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Experimental Investigation Mechanical Properties of Concrete Mix with Chopped Jute Fiber and Fly Ash

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ABSTRACT- The quest for substitutes for some concrete elements is ongoing with the goal of reducing the environmental impact of concrete production and improving the final concrete's strength. The management of demolishing waste poses a serious problem, and this is a reason why it has been tried as coarse aggregates in new concrete. However, the properties of aggregate and produced green concrete (concrete made with recycled aggregates from demolishing waste), particularly strength, are condensed and ways of justifying this problem create a dynamic investigation. This is due to the age of the concrete and old mortar adhered effects. Current advancements in waste utilization, waste processing to create coarse aggregates of the desired size, etc., have been presented in. Environmental effects of green concrete and green concrete towards sustainable environment have also been studied. The variation in waste-related published results demonstrates the need for more research in the field to increase trust in its operational application.

KEYWORDS- Concrete, M25, Fly Ash, Coarse Aggregate

I. INTRODUCTION

To satisfy the demands of globalization, India has made significant strides in the development of its infrastructure, including the construction of buildings, express motorways, power projects, industrial structures, dams, etc [1]. Concrete plays a major part in the building of civil engineering projects, and a lot of concrete is used. Both coarse aggregate and fine aggregate is a major constitute used for making conventional concrete, has become highly expensive and also scarce. In the background, there is a high need for recycled materials. Waste tyres management is a serious global concern [2]. Millions of waste tyres are generated and dumped or burned every year, often in an uncontrolled manner, causing a major environmental and health problem (Stephan al et. 2012). Carbon fibers will remain in dump sites with little degradation for a long time, leads to environmental hazard.

A. Fiber Reinforced Concrete

Fiber Reinforced Concrete can be designed as a composite material consisting of mixtures of cement, mortar or concrete and discontinuous, discrete, uniformly dispersed suitable Gbers [4]. Fiber reinforced concrete comes in a variety of forms and has several key benefits. Long wires or rods, continuous meshes, and woven materials are not regarded as distinct fiber [3]. Fiber is a small chunk of reinforcing material that possesses certain qualities. They can be circular or Hat. The "aspect ratio" is a handy characteristic that describes the Fiber. The fiber's aspect ratio is the ratio of its length to diameter. Typical aspect ratio ranges from 30 to 150 [2].

B. How to Make Concrete?

Concrete is manufactured or mixed in proportions w.r.t. cement quantity. There are two types of concrete mixes, i.e., nominal mix and design mix. For typical construction projects, such as modest residential structures, nominal mix is [5] employed. The most common notional mixture is in the ratio of 1:2:4. The proportions of design concrete mixtures are those for which the compressive strength of a cylinder or cube is tested in various lab settings [6]. These tests are carried out to identify an appropriate mixture based on locally accessible materials to provide the strength necessary according to structural design. A blended design allows economical ingredient utilisation [7]. When the proper mix quantities are known, the materials are combined in the chosen ratio. Two methods are used for mixing, i.e. Hand Mixing or Machine Mixing. The appropriate method of mixing is chosen based on the quantity and quality required. When mixing by hand, ingredients are arranged on a level surface, water is added, and the mixture is then completed using hand tools [7]. Several machine types are employed in machine mixing. In this situation, the elements are put in adequate amounts to mix and generate fresh concrete. When it has been thoroughly mixed, it is brought to the casting site and poured into formworks. There are several formwork kinds that may be chosen based on usage. Concrete that has been poured must cure in formwork for a predetermined amount of time depending on the kind of structural member [8]. When the formwork is removed, curing is carried out using a variety of techniques to replace the moisture lost through evaporation. Moisture, which is necessary for setting and endurance growth, is required for the hydration response. Thus, curing is often extended for at least 7 days following formwork removal [9].

II. STATEMENT OF THE PROBLEM

Concrete's low tensile strength, limited capacity and little resistance to cracking limited its application. Concrete naturally has tiny internal fissures. It has poor tensile strength due to the propagation of such micro cracks leading to brittle fracture of the concrete and brittle materials do not have post cracking ductility that cement concrete has negligible elongation at break. Therefore, it is normally reinforced with steel reinforced bars or restraining technique is applied. But this reinforcement makes the structure heavy and leads to structure failure due to corrosion of steel because of water or moisture diffusion through micro cracks. And also, it has difficulties in getting the desirable properties like toughness, ductility, controlling cracking and energy absorption because the reinforcement is found in some parts of the cross section of the structural member. Ordinary reinforced concrete is also expensive in production costs, transportation of precast members, maintenance costs and the supply of much amount of steel. Conventional concrete is designed on the basis of compressive strength in which it doesn't concern the functional requirements such as permeability, resistance to environment and frost, thermal cracking adequately. There is lack of cheap but durable building materials for the construction of low cost, low energy consumption and environmentally friendly housing.

