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Evaluation of possible degradation of synthetic reinforcement casted into concrete panels

A.Watn
SINTEF Geotechnical Engineering, Trondheim, Norway

ABSTRACT: A reinforced soil retaining wall was constructed using a concrete panel as front shuttering. The synthetic reinforcement was casted into the concrete panel to ease the construction procedure. The possible damage to the synthetic reinforcement was investigated by tensile testing of two types of geogrids casted into the panels. This was done 1, 6, 18 and 24 months after the casting. No sign of damage due to alkalinity was observed. The construction method was very effective and the costs were about 30% less than for a comparable traditional retaining wall at the same location.

1 INTRODUCTION

The use of geosynthetic reinforcement to construct retaining walls is a competitive solution compared to traditional structures. The reinforced soil is capable of retaining itself, but needs a front shuttering during the construction phase and protection against weathering and later surface damage. In Norway, various solutions for front covers have been used, such as concrete blocks, concrete panels and vegetation fronts.

In Trondheim, Norway, a retaining wall with maximum height 5.2 m was constructed as part of a new highway project.

The project was in an urban area and it was required that the face of the wall should have a design suitable to the surroundings. A solution with a patterned concrete facing was chosen.

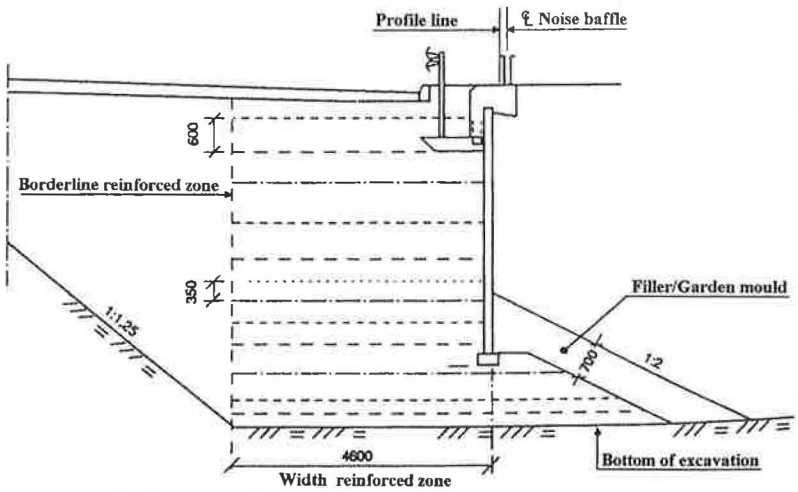

Figure 1 Reinforced soil retaining wall with concrete panel front

The durability of geosynthetics has in general been one of the main topics for several years. Especially the use of polyester-based geosynthetics in an alkaline environment have been stressed.

In the evaluation of the type of reinforcement to be used for this project the question of possible degradation due to alkalinity was put forward. The pH-values in the concrete during the hardening is likely to be in the range of 12.5 - 13.5 so the question was relevant for the project. It was therefore decided to perform a test programme to investigate the possible degradation of the geosynthetics when casted into concrete panels.

2 CONSTRUCTION PRINCIPLE

The structure was part of the highway foundation with a noise baffle and a guard rail located at the top of the front panel. The soil conditions in the area was sand overlying clay. At the foundation level the clay was stiff, with soft clay beyond.

A construction with prefabricated full height concrete panels as front cover was decided upon. The panels had a width of 2.4 m and was founded on a trimmed embankment of sand directly on the clay. The construction principle is presented in Figure 1.

The reinforcement was casted into the concrete panels in widths of 1m to obtain a rapid and easy construction method. Two alternative types of geogrid reinforcement were proposed as presented in Table 1.

GG1 was proposed installed as an unjointed geogrid casted into the panel. For the GG 2 it was proposed to make a joint by the use of PVC bars just behind the panel. The principle for the latter alternative is presented in Figure 2.

