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CRITICAL REVIEW ON COMPRESSIVE STRENGTH OF CONCRETE ON-CONSTRUCTION SITE

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Abstract:

*Concrete is the **second** most consumed material after water, with nearly **three tonnes** used annually for each person on the planet. India consumes an estimated **450 million cubic metre** of concrete annually, which approximately translates to **1 tonne** per Indian. Hence, concrete quality is mandatory to be maintained on –site despite several limitations. There are several unusual variations in compressive strengths of concrete on site which ultimately lead to either wastage of materials or structural damage. The investigations reported in this paper are carried out to highlight the compressive strength. Nominal mix (1:2:4) was adopted for this work. Total 45 (150 mm X 150 mm) cubes were casted to allow compressive strength at 7 and 28 days. Strength has been determined to check on different factors on site and amongst them which one affects the most. Results have been obtained accordingly with each probable factor keeping in mind. This would help the developers and contractors up to great extent in maintaining quality control of concrete on site, as experiment has been done in practical conditions.*

Keywords: Concrete, variation, compressive strength, quality control.

Introduction:

Construction industry has contributed to **7.5-8.5 per cent** of the country's **GDP** (at current prices) for the past eight years. Under this circumstance it is need of an hour to optimize the variations concrete strengths (IS 516:1959) (reprint 2006) to achieve better stability. It is estimated that the construction industry in India generates about **10-12 million tons** of waste annually. Projections for building material requirement of the housing sector indicate a shortage of aggregates to the extent of about **55,000 million cu.m.**

In today's world of Earthquake and natural incidents variation in compressive strength of concrete of same grade is matter of concern. In case of RMC (Ready Mix concrete), there are less chances of variations.

There are various reasons to list a few responsible for variation in compressive

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strength of concrete.

- Cement/Ingredient content.
- Curing.
- Water-cement ratio
- Fly-Ash.
- Cube Dimension.
- Material Variation.
- Mixing time.

This study reveals the fact that all factors do not affect the compressive strength greatly. It investigates which things should be controlled while on site to achieve minimum variation. While working in practical conditions, one cannot keep each and everything under control while concreting. Hence, in this study each time while casting cubes, different conditions are taken care of. Results of 7 days and 28 days compressive strengths are analyzed and compared. With the help of graphical representation we can know what things should be taken care of. The one with minimum variations should be considered and with maximum variations should be ignored, while concreting in future.

Current Scenario:

At present when normal mix design is followed, no care is taken whatsoever on the proportions. They aren't fixed and varied as per conditions. Developers and contractors are not aware of what loss they are causing to themselves as for M20 grade they get compressive strengths of around 30-35 N/mm2 If at all they know anyhow, then are helpless due to lack of adequate knowledge. When on construction site so many things are need to be taken care of, contractors don't pay attention to the variations in results. Fig. (a) Represents the overview of the compressive strength (M20 grade) in the entire span of a month. These variations tell the entire problem. If the strength is calculated keeping each factor in mind then problem may be solved.

Detailed Analysis of different factors:

Water/Cement Ratio: This property plays a significant role in the property of concrete. According to IS 10262:2009 certain criteria has been set for different water cement ratio with respect to the concrete grade and atmospheric conditions. This property mainly is responsible for the workability of the concrete. Water if taken in excess may lead to bleeding, which ultimately results in reduction in compressive strength of concrete. The excess water in concrete comes up (floats) above the mix and evaporates. Also, it leaves voids in the concrete and thus after some time cracks are seen due to heat of hydration. Experiment was done on site keeping water amount same and the results were analyzed of 7 days and 28 days. Fig. (b) shows the results of cubes obtained when w/c ratio (0.52) is kept constant while other properties not paid much attention. These low variations show that it does affect the compressive strength of concrete.

