



Underpinning Techniques for Existing Foundations

An Online Continuing Education Course for Engineers

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Underpinning Techniques for Existing Foundations

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Introduction

Underpinning is a method for repairing and strengthening building foundations. This course covers underpinning methods, procedures, and their applications in strengthening different types of foundations. There are situations where a failure in a foundation or footing happens unexpectedly after the completion of the whole structure (both sub and superstructure). In such an emergency, a remedial method is needed to regain structural stability. The method of underpinning helps to strengthen the foundation of an existing building or any other infrastructure. This involves the installation of permanent or temporary supports to an existing foundation so that additional depth is achieved.

What Is Underpinning?

Underpinning is the process of strengthening, supporting, and stabilizing the existing structure of the foundation. This Underpinning process is done by extending reinforcement in a breadth of the existing foundation or in-depth of an existing foundation.

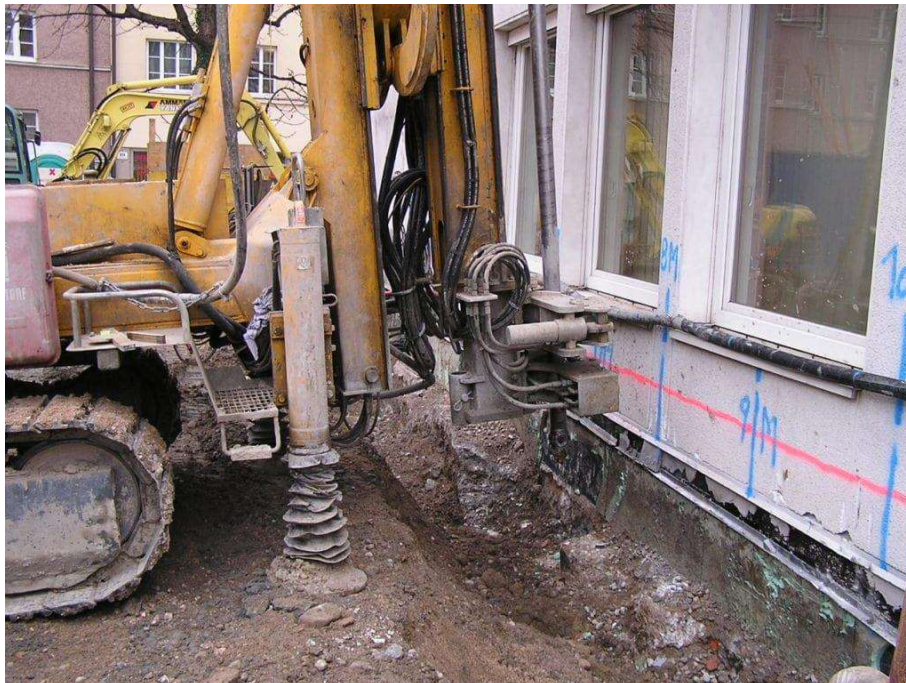


Fig. 1: Underpinning an existing foundation

Selection of Underpinning Methods:

Underpinning methods are chosen based on the age of the building and the kind of work it involves. Depending on how old a building is, it is classified as:

- i) Ancient structures that are older than 150 years.
- ii) Recent Structures: Ages between 50 and 150 years.
- iii) Modern Structures: Ages under 50 years.

Types of works for selection of underpinning methods:

Conversion Works

The structure must be converted to another function, which requires a stronger foundation compared to the existing one.

Protection Works

Below are a few examples of issues a building must have to undergo protection works:

- The existing foundation is not strong or stable.
- Nearby excavation would affect the soil that supports the existing footing.
- Stabilization of the foundation soil to resist natural calamities.
- Requirement of a basement below an already existing structure.

Remedial Works

- Mistakes in the initial foundation design caused subsidence of the structure.
- Repairs to present structure in lieu of building a new one.
- Structural conditions that require underpinning.

There are many reasons that may cause an engineer to suggest underpinning for stabilization of the substructure, such as:

- The degradation of timber piles is used as a foundation for normal buildings. This degradation of structures is due to water table fluctuations.
- Rising and lowering of the water table can cause a decrease in the bearing capacity of soil causing the structure to settle.
- Structures that are built over the soil with a bearing capacity not suitable for the structure can cause settlement.

