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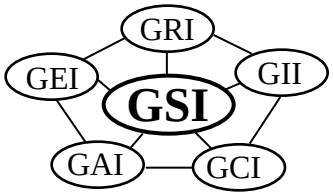

GSI White Paper #30

"In-Situ Repairs of Geomembrane Bubbles, Whales and Hippos"

by

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In-Situ Repairs of Geomembrane Bubbles, Whales and Hippos

Introduction

Unfortunately there are several common field situations where gases have impinged on the bottom of geomembranes with nowhere to go except upward thereby pushing against the geomembrane and exerting out-of-plane, or axisymmetric, pressure on it. Once initial geomembrane deformation occurs, these rising gases tend to concentrate in a localized area creating ever growing bubbles whether on land (as in landfill covers) or whales/hippos when in liquids covering a geomembrane liner (as in surface impoundments). Figure 1 shows a collection of bubbles in the final cover of landfills, the gas being largely methane from the degradation of the underlying waste mass. Figure 2 shows numerous whales or hippos (your choice of descriptive word) in surface impoundments, the gases coming from the underlying soil voids exacerbated by liquids from leakage getting beneath the geomembrane and forcing it upward. As X. S. Cao reports in the Journal of Environmental and Engineering Science (2014, in press) these whales/hippos have caused geomembrane bursting failures; they call them "explosions"!

In both land and water cases the situation is poor design to begin with in that there is generally no drainage or venting system beneath the geomembrane. Situations as shown in both figures are unfortunately not-so-rare occurrences. Remediation is obviously necessary before the geomembrane in question excessively thins or bursts and this white paper gives suggestions as to how one might proceed on land and in water.

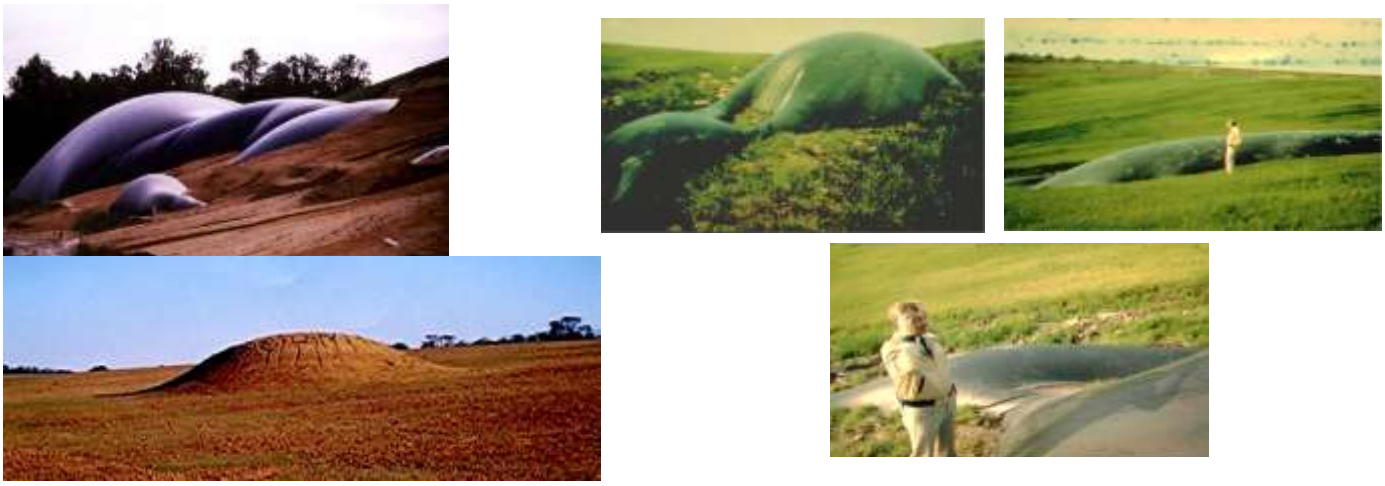


Figure 1. Various geomembrane "bubbles" through cover soils of landfills (photos compliments of SCS, Geosyntec, IFAI and GSI)

Figure 2. Various geomembrane "whales or hippos" expanding through and above the liquids of surface impoundments (photos compliments of GSI and IFAI)

Geomembrane Bubbles on Land as in Landfill Covers

Being accessible on firm ground surrounding a land bound bubble, the remediation situation is reasonably straightforward. Two scenarios are offered; one where the geomembrane has not thinned and the other where it has. For the nonthinned geomembrane situation the bubble is pierced at its highest point by maintenance workers using respirators. The bubble will

deflate and its condition can be assessed. If acceptable, a round hole is cut where it was initially pierced and a bulkhead (or Hayward) fitting is inserted, sees Figure 3a. This hole is sized according to the type of fitting selected, see Figure 3b. Take the fixed base of the fitting and push/wiggle it into the hole. As shown, it should be a tight fit. Then put the gasket on top of the geomembrane and thread the nut onto the fixed base of the fitting. An RTV adhesive might be needed. Tighten the assembly but not so much as to extrude the membrane out of its connection. Now you have the threaded end facing upward to fix anything onto it like the bicycle valve shown in Figure 3c. In this regard one might consider using a pressure release valve set at an appropriately low value so as to continually release gas buildup. See Figure 4 for the many types available. If future gas is to be collected, a pipe vent must be adapted to the pressure release valve as described in the next section.

(a) Bulkhead, or Hayward, fittings

(b) Base in hole in geomembrane

(c) Threaded nut on base with valve for air release

Figure 3. Final assembly ready for venting.

