

Numa's Dual Fluid System - the drilling solution

In the Finnish city of Turku, as with many European cities, there are numerous old buildings that were built years ago on wooden piles. At the time, the wooden piles were considered sufficient for supporting the structures but with the passage of years, problems have arisen.

Today's demanding environment make wooden piles vulnerable to elements that engineers long ago never accounted for. Groundwater levels that used to remain steady now have a tendency to drop to expose and aerate wooden piles causing them to rapidly decay. Sewage leaks have caused bacteria attacks on the wood to further weaken them and the installation of new foundations in nearby structures often cause uneven sinking (tilting) of the buildings with wooden piles. As a result, many buildings are required to have their wooded piles replaced with new steel pipe piles.

Replacing existing piles is no easy task but when you are also faced with difficult drilling conditions, it can become a real problem. In Turku, most drill sites are located in building cellars that are nearly always narrow and with very limited headroom. In addition, ground formations typically include a surface layer of up to 164 ft (50 m) of clay, a moraine and boulder layer running through groundwater producing very high back pressures and then

Combining traditional rotary & fluid with percussive air down hole drilling

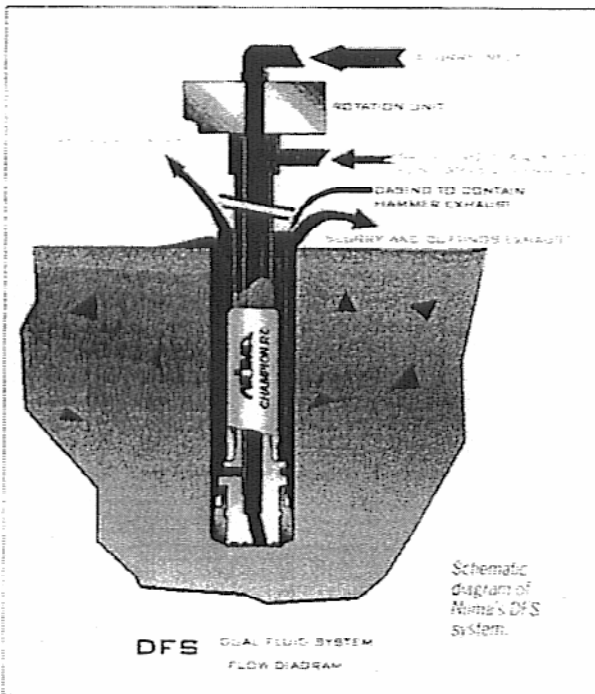
granite bedrock that may be up to 197 ft (60 m) deep. While the old wooden foundations can be from 33 to 98 ft (10-30 m) long, they are usually replaced with much larger steel piles that require every bit of space available for installation.

DFS solution

Numa, the prominent American down hole hammer and bit designer and manufacturer and its Finnish distributor, NDS - Nordic Drilling Systems Oy, were determined to devise a solution for drillers faced with these types of foundation strengthening projects in Finland and elsewhere. As a result, Numa developed the patented DFS - Dual Fluid System. The DFS is an innovative drilling system that combines traditional rotary & fluid drilling with air operated down-the-hole hammer drilling. When the system encounters soft material such as clay and timber, it uses rotary motion together with fluid flushing to offer the best cutting characteristics. However, the unique design of the DFS also incorporates the percussive

motion of the DTH hammer for acceptable penetration rates in gravel and bedrock. With the DFS method it is possible to achieve all the positive aspects from rotary and down-the-hole drilling without any of the possible drawbacks.

Central to the DFS concept is a reverse circulation down hole hammer that uses fluid or slurry to clean the hole instead of air that is commonly used with down hole hammers. Instead of the drill cuttings being exhausted up the centre collection tube as with traditional RC drilling, fluid is pumped down the centre tube and out the bottom of the drill bit. The pressure of the fluid being pumped down the drill string cleans the bit face and forces all the cuttings up the annulus and outside the casing. This acts to seal off the hole and to prevent any blowouts while drilling. The air that is used to operate the hammer is sent down an air inlet and goes through the hammer to cycle the piston. The air is then exhausted back up through the void located between the hammer and the inside of the casing. This new dual fluid method offers many benefits including the ability to drill perfectly straight holes, faster penetration rates in rock formations, no building damage resulting from vibration, installation of longer drill pipes than with drifters in a confined area, immediate full bearing capacity and immediate grouting. The DFS has been well received in the construction industry because it provides the ability to continuously drill holes in close proximity to each other, which has never been possible with other drilling methods. With Numa's Dual Fluid Drilling System, holes can be drilled side-by-side because there is virtually no risk of hole collapse and grouting can follow immediately behind to dramatically save time and money.



Below: Kauppakatu 6 in Turku chose Finnish construction company Teiera Oy to undertake its foundation rebuild project with Numa DFS system, which successfully met the demanding drilling conditions with a long term solution.



Turku project

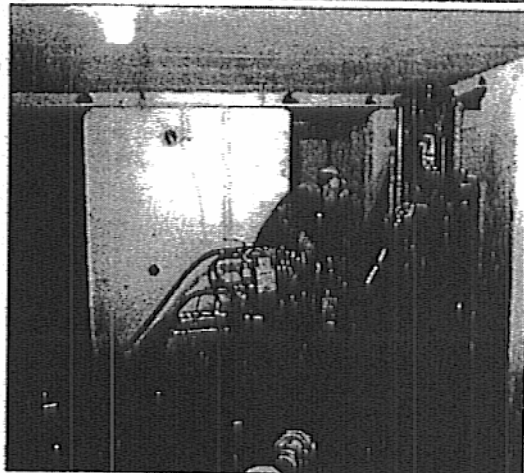
One project in Turku headed up by Tekra required the strengthening of old piles that supported the foundation of an eight-story building in Kerstall's Square. The strengthening of the piles became necessary when the original wooden piles began to sink due to the tremendous weight which they had to support.

