W. R. MEADOWS®
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HOT WEATHER GUIDELINE: REPAIR MORTARS AND NON-SHRINK GROUTS

Application of water-based cement products in hot weather present challenges and require steps that must be taken to minimize the potential for jobsite issues. For products such as our repair mortars (the MEADOW-CRETE line, the MEADOW-PATCH line, MEADOW-PLUG, SPEED-E-ROC, SPECTRUM-RE-KOTE TF, the FUTURA line and PARGE-ALL AF) or our non-shrink grouts (CG-86, CG-86 NE, 588-10K and 1428-HP) and typical mortars and concretes the main challenge facing the applicator of these cementitious materials in hot weather is the potential for rapid water loss from the mix (high rate of evaporation) causing accelerated cement curing (rapid hardening). Early water loss, rapid drying and accelerated cement curing due to high rate of mix water evaporation in elevated temperature, low humidity, direct sun or high wind speed may result in permanent damaging effects of the cement based material. Protection of cementitious materials from these damaging effects of early water loss or rapid drying is paramount to avoid costly job-site issues.

These damaging effects will cause loss of workability, shorter working or application time, quicker set time, plastic shrinkage cracking and surface crazing in the fresh state. In the hardened state, the damaging effects of rapid water loss, high rate of evaporation and accelerated curing will cause low physical properties, poor bond and compressive strengths, high permeability, drying shrinkage cracks and softness of the repair mortars, non-shrink grouts and concretes. They will primarily appear in the hardened product as surface crazing and fine cracks, bond failure or delamination of the repair mortar from the existing substrate and moderate to severe drying shrinkage cracks.

WHEN SHOULD YOU BE CONCERNED ABOUT HOT WEATHER?

American Concrete Institute ACI 305 defines hot weather as "any combination of the following conditions that tends to impair the quality of freshly mixed or hardened concrete by accelerating the rate of moisture loss and the rate of cement hydration or otherwise causing detrimental results", including an ambient temperature of 80°F (27°C) or higher, and/or an evaporation rate that exceeds 1kg/m^2/h. ACI 305 lists the following conditions as important factors in hot weather cement-based or concrete placements:

- High Ambient Temperature
- High Product Temperature
- Low Relative Humidity
- High Wind Speed
- Sun Light Heating (Solar Radiation)

Note, that only one of these factors listed above need to be present to cause lasting detrimental effects. High wind velocity or direct sun light heating even on a cool day can potentially lead to early water loss and a high rate of evaporation.

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WHAT HAPPENS WHEN CEMENTITIOUS PRODUCTS ARE EXPOSED TO HOT WEATHER CONDITIONS?

- Cement based repair mortars, non-shrink grouts or concretes will stop curing when too much water has been lost to the atmosphere through evaporation or absorbed into the existing substrate. When the water content inside the cementitious material drops below 80% RH, then cement curing and hydration stops.
- Up to 50% permanent strength loss can occur if the cementitious material loses too much water rapidly.
- In addition to the low strengths, this will cause poor bond, cracking, softness and decreased abrasion resistance along with surface scaling, dusting and delamination.
- Cement based repair mortars, non-shrink grouts or concretes may form fine plastic shrinkage cracks when exposed to hot weather conditions. Cracks typically occur within the first few hours after application due to rapid water loss from the surface quicker than it can be replenished by the bulk mix and can occur up to 72 hours later. In thinner patches, evaporation of the mix water is greater, and this effect is enhanced because there is less bulk thickness to maintain and resupply water to the surface during the initial curing, especially in the first 24 hours.
- Water evaporates faster with high temperatures, low humidity, solar heating and high winds which causes the cementitious material to lose water early (before final set) leading to plastic cracking, which is evident by the appearance of these fine cracks within hours of application out to 72 hours. Drying shrinkage cracks are made more severe in size and frequency by rapid water loss and improper maintenance of the critical mix water resulting from lack of, or improper, curing by increasing the rate of shrinkage (volume change due to water evaporation) and lowering the tensile strength of the material.
- Hot weather will speed up the set time (dramatically accelerate the rate of set and reduce the working time). For every 10°F difference from 75°F, set time will decrease by 30% of the initial value. For example, if the working time is 1 hour at 75°F, at 95°F the working time will be less than 30 minutes, approximately half the usual working time.

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- Cementitious repair mortars and non-shrink grouts have a minimum and maximum application temperatures as well as material temperature requirements. These cementitious products, unlike concretes, are not typically bulk applied in large mass applications and therefore maintenance of mix water to ensure proper curing and to reduce shrinkage is important. In hot weather conditions, it becomes more difficult to properly maintain the mix water in the repair mortar or non-shrink grout due to the high rate of evaporation.

HOW TO ADDRESS AND POTENTIALLY AVOID JOB-SITE ISSUES?

- Protect repair mortar or non-shrink grout from direct sun or have wind breaks set.
- Use cool mixing water. Do not store product in direct sunlight.
- Be prepared to work quickly. Have enough personnel to get the material applied within the accelerated work time schedule during hot weather apllications.
- Use evaporation retardants such as EVAPRE when conditions exist for rapid water loss.
- Cure the repair mortar or non-shrink grout or cementitious product in accordance with ACI 308.
- Ensure proper curing methods are used for conditions to minimize early water loss that will result in fine cracks that develop in a few hours to 72 hours typically. Cure immediately after finishing, delay in curing in hot weather may result in early water loss and cracks. Early water loss and proper maintenance of water to ensure adequate curing must be controlled on site and is a result of the mix water evaporating from the product, not a material related issue.
- Use a water-based curing compound conforming to ASTM C 309, such as 1150-CLEAR or 2250-WHITE from W. R. MEADOWS, applied at the required application rate. In almost all instances, two coats of curing compound are necessary to achieve the 8 mil wet film thickness (200 ft.^{2}/gal.) required by ASTM C 309 for vertical or overhead applications. Apply the initial coat and allow it to dry, then apply the second application of the curing compound. This is especially important in hot weather (80^o F or greater) ambient or material temperature.
- Prepare to wet cure per ACI 305 to minimize heat of hydration and rapid, early water loss for several hours to potentially days depending on severity of hot weather conditions if cracking occurs.

REFERENCES:

ACI Committee 305, "Hot Weather Concreting" (ACI 305R) American Concrete Institute, Farmington Hills, MI

ACI Committee 201, "Guide for Conducting a Visual Inspection of Concrete in Service" (ACI 201R) American Concrete Institute, Farmington Hills, MI

ACI Committee 308, "Guide to Curing Concrete" (ACI 308R) American Concrete Institute, Farmington Hills, MI

NRMCA Publication #12, "CIP 12 – Hot Weather Concreting", National Ready Mixed Concrete Association, Silver Spring, MD

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