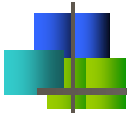


Underpinning

CM 420



Temporary Structures



Underpinning



CM 420

Temporary Structures

Underpinning

- Underpinning is the installation of temporary or permanent support to an existing foundation to provide either additional depth or an increase in bearing capacity.
- There are several existing conditions which may lead to the need for underpinning:
 - Construction of a new project with a deeper foundation adjacent to an existing building
 - Settlement of an existing structure
 - Change in use of a structure
 - Addition of a basement below an existing structure

Underpinning

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Underpinning

- Settlement of existing structures in many cases is caused by lowering of the water table due to tidal fluctuations, wells for a water district, etc.
- This lowering of the water table can cause the tops of timber piles to decay over time and will require remedial underpinning.




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Temporary Structures

Underpinning

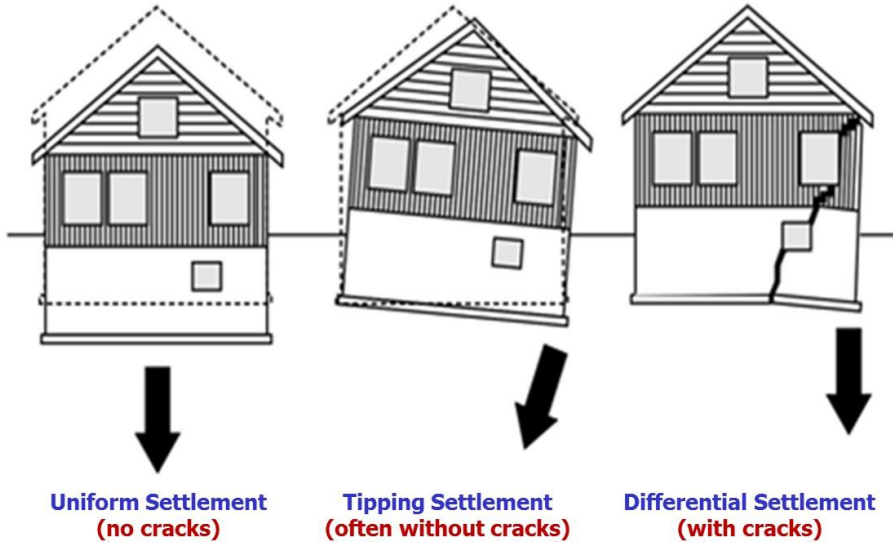
- With certain soil profiles, rising of the water table can effect a decrease in bearing capacity of the soil causing settlement and require underpinning.
- Construction of structures on unsuitable bearing material or over compressible layer (peat, organic silts, or poorly compacted backfill) may cause settlement.



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Underpinning

Cracks in Buildings – Foundation settlement



Cracks in Buildings – Foundation settlement



Underpinning**Underpinning**

- To prevent any unexpected settlement of a new structure, it is of utmost importance that proper field investigation be performed, including:
 - Test borings
 - Test pits
 - Laboratory soil tests

Underpinning

- Underpinning may also be necessary if the requirements of a structure have changed:
 - When heavier floor loads are imposed
 - When additional floors are added to an existing building
- Another use of underpinning is to provide extra basement space under existing buildings
 - Exterior walls are underpinned and the interior columns or wall loads are transferred to new columns, resting on new footings placed at the lower elevation.

Underpinning**Determining the Need for Underpinning**

- When a structure starts showing signs of settlement or distress, it is of utmost importance to establish level readings and offset readings on a daily, weekly, or monthly basis, depending on the severity of the movements.
- Plotting of these readings will indicate if the movements are decreasing or increasing, and by analysis, determining the need for underpinning or other measures to protect the structure.

Methods of Underpinning

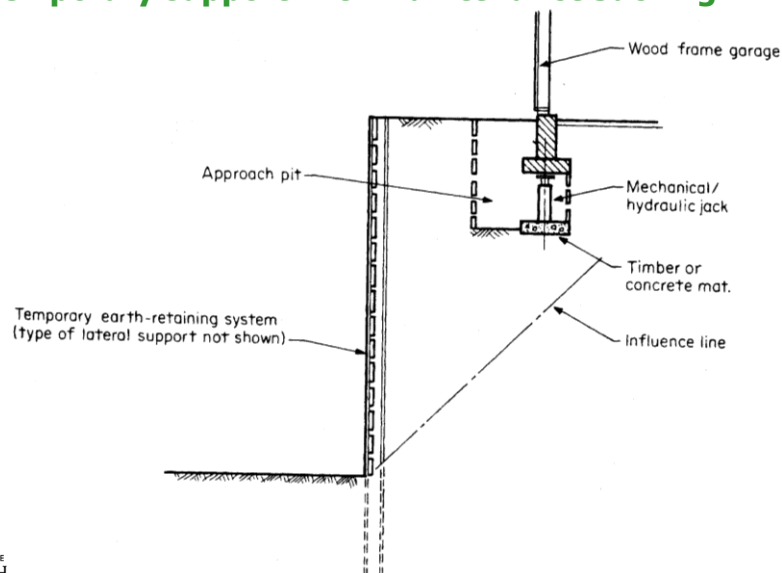
- Prior to the start of excavation for a new structure, it is advisable to have a professional examine all structures in close proximity to the construction site, to determine whether or not underpinning is necessary.
- Different methods of underpinning support are:
 - Temporary support with maintenance Jacking
 - Bracket Pile Underpinning

