

Mix design for Phoenix[®] Concrete



bringing materials to *life*

Phoenix[®] Portland-fly ash cement (CEM II/B-V 42,5N), can be used in most applications where conventional Portland cement (CEMI) is used. However, simply substituting Phoenix for Portland cement, weight for weight, in an existing concrete mix design is not appropriate and can often lead to subsequent problems with the concrete on site. This note describes the key modifications to concrete mix design required to optimise the performance of concrete containing Phoenix. *However, when using Phoenix for the first time, trial mixes are strongly recommended.*

When using Volumetric mixers, the mix designs or calibrations preset by the equipment manufacturer may not always be suitable for Phoenix concrete. The lower density of Phoenix compared to Portland cement (see section on sand content below), in particular, may be an issue. The manufacturer of the mixer unit should be contacted in order to make the necessary adjustments.

Workability and water content

The spherical shape of the fly ash particles in Phoenix reduces the water demand of the cement relative to Portland cement by around 10 litres/m³ for equivalent slump.

This water reduction is a key factor in the performance of Phoenix concrete. It should be noted that Phoenix concrete is cohesive and may appear to be quite dry in the mixer. However, when vibrated it will move in a similar way to Portland cement concrete. No additional water should be added until the slump has actually been measured.

Strength and cement content

At a fixed water/cement ratio, Phoenix concrete will develop a lower 28 day compressive strength than a Portland cement concrete. Some of this strength reduction can be compensated for by the water reduction discussed above, but for a concrete of equal slump and equal 28 day cube strength, increases in cement content of around 10%, relative to Portland cement may be required (in isolated cases this may be up to 15%). It should be noted that

Phoenix concrete will continue to gain significant strength after 28 days if properly cured.

In some cases it may be possible to take advantage of this post 28 days strength gain, by agreeing to specify the strength at 56 days. This would lead to possible economies in cement content. Trial mixes are recommended to determine the 28 –56 day strength gain.

Yield

The typical density of Phoenix at 2900 kg/m³ is lower than that of Portland cement (3150 kg/m³). Consequently Phoenix occupies a greater volume than the same batch weight of Portland cement. At 300 kg/m³ cement content, this extra volume would be about 8 litres. In practice, this volume is offset by the reduction in water content and it is therefore normally unnecessary to make significant changes to the total quantity of aggregate required to maintain a constant yield.

Sand content and grading

However, as Phoenix is also finer than Portland cement, it is important to look at the overall sand grading as well as just the sand content of the mix. If the amount of fine sand in the concrete is too high, this adds to the cohesiveness produced by Phoenix and may make the concrete more susceptible to plastic shrinkage cracking in hot, dry or windy weather (conversely, cohesive concrete reduces the risk of plastic settlement cracking).

Suggested changes to the sand proportion are as follows:

Cement Content (kg/m ³)	Sand Reduction (kg/m ³)	Coarse Agg Increase (kg/m ³)
200	15	15
250	20 (18)	20 (18)
300	20 (22)	20 (22)
350	25	25
400	30	30
450	35	35

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Reducing the sand content (as a proportion of the total aggregate content), will generally improve the rheology of the concrete and prevent problems with plastic shrinkage although care is needed not to encourage excessive bleed and thus increase the risk of plastic settlement.

Other possible remedies include using slightly coarser sand, or replacing a proportion of the sand with coarser material (such as clean crushed rock fines).

If the general use of coarse or poorly graded sands is unavoidable, Phoenix will act as a 'mix improver' by adding fine material to the sand. In such cases, it may be appropriate to reduce the sand content by less than 3%, or not at all and maintain yield by a small adjustment in coarse aggregate.

Use of Admixtures

Most concrete admixtures designed to be used with Portland cement will work equally well in Phoenix concrete. An exception would be air-entraining admixtures that may require an increased dosage for a given air content when used in Phoenix concrete. The admixture producer should be contacted for advice in such cases.

For further information

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