GSI

Report of
Non-Destructive Crosshole Sonic Logging

# DEMONSTRATION SHAFT
# INTERSTATE 235
# over DES MOINES RIVER
# DES MOINES, IOWA

GSI PROJECT NO. 026162
October 31, 2002


## Prepared By:

Geotechnical Services, Inc.
2853 99th Street
Des Moines, Iowa
50322-3858
(515) 270-6542


## Prepared For:

Mr. Dan Timmons
Jensen Construction Company
P.O. Box 3345
Des Moines, Iowa
50313

GSI

October 31, 2002

Mr. Dan Timmons
Jensen Construction Company
5550 NE 22nd Street
P.O. Box 3345
Des Moines, Iowa

**RE: CROSSHOLE SONIC LOGGING TESTS**
**NONDESTRUCTIVE TESTING OF**
**DEMONSTRATION SHAFT**
**INTERSTATE 235 at DES MOINES RIVER, DES MOINES, IOWA**
**GSI PROJECT NO. 026162**

Dear Mr. Timmons:

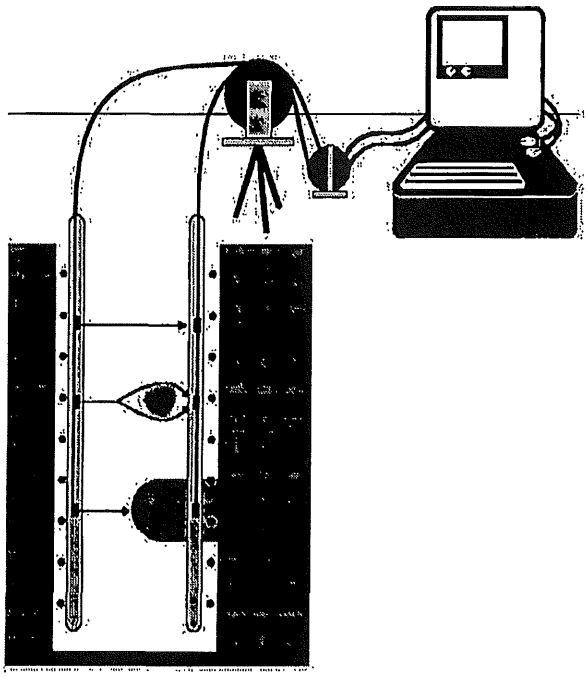
Geotechnical Services, Inc. (GSI) is providing this report of nondestructive test results for one drilled shaft at the above referenced bridge. We are providing these services in accordance with the project specifications of the Iowa Department of Transportation (IDOT) for this project.

Crosshole Sonic Logging tests were performed on October 29, 2002, on the demonstration drilled shaft for I-235 over the Des Moines River in Polk County, Iowa. The demonstration drilled shaft was constructed on October 25, 2002, using the direct rotary and tremie concrete placement method. The drilled shaft includes one reinforcing bar cage that extends above the drilled shaft concrete for the new pier. Four (4) sonic testing access tubes were attached to the inside of the shaft reinforcing steel cage and extended above the shaft concrete. The shaft included an Osterberg load cell located approximately 1.5 meters above the bottom of the shaft. The shaft diameter varies from 1060 mm in the rock socket to 1220 mm above the rock socket. The overall shaft length from the project plans is 22.15 meters and our scanned lengths varied between 19.8 to 19.9 meters. The access tubes consist of Schedule 40 steel pipe with an inside diameter of 51 millimeters and the tubes were filled with water prior to placement of shaft concrete.

Crosshole Sonic Logging (CSL) is a nondestructive test for determining the integrity of concrete in drilled shaft foundations and concrete slurry walls. The test requires that an ultrasonic pulse pass through the concrete between a source and receiver probe, both of which are pulled from the bottom to the top in water filled access tubes in the concrete. These access tubes are cast in the concrete at the time of concrete placement and filled with water to provide a good "connection" between the pulse and the concrete. The position of the probes with respect to the top of the shaft is recorded during the test with a calibrated measurement wheel for the probe cables.

During the test, a high voltage ultrasonic pulse is generated for every 3 to 6 centimeters of probe travel as the cables are pulled. The receiver response and the depth are recorded for each interval and processed with a personal computer based logging system. Please refer to the Crosshole Sonic schematic below for the test setup.

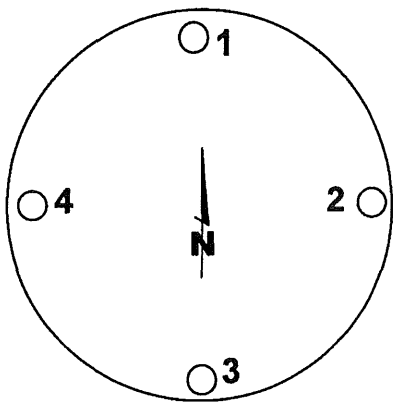
# GSI



CROSSHOLE SONIC LOGGING METHOD

The analysis of the concrete quality is based on the relationship between wave (pulse) travel times between the source and the receiver, and the receiver response energy. Wave velocities can be calculated from the wave travel times and the distance between tubes. Assuming that the access tubes are bonded to the concrete, longer wave travel times and corresponding slower velocities indicate poor quality concrete. If the signal is completely lost, a significant defect or void exists between the corresponding tubes tested.

