DISCUSSION

T. B. Edil[1] *(written discussion)*—The author concludes that the double ring separates the side flow. Does he have a test where he has side flow but no cracks in the center to prove this?

D. C. Anderson, W. Crawley, and D. Zabcik (authors' closure)—A test of this type is built into every permeability study. After compaction and before permeation by the test liquid, all samples are permeated by water. This yields a baseline permeability for both the inner and outer chambers. If there is significant sidewall flow, it is immediately apparent as a higher permeability in the outer chamber. Generally, 20 to 30% of the samples are discarded because of unacceptably high rates of sidewall flow. Routine inspection of these discarded samples has not revealed any obvious imperfection such as the cracks or aggregations seen in samples permeated by organic liquids.

T. B. Edil (written discussion)—How does he apply Darcy's law to the double-ring permeameter?

D. Anderson, W. Crawley, and D. Zabcik (authors' closure)—Darcy's law was applied as shown in the materials and methods section using values given in Table 1. Values for the cross-sectional area were determined as follows (see Fig. 2):

1. For the inner chamber, the area used was that inside the inner ring.
2. For the outer chamber, the area used was that inside the outer ring minus the area inside the inner ring.

C. M. Jones[2] *(written discussion)*—For the cracks shown in clay liners, what was the degree of compaction?

D. C. Anderson, W. Crawley, and D. Zabcik (authors' closure)—The soil-slurry mixtures discussed in the paper were not compacted. During the presentation, however, examples of laboratory and field clay liners with cracks were shown. The field clay liners had been compacted but the degree of compaction is unknown. The laboratory clay liner had been compacted to 95% of standard Proctor.

C. M. Jones (written discussion)—If the clay is compacted to a high density, such as 90% of standard Proctor, how much cracking occurs?

D. C. Anderson, W. Crawley, and D. Zabcik (authors' closure)—Many factors affect the extent, if any, that compacted clays will crack upon either

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desiccation or exposure to concentrated organic liquids. For instance, Seed and Chan (1959)[3] found that both water content and the method of compaction would affect the shrinkage potential.

G. W. Gee[4] *(written discussion)*—Is there any justification to running your fixed-wall permeability tests without any vertical confinement?

D. C. Anderson, W. Crawley, and D. Zabcik (authors' closure)—The double-ring test was developed to evaluate the compatibility of barrier materials for various permeant liquids rather than to exactly duplicate barrier trench conditions. Little or no vertical confining pressure would, however, be representative of conditions near the surface in a barrier trench. In addition, many barrier materials become stiff after consolidating (as with bentonite-soil materials) or setting (as with soil cement or asphalt-cement emulsions). These barrier materials can have localized areas of low vertical confining pressure due to arching.

The first series of tests evaluated two types of barrier material (asphalt-cement emulsion and "contaminant-resistant" bentonite clay) exposed to concentrated organic liquids (miscible and immiscible). These tests were all conducted using no vertical confining pressure. Additional tests are planned that will evaluate these barrier materials permeated by several dilutions of miscible organic liquids and under a range of overburden pressures.

G. W. Gee (written discussion)—Can't vertical confinement, including overburden pressures, etc., drastically affect your permeability test results?

D. Anderson, W. Crawley, and D. Zabcik (authors' closure)—Overburden pressure generally results in a decreased permeability for most barrier materials. The question that remains to be answered is whether larger overburden pressures would reduce the permeability increases observed in bentonite materials exposed to concentrated organic liquids at low overburden pressures.

G. W. Gee (written discussion)—Wouldn't there tend to be considerably less swelling and shrinkage of "active" soils, such as smectites, if the sample is confined vertically or put under some vertical stress?

D. Anderson, W. Crawley, and D. Zabcik (authors' closure)—Increasing vertical confining pressure would result in decreased vertical swelling. Such a vertical load, however, would have little effect on lateral shrinkage and would tend to increase vertical shrinkage.

G. W. Gee (written discussion)—What would be the effect of very low concentration (500 ppm) xylene on smectite clay permeability?

D. Anderson, W. Crawley, and D. Zabcik (authors' closure)—Several studies have found that xylene at its solubility limit (less than 200 ppm in water at 25°C) has no discernable effect on the permeability of clay liners. If concentrations greater than the solubility limit are found, a separate, concentrated, immiscible layer of xylene may well be floating on the sampled water.

[3]Seed, H. B. and Chan, C. K., "Structure and Strength Characteristics of Compacted Clays," *Journal of Soil Mechanics and Foundation Division*, Proceedings, ASCE, 85, SM5, Oct. 1959.

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