EGG-M--42487

DE89 009730

EGG-M-42487
CONF-880903--49

Received by OSTI

APR 13 1989

IN SITU GROUTING FOR IMPROVED CONFINEMENT OF BURIED TRU WASTE AT THE IDAHO NATIONAL ENGINEERING LABORATORY[a]

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INTRODUCTION

In situ grouting was experimentally examined as an improved confinement technique for buried transuranic (TRU) waste in a simulated waste trench at the Idaho National Engineering Laboratory (INEL). Prior to 1970, the INEL Radioactive Waste Management Complex (RWMC) served as a disposal site for defense-generated TRU waste. Between 1953 and 1970, approximately 56,000 m^3 of TRU waste were buried in shallow-land-filled trenches. As part of the Department of Energy's (DOE's) charter for managing the TRU waste,[1] improved confinement techniques are being examined as a long-term management alternative. The object of the INEL in situ grouting study was to examine the capability of the in situ grouting technique to reduce voids in the waste and to hydrologically isolate the waste. To be considered a successful candidate for long-term confinement of the TRU waste, the acceptance criterion was that the grouted trench have a hydraulic conductivity no more than 1×10^{-8} cm/s, which is 100 times less than the undisturbed soil of the RWMC. In addition, the injected grout must reduce accessible voids by 80%.

DESCRIPTION OF EXPERIMENT

The experimental waste trench was constructed adjacent to the TRU waste disposal area of the RWMC in a manner similar to the actual TRU waste pits. The waste trench (approximately 6.1 m long x 3.9 m deep x 2.4 m wide) consisted of three basic zones: randomly dumped 55-gallon drums, vertical stacked drums, and stacked boxes. All zones were backfilled with soil and consolidated with heavy equipment similar to actual RWMC operations. The drums and boxes contained simulated sludges, metals, and combustibles typical of the waste materials found in the RWMC.

Instrumented screened wells were placed throughout the waste trench to determine hydrological conductivity, void distribution, and the temperature associated with the heat of hydration of the grout material. The waste trench was consolidated to simulate aging by injecting 19.38 m^3 of water into screened wells, while the edges of the trench were compacted with a vibrating hammer. Prior to the grouting operation, the accessible voids within the test trench were estimated to be 5.88 m^3 and the hydrological conductivity was measured as 5.9×10^{-3} cm/s.

An in situ grouting technique, developed by Rockwell Hanford Operations (RHO),[b] using an ultrafine grout and dynamic compaction, was used to grout the test trench. Dynamic compaction was accomplished by using an I-beam (see Figure 1) driven into the trench by a vibrating hammer. An ultrafine particulate grout, MC-500 (trademark), was injected into the trench through the end of the I-beam as the I-beam oscillated.

RESULTS

The viability of using in situ grouting as an improved confinement technique focused on the amount of compaction of voids in the waste trench and the decrease in hydraulic conductivity in the waste trench. The compaction of voids and the decrease in hydraulic conductivity were determined by comparing pre-grouting and post-grouting data. In addition, a destructive examination was performed to determine deposition of the grout material.

[a]Work supported by the U.S. Department of Energy under DOE Contract No. DE-AC07-76ID01570.

[b]Mention of specific products and/or manufacturers in this document implies neither endorsement or preference nor disapproval by the U.S. Department , any of its agencies, or EG&G Idaho, Inc., of the use of a specific product for any purpose.

