Protection of groyne piles against attack of Teredo Navalis by means of geotextiles

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ABSTRACT: Within the last years, attack of a mollusc, *Teredo navalis*, to wooden structures in the coastal protection facilities on the baltic coast of Germany have caused severe damage and high costs. In particular wooden groyne piles have been subject to overall destruction. Remedies tested so far as use of plastic piles, tropical wood or various impregnations have prooved to be disadvantageous due to high cost, lack of ecological acceptance or inefficiency. The paper presents a new method to protect groyne piles by means of a geotextile cover, which is meant to inhibit settling of the *Teredo* larva. Although common installation techniques for groyne piles are rather rude (rammer), first experiments on piles dug out after installation showed that the geotextile survived the procedure without visible damage. In springtime 2000 a number of piles covered by geotextile were installed in a coastal area heavily affected by *Teredo*. First samplings show encouraging results, although long-time durability still has to be proven.

1 INTRODUCTION

Figure 1: Loss of piles in the groyne field off Rostock (Sordyl et al. 1998)

Attack by *Teredo navalis* currently leads to heavy damage on wooden structures along the western baltic coastline. In particular groynes consisting of pine piles, which form an important part of the coastal protection system, have been subject to overall destruction in some areas. Altogether some 58 km of groynes are affected. Even some more complex structures constructed of oak wood have been destroyed.

Figure 2: Shipworms in their passages which are lined with a calcareous layer (Sordyl et al. 1998)

Teredo navalis, belonging to the Teredinidae, is a worm-shaped marine mollusc also known as the shipworm. On its front end, it owns two degenerated shells, which serve as a drilling tool. Wood-particles chipped off by these shells serve as food for the animal. *Teredo* reaches a size of some 20 – 30 cm, with an estimated lifetime of two to three years. Reproduction is of typical mollusc-type: the animal's life is divided into a pelagical and a benthical phase. The pelagical phase consists of the larva-stadium, which serves for the spreading of *Teredo*. The benthical phase comprises the adult animal's life inside of wood.

