

Aperio Engineering's Hydraulic Column Plunging System HPF 300-625

Introduction

Where top-down construction techniques are used for the formation of deep basement structures, the placement of heavy structural columns to previously unprecedented levels of accuracy is now made possible by the modular plunging system (HPF 300-625 – Hydraulic Plunging Frame 300mm to 625mm) offered by Aperio Engineering Ltd of London UK. In The Shard of Glass project in London, UK, the Aperio Engineering system has been successfully used to place 68 large plunged columns to previously unattainable levels of accuracy and in record time.

The standard system can handle column sizes ranging between 300mm square and 625mm square, or any size in between, and works by guiding the column between 4 sets of reciprocating rollers, arranged in two sets – upper and lower. The roller sets are contained in 'modules' and spacer frames can be inserted in between these modules to separate the roller sets by the largest distance possible, thus providing a mechanical advantage in 'steering' the column and resulting in improved control and positional accuracy. Using powerful 10t positioning and clamping forces, the modular frame, which can be adjusted in length between 4.5m and 26.5m long is lowered into a pile casing where ideally it rests just above the cast level of the concrete. The frame is gimballed mounted at its head and can be easily 'steered' and locked into near perfect vertical alignment using four hydraulically extendible arms fixed to the bottom module in the frame. An operator works from a control console near to the top of the frame where he monitors vertical alignment using several in-built self-plumbing lasers. Once the frame has been centred and locked into position, the plunged column is lowered inside the frame where four sets of reciprocating rollers (two sets near to the top of the frame and two sets near to the bottom of the frame) firmly clamp and center the column within the frame as it is suspended just above the concrete. Once clamped and centered, the column can be lowered or 'plunged' into the concrete through the rollers. The column is brought to rest just above the final target level by allowing the weight of the column to rest on two extended, linked hydraulic cylinders (or screw jacks if preferred). Once the weight of the column has been taken on the jacks, releasing pressure from the jacks in a controlled manner allows the column to be brought to within a few millimetres of the target level. Thus the column is held firmly in near perfect alignment and level whilst the concrete cures around the base of the column.

Columns of up to 60 metric tonnes in weight can be plunged to accuracies well within 10mm in plan position at the column head, well within ± 10 mm of correct level, less than 0.25 degrees angular rotation, and well within 1:400 verticality. These tolerances can give structural designers the confidence to pre-drill fixtures and fittings to the plunged column safe in the knowledge that once exposed, the columns and fixtures will be where they are expected to be. In addition, the basic column profile can be pre-fitted with external stiffening plates since the adjustable rollers allow changing profiles along the length of the column to be accommodated during plunging by the simple expedient of opening and closing the rollers briefly at pre-determined positions as plunging takes place. The improved vertical tolerances achieved reduce buckling forces within the columns and designers are able to make economies in the column design as a result.

What's New Here?

Hydraulically operated column plunging devices have been in use for over 20 years. However, column sizes have increased dramatically over this period as basement depths have increased. In addition, structural engineers are increasingly demanding tighter plunging tolerances, particularly verticality, since this has a direct effect upon the stiffness requirements for the column. To meet the new demands placed upon contractors, Aperio Engineering Ltd (through its design trading partner AC Devco Ltd) has completely re-thought the process of plunging columns. The HPF 300-625 frame addresses these new requirements and offers a flexible, rapid, accurate and reliable way to plunge columns ranging in size from some of the smallest to the very largest, with in-built capacity to accommodate even larger columns in the future.

In order to achieve tighter tolerances and offer versatility, the column plunging frame has been made modular. Positioning the roller sets as far apart as possible offers a mechanical advantage over fixed-length plunging frames. 10t clamping forces in both the bottom guide arms and the four roller sets ensure that the frame and even the heaviest columns within it can be held in position as they are plunged into the concrete. Speed and simplicity of use is an essential requirement for column plunging and with very little practise, the entire head-works, the vertical frame and the column itself can be positioned, locked and plunged into position within 30 minutes of completing the concreting operation.

Safety around plunging operations is a major consideration. In order to provide the levels of safety required, the top-plate of the HPF300-625 frame comes with an integral, wrap-around safety walkway, access ladders and safety guards built in. Working from the platform, the primary operator has a conveniently placed control panel from where he has full visibility and control over the movements of the frame. Three additional operatives can simultaneously attend the operation to guide the column into position.

The reciprocating roller sets that are used to clamp the frame are operated on a rocker system to allow a far larger range of movements than traditional ratchet mechanisms employed by other plunging systems. In addition, the rollers themselves can easily be exchanged for larger items and this extends the lower working range of column sizes to 250mm square. Thus in one plunging frame a very wide range of column sizes can be plunged.

Conclusion

The HPF300-625 system offers degrees of flexibility and accuracy not previously available. The system is easy to use, highly versatile and in one device offers a reliable means by which the major of plunged columns may be positioned speedily and safely to levels of repeatable accuracy previously unattainable. The Shard of Glass tower (1086 feet tall and due for completion in 2012) relies on 68 primary columns, each of which was plunged into position well within allowable tolerances. The system is openly offered for sale to foundation contractors around the world by its inventor, Alex Cartwright, through his manufacturing business, Aperio Engineering Ltd and several enquiries from around the world are already receiving detailed attention.

