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RESEARCH ARTICLE

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AN EXPERIMENTAL INVESTIGATION ON THE BEHAVIOUR OF RETEMPERED CONCRETE

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ABSTRACT

Ready–mixed concrete industries, are faced with a common problem known as casting delay, which usually results in a considerable loss of workability, so that concrete may be unworkable. On the other hand, improper methods of handling, lack of site organization, work scheduling and breakdown of equipment are some other causes of unexpected long delays. 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 admixtures. The process of remixing of concrete, if necessary, with addition of just the required quantity of water is known as "retempering"of concrete. 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. In such situations addition of small quantity of cement and water along with admixture can bring back the plasticity to concrete.

INTRODUCTION

Concrete industries and, especially, ready–mixed concrete industries, are faced with a common problem known as casting delay, which usually results in a considerable loss of workability. Delay in the production and delivery of ready–mixed concrete is inevitable, which is influenced by the location of construction sites in relation to the central batching plant and traffic conditions on the route. On the other hand, improper methods of handling, lack of site organization, work scheduling and breakdown of equipment are some other causes of unexpected long delays. 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 admixtures.

The process of remixing of concrete, if necessary, with addition of just the required quantity of water is known as "retempering" of concrete. 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. In such situations addition of small quantity of cement and water along with admixture can bring back the plasticity to concrete. However it is well–known fact that retempering with water alone results in a substantial strength loss, since extra water increases the water to cement ratio of the concrete mixture. However in such situations the intelligent use of admixtures can eliminate the potential workability difficulties.

OBJECTIVES OF THE WORK

The main objective of this research work is to study the behavior and quality of retempered concrete and making it acceptable in concrete industry which would otherwise go as waste, thus saving the man hours, money and material.

To achieve the above objective the following different experimentations are planned on M 30 grade of concrete with 28 days of curing.

- To find out the workability (slump and compaction factor test) and strength properties of retempered concrete at different time intervals such as, after 0 min, 15 min, 30 min, 45 min, 60 min, 75 min, and 90 min.

Mix proportion

Cement	=	413.33 Kg/m^3
Water	=	186.00 Kg/m^3
Fine aggregate	=	634.30 Kg/m^3
Coarse aggregate	=	1178.99 Kg/m^3
W/C	=	0.45

M 30 was designed using IS10262 method of mix design. The mix proportion for M 30 grade concrete is given in the following Table .

Mix proportion for M 30 grade concrete

Sl. No.	Grade of concrete	Cement	Fine aggregate	Coarse aggregate	W/C
1	M 30	1	1.53	2.85	0.45

Mixing and casting of specimens

Calculate the material required for 3 cubes, 3 cylinders, 3 beams specimens using the mix proportion by mass as shown in table above and W/C of 0.45.

The mixing procedure was done according to following steps:

- Separately mix the cementitious materials.
- Dry mix the sand and cementitious materials.
- Add coarse aggregate to it and mix it thoroughly to achieve a homogeneous mix.
- Add the calculated quantity of water to the dry mix and mix thoroughly to get homogeneous wet mix.

Testing procedure

Workability tests

Slump cone test

The following procedure is adopted to conduct the slump cone test.

- Place the mixed concrete in the cleaned slump cone mould in four layers. Each layer is 1/4th of the height of the mould.
- Tamp each layer with 25 blows spreading the blows uniformly over the entire surface.
- For second and subsequent layer tamping rod should penetrate to the under lying layer. Strike of the top with a trowel or tamping rod so that mould is exactly filled.
- Raise the handle of the slump cone instrument vertically and bring it on the top of the slump cone.
- Measure the height between the handle and top of the slump cone, note this as H1.
- Lower the handle to the sides of the slump cone and lift the cone gradually without disturbing the concrete. Concrete starts settling, as soon as the settlement stops. Raise the handle and bring it on the top of the unsupported concrete. Measure the vertical height between the handle and the top of concrete, call this as H2.

- **Slump = (H2–H1)** in mm.