The CSL tests for this project were conducted by the author using an Olson Instruments, Inc. CSL-1 system. This system utilizes 10 volt, 35 kilohertz transducers with a diameter of 3.2 centimeters. The steel access tubes were extended to the bottom of the reinforcing steel cage. The CSL method cannot locate enlargements in the shaft because of the test geometry; however, the test is effective in locating neck-downs and voids because the signal paths are interrupted.




A sketch of the access tube configuration with respect to direction is shown at the left. CSL tests are conducted around the perimeter of the shaft, i.e., tubes 1 to 2, tubes 2 to 3, tubes 3 to 4, and tubes 4 to 1 initially. Crosshole tests are then conducted between tubes 1 to 3, and tubes 2 to 4. In crosshole testing, the source probe and receiver probe is interchangeable between pairs of access tubes.

Plots of six (6) Crosshole Sonic Logs performed for this drilled shaft are enclosed in Appendix A.

The sonic logs for the demonstration drilled shaft exhibit strong signal strength and relatively consistent wave arrival times. Therefore, it is our opinion that the sonic logs indicate sound quality concrete.

GSI

Our services were performed in accordance with generally accepted nondestructive testing practices. If we can provide additional service, please contact us at 515-270-6542.

Respectfully,
**GEOTECHNICAL SERVICES, INC.**

Roland C. Newton, P.G.
Senior Geologist

**Reviewed by:**

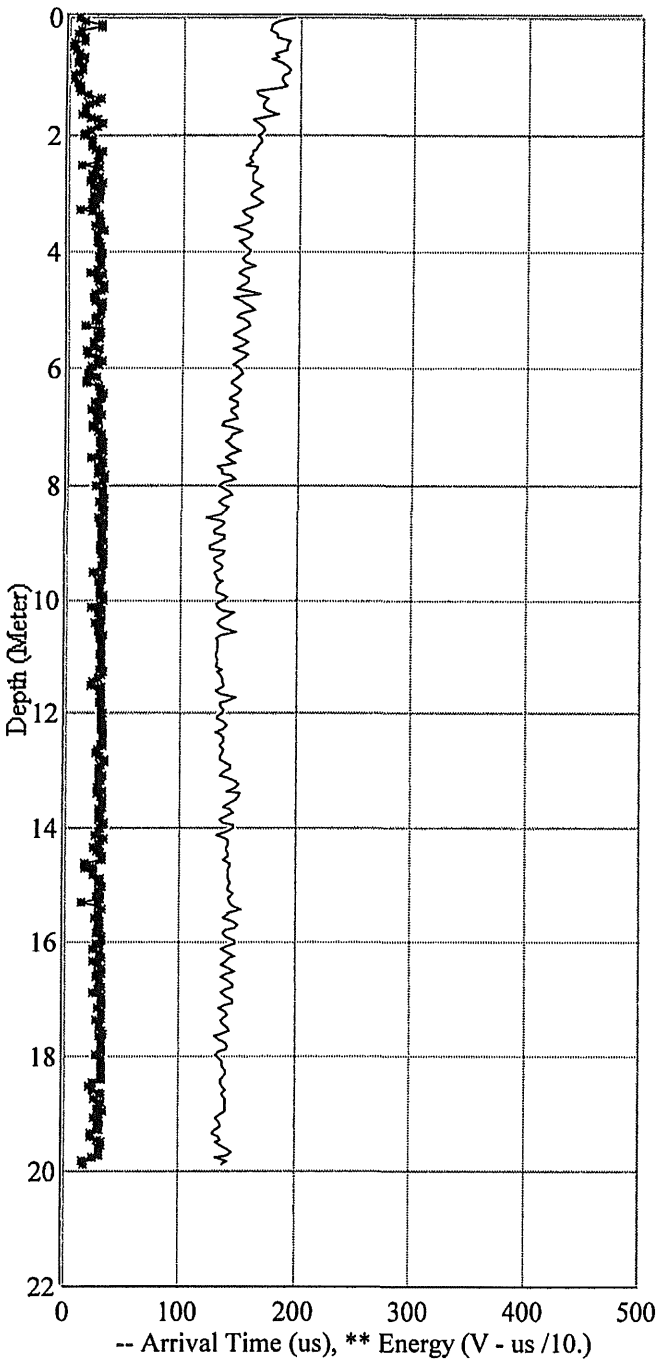
Michael T. Lustig, P.E.
Principal Engineer

