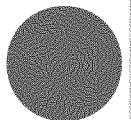


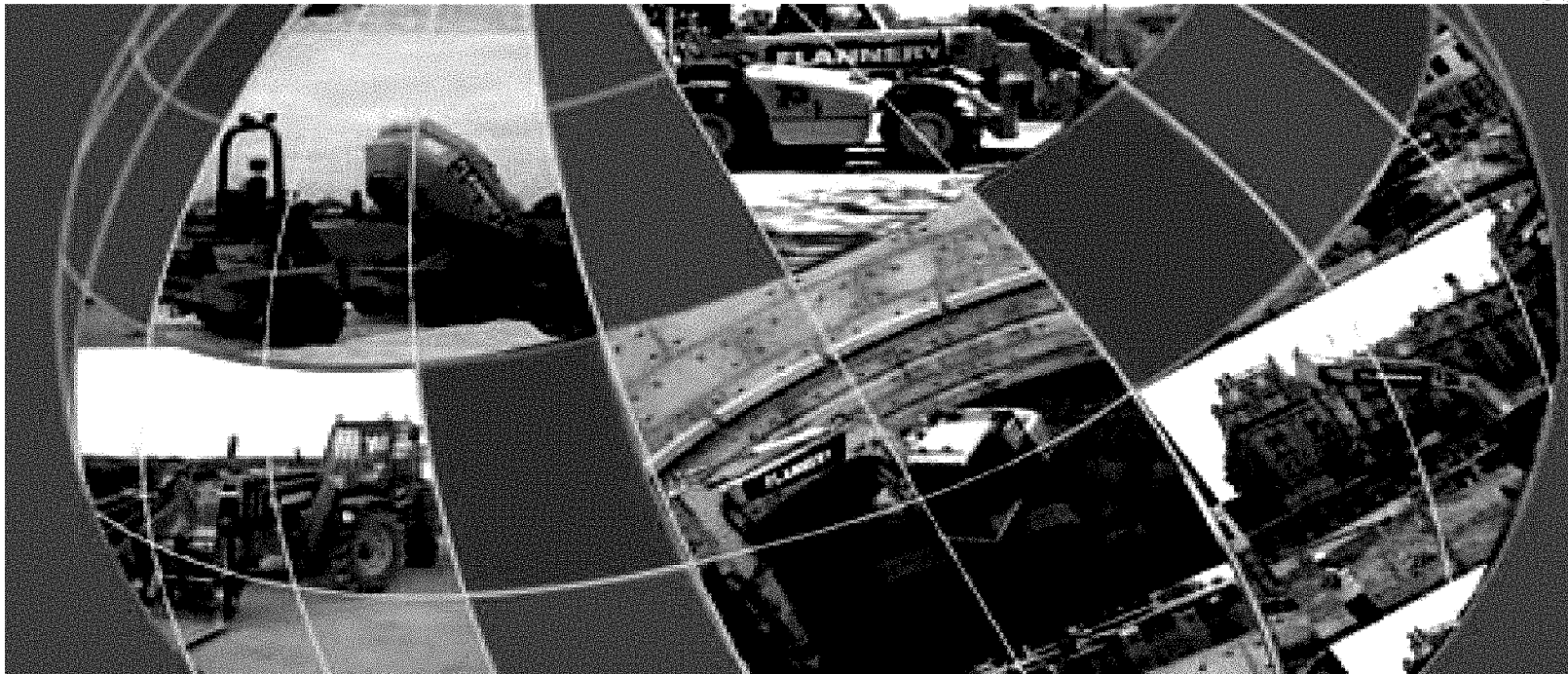
# **CONSTRUCTION TECHNOLOGY & maintenance**

**CEM 417**



# CODE : ECM 417

<b>COURSE</b>	<b>: CONSTRUCTION TECHNOLOGY &amp; MAINTENANCE</b>
<b>PROGRAMME</b>	<b>: BSc (Hons) CIVIL (Infrastructure)</b>
<b>CREDIT UNIT</b>	<b>: 2.0</b>
<b>CONTACT HOURS</b>	<b>: 2 HRS/WEEK (LECTURE)</b>
<b>PART</b>	<b>: 04</b>
<b>PRE-REQUISITE</b>	<b>: NIL</b>



# CONTINUOUS ASSESSMENT

## TEST 1 (30%)

**Introduction, stages for construction, construction plant , temporary work (formwork, scaffold and shoring**

## TEST 2 (30%)

**Temporary works (trench support system, underpinning), permanent work and latest technology**

**Soft Skill + Project Report**

**ASSIGNMENTS**

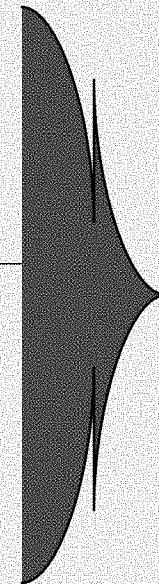
**TOTAL**

**60%**

**30%**

**10%**

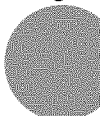
**100%**



# COURSE OUTCOME

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At the end of this course, student should be able to:-

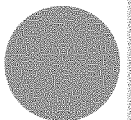
- 1) Explain the various construction processes in construction of building, infrastructures and maintenance.(PO2)
  - 2) Choose and explain suitable construction plants, equipment and machineries used in construction processes and maintenance works.(PO6)
  - 3) Analyze various techniques and problems in construction processes, infrastructure services and maintenance works.(PO6)
  - 4) Show the ability to explain the new technology for sustainable development in the construction industry including infrastructure services and maintenance works. (P10)
- 



# SYNOPSIS

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- ➔ This course covers basic construction techniques, equipments, plants and methods used in construction.
- ➔ This is to enable the students to understand the construction methods, techniques and plants adopted at the site and the considerations made in selecting them



# LESSON PLAN

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Week	Topics	Learning Outcomes	Lecture Hours
1	Introduction to the construction systems	<ul style="list-style-type: none"><li>- Identify the various divisions in construction industry, i.e., vertical construction and horizontal construction. (CO1)</li></ul>	2
	<b>Stages for construction:</b> Building	<ul style="list-style-type: none"><li>- Identify setting out works involve in building construction, i.e., site clearing, setting out and establish the building datum level. (CO1)</li><li>- Identify the accommodations, storage and security requirements during the building construction stage. (CO1)</li><li>- Describe the detail building stages involved during the building construction process. (CO1)</li></ul>	

# LESSON PLAN

---

Week	Topics	Learning Outcomes	Lecture Hours
2	<b>Stages for construction:</b> Retaining wall	- Identify the different types of retaining walls and their respective functions. (CO1; CO3)	2
	<b>Stages for construction:</b> Drainage	- Identify the functions of various subsoil drainage system. (CO1; CO3)	

# LESSON PLAN

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Week	Topics	Learning Outcomes	Lecture Hours
3	<b>Stages for construction:</b> Road & Highway	- Identify the different types of road and highways and their respective functions. (CO1; CO3)	2
	<b>Stages for construction:</b> Bridges	- Identify the functions of various bridges. (CO1; CO3)	

# LESSON PLAN

---

Week	Topics	Learning Outcomes	Lecture Hours
4	<b>Stages for construction:</b> Airports	- Identify the different types of airports and their respective functions. (CO1; CO3)	2
	<b>Stages for construction:</b> Off-shore structure	- Identify the functions of various offshore structure. (CO1; CO3)	



# LESSON PLAN

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Week	Topics	Learning Outcomes	Lecture Hours
5	<b>Stages for maintenance works:</b> Buildings	- Identify the different types of maintenance works for buildings and their respective functions. (CO1; CO3)	2
	<b>Stages for maintenance works:</b> Roads	- Identify the different types of maintenance works for roads and their respective functions. (CO1; CO3)	

# LESSON PLAN

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Week	Topics	Learning Outcomes	Lecture Hours
6	<b>Construction plants :</b> Principles and factors of plant selections Types, functions, capabilities and selection of moving machines.	<ul style="list-style-type: none"><li>- Describe the principles and factors of plant selections. (CO1; CO2; CO3)</li><li>- Identify various types of construction equipments, i.e., moving, stationary, compaction and lifting machines. (CO1; CO2)</li><li>- Identify the types, functions, capabilities and selections of moving machines. (CO2; CO3)</li></ul>	2

# LESSON PLAN

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Week	Topics	Learning Outcomes	Lecture Hours
7	<b>Construction plants :</b> Types, functions, capabilities and selection of stationary and compaction machines. Types, functions, capabilities and selection of lifting machines.	<ul style="list-style-type: none"><li>- Identify the types, functions, capabilities and selections of stationary machines. (CO2; CO3).</li><li>- Identify the types, functions, capabilities and selections of compaction machines. (CO2; CO3).</li><li>- Identify the types, functions, capabilities and selections of lifting machines. (CO2; CO3).</li></ul>	2

# LESSON PLAN

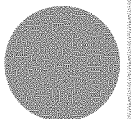
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Week	Topics	Learning Outcomes	Lecture Hours
8	<b>Temporary works :</b> Function, types and construction of formwork	<ul style="list-style-type: none"><li>- Identify the functions of formworks. (CO1; CO3)</li><li>- Explain the requirements of a good formwork. (CO3)</li><li>- Identify the suitable materials and their advantages/disadvantages for formworks. (CO3; CO4)</li></ul>	2
	<b>Temporary works :</b> Function, types and construction of -Scaffolding -Shoring	<ul style="list-style-type: none"><li>- Identify various types and functions of scaffolding and shoring. (CO1; CO3)</li><li>- Identify the suitable materials and their advantages/disadvantages for scaffolding and shoring. (CO3; CO4)</li></ul>	

# LESSON PLAN

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Week	Topics	Learning Outcomes	Lecture Hours
9	<b>Temporary works :</b> Function, types and construction of -Trench Support System -Underpinning	<ul style="list-style-type: none"><li>- Describe the factors affecting the method of selections of trench support system and underpinning. (CO1; CO3)</li><li>- Identify various types and functions of trench support system and underpinning. (CO1; CO3)</li></ul>	2





# LESSON PLAN

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Week	Topics	Learning Outcomes	Lecture Hours
10	<b>Permanent work</b> -Reinforced Concrete Technology	<ul style="list-style-type: none"><li>- Describe the different between plain and reinforced concrete. (CO1)</li><li>- Identify the elements of reinforced structures and their respective functions. (CO1; CO3)</li></ul>	2
	<b>Permanent work</b> - Precast Concrete	<ul style="list-style-type: none"><li>- Explain the benefits of precast technology over traditional construction method. (CO1; CO3; CO4)</li><li>- Identify various types and functions of precast system. (CO3; CO4)</li></ul>	
	<b>Permanent work</b> - Piling - Brick laying	<ul style="list-style-type: none"><li>- Explain various types, functions and factors of selections for piling. (CO1; CO3)</li><li>- Explain the definition, classifications, types and process of bricks. (CO1; CO3)</li><li>- Identify the various types of brickworks bonding, dampness protections and anchorage. (CO1; CO3)</li></ul>	

# LESSON PLAN

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Week	Topics	Learning Outcomes	Lecture Hours
11	<b>Latest Technology</b> IBS GREEN BUILDING GREEN CONSTRUCTION	<ul style="list-style-type: none"><li>- Explain the latest technology, i.e. IBS, Green Building and Green Construction. (CO1; CO3)</li><li>- Explain the functions and factors of selections that techniques (CO1; CO3)</li></ul>	2
12	<b>Latest Technology</b> Trenchless Technology Ground Improvement <b>Submit Project</b>	<ul style="list-style-type: none"><li>- Explain the latest technology, i.e. Trenchless Technology and Ground improvement. (CO1; CO3)</li><li>- Explain the functions and factors of selections that techniques (CO1; CO3)</li></ul>	2

# LESSON PLAN

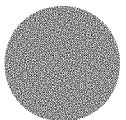
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Week	Topics	Learning Outcomes	Lecture Hours
13	<b>Presentation of project/assignment</b>	Group Presentation	2
14	<b>Presentation of project/assignment</b>	Group Presentation	2