The project called for drilling 115 x 5-1/2-in. (140 mm) OD piles through a basement floor into bedrock in order to shore-up a sinking building. Each of these piles needed to carry a 100-ton load and was grouted in position after the rock socket was completed.

Normal drilling equipment was strictly forbidden on the project because the drill site was located in the basement of the existing building and the air required to flush the hole could cause holes to blowout or washout, putting the stability of the building at risk. To tackle this difficult assignment, Tekra subcontracted Pirkanmaan Porakaivo Oy who consulted Nordic Drilling Supplies regarding Numa's Dual Fluid System.

In Kerstall's Square, Pirkanmaan Porakaivo Oy used Numa's DFS 140 including the Numa Champion DFS45 down hole hammer to drill 6-3/4-in. (170 mm) diameter holes while simultaneously installing 5-1/2-in. (140 mm) OD casing. All drilling was conducted by a specially designed Technodrill rig that supplied 162 lb/in² (11 bar) and 400 ft³/min (1134 litres/c) of air for holes drilled approximately 50 ft (15 m) into bedrock.

DFS rig operating in a building cellar. With Numa DFS system, long product pipes can be installed from limited floor area contrary to the top hammer systems, which often require cellar floor to be excavated for added space required by the rig, platform, hoister.



Fluid was pumped down the hole using an on-board Dynaset hydraulic water pump at a variable rate of up to 90 gal (150 litres) of fluid per minute at different pressures, normally up to 585 lb/in² (40 bar).

The Dual Fluid System was required to drill directly through old wooden piles and simultaneously install new steel casing.

Drilling through wood in many instances has proven to be very difficult for many drilling methods because wood is very elastic and does not fracture easily like rock. However, DFS's

special design features provide the flexibility to drill through soft formations like wood in addition to formations containing solid rock, gravel or boulders. Instantaneous penetration rates on the Turku project did vary between 150 ft (50 m) per hour in soft formations to 10 ft (3.3 m) per hour in the bedrock.

The conditions surrounding this project in Finland deemed that many traditional styles of drilling could not be used. Jacketed piles easily bend, cannot penetrate wood or rock efficiently and have a low bearing capacity. Driven piles also bend easily, cannot penetrate wood or rock and can cause severe damage to existing foundations. Drilled piles require the use of air that could result in hole collapse and they also require a large amount of space to operate. Numa's DFS was developed and utilized to overcome these types of obstacles to successfully replace deteriorating piles. Inherent to the system is the ability to provide for straight piles, no vibration damage to surrounding foundations, allow direct grout injection while drilling or immediately after and efficient penetration in both wood and rock applications.

The DFS has proven itself to be an effective solution for drilling in confined areas without incidence of hole collapse or blowout. By utilizing Numa's specially designed Dual Fluid Drilling System, the contractor was able to complete the project more quickly and safely than any other method could have.

At the time of writing this article, Tampere University of Technology in Finland was in the process of issuing the DFS a pile code that insures that it can be used safely, effectively and economically on any project that requires a high level of productivity. This further validates Numa's Dual Fluid System (DFS) as the drilling solution.

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Attributes of the DFS System

DFS not only cuts through wood and clay but also penetrates through moraine, boulders and bedrock. All piles can be securely socketed into the bedrock. High bearing capacity results in low cost per ton.

The DFS method uses rotary drilling principles while penetrating through elastic or soft materials and percussive & rotary drilling principles while penetrating through hard materials. Advantages include: straight piles; no damaging vibrations to existing foundations; large diameters possible; max. usable product element length achieved; normally 80% of drilling time rotary; quiet; no air introduced into the formation; no shock waves caused by compressed air; no over-flushing of the borehole; allowed where standard air down-the-hole prohibited.

Water/bentonite flushing the annulus of the pile (for example up to 200 litres/min at up to 60 bar); helps penetrating through all materials; also flushing can be closed circuit pile is not damaged/tensioned during installation; pile drilled into the bedrock; immediate full bearing capacity; can be grouted during or after drilling process.

DFS causes minimum disturbance during operation; causes no damage to existing foundations; allows direct grout injection while drilling in process or finished enabling immediate annulus grout-protection (in spite of flushing medium grout is injected filling the pile annulus); enables secure rock contact in most difficult drilling conditions; best bearing capacity; the most certain and secure solution.

The DFS method is completely new and unique having international patents pending. There are a number of other possible applications. The Numa DFS system can be used in any traditionally difficult drilling project but especially if there is a risk of damaging surrounding utilities, foundations or structures. There are several different applications that include railroad electrification projects where DFS enables simultaneous grouting (during drilling) eliminating potential damage to the railroad. DFS can be used for anchoring offering high penetration rates through soft formations making a smooth hole and allowing easy casing retraction from well lubricated hole. Casing can be drilled well inside rock and still easily retracted in preparation of the anchor installation.

Other uses are in drilling through potentially hazardous formations such as contaminated soil preventing any aeration taking place; dump site ventilation holes where its fluid flushing prevents gases from igniting during drilling operations; and finally in any application where simultaneous grouting is necessary, and any overburden drilling application utilizing the casing pipe.