February 10, 2007

Analysis of the London Avenue Canal Load Test

Impeded Drainage Analysis

T.L. Brandon

Analyses have shown that when there is direct hydraulic communication between the canal water and the sand layer, high toe exit gradients and large uplift pressures can exist, even for modest canal water levels. If the canal was "silted in," then these exit gradients and uplift pressures are substantially reduced.

A finite element seepage analysis, using the program SLIDE, was conducted to determine the effect of "silting in" of the canal bottom on the pore pressures beneath the levee toe. This analysis was conducted with the idea that measurement of the pore pressure at the interface between the marsh layer and the sand layer at the levee toe could be a useful parameter to determine the appropriate time to terminate the canal load test.

The cross section analyzed represents the east bank I-wall just north of Mirabeau Avenue. This cross section was analyzed by the IPET team, and is termed "London South" in the IPET report. Failure occurred at this location as part of the Katrina event.

The cross section is shown in Figure 1. At the bottom of the canal, a 0.5 ft thick layer was added to represent the canal "silting in." The permeability of this "silt" layer was varied during the analysis. The protected side hydraulic boundary condition, located at the far left of the domain, was a constant head boundary assigned a head of -8.4 ft NAVD88. This represents a phreatic surface about 3 feet below the ground surface at that location. The canal water level was varied during the analysis from 4 ft to 7 ft. The permeabilities used are the same as used in the IPET report.

Shown in Figure 2 is a summary of the results of the analyses for the "no gap" condition. If the silt layer is assigned a permeability about two orders of magnitude less than that of the sand layer ($1x10^{-3}$ cm/sec versus 2×10^{-1} cm/sec), the effective stress at the marsh/sand interface is negative for canal water elevations from 4 ft to 7 ft, indicating a potential for heave. If the permeability of the silt layer is about three orders of magnitude lower than the sand ($1x10^{-4}$ cm/sec versus 2×10^{-1} cm/sec), the effective stress at the toe is positive for canal water elevations from 4 ft to 7 ft. When the permeability of the silt layer is $1x10^{-6}$ cm/sec, a further decrease in permeability no longer causes a decrease in the effective stress at the toe, and the silt layer is essentially an impermeable blanket. Therefore, the "silting in" of the channel bottom is very important for conditions where no gap has developed between the sheet pile and the canal side embankment.

Shown in Figure 3 is a summary of the results of the analyses for the "gap" condition. For canal water levels of 4 ft and 6 ft, permeability values of the silt layer as low as $1x10^{-7}$ cm/sec do not result in positive effective stresses beneath the toe. Therefore, the "silting in" of the channel bottom appears to have much less effect on erosion and heave conditions when a gap has developed between the sheet pile and the canal side embankment.

