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DEVELOPMENT OF GAGE CANISTER RECOVERY TECHNIQUE.(U)

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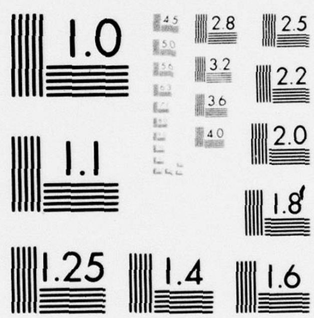

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DEVELOPMENT OF GAGE CANISTER RECOVERY TECHNIQUE

February 1977

Final Report

AIR FORCE WEAPONS LABORATORY
Air Force Systems Command
Kirtland Air Force Base, NM 87117

This final report was prepared by the Air Force Weapons Laboratory, Kirtland Air Force Base, New Mexico under Project ILIR-75-09. Mr. David J. Fogelson (DED) was the Laboratory Project Officer-in-Charge.

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DAVID J. FOGELSON
Project Officer

FOR THE COMMANDER

RUDOLPH V. MATALUCCI
Lt Colonel, USAF
Chief, Development Branch

FRANK J. LEECH
Lt Colonel, USAF
Chief, Civil Engineering Resech
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Because of the high cost of ground motion transducers used in high explosive simulation testing, a program was initiated to determine the feasibility and cost effectiveness of recovery techniques to retrieve and reuse the transducers. In-house research produced two approaches for recovery: (1) using a backhoe; and (2) overcoring with a drill rig. After a number of attempts using both methods, it was determined that the overcoring recovery technique was a failure because of differential displacement of the grout column during the explosive test.

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SECTION I

INTRODUCTION

The idea of recovering ground motion canisters to reuse the gages contained in them is now new. It has been accomplished on a limited scale of effort throughout the Air Force Weapons Laboratory's High Explosive Simulation Technique (HEST) test series over a number of years, but most of the recovery was accomplished for posttest analysis of the gages--particularly failure modes. There has never been a concerted effort to recover and reuse the gages for a subsequent test series.

The ground motion canisters were installed in bore holes which were backfilled with a soil matching grout (refer to figure 1). Normally after a test event, the canisters were left intact on the test site. In recent years, the price of the gages used to measure ground motion has increased. For example, accelerometers presently cost approximately $450 each. Up to three gages may be installed in each ground motion canister; therefore, it is readily apparent that if some of the gages could be economically recovered in working condition, a considerable amount of money could be saved in fielding succeeding tests.

Consequently, a project was undertaken to determine the feasibility and cost effectivenss of recovering ground motion canisters. Two approaches were evaluated. One approach was to use a backhoe to recover canisters at depths of 12 feet or less. The other approach was to use a drill rig with a core barrel to retrieve canisters from greater depths. These methods were tried during the HARD-PAN I test series conducted near Trading Post, Kansas.

