SQUID Tablet.

SQUID

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As part of the drilled shaft construction process, the excavated shaft base should be removed of excess material and inspected prior to placement of the reinforcing cage and concrete. This is generally accomplished using a cleanout bucket, airlift, or hydraulic pump to remove any material unsuitable for end bearing support. Inspection then follows, often by lowering a downhole camera to the shaft base.

"The SQUID (Shaft Quantitative Inspection Device) presents an alternative to visual inspection of the excavated shaft base."

The SQUID (Shaft Quantitative Inspection Device) presents an alternative to visual inspection of the excavated shaft base. It assesses cleanliness by measuring debris thickness or non-competent material remaining at the shaft base, and can also provide a quantitative evaluation of the bearing layer's strength.

Figure 1 shows the SQUID body which is made of stainless steel and high strength aluminum. The SQUID is octagonal in shape, with a side dimension of approximately 22 inches and height of 30 inches. A drill

stub column adaptor allows for a quick pinned connection to the Kelly bar of the drill rig, which lowers the SQUID to the base of the shaft.

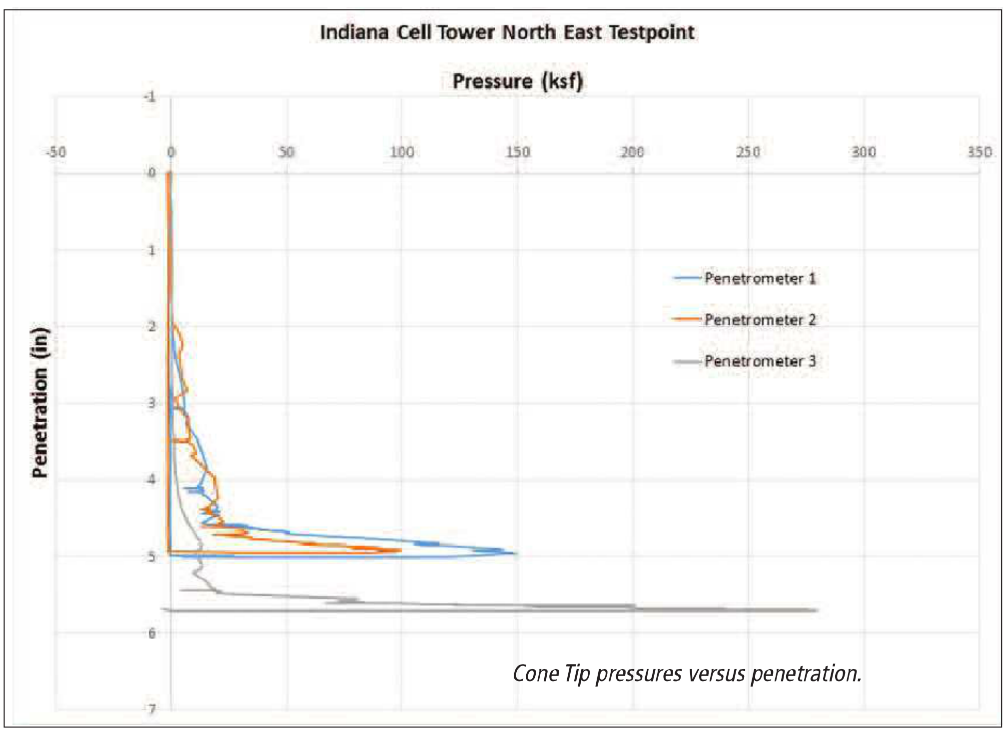
The SQUID system includes three retractable contact plates designed to exert only a low pressure (approximately 20 lb/sf) onto the bottom geomaterial. These contact plates are attached to high precision displacement transducers. The SQUID is also equipped with one 6-inch long penetrometer for each contact plate. The penetrometer cones penetrate through the debris layer and into the bearing material under the weight of the Kelly bar, and if needed under additional crowd pressure, while the contact plate remains on top of the softer material. Cone tip pressure is measured by resistance strain gages arranged in a Wheatstone bridge. The tip area of penetrometer is normally the same as that of a standard Dutch Cone (10 cm^2) although different shapes and sizes of penetrometer tips can be easily accommodated. A photo of one of the penetrometers extending below the contact plate is shown in Figure 2. The SQUID system includes a cable reel that attaches to a wireless transmitter at the edge of the borehole. Data is transmitted to the SQUID Tablet positioned at a safe distance from the borehole.

