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A Review on Prediction of Concrete Properties Using Artificial Intelligence

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ABSTRACT

Our thirst for progress as humans is reflected by our continuous research activities in different areas leading to many useful emerging applications and technologies. Artificial intelligence and its applications are good examples of such explored fields with varying expectations and realistic results. Generally, artificially intelligent systems have shown their capability in solving real-life problems, particularly in non-linear tasks. In this paper, we investigate a newly emerging application area for ANNs, namely structural engineering. We design, implement and test an ANN model to predict the compressive strength of different concrete mixes of self compacting concrete (SCC) which is a highly flow able type of concrete that spreads into form without the need of mechanical vibration. The models developed to predict 28 days compressive strengths using neural network techniques for 81 mix data set taken from literature (ANN-I) and 15 mix data set developed experimentally for cement, sand, coarse aggregates, fly ash, water/cement, super plasticizer (ANN-II) as input parameters and an output parameter that is 28- days compressive strength for ANN-I and ANN-II. Compressive strength of concrete, recognized as one of the most significant mechanical properties of concrete, is identified as one of the most essential factors for the quality assurance of concrete .Traditionally, the performance of concrete is affected by many non-linear factors and testing its strength comprises a destructive procedure of concrete samples.

***Keyword:** -Self Compacting Concrete, 28 days Compressive strength, Artificial Neural Network*

1. INTRODUCTION

Self Compacting Concrete is a type of concrete which has the ability to get compacted under its own weight without the need to get vibrated, and without the occurrence of bleeding or segregation. It could be used with areas with restricted feature as well as the places with heavily reinforcement in order to ensure the filling in a proper way. Its first innovation took place in the University of Tokyo in the last of 1986th by the team of professor Okamura, with the aim of improving the construction quality as well as overcoming the defects made by the workmanship. As opposed to the traditional concretes, the SCC has more mineral fillers as well as bigger quantities of high range water reducer admixtures. On the other hand, it has a smaller maximum size for the coarse aggregate. There are various pozzolanic materials which could be used in order to make SCC such as silica fume, granulated blast furnace slag, metakaolin and fly ash. Flyash was considered most suitable as opposed to the other pozzolanic materials considering the quality control. Other advantages could be gained by using the SCC such as

- Faster construction time.
- Reduction the noise caused by casting
- Reduction in site manpower
- Easier placing
- Improved durability
- Thinner concrete section
- Reduce noise level

2. METHODOLOGY

2.1 Material Used

- Cement

Cement is a binder which can bind other materials together. Several types of Ordinary cement are available and the most common is Ordinary Portland Cement (OPC) which is grey in color. In this investigation Ordinary Portland cement (OPC) of 53 Grade of Ultra Tech brand confirming to IS specifications was used. The physical properties of OPC obtained from the experimental investigation were confirmed to IS- 12269:1987[10] given below:

- **Natural Fine Aggregate**

The sand used for the experimental programmed was locally procured and conformed to Indian Standard Specifications BIS: 383-1970. The sand was first sieved through 4.75 mm sieve to remove any particles greater than 4.75 mm. The aggregates were sieved through a set of sieves to obtain sieve analysis. Aggregates used were in dry state and correction for water absorption.

Table-1: Properties of Cement

1	Specific gravity of cement(SC)	3.15
2	Initial setting time	38 min
3	Normal Consistency	32%
4	Soundness	4 mm

Table-2 Grading Analysis of Natural Sand Typical Sieve Analysis

Sieve Size (mm)	Mass retained (gm)	% Retained	% Retained cum.	% Passing	Specs. Limits	
					Lower Limit	Pper Limit
10	0	0.00	0.00	100	100	100
4.75	12	1.20	1.20	98.8	90	100
2.36	38	3.80	5.00	95.0	75	100
1.18	132	13.20	18.20	81.8	55	90
0.6	282	28.20	46.40	53.6	35	59
0.3	384	38.40	84.80	15.2	8	30
0.15	136	13.60	98.40	1.6	0	15
Pan	4.00	1.60	100.00	0.00		

Table-3: Properties of Natural fine Aggregate

Sr. No	Property	River sand
1	Shape	Spherical particle
2	Gradation	Cannot be controlled
3	Particle passing 75micron	Presence of silt shall be less than 3%(IS:383-1970)reaffirmed 2007
4	Silt and Organic impurities	Present (Retard the setting & Compressive Strength)
5	Specific gravity	2.61

- Coarse Aggregate

In this investigation coarse aggregate of size 12 mm used and obtained from the local quarry confirming to IS specifications was used. The properties of coarse aggregate are shown in Table.3.7.

