Dynamic Testing of Helical Piles

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*The **American with Disabilities Act (ADA)** is a US law that mandates that public buildings be accessible to individuals with impaired mobility, requiring, for example, the availability of ramps for wheelchairs. ADA improvements to the Amtrak Passenger Station of Alpine Texas required a new platform which was designed with more than 200 helical piles of 73 mm shaft diameter as a foundation system. The piles were to be advanced (helical piles are screwed into the ground by the application of torque) into the primarily granular soil profile to a minimum depth of 3 meters.*

Atwell, LLC from Southfield, MI, the construction manager for track owner Union Pacific Railroad and user Amtrak, retained **GRL Engineers** to perform dynamic load tests on 10 helical piles. Nine of the ten piles had not reached the desired depth and could not undergo static load tests because of their proximity to the tracks; the remaining test pile had been statically tested and was monitored under dynamic tests for comparison. Previously conducted dynamic tests in cohesive soils compared well with static tests for this type of pile.

Helical foundation systems offer a specialty solution for numerous applications including foundation underpinning, earth retention and residential and commercial foundations. Consisting of a central shaft with one or more helical-shaped bearing plates, extension shafts, and a bracket that allows for attachment to structures, the conventional helical foundation system is typically designed for maximum allowable design load of 60 kips (270 kN), with some systems designed for up to 200 kips (890 kN). The most common means of estimating helical pile capacity is found in AC358, Acceptance Criteria for Helical Foundation Systems and Devices, by the **International Code Council Evaluation Service, Inc.** (**ICC-ES**). For capacity verification of helical foundation systems, the AC358 acceptance criterion considers system dimensions, load test results and torsion resistance. A successful verification of system installation and allowable capacity is established provided the maximum allowable torque is achieved during system installation and all full-scale axial load tests exceeded the allowable capacity by at least a factor of two. For systems that fail this verification, the acceptance criteria specify additional testing.

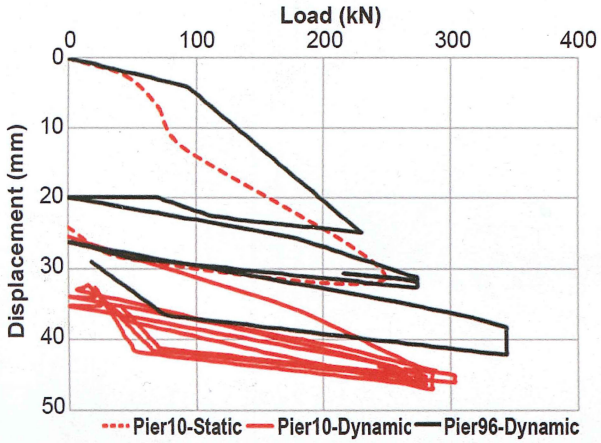
"The most common means of estimating helical pile capacity is found in AC358"

Drop hammer with pile extension

Atwell proposed high-strain dynamic testing of the non-conforming piles. A joint effort with GRL led to the development and construction of a simple, 680 kg drop hammer with a reusable, portable pile extension fitted for transducer attachment and drop hammer impact. GRL tested ten helical piles: one on which a static load test was conducted, for comparison, and nine production piles for additional verification. Three or four impacts with fall heights of up 0.9 meters were applied; the ensuing forces and velocities of the helical piles were measured by a Pile Driving Analyzer® Model PAX and analyzed by CAPWAP®. The simulated load set curves of the impact loadings, calculated by CAPWAP, were then plotted together considering the displacement history of previous loadings. A typical result is shown in Chart 1, showing similar results for static and dynamic tests.

The ten dynamic tests conducted on the helical piles provided an efficient and economical alternative to static load testing. ■

Chart 1: Typical Dynamic Testing Result and Static Load Test



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ينصّ "القانون الأميركي لرعاية ذوي الإعاقة" على أن تكون الأبنية العامة مجهزّة للأشخاص ذوي الحركة الضعيفة مما يتطلّب على سبيل المثال لا الحصر توفّر سلالم للكراسي المدولبة. وقد تطلّبت التحسينات التي أجراها "القانون الأمريكي لرعاية ذوي الإعاقة" على محطّة الركاب أمتراك "جبال الألب/تكساس" إنشاء رصيف جديد صُمّم بأكثر من مئتي كومة حلزونية ذات محور قطره ٧٣ مليمتر كنظام تأسيس. وقد لزم وضع الأكوام في التربة الحبيبية على عمق لا يقلّ عن ٣ أمتار.