

TECHNICAL PUBLICATION



Better Than Their Reputation!
PCE Based Super Plasticizers for the
Construction of Industrial Flooring

1st Edition, April 2011

 **DEUTSCHE
BAUCHEMIE**

INTRODUCTION



Industrial flooring made of concrete is an integral part of industrial construction. Since these floors must withstand heavy mechanical loads over the long term, the concrete used must have especially high performance properties to meet to these high requirements.

In the last years there have been many reports on damage found on industrial floors that was traced to errors during the production of these construction elements. In some cases, the cause of damage was attributed to the use of PCE based super plasticizers when producing the concrete. As a consequence, these products were expressly excluded from being used for the construction of industrial flooring in some tenders.

However, in the past years PCE based super plasticizers have proved to be reliable products in practically all areas of concrete construction and they are also highly suitable for use when constructing industrial flooring.

INDUSTRIAL FLOORING

Industrial flooring is the term used for floors made of concrete on which operational procedures in production buildings and warehouses take place. The construction consists of a compacted substrate, a base course made of gravel, broken stone or stabilised soil and then a concrete floor slab with a surface that meets utilisation requirements.

By far the greater part of industrial flooring is executed with smooth concrete. After the surface has been levelled, smoothing is carried out by means of power trowels. This creates closed, smooth surfaces that are pore-free.

These works require very good coordination of the necessary working operations, beginning with placing the concrete all the way to finishing the surface of the concrete. A special challenge in coordinating these works is the fact that at least three companies are usually involved: the producer of the ready-mixed concrete, the company that places the concrete and the company that smooths the concrete.

The concrete must be placed quickly and easily which is best achieved if the consistency of the concrete is as high as possible. The consequence of this may be that the time necessary for curing and standing, i.e. until the concrete can be subjected to foot traffic for finishing, is longer. As a result, the time frame for smoothing may be difficult to determine and too short. Intermediate curing measures to protect the concrete from evaporation between the time the concrete was poured and when it is finished must also be coordinated.

With the introduction of DIN EN 206-1 and the application rules for this standard found in DIN 1045-2, the requirements on the composition of concrete for certain exposure classes have changed in the last ten years. Because of the planned utilisation, exposure class XM2 or XM3 is required for industrial concrete flooring. Derived from the required compressive strength of C35/C45 for this exposure class, the maximum permissible water-cement ratio is limited to 0.45. Therefore, the permissible water content of concrete is limited to 162 l/m³ for a cement content of maximum 360 kg/m³ and less for lower cement contents. With such a low water content, it is practically impossible to work in broadcast hard grain materials. In these cases, a water content of approx. 180 l/m³ is recommended which obviously contradicts the requirement in the standard.



In the past, the production and placement of such concretes was an exception and this was taken into account when planning and executing the construction measures by especially thorough planning and coordination. Today, these concretes are no longer given such attention because they are now state-of-the-art.

PCE SUPER PLASTICIZERS

In the past few years, requirements in terms of durability and sustainability have continued to rise, especially for concretes used in industrial flooring areas. These requirements can only be accurately achieved by the use of super plasticizers that have been continuously enhanced in performance. With super plasticizers on a naphthalene and melamine sulphonate base traditionally used for industrial flooring, the limits of their performance capabilities are quickly reached. Today, particularly the requirement for a very low water-cement ratio in conjunction with comparably high pouring consistencies necessitates the use of high performance super plasticizers that are coordinated to the application.

In modern concrete technology, polycarboxylate ether (PCE) based super plasticizers are the ideal concrete admixtures for this. Because of the manifold variation possibilities in their chemical structure, it is possible to precisely coordinate the required effects in the concrete to the intended purpose with this type of admixture.

Due to the highly different requirement profiles of concretes which result from the specifications in the standard, the desire to retain consistency longer for practical purposes and the large number of different initial materials used, there is not just „one PCE“. A selection of different types of PCE super plasticizers with performance profiles coordinated to the respective application is available.

When the new super plasticizers on a PCE base were introduced in the field of ready-mixed concrete, an improvement in the retention of concrete consistency under the most different conditions was a principle requirement. With this desired property, a long „open time“ of the concrete is achieved at the same time. For applications in the prefab area, on the other hand, the central requirement here is to develop high early strength as quickly as possible. The PCE super plasticizers used for these applications show a much faster decline in consistency.

The action characteristic of PCE based super plasticizers thus clearly differs from the usual re-stiffening behaviour of conventional super plasticizers. Their potential for being able to retain consistency ranges beyond experience gained with concretes that have been traditionally used.

These high performance super plasticizers have demonstrated their outstanding properties in a multitude of applications in the fields of cement flow screeds as well as in construction and civil engineering where their use is meanwhile state-of-the-art.

EXPERIENCE IN THE USE OF PCE BASED SUPER PLASTICIZERS FOR INDUSTRIAL FLOORING

There are numerous examples for the successful production of industrial flooring using PCE based super plasticizers. Users especially appreciate the stability of the concrete which prevents bleeding and sedimentation even with very soft consistencies.

Regardless of the super plasticizer used, discussions repeatedly take place on the „correct“ consistency of concrete for industrial flooring. As a compromise between the user's desire to place the concrete as easily as possible and the necessity to limit concrete consistency for stability reasons (to avoid a concentration of cement paste on the surface), concretes in consistency class F4 have proved to work well.

In some cases, an increased content of air pores has been observed in set concrete industrial flooring. This can be attributed to either an undesired entrainment of air pores through individual initial substances or insufficient de-airing of the concrete when it is placed, which is often the case.



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To ensure that a reliable bond results between broadcast hard grains and the concrete, it is essential that the hard grains are broadcast fresh-in-fresh. In this case, the concrete must have re-stiffened uniformly over the entire cross-section so that it can be subjected to foot traffic. On the other hand, the surface of the concrete must still be soft and moist enough to bond the hard grains. To achieve this, the development of consistency in the concrete and curing must be adjusted to placement conditions, especially in regard to temperature. If this adjustment is not made, a behaviour can be observed that is described as „elephant skin“ or „thixotropy“.

Elephant skin designates a strengthening of the layer of cement paste/fine mortar on the surface which, according to our state of knowledge today, is mainly caused by drying out. This can be prevented by intermediate curing measures with atomized water or the use of plastic dispersions. Curing agents on a paraffin wax base should not be used.

Thixotropy (or more correctly, the rheological term shear thinning) designates a phenomenon in which the concrete appears to be load-bearing because of the elephant skin but has actually not re-stiffened sufficiently and becomes soft again when smoothing begins by machine because of the mechanical agitation.

It is thus important to control the development of concrete consistency through the composition of the concrete which also includes the selection of a suitable super plasticizer. PCE super plasticizers with moderate retention of consistency have proved suitable since they do not excessively delay the setting of the concrete.

SUMMARY / OUTLOOK

The producers of concrete admixtures represented by Deutsche Bauchemie e.V. stand in close dialogue with all of the experts involved in specifying, producing and placing industrial flooring and plan to jointly prepare an information pamphlet with recommendations for goal-oriented use of PCE based super plasticizers in industrial flooring construction.

The pamphlet is to provide information on possible applications, necessary requirements for successful use as well as the safe use of these super plasticizers.

EPILOGUE

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