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Ronald Kozikowski is a Professional Engineer, specializing in troubleshooting concrete construction issues. With 20 years of concrete construction industry experience, Ron has been the Vice President of North Starr Concrete Consulting since 2012. Throughout his career, he has developed extensive knowledge and expertise in a broad range of concrete materials related subject matter. Ron is a member and voting member of several industry organizations and is a well-respected and trusted educator having taught and given technical presentations numerous conventions and conferences. He has authored more than 30 technical articles and is co-author on a book focused on topping slab design for the American Society of Concrete Contractors. Ron is licensed in both Illinois and New Hampshire and holds a BS in Civil Engineering and a MS in Materials/Structural Engineering from the University of New Hampshire.



Wet-Weather Strategies for Concrete Placements Exposed To Rain

IOWA Better Concrete Conference

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November 18, 2020

Wet-Weather Strategies for Concrete Placements Exposed To Rain

Learning Objectives:

- Understand the four main properties of rainstorms and what affect they can have on concrete placements.
- Timing of a rainstorm during a concrete placement will influence how the rain event should be handled. Learn what options available to contractors during the main stages of placing and finishing concrete.
- Learn what repair options are available if a concrete placement is affected by rain.
- Understand what a “wet weather plan” is and what should be included in one.

Additional Information – Concrete International

- For more information see August 2019 article in Concrete International
“Concrete Placements Exposed to Rain”

Concrete Placements Exposed to Rain

Damage types, protection options, and repair methods

By Ronald L. Yarbrough, Scott M. Tan, Kevin Rosenblatt and Bruce A. Suprenant

Additional

- For more on Concrete
- "Concrete

International


article in

Concrete contractors in some parts of the country are being placed concrete in rainy weather. There is a concern that bleed water will collect on the surface and cause surface damage. Contractors should be prepared for weather conditions that may result in an excess of bleed water. Contractors should be prepared for weather conditions that may result in an excess of bleed water. Contractors should be prepared for weather conditions that may result in an excess of bleed water.

Rainwater and Bleed Water

Understanding rainwater and bleed water is important for contractors, designers, and owners. Rainwater is a natural phenomenon that can cause surface damage. Rainwater is a natural phenomenon that can cause surface damage. Rainwater is a natural phenomenon that can cause surface damage.

Rainwater vs. Bleedwater



Rainwater vs. Bleed Water

- Rain and bleed water are similar
- Neither will soak back into concrete
- Cannot work either into the surface or intermix with the concrete
- Must remove both prior to finishing

Properties of Rainstorms

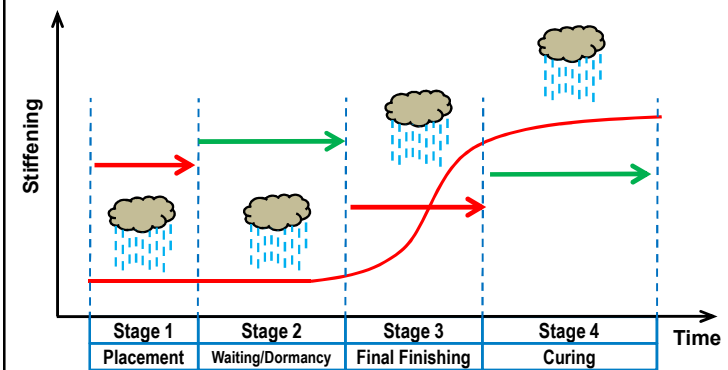
- ✓ Timing
- ✓ Duration
- ✓ Intensity
- ✓ Volume



Timing – Most Influential Property

- Most influential factor
- Will dictate if rainwater can or cannot be removed prior to finishing
- Can be broken down into 4 main stages of a concrete placement