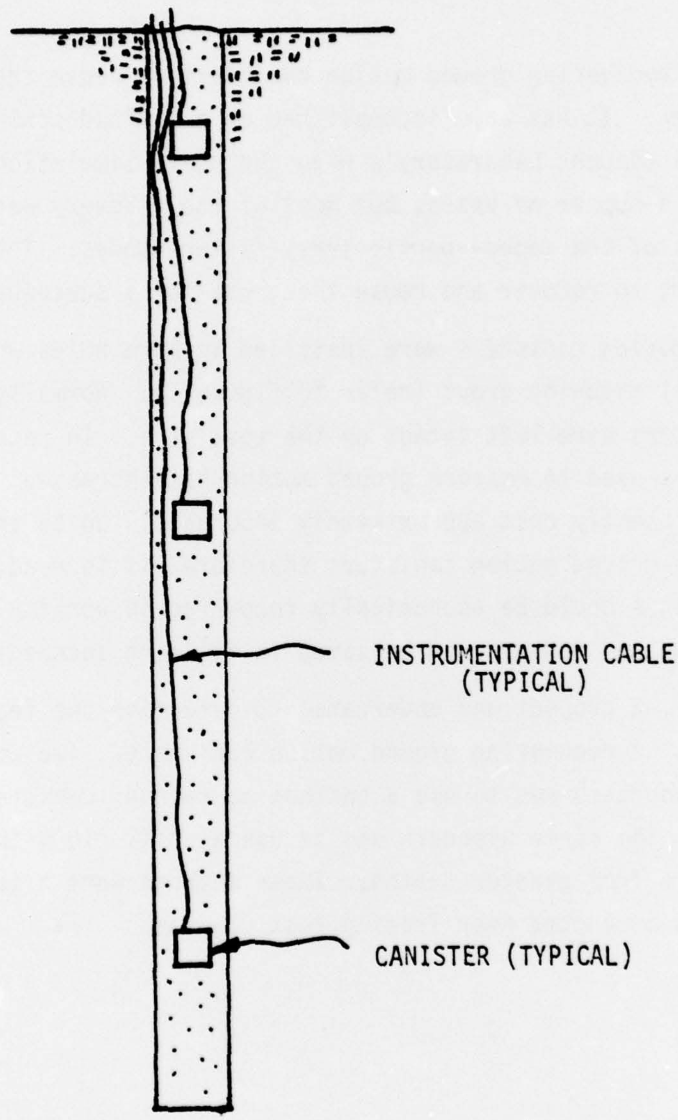

Figure 1. Typical Canister Installation

SECTION II

GAGE CANISTER RECOVERY TECHNIQUES

BACKHOE TECHNIQUE

The method of recovery with a backhoe was quite simple. The backhoe was positioned to dig down along one side of the grout column and a trench was dug next to the column to a depth slightly below the position of the canister. Field crew members descended into the trench, chipped the grout away from the canister, and removed the canister. This method is illustrated in figure 2. The method was employed successfully on a number of different test beds at the HARDPAN I test site.

This recovery method was cost effective. A backhoe and operator cost $35 per hour. The survey costs were $10 per hour. The equipment and services were provided by Rutherford Construction Company, the site contractor. It took approximately one hour of surveying to find the location of a grout column and one-half hour to dig the trench with the backhoe. If only one gage per two canisters recovered was in operating condition out of a potential six gages, the Government would save approximately $390.

OVERCORING TECHNIQUE

The overcoring technique was initially considered to be a viable method of recovering gage canisters located deeper than 12 feet. This method was proven to be not feasible after field experimentation was conducted. The approach was straightforward. A drill rig and core barrel were used to overcore a grout column and to pull the entire column out of the ground. For this operation, the equipment and crew were supplied by the U.S. Army Corps of Engineers, Waterways Experimental Station (WES), Vicksburg, MS. Numerous methods of operation were discussed with the WES field crew. The method which appeared to be the most feasible required the use of a 10-inch-diameter dual-tube core barrel. However, this coring tool was not available on the test site. After numerous unsuccessful attempts to obtain such a tool in a reasonable time, it was decided by the AFWL project officer to use plain 10-inch-diameter casing that was on hand.

A potential problem was noticed during the backhoe recovery. The grout columns located close to the explosive were observed to have been horizontally

