ON THE EFFECT OF DRAINAGE ON THE CONSOLIDATION BEHAVIOUR OF COHESIVE SEDIMENTS

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ABSTRACT

At K.U.Leuven consolidation tests have been performed in both drained and undrained columns (2 m high and diameter 0.1 m,), filled with mud dredged from the river Scheldt (sand content 7 % of the solid phase, bulk density 1095 kg/m^3). The bottom of each column consisted of a 0.1 m thick granular filter, covered with filter paper. The permeability of the filter was of the order of 20 10^{-3} ms^{-1} before, and 4 10^{-3} ms^{-1} after the experiment. The columns were equiped with water pressure gauges and a nuclear density probe. Four different cases were studied :

- undrained (column 2)
- drained, head difference over the filter only due to density difference between water and mud in the early stage of the experiment (column 1)
- drained, with head differences of resp. 0.8, and 1.6 m.(columns 3 and 4 resp.).

FIG. 1 shows that drainage has a positive effect on the consolidation speed. Although in the long run, the column with the highest head difference consolidates faster (the improvement compared to the undrained column is of the order of 30 %), the column with the smallest head difference consolidates faster during the first period of the test (approx. 1 week). Maybe this is due to the fact that the zone directly above the filter gets clogged faster in a strongly drained column.

FIG. 2 shows density profiles in the four columns after about 60 days. It is seen that drainage both increases the density at the bottom of the column, and the thickness of the dense bottom layer.

FIG. 3 shows the total stresses, the pore water pressure and the effective stress distribution in a drained column (column 4) and an undrained column (column 2).
In the vicinity of the filter, the effective stresses become very important in a drained column. Clearly, the throughflowing water manages to create a structure in the sediment that gradually takes over part of the total load

