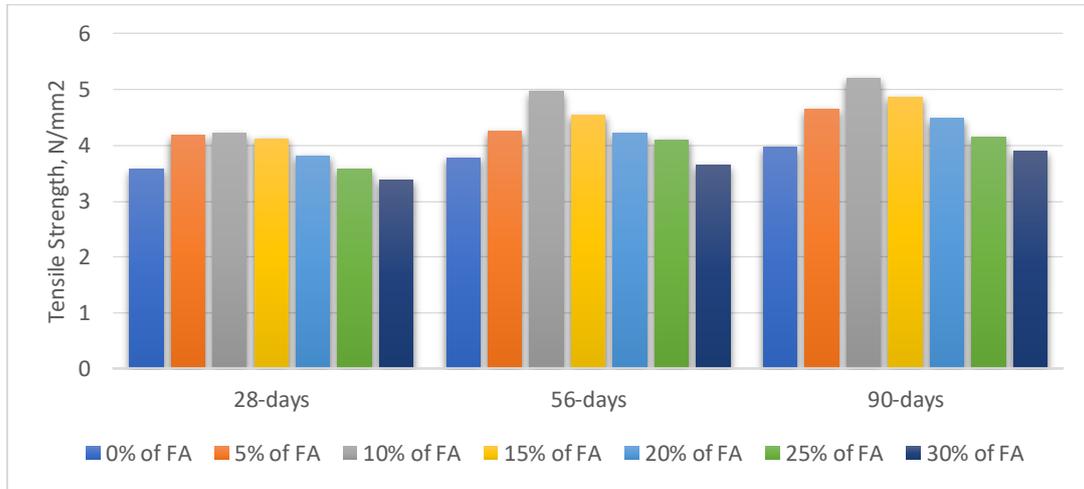
The test results for 28days, 56days and 90 days of flexural strength with various percentages replacement of cement by Fly Ash and Cow Dung Ash are presented in tables and then discussed. From the results it may observed that increment and decrement of results by replacing various percentages of materials with cement.

**4.3.1 Flexural Strength of Concrete on Fly Ash:**

The Flexural strength of M<sub>25</sub> grade concrete mixes replacing OPC by Fly Ash at 5%, 10%, 15%, 20%, 25% and 30% is investigated. The results flexural strength of concrete mixtures tested at 28 days, 56 days and 90 days are represented in table-4.3.1. A graphical representation age versus Flexural strength test is represented in Fig.4.3.1

**Table no4.3.1– Flexural strength test results for Fly Ash**

% replacement in cement	Flexural Strength N/mm <sup>2</sup>		
	28-Days	56-Days	90-Days
0	3.57	3.78	3.96
5	4.18	4.26	4.65
10	4.21	4.96	5.20
15	4.12	4.54	4.86
20	3.81	4.22	4.48
25	3.57	4.10	4.15
30	3.38	3.64	3.89

