The curriculum grid of this module is based on the curriculum used by Malaysian polytechnics.

<table>
<thead>
<tr>
<th>No.</th>
<th>TOPIC</th>
<th>UNIT</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Site Investigation and Preparation</td>
<td>1</td>
<td>3 H</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>4 H</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7 Hours</td>
</tr>
<tr>
<td>2</td>
<td>Foundation</td>
<td>3</td>
<td>4 H</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>3 H</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7 Hours</td>
</tr>
<tr>
<td>3</td>
<td>Temporary Support</td>
<td>5</td>
<td>3 H</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>4 H</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7 Hours</td>
</tr>
<tr>
<td>4</td>
<td>Plant Equipment</td>
<td>7</td>
<td>2 H</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 Hours</td>
</tr>
<tr>
<td>5</td>
<td>Observation and Site Organization</td>
<td>8</td>
<td>4 H</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>3 H</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7 Hours</td>
</tr>
</tbody>
</table>
UNIT 1  SITE INVESTIGATION AND PREPARATION
1.1 Site Investigation
1.2 Site Survey
1.3 General Enquiries And Preliminary Work
1.4 Embankment Construction
1.5 Soil Investigation
1.6 Site Clearance
1.7 Trench Excavation
1.8 Control Of Ground Water

UNIT 2  SITE INVESTIGATION AND PREPARATION
2.1 Side Preparation
2.2 Setting out for earthmoving plant
2.3 Retaining Walls
2.4 Setting Out

UNIT 3  FOUNDATION
3.1 Introduction
3.2 Definition of foundation
3.3 Choice of foundation
3.4 Types of foundation
3.5 Pile foundation
3.6 Classification of pile
3.7 Types of bearing piles
3.8 Timber piles
3.9 Concrete pile
3.10 Steel piles

UNIT 4  FOUNDATION
4.1 Pre-cast piles handling
4.2 Definition of slope piles
4.3 Factors that are taken into consideration when piling is carried-out.
4.4 Testing pile methods (load test)

http://modul2poli.blogspot.com/
UNIT 5  TEMPORARY WORKS
5.1  Introduction
5.2  Planking for shallow dig up
5.3  Scaffolding

UNIT 6  TEMPORARY WORKS
6.1  Shoring
6.2  Definition of shoring
6.3  Types of shoring, installation method, part of shoring and usage
6.4  Buttress
6.5  Formwork

UNIT 7  PLANT EQUIPMENT
7.1  Introduction
7.2  Definition of Plant Equipment
7.3  Types of Plant Equipment

UNIT 8  OBSERVATION AND SITE ORGANIZATION
8.1  Introduction
8.2  Types of construction material test on site
8.3  Site organization structure
8.4  Variation order
8.5  Progress work

UNIT 9  OBSERVATION AND SITE ORGANIZATION
9.1  Introduction
9.2  Planning
9.3  Network planning
9.4  Progress work
9.5  Work program.
9.6  Site daily book
9.7  Safety on site
9.8  Defect checking on completed work

http://modul2poli.blogspot.com/
MODULE GUIDELINES

To achieve maximum benefits in using this module, students must follow the instructions carefully and complete all the activities.

1. This module is divided into 9 units.
2. Each page is numbered according to the subject code, unit and page number.

C2001 / UNIT 1 / 5

Subject  Unit 1  Page Number 5

3. The general and specific objectives are given at the beginning of each unit.
4. The activities in each unit are arranged in a sequential order and the following symbols are given:

OBJECTIVES
The general and specific objectives for each learning topic are stated in this section.

INPUT
This section introduces the subject matter that you are going to learn.

ACTIVITIES
The activities in this section test your understanding of the subject matter. You have to complete this section by following the instructions carefully.

FEEDBACK
Answers to the questions in the activity section are given here

http://modul2poli.blogspot.com/
SELF-ASSESSMENT
Self-assessment evaluates your understanding of each unit.

FEEDBACK OF SELF-ASSESSMENT
This section contains answers to the activities in the self-assessment.

5. You have to follow the units in sequence.
6. You may proceed to the next unit after successfully completing the unit and you are confident of your achievement.

GENERAL AIMS
This module is prepared for students in the second semester who are following the Certificate/Diploma programmes in Malaysian Polytechnics. It aims to expose students to the Engineering Construction and Material types and function in each unit and to lead them towards self-directed learning or with guidance from their lecturers.

PREREQUISITE SKILLS AND KNOWLEDGE
The prerequisite for this module is at least a pass in Mathematics and Science at the SPM level and you must be finished a C1001 subject.

GENERAL OBJECTIVES
At the end of this module, students should be able to:

1. Explain the site survey, soil investigation and site clearance/site preparation process.
2. Identified the types of foundation, classification and suitability of foundation for each types of construction.

http://modul2poli.blogspot.com/
3. Describe the suitability of temporary support at each construction stage.
4. Know the types and functions of each plant equipment in the construction industry.
5. Explain the observation and site organization in construction industry.

TEACHING AIDS AND RESOURCES NEEDED

1. Transparency
2. Diagram
3. Photo

REFERENCES


http://modul2poli.blogspot.com/
SITE INVESTIGATION AND PREPARATION

UNIT 1

OBJECTIVE

General Objective: To know about the site and soil investigation, soil preparation, drainage system,

Specific Objectives: At the end of this unit, you should be able to:

- describe site investigation
- determined the suitable physical characteristics for construction
- described soil investigation techniques using the mackintosh probe, hand auger, bore holes and trial pits.
- describe the types and soil preparation techniques drainage.
- describe the techniques to flow out ground level water using geotextile, pumping from sumps, well and pumping from well points.

http://modul2poli.blogspot.com/
SITE INVESTIGATION AND PREPARATION

INPUT

1.1 TINJAUAN TAPAK

Site investigation refers to the procedure of determining surface and subsurface conditions in an area of proposed construction. Surface and subsurface features may influence what can be built, and will directly affect the design and construction procedures relating to how a structure is built. Information on surface conditions is necessary for planning construction techniques. Surface topography may affect access to the site with necessary construction equipment, including the ability of equipment to work on and travel across the area.

The thickness of vegetation, including the density and height of trees, affect the ease or difficulty associated with preparing a site for construction. Disposal of removed surface material may be a problem, particularly in urban areas. If a condition of surface water develops at times, its presence may hinder construction operations or affect the use of the site after construction. Other factors that could affect construction procedures or post construction use of an area include availability of water, availability of electrical power, the proximity to major transportation routes, and environmental protection regulations of various government agencies.

The land drainage pattern, a surface consideration but also partially a subsurface feature, is important, for it might affect construction. A finished grading pattern must be planned so that it does not harm the original area pattern or cause other environmental changes.
Information on subsurface conditions existing at a site is a critical requirement. It is this information that is utilized to plan and design a structure's foundations and other below ground work. Construction techniques are planned with the help of data on subsurface conditions. The possible need for dewatering will be revealed by the subsurface investigation. Information necessary to plan and design shoring or bracing of excavations for foundations and pipe trenches is obtained from such explorations. If the construction site is underlain by varying soil conditions, the explorations will be used to indicate better areas. For projects where there is flexibility in locating structures considerable savings in foundation cost may be realized by constructing in the ‘better soil area’.

In many locations, information about the area is frequently available in the form of maps showing surface topography, and maps and literature that provide general information on subsurface soil or rock conditions. Aerial photographs can also offer useful data on subsurface conditions.
1.2 SITE SURVEY

Site survey is an important task to do before construction work begins. This means, before starting, these following information must be considered:

1. The location of the site is most important. From this factors, we can identify from which direction the sun rises at dawn. It is important to make sure that each space in the building gets enough sunlight.

2. The view/scenery must also be considered. A beautiful scenery is well lined by all and guarantees good market.

3. The site must be void of draught during rainy season. Avoid from choosing locations which are near the river.

4. Public facilities such as water, electricity and telecommunication. Besides that, it is important to make sure that facilities such as transportation, education, shopping, medical care and recreational facilities are provided.

5. Make sure that the (site base) is from subsoil and not from any former paddy field or soft soil where dump is gathered.

6. Avoid mining area and airports because the noise and vibration might cause disturbances.
1.3 GENERAL ENQUIRIES AND PRELIMINARY WORK

Before work can start certain general enquiries should be made: these include a check information from local authorities, libraries, museums and other relevant sources. These checks may reveal records of previous or nearby soil investigation. Geological data, aerial photographs, historical information and local knowledge will help to establish the existence or particular problems. In some case the general enquiries will give enough information to obviate the need of further detailed investigation (e.g. in the case of structures with minimal loadings). However, where loadings are high and substrata investigation is necessary, reference should be made to the Country Geological Survey.

Where, however, detailed information is not available then a preliminary reconnaissance should be carried out by engineers. This reconnaissance, normally carried out by walking over the area, will reveal many local conditions which can be inspected in detail. The generally topography will often be indicative of the soil conditions below which will require further investigation typical example for this area stepped ground, which may be caused by geological faults broken or terraced round which may indicated landslip: depressions in limestone area may indicate the existence of shallow holes and the nature of vegetation may give some indication of the moisture and acidity characteristic of the soil.
1.4 EMBANKMENT CONSTRUCTION

The construction of embankments and the design profile of the sloping sides will depend on a number of factors, such as:

- The purpose for which the embankment is constructed, e.g. the loads involved.
- The consolidation of the fill in the embankment under the proposed loads.
- The stability of the ground on which the embankment is to be constructed.
- The extent to which the strength properties of the fill may be affected by the method of construction.
- The cost of obtaining suitable fill material. The difficulties in construction during adverse weather, when using clays and fine sands.

The method of constructing an embankment will depend upon the extent of the works, the type of fill material being used and the nature of the site. The site must be stripped of all vegetable matter which would readily consolidate under the heavy load of fill material. Fill material should be tipped and spread in layers of such a thickness that it can be compacted to the required density which will be established by laboratory testing. Where large volumes of fill are involved, the density factor obtained in the laboratory may not be achieved on account of practical difficulties in varying the moisture content of large volumes of earth between the two stages of excavating and filling.

This discrepancy can be minimized by the correct selection of compaction plant: the plant most suited will depend on the soil type and its working moisture content. Multi wheeled rubber tire vehicles (wobbly wheel rollers) are very effective for compacting fine fill materials such as PFA and sands; very heavy vibrating rollers, towed by bulldozers, are suitable for compacting PFA and coarser granular materials.

http://modul2poli.blogspot.com/
1.4.1 Construction in water

Where it is uneconomical to drain the water from the site, attention should be given to the maximum and minimum water levels and to the type of soil beneath these levels. All soft materials, such as mud and peat, should be removed and replaced with coarse granular material, such as rock waste. This material should be placed carefully where the foundation is subject to slip movement through uneven loading; in other conditions the fill can be tipped direct from lorries; or, in the case of deep water; bottom operating barges may be used. The shape of the embankment below the water line must be monitored to prevent wastage of fill material. In some cases, where appreciable settlement can be tolerated, material which would normally be classified as unsuitable can be used as the centre core of the embankment, provided that it is protected by other suitable material.

Where wave action is likely, the slopes of the embankment must be protected against erosion; and where water pressure affects only one side of the embankment, precautions must be taken to avoid seepage underneath.
1.5 SOIL INVESTIGATION

Soil investigation is specific in its requirement where site investigation is all embracing, taking into account such factors as topography, location of existing services, means of access and any local restriction. Soil investigation is a means of obtaining data regarding the properties and characteristics of subsoil by providing samples for testing and providing a means of access for visual inspections.

The actual data required and the amount of capital which can be reasonably expanded on any soil investigation programme will depend upon the type of structure proposed and how much previous knowledge the designer has of a particular region or site.

The main methods of soil investigation can be enumerated as follows:
1. Trial pits- small contract where foundation depth are not likely to exceed 3,000
2. Boreholes- medium to large contracts with foundation up to 30000 deep.

1.5.1 Trial pits

Relatively cheap and easy method of obtaining soil data by enabling easy visual inspection of the soil strata in its natural conditions. The pits can be hand or machine excavated to a plan size of 1.200 x 1.200 and spaced at centres to suit and scope of the investigation. A series of pits set out on a 20.000 grid would give a reasonable coverage of most sites. The pits need to be positioned so that the data obtained in truly representative of the actual condition but not in such of positions where they presence could have a detrimental effects on the proposed foundation.

http://modul2poli.blogspot.com/
SITE INVESTIGATION AND PREPARATION

In very loose soils or soil having a light water table trial pits can prove to be uneconomical due to the need for pumps and timbering to keep the pits dry and accessible. The soil removed will provide disturbed samples for testing purposes whereas undisturbed samples can be extracted from the walls of the pits.

1.5.2 Boreholes

These enable disturbed or undisturbed samples to be removed for analysis and testing but undisturbed samples are sometimes difficult to obtain from soil other than rock or cohesive soils. The core diameter the samples obtained by using a rotary flight auger or by percussion boring in a similar manner to the formation of small diameter bored piles using a tripod or shear leg rig. Undisturbed samples can be obtained from cohesive soil using 450mm long x 100 mm diameter sampling tubes which are driven into the soil to collect the sample within itself: upon removal the tube is capped, labelled and sent off to a laboratory for testing. Undisturbed rock samples can be obtained by core drilling with diamond tripped drills where necessary.
1.5.3 Mackintosh Probe

Mackintosh Probe is one of the easiest techniques to carry out. It is important to use in the early stage of soil investigation. This is because, there is not enough information in Malaysia. Soil investigation is also very costly.

This technique is normally used by JKR to estimate soil condition. JKR also uses the Makintosh Probe to collect data and information in order to complete a detailed soil investigation. The mackintosh probe will be depressed within a 25mm diameter cone into the soil using a 5 kg hammer which is dropped at a 0.28m height ratio.

At each thrust of the hammer, a depth of 0.3m is created. The area and type of the building to be built will determine the depth of the hole. For single and double storey buildings, the Makintosh Probe will stop at 9m deep or 300 barrier of buffet. For taller building, the probe will be stop at 1.5m. The test hole will also be excavated to determine the type of material blocking hole penetration (for example rocks, water pipes or wood)
SITE INVESTIGATION AND PREPARATION

Figure 1.1  Mackintosh Probe Equipment

Figure 1.2 Detail of Mackintosh Probe Equipment

(Source: Fig 1.1 and fig 1.2 Holmes, R. (1995), Introduction To Civil Engineering Construction, University of the West of England, Bristol)
1.5.4 Hand Augering

- Manual boring with no casing used.
- Usually used in soft to stiff cohesive soils above water level.
- Max depth is 5 meters or holes collapse
- Diameter of hole is about 100 mm
- Disturbed and undisturbed samples (U4) possible.
- Rough indication of water level.
- Shallow depth piezometer can be installed for more accurate groundwater monitoring.

(Source: Holmes, R. (1995), Introduction To Civil Engineering Construction, University of the West of England, Bristol)
1.6 SITE CLEARANCE

This should be undertaken as soon as the contractor gets on site, so as to permit the initial setting of access roads and site accommodation. The method of working will again depend on the type of site.

In the case of compact sites, trees and other growth might be removed by a specialist sub-contractor. This will be quickly followed by removal of the top soil, which will be deposited in heaps ready for re-use in finishing off verges and similar features immediately prior to completion. However, with an extensive site the problems are much greater. The clearance of such a site could involve diversion of sewers, drains, gas, power lines, GPO lines, and it might also involve phasing some or all of the work to facilitate harvesting of crops, all of these adding to costs and legal claims for compensation.

In particular, the problem of site drainage may be involved. When large scale earth moving is involved it often interferes with natural drainage which either causes a waterlogged site or causes a movement of mud into water courses. Both have their own disadvantages, the former making the site difficult to work and the latter bringing complaints from other land owners and river authorities because of contamination.

It may be an advantage to cut a perimeter or cut-off drain around major excavation works to intercept water during a rainy season. The same principle can be employed on large scale road works, where a carriageway can be cut to just above finished formation level during the dry months to intercept and channel water in the wet months. This will assist general earth-moving work in inclement weather. In a great many instances site clearance will also involve large or small scale demolition of existing works and buildings.
SITE INVESTIGATION AND PREPARATION

1.7 TRENCH EXCAVATION

The choice of method of excavating, supporting and backfilling trenches depends on the following factors:

- Purpose for which the trench is being excavated
- The nature of the ground
- The time scale of the work
- Ground water conditions
- The location of the trench
- Number of obstructions.

The first three factors greatly influence the choice of plant; some trenches can be dug and backfilled with a single pass of the machine, a flexible pipe having been laid as an integral operation. Where the trench has to be left open for pipe laying or other work for some hours or days, consideration must be given to ground support. Where possible, the sides of the trenches can be battered to prevent the use of shoring, which would hamper foundation work or pipe laying this must receive economic consideration, since the extra excavation and fill may not offset the cost of shoring and decreased production caused by supports.

Where supports are to be used, the method of support must be decided having regard to the ground water conditions and method of ground water control. The location of the trench, whether across open land or along public highways, will affect the selection of plant and in some cases, the method of ground support. Location may also involve organizational problems such as diversion and control of traffic, fencing, and lighting during the hours of darkness. The location will also have bearing on the last factor for consideration, namely obstructions. In built up areas there is a greater incidence of underground services which may have to be negotiated; this will affect the speed of the operations.

http://modul2poli.blogspot.com/
SITE INVESTIGATION AND PREPARATION

1.7.1 Excavation methods

The methods of excavating trenches are as follows:

- Full depth, full length excavation
- Full depth, successive stages of excavation
- Stage depth, successive stages of excavation.

The first method is suitable for long narrow trenches of shallow depth in which the machine completes the trench non stop ahead of any other operation. This method is suitable for pipe lines and sewers. The second method is suitable for deep trenches where several operations of work can proceed in sequence; this would prevent stretches of trench from being left open too long and, thereby being subjected to collapse. It also reduces the amount of support and protection employed at any one time. The third method of excavation is suitable for very deep trenches in confined areas or adjacent to existing property, it involves the support of the trench as the work proceeds and is most suited for operations such as deep foundations and underpinning.

