Under pinning

Objectives : At the end of this lesson you shall be able to
- **define under pinning**
- **describe the situations demanding underpinning**
- **state the purposes**
- **follow the guide lines for supervise underpinning**
- **explain the methods of underpinning.**

Introduction

The placing of new foundation below an existing foundation or the process of strengthening the existing foundation is known as the underpinning of foundation.

Situations demanding underpinning

1 A building with deep foundations is to be constructed adjoining to an existing building.

2 The settlement of existing foundation has taken place.

3 The basement is to be provided to an existing building.

4 The existing foundations are to be depended so as to rest them on soil of higher bearing power.

Materials: used timber or steel etc.

Purpose/Uses: mainly to strengthening of existing foundation.

Important points to consider before underpinning

1 Shoring and strutting

The necessary shoring and strutting should be provided to the structure to make it safe for carrying out the process of underpinning.

2 Examination of structure

The structure should be carefully examined before underpinning is commenced and poor masonry work should be suitably rectified.

3 Repairs

It is necessary to carry out urgent repairs such as grouting of cracks, insertion of tie rods between walls, etc. before commencing underpinning.

4 Checking arrangement

The levels may be marked on the structure and the movement of structure during underpinning should be checked and recorded.

5 Expensive operation

The process of underpinning is an art rather than a science. Due to advance made in the science of soil mechanics, much guess-work in underpinning is eliminated. But still it remains an expensive operation.

6 Bearing plate

When R.S. joist is used as needle, the bearing plate is provided to avoid the crushing of masonry

Methods of underpinning:

Following are the methods of underpinning:

i- Pit method, ii- Pile method, iii- Miscellaneous methods.

Pit method (Fig 1)

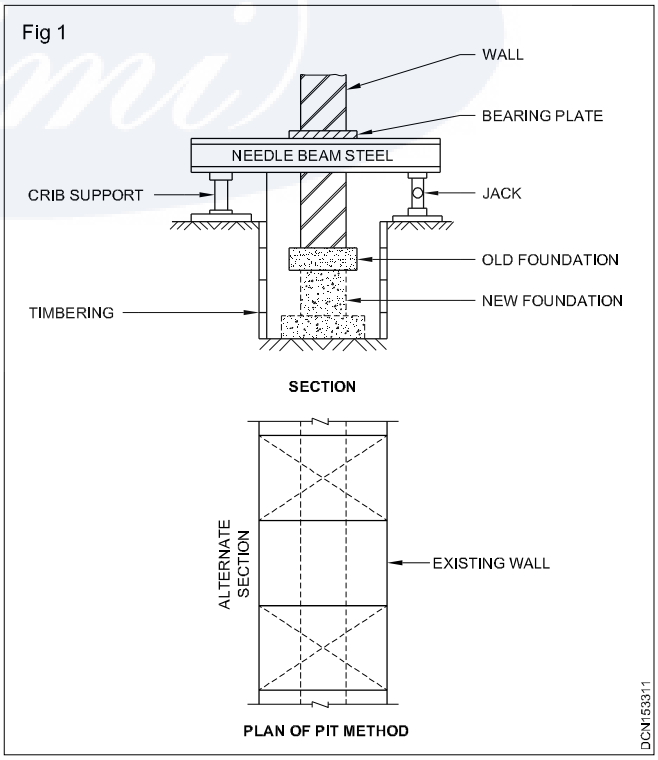
1 In this method the existing wall is divided into suitable sections of width about 1:20 m to 1:50 m.

