Topic: Site Formation

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Purpose of site formation is to prepare a piece of land in order to:

• Accommodate building/s or other facilities which will be placed within the area.

• Form the land to the required orientation, shape or levels in order to accommodate such facilities.

• Provide the required back-up facilities including access roadways, drainage and other related services, both temporary or permanent in nature.
What works are usually involved in site formation projects in Hong Kong

- Clearance of the site including the removal of buildings or unwanted structures, shrubs and trees, surface soil and debris.
- Excavation by cutting into slope or other land area to get the required/extra land
- Leveling of the land by necessary cutting or filling to get a piece of flat or terraced land.
- Stabilize natural or new slope within the site.
- Construct retaining wall (as part of the slope stabilization or trimming to terraced land).
- Forming of access road and drainage system
Clearance of the site including the removal of buildings or unwanted structures, shrubs and trees, surface soil and debris.

- usually done by the use of bulldozer, scraping or other excavating machines
Excavation by cutting into slope or other land area to get the required/extra land
Leveling of the land by necessary cutting or filling to get a piece of flat or terraced land.
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• Forming of access road and drainage system
Slope can be classified into a few types:

1. Natural Slope
2. Man-made Slope, including cut-back slope or slope formed by filled material with adequate compaction, usually retained by retaining structures
3. Rock Slope, Soil Slope, Mixed
4. Stable slope, Slope with potential hazard, Dangerous slope
What to do with slope

1. Surface protection such as vegetation (rigid cover (masonry, plaster or shotcrete))

2. Surface drainage (including surface channels, catch pits and sand traps)

3. Subsurface drainage (including weepholes and subsoil drain etc.)

4. Other protective provision such as prestressed ground anchors
Factors affecting the stability of slope

1. **Topography** and its surrounding physical conditions. Detail analysis can be done by appropriate site investigation process.

2. **Geological conditions** such as the nature and depth of its subsoil, degree of decomposition, or location of fracture etc. This data can be obtained by soil investigation.

3. **Shear strength** of the slope-forming materials. Data can be obtained using laboratory tests.

4. Surface and ground **water condition**

5. External **loading and surcharges**, such as from traffic, nearby structures, possible vibration etc.
Stability of slope can be effectively improved by the provision of an appropriately designed drainage system, this can be achieved by:

1. A surface drain system that is capable to discharge all the storm water within the rain water catchment area affecting the slope in a designated period of time (say, 200mm rainfall/hour).

A surface drain system usually consists of:

- surface channel
- stepped or trapezoidal channel
- catchpit or sand trap
Stability of slope can be effectively improved by:

2. A subsoil drain system that is laid below surface for the discharging of ground water and to maintain the water pressure be kept in a safe level filter layer behind the slope leading water to outlets

- weepholes
- cut-off drain
- subsoil drain pipe
Drainage detail for retaining walls
Forming surface drainage channel to slope
Protection and treatment to Rock Slope

Most rock slopes need some forms of treatment to ensure continued stability. Improvement methods include:

1. Scaling – loose blocks or boulders to be removed from exposed rock surfaces, this is usually done by manual method.

2. Construct buttress support – this is concrete or masonry gravity structure use to retain the unstable rock mass

3. Dentition – exposed soft material in a rock face be trimmed back. The resulting slot be filled with filter material and protected by masonry or concrete to prevent erosion.
Protection and treatment to Rock Slope (continue)

4. Sprayed concrete – apply concrete protection to zones of weak or highly fractured rock faces by spray-on method.

5. Dowel – a hole is drilled and provide untensioned steel bars, usually 25mm to 35mm dia. and 1m to 3m long, to stabilize a weak rock zone. The hole would be grouted afterward.

6. Rock bolt/nail – this is tensioned bar inserted into rock forming a short anchorage zone in rock so that an unstable slope area being reinforced by tension. Typical rock bolts are 25mm to 40mm in dia. 3m to 6m long, and have a tensile working load around 100kN.
Scaling a rock slope surface

Forming a steep slope in set-back benches and in phases starting from the top downward. Note that the upper benches are strengthened by soil nails.
Various methods to stabilize a rock slope
Forming soil nail and rock bolts
Protection and treatment to Earth-filled slope

Where a slope is to be stabilized to eliminate possible flow-slide, the surface layers should be stripped to a vertical depth not less than 3m and replaced it with dry and well compacted fill.