The first method is also suitable for trenches with battered sides, and would be most suited to works requiring freedom from struts, e.g. cast in place foundations, walls and culverts. The plant used for battered trenches ranges from special trenching machines which are capable of producing the required batter in a single pass, to standard dragline equipment or backacting machines.
SITE INVESTIGATION AND PREPARATION

Special equipment is available for the formation of narrow trenches; these may be mechanical trenchers with a continuous chain action, or plough type trenches which are hauled through the ground by winches. Mole drainage can be carried out in clay soil by means of a mole plough and small pipes and cables can be laid in a similar manner without the formation of a trench. This work is carried out by a special machine equipped with a self-leveling device; the machine cuts the hole with a mole type blade and feeds the flexible pipe into the holes as it proceeds along a pre-determined line.
1.8 CONTROL OF GROUND WATER

There are many ways in which ground water may be controlled during the construction period; some methods deal with water lowering and others with water exclusion. The control of ground water by pumping is the cheapest and commonest form of control: the various systems of pumping include:

1. Pumping from sumps
2. Pumping from wells
3. Pumping from well points

1.8.1 Pumping from sumps

Pumping from sumps is the most widely used method of ground water control, since it can be applied to all types of ground conditions and is economical to install and maintain. The only problem is settlement on the ground is likely to move as the water flows towards the sump area. There is also a risk of instability at the formation level in timbered excavations, owing to the upward movement of water. These problems can be partially overcome by positioning the sump at a corner of the excavation at a level below the formation level (Fig 1.4). For excavations which are likely to be open for long periods of time a peripheral drain filled with gravel can be dug to intercept water at formation level and channel it to the sump, thereby giving a drier and more stable work area.

When the excavation is taken through permeable soil and continues in impermeable soil, it is preferable to form a drain at the line where the two soils meet. This type of drainage channel, known as a 'Garland' drain, prevents the impermeable soil being softened by the flow of water (Fig 1.5), and carries the ground water to a sump at one corner.
SITE INVESTIGATION AND PREPARATION

Figure 1.4 Sump below formation level in corner of excavation

Figure 1.5 Garland drain intercepting water at the impermeable level.
(Source: Fig 1.4 and fig 1.5 Holmes, R.(1995), Introduction To Civil Engineering Construction, University of the West of England, Bristol)

http://modul2poli.blogspot.com/
An alternative method of preventing soil movement due to open sump pumping is the use of jetted sumps. The sump is formed by jetting a metal tube in the ground by means of water pressure. A disposable well point, consisting of disposable hose and intake strainer, is lowered into the tube and a sand media placed around it. The metal tube is then withdrawn and the flexible suction pipe is connected to a pump.

Figure 1.6 Jetted Sump

(Source: Fig 1.6 Holmes, R.(1995), Introduction To Civil Engineering Construction, University of the West of England, Bristol)
1.8.2 Pumping from wells

Since normal pumping methods limit the depth of suction lift to a maximum of 9 m and conditions may not allow the pump to be placed in the excavation, well pumping may be employed. The main use is the lowering of ground water to a considerable depth below 9 m or where the ground may not be suitable for the wellpoint system. The well is formed by sinking a lined borehole, of a diameter between 300 and 600 mm to the required depth. Into this borehole another tube is placed, known as the inner well lining (Fig 1.7), which is provided with a perforated screen for that section over which the dewatering is required.

The lower end of the inner lining is unperforated and acts as a sump for the settlement of fine material. The annular space between the two linings is filled with filter material over the length of the perforated section: the remainder of the borehole is backfilled with any suitable material. Depending on the depth of the well, the outer lining is withdrawn as the annular space is filled, or on completion. Before the pump is placed in position, the water in the well is 'surged' by some form of plunger to promote flow through the filter and wash out unwanted 'fines'.

The pump used is the submersible type as described in Section 2.8.2. The spacing of the wells is determined by the type of soil being dewatered. The depth of the well depends on the depth of the impermeable stratum: where this stratum is well below the excavation formation level the spacing between the wells can be increased until the draw-down curve is just below the formation level (Fig 1.8).

http://modul2poli.blogspot.com/
Figure 1.7 Section through tube well

Figure 1.8 Wells used to lower water table to a level below formation of excavation.

(Source: Fig 1.7 and fig 1.8 Holmes, R. (1995), Introduction To Civil Engineering Construction, University of the West of England, Bristol)

http://modul2poli.blogspot.com/
Pumping from horizontal wells is suitable when the formation level is at or just slightly within an impermeable stratum in which the draw down curve in vertical wells would not lower the water to the required level. A well is sunk outside the excavation area to a level below the proposed formation, and horizontal borings are made in a radial pattern from the vertical well. This allows water to drain from the upper surface of the impermeable stratum into the large well and then to be pumped out by a submersible pump.

1.8.3 Pumping from well points

The well point system of dewatering is perhaps one of the most well known on civil engineering projects since it is used very frequently for ground water control in non cohesive soils. The system consists of a number of small diameter vertical wells connected to a header pipe which is under vacuum from a pump. The ground water is forced out of the soil by atmospheric pressure into the header pipe, via the well points, and discharged by the pump.

The well point itself is only a small part of the equipment, consisting of a perforated or slotted tube covered with a strainer or fine mesh, approximately 1300 mm long. A cast iron or steel jetting shoe is fixed to the well point, containing a rubber ball which allows the 'jetting' of the well point and prevents solids from rising up the tube when under vacuum.

The well point is connected to 38 mm internal diameter mild steel riser pipe which in turn is connected by swing connection to the header pipe. A recent development is the fully disposable well point, which consists of a 65 mm diameter perforated plastic inner strainer with a nylon filter sleeve the strainer is capped top and bottom, the former to receive a 40 mm diameter flexible riser pipe. The riser pipe is also made of plastic and is disposable: since the riser pipe is flexible it eliminates the swing connection normally used in conventional systems.

http://modul2poli.blogspot.com/
The well-point system is limited in its suction lift to a practical height of 6 m maximum any attempt to lift water by well-points above this height results in loss of pumping efficiency, owing to air being drawn into the system through the joints in the pipes. Where dewatering is necessary in depths over 5 m it is common practice to introduce multi-stage well-points. These allow dewatering to any depth, providing the pump can work against the head involved; but practical aspects of excavation limit the number of stages employed.

The use of multi-stage well-points involves the formation around the excavation of platforms on which the header pipe is situated; it may also involve battering the sides of the excavation to a safe angle of repose. While the safe angle of repose for dewatered sands is much steeper than that for normal soil, it still produces a large area of excavation for the first stage. The number of stages to be employed can be reduced if the excavation is taken down to the original ground water level before installing the first header pipe: in many instances this operation will eliminate one stage (Fig. 1.9).

Figure 1.9 Excavation of basement to natural water level before positioning well-point
(Source: Fig. 1.9 Holmes, R. (1995), Introduction To Civil Engineering Construction, University of the West of England, Bristol)
Regardless of the number of stages involved in dewatering a deep excavation, the depth of the inclined layer of soil being dewatered is limited to approximately 5 m and is therefore subject to seepage pressure from the mass of soil surrounding the excavation, which could cause instability. This pressure can be reduced by the use of deep wells positioned at the edge of the upper slope (Fig 1.10).

Figure 1.10 Combination of deep wells and well point system.
(Source : Fig 1.10 Holmes, R.(1995), Introduction To Civil Engineering Construction, University of the West of England, Bristol)
1.8.4. Geotextiles in Drainage

A Geotextiles functions as a drain when it collects liquid or gas and conveys it towards an outlet. Thin woven fabric obviously has less or almost negligible capacity than a thick needlepunched nonwoven. Geocomposite drains can also be used to increase the drainage capacity. The flow of water into capacity due to soil entry the drain is controlled by the geotextile which must also perform the filter function to prevent loss of flow capacity due to soil entry the drain.

Figure 1.11 Geotextile Functions.
Drainage applications.

Composite pre-fabricated drains placed behind retaining wall or bridge abutment. The drain is made of plastic core attached to a geotextile filter. In this case, the cross-plane drainage and filtration characteristics of the geotextile are important functions.

Drain next to geomembrane to intercept and convey liquids or gases to collection points. The geotextile also functions as a protective layer to the geomembrane. Geotextiles or composite drains used in multiple horizontal drains to control pore water pressures in saturated fills. Cross-plane permeability and filtration are important functions. Vertical drains may be installed in fine-grained foundation soils under embankments to accelerate the dissipation of excess pore water pressures.
1. Site investigation refers to the procedure of determining __________________ and __________________ conditions in an area of proposed construction.

2. List down the methods of soil investigation.
   ____________________________________________________________________
   ____________________________________________________________________
   ____________________________________________________________________

3. List down the various methods of ground water control
   ____________________________________________________________________
   ____________________________________________________________________
   ____________________________________________________________________
1. surface and subsurface

2. Methods of soil investigation
   a. Mackintosh probe
   b. Hand Augering
   c. Bore holes
   d. Trial Pits

3. The various methods of ground water control
   a. Pumping from sumps
   b. Pumping from wells
   c. Pumping from well points
   d. Geotextile in drainage
You are approaching success. Try all the questions in this self-assessment section and check your answers with those given in the Feedback on Self-Assessment 6 given on the next page. If you face any problems, discuss it with your lecturer. Good luck.

1. Explain the term ‘soil investigation’

__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
__________________________________________________________________

2. Define the term ‘site investigation’?

__________________________________________________________________
__________________________________________________________________

3. Explain the temporary exclusion of ground water using of the following method:
   a. Pumping from sumps
   b. Pumping from wells
   c. Pumping from well points
   d. Geotextile in drainage
SITE INVESTIGATION AND PREPARATION

Have you tried the questions???????? If “YES”, check your answers now.

1. Soil investigation is specific in its requirement whereas site investigation is all embracing, taking into account such factors as topography, location of existing services, means of access and any local restriction. Soil investigation is a means of obtaining data regarding the properties and characteristics of subsoil by providing samples for testing and providing a means of access for visual inspections.

2. Site Investigation.
The works carried out to obtain information relevant to civil engineering design and construction.

- Surface investigation
- Confirm information obtained from desk study
- Site Survey
- Surface geological study (study rock outcrop, degree of weathering)
- Vegetation
- Nearby Structure
- Human Activities
SITE INVESTIGATION AND PREPARATION

2. The temporary exclusion of ground water using of the following method.

a. Pumping from sumps

Pumping from sumps is the most widely used method of ground water control, since it can be applied to all types of ground conditions and is economical to install and maintain. The only problem is one of soil movement due to settlement; the ground is likely to move as the water flows towards the sump area. There is also a risk of instability at the formation level in timbered excavations, owing to the upward movement of water. These problems can be partially overcome by positioning the sump at a corner of the excavation at a level below the formation level (Fig 5.4).

![Sump below formation level in corner of excavation](http://modul2poli.blogspot.com/)

b. Pumping from wells

Since normal pumping methods limit the depth of suction lift to a maximum of 9 m and conditions may not allow the pump to be placed in the excavation, well pumping may be employed. The main use is the lowering of ground water to a considerable depth below 9 m or where the ground may not be suitable for the wellpoint system. The well is formed

http://modul2poli.blogspot.com/
by sinking a lined borehole, of a diameter between 300 and 600 mm to the required depth. Into this borehole another tube is placed, known as the inner well lining (Fig 5.7), which is provided with a perforated screen for that section over which the dewatering is required. The lower end of the inner lining is unperforated and acts as a sump for the settlement of fine material. The annular space between the two linings is filled with filter material over the length of the perforated section: the remainder of the borehole is backfilled with any suitable material.

![Section through tube well](http://modul2poli.blogspot.com/)

c. Pumping from well points

The well point system of dewatering is perhaps one of the most well known on civil engineering projects since it is used very frequently for ground water control in non cohesive soils. The system consists of a number of small diameter vertical wells

http://modul2poli.blogspot.com/
SITE INVESTIGATION AND PREPARATION

connected to a header pipe which is under vacuum from a pump. The ground water is forced out of the soil by atmospheric pressure into, the header pipe, via the well points, and discharged by the pump.

The well point itself is only a small part of the equipment, consisting of a perforated or slotted tube covered with a strainer or fine mesh, approximately 1300 mm long. A cast iron or steel jetting shoe is fixed to the well point, containing a rubber ball which allows the 'jetting' of the well point and prevents solids from rising up the tube when under vacuum. The well point is connected to 38 mm internal diameter mild steel riser pipe which in turn is connected by swing connection to the header pipe.

![Figure 1.9 Excavation of basement to natural water level before positioning well-point](http://modul2poli.blogspot.com/)

Figure 1.9 Excavation of basement to natural water level before positioning well-point
Geotextiles in Drainage

Composite pre-fabricated drains placed behind retaining wall or bridge abutment. The drain is made of plastic core attached to a geotextile filter. In this case, the cross-plane drainage and filtration characteristics of the geotextile are important functions.

Drain next to geomembrane to intercept and convey liquids or gases to collection points. The geotextile also functions as a protective layer to the geomembrane.

Geotextiles or composite drains are used in multiple horizontal drains to control pore water pressures in saturated fills. Cross-plane permeability and filtration are important functions. Vertical drains may be installed in fine-grained foundation soils under embankments to accelerate the dissipation of excess pore water pressures.
SITE INVESTIGATION AND PREPARATION

OBJECTIVE

General Objective: To understand about site investigation and site preparation for a building.

Specific Objectives: At the end of this unit, you should be able to:

- describe the procedure of site preparation and procedure.
- determine the calculation to balance the cut and fill.
- explain the types of retaining walls.
- determine the setting out for buildings.

http://modul2poli.blogspot.com/
2.1 Site preparation

Before commencing earth moving, a plan should be produced showing all areas for excavation, tipping and filling. The quantities of excavated material and required fill should be shown on this plan, so as to facilitate the most economic movement of soil. When large quantities of soil have to be moved, a 'mass haul' diagram should be prepared (Fig 2.1). Such a diagram shows the distances and direction of haul and gradients calculated to balance the cut and fill.
Fig 2.1 Mass Haul Diagram
(Source: Fig 2.1 Holmes, R.(1995), Introduction To Civil Engineering Construction, University of the West of England, Bristol)

http://modul2poli.blogspot.com/
SITE INVESTIGATION PREPARATION

If the excavated material is likely to be particularly variable some indication should be given of its method of disposal, i.e. whether to haul to spoil heap rather than fill areas.

Construction methods for smaller sites, eg basements, deep pits, trenches etc, will depend to a great extent on the following factors:

- Type of soil or rock
- Quantity of material to be moved
- Presence of water
- Depth of dig
- Working space available
- Whether excavated material can be left on site.

As a general rule, for large pits and basements, where space will allow, the excavation should be achieved by 'battering' the sides of the dig. This allows a clear working area, free from obstruction or shoring (Fig 1.2).

Figure 2.2 Excavate with battered sides
(Source: Fig 2.2 Holmes, R.(1995), Introduction To Civil Engineering Construction, University of the West of England, Bristol)

http://modul2poli.blogspot.com/
2.2 Setting out for earthmoving plant

On some projects, the speed of earthmoving is more important than the achievement of precise final levels, e.g. road construction in forward areas. On the other hand, as e.g. in airfield construction, precision of final levels may be as important as speed of construction. This difference in approach affects the setting out procedure, which will vary from project to project. The normal procedure is to use timber pegs or stakes as guides and refer once markers for earthwork operations. These stakes are used for centre lines, shoulder lines, batter and reference points. They are approximately 600 mm long x 75 x 25 mm in section and are marked according to purpose (Fig 1.3).

![Setting out for earthmoving plant](http://modul2poli.blogspot.com/)

**Figure 2.3: Setting out for cuttings**

(Source: Fig 2.3 Holmes, R.(1995), Introduction To Civil Engineering Construction, University of the West of England, Bristol)

In Fig 7.3 the batter stake shows the depth of cut (C = 2.6 m) and its distance from the centre line 12 m. On the edge of the stake the slope (11 in 2) is marked as a fraction, and on the back face of the stakes the distance along the centre line from the first station. After reducing the levels a series of final level pegs are positioned at the shoulder and centre line. This procedure can be used for almost any form of mass excavation.

http://modul2poli.blogspot.com/
2.3 Retaining Walls

There are two main types of retaining wall: the gravity retaining wall and the cantilever retaining wall. The former is mainly used for the support of solids such as soil, fuel, chemical and waste materials. The latter may be used for both solids and liquids. Reservoir walls are often constructed in a cantilever form. In some cases the wall may be designed to support dead loads in addition to the normal lateral loads, but essentially these walls are designed to resist lateral movement. Both types of retaining wall must be designed to resist the following factors:

![Possible Failures in Retaining Wall](http://modul2poli.blogspot.com/)

**Figure 2.4 Possible Failures in Retaining Wall**

(Source: Fig 2.4 Holmes, R.(1995), Introduction To Civil Engineering Construction, University of the West of England, Bristol)
SITE INVESTIGATION PREPARATION

These possible factors of failure are shown diagrammatically in Fig 7.4. Gravity retaining walls depend on their dead weight for strength and stability. They are limited in height to approximately 3 metres if inclined, or 2 metres if the wall is vertical. Over these heights the thickness of wall, to comply with the safe height/thickness ratio, would make the construction uneconomical. They are designed so that the width of wall is sufficient to distribute the resultant loads of the wall and the earth pressure to the soil below the base of the wall without under settlement. High tensile stresses at the back of the wall can be offset by designing the width of the wall so that the resultant force is kept within the middle third of the base. A suitable width of base can be taken as between one quarter and one-half of the wall height. The width at the top of the wall can be taken as one-seventh of the wall height.
2.3.1 Cantilever Retaining Wall

Cantilever walls are used for retaining walls up to 7 metres in height without counterforts, and if counterforted can be designed for greater heights without being excessively thick. The wall shape may vary to suit the loading and the material to be supported. The walling material is normally reinforced concrete, although pre-stressed concrete may be used for liquid-retaining structures.