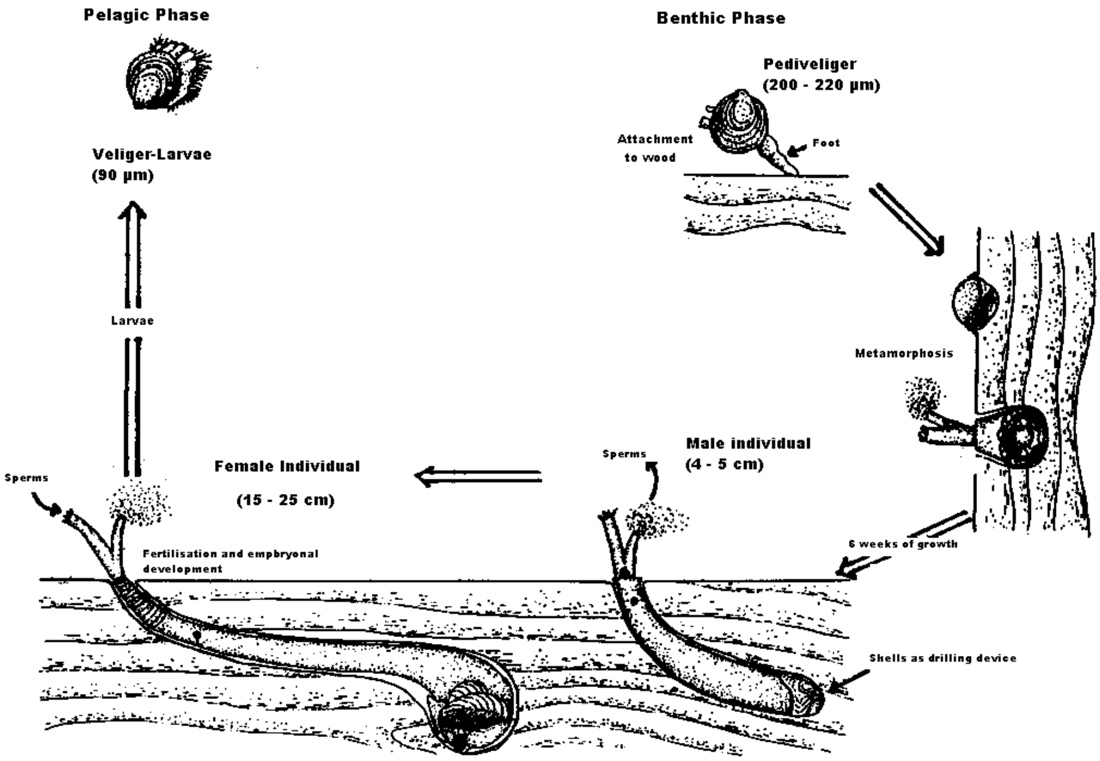

Figure 3: Reproductive cycle of the shipworm *Teredo navalis* (Nair &Saraswathy 1971 in Sordyl et al. 1998)

The adult animals develop remarkably high rates of drilling: brand-new piles of pine wood as used for groyne construction (diameter approx. 30 cm) can be completely destroyed within only one year, which in fact means within one summer.

Figure 4: Pine wood completely destroyed by *Teredo* (Sordyl et al. 1998)

The baltic sea water has a considerably lower salinity than the standard mean ocean water (approx. 10 – 15 g/l against 35 g/l). Due to this fact, Teredo was not fertile in the baltic, and problems stayed

linked to limited invasions every 20 or 30 years. Nevertheless, since the beginning of the 90´s, Teredo seems to have adopted to brackish conditions. Damages sum up to 25 million Marks in the state of Mecklenburg – Vorpommern since then.
Due to the costliness of the problem, various technical and scientific efforts are undertaken in order to find ways to deal with the problem. Technical approaches investigated up to now include the installation of plastic groyne piles, use of resistant tropic wood and tests of various chemical impregnations on local wood. Main disadvantages of these methods are an unsatisfying mechanical performance during installation (plastic piles), ecological objections, and consequently, lack of acceptance by widespread ecological movements (tropical wood) and negative effects on the local eco-system, linked with lack of long-term effectiveness (impregnations). Plastic and tropical wood piles in addition have the disadvantage of comparatively high costs (two – three-fold price of local wood).

2 GEOTEXTILES AS A BARRIER FOR *TEREDO*

The Institute for Hydraulic and Coastal Engineering of the Rostock University currently is running a research project, in which a cover of geotextiles is supposed to prevent access of *Teredo* to the piles. As have most molluscs, *Teredo* has a pelagical phase, in which the attack to wood occurs. Once attached to the wood, metamorphosis takes place and the adult animal starts its destructive work.
The so-called velliger-larva has a size of about 90µm in maximum. The larva attaches itsself to the wooden groyne-piles closely above the sea-floor. The larva lives in a more or less planctonic way: though it disposes of a pair of so-called wings, it does not have entire control of its movements, but is subject to drift by waves and currents.
This specific way of life allows to protect the piles by a cover of needle-punched geotextiles in the area closely above and below the sea floor. Even if some of the larvas should be smaller than the characteristical opening size of the geotextile, it is not very probable that it will find and make its way through a dense forest of fibres formed by the geotextile on a way of about 70 times its own size.
For first essays, a needle-punched PP-geotextile of 650 g/m² was chosen. The material has an characteristical opening size of 80 µm and a thickness (6.5 mm to 6.8 mm) and mechanical strength sufficient to meet the high forces acting on any structure in the shore zone: wave attack and abrasion due to high sand content of the water as well as ice in winter time.
The geotextile is attached to the pile by means of a stainless steel belt and screws. With an average circumference of about 1 m, between 2 m² and 4 m² are to be installed per pile, depending on water depth. The installation requires a few minutes only, thus keeping overall costs low.