A drainage system is also required between old and re-compact ed fill to prevent development of water pressure behind the filled zone.

If it is possible, try to reform the profile of the slope to a safe angle which is determined by mathematic analysis.
Typical man-made items on slope and retaining wall that require maintenance
Protection to slope by rigid surface

Rigid surface protection on slopes are commonly used to reduce rainwater infiltration and to prevent erosion of the slope-forming materials. This can be done by:

Chunam plastering – this is an applied-on surface protection to slope using a clay and cement mixed plaster. Thickness of the plaster is around 40mm to 50mm for permanent works.

Sprayed concrete (shotcrete) – protection by applying a spraying mortar onto surface of slope.
Protection to slope by rigid surface (continue)

Masonry or stone pitching – lay stone rubble or block (with filter layer underneath) onto surface to protect slope from weathering

In general, rigid surface may create a very awkward appearance. Besides, the surface is highly impermeable thus weep holes are required for draining out of the ground water to avoid the development of high water pressure behind the slope
Protect a slope by the use of retaining wall

Retaining wall are structures usually provided at the toe of a slope to stabilize it from slide, overturn or collapse.

A slope will be relatively stable when its profile (section angle) is kept below its angle of repose.

Angle of repose is an angle that maintains naturally to a safe equilibrium by the composing material of a slope. This angle deviates from differing materials depending on their compaction, particle size and the nature of the material itself. (e.g. cohesiveness and shear strength)
Principle to retaining wall design can be of three main types
- cantilever type
- Gravity type
- Earth reinforced type

Various forms
RC cantilever type retaining wall structures
Construction of typical cantilever type retaining wall and its drainage arrangement
Example of Gravity type retaining wall –
Stone mass at the toe of a bench serves to provide a gravity hold for the retaining soil-filled slope
Construction of RC cantilever/gravity mixed type retaining wall

Buttress of wall

Footing of wall
Construction of Earth-reinforced retaining wall
Detail of the precast panel as surface panel of the retaining wall
Detail seeing the tie behind the panel of the earth reinforced wall
External view of some of the partially completed earth reinforced retaining wall
Actual cases of site formation for building works
Site formation to obtain a terraced land for the placing of a building - producing a retaining structure to support an adjacent structure
Sequence showing the forming of a multi-construction retaining wall using bore-pile and soldier-pile wall with in-situ concrete facing wall.
Covering the retaining pile walls with reinforced concrete
Completion of the site formation with the retaining wall and the terrace ground formed.
Site formation for Festival Walk
Construction of the main structure of Festival Walk upon the completion of the site formation

Approximate profile of slope before site formation
Forming of a temporary vertical cut as part of the site formation work to acquire land for the placing in of the main/basement structure.
Site formation producing a temporary slope before the construction of the main structure – CityU Academic Exchange Centre
Site formation producing a temporary slope before the construction of the main structure – CityU Academic Exchange Centre
Site formation – Extension to South China Sport Association

Cut-off wall formed by contiguous bored piles and soldier piles
Site formation – Extension to South China Sport Association

Cut-off wall formed by contiguous bored piles and soldier piles
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Preserved tree (die afterward)
Site formation –
preservation of a protected tree species
Tree under preservation by encasing with a concrete trough and supported using horizontal steel pipes

Other examples with tree to be preserved in a development – KCR East Tsim Sha Tsui Station
View of the preserved tree and the re-touched landscape environment after the completion of the station complex.

The preserved tree grow in healthy condition along the re-aligned road side.
Setting-back and stabilizing of a natural slope using buttress wall for a residential development project in Repulse Bay, Hong Kong
Site formation (overview) –

Housing Authority project in Ma Tau Wai
Site formation – slope side and prepare to form terraced land using temporary retaining pile wall
Site formation (overview) – Belcher’s Garden in Kennedy Town, HK

Approx. profile of previous slope with buildings

Buildings demolished
Site formation – cutting to set-back the slope
Site formation— cutting and setting back the rock slope
A piece of flat land formed upon the completion of site formation. Part of the slope remain untouched due to the impossibility to remove the large amount of rock. The layout of building was so designed to fit the situation.
Final building layout fitting the formed site
The main structure (podium) gradually covering up the entire site area with remaining slope permanent concealed
Ground beams constructed on the slope are used to support the podium structure.
Final front view of the project as seen from the Belcher’s Street
End of presentation for Site Formation