The form shown in Fig 2.5 (a) is used in situations where the wall is to support soil and where it is not possible to excavate behind the wall. The form in (b) may be used where excavation behind the wall is necessary; this type makes use of the backfill for stability. When the height exceeds 7 meters the extra thickness of the wall must be considered against the cost of constructing counterforts. The forms in Fig 2.5(c) and (d) show the use of counterforts; (c) shows a buried counterfort which reduces the cost of finished concrete (since it can be cast from rough shuttering without any finishing work whereas (d) produces a very strong buttressed retaining wall which is not dependent on the weight of backfill material.
Figure 2.4: Cantilever Retaining Wall
(Source: Fig 2.5 Holmes, R. (1995), Introduction To Civil Engineering Construction, University of the West of England, Bristol)
Other forms and types of retaining wall can be used, such as:

- Diaphragm walls
- Steel sheet piling
- Concrete crib walls
- Contiguous piling
- Anchored walls

Figure 2.5 Concrete Crib Wall
2.3.2 Turfing

The idea of turfing is to stabilize the slope. Turfing can help to prevent a landslide on rainy days. There are two types of turfing, the first is sport turfing. Grass will be planted at every 150mm-300mm each. The second type is close turfing. Grass will be planted closely.

Figure 2.7: Turfing (Source: Fig 2.6 and fig.2.7 Hafidzah, A. (1995), Binaan Bangunan, Nota Panduan Politeknik Malaysia)

http://modul2poli.blogspot.com/
2.4 Setting Out

The purpose is to build up the proposed building at the exact place/spot and also as a guide for excavation and building construction. Setting out will be fixed at least 1m from the building line to avoid any damage due the trench excavation works. Wall thickness and base trench will be marked clearly on the setting out by using nail or saw cutting edge or painted.

The procedure of Setting Out.

1. Usually one of the building corners will be set up as a bench mark by the planner.
2. Then set up any of the building corner and mark the spot with ‘A’.
3. Measure the length of A to B and mark the spot with ‘B’.
4. The corner at ‘B’ can be exact by using the ‘elbow’ or 3:4:5 ratio.
5. Then continue the process to set up the ‘C’ and ‘D’ points.
6. After completing all the ABCD points, check the diagonal to establish whether the building is square.
SITE INVESTIGATION PREPARATION

Figure 2.8: Setting Rail

Figure 2.9: Setting Out Plan

(Source: Fig 2.8 and fig.2.9 Hafidzah, A.(1995), Binaan Bangunan, Nota Panduan Politeknik Malaysia)

http://modul2poli.blogspot.com/
2.4.1 Bonning Rod

Bonning rod is made up of 2 wooden sticks in T shape, measuring 100mm X 30mm. The length of the rod is standard, based on the depth of excavation.

Usage of Bonning Rod:-
a. to control/monitor the quantities of excavated soil.
b. to monitor the excavate slope.
c. to monitor /checked the level of any excavation surfaces.

Bonning rod must be used in conjunction with straight reel in order to determine the slope of any excavation works. Straight rail is a wooden stick joined to 2 wooden stump horizontally. The size is 150mm X 50mm. Stump height are based on the depth of excavation work.

Process
1. Straight reel will be fixed at every +30.00mm along the excavation lane. The top of the rods must be levelled using water level.
2. The bonning rod will be set up at the length of excavation based and the top of the right reel.
3. Threads line will be fixed on the top of the sight rails. This is to determine that the thread line is parallel to the excavation lane.
4. Any section of the excavation area can be examined using the bonning rod, by making sure that the bonning rod levelled the top of the rail on sight.

http://modul2poli.blogspot.com/
2.4.2 Rubber Hose

A transparent rubber hose filled with water is a useful tool to use as this will give the same level for different places at the construction site. A transparent rubber hose enables water level to be seen clearly.
Process

Fill the rubber hose with water and mark ‘A’ at one end. (reference level) then put the second end to the place to be levelled as and mark ‘B’. Move the hose up and down till the water level at that end is stable. Make sure the, water level at ‘A’ is fixed. Now point B is levelled with point ‘A’.

Figure 2.11: Rubber Hose

(Source : Fig 2.10 and fig.2.11 Hafidzah, A.(1995), Binaan Bangunan,Nota Panduan Politeknik Malaysia)

2.4.3 Water Level

Usage of this tools is to test and determine the vertical and horizontal surfaces. Tools are made of wood and steel. For the flat horizontal on vertical surface, the bubble in this water level will be centered/ in the middle.

http://modul2poli.blogspot.com/
TEST YOUR UNDERSTANDING BEFORE YOU MOVE TO THE NEXT INPUT.....!

1. Construction methods for smaller sites, e.g. basements, deep pits, trenches etc, will depend to a great extent on the following factors. List down the following factors.
   i. 
   ii. 
   iii. 
   iv. 
   v. 
   vi. 

2. List down types of retaining wall that can be used
   i. 
   ii. 
   iii. 
   iv. 
   v. 

3. Define the Bonning Rod

http://modul2poli.blogspot.com/
1. Factors affecting construction methods for smaller sites:
   a. Type of soil or rock
   b. Quantity of material to be moved
   c. Presence of water
   d. Depth of dig
   e. Working space available
   f. Whether excavated material can be left on site.

2. List of Retaining Walls
   a. Steel sheet piling
   b. Diaphragm walls
   c. Concrete crib walls
   d. Contiguous piling
   e. Anchored walls

3. Definition of Bonning Rod
   Bonning rod is made up of 2 wooden sticks in T shape, measuring 100mm X 30mm. The length of the rod is standard, based on the depth of excavation.
You are approaching success. **Try all the questions** in this self-assessment section and check your answers with those given in the Feedback on Self-Assessment given on the next page. If you face any problems, discuss it with your lecturer. Good luck.

1. Draw and label the possible failures in retaining wall:
   a.  
   b.  
   c.  
   d.  

http://modul2poli.blogspot.com/
2. List down the procedure of setting out.

   i.

   ii.

   iii.

   iv.

   v.

   vi.
Have you tried the questions???????? If “YES”, check your answers now.

1. Figure shows the possible failures in retaining wall

http://modul2poli.blogspot.com/
2. The procedure of Setting Out.
   1. Usually one of the building corner will be set up as bench mark by the planner.
   2. Then set up any of the building corner with marked ‘A’.
   3. Measured the length of A B and marked the spot with ‘B’.
   4. The corner at ‘B’ can be exact by using the ‘elbow’ or 3:4:5 ratio.
   5. Then continue the process to set up the ‘C’ and D points.
   6. After completing all the ABCD points, check the diagonal to establish whether the building is square.
General objective: To define foundation and the various functions pertaining to foundation.

Specific objectives: At the end of this unit you should be able to:

- List the different types of foundation
- Describe the different types of foundation.
- Compare the different types of shallow foundation.
- Explain the different types of deep foundation which are used in construction.
3.1 Introduction

Loading in buildings consist of the combined dead and imposed load which exert a downward pressure upon the soil on which the structure is founded. This in turn prompts an active force in the form of an upward pressure from the soil. The structure is in effect sandwiched between these opposite pressure thus the design of the building must be able to resist the resultant stresses set up within the structural members and the general building fabric. Hence supporting subsoil must be able to develop sufficient reactive force to provide stability to the structure to prevent failure due to unequal settlement and to prevent failure of the subsoil due to shear.

3.1.1 Definition of Foundation

A foundation is the base on which a building rests and its purpose is to safely transfer the load of the building to a suitable subsoil.

3.2 Choice of foundation type

The choice and design of foundation for domestic and small types of buildings depends mainly on two factors. The total loads of the building are taken per metre run and calculated for the worst case.
The nature and bearing capacity of the subsoil can be determined by:

a. Trial holes and subsequent investigation.
b. Bore holes and core analysis.
c. Local knowledge.

3.3 Types Of Foundation

Foundation is usually made of either mass or reinforced concrete and can be classified under two headings:

a) Shallow foundation

Those which transfer the loads to subsoil at a point near to the ground floor of the building such as strips and raft.

b. Deep Foundation

Those which transfer the loads to a subsoil some distance below the ground floor of the building such as piles.

3.3.1 Raft Foundation

Raft foundation is often used on poor soils of lightly loaded buildings and is capable of accommodating small settlement of soil. In poor soil the upper crust of soil (450-600mm) is often stiffer than the lower subsoil and to build a light raft on this crust is usually better then penetrating it with a strip foundation.
Figure 3.1: Raft Foundation

Figure 3.2: Raft Foundation for Wall

(Souce:Fig. 3.1 and fig 3.2:Chudley,R. (1999), Construction Technology, Addison Wesley; Longmans)

http://modul2poli.blogspot.com/
3.3.2 Pad Foundation

This type of foundation is used to support and transmit the loads from piers and column. The most economized plan shape is a square but if the columns are closer to the site boundary, it may be necessary to use a rectangular plan shape of equivalent area. The reaction of the foundation on the load and ground pressures is to cup, similar to a saucer and therefore main steel is required in both directions. The depth of the base will be governed by the anticipated moment and shear force, the calculation involved is beyond the scope of this volume.

Figure 3.3: Type of Pad Foundation
(Source: Fig 3.3: IKRAM Note)
3.3.3 Strip Foundation

The oldest and the most common form of foundation is a strip foundation where a trench is excavated, concrete placed in the bottom and the wall built upon it. The depth is determined by the need to place the strip below the level where expansion due to frost will affect its stability (usually 1m) and the nature of the sub-soil. The width is governed by the relationship between the imposed load and the bearing capacity of the ground and also by the practical necessity of making it wide enough for a man to work it.

Figure 3.4: Strip Foundation

(Source: Fig 3.4 Holmes, R. (1995), Introduction To Civil Engineering Construction, University of the West of England, Bristol.)
3.3.4 Buoyancy foundations

If a building is required to have a basement storey, the formation of that basement will involve the removal of a large quantity of sub-soil. The mass of this sub-soil, in many cases, can equal or exceed the total mass of the finished building and its designed imposed loads. If this occurs then the completed structure will impose no greater stress on the sub-soil through its basement floor than did the soil it replaced. Therefore the capacity of the soil to carry the load is not in doubt and the building 'floats' in the ground precisely the same way that an ocean liner floats in the sea.

As the sub-soil at the levels to which this form of substructure is carried is almost always water-bearing the basement would need to be lined with a waterproof membrane which would then cause the upward hydrostatic pressure to counter-balance a proportion of the downward thrust of the building.

![Figure 3.5: Buoyancy foundations](http://modul2poli.blogspot.com/)

http://modul2poli.blogspot.com/
3.4 Pile Foundation

A pile can be loosely defined as a column inserted in the ground to transmit the structural loads to a lower subsoil. Piles have been used in contact two hundred years ago and until the twentieth century were invariably of driven timber.

Figure 3.6: Piling

http://modul2poli.blogspot.com/
3.5 Classification of Piles

Piles may be classified by the way in which they transmit their loads to the subsoil or by the way they are formed. Piles may transmit their loads to a lower level by:

a) **End Bearing**

The shafts of the piles act as column carrying the loads through the overlaying weak subsoil to firm strata into which pile toe has penetrated. This can be a rock strata or a layer of the firm sand or gravel which has been compacted by the displacement and vibration encountered during the drive.

![Friction Pile](http://modul2poli.blogspot.com/)

*Figure 3.7: Friction Pile*
b) Friction

Any type of foundation imposes on the ground a pressure which spreads out to form a bulb of pressure. If a suitable load bearing strata cannot be found at an acceptable level, particularly in stiff clay soils, it is possible to use a pile to carry this bulb of pressure to a lower level where a higher bearing capacity is found. The friction of floating pile is mainly supported by the adhesion or the friction action of the soil around the perimeter of the pile shaft.

Figure 3.7: End Bearing Pile
3.5.1 Types of bearing piles

The classification of bearing piles is related to the effect on the soil. There are two main types: displacement piles and replacement piles.

a. Displacement Piles

A displacement pile is either driven, jacket, vibrated or screwed into the ground. This section displaces the soil outwards and downwards but the material is not actually removed. There are two types of displacement pile: large displacement piles which includes all solid driven piles and small displacement pile, in which very little soil is displaced. This would include the screwed piles and H piles.

b. Replacement Piles

Replacement piles may be classified as Supported or Unsupported. In both cases a hole is formed in the ground by some form of cutting or boring tool and is then filled with reinforced concrete. The unsupported hole will normally require a short tube at the top to prevent debris from falling into the concrete during placing. Support to holes may be provided by means of medium or heavy sectional casing, screwed together as boring proceeds, or by means by a head of drilling mud (usually bentonite suspension).
3.6 Types Of Pile

3.6.1 Driven Piles

a) Timber piles
Timber piles are usually square sawn hardwood or softwood in lengths up to 12,000m in sections, with sizes ranging from 225 x 225 mm to 600mm x 600 mm. Most timber piles are fitted with an iron or steel driving shoe and have an iron ring around the head to prevent splitting due to driving. Although not particularly common they are used in sea defences such as groynes and sometimes as guide piles for large in conjunction with steel sheet piling.

Load bearing capacities can be up to 350 kn per pile depending upon section size and or species. There are two types of timber piles: Natural logs named as Bakau Piles, and treated timber piles which are chemically treated against the decay.

http://modul2poli.blogspot.com/
b) Bakau Piles

The bakau pile is generally tapered and has a diameter of 75 to 125mm. The piles are generally used as friction piles at poor ground condition which have a high ground water table. The bakau piles are generally used for light buildings (column load of approximately 30 tonnes). Suitable in soft clay areas.

c) Treated Timber Pile

The piles are made from kempas, a kind of broadleaf tree. The cross sectional area of the pile is 5 inches by 5 inches and six inches by 6 inches, and the pile is 20 to 24 feet long. The permissible degree of bow or wrap of the pile within 20 feet long is $1\frac{1}{2}$ inches from a straight axis through the pile.

The permissible degree of wrap of a pile more than 20 feet long is 2 inches. Design working ads of 5 inches by 5 inches piles and 6 inches by 6 inches piles are the 15 ton/pile and the 20 tonnes respectively.

d) Composite Piles

It is composite wood and concrete pile. The timber is kept below groundwater and a greater over-all length is achieved. A closed-end pipe pile may be used in place of the timber section.

Combination of two or more of a preceding type or combination of different materials in the same type of pile. Composite piles are used in ground conditions where conventional piles are unsuitable or uneconomical concrete and timber are the type used because it is cheap and easy to handle.
durability concrete. The timber is terminated below ground water level and the upper portion formed in concrete.

e) Steel Piles

Steel piles, like timber, are driven by percussion means and have a variety of suitable cross-sections. In addition to the common sheet piles, the three main types are H sections, Box piles and tube piles. The main use of steel piles is for temporary works, retaining walls and marine structures. The problem of corrosion of the steel can be overcome by suitable protection.

Sheet piles have the advantages of being robust, light to handle capable of carrying high compressive loads when driven on to a hard stratum, and capable of being driven hard to a deep penetration to reach a bearing stratum or to develop a high skin frictional resistance, although their cost per metre run is high compared with precast concrete piles.

f) Precast Concrete Piles

Precast concrete piles used on medium to large contracts where soft soils overlaying a firm strata are uncountered and at least 100 piles will be required. The precast concrete driven pile has a little frictional bearing strength since the driving operation moulds the cohesive soils around the shaft which reduces the positive frictional resistance.
i) Steel H-Section Piles

H section piles are in the form of wide-flanged steel section and rolled in accordance with standard. The displacement piles, and the H section piles may be driven by any type of hammer, but the head of the pile should be protected by a helmet.

3.6.2 Driven Cast-In-Place Pile

- Driven cast-in-place pile installed by driving, to the desired penetration, a close ended steel tube or concrete shell and the void created is filled with concrete. Steel tube or concrete shell can be withdrawn or left in place.
- Readily adjustable in length to suit the desired depth of penetration.
- Economic if no casing required.

3.6.3 Bored Cast-In-Place Pile

- A borehole is formed in the ground by sugar etc and the void concrete to form bored pile.
- Usual sizes varies from 400mm diameter to 1000mm diameter.
- Allowable load varies from 800kN to 1500kN.
- Length of bored piles easily adjustable to suit the penetration depth.
- Suitable in residual soil
- Uses high slump self compacting concrete.
- Trem concreting if water in borehole.
TEST YOUR UNDERSTANDING BEFORE YOU MOVE TO THE NEXT INPUT…..!

1. Explain the definition of foundation used in construction.

2. List down the types of foundation in highrise buildings that are presently used.

   i. 

   ii. 

   iii. 

   iv. 

   v. 

3. List down the types of shallow foundation

   i. 

   ii. 

   iii. 

   iv. 

   v. 

http://modul2poli.blogspot.com/
4. How do you determine the nature and bearing capacity of subsoil

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

5. How are piles classified?

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

6. Make a comparison between bakau piles and treated timber piles.

<table>
<thead>
<tr>
<th>Bakau Piles</th>
<th>Treated Timber piles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
You can go to the next unit if you can answer all the questions in this activity.

1. Definition of Foundation
   A foundation is the base on which a building rests and its purpose is to safely transfer the load of the building to a suitable subsoil.

2. Types foundation in highrise building that we used now days is:
   a) Steel piles
   b) Precast Concrete Piles
   d) Steel H – Section Piles

3. Shallow foundation those which transfer the loads to subsoil at a point near to the ground floor of the building such as:
   a) Strips foundation
   b) Raft foundation
   c) Pad foundation
The nature and bearing capacity of the subsoil can be determined by:

d. Trial holes and subsequent investigation.
e. Bore holes and core analysis.
f. Local Knowledge.

