Standard Operating Procedures (SOP) for Sustainable Hillside Development

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Abstract. In the wake of the recent landslide at Bukit Antarabangsa, there has been intense debate on the sustainability of hillside development. The public's response is understandable and the need for a transparent and safe procedure for hillside development is great in order to safeguard public interest and safety. Some of the proposals being put forward include a total ban of hillside development in order to prevent the reoccurrence of tragedies such as the collapse of Block 1 of Highland Towers which claimed 48 lives in 1993 and the recent landslide which has resulted in five casualties. However, a total ban of hillside development is a simplistic approach and does not address the root causes of the problem. It is akin to banning cars simply because there is a risk of fatality resulting from car accidents. In this paper, the history and role of geotechnical engineering in addressing the issue of safe hillside development are discussed together with some examples of natural landslides which demonstrate the importance of proper studies of all slopes, whether natural or man-made slopes. The paper also puts forward a preliminary proposal on standard operating procedures (SOP) for sustainable hillside development so that public interest and safety are safeguarded.

Keywords: Hillside development, geotechnical engineering, landslides

Introduction

In the wake of the recent landslide at Bukit Antarabangsa, there has been intense debate on the sustainability of hillside development. The public response is understandable and the need for a transparent and safe procedure for hillside development is great in order to safeguard public interest and safety. Some of the proposals put forward include a total ban on hillside development to prevent the reoccurence of tragedies such as the collapse of Block 1 of Highland Towers which claimed 48 lives in 1993 (Figure 1) and the recent landslide which resulted in five casualties (Figure 2).

Figure 1. Highland Towers collapse
(from MPAJ, 1994)

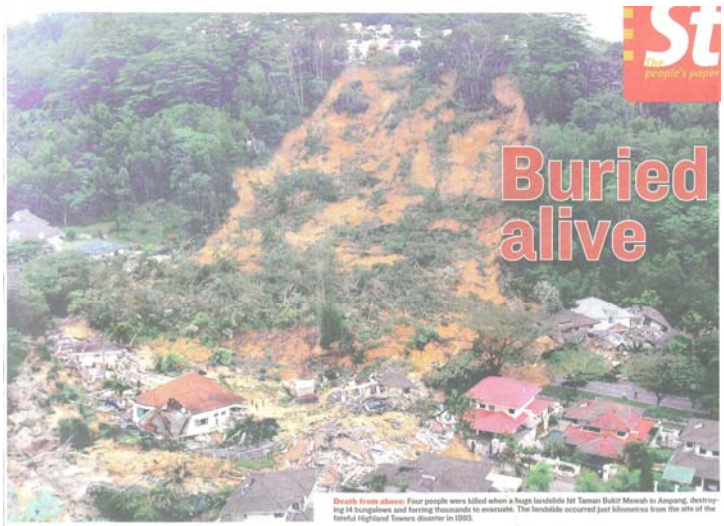
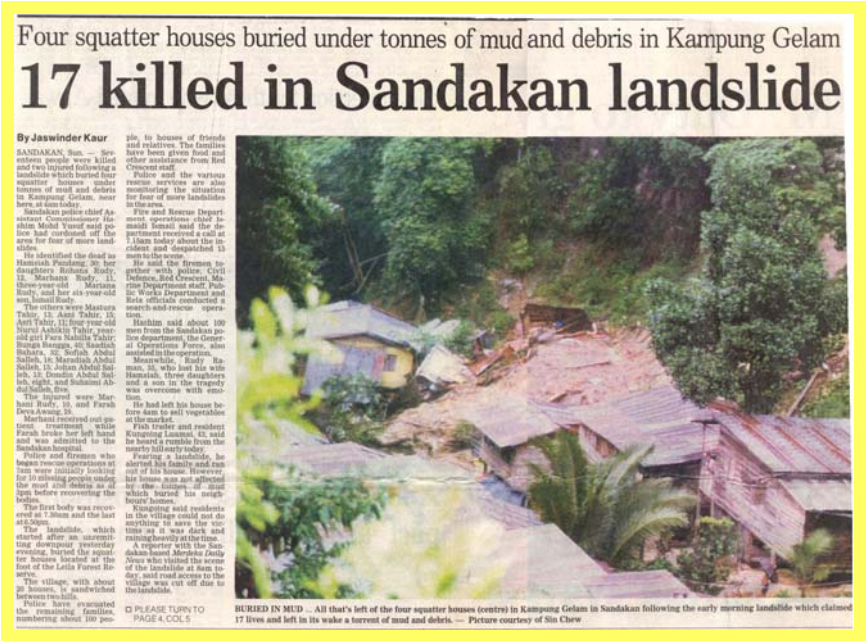


Figure 2. Landslide at Bukit Antarabangsa, 2008
(from The Star Newspaper)

However, a total ban on hillside development is a simplistic approach to the problem as it does not address the root causes of the problem. Several landslides which caused heavy casualties had occurred on natural slopes, e.g. Sandakan in 1999 with 17 deaths (Figure 3). This could not have been prevented by a total ban on hillside development. Furthermore, many sub-standard slopes around the country need immediate strengthening works in order to ensure public safety. An example would be the Taman Hillview tragedy (Figure 4) in 2002 which claimed eight lives. The Taman Hillview tragedy is due to

collapse of a previously constructed rubble wall at an abandoned site. The impact from the sliding soil mass flattened the bungalow at the foot of the hill which is on relatively flat ground.

