Reinforcing the foundation for concrete block paving.

Case-studies, design-methods and practical use.

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Abstract:

The use of geosynthetic reinforcements, in the market named as geotextile, geogrid and geocomposite, are increasing year by year. The same do the number of products and producers in the market. The benefits in the use of these new products and methods are increased quality and reduced costs, but that only if good solutions and correct type of product are chosen.

Introduction:

The mother soil is still the same, but very often we now have to build on softer soils than earlier, because of limitations on building ground. At the same time the loads and intensity from vihicles and airplanes have been greater, and the claims on strength and quality on the constructions have therefore been increased. These parameters are not fitting together, and therefore the use of stone alone can't take the challenge itself. We need to use new methods and products, as concreate blocks and soil-reinforcment, in our daily design of trafficed areas. Geosynthetic products mentioned are:

- Geotextiles used as soil-reinforcement are strong woven or knitted textiles made from polypropylen, polyester or glassfiber, or combinations of these.
- Geogrids are stiff grids where the joints between the ribs are strongly hold in place. Geogrids are made by polypropylen, polyethylen, polyester or glassfiber, or combinations of these.
- Geocomposites used as soil-reinforcement are a combination of a separation geotextile and a reinforcing textile or a geogrid, as described earlier.

Soil-reinforcement, choice and design:

When starting to design a project, it is important to describe the projects by defining the following parameters:

- Subgrade strength, grading and quality.
- Limitations in digging out existing soils, top-level of the construction, and type and costs of quality soils in the area.
- Design parameters as loads and intensity on the construction, and the claims on strength and quality.

Soil-reinforcement is being used to increase the strength and bearing capacity of the designed construction, and therefore to increase its lifetime, or to reduce the thicknesses of the subbase and base to maintain the designed lifetime. All together soil-reinforcement save both construction and maintenance costs.

Where are we then placing the reinforcement ? In general I will suggest:

- **Place the geogrid on top of the soil-layer causing the problem.**

The soil-reinforcement can be places on different levels in constructions with concreate block-paving, depending on effect you design for.

- On soft subgrade the soil-reinforcement is placed in the subbase, as one bottum layer or as 2 layers in the lower half of it. The reinforcement is designed to increase the geotechnical bearing capacity and to decrease the subbase thickness or to increase the lifetime.
- On heavy trafficed areas, both regarding weight and intensity, the soil-reinforcement is placed at the bottum of the base-layer, or as close to the pavement, here concrete blocks, as possible. The reinforcement is in the same way to increase the geotechnical bearing capacity and to decrease the subbase thickness or to increase the lifetime.

When designing the construction and choosing type of soil-reinforcement and raw-materials acceptable, it is important to know the limiting design-parameter and therefore the most important function for the soil-reinforcement. These factors can be:

1. needed strength at a designed strain.
2. interaction with the soil, friction or interlocking to achieve the function.
3. degradation of the reinforcement by construction and in survice.
4. degradation of the reinforcement by chemicals or liquids in the area.

There are lots of different products on the marked. To design with the most effective type in every situation, claims knowledge and experience. Some general points can bee said oabout the products:

- Strong geotextiles are best to increase the geotechnical bearing capacity. They don't interlock with the soil, and don't allow the same thickness-reductions because of traffic as geogrids. Geotextiles need deformations before being active. If very high strength at exstreme low strain is needed, with few loadings, glassfiber-grids or geocomposites can be recommended.

- Geogrids absorb the traffic intencity because of the interlocking with the stones. Therefore it allows considerable reductions in layer-thicknesses. Geogrids have today the best confirmed design-methods for road traffic. Geogrids are therefore the best to use in the the base and when designing layer-thicknesses.

Project experiences:

All 3 projects are from the west-coast of Norway.

1. Bergen Community:

An old road in the center of Bergen was built on clay with stone-block pavement. The raod was rebuilt using the ols stone-blocks. The client wished to achieve the nessessary strength and durability of the road by replacing as little as possible of the exsisting base and subbase. To separate the existing soil from the new gravel, they used a class 2 nonwoven geotextile directly on the new subgrade. From the design the client decided to use a geogrid with a strength of min. 5,0 kN/m at 2 % strain and min. 10,0 kN/m at 5 % strain, and aperture size approx. 30 mm.

So far the road has performed as expected, and the client has therefore later on rebuilt at least 2 similar roads using the same solution.

