Flat Drain Laboratory Tests and Practical Applications

A. Polunovsky
Russian Highway Research Institute, Moscow, Russia

ABSTRACT: Results are given on laboratory tests of the flat drains to determine the compressibility characteristics needed in the drainage structure design. A change in the drain thickness and working section was evaluated under the static and dynamic loading both in the free state and in the soil body medium. In the course of tests, velocities of the deformation development and recovery were registered. The compressibility data are complemented by the results of the compressibility in the soil medium under the action of stamp. Study of peculiarities of the drain performance in the road structure has allowed an approach to drainage embedment specifications to be changed on the basis of considering the water-and-temperature regime of cuts exposing the ground water levels.

1 INTRODUCTION

The flat drain installation in the soil depth permits to create in it practically a hollow space that influences the water and temperature regime of drain-contained soil body and its deformations under the mechanical actions (Olsene, 1990). Therefore, together with the hydraulic characteristics of flat drains and their durability under the action of natural factors, of great importance are their mechanical properties and deformability under static and dynamic loading.

2 LABORATORY TESTS

For determining the mechanical characteristics of drains under various loading conditions laboratory experiments have been undertaken. Tests were carried out on a flat drain that included a 16mm thick, placed-in-filter-envelope, corrugated mesh core made of contininuous bended fibres and molded in the form of staggered opposide-directed projections. The latter had the form of truncated cones with an increased density of the fibre arrangement in their vertices. The drain compressibility was determined by stamp test. A circular stamp 100 mm in diameter was statically loaded step-by-step with a 5 minute time lag up to a maximum load of 0,2MPa and then unloaded stepwise. The recoverable deformation for all loading steps was about 30% from the total one. This circumstance as well as fast deformation recovery and the type of load deformation curve make it possible to conclude that loading does not result in the drain structure failure and that a similar method may be recommended for the laboratory test of flat drains to assess their suitability for the application in the drainage structures. For evaluating the deformability behavior of drain in the structures exposed to the action of multiple loading, as in the roads and railways, a test program was also included tests on transferring a 0.1MPa pulsating load to the drain through a 100mm in dia stamp. The drain compression after 500 loading cycles did not exceed 31% at a 0.7 to 1.0mm absolute magnitude of deformation and the recoverable deformation of 30-40%, which was considered as a proof of the sufficient drain stability under actual drain conditions of the road structure performance, for which the flat drain was designated. The loading parameters accepted seem to be suitable for the experimental evaluation of the drain dynamic stability if taking into consideration that the load is directly transferred through the stamp, without an intermediate soil layer occuring in the real structures.

To evaluate the drain stability under the action of compacting machines and the drain influence on the compaction degree of overlying soil layers, a test series was carried out in the Proctor device cylinder. The load was applied by series of 20 impacts up to 400 ones in total. The drain did not cause a reduction in a degree of soil compaction in spite of its deforming effect.

To check the flexibility of drain after multiple bending, it was subjected to the static test by stamp installed at the place of bend and results obtained were compared with those from the drain stamp tests before the bend at the same point.

From the results it may be concluded that the drain core is flexible enough provided that a reduction in the modulus of deformation after multiple bending does not exceed 20 to 25%.

3 FLAT DRAIN APPLICATION IN ROAD CONSTRUCTION

The flat drains may be used instead of the pipe trench drainage and draining courses in the bases (Cedergren, 1985). They are applied in the drainage of road base courses and sport grounds, slope drainage in the cuts exposing the ground water levels, and in many other cases when there is a need to dry large areas.

One of thrench drainage variants, where the flat drains may be applied, is the underditch drainage that is widely used in the practice of road construction in Russia. The underditch drainage is usually installed in the cuts put below the ground water level to protect the road base against the ground water infiltration and the frost heave in winter. For this purpose under the side ditch of the cut a drainage trench is usually made, which includes pipe drains in the filter blanket. The experience of building several road sections has shown that the flat drain may be used for installing the underditch drainage.

4 DECREASED EMBEDDMENT OF THE FLAT DRAIN

Design features of the flat drains cause essential peculiarities in the underditch drainage performance, which can affect the design of the latter. These peculiarities are connected with differences in the propagation of freezing front in the cases of flat and pipe drainage. When the front of freezing reaches the drainage trench, there appear differences connected with the heat-insulating properties of flat drain. The freezing process stops since, from one side, it is attenuated by the drain as a heat-insulating interlayer, and, on the other hand, due to a warming effect of the ground water flow directed to the drain.

If the drain is situated within the depth of soil freezing, the process of freezing either may stop totally, or stop at any portion of the drain height, or slow down substantially. Even in an extreme, undesirable case of complete freezing of the drain, the latter retains the permeability and on subsequent thawing of the road pavement provides the water discharge from the base into the longitudinal drainage, with simultaneous warming the ditch frozen bottom by thawing water at the contact with the flat drain or drainage pipe and restoring the function of ground water deversion, even in the case of complete ceasing the drainage function. Thus, on installing the flat drainage, the depth of its construction may be taken to be less than the depth of freezing (though in this instance it is desirable to avoid the drainage freezing).

The embedment is specified on the basis of completely different conditions: lowering the water ground level to a position where the water inflow under the road pavement is excluded; preventing the complete drainage freezing as well as technological opportunities of the equipment for flat drain installation. Considering a possibility of using the capillary-intercepting courses in the road pavement base, a depth of strip drainage installation may differ very essentially from the depth of freezing and embedment of conventional pipe underditch drainage.

5 CONCLUSION

The laboratory test proposed may be used for evaluating the flat drain properties, application opportunities and conditions. Along with using the flat drains in the behind -wall drainage and for drying areas of various designation, they may be applied in the structures of road underditch drainage. In this case the flat drain usage makes it possible to decrease the drainage embedment.

REFERENCES

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