IMPACT OF WEATHER CONDITIONS
ON CONCRETING

Compiled By **Martha Mwatile**

Concreting in adverse weather conditions such as hot weather, cold weather and windy conditions presents a unique set of challenges, which must be thoroughly planned for. These weather conditions can have negative impacts on the fresh concrete properties such as workability, as well as the hardened concrete properties such as strength and durability. Different parts of the world experience varied weather conditions, and ready-mix concrete producers as well as construction professionals need to adapt their construction material designs and construction methods to these weather conditions so that they can produce good-quality concrete despite the climatic drawbacks they face.

CONCRETING IN HOT WEATHER

SANS 10100-2 defines hot weather as weather in which the ambient temperature exceeds 32°C. Temperature above 25°C may also be defined as hot weather if: the ambient relative humidity is low and the wind speed is high; the temperature of the concrete is high, or solar radiation is present. High temperatures increase the rate of the hydration reactions between the cement and the water, and thus the movement of moisture within and from the surface of the concrete. The following are the negative impacts of hot weather concreting:

- Increased water demand for a given workability
- Increased rate of loss of workability
- Increased rate of setting
- Increase in plastic shrinkage cracking
- Lower long-term strength (although early strength is higher)
- Decreased durability
- Variations in concrete appearance

Figure 1 below demonstrates the impact of high temperatures on water demand. It shows the amount by which the water content needs to be increased in order for the consistence of the concrete to be maintained.

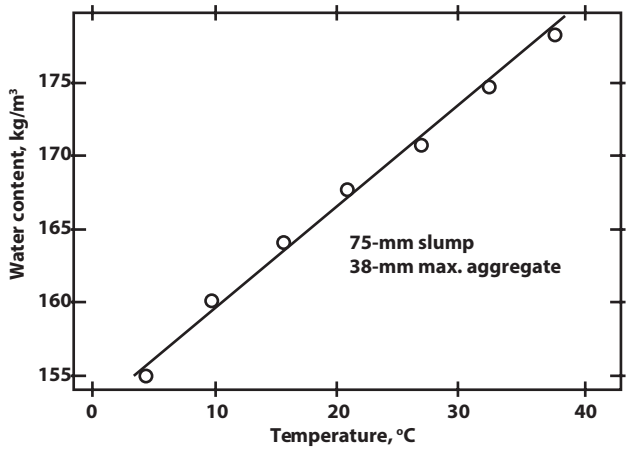

Figure 1:

Effect of temperature increase on the water requirement of concrete

Avoiding the negative impacts of concreting in hot weather requires a reduction in the temperature of the concrete by controlling or adjusting the concrete mix and/or by adjusting construction methods to ultimately reduce the temperature of the concrete. The following measures may be implemented when concreting in hot weather:

- Cooling the mixing water or substituting flaked or well-crushed ice for part or all of the mixing water; ice particles have to be small enough to melt completely during the mixing process;
- Cooling the aggregates, for example by shading the stockpiles and by wetting the stone to cause evaporative cooling;
- Injecting liquid nitrogen into the mix during mixing;
- Concreting activities should be carried out during the cooler parts of the day;
- Painting construction material storage silos white to prevent rise in temperature;
- Shading of batching or mixing plant as far as possible, and/or painting it white;
- Reducing transport time of concrete as far as possible and covering concrete with damp material;
- Spraying of ready-mix vehicles and/or pump pipelines with water to cool them; and also shading pump pipelines where possible;
- Using a suitable retarder in the concrete mix to extend the concrete open time;
- Selecting aggregates and designing the mix to minimise the water content required and thus reducing the cement content required;
- Replacing some of the cement with an extender such as fly ash or ground granulated blastfurnace slag; and
- Sheltering the area being concreted from direct sunlight as far as possible.

CONCRETING IN COLD WEATHER

Cold weather is defined in SANS 10100-2 as weather in which the ambient temperature is less than 5°C. Although extreme cold temperatures are not regularly experienced in Southern Africa, it is necessary to be aware of impacts of cold weather concreting for the few occasions that it may occur. Cold weather concreting negatively affects the concrete by freeze and thaw action. At early ages, if the water in the concrete freezes before the concrete has had an opportunity to set, or even after the concrete has set but before it has gained sufficient strength, then there will be an increase in the overall volume of the concrete due to the expansion of the water, especially in the capillary pores of the concrete. When thawing takes place, i.e. when the water 'unfreezes', the concrete will set with an enlarged volume of pores. These pores reduce the strength and durability of the concrete. If the freezing cycle takes place after the concrete has gained sufficient strength of about 3 to 5 MPa, then it can resist any possible negative impacts from the freezing. This is mainly due to the fact that a majority of the mixing water in the concrete mix has already been combined with the cement through hydration, and also because the concrete has a high resistance to the pressure of ice.
The following measures may be implemented when concreting in cold weather:

- Heating the mixing water and the aggregate (if water or aggregate is heated above 60 °C, combine the water with the aggregate in the mixer before adding the cement. Cement shall not be mixed with water or mixtures of water and aggregate of temperatures exceeding 60 °C);
- Increasing the cement content in the mix;
- Using a cement that hardens more rapidly; Portland cement (CEM I 42.5R and CEM I 52.5N) is recommended, as extended cements have a slower rate of setting and slower rate of strength gain;
- Incorporating an accelerator. (Chloride-free accelerators should be used when the concrete contain reinforcement or other embedded metal.);
- Fresh concrete should not be placed against frozen surfaces;
- Water in aggregates should be prevented from freezing by covering stockpiles with tarpulins; and
- Preventing heat loss from freshly placed concrete by covering exposed concrete surfaces with insulated material.

CONCRETING IN WINDY CONDITIONS

Concreting during windy conditions has a negative impact on the curing of freshly placed concrete. High winds result in moisture loss and premature drying out of concrete, which interferes with the maintenance of continued hydration of cement required for the hardening of the concrete. Windy conditions encourage evaporation from the concrete, which further exacerbate the negative impact associated with concreting at high temperatures, discussed earlier. In coastal environments, concrete is also exposed to wind-driven, salt laden air, which can increase the chlorides content in concrete and lead to the corrosion of reinforcement in concrete and the subsequent cracking and spalling of concrete.

CONCLUSION

When concreting in adverse conditions such as hot weather, cold weather and windy conditions, certain precautions need to be taken to prevent the negative impacts associated with concreting in these conditions. Failing to address the possible negative impacts of concreting in these conditions may negatively affect both the properties of the fresh concrete and the properties of the hardened concrete. In particular, the water demand and the workability are largely negatively impacted by hot weather concreting. Hot weather concreting also reduces the later strength of concrete. Cold weather concreting results in air voids in the concrete due to freeze-thaw action, reducing the later strength and durability of concrete. Windy conditions may lead to cracking of concrete by drying out concrete prematurely and encouraging evaporation.

REFERENCES:

- Neville, G. (2010). Concrete Technology. England, Pearson Education Limited.
- Kellerman, J. (2006). Manufacture and Handling of Concrete. In: Owens, G (ed) Fulton's Concrete Technology. Midrand, Cement and Concrete Institute, pp 229 - 250.
- SANS 10100-2. (2006). The Structural Use of Concrete, Part 2: Materials and Execution of Work. Pretoria. South African Bureau of Standards.