

# Reinforced concrete piles – the inside story

Developments in pile foundations have come a long way since the days of universal dependence on timber or metal pile structures alone. The revolution came with the introduction of reinforced concrete techniques. **Glyn Dawson of Whitelegg Machines** charts the move towards today's off-site reinforcing bar prefabrication systems.

**P**ile foundations have been used as load-carrying and load-transferring systems throughout history. In times past, when villages and towns were sited strategically close to rivers and lakes to meet defensive or logistical needs, it was essential to strengthen the bearing ground of any construction with some form of piling.

From the Roman era to the early 18th Century, timber piles were virtually the only option, driven in to the ground by hand or positioned in dug holes, which were then filled with sand and stones. The first breakthrough in technique came in 1740, when Swedish engineer Christoffer Polhem invented mechanical pile driving equipment not dissimilar to that in use today. This innovation spurred on the use of more permanent piling materials, with cast iron being introduced around 1800 and concrete piles from the beginning of the 20th century.

The industrial revolution created the need for larger load-bearing structures to house heavy manufacturing and processing plant, often in difficult and varied

terrain. This rapid growth of capital industries triggered important changes to mechanical pile driving systems, resulting in the invention of steam-driven and, ultimately, diesel-engine power for machines.

## Exploiting areas with poor soil

In modern times, high demand for land available for commercial and domestic construction has often led local authorities and development agencies to exploit areas with poor soil characteristics. This limitation has resulted in the development and refinement of pile techniques and pile driving systems.

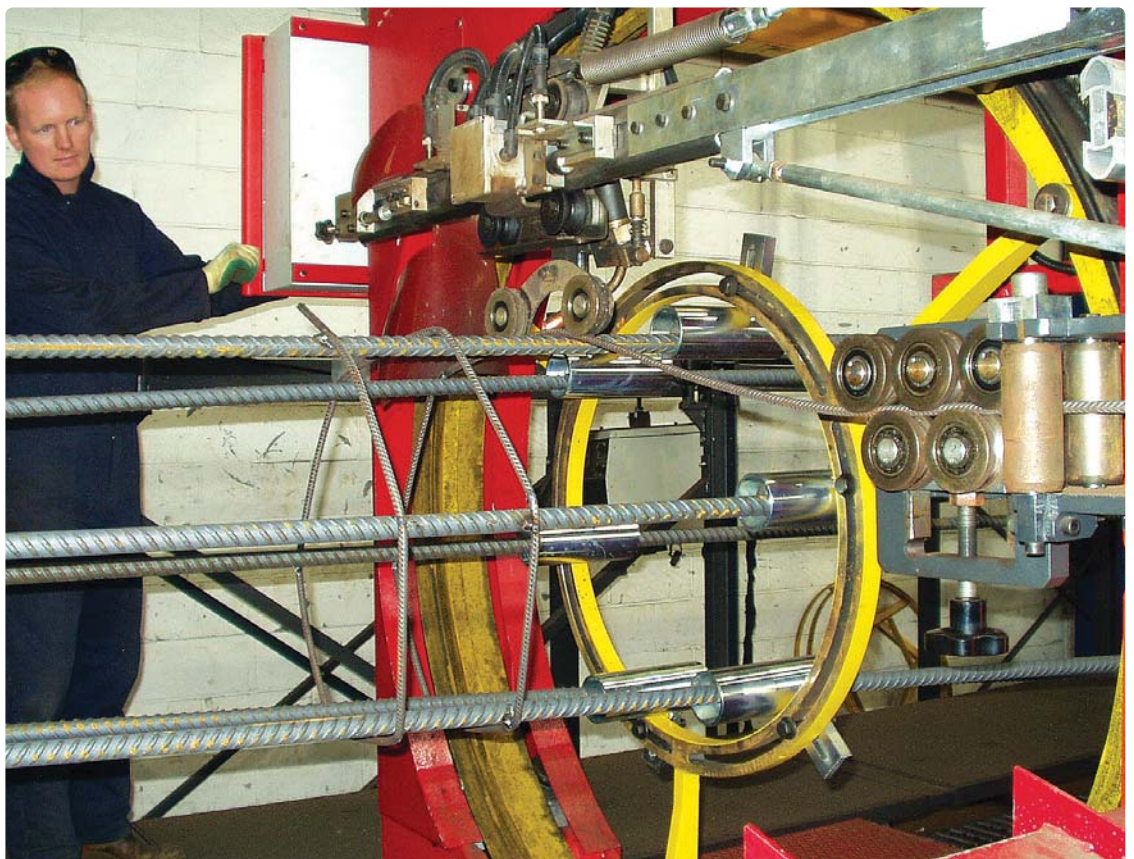
There are specific advantages of reinforced concrete piles that are bored and cast in-situ. They can be installed with the minimum of noise and little or no vibration to disturb the subsoil and other neighbouring structures. Very long lengths and large diameters are achievable and these dimensions can be varied to suit specific ground conditions. For increased stability in clays, pile end enlargements of up to two or three diameters are possible. An added advantage is that site condition information can be gathered from in-situ inspection and testing of the bored-out soil. Finally, the choice of actual pile material used is not dependent upon its handling characteristics or its resistance to pile driving stresses.