A blanket ban on hillside development will result in dangerous natural slopes and sub-standard slopes going undetected, which is akin to a time bomb similar to the recent failure at Bukit Antarabangsa.



Four squatter houses buried under tonnes of mud and debris in Kampung Gelam

17 killed in Sandakan landslide

By Jaswinder Kaur

SANDAKAN, Sun. — Seventeen people were killed and two injured following a landslide which buried four squatter houses under tonnes of mud and debris in Kampung Gelam, near here, at 6am today.

Sandakan police chief Assistant Commissioner Hashim Mohd Yusof said police had cordoned off the area for four of more landslides.

He identified the dead as Hamisah Pandang, 30, her daughters Rubana Rudy, 12, Marhana Rudy, 11, three-year-old Mariana Rudy, and her six-year-old son, Ismail Rudy.

The others were Mastura Tahir, 13, Asni Tahir, 15, Asri Tahir, 11, four-year-old Nurul Ashikin Tahir, year-old girl Fara Nabilla Tahir; Bunga Bangga, 40, Saadiah Bahara, 32, Sofiah Abdul Salleh, 16, Marathah Abdul Salleh, 15, Johan Abdul Salleh, 13, Dondin Abdul Salleh, eight, and Sulaimi Abdul Salleh, five.

The injured were Marhani Rudy, 10, and Farah Deva Awang, 10.

Marhani received out-patient treatment while Farah broke her left hand and was admitted to the Sandakan hospital.

Police and firemen who began rescue operations at 7am were initially looking for 10 missing people under the mud and debris as of 1pm before recovering the bodies.

The first body was recovered at 7.30am and the last at 6.30pm.

The landslide, which started after an unremitting downpour yesterday evening, buried the squatter houses located at the foot of the Leila Forest Reserve.

The village, with about 20 houses, is sandwiched between two hills.

Police have evacuated the remaining families, numbering about 100 people, to houses of friends and relatives. The families have been given food and other assistance from Red Crescent staff.

Police and the various rescue services are also monitoring the situation for four of more landslides in the area.

Fire and Rescue Department operations chief Ismaidi Ismail said the department received a call at 7.15am today about the incident and despatched 15 men to the scene.

He said the firemen together with police, Civil Defence, Red Crescent, Marine Department staff, Public Works Department and Rela officials conducted a search-and-rescue operation.

Hashim said about 100 men from the Sandakan police department, the General Operations Force, also assisted in the operation.

Meanwhile, Rudy Raman, 30, who lost his wife Hamaiah, three daughters and a son in the tragedy was overcome with emotion.

He had left his house before 6am to sell vegetables at the market.

Fish trader and resident Kungsing Luamai, 43, said he heard a rumble from the nearby hill early today.

Fearing a landslide, he alerted his family and ran out of his house. However, his house was not affected by the tonnes of mud which buried his neighbours' homes.

Kungsing said residents in the village could not do anything to save the victims as it was dark and raining heavily at the time.

A reporter with the Sandakan-based *Merdeka Daily News* who visited the scene of the landslide at 8am today, said road access to the village was cut off due to the landslide.

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BURIED IN MUD ... All that's left of the four squatter houses (centre) in Kampung Gelam in Sandakan following the early morning landslide which claimed 17 lives and left in its wake a torrent of mud and debris. — Picture courtesy of Sin Chew

Figure 3. Sandakan Landslide (February 1999)

Figure 4. Taman Hillview, Ampang Landslide (2002)

Throughout human history, fascination with hillsides can be seen through various great structures constructed on hillsides such as the Ronda Village in Spain (Figure 5) and the Tiger's Nest Monastery in Bhutan (Figure 6). The construction of such structures demonstrate the application of geotechnical engineering since ancient times.

