How early should the curing begin to prevent plastic shrinkage cracking in Concrete Slabs?

G.Sivakumar

sivakumar@icomat.in

January 2014

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

William Lerch

"Plastic shrinkage is the shrinkage that occurs in the surface of fresh concrete within the first few hours after it has been placed, that is, while the concrete is still plastic and before it has attained any significant strength"

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

It is known that early curing will prevent Plastic Shrinkage Cracking.

The question that often goes unanswered in construction practice is “When to start early curing?”

How early should the curing begin ?

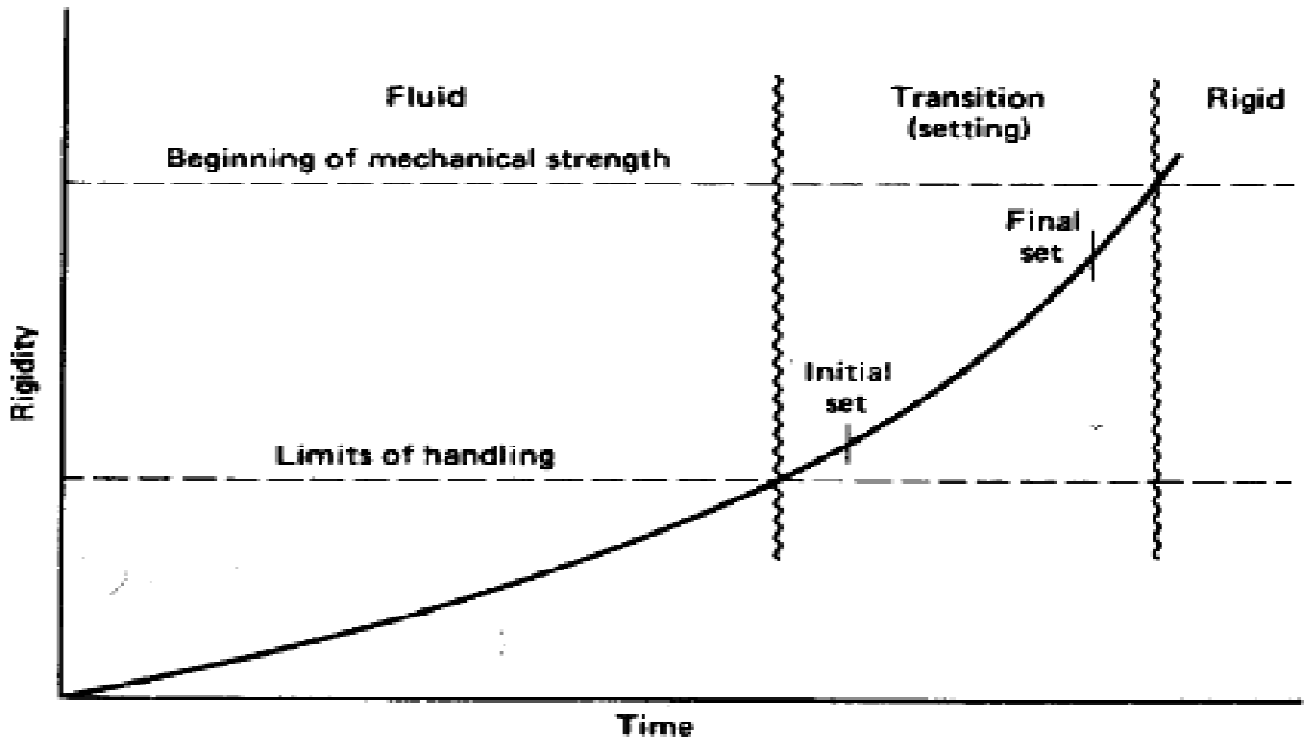
Holt, in 2000

"The most common solution to reduce early age volume changes is to avoid drying by proper handling of the concrete for the first few hours after placement. It is imperative that the concrete curing begins immediately and follows correct methods."

Early Curing Period
- immediately after finishing and until concrete gets hardened.

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?