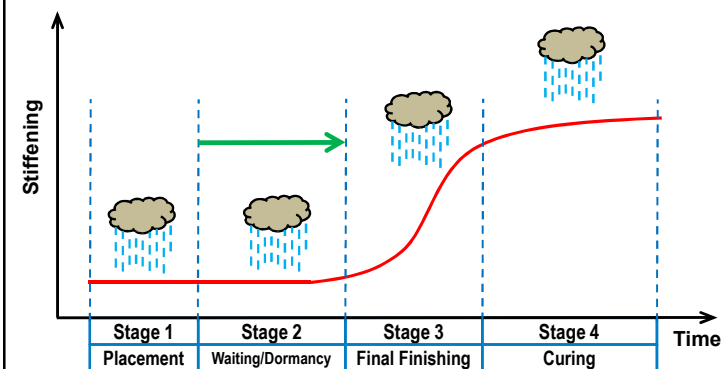
Timing – Most Influential Property



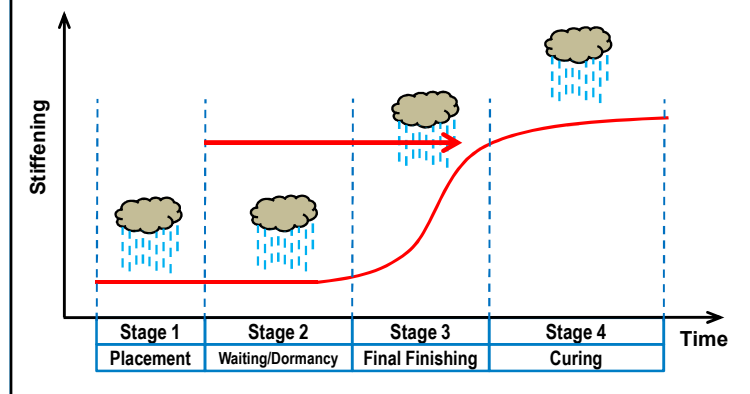
Duration – How Long Does It Last?

- Once rain starts, how long does it last?
- Timing of a storm may be favorable, but duration could limit or prevent water from being removed

Timing – Most Influential Property



Timing – Most Influential Property



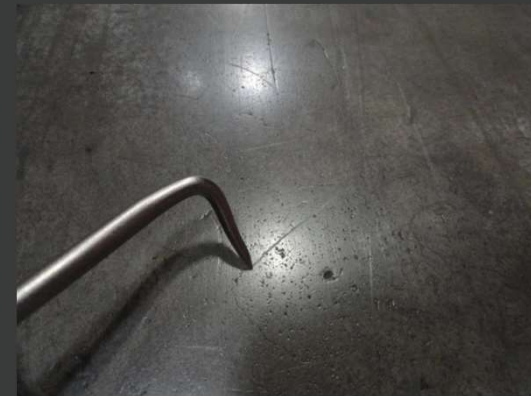
Intensity – How Hard Will It Rain?

- More intense storms increase the potential for washing away surface paste
- Contractors may have to consider methods for minimizing washout and/or cushioning blows from rain droplets on the surface

Volume – How Much Rainwater?

- Least of the four rainwater concerns
- Can pose labor concerns associated with manpower to remove excess water
- Large volumes of flowing water can remove surface paste

Surface If Rainwater Is Properly Handled

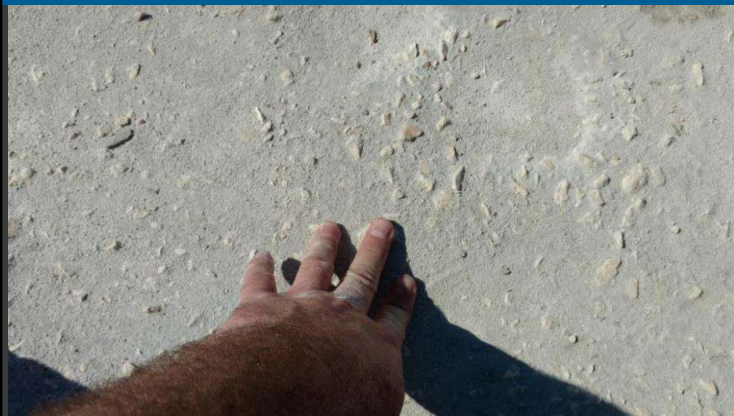


- If rainwater is not properly handled, the following types of damage can occur...