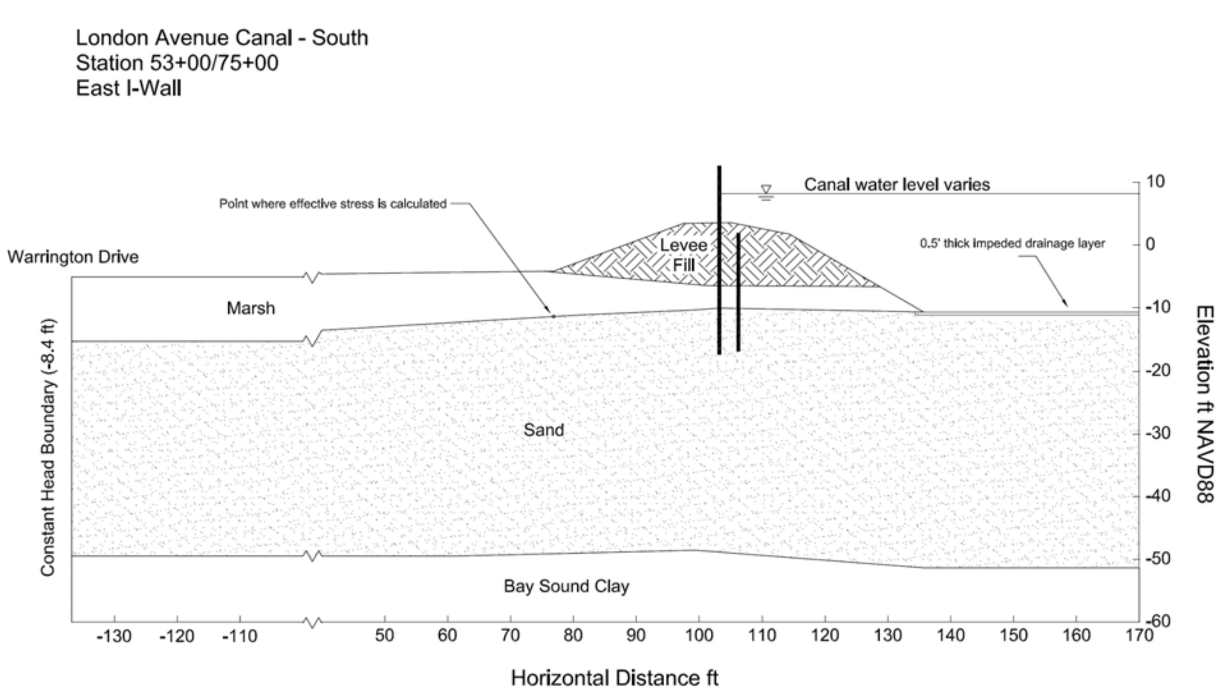

Figure 1 Cross section used for analysis of “silting up” of channel. This cross section was called “London South” in the IPET analysis.

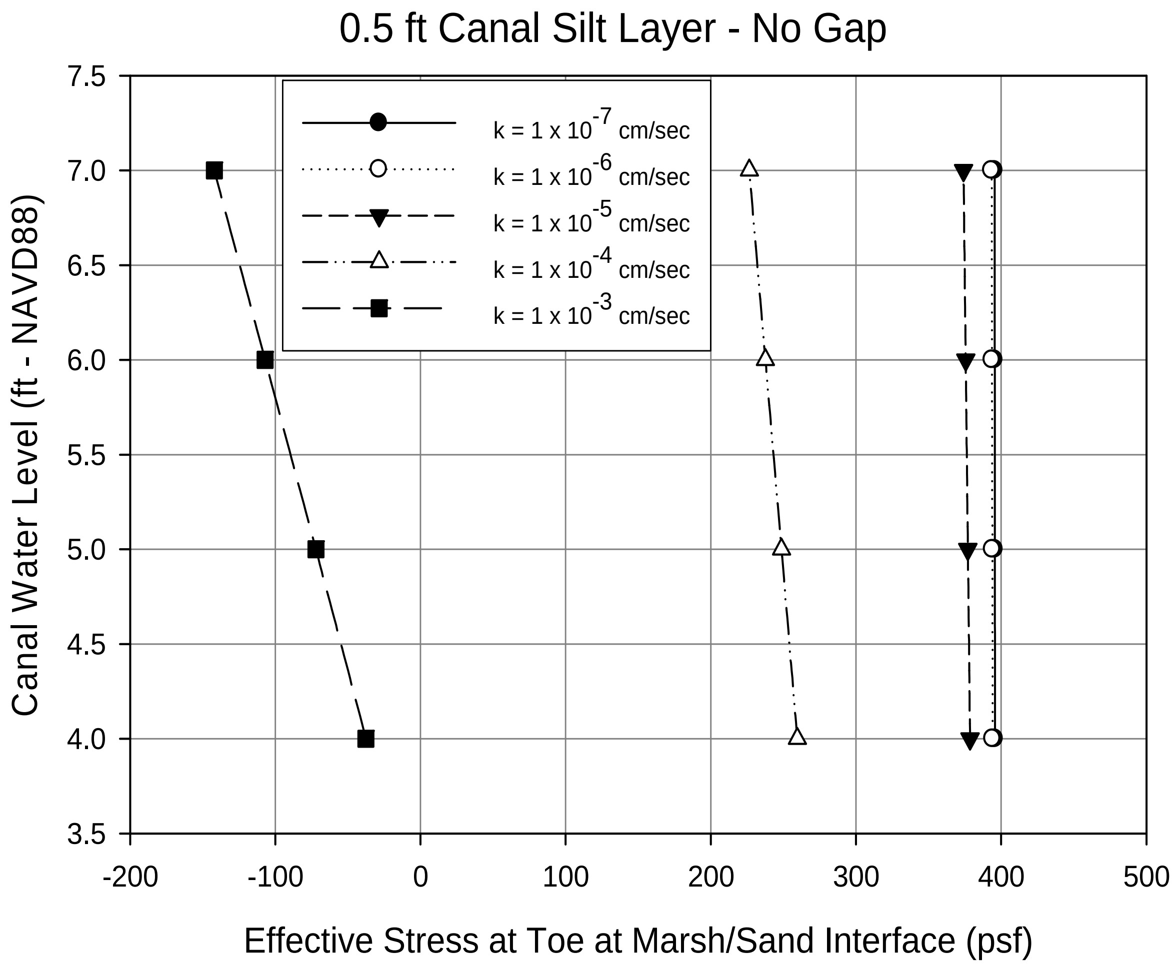

Figure 2 Effective stress beneath levee toe at sand/marsh interface for the “no gap” condition.