2 The holes are then made in the existing wall.

3 The needles with bearing-plates are then inserted through these holes and supported on jacks.

4 The pit is excavated and the existing foundation is taken up to the required level.

Fig 1



Following precautions are necessary

1 One section should be excavated at a time.

2 The alternate sections should be taken in succession.

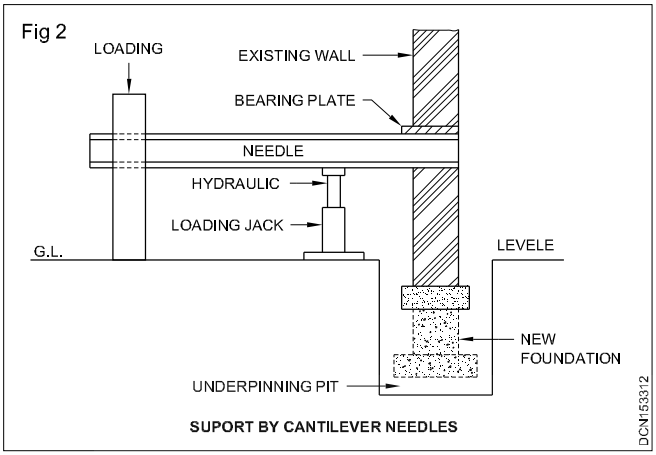
3 If the length of wall is more, the underpinning is started from the middle and it is then extended in both the directions.

4 The proper timbering should be provided for the trench.

5 It is desirable to carry out the new foundation work in concrete.

6 If space to support needles on outside is not available, the cantilever needles, projecting inside and provided with fulcrums and loadings, may be adopted as shown in (Fig 2). A hydraulic jack is placed between the needles and fulcrum.

Fig 2



SUPORT BY CANTILEVER NEEDLES

Pile method

1 In this method, the piles are driven along both the sides of the existing wall and

2 Then needles in the form of pile caps are provided through the existing wall as shown in fig.

3 Thus the existing wall is relieved of the loads coming on it.

4 This method is useful in clayey soils and for water-logged areas and for walls carrying heavy loads.

5 For structure and then brackets or cantilever needles are provided to carry the structure.

Miscellaneous methods

Following are some of the specialized underpinning methods which may sometimes be successfully adopted:

1 Cement grouting,

2 Chemical consolidation

3 Freezing ,

4 Vibroflotation.

1 Cement grouting

This method is used to restore slab or pavement which has settled. The operation is simple. The holes are drilled in the slab and the cement grout is forced under pressure through these holes. The pressure is maintained until the cement grout has set.

2 Chemical consolidation

In this method, the soil under the existing footing is consolidated by using chemicals.

The procedure for chemical consolidation is as follows

1 The perforated pipes are driven in an inclined direction.The inclination slopes are so adjusted that the entire area under the existing footing comes under the command of the inclined pipes.

2 When the pipes are being driven, the solution of sodium silicate in water is injected through the pipes.

3 The pipes are then withdrawn and during the withdrawal of pipes, the calcium or magnesium chloride is injected through the pipes.

4 The chemical reaction takes place between these two chemicals and the soil is consolidated.

5 This method is useful when the soil consists of sand or granular materials and the cost of consolidation depends on nature of soil, depth of consolidation, site of work, etc.

3 Freezing

1 In this method, the freezing pipes are driven below the existing footing and the soil is frozen.

2 This method is rarely adopted, mainly because of two reasons: (i) it is expensive and (ii) more time is required for the installation of freezing pipes.

4 Vibroflotation

1 In this method, the underpinning is carried out by vibrating the sand and

2 Thereby increasing its density which ultimately results in the increase of bearing capacity of soil.

3 This method is useful for granular or sandy soil and before the process of underpinning starts, the building or any of its structural components is shored carefully.

4 The vibrating equipment or soil to be compacted is to be isolated from the building and its shoring.

Formwork or shuttering

Objectives : At the end of this lesson you shall be able to,
- **definition of formwork.**
- **state requirements of formwork**
- **explain removable of formwork**
- **describe centering for various building components.**

Introduction

Temporary boarding or shuttering or sheeting created to hold concrete work for some days to allow the hardening and strengthening, of concrete is known as formwork (casing or shuttering).

Moulds: The term moulds is sometimes used to indicate formwork of relatively small units such as lintels, cornices.

Centering: For circular work such as arch, dome, etc. the term centering is generally used.

Materials: Materials used for formwork such as wooden, plywood, steel, combined wooden-steel etc.

Requirement of formwork:

1 It should be sufficiently strong to take the dead and live loads during construction.

2 It should be as water tight as possible.

3 It should be easily removable without damage to it.

4 Formwork gives a smooth level surface concreting.

Removal of formwork: (Stripping)

The operation of removing the formwork is commonly known as stripping.

