Innovative Systems Design and Engineering www.iiste.org
ISSN 2222-1727 (Paper) ISSN 2222-2871 (Online)

# Effect of retempering with retarding admixture on properties of concrete subjected to prolonged mixing

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**Abstract**
In situations like delivery of concrete from central mixing plant, in road construction, in constructing lengthy tunnels, in transportation of concrete by manual labor, in hilly terrain long hauling of concrete is required. Loss of workability and undue stiffening of concrete may take place at the time of placing on actual work site[1]. In such situations engineers at site, many a time reject the concrete partially set and unduly stiffened due to the time elapsed between mixing and placing. Mixed concrete is a costly material and it cannot be wasted without any regard to cost. It is required to see whether such a stiffened concrete could be used on work without undue harm with use of retarding admixtures. The process of remixing of concrete, if necessary, with addition of just the required quantity of water is known as 'retempering' of concrete[1]. Sometimes, a small quantity of extra cement is also added while retempering. In the site sometimes the concrete has to wait for some time to enter in the formwork after it is mixed. This may be due to some break down in the conveyance or quarrel between the labors. In such situations the concrete looses its plasticity. But since the quantity is enormous[2], such concrete cannot be wasted. In such situations addition of small quantity of cement and water along with retarding admixture can bring back the plasticity to concrete. Thus retempering becomes important in such odd situations[2]. In this paper an attempt is made to study the strength characteristics of concrete containing retarding admixture at retempering time of 15min upto 90 min. The tests are conducted to evaluate the strength characteristics of concrete like compressive strength, tensile strength, flexural strength for different retempering times.

**Keywords:** admixtures, retarder, retempering.

## 1. Introduction:

One of the adverse effects of hot weather concreting is loss of slump. Delay in the delivery of ready mixed concrete has the same result and leads many people in the concrete industry to regain the original slump by adding water, a process known as 'retempering'[3].

Ready-mixed concrete, which is mixed at the plant, using a normal, well-designed concrete mix, should arrive at its destination with sufficient workability to enable it to be properly placed and fully compacted. In such circumstances, where there is a significant period of time between mixing and placing the concrete, there will be a noticeable reduction in the workability of the fresh concrete. If for any reason, the placement of the concrete is unduly delayed, then it may stiffen to an unacceptable degree and site staff would normally insist on the rejection of a batch or otherwise good concrete on the grounds of insufficient workability[3]. If not rejected, excessive vibration would be needed to attempt to fully compact the concrete, with the risk of incomplete compaction, expensive repair, or, at worst, removal of the hardened concrete.[4]

If abnormal slump loss is anticipated or if transport times are significant, then the intelligent use of admixtures can alleviate the potential workability difficulties, although at additional cost, and this practice is common place. However, in cases where unforeseen delay or some other cause has lead unexpectedly to poor workability, retempering of the concrete by water, while normally considered to be bad practice, may, in reality, be contemplated as a possible course of action. The increase in the water content of the concrete immediately prior to discharge will improve the consistency, but it is widely held that there must be a subsequent increase in the water/cement (w/c) ratio which will be detrimental to the hardened concrete.[5]

Adding water to a plastic mix to increase slump is an extremely common practice, even though it is not recommended because it increases the porosity of concrete. Concrete often arrives on site more than half an hour after initial mixing. Placement operations can take anywhere from 10 to 60 minutes, depending on the field conditions and the size of the load. When the slump decreases to an unacceptable level during the operations, water is added to the mix and, very often, experienced field inspectors will tolerate what can be termed 'reasonable' retempering, i.e., enough to increase slump by 50 or 60 mm.

**2. Research Significance:**

In the circumstances like breakdown of any concreting equipment or quarrels between the labors or suddenly erupted strikes on the site may put the green concrete into difficult situation. In such above situations the concrete which is already mixed may have to wait for a longer time before entering into the formwork. This causes the loss of plasticity and if such concrete is used, the strength and other characteristics of concrete are affected. Such concrete has to be either discarded or used with little addition of extra water and cement so that a part of plasticity is regained, and such concrete is called retempered concrete. Probably use of some admixtures may induce some good qualities to such retempered concrete. Therefore it is essential to study the characteristic properties of retempered concrete containing retarding admixtures.

**3. Experimental Program:**

The main aim of this experimentation work is to find the effect of addition of retarding admixtures on the properties of retempered concrete.

Ordinary Portland cement and locally available sand and aggregates were used in the experimentation. The specific gravity of fine and coarse aggregate was 2.62 and 2.94 respectively. The experiments were conducted on a mix proportion of 1: 1.95: 3.64 with w/c = 0.45 which corresponds to M20 grade of concrete. The retarder and its dosages used in the experimentation are shown in table 1.