# IMPORTANT DATE

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- **Test 1:** **25/2/2011;8-10pm;Dewan**
- **Test 2:** **8/4/2011;8-10pm;Dewan**
- **Presentation:** **Week 13/14**
- **Assignment 1:** **G: Week 5, S: Week 7**
- **Assignment 2:** **G: Week 9, S: Week 11**
- **Project:** **G: Week 7, S: Week 12**



## ◉ **RECOMMENDED TEXT**

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- Roy, C. and Roger, G. (1999). Construction Technology 3<sup>rd</sup> Edition. Longman Scientific and Technical, United Kingdom

## ◉ **REFERENCES TEXT**

- Roy, C. (1989). Construction Technology Vol. 1,2,3 & 4. Longman Scientific & Technical, United Kingdom
  - Illingworth, J.R. (2000). Construction Methods and Planning. E & FN Spon, United kingdom
  - Kamaruddin, K. (2002). Construction Technology 1. Faculty of Civil Engineering, Universiti Teknologi MARA, Shah Alam, unpublished
- 



# WEEK 1



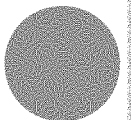
## **Introduction to the Construction System**

# LEARNING OUTCOME

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At the end of week 1 lectures, student will be able to :

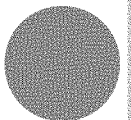
Identify the various groups in construction industry, i.e., vertical construction and horizontal construction. (CO1)



# CONSTRUCTION IN CIVIL ENGINEERING

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- ➔ **construction** is a process that consists of the building or assembling of infrastructure. Far from being a single activity , large scale construction is a feat of multitasking. Normally the job is managed by the project manager and supervised by the construction manager, design engineer, construction engineer or project architect.
- ➔ For the successful execution of a project, effective planning is essential. Those involved with the design and execution of the infrastructure in question must consider the environmental impact of the job, the successful scheduling, budgeting, site safety, availability of materials, logistics, inconvenience to the public caused by construction delays, preparing tender documents,



# 1. BUILDING TECHNOLOGY

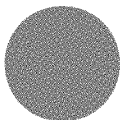
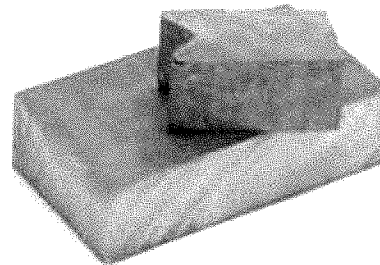
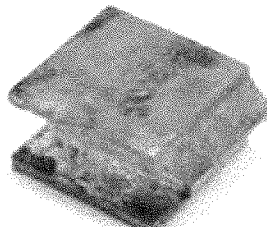
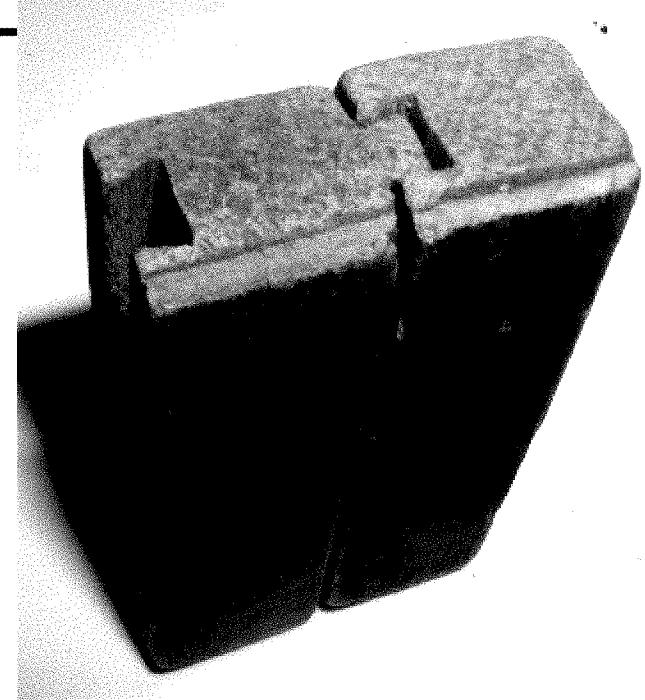
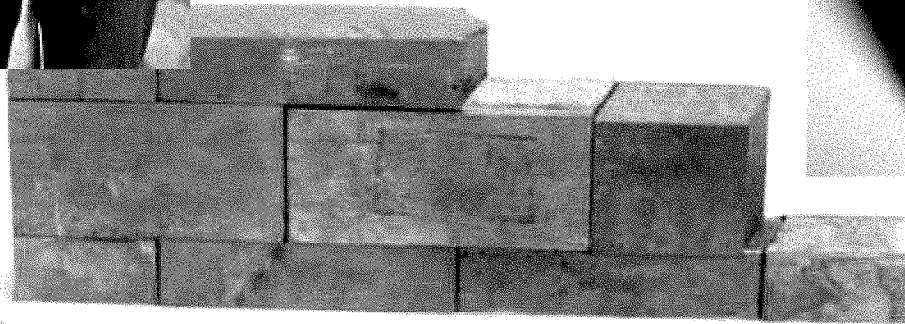
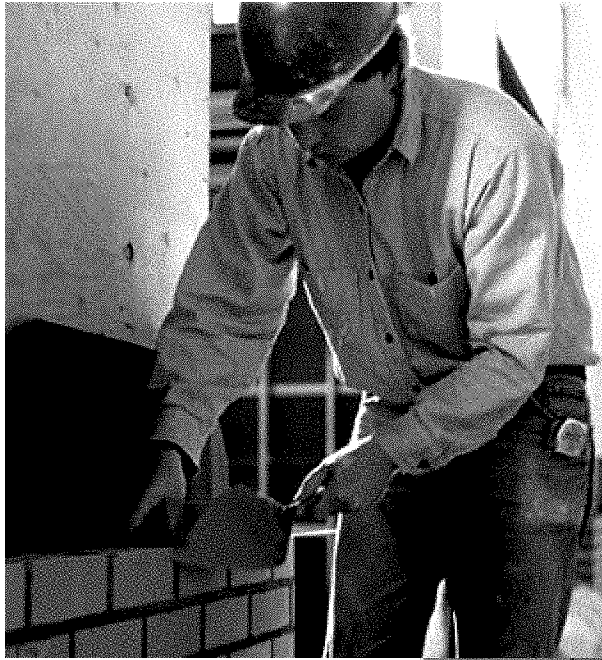
## a. Conventional or Traditional method



b. Modern or Industrialized methods

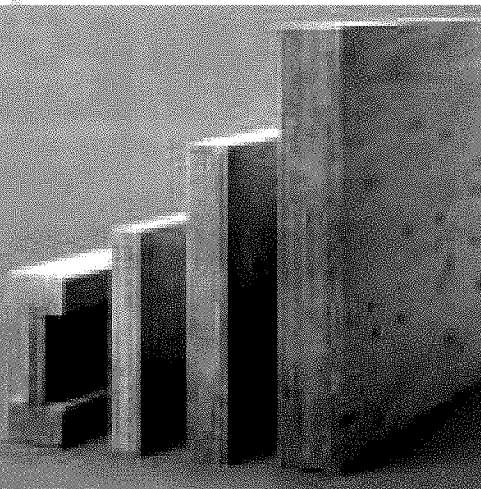
➔ Interlocking brick

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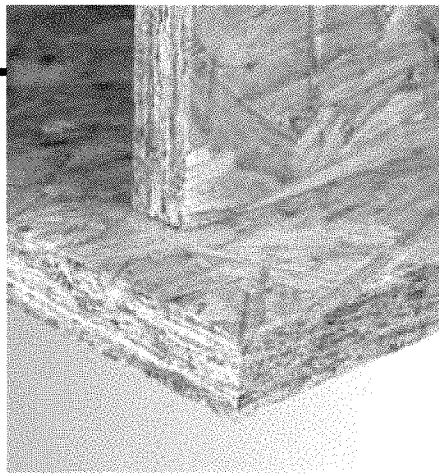




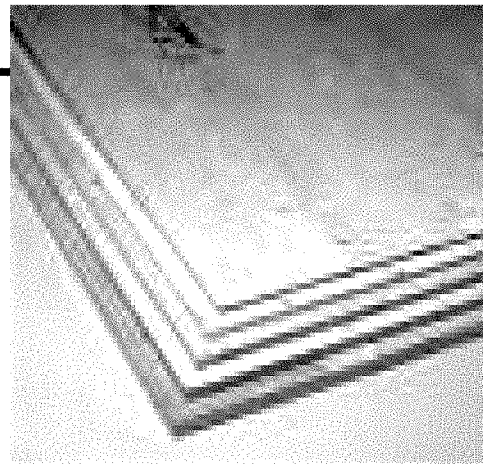
## → Timber composite



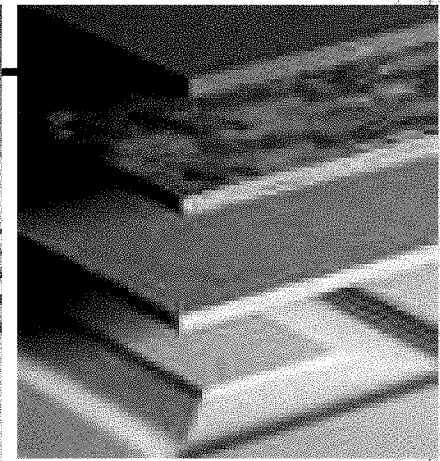
LVL



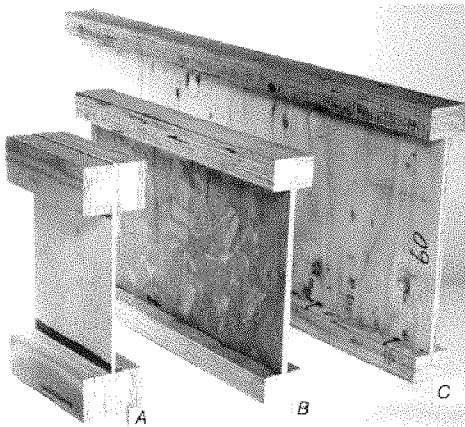
OSB



Plywood



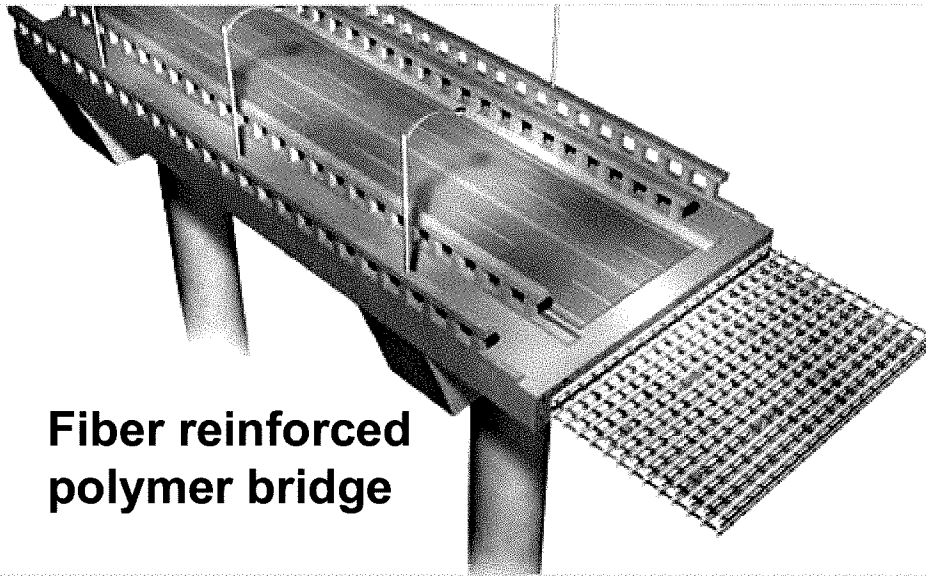
Densified  
board



**Prefabricated I-joists with laminated veneer lumber flanges and structural panel webs. (A) a hardboard web (B) oriented strandboard and (C) plywood webs.**

➔ Polymer composite in the construction of the bridge

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**Fiber reinforced polymer bridge**



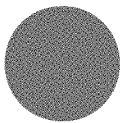
Polymer deck panel



- ➔ steel/RP plates, rods or bolts are bonded into timber with high strength adhesives to produce concealed timber connections.