III. OBJECTIVE OF STUDY

- To examine the workability by using slump test by replacing of cement with fly ash and using chopped jute fiber as an additive on M25 grade of concrete.
- To investigate the compressive strength by replacing of cement with fly ash and using chopped jute fiber as an additive on M25 grade of concrete.
- To investigate the split tensile strength by replacing of cement with fly ash and using chopped jute fiber as an additive on M25 grade of concrete.
- To investigate the flexural strength by replacing of cement with fly ash and using chopped jute fiber as an additive on M25 grade of concrete.The compressive strength tests on specimens of different mixes were tested after 7 days and 28 days of curing is analyzed and represented in this section. For the construction work, the size of 15 cm x 15cm x 15 cm was selected. Then the concrete mix prepared is poured into the mould is thoroughly tampered to eliminate voids. After 24 hours cube specimens are carried out and then immersed in water for curing. To procure smooth surface, cement paste is spread uniformly on the surface area of specimen. The rate of loading is 350 kg/cm2/minute and uniform. Concrete cube specimens were tested after 7 days and 28 days of curing. Specimens stored in water should be tested immediately after they are taken from water. Compression test was performed on standard compression testing machine of 2000 kN capacity in the usual manner as per Indian Standard guidelines.

IV. MATERIALS USED

- **OPC Cement 43 Grades:** The quality of the building materials (such as cement) can be used to assess the construction's quality. Moreover, the cement grade's chemical and physical characteristics determine its quality [10]. Before purchasing any cement, it is highly recommended to check whether the cement properties of that brand adhere to the Indian Standard codes.

Figure 1: Sample of cement used

- **Fly Ash:** A byproduct of burning pulverised coal in electricity producing facilities is fly ash. Mineral impurities included in coal, such as clay, feldspar, quartz, and shale, fuse in suspension during burning and float out of the combustion chamber with the exhaust gases. Fly ash, which are spherical glassy particles, are created as the fused material cools and hardens as it rises. With the use of bag filters or electrostatic precipitators, [11] fly ash is removed from the exhaust gases. While the fine powder resembles Portland cement, it differs chemically. Concrete frequently contains the fly ash categories Class C and Class F. Class F are often low-calcium fly ashes with carbon levels less than 5% but occasionally as [12] high as 10%, in contrast to Class C which are frequently high-calcium fly ashes with carbon contents less than 2%. Class C ashes are often created by burning lignite or sub-bituminous coals [13], whereas Class F ashes are created by burning bituminous or anthracite coals. Performance properties between Class C and F ashes vary depending on the chemical and physical properties of the ash and how the ash interacts with cement in the concrete [13]. Class F ashes do not respond the same way as Class C ashes when exposed to water, instead becoming hard like cement. The majority of Class F ashes, if not all of them, will only react with the byproducts created when cement combines with water.

Figure 2: Same of fly ash used

- **Coarse Aggregate:** Coarse aggregates are irregular broken stones or naturally occurring round gravels that are used to make concrete, coarse aggregates for structural concrete consist of broken stones of hard rock like granite and limestone (angular aggregates) or river gravels (round aggregates) [14]. Aggregates greater than 4.75 mm in size are described as coarse aggregates. For the purpose of building concrete, coarse aggregates are naturally occurring rounded gravel or irregularly fractured stone [15]. Coarse aggregates are substances that are too big to pass through a 4.7 mm screen, with a maximum size of 63 mm. In stone quarries, coarse aggregates are often produced by blasting, breaking by hand, or using crushers. Stones that have been crushed by a machine come in several sizes, but aggregates that have been broken by hand only come in one size.

Figure 3: Sample of coarse aggregates used

- **Jute Fibre:** Jute fiber is a type of plant fiber which is widely known for its ability to be spun into strong and coarse threads. Individual jute fibers are known to be soft, long, and shiny in nature. It is thought that the Corchorus genus of plants are the main sources of this fibre [16]. It is significant to note that jute fibres are often utilised in the creation of cloths like gunny cloth, hessian fabric, and burlap cloth. Jute is regarded as one of the most inexpensive and practical plant fibres for use in commerce (along with cotton fibers). Lignin and cellulose make up the majority of the jute fibres' chemical makeup [17]. Lignin is a name used to describe a group of intricate organic polymers. A linear chain (straight-chain) of hundreds or even thousands of D-glucose molecules joined together forms the organic polysaccharide known as cellulose.

