Building Control (Amendment) Act 2007 and Regulations 2008: Underground Building Works – Requirements on PE(GEO) and AC (GEO)

Building Engineering Division
Building and Construction Authority
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General Definitions

• **Geotechnical Aspects**
  – An analysis of the geological structure and earth materials of the site of the underground building works and its influence on the underground building works
  – An analysis of the ground-water regime and its influence on the wall stability and integrity of the underground building works over time; and
  – Such other applications of earth sciences to and engineering aspects of the underground building works as may be prescribed

• **Earth Retaining Structure**
  – Any structure, structural system or other means used to maintain the shape of excavation during construction, earth filling or cutting
General Definitions

• Geotechnical Engineer, PE(Geo)
  – A professional engineer who is registered under the Professional Engineers Act (Cap. 253) as a specialist professional engineer in the specialised branch of geotechnical engineering

Specialist Accredited Checker, AC(Geo)

  – An accredited checker who is registered under section 16 to undertake the work of an accredited checker as regards the geotechnical aspects of any underground building works
What is Underground Building Works (UBW)?

- **Tunneling Works**
  - Any excavation or other building works to make a tunnel with a diameter, width or height or more than 2 m

- **Excavation Works and Earth Retaining Structures**
  - Any excavation or other building works to make a caisson, cofferdam, trench, ditch, shaft or well with a depth of more than 6 m
  - Any building works for constructing, altering or repairing any earth retaining structures in or for a trench, ditch, shaft or well with a depth or height or more than 6 m

- **Foundation Works**
  - Foundation for buildings of 30 or more storeys
# Submission Requirement for Earth Retaining or Stabilising Structures (ERSS)

<table>
<thead>
<tr>
<th>All permanent or temporary building works that involve</th>
<th>Appointments Required</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Qualified Person (QP)</strong></td>
</tr>
<tr>
<td>Excavation/ERSS ≤ 1.5 m** deep</td>
<td>Plan approval is not required</td>
</tr>
<tr>
<td>1.5 m** &lt; Excavation/ERSS ≤ 4 m deep</td>
<td>QP(ST)</td>
</tr>
<tr>
<td>4 m &lt; Excavation/ERSS ≤ 6 m deep</td>
<td>QP(ST)</td>
</tr>
<tr>
<td>Excavation/ERSS &gt; 6 m deep and not classified as UBW: e.g. non-basement excavation involving hill-slope</td>
<td>QP(ST)</td>
</tr>
<tr>
<td>Excavation/ERSS &gt; 6 m deep and classified as UBW. e.g. basement excavation.</td>
<td>QP(ST) QP(Geo)</td>
</tr>
</tbody>
</table>

Notes:
- Plan approval is not required for insignificant building works listed on First Schedule of Building Regulation 3A.
- ** If the structure that retains earth is not constructed of reinforced concrete or steel, then the applicable depth is 1 m instead of 1.5 m.
- Planning approval is no longer required for any retaining wall or earth-retaining structure for supporting the face of an excavation made for the purpose of constructing any pile cap, footing, sump, lift pit or trench, provided that the size of these structures does not exceed 10 square meters in area and 2 meters in depth.
• **Plans Submission**
  (a) Plans approval is required for ERSS/UBW
   - To attach Exc UBW Annex A
   - To include site investigation report with PE certification
  (b) Require Permit to commence work
   - to attach Exc UBW Annex B
   - Commencement of work: to notify BCA

• **During Construction Stage**
  - To implement Exc UBW Annex C and D at site
  - To submit Exc UBW Annex E to BCA monthly
Advisory Note 1/09 on ERSS

Table 1: Allowable maximum ERSS wall deflection limits

<table>
<thead>
<tr>
<th>Wall deflection limits/Zones</th>
<th>Locations of buildings, structures and critical utilities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Zone 1</td>
</tr>
<tr>
<td></td>
<td>(x/H &lt; 1)</td>
</tr>
<tr>
<td>Allowable maximum ERSS wall deflection limits (δw/H)</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

Ground Type A refers to over-consolidated stiff clays and silts, residual soils, and medium to dense sands; and Ground Type B refers to soft clays, silts or organic soils extending to or below formation level (e.g. Kallang Formation) and loose fills.

10 In any case, the allowable wall deflection limits shall also be determined by the prevention of structural damage to neighbouring buildings or structures arising from ground deformations.

Table 2: Control strategies guides for ERSS.

<table>
<thead>
<tr>
<th>Zone 1</th>
<th>Allowable limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alert level</td>
<td>Work suspension level</td>
</tr>
<tr>
<td>70% WSL</td>
<td>Allowable wall deflection limit</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ZONES 2 and 3</th>
<th>Allowable limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check level</td>
<td>Alert level</td>
</tr>
<tr>
<td>50% WSL</td>
<td>70% WSL</td>
</tr>
</tbody>
</table>
Use of Ground improvement within retaining wall

- In view of uncertainty in using ground improvement, ground improvement shall be limited to soil improvement work only and shall NOT be used as part of retaining wall especially acting as cantilever retaining wall. This is in line with COI report and BCA's Advisory Note 1/09.

- If grout mixed piles are present within the retaining wall, as a minimum the following conditions shall be met:

  a) all wall forces such as bending moments and shear forces shall be resisted by a separate structure system (such as soldier piles steel section inserted within the grout mixed pile, a separate analysis for obtaining wall forces shall be carried out with steel section only with grout mixed piles ignored in this analysis)

  b) separate structural laggings (concrete, timber, or steel) shall be provided between structural wall member.
Supervision QP and his team shall not be a partner, an officer or an employee of the developer or builder.