Mixing Time: Whenever we talk of bonds we talk of mixing time. Proper binding between the aggregates and cement is necessary to get the strength. Usually as per IS 456:2000 the mixing time varies from 1-3 min with respect to conditions. Here, results were taken keeping mixing time constant 1 min. On-site contractors generally don't bother

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about this. They are unaware of the fact that if mixing isn't kept appropriate it will result in segregation. Hence, while pumping concreting strength will be lost and proper workability also won't be achieved. Improper inter-locking among aggregates result in reduction of strength. Fig. (C)

Displays results obtained when mixing time is kept constant at 1 min, meanwhile other things not given proper attention. These low variations do show that it's an important factor, but not as much as W/C ratio.

Curing Time: **(IS 456:2000)** Curing is the process of controlling the rate and extent of moisture loss from concrete during cement hydration. Curing plays an important role on strength development and durability of concrete. Curing takes place immediately after concrete placing and finishing, and involves maintenance of desired moisture and temperature conditions, both at depth and near the surface, for extended periods of time. The length of adequate curing time is dependent on the following factors:

I. Mixture proportions
II. Specified strength
III. Size and shape of concrete member
IV. Ambient weather conditions
V. Future exposure conditions

Some builders on a tight schedule water cure for 3 days as this achieve approximately 80% of the benefit of water curing for 7 days. Slabs on ground (e.g. pavements, sidewalks, parking lots, driveways, floors, canal linings) and structural concrete (e.g. bridge decks, piers, columns, beams, slabs, small footings, cast-in-place walls, retaining walls) require a minimum curing period of seven days for ambient temperatures above 40 F. Fig (d) shows the results obtained when the cubes are casted when curing time is taken care off. Results derive fact that curing time is a factor of concern on site, as improper curing may lead to reduction in durability of member. The low variations prove this fact.

Proper Materials: Material conservation is the need of an hour looking to the current construction industrial growth. Materials content depends upon the grade of concrete. Materials if not added properly may lead to reduction in strength. Sometimes, excessive materials are added. This results in to more strength which isn't required actually. This leads to wastage of materials. Fig. (e) Shows results when proper care of materials have been taken. The variations are seen though materials are proper poured. Thus it concludes that material doesn't affect that much. It is due to the reason that if there is a difference of 3-4 kg also then also it isn't going to matter that much, as at a time 0.5 CUM concrete is mixed.

Fly-Ash: About 43% is recycled, often used as a pozzolan to produce hydraulic cement or hydraulic plaster; fly-ash is a partial replacement for Portland cement in concrete production. Since the particles solidify rapidly while suspended in the exhaust gases, fly ash particles are generally spherical in shape and range in size from 0.5 μm to 300 μm. Fly-ash doesn't affect the compressive strength of

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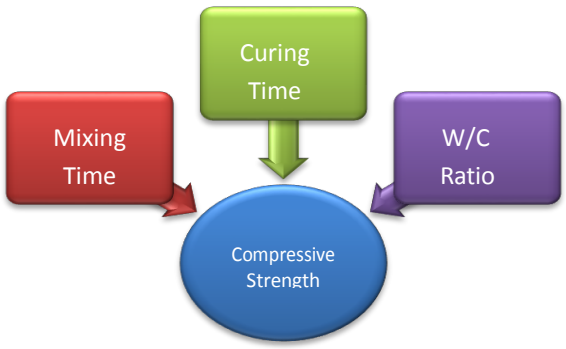
concrete, but has impact on workability. When Portland cement cures, it leaves behind some hydrated lime. Adding fly ash or another pozzolan allows that lime to cure as well, making the concrete stronger and less porous. Fig. (f) Represents the results when fly-ash content (18% here) is kept constant. AS per IS 3812(Part1):2003 fly- ash content in concrete should not exceed 32%. The more variations in strengths show that fly- ash more addition/subtraction doesn't affect much. Hence, while manufacturing concrete if fly-ash varied due to any reason, there is no reason to worry as far as compressive strength is concerned.

