1. DEFINITION

2. CONSTRUCTION CONSIDERATION

3. DESIGN REQUIREMENT

4. METHOD OF CONSTRUCTION
   a. Open Cut Construction
   b. Cut and Cover Construction
   c. Top Down Construction
   d. Composite Construction

   (to discuss sequence of operation & advantages / disadvantages)

5. ELEMENT OF BASEMENT

   (excavation, retaining wall, dewatering system, structural basement wall & floor & waterproofing)

6. PRACTICAL DIFFICULTIES IN DEEP BASEMENT CONSTRUCTION

7. GROUND WATER CONTROL

Prepared By: NOOR AISYAH ASYIKIN MAHAT
A basement is a storey or several storeys of a building that are either completely or partially below the ground floor.

USED OF BASEMENT AS:
1. WORKING PURPOSE (SHOPPING COMPLEX)
2. STORAGE (PARKING & BUILDING SERVICES)
### Construction Consideration

1. Size of a site
2. Volume of work
3. Shape and Typographical conditions of site
4. Neighbourhood conditions of a site
5. Geotechnical conditions
6. Internal layout of the basement or other related structures
7. Availability of resources for the project
8. Availability of expertise skill
9. Appropriateness of the methods selected for the construction

*basement_01/ march2011*
**IMPORTANT FACTORS IN DESIGN:**

- Dead and live load of the superstructure
- Wind loads (higher structure)
- Water pressure (during & after construction)

### i. During construction
- Machine difficult to move
  - It is necessary to protect the entry of water by providing retaining walls:
    - **A. Excessive water** – use retaining wall (e.g. retaining wall)
    - **B. Water from below** – pump out water (dewatering system)

### ii. After construction
1. **Continuous water pressure**
   - (Coming from the sides – cracks in wall; therefore wall must be water tight, reinforced concrete using designed mix, massive thickness of concrete)
2. **Continuous water from the underside**
   - (Provide release sump)
3. **Water from top level/above**
   - (to avoid basement flooding; require proper drainage and water tight door to basement)
As part of a drainage system, a pit in the basement to collect excess moisture and liquids. To avoid flooding, a sump pump may be installed to remove accumulated water in the sump pit.
i. Client general requirements
   • Purpose of the basement (parking, shopping, defense)
   • Will influence the method of construction, machine to be used, frame structure, finishes, etc.

ii. Depth of basement – in relation to the ground water (shallow or deep)
   • High water level – floor & wall must be watertight
   • Low/deep water level – easier wall construction (no water)
iii. Water tightness

- Level of water tightness depends on the purpose of the basement
- Shopping; important to have complete ‘dryness’ compared to parking

v. Heave

Require pitting system to restrain from up heave (2 storey basement with high water level-structure cannot fully sunken-partially located above ground ‘semi basement’).
vi. Economic depth of basement

vi. Construction method

vi. Overall stability

vi. Adjacent building/property
To prevent crack to the adjacent structure (retaining walls, shoring etc.)
Involvement/provision when constructing basement:

1. Ground stabilization provisions
2. Cut-off walling provisions
3. Lateral soil support provisions
4. Excavation arrangement
5. Dewatering arrangement
6. Spoil removal arrangement
7. Basement construction arrangement
1. open-cut excavation
method of construction

• Very **old method**
• Used in open space area where there is no obstruction & no building/structure nearby
• Economical compared to the other type
• Beyond 6m deep, uneconomical as it will involve a **massive excavation work** and will require retaining wall

• Can be used in almost any soil condition
• A **sloped open cut** excavation is the most cost and schedule effective.
• When the trench is very deep and/or expensive backfill materials are required, then a **vertical cut** at the toe of the slope **supported by shoring** may be effective.

**OPEN - CUT EXCAVATION**
method of construction

suitable for site with abandon of unobstructed working space

OPEN - CUT EXCAVATION
method of construction

shoring

OPEN - CUT EXCAVATION
advantages

1. Allows continuous excavation, laying and backfilling operations.
2. Minor breakdowns usually do not cause delays to all activities.
3. The open trench needs only the design of the cut bank slope.
4. Because there are no additional support operations and equipment, it is the economical choice.
5. The open trench provides easy access to the work because equipment and construction materials are minimized.
6. The open cut method is suitable for most ground conditions, except for oozing mud (soft mud or slime) and running sands.
disadvantages

1. The slope of the bank requires more excavation and backfill volume than the other options.

2. The only bank support is the strength of the soil. If drying, flooding, or change of soil properties weakens the soil, then sloughing and collapse can happen with little or no warning.