Early age shrinkage phases: liquid, hardening transition with setting, and rigid hardening. [Mehta & Monteiro 1993]

When concrete attains sufficient strength it can resist early age stresses caused by volume change. Until then.....?

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

The sequence of events after placing concrete……..

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Bleeding Water comes upto slab surface immediately after casting

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Surface can become dry/sheen-less when Concrete is still plastic within few minutes to few hours depending on the atmospheric conditions and mix used

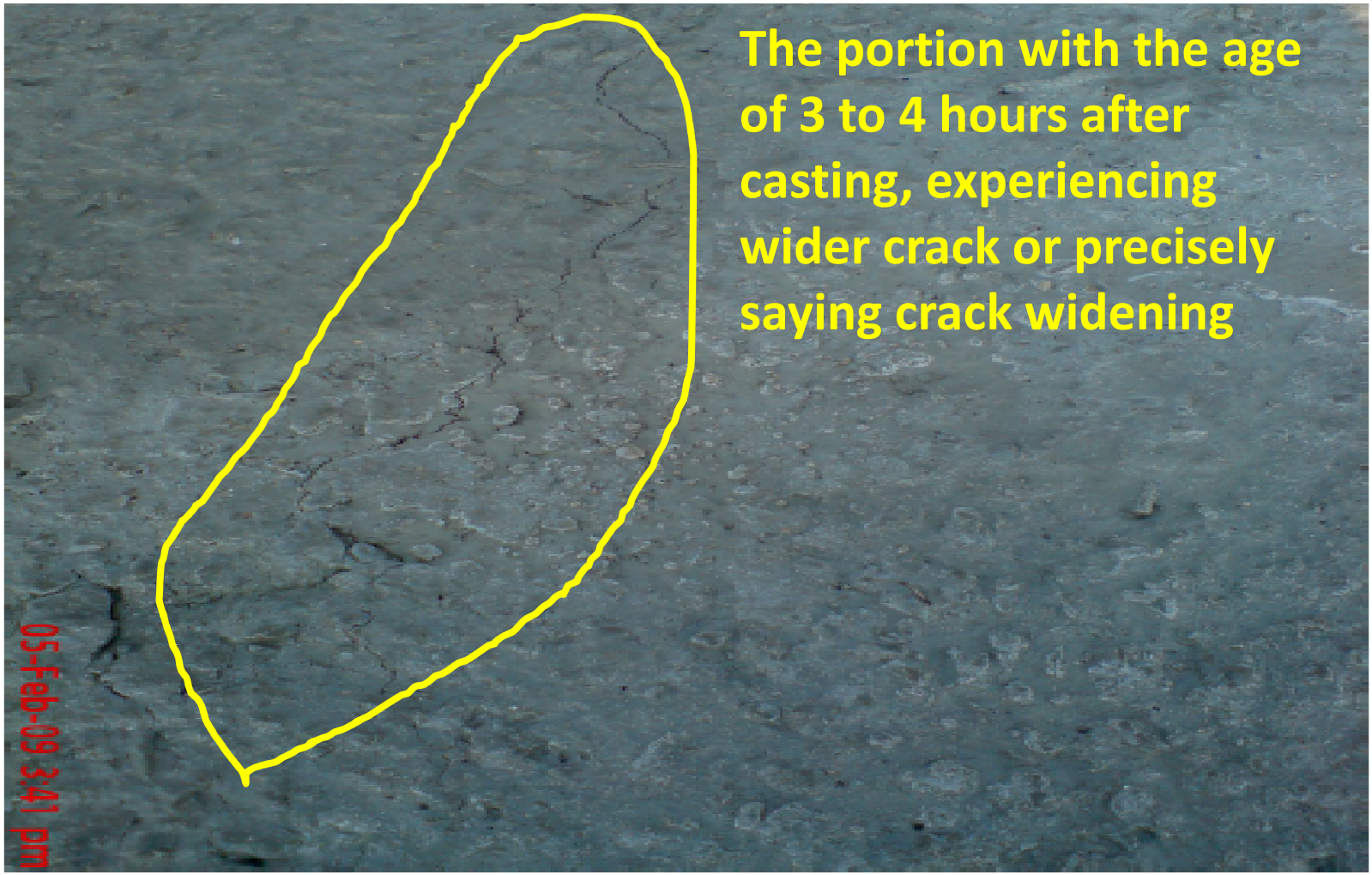
ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Stage & environment conducive for plastic shrinkage cracking

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?



