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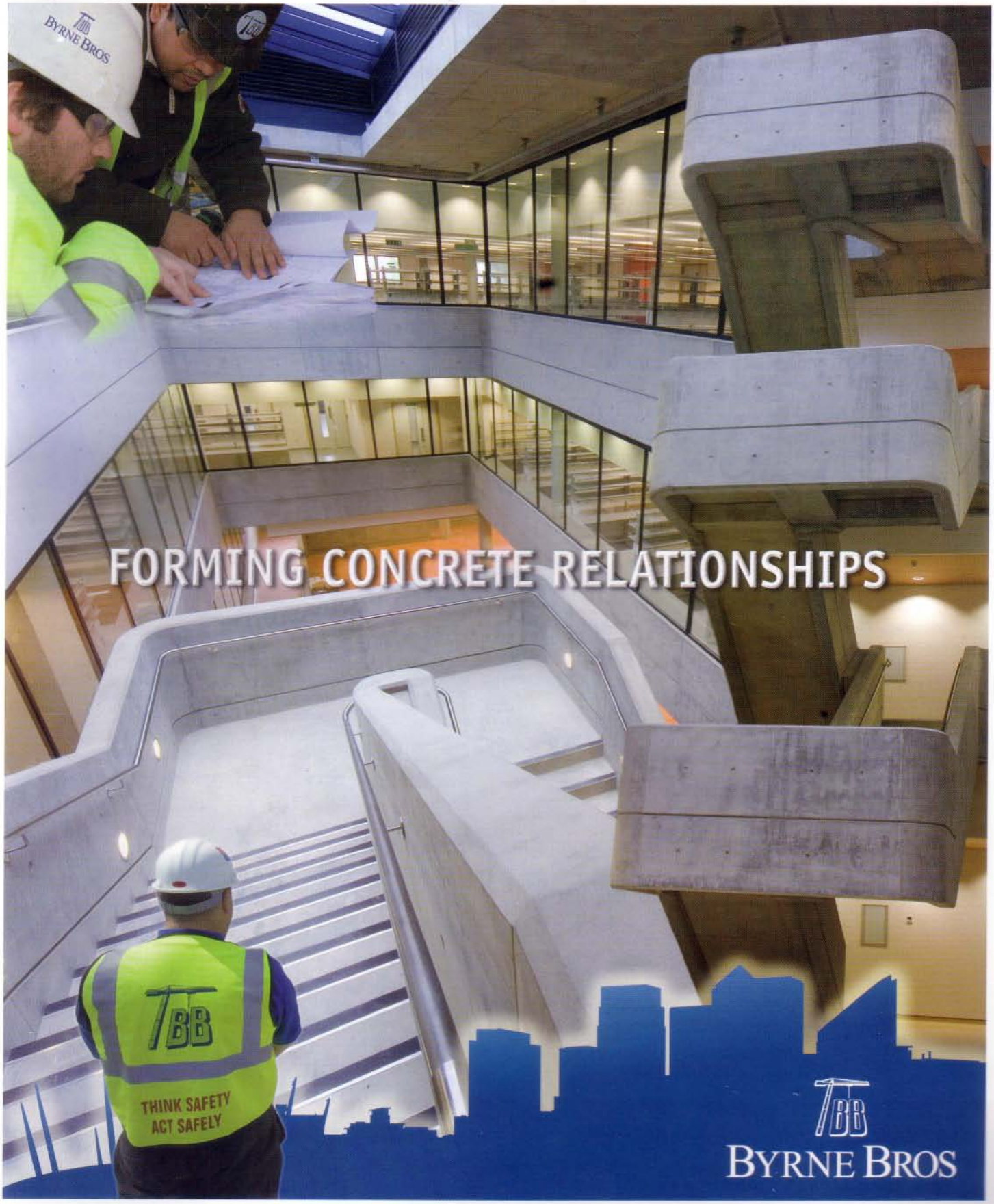

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THE FEBRUARY 2008 COVER

Byrne Bros specialises in high-quality, award-winning structures, with both in-situ and precast elements. In 2007, the Diamond Synchrotron project won a Concrete Society award for Excellence in Concrete. The in-situ feature staircase was constructed at the Old Road Campus in Oxford.