“Independence of QP is essential to avoid situations of conflict of interest”

COI Report 2005

*shall not have any financial or professional interest on the project
*shall be appointed by developer including for ERSS(UBW) submission

Developer

- QP(D)
- QP(S)
- QP(Geo)(D)
- QP(Geo)(S)
- AC*
- AC(Geo)*

Builder

Instrumentation contractor

- QP(Geo)(D)
- QP(S)
Examples of Underground Building Works (Excavation/earth retaining structures)
Basement Excavation Works: Open cut method

Single tier open cut slope

H > 6 m

UBW
Basement Excavation Works: Open cut method

Multi-tier open cut slope

\[ H = h_1 + h_2 \]

\[ H > 6 \text{ m} \]
Excavation Works: Earth Retaining System

Note: Besides retaining wall and strutting supporting system, ground improvement layer is also need to be submitted as part of the UBW(ERSS) system.
Excavation Works: Basement in sloping ground

$H = h_1 + h_2$

Existing ground level

$H > 6 \text{ m}$

Note: For computation of excavation depth of UBW, $H$ is computed from where the excavation started and to the final formation level.

UBW = Earth retaining & support system, slope
Excavation Works: Basement in sloping/varying ground

UBW = Earth retaining & support system

Non-UBW

UBW
Localise pits to be excavated in sequential manner and it is independently supported and not adversely affecting the main excavation.

Excavation depth = H

**Note:** In determining the general depth of excavations for ERSS(UBW), the depth of localized pits can be disregarded if they are to be constructed in sequential manner; otherwise the depth of localized pits or trenches shall be added if they fall within the zone of influence, and may be disregarded if they fall outside the zone. In general, the zone of influence shall be taken as the area formed within a distance $D$ from any face of the excavation, where $D = 2$ times the depth of the localized pit or trench (for stiff residual soil condition).
Localise pits to be excavated not in sequential manner or to be excavated all together

**Excavation depth** = h₁ + h₂

**Note:** In determining the general depth of excavations for ERSS(UBW), the depth of localized pits can be disregarded if they are to be constructed in sequential manner; otherwise the depth of localized pits or trenches shall be added if they fall within the zone of influence, and may be disregarded if they fall outside the zone. In general, the zone of influence shall be taken as the area formed within a distance $D$ from any face of the excavation, where $D = 2$ times the depth of the localized pit or trench (for stiff residual soil condition).
Excavation Works: Construction of Basement structures

UBW = Temporary earth retaining & support system
Basement structures which is within the excavation support system, is not UBW
Excavation Works: Construction of Basement structure

Note:

a) The plan submission for the temporary retaining wall and permanent basement structure shall be submitted under the same ST and to be submitted as UBW (not submit as piling)

As temporary retaining wall also serves as permanent retaining system of basement structure, UBW = Temporary and permanent earth retaining & support system including basement structure
Excavation Works: Drainage Works

UBW = Temporary earth retaining & support system
Box culvert which is within the excavation support system, is not UBW
Excavation Works: Utilities pipes (such as sewers, water and gas pipes) with diameter larger than 2 m and its associated shafts or manholes

UBW = Temporary earth retaining & support system
Utilities pipes or manholes which is within the excavation support system, is not UBW
Examples of Underground Building Works
(Tunneling Works)
Tunneling Works: Bored Tunnels/Jacked-in tunnel

UBW = Permanent (tunnel lining) and temporary tunnel support system
Tunneling Works: Cut-and-cover Tunnels

Cut-and-cover tunnels

H > 6 m

UBW = Temporary earth retaining & support system
Tunnel box structure, which is within the excavation support system, is not UBW
Tunneling Works: Mined Tunnel

UBW = Temporary tunnel support system
Permanent tunnel structure which is within the tunnel support system, is not UBW

$h, w > 2 \text{ m}$
Examples of Underground Building Works (Foundation Works)
Foundation of High-rise

UBW = Raft foundation

H ≥ 30 storey

UBW = Caisson, barrette piled foundation or Piled raft foundation

H ≥ 30 storey
Examples of Non Underground Building Works
Any excavation for shaft and trenches with plan area of the excavation not exceeding 10 square metres (e.g. trench excavation for diaphragm wall, excavation for bored piles) is exempted from the requirements of underground building works. (UBW). For example, an excavation for a small shaft with plan area less than 10 sq m is exempted from the requirement of UBW but still subjected to ERSS submission requirements.
Insignificant Building Works: Utilities such as Sewers, water and gas pipes with diameter of 1m or less

Any trenches for the purpose of laying sewers/utilities (including its associated shaft or manholes) not exceeding 1m in diameter in conjunction with any public sewerage/utilities system is classified as insignificant work which requires no plan submission. This exemption does not apply to cases where the trenches for the purpose of laying sewers/utilities (diameter less than 1m) are within a construction site where the size of trench exceeds 10 square metres or exceeds 2m in depth.
Excavation Works: Utilities pipes (such as sewers, water and gas pipes) with diameter larger than 1 m and not greater than 2 m and its associated shafts or manholes

Submission requirement:
- $H \leq 4 \text{ m}$ – ERSS plan to be submitted by QP
- $H > 4 \text{ m}$ – ERSS plan to be submitted by QP and AC
- Utilities pipe – Plan to be submitted by QP and AC
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