Loss of Surface Paste

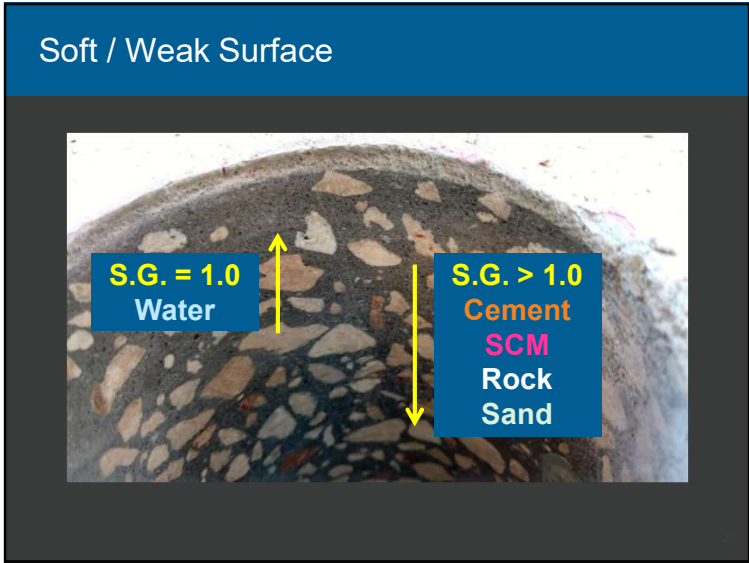
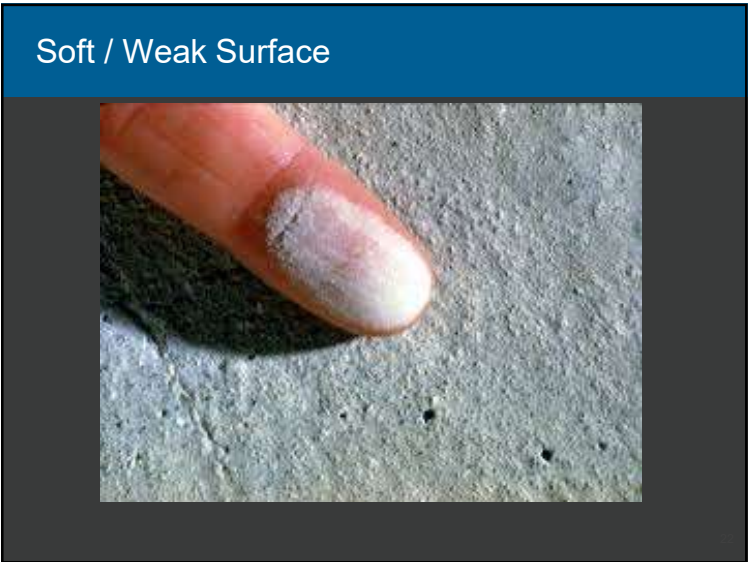
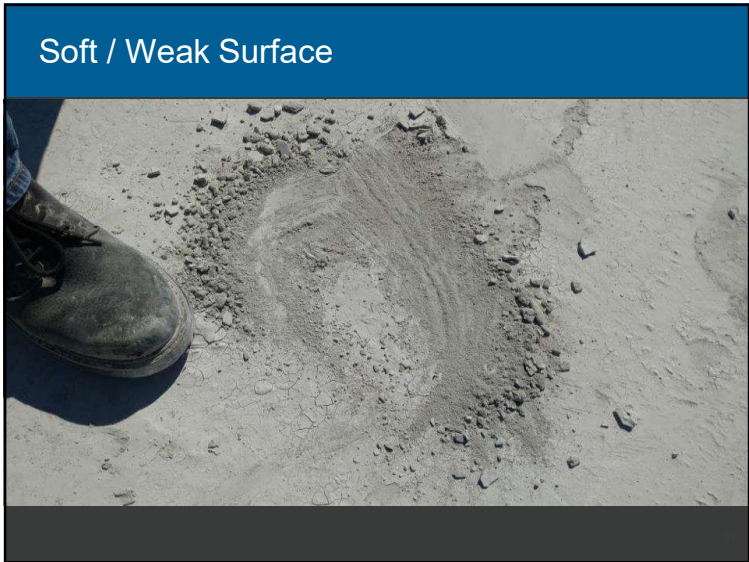


