International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 09 | Sep 2021 www.irjet.net p-ISSN: 2395-0072

Studies on Performance of Concrete under Different Exogenous Condition

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Abstract – *Concrete is a composite material composed of coarse aggregates, fine aggregates, and those bonded together with cement. Concrete is a basic component of a structure. Concrete may be classified into the following types, plain or ordinary concrete, reinforced concrete, prestressed concrete, precast concrete, lightweight concrete, high-density concrete, air-entrained concrete, and many more. All such concrete plays different roles and has a unique characteristic. The strength and durability of concrete depend on both internal and external factors. Internal factors generally deal with the ingredients and the other phenomenon of the concrete itself. The external factor is referred to as the factor imposed externally on the concrete, i.e., the concrete does not achieve its target strength and even it may lower the long-term strength. The external factor may also decrease the durability of a structure. The main external factors are extreme wreathing conditions, earthquakes, fires, groundwater table, slope movement, carbonation, etc. Among these external factors one of the important factors taken into consideration, that is "Extreme weathering condition". The performance of concrete on the stated circumstances is to be analysed experimentally. The process has been carried out by the simulation of different weathering conditions.*

Key Words: **Concrete, external factors, simulation, extreme weathering condition.**

1.INTRODUCTION

The performance of concrete is highly influenced by the different exogenous conditions. This condition may be natural or artificial. In this research, hot and cold weathering condition has taken into consideration exclusively as these conditions have most of the domination on the behavioural aspect. The negative impacts of extreme weathering conditions under the above-stated circumstances have a huge impact on the properties and performances of concrete.

1.1 Hot weathering Condition

To increase water demand for a required workability.

To increase rate of loss of workability.

To increase rate of setting.

To increase the plastic shrinkage cracking.

To lower the long-term strength.

To decrease the durability of a concrete structure.

1.2 Cold weathering Condition

To delay the setting time.

To freeze the concrete at early age.

To repeat freezing and thawing of concrete.

To develop stress due to temperature differential**.**

2. METHODOLOGY

To analyse the performance of concrete there are three types of casting operation are taken into consideration under the weathering conditions as normal ambient condition, hot weathering condition, and cold weathering condition.

2.1 Normal ambient condition

To analysis the normal ambient condition, the laboratory temperature is considered. The location of the laboratory is in Kolkata, West Bengal and during the concreting operation, the temperature is 32 °C. The designation of concrete is to be taken as the same for the stated circumstances. In this study, M25 grade concrete is prepared according to the process as followed by IS 10262:2009[1]

2.2 Hot weathering condition

The grade of concrete has already been selected as M25. The temperature of hot weathering conditions is considered as 45 °C [2,3]. As discussed before during the concreting the laboratory temperature was 32°C, which is taken as a normal ambiance temperature. The hot ambient condition is achieved by the process of simulation.

2.2.1 Simulation of hot weathering condition

The concrete is cast in a hot weather environment and this hot weathering ambient is created in the laboratory artificially by the process of simulation. There are several types of simulation that have already been attempted in a complicated way. A new process is introduced as a simulation technique so that it can be analysed and carried out throughout the experimental process in the laboratory by considering the site environment. The simulation process is conducted with the help of an oven. A hot oven is easily available to all the concrete and structural laboratory. For this process, the M25 grade of concrete is selected, and concrete is made according to IS 10262:2009. There are few

changes such as varying water content and admixture [4] is also used to make the concrete more effective and durable. First to create the temperature is 45°C in a laboratory artificially, all the ingredients of concrete such as coarse aggregates, fine aggregates, cement are heated in an oven at 45°C. Then batching these ingredients thoroughly and due to loss of heat, those are again inserted in the preheated oven. Thereafter mixing the hot ingredients are mixed with warm water and the retarding superplasticizers admixture is added. After mixing fresh concrete, it is poured into nine numbers of (100mmX100mmX100mm) moulds and all are inserted into the oven to maintain the specified temperature of 45°C. After 24 hours, the concrete cubes are taken through the curing process. As the concreting is done under hot weather simulation, the curing is also performed in some uncommon way. The temperature of the water which is used for curing purposes is maintained as the site temperature,45 °C. It is also carried out with the help of an oven. The concrete cubes are placed in a container filled with water and kept in the oven for 28 days. Due to the evaporation water reduced at a very faster rate. To prevent such a situation, some special treatment is implemented during curing work. After 28 days of curing the compressive strength test is performed.

2.3 Simulation of cold weathering condition

Cold weather is defined as the weather in which the ambient temperature is less than 5°C [5]. Cold weather concreting negatively affect the concrete by freezing and thawing action. Besides the freezing and thawing action, the performance of concrete has other demerits too. The performances of concrete at the cold weathering ambient are also analysed by the process of simulation. The grade of concrete is adopted as M25.

2.3.1 Simulation process

Construction in cold weathering conditions is very much crucial and challenging for civil engineers. Lots of difficulties may arise during concreting due to extreme cold weather. This weathering effect affects the concrete in many ways mainly reduces the strength and durability of concrete. To simulate such weathering conditions in the laboratory is very difficult. During concreting, the room temperature of the laboratory is around 35°C. Creating a cold ambient temperature of 5°C, the entire concreting work performed in the air conditioning room so that the room temperature can be controlled as per requirement. The concrete of M25 grade is prepared following the mix design according to IS 10262: 2009. There are some changes were made during concreting by varying the water content, type of cement and the type of admixture. First, the simulated temperature was selected as 5°C. To achieve such temperature the freezer is used throughout the process. All the ingredients of concrete, such as cement, coarse aggregates, and fine aggregates cooled for 24 hours before casting. After 24 hours, all the ingredients are mixed thoroughly to make it into a homogeneous mix. Thereafter, the required quantity of water is added which was previously taken into consideration along with the admixtures. After the mixing, the fresh concrete is poured into several 100mmX100mmX100mm moulds for 24 hours. All the mould is taken into the freezer and the desired temperature is maintained. After 24 hours of the casting of the concrete cubes, they are taken to the curing.

