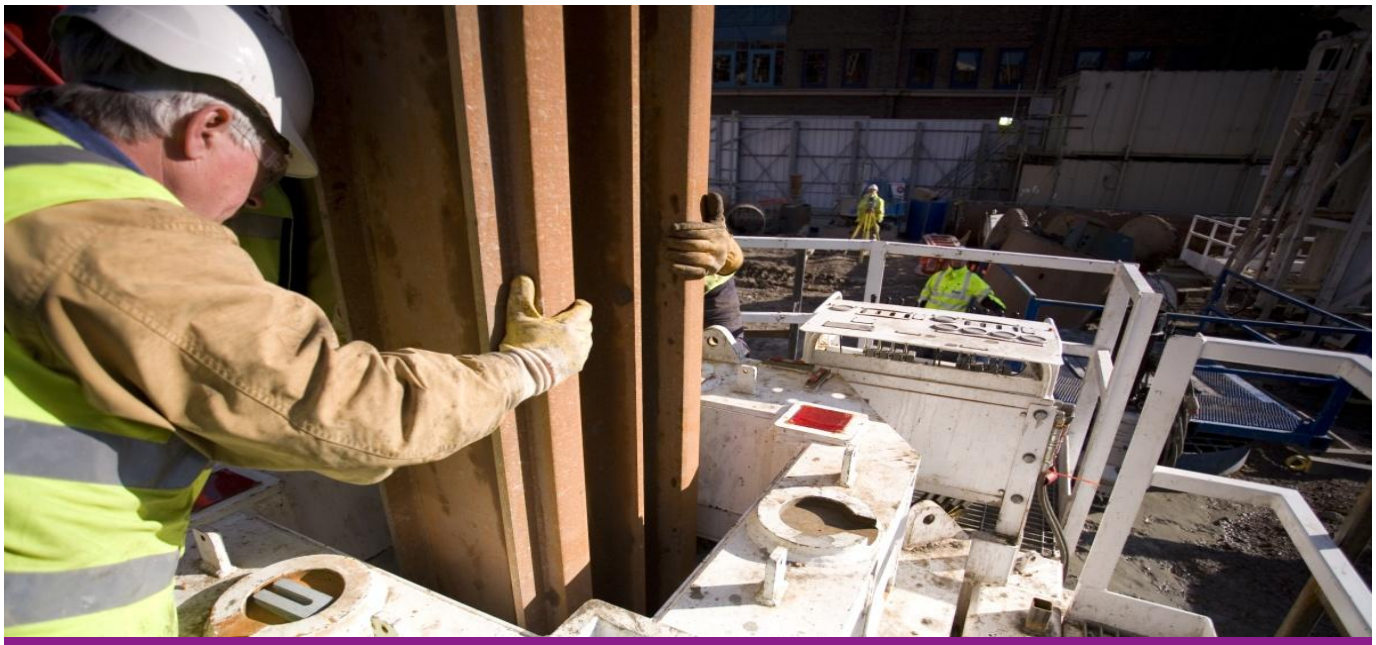
TECHNIQUE SHEET

Balfour Beatty
Ground Engineering



PLUNGE COLUMNS

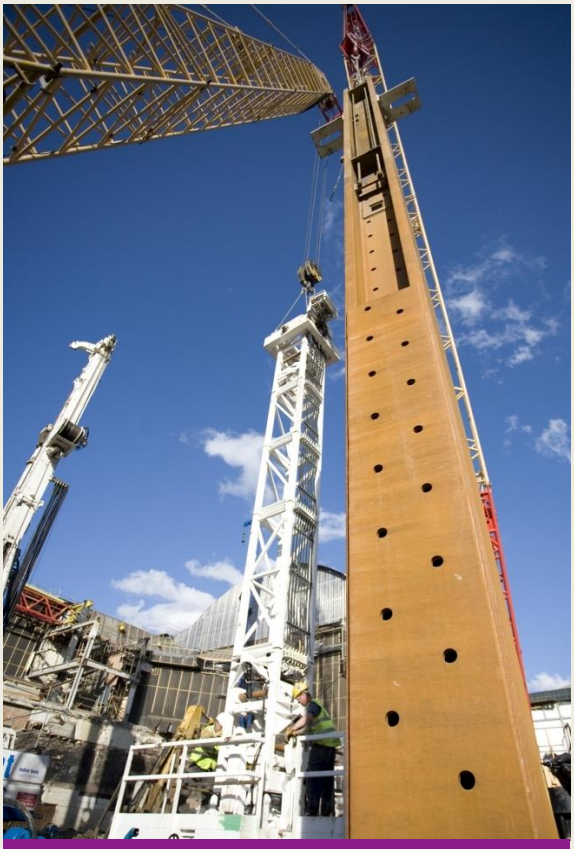
Plunge columns are the key to Top-down construction which allows simultaneous superstructure construction and basement excavation, significantly improving project programmes.

