BENTOMAT® IN SECONDARY CONTAINMENT APPLICATIONS THE POTENTIAL FOR HYDROSTATIC UPLIFT

This discussion addresses the possibility that subterranean hydrostatic pressures potentially present at a diked above ground storage tank site may affect the performance of the Bentomat geosynthetic clay liner (GCL). Although there is no field experience or hard data regarding the magnitude of the forces required to affect the Bentomat, a simple mathematical analysis can provide some insight into this phenomenon. Consider a scenario in which external hydrostatic pressures are present due to localized flooding around a diked containment area. In this case, there may be a hydraulic gradient towards the interior of the dike due to the head of water outside the dike:

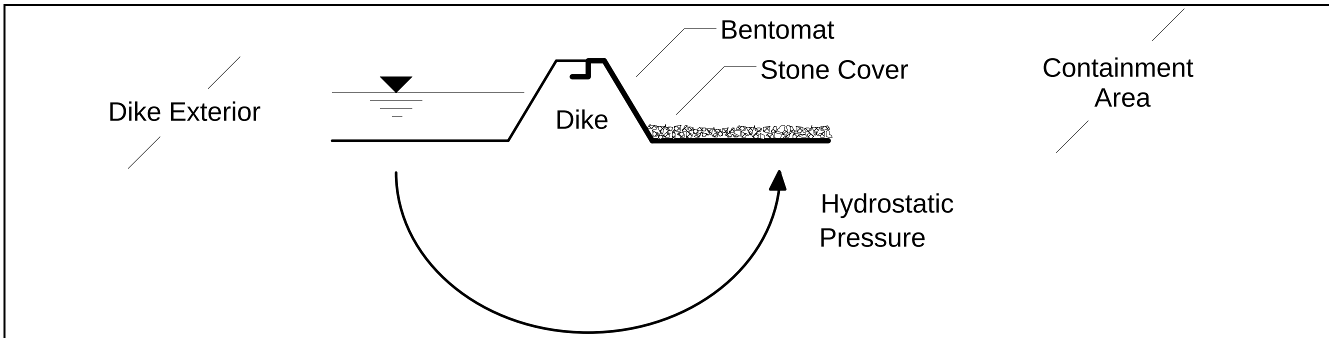

Figure 1

Applying the principals of hydraulics, we may assume that the uplift pressure on the Bentomat is equal to the difference in hydrostatic head levels outside and inside the dike. The Bentomat will be uplifted if the hydrostatic pressure from outside the dike exceeds the total weight of the liner and cover system inside the dike. In a typical Bentomat secondary containment application, the hydrated Bentomat has a weight of approximately 3.3 psf, and the stone cover has a weight of approximately 125 pcf, or 125 psf for a minimum 12-inch layer often specified. Thus, the total weight of the liner and cover system is 125 + 3.3 = 128.3 psf. Therefore, the force required to uplift the Bentomat must exceed 128.3 psf. Because water has a density of 62.4 pcf, this uplift force equates to 128.3/62.4 = 2.05 ft of water head.

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Assuming the dike interior is empty and that the subsoils are saturated (a necessary condition to provide a hydraulic connection to the liner system), it may be concluded that a water head outside the dike of approximately two feet is theoretically sufficient to cause uplift of the liner. In reality, there will be a significant head loss as water flows through the soils beneath the dike, which means a water head *greater* than two feet would be required to cause uplift.
It is important to note this is a "worst-case" scenario, which assumes that the soils surrounding the dike are entirely, saturated and are sufficiently porous to allow relatively unrestricted flow. It is further assumed the flooding is so extensive that the hydrostatic pressures would not be naturally relieved as the groundwater seeks the path of least resistance to flow. If these conditions could be present at the site, it may be necessary to institute one of the flood control measures suggested below:

1. Install a pressure relief system in areas of the liner where excessive hydrostatic pressures are anticipated. This system would consist of a pipe penetration through the liner, which hydraulically connects the subgrade to the interior of the containment area. A one-way flapper or ball valve would allow rising groundwater to enter into the dike during flood events, thus relieving the hydrostatic pressure. Water or spilled liquid could not flow in the opposite direction, however. This option is subject to regulatory approval and would also render it necessary to increase the total containment capacity of the dike system. Implementation of this concept would be relatively straightforward.

2. Design the liner system with a subdrain beneath the dike. Construction of the subdrain would involve the placement of a porous granular subbase and drain pipes to convey groundwater out from beneath the dike.

3. During the flood event, allow the interior of the diked area to collect rainwater, such that the hydrostatic head levels are equalized.

4. Design the liner system such that the cover is of sufficient weight to prevent uplift. A combination of soil and stone cover could be designed to provide a confining pressure greater than the maximum anticipated uplift force. This cover system would provide an added benefit of enhanced liner protection from traffic loading.

5. Design the liner system with a structural component (such as concrete) to be installed above the liner. The concrete would be able to withstand greater uplift forces.

6. Construct a perimeter cutoff wall in order to divert groundwater away from the dike. This could be accomplished by constructing a slurry wall or inserting sheet metal piling. The wall would eliminate the hydraulic connection between the dike and the groundwater.

The actual feasibility of any of these options depends on the magnitude and frequency of the flooding problem and other site-specific concerns.

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Lastly, the impacts of an uplift should be examined. If the uplift forces are high enough, the liner may be lifted. It is likely to assume that the overlapped seams are, structurally, the "weak points" in the liner system, and that the uplift pressure would be relieved by localized seam separation. Pressure relief in this manner would tend to minimize the damaging effects of the hydrostatic forces on the liner system, and the separated seam could likely be repaired by compacting the subgrade, cleaning the overlap area, and replacing the liner to its original position. Although a patch of new Bentomat may also be required in this area, there is no reason to suggest that a properly executed repair would be anything less than entirely functional in the event of a spill.

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