SONIC PULSE METHOD OF TESTING CAST-IN-SITU CONCRETE PILES

Recently the Greater London Council arranged for a series of tests to be carried out on a method developed in France for checking the soundness of cast-in-situ concrete piles.

The need to have some such means available became increasingly evident when occasional failures of cast-in-situ piles on LCC and GLC sites raised the question of whether the basic reason for the failures was the overloading of the subsoil or defects in the piles themselves. Further investigation of the piles revealed fractures, cavities and the inclusion of foreign matter in the concrete. Since the piles under discussion had usually been cast for the specific purpose of carrying out a load test, so that the exercise of normal care at least could have been expected in their making, some concern was aroused over the possible condition of ordinary working piles, only a very small proportion of which are ever subjected to any form of test.

When cast-in-situ piles were no larger than 18 in (457 mm) or so in diameter, with the occasional use of some 24 in (610 mm) in dia., the possible existence of one pile in a group being below an acceptable standard was of less vital concern. In recent years, however, the increasing use of piles up to 6 ft (1.83 m) dia. with a single pile loaded with anything up to 1,000 tons has introduced a new element into the situation. Any major defects in a pile of this size could have serious consequences, but it seemed to be accepted generally that the likelihood of such an occurrence in any of the larger diameters of pile was remote. When, however, as a result of the exercise of the GLC's function of statutory control, information was received of serious defects being encountered in large diameter piles, it was obvious that stricter measures of control were necessary.

The defective piles mentioned occurred in every case on sites where a temporary casing had to be driven through water-bearing sand and gravel or peaty soil, and subsequently withdrawn. Although careful design of the concrete mix and strict control of its placing and the method of withdrawal of the casing could do much to prevent the formation of defective piles, it was plain that some effective method of testing the soundness of a cast-in-situ concrete pile was needed badly.

The Centre Experimental de Recherches et d'Etudes du Batiment et des Travaux Publics (CEBTP) of 12 rue Brancion, Paris, was the only organisation known to have designed apparatus for this purpose, although equipment designed for seismic investigation of the subsoil had been adapted for pile testing in the USA.
During a visit to the Paria headquarters of CEBTP, the method was described in some detail and the apparatus seen in use on a site on the outskirts of the city.

**CEBTP method**

This method of testing piles is based on the transmission of a sonic pressure wave across the pile. Two or more tubes of 42 mm internal dia. are cast into the pile to enable a transmitter and receiver to be lowered to the foot of any pair of tubes. Although these tubes were originally of PVC, latterly metal tubes have been used more generally. The transmitter and receiver are identical and consist of ceramic transducers about 150 mm long sheathed in sealed PVC tubes of 38 mm external dia. During the test the tubes are filled with water to provide an air-free path for the pressure wave.

A sawtooth voltage with a peak of about 800 V is applied to the transmitter to produce a piezo-electric effect in the ceramic and a shock wave is transmitted to the receiver. The transmitted pulse shows as a continuous horizontal line on an oscilloscope screen. The waveform of the signal received is represented by “Z modulation” of the oscilloscope and appears as a continuation of the trace of the transmitted pulse but shows instead as a row of alternating bright and dark sections, corresponding to the peaks and troughs of the received waveform.

The distance from the start of the trace to the beginning of this waveform is a measure of the time of transmission of the pulse through the concrete and is thus an indication of its quality. Faults in the region of the path of the sonic pulse cause an increase in the time of transmission and hence also in this distance. There is also a reduction in the intensity of the received signal. The magnitude of both the increase in the time of transmission and the reduction in intensity depends on the nature and size of the defect; the complete loss of the received signal from the screen is indicative of the absence of sound concrete in that position.

The transducers are raised within the tubes by means of a winch. A constant voltage source applied through a potentiometer control on the winch to the Y shift of the oscilloscope relates the position of the trace on the screen to the depth of the transducers within the pile. A three-dimensional picture is then built up of depth, time and intensity of the received waveform. A polaroid camera, which forms part of the apparatus, is used to obtain a permanent record of the results.

It should be emphasised that correct interpretation of the results, based on thorough knowledge of the technique and experience gained from previous use of the apparatus, is all-important if wrong conclusions are not to be drawn.

The apparatus was seen in use on a site on the outskirts of Paris. The piles under test were normal working piles about 30 m in depth and once the apparatus was set up it took about ten minutes to carry out the test on a pair of tubes cast into the pile. It was said that twelve piles a day could be investigated, allowing for setting-up time. It was noted that the equipment, with the oscilloscope housed in a small van, worked satisfactorily in heavy rain and on a waterlogged site.

The next stage in the investigation was to carry out a controlled test of the apparatus in London in an attempt to determine its limitations.

**London trial**

The GLC was joined by Jan Bobrowski and Partners in carrying out the trial of the apparatus and technique which took place during March, 1969, on two different sites. Different
Ireland's deepest piles

Cementation (Northern Ireland), Ltd., have been awarded its biggest ever piling and foundations contract—worth £363,000—by the Northern Ireland Ministry of Finance on behalf of the Post Office. It is for the new Head Post Office in Belfast and will involve the construction of over a hundred large diameter cylinder piles to depths of 170 ft (51.8 m), the deepest ever in Ireland.

In addition to the cylinder piles which will be up to 4 ft 6 in (1.37 m) in dia., there will be 15 friction piles of up to 30 in (762 mm) dia. to depths of about 100 ft (30.5 m). All pile shaft excavations will be supported by a bentonite suspension as the ground, before reaching rock to provide an end bearing for the cylinder piles, consists of fill, sleech, gravel, boulders and clay.

Helical steel reinforcing cages are placed through the bentonite slurry, and concrete is then poured through a tremie pipe from the bottom of the shaft upwards, thus displacing the slurry. Adequate reinforcement will be left standing to key into the subsequent pile caps and beams. The whole will then support an eleven storey steel frame building some 125 ft (38.1 m) high together with an adjoining four storey sorting office block. The work represents Cementation's third major government foundation contract in Belfast in recent years.

Shell Haven refinery

Shell UK have announced plans for building a major process unit costing £20 million at the Shell Haven oil refinery, Essex, their second largest in Britain.

Work on the project is due to start this year and should take four years to complete. The new unit will increase the refinery's annual processing capacity from 10 million tons to 13½ million tons.