RAINSTORE3 INSITU TESTING RESULTS

INTRODUCTION

From 10 February to 17 February 2000 Invisible Structures Inc. (ISI) and Advanced Terra Testing, Inc. (ATT) conducted insitu testing on the Rainstore^3 product produced by ISI. ISI excavated the test hole, installed the product per their specifications, and supplied and operated the loading vehicles. ATT installed the load cells and displacement transducers, organized the testing parameters, monitored the results of the installed equipment, observed the physical reactions of the roadbase and performed a forensic inspection on the excavated product after testing.

The testing plan consisted of constructing a 3x3 meter Rainstore^3 infiltration structure 2.5 meters high installed by ISI to their specifications. ISI used thirty individual sections of the Rainstore^3 product to form 1x1 meter by 2.5 meter prefabricated structures to complete the full size structure (Photograph 1). ATT installed monitoring equipment within the structure in order to observe displacement of the structure and the actual loading the structure experienced under different loading conditions. The loading conditions were placed on the structure with varied wheel loads provided by different vehicles with increasing axle loads. Two different loading conditions were planned for the structure; static loading provided by slowly driving the subject vehicle on top of the load cell and allowing it to remain there for several seconds, and dynamic loading provided by breaking the subject vehicle from a 5 mph roll on top of the load cell. After several tests it was noted that the dynamic loading from a 5 mph roll was nearly equivalent to the dynamic loading from breaking, and was easier to control; thus later tests included dynamic loading by rolling.

TESTING

Testing consisted of measuring the loads the test vehicles were transmitting to the structure and the displacements the structure was experiencing during the loading events. Four load cells were placed within the structure; three were located at intervals along the bottom of the structure and one at the top of the structure. The loads transmitted to the structure were compared to the loads for catastrophic failure from the laboratory testing previously conducted. The loading conditions were applied to the structure with wheel loads from different vehicles under various loaded conditions. Two different loading conditions were initially planned; static loading provided by slowly driving the subject vehicle on top of the load cell and allowing it to remain there for several seconds, and dynamic loading provided by breaking the subject vehicle from a 5 mph roll on top of the load cell. After several tests, it was noted that the dynamic loading from a 5 mph roll was nearly equivalent to the dynamic loading from breaking and was easier to control; thus later tests included dynamic loading by rolling.

LOAD CELLS

It was decided to use four load cells for the testing program to determine if loading varied across the structure (vertically or horizontally) and to determine repeatability of the loading. Three cells were located at the bottom of the structure (Photographs 11-15) to measure the loading as the vehicle moved along the surface (see diagrams) and one cell was located at the top of the structure. The load cell at the top of the structure was located directly above one of the lower load cells (in the same column) to determine if there was any load distribution through the structure. The lower load cells were placed in positions that varied their proximity to the nearest compacted side wall. One load cell was located relatively close to the side wall, while one was located in the center to be as far away from the compacted soil as possible; the third load cell was located at a distance approximately a third of the way in from the side wall. These locations were selected to determine if loading was spreading to the side wall compacted soils. After the conclusion of the testing it was noted that the locations of the bottom load cells had relatively little effect on the maximum readings recorded. All of the load cells used were 3000 lb. cells with a safety limit of 150% or 4500 lb., which was the maximum safe limit of the structure as determined by laboratory testing.

DISPLACEMENT TRANSDUCERS

Two displacement transducers were used to monitor the movements of the Rainstore^3 structure in place. Both displacement transducers were mounted on the center stack of Rainstore^3 product with one measuring the vertical displacement and the other measuring the diagonal displacement of the stack (Photographs 14 & 15). The vertical displacement transducer was mounted at the excavated ground surface, with the opposing end of the monitoring wire mounted to the top core of the column to allow measurement of the entire column height. The diagonal displacement transducer was also mounted at the excavated ground surface, with the opposing end of the monitoring wire mounted to the top core of the column opposite to where the bottom was mounted (see diagrams) to allow measurement of the entire structure from bottom corner to the opposite top corner. The displacement transducers used had the ability to measure displacements of +/- 20 inches.

TEST PROCEDURES

The general test procedure for the evaluation of the Rainstore^3 product was as follows: static testing over each of the load cell locations, dynamic breaking testing over each of the load cell locations; and, later in the testing program, dynamic roll testing over each of the load cell locations. The operator of the test vehicle was informed by ATT personnel as to which test was being performed and directed into the proper position over the load cells for each test sequence to be performed. The testing was run sequentially from the lightest load to the heaviest loading and all of the results were monitored to ensure that the maximum safe load was not exceeded. The deflection measurements were also monitored and displayed on screen during the testing procedure to help evaluate

changes within the structure. However, the loads were the primary focus during the actual testing phase.

TEST VEHICLES

After ISI had completed the construction of the infiltration structure, the monitoring portion of the testing was initiated. The plan for the loading test was to use several different vehicles loaded to varying cargo capacities, to test the structure from normal personal vehicle loading up to H-20 loading. The personal sized vehicles chosen at the beginning of testing were an unloaded Light Truck (~6,500 lb.) and a Sport Utility Vehicle. The Sport Utility Vehicle testing was dropped after it was discovered to weigh approximately the same as the unloaded Light Truck, and this type of testing would add little significant information. The heavy loading was tested with the use of a Heavy Truck in an unloaded condition (~16,000 lb.), in a partially loaded condition (~27,000 lb.) and in a fully loaded condition (~36,000 lb.). The fully loaded truck met the H-20 loading condition set forth by AASHTO as a six tired, two axle truck, with a rear axle weight of 32,000 lb. After the final loading test was performed, the rear axle weight was recorded by certified scale as 31,740 lb. However, this was actually lighter than the rear axle weight during the test due to balancing of the load after testing to allow for a safe driving condition of the vehicle to the scales.

TEST RESULTS

Overall, the testing was very promising for the structure to maintain the loads of concern. The major loading event of concern, was that the test vehicles would exceed 4,500 lb. on a single column, causing catastrophic failure of the structure. None of the test vehicles exceeded the 4,500 lb. loading condition on any of the monitored columns and no visible damage to the structure was noted upon disassembly. Therefore, the general testing program was a success. No upper limit was preset for the displacement limits and therefore no general conclusion can be stated for the success of this phase of the testing. Graphical results of the testing are located later in the report.

FORENSIC INSPECTION

At the conclusion of the testing, the infiltration structure was excavated to allow inspection of the structure and the removal of the monitoring equipment (Photographs 19-20). The first device excavated was the top load cell (load cell 4). Upon excavation, slight damage was noted to one cross member between cores; however it is believed that this damage was caused during the excavation work. Two other locations were excavated to expose the geogrid on top of the structure. In both cases no damage was noted to the geogrid, geotextile or the Rainstore^3 structure that was not related to the excavation. During the remainder of the excavation work to allow the removal of the remaining load cells and the displacement transducers, no indication of preexisting damage was noted to the Rainstore^3 product.