Compaction factor test

The following procedure is adopted to conduct the compaction factor test.

- Keep the compaction test set up on a level ground and applying grease on the inner surface of hopper and cylinder.
- Tighten the flap doors of hoppers.
- Take the empty weight of cylinder (W1).
- Fix the cylinder below the hoppers in such a way that center point of hoppers and cylinder should lie in the same vertical line.
- Fill the mixed concrete in upper hopper gently and carefully with hand without compacting.
- After two minutes release the flap door of the upper hopper so that concrete may fall in to the lower hopper bringing the concrete into standard compaction.
- As soon as concrete comes to rest in the second hopper, open the flap door of lower hopper and allow the concrete to fall in the cylinder, bringing the concrete into compaction under its free fall.
- Remove the excess concrete above the top of the cylinder by a trowel keeping the blades horizontal.
- Clear the cylinder from all the sides properly and then find the mass of partially compacted concrete, thus filled in the cylinder (W2).
- Take out all concrete from the cylinder and refill it in the cylinder in three layers. Each layer is being compacted with a standard rod for 25 blows.
- Remove the excess concrete and level the top surface of cylinder. Take the weight of the cylinder filled with compacted concrete (W3).
- Compaction factor is obtained as follows.

Compaction Factor = (W2-W1) / (W3-W1)

Strength tests

Compressive strength test

The following procedure is adopted to conduct the compressive strength test.

- Size of the test specimen is determined by averaging perpendicular dimensions at least at two places. The size of the cube specimen is 150x 150 x 150 mm.
- Place the specimen centrally on the compression testing machine and load is applied continuously and uniformly on the surface perpendicular to the direction of tamping.
- The load is increased until the specimen fails and record the maximum load carried by each specimen during the test as shown in fig.

Fig. compression test on cubes

- Compressive stress was calculated as follows

Compressive strength= P / A× 1000

Where,

P = Load in kN

A = Area of cube surface = 150 x 150 mm^2

Tensile strength test

The following procedure is adopted to conduct thetensile strength test.

Fig. split tensile test on cylinders

- Draw diametrical lines on two ends of the specimen so that they are in the same axial plane.

- Determine the diameter of specimen to the nearest 0.2 mm by averaging the diameters of the specimen lying in the plane of premarked lines measured near the ends and the middle of the specimen. The length of specimen also shall be taken be nearest 0.2 mm by averaging the two lengths measured in the plane containing pre marked lines. The size of the cylinder specimen is of 150 mm diameter and 300 mm length.
- Centre one of the plywood strips along the centre of the lower platen. Place the specimen on the plywood strip and align it so that the lines marked on the end of the specimen are vertical and centered over the plywood strip. The second plywood strip is placed length wise on the cylinder centered on the lines marked on the ends of the cylinder.
- Apply the load without shock and increase it continuously at the rate to produce a split tensile stress of approximately 1.4 to 2.1 $N/mm^2/min$, until no greater load can be sustained. Record the maximum load applied to specimen as shown in fig. 4.17
- Computation of the split tensile strength was as follows.

  Split tensile strength = 2P / (3.142 × dL) × 1000

  Where,

  P = Load in kN

  d = Diameter of cylinder = 150 mm

  L = Length of cylinder = 300 mm

Flexural strength test

The following procedure is adopted to conduct theflexural strength test.

- Brush the beam clean. Turn the beam on its side, with respect to its position as molded, and place it in the breaking machine. The size of the beam specimen is 150 x 150 x 700 mm.
- Set the bearing plates square with the beam and adjust for distance by means of the guide plates furnished with the machine.
- Place a strip of leather or similar material under the upper bearing plate to assist in distributing the load.
- Bring the plunger of the jack into contact with the ball on the bearing bar by turning the screw in the end of the plunger.
- After contact is made and when only firm finger pressure has been applied, adjust the needle on the dial gauge to "0".

