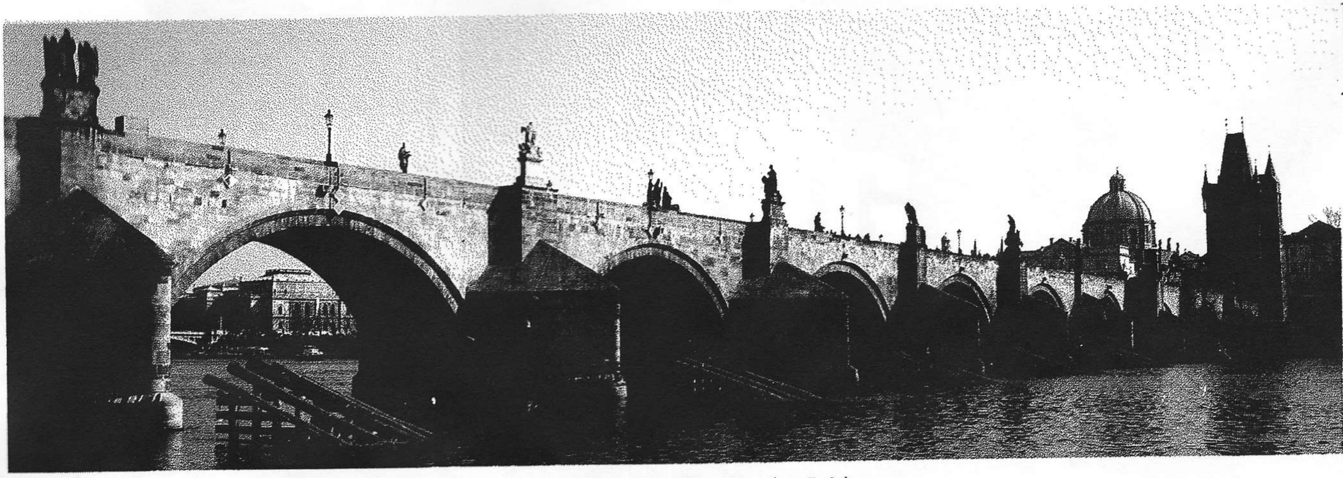

Figure 4: Close-up of the Charles Bridge.

the required thickness has been applied. This quality-control procedure was backed up by wet film thickness tests being carried out throughout the application. These on-site controls ensure that the minimum specified thickness of 1.2mm is applied for each coat. The membrane cures rapidly; the actual time is dependent on ambient temperatures but it has always been less than one hour, even in the depths of a Prague winter, enabling speedy progression on each section.

Once the first coat was cured, the second coat was applied immediately, with no preparation required. When this had cured, Stirling Lloyd's Metaset Structural Adhesive was applied, in spots. While the adhesive was still tacky the drainage geotextile being used on the contract was put into place. This was covered with 100mm of concrete, on top of which the original numbered paving was placed in a layer of sand, returning the bridge's exposed wearing surface to its highly aesthetic appearance, exactly as it was before the refurbishment.

Standing the test of time

Having been an iconic landmark and a representation of Prague's heritage for 650 years, protecting this structure for future generations is imperative.

With the refurbishment programme due to finish in December 2009, Eliminator's durability and long service life is set to ensure that the Charles Bridge is protected against the harmful effects of water ingress and will remain a prized asset for the Czech capital for many years to come. ■

CEMENTITIOUS MATERIALS

How additions contribute to more sustainable concrete

This article reviews the types of additions available in the UK, the extent of their use and their environmental impacts. By comparing the embodied carbon dioxide for typical concrete mixes, it demonstrates how additions can make significant contributions towards reducing environmental impacts.

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According to EN 206-1[1], an addition is "a finely divided material used in concrete in order to improve certain properties or to achieve special properties". There are two types:

- nearly inert additions (Type I)
- pozzolanic or latent hydraulic additions (Type II).

Type II additions, which are cementitious and actively contribute towards the strength development of concrete, can be considered as part of the 'cementitious content'. However, they are normally not as reactive as Portland cement (PC) and the total cementitious content may need to be increased to achieve similar concrete performance. They generally have significantly lower environmental impacts than Portland cement and their use can have sustainability benefits. Such materials can also be used as part of the composition of factory-produced, blended cements to achieve similar sustainability benefits.

Type II additions are generally by-products from high-temperature processes:

- ground-granulated blast-furnace slag (GGBS) from iron blast furnaces
- fly ash from coal-fired power stations
- silica fume from ferrosilicon arc-furnaces
- natural pozzolanas from volcanic eruptions.

Their 'heat treatment' is what makes them chemically reactive when combined with water and alkali.

Limestone fines can also be used as an addition in concrete. Limestone is chemically relatively inert but limestone fines, because of their fine particle size, can contribute towards strength by a physical, void-filling mechanism. Views differ on whether they should be considered as Type I or Type II additions.

Table 1 (page 42) indicates the extent to which these additions are used in the UK.

Properties

Table 2 (page 42) shows typical ranges of fineness and chemical compositions for UK cementitious materials.