THE INSTITUTION OF ENGINEERS, MALAYSIA

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POSITION PAPER

FOR

MITIGATING

THE RISK OF LANDSLIDE

ON HILL-SITE DEVELOPMENT

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EXECUTIVE SUMMARY

This paper aims to provide uniform, consistent and effective policies and procedures for mitigating the risk of landslide on hill-site development for the consideration and implementation by the Federal Government. Frequent landslide problems at hill-site in residential areas have become serious public issues and concerns. Appropriate policies to check the problems are imperative as the existing policies and procedures by the local Governments are deficient and not comprehensive.

Recommendations by The Institution of Engineers, Malaysia (IEM) after detail deliberations and discussions with the concerned parties / groups and finally through a formal forum are summarized below:-

The slopes for hill-site development shall be classified into **Class 1** to **Class 3** according to the level of risk. **Class 3** being the highest level of risk. The classification is based on the geometry of the slopes such as height and angle. For **Class 1** development, existing legislation procedures can be applied. For **Class 2** development, a Geotechnical Report by "Qualified Professional Engineer" is mandatory. For **Class 3** development, the developer shall also engage an "Accredited Checker".

The Board of Engineers Malaysia **IS RECOMMENDED** to carry out the registration of "Accredited Checker" immediately to ensure only suitably **EXPERIENCED** and qualified engineers are engaged for hill-site development projects.

A new federal department to be called "**Hill-Site Engineering Agency**" **IS PROPOSED** to be formed under the Ministry of Housing and Local Governments to assist Local Governments in respect to hill-site development. This Agency is to act**, REGULATE** and approve all hill-site developments. The Agency could engage **OR OUT SOURCE , WHENEVER NECESSARY,**a panel of consultants to assist and expedite in implementation. For existing hill-site development, the Agency should **ADVISE** the local government to issue "Dangerous Hill-Side Order" to owners of doubtful and unstable slopes.

IEM strongly recommends that the above policies and procedures be implemented by the Government as soon as possible to mitigate the risk of landslide on hill-site development.

1. INTRODUCTION

1.1 The Issues:

- Frequent occurrences of slope failure at hill-site in residential areas during the rainy season have resulted in public fear for the safety of lives and properties located in those areas. Lack of systematic regulatory measures to address the safety problems of hill-site development is the root cause of the problem.

- Existing legislations and guidelines on slope failure mitigation have not been effective to produce a satisfactory solution.

- Lack of slope maintenance culture is prevalent in both public as well as private sector.

1.2 Objectives and Scope of the Position Paper Committee

Objectives:

- To draw up proposal on mitigation policy and guidelines for the consideration and acceptance of the government.

- To ensure developers, consultants, contractors and property owners in `hill-site areas' comply with good engineering practice relating to the stability of hill slope.

- To enable easy and effective enforcement and monitoring by the regulating agencies or authorities.

- To regulate the skill and competence of consultants involved in hill slope stability.

- To create a complete Management Information System (MIS) and overall slope management programme.

Scope:

- Research into the existing legislations and practices in comparison with overseas examples.

- Examine and grade classification of slope in the order of risk of landslide.
- Examine and recommend procedures for hill-site development approval by regulatory agencies or authorities.

- Regulate qualified persons on competence in design, supervision and maintenance of hill-site slopes.

- Prepare recommendations on policy, guidelines and procedures for the consideration and acceptance of government.

1.3 The Formation of the Position Paper Committee

- A committee was set up by the Institution of Engineers, Malaysia (IEM) headed by Ir. Dr. Gue See Sew with members from Building Control Unit, Ministry of Housing, universities and practising engineers in private practice to formulate position paper for mitigating the risk of landslide on hill-site. The list of members is given in Appendix. IEM will forward the recommendations to higher authority for effective implementation.

1.4 Proposed Policies Related to Hill-Site Development:

The proposed policies are meant for the following :-

- For new developments

- For old and existing hill-site of doubtful stability

- Maintenance of hill slopes

- Integration of hill-site development and maintenance and cost sharing on hill slope maintenance by the owners of hill-site properties.

- Hill-site home owner ‘do and don’t’ guidelines.

- MIS and hazard mapping including risk zoning.

2. BACKGROUND

2.1 History of Landslides in Hill-Site or Related Development

2.1.1 The most dramatic case history of landslide related to hill-site development is the collapse of Block 1 of Highland Towers, which occurred on 11 December, 1993. The collapse of the condominium was attributed to, among other factors, a series of landslides behind the condominium.

