**Technical Note TN125**

# Long Distance Transport and Extended Placement Times for Concrete

**July 2022**

Queensland Government

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## 1 Scope

This Technical Note provides additional guidance for transporting concrete for long distances or where an extended time period to the completion of placement and compaction is required.

Extended time periods are defined based on the relevant version of MRTS70 *Concrete*, as greater than:

a) 75 minutes, as per MRTS70 July 2022 Clause 10.5.1, or

b) 60 minutes, as per MRTS70 Nov 2018 Clause 10.4.1[1].

Time is measured from the charging of the mixer to the completion of placement and compaction.

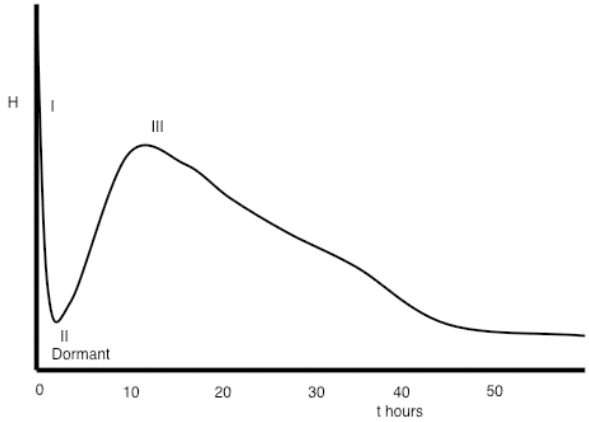
Where these times are likely to be exceeded, MRTS70 requires a procedure to be submitted for Administrator approval, and a trial mix to be completed prior to placement. Structures Construction Materials is available to assist with the review of these procedures if required.

## 2 Context - Cement hydration and workability

Time limits are placed on the delivery and placement of concrete to prevent premature stiffening and setting of the concrete mix. If the concrete becomes too stiff, or even goes hard, then it cannot be properly placed and adequately compacted, resulting in voids, cracks or cold joints. Further addition of water to overcome this premature stiffening is also detrimental to the concrete's performance.

The hydration reaction of cement commences as soon as it is mixed with water but occurs in stages that can be manipulated, typically with admixtures. Figure 2(a) is a typical hydration curve showing an instant reaction when cement and water meet and then a dormant stage. It is during this dormant stage that concrete can be successfully placed and compacted. As the reaction builds up again the concrete stiffens and sets. An increase in the concrete temperature at time of placement will generally speed up all stages, hence the shorter permitted timeframe for concrete above 32°C and the prohibition of using concrete with a temperature at time of placement above 35°C.

***Figure 2(a) - Example cement hydration curve***



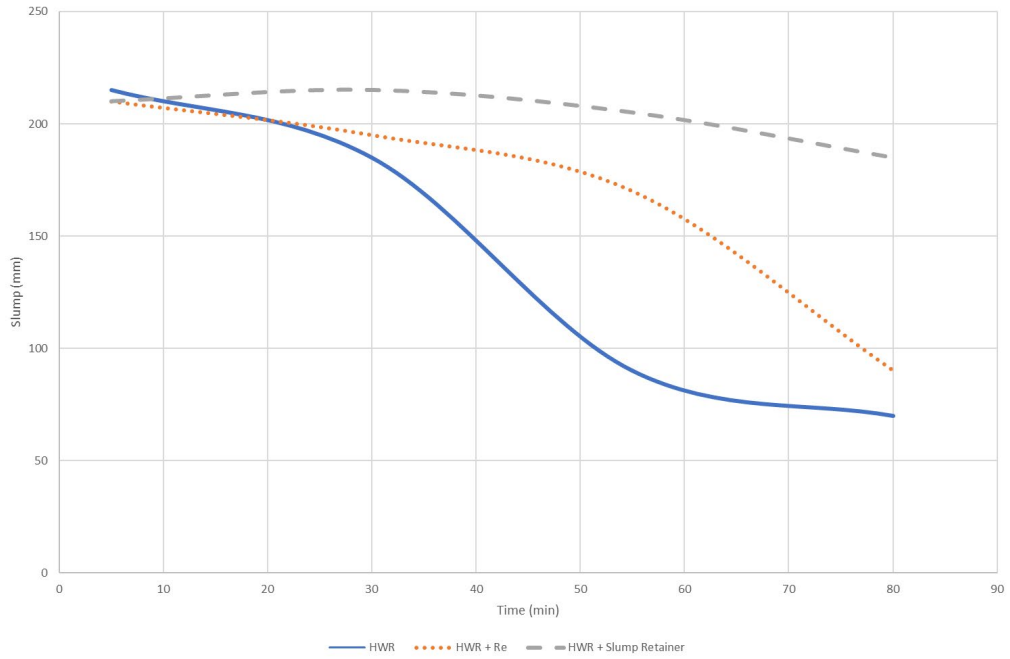

Cement hydration (understanding-cement.com)

The workability of concrete, measured by slump or spread, is impacted by the hydration reaction and also other factors (such as aggregate gradings). Slump retention and set time can also be

[1] These times are based on concrete temperatures (at placement) of no more than 32°C.

manipulated by the use of chemical admixtures, noting that some of these also often have a limited life and workability can decrease quickly at the end of the admixture's life (see Figure 2(b)).

***Figure 2(b) - Effect of admixtures on slump retention***




## 3 Options

MRTS70 *Concrete* permits three approaches, depending on the anticipated time extension required to place and compact the concrete. For all approaches the concrete temperature at the time of placement shall not exceed 35°C.

