GUIDELINES for Concreting in Cold Weather

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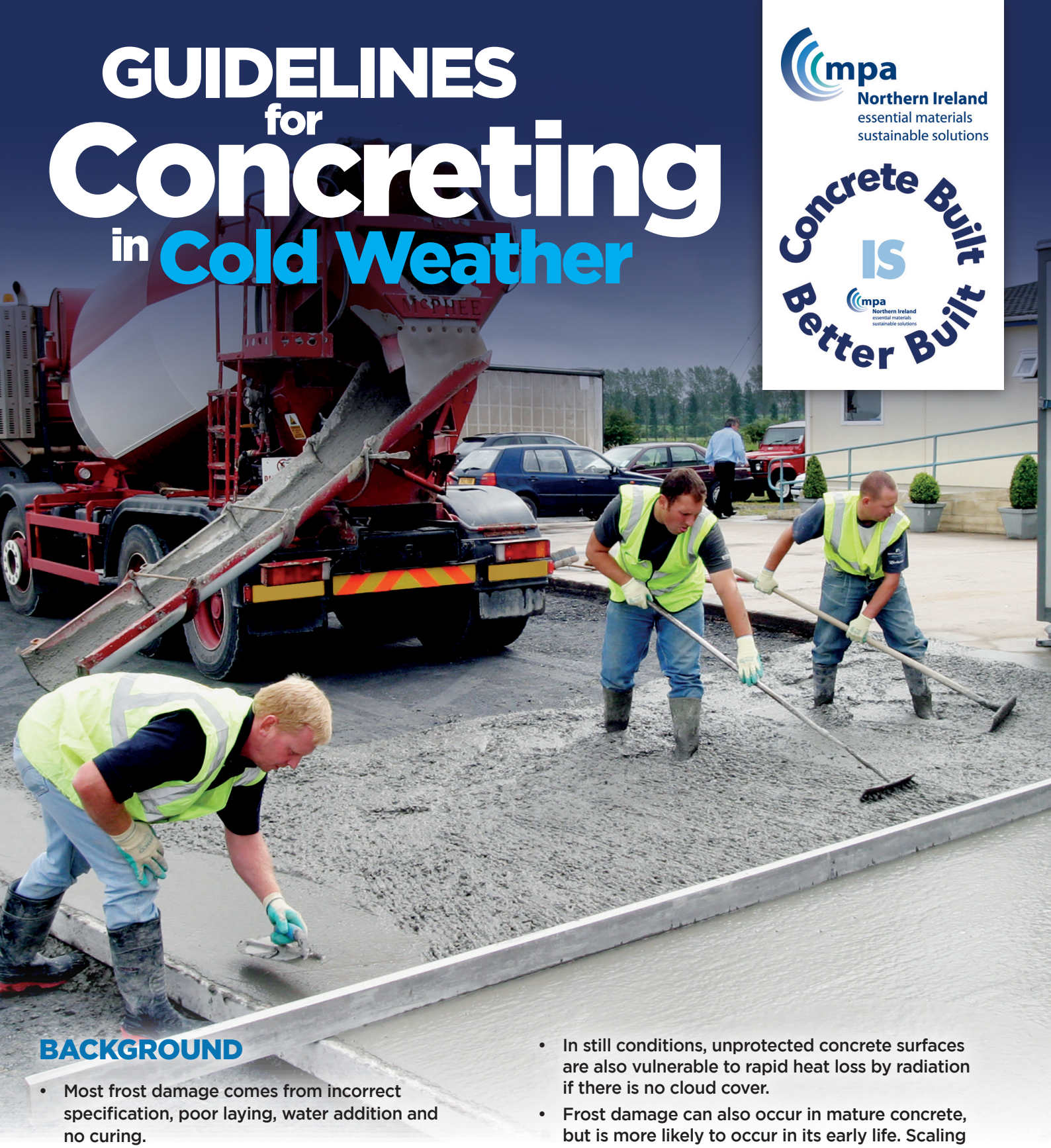