2.1.2 The next recent major landslide disaster was the Genting Sempah debris flow, which occurred on 30 June 1995. The debris flow was initiated as several landslides occurred uphill along stream banks, coupled with the breaching of landslide-impounded dams upstream.

2.1.3 More recent landslides include the Bt. Antarabangsa slope failures (May, 1999), which were attributed to weak uncompacted fill materials forming the affected slopes.

2.1.4 Another case history involved with the collapse of a bungalow on a steep slope on 18th Sept, 1988*. This collapse and the associated slope failure was attributed to, among others, an excavation on a neighbouring land and toe erosion at the river banks below the bungalow. (* Dr. Abdul Hamid Abdul Rashid & Anor v Jurusan Malaysia Consultants (sued as a firm) & Ors, High Court (Shah Alam) – Civil Suit No. 22-9 of 1990, James Foong J, 15 November 1996).

2.2 Consequences of the Landslides

2.2.1 The Highland Towers Block 1 collapse killed 48 people. The condominium was also totally destroyed. In addition, the remaining two blocks were abandoned for safety reasons, and this has caused millions of ringgit in economic losses to the owners of the condominiums. (Condominium owners are currently suing for compensations).

2.2.2 The Genting Sempah debris flow killed 20 people and injured 23 others. Economic losses include the destruction of several vehicles, and the excavation and abandonment of the Genting slip road. (Attributed to natural causes – no court case).

2.2.3 The Bt. Antarabangsa landslides did not result in any fatalities or casualties. However, financial losses were incurred by the residents of

the apartment blocks and other affected houses since they were evacuated and had to stay in hotels, etc. up to several months.

2.2.4 The collapse of the bungalow did not result in any casualties. However, the bungalow was destroyed and the owners suffered rental and other miscellaneous losses. Total sum involved was about RM360,000. (Owners sued and were compensated for financial losses).

2.3 Mitigating the Risk of Landslides

In terms of the after-effects of the landslides, the following major efforts or recommendations were either proposed or implemented.

2.3.1 The Highland Towers Block 1 collapse triggered a series of seminars, dialogues, etc which resulted in more stringent rules and regulations and better practices for hill-site development. E.g., the practice of "independent checkers" for every hill-site development especially for high-rise buildings was introduced and implemented.

2.3.2 The Genting Sempah debris flow brought to light the common occurrence of landslides in uphill streams and the associated "landslide dams" which are intrinsically unstable and potentially hazardous. Periodic aerial surveys or hazard mappings of hilly terrains were recommended to tackle the debris flow problem.

2.3.3 The Bt. Antarabangsa landslides highlighted the problem of fill ground or fill materials and their susceptibility to landslides when not properly engineered.

2.3.4 The case of the collapse of the bungalow showed that the construction or excavation on a piece of land can seriously affect the stability / integrity of the adjacent lots.

2.3.5 It can be summarised that the causes of collapse are:-

(1) Design - inadequate ground investigation, lack of understanding of structural analysis and design.

(2) Construction - lack of quality assurance and quality control by Contractors.

(3) Site supervision - lack of proper site supervision by consulting engineers.

(4) Communication - lack of communication amongst various parties involved in construction

2.3.6 Recommendations

(1) To appoint qualified and experienced checking consultants to audit submitting Engineers' design for major development.

(2) To appoint a full time resident professional Engineer to supervise the construction.

(3) Developers, contractors and supervisors be made accountable to the authorities for the construction safety. There should be deterrent imposition of penalties on the defaulting parties in the approval, design, supervision and the construction process.

3.0 LITERATURE REVIEW

The literature review has highlighted Hong Kong's successful management of hill-site development and mitigation of risk of landslides.

Slope safety is regarded as a serious problem in Hong Kong. Landslips have been responsible for the deaths of more than 470 people in Hong Kong since 1948. Most of the deaths resulted from the collapse of man-made slopes. Evidence from investigation of fatal landslips suggests that a significant portion of them originated from inadequacies in the design and construction works, along with lack of subsequent maintenance. Almost all of Hong Kong's landslips are rain-induced. They tend to occur suddenly and developing into large rapid mobile flows, capable of toppling buildings.