Cube-dimensions: Sometimes due to wear and tear of cubes, results aren't obtained properly. Many times it might be the case that any defect in the cubes only may lead concrete variations. Dimensions of cube taken were 150mm x 150mm x 150mm.There are chances as every time the moulds are opened and cleaned, oiled and then again tightened to fill the concrete. Oiling is done so that concrete doesn't get stuck to the periphery of mould and gets smooth. Fig. (g) Represents results of the cubes when dimensions of the cubes kept proper and moulds are filled up to appropriate limit.



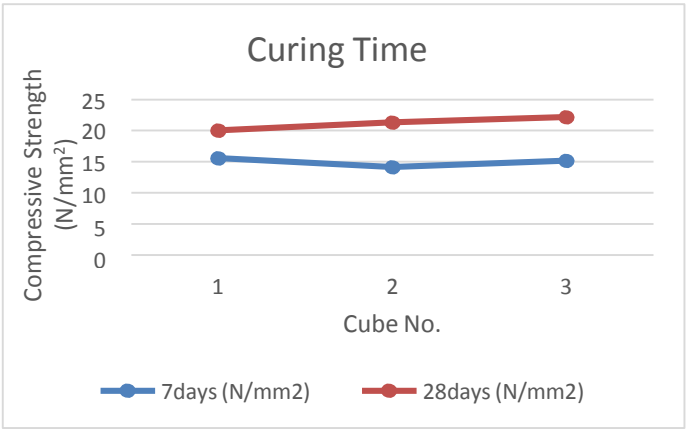


Figure (a) Current Scenario where variations in compressive strengths of M20 grade concrete are seen

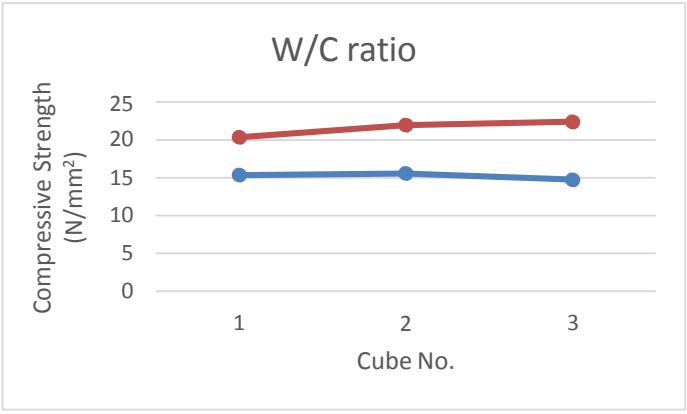


Figure (b) Readings taken with W/C ratio constant

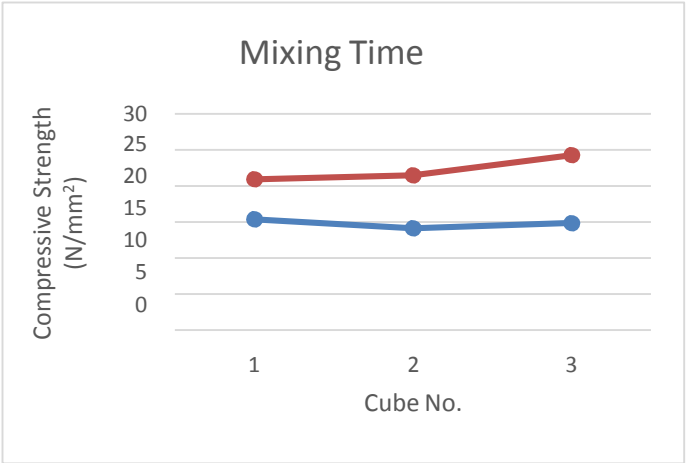


Figure (C) Results with mixing time (1 min) constant

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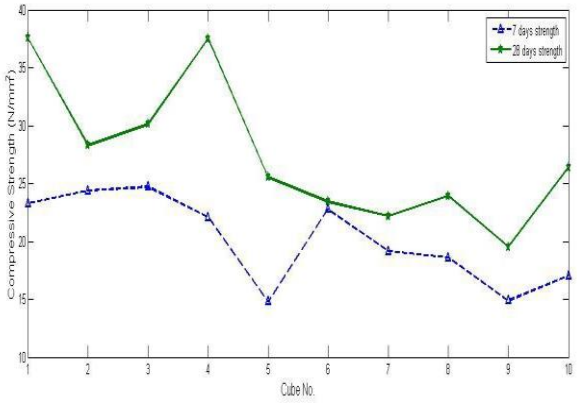