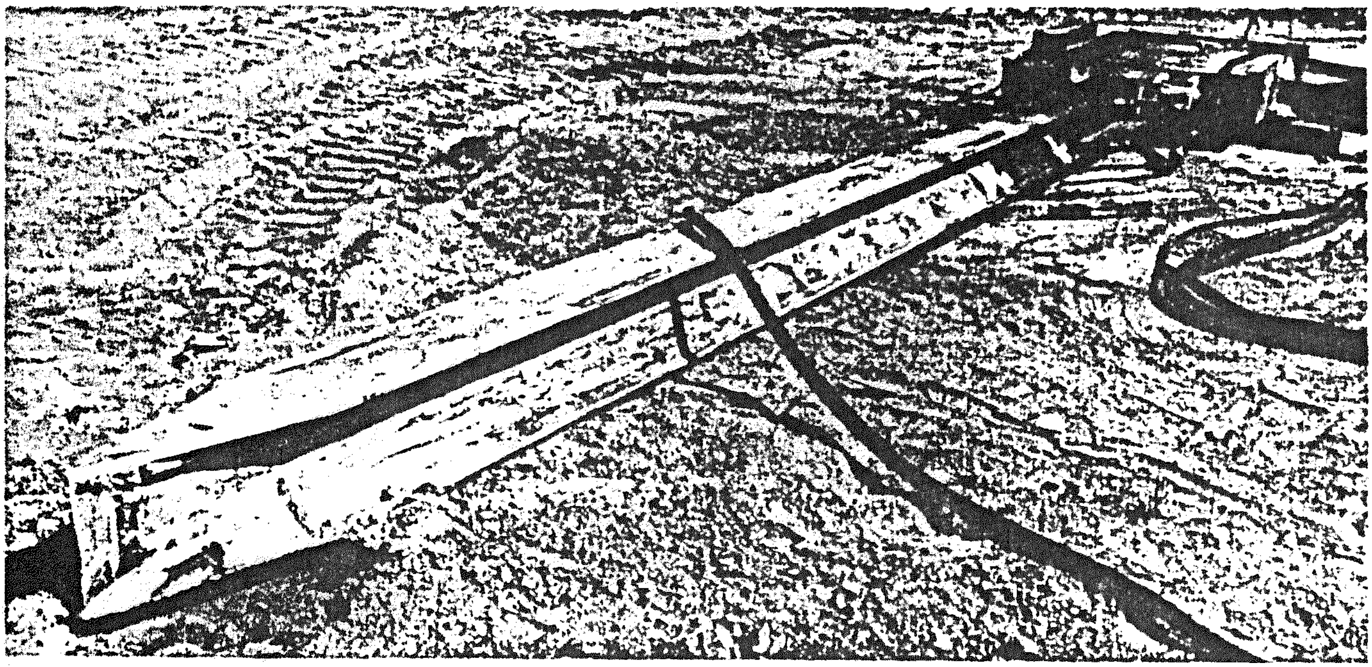

Fig. 1. RHO dynamic compaction device--vertical I-beam driver.

The RHO dynamic compaction process caused a considerable redistribution of voids in the waste trench such that the voids were more accessible to grout take. The pre-grouting estimation of voids in the waste trench was 5.88 m^3 which compares to the grout take of 11.03 m^3. Since the voids were reshaped into configurations that made them more readily accessible to grout take, it is difficult to assess the acceptance criterion that at least 80% of the voids be filled with grout. However, the fact that the quantity of grout take was so much higher than anticipated from the original estimate implies that the 80% criterion was met.

A hydrological assessment of pre- and post-grouting conductivities indicated that hydrological confinement (10^{-8} cm/s conductivity) was not achieved. The grouting process decreased the pre-grouting hydraulic conductivity from 5.9×10^{-3} cm/s to about 5×10^{-5} cm/s, as shown in Table 1; however, this was not enough to be considered hydrologically confined. The basic reason that the operation failed was that the grout could not penetrate the soil types of the Subsurface Disposal Area (SDA) at the RWMC, which are primarily loess-type fine-grained soils. The grout was effective at filling large, readily accessible voids such as boxes, but was not effective in grouting the waste within the drums or the soil surrounding the waste containers.

A destructive examination of the simulated waste trench revealed that the injection/compaction process dislodged simulated waste from the containers allowing it to intermix with the grout. The grout tended to form vertical columns surrounded by ungrouted soil near the I-beam injection pass as shown in Figure 2. Details in the destructive examination and the void compaction and hydraulic conductivity are found in Reference 5.

TABLE 1. AVERAGE TRENCH HYDRAULIC CONDUCTIVITIES FOR THE IN SITU GROUTING STUDY

Condition of Trench	Hydraulic Conductivity (cm/s)
Pre-consolidation	8.6×10^{-2}
Post-consolidation/ Pre-grouting	5.9×10^{-3}
Post-grouting	5.90×10^{-5} [a] 3.99×10^{-5} [b] 9.35×10^{-5} [c]
Undisturbed SDA soil	1.0×10^{-6}

a. Determined by constant-head, steady-state method.[2]

b. Determined by nonsteady head buildup.[3]

c. Determined by Hvorslev method.[4]

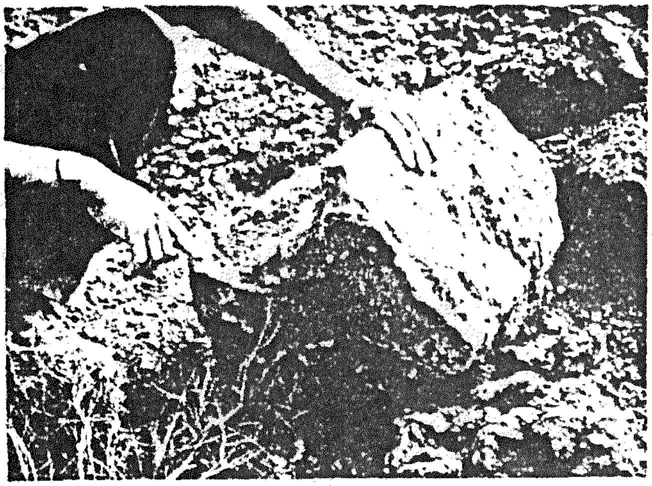

Fig. 2. Section from a vertical grout column resulting from an injection pass.

CONCLUSIONS

The field study provided overwhelming evidence that in situ grouting of simulated TRU waste with an ultrafine particulate cement, using the dynamic/compaction grouting technique in INEL's RWMC fine-grained soils, will not result in hydrologic isolation of the waste. The grouting operation did not result in hydrologic isolation of the test trench since the grout could not permeate the soil that surrounds the waste containers. The grout was effective at filling large, readily accessible voids, but was not effective in grouting the waste within the drums or surrounding the waste containers with cement. Post-grouting hydraulic conductivity was approximately three to four orders of magnitude greater than that necessary to provide hydrologic isolation.

The RHO dynamic compaction technique offers a potential for redistributing voids within the waste trench into voids that are readily accessible by grout. This tends to stabilize the waste form and could be used as a technique for creating a stabilized pit that would serve as an installed engineered barrier.

REFERENCES

1. U.S. Department of Energy, "The Defense Waste Management Plan," April 1983.

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4. M. J. Hvorslev, "Time Lag and Soil Permeability in Groundwater Observation," U.S. Army Corps of Engineers, Waterways Experiment Station, Bulletin No. 36, 1951.

5. G. G. LOOMIS and J. O. LOW, "Annual Technology Assessment and Progress Report for the Buried Transuranic Waste Studies Program at the Idaho National Engineering Laboratory (1987)," EGG-2525, January 1988.