**Bonded-in rod**





## 2. EQUIPMENT & INSTRUMENT

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➔ Function, types, capabilities and selection



# INTRODUCTION

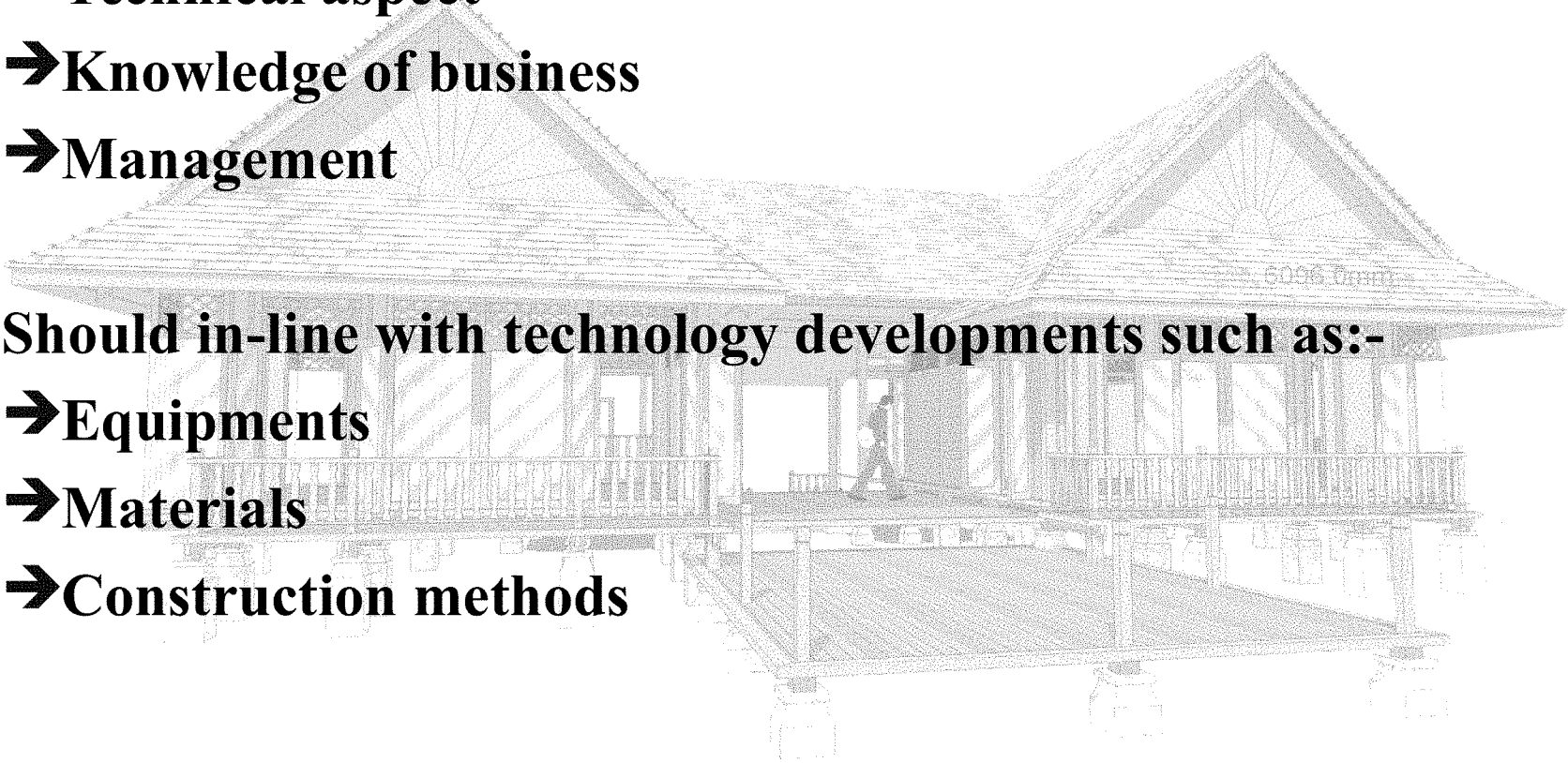
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## Discipline in Construction Industry

- Technical aspect
- Knowledge of business
- Management

Should in-line with technology developments such as:-

- Equipments
- Materials
- Construction methods



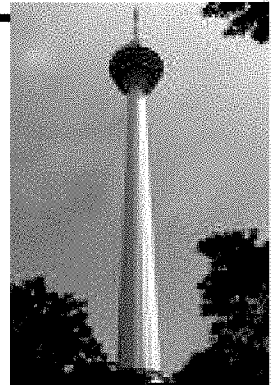
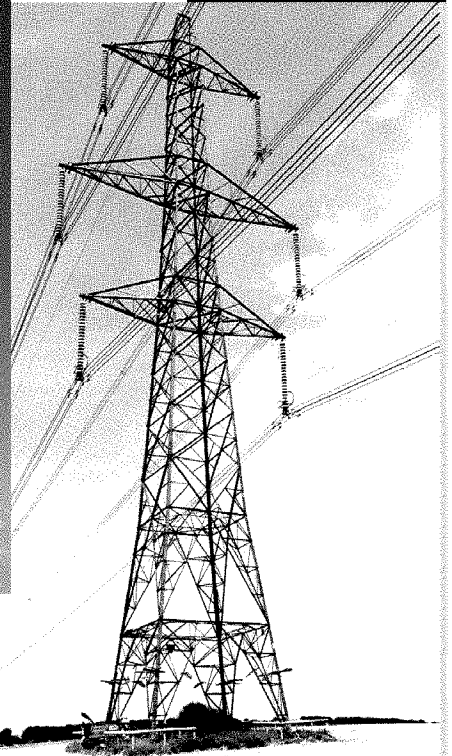
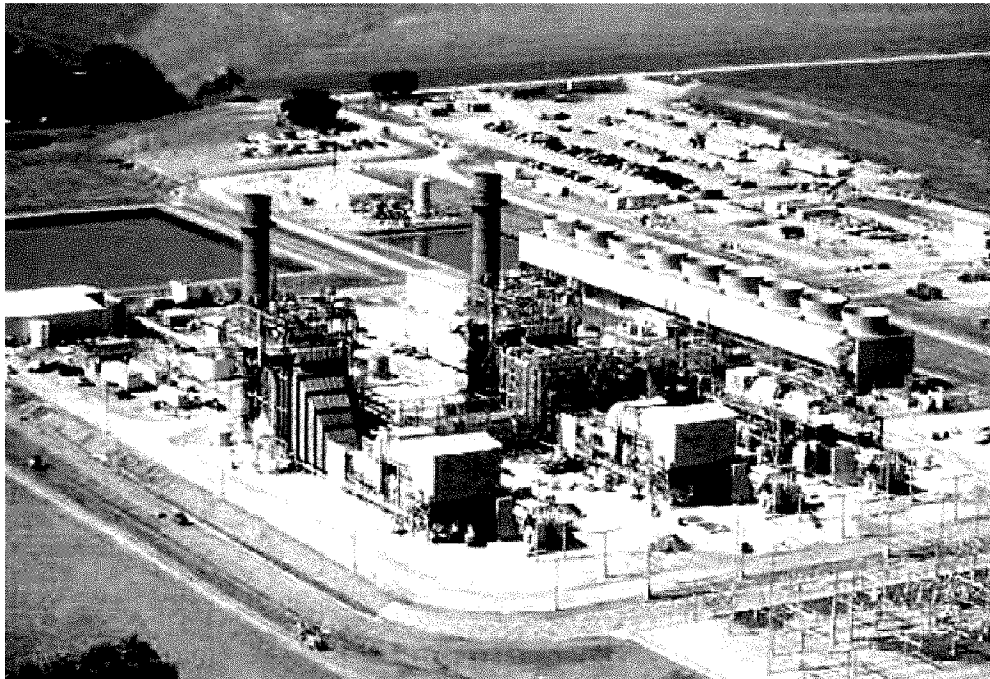
# CONSTRUCTION INDUSTRY GROUP

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Divided into :-

## 1. Building (Vertical Construction)

- Buildings and heavy construction



# CONSTRUCTION INDUSTRY GROUP

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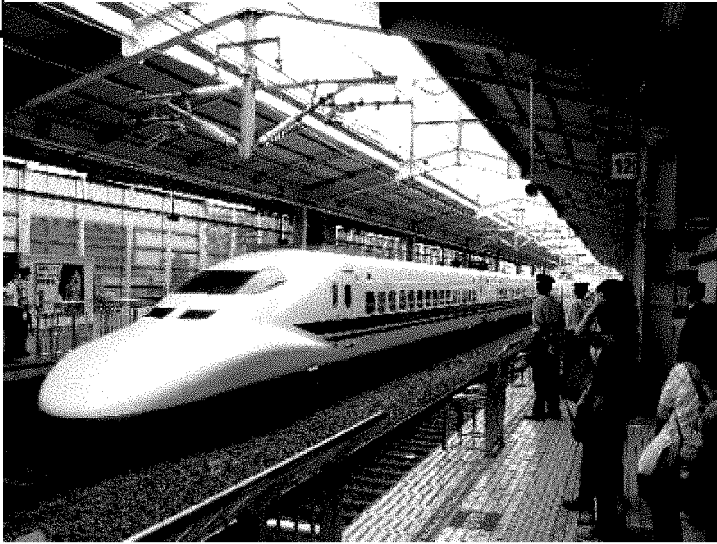
## 2. Civil Engineering (Horizontal construction)

- Highways
- Airports
- Railroads
- Bridges
- Canals
- Dams
- Other major public works