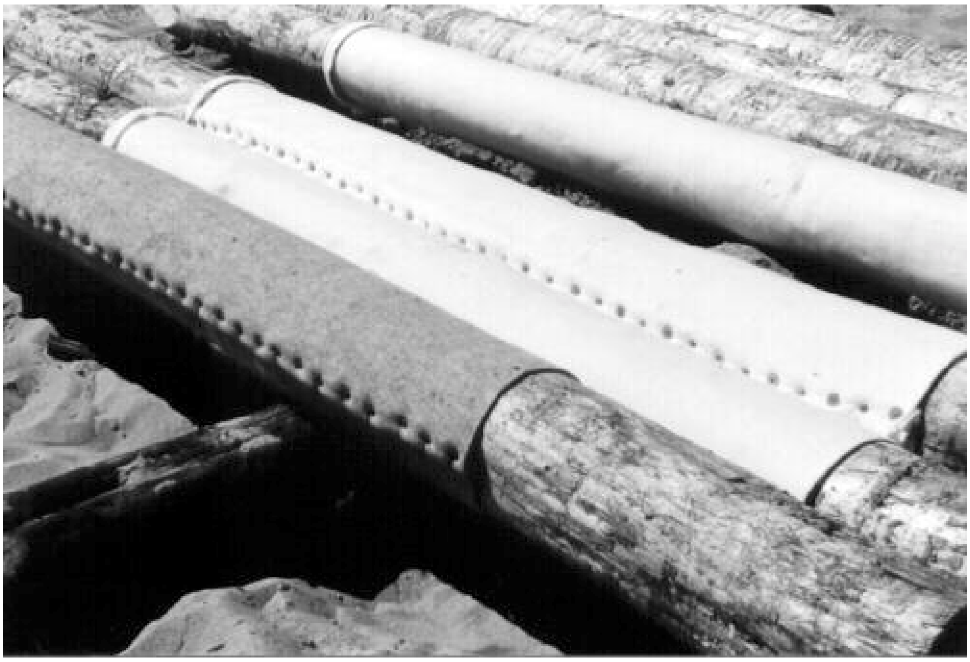

Figure 5: Test piles covered by needle-punched geotextile of 650 g/m²

3 FIELD EXPERIMENTS

3.1 *Installation*

First considerations about the feasibility of the method described above were jeopardized by concerns about the heavy forces acting upon the geotextile during pile installation. Groyne piles are usually driven into ground by means of hydraulic rammers, which induce considerable energy upon the pile (at times the pile top starts to burn). Most glacial sediments along the baltic coast are extremely well consolidated, and general opinion was that no geotextile could survive installation under these circumstances.

Consequently, first experiments were carried out on dry land, were rammed piles could easily be excavated after installation. Geotextile-covered piles were examined after excavation: no visible damage was to be noticed neither on the tested piles, nor on the geotextile cover.

In early spring 2000 a number of piles were installed on a part of the shoreline of Mecklenburg-Vorpommern that was most severely effected by *Teredo navalis*. The coast along the town of Kühlungsborn in the federal state of Mecklenburg-Vorpommern consists of boulder clay of medium to hard consistence, making installation difficult but still finally successful. Piles were installed in groups of two, each pair consisting of one pile covered in the way described above, and a reference pile without any treatment. These couples of test piles were installed in different water depths, ranging from 0.5 m to 2.0 m.

Figure 6: Installation of geotextile-covered groyne piles by rammer off Kuehlungsborn (Mecklenburg-Vorpommern)

