A Glass Fiber Compressive Strength Prediction Using Artificial Intelligence (ANN)

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Abstract- **Concrete, being widely used, is the most important building material in civil engineering. Concrete is a highly complex material, which makes modeling its behavior a very difficult task. Many attempts were taken earlier to develop suitable mathematical models for the prediction of compressive strength and flexural strength of different concretes. Those traditional methods have failed to map non-linear behavior of concrete ingredients. The present study has used artificial neural networks (ANN) to predict the compressive strength and flexural strength of glass powder concrete. The ANN model has been developed and validated in this research using experimental strength data of different mixes. The artificial neural networks (ANN) model is constructed trained and tested (in MATLAB. For study models were developed. Strength was modeled in ANN model as a function of input data collected by the experimental result in laboratory. In this study, an attempt was also made to develop a multiple regression model for predicting strength (in EXCEL) as it is being used largely by researches in prediction. Finally, this model was used to predict the strength of concrete for different different days.**

Keywords:- **ANN (Artificial neural network), glass powder, MATLAB, compressive strength, Flexural strength, excel sheet.**

I.INTRODUCTION

Now a day's concrete is one of the most important materials which are used in the construction field all over the world. It consists of two main components which contains cement and aggregates. The aggregate contains sand and blue granite metals. Cement in combination with water is the most important binding material for the preparation of concrete in the construction because it contains good mechanical strength, flow ability, durability and these properties are mainly required for concrete to be cast in any desired shape and resist load applied on it at relatively less cost. This may mostly be attributed lack of proper quality control and supervision during the course of construction. So it has to perform satisfactorily over the reasonably expected life.Cement is one of the main components which plays an important role in concrete and is also a most uneconomical and it causes some impact on environment. The wide use of concrete as the basic construction material may be due to its adaptability for a wide range of strength and workability. To achieve different strength requirements, it is the "Mix-design process" that makes the difference as the basic ingredients are same all the way. Very likely to other methods of Concrete

Mix Design, Guidelines recommended by Bureau of Indian Standards for concrete mix design is based on certain empirical relations established through vast number of experiments conducted upon materials used in Indian conditions. IS:10262 is the specified code to serve the purpose. But at present due to demand in high strength concrete and for economic production, use of supplementary materials has become essential. With the advanced technology a number of additives have been identified and are being used extensively now-a-days. These additives are not only enhancing the quality of concreting but also make the process economic and eco-friendly too.

In recent time, Artificial Neural Network (ANN) is being successfully used for modelling purpose in several fields of engineering like thermodynamics, electronics. In civil engineering, it has been applied to mainly hydrologic fields for predicting flood, rainfall runoff correlation etc. Artificial neural network (ANN) does not require such a specific form. Instead of that, it needs sufficient input-output data. The fundamental methodology to create a neural system based model for prediction is to train a neural network on the results of a series of experiments, thus, minimizing the absolute difference between the target (desired) outputs and the actual outputs (from model), thereby, resulting in approximate optimal solutions.

II.PRESENT WORK

In this experimental work, the effect of partially replacing of glass powder in concrete is studied. The cement in concrete is replaced by waste glass powder in steps of 0%, 10%, 20%, 30% & 40% respectively by weight of cement

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and its effects on slump test, compressive strength, and flexural strength are determined.

At 7th, 14th, 21thand 28th day the compressive strength is measured while the flexural strength is measured at 28th day.Concrete Specimens were cured in water for 28 days, through which slump test, compressive strength, flexural strength were tested at ages of 7, 14, 21 and 28 days. For this concrete cube of size 150mm x150mm x 150 mm and beam size 150mm x150mm x 700 mm were casted.Along with that work analysis of compressive strength and flexural strength through Artificial neural network (ANN) is also done.

III. OBJECTIVE OF STUDY

- Develop ANN from data collected to predict compressive strength and flexural strength.
- Analysis results of ANN prediction and compare its results with experimental/ observed results obtained from laboratory.
- The aim of this study is to study the behavior of M20, M30 & M40 grade of concrete.
- Determine the Slump test, compressive strength and flexural strength by partially replacement of cement by waste glass powder.
- Cement was partially replaced by waste glass powder in 0%, 10%, 20%, 30% and 40 % by weight. All the tests were performed according to Bureau of Indian standards.