2. Sola Airport, Stavanger:

In 1988 Sola Airport, Stavanger, built a parking-area for airplanes. The subgrade in the area is relatively fine sand with very high waterlevel. The area is also crossed by known and unknown cables and pipes. By these reasons, and to reduce the total construction-time and -costs, the consult designed the area using a stiff geogrid as subbase reinforcement. The consult described a stiff geogrid with full strength in the joints and with a strength of min. 8,0 kN/m at 2 % strain and min. 15,0 kN/m at 5 % strain in both directions, and apperture size approx. 30 mm.

The client is very satisfield with the solution, and has used the same design on similar projects at Sola Airport in 1991 and 1992.

3. Stavanger Forum:

Stavanger Forum is a big exhibition area outside Stavanger town. In 1986, they extended their outside exhibition-area. The area was designed and planned to be used for light equipment, private cars being the heaviest. The exhibition-area was placed on an area with all kind of wasted soils, mostly silt, clay and moraine, but also some peat.

A nonwoven geotextile class 2 was used to separate the subgrade from the new base material. To keep the compaction in the base material, to reduce the effects of uneven settlements, and to increase the strength of the construction, a geogrid with a strength of min. 5,0 kN/m at 2 % strain and min. 10,0 kN/m at 5 % strain in both directions, and apperture size approx. 30 mm, was used onto the geotextile, at the bottom of the baselayer. They also chose to use a flexible pavement, as concrete blocks, because of the soft and uneven subgrade and the consentrated loads.

At the first exhibition this particular area was used by the heaviest vihicles, with no significant problems. Also today the area is performing very well.

Conclutions:

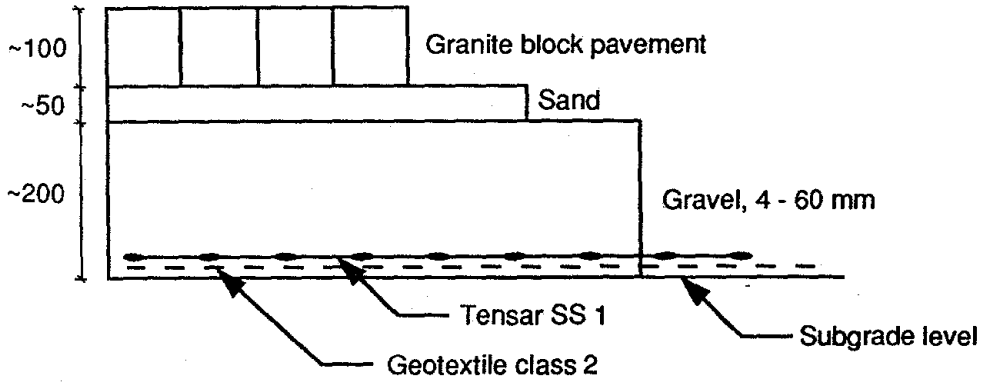
The use of soil reinforcement in constructions with concrete block paving can give the clients positive benefits both regarding costs and quality. Using geogrids the thickness of the subbase and base can be reduced by 30 - 50 %, saving construction time and costs. Quality design can be made even on soft subgrade, without exstreme costs.

Even though my presented projects and most experience is on geogrids, I see an interesting future for strong geotextiles and geocomposites made from polyester and glassfiber.

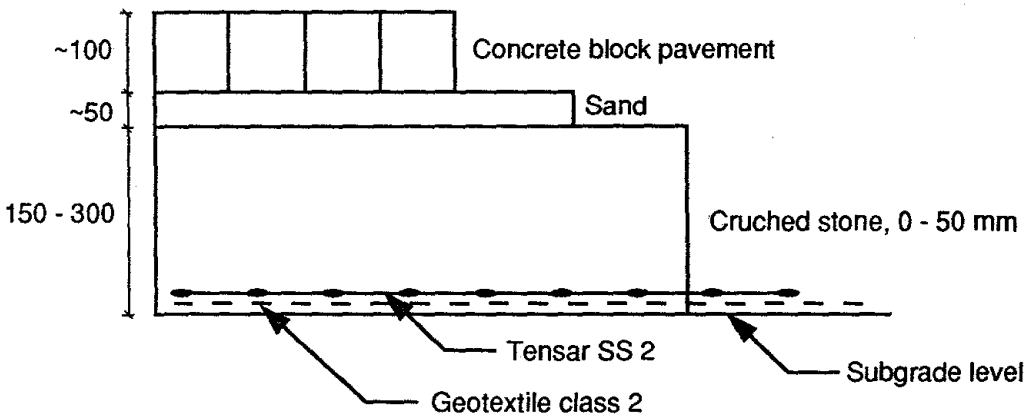
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Project 1



Project 2



Project 3

