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An Experimental Study on Prediction of Compressive Strength of Concrete by Cloud Monitoring

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Abstract - *Due to the development in the advancement of the technology the health monitoring of the structure is necessary now a days, as there is a drastic change in infrastructure. This project is to design a smart material by fixing a required sensing module inside the concrete specimen for monitoring the specimen, which will be useful to predict the compressive strength of concrete. The maturity of the concrete can be monitored valuably for identifying the strength of concrete these strength will be preferred for field applications in real time structures, this can be done by monitoring a developing structure. The temperature based compressive strength can be monitor similarly with the help of smart sensing materials. The temperature of the specimen can monitoring through IoT and the values getting from smart sensing materials are stored for the future reference to calculate compressive strength. In this project the fast construction work done, by predicting the compressive strength of the concrete by the applications of smart materials.*

Key Words: Smart sensing material, *Compression strength, IoT (Internet of Things), Compressive Strength, Maturity.*

1.INTRODUCTION

Designers and builders should however ensure that the formwork being used is strong and sturdy enough to carry the loads that have been produced by the concrete, workers and any other type of equipment that are used to provide further support to the forms so as to ensure satisfactory results and performance at the end of the construction. Formwork construction may involve high risk activities like operating powered mobile plant like cranes, working at height and excavating foundations.

Cure the concrete in a timely manner. Do not finish concrete until all water has evaporated. Do not dust dry cement on the surface while water is present. Do not sprinkle water over the concrete while finishing it. If the weather could produce high evaporation rates, spray some water onto the subgrade, so it will not absorb the water from the concrete mix.

Structural Health Monitoring (SHM) is a vital tool to improve the safety and maintainability of critical structures such as buildings, bridges and formwork. SHM provides real-time and accurate information about the structural health condition. It is a process of non-destructive evaluation to detect location and strength attained in that. Structural health monitoring involves the Health monitoring, operational Evaluation, Data Feature Extraction and Statistical Models Development.

If the work involves high risk construction work, a Safe Work Method Statements (SWMS) must be developed in consultation with workers and their representatives who are carrying out the high risk construction work as defined under the Work Health and Safety (WHS) Regulations.

The study of few literature papers has been reviewed S.Na et al [1] presented about a multi sensing electrochemical impedance method for non-destructive evaluation of metallic structure. Dongsheng Li shuaifang zhang et al [2] investigated about the corrosion monitoring and evaluation of reinforced concrete structure. Shuli fan et al [3] and Julian sierra perez et al [4] studied about the real time monitoring by means f early warning utilization and on the strain field pattern recognition on basis of PCA. Duijian Zou et al [5] investigated the health monitoring of concrete structures using piezo electric transducer at various environmental temperatures. P.Frojd et al [6] studied about the amplitude and phase measurement of continuous diffuse field for structural health monitoring of concrete structure. Mohamed maalejetal and Geoffrey R Thomas et al [8] presented structural health monitoring of smart materials under various loading conditions. Akira Mita et al [9] investigated about bio field building for active and healthy ageing using sensor agent robots. Constantin E. Chaliorisa et al [10] investigated the paper about the Applications of smart piezoelectric materials in a wireless admittance monitoring system

The structural health monitoring using smart sensing module reduces the regular laboratory test of breaking cube while time of the slab, beam, and column cast, instead while monitoring it gives the relevant information(compressive strength) through uploaded code into the sensing module by the help of micro-controlling interface. The experimental study has been carried out on cube of specimen size 0.15 m x 0.15 m x 0.15m and the results were validated by the analytical study. The temperature sensor is placed into the cube and it level of temperature been monitoring every five to ten seconds and programming has been done to send collection of data to cloud for monitoring.

Here in this experimental study we will be looking forward towards cloud monitoring. Cloud monitoring is the process of evaluating, monitoring, and managing cloud-based services, applications, and infrastructure. The program coding will be done to step-up the activation cloud service. By the help of IoT(Internet of Things) the data transfer is been made to cloud also at mean time with the help of mobile applications we can view check the status of structure anywhere at the world with internet connection.

