Curing concrete

Hanson HEIDELBERGCEMENT Group

Fresh concrete must be protected whilst in its early life from the detrimental effects of hot sun, dry air, drying winds and frost. In order to achieve the required durability and strength of any concrete, care must be given to curing.

The main reasons for curing are to assist strength development and to improve the durability potential of freshly-placed concrete. In some cases curing also reduces the effects of thermal contraction and the production of satisfactory surface finishes.

Effective curing prevents the evaporation of water from a concrete surface. Curing using applied insulation can also help control damaging internal temperature differentials in large masses of concrete, and to maintain an adequate temperature in the concrete during cold and frosty weather to fully hydrate the cementitious material present.

To ensure that the full benefits of curing are achieved, all involved in concrete production (designers, engineers, operatives) must clearly understand why and how a particular curing process is to be used.

This guide explains what curing of concrete is and gives practical recommendations for its application.

Influence of hydration on the properties

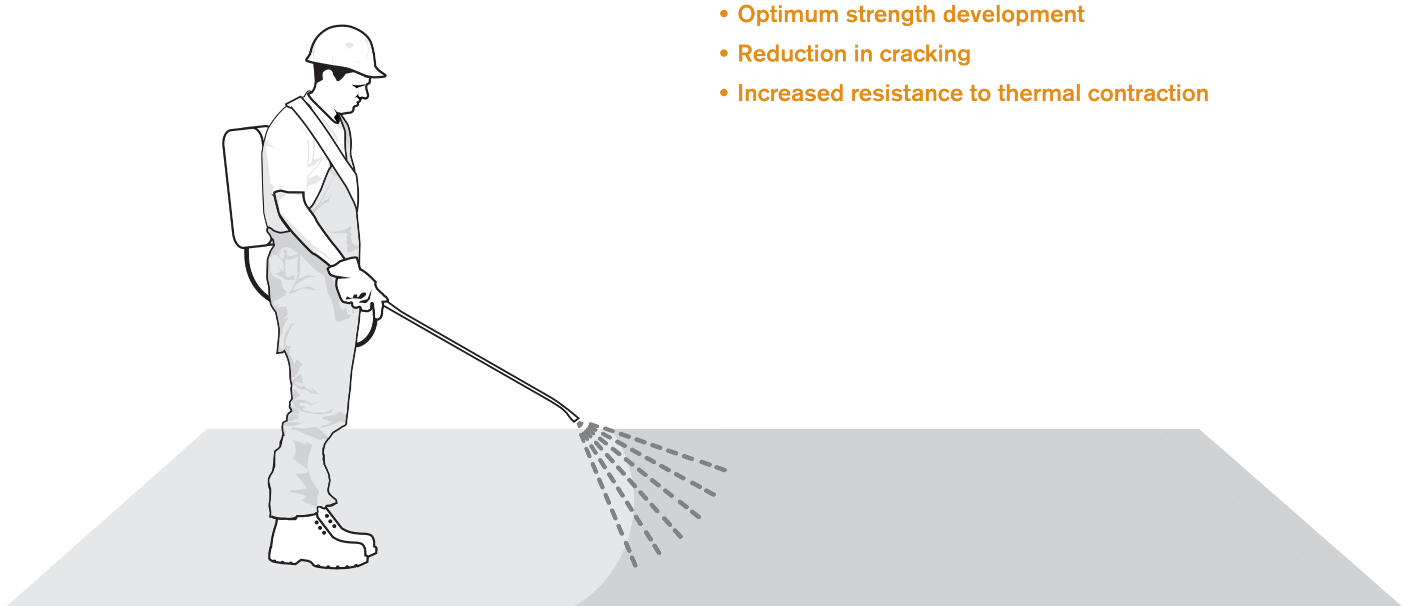
The development of strength and durability of any concrete mix, regardless of the type of cement used, depends on maximum hydration of the cement since these properties depend upon the production of a dense matrix of low permeability that is resistant to the passage of water, carbon dioxide and oxygen. The chemical reaction between the cement and water must be allowed to continue to its maximum level.

If concrete is allowed to prematurely dry, this reaction ceases and the designed strength and durability properties are seriously reduced. This is a major concern with surface wear properties on concrete slabs. Slabs that are insufficiently cured can lose up to 50% of their surface durability causing cracking, dusting and surface erosion within a short time frame.

Premature loss of water must be prevented, if the full benefits of cement hydration on the properties of hardened concrete are to be achieved.