Classification Of Piles

Piles may be classified by the way in which they transmit their loads to the subsoil or by the way they are formed. Piles may transmit their loads to a lower level by:

a) End Bearing

The shafts of the piles act as columns carrying the loads through the overlaying weak subsoil to firm strata into which pile toe has penetrated. This can be a rock strata or a layer of the firm sand or gravel which has been compacted by the displacement and vibration encountered during the driving.

b) Friction

Any foundation imposes on the ground a pressure which spreads out to form a bulb of pressure. If a suitable load bearing strata cannot be found at an acceptable level, particularly in stiff clay soils, it is possible to use a pile to carry this bulb of pressure to a lower level where a higher bearing capacity is found. The friction or floating pile is mainly supported by the adhesion or friction action of the soil around the perimeter of the pile shaft.

a) Bakau Piles

The bakau pile is generally tapered and has a diameter of 4 to 5 inches at the one end, and 5 to 6 inches at the other end with the strength of 20 to 24 feet. The piles are generally used as friction piles at poor ground condition with high ground
b) Treated Timber Pile

The piles are made from kempas, a kind of broadleaf tree. Cross sectional area of the pile are 5 inches by 5 inches and six inches by 6 inches, and the pile is 20 to 24 feet long. The permissible degree of bow or wrap of the pile within 20 feet long is 1½ inches from a straight axis through the pile. The permissible degree of wrap of a pile more than 20 feet long is 2 inches. Design working ads of 5 inches by 5 inches piles and 6 inches by 6 inches piles are 15 ton/pile and 20 tonnes respectively.
The construction industry for highrise buildings use piling foundation. The main of classification of bearing piles is related to either effect on the soil. There are two main types: displacement piles and replacement piles. Explain both of the types of piles.

QUESTION 2

Explain the following types of foundation. Your answer must be completed with a drawing.

a) Pad Foundation
b) Raft Foundation
c) Strip Foundation
Types of bearing piles

The main of classification of bearing piles is related to either effect on the soil. There are two main types: displacement piles and replacement piles.

a) Displacement Piles

A displacement pile is either driven, jacket, vibrated or screwed into the ground. This section displaces the soil outwards and downwards but the material is not actually removed. There are two types of displacement pile: large displacement piles which includes all solid driven piles, and small displacement pile, in which very little soil is displaced. This would include the screwed piles and H piles.

b) Replacement Piles

Replacement piles may be classified as:
- Supported or
- Unsupported

http://modul2poli.blogspot.com/
In both cases a hole is formed in the ground by some form of cutting or boring tool and then filled with reinforced concrete. The unsupported hole will normally require a short tube at the top to prevent debris from falling into the concrete during placing.

Supported to holes may be provided by means of the medium or heavy sectional casing, screwed together as boring proceeds, or by means by a head of drilling mud (usually bentonite suspension)

1. **Raft Foundation**

Raft foundation are often used on poor soils of lightly loaded buildings and are considered capable of accommodating small settlement of the soil. In poor soil the upper crust of soil (450-600mm) is often stiffer than the lower subsoil and to build a light raft on this crust is usually better and penetrating it with a strip foundation.

http://modul2poli.blogspot.com/
2. Pad Foundation

This type of foundation is used to support and transmit the loads from piers and column. The most economics plan shape is a square but if the column are close to the site boundry it may be necessary to use a rectangular plan shape of equivalent area.

The reaction of the foundation to the load and ground pressures is to cup, similar to a saucer, and therefore main steel is require in both directions. The depth of the base will be governed by the anticipated moment and shear force, the calculation involved being beyond the scope of this volume.
3. Strip Foundation

The oldest and the most common form of foundation is a strip foundation where a trench is excavated, concrete placed in the bottom and the wall build upon it. The depth is determined by the need to place the strip below the level where expansion due to frost will affect its stability (usually taken 1m) and the nature of the sub-soil.

The width is governed by the relationship between the imposed load and bearing capacity of the ground and also by the practical necessity of making it wide enough for a man to work it.
CONGRATULATIONS

YOU CAN GO TO THE NEXT UNIT

http://modul2poli.blogspot.com/
General Objective : To be able to understand installation and handling of the precast pile, sheet pile as cofferdams, driving pile and load test.

Specific Objectives : At the end of this unit, you should be to:

- describe the lifting and handling of the precast pile
- define a sheet piling and effectiveness of sheet piling.
- explain a cofferdam and retaining wall used in rivers and canals.
- describe the method of driving piles.
- explain the load test.
4.1 Lifting and handling a pre-cast pile

The Contractor shall exercise greater care in the lifting and handling of piles and no pile shall be lifted other than at the designed lifting points.

Installation and handling method are very important in ensuring that pile is utilized to give maximum potentials and unnecessary damages do not occur. Precast piles should be handled carefully to prevent any excessive loads. However, should cracking occur, these will be closed up when the load is removed, hence ensuring that corrosion of the prestressing bars is prevented.

In the factory, large overhead or gantry cranes are used to ensure that the finished products are handled safely to minimize risk or damages. At site, lifting of the pile should use a be by proper method recommended. Lifting points are marked on all piles 2/10 of the length from the ends and lifting is by wrapping wine rope round the piles at these points. Figure 5.1 show correct and incorrect ways in handling and lifting a precast pile.
4.2 Pile Driving Plant

When selecting plant for piling operations it is necessary to establish the type of pile to be used. In the case of displacement piles, in which some form of pile or tubular casing is driven into the ground, consideration must be given to the support of the unit being driven. This normally takes the form of a pile frame or crane and leader, although latest developments use hydraulically operated telescopic back struts in lieu of a crane jib. In the case of replacement piles a hole is formed in the ground and then filled with reinforced concrete, the plant used varying with the size of hole formed. A tripod rig is used for small diameter holes (up to 600 mm).
This rig is equipped with a winch for raising the cutting auger and the whole equipment weighs approximately 1.5 tones. For larger diameter holes the percussion equipment varies considerably; most systems use a crane and hammer grab for excavating the spoil inside the casings, but the method of inserting the casing varies. Some casings are placed with the use of oscillating machinery, which is part of the driving equipment; others are sunk by the use of a separate vibrator unit. Where large diameter auger holes are required the machinery is either purpose-built, or special attachments are mounted on standard cranage.

In each case consideration must be given to the height and manoeuvrability available on site, and whether vibration and noise would create problems to either adjoining buildings or residents. Further considerations include type of sub-soil, surface conditions, eg slope of site, surface drainage eg waterlogged conditions and the obstructions eg old basements, and existing services.

4.3 Methods of driving piles

Pile frames and leaders are used to locate and guide a pile during the initial stages of penetration as well as guiding and supporting the hammer. The leaders for guiding the hammer and pile extend the full height of the frame and consist of steel channels set some 150 mm apart. This space allows the lugs of drop hammers to be accommodated and facilitates the sliding of the hammer. A winch is used to lift the hammer in position and may also be used for positioning the pile. Pile frames may be vertical or raking and vary in height from 10 meters to 25 meters, adjustment for a raking frame being made by raking screw jacks. Stability is achieved by guy ropes from the head of the frame (Fig 4.2)
Fig 4.2 Pile Frame (Adjustable)

Fig 4.3 Crane and Leader

(Source: Fig.4.2 and fig. 4.3; Holmes, R.(1995), Introduction To Civil Engineering Construction, University of the West of England, Bristol.)

http://modul2poli.blogspot.com/
Table 4.1 Sample of Piling Records (IKRAM NOTE)

<table>
<thead>
<tr>
<th>No</th>
<th>Tanda Penembusan</th>
<th>Ukuran Cerucuk</th>
<th>Panjang Cerucuk</th>
<th>Tarikh Di Tuang</th>
<th>Lokasi Di Pelan Tapak</th>
<th>Kuub Ujian</th>
<th>Lain-Lain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Aras Tanah)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>34 - 35</td>
<td>68 - 69</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>35 - 36</td>
<td>69 - 70</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>36 - 37</td>
<td>70 - 71</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>37 - 38</td>
<td>71 - 72</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>38 - 39</td>
<td>72 - 73</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>39 - 40</td>
<td>73 - 74</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>40 - 41</td>
<td>74 - 75</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>41 - 42</td>
<td>75 - 76</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td>42 - 43</td>
<td>76 - 77</td>
<td>64</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>10</td>
<td>43 - 44</td>
<td>77 - 78</td>
<td>36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>11</td>
<td>44 - 45</td>
<td>78 - 79</td>
<td>79</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>45 - 46</td>
<td>79 - 80</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>13</td>
<td>46 - 47</td>
<td>80 - 81</td>
<td>112</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>14</td>
<td>47 - 48</td>
<td>81 - 82</td>
<td>145</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>15</td>
<td>48 - 49</td>
<td>82 - 83</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>16</td>
<td>49 - 50</td>
<td>83 - 84</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>17</td>
<td>50 - 51</td>
<td>84 - 85</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>18</td>
<td>51 - 52</td>
<td>85 - 86</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>19</td>
<td>52 - 53</td>
<td>86 - 87</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>20</td>
<td>53 - 54</td>
<td>87 - 88</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>21</td>
<td>54 - 55</td>
<td>88 - 89</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>22</td>
<td>55 - 56</td>
<td>89 - 90</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>23</td>
<td>56 - 57</td>
<td>90 - 91</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>24</td>
<td>57 - 58</td>
<td>91 - 92</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>25</td>
<td>58 - 59</td>
<td>92 - 93</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>26</td>
<td>59 - 60</td>
<td>93 - 94</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>27</td>
<td>60 - 61</td>
<td>94 - 95</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>28</td>
<td>61 - 62</td>
<td>95 - 96</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>29</td>
<td>62 - 63</td>
<td>96 - 97</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>30</td>
<td>63 - 64</td>
<td>97 - 98</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>31</td>
<td>64 - 65</td>
<td>98 - 99</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>32</td>
<td>65 - 66</td>
<td>99 - 100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>33</td>
<td>66 - 67</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>34</td>
<td>67 - 68</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

http://modul2poli.blogspot.com/
Cranes and leaders are commonly used instead of specialized piling frames. This equipment consists of a standard crane with a purpose-built leader unit attached to the crane at both top and bottom. These leaders can be obtained 30 meters high and are used on sites when normal piling frames would otherwise prove cumbersome. The crane can lift the leader unit and move easily across the site (Fig 4.3).

Pile driving rigs are similar in construction to the crane and leader unit but the crane jib is not used for lifting the leader. With this piece of equipment the leader is fixed to the crane with telescopic props from the rear of the crane, and the bottom of the leader is positioned by a hydraulic boom.

The actual 'driving' mechanism will depend on the type of pile, as set out below:

<table>
<thead>
<tr>
<th>Pile Type</th>
<th>Driving Mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driven steel casing</td>
<td>Driven from the top by drop hammer or compressed air, diesel or steam hammer; by driving a mandrel and casing or by driving a shoe or plug of material by internal drop hammer.</td>
</tr>
<tr>
<td>Precast pile</td>
<td>All types of hammer are suitable but the hammer should weigh a minimum of half the weight of the pile being driven. The head of the pile must be protected against spelling. This is achieved by using a special helmet and dolly described below.</td>
</tr>
<tr>
<td>Special preformed steel piles</td>
<td>Any type of hammer, but the heavier the hammer with reduced drop the less damage is done to the pile head.</td>
</tr>
<tr>
<td>Timber pile</td>
<td>Drop hammers and single or double acting hammers are suitable. Where hard driving is anticipated the weight of the hammer should equal the weight of the pile.</td>
</tr>
</tbody>
</table>
4.3.1 Pitching and Driving

Pitching shall be pitched accurately in the specific one point lift position and driven to the appropriate lines and levels. Piles may be suitably constrained to maintain their correct position by means of guys and guides but no pile which has been deflected from its course, or has been incorrectly aligned shall be forcibly brought back to its correct alignment.

Where piles are driven below the level of the bottom of the leads of the pile frame, extension leads shall be fitted. During driving the heads of the piles shall be protected by a helmet, of cast steel, fitting closely around the pile. A packing of coiled hemp rope or asbestos fibre, minimum 100mm thick, covering the head of the pile, shall be placed within the helmet to separate the helmet from the head of the pile. The top of the helmet shall be recessed and fitted with a timber stud dolly 1 ft. long. The packing and stub dolly shall be renewed as often as necessary to prevent damage to the pile. Screw pile requires a crane for pitching and some form a guide frame to hold the pile during its screwing operation.

Protection of concrete piles during driving is achieved by using a steel helmet. The helmet is padded with a bed of sand on the top of the pile and the elbow from the hammer is cushioned by a hardwood ‘dolly’.
4.3.2 Cut-off Length

After piling to set the excess length above the ground is easily cut off using a chain saw. Such cut off length can be reused satisfactorily. However it is recommended that such cut of length be used as the bottom section of another pile. Unused cut off length are easy to dispose.

Treatment of Cut-offs
The cut-off pile head of the driven pile in 4 above should be given two coats of an approved wood preservative. The preservative should be allowed to soak generously into
the end grain complete followed by a second application an hour later before concreting of pile cap.

4.3.3 Stripping Of Pile Head

In the absence of available specification the following procedure can be adopted. After the pile has been driven to the required set or level the concrete shall be cut away from for a distance of 600mm reinforcement shall be removed and the main reinforcement shall be bent as required for incorporation into the pile cap. Should the piles extend more than 600mm, the surplus length shall be cut off and removed.

Pile Cap Construction

a. Excavation to finished level for construction of pile cap
B.Formwork for construction of pile cap
C.Placing of reinforcing bars into position
D.Pile cap after concreting
E.Complete pile cap after stripping formwork.

Timber piles normally just protrude about 75mm into the pile cap. RC. Pile is made of the same material (concrete) as pile cap will bond better. This is further enhanced by stripping pile head to expose steel bar which can be embedded well in the pile cap.
4.3.4 Jointing the pile

If one length of the timber pile being driven is insufficient to reach a suitable depth an additional length may be jointed to the undriven portion of the previous pile. The jointing of length of timber piles is extremely easy and inexpensive. This can be done by using a mild steel welded box joint which is easily available.

Figure 4.5 Details Jointing a Pile
(Source Fig 4.5 IKRAM Note)

http://modul2poli.blogspot.com/
Tanalised timber pile is not recommended to have more than one joint using m.s sleeve as it is not rigid. R.C pile joint which is done by welding is not only as strong as the parent concrete, it is also cheaper.

4.3.5 Piles out Of Alignment

During driving, guys may be used to assist in positioning the pile but no pile which has deviated more than 75mm out of position shall be forcibly constrained in an effort to rectify this. The extraction and re-driving of pile which has deviated more than the above amount from its correct positions may be necessary then. Alternatively should circumstances require this, the substructure over the piles shall be constructed to a modified design, which takes into account of the variations in the pile positions or any extra cost in a modified foundation shall be borne by a contractor if such extra cost has been occasioned by the incompetence and or negligence of the contractor.

4.4 Load Test

This procedure may be varied by agreement as it very much depends upon the purpose of the test and the behavior of the pile. The bearing capacity of a pile will depend upon several factors, such as the size, shape and type of pile, and the particular properties of the soil in which the pile is embedded. The ultimate bearing capacity is that which equals the resistance of the soil; further loading than this will cause the pile to penetrate still further into the ground.

The Code of Practice CP 2004 (1972) states: ‘For practical purposes, the ultimate bearing capacity may be taken to be that load, applied to the head of the pile, which causes the
head of the pile to settle 10% of the pile diameter, unless the value of the ultimate bearing capacity is otherwise defined by some clearly recognizable feature of the load/settlement curve.’ This statement has been qualified by experts as being a settlement of 10% of the dial meter for end bearing piles in clay but as little as 1% of the pile diameter for a friction pile. The method of calculating ultimate bearing capacity of a pile will depend upon the magnitude of the work involved, the type of soil and the specifications laid down by the client.
1. _____________ and _____________ methods are very important ensuring that pile is utilized to give maximum potentials and unnecessary damages do not occur.

2. _______________ in which some form of pile or tubular casing is driven into the ground, consideration must be given to the support of the unit being driven.

3. The actual 'driving' mechanism will depend on the type of pile. What is suitable in precast pile?

__________________________________________________________________
__________________________________________________________________
1. Handling and Lifting

2. Displacement piles.

3. Precast pile- All types of hammer are suitable but the hammer should weigh a minimum of half the weight of the pile being driven. The head of the pile must be protected against spelling this is achieved by using a special helmet and dolly described below.
You are approaching success. **Try all the questions** in this self-assessment section and check your answers with those given in the Feedback on Self-Assessment given on the next page. If you face any problems, discuss it with your lecturer. Good luck.

**QUESTION 1**

1. Explain correct and incorrect ways in handling and lifting a precast pile. Please draw your diagrams in the space provided below.
2. What do you understand by jointing a pile? Illustrated your answer in the space provided below.
Have you tried the questions???????? If “YES”, check your answers now.

1. Figure shows handling and lifting a precast pile.
# FOUNDATION

2. If one length of the timber pile being driven is insufficient to reach a suitable depth an additional length may be jointed to the undriven portion of the previous pile. The jointing of length of timber piles is extremely easy and inexpensive. This can be done by using a mild steel welded box joint which is easily available.

---

Details Jointing a Pile

http://modul2poli.blogspot.com/
4.5 Sheet pile

4.5.1 Types of pile

Sheet pile are normally of steel or reinforced concrete, they can however be formed of timber in countries where there is an ample supply. Figure 5.1 shows a typical diagram of sheet piling available.

Figure 6.6 Typical diagram of sheet piling available
Timber sheeting, where it is used, is suitable for temporary work such as cofferdams and sound support where sound pressure is within the capabilities of the material strength. The pile maybe formed in various ways to provide interlocking joints for waterproofing or strengthening.