3. The sloped banks require a wider work area.

4. The bank slopes may force the use of larger equipment because the distance to reach into the trench is increased and a greater volume of soil must be excavated and backfilled.
2. cut and cover construction
The cut and cover construction technique has been used for many years as a means for building underground transportation facilities.

This method involves the installation of temporary walls to support the sides of the excavation, a bracing system, control of ground water, and underpinning of adjacent structures where necessary.
introduction

i. Deep basement (3 storey plus where the use of sheet piling is impractical)

ii. Normally carried out in congested area (urban)

iii. The choice of using permanent or temporary retaining wall depends on the ground water conditions
sequence of construction

1. Construction of retaining wall
2. Excavation works

DIAPHRAGM WALL
CONTIGOUS OR SECANT PILES
Secant Piles
sequence of construction

Cut and Cover Construction Illustration

1. Construction of diaphragm wall decking, and pin piles at left area.
2. Construction of diaphragm wall decking, and pin piles at right area.
3. Decking, excavation, and strut installation at central area.
4. Construction of main structure (down-up)
5. Pavement restoration in section
6. Completion of underground station

Excavation & construction  cut and cover construction
sequence of construction

3. Construct structure

4. Backfilling (where required)

5. Removing of any temporary retaining walls
cut and cover construction
The main disadvantages of a cut and cover construction are its disruptive effects in congested urban environment.

Cost of cut and cover construction increases sharply with increased depth.
3. top down construction
sequence of construction

Typical sequence of top down construction

1) Install perimeter secant wall piles
sequence of construction

2. Install bearing piles with plunge columns
3) Cast ground floor slab
sequence of construction

4) Excavate and cast upper basement floor slab

5) Extend columns and cast first floor slab

Typical sequence of top down construction
6) Excavate and cast middle basement slab

7) Extend columns and cast second floor slab (not shown)
sequence of construction

8) Excavate and cast lower basement slab.

9) Extend columns and cast upper floor slabs (not shown)
sequence of construction

top down construction
advantages

i. Superstructure works can be constructed without affecting the basement works

ii. Speed – an estimated saving of 3-6 months in construction period

iii. Fast completion, early return on investment
disadvantages

i. Problems of excavating in dark & dusty situation even with artificial lighting

ii. Limited head room & working area during casting of concrete slab, boring of holes and inserted pre-founded column
Construction of a basement using top-down arrangement, that is, the ground floor slab of the basement will be constructed first. After that, the basement below ground floor will be excavated and constructed from top to bottom using the completed basement floor slab as support to the sides.
top down construction
top down construction
top down construction

Rig boring wall piles

Secant walls and Columns
top down construction

Completed Hard / Hard Secant Piled Wall
top down construction

Spoil removal was from one of two moling holes.
Piling gets under way from the former ground floor slab.
Top-down excavation for basement levels 1 and 2

The existing massive piled raft at new basement 2 level was broken up with explosive charges at night and cleared during the day.

Excavation at basement 3 level finally included breaking up existing large-diameter piles that were part of the observational method contingency arrangements.
4. composite construction
This method is basically the combination of:

• Perimeter area – top down method
• Core area – bottom up method
## Compare Feature of Various Basement Methods

<table>
<thead>
<tr>
<th></th>
<th>Open Cut</th>
<th>Cut and Cover</th>
<th>Top Down</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size of site</strong></td>
<td>Very large open site</td>
<td>Congested / small</td>
<td>Large size site</td>
</tr>
<tr>
<td><strong>Site environment</strong></td>
<td>Unobstructed</td>
<td>Adaptable for most environment</td>
<td>Complex environment</td>
</tr>
<tr>
<td><strong>Protection</strong></td>
<td>Simplest protection</td>
<td>Support required</td>
<td>Limited shoring support req.</td>
</tr>
<tr>
<td><strong>Special provision</strong></td>
<td>Not much</td>
<td>Not much</td>
<td>Temporary vertical support req.</td>
</tr>
<tr>
<td><strong>Machine suitability</strong></td>
<td>Large machine</td>
<td>Small machine</td>
<td>Large machine</td>
</tr>
<tr>
<td><strong>Spoil removal</strong></td>
<td>Using ramp</td>
<td>Staged platform / bucket</td>
<td>Ramp, vertical shaft, bucket</td>
</tr>
</tbody>
</table>