Loss of Surface Paste



Soft / Weak Surface





- Soft / Weak Surface
- Standing rainwater will not be absorbed by concrete
 - If rainwater cannot be removed prior to finishing it could weaken a shallow surface layer
 - American Concrete Paving Association (ACPA) states rainwater typically affects top 1/8-inch of concrete surface and can be repaired by grinding

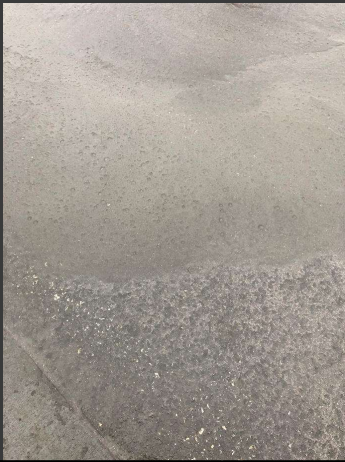
Surface Marring



Indentations From Rain Droplets



Indentations From Rain Droplets



Indentations From Rain Droplets

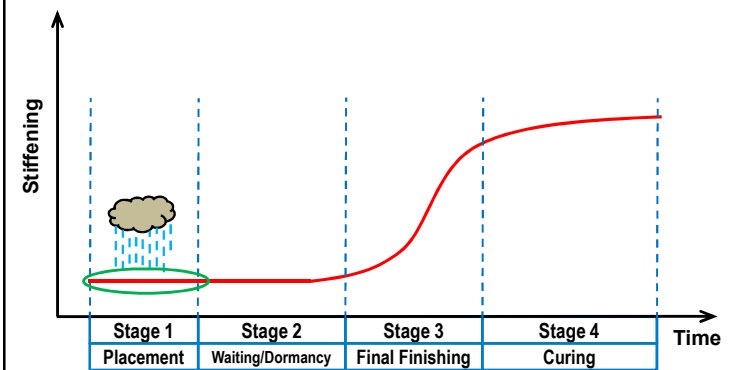


Planning and Protection Options

- Timing and duration of a rain event is usually unpredictable
- Understand situational protection options for the 4 stages of a concrete placement:

Placement
 Waiting / Dormancy
 Final Finishing
 Curing

STAGE 1 – Concrete Placement



STAGE 1 - OPTIONS

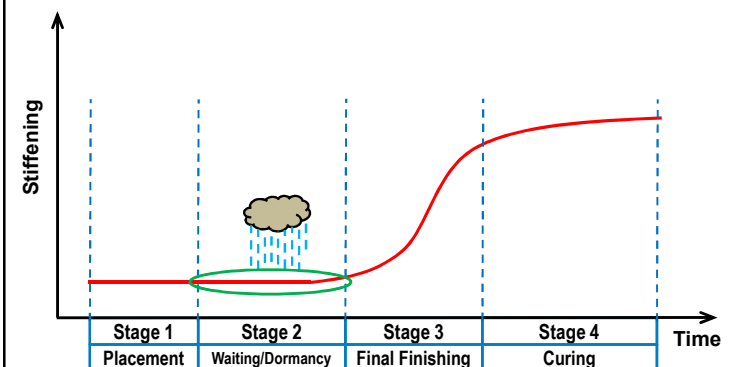
- Involves placement, screeding, and floating
- ONLY stage where rainwater could get intermixed while workers walk through, consolidate, and strike off concrete
- ONLY stage where higher w/c and possibly lower compressive strengths could occur due to intermixing

STAGE 1 - OPTIONS

- Stop placement
- Install emergency bulkhead
- Evaluate the affected concrete



STAGE 2 – Waiting Period / Dormancy



STAGE 2 – Waiting Period / Dormancy

- A favorable window of time during which rain can occur (typically extends several hours)
- Rainwater should be removed prior to final finishing
- Rainwater will not be absorbed into the slab
- If storm is intense may need to consider methods to minimize loss of surface paste

Should Slab Be Covered w/ Plastic?