3.2 *Sampling*

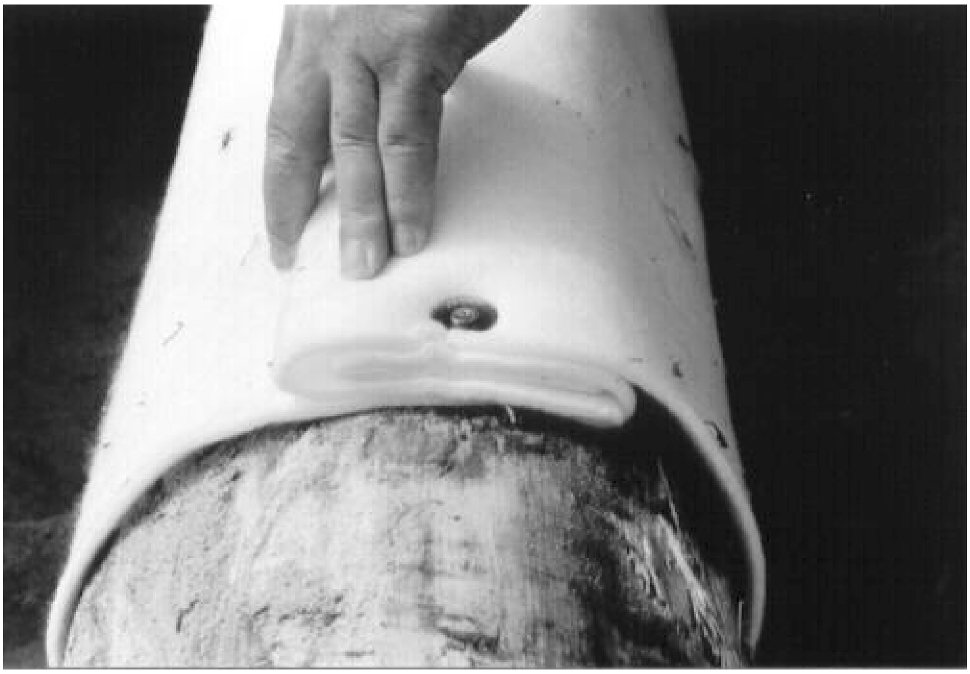

Figure 7: Joint of geotextile cover fixed by stainless steel screw

As the geotextile was fixed to the piles by means of screws, the cover can be easily opened by divers.

Cores can be taken from the wood and the cover can be closed again. The cores can be analysed for population of *Teredo*.

Sampling will take place in regular intervals during the summer months, when higher water temperatures result in an increased activity of *Teredo*. As the reference piles are being sampled at the same time, the efficiency of the new method can easily be evaluated.

4 DURABILITY

A second important feature aside the efficiency of the applied method is the durability of the structure. Groynes are usually built for an expected lifetime of about 30 years. If the newly developed geotextile cover shall provide an effective protection against *Teredo navalis*, it must have a lifetime of the same duration.

Main forces acting upon the geotextile in this case are waves, abrasion induced by the high sand content in the zone of turbulence, and ice.

There are already some experiences in the durability of geotextiles against wave attack, coming from geotextile application as cover for packed materials.

The behavior of needle-punched geotextiles against abrasion by sand is still unknown and is subject to the current research program. Samples of the geotextile will be taken at regular intervals and will be tested both optically (by microscope) and mechanically (standard tests in the institute’s geotextile laboratory).

The influence of ice on the installed structure is difficult to assess in field studies because ice does not occur in every winter on the baltic coast of Germany. Thus, parallel laboratory tests are planned in the frame of another research program, dealing with the mechanical behavior of groyne piles. First results of these investigations are supposed to be available by the end of 2001.
The influence of ice has to be divided into to different effects:
First, drifting ice may damage the geotextile cover by impact. This effect can be simulated in laboratory by various tests for testing impact strength of geotextiles.

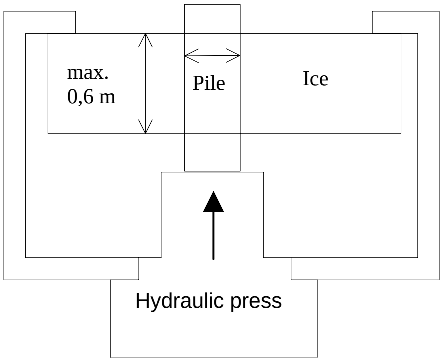

Figure 8: Sketch of machine for ice-experiments

Second, ice may freeze around the groyne piles and the geotextile, and then be lifted or lowered by changing water levels. This effect will most probably be more efficient in destroying the structure. It is planned to construct a machine inside the climate chamber of the institute to test the effect of such stress, which only rarely occurs in nature. Figure 3 shows the principal components of such a machine.

5 CONCLUSION

Attack of *Teredo navalis* to wooden structures of the coastal protection system of the baltic coast of Germany presents a serious and costly problem. A geotextile cover around wooden groyne piles presumably presents a cost-effective solution for this problem. First experiments show that installation, which was suspected to represent the most severe technical problem, works without difficulties. Effectiveness of the new method can be assumed, though long-term stability still has to be proven by further research work.

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