Table-4: Properties of Coarse Aggregate

1	Specific Gravity	2.58
2	Water Absorption	0.3%

- Chemical Admixture

GLENIUM B233 is using as a Super-plasticizer (chemical admixture) and viscosity modifying agent in this work. This brand is a high performance super plasticizer intended for applications where high water reduction and long workability retention are required, and it has been developed for use in Self Compacting concrete, Pumped concrete, Concrete requiring long workability retention, High performance concrete. The main reason of utilizing super-plasticizer in SCC it gives good flow ability with very high slump that is to be used in heavily reinforced structural member.

- Water

The water used for casting and curing of concrete test specimens was free from acids, organicmatter, suspended solids and impurities which when present can adversely affect the strength ofconcrete. The local drinking water free from such impurities has been used in this experimentalprogramme for mixing and curing.

Generally, water which is used for drinking is satisfactory for usage in concrete. The water usedin concrete plays an important part in mixing, laying and compaction, setting and hardening of concrete. The strength of concrete directly depends on the quantity and quality of water used inthe mix. Ordinary potable water of pH 7 is normally used for mixing and curing the concretespecimen.

Table-5: Properties of Chemical Admixture

Parameters	Specifications (As per IS 9103-1999)
Physical state	Light brown liquid
Chemical name of active ingredient	Polycarboxylate polymers
Relative density at 25o C	1.09 + 0.01
pH	Min. 6
Chloride ion content (%)	Max 0.2
Dry material content	34 + 5 (%)

Table-6: Typical Properties of VMA

Aspect	Colorless free flowing liquid
Relative density	1.01 ± 0.01 at 25°C
Ph	>6
Chloride ion content	< 0.2%

- Fly ash

  It is a byproduct of the thermal power plants and the quantity of them are increasing. Dust collection system removes the fly ash, as a fine particulate residue, from combustion gases before they are discharged into the atmosphere. The types and relative amounts of incombustible matter in the coal used determine the chemical composition of fly ash. More than 85% of most fly ashes is comprised of chemical compounds and glasses formed from the elements silicon, aluminum, iron, calcium, and magnesium.

3. SYSTEM MODELLING

The present research work is experimental and requires preliminary investigations in a methodological manner.

3.1Material and Grade of Control Mix

- Selection of type and grade of control mix, mix design by an appropriate method, trial mixes, final mix proportions.
- Estimating total quantity of concrete required for the whole experimental work.
- Estimating quantity of cement, fine aggregate, coarse aggregate, Quarry Dust, rice husk ash, super plasticizers required for the work.
- Testing of properties of cement, fine aggregate, coarse aggregate.
- Obtaining the properties of Quarry Dust and rice husk ash.

3.2 Production of Concrete Mixes

- Production of control mix(concrete of grade M-50) in laboratory is carried out by ACI method.
- Modified Concrete is produced by adding Quarry Dust to the plain concrete as fine aggregate replacement. Rice husk ash was added to the modified concrete as a cement replacement varied from 5% to 20% at constant interval of 5% by weight of cement.

3.3 Test Conducted on Material used in Experimental work

The ingredient ofconcrete *i.e.* cement, fine aggregate are tested before producing the concrete. The relevant Indian standard codes were followed for conducting various tests on concrete.

3.3.1Tests on cement

The cement used in this experimental work is "53 grade ordinary portland cement". All properties of cement are tested by referring IS 12269 – 1987[18] specification for 53 grade ordinary portland cement. Test results are presented in Table 3.1.