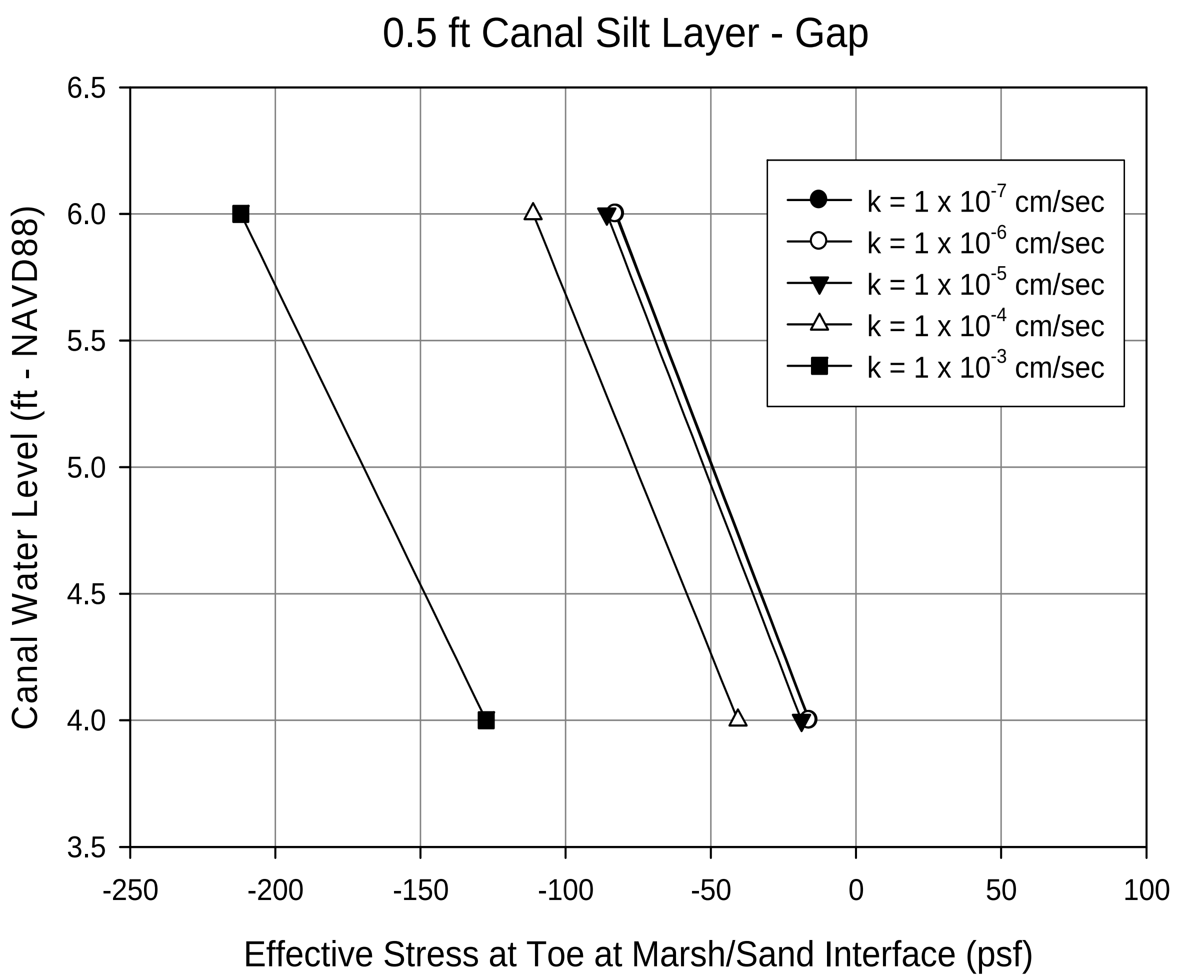

Figure 3 Effective stress beneath levee toe at sand/marsh interface for the “gap” condition.