Fellenius B.H., 1977. The equivalent cylinder diameter of the bandshaped drain. Discussion. Proc. 9th ICSMFE, Tokyo, July 10-15, Vol. 3, p. 395.

This discussion deals with the evaluation of the Skå-Edeby test results with respect to the bandshaped drains (Hansbo and Torstensson, Session 2). The mentioned authors assume the Geodrain to have an equivalent cylinder diameter of 50 mm, and, using this value, they evaluate that the drains mobilize a c_h-coefficient of 1.2×10^{-8} m^2/s (3.8 m^2/year). In comparison, the results from the area with the 180-mm diameter sand drains, placed at the same spacing, are evaluated to mobilize a c_h of 0.9×10^{-8} m^2/s (2.9 m^2/year).

The Geodrains in Skå Edeby were installed with very crude equipment, far inferior to the modern flat, low-disturbance mandrels. Therefore, it is surprising that they should have shown such good result or in comparison with the sand drains, as indicated by their higher c_h-coefficient.

The evaluated c_h-coefficient depends very much on the mentioned assumed value of the equivalent drain diameter. The authors mention that the equivalent diameter corresponds to the diameter of a sand drain with the same circumferential area. However, the Geodrain gross circumferential area (200 mm^2/mm) corresponds to a circumference of the cylinder with a diameter of 65 mm, not 50 mm as stated by the authors. Still, this mathematically adjusted value may not be the correct equivalent drain diameter to use.

While it is true that it is the surface of the drain—bandshaped or sand drain—that governs the function of the drain, it is not the total surface, but the free unobstructed surface that should be used in establishing the value of the equivalent sand drain diameter.

The free (or open or unobstructed) surface of the Geodrain is (was 1972) 139 mm^2/mm = 68 % of the gross area. The free surface of a sand drain is not as simply determined. However, in an arbitrary cut through soil, the area ratio of cuts through voids to cuts through solids is equal to the void ratio (e.g., Windisch and Soulie 1970). This relationship is valid also close to the outer boundary of the sand drain. Therefore, the free surface area over the solid surface area is equal to the porosity of the soil. In case of a relatively uniform sand in a medium density state, as in the sand drain column, the porosity is about 0.4 and the free surface of the sand drain can be taken to be 40 % of the total circumferential area, i.e., $0.4 \pi 180 = 226$ mm^2/mm. The Geodrain equivalent sand drain diameter is $204 \times 0.68/0.4\pi =$ 110 mm.

The 110-mm value is a more logically derived value of equivalent sand drain diameter to use for the Geodrain. If the Skå Edeby results would be evaluated with this value instead, the results would be a smaller c_h-coefficient than that presented by the authors and, probably, quite close to the c_h-coefficient of the sand drain result. Still much ager than the vertical coefficient, c_v.

Determining the equivalent sand drain diameter, as based on the free surface, provides a means of theoretically comparing different types of equal width bandshaped drains with each other, which means is lacking when using the approach of total surfaces.

Reference

Windisch, S.J. and Soulie, J., 1970. Techniques for study of granular materials. ASCE J. SMFE 96(SM4) 1113-1126.