Stripping time:

Formworks may be struck after expiry of following periods:

1 Walls, columns and vertical sides of beams- 24 to 48 hours as may be decided by the engineer-in-charge.

2 Slab soffits (props left under)- 3 days.

3 Beam soffits (props left under)- 7 days.

4 Removal of props to slabs:

i) Spanning up to 4.5 m- 7 days.

ii) Spanning over 4.5 m - 14 days.

5 Removal of props to beams and arches:

i) Spanning up to 6 m- 14 days

ii) Spanning over 6 m - 21 days.

Centering for square and circular columns

Shuttering for a column is probably the simplest.

It consists of the following main components:

1 Sheeting all round the column periphery,

2 Side yokes and end yokes,

3 Wedges and

4 Bolts with washers.

5 The side yokes and end yokes consist of two numbers each, and are suitably spaced along the height of the column.

6 The two-side yokes are comparatively of heavier section, and are connected together by two long bolts of 16 mm dia. Four wedges, one at each corner, are inserted between the bolts and the end yokes.

7 The sheathing is nailed to the yokes shuttering for octagonal and round columns.

Centring for beam and slab

1 The formwork for beam and slab floor.

2 The slab is continuous over a number of beams.

3 The slab is supported of 2.5 cm thick sheathing laid parallel to the main beams.

4 The sheathing is supported on wooden battens which are laid between may be propped at middle of the span through joints.

5 The side forms of the beam consist of 3 cm thick sheathing.

6 The bottom sheathing of the beam form may be 5 to 7 cm thick.

7 The ends of the battens are supported on the ledger which is fixed to the cleats throughout the length.

8 Cleats 10 cm X 2 cm to 3 cm are fixed to the side forms at the same spacing as that of battens, so that battens may be fixed to them.

9 The beam form is supported on a head tree.

10 The shore or post is connected to head tree through cleats.

11 At the bottom of share, two wedges of hard wood are provided over a sole piece.

Centering for concrete wall

1 Fix form for walls.

2 The boarding may be 4 to 5 cm thick for walls up to 3 to 4 m high.

3. The boards are fixed to 5 cm x 10 cm posts, spaced at about 0.8 m apart, known as studs or soldiers,

4. Horizontal waling of size 7.5 cm x 10 cm are fixed to the posts at suitable interval.

5. The whole assembly is then strutted using 7.5 cm x 10 cm struts.

6. The two shutters are kept apart equal to the thickness of the wall, by providing a 5 cm high concrete kicker at the bottom and by 2.5 cm x 5 cm spacers nailed to the posts.

Centering for arches:

1 A temporary structure (centering) is required to support brick, stone or concrete arches during their construction.

2 The upper surface of the centering corresponds to the shape of intrados of the arch.

3 The centering for arches consists of two parallel boards having their upper edges shaped to the required curvature.

4 The boards are connected through their curved length by mans of narrow wooden strip which are known as the laggings. These laggings are used to support the bricks or stones.

5 The centering is supported by props at each end.

6 The boards are prepared from two ribs whose thickness varies from 25 mm to 40 mm and whose width varies from 200 mm to 300 mm.

7 The struts and braces are provided to strengthen the

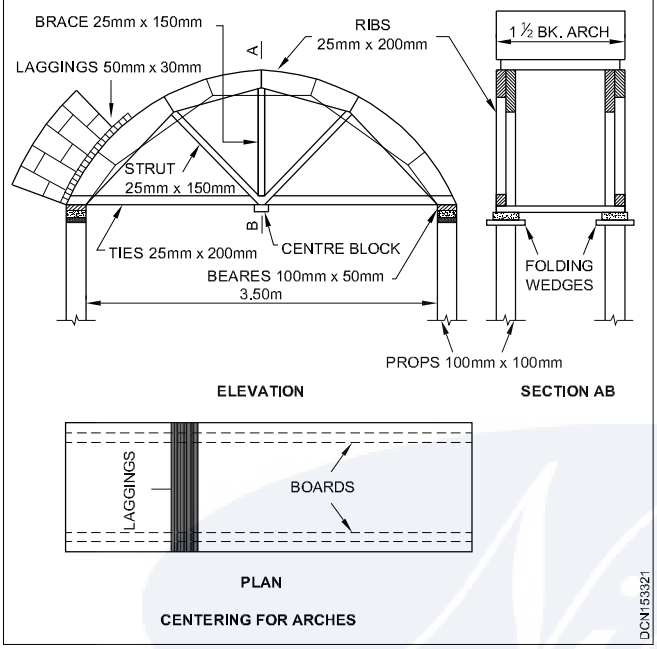
ribs to prevent them from spreading.

