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The Behavior of Sett Pavements Constructed of VS 5 – Shaping Pavers

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Introduction and description of the problem

Due to the creative opportunities they open, pavement construction techniques are currently very important for local road building efforts in Germany. Furthermore, increasing amounts of damage to sett pavements during the last few years have stimulated increased research in this area. Images of roadway damage show both significant vertical deformations in the form of settling and bulging of the pavement as well as clearly perceptible horizontal movement, especially where the pavement is subjected to horizontal forces like vehicle braking and acceleration (such as bus lanes and intersections).

The selection of the bedding and subbase material strongly influences vertical deformation. On the other hand, the stone's shape and composition (stone material, underside configuration) strongly influence horizontal deformation, a fact that naturally leads to the development of new stone designs. This research project investigates shaping pavers designated as Shifting Prevention (VS) 5 (on five sides). In contrast to conventional paving stones, these pavers use specially arranged spacers that produce a four-sided toothing effect after installation, thereby creating unique chambered joints between the stones. Another characteristic of these stones is their underside profiling that—as earlier experiments have shown [1]—increases their resistance to horizontal shifting.

The experimenters at the Ruhr-Universität in Bochum constructed realistic test beds in their road-testing facility. The experimental surfaces were then subjected to dynamic loads produced by a heavy truck wheel. Finally, the experimenters measured the amount of deformation caused by the loads. An important distinguishing aspect was the method of installing the pavement, which depended on the profiling on the underside of the stones. Expansion tests determined the level of resistance to horizontal shifting. The final component of the test consisted of infiltration measurements for determining water's ability to permeate the pavement.

Conclusions

Overall, the four test beds that were examined in the road-testing facility exhibited only minimal amounts of vertical deformation. Installing the elements with the profile grooves arranged uniformly in a single direction proved to be advantageous. Unlike other similar pavement surfaces previously tested in the road-testing facility, braking rollover maneuvers exerted no recognizable influence on the pavement surfaces.

This was also true for longitudinal horizontal shifting in two of the three test beds. On average, these effects can also be classified as very minimal. One noticeable characteristic is that no single stone moves in the tested cross section. Instead, the entire cross section moves in a homogenous manner. This indicates a good toothing effect among the stones. The best results in the test bed were achieved when the profile grooves were installed in the direction of travel, a phenomenon that encourages further research.

The direction of horizontal shifting in the stones' crosswise direction within a test bed did not follow any clear pattern, although the magnitude of the maximum shifting was negligible in all of the test beds, making further assessment of the crosswise shifting unnecessary.

The measurements conducted with the expansion device confirm the result of the horizontal shifting in the longitudinal direction. Installing the profile grooves in the direction of the load movement offers a small advantage over the other two methods of installation. All three test beds, however, exhibit a comparatively high resistance to horizontal shifting.

The infiltration measurements indicated that the tested pavement surfaces are permeable. It remains difficult to draw conclusions about the measurement values because there are no comparable tests from the road-testing facility and it was not possible to simulate how weather and cleaning will influence the surfaces, two things that will be present in practical scenarios. On-site measurements would be useful in order to provide more in-depth statements.

However, we can summarize by saying that the special joint configuration and the arrangement of the spacers achieve positive interlocking performance between the stones, thereby resulting in minimal deformation and shifting when compared to other pavement surfaces tested in the road-testing facility. Grain size 0/2 mm is a good joint-filling material.

Summary

The Ruhr-Universität in Bochum, Germany was contracted to test sett pavements (VS 5 shaping pavement) in their large-scale experimental facility for roadway structures. These tests involved the ascertainment and assessment of the deformation behavior exhibited by various experimental surfaces under a rolling load provided by a heavy truck wheel.

The differences between the test beds consisted of the type of installation depending on the stones' profiled undersides. All stones were installed as "crosswise runners", but the profile grooves ran (1) in the direction of travel, (2) crosswise to the direction of travel, and (3) alternating between crosswise and the direction of travel. The amount of vertical deformation and horizontal shifting was determined for all test beds in consideration of the roll-over forces. After all roll-overs were complete, the expansion device was used to determine the level of resistance to horizontal shifting and infiltrometer measurements were taken. The same subbase and the same bedding material were used for all test beds.

After the first test bed it was necessary to renew the filling material because the joints emptied when subjected to driving forces. In order to test the filling material's influence on the results, an additional surface was continuously subjected to loads until we were able to determine that the filling material has no or very little influence on deformation and shifting when compared to the influence of the profile groove direction.

In comparison, all test beds exhibited vertical deformation that was not apparent visually, just like a positional change or tilting of the stones.

Horizontal shifting in the longitudinal direction was likewise very minor, whereby the "profile grooves in the direction of travel" installation method was insignificantly advantageous. It would be desirable to confirm this with practical experiments. The measurement results recorded with the expansion device confirmed this phenomenon. We arrive at the following order: "profile grooves in the direction of travel" is more effective than "profile grooves crosswise and in the direction of travel" is more effective than "profile grooves crosswise". The values established for horizontal shifting in the crosswise direction were negligible and we were not able to establish a pattern of the stones' movement in any single direction. The infiltration measurements indicated a similar level of permeability for all of the tested surfaces.

However, we were not able to complete an in-depth assessment of the measurements; on-site experiments appear necessary.
Overall, the VS 5 shaping pavement exhibits good positional stability and good interlocking performance, whereby the special joint geometry is considered to be a positive aspect.