Underpinning

Temporary Support with Maintenance Jacking

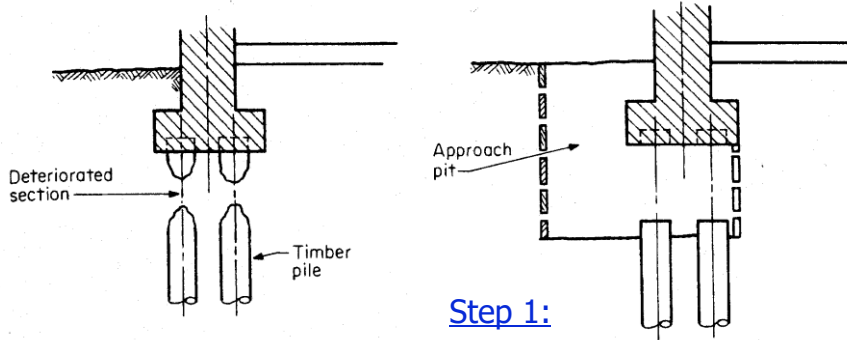
- If settlement occurs in light structures (i.e., wood-frame garages) that fall within the influence line of an adjacent excavation, the structure will be kept at the same level by means of mechanical or hydraulic jacks.
- At completion of the work in the adjacent lot, the jacks are replaced with short steel columns and the void is filled with concrete.

Underpinning Methods
Temporary support with Maintenance Jacking



Underpinning

Underpinning Timber-Pile Foundations



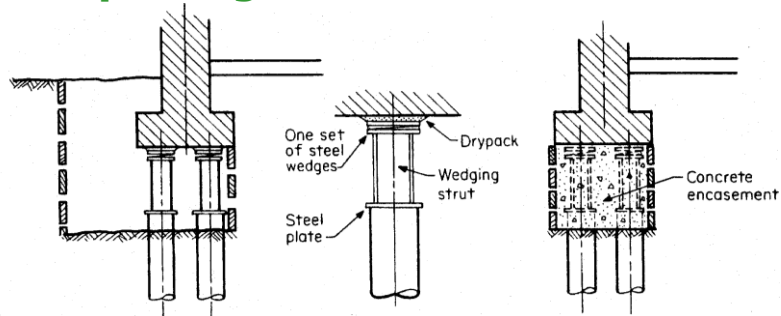
Existing foundation condition prior to underpinning

Step 1:

Shore existing construction, excavate approach pit, and expose existing timber piles.

Remove top portion of the piles and cut piles at new cut-off elevation.

Underpinning Timber-Pile Foundations



Blown-up detail load transfer

Step 2:

Install steel plates, drypack, and wedging strut.

Transfer load into pile by means of steel wedges.

Step 3:

Placement of concrete encasement, backfill approach pit.

Underpinning————— **CM 420** —————————— **Temporary Structures** —————**Underpinning Methods**
Bracket Pile Underpinning

- When both the existing and future structures belong to the same owner, the use of bracket piles is very economical (most municipal building codes do not allow a building to be supported on the foundation that is located on someone else's property).

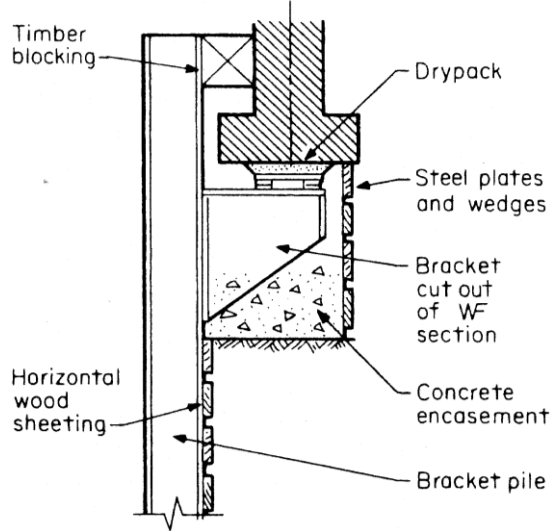
————— **CM 420** —————————— **Temporary Structures** —————**Underpinning Methods**
Bracket Pile Underpinning

- The steel bracket piles are driven or placed adjacent to the future structure in pre-augured holes which are then backfilled with a lean sand-cement mix.
- The load is transferred from the structure into the pile through a steel bracket welded to the side of the pile.

Underpinning

Underpinning Methods
Bracket Pile Underpinning

- A combination of steel plates, wedges, and drypack is installed to ensure a tight fit between the structure and the bracket.



Underpinning Methods
Bracket Pile Underpinning

- This type of underpinning can be utilized for structures up to two stories high, depending on the weight of the building and the the quality of the bearing material at subgrade or the new structure.
- The toe penetration of the piles is determined by the vertical load distribution of the bracket pile.

Underpinning

CM 420

Temporary Structures

Underpinning Methods Bracket Pile Underpinning

- The spacing of the piles depends on the load distribution in the existing structure.
- The maximum spacing should not exceed 8 feet.



CM 420

Temporary Structures

California Palace of the Legion of Honor San Francisco, California



- Legion of Honor Memorial, originally built in 1922. The construction of new galleries underneath the existing courtyard required shoring the perimeter of the building with conventional soldier beams, tiebacks and lagging.

Underpinning**CM 420**

Temporary Structures

**California Palace of the Legion of Honor
San Francisco, California**

- The courtyard colonnades, the entrance arch and the porch structure of the building needed to be supported during construction.
- The contractor supported the structures with needle beams spanning between drilled soldier beams and/or existing walls.
- The structures were jacked to transfer the load to the underpinning elements.



[Colonnade: a row of columns supporting a roof]

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CM 420

Temporary Structures

**California Palace of the Legion of Honor
San Francisco, California**

- New service and ventilation tunnels were added inside and underneath the existing building which required underpinning a total of 46 columns with load of up to 250,000 pounds.
- Underpinning of the columns was done using different systems including hand dug piers, rakers supported on heel blocks, shear plates bolted to existing columns spanning between support frames, and drilled piles supporting shear walls built from top down.



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Underpinning