Reinforced concrete sheet piles are similar in design to timber sheeting, but are of much greater value in the construction of permanent embankments to rivers, canal and other forms of water-oriented structures. The piles are suitable interlocked and the toes of the piles are shaped to facilitate easy driving and interlocking.

Steel sheet piling is the most common form of sheet piling used in temporary and permanent works. It is used in such structures as cofferdam, retaining walls, river frontages, quays, wharves, dock and harbor works land reclamation and sea defense works. It has an advantage over other forms of sheeting in that it has high structural strength combined with water tightness and can be easily driven into most types of ground.

4.5.2 Steel Sheet Piling

Steel sheet piling is the most common form of sheet piling which can be used in temporary works such as timbering to excavations in soft and/or waterlogged soils and in the construction of coffer. This material can also be used to form permanent retaining walls especially those used for river bank strengthening and in the construction of jetties. Three common forms of steel sheet pile are the Larsen, Framingham and straight-web piles all of which have an interlocking joint to form a water seal which may need caulking where high water pressures are encountered. Straight-web sheet piles are used to form cellular cofferdams as described above Larsen and Frodingham sheet piles are available for...
suitable for all uses except for the cellular cofferdam and can be obtained in lengths up to 18.000 according to the particular section chosen.

To erect and install a series of sheet piles and keep them vertical in all directions usually requires a guide frame or trestle constructed from large section timbers. The piles are pitched or lifted by means of a crane, using the lifting holes sited near the top of each length, and positioning them between the guide wailings of the trestle and 25. When sheet piles are being driven there is a tendency for them to creep or lean in

![Figure 4.6 Timber and reinforced concrete sheet pile](image1)

![Figure 4.7 Frodingham steel sheet piling](image2)

(Source Fig 4.6 and Fig 4.7; Holmes, R. (1995), *Introduction To Civil Engineering Construction*, University of the West of England, Bristol.)
Figure 4.8 Frodingham straight web section

Figure 4.9 Larssen steel sheet piling

(Source Fig 4.8 and Fig 4.9; Holmes, R.(1995), *Introduction To Civil Engineering Construction*, University of the West of England, Bristol.)
4.6 Cofferdam

A cofferdam may be defined as a temporary box structure constructed in earth or water to exclude soil and/or water from a construction area. It is usually formed to enable the formation of foundations to be carried out in safe working conditions. It is common practice to use interlocking steel trench sheeting or steel sheet piling to form the cofferdam but any material which will fulfill the same function can be used, including timber piles, precast concrete piles, earth-filled crib walls and banks of soil and rock. It must be clearly understood that to be economic and effective cofferdams must be structurally designed and such calculations are usually covered in the structural design syllabus of a typical course of study and have therefore been omitted from this text.

4.6.1 Sheet Pile Cofferdams

Cofferdams constructed from steel sheet piles or steel trench sheeting can be considered fewer than two headings:

2. Double-skin cofferdams.

Single-skin cofferdams: these consist of a suitably supported single enclosing row of trench sheeting or sheet piles forming an almost completely watertight box. Trench sheeting could be considered for light loadings up to an excavation depth of 3.000 below the existing soil or water level whereas sheet piles are usually suitable for excavation depths of up to 15.000. The small amount of seepage which will occur through the interlocking joints must not be in excess of that which can be comfortably handled by a pump, or alternatively the joints can be sealed by caulking with asbestos rope, suitable mastics or a bit mastic compound.
Single-skin cofferdams constructed to act as cantilevers are possible in all soils but the maximum amount of excavation height will be low relative to the required penetration of the toe of the pile and this is particularly true in cohesive soils. Most cofferdams are therefore either braced or strutted or anchored using tie rods or ground anchors. Standard structural steel sections or structural timber members can be used to form the support system but generally timber is only economically suitable for low loadings.

The total amount of timber required to brace a cofferdam adequately would be in the region of 0.25 to 0.3 m per tone of steel sheet piling used whereas the total weight of steel bracing would be in the region of 30 to 60% of the total weight of sheet piling used to form the cofferdam. Typical cofferdarm support arrangements are shown in Figs. 1.19 and 20. Single-skin cofferdams that are circular in plan can also be constructed using ring beams of concrete or steel to act as bracing without the need for strutting. Diameters up to 36.000 are economically possible using this method.

Cofferdams constructed in water, particularly those being erected in tidal waters, should be fitted with sluice gates to act as a precaution against unanticipated weaknesses in the arrangement and in the case of tidal waters to enable the water levels on both sides of the dam to be equalized during construction and before final closure. Special piles with an integral sluice gate forming a 200 mm wide x 400 mm deep opening are available. Alternatively a suitable gate can be formed by cutting a pair of piles and fitting them with a top-operated screw gear so that they can be raised to form an opening of any desired depth.

Double-skin cofferdams: these are self-supporting gravity structures constructed by using two parallel rows of piles with a filling material placed in the void created. Gravity-type cofferdams can also be formed by using straight-web sheet pile sections arranged as a cellular construction.
The stability of these forms of cofferdam depends upon the design and arrangement of the sheet piling and upon the nature of the filling material. The inner wall of a double-skin cofferdam is designed as a retaining wall which is suitably driven into the sub-strata whereas the outer wall acts primarily as an anchor wall. The two parallel rows of piles are tied together with one or two rows of tie rods acting against external steel walling. Inner walls should have a series of low level weep holes to relieve the filling material of high water pressures and thus increase its shear resistance. For this reason the filling material selected should be capable of being well drained. Therefore materials such as sand, hardcore and broken stone are suitable, whereas cohesive soils such as clay are unsuitable.

Cellular cofferdams are entirely self supporting and do not require any other form of support such as that provided by struts, braces and tie rods. The straight web pile with its high web strength and specially designed interlocking joint is capable of resisting the high circumferential tensile forces set up by the non-cohesive filling materials. The interlocking joint also has sufficient angular deviation to enable the two common arrangements of circular cell and diaphragm cellular cofferdams to be formed like the double-skin cofferdam the walls of cellular coffer laps have weep holes to provide adequate drainage of the filling.

The circular cellular cofferdam has one major advantage over its J d counterpart in that each cell can be filled independently 4 (care must be exercised when filling adjacent cells in a diaphragm J pipe to prevent an unbalanced pressure being created on the cross-walls or j diaphragms. In general, cellular cofferdams are used to exclude water from construct areas in rivers and other waters where large structures such as docks are to be built.
Diagram 4.1 Cofferdams Types
Figure 4.10 Typical cofferdam strutting arrangement

Figure 4.11 Typical cofferdam strutting arrangement

(Source: Fig.4.10 and Fig.4.11; Chudley, R. (1999), Construction Technology, Addison Wesley; Longmans)

http://modul2poli.blogspot.com/
TEST YOUR UNDERSTANDING BEFORE YOU CONTINUE TO THE NEXT INPUT.....!

1. List down the three types of sheet piles
   a) ___________________
   b) ___________________
   c) ___________________

2. What is a cofferdam?
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

3. List down the types of steel sheeting piles in the boxes below:

<table>
<thead>
<tr>
<th>Single skin</th>
<th>Double skin</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)________________</td>
<td></td>
</tr>
<tr>
<td>b)________________</td>
<td></td>
</tr>
<tr>
<td>c)________________</td>
<td></td>
</tr>
<tr>
<td>d)________________</td>
<td></td>
</tr>
</tbody>
</table>

http://modul2poli.blogspot.com/
1. Types of sheet piles.
   a) Steel pile
   b) Timber pile
   c) Reinforce Concrete

2. A cofferdam may be defined as a temporary box structure constructed in earth or water to exclude soil and/or water from a construction area.

3. | **Single skin**                  | **Double skin**              |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Support by struts and walings in steel or timber.</td>
<td>a) Double wall type</td>
</tr>
<tr>
<td>b) Anchored by cables or rods.</td>
<td>b) Cellular type</td>
</tr>
<tr>
<td>c) Supported by ring walings</td>
<td></td>
</tr>
<tr>
<td>d) Supported by soil</td>
<td></td>
</tr>
</tbody>
</table>
You are approaching success. Try all the questions in this self-assessment section and check your answers with those given in the Feedback on Self-Assessment. If you face any problems, discuss it with your lecturer. Good luck.

**QUESTION 1**

1. What is similar in design to timber sheeting?

**QUESTION 2**

2. What is the most common form of sheet piling used in temporary and permanent works? Give your reasons to prove your answer.

**QUESTION 3**

3. Compare the following cofferdams
   2. Double-skin cofferdams.
Have you tried the questions????????? If “YES”, check your answers now.

1. Reinforced concrete sheet piles are similar in design to timber sheeting, but are of much greater value in the construction of permanent embankments to rivers, canal and other forms of water-orientated structures.

2. Steel sheet piling is the most common form of sheet piling used in temporary and permanent works.

3. (a). Single-skin cofferdams: these consist of a suitably supported single enclosing row of trench sheeting or sheet piles forming an almost completely watertight box. Trench sheeting could be considered for light loadings up to an excavation depth of 3.000 below the existing soil or water level whereas sheet piles are usually suitable for excavation depths of up to 15.000. The small amount of seepage which will occur through the interlocking joints must not be in excess of that which can be comfortably handled by a pump, or alternatively the joints can be sealed by caulking with asbestos rope, suitable mastics or a bit mastic compound.

http://modul2poli.blogspot.com/
(b). Double-skin cofferdams: these are self-supporting gravity structures constructed by using two parallel rows of piles with a filling material placed in the void created. Gravity-type cofferdams can also be formed by using straight-web sheet pile sections arranged as a cellular construction.

The stability of these forms of cofferdam depends upon the design and arrangement of the sheet piling and upon the nature of the filling material. The inner wall of a double-skin cofferdam is designed as a retaining wall which is suitably driven into the sub-strata whereas the outer wall acts primarily as an anchor wall. The two parallel rows of piles are tied together with one or two rows of tie rods acting against external steel walling. Inner walls should have a series of low level weep holes to relieve the filling material of high water pressures and thus increase its shear resistance. For this reason the filling material selected should be capable of being well drained. Therefore materials such as sand, hardcore and broken stone are suitable, whereas cohesive soils such as clay are unsuitable.
UNIT 5

TEMPORARY SUPPORT

OBJECTIVES

General Objective : To be able to understand works related to temporary support such as planking, scaffolding and shoring.

Specific Objectives : At the end of this unit, you should be able to:

- define planking work for shallow dig up.
- explain planking and planking installation technique for good ground, moderately firm ground and loose ground.
- state the safety procedure in dig up and planking work.
- define scaffolding.
- describe the materials used for scaffolding.
- explain the types of scaffolding and their parts.
- describe the safety procedure in scaffolding construction including installation techniques.
- highlight material care during scaffolding dismantling.
5.1 Introduction

They are many types of temporary construction in engineering works. These temporary construction will be dismantled once actual work is completed. In the case of excavations, holes left for a period of time may cause the sides to collapse. This will jeopardize the workers’ safety. As such, planking works need to be done for shallow dig-ups.

A building only requires support if there exists a possibility that it will collapse. This possibility arises either because the structure support has deteriorated to a dangerous extent or because the support is to be removed in the course of proposed building operations.

The loss of support due to deterioration arises, most commonly, as foundation failure due either to faulty assessment of the bearing capacity of the soil or to inaccurate or inadequate construction. The support will, firstly, be required to restrain the overturning of any walls which are moving out of plumb, and subsequently may be required in connection with remedial work to the foundation, such as underpinning.
5.2 Planking measurement and installation technique

5.2.1 Good ground

For shallow holes located on good ground, detention wood can be used. It consists of a pair of poling boards (not more than 1 m in length) and placed at a distance of 2 m in diameter. It is supported by shoring also placed at the same distance. The poling boards used is 200 x 38 mm. Figure 3.1 shows the pinchers on good ground.

Figure 5.1: Pinchers in good ground
(Souce:Fig 5.1;Sam, S. (1977), Builders detail sheet series 1 and 2, International Thomson Publishing )
5.2.2 Moderately firm ground

On firm ground, poling board is placed along the hole at a distance of 230 mm measuring 100 x 100 mm from the horizontal wood, will be placed to poling boards and then will be shored. Figure 3.2 shows the open poling in moderately firm ground.

Figure 5.2: Open poling in moderately firm ground

(Source: Fig 5.2; Sam, S. (1977), Builders detail sheet series 1 and 2, International Thomson Publishing)
5.2.3 Loose ground

On loose ground, the banks should be covered using boards which are arranged closely. This is to prevent loose soil from seeping through. Walings is prepared to support the boards. Shoring will be installed between the walings to balance the board. Figure 3.3 shows the close poling on loose ground.

Figure 5.3: Close poling in loose ground

(Source: Fig 5.3; Sam, S. (1977), Builders detail sheet series 1 and 2, International Thomson Publishing)
5.3 Definition of scaffolding

When a building construction reaches a height of 1.5 m from ground level, it is necessary to prepare a temporary support. This is called scaffolding. A scaffolding is built to support several platforms at different heights from the ground. It facilitates workers as they work and assemble the construction materials. When ladders are not considered safe, then scaffolding is necessary.

5.3 Scaffolding materials

The materials used for scaffolding are timber, steel pipe tube and also bamboo. This pipe tube will be connected to the coupler, bolt and clip. Actually, the scaffolding materials are made from either timber, steel or bamboo.

Among the three types of these materials, steel is the most popular because it is stronger and economical. Besides, steel alternatives are easily available in Malaysia.

http://modul2poli.blogspot.com/
1.1 Describe planking measurement at:
   a) Good ground
   b) Moderately firm ground
   c) Loose ground

1.2 Define scaffolding

1.3 List the materials used for scaffolding
   a) 
   b) 
   c) 

http://modul2poli.blogspot.com/
1.1 Planking measurement:-

a) Good ground

For shallow hole at good ground, detention wood can be used. It contained a pair of poling boards which are not more than 1 m long which is placed at 2 m diameter distance and supported with shoring at the same distance. The poling board which is used is 200 x 38 mm.

b) Moderately firm ground

For this type of firm ground also, poling board is put besides the hole at about 230 mm distance. Walings 100 x 100 mm from horizontal wood will also be placed to the poling boards and then will shored.

c) Loose ground

For loose ground, the banks must be closed with boards which are arranged collects closely to avoid the loose ground seeping ground through the board. Walings is prepared to support the board in its place. Shoring will be installed between the walings to make the board balanced. Figure 3.3 show the close poling in loose ground.
1.2 Definition of scaffolding

Scaffolding is a temporary support which must be prepared in building construction that have a 1.5 m height in the ground. Normally the scaffolding is built to support elevated platforms at the different heights from the ground. It is also to facilitate for work to and assemble the construction materials. When ladders are considered unsafe, then scaffolding is used.

1.3 Scaffolding material:-

a) Timber
b) Steel
c) Bamboo

http://modul2poli.blogspot.com/
TEMPORARY SUPPORT

QUESTION 1

Draw and label the following:-

a) Good ground

b) Moderately firm ground

c) Loose ground

http://modul2poli.blogspot.com/
TEMPORARY SUPPORT

ANSWER 1

a) Good ground
b) Moderately firm ground

c) Loose ground
TEMPORARY SUPPORT

CONGRATULATIONS!!!!!
YOU CAN GO ON TO THE NEXT INPUT

http://modul2poli.blogspot.com/
5.4 Types of scaffolding

5.4.1 Putlog scaffold

Putlog scaffold, sometimes called bricklayer’s scaffold, depend for their support on the walls of the buildings on their inner side, and rows of standards on their outer side. The putlog scaffold is made up of eight components namely foundations, standards, ledgers, putlogs, bridle, guardrails, ties and bracing.

a) Foundations

It is essential that a good base is provided for the standards. The ground should be level and well consolidated. Timber soleplates at least 228 mm wide and 38 mm thick should be placed as support for the baseplates for the standards. Soleboards should, wherever possible, parallel to the building, and should support at least two standards. There is a very good reason for this, in that the soleboard will ensure that the load carried by each standard is evenly distributed over a larger area than the baseplate, and prevent the standards sinking into the ground.
b) Standards

Standards should be erected vertically in a row parallel to the wall at intervals of 2 m for a heavy duty putlog, or 2.1 m for a general duty putlog according to the load. The working platform should be wide enough to accommodate five boards, with a gap left between the boards and the wall to allow for a level or plumb line.

c) Ledgers

Ledgers are fixed at approximately 1.37 m intervals to the standards with right-angle couplers. A height of 1.37 m is taken as the most convenient height for bricklayers to work to before becomes necessary to erect a further lift. Only one working platform should be in use at any one time. Ledgers must remain in position as the scaffold is erected higher but if necessary the first ledger may be removed, providing another ledger which is fixed at not more than 1.8 m from the ground.

d) Putlogs

Putlogs are fixed with one end to the standard and, at the other end, the blade of the putlog, or adaptor, must rest on the brickwork. The putlog or putlog adaptor must rest ‘flat’ on the brickwork, to a depth of at least 75 mm. On the working platforms, intermediate putlogs are fixed to the ledgers. It may be necessary from time to time to remove the intermediate putlogs, especially when raising the working lift. If so, it is essential to leave the main putlogs in position, secured to the standards with right-angle couplers.
e) Bridle

If a putlog is required opposite an opening in the building face, a bridle should be used. A bridle tube is a length of tube underslung from the inner ends of the putlogs on either side of the opening with right-angle couplers. The intermediate putlog will now be supported by the ledger and bridle tube.

f) Guardrails

Guardrails must be fixed at a height between 914 mm and 1.15 m and toe-boards must be provided. The space between the guardrails and toe-boards must not be greater than 0.75 m. It is important to remember that materials should not be stacked higher than the toe-boards, unless brick-guards or similar are fitted.

g) Ties

The security of the scaffold will depend on the effectiveness of the ties. With a putlog scaffold all ties must be two-way ties.

h) Bracing

The only form of bracing necessary is longitudinal or sway bracing, providing the brace is fixed from the base to the full height of the scaffold and adequately tied. Figure 5.1 shows the putlog scaffolding.
5.4.2 Independent tied scaffold

An independent tied scaffold consist of two rows of standards, each row parallel to the building. The inner row of standards is set as close to the building as practical, or not further away than just enough to allow for an inside board between the inside standards and the building or structure. The distance between the inside standards and the outside standards will be governed by the number of boards which will be required.