2. Experimental Setup

2.1 Preparation of Sensing Module

The temperature sensor is taken for measuring the specimen (cube) present temperature. As we planned to identify the temperature of specimen at the stage of fresh concrete itself, the prefect water resistive protective coating is done on the temperature sensor. Before that the lead of the temperature sensor is to be soldered with lengthy wiring to bring the connection outside the specimen. So that the prepared sensing module can work immediately after the setup connection is done with the micro-controller when the concrete is fresh itself.

Fig -1: Sensing module after preventive coating

2.2 Casting of Specimen

The concrete cube of size 0.15m x 0.15m x 0.15m was cast with the mix ratio of M20 grade of concrete. The water-cement-sand-aggregate weight ratio of the concrete mix was 0.5 : 1 : 1.5 : 3. The cube specimen was tested on 3rd , 7th , 14th and 28th days of curing. The specimen was tested using compression testing machine to find the amount of compressive strength in the cube specimen.

2.3 Materials and circuit connection

The Node MCU is a micro controller which we used as an interface for temperature sensor and the coded programme is also been sent to this micro-controller by Arduino open source coding software. Code converts the unknown outcome as an understandable outcome using certain formula to identify the temperature. Also only with the help of coding the micro-controller can be able to get into access with cloud for monitoring purposes.

Fig -2: Node MCU

Fig -3: sensing module

By using the micro-controller (Node MCU) the sensing module (Temperature sensor) is been circuited. The 3.3v supply is given at one of the three lead of sensing module and ground at other lead then finally in at reaming one lead the surrounding environment data has been collected and received data has been validated through the coded formula and sent to the cloud monitoring process.

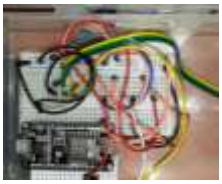

Fig -4: Circuit setup & specimen with sensor

Fig 4 shows the circuit setup and the specimen with inbuilt sensing module. The above mentioned setup will be considerable working to take the temperature of that specimen as much as it's necessary for our work.

2.4 Testing procedure

The required number of cube were been casted for the 3rd , 7th , 14th , 21st ,and 28th as three trial specimens for each day test and one more for calculating the temperature value of the specimen. As per the general testing procedure for compressive strength the cube were been tested properly for 28 days. Now the noted temperate data for 28days were taken into account and by using the ASTM C 1074 code the maturity curve for the cube has been drawn using the formula specified in that code. The ASTM C 1074 – 98 is the Standard practice for estimating concrete strength by the maturity curve

3. RESULT AND DISCUSSION

Compressive strength of concrete depends on many factors such as water-cement ratio, cement strength, quality of concrete material, and quality control during production of concrete etc. Test for compressive strength is carried out either on cube. Various standard codes recommend concrete cube as the standard specimen for the test. American Society for Testing Materials ASTM C 1074 provides Standard Test

Table 1: Compressive stress with temperature at time of load

SPECIMEN SIZE (mm)	DAY	LOAD (KN)	STRESS N/mm²	Degree Celsius
150X150X150	3	327	14.533	24.45
150X150X150	7	341	15.155	22.88
150X150X150	14	367	16.311	22.38
150X150X150	21	445	19.8	21.8

3.1 Maturity in Concrete

Concrete maturity indicates how far curing has progressed. Maturity is the relationship between concrete temperature, time, and strength gain. It is represented by an index value that can be measured in real time in the field. Maturity in concrete is taken in graph as per the instructed rule at ASTM C 1074 code.

$M(t) = \sum(Ta - T0\ ).\ \Delta t$

Where,

M(t) is the maturity index at age t,
Ta is the average temperature during time interval,
Δt is cumulative time period,
T0 is the datum temperature (0).

Table 2: Comparison of TTF and Stress

Days	TTF	stress
1	374.4	0
2	913.1	7
3	1417.3	14.5
4	2076.1	14.56
5	2365.3	14.8
6	2937.3	14.99
7	3282.2	15.15
8	3731.9	15.2
9	4244.5	15.3
10	4623.2	15.4
11	5140.0	15.6
12	5819.6	15.8
13	6146.0	16
14	6456.2	16.3
15	6936.3	16.8
16	7452.5	17.3
17	7785.1	17.8
18	8244.9	18.3
19	8623.8	18.8
20	9140.4	19.3
21	9894.8	19.8

The cumulative calculation for temperature is made, through the above mentioned formula the maturity index is identified and that's known as Temperature Time Factor.