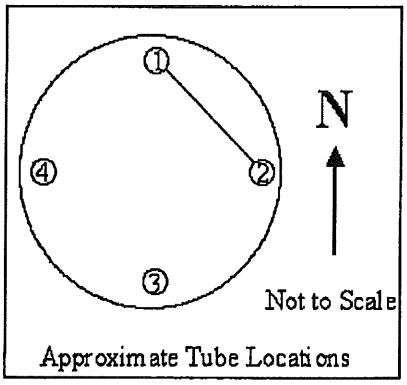
cc: 4 pc above

# APPENDIX A

## CROSSHOLE SONIC LOGS

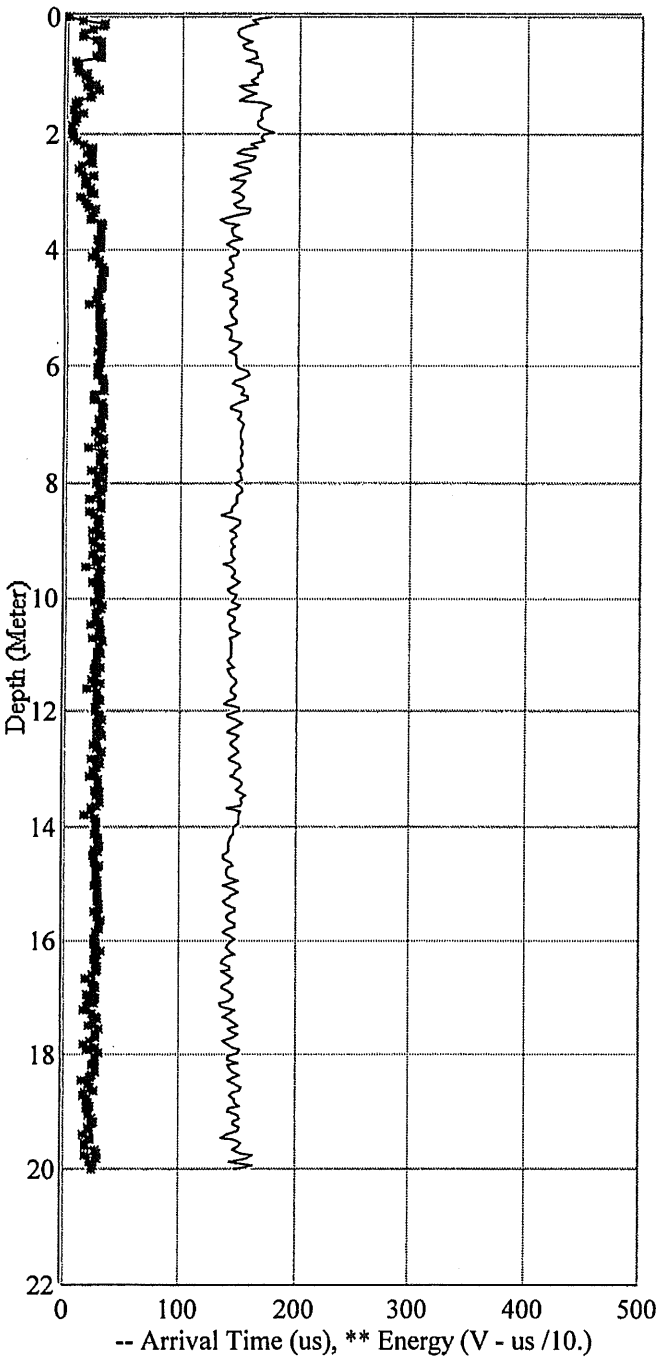
Demonstration Shaft -- Tubes 1 - 2

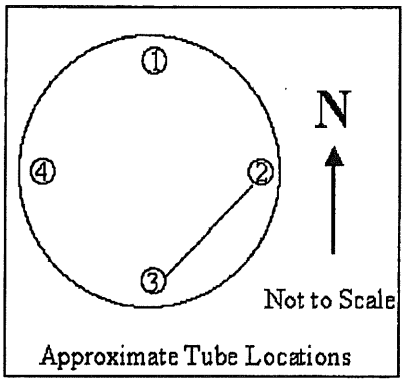



| | | |
|---|---|---|
| Tube Spacing : | 59.69 | cm |
| Signal Gain : | 1 | |
| Threshold : | 2.00 | |
| At Depth of | 2.01 | meter |
| Velocity | 3600 | meter/sec |
| First Arrival Time | 164 | us |
| Signal Energy | 1337.75 | V-us |