Figure 5. Ronda Village, Spain (pie.blogs.com)

Figure 6. Tiger's Nest Monastery, Bhutan (www.buddhanet.net)

Geotechnical Engineering

Geotechnical engineering is the branch of civil engineering concerned with the engineering behaviour of earth materials (Wikipedia, 2009). The studies on behaviour of slopes started as early as 1846 (more than 160 years ago!) by the French engineer, Alexandre Collin (Figure 7) through the publications of *Recherches expérimentales sur les glissements spontanés des terrains argilleux* where he made outstanding contribution to knowledge on the stability of clay slopes, principally in terms of first-time slides in cuttings, embankments and earth dams (Skempton, 1979).

Figure 7. Alexandre Collin (1808-1890)

Figure 8. Charles-Augustin de Coulomb (1736-1806)

Another famous engineer who made outstanding contribution to the field of geotechnical engineering is Charles-Augustin de Coulomb (Figure 8). Although the public may be more familiar with his works on physics and electricity, he also studied soil behaviour and retaining walls.

As such, it can be seen that existing knowledge in geotechnical engineering and slopes has gone through a long period of development and is an established branch of engineering. The application of the principle of geotechnical engineering in hillside development is well illustrated in the success of Hong Kong's hillside development where by 2000, Hong Kong's Slope Safety System had reduced the overall landslide risk of old man-made slopes to less than 50% of that in 1977. Hong

Kong's Geotechnical Engineering Office (GEO) strives to reduce landslide risk further to less than 25% by 2010 (HK GEO, July 2008).

The success of Hong Kong's hillside development is primarily attributed to the formation of Geotechnical Engineering Office (GEO) which is a central body to regulate geotechnical engineering and slope safety in Hong Kong. Its key responsibility is to reduce the risk of landslide (Figure 9).

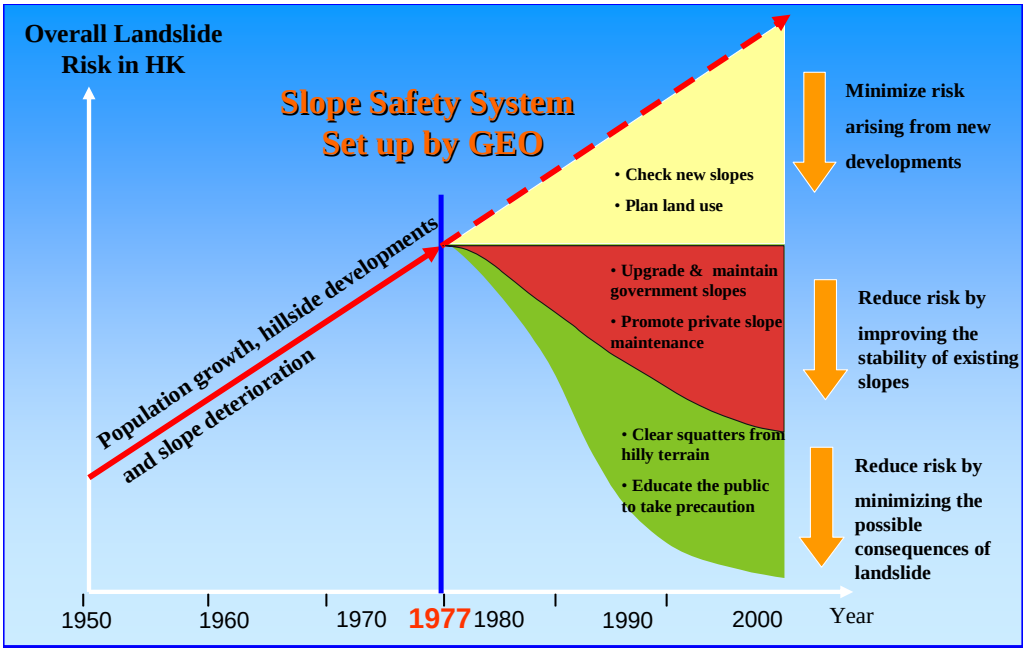

Figure 9. Landslide Risk Reduction Strategy (HK CEDD)

Therefore, it has been demonstrated that safe and sustainable hillside development is achievable. The key is to formulate standard operating procedures (SOP) and set up a centralised institution/agency dedicated for hillside development to ensure safe and good engineering practices in hillside development.

SOP for Sustainable Hillside Development

The creation of standard operating procedures (SOP) and the formation of a centralised institution/agency for hillside development are important to ensure sustainable hillside development. The effectiveness of an institution compared to promises by political parties is described by Tim Harford in his book "The Logic of Life: Uncovering the new economics of everything". Tim Harford argued that institutions are more effective simply because it is far more difficult to overthrow them while policies can easily be changed due to change of political parties. This is the current dilemma facing hillside development. The public has no confidence in the credibility of various stakeholders in ensuring safe and sustainable hillside development and therefore, demand a total ban on hillside development. As such, the way to move forward is for the creation of SOP and a centralised institution/agency for hillside development together with strict enforcement of the SOP to re-establish credibility in the eyes of the public. This is also advantageous to other stakeholders as protests against hillside development will definitely reduce if the competency of the centralised institution/agency is demonstrated.

