



Heave Protection Systems



Federation of Piling Specialists



Deep Foundations Institute



Association of Specialist Underpinning Contractors and Engineered Foundations

Description

Heave protection is required in stabilisation situations where heave / shrinkage of clays is identified as either a current problem or, in some instances, a potential problem. Tests and theories vary regarding types and depths of heave protection. This data sheet seeks to give outline information on some systems for the prevention or minimisation of the effects of heave / shrinkage.

Heave / shrinkage occurs predominantly, although not exclusively, within clay strata. The systems shown attempt to isolate those parts of the structure which are vulnerable to movements caused by volumetric change of the subsoils.

Many of the RB underpinning systems shown on other data sheets can be adapted to provide heave protection.

Reference may be made to these sheets which are detailed below:

- U1 RB Traditional Mass Concrete Underpinning
- U2 RB Pile & Beam
- U3 RB Pile & Cantilever Beam
- U4 RB Knuckle Pile
- U5 RB Piled Raft
- U8 RB Cantilever Ring Beam

Loading Capabilities

Loadings are based upon the bearing capacity of the strata underlying the desiccated clay layers, and mini-pile size will be chosen to suit the particular loading requirement and system adopted. In circumstances where pile sleeving products are used, uplift and down-drag may occur and reference should be made to pile calculation criteria applicable to clay soils.

General Guidelines for Augered Mini-Pile Sizing

Assumptions, $C_u = 100\text{kN/m}^2$ average
Depth of competent, non-desiccated strata 3.0m - 6.0m

150mm dia	SWL	30 - 65kN
200mm dia	SWL	40 - 85kN
220mm dia	SWL	45 - 95kN
250mm dia	SWL	50 - 100kN
300mm dia	SWL	60 - 130kN
450mm dia	SWL	95 - 200 kN

In certain ground conditions these loadings can be exceeded.

Application

Many of the RB underpinning / mini-piling systems are capable of being adapted to provide heave protection. This data sheet demonstrates two of the most widely used heave protection methods, namely Pile & Beam and R.C. Piled Raft.

