

## A Safety Guideline for Hill-Site Development of Penang, Malaysia – Challenges and a Way Forward



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**Abstract** A safety guideline for hillsite developments of a state government has been developed with the aim of mitigating landslides and save lives. Landslides often occur in areas with steep hills especially hills with activities such as hillsite developments for residents and commercial or agricultural purposes. The risk to lives and properties is higher in hillsite developments for residents and commercial purposes. This paper describes the initiatives taken by a state government in Malaysia to improve the practice of engineering on slopes for new developments. This safety guideline was developed for a more transparent and clearer on what needs to be done by main stakeholders, namely developers and their consultants, contractors and the local authority. The Guideline starts with a simple slope classification based on gradient for planning approval. The design requirements for a hillsite development are based on the hazard levels. The required expertise to ensure safety of slopes with gradient steeper than  $25^\circ$  and above is specified. It also requires an independent checker to audit the design and make regular inspection of the site to check the compliance of construction. The qualifications of submission engineers for a proposed development and its independent checker on slopes greater than  $25^\circ$  are specified to ensure competent geotechnical engineers with relevant experience to undertake the design and supervision and independent checking works. The Guideline also details the submission requirements needed for a proposed development including the formats of geotechnical design and independent checker reports.

**Keywords** hill-site, safety, policy, guideline, planning, slope

### Introduction

A clear and transparent Guideline for hillsite development is very important to ensure safety. A local Government or authority needs to spell out systematic ways for developers to submit their proposal of a hillsite development from planning to design, construction and maintenance.

### Objectives

The objectives of the Guideline are to improve safety and environment of hillsite developments. It provides clear and consistent application procedures together with transparent approving mechanism for Governmental Approval and control during construction and maintenance.

The Guideline, among others :

- Has made clearer classification of slopes for ease of implementation at planning stage.
- Has stated the duties and responsibilities of Engineers and Independent Checkers during design and construction stages.
- Requires Independent Checkers to visit project sites during constructions and report any non-compliance directly to the local authority for prompt enforcement.
- Has defined better the qualification and experience of key personnel (geotechnical engineer and independent checkers) to ensure quality of works for hillsite developments during the design and construction stages.
- Has made it mandatory for developers to engage qualified engineers and independent checkers - having the required expertise and

experience on hillsite developments and sufficient capacity to design and supervise the constructions.

- Requires contractors to comply with the design drawings and specifications for the slope works.
- Has reduced the requirement for plinth area (maximum allowable hard surface footprint) for buildings on Class 3 and Class 4 hillside lands, with the intention of preserving more natural green areas.
- Requires engineered slopes including earth retaining systems to incorporate green features to enhance Penang's natural environment.

### Towards a Safe and Green Penang

The Guideline addresses and upgrades existing safety measures and outlines better project implementation procedures and effective enforcement. It strives to inculcate good slope design, construction and maintenance culture. With its proper implementation, the Guideline will inspire confidence in the safety of hillsite developments in Penang.

The advisory panel, which drew up the Guideline, will continue to assist the authorities to effectively implement and enforce it. This is to ensure that developers, engineers, contractors and property owners in hillsite areas comply with good engineering practices relating to the stability of hill slopes.

Still lingering in the Malaysian public's consciousness are the many hill land failures which caused tragedies over the past 20 years.

The major causes of slope failures can be summarised as follows:

- **Design** – inadequate ground investigation, lack of understanding of engineering analysis and design.
- **Construction** – lack of quality assurance and quality control by contractors and lack of proper site supervision by engineers.
- **Maintenance** – lack of slope maintenance culture is prevalent in both the public and private sectors.
- **Communication** – lack of communication amongst various parties involved in construction.

The resulting loss of lives, destruction to public and private properties as well as the ensuing legal tangles that may be still ongoing have triggered various reactions; there had been conferences, seminars, dialogues, more stringent rules and regulations and better practices for hillsite development.

This Guideline makes a concerted attempt to incorporate all the lessons learnt.

### Major Considerations

Numerous guidelines for hillsite developments from various agencies have been produced after the collapse of Block 1 of Highland Towers in 1993. This Guideline aims to simplify existing procedures and to improve the safety of hillsite developments.

To further improve the safety of slopes and earth retaining systems, this Guideline has some major considerations that include :

- Slope classification for planning approval has been simplified for clarity and consistency.
- Design requirements of slope have been strengthened through clearer definitions.
- The required qualifications of engineers including geotechnical engineers needed for different terrain classification of slopes are established.
- The requirement and need for independent checkers is not better defined and the input is extended beyond design to include inspection during construction.
- Maintenance of slope needs proper input by the Engineers which includes the need to produce maintenance manuals so that owners know their responsibilities and what entails in the maintenance of slopes.
- The maximum allowable hard surface footprint has been intentionally reduced by more than 5% for Class 3A and 3B and about 20% for Class 4A and 4B slopes. This will improve safety and enhance the preservation of the green environment.
- Geotechnical engineer shall provide solution for localised Class 3 and 4 slopes within the proposed development.
- Proposed development on flat land adjacent to potentially unstable slope, as shown in Fig. 1 which could not be strengthened for any reason including its inaccessibility due to trespass and/or land issues, will require a suitable buffer zone. The width of the buffer zone should be at least the height of the slope.
- Proposed development on potentially unstable slope as shown in Fig. 2, which could not be strengthened due to inaccessibility and/or land issues, shall not be allowed.