Should Slab Be Covered w/ Plastic?



Should Slab Be Covered w/ Plastic?

- Obstacles (rebar, blockouts, etc.) can make it hard to cover slab
- Sheets not usually wide enough to cover entire slab. Water gets between seams.
- Removing plastic and standing water can be challenging
- Plastic will trap heat & increase setting time of slab surface. This shortens amount of time to get rainwater off and finish slab.

Removing Water From Surface Is Critical!

- Timely removal = success!
- Goal – Remove water quickly without removing excess surface paste
- Rainwater Removal Equipment
 - Squeegees
 - Rigid polystyrene foam board
 - Garden hose
 - Old compressor hose
 - Large fans
 - Leaf blowers

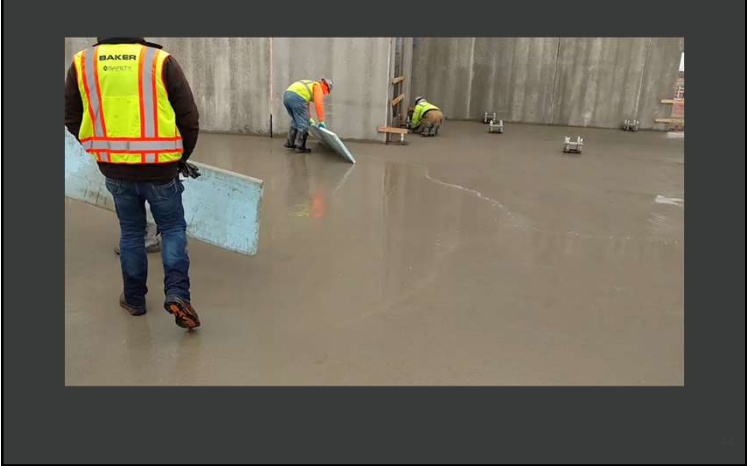
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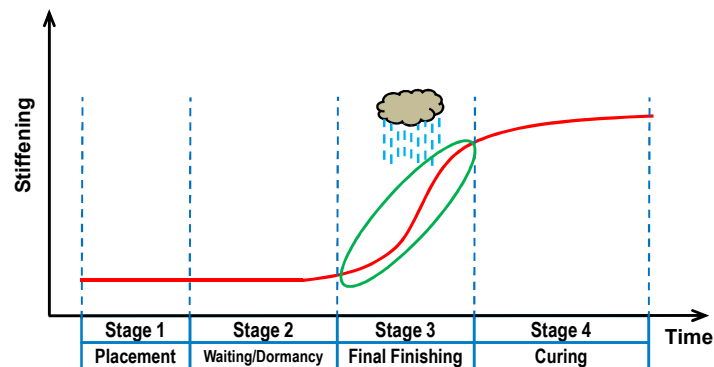
Removing Water From Surface Is Critical!



Don't Forget To Keep Water Off Surface



Stage 3 – Final Finishing



Stage 3 – Final Finishing

- Not a favorable time for rain
- Slab is rapidly stiffening and minimal protection options are available.
- A light rain between passes may be removed but heavy rain during this period may need to be addressed with repair.
- Do not mix water into surface
- Do no sprinkle dry cement on rainwater