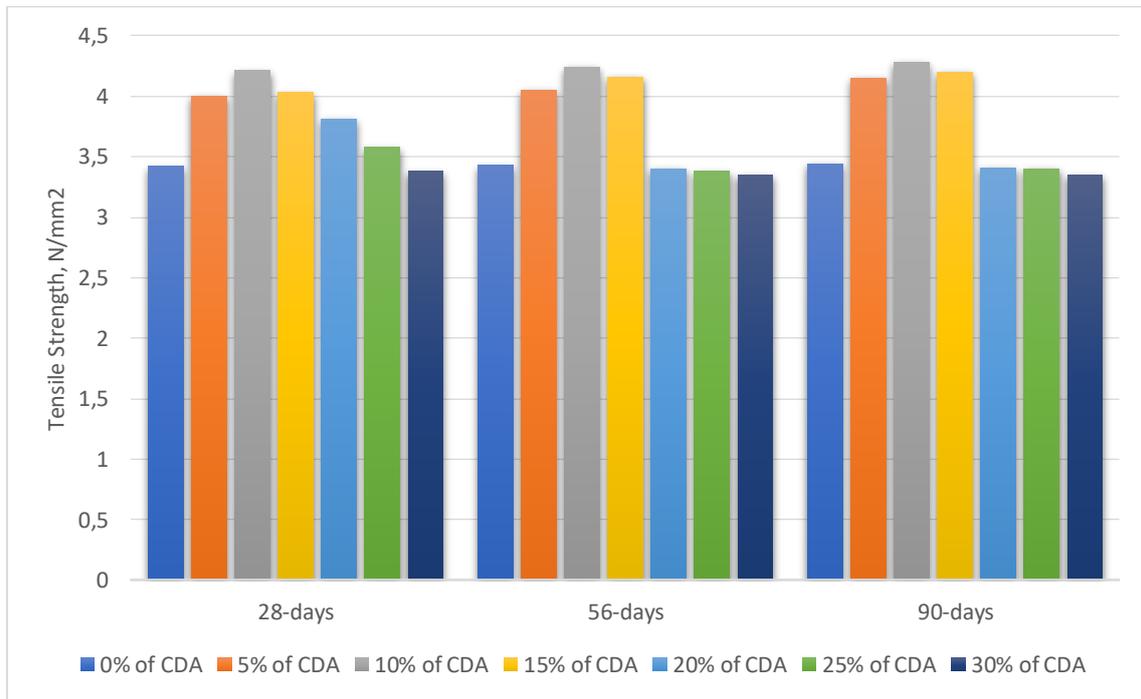


**4.3.2 Flexural Strength of Concrete on Cow Dung Ash:**

The Flexural strength of M<sub>25</sub> grade concrete mixes replacing OPC by Fly Ash at 5%, 10%, 15%, 20%, 25% and 30% is investigated. The results flexural strength of concrete mixtures tested at 28 days, 56 days and 90 days are represented in table-5.3.2. A graphical representation age versus Flexural strength test is represented in Fig.5.3.2

**Table no. 4.3.2– Flexural strength test results for Cow Dung Ash**

% replacement in cement	Flexural Strength N/mm <sup>2</sup>		
	28-Days	56-Days	90-Days
0	3.42	3.43	3.44
5	4.00	4.05	4.15
10	4.21	4.24	4.28
15	4.03	4.16	4.20
20	3.81	3.40	3.41
25	3.58	3.38	3.40
30	3.38	3.35	3.35



## V. CONCLUSION AND SUGGESTIONS FOR FUTURE STUDY

### 5.1 Conclusion:

1. The compressive strength of concrete increases up to 20% replacement of fly ash but high strength shown at 15% in cement.
2. The compressive strength of concrete increases at 5% and 10% of cow dung ash replacement in cement and then decreases its strength while increasing it.
3. The comparison between them shows the fly ash gives high strength in high percentage than cow dung ash.
4. The tensile strength of concrete increases upto 25% of fly ash replacement but the high strength shown at 15% is 17.01 N/mm<sup>2</sup>.
5. The tensile strength of concrete increases up to 10% of adding and then decreases its strength while adding the cow dung ash.
6. The Flexural strength test shows that the fly ash gives high strength in high percentage than cow dung ash
7. While comparing, the tensile strength of concrete shows high strength for fly ash than cow dung ash for all the curing days of concrete.
8. The concrete of cow dung ash absorbs more water than fly ash in concrete.

### 5.2 Suggestions for Future Study:

The research work on pozzolanic materials is still limited. But it promises a great scope for future studies. Following aspects are considered for future study and investigation.



1. By adding super plasticizers, the mechanical and durability properties of concretes with the cow dung ash as replacements for cement in concrete can be studied.
2. Optimising the combination of cow dung ash and fly ash as replacement in cement to be studied for better strength result.
3. The sustainability of combination in concretes for RCC can be studied.
4. The workability properties of concrete can be studied.
5. The sustainability of using cow dung ash, fly ash and combinations in concrete pavements can be studied for better strength.

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