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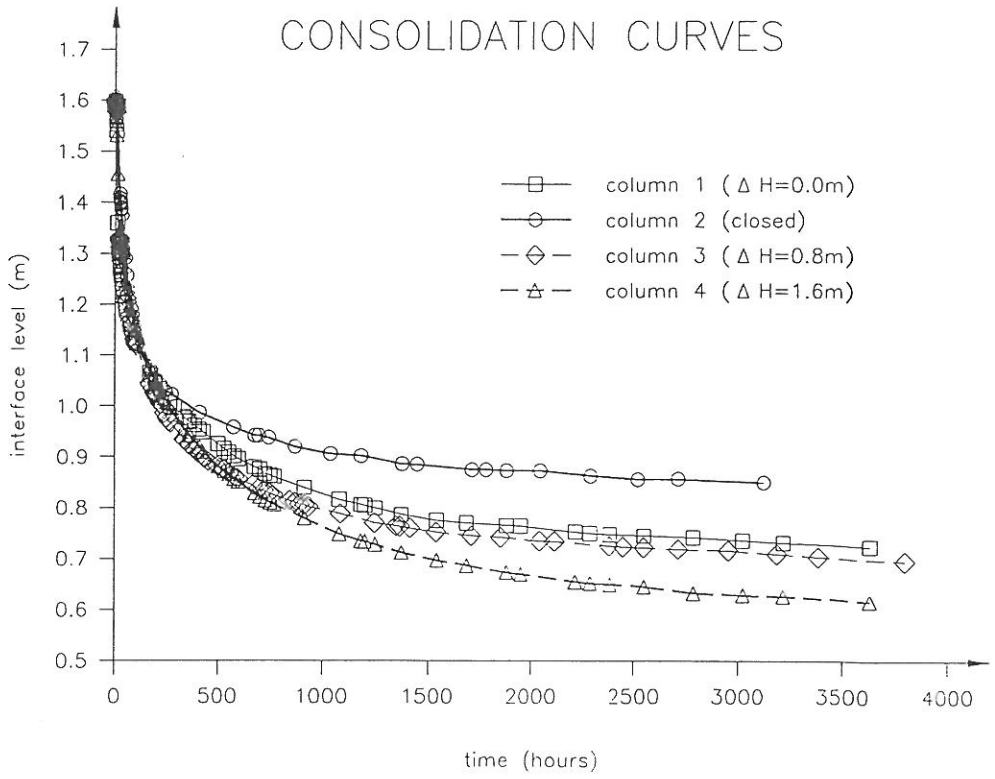
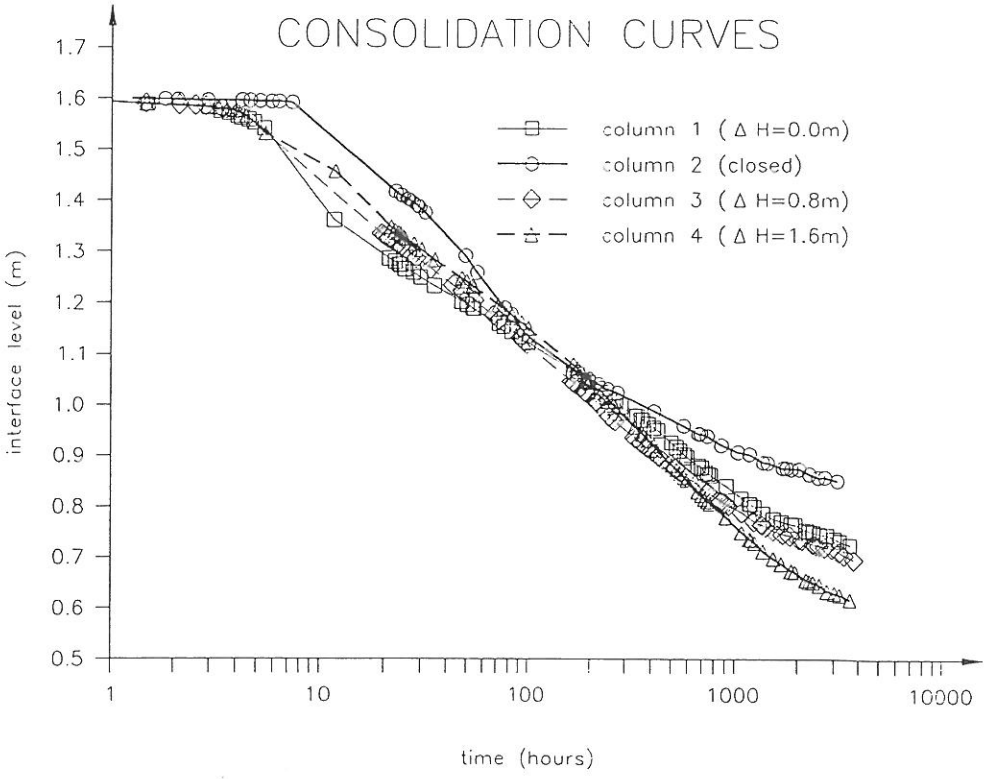

CONSOLIDATION CURVES
column 1 (Δ H=0.0m)
column 2 (closed)
column 3 (Δ H=0.8m)
column 4 (Δ H=1.6m)
interface level (m)
time (hours)
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0
500
1000
1500
2000
2500
3000
3500
4000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1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
1
10
100
1000
10000