Stage 3 – Final Finishing



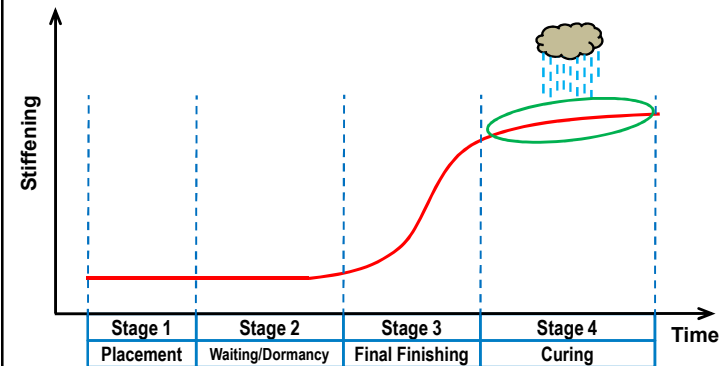
Stage 3 – Final Finishing



Stage 3 – Final Finishing



Stage 4 - Curing



Stage 4 - Curing

- Most favorable time for rain event to occur
- Generally slab has achieved final set after hard trowel passes are complete
- Unlikely for washout to occur at this point but finishers may want to have plastic on hand in the event that a very intense rain occurs

Rain Slab Repair Options

- Unfortunately not all rained-on slabs are successfully finished
- If substantial intermixing of rainwater did not occur then damage is usually very superficial (1/8 inch)
- Surface repairs are available
 - Consider depth of damage
 - Acceptance criteria for final surface appearance
 - Review Div 9 requirements & investigate what level of surface repair is necessary.

Repair Options – Apply Silicate Hardener



Repair Options – Apply Silicate Hardener



Repair Options – Apply Silicate Hardener



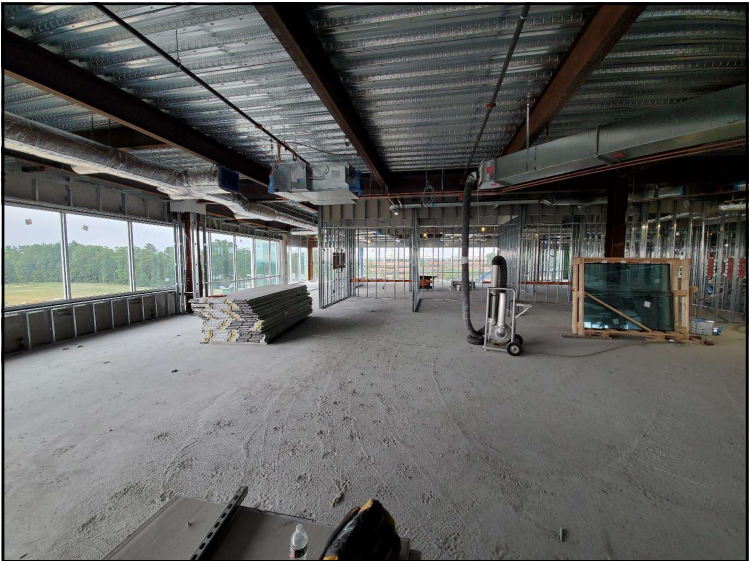
Repair Options – Grind Surface



Repair Options – Bonded Topping Slab

- Proprietary products available for bonded overlays where 1/2" or less is being restored
- Consider placing 4x4 ft mockup for approval and evaluating process





Wet-Weather Protection Plan

- ACI 301-16 “Specification for Structural Concrete”, references possible wet-weather plan submittal along with hot and cold weather submittals.