Ledgers are fixed to the standards with right-angle couplers and the ledgers, like the standards, are fixed parallel to the building. Transoms are fixed to the ledgers with putlog couplers and the transoms are fixed at right angles to the ledgers.
TEMPORARY SUPPORT

Sway bracing or longitudinal bracing is fixed to the standards or transoms and is fixed across the face of the scaffold.

The self-weight of the scaffold together with any loads on it are transferred to the ground via the standards. The type of load, whether it is a distributed load or a point load of any other loading, may be specifically designed. If no load-rating is quoted by the specification then one should be selected from the Code of Practice table of loads.

The spacing of the standards or the bay length depends on the height and loading of the scaffold. The spacing of the ledgers or the lift height is normally 2 m but in certain circumstances lifts may be greater, provided the standards are capable of supporting the load.

It is generally accepted that there are five types of independent tied scaffold:

a) **Inspection and very light duty**
Inspection and very light-duty scaffold, as the name suggest, should be used for work of a very light nature and is used mainly for inspections, painting, stone cleaning without heavy tools: it should have a maximum of one working platform only. It should be not less than 3 boards wide, have a maximum bay length of 2.7 m and a maximum loading of 75 kg/m² on the one platform.

b) **Light duty**
Light-duty scaffolding is also used for light work, i.e. painting, stone cleaning, glazing, pointing and plastering. It should have a maximum of 2 working platforms, 4 boards wide, a maximum bay length of 2.4 m and a maximum loading of 150 kg/m².

http://modul2poli.blogspot.com/
TEMPORARY SUPPORT

c) General purpose
General-purpose scaffold is, as the name suggests, a general, all-purpose scaffold used by all trades, e.g. brickwork, window fixing, mullion, fixing, rendering, plastering. It should have a maximum of 2 working platforms with a maximum loading of 200 kg/m² plus 1 working platform with a maximum loading of 75 kg/m². It should have a maximum width of 5 boards or 4 boards plus 1 inside board, and a maximum bay length of 2.1m.

d) Heavy duty
Heavy-duty scaffold is used for heavier loads, e.g. brickwork, blockwork, heavy cladding, etc. It should have a maximum of 2 working platforms with a maximum loading of 250 kg/m², plus 1 inspection platform with a maximum of 75 kg/m². It should have a maximum of 5 boards or 5 boards plus 1 inside board, or 4 boards plus 1 inside board, and a maximum bay length of 2 m.

e) Masonry or special duty
Masonry/special-duty scaffold is used for masonry, blockwork or very heavy cladding. It should have only 1 working platform with a maximum loading of 300 kg/m² plus 1 inspection platform with a maximum loading of 75 kg/m². It may have a 6 or 8-board wide platform, but must be restricted to a maximum bay length of 1.8 m. Figure 5.2 shows the independent tied scaffold.

http://modul2poli.blogspot.com/
5.4.3 Birdcage scaffold

The birdcage scaffold is so called because of its appearance. It is normally an internal scaffold and is mainly used for ceiling work in churches, large hall, etc. It consists of an arrangement of standards with ledgers and transoms supporting a closely boarded platform at the required level. The side and end bays may also be required to form access scaffolding to the walls supporting the soffit.

Birdcage scaffold is the general term used, but it can be divided into two types:-

a) Birdcages with more than one lift
b) Single-lift birdcages

(Souce: Fig 5.5: Doughty, R. (1986), *Scaffolding*, Longman Group UK Ltd)
a) **Birdcage with more than one lift**

This type of scaffold is a light-duty scaffold, therefore light loads only should be placed on the scaffold: a maximum of 75 kg/m² should be used as a guide, with a maximum standards spacing of 2.5 m in either direction. It is recommended that, apart from the working lifts on the end or outside bays, a birdcage scaffold has only one working lift.

The foundations for a birdcage scaffold must be pitched on steel baseplates, but may require special consideration for different conditions, e.g. if the birdcage has to be erected on a slope, wedge-shaped pieces of timber should be used up to a maximum of 1 in 4 and in some cases it may be necessary to put foot-ties in. In fact it is a good idea to put in as many foot-ties as possible.

Provision must be made for a scaffold that is placed on highly polished wood, mosaic, marble or similar floors. Protective materials should be laid under the soleboards, e.g. tarpaulin sheets, hardboard, etc. Baseplates should be nailed or screwed to the soleboards to prevent movement at the base of the scaffold. Bearing in mind the type of scaffold used, the first lift height should not exceed 2 m and the subsequent lifts should be at 2 m intervals. Ledgers and transoms should be fixed to the standards except, if necessary, at the top lift where transoms may be fixed direct to the ledgers.

Sufficient diagonal bracing is required to ensure stability, i.e. for every alternate pair of standards from the base to the full height of the scaffold in both direction.
TEMPORARY SUPPORT

Birdcage scaffold must be securely tied to columns or the side walls throughout their length and height to prevent movement of the scaffold.

Although it is becoming increasingly popular to leave bracing out of this type of scaffold and extend the ledgers and transoms to butt the walls, great care must be taken to ensure that the scaffold has the facility of internal columns to tie to or at least reveal ties fixed to alcoves or returns. If ledgers and transoms butt the walls plastic tube-caps must be fitted on to the ends of the tubes. Guardrails and toe-boards are necessary when the working platform finishes more than 155 mm from the walls or is higher than 2 m from the ground.

b) Single-lift birdcages

At first glance a single-lift birdcage may look stable; in fact it may be considerably less stable than a multi-lift birdcage. Because it is one lift, some think bracing may be omitted. The following are required to ensure stability:

a) Bracing must be fixed to each corner at least, and every alternate pair of standards in both directions.

b) There must be foot-ties all the way round and internal standards should be foot-tied in pairs in one direction at least.

c) Foot-ties must be fixed to the bottom of the standards to which the bracing is connected.

Needless to say, where possible the scaffold should be box-tied round existing columns and if possible should butt the walls with extended transoms fitted with plastic tube-caps to prevent damage to walls. One final point – it is necessary to stagger the joints in ledgers and transoms. Sleeve couplers are used for this. Figure 5.6 shows the birdcage scaffolding.
5.4.4 Truss-out scaffold

A truss-out scaffold is an independent tied scaffold not erected from the ground but supported by a truss-out scaffolding structure projecting from the face of a building or structure. It is essential that assurances are obtained concerning the ability of the building to support the scaffolding safely. Only right-angle couplers should be used in the construction of the truss-out.

The standards inside the building from which the truss-out is fixed must be strutted between floor and ceiling and firmly secured to prevent displacement – this part of truss-out is usually referred to as the ‘horse’.

Figure 5.4: Birdcage scaffolding
(Source: Fig 5.4: Doughty, R. (1986), Scaffolding, Longman Group UK Ltd)
TEMPORARY SUPPORT

Timber soleplates and headplates must be used to distribute the load. Tubes projecting from the built-up inside scaffold (the horse) are known as needle transoms and must be secured with right–angle couplers and when possible rest on sills and be right up against reveals. The tie tubes must always be fixed at the back of a window or opening with right-angle couplers. The inner and outer ledgers should be fixed to and on top of the needle transoms, with right-angle couplers.

Rakers should be set at an angle of not more than 35 degrees from the vertical and be fixed with right-angle couplers with a check coupler fixed immediately underneath and in contact with the ledger coupler. The raker should be fixed to the outside ledger with a right-angle coupler and the lower end of the raker secured to prevent displacement. The upper end of the raker should be fixed as close to the needle transom as possible.

The unbraced length of rakers should never exceed 3 m. The standards for extending the scaffold vertically are puncheoned off the bottom ledger next to the rakers with right-angle couplers, with a check coupler fixed on top. The scaffold should be erected in accordance with the same recommendations as access scaffolds. The maximum height for a truss-out scaffold is 12 m. The first lift above the truss-out should be tied back to the building. The ties at higher levels should be distributed at the same frequency as for a ground-based independent tied scaffold.
5.4.5 Suspended scaffold

Most people think of suspended scaffolds as cradles and there is some confusion between these terms, so they are worth defining. A cradle is a lightweight scaffold suspended by a fibre rope and pulley block or winch and is used for work of a light nature. The platform is at least 440 mm wide, and any fibre ropes used with pulley blocks are not more than 3 m apart. For simplicity this type of scaffold will be referred to as a manually operated suspended scaffold.

The term ‘suspended scaffold’ has come to mean a power-operated suspended scaffold. Two or more platform are used, suspended one above
TEMPORARY SUPPORT

the other, to meet the need for faster building programmes where more than one working level is needed to follow on with finishings.

Suspended scaffolds are most frequently used for painting, glazing, cladding, scaling, cleaning and any light work on tall buildings or structures above busy streets, or where other obstructions intervene to make it neither feasible nor economic to erect scaffolding from the ground.

There are three major factors in considering the use of suspended scaffolds in preference to traditional scaffolding whether it is tubular or a proprietary system.

a) Economy: a good contractor will always compare the cost of one system against the cost of another system.

a) Versatility of the system: suspended scaffolds may be traversed, raised and lowered, height being virtually irrelevant. Section can be built up to span the perimeter of a structure and stagings can be adapted to meet specific requirements, e.g. two and three-tier stagings for cladding work, underside stagings for underneath hopper heads, sloping stagings for lighthouses, dam faces, etc.

b) Speed of erection: as buildings or structures increase in height, the sheer physical effort of erecting traditional scaffolds. Labour charges and hire charges for traditional scaffolds for high-rise structures can never undercut labour cost and hire charges for power-operated suspended scaffolds.
5.4.6 Slung scaffold

A slung scaffold is suspended at a fixed height either below load-bearing projecting brackets or beams, or from the structural members of a roof or other overhead structure. The suspension may be by tubular members or by lifting gear and wire ropes which are not provided with the means of raising or lowering a suspended scaffold.

The purpose of a wire rope slung scaffold is to provide a working platform for the underside of a structure without restricting movement in the area below. Common applications are for gaining access to the ceilings of large halls, cinemas, bridge soffits, oil rigs, etc.

a) Suspension ropes

It is becoming increasingly popular to use 12 mm high tensile, flexible wire rope with 75 mm soft eye splices in preference to the 9 mm wire rope. Although the safe working load of the wire rope will be specified, it should have a safety factor of six. The ropes must not be fouled or weakened by any part of the structure. This problem can usually be overcome by the use of suitable packing around the suspension points.

The suspension ropes should be secured to the structure with two round turns, and the dead end and the live ends secured with at least two bulldog grips. In some cases it may be necessary to make suitable anchorage points with tubular scaffolding or prefabricated beams.
b) Suspension points

Spacings should be limited to 2.4 m centers, or if the spacings have to be greater than this it is necessary to use prefabricated beams as ledgers with additional suspension ropes.

c) Ledgers

Ledgers hung from the wire ropes either by being passed through soft eye splices in the ends of the wire rope, or with a round turn and two half hitches with the end seized with a minimum of two bulldog grips. A right-angle coupler should be fixed on each side of the eye or hitch to keep the wire rope in place. Joints in ledgers should be made with sleeve couplers and a short tube spliced on with parallel couplers or two universal couplers or, if this is not practical, longer ledgers may be used provided each ledger is underslung from at least two transoms. Transoms should be spaced on the ledgers at intervals to suit the boards in use.

d) Erecting

The contractor must first check the anchorage points to ensure that they are strong enough to carry the weight of the slung scaffold and the load it will carry with due regard to any shock loadings. The scaffoldor should check all his materials for serviceability before use, especially the wire ropes. The ropes should show no sign of kinking, and there should be no broken wires in the lay. Figure 5.6 show the slung scaffolding.
5.4.7 Mobile towers

A mobile tower is a scaffold mounted on wheels or castors. It usually consists of four standards, and is square in construction. It should not have more than one working platform and guardrails and toe-boards must be provided. Access may be gained to the working platform via a ladder or stairway positioned from either the inside or the outside of the structure. A mobile scaffold must only be used for lightweight work, e.g. painters, plumbers etc.
TEMPORARY SUPPORT

The height of the lifts should not exceed 2.7 m or be greater than the minimum spacing between standards. The base lift should be fixed as near to the castors as possible. Bracing should be fixed on all four sides with the bracing at an angle of approximately 45\(^0\) to the horizontal.

No persons, equipment or material should be on the working platform or elsewhere on the structure when it is being moved. The wheel brakes must be secured when the tower is in use.

To avoid instability a mobile tower should only be moved on a firm and level surface. If the ground is uneven or soft it is necessary to lay a temporary foundation or track to make it easier to erect and move the tower.

Towers must be maintained rigid in plan by the use of plan bracing placed at the base lift, every alternate lift, and under the working platform. The tower also should be constructed to support, in addition to its own height and the weight of the scaffold boards, a distributed load of 150 kg/m\(^2\) over the working platform.

When the means of access to the working platform is fixed to the outside of the tower, care should be taken regarding the effect this may have on the stability of the tower. Figure 5.9 shows the mobile tower scaffolding.

http://modul2poli.blogspot.com/
5.5 Safety measures in scaffolding construction

a) Ensure that the materials used are in a good condition and do not have defects.

b) Ensure that the erected structure is in a vertical position. If it is sloping, then it should be inclined towards the building.

c) Foot of erection should be reinforced or a pallet is available to prevent soil movement or sinking.

d) Whenever steel pipes are used, pole should be tightened using bolt and nuts.

e) When joining two floor boards, it is necessary to have a layer of 150 mm in thickness at the end of the boards.
You can test your comprehension by answering the following questions before you go to the next unit. You can check your answers based on the feedback given on the following page.

1.1 List down the types of scaffolding which are normally used in building construction.
1.2 Describe the safety procedure which must be considered in the construction of scaffolding.
1.3 List down the components of putlog scaffold
1.4 List down the types of independent tied scaffold used in building construction
1.5 Describe the use of the birdcage scaffold
1.6 Describe the parts of truss-out scaffold which is usually referred to as the ‘horse’
1.7 Describe the term ‘suspended scaffold’
1.8 Describe the purpose of a wire rope slung scaffold

http://modul2poli.blogspot.com/
You can only go to the self-assessment if you can answer all the questions in this activity.

1.1 Types of scaffolding:-
   a) Putlog scaffolding
   b) Independent tied scaffolding
   c) Birdcage scaffolding
   d) Truss-out scaffolding
   e) Suspended scaffolding
   f) Slung scaffolding

1.2 Safety procedure in scaffolding’s construction
   f) Determine that the use of material is in good condition and don’t have any defect.
   g) Make sure the erected is already in vertical, if slope, it must be to the building faces.

http://modul2poli.blogspot.com/
TEMPORARY SUPPORT

h) The foot erected must be standing to avoid the washed over by water or prepared the pallet to avoid any movement

i) The steel pipe tube must be used carefully so that the erection is bind with bolt and nutt.

j) If want to joint the two floor board, it must be put 150 mm thickness layer at the end of that board.

1.3 Components of putlog scaffolding:-
   a) Foundations
   b) Standards
   c) Ledgers
   d) Putlogs
   e) Bridle
   f) Guardrails
   g) Ties
   h) Bracing

5.5 Types of independent tied scaffold:-
   a) Inspection and very light duty
   b) Light duty
      a) General purpose
      b) Heavy duty
      c) Masonry or special duty

5.6 The birdcage scaffold is normally used for ceiling work in churches, large halls, etc.
TEMPORARY SUPPORT

5.7 The part of truss-out is usually referred to as the ‘horse’ is a fixed part which must be strutted between floor and ceiling and firmly secured to prevent displacement.

5.8 The term ‘suspended scaffold’ means a power-operated suspended scaffold. Two or more platform are used, suspended one above the other, to meet the need for faster building programmes where more than one working level is needed to follow on with finishings.

5.9 The purpose of a wire rope slung scaffold is to provide a working platform for the underside of a structure without restricting movement in the area below. Common applications are for gaining access to the ceilings of large halls, cinemas, bridge soffits, oil rigs, etc.

WELL DONE!!!!
YOU CAN GO TO THE SELF-ASSESSMENT SECTION

http://modul2poli.blogspot.com/
The birdcage scaffold can be divided into two types. Describe both of them.

Describe three major factors in considering the use of the suspended scaffold.

Describe five types of independent tied scaffolds.
You can go to the next unit if you can answer all the question.

**ANSWER 1**

The birdcage scaffold can be divided into two types such as:-

a) **Birdcage with more than one lift**

This type of scaffold is a light-duty scaffold, therefore light loads only should be placed on the scaffold: a maximum of 75 kg/m² should be used as a guide, with a maximum standards spacing of 2.5 m in either direction. It is recommended that, apart from the working lifts on the end or outside bays, a birdcage scaffold has only one working lift.