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Total concrete protection at Milan South waste water treatment plant

"Repair of construction joints between different concrete castings, micro-hairline cracks, errors in workmanship was carried out by cutting out and chiselling back to sound concrete."

The Lambro River in Northern Italy flows through the city of Milan and was considered the main cause of pollution into the Po River, the Adriatic Sea and the Romagna region. In order to improve the water quality, the Municipality of Milan approved the construction of a series of purification plants in May 1972 to treat river waters in the outskirts of the town.

Florian Klouda, ICS Penetron International

The first project carried out – the Nosedo purification plant – was only completed after more than 30 years from the approval and this major delay resulted in a fine for the Italian Government by the European Court of Justice. After the court fine, the works for the rest of the project were significantly accelerated. The most important water treatment plant, Ronchetto delle Rane or sometimes simply called Milan South (Milano Sud), was finally completed in the autumn of 2004 and it concluded the process of purifying the water supply in the Milan area. It drains the water of the Lambro channel that rises in the Naviglio Pavese.

The three plants (Milano Sud, Peschiera and Nosedo) drain and purify the water of Southern Lambro with a catchment area of 1.8 million inhabitants, giving environmental protection to the habitat and improving the citizens' quality of life. Ronchetto delle Rane/Milan South is located between the municipal districts of Milan and Rozzano, close to the Milan 'ovest' ring road and drains the waste water of the north-west part of Milan city with a catchment area of 1.05 million inhabitants. The project was carried out by a consortium comprising of Ondeo Degremont (specialising in water treatment plants), Consorzio Cooperative Costruzioni CMB, (Cooperativa Muratori e Braccianti di Carpi), Carlo Gavazzi Impianti, SO.GE.MA and over 20 subcontractors.

The Milan South plant has an area of 98,200m^2 and a capacity of:

- daily average flow – 345,600m^3/day
- average flow (dry conditions) – 14,400m^3/hour
- maximum flow (raining conditions) – 43,200m^3/hour.

The strength of this purification plant is the simplicity of the treatment processes. The water is purified biologically on its way through the plant involving 'active mud', step feed technology and an alternate zone.

The purifying process ensures that the treated water achieves results well below the limits of the existing standards for environmentally protected habitat. Moreover, for a part of the water, equal to the flow in dry conditions, the purification is increased to a much higher level by using ultra-violet radiation, which prepares the water for irrigation (agricultural use). Finally, the process uses a drying stadium, which reduces the production of mud.

The plant features several concrete structures and therefore needed to be protected against problems of impermeability and chemical resistance. Special attention had to be paid to the delivery and outlet tunnels, which channel the Lambro's aggressive water, and to all the concrete basins of the purifying plant with a total area of 120,000m^2.

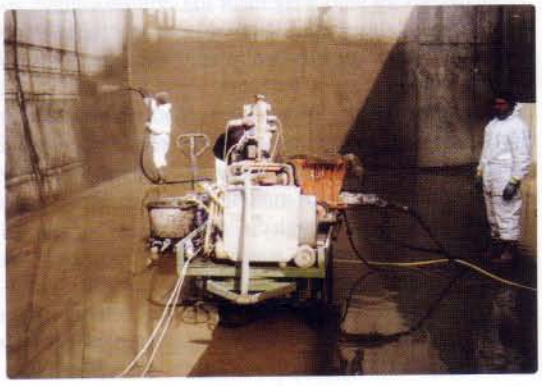
The original design for the plant's basins used epoxy-bitumen resin as chemical protection. However, this could not be used because the large number of bolts necessary to fix the oxidising tubes in the purifying basins would have pierced the external protection. To overcome this problem and to completely protect these critical areas of the plant, a crystalline waterproofing system was finally chosen. When such products are applied to concrete, a chemical reaction causes the pores, capillaries and micro-cracks to be filled with insoluble crystals. Water and a large number of chemicals (pH 3–11) are unable to pass through these crystal formations and as a result the concrete becomes waterproof and protected.