After thoroughly mixing all the ingredients in dry state, the required quantity of water was added in the mix and thoroughly mixed. At this stage the Retarding admixtures were added and a homogeneous concrete mix was obtained. This concrete mix was covered with gunny bags for 15 minutes. The time was reckoned, the moment the water was added to the concrete mix. After 15 minutes the mix was poured into the moulds and the specimens were cast with sufficient compaction through vibration. This forms retempered concrete for 15 minutes. Similarly the specimens were prepared with retempered concrete with a retempering time of 30, 45, 60, 75 and 90 minutes.

Another set of retempered concrete specimens were cast by adding 5% extra cement and the required extra amount of water to balance a w/c ratio of 0.45. All the specimens were demoulded after 24 hours of their casting and were transferred to curing tank to cure them for 28 days. After 28 days of curing the specimens were tested for their compressive strength, tensile strength, flexural strength and as per IS specifications.

For compressive strength test, the cubes of dimensions 150 x 150 x 150 mm were cast and were tested under compression testing machine as per IS 516-1959. For tensile strength test, the cylinders of diameter 100 mm and length 200 mm were cast and were tested under compressive testing machine as per IS 5816-1999.[9] For flexural strength test the beams of dimensions 100 x 100 x 500 mm were cast and were tested on an effective span of 400 mm with two point loading as per IS 516-1959.

**TA**BLE No. 1.
THE RETARDING ADMIXTURE AND THEIR CHEMICAL CONTENT AND DOSAGES USED IN EXPERIMENTATION

| Sr.No. | Admixture | Abbreviations used | Dosages used (by wt. of cement) |
|---|---|---|---|
| 1 | Retarding admixture Hydroxylated carboxylite acids | Retarding admixture | 0.4% |

TABLE No. 2.
RESULTS OF COMPRESSIVE STRENGTH (MPa)

| Retempering time in minutes | Reference mix without admixture | | with addition of 0.4% dosage of retarder | | Percentage increase or decrease of compressive strength w.r.t. reference mix. | |
|---|---|---|---|---|---|---|
| | without addition of 5% extra cement & water | with addition of 5% extra cement & water | without addition of 5% extra cement & water | with addition of 5% extra cement & water | without addition of 5% extra cement & water | with addition of 5% extra cement & water |
| 15 minutes | 21.50 | 22.40 | 26.2 | 27.2 | 21.86 | 21.42 |
| 30 minutes | 22.25 | 23.2 | 26.8 | 27.40 | 20.44 | 18.10 |
| 45 minutes | 25.5 | 24.0 | 27.33 | 28.42 | 7.17 | 18.41 |
| 60 minutes | 27.60 | 25.43 | 29.28 | 30.05 | 6.08 | 18.16 |
| 75 minutes | 23.80 | 22.8 | 24.8 | 23.80 | 4.20 | 4.38 |
| 90 minutes | 23.50 | 23.2 | 24.2 | 24.44 | 2.97 | 4.34 |

TABLE No. 3.
RESULTS OF SPLIT TENSILE STRENGTH (MPa)

| Retempering time in minutes | Reference mix without admixture | | with addition of 0.4% dosage of retarder | | Percentage increase or decrease of split tensile strength w.r.t. reference mix. | |
|---|---|---|---|---|---|---|
| | without addition of 5% extra cement & water | with addition of 5% extra cement & water | without addition of 5% extra cement & water | with addition of 5% extra cement & water | without addition of 5% extra cement & water | with addition of 5% extra cement & water |
| 15 minutes | 3.97 | 4.23 | 4.97 | 5.18 | 25.18 | 22.45 |
| 30 minutes | 4.15 | 4.30 | 5.33 | 5.45 | 28.43 | 26.74 |
| 45 minutes | 5.33 | 5.48 | 6.01 | 7.02 | 12.75 | 28.10 |
| 60 minutes | 6.28 | 6.98 | 7.22 | 7.45 | 14.96 | 6.73 |
| 75 minutes | 5.20 | 5.86 | 6.18 | 6.65 | 18.84 | 13.48 |
| 90 minutes | 5.01 | 5.20 | 5.98 | 6.1 | 19.36 | 17.30 |

