Dynamic Monitoring of Piles Using **Remote Testing Capabilities**

Dynamic foundation testing systems with remote capabilities have been around for more than a decade. Systems such as the Pile Driving Analyzer® (PDA) model PAL-R were ahead of their time, really. They relied on cellphone technology that was a bit clunky and quite spotty, especially in remote areas. Sure, some pioneers embraced it right away, but the majority of the geotechnical community sat on their hands, waiting for the so-called "Moore's law" to bring remote data transmission technology to the point where dynamic foundation testing needed it to be. The technology is certainly there now, and GRL is taking full advantage of it, as the case study described here clearly shows.

Jensen Construction Company is currently erecting the U.S. 34 over the Missouri River Bridge in Plattsmouth, Nebraska. The pile foundations for Piers 5 and 6 are located in the river and were driven inside cofferdams. Each pier consisted of thirty - 48 inch (1220 mm) diameter by 1 inch (25.4 mm) thick open-end pipe piles approximately 170 feet (52 meters) long. The piles were driven in granular soils to bedrock with a Pileco D160-32 hammer, reaching 105 to 110 (32 to 33.5 meters) feet below the bottom of the cofferdam. The piles had a nominal resistance (ultimate capacity) of approximately 4,000 kips (1800 kN) plus the soil resistance in the scour zone. Jensen Construction retained GRL Engineers to perform the dynamic testing, which was required for each pile to evaluate the nominal resistance and scour zone friction.

GRL used a PDA model PAX with SiteLink® for the test. After an initial on site visit during installation of a test pile, the GRL engineer did not leave their office again during the production phase of the project – everything was done via the Internet and only the PDA system travelled to the job site. The test pile was installed at a non-production location along the river bank in order to check the suitability of the hammerpile- nominal soil resistance combination as calculated with the preconstruction GRLWEAP wave equation analysis. GRL performed on-site pile driving monitoring during initial installation and on a series of restrikes. GRL provided Jensen personnel with onsite training on the remote system at that time.

Production piles at each pier were installed over approximately three weeks. The sensors required for dynamic testing were mounted by Jensen, and the test was performed remotely, transmitting the measured force and velocity data to GRL in real time. Jensen consistently provided personnel for handling and operating the testing equipment onsite, and GRL and Jensen were in constant contact for coordination. The SiteLink approach was instrumental in meeting the strict deadlines that the job entailed. *Landon Streit*, Project Engineer with Jensen, recalled how "no pile driving was allowed between February 1st and June 30th due to restrictions involving the pallid sturgeon", an endangered fish with a unique dinosaur-like appearance. Jensen drove piles seven days a week as long as there was daylight, in order to complete all driving before the end of January, and the dynamic testing did not slow them down as much as it would have, had it been done without SiteLink. ■

Each pier consisted of 30 open end pipe piles

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إن الأنظمة الديناميكية لاختبار الأساسات ذات القدرات عن بعد موجودة منذ أكثر من عقد من الزمن. وقد ظهرت أنظمة وأجهزة مثل نموذج (Pile Driving Analyzer) قبل أوانها. اعتمدت هذه الأنظمة على تكنولوجيا الهاتف المحمول التي كانت غير ملائمة نسبياً ومتقطعة خاصة في المناطق النائية. وبالطبع قام بعض الرواد باحتضان هذه الأجهزة على الفور لكن غالبية المجتمع الجيوتقني وقفت مكتوفة الأيدي منتظرة بما يُعرف بـ"قانون مور" بأن يوصل تقنية نقل المعلومات من أماكن بعيدة إلى النقطة التي يجب أن يكون فيها إختبار الأساس الديناميكي. إن هذه التقنية موجودة حتماً الآن وتقوم شركة (GRL) بالاستفادة منها على أكمل وجه كما تظهر بوضوح دراسة إحدى الحالات في المقال أعلاه.