REFERENCES

[1] N. Bouzoubaa, M. Lachemi, Self-compacting concrete incorporating high volumes of classF fly ash preliminary results, Cem. Concr. Res. 31 (2001) 413–420.
[2] B. Sukumar, K. Nagamani, R. Raghavan, Evaluation of strength at early ages of self- compacting concrete with high volume fly ash, Constr. Build. Mater. 22 (2008) 1394– 1401.
[3] E. Guneyisi, M. Gesoglu, E. Ozbay, Strength and drying shrinkage properties of self- compacting concretes incorporating multi-system blended mineral admixtures, Constr.
[4] Build. Mater. 24 (2010) 1878–1887
[5] P. Dinakar, Design of self-compacting concrete with fly ash, Mag. Concr. Res. 64 (5) (2012) 401–409.
[6] R. Patel, K. Hossain, M. Shehata, N. Bouzoubaaˆ, M. Lachemi, Development of statistical models for mixture design of high- volume fly ash self-consolidating concrete, ACI Mater. J. 101 (4) (2004) 294–301.
[7] J. Jawahar, C. Sashidhar, I. Reddy, J. Peter, Micro and macrolevel properties of fly ashblended self compacting concrete, Mater. Des. 46 (2013) 696–705.
[8] V. Boel et al, Transport properties of self compacting concrete with limestone filler or fly ash, Mater. Struct. 40 (2007) 507–516.
[9] M. Jalal, E. Mansouri, Effects of fly ash and cement content on rheological, mechanical, and transport properties of high- performance self-compacting concrete, Sci. Eng. Compos. Mater. 19 (4) (2012) 393–405.
[10] P. Dinakar, K. Babu, M. Santhanam, Mechanical properties of high-volume fly ash self- compacting concrete mixtures, Struct. Concr. 9 (2) (2008) 109–116.
[11] M. Nehdi, M. Pardhan, S. Koshowski, Durability of self- consolidating concrete incorporating high-volume replacement composite cements, Cem. Concr. Res. 34(2004) 2103–2112.
[12] R. Venkatakrishnaiah, G. Sakthivel, Bulk utilization of fly ash in self compactingconcrete, KSCE J. Civ. Eng. 19 (7) (2015) 2116–2120
[13] T. Hemalatha, A. Ramaswamy, J. Kishen, Micromechanical analysis of self compacting concrete, Mater. Struct. 48 (2015) 3719–3734.
[14] V. Bui, Y. Akkaya, S. Shah, Rheological model for self- consolidating concrete,ACI Mater. J. 99 (6) (2002) 549– 558.
[15] R. Douglas, V. Bui, Y. Akkaya, S. Shah, Properties of self- consolidating concrete containing class F fly ash: with a verification of the minimum paste volume method, ACI Mater. J. 233 (2006) 45–64
[16] M. Liu, Self-compacting concrete with different levels of pulverized fuel ash, Constr.Build. Mater. 24 (2010) 1245–1252
[17] A. Bingol, I. Tohumcu, Effects of different curing regimes on the compressive strength properties of self compacting concrete incorporating fly ash and silica fume, Mater. Des. 51 (2013) 12– 18.
[18] S. Barbhuiya, Effects of fly ash and dolomite powder on the properties of self- compacting concrete, Constr. Build. Mater. 25 (2011) 3301–3305.
[19] Z. Sun, W. Duan, M. Tian, Y. Fang, Experimental research on self-compacting concrete with different mixture ratio of fly ash, Adv. Mater. Res. 236 (2011) 490–495
[20] N. Pathak, R. Siddique, Properties of self-compacting-concrete containing fly ash subjected to elevated temperatures, Constr. Build. Mater. 30 (2012) 274–280
[21] Sonebi M. Application of statistical models in proportioning medium strength self-consolidating concrete. ACI Mater J 2004; 101(5):339–46.
[22] R. Siddique, Properties of self-compacting concrete containing class F fly ash, Mater. Des. 32 (2011) 1501–1507P.G. Asteris, K.G. Kolovos, M.G. Douvika & K. Roinos, Prediction of self-compacting concrete strength using artificial neural networks, European Journal of Environmental and Civil Engineering, Vol. 20, No. S1, s102–s122 (2016).