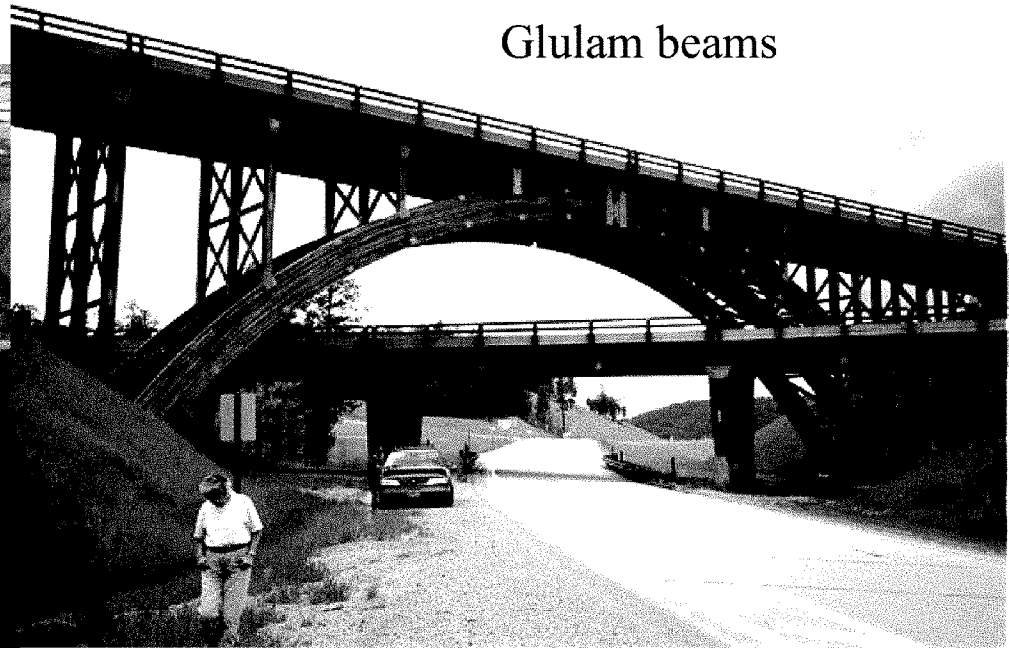




- Different construction technique, technologies and equipments



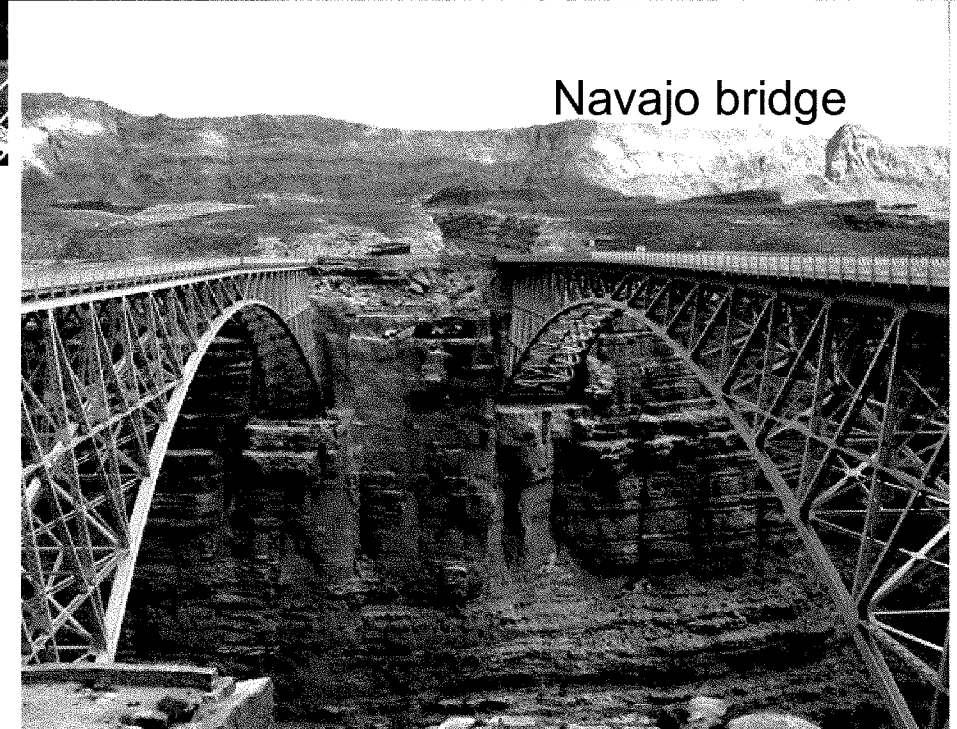
# BRIDGE



Glulam beams



Donghai bridge



Navajo bridge

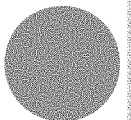
# TYPES OF CONSTRUCTION PROJECTS

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In general, there are three types of construction:

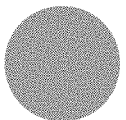
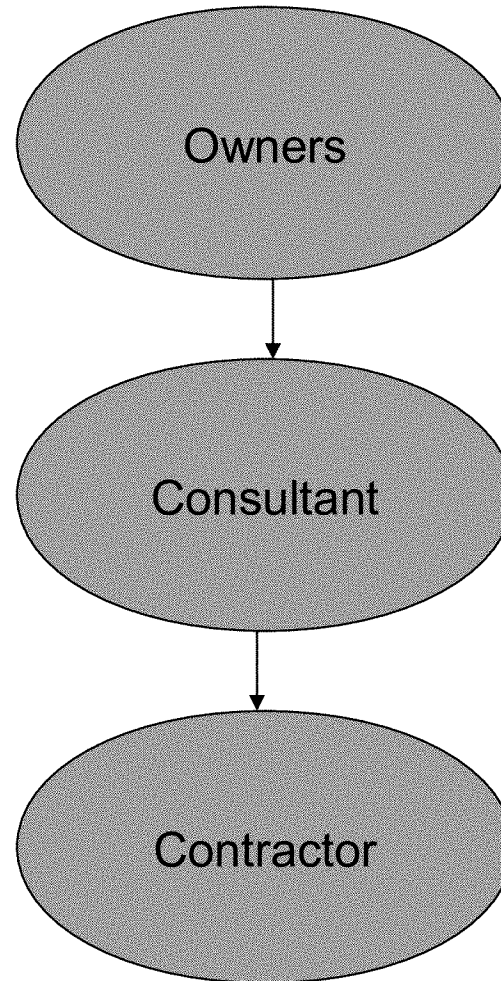
- ➔ Building construction
- ➔ Heavy/civil construction
- ➔ Industrial construction

Each type of construction project requires a unique team to plan, design, construct, and maintain the project.



# CONSTRUCTION PEOPLE

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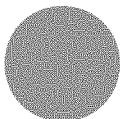




# BUILDING TEAM

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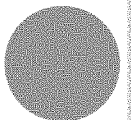
- ➔ Building Owner
- ➔ Architect
- ➔ Clerk of works
- ➔ Quantity surveyor
- ➔ Consulting engineers
- ➔ Main Contractor
- ➔ Site agent



# BUILDING TEAM

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- ➔ Estimator
- ➔ Buyer
- ➔ Accountant
- ➔ Administrator
- ➔ Assistance contract manager
- ➔ Nominated sub contractor
- ➔ Domestic sub contractor
- ➔ Operatives



# OWNER

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**Owner** is the people that have exclusive rights and control over property. Owner can be:-

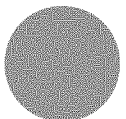
Government (biggest owner in Malaysia)

Private sector

Cooperate sector

Individual

Developer



# MALAYSIAN GOVERNMENT

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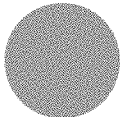
Federal Government

State Government

District office

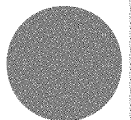
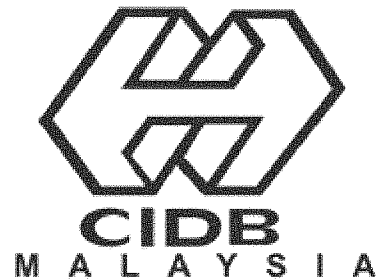
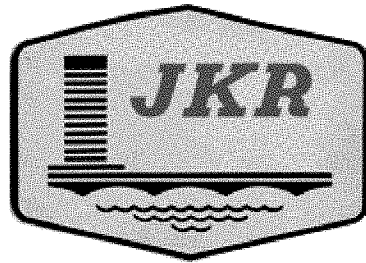
Town council

Peoples/Villages



# AGENCIES IN MINISTRY OF WORKS

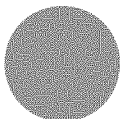
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# CONSULTANT

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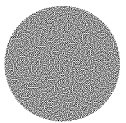
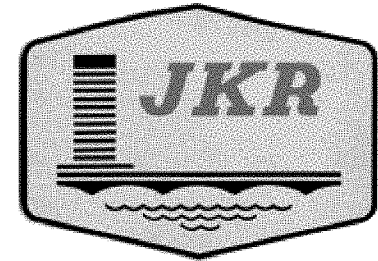
- A **consultant** is a professional who provides advice in a particular area of expertise.
- *A consultant is usually an expert or a professional in a specific field and has a wide knowledge of the subject matter.*
- A consultant usually works for a consultancy firm or is self-employed, and engages with multiple and changing clients.
- The biggest construction consultant in Malaysia is JKR



# JKR core business

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- Consulting services
- Project management services
- Maintenance management services



# JKR SECTORS

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- **Infrastructure**

- Airport & Port Unit

- Road Unit

- Slope Unit

- **Building**

- General building unit

- Healthy works unit

- Education unit

- Security unit

- **Specialized Engineering**

- Mechanical unit

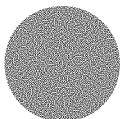
- Electrical unit

- Contract and QS

- Specialized unit

- Environmental unit

- Architect unit





# CONTACTOR

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- **Contractor** may refer to:

Organization or individual that contracts with another organization or individual (the owner) for the construction of a building, road or other facility.

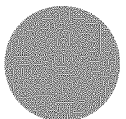
Contractor can be:

Main contractor

Sub contractor

License contractor

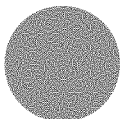
Un-license contractor



# CLASS OF CONTRACTOR IN MALAYSIA

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Class	Project limit (RM)
A	More than RM 10,000,000
B	RM 5,000,001 to RM 10,000,000
C	RM 2,000,001 to RM 5,000,000
D	RM 500,001 to RM 2,000,000
E	RM 200,001 to RM 500,000
F	to RM 200,000



## Heading

Heading I	<i>Civil Engineering Works</i>
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Heading II	<i>Building Works</i>
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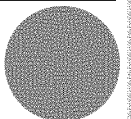
Heading III	<i>Mechanical, Sanitary and Water Engineering Works</i>
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Heading IV	<i>Other Specialist Civil Engineering Works</i>
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Heading V	<i>Quarrying Metal and Earth Supply, Cartage and Transport</i>
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Heading VI	<i>Forest and Land Development</i>
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Heading VIII	<i>Telecommunication Works</i>
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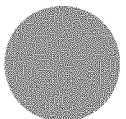


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In general (differs from small to big project):-

- Recognizing the need for the project
- Determining the technical and financial feasibility
- Preparing detail plans, specifications and cost estimation
- Obtaining approval from regulatory agencies such as zoning regulations, building codes and environmental. Needs, idea, conceptual design, financial and legal considerations.
- Details design, budgeting and contract document.
- Tendering, project offer and construction works

**CONSTRUCTION  
PROCESS**



# WEEK 1

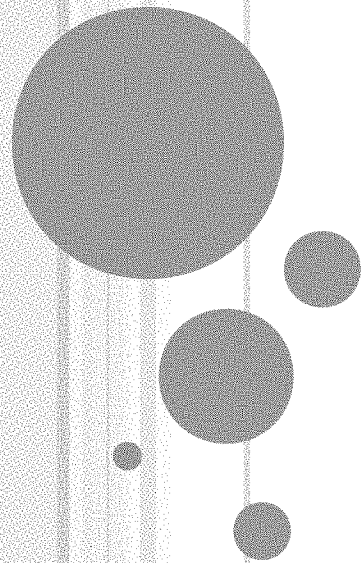
## Stages for construction

1. Building
2. Retaining walls, Drainage
3. Road, Highway, Bridges
4. Airports, Offshore/Marine structure

# WEEK 1

## Stages for construction

1. **Building**
2. Retaining walls, Drainage
3. Road, Highway, Bridges
4. Airports, Offshore/Marine structure



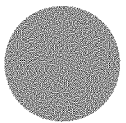
**BUILDING**

# WEEK 1

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At the end of week 1 lectures, student will be able to :

- Identify setting out works involve in building construction, i.e., site clearing, setting out and establish the building datum level. (CO1)
- identify the accommodations, storage and security requirements during the building construction stage. (CO1)
- describe the detail building stages involved during the building construction process. (CO1)

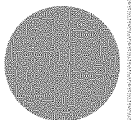




# BUILDING

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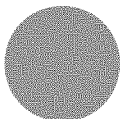
1. Site works and setting out
2. Accommodation, storage and security
3. Detail building stages



# 1. SITE WORKS AND ~~SETTING OUT~~

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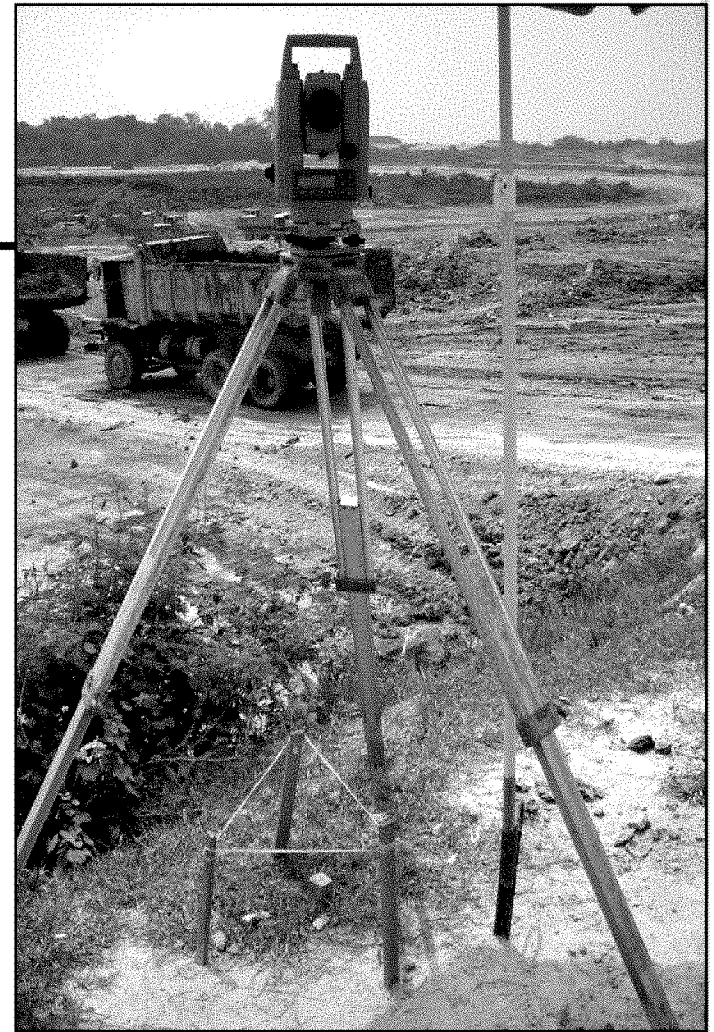
- Contractors responsibility after being given possession and site layout plan and detail drawings necessary
- Commencing tasks:-
  - a. Clearing the site
  - b. Setting out the building
  - c. Establishing a datum level



# LEVELING

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The land surveyor will determine the original ground level for the land and mark a survey peg for drain, pipes, cables and main sewerage treatment plant (MSTP), also the road complying with the Jabatan Pengairan dan Saliran (JPS).