Purpose of Underpinning

Underpinning is done for the following purposes:

- a) For leading an old shallow foundation to a deeper depth when the adjoining building is constructed with a deep foundation.
- b) Underpinning is done for *building a basement* in the existing building.

- c) Underpinning is done to deepen the existing foundation (resting on poor strata) and make it rest on deeper soil strata of higher bearing capacity.
- d) To strengthen a settled foundation that may have caused cracks in the walls.
- e) Stabilize foundation soils: The soils supporting a building's foundation can sometimes become unstable due to various reasons such as erosion, flooding, or seismic activity. Underpinning can be used to stabilize these soils and ensure the safety of the structure.
- f) Comply with building regulations: In some cases, underpinning may be necessary to comply with modern building codes and regulations, especially for older buildings.

Need for Underpinning

The decision to perform underpinning can be made based on observations. When an already existing structure starts to show certain change through settlement or any kind of distress, it is necessary to establish vertical level readings as well as at the offset level, on a timely basis. The time depends upon how severe the settlement is.

Now, before the excavation for a new project, professionals must closely examine and determine the soil's capability to resist the structure that is coming over it. Based on that report the need for underpinning has been decided. Sometimes such tests would preclude underpinning to be done after the whole structure is constructed. The necessity for underpinning can be summarized in the following points:

Necessity of Underpinning Foundation

- a) When an original or existing foundation is not stable at that time underpinning is required.
- b) When the purpose of the structure is changed.
- c) The supporting or strengthening soil property of the foundation is changed.
- d) When mischaracterized during the design of the foundation.
- e) Disturbing the existing foundation soil structure when construction of the nearby structure(s) at that time underpinning foundation is required.

Methods of Underpinning

Underpinning can be carried out by the following methods:

- 1) Pit method
- 2) Pile methods
- 3) Underpinning to walls
- 4) Jack pile underpinning
- 5) Needle and pile underpinning
- 6) 'Pynford' Stool method of underpinning
- 7) Root pile or angle piling underpinning columns

Pit method

In this method, the entire length of the foundation to be underpinned is divided into sections of 1.2 to 1.5 m lengths. One section is taken up at a time.

First, a hole is made in the wall for all divided sections above the plinth level, and a needle is inserted in the hole. The needle may be made of a material of stout timber or steel section.

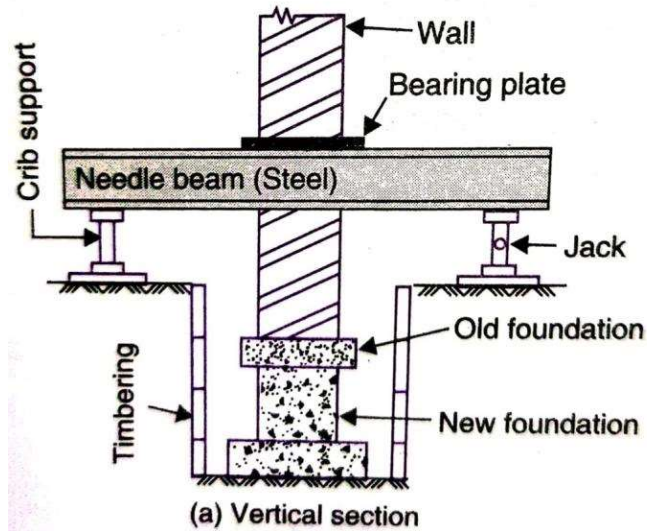


Fig. 2: Pit Method of Underpinning

Bearing plates are placed above the needle to support the masonry above it. The supporting arrangement of the needle is made by crib supports (wooden blocks) on both sides of the wall and screw jacks.

After that, a foundation pit is excavated up to the required level of the new foundation. Then the new foundation is laid in the pit. When the work of one section is over, work on the next section is taken up, i.e., alternate sections are underpinned in the first round, and then the remaining sections are taken up. Fig. 2 above shows the section.

Some *important precautions* should be taken during the work, such as raking shores provided in weak walls and supporting floors.

In this process, cantilever needle beams may be used when a strong interior column is there, or if there is a required foundation increasing in only one side, as shown in Fig. 3.