Figure 2 close-up of one of the SQUID penetrometers.

On December 30th, 2015 the SQUID was used to test the bottom of one of the drilled shafts that was part of the foundation of a 300 ft tall, self-support wireless communications tower in Montgomery, Indiana, part of a Skyway Towers LLC project. Illini Drilled Foundations, Inc., a leading ADSC member since its inception, was the drilled shaft contractor. The hole tested had a 42 inch diameter and 37.5 foot depth; three SQUID tests were performed in the same hole, so as to obtain measurements over the whole bottom area. In this case, clean-out of the shaft bottom had not been attempted prior to the SQUID test.

Soil borings near the tower site encountered approximately 5 inches of topsoil at the existing ground surface underlain

(continued on page 54) ➤



Cone Tip pressures versus penetration.

Table 1: Summary of Results.

	Tower NorthEast	Tower SouthWest	Tower Center 1
Max Force applied to the SQUID - kips	9	8	12
Max Cone 1 pressure - ksf	150	88	325
Max Cone 2 pressure - ksf	100	183	105
Max Cone 3 pressure - ksf	280	193	290
Max Displacement - inch	5.6	5.3	5.5

with silty clay soil of low plasticity. The SPT N-values in the silty soil ranged from 7 to 38 (blows per foot), generally indicating a medium stiff to hard consistency. A highly weathered shale with N-values between 50 and 80 was encountered at and below an approximate depth of 28.5 feet. The boring shown in Figure 3 was terminated in the shale at 40 feet depth.

The shafts were designed to be rock socketed in 8 feet of the highly weathered shale. The geotechnical report states that drilled shafts that bear in the highly weathered shale bedrock below a depth of about 28 feet can be designed for a net allowable end bearing pressure of 20 kips/square foot (ksf).

Using the contractor's Watson 31-10 drill rig, the SQUID body was lowered into the shaft excavation until the contact plate started to move relative to the housing, indicating that the SQUID was in contact with material at the base. The unit was then slowly lowered until one or more penetrometers showed force readings. After the maximum penetration was achieved (maximum displacement of the contact plate is 6 inches), the SQUID was lifted and moved to the next location within the same bore hole. Table 1 summarizes the results of the tests.

The table shows that the Kelly bar exerted loads between 8 and 12 kips onto the three penetrometers, corresponding to cone contact pressures of 750 to 1100 ksf. Figure 4 shows the Cone Tip Pressures (ksf) versus Cone Penetration relative to the Contact Plate location (top of debris layer) for the Northeast test point. Since a tapered drill bit had been employed during the end of drilling, the displacement and pressure readings varied among the three penetrometers.

The SQUID contact plates measured soft material thickness values of approximately 5.6 inches at the borehole center and 4 to 5 inches at the Northeast and Southwest test locations. Had the shafts been designed for end bearing a repeat test would have been recommended after clean out.

POD
POWER OF DESIGN

Boring Log

Boring: B-1
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Project: Montgomery Daviess — **City, State** Montgomery, IN

Method: H.S.A. — **Boring Date:** 24-Jul-15 — **Location:** Proposed Lease Area

Inside Diameter: 3 1/4" — **Drill Rig Type:** Truck — **Hammer Type:** Auto

Groundwater: DRY at completion — **Weather:**

Driller: Hoosier Drilling — **Note:** About 5 inches of topsoil was encountered at the ground surface

From (ft)	To (ft)	Material Description	Sample Depth (ft)	Sample Type	Blows per 6-inch Increment	Recovery (in)	SPT-N value	Rock Quality (RQD, %)	Atterberg Limits	Moisture Content (%)	% Fines (clay & silt)	Unconfined Compressive Strength, (ksf)
0.0	28.5	SILTY CLAY (CL) - medium stiff to stiff, gray	1-2.5	SS	3, 3, 4	8	7,					
	3.5	- brown and light gray	3 1/2	SS	5, 5, 6	12	11,					
			6-7.5	SS	4, 4, 5	12	9,					
			8.5	SS	4, 5, 7	14	12,					
	13.5	-hard with shale fragments	13.5	SS	11, 17, 21	18	38,					
			18.5	SS	4, 5, 8	16	13,					
			23.5	SS	10, 19, 19	0	38,					
28.5	40.0	highly weathered SHALE - gray	28.5	SS	50,	5	50,					
			33.5	SS	50,	5	50,					
			38.5	SS	37, 36, 50	12	86,					
		Boring Terminated at 40.0 feet										

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