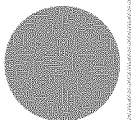


**Land surveyor  
determine the  
OGL**

# CLEARING THE SITE

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- May involve:-
  - Demolition of existing buildings (by experienced contractor)
  - Grubbing out bushes and tress (by manual or mechanical means, or by specialist for the large tress)
  - Removal of soil to reduce levels following to Building Regulation C1 (sterilize the top 300 mm to contain plant life and decaying vegetation)



## Topography of the site and some common material on site

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# Removal of tree trunks





Grubbing of trees, shrubs and roots

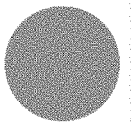
# Site clearing work carried out







Excavator heaping up top soil

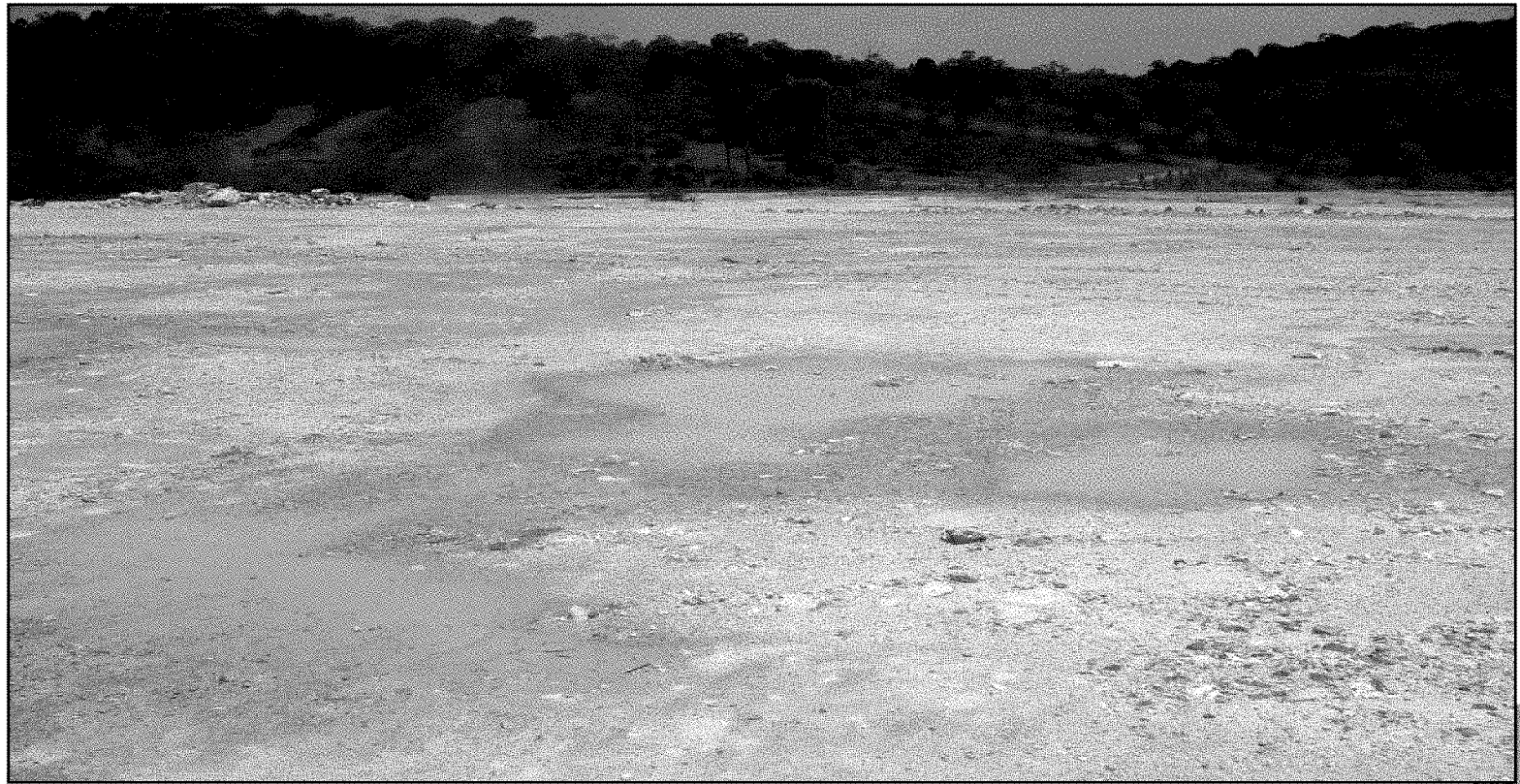




Earthwork  
operation

## A) **SITE BOUNDARY**

The surveyor must to determine the site boundary of the construction area to avoid trespass to the another construction area.

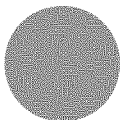




# SETTING OUT THE SITE

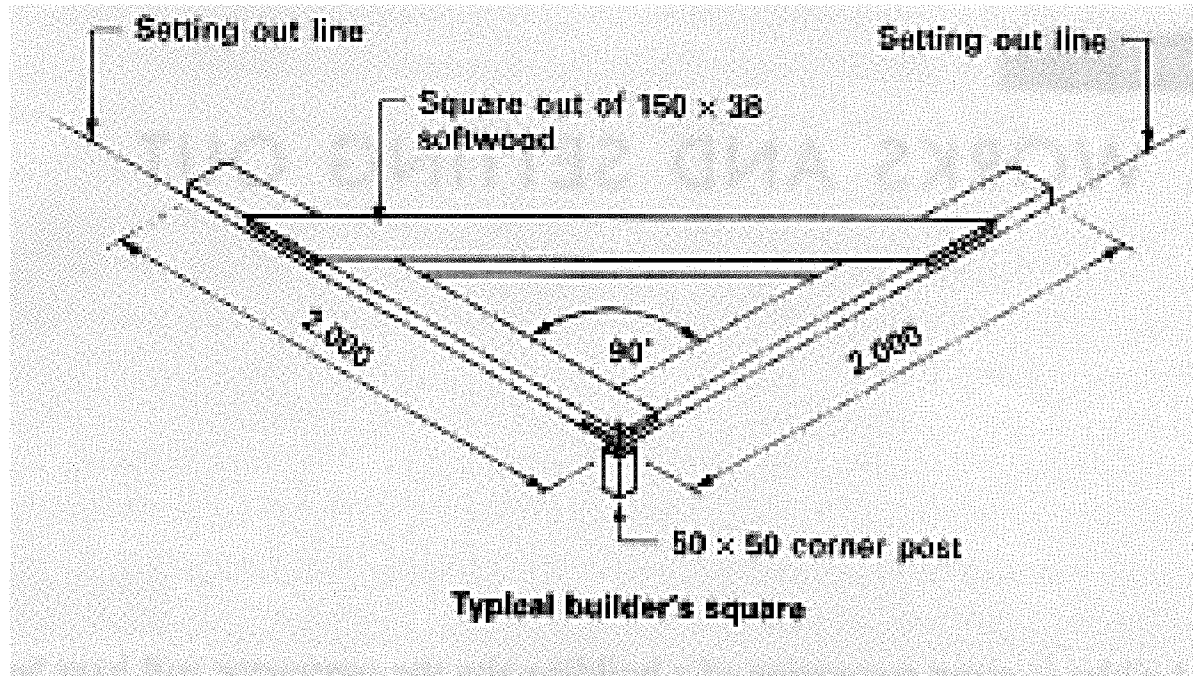
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1. Establish a base line from which the whole of the building can be set out.
  - Marked on site clearly so that it can be re-established at any time
  - Using steel tape (30 meters and not stretchable is more suitable)
  - Marked each corner with a stout peg
  - Check on the right angle and correct lengths (advisable using different method)



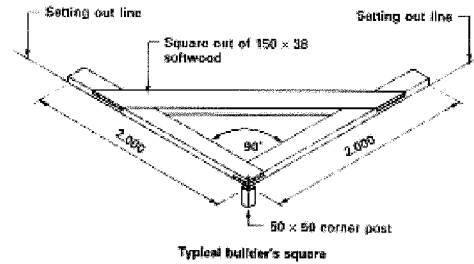
# TYPICAL BUILDER SQUARE

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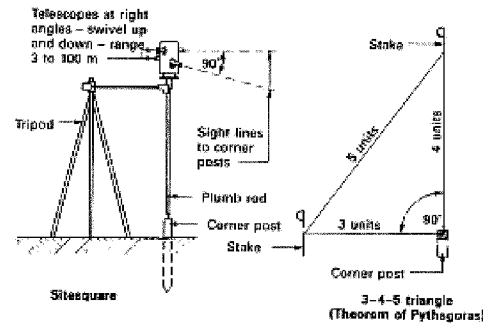


# SETTING OUT AND CHECKING METHODS

## 14 Construction Technology



Typical builder's square



Sitesquare

3-4-5 triangle  
(Theorem of Pythagoras)