3. Results and discussion

Simulating weathering conditions in the laboratory, nine cubes are cast for each of the two pre-defined extreme weather conditions along with normal weathering conditions. The compressive strength [6] is one of the main criteria for analysing the strength of concrete under such circumstances. The compressive strength is examined for 7 days, 14 days, and 28 days and the strength are recorded accordingly under two weathering conditions [7]. The test results are tabulated to get the mean compressive strength of concrete and compare it with the design strength.

3.1 Normal ambient condition

Test results of the specimen concrete cubes are recorded for 7 days, 14 days & 28 days

Table-1: Compressive strength test (7 days)

S.L No.	Area of sample mm²	Peak load KN	Compressive strength developed N/mm²	Mean Compressive Strength N/mm²
1.	4984.36	107.39	21.54	21.57
2.	4984.36	107.58	21.58	
3.	4984.36	107.62	21.59	

Table-2: Compressive strength test (14 days)

S.L No.	Area of sample mm²	Peak load KN	Compressive strength developed N/mm²	Mean Compressive Strength N/mm²
1.	4984.36	132.25	26.53	26.68
2.	4984.36	133.01	26.68	
3.	4984.36	133.87	26.85	

Table-3: Compressive strength test (28 days)

S.L No.	Area of sample mm²	Peak load KN	Compressive strength developed N/mm²	Mean Compressive Strength N/mm²
1.	4984.36	145.25	29.14	29.22
2.	4984.36	145.85	29.26	
3.	4984.36	145.91	29.27	

After the analysis of the data obtained from the compressive strength values, it is very clearly observed that the concrete has achieved its desired strength under normal weathering conditions. The target strength was 25 Mpa after 28 days of curing. It is also noted that the strength is increasing gradually from 7 days to 14 days.

3.2 Hot weathering condition

The test results of the specimens are recorded for 7 days, 14 days & 28 days are as follows

Table-4: Compressive strength test (7 days)

S.L No.	Area of sample mm²	Peak load KN	Compressive strength developed N/mm²	Mean Compressive Strength N/mm²
1.	4984.36	86.36	17.33	17.38
2.	4984.36	86.64	17.38	
3.	4984.36	86.92	17.43	

Table-5: Compressive strength test (14 days)

Sample No.	Area of sample mm²	Peak load KN	Compressive strength developed N/mm²	Mean Compressive Strength N/mm²
1.	4984.36	92.36	18.53	18.54
2.	4984.36	92.41	18.54	
3.	4984.36	92.48	18.55	

Table-6: Compressive strength test (28 days)

S.L No.	Area of sample mm²	Peak load KN	Compressive strength developed N/mm²	Mean Compressive Strength N/mm²
1.	4984.36	103.29	20.72	20.87
2.	4984.36	104.36	20.93	
3.	4984.36	104.45	20.95	

After the analysis of the data obtained from the compressive strength, it is observed that the concrete does not achieve its desired strength under the effect of hot weathering conditioned simulated in the laboratory. The target strength was 25 Mpa after 28 days of curing, but the result obtained after 28 days is 20.87 MPa, which is very less. It is also noted that the effect of the extreme hot ambient temperature does not allow the concrete to achieve it is desired strength. There were several cracks are also formed as the days go on. Most of the cracks are thermal cracks.

3.3 Cold weathering condition

The test results of the specimens prepared in cold weather condition are recorded for 7 days, 14 days & 28 days are as follows

Table-7: Compressive strength test (7 days)

S.L No.	Area of sample mm²	Peak load KN	Compressive strength developed N/mm²	Mean Compressive Strength N/mm²
1.	4984.36	76.36	15.31	15.38
2.	4984.36	76.84	15.41	
3.	4984.36	76.93	15.43	

Table-8: Compressive strength test (14 days)

S.L No.	Area of sample mm²	Peak load KN	Compressive strength developed N/mm²	Mean Compressive Strength N/mm²
1.	4984.36	78.14	15.67	15.75
2.	4984.36	78.49	15.74	
3.	4984.36	78.90	15.83	

Table-9: Compressive strength test (28 days)

Sample No.	Area of sample mm²	Peak load KN	Compressive strength developed N/mm²	Mean Compressive Strength N/mm²
1.	4984.36	89.68	17.99	18.02
2.	4984.36	89.85	18.02	
3.	4984.36	89.99	18.05	

From the results, it is very clear that the concrete does not achieve its desired strength. The target strength was 25 Mpa after 28 days of curing but the result we obtain after 28 days is 18.02 Mpa. It is also noted that the concrete did not harden even after 28 days of curing [8]. The strength developed after 7 to 14 days are almost the same, but after 14 days the strength increment got some pace.

4. CONCLUSIONS

Environmental conditions play an important role in achieving the strength of concrete. Extreme hot or cold temperatures during the curing process are the most effective factors for achieving a reliable concrete structure. It is an experimentally proven fact that if the temperature drops near the freezing condition, it slows down the hydration process as well as reduces the firmness of the concrete significantly under loading. When concrete is mixed and placed in either very hot or very cold weather, it is required to take precautions to ensure that the concrete is not dislodged, cracked, or adversely suffering from the consequences of the ambient weather. As concrete is highly influenced by the weathering effect so that before concreting, the ambient temperature must be checked.

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BIOGRAPHIES

Anirban Choudhuri has performed various research work in the field of Concrete Technology and behaviour of cement.