IV. DESIGNED MIXES

In these mixes the execution of the concrete is indicated by the creator however the mix extents are controlled by the maker of concrete, with the exception of that the base concrete substance can be set down. This is most judicious way to deal with the choice of mix extents considering particular materials having pretty much extraordinary quality.

The methodology brings about the generation of concrete with the fitting properties most financially. Nonetheless, the composed mix does not serve as an aide since this does not ensure the right mix extents for the endorsed execution. For the concrete with undemanding execution ostensible or standard mixes (recommended in the codes by amounts of dry fixings per cubic meter and by droop) may be utilized just for little employments, when the 28-day quality of concrete does not surpass 30 N/mm2. No control testing is important dependence being put on the masses of the fixings.

1. Mix proportion assignments:
The normal strategy for communicating the extents of elements of a concrete mix is in the terms of parts or proportions of concrete, fine and coarse totals. The extents are either by volume or by mass. The water-bond proportion is generally communicated in mass.

2. Mix design according to is 10262: 2009:
A total of 30 concrete mixes were prepared; three of the mixes were made of 100% ordinary Portland cement (no glass powder content). The remaining 27 mixes were prepared by adding glass powder content as partial replacement to cement i.e. 0 %, 10 %, 20 %, 30 % and 40%. The amount of water, coarse aggregate and fine aggregate were calculated for all the mixes.

Mix design for M20, M30 and M40 grade with 0 %, 10 %, 20 %, 30 % and 40%. Glass powder are reported in the table (3.6, 3.7&3.8) shown below.

V. RESULT AND ANALYSIS

Table 1. Mix Proportions M20 grade.

S.No.	Mix	Glass powder (Kg/m^3)	CoarseAggregate (Kg/m^3)	Cement (Kg/m^3)	Water (Kg/m^3)	Fine Aggregate (Kg/m^3)
1	M20 GP0	0	1072.5	432	186	664.56
2	M20 GP10	43.2	1072.5	388.8	186	664.56
3	M20 GP20	86.4	1072.5	345.6	186	664.56
4	M20 GP30	129.6	1072.5	302.4	186	664.56
5	M20GP40	172.8	1072.5	259.2	186	664.56

1. Experimental plan:
The test performed for testing the Compressive strength & flexural strength of concrete using glass powder. Various cubes and beams are made with various percentage of glass powder by weight of cement, tested and then analyzed for finding the effect of using glass powder.

Concrete cube & beam specimens for the test is made for each M-20, M-30 and M-40 with 0%, 10%, 20%, 30 % and 40% glass powder composition.The cube specimen is of size 150*150*150mm and beam size is 150*150*700 mm.

Table 2. Mix Proportions M30 grade.

S.No.	Mix	GlassPowder (Kg/m^3)	Coarse Aggregate (Kg/m^3)	Cement (Kg/m^3)	Water(Kg/m^3)	Fine Aggregate (Kg/m^3)
1	M30 GP0	0	1087.75	383.2	191.6	800.94
2	M30 GP10	38.32	1087.75	344.88	191.6	800.94
3	M30 GP20	76.64	1087.75	306.56	191.6	800.94
4	M30 GP30	114.96	1087.75	268.24	191.6	800.94
5	M30 GP40	153.28	1087.75	229.22	191.6	800.94

Table 3. Mix Proportions M40 grade.

S.No.	Mix	GlassPowder (Kg/m^3)	Coarse Aggregate (Kg/m^3)	Cement (Kg/m^3)	Water(Kg/m^3)	Fine Aggregate (Kg/m^3)
1	M40 GP0	0	1283	380	160	711
2	M40 GP10	38	1283	342	160	711
3	M40 GP20	76	1283	304	160	711
4	M40 GP30	114	1283	266	160	711
5	M40 GP40	152	1283	228	160	711

2. Casting:

- The moulds are used for making of concrete Block as per IS: 15658-2006 methods of tests for Strength of concrete.
- Paver block mould of 150×150×150 mm size and beam size is 150 mm x 150 mm x 700 mm.
- Firstly decide the number of sample to be taken during concreting.
- Before casting of materials shuttering oils should be used inside the mould properly.
- Collect the all material in the pan before the mixing properly.
- Mix the all material in pan Submerge the specimen in water at a temperature of 27oC for 7 days, 14 days 21 and 28 days respectively.
- Finally check its compressive strength and flexural strength as per as IS: 15658-2006.
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Fig 1. Casting of Cubes.