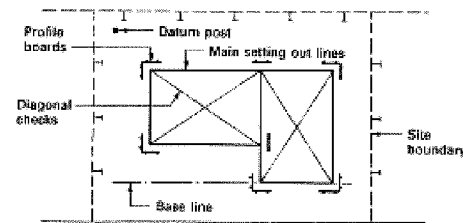
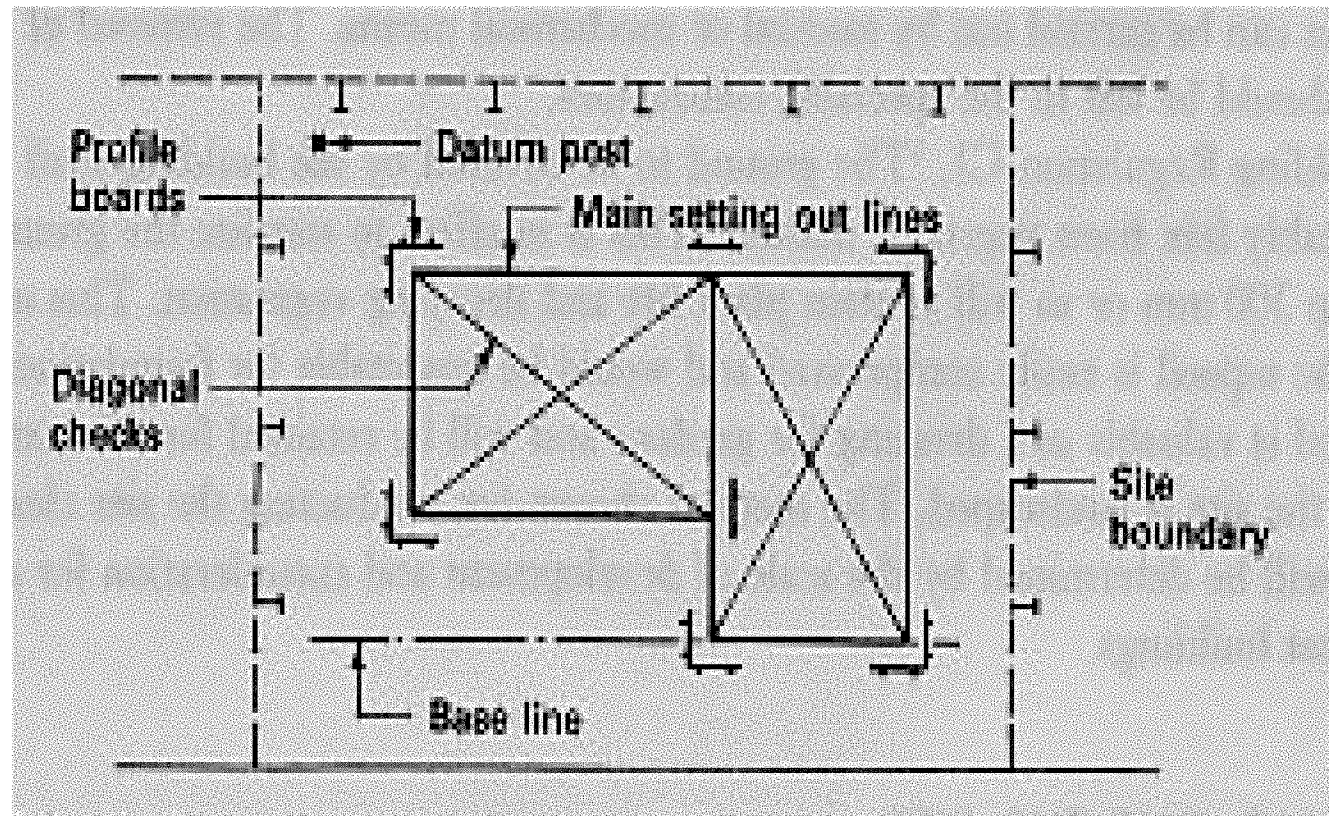


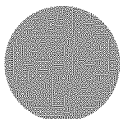
Figure 1.1.1 Setting out and checking methods



# SETTING OUT THE SITE

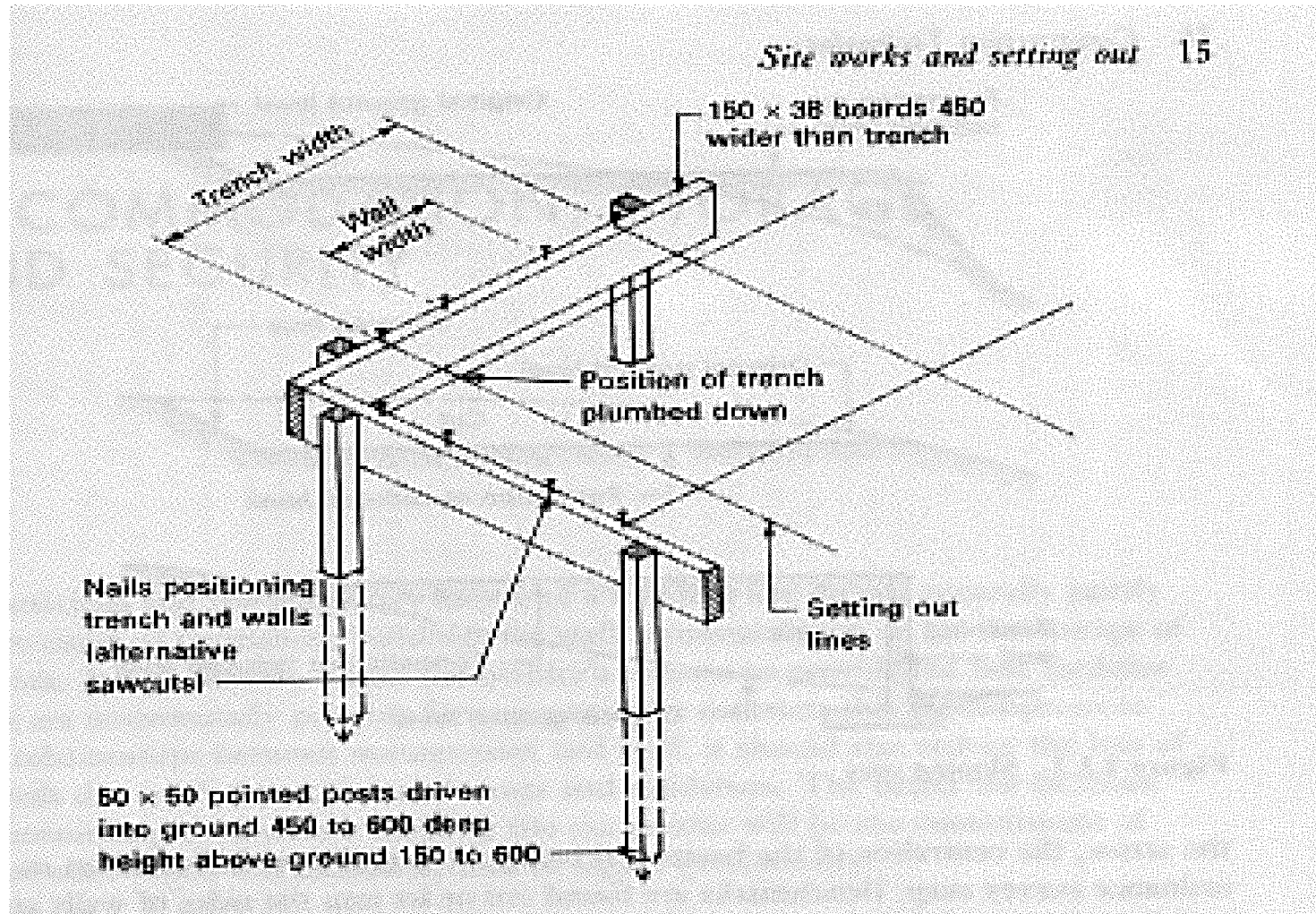
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2. Set up profile board-after the main building lines
  - Should set up clear of the foundations trench positions to locate the trench, foundations and walls
  - Required at all trench and wall intersections





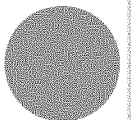
# TYPICAL PROFILE BOARD



# ESTABLISHING A DATUM LEVEL

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- All levels in a building are taken from a fixed point called a 'datum'
- Should establish after the setting out and related to ordnance benchmark
- An arrow with a horizontal mark above the arrow
- The centerline of the horizontal being the actual level indicated on an ordnance survey maps

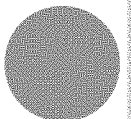


# SLOPING SITES

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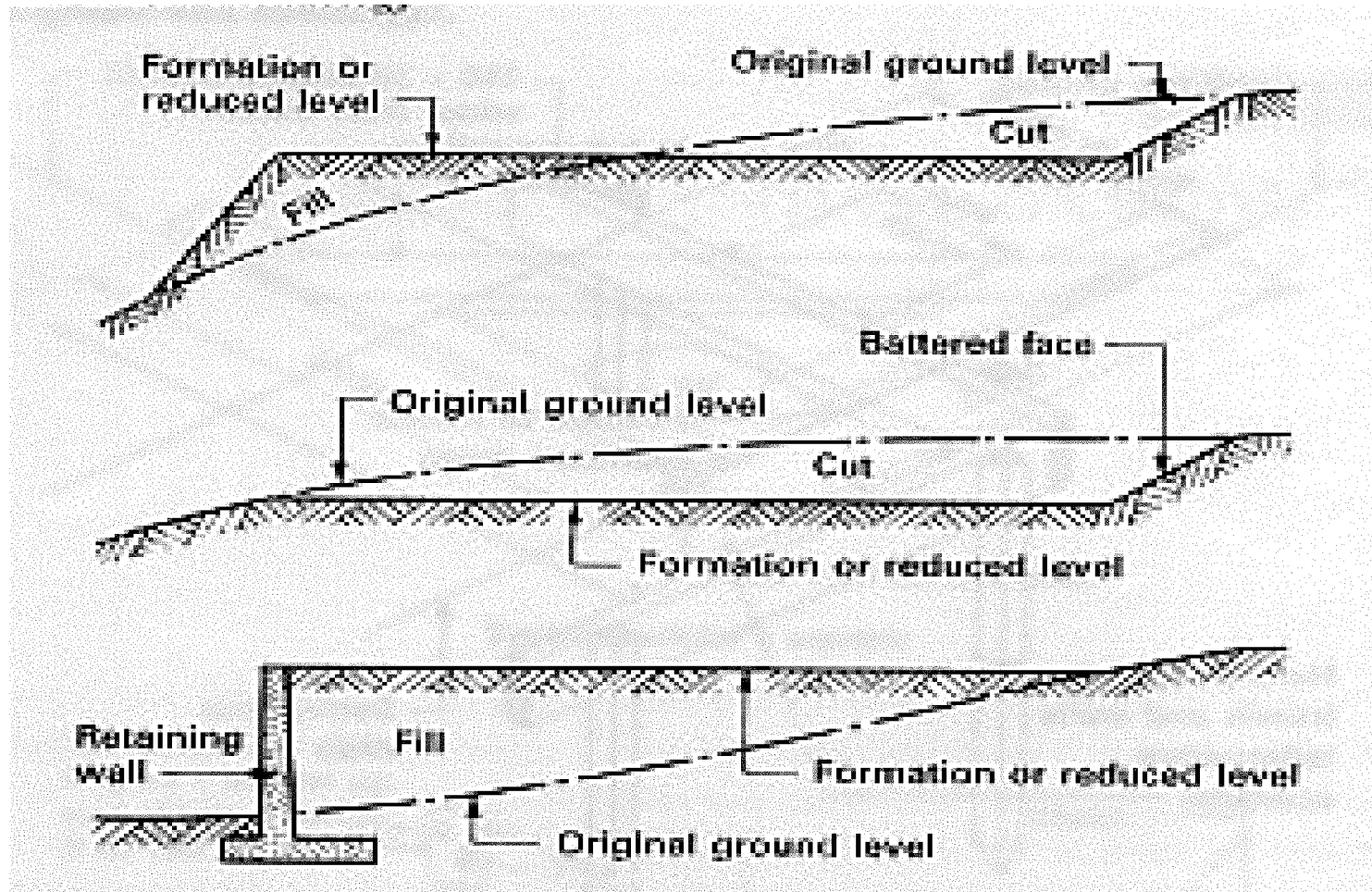
Three methods in reducing levels:-

1. **Cut and Fill** - usual method, the amount of cut will equal the amount of fill
2. **Cut** – Advantages of having undisturbed soil over the site, but having disadvantages of cost of removing the spoil from the site
3. **Fill** – Not to be recommended, deep foundation would be needed, the risk of settlement and the amount of fill should be limited to 600 mm

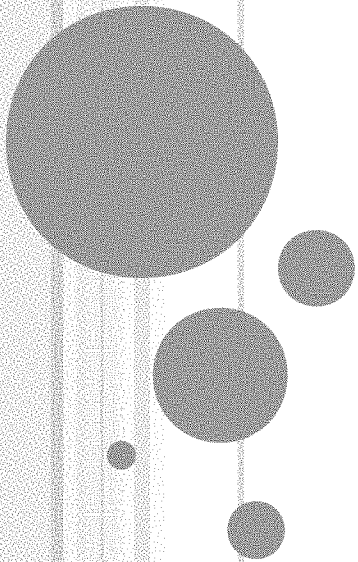


# SLOPING SITES

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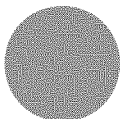
# **ACCOMMODATION, STORAGE AND SECURITY**



# ACCOMMODATION

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- Regulations 1996 (Health, safety and welfare)
- Requirements defers due to numbers of site workers and duration of contract
- Staff accommodations usually:-
  - Sectional timber huts
  - Mobile caravan or cabins
- Facilities provided:-
  - First aid, stretcher ambulance, first aid room, shelter and clothing, meals room, washing facilities and sanitary facilities



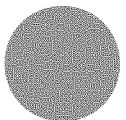
# STORAGE

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- Type of storage depend on:-
  - Durability
  - Vulnerability to damage
  - Vulnerability to theft

Examples..

