# Performance Concrete and Consistency

This Flooring Technical Note looks at what performance requirements should be considered to ensure that the concrete specified is suitable for constructing a concrete industrial floor.

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## Introduction

Performance concrete for industrial concrete floor slabs is achieved through careful understanding of the constituent materials of concrete. The constituents of concrete are naturally occurring materials that vary regionally and their variation can have a huge effect on the suitability of a concrete for use when constructing an industrial concrete floor.

Concrete specification for the construction of industrial concrete floor slabs should aim to provide a concrete that is reasonably cohesive, produced using aggregates of a consistent grading. Priority should be given to the properties of concrete that affect the consistence class, as variability in the workability between concrete batches will lead to difficulty in power trowelling.

## Commentary

Contractors should discuss with concrete suppliers the following performance requirements during the pre-construction phase to ensure that the concrete specified is suitable for the intended use.

### 1) Consistence class

It is recommended that a target slump is specified, with a tolerance of +/- 30mm on spot samples. This is a tighter tolerance than outlined in BS 8500-1 and must be discussed with the concrete supplier. Tight control on concrete slump will produce a more consistent concrete.

### 2) Consistency of concrete supply

Controlling variability between batches of concrete is important. Variability will have an effect on setting time and therefore the finishing process and will determine the final quality of the finished floor. Surface regularity problems and surface characteristics including blemishes and delamination can be the result of inconsistent concrete quality and supply rate. It is also important that concrete trucks are discharged as soon as possible to ensure that waiting time does not contribute to inconsistent concrete supply.

### 3) Water:cement ratio

A maximum water:cement ratio (wcr) of 0.55 should be specified for concrete to be used in the construction of concrete floor slabs. Greater wcrs can affect the long term durability of the finished floor.

The use of superplasticisers that have been specially developed for use in direct finished concrete floors should be used to improve consistence without adding additional water.

### 4) Recycled water

The use of recycled water within concrete for use in direct finished concrete floors is not recommended as there is a risk of potential admixture contamination that could affect the setting time and consistence of the concrete.

### 5) Cement content

The primary factor that influences the drying shrinkage of a concrete slab is the cement content and its associated water content to maintain the required wcr. The cement content should be kept as low as possible, such that the required compressive strength is achieved and the concrete is suitable for placing and finishing. Contrary to BS 8204, a minimum cement content is not recommended.

### 6) Use of cement replacements

Fly ash and ground granulated blastfurnace slab (ggbs) are often used as cement replacements within concrete for floor slabs. In summer months their use is beneficial as they reduce heat developed by hydration and extend the setting time of the concrete.

A maximum ggbs content of 35% and a 30% replacement of fly ash is recommended, dependent upon the environmental conditions at the time of construction and availability at the batching plant. The use cement replacements have an effect on the colour of the concrete, where ggbs lightens and fly ash darkens the concrete.

### 7) Fine aggregate content

Fine aggregate, combined with cement paste, is power trowelled and densified to leave the durable working surface expected of a concrete floor. Its specification is therefore important.

When using dry shake it is often beneficial to specify a maximum fine aggregate content as using a dry shake places additional fines on the surface of the concrete that are subsequently power trowelled. Excessive fine aggregate at the surface can increase the risk of delamination. For more information please refer to *ACIFC Flooring Technical Note 05 – Delamination*. The fine aggregate content within the concrete has an effect on water demand which can affect slump and cohesiveness.

### 8) Setting time

The setting of concrete is a chemical process that is primarily controlled by heat. The process is exothermic, so for comparatively deep slabs (300mm and above) the setting time is often less as a result of the increased heat of hydration produced by the larger volume of concrete. The setting time is reduced for hot weather conditions, and is extended by cold weather. Humidity and wind also have an influence and it is recommended that the construction of powertrowelled concrete floor slabs is undertaken with protection from environmental factors including wind, sunlight and

rain. Seasonal temperature variation has an effect on the setting time of concrete. In summer months, this can be counteracted by using cement replacements. Cement replacements should not be used in winter months.

### 9) Air content

The maximum permitted air content of concrete for use in floors should be 2.5%. Air entrained mixes not to be used as excessive air increases the risk of delamination. For more information please refer to the *ACIFC Flooring Technical Note 05 – Delamination.*

### 10) Admixtures

Plasticisers developed for industrial flooring sector can be used where appropriate to control the water content within the concrete. Care should be taken to ensure that the admixture used does not increase workability by air entrainment.

Accelerators and retarders should only be used in exceptional circumstances and with care as their affect can significantly alter the setting time of the concrete. The use of cement replacements is preferred, as the UK industrial flooring sector now has extensive experience with these materials.

### 11) Steel fibres

The use of steel fibres will potentially reduce the slump of a concrete by up to 30mm so if added onsite a higher target slump than required for placing should be specified to compensate for this.

Steel fibres also improve the cohesiveness of a concrete which means that the fine aggregate content can be adjusted. Care should be taken to ensure that the concrete is suitable for power trowel operations.

For more information please refer to *ACIFC Flooring Technical Note 06 – Steel Fibres on Surface.*

## Summary

It must be recognised that while an ‘ideal concrete mix design’ should be strived for, specialist flooring contractors are often limited to the use of materials found in the immediate vicinity of the project and this means that no ‘standard’ mix design is possible.

Contractors and concrete suppliers must also recognise the impact that temperature has on the setting time and power trowelling operations. Therefore contractors should have several ‘ideal concrete mix designs’ available to cater for seasonal temperature variation.

## Further Reading

ACIFC, *ACIFC Flooring Technical Note 05 – Delamination,* 2014

ACIFC, *ACIFC Flooring Technical Note 06 – Steel Fibres on Surface*, 2014

The Concrete Society, *Concrete Industrial Ground Floors; A Guide to Design and Construction*, Technical Report 34 (4th Edition 2013)



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