Equal Rights for Grouters

Dr. Donald A. Bruce

"Grouting doesn't work!" - for some of us, the three most dreaded words in the English language. We hear it from disillusioned consultants who have, as a last desperate resort, been forced to try grouting as the immediate solution to the impossible problem. We infer it from the number of major dam owners now suffering from leaky dams as a result of flawed grouting practices in earlier decades. And we certainly get it from contractors who have been ripped off by so-called experts who have been paid by the gallon of grout pumped, and not by the results achieved.

Now, we do accept that grouting, like every other specialist geotechnical technique, has its limitations. We do acknowledge that aspects of its design and execution, especially in the U.S., have now been exposed as inappropriate. We cannot deny that it has traditionally created more than its fair share of income for attorneys and their ilk. However, there are those of us who firmly believe that grouting can be made to work if it is aptly applied, properly designed, conscientiously executed and equitably rewarded.

A paper recently presented at the ASCE Convention in San Francisco confirms this view. The paper is a structured compendium of published case histories of major dam repairs by grouting. It illustrates how modern grouting techniques have been used to seal existing concrete and embankment dams against seepage through, around, and under these structures. It shows how the same techniques can be used to fill voids caused by erosion, and strengthen heterogeneous rock masses to prevent differential settlement and unacceptable lateral deflections. Today, at least as significant is its more recent emergence as a reputable and controllable engineering tool to combat liquefaction potential in susceptible foundation soils.

Despite this body of evidence, the grouting brotherhood has the distinct feeling that it is an oppressed and repressed minority. The main focus of this ire (some would say jealousy) is its perception that the major dam repair market is falling prey to the apparently indiscriminate use of the diaphragm wall (slurry trench) as the universal solution to sealing existing embankment dams. Using a sporting parallel, some of the brothers liken it to the current obsession in the NFL with the "run and shoot" offense, and readers in Detroit and Atlanta may draw their own conclusions.

Grouters feel that the growing popularity of diaphragm walls in existing dams is a result of several factors, but principally a historic distrust of grouting on the one hand, and a fantastic promotional campaign by vested interests on the other. These interested parties include certain consultants, out to establish a new "niche" in the market, and certain (European) specialist contractors who are trying to shape the dam remediation market in North America to suit certain exclusive skills and equipment. We find it rather droll that our (European) brothers note that these same (European) specialist contractors systematically have repaired their leaky (European) dams by grouting.

It would be wrong to think that this viewpoint is entirely due to sour grapes (and empty pockets) amongst the brothers. No sir, not entirely, and, in fact, many of us are also actively involved in the diaphragm wall technique as used in other markets. We have followed the progress of these diaphragm wall contracts over the past few years in the popular and technical press, and the (sour) grapevine. We would be almost the first to admit that there have been stunning successes, wherein the concept and design of the solution, and the efforts of the contractors have been outstanding. However, we would certainly be among the first to ponder on some of the darker facets of this phenomenon.

> *Example 1* - A 127 m high dam in Washington where massive escape of slurry during trench excavation caused fundamental splitting of the embankment. With great aplomb, however, the contractor negotiated a huge remedial grouting extra, to repair the dam --- to allow the continued construction of the diaphragm wall.
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> *Example 2* - An important utility-owned dam in the Northeast where the glacial foundation material has again defied attempts to economically excavate it. In this instance, an intensive grouting operation was conducted over 30 years ago, and which yielded impressive results - within the barriers of the contemporary technology.
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> *Example 3* - A landmark dam repair in the East, where intensive monitoring has been maintained for well over 10 years. One writer recently concluded "____ site observations

indicate that the embankment has performed in a satisfactory manner; however, near the tie-in of the embankment wall and the concrete-gravity structure, the piezometric head drop across the wall has been less than was expected."

Example 4 - A more recent, extremely well publicized repair of a major embankment dam in the Southwest. During construction there were five separate major losses of slurry at various times, the largest being about 400 m^3 of slurry and 80 m^3 of sand and gravel. In one instance 15-40 m^3 of slurry was observed to exit 120 m "downstream at the dam's groin." Again the brothers have noted the comment that "the area was then grouted and wall construction was completed successfully ... ." So, having finally built this "positive" cut-off, how did it function? "The amount of seepage stopped by the wall is, however, not as much as had been hoped for. Water levels in the downstream portion of the embankment immediately adjacent to the wall dropped a maximum of 30 feet. This was less than anticipated." "The piezometric contours within the core did not change substantially." "All (wall) panels have cracks which are presumed to be caused by shrinkage", although we must admit that they were "predominantly not open." "The joints between the panels were found to range from concrete to concrete bonding with a thin bentonite coating to some with 1/4 inch bentonite seams between the concrete." This state of affairs does not seem to have caused undue alarm to the owner, although the brothers would regard these observations in a 80 cm wide membrane 120 m deep as being, perhaps, potentially classifiable as defects.

Some of you may think we have been highly selective in extracting the above information, without referring to the trouble-free repair of the handful of other dams repaired recently with diaphragm walls. We do not deny it. You may even think we are even taking cheap xenophobic shots at the diaphragm wall industry as applied to existing dams, and you may well be right. However, the brothers felt that we should set out the other side of the argument, because feelings are running high in our community.

We're tired of being prevented from drilling 10 cm diameter holes through dam cores, for fear of causing hydrofracture, whereas others are permitted to open up (and fill with bentonite slurry, sand and gravel) panels perhaps 1 m thick, 10 m long, and 120 m deep. We don't understand the logic, especially given recent developments in overburden drilling technology.

We're tired of hearing that grouting is precluded "because we tried it years ago and it was not good." What happened in the days of our industry's dinosaurs and black magicians, and hamstrung inspectors, really has little bearing on the potential of the techniques and materials we now have at our disposal today, as grouters.

Grouters should not fall into the trap, on the other hand, of advocating grouting for every problem involving seepage, settlement or liquefaction: we must acknowledge - however painful it may be to some of us - that diaphragm walls are the logical solution at times, and we should be ready to bid accordingly.

All we ask for, however, it the right to be heard, the right to introduce and describe the new grouting technologies and materials, and the right to bid grouting based alternatives to open-minded owners, given the appropriate application.

Already we hear the cry of "Death to the Diaphragm!" in certain (albeit biased) circles. Perhaps it would be kinder and gentler to instead press for "Equal Rights for Grouters" as the rallying call?

References

Bruce, D.A. (1990), "The Practice and Potential of Grouting in Major Dam Rehabilitation". ASCE Annual Civil Engineering Convention, Dan Francisco, CA, November 5-8, Session T13, 41 pp.

Bruce, D.A. (1990), "Major Dam Rehabilitation by Specialist Geotechnical Construction Techniques: A State of Practice Review". Proc. Canadian Dam Safety Association 2nd Annual Conference, Toronto, Ontario, September 18-20, 63 pp.

Bruce, D.A. (1989), "Methods of Overburden Drilling in Geotechnical Construction - A Generic Classification". Ground Engineering, 22 (7), pp. 25-32.

Also ICOLD (1988) Transactions: Minutes of the Sessions, Volume 5, San Francisco, CA, June 13-17, 877 pp.

USCOLD (1990), "Dam Foundation Engineering". Proc. 10th Annual USCOLD Lecture Series, New Orleans, LA, March 6-7.

Dr. Donald A. Bruce, Technical Director, Nicholson Construction of America, P.O. Box 308, Bridgeville, PA, USA 15017.