Figure (d) Readings taken with Curing time constant

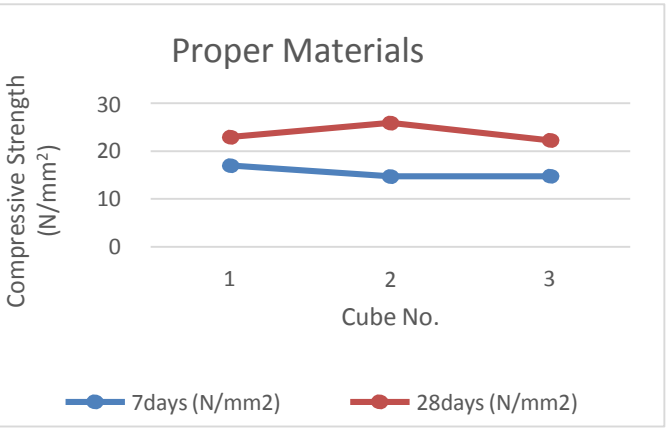

Figure (e) Readings taken with Proper Materials

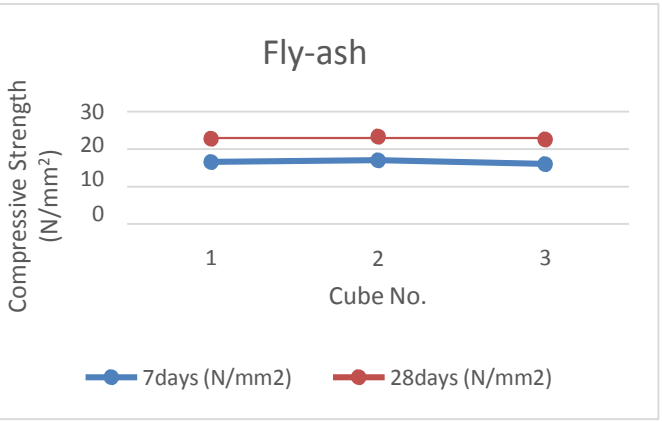

Figure (f) Results with Fly-ash content (18%) constant

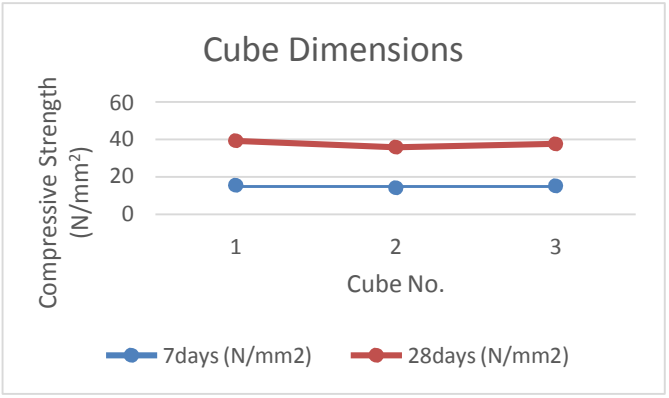

Figure (g) Results with Cube Dimensions constant

Concluding Remarks: As explained earlier examining to current growth of industry its essential to maintain strength. The results with different factors keeping in mind conclude that W/C ratio is the key factor responsible for variation in compressive strength of concrete. It mainly hold importance as it effects many physical properties. Then comes the curing time as it is responsible for the durability of concrete. At last comes the mixing time, which affects the improper bonding amongst aggregates. Rest other factors need not be worked upon as far as compressive strength of concrete is concerned. The contractors and mainly site- engineers are advised to keep these things in mind while casting any loading member.

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