YaYa Materiales, S.L.U., San Miguel de La Palma (TF) - Islas Canarias

European patented superplasticizer with retarding effect

Conventional superplasticizers for concrete – regardless of the generation or raw material basis – mainly work via the mechanisms of 'dispersion' or 'steric repulsion'. All superplasticizers up to now have demonstrated good results with Portland cements, for which they were originally conceived. However, in the case of cements that tend towards the fast formation (from approx. 2 minutes after the addition of water) of large, plate-shaped crystals, e.g. felspars, the function of many superplasticizers is considerably limited. Cements that tend towards this behaviour are, among others, the puzzolanic cements such as CEM II/A-P, CEM II/B-P and in particular CEM IV cements, if they come from 'young' puzzolanic regions, such as the Canary Islands, but also some blast furnace or composite cements.
The superplasticizer Duroretard V5.48 from YaYa Materiales, S.L.U., whose development up to series production maturity took nearly 3 years, has a differentiated action.

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Depending upon the chemical composition of the added natural puzzolan, the dispersing effect of the superplasticizer collapses after a short time (approx. 15 minutes) and the concrete stiffens. The minerals contained in the cement that are responsible for these undesirable effects have been identified for the Canary Islands cement as Brownmillerite, Gismondine and Albite. However, in the case of other sorts of cement, other minerals come into question as initiators of the above-described effects, in particular if they have a high iron content. In addition, the large, plate-shaped crystals appear to hinder the later development (from approx. 90 minutes onward) of the needle-shaped crystals (C_2S and C_3S) that are typical of the concrete matrix, which in turn leads to problems with the required concrete compressive strength after 28 days.

28-day compressive strengths of only 22 N/mm² with 300 kg/m³ cement are currently achieved in the Canary Islands with the predominant cement CEM II/A-P 42.5 R and with traditional superplasticizers. In order to achieve the minimum compressive strength for supporting structural elements of 25 N/mm² as demanded in Spain, the use of 340-360 kg/m³ cement is normally necessary. It is not uncommon for 380-400 kg/m³ cement to be used for a C 30/37. Things are no different where the consumption of superplasticizer is concerned: in practice, when using the aforementioned cement quantities, the superplasticizers, which typically consist of naphtalenes or polycarboxylates, are often (over)dosed on average with 2 to 3% of the cement weight in order to be able to achieve the necessary liquefaction over the specified transport time at all.

Duroretard V5.48 is in this respect a completely new development that can cope with the aforementioned problems: the development of the initially unwanted, plate-shaped crystals is retarded or suppressed (initial retarding effect) until the needle-shaped crystals have interlocked into the young concrete matrix without problems. As a result, a working time and pumpability of the concrete of up to 120 minutes are achieved, even at unfavourable temperatures.
Outstanding values for strength development are also obtained with Duroretard V5.48. Concrete with a final strength of 36 N/mm² is currently being manufactured in the Canary Islands with 300 kg CEM II/A-P 42.5 R. 40 N/mm² are achieved with 320 kg CEM. Even with 320 kg of a CEM IV/B 32.5 N, a strength of 38 N/mm² is still reached here (all values given are 28-day compressive strengths). The early strength of the concrete is not affected negatively despite the retarding effect of Duroretard V5.48: the values are typically around 16-18 N/mm² after 3 days.

These results are achieved on the one hand by the purposeful formation of chelate complexes of the surplus, initially undesired iron parts in the cement immediately after or even while they are dissolving in the mixing water. In addition to the chelatising and hence stabilising substance, further characteristics are still necessary in order to design a superplasticizer that works well. A high performance superplasticizer must be able to reduce the water requirement of the concrete so far that a good slump is achieved despite very low water-cement ratios. A combination of 5 active ingredients (gluconic acid, sodium gluconate as a chelatiser, mixed with polycarbonic acid, polycarboxylate ether and lignosulphonic acid) has proven to be particularly successful and innovative.

The aforementioned constituents can be varied proportionally within wide ranges by careful selection with respect to their miscibility with one another. It is thus possible to adapt the characteristics of the superplasticizer within a short time to a certain cement and to optimise its action. This gives rise to a large number of individual variations.

The liquefying characteristics of this superplasticizer are comparable to those of the high performance superplasticizers from the market leaders. Depending upon the required consistency and the dosage (even at maximum dosage without segregation inclination due to the stabilising characteristics), Abram's cones of between 9 and 22 cm are reached. Consequently, an easy-compacting concrete > F4 is easily attainable with appropriate dosage. The water-cement ratios are around 0.40 – 0.45 at the aforementioned values, i.e. within the ideal range for the durability of the concrete. Concrete manufactured with Duroretard V5.48 is in addition extremely pumpable. Practically no segregation inclination can be determined even under unfavourable conditions. The danger of pipe blockages is minimised by the easily adjustable fluid consistency.

The use of Duroretard V5.48 is also very interesting from an economical point of view: a Canary Islands concrete manufacturer must reckon with approximately € 5.40/m³ concrete for the Duroretard V5.48 superplasticizer. With this dosage it is possible to save approximately 40 kg cement (current price in the Canary Islands approx. € 4.40) and the previous admixture (price approx. € 2.70/m³ at the most economical dosage for concrete with regular consistency). The savings per m³ concrete can thus amount to around €1.70 for a C 25/30 concrete. The more demanding the plan-

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ned concrete is, both with regard to the compressive strength class and to the consistency, the greater the savings can be.
Since Duroretard V5.48 was specially developed for puzzolanic cements, retard times may be prolonged when using Portland cements (but not more than 4 to 6 hours). This effect causes an extended and more complete hydration of the cement, which leads to increased final strength. Experience so far has shown that the dosage can be limited to half of the usual quantity with Portland cement. This gives rise to costs of approx. € 2.70/m³ concrete (the example is based on CEM I 52.5 R for the production of precast elements). Due to the slight retarding effect, the 42-day strengths in these cases are regularly around 2 N/mm² higher than the 28-day values.

Based on the same European patent there is a sister product named Durorapid V2.02, which exhibits only a very slight retarding effect, develops extreme early high strength and is conceived exclusively for use in prestressed concrete works using CEM I 52.5 R. The (adjustable) working time is approx. 15 minutes here, and approx. 26 N/mm² are reached after approx. 18 hours without heat treatment. The final strength is approx. 65 N/mm² when using 380 - 400 kg/m³ cement.

All products have been brought onto the market and homologated according to EN 934-2, and they possess the corresponding CE mark.

FURTHER INFORMATION

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