Figure 1

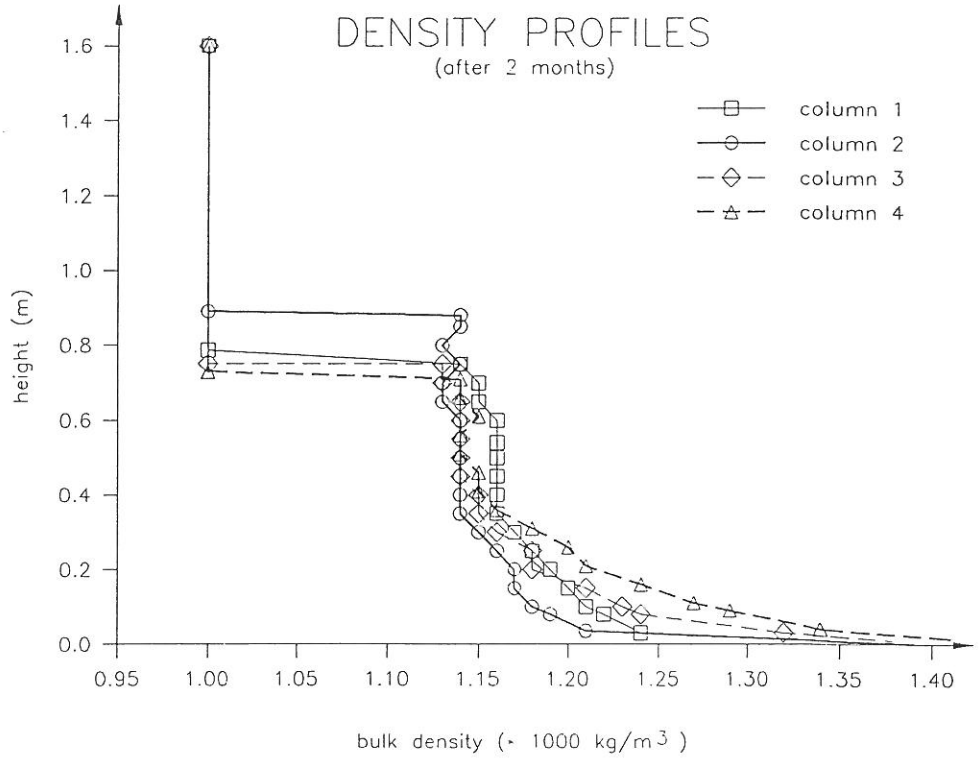

Figure 2

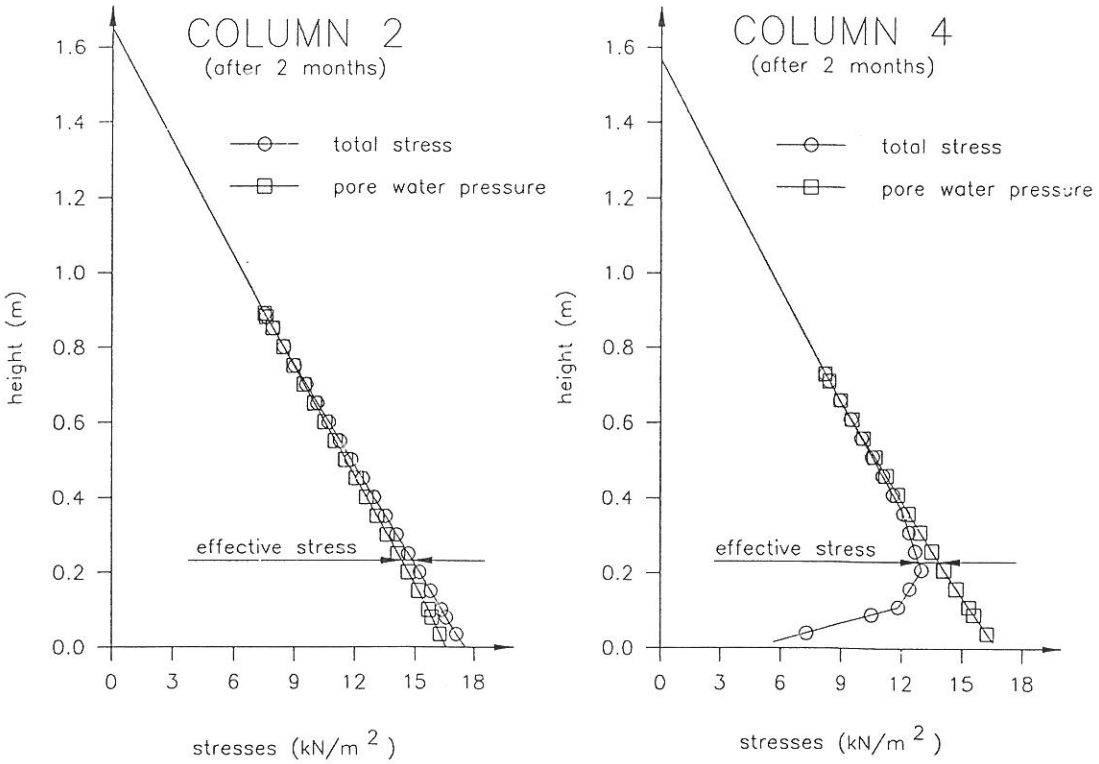

Figure 3 : stress distribution

and therefore is compressed, which results in the consolidation of the mudlayer as a whole.

FIG. 4 shows the variation of the global permeability of two drained columns with the increase of the mean dry density. The permeability decreases exponentially with dry density up to a certain limit, which in this experiment was larger than 1210 and 1240 kg/m^3 for a head difference of 0.8 and 1.6 m respectively. The permeability decreases slower when the head difference is large.