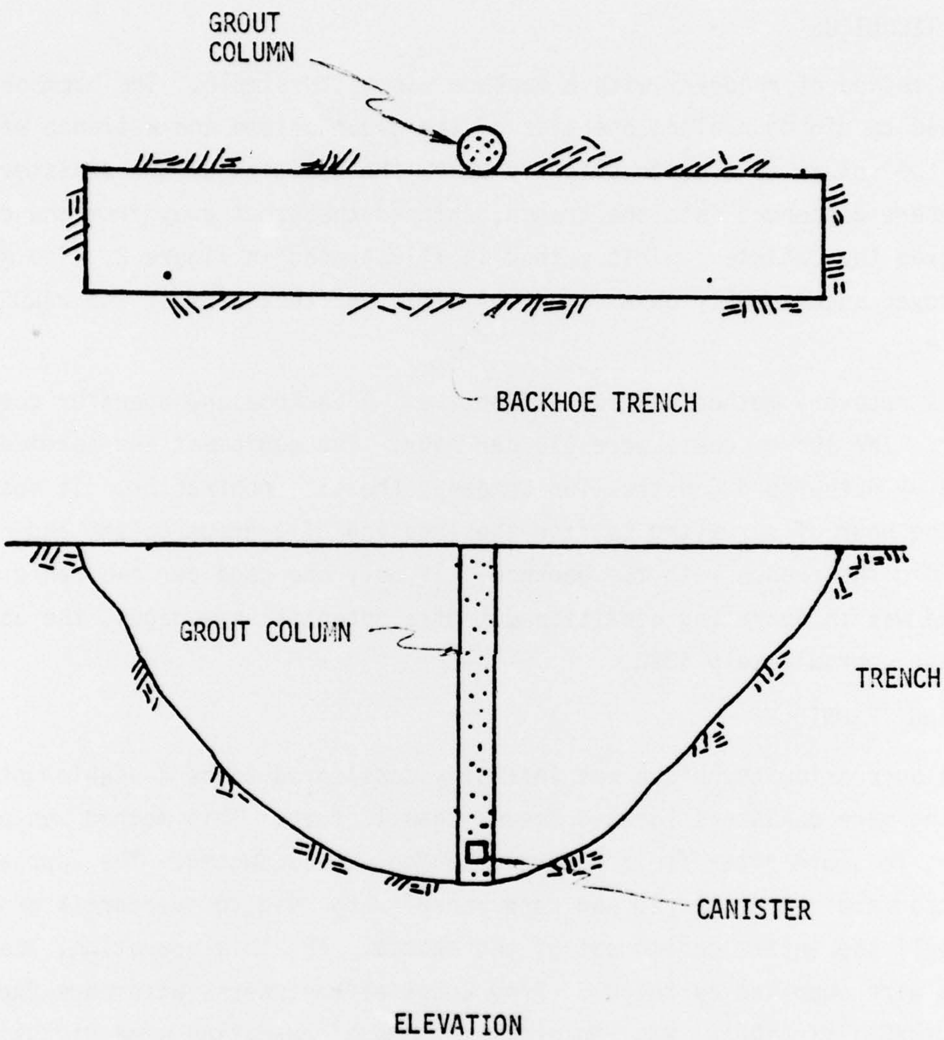

Figure 2. Backhoe Recovery

displaced a few feet. This situation is described in figure 3. Because of the vertical misalignment of the grout column, recovery of the deeply placed canisters was limited to canisters that were located far enough away from the explosive to have a small horizontal displacement to allow overcoring with the 10-inch casing.

The first overcoring recovery attempt was limited to a depth of 18 feet, the depth of the soil limestone interface in the ICAL 2 test bed at the HARDPAN I site.

Three grout columns were selected for recovery at three different distances from the explosive to determine the amount of displacement that could be tolerated in this type of recovery. The first column to be overcored was one of intermediate distance from the explosive. A small mud pit was dug with a backhoe and the drill rig positioned over the grout column. The casing was inserted to a depth of 15 feet with normal waterflow through it. An additional three feet of casing were forced dry to allow the grout column to adhere to the casing. When the casing and contents were removed from the hole, it was apparent that the column was displaced by the explosion. Approximately eight feet of grout were recovered and only the canister nearest to the test bed surface was in the contents. Refer to figure 4 for a pictorial description of the displaced grout column.

The column closest to the explosive was recovered to determine the amount of displacement which took place at that location. Only one foot of the grout column was recovered. A considerable amount of displacement had occurred.

