Hydrophobic impregnation as an effective way to increase the resistance of high strength concrete (HSC) bridge beams to frost and defrosting salt attack

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Summary

HSC (High Strength Concrete) is increasingly used for bearing bridge structures nowadays. Bridge structures in the Czech Republic are exposed to severe conditions in winter time. Durability of the concrete is therefore a crucial requirement for bridge structures in the Czech Republic. The design and production of HSC concrete resistant to deterioration caused by freezing, thawing, and de-icing salt sometimes raises difficulties. The possibility of improving the frost resistance of HSC by applying a hydrophobic agent will be discussed here on the basis of an example of dealing with the poor frost resistance of concrete C70/85 applied to real bridge bearing beams. Hydrophobic impregnation of the building structure is one option for protecting this porous construction material against contact with water and hydrous salt water solutions, and also against grease and impurities. This paper presents the results of comparative tests of four hydrophobic impregnations in order to chose one for use to increase the resistance of the concrete of a real bridge structure.

Keywords: Concrete, hydrophobic agent, frost resistance, crack, spalling.

1. Introduction

The problem of concrete durability is very important for transport structures in the Czech Republic. Our experience has shown that the application of HSC concrete leads to new problems in this area. The high strength and low water absorption of HSC suggests that the material will have high durability. However, the situation may not be so straightforward. In 2010-2011, we carried out a study of the very poor durability of HSC concrete C70/85 used to produce prestresed beams 37,1 m in length to build a 6-span highway bridge (see picture 4). There was a danger that 42 of the beams would not be suitable for use. After the beams were cast, a control test indicated some problems with the durability of the concrete. This problem is not easy to solve. All participants in the bridge project finally decided, after extensive discussions, to attempt to improve the durability of the concrete by applying a hydrophobic agent.

2. Conclusions

Only two of the four tested agents marked by their suppliers in the technical data sheet as agents for hydrophobic impregnation of concrete met the criteria of standard EN 1504-2 [4].

A comparative test of the resistance of concrete surfaces in the case presented here has proved that hydrophobic impregnation has a remarkable positive impact (even unsatisfactory parameters according to EN 1504-2 [4]) on the resistance of the concrete surface against the impact of frost, water, and defrosting salt attack.

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However, long-term durability and effectiveness is very important when applying hydrophobic impregnation. Resistance against the impact of weather conditions is mainly related to the ability to penetrate as deep as possible into the structure of the concrete, in order to slow down any degradation of layers caused by weather conditions as much as possible. At the same time, there is a very important effect of an alkaline environment on the resistance of hydrophobic impregnation against degradation.

There has been relatively little practical field experience in the Czech Republic with the effect of protecting concrete on the long-term behaviour of hydrophobic impregnations. However, our results confirm the possibility that there is an important increase in the resistance of the concrete.

The practical application of a hydrophobic agent on the surface of concrete C 70/85 XF4 will provide relevant data on the efficiency of surface treatment with a hydrophobic agent. The bridge structure is now under long-term supervision. If the results are satisfactory, we can expect an increased number of applications of surface protection with hydrophobic impregnations in the Czech Republic.

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[4] ČSN EN 1504-2 Products and systems for protection and repairs of concrete structures – Definitions, requirements, quality control and conformity assessment – Part 2: Systems of concrete surface protection
[5] EN 13579 Products and systems for the protection and repair of concrete structures - Test methods - Drying test for hydrophobic impregnation
[6] EN 13580 Products and systems for the protection and repair of concrete structures - Test methods - Water absorption and resistance to alkali for hydrophobic impregnations
[7] ČSN 731326 Stanovení odolnosti povrchu cementového betonu proti působení vody a chemických rozmrazovacích látek *(Czech standard ČSN 731326 Test of concrete against attack of water, frost and defrosting salt)*