In order to ensure an effective application of the crystalline waterproofing system, the surface of the walls and ceilings of tunnels and underground structures were roughened by dry sandblasting. This provided an open capillary system for the concrete and ensured the necessary bond of the slurry-applied crystalline waterproofing product and the penetration of the material deep in the concrete as a result of a complex chemical reaction involving osmosis, dry particle reactions and Brownian movement. The preparation of the walls in the open basins required even more incisive sandblasting to ensure complete water absorption and penetration of the crystalline material into the RCK 50-class concrete.

The concrete floors, hardened with quartz sand, were

Figure 1 below: Spray application of the crystalline waterproofing material in the concrete basins.

Figure 2 below right: Spray application works in the concrete basins.



(Photos: ICS Penetron International Ltd.)

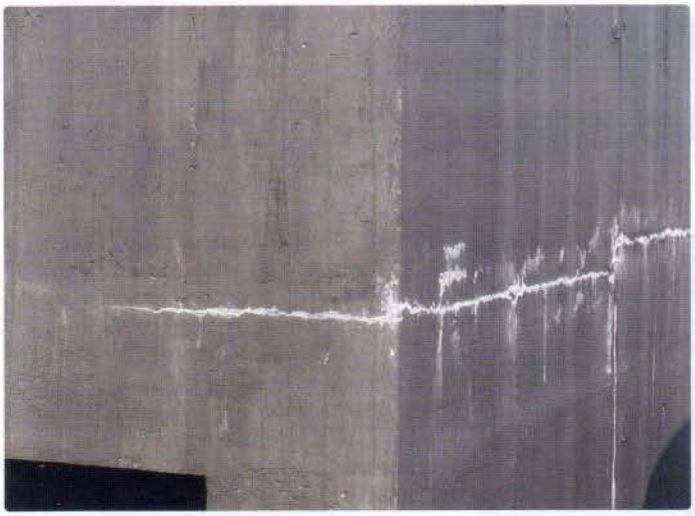


Figure 3 top left: Long-term protection – cracked concrete surface sealed entirely by dendritic crystals.

Figures 4–6: Protected concrete basins in use.

'In total, a concrete surface of 150,000m² was treated and repaired at Milan South using almost 200 tonnes of crystalline waterproofing materials.'

prepared for treatment using shot blasting to achieve a rough surface, with an open capillary system to absorb the components of the waterproofing product. Floors that had not been cast prior to the start of the waterproofing and protection work were treated and hardened with a special crystalline product containing quartz sand, dry-shake onto horizontal surfaces once the concrete was hard enough to walk on.

Repair of construction joints between different concrete castings, micro-hairline cracks, errors in workmanship (honeycombing, surfacing reinforcement, leaking water stops between horizontal and vertical structures, etc) was carried out by cutting out and chiselling back to sound concrete. Such areas were first primed with a bond-coat of the crystalline waterproofing slurry and then repaired using a crystalline repair mortar. Finally, a double coat of crystalline waterproofing slurry was applied. In all tunnels and enclosed spaces, the crystalline waterproofing material was mixed to a thin slurry and then spray-applied onto the prepared concrete surface.

After the basins were filled with water, the pores and capillaries of the structure were sealed by an intricate web of insoluble crystals that formed in the presence of the crystalline waterproofing material and H_2O, creating a permanent protective seal against chemical attacks and water ingress.

In total, a concrete surface of 150,000m² was treated and repaired at Milan South using almost 200 tonnes of crystalline waterproofing materials. The adoption of a crystalline system ensures long-term protection of the facilities on this project, effectively protecting the concrete against the aggressive chemicals contained in the waste water purified in the plant, and provides a cost-effective and low-maintenance solution, due to the self-healing capabilities of the product.

Concluding remarks

During the execution of the works, all petrographical analysis and periodical sampling were controlled by the University of Bologna. Similar projects around the world and in different climate zones have already been successfully and satisfactorily treated with crystalline waterproofing systems offering total concrete protection to end users and infrastructure projects. Furthermore, this system offers an effective, economical alternative to traditional waterproofing methods such as membranes and cementitious coatings. ■