(a)

(b)

Figure 4: Sample of jute fiber

- **Water:** Water which has relatively free from harmful ingredients like oils, acidic and alkaline impurities as well objectionable organic matter determined to describe quality of cement. In general, water used for concrete mixing should be as such as fit for drinking [18]. Water from lakes as well as streams that contain marine life and free from any industrial pollution is also suitable. Water polluted by sewage, industrial wastes and other harmful ingredients should be rejected if its use is inevitable; it must be subjected to proper treatment [20].

V. RESULT & DISCUSSION

The compressive strength tests on specimens of different mixes were tested after 7 days and 28 days of curing is analyzed and represented in this section. For the construction work, the size of 15 cm x 15cm x 15 cm was selected. Then the concrete mix prepared is poured into the mould is thoroughly tampered to eliminate voids. After 24 hours cube specimens are carried out and then immersed in water for curing. To procure smooth surface, cement paste is spread uniformly on the surface area of specimen. The rate of loading is 350 kg/cm2/minute and uniform. Concrete cube specimens were tested after 7 days and 28 days of curing. Specimens stored in water should be tested immediately after they are taken from water. Compression test was performed on standard compression testing machine of 2000 kN capacity in the usual manner as per Indian Standard guidelines.

A. Compressive Strength After 7 days

Table 1: Compressive strength after 7 days

Mix	**Percentage of cement**	**Percentage of fly ash**	**Wt. of chopped jute fibber (gm)**	**Compressive strength after 7 days (N/mm^2)**
MN01	100	0	0	21.32
MN02	92.5	7.50	2.5	21.67
MN03	85.0	15.0	2.5	22.03
MN04	77.5	22.5	2.5	22.82
MN05	70.0	30.0	2.5	23.27

MN06	92.5	7.50	5.0	23.62
MN07	85.0	15.0	5.0	23.91
MN08	77.5	22.5	5.0	24.55
MN09	70.0	30.0	5.0	24.08
MN10	92.5	7.50	7.5	23.69
MN11	85.0	15.0	7.5	23.13
MN12	77.5	22.5	7.5	22.41
MN13	70.0	30.0	7.5	21.98

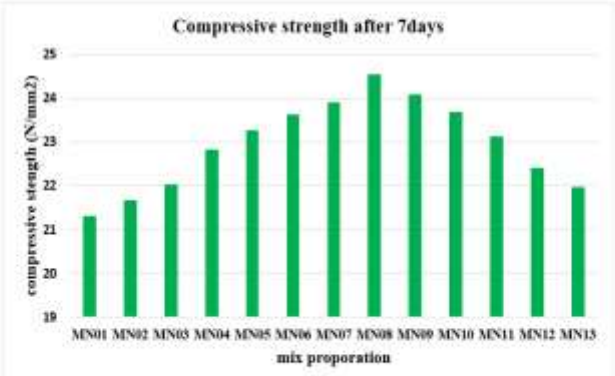

Figure 5: Compressive strength after 7 days

B. *Compressive Strength After 28 days*

Table 2: Compressive strength after 28 days

Mix	Percentage of cement	Percentage of fly ash	Wt. of chopped jute fibber (gm)	Compressive strength after 28 days (N/mm^2)
MN01	100	0	0	31.43
MN02	92.5	7.50	2.5	31.84
MN03	85.0	15.0	2.5	32.21
MN04	77.5	22.5	2.5	33.23
MN05	70.0	30.0	2.5	34.28
MN06	92.5	7.50	5.0	34.95
MN07	85.0	15.0	5.0	35.51
MN08	77.5	22.5	5.0	35.81
MN09	70.0	30.0	5.0	36.45
MN10	92.5	7.50	7.5	37.18
MN11	85.0	15.0	7.5	36.77
MN12	77.5	22.5	7.5	36.05
MN13	70.0	30.0	7.5	35.23

