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Pre-applied waterproofing membranes – Comparison vs. White Tank System

Executive Summary

The STUVAtec - Studiengesellschaft für Tunnel und Verkehrsanlagen mbH (Research Association for Tunnels and Transportation Facilities Ltd.) has produced a technical report including a survey of the various pre-applied fully bonded membrane systems that are currently available on the German market, in comparison with watertight concrete (white tank) systems.

Pre-applied fully bonded membranes provide several advantages vs. watertight concrete. They solve the issue of cracks that could appear even in watertight concrete structures, and provide an effective protection of the structure from water, vapour diffusion, aggressive soils, etc.

This is the main reason why the pre-applied membranes can be used as the sole waterproofing layer without the waterproofing concrete construction acting as a second, inner and redundant waterproofing layer. In any case, the pre-applied membrane should be considered as primary barrier and not as a supporting (secondary) one in combination with a white tank system.

The crack bridging capability of these membranes also allows a more efficient use of steel reinforcement, reducing the costs for reinforcing steel by up to 40%.

Overall, it is stated that the development of the pre-applied fully bonded membrane technology has contributed to considerable advantages and cost benefits in the construction and waterproofing of reinforced concrete structures exposed to groundwater, seepage water and soil moisture.

Introduction

- For protection against water under pressure, in Germany structures have been increasingly built of **watertight concrete (white tank)** for more than 50 years. This technology has meanwhile proved successful in many ways. For such waterproofing technology, particular attention has to be paid to the arrangement and detailing of movement and working joints as well as **crack limitation**.
- Such structures suffer systematically from the problem of **crack formation**. In order to distribute the cracks better and limit their opening widths, a considerable **extra amount of reinforcement steel**, compared to what is necessary anyway for structural reasons, is required, thus causing considerably **higher costs**.
- However, this additional reinforcement does not absolutely prevent the occurrence of isolated water-bearing cracks with crack widths of more than 0.10 or 0.15 mm with pressured water. About 5% of cracks show **a larger crack width** and can carry water. They do not self-heal and therefore have to be subsequently grouted to recover the waterproofing function, thus producing extra costs.
- The new development for structures of watertight concrete are **pre-applied fully bonded membranes** on the water-side surface of the structure. Such a system bonds with the concrete placed on it to provide **security against water tracking** along the surface. In case of damage of the membrane, water is confined to the point of puncture and cannot migrate laterally between the membrane and the concrete, keeping below-grade areas of a building leak free or, in worst case, easier to remediate.
- Another advantage of the pre-applied fully bonded membranes compared to traditional watertight concrete construction is that due to their **capability of bridging cracks** up to a crack width of at least 0.4 mm, the crack-limiting additional reinforcement can be omitted and thus the **costs for steel reinforcement be reduced significantly by 20 to 40%**.


Pre-applied fully bonded membranes in comparison with watertight concrete systems (white tank)

System relevant comparative aspects are as follows:

Differentiation aspects	Pre-applied fully bonded membranes	Watertight concrete (white tank)
1. Waterproofing concept	Pre-applied fully bonded membranes are an external waterproofing system using a single layer of membranes. No waterproofing concrete construction is needed as a second, inner and redundant waterproofing layer.	A waterproofing concrete construction is watertight in itself and does not need any external waterproofing membrane but several additional components like waterstops and crack-limiting reinforcement.
2. Point of time the effective water tightness begins	A pre-applied fully bonded membrane system is immediately and directly in contact with seepage or pressurized water in the ground (if there is any water at all). It fulfills the waterproofing function primarily. The concrete behind it only serves as a static support to the membrane against water pressure. The concrete structure is only wetted by water, if the pre-applied fully bonded membrane fails locally. But, due to the continuous bond inherent to the system of the pre-applied fully bonded membrane, the area of leakage is very restricted and, in case, easy to fix.	A watertight concrete structure (white tank) inevitably tends to form cracks. These cracks have to be grouted where they are not self-healing. Such a self-healing process is limited to small crack widths and needs time. During this time the construction will leak temporarily. To avoid such major leaking additional reinforcement is needed, thus reducing crack widths and optimizing the distribution of cracks. In case of a lower groundwater table higher located water-bearing cracks cannot be recognized. For such initially dry cracks the self-healing process will not start before the area becomes wet.
3. Crack control	Pre-applied membranes show a capability of bridging cracks up to a crack width of at least 0.4 mm. No crack-limiting additional reinforcement is needed, reducing the cost of that by 20% to 40% compared to traditional watertight concrete.	The effectiveness of watertight concrete (white tank) is based on crack control. In order to distribute the cracks better and to limit their opening widths an extra amount of steel is needed depending on the thickness of the construction element, the diameter of the reinforcement bars used and the calculated design crack width. Compared to the reinforcement that is necessary anyway for structural reasons, this can cause additional costs.
4. Protection against water and aggressive soil	Pre-applied fully bonded membranes protect the supporting concrete structure, especially in case of contaminated water or aggressive soils. Even in the special case where a double waterproofing system is chosen, the bonded system provides the real first barrier with a sealing effect that is independent of the selected concrete grade.	In case of ground aggressive to concrete, the waterproofing concrete needs to be formulated according to the appropriate grade of resistance against all the contaminants in soil and water, thus possibly causing additional costs.

More details regarding the comparison between the pre-applied fully bonded membrane systems and the watertight concrete (white tank) can be found in an expertise prepared by STUVAtec GmbH, Cologne Germany for GCP Applied Technologies Inc., USA. This expertise can be ordered from GPC or STUVAtec (e-mail: info@stuva.de).

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