A central slope policing body, GEO, was created in Hong Kong in 1977, soon after two catastrophic landslides in the same area which occurred in 1972 and 1976. GEO regulates the whole process of investigation, design, construction, monitoring and maintenance of slopes in Hong Kong. The setting up of this body has been estimated to result in a ten-fold reduction in landslip fatality.

Before the formation of the policing body, site formation and subsequent maintenance of the constructed slope works went largely unregulated. An upgrading programme for the existing man-made slopes was also initiated by GEO in 1977 and is continuing into the present.

3.1 Hong Kong Slope Classification

3.1.1 New Slopes

The Hong Kong Building Authority requires a detailed geotechnical assessment to be carried out on a proposed site when any of the following applies:

(a) where the maximum gradient across a site from boundary or, for a large site, across any 50m long strip, is greater than 15^{o},

(b) Where a slope inclined at more than 30^{o} and greater than 7.5m high (including the height of any retaining wall at its toe or crest) exists on the site or within 7.5m of the site,

(c) Where a retaining wall greater than 6m high (retained height) exists on the site or a 6m or longer portion of such a wall exists within 6m of the site,

(d) Where special geological conditions exist, such as previous landslides, debris flows, threatening boulders and potential rockfalls.

The essential contents of a geotechnical assessment are:

(a) an outline of the topography, geology and presumed groundwater conditions of the site,

(b) a general description of the proposed works and discussion of how the existing geotechnical features (such as slopes, retaining walls and adjacent foundations) will affect or be affected by such works,

(c) a discussion to demonstrate the feasibility of the proposed development, including descriptions of construction methods and sequence of works,

(d) schematic plans and sections of the proposed site formation works and foundation works, taking the above discussion (c) into account,

(e) a plan showing the scope and extent of the proposed ground investigation specifying, by reference to section 15.3 of GEOGUIDE 2 : Guide to site Investigation, the level of independent site supervision of the works that may be needed.

3.1.2 Existing Slopes

Under the Hong Kong Government's Landslip Preventive Measures (LPM) Programme, batches of old man-made slopes (constructed before 1977) are selected for further study. The studies are to confirm whether the selected slopes pose any danger to the public. Where old government owned slopes are found to be below current safety standards, they will be upgraded under the LPM programme. If sub-standard privately owned slopes are identified, a "Dangerous Hillside or DH Order" will be served by the authorities to direct owners to upgrade their slopes.

4. Classification of Risk of Landslide on Hill-Site Development

Hill-Site Development shall be classified into 3 classes as follows:

4.1 Class 1 Hill-site Development

For slopes either NATURAL or MAN MADE, in the Site or Adjacent to the Site not belonging to Class 2 or Class 3.

4.2 Class 2 Hill-site Development

For slopes either NATURAL or MAN MADE, in the Site or Adjacent to the Site where :

- $6m \leq H_T \leq 15m$ and $\square_G \geq 27^o$ or
- $6m \leq H_T \leq 15m$ and $\square_L \geq 30^o$ with $H_L \geq 3m$ or
- $H_T \leq 6m$ and $\square_L \geq 34^o$ with $H_L \geq 3m$ or
- $H_T \geq 15m$ and $19^o \leq \square_G \leq 27^o$ or $27^o \leq \square_L \leq 30^o$ with $H_L \geq 3m$

4.3 Class 3 Hill-site Development

Excluding bungalow (detached unit) not higher than 2-storey.

For slopes either NATURAL or MAN MADE, in the Site or Adjacent to the Site where :

- $H_T \geq 15m$ and $\square_G \geq 27^o$ or
- $H_T \geq 15m$ and $\square_L \geq 30^o$ with $H_L \geq 3m$

DEFINITIONS :

H_T	=	Total Height of Slopes
	=	Total Height of NATURAL SLOPES & MAN MADE SLOPES at site and immediately adjacent to the site which has potential influence to the site. It is the difference between the Lowest Level and the Highest Level at the site including adjacent site.
H_L	=	Height of Localise Slope which Angle of Slope, $\square_L$ is measured.
$\square_G$	=	Global Angle of Slopes (Slopes contributing to H_T).
$\square_L$	=	Localise Angle of Slopes either single and multiple height intervals.

Notes : Table 1 & Figure A1 further illustrate the classification.