TABLE No. 4.
RESULTS OF FLEXURAL STRENGTH (MPa)

| Retempering time in minutes | Reference mix without admixture | | with addition of 0.4% dosage of retarder | | Percentage increase or decrease of flexural strength w.r.t. reference mix. | |
|---|---|---|---|---|---|---|
| | without addition of 5% extra cement & water | with addition of 5% extra cement & water | without addition of 5% extra cement & water | with addition of 5% extra cement & water | without addition of 5% extra cement & water | with addition of 5% extra cement & water |
| 15 minutes | 1.98 | 2.15 | 2.4 | 2.43 | 21.21 | 13.02 |
| 30 minutes | 2.32 | 2.48 | 3.6 | 3.63 | 55.17 | 46.37 |
| 45 minutes | 3.28 | 3.48 | 4.92 | 4.95 | 50 | 42.24 |
| 60 minutes | 4.63 | 5.23 | 5.6 | 5.68 | 20.95 | 8.60 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 75 minutes | 3.65 | 4.18 | 4.82 | 4.90 | 32.05 | 17.22 |
| 90 minutes | 3.1 | 3.27 | 3.8 | 3.98 | 28.38 | 21.71 |

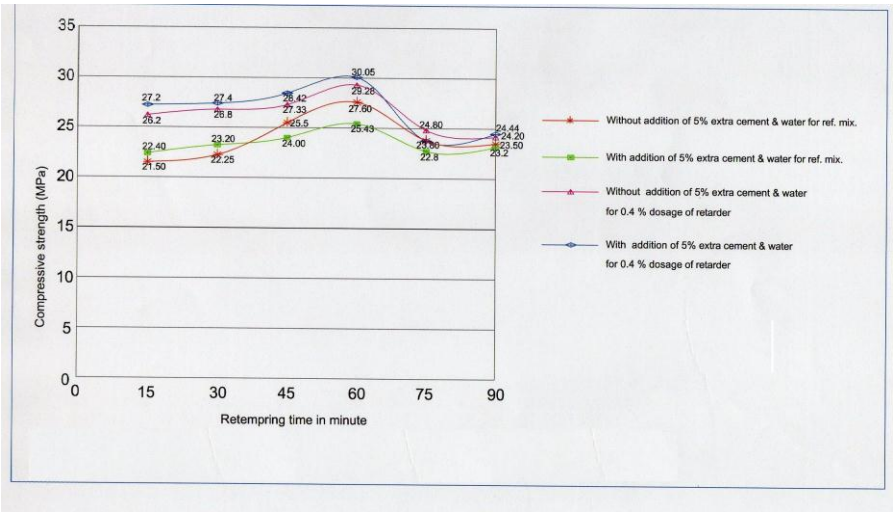


Fig. 1. Variation of Compressive Strength w.r.t. different retempering times

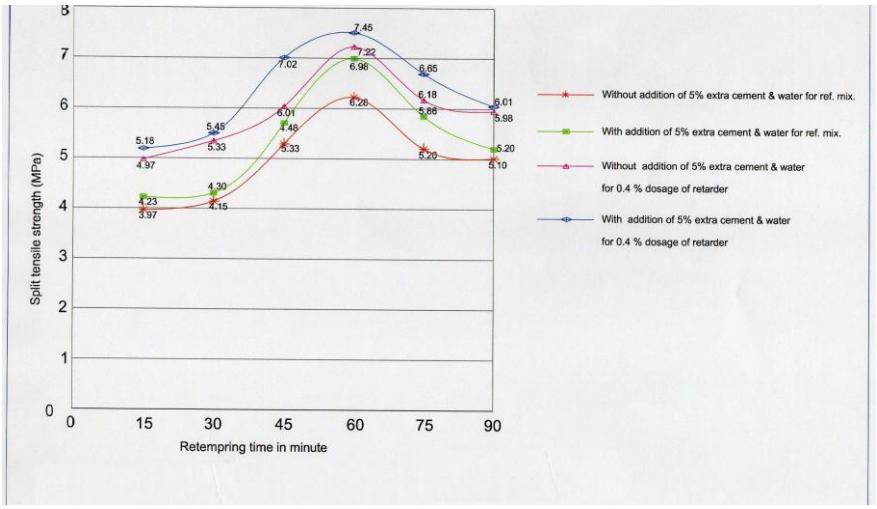


Fig. 2. Variation of Split Tensile Strength w.r.t. different retempering times

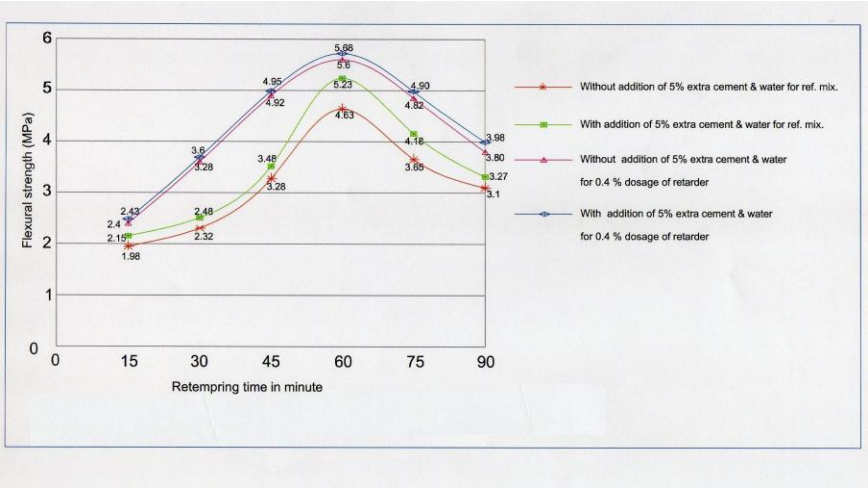


Fig. 3. Variation of Flexural Strength w.r.t. different retempering times

**4. Test Results:**

Table 2 gives the compressive strength test results of retempered concrete. It also gives percentage increase or decrease of compressive strength w.r.t. reference mix. Table 3 gives the tensile strength test results of retempered concrete. It also gives percentage increase or decrease of tensile strength w.r.t. reference mix. Table 4 gives the flexural strength test results of retempered concrete. It also gives percentage increase or decrease of flexural strength w.r.t. reference mix.

The variations of these strengths are depicted in the form of graphs as shown in fig. 1, 2 and 3.

**5. Results and Discussion:**

1. It has been observed that the concrete without any admixture shows maximum compressive strength, tensile strength, flexural strength at a retempering time of 60 minutes. It is true for both concretes which are produced by adding 5% extra cement and water and concrete without adding 5% extra cement and water. This may be due to the fact that the evaporated water up to 60 minute may bring down the w/c ratio resulting in an enhanced strength. Thus it can be concluded that the concrete without any admixture show maximum strengths at a retempering time of 60 minutes.

2. It has been observed that the concrete produced with addition of 5% extra cement and water show higher compressive strength, tensile flexural compared to concrete produced without 5% extra cement and water. This is true for all the retempering times from 15 minutes to 90 minutes. Obviously this may be due to the fact of presence of 5% excess cement. Thus it can be concluded that the concrete produced with addition of 5% extra cement and water yields more strength, for all the retempering times up to 90 minutes.