Table 1 Types of reinforcing grids

Geo-grid	Type	Nominal characteristic long term strength (kN/m)
GG 1	Woven, polyester coated with PVC	32
GG 2	Punched and stretched polyethylene	30.5

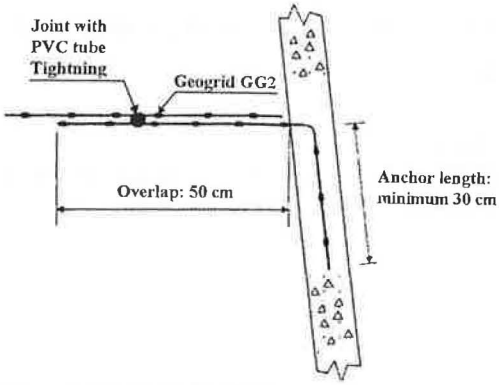

Figure 2 Detail of the casting and the reinforcement joint

A well-graded self draining gravel was chosen as the backfill material. The material was frost resistant to avoid deflection of the front due to frost heave in the backfill masses.

A drainage pipe was installed at the foundation level just behind the facing to avoid pore pressure build-up in the backfill masses.

3 DEGRADATION TESTING

To obtain a realistic test result it was chosen to use the same type of geogrids and concrete panels as in the project.

The testing included short term tensile tests performed on geogrids casted into the concrete panels. In addition tests on virgin samples of the same types of reinforcement were performed to provide a reference basis. The evaluation criteria for the possible degradation were the stress-strain behaviour, the ultimate failure strength and the location of the failure. A degradation caused by the alkalinity should be expected to give a geogrid failure in the area in contact with the concrete.

The tests were performed with grid elements cut to a width of about 40 cm, and a length of about 60 cm. A minimum of two tests were performed on each type of grid. The load was applied in steps of 3 kN/m. The elongation was measured for each load step at two locations.

The testing was performed 1 month, 6 months, 18 months and 24 months after the casting. In the period between the tests, the concrete panel with the geogrids were stored outdoors, exposed to the sun and temperatures ranging from -15°C to +25°C.

The principle for the tensile test is presented in Figure 3. The stress-strain curves found from the tests are presented in Figure 4 and Figure 5.

