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Project Summary

Compilation of Information on Alternative Barriers for Liner and Cover Systems

David E. Daniel and Paula M. Estornell

On June 7–8, 1990, a workshop attended by approximately 75 people was held in Cincinnati, OH, to present and discuss alternative barriers for liner and cover systems for landfills, waste impoundments, site remediation projects, secondary containment structures, and other facilities. In some cases, the materials are being considered as an extra component of a liner or cover system, e.g., to back up a flexible membrane liner (FML), and in other cases the alternative barriers are being considered as a substitute for a thicker layer of compacted, low-permeability soil.

This report contains a compilation of information available concerning alternative barrier materials and summarizes the main points brought out in the workshop. There are four main alternative barrier materials currently being produced. Three of them consist of a thin layer of bentonite sandwiched between two geotextiles and the fourth consists of a thin layer of bentonite glued to an FML. All of the materials appear to have a very low hydraulic conductivity to water (between 1 x 10^{-10} cm/s and 1 x 10^{-8} cm/s, depending upon the conditions of testing). All of the materials are seamed in the field by overlapping sheets of the material and relying upon the bentonite to form its own seal when it hydrates. Data on the hydraulic integrity of the seams are much less complete compared to data on the materials themselves. The expansive nature of bentonite provides the bentonitic blankets with the capability of self-healing small punctures, cracks, or other defects. The materials have many advantages, including fast installation with light-weight equipment. The most serious shortcomings are a lack of data, particularly on field performance, and the low shear strength of bentonite. The advantages of alternative barrier materials are significant, and the materials warrant further evaluation.

This Project Summary was developed by EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

On June 7–8, 1990, a workshop attended by approximately 75 people was held in Cincinnati, OH, to present and discuss alternative barriers for liner and cover systems. Alternative barriers are thin, manufactured, low-permeability materials that are being used and being proposed for use in liner and cover systems for landfills, waste impoundments, site remediation projects, secondary containment structures, and other facilities. In some cases, the materials are being considered as an extra component of a liner or cover system, e.g., to back up a flexible membrane liner (FML); and in other cases, the alternative barriers are being considered as a substitute for a thicker layer of compacted, low-permeability soil.

There are four principal alternative barrier materials currently being produced. Three of them consist of a thin layer of bentonite sandwiched between two geo-

textiles, and the fourth consists of a thin layer of bentonite glued to an FML. All of the materials are seamed in the field by overlapping sheets of the material and relying upon the bentonite to form its own seal when it hydrates.

The purpose of this report is to summarize available information concerning alternative barrier materials, to identify concerns about the materials, and to identify research needs.

Procedure

This report was prepared from various sources, including reports prepared by independent testing laboratories that have tested the products for the manufacturers, a very limited amount of information in the literature, and information presented at the workshop. The information was collected, compiled, categorized, analyzed, and summarized in this report. Concerns about the materials and research needs were identified based upon discussions at the workshop.

Results and Discussion

One of the alternative barrier materials is Bentomat,* which consists of 1 lb/ft^2 (4.9 kg/m^2) of bentonite sandwiched between two geotextiles that are needlepunched together. Limited direct shear and tilt table tests produced failure along the contact between the Bentomat and adjacent materials, not through the bentonite. Hydraulic conductivity of small specimens permeated in the laboratory with water was found to vary with effective confining stress but is generally in the range of 10^{-9} to 10^{-8} cm/s for confining stresses of 8 to 12 psi (55 to 82 kPa). Practically no data were available on hydraulic properties of overlapped seams or hydraulic properties when the material was permeated with liquids other than water.

Claymax consists of 1 lb/ft^2 (4.9 kg/m^2) of bentonite sandwiched between and glued to two geotextiles. When sheared in-plane under fully hydrated and drained conditions, the angle of internal friction of the bentonite is approximately 10°. Hydraulic conductivity of small laboratory specimens was found to vary from approximately 1×8^{-8} cm/s at an effective confining stress of 2 psi (14 kPa) to 3×10^{-10} cm/s at an effective confining stress of 30 psi (207 kPa). Hydraulic conductivity to chemicals was found to vary with the chemical and to be very sensitive to whether or not the bentonite was prehydrated with water prior to introduction of the chemical. The material possesses some self-healing capacity and is able to recover, to some extent, low hydraulic conductivity if the material desiccates and then rehydrates or if the material is punctured. Under carefully-controlled test conditions, overlapped seams were found to self-seal, provided the minimum recommended overlap width (6 in. or 150 mm) was provided.

Gundseal consists of 1 lb/ft^2 (4.9 kg/m^2) of bentonite glued to a 20-mil (0.5 mm) high density polyethylene (HDPE) sheet. Practically no data were available on the hydraulic conductivity of the bentonite or the shear strength of the material. Under carefully-controlled test conditions, overlapped seams were found to self-seal, even with as little as 1.5 in. (38 mm) of overlap.

Bentofix is similar to Bentomat in that bentonite is sandwiched between two geotextiles that are needlepunched together. The angle of internal friction for in-plane shear through the bentonite was found to be approximately 30° in one series of tests. The hydraulic conductivity of small samples of the material is reported to be approximately 1×10^{-9} cm/s. Information on other characteristics of the material could not be located.

Various other alternative materials have been proposed. Flyash-bentonite-soil mixtures show promise in terms of providing low hydraulic conductivity and high strength. Super-absorbent geotextiles, such as Fibersorb, have been proposed. Sprayed-on geomembranes, applied to a bentonitic blanket material, have been manufactured.

Conclusions and Recommendations

There are fundamental differences between low-permeability, compacted soils and the alternative barriers identified in this report. The alternative barrier materials should not be thought of as "equivalent" barriers. For example, the alternative barriers are all much thinner than compacted soil barriers and can never be equivalent in this respect. However, it is conceivable that the alternative barrier materials may be able to provide equivalent hydraulic functions and serve other important functions adequately well.

The potential advantages of alternative barriers (compared to low-permeability, compacted soil) are (1) rapid and simple installation of the alternative barrier; (2) the potential for a more predictable end-product with manufactured, alternative barriers; (3) a more predictable cost for alternative barriers that in some instances may be much lower than for compacted soil; (4) the possibility of utilizing light-weight equipment to install alternative barriers, which minimizes the risk of damaging underlying materials, e.g., FMLs; and (5) the possibility of developing a detailed data base on an alternative barrier material so that the data base does not have to be recreated for every project.

The main disadvantages of alternative barrier materials are (1) a general lack of data and independent research; (2) lack of field experience and performance data; (3) vulnerability to puncture; (4) the possibility of chemical attach of the bentonite; (5) uncertainties about performance of seams; and (6) low shear strength of bentonite.

The research needs, in order of priority, appear to be (1) characterization of the shear strength of the materials; (2) determination of the hydraulic properties of the materials for both water and waste liquids; (3) documentation of performance of seams; and (4) determination of probable long-term performance in the field and useful life.

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* Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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David E. Daniel and Paula Estornell are with the University of Texas, Austin, TX 78712.
***Walter E. Grube, Jr.**, is the EPA Project Officer (see below).*
The complete report, entitled "Compilation of Information on Alternative Barriers for Liner and Cover Systems," (Order No. PB91-141846/AS; Cost: $17.00, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650
The EPA Project Officer can be contacted at:
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