Further research will focus on
1. the effect of different sand content (mixtures),
2. the effect of layering of the sediment (introducing the material at different time intervals, thus simulating a tidal cycle), and
3. on the effect of the variation of the head difference with time: in particular, it would be of interest to take advantage of the faster consolidation due to a moderate head difference during the first period of consolidation, and afterwards of the faster consolidation due to a higher head difference (Fig. 1).

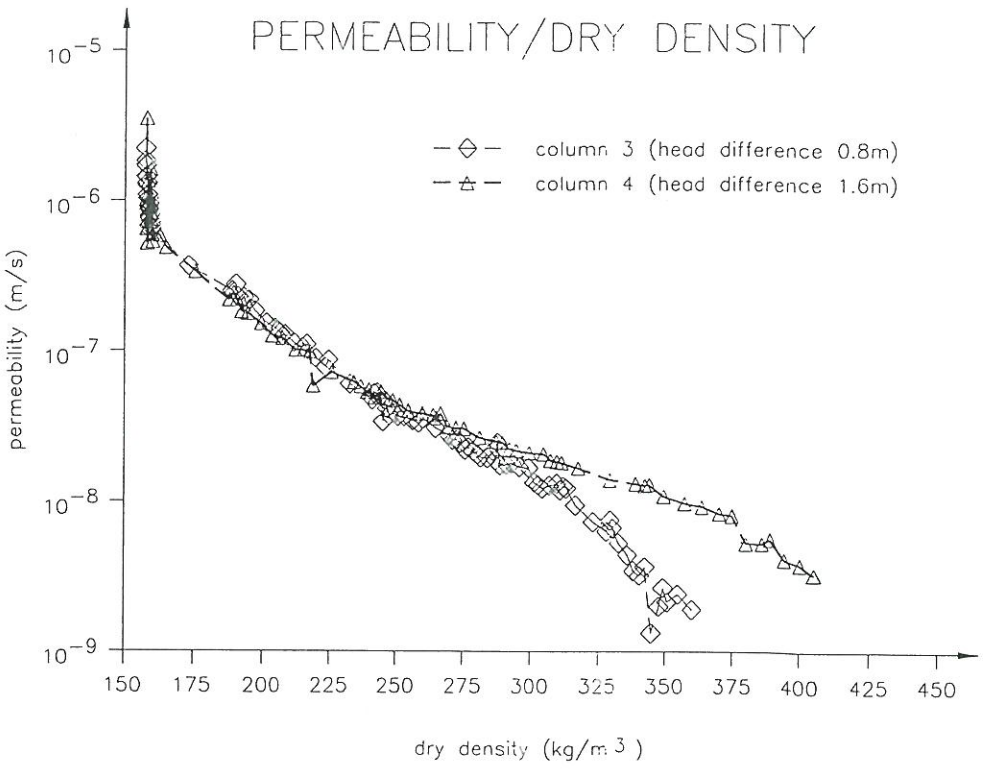

Figure 4