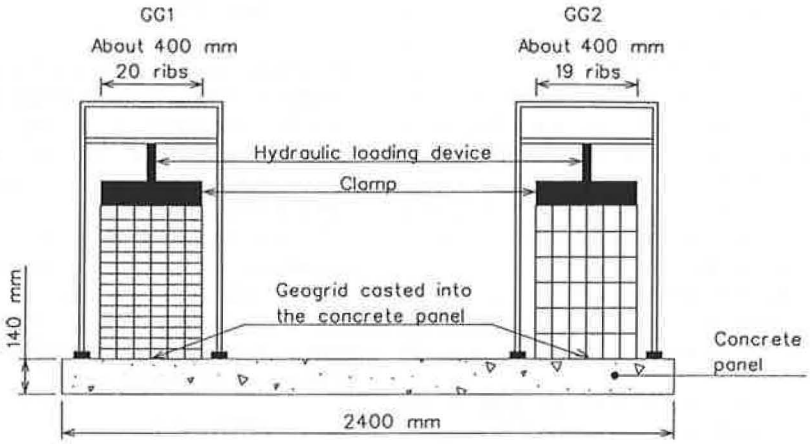

Figure 3 Tensile test principle

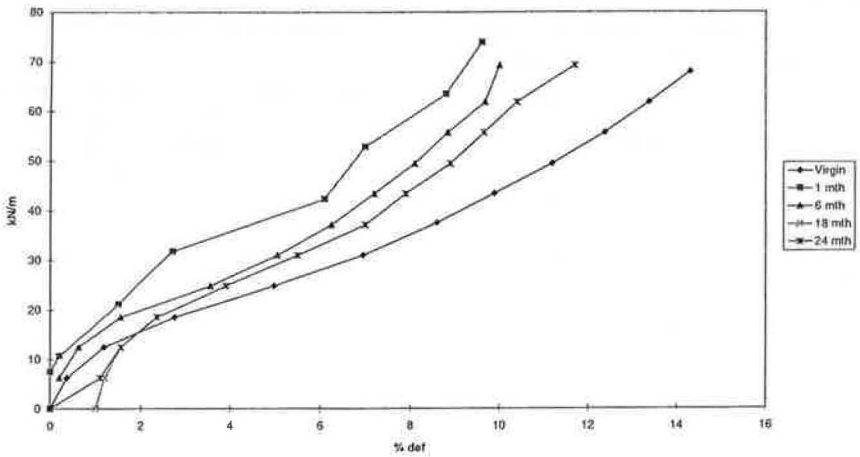

Figure 4 Stress-strain curves, GG1

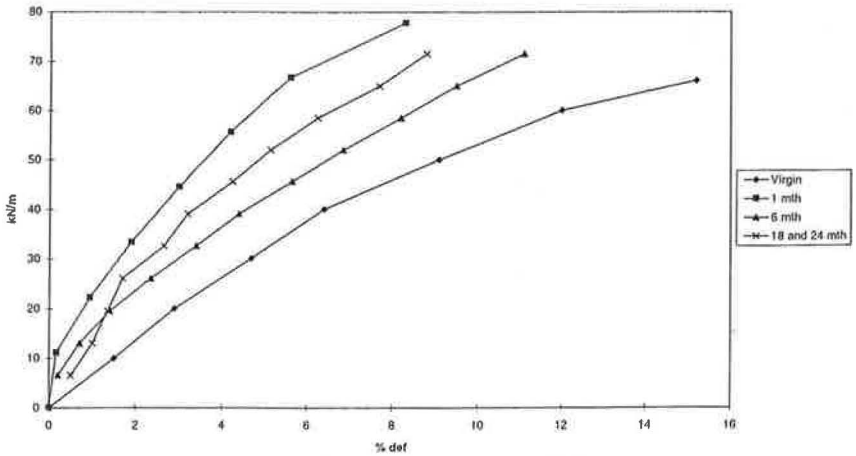

Figure 5 Stress-strain curves, GG2

The stress strain curves do not indicate degradation of the grids. The resulting average failure strength is slightly higher for the tests with grids casted into the concrete panels compared to the tests on virgin samples. This is most likely due to a difference in the clamping system for the virgin sample testing, compared to the casted solution.

For the casted grid tests there are a tendency that the strain at failure becomes higher with increasing time after the casting.

In most tests with casted grids the failure occurred at the steel clamp, but occasionally failure was also observed in the middle of the grid and near the concrete panel.

Based on the results from the tests it was concluded that no degradation on any of the geogrids could be found due to the alkaline exposure after 24 months in the concrete.

The tendency to increased strain at failure is more likely to be caused by degradation due to molecular changes in the geogrids because of exposure to sunlight and to temperature effects.

4 CONSTRUCTION EXPERIENCES

The construction work was completed in 1992. The construction procedure was rapid as the concrete panel functioned as a front shuttering during backfilling. The panel was raised by the use of the grab of an excavator and was then temporarily fixed by wooden rods during the backfilling.

It was important to obtain good compaction of the backfill material. Differential settlement between the concrete panel and the backfill may result in shear failure in the geogrids at the panel surface. Close to the panel, the fill masses were placed in thin layers and compacted with light equipment.

The total front area of the construction covered 360 m^2 and was built of a team of three workers and an excavator in one month. The total construction costs including labour and materials was 830.000 NOK (103 kECU), giving a price of 2.300 NOK/m^2 (285 ECU/m^2) front wall.

At the same project a conventional retaining wall was build under comparable conditions. This wall had a maximum height of 4.5 m and a total area was 340 m^2. This construction was built by three workers in three months with a total costs of NOK 1.020.000 (127.5 kECU), corresponding to 3.000 NOK/m^2 (371 ECU/m^2) front wall.

5 CONCLUSIONS

The project has provided useful information on the possibility for building reinforced soil retaining walls with the reinforcement casted into a concrete panel facing. The construction method have proved to be rapid and give about 30 % cost savings compared with a traditional solution.

The test programme have given no indication of degradation of any of the geogrids due to the alkalinity exposure in the concrete within 24 months after the in casting. This gives the possibility for using a wide range of geosynthetics for reinforcement in these type of construction work.

6 REFERENCES

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