The foundations for a birdcage scaffold must be pitched on steel baseplates, but may require special consideration for different conditions, e.g. if the birdcage has to be erected on a slope, wedge-shaped pieces of timber should be used up to a maximum of 1 in 4 and in some cases it may be necessary to put foot-ties in. In fact it is a good idea to put in as many foot-ties as possible.

http://modul2poli.blogspot.com/
Provision must be made for scaffold that is placed on highly polished wood, mosaic, marble or similar floors. Protective material should be laid under the soleboards, e.g., tarpaulin sheets, hardboard, etc. Baseplates should be nailed or screwed to the soleboards to prevent movement at the base of the scaffold. Bearing in mind the type of scaffold used, the first lift height should not exceed 2 m and the subsequent lifts should be at 2 m intervals. Ledgers and transoms should be fixed to the standards except, if necessary, at the top lift where transoms may be fixed direct to the ledgers.

b) **Single-lift birdcages**

At first glance a single-lift birdcage may look stable; in fact it may be considerably less stable than a multi-lift birdcage. Because it is one lift, some think bracing may be omitted. The following are required to ensure stability:

i) Bracing must be fixed to each corner at least, and every alternate pair of standards in both directions.

ii) There must be foot-ties all the way round and internal standards should be foot-tied in pairs in one direction at least.

iii) Foot-ties must be fixed to the bottom of the standards to which the bracing is connected.

Needless to say, where possible the scaffold should be box-tied round existing columns and if possible should butt the walls with extended transoms fitted with plastic tube-caps to prevent damage to walls. One final point – it is necessary to stagger the joints in ledgers and transoms. Sleeve couplers are used for this.

http://modul2poli.blogspot.com/
The three major factors in considering the use of suspended scaffolds in preference to traditional scaffolding whether it is tubular or a proprietary system is as following:-

a) Economy: a good contractor will always compare the cost of one system against the cost of another system.

b) Versatility of the system: suspended scaffolds may be traversed, raised and lowered, height being virtually irrelevant. Section can be built up to span the perimeter of a structure and stagings can be adapted to meet specific requirements, e.g. two and three-tier stagings for cladding work, underside stagings for underneath hopper heads, sloping stagings for lighthouses, dam faces, etc.

c) Speed of erection: as buildings or structures increase in height, the sheer physical effort of erecting traditional scaffolds. Labour charges and hire charges for traditional scaffolds for high-rise structures can never undercut labour cost and hire charges for power-operated suspended scaffolds.
Five types of independent tied scaffolds are as:-

a) Inspection and very light duty scaffolds

Inspection and very light-duty scaffold, as the name suggest, should be used for work of a very light nature and is used mainly for inspections, painting, stone cleaning without heavy tools: it should have a maximum of one working platform only. It should be not less than 3 boards wide, have a maximum bay length of 2.7 m and a maximum loading of 75 kg/m² on the one platform.

b) Light duty

Light-duty scaffolding is also used for light work, i.e. painting, stone cleaning, glazing, pointing and plastering. It should have a maximum of 2 working platforms, 4 boards wide, a maximum bay length of 2.4 m and a maximum loading of 150 kg/m².

c) General purpose

General-purpose scaffold is, as the name suggest, a general, all-purpose scaffold used by all trades, e.g. brickwork, window fixing, mullion, fixing, rendering, plastering. It should have a maximum of 2 working platforms with a maximum loading of 200 kg/m² plus 1 working platform with a maximum loading of 75 kg/m². It should have a maximum width of 5 boards or 4 boards plus 1 inside board, and a maximum bay length of 2.1m.

http://modul2poli.blogspot.com/
d) **Heavy duty**

Heavy-duty scaffold is used for heavier loads, e.g. brickwork, blockwork, heavy cladding, etc. It should have a maximum of 2 working platforms with a maximum loading of 250 kg/m², plus 1 inspection platform with a maximum of 75 kg/m². It should have a maximum of 5 boards or 5 boards plus 1 inside board, or 4 boards plus 1 inside board, and a maximum bay length of 2 m.


e) **Masonry or special duty**

Masonry/special-duty scaffold is used for masonry, blockwork or very heavy cladding. It should have only 1 working platform with a maximum loading of 300 kg/m² plus 1 inspection platform with a maximum loading of 75 kg/m². It may have a 6 or 8-board wide platform, but must be restricted to a maximum bay length of 1.8 m.
TEMPORARY SUPPORT

http://modul2poli.blogspot.com/
UNIT 6

TEMPORARY SUPPORT

OBJECTIVES

General Objective  : To be able to understand works related to temporary support such as shoring, staking and installation technique for formwork.

Specific Objectives  : At the end of this unit, you should be able to:-

- define shoring
- describe types of shoring, installation technique, part of shoring and uses of shoring.
- define staking
- understand staking techniques
- explain installation technique for formwork
- describe formwork shoring technique for beams, columns and floors.

http://modul2poli.blogspot.com/
6.1 Introduction

By far the most common use of temporary support is as a provision to allow the removal of all or part of an element in the building fabric. Other works giving rise to the need for temporary support are demolitions where the removal of a building has weakened an adjoining structure, or where it is proposed to move a building bodily from one position to another when shoring will be required not only to support the building on the moving platform but also to prevent it distorting on its journey. Whatever the reason, the provision of shoring is a highly skilled craft and must be installed by someone with experience.

6.2 Definition of shoring

Shoring is designed to consider the loads and stresses of a building or found to be acting through specific points in the structure. Accurate analysis is essential, otherwise a shoring system may be erected for instance against the middle of a wall. There are instances where by the support just restrains the center section whilst the two ends continue to collapse.

Actually shoring is built to avoid the wall from collapsing, given a load. If one brick is supported, it will support two above it and they, in turn, will support three above them and so on, the amount of wall being supported increases in each course until the bonding

http://modul2poli.blogspot.com/
TEMPORARY SUPPORT

is interrupted by an opening or the end of the wall. So shoring is needed in each building construction to stabilize the wall structure.

6.3 Types of shoring

They are three types of shoring which are normally used in building construction such as:

6.3.1 Dead shores

These are the most common and are used whenever the permanent support is to be taken away. Each must be individually designed but all dead shores consist of a horizontal beam called a needle which takes the load and two struts, one each end, to transfer the load from the needle to the ground or other stable surface capable of carrying it.

http://modul2poli.blogspot.com/
Figure 6.1 (a) shows a dead shoring system in a brick wall preparatory to cutting a large opening and it can be seen that it is necessary to ensure the struts have a firm foundation, even to the extent of removing some of the ground floor, if it is of suspended timber construction, to obtain a bearing on the oversite concrete below. To limit the length of the needle and thus reduce the bending stresses, the props should be as close as possible while allowing adequate working space. The spacing of the needles will be dictated by the loads to be supported and the nature and condition of the wall. The maximum distance apart is usually 2.0m.

Figure 6.1 shows structural softwood needles and props and this is the material most commonly used because of the ease of fixing and a good strength/weight ratio, but a convenient alternative is steel needles either on timber struts or supported by steel expanding props or scaffolding. Whichever method is employed provision must be made to tighten the needles up against the points of support.

In the case of steel props this is achieved by a screwed thread jacking system but with timber the traditional arrangement of folding wedged is employed, whereby two wedges of complementary angles are driven one over the other below the foot of the strut thus increasing the distance between their horizontal faces and tightening the dead shore (see fig 6.1 c). Driving the wedges in the opposite direction released the pressure and permits easy removal. Figure 6.1b shows a similar dead shore arrangement applied to a column prior to work on the foundation.
Figure 6.1: Dead shores
(Source: Fig 6.1: Chudley, R. (1985), Building Site Work, Substructure and Plant, London and New York)

http://modul2poli.blogspot.com/
6.3.2 Raking shores

These are shown in figure 6.2 and are mainly intended to restrain the horizontal movement of a wall but will also take some of the dead weight as well. They are used either where a building failure has already occurred and the structure has moved or where building operations may affect the stability of the wall. In the latter case they may be used in conjunction with dead shores.

The angle of rake will, in many cases, be restricted by the space available but, to obtain the most efficient system, the lowest raker should be set at about 45 degree to the horizontal. At the top end the rakers fit to the underside of a short needle let into the wall and passing through the wall plate. Strengthening is provided by a cleat fixed into the wall plate.

The position and angle of the raker must be so arranged that its axis intersects the center line of any imposed load or, if no load is imposed, the center line of the wall and floor, as shown in figure 6.2. Tightening of the rakers is achieved by levering them down the sole plate which is arranged so that the angle it makes with the rakers never exceed 89 degree.
6.3.3 Flying shores

When the need for temporary support arises because of the removal of a building in a row such as the demolition of a mid-terrace house, where the feet of raking shores would obstruct operations and a wall of adequate strength is convenient, flying shores should be used. This form of support is shown in figure 4.3 and is totally independent of the ground. For this reason this system can only restrain lateral movement and dead shores must be inserted if a vertical load is to be carried as well.
TEMPORARY SUPPORT

Figure 6.3: Flying shores

(Source: Fig 6.3: Chudley, R. (1985), Building Site Work, Substructure and Plant,
London and New York)
Please test your comprehension by answering the questions.

1.1 Define shoring

1.2 List the types of shoring

   a) __________________________

   b) __________________________

   c) __________________________

1.3 Described the use of the following shoring:

   a) Dead shores

   b) Ranking shores

   c) Flying shores
1.1 Shoring is designed to consider the loads and stresses of a building or found to be acting through specific points in the structure. Accurate analysis is essential, otherwise a shoring system may be erected for instance against the middle of a wall. There are instances where by the support just restrains the center section whilst the two ends continue to collapse.

1.2 Types of shoring:
   a) Dead shores
   b) Ranking shores
   c) Flying shores

1.3 Uses of shoring
   a) Dead shores

These are the most common and are used whenever the permanent support is to be taken away. Each must be individually designed but all dead shores consist of a horizontal beam called a needle which takes the load and two struts, one each end, to transfer the load from the needle to the ground or other stable surface capable of carrying it.

http://modul2poli.blogspot.com/
b) **Raking shores**

Raking shores are used either where a building failure has already occurred and the structure has moved or where building operations may affect the stability of the wall. In the latter case they may be used in conjunction with dead shores.

c) **Flying shores**

When the need for temporary support arises because of the removal of a building in a row such as the demolition of a mid-terrace house, where the feet of raking shores would obstruct operations and a wall of adequate strength is convenient, flying shores should be used.
TEMPORARY SUPPORT

SELF-ASSESSMENT

QUESTION 1

Draw and label the following types of shoring:

a) Dead shores
b) Ranking shores
c) Flying shores

QUESTION 2

Describe the installation technique for ranking shores
a) Dead shores

http://modul2poli.blogspot.com/
b) Ranking shores

http://modul2poli.blogspot.com/
c) Flying shores

The angle of rake will, in many cases, be restricted by the space available but, to obtain the most efficient system, the lowest raker should be set at about 45 degree to the horizontal. At the top end the rakers fit to the underside of a short needle let into the wall and passing through the wall plate. Strengthening is provided by a cleat fixed into the wall plate.

http://modul2poli.blogspot.com/
6.4 Definition of staking

The words ‘shoring’ and ‘staking’ are always used together because they refer to the same work. Actually, shoring is refers to the temporary support which will be dismantled once work is completed but staking refers to the permanent support which will remain in place when work is completed. Basically, shoring work should be done prior to staking.

6.4.1 Reasons For Structure Shoring/Staking.

1) When structure movement occurs due to damage or insufficient foundation caused by:-
   a) big roots nearby (causing damaged to the pad foundation)
   b) vibrations by heavy machineries (operating near the structure)
   c) soil depreciation as a result of mining activities or erosion

2) When too much load is present in a building, reinforcement of the the foundation is necessary. Example: a single storey building is to be renovated into a double storey building or enlarged. The foundation for the new structure needs reinforcement. Dead shores should be used together with other related supports.

http://modul2poli.blogspot.com/
3) A deep foundation construction near the original building requires shoring and staking. Dead shores should be used at the present building to support the upper part of the building. After the piles are fixed firmly around the building, dead shores will be fixed away from the building. Jointing equipment is used to hold the lower part of the wall and foundation. A new foundation will be laid and thus brick work is carried out to build a new wall.

6.5 Formwork

Concrete structure needs temporary shore and formwork to make the concrete mould the concrete until it becomes hard enough. Formwork can be made from timber, steel and also plastic. Actually, timber is usually used in most construction work because this material has its own advantages. Timber is also easier to use and to install. For each building construction, the formwork’s cost can attain 20 – 75 % of the total construction cost.

To get good faces, formwork must only be used one. The defect of formwork will influence the concrete faces. The use of timber for formwork is more economical if use not more than, four times. If want to be used the many time in each construction, a steel formwork is more suitable. Actually, steel is a durable material. Sometimes, both materials (timber and steel) are also used at the same time.

Timber which is used as formwork is to arrest the wet concrete until it becomes hard enough. If the timber is of low quality, formwork will expand and bend when it absorbs water from the concrete. From this situation, it becomes a honeycomb. If the timber is slightly wet, the timber will shrink estranged.

http://modul2poli.blogspot.com/
TEMPORARY SUPPORT

6.5.1 Opening the formwork

Formwork must be opened slowly without any effect or great shock to avoid any damage to concrete structure faces. Before opening the whole formwork, it is better to open part of the formwork to ensure the concrete structure is hard enough. The minimum period to dismantle the formwork is shown below:

<table>
<thead>
<tr>
<th>Part of formwork</th>
<th>Normal cement</th>
<th>Hardly cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side of wall, column log (branch)</td>
<td>3 days</td>
<td>2 days</td>
</tr>
<tr>
<td>Staking to floor</td>
<td>10 days</td>
<td>5 days</td>
</tr>
<tr>
<td>Staking to branch</td>
<td>21 days</td>
<td>8 days</td>
</tr>
<tr>
<td>Side of branch (take off staking)</td>
<td>8 days</td>
<td>5 days</td>
</tr>
<tr>
<td>Side of floor (take off staking)</td>
<td>4 days</td>
<td>3 days</td>
</tr>
</tbody>
</table>

6.5.2 Technique used for to shoring the formwork for beam, column and floor.

6.5.2.1 Formwork for column

Normally, column is built to support beam at each floor. Formwork has a board called ‘sheeting’. Sheetting is arranged and installed in vertical condition depending on the column form whether circular, rectangular and so on. Actually, the thickness of sheeting is 1”, 1 ¼”, 1 ½” and this board is installed together with the cleats. Formwork is consolidated with yokes at different distances based on the sized and column height. Cleats are needles to sheeting which become a staircase. For the column, it needs two staircases which are installed in opposite direction. After that, yokes are installed through this staircase. The following figure 4.1 is shows the formwork for column.

http://modul2poli.blogspot.com/
6.5.2.2 Formwork for floor

Floor can be divided into beams and slabs. Formwork for beams is a form which has two borders which are called side shutter and soffit. It is similar to the form for column which has the cleat. The thickness of the board is 1” – 1 ½” and the thickness of the soffit is 1 ¾” – 2”. For the side shutter, it can also use the layer board. Formwork is supported by props, where the distance of props is based on the size and height of props, load and quality of timber used.
The horizontal part at the props is called the head tree or cross head transome. The needles at the top props and brace are installed in the opposite direction. Props is also supported by solepiece to disseminate the load. Formwork for concrete floor is like a timber floor which has the boarding or decking. It is supported by joist and bearer. The thickness of decking is 1 ¼” to 1 ½” and the joist size also is 4” – 9” x 2” or 9” x 3” or 9” x 4”. Joist is supported on the bearer with needles beside the shuttlers. The purposed is to make the work easier and stable. Figure 4.5 shows the formwork for floors.

Figure 6.5: Formwork for floors

(Source: Fig 6.5: Nota Politeknik)
6.5.2.3 Formwork for Wall

Besides the column and floor, formwork is also used for walls. Usually, this formwork use the twin soldiers which are screwed with ‘H’ type clamp and ‘L’ bolt. The following figure (figure 6.6) shows the formwork for walls.

![Formwork for Wall](http://modul2poli.blogspot.com/)

**Figure 6.6: Formwork for wall**

(Source: Fig 6.6: Nota Politeknik)
6.5.3 The condition of formwork firmness

a) Good jointing will enable water to flow out.
b) To get good quality concrete, formwork should be made of material that does not absorb water.
c) Formwork should have accurate measurement.
d) It should be easily dismantled.
e) It can be used again.
Please test your comprehension by answering the questions below before you continue with the next unit. You can check the answers based on the feedback given on the next page.

1.1 Define staking

1.2 List out the condition of formwork firmness

a) 

b) 

c) 

d) 

e) 

f) 

g) 

http://modul2poli.blogspot.com/
TEMPORARY SUPPORT

1.3 Describe formwork opening method

http://modul2poli.blogspot.com/
You only can go to the self-assessment part if you have answered all the questions given in the activity page.

1.1 The word of ‘shoring’ and ‘staking’ is always used together because it referred to the same work. Actually, shoring is referred to the temporary support which take off after the work is completed but staking also is referred to the permanent support which will live at their place although the work completed. Basically, before carried out the staking work, the shoring work must be carried out first.

1.2 The condition of firmwork firmness are :-

a) Firm to support the dead load which stand from concrete and movement load as workers and equipment.

f) Determined to make a concrete to compress with jolt equipment. So formwork must be effort to arrest any movement.

g) Good jointing to avoid the concrete’s water is flow out.

h) Formwork must be unpermeable water to get a good quality of concrete.

i) Have a true measure

j) Easier to take off

k) Can re-used after the formwork is take off.
1.3 Firmwork opening method

Formwork must be opened slowly without any effect or great shock to avoid any damage to concrete structure faces. Before opened the whole formwork, it better to open apart from that to ensure the concrete structure is enough hardly. The minimum period to take off the formwork is such as the following table:

<table>
<thead>
<tr>
<th>Part of formwork</th>
<th>Normal cement</th>
<th>Hardly cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side of wall, column ang log (branch)</td>
<td>3 days</td>
<td>2 days</td>
</tr>
<tr>
<td>Staking to floor</td>
<td>10 days</td>
<td>5 days</td>
</tr>
<tr>
<td>Staking to branch</td>
<td>21 days</td>
<td>8 days</td>
</tr>
<tr>
<td>Side of branch (un take off staking)</td>
<td>8 days</td>
<td>5 days</td>
</tr>
<tr>
<td>Side of floor (un take off staking)</td>
<td>4 days</td>
<td>3 days</td>
</tr>
</tbody>
</table>

http://modul2poli.blogspot.com/
TEMPORARY SUPPORT

SELF-ASSESSMENT

QUESTION 1

Describe formwork shoring technique for:-

a) Column

b) Floor

c) Wall

QUESTION 2

Draw the formwork for column, wall and floor and label the drawing.

http://modul2poli.blogspot.com/
TEMPORARY SUPPORT

a) Column

Normally, column is built to support beam at each floor. Formwork has a board called ‘sheeting’. Sheeting is arranged and installed in vertical condition depending on the column form whether circular, rectangular and so on. Actually, the thickness of sheeting is 1”, 1 ¼”, 1 ½” and this board is installed together with the cleats. Formwork is consolidated with yokes at different distances based on the sized and column height. Cleats are needles to sheeting which become a staircase.