The recovery of the last grout column was a total success. The entire grout column was removed intact. Therefore, it appears that the degree of success in using this method of recovery is dependent on the amount of horizontal displacement of the grout column and the type of tool used to overcore. The 10-inch dual-tube core barrel would have been twice as effective.

The next step was an attempted recovery of canisters in one of the major test sites. The HARDPAN I-2B test site had a large number of canisters. The experiments planned for this attempt were more complex. It was hoped that this effort would more closely approximate the operational canister recovery technique than the effort with the single 10-inch casing. A diamond shoe was purchased to allow recovery in the rock layer. A crane was to be employed to pull long (over 20 feet) casing sections from the ground. This was to test the idea that the

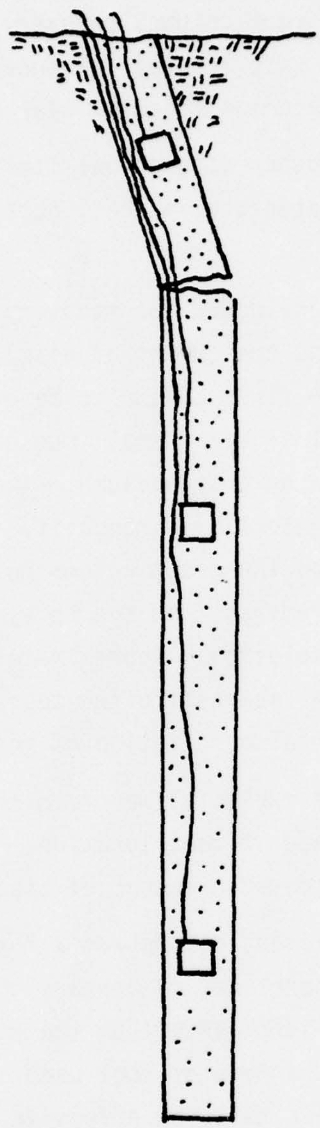

Figure 3. Displaced Column

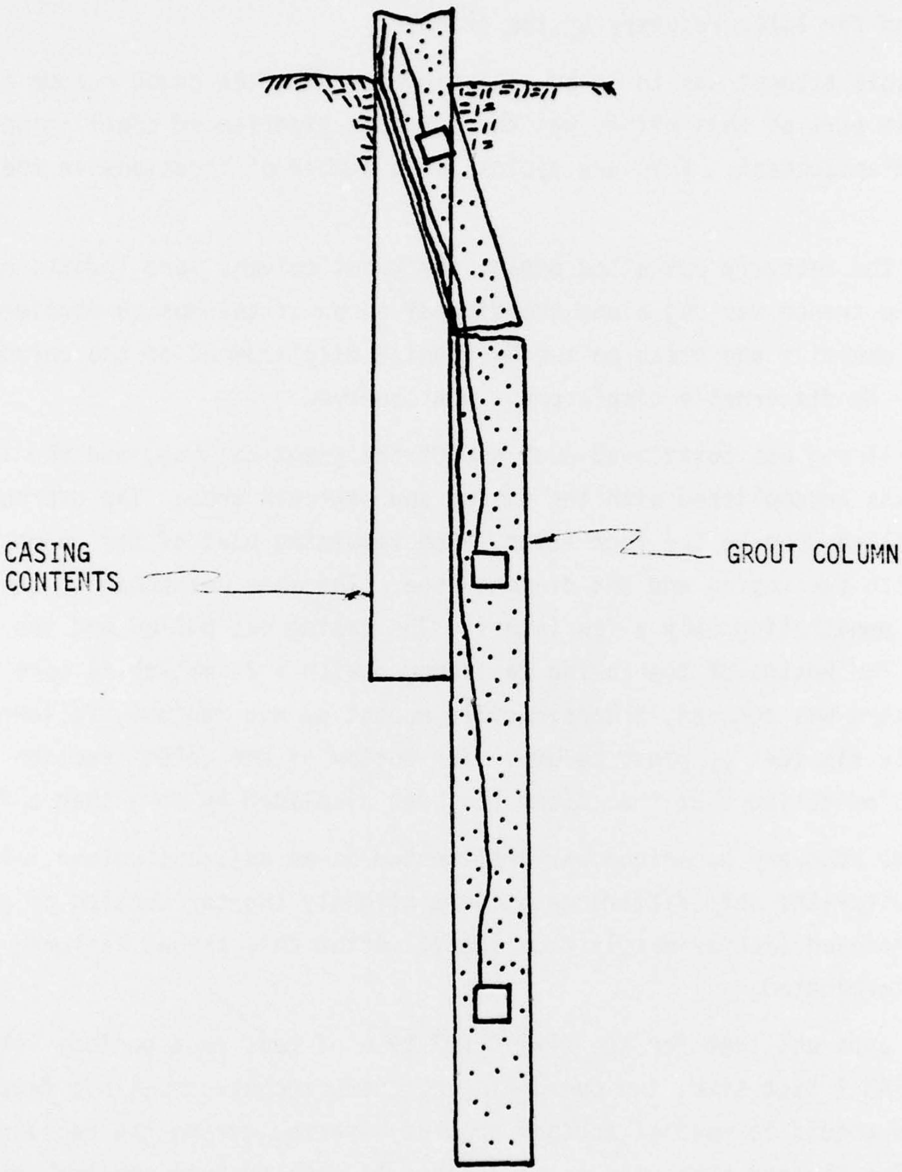

Figure 4. Overcoring Displaced Columns

drill rig could be used to sink a number of casings over grout columns to be left in the ground for later recovery by the crane.

Since this attempt was to be an operational study, the grout column chosen for the first part of this effort was the one that experienced small amounts of horizontal displacement. This was typical of a number of locations in the test bed.

Before the recovery operation began, the grout columns were located by survey. A 5-foot-deep trench was dug along the side of a row of columns to recover the upper level canister and check on the horizontal displacement of the columns to this depth. No discernable displacement was observed.

The drill rig was positioned over one of the grout columns, and the initial overcoring was accomplished with the casing and sawtooth shoe. The overcored hole was drilled down to the rock layer. The remaining part of the operation was continued with the casing and the diamond shoe. The shoe was bound in the rock layer after penetrating only a few inches. The casing was pulled and the contents