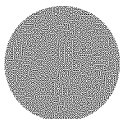
- Cement and plaster (in bag form) – dry store free from moist air
- Aggregates and sand – clean firm base, separate different materials and grade, watch on moisture content
- Bricks and blocks – stacked in stable piles, covered adequately



# SECURITY AND ~~PROTECTION-FENCING~~

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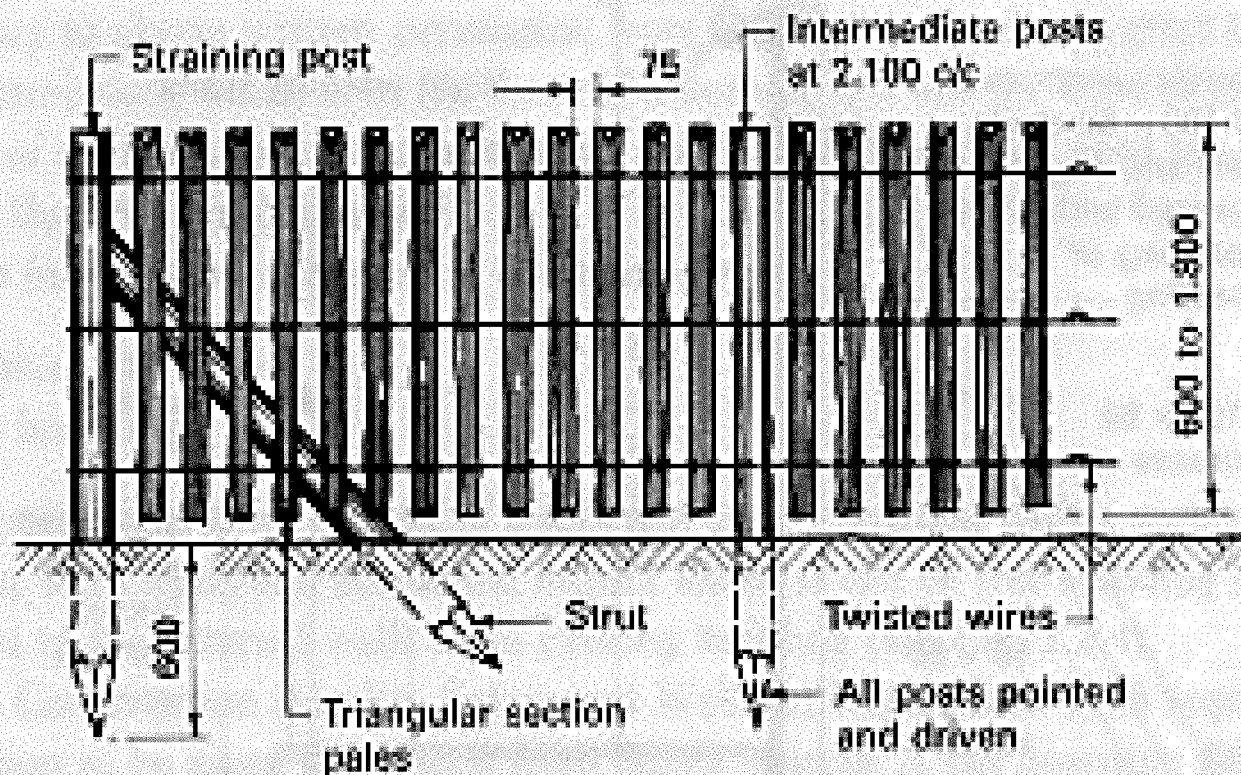
- ➔ To defines limit of site and acts as a deterrent to trespasser or thief
- ➔ To provide a physical barrier or visual barrier
- ➔ Should start at the beginning of construction
- ➔ Type depend on degree of security, cost, neighborhood and duration of contract
- ➔ At least 1.8m high
- ➔ Minimum number of access and with lockable barrier
- ➔ Standard fences – BS 1722





# TYPICAL FENCING DETAILS

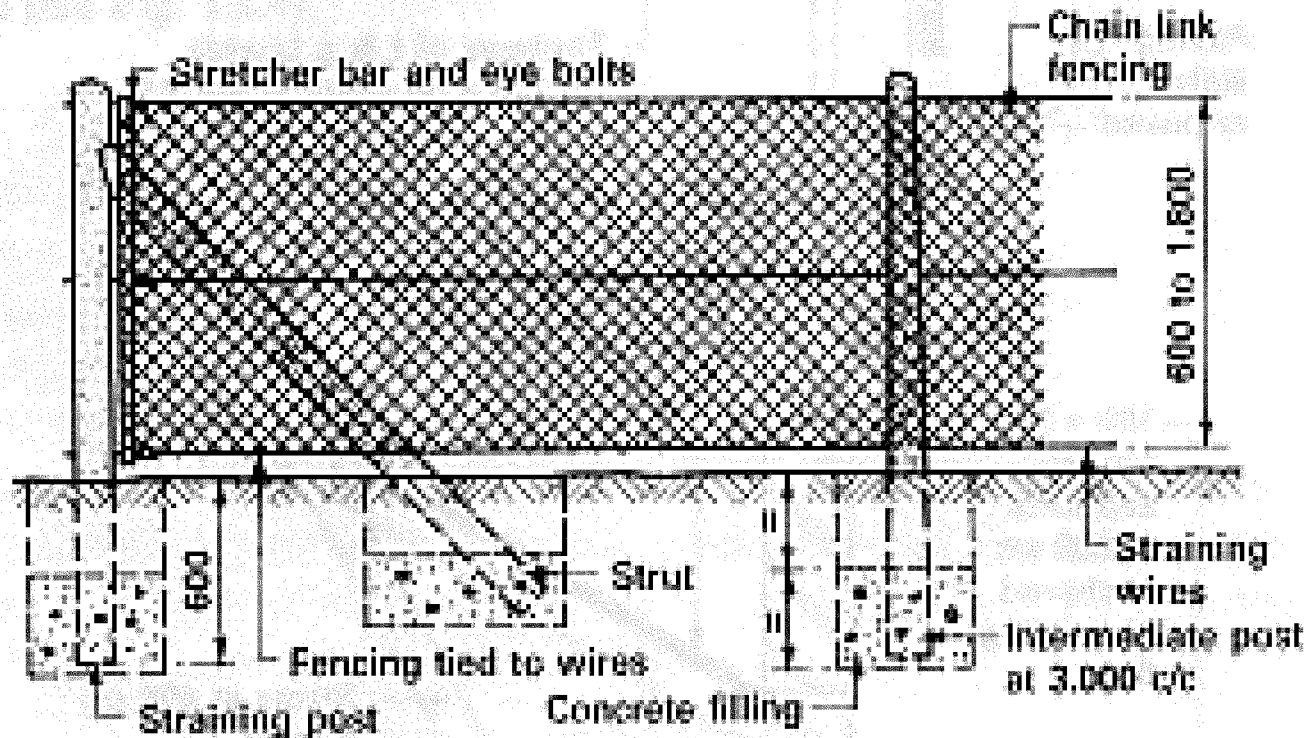
## ~~CLEFT CHESTNUT PALE~~



Cleft chestnut pale fencing

# CHAIN LINK FENCE WITH CONCRETE POSTS

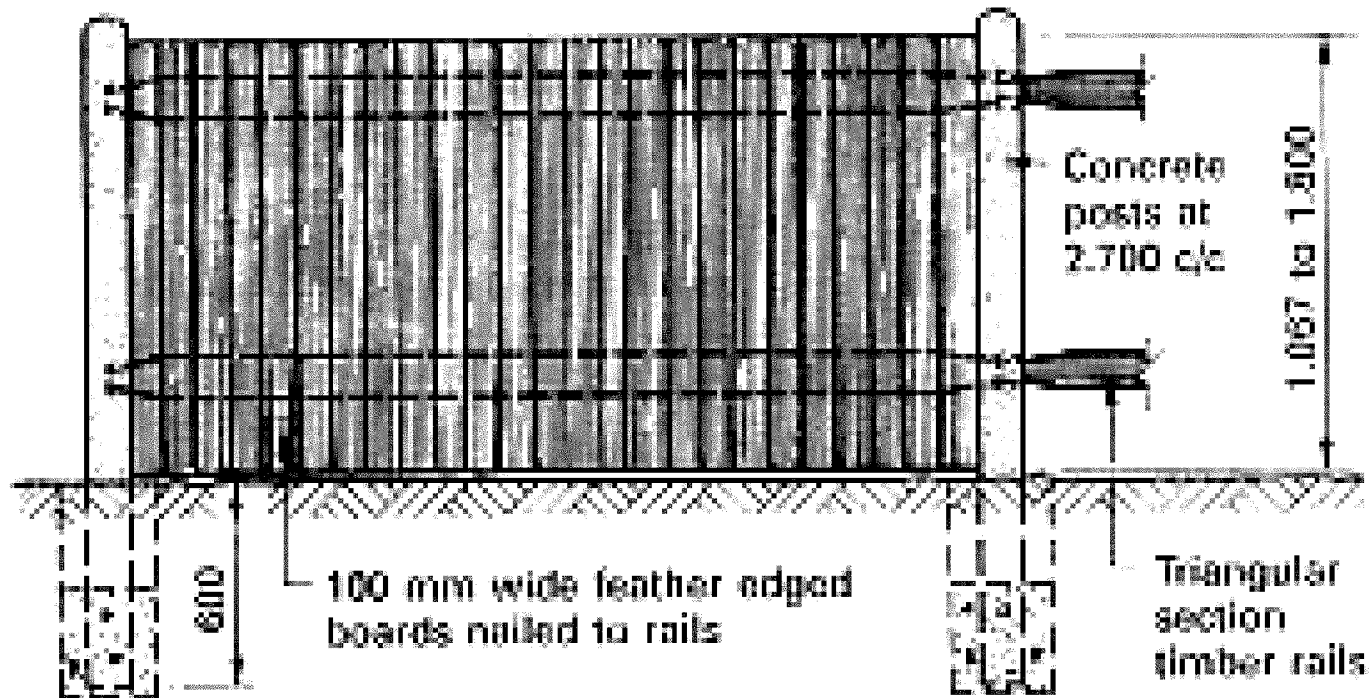
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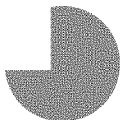
Chain link fence with concrete posts



# CLOSE BOARDED FENCE WITH CONCRETE POST



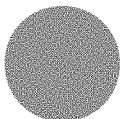
Close boarded fence with concrete posts



# SECURITY AND ~~PROTECTION-FENCING-~~

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- Hoardings are fences of barriers erected adjacent to a highway or public footpath
- Prevent unauthorized persons obtaining access to site and protect public from dust and noise
- Necessary to obtain written permission from the local authority to erect a hoarding (Highways Act 1980)



# HOARDINGS

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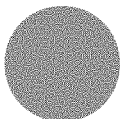
- Two forms:-

- Vertical hoardings

- a series of closed boarded panels securely fixed to resist wind load and accidental impact load
    - Can be free standing or fixed by stays by the external walls of an existing building