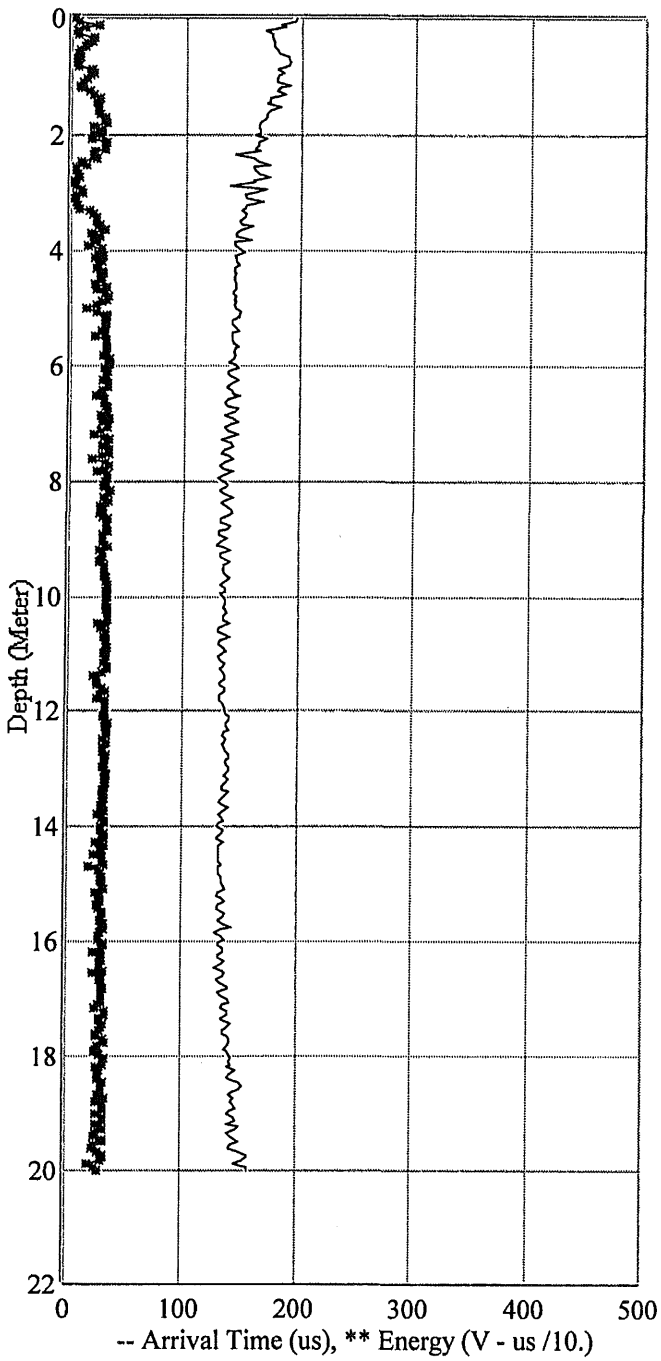
Demonstration Shaft -- Tubes 2 - 3

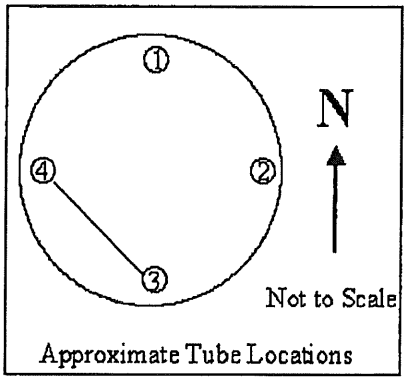



| | | |
|---|---|---|
| Tube Spacing : | 50.80 | cm |
| Signal Gain : | 1 | |
| Threshold : | 0.00 | |
| At Depth of | 2.07 | meter |
| Velocity | 3000 | meter/sec |
| First Arrival Time | 166 | us |
| Signal Energy | 548.83 | V-us |