8 The ties are generally 25 mm to 50 mm thick and 200 mm to 250 mm wide.

9 The bearers support the ribs and a pair of folding wedges is provided at the top each drop to tighten or to loosen the centering.

Figure shows an arch centering for a span of 3.50 m and of width equal to 1½ brick thickness.Fig 1.

Fig 1



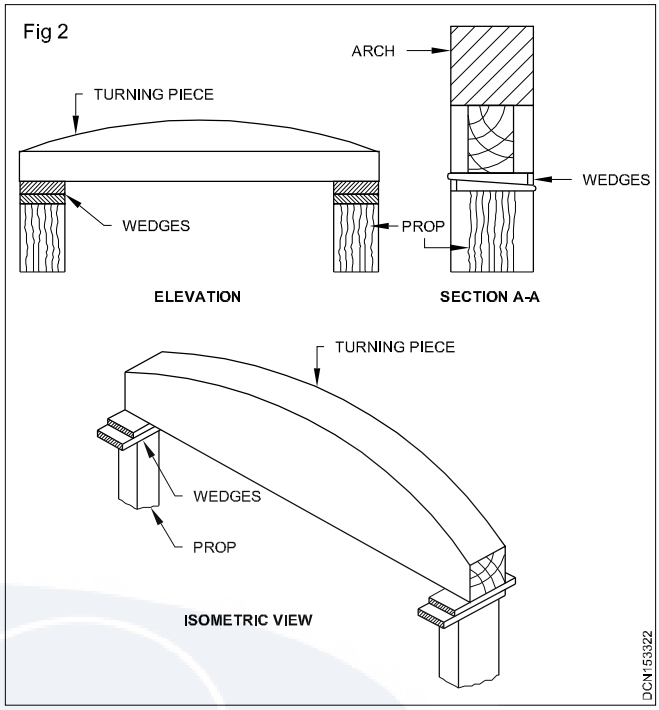
Following points should be noted in connection with the arch centering.

1 The length of laggings and the distance between the boards depend on the width of an arch. For rough and axed arches, the laggings are provided 20mm apart. But for gauged work, they are closely spaced.

2 The laggings should be kept 10 mm to 12 mm back from the face of arch work so that they will not form an obstruction to the line and plumb rule observed by the masons during construction.

3 A thick wooden plank can be used as centering for arch of thickness one-half brick. The plank is shaped to the curvature of the arch and it is supported on the props. Fig 2 shows the elevation, section and isometric view of centering with turning piece. The thick wooden plank with horizontal bottom and the upper surface shaped to the underside of the soffit is known as the center of turning piece. Its width is normally 100 mm and it is supported on vertical timber posts known as the props. The wooden wedges are provided to tighten or loosen the centering.

Fig 2



4 For small spans, the single ribs may be provided on side and laggings, bearers and folding wedges may be provided as usual.

5 The centering for arch should be removed after the arch has developed sufficient strength. For small spans, the removal of centering is done by slightly loosening the folding wedges. But when the span exceeds 7 m or so, a method known as the sand box method, is adopted to avoid shocks. A box is filled with sand and a hole is provided at the bottom of box. The hole is plugged to retain sand. The bottom of prop rests on a plate which is provided at the top surface of sand when it is desired to lower the centering, the plug is taken out and the sand is allowed to come out of the box. The prop is thus lowered gradually.

6 The construction of centering for an arch depends on the span of arch, rise or arch, form of arch curve and the materials of which arch is constructed .