BACKGROUND

- Most frost damage comes from incorrect specification, poor laying, water addition and no curing.
- Freshly placed concrete is vulnerable to freezing temperatures, rain, sleet and snow both before and after it has set.
- Concrete which has not attained sufficient maturity (>5N/mm2) can be permanently damaged due to free water freezing, thereby reducing the ultimate strength of the concrete, leading to a loss of durability. In addition ice lenses may form and cause spalling.
- In strong winds, heat loss from concrete increases rapidly leading to a reduction in the temperature of exposed surfaces.
- In still conditions, unprotected concrete surfaces are also vulnerable to rapid heat loss by radiation if there is no cloud cover.
- Frost damage can also occur in mature concrete, but is more likely to occur in its early life. Scaling and popouts are features of this effect which can be severe, particularly in saturated concrete subjected to exposure to freezing temperatures.
- Concrete walls and slabs which have large areas exposed at low temperatures are most at risk. In addition, external paving which is placed on cold ground is vulnerable to the effects of low temperatures.
- At low temperatures the rate at which concrete hardens is considerably reduced and appropriate extra care must be taken when striking formwork and supporting members.

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TEMPERATURE

- Three different temperatures have to be considered when working with concrete in cold weather i.e. that of the ground, of the concrete itself and the ambient air temperature.

1. GROUND TEMPERATURE

- Fresh concrete should not be placed on frozen ground or against other frozen surfaces.

2. CONCRETE TEMPERATURE

- BS8500 requires that the temperature of concrete on delivery shall not be less than 5°C.
- The temperature of the concrete should be maintained above 5°C for at least the first 48 hours after placing, to enable it achieve sufficient strength to resist frost damage.
- Temperatures less than 5°C in hardened concrete will severely reduce strength development.

3. AIR TEMPERATURE

- Most specifications prohibit concrete placement at ambient air temperatures below 5°C on a falling thermometer or below 3°C on a rising thermometer. Specialist advice should be sought for concreting below these temperatures.

CONCRETE MIX CONSIDERATIONS

- It is possible to speed up the hardening process and strength development of concrete by the following:

(a) Increasing the binder content.
(b) Increasing the concrete strength class.
(c) Increasing the cement strength class.
(d) Use of a water reducing admixture to improve early strength gain.
(e) Use of an accelerating admixture.
(f) Reducing the use of additions by agreement with the specifier.

- Precautions should be taken to prevent admixtures from freezing.Manufacturers' instructions should be followed.
- For concrete which will be exposed to freeze thaw cycles, reference should be made to BS8500.

PLACING AND CURING

- Specification of cement types used in concrete is determined by performance requirements. Strength gain and striking times for concretes containing Pulverised Fuel Ash (PFA) or Ground Granulated Blastfurnace Slag (GGBS) also need to be considered as using GGBS/PFA in cold weather will greatly slow down the strength gain and setting of the concrete.
- All plant should be protected against frost with smaller items being kept under cover. If ice forms on plant remove it before concreting begins.
- All surfaces with which concrete is to come in contact should be covered at night in frosty weather or allowed to warm up before work begins.
- Concrete should not be placed against any formwork or reinforcement covered in ice or snow.
- Concrete should be discharged and placed in its final position as quickly as possible, thereby ensuring as little heat loss as possible.
- Concrete placed late in the day is more vulnerable to freezing conditions at night.
- Full compaction, particularly in slabs, is important to remove excess air and water and increase density. This will benefit heat retention and increase surface durability.
- When there is a risk of frost, all new concrete must be protected as soon as it has been placed.
- Even in cold weather, wind will have a drying effect. Wind breaks will reduce wind chill and evaporation and reduce heat loss especially from slabs.
- As with all concrete work, proper curing techniques should be used. However, wet curing of concrete should be avoided.
- Concrete exposed to low temperatures or strong winds should be protected from heat loss. Frost blankets or the use of insulated formwork may be required. A number of materials can be used as frost blankets to provide insulation for exposed concrete surfaces, e.g. mineral wool quilts, foam mats, polythene sheet with a dead air space.
- Formwork (and insulation) should be left in place for as long as possible.
- The removal of insulation should be controlled to avoid thermal shock.
- Where space heaters are used, care must be taken to avoid direct application of heat to the concrete surface. Ensure adequate venting of heater exhaust fumes.

TESTING

- Cubes should be stored indoors in moist conditions and at temperatures of 20C +/- 5C for moulded specimens and thereafter in a curing tank at 20C +/- 2C for demoulded specimens as per standard.
- It is advisable to use temperature matched curing / maturity calculations, to accurately determine the development of in-situ strength in critical structural elements (in addition to standard cube testing)
- It is advisable also to cast additional cubes for 56-day testing in case of lower initial strengths.

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