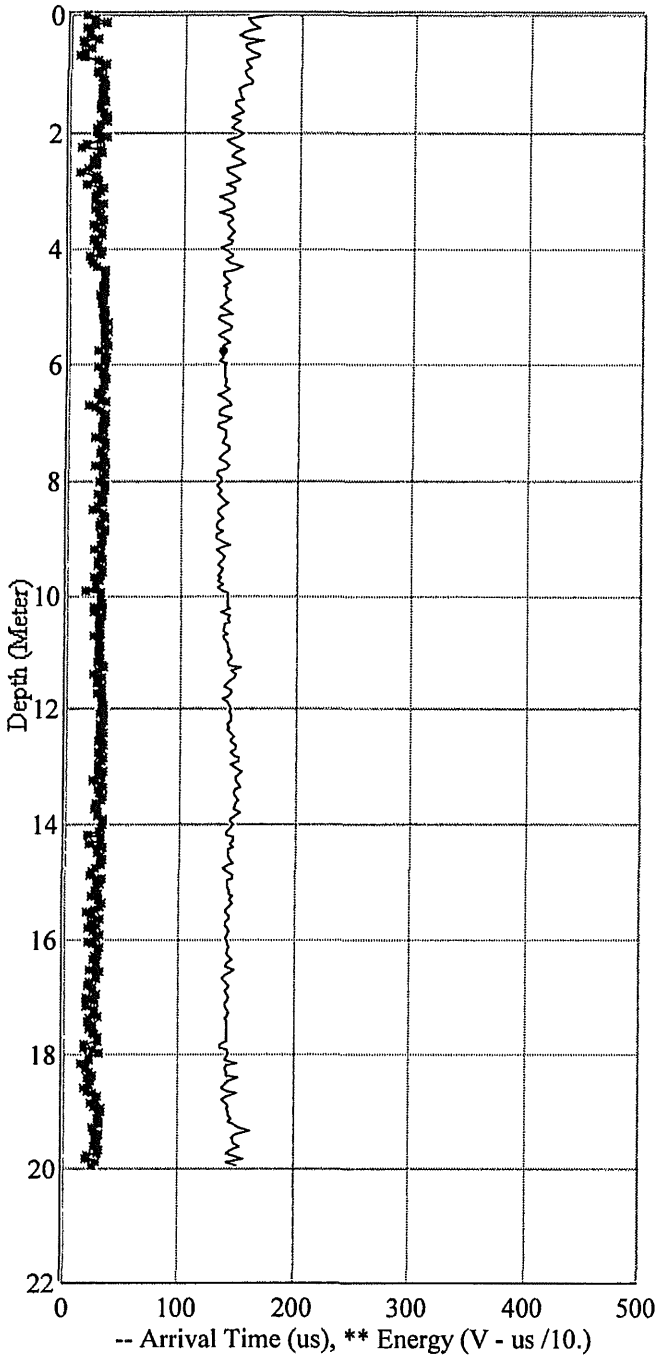
Demonstration Shaft -- Tubes 3 - 4

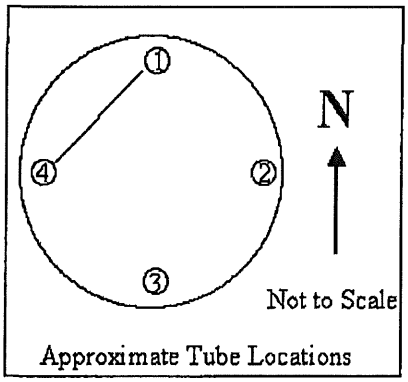



| | | |
|---|---|---|
| Tube Spacing : | 64.77 | cm |
| Signal Gain : | 1 | |
| Threshold : | 1.50 | |
| At Depth of | 2.01 | meter |
| Velocity | 4000 | meter/sec |
| First Arrival Time | 160 | us |
| Signal Energy | 2568.09 | V-us |

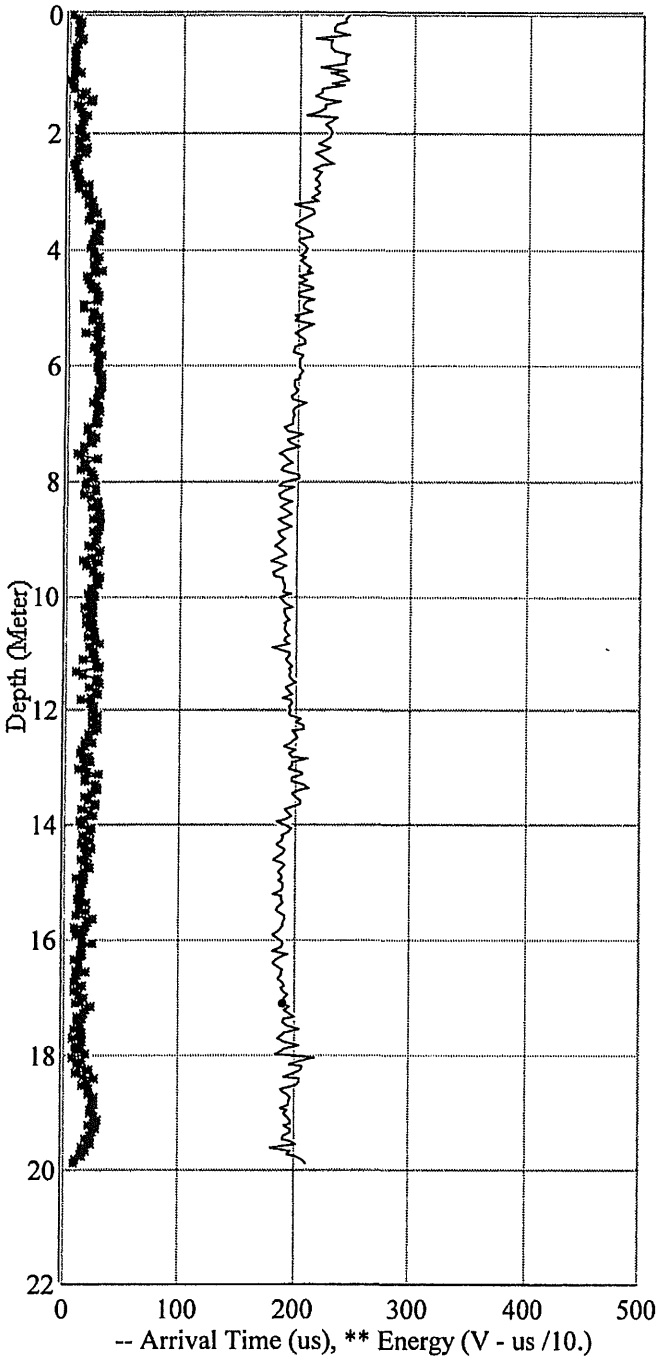
Demonstration Shaft -- Tubes 4 - 1

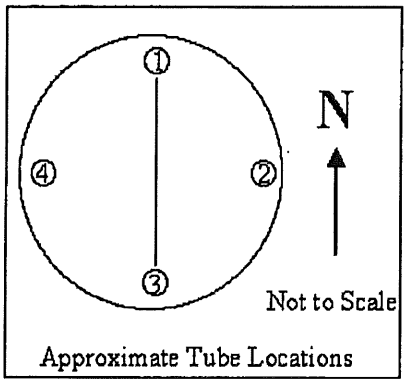



| | | |
|---|---|---|
| Tube Spacing : | 50.80 | cm |
| Signal Gain : | 1 | |
| Threshold : | 1.50 | |
| At Depth of | 2.01 | meter |
| Velocity | 3300 | meter/sec |
| First Arrival Time | 150 | us |
| Signal Energy | 2434.11 | V-us |