## Reinforcing bars

As concrete is very strong in compression but relatively weak in tension, embedded steel reinforcing bars provide tensile strength and compensate for this imbalance.

While steel reinforcement is obtainable in a variety of forms of bars and fabric, circular-section rolled bars or rods are mostly commonly used for all forms of

Lemon Groundworks setting the first tack weld.





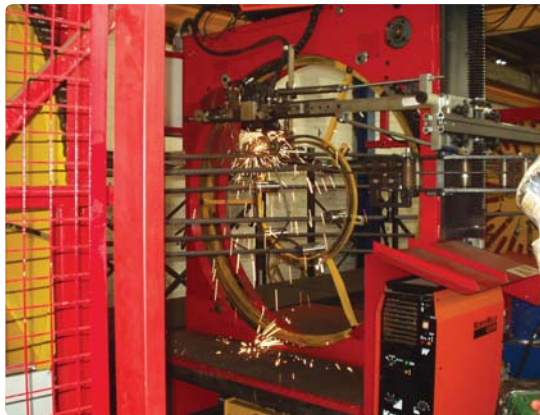
GAM machine from MEP.

reinforced work. High-tensile rods are also employed and because of the higher working stress, less steel is required to provide the same strength as mild steel. However, in developing its higher strength it stretches more than mild steel and any resultant cracks in the concrete around it will be larger. The better the bond the less risk there is of large concentrated cracks developing and as a means of increasing bond and limiting cracking to fine well-distributed cracks, deformed bars provide the answer.

Deformed bars are produced in a number of ways. First, as high-tensile steel bars rolled with projecting ribs or corrugations along the length, or second, from mild steel bars that are cold-worked to increase the ultimate tensile strength and raise or eliminate the yield-point of the steel, the amount of increase depending upon the nature of the basic steel and the amount of cold-working. Both stretching and twisting are used as methods of cold-working and may be applied to circular ribbed bars or to square bars, which become deformed by the twisting process and thus afford better bond.

The greater bond stress obtainable makes it possible to stress the steel to higher limits and thus develop its

GAM system in use.



strength to a maximum. Greatest advantage is obtained when a large number of small-diameter bars are used rather than a few larger bars because the surface area in contact with the concrete is thereby increased.

**Pile cage assembly**

The common method of introducing steel reinforcement for in-situ bored pile casting is in the form of pile cages comprising a tubular or profiled assembly of reinforcing bar lengths connected by rings or wire fixings.

With the exception of short-run specialist applications, the manual assembly of pile cages on site for bored pile, cast-in-situ reinforced concrete piles is a labour-intensive operation involving steel fixers constructing the reinforcing bar cages with rings and by wire tacking or hand welding.

The economic alternative is off-site prefabrication methods, which offer the opportunity to carry out fast, accurate pile cage assembly, producing automatically welded cages from 150mm outside diameter up to 2000mm o/d and up to as much as 21m long. Such mechanised methods free-up site operatives for other specialised duties and at the same time reduce the casting process time by requiring fewer splicing and coupling operations for pile cage connection.

**Leading innovator**

One of the innovators of automatic assembly techniques is an Italian company, MEP – Macchine Elettroniche Piegatrici – based in Undine, Italy, which specialises in all aspects of cold steel reinforcement bar processing.

The company has developed the compact GAM assembly system, the configuration of which is unique in that the spiral welding head moves along the longitudinal bars. In other systems, machines ‘push’ the cage through the welding head, so requiring a 15m cage to have a 30m operational length during its assembly.

The forming operation commences with the chosen number of longitudinal, cage-forming reinforcement rods being loaded and secured into the end indexing plate. The spiral forming coil is fed from an adjacent pay-off coil into the automatic robot weld head, which after the first few manual tacks can be left to rotate and weld automatically via a dedicated programmable logic controller (PLC) unit.

**Pitch can be set automatically**

The main mobile head moves along the guide rails, carrying the welding unit and the spiral forming mechanism. The spiral pitch can be set automatically and is controlled by the rotation speed of the longitudinal bars. Welding time is adjustable to suit the bar and weld wire diameter and speed of rotation with automatic control giving even, consistent welds.

To add to the speed of changeover, the patented tooling can be quickly set for any cage diameter. The PLC automatically calculates the position for the holding bushes, enabling the operator to be sure that the tooling set up is in the correct position first time.

One UK steel reinforcement specialist company now using the GAM system is Wickford-based supply and fix expert, Lemon Groundworks. The GAM machine from MEP was supplied through UK agent, Whitelegg Machines, which has a long association with Lemon Groundworks that runs three MEP link benders at two sites in Wickford and Rugby.

It all goes to confirm that pile technology has come a long way from the timber methods of old and the original concepts and procedures of the early days of concrete reinforcement development. ●