Fig. Flexural test on beams

- Here we are applying two point loading on the beam specimen, apply load till it breaks and note that as failure load as shown in fig. 4.18.
- Computation of the flexural strength was as follows.

  Flexural strength = PL / bd²× 1000

  Where,

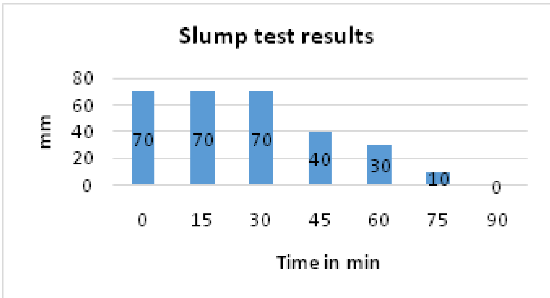
  P = Load in kN

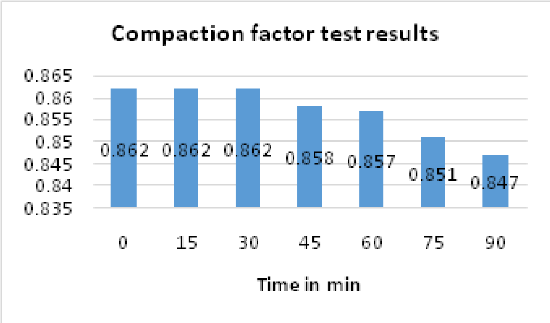
  L = Effective length of beam = 700 mm

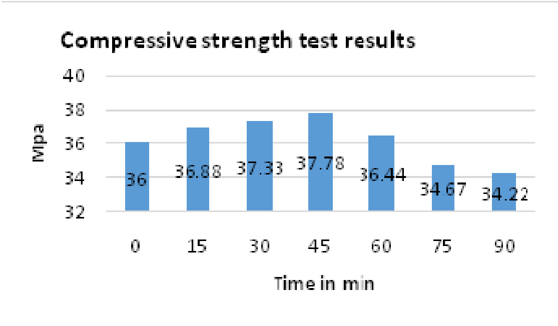
  b = Width of the beam = 150 mm

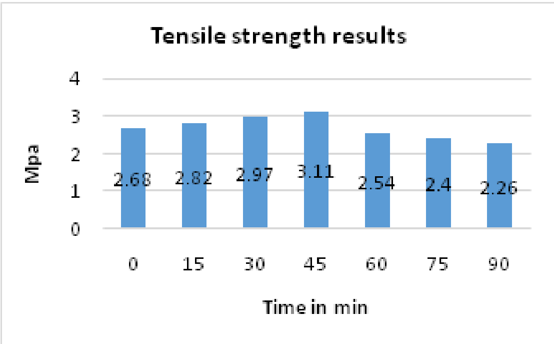
  d = Depth of the beam = 150 mm

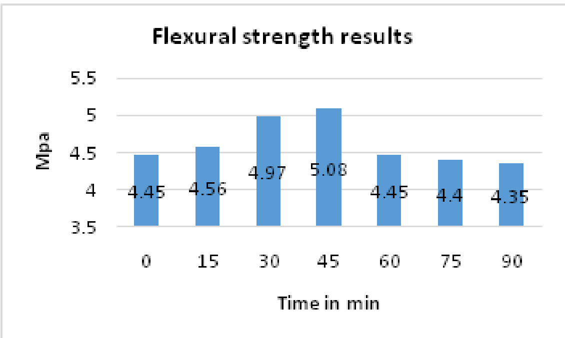
EXPERIMENTAL RESULTS











CONCLUSIONS

Following conclusions can be drawn based on the experimentations conducted on the retempered concrete.

1. Workability goes on decreasing as the retempering time increase
2. Compressive strength of concrete goes on increasing up to 45 minutes of retempering time. Therefore retempering can be allowed up to 45 minutes.
3. Tensile strength of concrete goes on increasing up to 45 minutes of retempering time.
4. Flexural strength of concrete goes on increasing up to 45 minutes of retempering time.

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