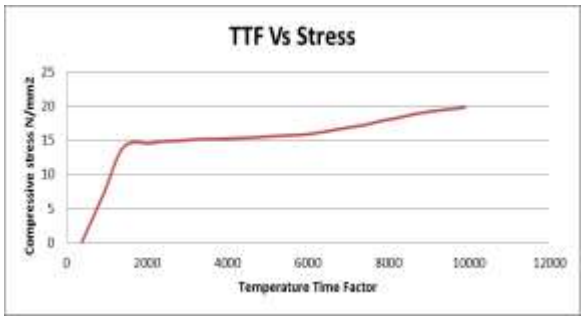

Fig -5: Temperature Time Factor vs. Stress

Fig 5 shows the maturity curve through which the compressive strength of a M20 concrete has been identified. By keeping this plotted graph value the compressive strength of concrete can be identified anytime while the same mix ratio been preferred to be done in construction.

4. CONCLUSION

The maturity curve for M20 is drawn in this work. By fixing these values as a standard one for M20 grade the future structures were been developed and in that the temperature sensing module has been fixed and based on that the collection of temperature data is taken in cloud and the cumulative value been calculated whenever we need to

know its compressive strength. Maturity curve is drawn with comparison of compressive strength and TTF. As per the execution of this process compressive strength of concrete has been identified.

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REFERENCES

[1] S Na and H K Lee (2013) 'A multi-sensing electromechanical impedance method for non-destructive evaluation of metallic structure', IOP Publication Smart materials and structures Vol.22,pp 8.

[2] Dongsheng Li, Shuaifang Zhang, Wei Yang, and Wenyao Zhang(2014) 'The Corrosion Monitoring and Evaluation of Reinforced Concrete Structures Utilizing the Ultrasonic Guided Wave Technique', International Journal of Distributed Sensor Networks Vol.10,pp 9.

[3] Shuli Fan , Liang Ren, Hongna Li, and Biao Song(2015) 'Real time monitoring and early warning method utilizing FBG sensor in the retrofitting process of structure', International Journal of Distributed Sensor Networks Vol.10,pp 9.

[4] Julian Sierra-Pérez, Miguel A, Torres-Arredonndo, Guenael Cabanes,Alfredo Guemes and Luis E Mujica (2015) 'The Structural health monitoring by means of strain field pattern recognition on the basis of PCA and automatic clustering techniques based on SOM' Science direct Vol. 48-28,pp 987-992

[5] Dujian Zou1, Tiejun Liu, Yongchao Huang, Fuyao Zhang and Chengcheng Du (2015) 'An experimental investigation on the health monitoring of concrete structures using piezoelectric transducers at various environmental temperatures', Journal of intelligent Material systems and structures Vol. 26(8),pp 1028-13.

P.Frojd and P.Ulriksen (2015) 'Amplitude and phase measurement of continuous diffuse fields for structural health monitoring of concrete structures', NDT&E International Vol77(2016), pp 35–41

[6] Mohamed Maalej, Anestis Karasaridis,Stavroula Pantazopoulou3 and Dimitrios Hatzinakos (2002) 'Structural health monitoring of smart structures' Smart Mater. Struct. Vol.11 (2002) , pp 581–589

[7] Geoffrey R Thomas, Akbar A Khatibi (2017) 'Durability of structural health monitoring systems under impact loading' Science direct Vol. 188 (2017),pp 340-347.

[8] Akira Mita (2017) 'Biofied Building for Active and Healthy Ageing using Sensor Agent Robots' Science direct Vol. 188 (2017),pp 3-8.

[9] Constantin E. Chaliorisa,, Chris G. Karayannisa, Georgia M. Angeli (2016) 'Applications of smart piezoelectric materials in a wireless admittance monitoring system (WiAMS) to Structures—Tests in RC elements', Case Studies in Construction Materials Vol.5, pp 1–18.

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