For moderate extensions of time, up to around 90 minutes, set-retarding admixtures (type Re) can be used. These admixtures are added at the batch plant to extend the dormant stage of hydration along with the water reducing admixtures. The dosage required should be determined by experience and trials. Excessive use of retarding admixtures can result in concrete where the initial and final set of the concrete is delayed too long, leading to undesirable effects. Proper dosing of retarders generally does not reduce seven and 28 day compressive strengths, but may reduce early strengths at one to three days depending on the dose rate and ambient conditions.

If longer extensions of time, up to around two hours, are required a High-Range Water Reducer (HWR, superplasticiser) can be added on site in combination with the set-retarding admixture and other compatible water reducing admixture added at the batch plant. The HWR will increase the slump, without the need to add water at the site giving the mix the increased workability over the shorter time period required during placement. This avoids issues related to the loss of slump due to the reduction in the effect of the high range water reducer during the extended transport period. Care must be taken to achieve the required slump at the batch plant as this may be different to the target slump at time of placement after the addition of the admixture. Therefore, there will need to be some control and monitoring of the slump either at the batch plant, and/or before and after addition of HWR admixture on site.

For longer extensions of time generally over two hours, hydration stabilising admixtures, which significantly slow or pause hydration, can be added to the mix at the batch plant. Depending on the

dose rate the effect of the hydration stabiliser will decrease slowly with time, or require an activating admixture to cancel the effect to allow hydration to restart. For this option, the HWR may be added at the batch plant since the hydration stabiliser typically prolongs the effect of the HWR admixtures[2].

### *3.1 Options not permitted*

The following approaches are not permitted:

a) Transporting dry cementitious materials and aggregates together to site and then adding water and admixtures. This option is not permitted as it is difficult to completely dry aggregates and some hydration of the cement with the moisture in the aggregates will commence during transport, leading to inconsistent concrete performance and a general decrease in concrete quality.

b) Adding water after 45 minutes has elapsed since batching. This option is not permitted as adding additional water after the hydration reaction has commenced and/or after the admixture life has started to end is not consistent with producing good quality durable concrete.

## 4 Trial mix

MRTS70 *Concrete* mandates trials whenever the specified placement times are going to be exceeded. These trials follow the procedure developed by the Contractor and are used to determine the effectiveness of the proposed time extension method, the compliance of the concrete with respect to slump or spread at the time of placement, and the compressive strength. A specific slump or spread versus time curve can be determined from the trial to ensure that placement and compaction are possible up to the extended time. Slump, or spread, tests are taken at regular intervals of no more than 30 minutes up until the time that the concrete arrives on site and then at intervals of no longer than 15 minutes up until the anticipated time to completion of placement and compaction with a safety buffer. Temperature is also recorded at each stage, as this can indicate that the admixture effectiveness is decreasing or that initial set may be commencing. Example results may look like this:

***Table 4 – Example trial results (40 MPa, 100 mm nominal slump)***

| Time (minutes) | Slump (mm) | Concrete Temperature (°C) | Cylinders prepared for testing |
|---|---|---|---|
| 0 – slump stand | 120 | 27 | |
| 30 | 120 | 28 | |
| 60 – anticipated earliest delivery time | 110 | 29 | |
| 75 | 100 | 31 | |
| 90 – anticipated latest placement and compaction time | 90 | 33 | Yes |
| 105 | 70 | 36 | |

[2] Note: This is not due to a reaction between the two but due to competing reactions with the cement.

Note that cylinders for strength testing are only taken once, at the anticipated latest time for placement and compaction. The 28 day strength typically does not change once all additions to the concrete have ceased.

It is best to target a higher than nominal slump at the slump stand (within the bounds of the approved mix design and the slump tolerances for the nominated slump) to give the concrete the best chance of remaining in the specified slump range during placement. Deliberately batching the concrete at lower than the design water to cementitious material ratio for the concrete mix may also decrease the working time for the mix as this places further reliance on the admixtures to achieve and retain the slump or spread.

In the example above, an extension of time out to 90 minutes would likely be approved. The concrete temperature is below 35°C and the slump stayed above 80 mm (100 mm nominal minus 20 mm tolerance). An extension out to 105 minutes would not be approved as at this time the slump and concrete temperate were outside the specified limits.

## 5 Other considerations

It is important that the process is documented, and all people involved are familiar with the requirements and their required actions at the appropriate times. The trial also serves the purpose of a training exercise for people involved and to review and improve the process which are both important particularly on critical concrete pours.

It should be noted that commercially available admixtures can be a combination of basic admixture designations (e.g. WR and Re) referred to in this Technical Note, and that in some cases a combination of the options discussed in this Technical Note may be applicable.

The effectiveness of most of the strategies described in this Technical Note are somewhat dependent on both the ambient temperature and the concrete temperature and may need to be adjusted or re-trialled if there are significant changes in temperatures. This is particularly relevant on an unusually cold day or night, where set times may be significantly longer with associated detrimental effects, and on unusually hot days where the effective times reduce dramatically leading to concrete that cannot be used and or risks inadequate compaction and/or the formation of cold joints.

For cast in place piles the workability of the concrete is sometimes required to be maintained after the concrete has been discharged from the truck down the tremie into the pile. This may be required to ensure:

- the concrete that sits in the tremie during an interruption or delay in the pour will continue to flow down the tremie when the pour recommences.
- the initial loads of concrete that are placed in a pile will flow up to the top of the pile and be discharged from the top of the pile at the completion of the pour.

In these cases, it is important that the extended working time trial includes sufficient time for these activities and that depending on the duration of the pour and the depth of the pile, some variation in the working time of different pile pours on the project may be required. However caution should also be exercised in not extending the working time too long, or being too conservative as the longer the concrete sits in a completed pile in the fluid or plastic state, the higher the risk of segregation and consolidation of the coarse aggregate, and or excessive bleed of the concrete in the pile which may lead to a non-conforming pile.