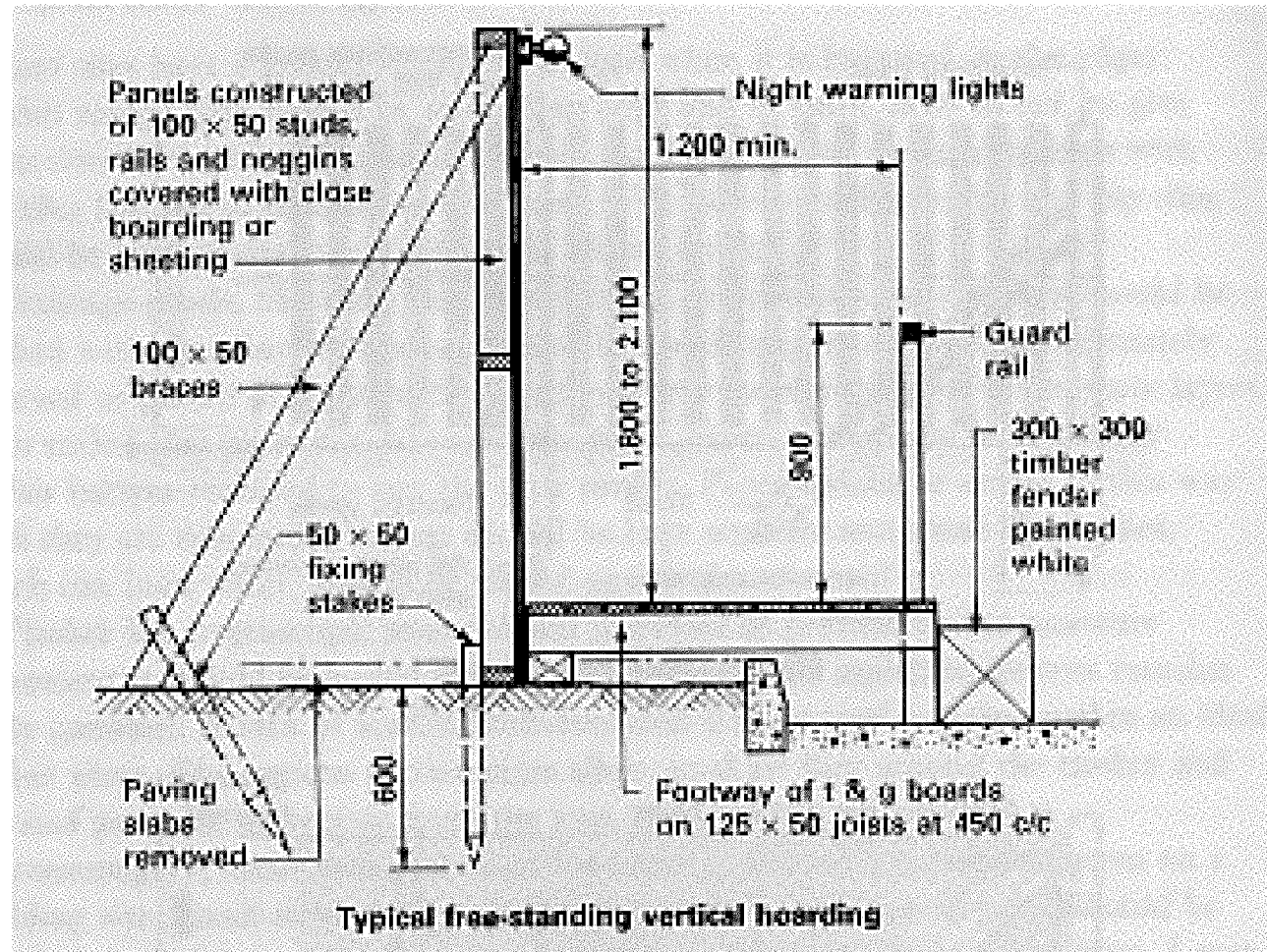
- Fan hoardings

- To protect persons from falling objects
    - Place at a level above the normal traffic height and ensure any falling debris is directed back towards the building or scaffold



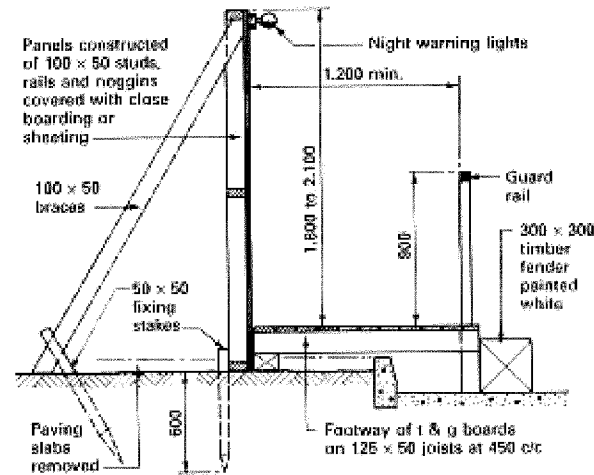
# TYPICAL FREE STANDING VERTICAL HOARDING

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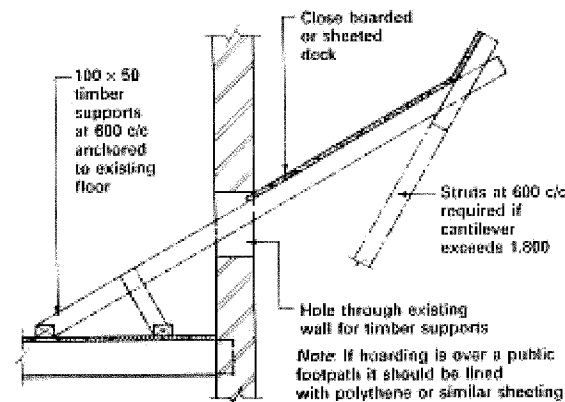


# TYPICAL FAN HOARDING

## 24 Construction Technology



Typical free-standing vertical hoarding



Typical fan hoarding

Figure 1.2.4 Timber boardings



# BUILDING STAGES

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## Order of construction

- Excavation and timbering
- Foundations
- Concrete floors
- Reinforced concrete frames
- Roofs
- Brickwork
- Internal fixtures and fittings
- Insulation
- Plumbing and wiring
- Painting and decorating





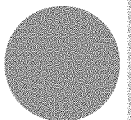
# EXCAVATION AND TIMBERING

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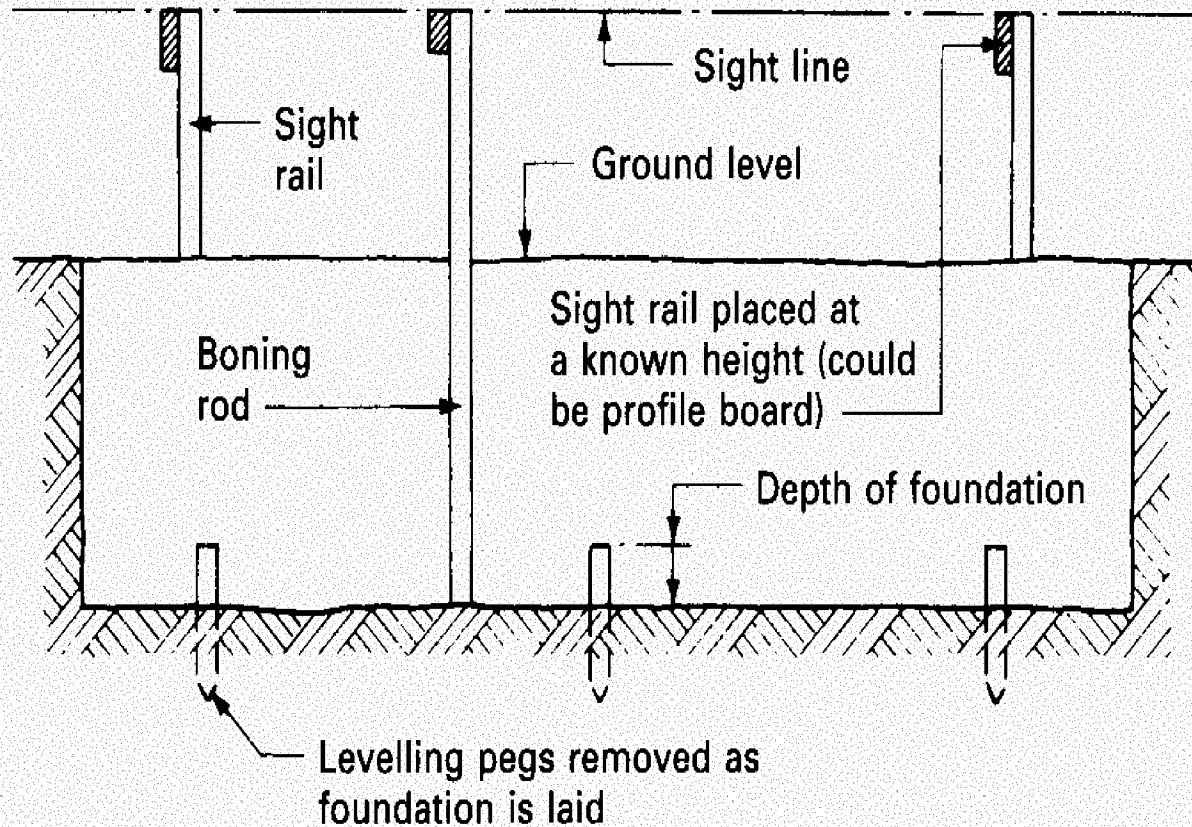
- Before a foundation can be laid, it is necessary to excavate a trench of the required depth and width (by hand or mechanical excavator)

**Timbering – term used to cover temporary supports to the sides of excavations and is sometimes called planking and strutting**

- Type and amount – depend on the depth, nature of subsoil, weather conditions and duration

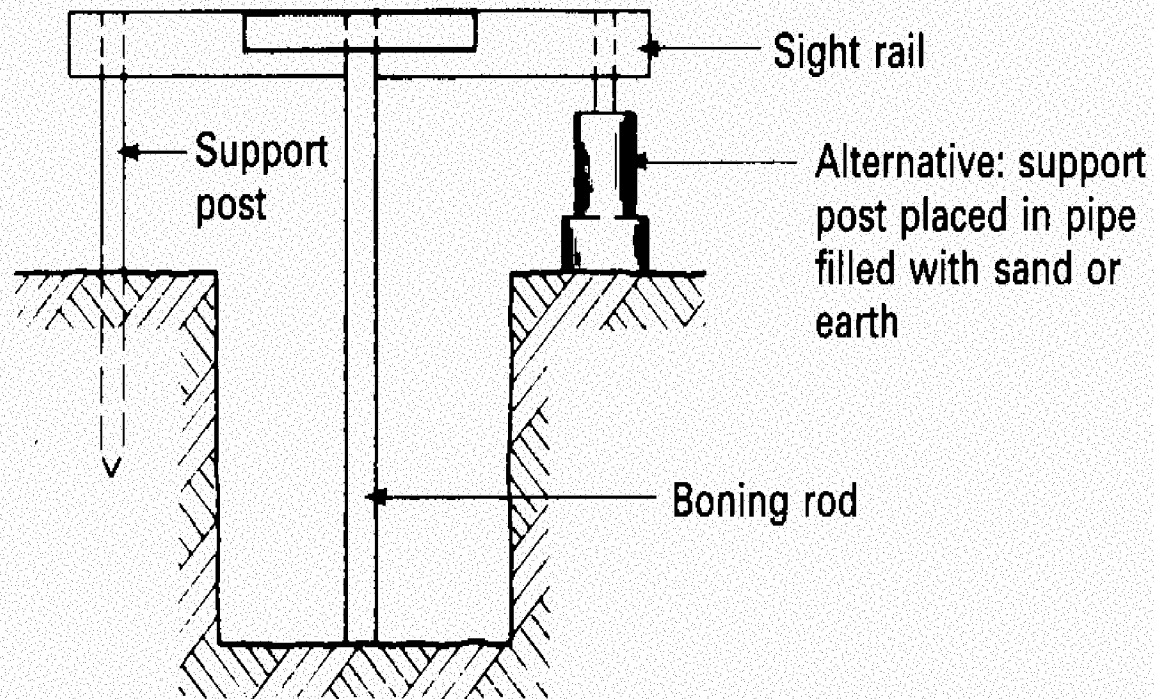


# TYPICAL EXAMPLE OF TRENCH EXCAVATIONS



# TRENCH EXCAVATION

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# FOUNDATIONS

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- Foundation is the base on which a building rests and its purpose is to safely transfer the load of a building to suitable subsoil
- **Building regulations :-**
  - Safely sustain and submit to the ground the combined dead and imposed loads so as not to imposed any settlement or other movement in any part of the building or of any adjoining buildings or works
  - Be a such a depth, or be so constructed, as to avoid any damage by swelling, shrinkage or freezing of the subsoil
  - Be capable of resisting attack by deleterious material, such as sulphates, in the subsoil