



30 Years of Efforts on Slope Safety

**Geotechnical Engineering Office
Civil Engineering and Development Department**

30th Anniversary Brochure



斜坡安全三十載

**土木工程拓展署
土力工程處**

三十周年紀念特刊



斜坡安全 人人受惠
Slope Safety For All

三十多年前，寶珊道和秀茂坪山泥傾瀉慘劇傷亡無數，我和不少香港市民至今依然記憶猶新。儘管山泥傾瀉災害在社會引起不少隱憂，香港仍不斷向前發展，經濟蓬勃增長，城市建設一日千里，令香港躋身為世界級都會之一。興土木、建高樓，以至提供基礎設施，無不需要開拓土地，因此斜坡安全改善工作不可或缺。土木工程拓展署土力工程處在這方面的貢獻，是本港能持續發展的一項主要因素。

隨著香港城市的發展，斜坡舉目皆是。我們必須適當地維修和美化斜坡，改善市容。土力工程處統籌鞏固及維修政府斜坡，並致力向公眾推廣斜坡安全和維修的意識，成績斐然。在這個值得紀念的時刻，我很多謝土木工程拓展署轄下的土力工程處全體員工竭誠工作，提供優良的專業服務，祝願他們百尺竿頭，更進一步，繼續為香港的安全、繁榮而努力。

林鄭月娥

Like many Hong Kong people, I cannot forget the tragedies of the Po Shan Road and Sau Mau Ping landslides that took many lives, some thirty years ago. The disasters had aroused major concern in the community. Undeterred, Hong Kong has continued to develop into one of the most vibrant and fast growing economies in the world. One of the key success factors, I believe, is the efforts put in by the Geotechnical Engineering Office (GEO) of the Civil Engineering and Development Department (CEDD) in improving slope safety, as a pre-requisite to land development for building and infrastructure construction.

Slopes are found everywhere amidst Hong Kong's urban developments. It is essential that they are properly maintained and landscaped to enhance the city outlook. In this respect, the GEO has made significant progress in spearheading the upgrading and maintenance of government slopes and promoting public awareness in slope safety and maintenance. On this commemorative occasion, I would like to thank the staff of GEO in CEDD for their dedicated efforts and professional excellence and wishing them every success in their continued contribution to the safety and prosperity of Hong Kong.

Carrie Lam



林鄭月娥女士
Mrs Carrie Lam

發展局局長
Secretary for Development

發展局常任秘書長(工務)賀辭

MESSAGE FROM THE PERMANENT SECRETARY
FOR DEVELOPMENT (WORKS)

土力工程處成立至今已有三十年，在斜坡安全方面的工作，成績卓越。我謹藉此機會衷心致賀。

香港山多地少，戰後社會發展迅速，依靠大量削坡填窪，開拓土地。在土力工程處成立以前，很多斜坡工程只靠較為原始的知識建造，因而存在山泥傾瀉對社區的威脅。除了人造斜坡外，香港還要面對天然山坡山泥傾瀉的風險。近年，由於社會普遍不接受填海造地，香港日後的城市發展難免需向山上伸延，因此天然山坡的山泥傾瀉風險，仍會逐漸增加。

斜坡安全在香港過去的發展是重要一環，將來也不能忽視。我深信土力工程處將能繼續扮演領導角色，控制山泥傾瀉災害，確保公眾安全。



麥齊光先生
Mr C K Mak

發展局常任秘書長(工務)
Permanent Secretary for Development (Works)

Hong Kong is hilly. In the post-war years, land for the fast development was formed by cutting into hillsides and filling up valleys. Before the establishment of the GEO, many slopes were constructed with relatively primitive engineering knowledge, resulting in major landside hazards to the community. Apart from man-made slopes, Hong Kong is also faced with the hazard arising from natural terrain landslides. As reclamation is now the less favoured option for land formation, further urban development would inevitably extend into the natural hillside. This will increase the landslide risk from the natural terrain.

Slope safety has been, and will remain to be, an important element in Hong Kong's development. I am confident that the GEO will continue to play the leading role in combating landslide disasters to ensure public safety.

On the occasion of its 30th Anniversary, I would like to offer my congratulations to the Geotechnical Engineering Office (GEO) for its achievements in slope safety.

土木工程拓展署轄下的土力工程處於一九七七年成立至今三十年，是政府在七十年代寶珊道和秀茂坪山泥傾瀉事故發生後開設的岩土工程中央監管體系，負責管理山坡發展工程和斜坡的設計、建造和維修。該處其後致力研發的一套綜合斜坡安全系統，備受世界各地工程界人士和天然災害管理人員推崇，令香港在全球的土力工程界佔有一定地位。

回顧過去三十年的斜坡安全工作，土力工程處成就非凡，深受市民讚賞。本港的山坡如今不但較以往更安全、且更翠綠美觀。該處在岩土工程方面，三十年來力求卓越、屢創佳績，亦令港人引以為榮。我深信該處日後仍會繼續努力，建立更完善的斜坡安全系統，以配合香港市民與日俱增的訴求。最後，我藉此機會勉勵土木工程拓展署轄下的土力工程處全體人員致力為香港帶來更理想的居住環境，並向他們的貢獻致以衷心的謝意。

The year 2007 marks the 30th Anniversary of the Geotechnical Engineering Office (GEO) of the Civil Engineering and Development Department (CEDD). This Office was set up in 1977, following the landslide disasters at Po Shan Road and Sau Mau Ping in the 1970s, to serve as a centralized geotechnical control body to regulate hillside developments and the design, construction and maintenance of slopes. Since then, the GEO has developed a comprehensive Slope Safety System which has won high regard from engineering practitioners and natural hazard managers around the world.