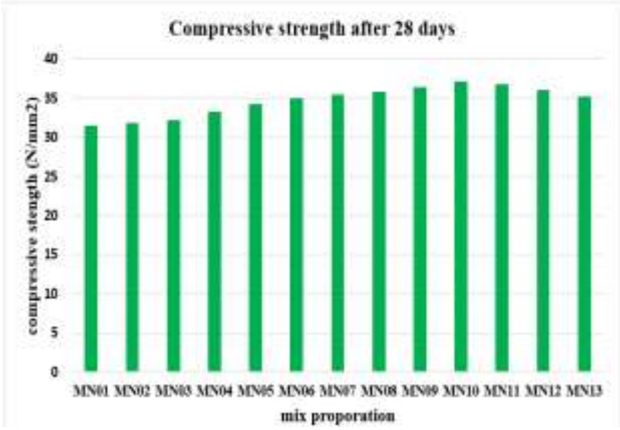

Figure 6: Compressive strength after 28 days

C. *Split Tensile Test*

The split tensile strength was observed at 7 days and 28-days of concrete mixes. Tensile tests were conducted on concrete cylinders of size 150 x 300 mm cast from concrete of each proportion.

D. *Split Tensile Strength After 7 days*

Table 3: Split tensile strength after 7 days

Mix	Percentage of cement	Percentage of fly ash	Wt. of chopped jute fibber (gm)	Split tensile strength after 7 days (N/mm^2)
MN01	100	0	0	2.65
MN02	92.5	7.50	2.5	2.77
MN03	85.0	15.0	2.5	2.82
MN04	77.5	22.5	2.5	2.88
MN05	70.0	30.0	2.5	2.94
MN06	92.5	7.50	5.0	3.01
MN07	85.0	15.0	5.0	3.09
MN08	77.5	22.5	5.0	3.15
MN09	70.0	30.0	5.0	2.95
MN10	92.5	7.50	7.5	2.88
MN11	85.0	15.0	7.5	2.86
MN12	77.5	22.5	7.5	2.84
MN13	70.0	30.0	7.5	2.80

Figure 7: Split tensile strength after 7 days

E. Split Tensile Strength After 28 days

Table 4: Split tensile strength after 28 days

Mix	Percentage of cement	Percentage of fly ash	Wt. of chopped jute fibber (gm)	Split tensile strength after 28 days (N/mm^2)
MN01	100	0	0	3.55
MN02	92.5	7.50	2.5	3.72
MN03	85.0	15.0	2.5	3.97
MN04	77.5	22.5	2.5	4.26
MN05	70.0	30.0	2.5	4.29
MN06	92.5	7.50	5.0	4.38
MN07	85.0	15.0	5.0	4.49
MN08	77.5	22.5	5.0	4.61
MN09	70.0	30.0	5.0	4.52
MN10	92.5	7.50	7.5	4.13
MN11	85.0	15.0	7.5	3.86
MN12	77.5	22.5	7.5	3.54
MN13	70.0	30.0	7.5	3.28

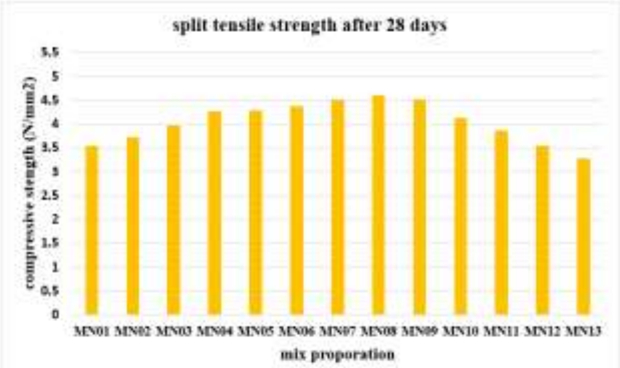

Figure 8: Split tensile strength after 28 days

F. Flexural Strength Test

The flexural strength was observed at 7 days and 28-days of concrete mixes. Flexural tests were conducted on concrete beam of size 150 x 150 x 700 mm cast from concrete of each proportion.

G. Flexural Strength After 7 days

Table 5: Flexural strength after 7 days

Mix	Percentage of cement	Percentage of fly ash	Wt. of chopped jute fibber (gm)	flexural strength after 7 days (N/mm^2)
MN01	100	0	0	3.02
MN02	92.5	7.50	2.5	3.12
MN03	85.0	15.0	2.5	3.17
MN04	77.5	22.5	2.5	3.22
MN05	70.0	30.0	2.5	3.27
MN06	92.5	7.50	5.0	3.34
MN07	85.0	15.0	5.0	3.39
MN08	77.5	22.5	5.0	3.46
MN09	70.0	30.0	5.0	3.37
MN10	92.5	7.50	7.5	3.34
MN11	85.0	15.0	7.5	3.29
MN12	77.5	22.5	7.5	3.25
MN13	70.0	30.0	7.5	3.19