Fig 2. Casting of Beams.

3. Curing process:
Curing is a process where a concrete specimen or concrete structure is cured under water for different no. of days for different specimen. For example paver block is cured for 15 to 21 days and then its compressive strength will be checked.

Fig 3. Curing of cubes and beams.

4. Testing procedure:
The test was carried out with specimens at different curing ages in the UTM machine to find the maximum load at which the concrete fails by compression. The test was initiated at 7, 21 and 28 days of age of the concrete mixes. The testing procedure that was undertaken in the lab followed the procedure that is specified in AS (1012.9).

The test procedure was carried out as follows.

- The testing was done immediately after removing the samples from the curing environment (in this case the water tank was the curing environment).
- Loose particles on the ends of the specimens were removed.
- Platens of the machine were cleaned.
- A rubber cap was placed and centred on the bottom platen of the machine.
- The specimens were placed and centred on the top of the rubber cap.
- Another rubber cap was placed and centred on the top of the specimen.
- A force was applied and increased continuously.
- The maximum force applied to the specimen was recorded as indicated by the testing machine.
- The compressive strength of the specimen is calculated by dividing the maximum applied force on the specimen by its cross sectional area.

Fig 4. UTM machine for testing.

Table 4. Flexural strength of cement concrete for M20 grade ANN Time series prediction DATA set (MSE).

S.No.	Mix	Flexural strength, N/mm^2 At 28 Days	ANN PREDICTION
1	M20 GP0	3.33	3.35
2	M20 GP10	3.68	3.59
3	M20 GP20	4.74	4.70
4	M20 GP30	4.12	4.15
5	M20 GP40	3.75	3.70

Table 5. Flexural strength of cement concrete for M30 grade ANN Time series prediction DATA set (MSE).

S.No.	Mix	Flexural strength, N/mm2 at 28 Days	ANN PREDICTION
1	M20 GP0	3.33	3.35
2	M20 GP10	3.68	3.59
3	M20 GP20	4.74	4.70
4	M20 GP30	4.12	4.15
5	M20 GP40	3.75	3.70

Table 6. Flexural strength of cement concrete for M40 grade ANN Time series prediction DATA set (MSE).

S.No.	Mix	Flexural strength, N/mm^2 at 28 Days	ANN PREDICTION
1	M30 GP0	3.8	3.77
2	M30 GP10	3.78	3.80

3	M30 GP20	4.65	4.68
4	M30 GP30	4.36	4.38
5	M30 GP40	3.86	3.89

The effect of glass powder on the properties of cement has been studied in this research. The various properties of concrete such as compressive strength and flexuralstrength are studied. The tests are performed for three grade of concrete, M20, M30and 40. As the glass content increases (i.e. cement content decreased) workabilitydecreases. As there is a reduction in fineness modulus of cementations material, quantity of cement paste available is less for providing lubricating effect per unitsurface area of aggregate. Therefore, there is a restrain on the mobility.

There was an appreciable increment in the compressive strength of concrete when the percentage of glass powder was increased upto 20% at 7th, 21st and 28th dayfor M 20, M30 and M40 grade of concrete. Similarly the flexural strength of concrete increases upto 20% waste glass powder. For M 20 grade of concrete the flexural strength is 4.74N/mm2, for M30 it was 4.65N/mm2while that of M 40 is 4.82 N/mm2.

VI. CONCLUSIONS

The effect of fiber length distribution and fiber orientation of glass fiber reinforced thermoplastic composites was described. Tensile strength of glass fiber reinforced composites increased as the glass fiber contents increased. The short glass fibers can be moved along the flow direction better than the long fibers. The tensile strength calculated according to the Kelly-Tyson analysis is also used for predicted the interfacial shear strength of short fibers reinforced composites.

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