For the column, it needs two staircases which are installed in opposite direction. After that, yokes are installed through this staircase. The following figure 4.1 is shows the formwork for column.

b) Floor

Floor can be divided into beams and slabs. Formwork for beams is a form which has two borders which are called side shutter and soffit. It is similar to the form for column which has the cleat. The thickness of the board is 1” – 1 ½” and the thickness of the soffit is 1 ¾” – 2”. For the side shutter, it can also use the layer board. Formwork is supported by

http://modul2poli.blogspot.com/
TEMPORARY SUPPORT

props, where the distance of props is based on the size and height of props, load and quality of timber used.

The horizontal part at the props is called the head tree or cross head transome. The needles at the top props and brace are installed in the opposite direction. Props is also supported by solepiece to disseminate the load. Formwork for concrete floor is like a timber floor which has the boarding or decking. It is supported by joist and bearer. The thickness of decking is 1 ¼” to 1 ½” and the joist size also is 4” – 9” x 2” or 9” x 3” or 9” x 4”. Joist is supported on the bearer with needles beside the shuttlers. The purposed is to make the work easier and stable. Figure 4.5 shows the formwork for floors.

c) Wall

Beside the column and floor, formwork also used for wall. Usually, this formwork used the twin soldiers which skrued with ‘H’ type clamp and ‘L’ bolt.

http://modul2poli.blogspot.com/
a) Formwork for column

b) Formwork for floor
TEMPORARY SUPPORT

c) Formwork for wall

WELL DONE!!!!!!
YOU CAN GO ON TO THE NEXT UNIT

http://modul2poli.blogspot.com/
General objective: To know the types and functions of each plant equipment employed in the construction industry.

Specific objectives: At the end of this unit you should be able to:

◇ define plant equipment in construction
◇ state the types of plant equipment which are used in construction
◇ describe the functions of the following:-
  a) foundation site preparation plant equipment
  b) moving excavating machine
  c) water pump
  d) piling crane
◇ explain the types of plant transportation and plant equipment.
7.1 Introduction

Man as the builder has sought to develop mechanical devices to facilitate his work in adapting the earth to serve the needs and desires of mankind. From the crude construction equipment utilized by ancient people has envolved the modern construction equipment used in buildings today, highways, airports, utility systems, factories, stores and housing. The movement of materials around and between building sites can be very time-consuming and non-productive; therefore wherever economically possible most contractors will use some form of mechanical transportation.

7.2 Definition of plant equipment

Plant equipment is a heavy machine which is used in any construction. The choice of system in transporting material from the loading point depends on many factors such as:-

a) Site conditions
b) Volume of material
c) Type of material
d) Time available
7.3 Types of plant equipment

7.3.1 Foundation site preparation’s plant equipment (Excavator)

There are many types of plant equipment which are normally used to excavate at the site such as excavating holes, drains etc. There are many types of excavators. Some of the popular excavators are the back hoe, dragline and general excavators.

Back hoe is normally used for digging trenches. The general excavator is a plant which is normally used to dig and load. The size of the general excavator is smaller than the back hoe. Their tyres are made of rubber. It is also very effective for average or small construction industries.

Two examples of excavators are is a excavator plant (figure 7.1) and backhoe (figure 7.2)
Figure 7.1: Excavator
(Source: Fig 7.1; Vallings, H.G. (1975), Mechanization in Building (Second Edition), Applied Science Publishers LTD)

Figure 7.2: Backhoe/loader
(Source: Fig 7.2; Vallings, H.G. (1975), Mechanization in Building (Second Edition), Applied Science Publishers LTD)

http://modul2poli.blogspot.com/
7.3.2 Pump and dewatering plant equipment

When selecting pumps for sites, the use of pumps must be considered as the following operations may be involved:

a) keeping the foundation, pits, etc free from water
b) lowering of the water table below the level of excavation
c) pumping out cofferdams or other large quantities of water
d) supplying water for general purposes
e) supplying water for jetting and sluicing

Pumps for general uses can be grouped as follows:

a) Centrifugal – normal, self-priming, air-operated
b) Displacement – reciprocating, diaphragm
c) Submersible
d) Air-lift

7.3.3 Pile-Driving Plant

When selecting plants equipment for piling, consideration must be given to:

a) the type of sub-soil
b) surface conditions, eg slope of site
c) surface drainage, eg waterlogged conditions
d) obstructions, eg old basements, existing services

The most common types of load dropping tools used in conjunction with the crane-shovel are the skull crackers and the pile drivers. The skull cracker is a heavy weight equipment that is hoisted by the crane and then it is swung or allowed to drop free to perform like a huge sledge hammer.
PLANT EQUIPMENT

The simplest form of pile driver is a drop hammer which uses a similar action as a skill crater to drive piles. The pile driver’s attachment utilizes the crane boom plus adapter plates, leads, catwalk, hammer, a pile cap, and necessary wire rope as illustrated in figure 1.3. Figure 1.4 also show the example of pile driving plant (hydraulic power vibratory driver)

The leads serve as guides for the drop hammer as it is raised and dropped as well as to assist in aligning the pile during driving. The leads are attached to the foot of the boom by braces. They are called catwalks. To reduce energy losses, the hammer is used. It made up of two parts: a head and a drop weight. The head is attached to the end of the hoist line and fastened to drop weights for hoisting up the weight. The pile cap is used to protect the end of the pile from damage by the hammer during driving.

Figure 7.3: Pile driver attachment
(Source: Fig 7.3; Harris, F. (1989), Modern Construction Equipment and Methods, London; Longman)

http://modul2poli.blogspot.com/
7.3.4 Transporting Plant Equipment

7.3.4.1 Dumper

These plant equipment are the most versatile, labour-saving and misused pieces available to the builder for the horizontal movement of materials ranging from bricks to aggregates, sanitary fittings to scaffolding and fluids such as wet concrete.

These diesel-powered vehicles require only an operative and a driver. They can transverse the rough terrain encountered on many building sites. Actually, many sizes and varieties are produced, giving options such as:

http://modul2poli.blogspot.com/
PLANT EQUIPMENT

i) two or four wheel drive
ii) hydraulic or gravity operated container
iii) side or high level discharge
iv) self loading facilities
v) specially equipped dumpers for collecting and transporting crane skips.

Specification for dumpers is usually given by quoting the container’s capacity in litres for heaped, struck and water levels such as shown in figure 7.5.
Figure 7.5: Standard type dumper and diesel dumper

(Source: Fig 7.5; Chudley, R. (1985), *Building Site Work, Substructure and Plant*, London and New York.)

http://modul2poli.blogspot.com/
7.3.4.2 Tractors

a) Crawler Tractors

One of the earliest pieces of selfpowered earthmoving equipment. These types of tractors have excellent all-terrain versatility because of its low ground bearing pressure and excellent traction. Crawler tractors can operate on side slopes up to a gradient 100%.

The track used on crawler tractors consist of linked shoes of heat-treated steel designed to resist wear. The track runs on rollers mounted on the track roller frame. Since track rollers are lubricated and protected by seals to keep out water and abrasives, crawler tractors may operate in water as deep as the height of the track. If it is properly waterproofed, a tractor may be operated for short periods of time in even deeper water.

Figure 7.6: Tractor

http://modul2poli.blogspot.com/
b) Wheel Tractors

Wheel tractors were developed to yield higher speeds in towing scrapers, wagons and other similar equipment. They are available in both 2-wheel and 4-wheel models. Two-wheel models must be operated with specially designed matching components (scrapers) in order to maintain their balance. Four-wheel tractors are available in either 2-wheel or 4-wheel drive models and may be used with any type of equipment.

Wheel tractors may be equipped with dozer blades or any of the other attachments previously mentioned for crawler tractors. However, the wheel tractor’s ability to perform dozing is limited by its traction and comparatively high ground pressure (typically 25 to 35 psi).
In addition to possessing high travel speeds, wheel tractors may operate on paved roads without damaging the surface. Another advantage of the wheel tractor is its ability (because of its high pressure) to assist in compacting soils. Figure 1.7 shows one type of wheel tractor (rubber tired dozer).

![Rubber tired dozer](https://modul2poli.blogspot.com/)

**Figure 7.8: Rubber tired dozer**

### 7.3.4.3 Cranes and hoist

1) **Crane**

A crane may be defined as a device or machine for lifting loads by means of a rope. The use of cranes has greatly increased in the construction industry due mainly to the need to raise large and heavy prefabrication components often used in modern structure. When selecting
the type of crane, the following factors should be considered.

a) access – type of ground over which the crane may travel
b) radius of swing
c) amount of lateral movement
d) whether ‘luffing’ will be required
e) type of plant equipment is being used in conjunction with craneage, eg in concrete plant

The range of cranes available is very wide and therefore actual choice must be made on a basis of sound reasoning, overall economics, capabilities of cranes under consideration, prevailing site condition and the anticipated utilization of the equipment.

A crane is fastened to a specially reinforced scaffold standard, incorporated within the general scaffold framework, with extra bracing to overcome the additional stresses when necessary. The usual maximum lifting capacity of this form of crane is 200 kg.

Cranes can be divided into three types; mobile cranes, derrick cranes and tower cranes.

a) Mobile cranes

Mobile is applied to many types of crane that travel under their own power such as self-propelled wheel or crawler mounted cranes, truck mounted cranes but it excludes tower cranes. Some of the smallest models used in building are those that have power operated hoisting and slewing but hand-operated derricking. These are mounted on four small pneumatic-
tyred wheel, two of which are power driven, giving mobility on hard, near-level, and surface. This type of crane can also be fitted with a vertical tubular mast that supports a short fixed jib.

This crane is suitable for lifting loads onto scaffolds platforms, or to the edge of a building. It has been used for placing lightweight façade panels in position and also for placing roof trusses or light steel framework, working from the ground floor slab within a building. In most mobile cranes all motions are power driven. A vast range of sizes exists, capable of lifting up to 200 tonnes or more. A model is usually classified by the maximum load it is capable of throughout the range of radius and hook height.

b) Derrick cranes

In the guyed derrick, a vertical mast is supported by at least three guy ropes anchored to the ground. The jib is pivoted near the base of the mast and supported by a luffing rope. The mast rotates to provide the slewing action and if the jib is shorter than the mast, full circle slewing is possible. Although this is a cheap form of crane in relation to its lifting capacity, the guy ropes occupy a great deal of space which may be inconvenient, or impossible to find on many building sites.

A difficulty in using this type of crane outside a building is that it occupies a great deal of space on the ground. It can, however, be mounted on rails to give greater coverage, or it may be erected on towers to increase the effective reach of the job over a building, as well as to increase the hook height.
c) Tower cranes

Tower crane is normally used because the main advantage is that the jib is supported at the top of a tall vertical tower. If the type of crane with a jib pivoted close to the ground is used, the jib has to be prevented from fouling nearby walls or scaffolding by elevating the jib, or by standing off at some distance from the structure, or by both these means, with the result that the effective reach over the building is reduced and the higher the building, the more pronounced is this effect.

But with a tower crane, because the entire jib clears the building, the crane can stand in close and the effective reach of the jib is much greater. To give complete coverage for the working area from one side of a building, it is often found that the tower type is the cheapest form of crane, particularly for tall structures. Tower cranes can have a luffing jib, or a fixed horizontal jib with a traversing trolley, commonly known as a saddle jib, for varying the working radius.

2) Hoist

Hoist is a means of transporting material or passengers vertically by means of a moving level platform. Recent designs have been orientated towards the combined materials/passenger hoist.

Materials hoists come in basically two forms, namely the static and mobile models. The static version consists of a mast or tower with the lift platform, either cantilevered from the small section mast or centrally suspended with guides on either side, within an enclosing tower. Mobile hoists should be positioned on a firm level base and jacked to ensure
stability. The operation of a materials hoist should be entrusted to a trained driver who has a clear view from the operating position. Figure 1.8 shows a type of crane namely wheel mounted crane. Figure 1.9 also shows the type of host namely mobile host and figure 1.10 is a material/passenger host.

Figure 7.9: Wheel mounted crane
(Source: Fig 7.9; Holmes, R. (1995), Introduction To Civil Engineering Construction, University of the West of England, Bristol.)

Figure 7.10: Mobile host
(Source: Fig 7.10; Holmes, R. (1995), Introduction To Civil Engineering Construction, University of the West of England, Bristol.)
Figure 7.11: Material/passenger hoist

(Souce:Fig 7.11; Holmes, R. (1995), Introduction To Civil Engineering Construction, University of the West of England, Bristol.

7.3.4.4 Lorries

Transportation to sites of man, machines and materials is usually carried out by using suitably equipped Lorries. Most lorries are designed and developed for building contractors’s use and are powered by diesel. Using diesel is more economical as compare to the petrol engine.

The vast range of lorries produced by leading motor car manufacturers are now available with refinements such as tipping, tailhoist and self-loading facilities using hydraulic lifting gears.

http://modul2poli.blogspot.com/
Figure 7.12: Lorries

(Source: Fig 7.12; Holmes, R. (1995), *Introduction To Civil Engineering Construction*, University of the West of England, Bristol.)

http://modul2poli.blogspot.com/
Please test your comprehension by answering the questions below before you continue with the next unit. You can check the answers based on the feedback given on the next page.

1.1 Define plant equipment.

_________________________________________________________________________
_________________________________________________________________________

1.2 List down the types of plant equipment used in the construction industry.

a) ____________________________________________

b) ____________________________________________

c) ____________________________________________

d) ____________________________________________

1.3 List down the different types of pumps.

a) ____________________________________________

b) ____________________________________________

c) ____________________________________________

d) ____________________________________________
1.4 What are the considerations when you select plant equipment for piling?
   a) 
   b) 
   c) 
   d) 

1.5 List down the types of transporting plant equipment which are used in the construction industry.
   a) 
   b) 
   c) 
   d) 

1.6 Considerations in selecting cranes and hoists are:
   a) 
   b) 
   c) 
   d)
You can go to the next unit if you can answer all the questions.

1.1 Plant equipment are heavy machines which are used in any construction. An equipment should be selected based on the site conditions, volume of material, type of material and time available.

1.2 Types of plant equipment used in the construction industry.
   a)  Foundation’s site preparation plant equipment.
   b)  Pump and dewatering plant equipment
   c)  Pile driving plant equipment
   d)  Transporting plant equipment

1.3 Types of pumps
   a)  Centrifugal
   b)  Displacement
   c)  Submersible
   d)  Air-lift

http://modul2poli.blogspot.com/
1.4 Considerations in selecting plant equipment for piling
   a) Type of sub-soil
   b) Surface conditions, eg slope of site
   c) Surface drainage, eg waterlogged conditions
   d) Obstructions, eg old basements, existing services

1.5 Types of transporting plant equipment.
   a) Dumpers
   b) Tractors
   c) Cranes and hoists
   d) Lorries and truck

1.6 Considerations in selecting cranes and hoists
   a) Access – type of ground over which the crane may travel
   b) Radius of swing
   c) Amount of lateral movement
   d) Whether ‘luffing’ will be required
   e) Type of plant being used in conjunction with craneage, eg concreating plant
You are approaching success. Try all the questions in this Self-Assessment section and check your answers with those given in the feedback on self-assessment on the next page. If you face any problems, discuss it with your lecturer. Good luck.

QUESTION 1

Explain pile’s driver attachment. Sketch the diagram.

QUESTION 2

An excavator is the most important plant equipment which is normally used in foundation’s site preparation work. Explain the types of excavators and draw the tracked loader shover.

QUESTION 3

Explain the following:
   a) material and
   b) mobile hoist.
   Sketch the diagrams for both hoists.
The pile driver’s attachment consist of the crane boom plus adapter plates, leads, catwalk, hammer, a pile cap, and necessary wire or rope as illustrated in figure. The leads serve as guides for the drop hammer as it is raised and dropped as well as to assist in aligning the pile during driving. The leads are attached to the foot of the boom by braces. They called catwalks. To reduce energy losses, the hammer is used it made up of two parts: a head and a drop weight. The head is attached to the end of the hoist line and fastened to drop weights for hoisting up the weight. The pile cap is used to protect the end of the pile from damage by the hammer during driving.

http://modul2poli.blogspot.com/
Back hoe, dragline and general excavators. Back hoe is normally used for digging trenches. The general excavator is a plant equipment which is normally used to dig and load. The size of the general excavator is smaller than the back hoe. Their tyres are made from rubber. It’s also very effective for average or small construction industries.
Materials hoists come in basically two forms, namely the static and mobile models. The static version consists of a mast or tower with the lift platform, either cantilevered from the small section mast or centrally suspended with guides on either side, within an enclosing tower.

Mobile hoists should be positioned on a firm level base and jacked to ensure stability. The operation of a material hoist should be entrusted to a trained driver who has a clear view from the operating position.
PLANT EQUIPMENT

Mobile host

CONGRATULATIONS YOU HAVE DONE WELL!!!!!!

YOU CAN GO ON TO THE NEXT UNIT

http://modul2poli.blogspot.com/