Demonstration Shaft -- Tubes 1 - 3

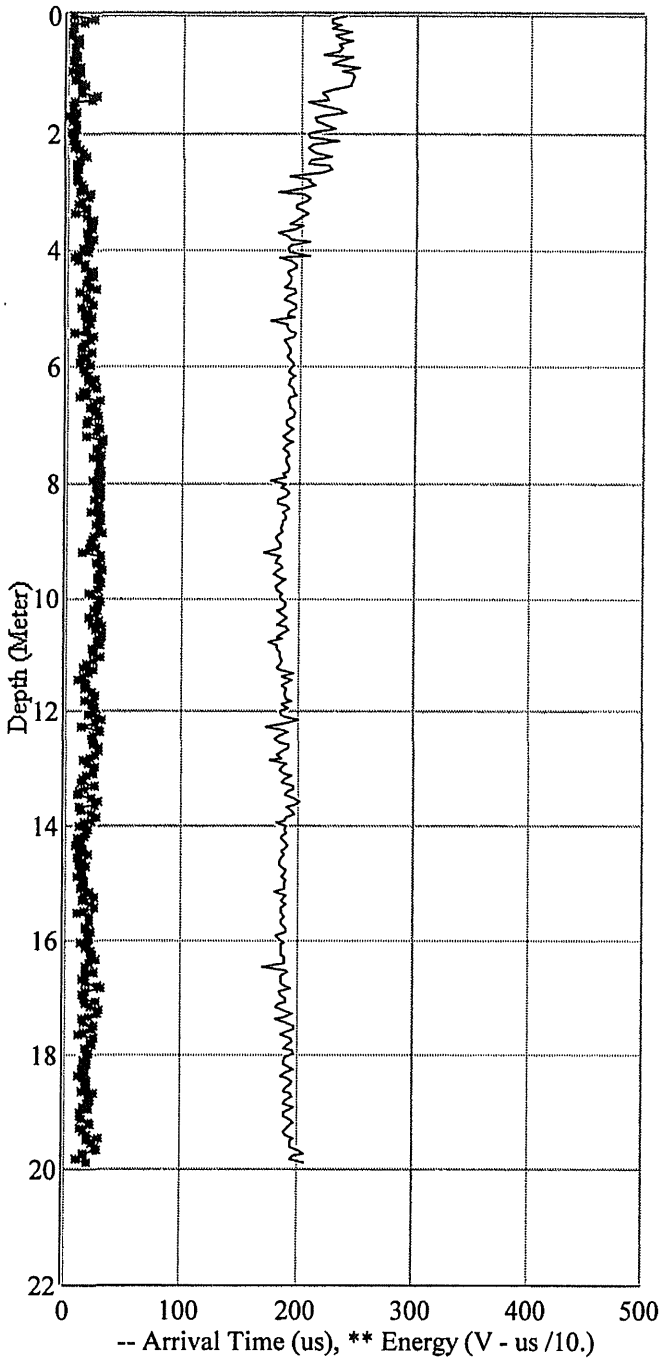


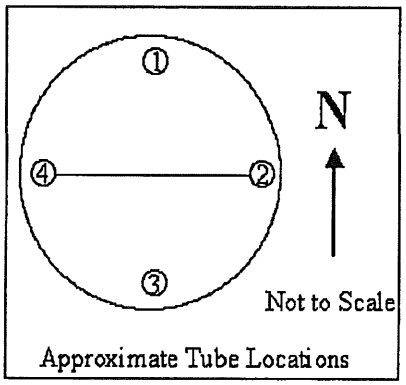




| | | |
|---|---|---|
| Tube Spacing : | 81.28 | cm |
| Signal Gain : | 1 | |
| Threshold : | 1.50 | |
| At Depth of | 2.01 | meter |
| Velocity | 3500 | meter/sec |
| First Arrival Time | 228 | us |
| Signal Energy | 1027.76 | V-us |

GSI Project No. 026162

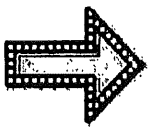
Demonstration Shaft -- Tubes 2 - 4




| | | |
|---|---|---|
| Tube Spacing : | 78.74 | cm |
| Signal Gain : | 1 | |
| Threshold : | 1.50 | |
| At Depth of | 2.01 | meter |
| Velocity | 3800 | meter/sec |
| First Arrival Time | 206 | us |
| Signal Energy | 427.89 | V-us |

GSI Project No. 026162



**Robert Stanley**

10/18/02 11:14 AM

To: Kevin Merryman/DOT/StateIA, Brian Jacob/DOT/StateIA, Wes W Musgrove/DOT/StateIA
cc: Wayne Sunday/DOT/StateIA@StateIA, Ahmad Abu-Hawash/DOT/StateIA@StateIA, curtis.monk@FHWA.dot.gov
Subject: I-235 Des Moines River Bridge Demonstration Drilled Shaft And Load Test

I received a FAX this morning from GSI on their pre-shaft-installation soil boring at the location of the above-noted demo shaft (with UC lab testing information on the shale cores), and have compared this information to Sheet 13 in the bridge plans, which has information about the demo shaft and the load test. I have the following comments.

