

Fire-resistant plaster coating protects bored tunnels

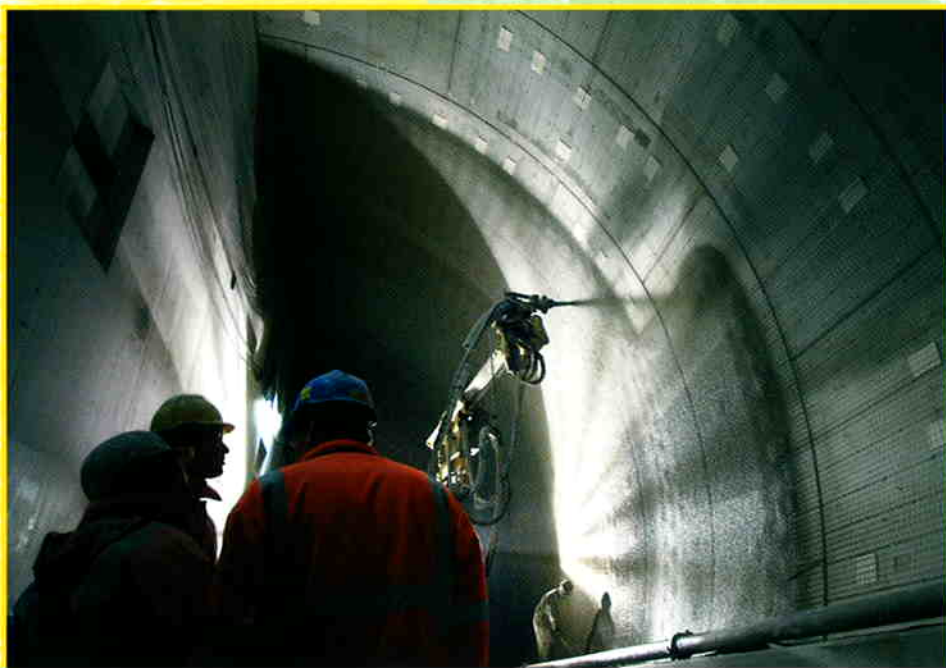
CBBN Fireproofing int.



Successful method

CBBN Fireproofing Int. has employed an innovative approach to apply a fire-resistant plaster coating to the two largest bored tunnels in the Netherlands. The method used guarantees that the underlying concrete will not be damaged in the event of a tunnel fire. The coating is quick and easy to repair, which reduces the amount of economic loss. So far, the Netherlands is the only country in the world to make a fire-resistant plaster coating for tunnels

compulsory, but there is a growing realisation internationally that this approach should be more widely adopted. The method's success has been demonstrated in both the Westerschelde Tunnel – a road tunnel – and the Groene Hart Tunnel – a rail tunnel. The three main components of the method are an optimised plaster coating, a special stainless steel mesh reinforcement system and a robotised application technique.



The three main components

Plaster coating

The fire-resistant coating used is a modified spray plaster based on vermiculite and cement. Extensive tests by the Construction Division of TNO (the Netherlands Organisation for Applied Scientific Research) proved that the spray plaster meets all the requirements during a tunnel fire lasting two hours with a peak heat load of 1350° C (RWS fire curve). The plaster also behaves 'ideally' when applied in a single spray pass to the required thickness of 45 mm with the robot equipment.

Mesh reinforcement

To guarantee the durability of the structure, a stainless steel mesh reinforcement system is mechanically attached to the concrete. The mesh reinforcement provides an additional guarantee that the adhesion of the fire-resistant plaster system to the underlying structural concrete will retain its integrity under all conditions.