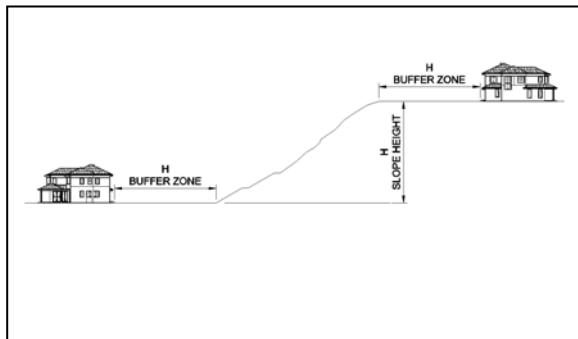


Fig. 1 Buffer Zone



Fig. 2 Development on Slope

### Classifications of Slopes

Slopes are classified according to slope gradient and type.

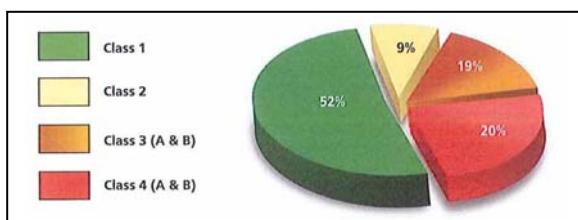


Fig. 3 Penang Island's Hill Land Distribution

The slope gradient, in degrees, is measured from the horizontal plane. Sufficient survey points shall be obtained to produce accurate contour lines at 5m intervals. More survey points shall be obtained at localized areas such as existing slip, man-made slopes/structures, etc. The extent of survey shall include an area beyond the land boundary not less than 20 metres.

The type of slopes is divided into natural or man-made slope. Man-made slope is further divided into cut or fill slope. Higher risk is associated with fill slope.

Tab. 1 shows the Slope Classification for Design Purposes. The table also shows the associated risk and the maximum allowable hard surface footprint. The maximum allowable hard surface footprints for Class 3A, 3B, 4A and 4B are reduced in this guideline as compared to the previous guidelines. This is to preserve green areas and to allow easy maintenance and strengthening of slopes.

The maximum allowable hard surface in Tab. 1 below is applicable to all allowable developments. Nonetheless, the state's planning policy at the material time, including any height restriction shall take precedence.

Table 1 Slope Classification for Design Purposes

CLASS	SLOPE GRADIENT	NATURAL SLOPE	ASSOCIATED RISK		MAXIMUM ALLOWABLE HARD SURFACE FOOTPRINT
			CUT	FILL	
1	$0^\circ - 15^\circ$	Low	Low	Low	Refer to current policy
2	$>15^\circ - 25^\circ$	Low	Low	Low	
3A	$>25^\circ - 35^\circ$	Medium	Medium	Not Applicable	35%
3B	$>25^\circ - 35^\circ$	Not Applicable	Not Applicable	High	35%
4A	$> 35^\circ$	High	High	Not Applicable	30%
4B	$> 35^\circ$	Not Applicable	Not Applicable	Very High	30%

Tab. 2 shows the submission requirements for all the classes of slopes by submission engineers. The qualifications of the submission engineers are stated in Tab. 3. Tab. 4 states the responsible party for the appointment of Geotechnical Design Engineer and Independent Checkers.

Please take note of the following:

- The Civil Engineer and Geotechnical Engineer for a particular project can be the same or different engineer.
- The Geotechnical Engineer and Independent Checker for a particular project must be different engineers. They must also not be from the same firm.

During construction, proper and adequate supervision are important. Tab. 5 states the construction supervision requirement.

Table 2 Submission Requirements

CLASS	SUBMISSION REQUIREMENTS
1 (Low Risk)	Slope Stability Analysis by Civil Engineer
2 (Low Risk)	Geotechnical Design Report by Geotechnical Design Engineer
3A (Medium Risk), 3B, 4A (High Risk)	Geotechnical Design Report by Geotechnical Design Engineer and Geotechnical Review Report by Independent Checker
4B (Very High Risk)	Independent Checker

Table 3 Qualifications of Engineers

SUBMISSION ENGINEER	QUALIFICATIONS
Civil Engineer	<ol style="list-style-type: none"> <li>1. Meets relevant Local Authority's requirements.</li> <li>2. Registered Professional Engineers with Board of Engineers, Malaysia (BEM).</li> </ol>
Geotechnical Design Engineer	<ol style="list-style-type: none"> <li>1. Meets relevant Local Authority's requirements.</li> <li>2. Registered Professional Engineers with BEM with minimum three years practical geotechnical experience and one year gained in Malaysia.</li> </ol>
Independent Checker	<ol style="list-style-type: none"> <li>1. Meets relevant Local Authority's requirements.</li> <li>2. Registered Professional Engineers with BEM with:             <ol style="list-style-type: none"> <li>i. At least 10 years relevant practical experience in the design or construction of buildings and, during the period 7 years immediately preceding the current appointment, has been engaged in geotechnical design after registration as a professional engineer with at least one year of such practical experience gained in Malaysia.</li> <li>ii. At least 3 years relevant practical experience in slope engineering with at least one year of such practical experience gained in Malaysia.</li> </ol> </li> </ol> <p>OR</p> <p>Registered Accredited Checkers (Geotechnical) with BEM</p>