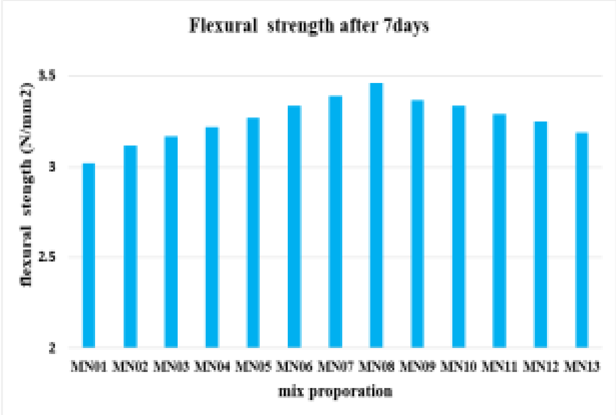

Figure 9: Flexural strength after 7 days

H. Flexural Strength After 28 days

Table 6: Flexural strength after 28 days

mix	Percentage of cement	Percentage of fly ash	Wt. of chopped jute fibber (gm)	flexural strength after 28 days (N/mm^2)
MN01	100	0	0	4.65
MN02	92.5	7.50	2.5	4.85
MN03	85.0	15.0	2.5	4.92
MN04	77.5	22.5	2.5	5.05
MN05	70.0	30.0	2.5	5.13
MN06	92.5	7.50	5.0	5.19
MN07	85.0	15.0	5.0	5.26
MN08	77.5	22.5	5.0	5.33
MN09	70.0	30.0	5.0	5.37
MN10	92.5	7.50	7.5	5.28
MN11	85.0	15.0	7.5	5.20
MN12	77.5	22.5	7.5	5.10
MN13	70.0	30.0	7.5	5.07

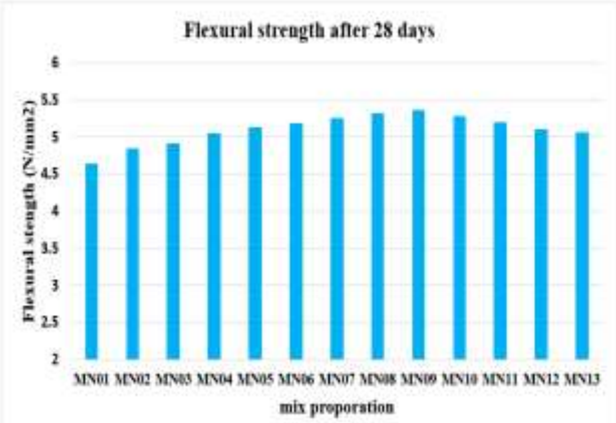

Figure 10: Flexural strength after 28 days

VI. CONCLUSION

During the investigation it was find out with the replacement of cement with fly ash and Jute fiber as an additive the in the concrete mix of M25 was made and the hardness test were examined after 7 and 28 days. The investigation was achieved on cement concrete in which cement was partially replaced by fly ash with the percentage of 0 %,7.5%,15.0%,22.5% and 33.0 % and chopped jute fiber were used as additive 0%, 2.5%,5.0% and 7.5% in grams in M25 grade of concrete. The results are summarized in following pointers.

- The workability of the concrete mix increases with the increase in the fly ash percentage add user jute fiber as an additive M25 grade of concrete.
- The compression strength of 7 days concrete was examiner and was found out to be 24.55 N/mm2 when fly ash was replaced by this is 22.5%by cement and chopped jute fiber as 5 grams by the weight in grams was used as additive and therefore percentage of cement in the concrete was 77.5% which was designated mix MN08.
- The compression strength of 28 days strength was examined also and was found out maximum 37.18 N/mm2 when fly ash was used 7.5% and chopped jute fiber was used as additive 7.5 grams in the mix designed M25 this name designated as MN10.
- The split tensile strength was achieved maximum at MN08 which was 3.15 N/mm2 for 7 days in which fly ash was used 22.5% and jute fiber as additive was used as 5.0 grams.
- The split tensile strength for 28 days was also examined and was achieved maximum at MN08 which was 4.6 N/mm2 in which fly ash was used 22.5% and Jute fiber was 5 grams.
- The flexure strength was also examined for 7 days which was 3.46 N/mm2 when fly ash was replaced by 22.5 % of cement and jute fiber was used as additive by 5 grams in the mix name it as MN08 which was optimum during whole examination of 7 days.
- The flexure strength for 28 days was also examined which was attained optimum at MN09 and was 5.37 N/mm2 in which fly ash was used 30% and jute fiber was used 5 grams which was optimum in the whole examination after 28 days.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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