BASIC TECHNIQUE

Balfour Beatty Ground Engineering (BBGE) can install Plunge Columns into rotary bored piles to allow for a 'top-down' construction sequence, 'launching' structures before the basement is excavated. Top down construction can significantly reduce the overall construction programme resulting in earlier project completion dates. Plunge columns can either be installed with a hydraulic or fixed frame and have become popular in the construction industry as they facilitate deeper basements and taller structures.

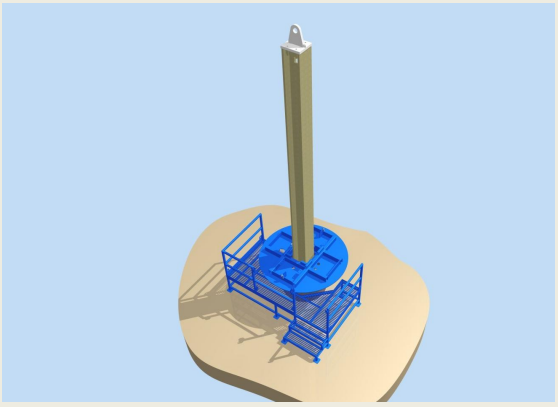
CONSTRUCTION PROCESS

Generally the construction process is as follows; a rotary bored pile is excavated to the required depth, a reinforcement cage is then installed and then the void is filled with concrete stopping the required distance below ground level. Whilst the concrete is still wet a hydraulic plunging frame is installed within the temporary casing and then the plunge column is installed to structural tolerances. The concrete is then left to set in the pile and once this is complete the empty bore above is backfilled. When all the plunge columns are installed the construction of the structural frame above ground level can begin.



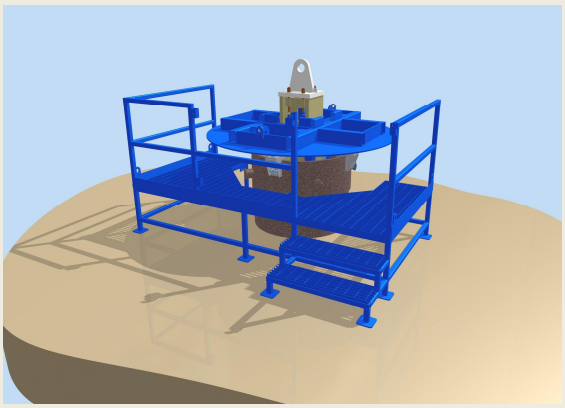
INSTALLATION OF PLUNGE COLUMNS

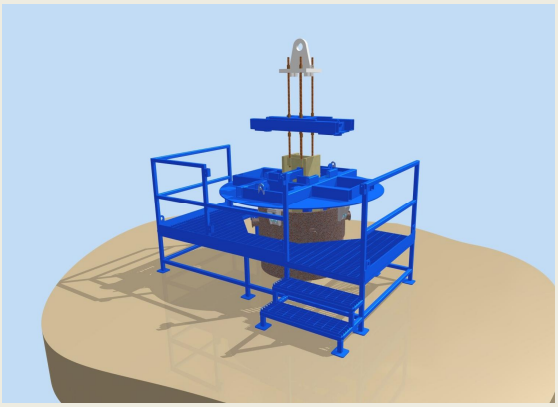
EXPLAINING THE PROCESS...



Stage 1
Once the pile is dug to toe level and concrete is placed, install plunge column frame into casing and brace off. Accurately level and plumb the frame using lasers.

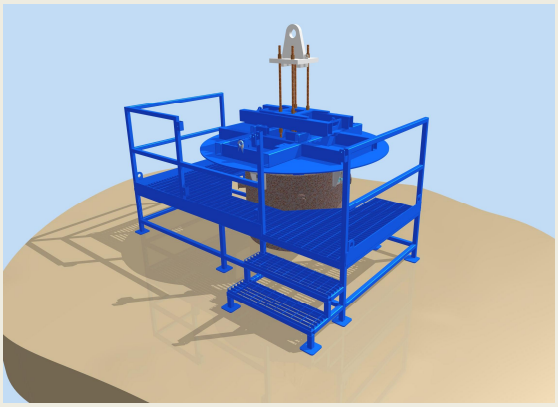
Stage 2
Insert plunge column into frame using lifting head or follower if required.

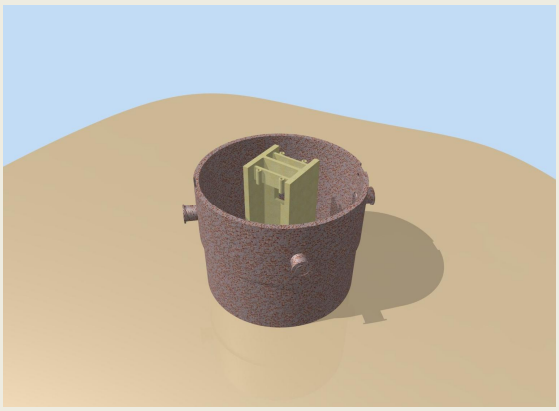




Stage 3
Trap off plunge column and remove lifting head. Check column for level and verticality.

