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Enhanced Durability of Post-Tensioning Tendons

Durabilité des fils d'aciers de post-contrainte

Verbesserte Dauerhaftigkeit von Spanngliedern

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For many years the corrosion resistance of conventional prestressing tendons has been assumed to be adequate by virtue of the concrete cover and the embedment of the prestressing steel in grout. This is true for the majority of the structures but recent evidence of corrosion damages in many countries has created increasing concern among engineers. Corrosion protection measures are of particular importance for partially prestressed concrete structures. Cracks can occur already under service conditions, resulting not only in an increased vulnerability to corrosion but also in a higher stress range of prestressing steel and reinforcement. Plastic ducts are insensitive to most chemical attacks. They are elastic and are therefore able to adapt to local crack propagation, and - as extensive experimental investigations at ETH Zurich have indicated [1] - show almost a doubling of the stress amplitude which can be withstood.

2. DEVELOPMENT WORK PT PLUS [1)]

With the newly developed PT Plus duct (Fig. 1) a series of experiments were carried out and the behaviour evaluated.

a) Groutability: To have a direct comparison of the groutability of the PT Plus plastic duct and a conventional steel duct two 80 m long ducts with identical boundary conditions were grouted. Upon hardening both ducts were opened and the grouted cables were visually inspected and assessed. Both injections were of good quality. Important was the fact that also the corrugations in the plastic duct were fully filled with grout.

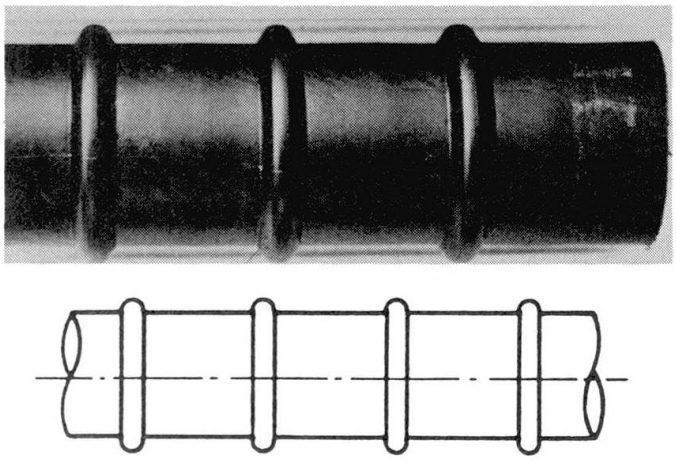

Figure 1: PT Plus duct

1) Trademark applied for

b) Bond behaviour: The bond between strands, grout mortar, duct and concrete ensures that, after cracking, cable forces can be activated which exceed the initial prestress. The question was therefore whether the polyethylene duct would be able to develop the yield strength of the prestressing cable. Results based on pull-out tests (with cables of 4 and 7 strands 0.6" dia., duct dia. of approx. 60 mm and 70 mm) allow the following statements:

- The yield force can be reached with this type of polyethylene duct.
- In the serviceability limit state the crack behaviour with a PT Plus duct is similar to the one with a normal steel duct.
- With a PT Plus duct the bond length required to anchor the force difference between the yield force and the actual prestressing force is about twice as big as compared to a conventional steel duct.
- In the ultimate limit state the crack widths are approx. double when comparing PT Plus and steel ducts.

c) Abrasion: The abrasion tests carried out at the ETH allowed a 0.6" dia. strand to be stressed to 75 % of its nominal tensile strength with a simultaneous simulating of an elongation of 1000 mm under various lateral pressures ranging up to 9 kN on a 25 mm specimen. With minimum tendon curvatures, depths of penetration of the prestressing steel into the duct wall of max. 0.5 mm to 1.0 mm are not exceeded. These values are clearly smaller then the wall thickness chosen for the new PT Plus duct and therefore an intact encapsulation of the prestressing steel is ensured.

3. CONCLUSIONS

The results of these tests show that the new plastic duct PT Plus can be safely used for post-tensioning systems. Its application is recommended to wherever an improved corrosion protection is desired (i.e. bridge decks, parking garages, marine structures) but also for structures subjected to fatigue loading.

[1] Oertle J.: Reibermüdung einbetonierter Spannkabel (Fretting fatigue of bonded prestressed tendons). Institut für Baustatik und Konstruktion, ETH, Report No. 166, September 1988.