5. RECOMMENDATIONS ON POLICIES AND PROCEDURES FOR HILL-SITE DEVELOPMENT

5.1 General

GENERAL PROCEDURES	ACTION
5.1.1 Formation of a "HILL-SITE ENGINEERING AGENCY" (Agency) coordinated and regulated by Ministry of Housing and Local Governments to assist Local Governments. - All newly proposed and existing hill-site developments must be approved by the respective agency. - Evaluation of submission for hill-site development. - Set up panel of consultants to service the agency. - The consultant in the panel shall have Accredited Checker.	Government
5.1.2 Registration of "ACCREDITED CHECKER" - Registration by the Board of Engineers, Malaysia. - At least 10 years relevant experience	The Board of Engineers, Malaysia.

5.2 Procedures for NEW Hill-Site Development

In addition to the existing legislation in force, the following procedures shall be followed:

PROCEDURES	ACTION
5.2.1 Classification of the Hill-Site Development into **CLASS 1, CLASS 2** and **CLASS 3**.	Regulatory Agencies and Consultant
5.2.2 For **CLASS 1** development Follow existing legislation in force.	
5.2.3 For **CLASS 2** Hill Site Development : (a) The consulting team shall have qualified professional engineer to submit Geotechnical Report to the Agency. (b) Evaluation by the Agency with the help of the consultant. (c) Formulate a client charter for a systematic procedure for evaluation of submission for approval of hill-site development.	(a) Developer, Qualified Professional Engineer. (b) & (c) Hill-Site Engineering Agency.
5.2.4 For **CLASS 3** Hill Site Development : (a) The consulting team shall have qualified professional engineer to submit Geotechnical Report to the Agency. (b) The developer shall engage Accredited Checker to check the	(a) Developer, Qualified Professional Engineer. (b) Developer, Accredited

	adequacy of design and safety of Hill-Site Development. (c) Evaluation by the Agency with the help of consultants (d) Formulate a client charter for a systematic procedure for evaluation of submission for approval of hill-site development.	Checker. (c) & (d) Hill-Site Engineering Agency.

5.3 Procedures for <u>EXISTING</u> Hill-Site Development

PROCEDURES	ACTION
5.3.1 Classification of the Hill-Site Development into **CLASS 1, CLASS 2** and **CLASS 3.**	Regulatory Agencies and Consultant.
5.3.2 Issue "Dangerous Hillside Order" to owners of doubtful and unstable slopes after evaluation.	Hill-Site Engineering Agency.
5.3.3 Evaluation of the stability of slopes by Accredited Checker.	Accredited Checker.

6. CONCLUSION

IEM strongly recommends that the above position paper be implemented by the Government as soon as possible to mitigate the risk of landslide on Hill-Site Development.

COMMITTEE MEMBERS

IR. DR. GUE SEE SEW	CHAIRMAN
IR. DR. TING WEN HUI	ADVISOR
IR. DR. CHAN SIN FATT	ADVISOR
IR. DR. OOI TEIK AUN	PANELIST
IR. FONG TIAN YONG	PANELIST
IR. NEOH CHENG AIK	CHIEF EDITOR
IR. TAN YEAN CHIN	SECRETARY
IR. PROF. DR. RUSLAN HASSAN	MEMBER
IR. MC HEE	MEMBER
IR. YEE YEW WENG	MEMBER
PROF. TAN BOON KONG	MEMBER
IR. TEE CHOON HENG	MEMBER
IR. TU YONG ENG	MEMBER
IR. DR. LEE JIN	MEMBER
SDR. EDDIE NG	MEMBER

Table 1

CLASSIFICATION OF RISK OF LANDSLIDE ON HILL-SITE DEVELOPMENT

Class	Total Height (H_T)	Global Angle (α_G)	Localised Height (H_L)	Localised Angle (α_L)
CLASS 1 (Low Risk)	$\geq$ 15 m	< 19°	< 3 m	< 27°
	6 m – 15 m	< 27°	< 3 m	< 30°
	< 6 m	-	-	< 34°
CLASS 2 (Medium Risk)	> 15 m	19° - 27°	-	-
		-	$\geq$ 3 m	27° – 30°
	6 – 15 m	$\geq$ 27°	-	-
		-	$\geq$ 3 m	$\geq$ 30°
	< 6 m	-	$\geq$ 3 m	$\geq$ 34°
CLASS 3 (High Risk)	> 15 m	> 27°	-	-
		-	$\geq$ 3 m	$\geq$ 30°