Generally, most things look pretty good. The top of shale by comparison between the boring log and Sheet 13 seems to match within about 1/4 meter in elevation, so that seems good. **NOTE**: I did all of my comparisons by elevations, not by depths, and I would recommend that all demo shaft and load test installation, etc be strictly correlated to elevations rather than simply going by depth without strict correlation to elevation.

The shale below the load cell looks pretty consistent, so we should get good load test info between the cell and the bottom strain gauge. Between the cell and the strain gauge immediately above it, and also between that strain gauge and next one up, shale strengths are also fairly consistent, so those load test results should be good.

However, between the first (top) and second strain gauges, and also between the second and third strain gauges down from the top, the shale strengths vary quite drastically, and load test results will be hard to match to shale strengths in those locations. I looked for different combinations of strain gauge elevations to try to come up with places to move the top 3 strain gauges, in order to get better load test interpretations with shale strengths, but I could not identify anything that worked really good (any better than what we now have) with the shale strengths that jump around a great deal in that zone.

So, the end result is that I think we can go with the demo shaft and load test basically as shown on Sheet 13 in the plans. I am going to send a copy of GSI's boring log to Curtis Monk, Wayne Sunday, and Ahmad Abu-Hawash for their information and comment as they see appropriate.

Kevin and Brian, I would get a copy of GSI's boring log (and maybe this e-mail?) to Load Test as fast as possible. Also, should we be getting HNTB involved in any of this?

If any questions, let me know. Also, if anyone else has any different interpretation or twist to any of this, let me know.

Geotechnical Services Inc.
2853 99th Street • Des Moines (Urbandale), IA 50322-3858

# *Fax Cover Sheet*

**DATE:** 10-18-02 **TIME:** 8:50 AM

**TO:** DAN TIMMONS, V.P. **PHONE:**
JENSEN CONST. CO. **FAX:** 515-266-5152

**FROM:** MIKE LUSTIG **PHONE:** (515) 270-6542
GSI, Des Moines **FAX:** (515) 270-1911

**RE:** TEST SHAFT FOR DES RIVER BRIDGE

**Number of pages including cover sheet:** 3

**Message:**

(1) ATTACHED IS 2 PAGE BORING LOG FOR TEST SHAFT

(2) PLEASE NOTE: STRENGTH VALUES FOR ROCK SHOWN ON THIS LOG ARE IN KPa, not $kg/cm^2$ as shown

(3) ROCK CORES ARE IN OUR OFFICE IF ANYBODY WANTS THEM

CC: Bob STANLEY, IDOT SOILS, by fax 515-239-1873

Quad Cities Office: 258 East 90th Street • Davenport, IA 52706-7341
Phone: 319-285-8541 • Fax: 319-285-8545

Omaha Office: 7050 South 110th Street • Omaha, NE 68128-5716
Phone: 402-339-6104 • Fax: 402-339-6297

Offices also located in: Kansas City, MO • Wichita, KS • Lincoln & Grand Island, NE

# BORING LOG No. Test Shaft

| BORING NO. | LOCATION OF BORING | ELEVATION | DATUM | DRILLER | LOGGER |
|---|---|---|---|---|---|
| Test Shaft | Sta. 25439 + 08.023, 10.753R | 245.789 | IDOT I-235 | DAH | MTL |

| WATER LEVEL OBSERVATIONS | | | TYPE OF SURFACE | DRILL RIG |
|---|---|---|---|---|
| WHILE DRILLING | END OF DRILLING | 24 HOURS AFTER DRILLING | Grass | B-57 |
| | | | DRILLING METHOD | TOTAL DEPTH |
| 5.64m | NA | | 0m to 14.63m 83mm HSA, 14.63m to 25.15m NQ2 Core | 25.15m |