Stage 4
Add lowering frame if required and plunge into wet concrete.





Stage 5
Trap off at correct level and complete a final check on position. Leave over night to allow concrete to set. Next day remove frame and brace and fill annulus with pea gravel, to support column.

PLUNGE COLUMN EMBEDDED IN CONCRETE AT DEPTH

COLUMN AND FRAME ARRANGEMENT – BORED PILING

THE BENEFITS

Plunge columns have a number of advantages in foundation construction, some of which are outlined below:

- ✓ Frame accommodates a wide range of column sizes from 350mm to 650mm square.
- ✓ Frame is compatible with a range of pile diameters from 1500mm to 2500mm.
- ✓ Segmental plunge frame allows for a wide range of depths to cut off level.
- ✓ Very high levels accuracy for both position (+/- 10mm in plan and level) and verticality (1:400).
- ✓ Frame can be centred independently of the pile position allowing the difference between the pile tolerance and the column to be neutralised. It is also possible to accommodate plunge columns designed to be located off the pile centre, subject to pile diameter.

LASER SYSTEM ENSURES HIGH LEVEL OF VERTICAL ACCURACY

HYDRAULIC VS. FIXED FRAME

Plunge columns can be installed using one of two methods; hydraulic frame or fixed frame. The fixed frame method involves creating a bespoke frame to fit the column size whereas the column on the hydraulic frame is trapped by rollers. Both are pre located on the casing and checked for position prior to concreting and then repositioned at the end of the pour with the column then being plunged through the frame. There are advantages and limitations to both methods which are outlined below.

Fixed

+ Plunge columns installed in 1.2m dia. piles
+ Simple method
+ Modifiable system for bespoke uses – can accommodate protrusions and different section sizes , good for high cut offs
– Typical maximum column weight of 15T, though heavier columns can be accommodated
– Requires welded spacers

Hydraulic

+ The flexibility of this frame allows for easy plunging of columns with additional plates, fins or shear studs welded to the sides.
+ Frame length can be adjusted
+ Very large columns can be plunged - 600 x 600, Up to 50t, Length unlimited (within reason!)
– Requires a minimum pile 1,800mm diameter.
– Cannot accommodate small columns (less than 300mm sq)
– Min depth to cut off >6m

PLUNGE COLUMNS AT THE SHARD (FOLLOWING BASEMENT EXCAVATION)

PREVIOUS EXPERIENCE

BBGE have designed and installed plunge columns on many different projects, including most recently at Nova Victoria, 100 Bishopgate, Heathrow T2B, The Shard London, Coleman Street and Oxford University.

THE SHARD CASE STUDY

The Shard's 87 stories, including a three level basement are supported by BBGE Plunge Column foundations. The project called for 9 different types of Plunge Column in piles of 1,800mm diameter. The use of plunge columns was selected by the project team in order to reduce programme as they allow for a top down construction sequence. The scope involved installing 67no. 17t plunge columns that were up to 25m long into 1800mm diameter piles that were up to 55m deep.

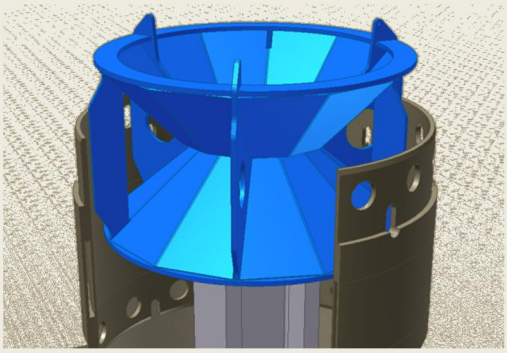
Each of the Plunged Column piles was designed to carry a maximum working load of 24,000kN.

To achieve the specified high construction tolerances and to accommodate the multiple sized plunge columns with external protrusions BBGE developed a bespoke hydraulic plunge column frame. All columns were installed to better than the specified vertical tolerance of 1 in 400, with an average tolerance of 1 in 800 being achieved. The works on The Shard were completed on time and to budget.

INSPIRING INNOVATION IN CONSTRUCTION

BBGE constantly strive to make improvements to our processes and systems so when evaluating the plunge column system it was decided that there was room for advancement. Plunge Columns typically need to be supported inside the excavation after the Frame has been removed. To achieve this support gravel is typically added around the column. It is imperative that the gravel exerts an even pressure around the column so it does not push the column out of position.

The initial method was to loosely tip gravel around the plunge column however this method could cause a gravel build-up on one side of the column, potentially causing the column to lean. Therefore BBGE developed the gravel spreader which guaranteed that gravel would build evenly around the column; thus exerting an even load on the Plunge Column and vastly reducing the risk of leaning columns.



Funnel used to place pea gravel evenly around the plunge columns

CONTACT US

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