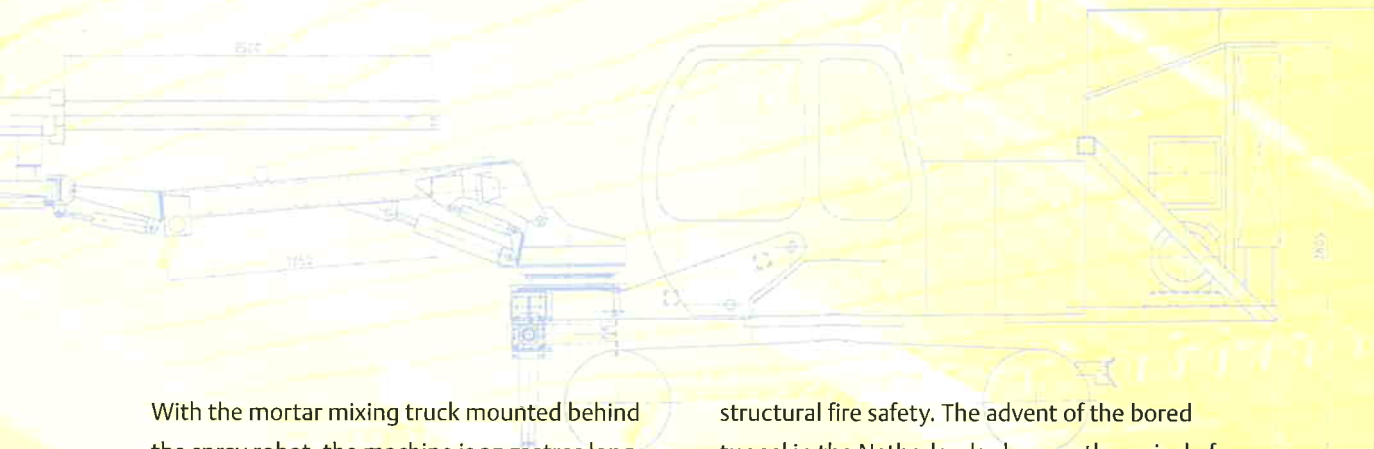


Spray robot

The process of applying the fire-resistant plaster to the huge areas of concrete in bored tunnels simply *has* to be automated.

So CBBN Fireproofing Int. developed a spray robot mounted on the frame of a caterpillar crane. The spray lance is controlled by a laser that continually scans the surface from two angles and stores the data on a computer. The hinged arm then knows the exact shape of the surface to be sprayed.

The robot adjusts the position of the spray nozzle accordingly and the result is a uniform layer sprayed on the concrete surface.



With the mortar mixing truck mounted behind the spray robot, the machine is 35 metres long. The dry, premixed fire-resistant mortar is dumped from big bags into a silo truck, which is connected to the mortar mixing truck. The premix is automatically dosed and mixed with water in the mixing truck, after which the robot sprays the fire-resistant plaster on the tunnel wall in 3-metre strips. The spray robot is fast and accurate. The equipment does away with the prolonged and heavy physical load that a manual spray system entails. In other words, it is a safer, healthier method.

Previous research

Over the past twenty to thirty years a great deal of work has been done in the Netherlands on improving fire safety in new and existing tunnels, including the application of a fire-resistant coating to the concrete ceiling and walls. The serious tunnel fires that have occurred in Europe in recent years have intensified the call for better,

structural fire safety. The advent of the bored tunnel in the Netherlands also saw the arrival of other forms, systems and concrete grades in the tunnel-building sector. This called for in-depth research into how tunnels behave in a fire. The required research programme was therefore commissioned by the Dutch Directorate-General for Public Works and Water Management (Rijkswaterstaat – RWS). Initially the research concentrated on the construction of the Westerschelde Tunnel. Eventually the focus narrowed to fire-resistant coatings, which in turn led to the current fire-resistant plaster system.

CBBN Fireproofing Int., in which Vogel B.V. and BAM Betontechnieken are partners, went on to develop various unique methods for the fast, robotised application of large quantities of high quality fire-resistant coating. The methods and materials all passed with flying colours when subjected to fire tests by the Construction Division of TNO.



Approach to bored tunnels

In Dutch excavated or submerged tunnels with a rectangular profile and made from B35 concrete, a finish of spray plaster or sheeting with an insulation thickness of 23 mm and 27 mm respectively meets the safety requirements. But bored tunnels and other types of tunnel made from high strength concrete are a different matter.



Bored tunnels are constructed using precast concrete sections. The concrete in these sections is much more susceptible to thermal shock – an excessive rise in temperature per unit of time – than traditional concrete. Concrete in the B50 strength class starts to shatter at temperatures as low as 225° C. Bored tunnel sections of this kind therefore require a differently conceived, thicker fire-resistant plaster coating and – because of their round shape – a different finishing method too. Connections, movement joints, expansion joints, damage by moisture and so on are also important factors.

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