| DEP. M. | SAMPLE DATA: SAMPLE NO. & TYPE | "N" BLOWS 30 CM. | % REC. | SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS | USCS CLASS. | LABORATORY DATA: % MC | DRY DENS. kg/m³ | Qu kg/cm² | DEP. M. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Dark brown, Dry, STIFF SANDY GLACIAL CLAY | | | | kPa | |
| | S-1 | 22 | | | | | | | |
| 2.2 | | | | | CL | | | | 2.2 |
| | S-2 | 21 | | | | | | | |
| | | | | FILL 1.1 | | | | | |
| 4.4 | S-3 | 26 | | Light gray, Dry, FINE-MEDIUM SAND | | | | | 4.4 |
| | S-4 | 1 | | | | | | | |
| 6.6 | | | | | | | | | 6.6 |
| | S-5 | 12 | | Dark gray with silt in S-5 | | | | | |
| 8.8 | | | | | | | | | 8.8 |
| | S-6 | 8 | | | SP-SM | | | | |
| | S-7 | 7 | | | | | | | |
| 11 | | | | | | | | | 11 |
| | S-8 | 16 | | | | | | | |
| 13.2 | | | | | | | | | 13.2 |
| | S-9 | 26 | | | | | | | |
| 14.3 | S-10 | 50/.06 | | ALLUVIUM El. 231.769 14.0 | | | | | |
| | NQ | | Layer 1 | Light gray, Moist CLAY SHALE | | | | | |
| 15.4 | NQ | | | NQ Core Run 1 REC=100 RQD=100 | | | 2284 | 10314 | |
| | | | | NQ Core Run 2 REC=100 RQD=100 | | | 2320 | 1791 | 15.4 |
| 16.5 | NQ | | Layer 2 | NQ Core Run 3 REC=100 RQD=100 | | | 2257 | 448 | |
| 17.6 | | | | NQ Core Run 4 REC=100 RQD=82 | | | 2349 | 10087 | 17.6 |
| | NQ | | | Black Coal between 18.4m to 18.8m | | | 2288 | 4037 | |
| 18.7 | | | Layer 3 | NQ Core Run 5 REC=100 ROD=83 | | | 1582 | 4037 | |
| 19.8 | NQ | | | | | | 2240 | 1781 | 19.8 |
| 20.9 | NQ | | | NQ Core Run 6 REC=100 RQD=82 | | | 2288 | 3362 | |
| | | | | | | | 2288 | 3362 | |
| 22 | | | Layer 4 | NQ Core Run 7 REC=100 RQD=88 | | | | | 22 |

"Rock Layers" as per Sheet 13

vs 232.0 on Sheet 13

Bottom of casing as per Sheet 13 (Elev 231.4)

Top Strain Gauge as per Sheet 13 (Elev 231.4)

2nd Strain Gauge as per Sheet 13 (Elev. 230.0)

3rd Strain Gauge as per Sheet 13 (Elev 228.0)

4th Strain Gauge as per Sheet 13 (Elev. 225.5)

Top of Load Cell as per Sheet 13 (Elev. 224.5

Geotechnical Services Inc.
2853 98th Street, Des Moines, IA 50322-3858
(515) 270-8542 * FAX (515) 270-1011

PROJECT: Des Moines River and I-235 Bridge Test Shaft
LOCATION: I-235 and West River Drive, Des Moines, IA
JOB NO.: 026162
DATE: 10/14-15/02

# BORING LOG No. Test Shaft

| BORING NO. | LOCATION OF BORING | ELEVATION | DATUM | DRILLER | LOGGER |
|---|---|---|---|---|---|
| Test Shaft | Sta. 25439 + 08.023, 10.753R | 249.769 | IDOT I-235 | DAH | MTL |

| WATER LEVEL OBSERVATIONS | | | TYPE OF SURFACE | DRILL RIG |
|---|---|---|---|---|
| WHILE DRILLING | END OF DRILLING | 24 HOURS AFTER DRILLING | Grass | B-57 |
| | | | DRILLING METHOD | TOTAL DEPTH |
| 6.64m | NA | | 0m to 14.63m 83mm HSA, 14.63m to 25.15m NQ2 Core | 25.15m |

| DEP. M. | SAMPLE DATA: SAMPLE NO. & TYPE | "N" BLOWS 30 CM. | % REC. | SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY — GEOLOGIC DESCRIPTION & OTHER REMARKS | USCS CLASS. | LABORATORY DATA: % MC | DRY DENS. kg/m3 | QU (kg/cm2) | DEP. M. |
|---|---|---|---|---|---|---|---|---|---|
| 23.1 | NQ | | | Bottom Strain Gauge as per Sheet 13 (Elev. 222.9) | | | 2270 | 4485 | |
| 24.2 | NQ | | | NQ Core Run 8 REC=95 RQD=100 | | | 2362 | 4485 | 24.2 |
| 25.3 | NQ | | | NQ Core Run 9 REC=100 RQD=100 | | | 2390 | 4485 | |
| | | | | PENNSYLVANIAN BEDROCK | 25.2 | | | | |
| | | | | Bottom of Boring @ 25.15m. | | | | | |
| 26.4 | | | | | | | | | 26.4 |
| 28.6 | | | | | | | | | 28.6 |
| 30.8 | | | | | | | | | 30.8 |
| 33 | | | | | | | | | 33 |
| 35.2 | | | | | | | | | 35.2 |
| 37.4 | | | | | | | | | 37.4 |
| 39.6 | | | | | | | | | 39.6 |
| 41.8 | | | | | | | | | 41.8 |
| 44 | | | | | | | | | 44 |

kPa

Bottom of Shaft as per Sheet 13 (Elev. 222.75)

Geotechnical Services Inc.
3955 98th Street, Des Moines, IA 50322-3958
(515) 270-0542 * FAX (515) 270-1011

PROJECT: Des Moines River and I-235 Bridge Test Shaft
LOCATION: I-235 and West River Drive, Des Moines, IA
JOB NO.: 026162
DATE: 10/14-15/02