3. It has been observed that the concrete produced with addition of 5% extra cement and water show higher compressive strength, tensile strength, flexural compared to concrete produced without 5% extra cement and water, when the Retarder is used. This is true for the retempering times from 15 minutes to 90 minutes. Obviously this may be due to the fact of presence of 5% excess cement. Thus it can be concluded that the concrete produced with addition of 5% extra cement and water and with retarding yields more strengths for all the retempering times up to 90 minutes.

4. It has been observed that the compressive strength, tensile strength, flexural strength of concrete produced with the retarding of admixture is higher than that without any admixture. This is true for all the retempering times and also it is true for the concrete produced by addition of 5% extra cement and water and concrete without 5% excess cement and water. This may be due to the fact that the addition of retarder induces more workability which will facilitate for full compaction and in turn this results in higher strengths. Thus it can be concluded that the concrete produced with the Retarding admixture show higher strengths than that of without admixtures for all the retempering times.

**6. Conclusion:**

1. The concrete without any admixture show maximum strengths at a retempering time of 60 minutes.

2. The concrete produced with addition of 5% extra cement and water yields more strength, for all the retempering times up to 90 minutes.

3. The concrete produced with addition of 5% extra cement and water and with retarding admixture yields more strength for all the retempering times up to 90 minutes.

4. The concrete produced with the retarding admixture show higher strengths than that of without admixtures for all the retempering times.

5. Thus instead of wasting the bulk concrete, the retempering can be recommended either the use of Retarding admixture or without admixture.

**7. Acknowledgements:**

The author would like to thank Dr. D. K. Kulkarni, Professor Rajarambapu Institute of Technology Rajaramnagar, Islampur (Dt:Sangli), Maharashtra-India for giving all the encouragement needed which kept my enthusiasm alive. Thanks are also due to the management authorities and others who constantly boasted my morale by giving me all the help required. Thanks are also due to Yashdhan controlab (ISO 9001: 2000 certified laboratory), Kolhapur for permitting me to conduct my experimental work.

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