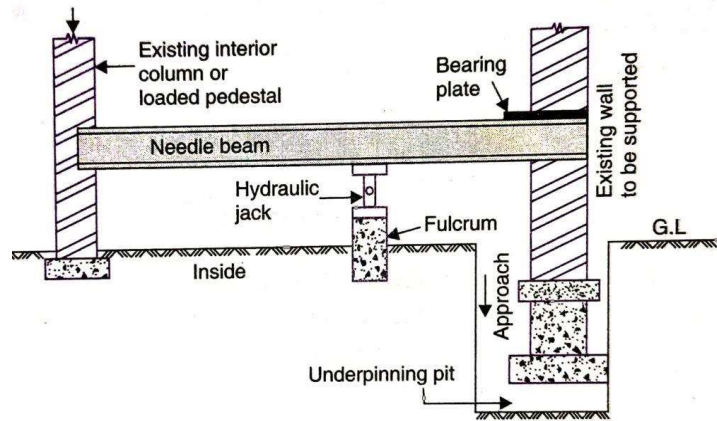


Fig. 3: Pit Method of Underpinning with Cantilever Needle

The following points are to be considered in the pit method:

- 1) Alternate sections are taken up in the first round. The remaining intermediate sections are then taken up. Only one section should be taken at a time.
- 2) It is better to start the work from the middle in the case of longwall extended in both directions.
- 3) If the new foundation is deeper, proper timbering of the foundation trench may be done.
- 4) When the foundation has gained full strength then only all the arrangements like needle beams etc. should be removed slowly.
- 5) The needle holes etc. should be closed in masonry using cement mortar.

Pile method

In this process, concrete piles are pushed on both sides of the wall. The needle beams are then used over the piles through the wall, where the needle beams act as pile caps, which alleviates the load from the wall.

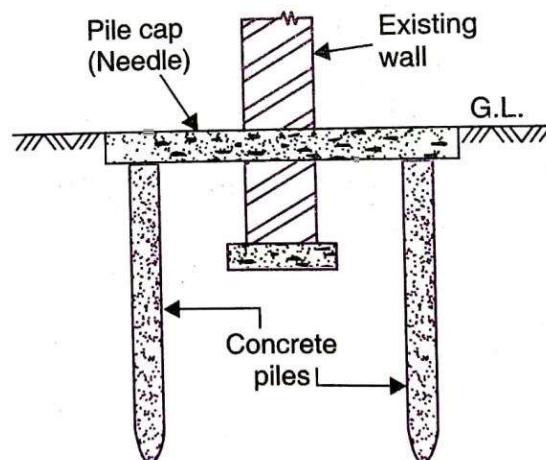


Fig. 3: Pile Method of Underpinning

This strategy is helpful for waterlogged soils where walls convey heavy loads. In this situation, piles, needles, and beams turn into a perpetual part of the establishment, and the existing foundation of the walls is not disturbed.

The pile method is also suitable for clayey soils and in bearing strata

Underpinning to walls:

For underpinning of walls, the existing foundation should be treated in the following manner:

The following are the steps:

- a) The existing foundation is excavated to a depth of 1.5 m, and for masonry walls the length is 1.5 to 3 m.
- b) The excavation is reinforced with a concrete wall.
- c) The base of the wall is widened to a depth of 1.5 m, and for masonry walls the length is 1.5 to 3 m.
- d) The structure is underpinned on the new foundation.
- e) The existing foundation is removed.

For mass concrete walls, the existing foundation is excavated to a depth of 1.5 m, and for masonry walls the length is 1.5 to 3 m.

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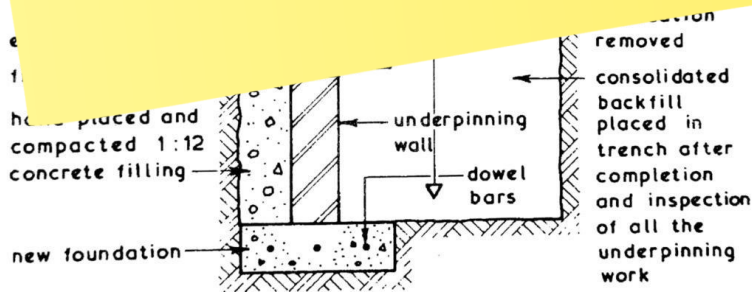


Fig. 4a: Typical Traditional Underpinning details- typical section of Underpinning Bay