Timbering of trenches

Objectives : At the end of this lesson you shall be able to,
- **definition of timbering of trenches.**
- **technical terms used for timbering**
- **method of timbering.**

Timbering of trenches

When the depth of trench is large, or when the sub-soil is loose, the sides of the trench may cave in. The problem can be solved by adopting a suitable method of timbering. Timbering of trenches, sometimes also known as shoring consists of providing timber planks or boards and struts to give temporary support to the sides of the trench.

Technical terms used for timbering

Following terms are used to denote the various members of the timbering

1 **Sheeting:** This is defined as the main plank which remains in contact with the sides of trench. The term sheathing is used to indicate vertical members of timbering which directly resist pressure from the side of a trench.

2 Ranger or wale: This is the name given to the piece of timber which transfers the load from the sheeting to the strut.

3 Strut: The piece of timber which maintains a fixed distance between the sheeting or between the walls is known as the strut.

4 Bracing: The diagonal piece of timber used to give rigidity to the framework is known as the bracing.

Methods of timbering

Following are the five methods of timbering:

1 Stay bracing

2 Box sheeting

3 Vertical sheeting

4 Runners

5 Sheet piling.

1 Stay bracing

1 This arrangement of preventing the slip of earth in foundation trenches is used when excavation is to be carried out in moderately firm ground and when the depth of excavation does not exceed 2 meter.

2 The vertical sheets or poling boards are placed opposite each other against the walls of the trench and they are held in position by one or two rows of struts.

3 The sheets are placed at an interval of 3 to 4 meter and generally, they extend to the full depth of the excavation.

4 The width of poling boards may be equal to 200 mm with thickness of about 40 mm to 50mm.

5 The struts may have size of 100 mm x 100 mm for trench up to 2 m width and 200 mm x 200 mm for trench exceeding 2 m in width.

2 Box sheeting

This arrangement of preventing the slip of earth in foundation trenches is used when excavation is to be carried out in loose soil and when the depth of excavation does not exceed 4 meters.

A box like structure is formed by providing sheeting, Wales, struts and bracings.

The arrangement is adopted for loose soil. In this arrangement, the vertical sheets are placed nearer or sometimes, touching each other as shown. The sheets are kept in position by longitudinal rows of Wales, usually two in number and then, the struts are provided across the Wales as shown.

The arrangement is adopted for very loose soil. In this arrangement, the sheets or planks are placed horizontally in plan and they are supported by Wales and struts as shown.

3 Vertical sheeting

For deep trenches up to about 10 meters in soft ground, the vertical sheeting is adopted.

The method is similar to box sheeting except that the work is carried out in stages and at each stage, an offset is provided. For each stage, vertical sheets, horizontal Wales, struts and braces are provided as usual. The offset is provided at a depth of 3 to 4 meters and its value varies from 300 m to 600 mm per stage.

Suitable movable working platform may be provided across the struts. This arrangement is very much suitable for laying sewers or water pipes at considerable depths.

4 Runners

In case of extremely loose and soft ground which requires immediate support as the excavation progresses, the arrangement, is adopted.

The runners which are long thick wooden sheets or planks are used in this arrangement. One end of a runner is made of iron shoe. The runners are driven by hammering about 300 mm in advance of the progress of the work. The Wales and struts are provided as usual.

5 Sheet piling

This arrangement of preventing the slip of earth in foundation trenches is adopted when-

a Large area is to be excavated for a depth greater than 10 meters or so;

b Soil to be excavated is soft or loose;

c Width of trench is also large; and

d Sub-soil water is present.

It should be noted that the sheet piles are designed to resist earth pressure only. The timber sheet piles can be used up to a depth of about 10 meters, depending upon the joints between them. The steel sheet piles are available in various sizes and patterns and can be used up to a depth of 30 meters.

The process consists of driving the sheet piles along the boundary of the area to be excavated. The sheet piles are driven slightly more than the depth of excavation. The work of excavation is then started and as soon as the excavation reaches a certain suitable depth, the vertical sheeting and struts are provided us usual, if required.