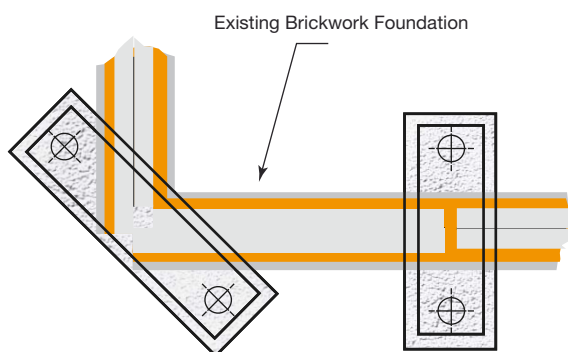


Fig 1 - Part plan of foundation at lintel level

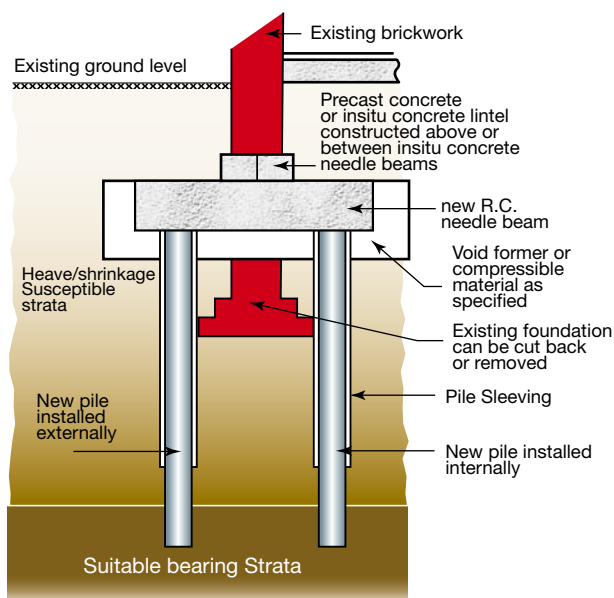


Fig 2 - Section through foundation

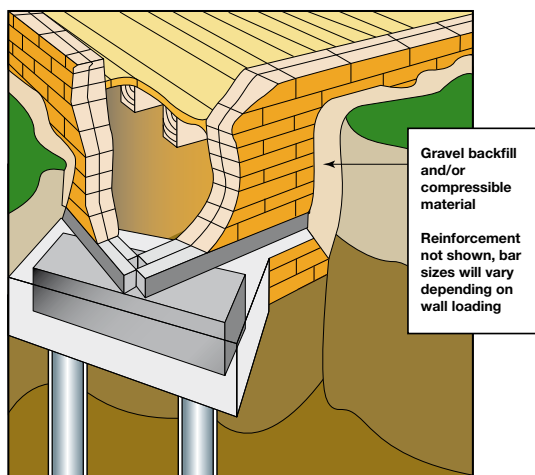


Fig 3 - View of foundation at a typical corner detail





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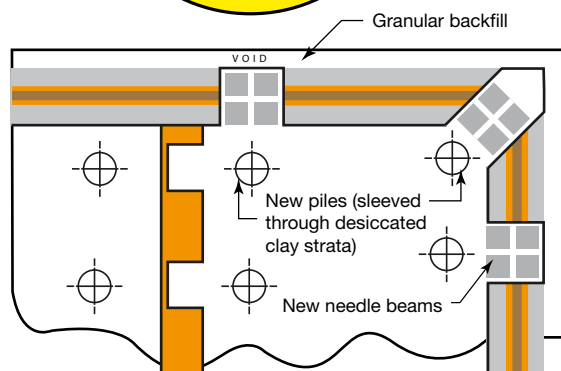


Fig 4 - Part plan of foundation at lintel level

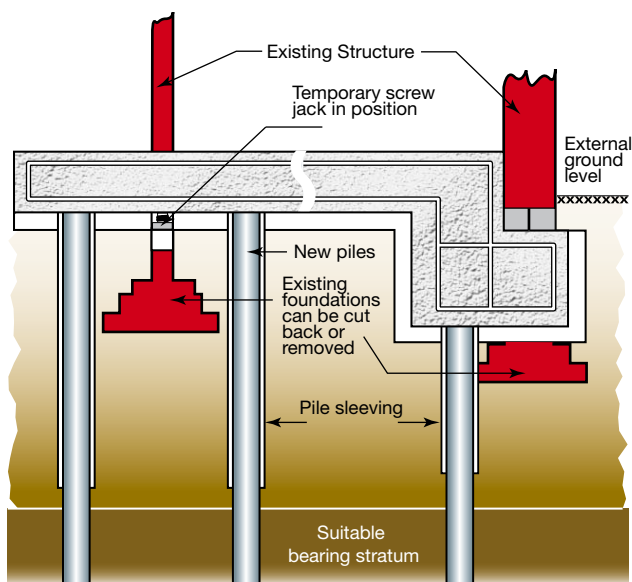


Fig 5 - Section through foundation

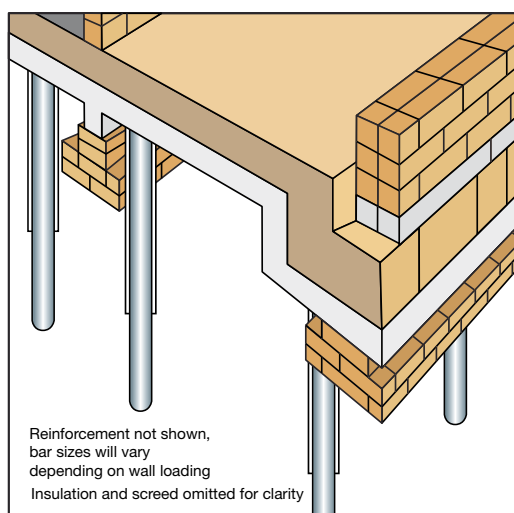


Fig 6 - View of foundation - external backfill removed for clarity - use gravel or compressible material

Figure 1 shows a part plan of a foundation being treated with a pile and beam scheme.

Figure 2 gives a clear view of the section through the foundation. The three main and crucial elements are:

- Isolation of the mini-pile within the desiccated clay strata and/or the provision of sufficient tensile capacity within the mini-pile to withstand heave forces acting on it.
- Isolation of the needle beams from the desiccated clay.
- Isolation and support for the walls between the needle beams.

Figure 3 shows a cut-away representation of the same corner.

Figures 4, 5, and 6 show similar information for the RB piled raft solution. However, this system extends itself to providing heave protection to the whole structure including the floor.

Installation Procedures:

The method statement may be separated into two parts:-

a) Mini-Piling

The size, depth and length of mini-pile will be determined by taking site investigation results and applying well-known soil mechanics/piling calculations. Mini-pile installation will normally be by a replacement method, usually augered or pre-bored and driven piles.

Mini-piles may be constructed with an isolation sleeve which will negate heave forces. Isolation sleeves may comprise two part sliding plastic sleeves, or liquid sleeves such as bentonite. Slip sleeves may be cardboard, plastic or slipcoated steel.

b) Substructure Support System

This may comprise of reinforced concrete needle beams, rafts or knuckle systems, intermediate isolation is normally achieved by precast concrete or cast insitu lintels.

All support structure elements, whether needle beams, lintels or rafts must be constructed over compressible or void forming materials. Low density polystyrene or water degradable corrugated cardboard void formers may be used. Great care must be taken to isolate all elements of the existing structure and new support structure, since any remaining connection (Hard Spot) will inevitably result in further damage.

Any temporary support systems, (screw jacks or steel stools) used during the course of construction **must** be removed.

Upon completion of the underpinning works special consideration should be given to the provision of flexible connections for the incoming and outgoing underground services.