Cracks widening (effect of surface tension in pore water & due to continuous loss of water)

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Plastic shrinkage cracking on surface of Concrete Road (with silica fume) - no bleed water and no early curing!

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Prevention of moisture loss from concrete surface through early Curing

How early should the curing begin ?

Curing (Early) is prevention!

How early should the curing begin?

Curing should begin as soon as compaction and finishing is completed and before concrete surface looses its water and undergo shrinkage.

This is very important for concrete with low to very low water/cement ratio, which does not have much water to bleed to the surface.

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Curing (Early) is prevention!

Is one time sprinkling sufficient?

Surface drying and cracking can happen as soon as the finishing is completed.

Hence early curing should begin portion after portion in sequence with slab casting, and shall not wait to start for the completion of entire slab casting.

This should be followed by covering with plastic sheets, because one time sprinkling will not be sufficient to compensate for moisture evaporation occurring continuously.

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Curing (Early) is prevention

Could curing be started even before concrete "set"?

It is the concrete that is still plastic and weak that requires cover to prevent moisture loss.

Sprinkling, a form of early curing, cannot penetrate the compacted saturated bed of concrete and hence will not disturb the concrete.

It could only disturb laitance or fines deposited and this is an added advantage, too.

Can rain droplets disturb concrete quality?

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Practice of “Focusing in one direction, i.e., casting concrete alone” should change……

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Scenario in slab casting that needs to change

Slab casting continuing but without early curing

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Scenario in slab casting that needs to change

Late Beginning of curing after cautioning about cracks!!

Is this the right way to walk across a good 30’ X 80’ freshly laid but drying surface with a bucket of water to start early curing?

(Total area under casting on this particular day was 10000 sq. feet.)