The benefits of proper curing include:

- Increased wear resistance
- Reduction of surface erosion
- Increased frost resistance
- Improved life span
- Optimum strength development
- Reduction in cracking
- Increased resistance to thermal contraction



Propriety spray-applied membrane

To find out more, contact your regional sales office:

North: 0845 120 6300 | **Central:** 0845 845 6688 | **London:** 0845 120 5750 | **South West:** 0845 120 6312 | **South East:** 0845 758 5634

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Horizontal surfaces

The materials commonly used for curing horizontal surfaces such as roads, pavements, domestic and industrial floor slabs include:

- **Proprietary spray-applied membrane (at least 90% efficiency recommended). The timing of application is critical; it must be applied as soon as the concrete has lost its surface sheen.**
- **Impervious sheeting laid in close contact with the concrete surface.**

Early curing of slabs is vital to minimise the risk of plastic shrinkage cracking, especially in climatic conditions combining high temperatures with strong drying winds.

Spray-applied curing compounds are rated by their manufacturers according to the efficiency with which they provide a barrier to evaporation. This is measured as a percentage of total water retained in the concrete. Research has shown the effects of delay in the application of curing compounds to flat slabs and formed vertical surfaces, by measuring the water loss from concrete specimens at various ages. The results of the tests on a trowelled slab, where one of the best resin-based curing compounds was used, clearly shows the rapidity with which water can be lost if curing is delayed.

Although membranes formed by curing compounds normally degenerate after a period of time, their use is not recommended on surfaces, which are subsequently to receive an applied finish, such as a screed, because of the likelihood of reduced bond.

Water is the most effective and cheapest curing medium but it is seldom used because of the practical problems associated with supply, containment and ultimate disposal. Materials such as wet hessian or wet sand are sometimes used but they must be kept continually wet and not be allowed to dry out.

In extreme weather conditions special precautions are necessary to minimise evaporation of hydration water and to control temperature differentials.

Special precautions in hot weather

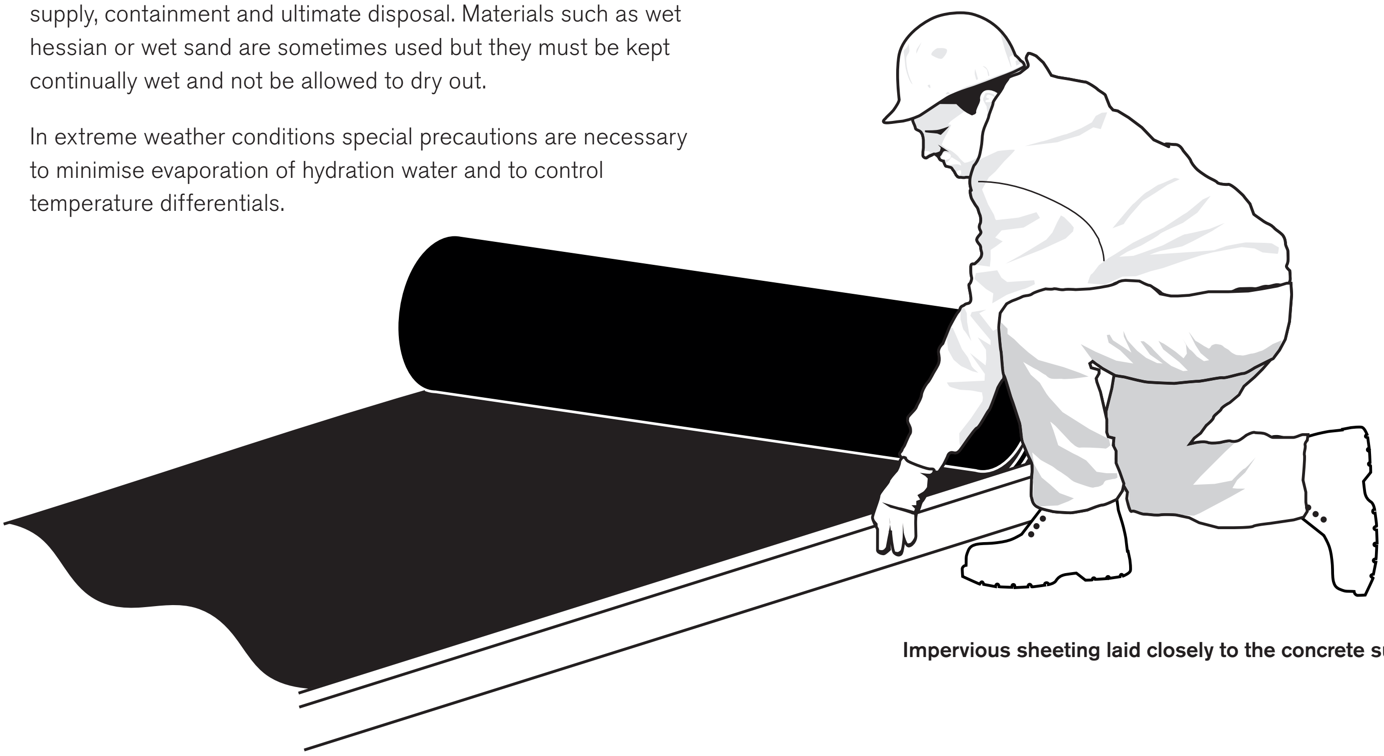
In the worst condition of hot dry weather with high winds, to cope with the fast drying conditions:

- **Provide wind shields to cut down air movement and minimise loss of water.**
- **Provide effective shading to minimise surface temperature variations.**
- **Be extra careful with the early application of a waterproof membrane. (Polythene or similar sheeting, laid in close contact with the fresh concrete, is extremely effective provided it is applied quickly.)**

Special precautions in cold weather

In a cold but dry atmosphere, particularly during frosty conditions, immediate application of combined curing and protective measures is necessary. This is not only to minimise loss of water but to maintain an adequate temperature and, in the case of thick sections, to control the surface temperature so that the temperature gradient between the core and the surface does not become excessive.

One of the most effective ways for slabs is to apply waterproof glass fibre or mineral wool insulation blankets directly on the freshly placed concrete. Alternatively, straw or other lightweight insulation material laid over polythene sheeting provides adequate protection provided the insulation material is kept dry. Under no circumstances should water be used in periods of cold weather.



Impervious sheeting laid closely to the concrete surface

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Vertical surfaces

In temperate conditions, such as the UK, for most of the year, formwork left in place for two or three days is sufficient to protect the immature concrete from loss of water by evaporation.

In dry, windy or arid conditions the formwork may need to be left in place significantly longer, depending on wind speed, air temperature, and relative humidity.

Where formwork has to be removed for use the day after placing, additional curing may be required. The use of plastic sheeting or insulating panels can be effective, providing they are applied immediately after the formwork is struck and are held in close contact with the concrete surface at all times through the process.

The use of spray-applied curing compounds on formed vertical surfaces is difficult and is unlikely to be effective unless the selected grade of compound is applied immediately after the formwork is removed. Furthermore, coverage must be total, leaving no areas unprotected by the membrane.

Spray-applied curing membranes can be useful where slip form construction is used and where the concrete emerges from the form within four to six hours after placing. Alternatively, wet hessian draped beneath the formwork can be used.

Curing compounds are not recommended on surfaces, which will subsequently receive an applied finish such as rendering, paints and other coatings.

The use of cold water can be hazardous, especially in hot climates, because of the risk of thermal shock leading to cracking and surface defects. Although expensive to apply, artificial fog spray can be a most effective curing method, since the creation of a high-humidity environment surrounding concrete surfaces virtually stops evaporation and the premature loss of water. Like any other curing process, however, it depends for its effectiveness on rapid application following formwork removal.

Special precautions in cold weather

When formed concrete is placed during cold weather, formwork should be left in place for at least seven days and insulation should also be provided over exposed concrete surfaces. Additionally, the use of insulating materials laid over formwork helps to limit the effects of changes in ambient temperature.

Duration and effectiveness of curing

Curing periods required by most specifications range from approximately three to seven days, irrespective of weather conditions. Rates of moisture loss from laboratory controlled specimens made with ordinary Portland Cement show that the rate of evaporation decreases rapidly after the first 24 hours and reaches an almost insignificant value within three or four days. The first 24 hours are therefore the most critical.

CP 11013 recommends different curing periods depending on the type of cement used. Four days is recommended for ordinary Portland Cement concrete, and two days when rapid-hardening Portland Cement is used. In adverse conditions, i.e. hot or windy weather, full curing should continue for a minimum of seven days with all Portland Cements.

Slightly longer periods of curing may be necessary when Hanson Regen has been incorporated in the concrete.

CURING OF CONCRETE TEST CUBES

The detrimental effects of not curing concrete test cubes cannot be stressed enough. Results obtained from test cubes that HAVE NOT been correctly cured are INVALID and are not wholly representative of the quality of concrete delivered. Extreme care must be given to correctly curing any test specimen. Failure to do so can cause unjustified concern and the instigation of further costly assessments of compliance.

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