(ref. Wikipedia)

Figure 4. Various pressure relief valves and details of spring-loaded mechanism.

For the excessively thinned geomembrane situation, e.g., HDPE which is beyond its yield value, the maintenance workers, protected by respirators, pierce the bubble. When the gas dissipates the lateral extent of the thinned geomembrane can be assessed. It is cut back to where acceptable geomembrane exists. A relatively thick needlepunched nonwoven geotextile, which has been tailored to the appropriate shape of the bubble's footprint is slid under the opened geomembrane. The new and existing geomembranes are trimmed so as to have about 100 mm (4.0 in.) overlap and are seamed according to the specific geomembrane type by either fillet extrusion, hot air, solvent or adhesive. Lastly, at the highest point of the original bubble, a vent pipe is attached by means of a pipe boot so as to accommodate future gas release, see Figure 5. The gases will then be either vented, flared or captured depending on site-specific conditions. It might be added that future bubbles will likely occur at other locations and one could even envision the entire landfill closure be treated in a similar (and very expensive) manner.

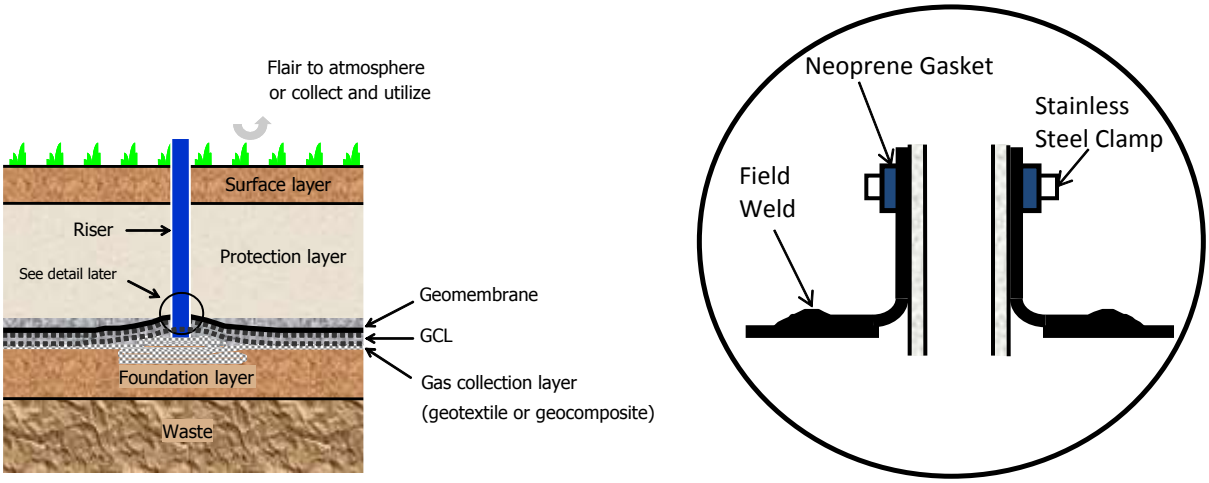
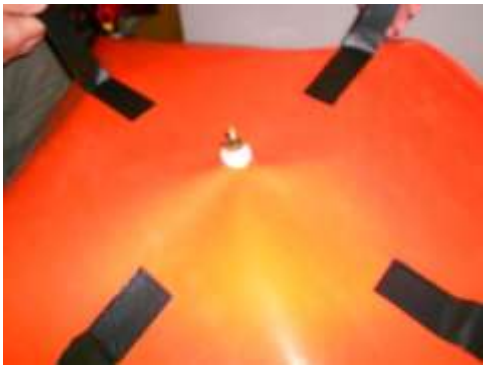


Figure 5. Venting system from a gas collecting geotextile beneath a geomembrane.

Geomembrane Whales/Hippos in Water as in Surface Impoundments

Assuming that the surface impoundment in which whales/hippos appear cannot be completely dewatered, one must work from rafts or rowboats within the surface impoundment. The whale/hippo is approached and the geomembrane is "grabbed" using vice-grip pliers (as shown in Figure 6a) if it is relatively thin and flexible, or "adhered to" with adhesive tape (as shown in Figure 6b) if it is relatively thick and stiff, e.g., HDPE, Denso Butyl 35 tape has been used with success even for HDPE in this regard.

(a) Gripping thin, flexible GM's with vice grips



(b) Gripping thick, stiff GM's with adhesive tape

Figure 6. Two different methods of attachment to whale/hippo.

In either situation the geomembrane is pierced at which point the gas will be released at least to the top of the water level surrounding the whale/hippo. While maintaining a hold onto the geomembrane (remember that only polyethylene's will float, all others will begin to sink), cut a round hole for insertion of a bulkhead fitting as shown in Figure 3. The terminus of the fitting will likely be a pressure release valve which must be set for the "back-pressure" of the maximum liquid head in the surface impoundment. In this sense it will just bubble or even burp the escaping gases to the surface. If water pressure is beneath the geomembrane it might rise again but not above the water's surface in the future.

Of course, all types of questions can be asked as to the permancy of such repairs but short of emptying the surface impoundment and proceeding as described previously with landfill bubbles the above method has been used somewhat successfully.

Summary

To be sure, at a site where they have appeared, additional bubbles or whales/hippos might very well occur in the future unless the source of the problem, i.e., rising gases and/or liquids, has been resolved or corrected. Bubbles, whales/hippos are the price one must pay for poor design. The lesson learned in this regard is that proper drainage design and subsequent

installation cannot be taken for granted when dealing with landfill covers or surface impoundments.