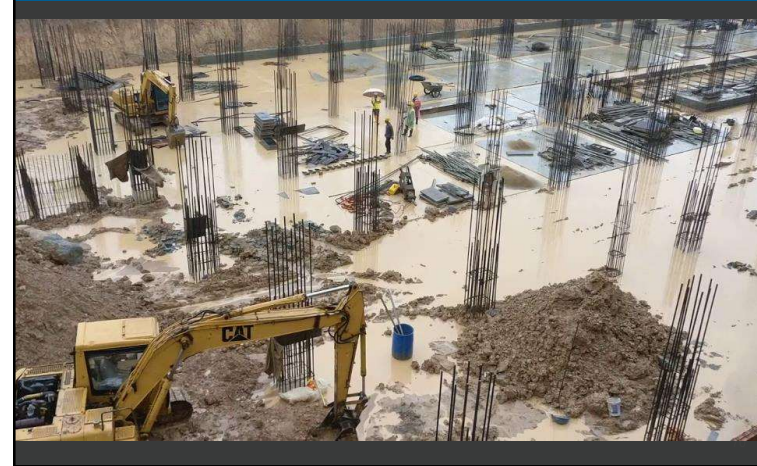
Section 5.1.2 Submittals

5.1.2.2(c) *Wet-weather protection*—Wet-weather protection activities.

5.1.2.2(d) *Hot-weather placement*—Request for concrete temperature limit different than specified in 5.3.2.1(c), including documentation and procedures to demonstrate compliance with other requirements in Contract Documents.

5.1.2.2(e) *Cold-weather placement and protection activities*—Request for acceptance of proposed cold-weather placement, temperature-measuring methods, and protection activities.

Wet-Weather Protection Plan – SITE ACCESS



Wet-Weather Protection Plan – SITE ACCESS



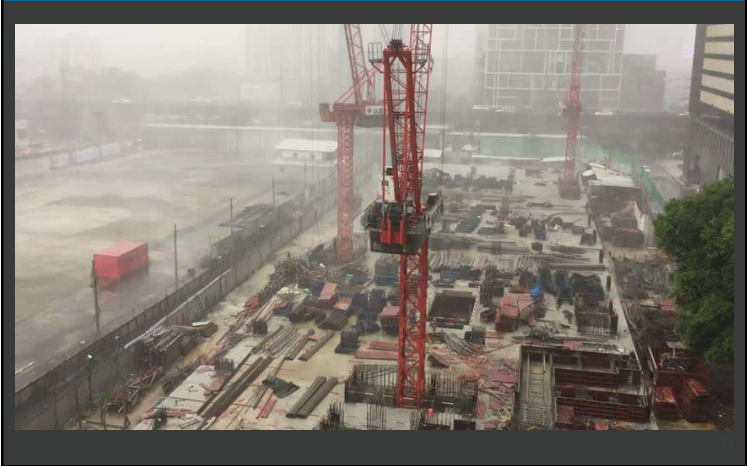
Wet-Weather Protection Plan – Material Storage



Wet-Weather Protection Plan – Material Storage



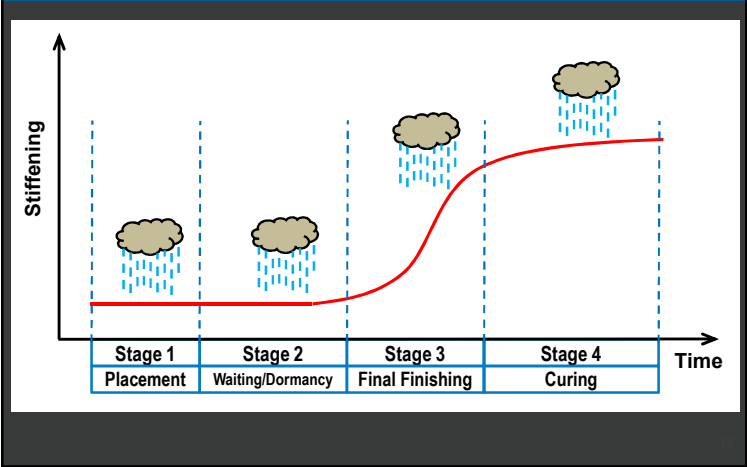
Wet-Weather Protection Plan – Material Storage



Wet-Weather Protection Plan



Wet-Weather Protection Plan



Wet-Weather Protection Plan

- Plan should include what protection options contractor may utilize during the 4 stages of concrete placement
- Plan should include list of equipment & supplies
- Discuss plan and proposed procedures during preconstruction meeting.
- Discuss potential repairs should the need arise

Questions?

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Placements Exposed to Rain

Iowa Better Concrete Conference

Virtual

November 18, 2020