From previous failures, we observe knee-jerk reactions from political parties but we know that things easily revert to previous bad practices when time passes. This is why the establishment of a centralised institution/agency and SOP are important to ensure sustainable hillside development even after the issue is no longer 'hot'. Promises can easily be broken while institutions often last and are more difficult to overthrow.

The SOP for sustainable hillside development shall address the following key issues:

a) Classification of slopes
b) Submission requirements
c) Approval and enforcement by Authorities
d) Qualifications of geotechnical engineers to undertake geotechnical design and checking hillside development

e) Construction supervision

f) Requirements of accredited checkers

A preliminary proposal on guidelines for hillside development is attached in Appendices 1 and 2. The major factor in ensuring safe and sustainable hillside development is to ensure the developer carry out proper engineering studies on the proposed development and the engineering studies are subjected to rigorous checking and review by an independent geotechnical engineer.

The enforcement of development guidelines is very important and the setting up of a centralised agency modelled after Hong Kong's GEO will provide the necessary technical expertise and manpower to ensure good engineering practice is adhered to in all hillside development. The objectives and functions of the centralised agency shall be clearly identified and its performance subject to review with respect to key performance index (KPI). Some of the major KPI include:

a) Incidences of non-compliances to hillside development guidelines

b) Frequency of occurrences of landslides

c) Number of unstable slopes strengthened

In order to be effective, the centralised agency should implement strict internal QA/QC procedures on the review of technical submission for hillside development. An effective mechanism to accumulate and disseminate information and best practices (i.e. knowledge management) related to hillside development is also important to advance hillside development and further reduce the risk of landslide.

In addition, the centralised agency should carry out landslide prevention by identifying areas with high risk and strengthening unstable slopes. The main priority shall be in areas with the following features:

a) Filled slope

b) High retaining wall especially rubble wall, brick wall and ground anchors

The procedures for identifying high risk areas are generally as follows:

a) Carry out hazard mapping and risk assessment to identify areas with high risk-to-life and economic losses. This will be similar to Hong Kong's Landslip Preventive Measures (LPM) Programme.

b) Upon identification of areas with high risk. Carry out detailed stability assessment.

c) From the stability assessment, propose strengthening measures for unstable slopes. The land owner should carry out the necessary strengthening measures recommended. The approach will be similar to Hong Kong's Dangerous Hillside Order.

For sustainable hillside development, it is also important to carry out proper maintenance on slopes and existing drainage. As such, the centralised agency needs to carry out programmes to educate the public, local authorities and private land owners on the importance of slope maintenance as illustrated in Figure 10.

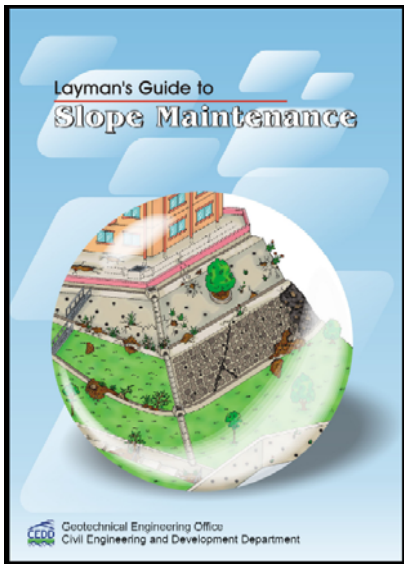

Figure 10. Layman's Guide to Slope Maintenance
(HK CEDD)

The above descriptions of the centralised agency attempt to give a simple overview of some of the major responsibilities of the proposed centralised agency against a broader framework which will encompass other aspects such as:

a) Legal and regulatory framework (i.e. enforcement)
b) Development planning
c) Capacity building
d) Resources allocation
e) Partnerships and networks
f) Organisational aspects
g) Risk assessment and awareness

The proposed framework is summarised in Figure 11.

Summary

Recent landslides which had caused unnecessary loss of lives have highlighted the urgent need of a sustainable and safe development guideline on hillside. The current knee-jerk reaction of imposing a total ban on hillside development does not address the root cause of the problem and is difficult to impose due to the scarcity of land and "human behaviour" where priority changes with time. The formulation of a national guideline and the setting-up of a centralised agency to regulate geotechnical engineering works on hillside will ensure sustainable hillside development is implemented even after the issue is no longer 'hot'. Promises can easily be broken while institutions often last and are more difficult to overthrow. The performance of the centralised agency dedicated for hillside development also needs to be monitored with fixed sets of key performance index (KPI) to ensure compliance to the guidelines.

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