Table 4 Appointment of Geotechnical Engineer and Independent Checker

CLASS	APPOINTMENT
1 (Low Risk)	Geotechnical Design Engineer is not required
2 (Low Risk)	Appointment of Geotechnical Design Engineer by Developer
3A (Medium Risk), 3B & 4A (High Risk)	Appointment of Geotechnical Design Engineer and Independent Checker by Developer
4B (Very High Risk)	Appointment of Geotechnical Design Engineer and Independent Checker by Developer and concurred by Local Authority

## Submission Requirements

### Pre-Submission Consultation

Submitting Person (SP) – be it the Planner, Architect, Engineer, Geotechnical Engineer or Surveyor – shall engage in pre-submission consultation with the relevant departments prior to submission of Layout Plan and Geotechnical Report for all hillslope development projects.

Table 5 Construction Supervision Requirements

CLASS	SUPERVISION REQUIREMENTS
1 & 2 (Low Risk)	No changes to existing requirements as stipulated in UBBL Sections 5 and 7
3A (Medium Risk), 3B & 4A (High Risk)	Additional audit via site visits shall be carried out by Independent Checker. Minimum frequency of site visits shall be once a month.
4B (Very High Risk)	Additional audit via site visits shall be carried out by Independent Checker. Minimum frequency of site visits shall be once every fortnightly. Instrumentation monitoring shall be carried out to monitor conditions of slopes.

The submitting person shall compile or make available some basic documents and/or information for discussion during the pre-submission consultation with the relevant authorities. For example land classification, land suitability, preliminary proposed Layout Plan, Land Survey plan and Terrain Mapping.

### Preparation of Final Layout Plan & Geotechnical Report

The SP shall ensure that there will be no more changes made to the Layout Plan and shall order the Final

Geotechnical Report to be prepared for concurrent submission to One-Stop Centre (OSC) of the authority.

Changes made during the delivery process may result in re-submission of Layout Plan and Geotechnical Report for approval.

The table below shows the colours to use in preparing terrain map and submission flow chart with timeline for approval was also included to ensure effective implementation.

Table 6 Colour Code for Terrain Mapping

Slope Classification	Colour	Decimal RGB Codes			Equivalent AutoCAD Colour Index #
		Red	Green	Blue	
Class 1	Light Green	212	255	170	71
Class 2	Beige	255	255	170	51
Class 3A	Brown	255	234	170	41
Class 3B	Orange	255	170	170	11
Class 4A	Light Red	255	63	0	20
Class 4B	Red	255	0	0	1

#### Notes to the Submission Flow Chart

1. Pre-Submission Consultation
2. Preparation of final Layout Plan and Geotechnical Report for Submission
3. Submission to One-Stop Centre
4. Submission of Geotechnical Report to JKR (Malaysian Public Works Department)
5. Comments and Requirements by Geotechnical Engineer
6. Compliance of Requirements by Geotechnical Engineer
7. Approval of Geotechnical Report

#### Appointment of Competent Engineers

The Guideline also include the method and procedure of selecting engineers by ability shall be as follows:

- Technical competence
- Managerial ability
- Availability of Resources
- Professional Independence & Integrity
- Fairness of Fee
- Quality Assurance System

These are very important criteria to be considered in selecting a competent engineer.

The other considerations are the engineer's personal attributes such as having good commitment towards project, communication skills and engineering judgement, and these should be well augmented with his experience in the industry.

#### Maintenance Inspection

The maintenance of slopes and earth retaining walls should generally follow the specific guidelines with a

maintenance manual prepared by the Consulting Engineer.

#### A Way Forward

This Guideline needs the commitment of all the stakeholders to improve safety of hillslope development and enhance the environment. To succeed, it demands :

- Developers must engage their competent engineers and contractors with capability and capacity.
- Engineers must exercise due skill and care when performing their duties in planning, analysis, design and supervision, and must complement these duties with a regimen of quality checking and review. Their service must include the preparation of maintenance manuals and the duty of adequate post-construction inspections.
- Contractors must have trained personnel and proper and adequate plant and equipment to meet the design and specification requirements of the works. The importance of implementing temporary works for safety, site control and erosion protection must be instilled in the workers and implemented at the construction site.
- Approving authorities must have experienced engineers in their geotechnical units to facilitate and enforce compliance with the Guideline.

When hard surfaces such as earth retaining systems and reinforced slopes have to be constructed to enhance or achieve safety, all stakeholders must be committed to the green initiative to incorporate planting provisions on these facilities to achieve a friendlier environment.

#### Acknowledgments

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