AGS (HK)
香港岩土及岩土環境工程專業協會
ASSOCIATION OF GEOTECHNICAL & GEOENVIRONMENTAL SPECIALISTS (HONG KONG)
Website : www.ags-hk.org

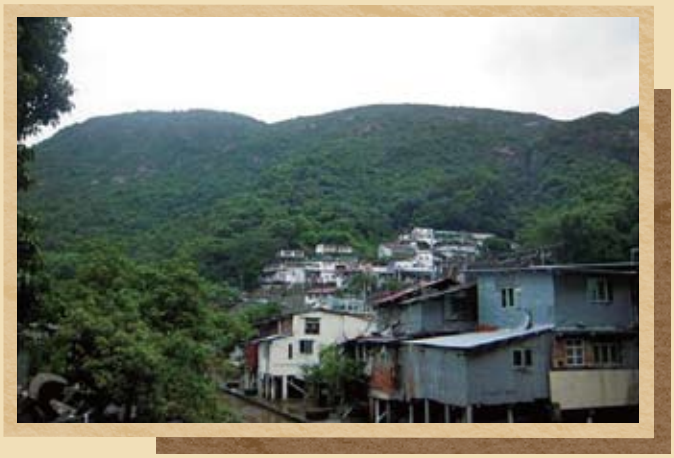
GROUND INVESTIGATION GUIDELINES
04.8 – NATURAL TERRAIN MITIGATION WORKS

(This guideline should be read in conjunction with GIG 04.5 Landslides)

WHAT WE NEED TO KNOW?

General information needed

- Geological model
- Topographical and hydrogeological profiles
- Natural terrain hazard model
- Type of potential natural terrain hazards (open hillside failure, channelized debris flow, boulder or rock fall)
- Groundwater and surface water
- Presence of adverse geological features
- Signs of progressive failure



Other information that may be needed

- Location of water carrying services (catchwater, reservoirs)
- Tunnels (running beneath hillsides)
- Overhead cables / pylons

Information to be acquired from

- Desk study
- API
- Walkover survey
- Preliminary geological mapping (where accessible)
- Available GI and laboratory records
- Relict / present landslides records from ENTLI / incident reports

GROUND INVESTIGATION

Methods

1. Drillholes
   - Identify geological condition
   - Determine soil and rock parameters through sampling, in-situ and laboratory testing and geophysical testing
   - Identify groundwater condition by installation of standpipes and piezometers

2. Trial pits / trial trenches
   - Identify geological features, especially near or across areas of failures
   - Determine soil / rock parameters through sampling and laboratory testing

3. Geophysical survey (seismic, resistivity and ground penetrating radar)
   - Identify localised geological features
   - Indirect interpretation required

4. Slope stripping / vegetation clearance stripping

- Identify presence of surface features
- Ground-truthing of relict landslide scars identified from API and / or past landslide records

Sampling

1. In drillholes

- Continuous Mazier sampling to identify geological conditions in critical areas (landslide scarp, progressive movement zone)
- Alternate sampling of Mazier and SPT with liner if determination of soil parameters required for mitigation design
- Piston sampling if very soft soils encountered
- Double tube drilling in rock, preferably with air foam flushing for better recovery
- Triple tube coring with air foam flushing if highly fractured, shear zones, fault gouge or hydrothermally altered rock encountered
- Groundwater samples

2. In trial pits / trial trenches

- Block samples across failure plans, soft seams, clay rich zones etc to determine its properties through laboratory testing
- Bulk samples for soil index test
- U-samples with bulk samples as alternative for block sample if difficult to obtain (e.g. colluvium dominantly comprising gravel and cobbles)

3. In slope stripping

- U-sample for soil index test
- Bulk samples where necessary

TYPICAL PROPERTIES TO BE DETERMINED

For hazard study

- Adverse geological features / signs of deterioration (e.g. soil pipes, tension cracks, opening of joints, clay infill, weak zones, slickensided joint surfaces etc)
- Geological condition across critical areas (e.g. areas where landslides occurred and / or potential landslides may occur)
- Soil and rock properties for potential landslide source areas
- Rock joint properties and characteristics that may potentially be favourable to occurrence of landslides
- Groundwater profile across the study area
- Age dating of colluvium samples may be useful

For design of mitigation works

- Soil and rock parameters for design of mitigation works
- Soil nails, flexible barriers, rigid barriers etc
- Groundwater profile for design
- Rock joint characteristics, geometry and parameters

TYPICAL DESIGN PARAMETERS REQUIRED

In-situ tests

1. Drillholes

- SPT
- Impression packer / acoustic televiewer test for rock joint measurements
- Falling / constant head permeability test
- Vane shear test for very soft soil

2. Trial pits / trial trenches

- In situ density test (for fill, landslide debris material)
- Vane shear test for very soft soil

Long term monitoring

- Standpipes / piezometers provided with automatic groundwater monitoring device (AGMD)
- Additional instrumentation on slope movement depending on the mode of hazard identified

Laboratory tests

- PSD
- Atterberg limits
- Water content
- Bulk density
- Proctor test
- Triaxial test
- Direct shear box test (along failure surface, soft clay layers, rock joints etc)
- Chemical tests for groundwater (pH, sulphate and chloride)
- Chemical tests for soils (pH, sulphate, chloride, organic matter, carbonate content and resistivity)
- Longitudinal splitting of Mazier samples

SPECIAL CONSIDERATIONS

Pre-GI preparatory works

1. Land matter

- Land often within unallocated government land, obtain STLA from DLO, LandsD
- For works in close vicinity with residential areas, either in villages or estates, close liaison with residents informing them on the nature and purpose of GI works prior to commencement will be beneficial for smooth progress of the project
- For land falling within or in vicinity to the following areas, consent will be required from (in brackets):
  - Country park (AFCD)
  - Water gathering ground (WSD)
  - Burial ground (owner contacted via DO or HAD)
  - Private lot (owner contacted via DO, HAD or Estate Management Office)
  - Tunnel reserve (WSD / DSD / MTR / other utility undertakers)
  - Presence of archaeological remains (AMO)

2. Mobilisation of equipments

- Pre-GI site visit to identify feasible route for mobilisation of drilling rigs, locate possible temporary storage area and water source

3. Cost estimation

- Special attention required when estimating the cost for access, type of rigs to be used due to remoteness and steep nature of hillside

During GI works

1. Access problem

- Due to steep terrains and remoteness of the site
- Long access often required, contributed to significant cost in the overall GI works

2. Mobilisation of drilling rigs

- Mobilisation by helicopter is common, thus shall be considered during cost estimation

- Use of portable drilling rigs in some remote areas where mobilisation of conventional rigs is impossible due to:
  - Prohibited helicopter flight (close vicinity with public roads, residential area, pylon etc)
  - Terrain too steep or within steep valley region where manual mobilisation is unlikely
- Maximum drilling depth for portable drilling rig is about 15m

3. Protection of extreme weather conditions

- Appropriate measures to guard against heavy rainfall or typhoon shall be implemented

4. Safety and health

- Work within natural hillsides, often rural areas
- Potential exposure of workers to extreme weather conditions and attack by animals / insects
- Safety issues arisen from working at sloping ground / heights, limited working space
- Safety plan shall detail any potential hazards and corresponding preventive measures