inspected. The bottom of the casing was plugged with a 2-inch-thick core of rock. After this core was removed, a considerable maount of mud ran out, followed by approximately six feet of grout column. The bottom of the column section was cut at an angle indicating that the column had been displaced by more than a foot.

The same recovery technique was implemented on an adjacent column, with similar results--the only difference being a slightly shorter section of grout column was removed (approximately four feet). After this second failure, the effort was terminated.

It was apparent that for the HEST-BLEST type of test in a geology like that of the HARDPAN I test site, the overcoring recovery technique was not feasible. Further note should be made of another problem observed during the recovery attempts. The diamond shoe used in an attempt to core through the rock did not cut enough clearance to prevent the casing from binding.

The WES drill rig and crew cost $65 per hour, and it took almost 10 hours for removal of one column. Adding in the surveying and backhoe brought the cost to approximately $680 per column. If just two accelerometers recovered were found to be in working order, out of a possible four in a column, it would appear to be a cost-effective method of recovery. However, most of the gages are emplaced in the test bed areas where large soil displacement occurs. Therefore, for the small number of gages located in the low stress regions, the overcoring recovery method is not economical.

SECTION III

CONCLUSIONS AND RECOMMENDATION

CONCLUSIONS

The project of evaluating the feasibility and cost effectiveness of recovering ground motion canisters was a partial success. The backhoe method was feasible and cost effective; but because of layering, differential motions, and the nearness of the grout columns to the explosive, the overcoring technique of canister recovery proved to be not economically feasible.

RECOMMENDATION

If the overcoring canister recovery is attempted again, preliminary experimentation must be conducted to determine the proper type of diamond shoe cutter required.