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Slab under casting

Portion 2- cast next having bleed water

Portion 1 - having lost its bleed water

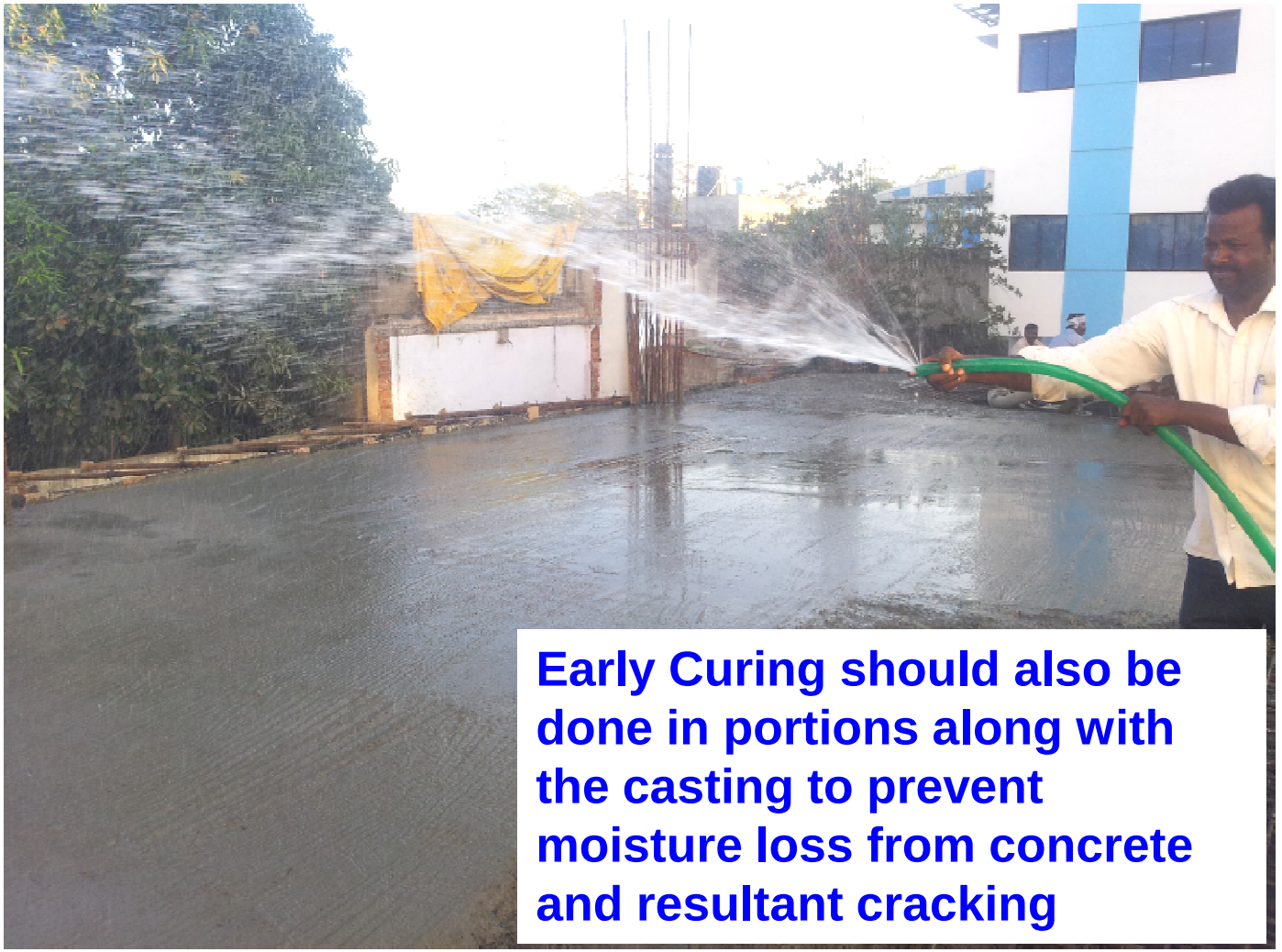
ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

What should be the compulsory practice in slab casting?

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?



Early Curing should also be done in portions along with the casting to prevent moisture loss from concrete and resultant cracking

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Perfect timing! – Sprinkling begins as the truck (that delivered concrete for that portion) leaves

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Application of Curing compound – A form of Early Curing

However Sprinkling and covering should follow

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Sprinkling water and covering – A better practice

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Sprinkling water and covering – The best practice

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Wetting of formwork is being practiced for ages religiously

Wetting of fresh concrete surface should happen the similar way

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Early curing and hardening of concrete as early as possible found to be perfect combination to prevent PSC.

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Earlier is better – both Curing and Hardening

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Surface of concrete with Synthetic (micro) fibers of particular type

Fibers can control the propagation of cracks.
May or may not be able to eliminate cracks completely without early curing.

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Plastic shrinkage Cracking is influenced by

- **High Ambient temperature**
- **High Wind Velocity**
- **Low Relative Humidity**

as these accelerate the rate of evaporation of water from the surface.

Prevention is better than cure, in general.

But Curing (early) is the prevention for Young Concrete!

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Solutions to nurture the concrete in three easy ways

1. **Protecting a weak and early age concrete with flawless Curing cover**

2. **Protecting hardened but not strong concrete with Continuation of Curing**

3. **Protecting concrete that is maturing to become stronger with continuous curing.**

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

How early should the curing begin ?

Delay Setting

If delay setting is encountered, more importance shall be given to sprinkling and covering of surface.

The reason is, delayed set concrete could offer more water to atmosphere (due to its prolonged fresh state) and undergo shrinkage.

It shall also be ensured that the surface is not disturbed at all in the form of inspection. Inspection and advice by competent person is very important, though.

How early should the curing begin ?

Good work has to go on….

Continuous curing after the surface gets hardened is very crucial to avoid “Porosity and Drying shrinkage cracks”.

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS

Going green is not just choosing alternate resources but also preserving the consumed resources

Thank You

ICOMAT
CONCRETE INITIATIVES AND INNOVATIONS