Throughout the thirty years of slope safety work, the achievement of the GEO has been astounding and is well appreciated by the community. Today, we find our slopes not only safer, but also greener. I am very proud of the success of the GEO, especially in its striving for geotechnical engineering excellence for the last three decades. Looking forward, I believe the GEO will continue to build on the existing Slope Safety System to meet the ever-increasing aspiration of the Hong Kong people. Finally, I would like to take this opportunity to express my gratitude to all the staff in GEO of CEDD for their contribution in providing Hong Kong with a better living environment.

土木工程拓展署署長獻辭

MESSAGE FROM THE DIRECTOR OF
CIVIL ENGINEERING AND DEVELOPMENT



蔡新榮先生
Mr John S V Chai

土木工程拓展署署長
Director of Civil Engineering and Development



陳健碩先生
Mr Raymond K S Chan
土力工程處處長
Head of Geotechnical Engineering Office

回望三十年前，政府在一九七七年成立首個岩土工程監管體系，當時香港正飽受嚴重山泥傾瀉事件的威脅，並經常導致人命傷亡。時至今日，在斜坡安全與綠化方面，香港明顯較以往進步良多。

我任職土力工程處已接近三十年，最初加入政府時的任務之一，是負責監督三幅大型填土坡的鞏固工程。當時，斜坡安全極受社會人士關注，甚至港督也定期到工地視察。由於斜坡安全工作不僅有挑戰性，而且饒富意義，於是我不久便加入土力工程處服務。過去三十年，我見證了土力工程處的發展和成就。山泥傾瀉死亡人數大幅下降，正好反映山泥傾瀉風險得到紓解。除了政府的努力外，我認為這個成果部分有賴公眾群策群力，積極參與維修私人斜坡，以及在暴雨期間自行採取防禦措施。

本冊子載述香港斜坡安全系統的背景和詳細資料、工程卓越的關鍵之處，以及所取得的成就。我謹向各位參與籌備這本紀念冊子的同事致謝，特別是歐陽仁生先生、郭維先生及楊暉小姐。並謹此將本冊子獻給過往和現職的土力工程處全體人員，感謝他們多年來努力不懈，不斷致力達至斜坡安全的最高標準，以配合社會的需要。

陳健碩

If we look back 30 years, to 1977 when the first geotechnical control organisation was set up in the government, and when Hong Kong was faced with the threat of repeated fatal landslide disasters, we can easily see how much safer Hong Kong is in terms of slope safety and how much greener our slopes are today.

I have been with the Geotechnical Engineering Office (GEO) (formerly known as the Geotechnical Control Office) for almost 30 years. One of my first jobs with the government was to supervise upgrading works of three major fill slopes. Slope safety was of such a grave concern to the community at that time that even the then Governor came to visit the slope sites regularly. I found slope safety work very challenging and meaningful and joined the Geotechnical Control Office shortly after that. Over the past 30 years, I have witnessed GEO's growth and achievements. The successful reduction in landslide risk is reflected in the substantial drop in the landslide fatality rate. Apart from the government's effort to enhance slope safety in Hong Kong, I would consider part of the

contribution to this success came from the public, mainly in the form of community participation in maintenance of private slopes and undertaking self-precautionary measures during periods of heavy rain.

I would like to thank my colleagues, in particular Messrs Y S Au-Yeung and David Kwok and Miss Jenny Yeung, for the preparation of this memorial brochure. It gives an account of the background and details of the Hong Kong Slope Safety System, the engineering excellence behind it and the achievements made. The brochure is dedicated to all the staff of the GEO, past and present, for their hard work over the years in achieving our mission of meeting Hong Kong's needs for the highest standards of slope safety.

Y S Au-Yeung



前排，由右至左 Front row, from right to left

陳健碩先生 Mr Raymond K S Chan
土力工程處處長 Head of Geotechnical Engineering Office

蔡新榮先生 Mr John S V Chai
土木工程拓展署署長 Director of Civil Engineering and Development

伍國基先生 Mr Adrian K K Ng
土木工程拓展署副署長 Deputy Director of Civil Engineering and Development

後排，由右至左 Back row, from right to left

汪學寧先生 Mr H N Wong
土力工程處副處長(規劃及標準) Deputy Head of Geotechnical Engineering Office (Planning & Standards)

麥樹熹先生 Mr S H Mak
土力工程處副處長(港島) Deputy Head of Geotechnical Engineering Office (Island)

馬碩宜先生 Mr John B Massey
土力工程處副處長(九龍及新界) Deputy Head of Geotechnical Engineering Office (Mainland)

鄧滿祥先生 Mr M C Tang
土力工程處副處長(防止山泥傾瀉) Deputy Head of Geotechnical Engineering Office (Landslip Preventive Measures)

謝金偉先生 Mr K W Tse
主任秘書 Departmental Secretary

發展局局長賀辭

MESSAGE FROM THE SECRETARY FOR DEVELOPMENT

發展局常任秘書長(工務)賀辭

MESSAGE FROM THE PERMANENT SECRETARY FOR DEVELOPMENT (WORKS)

土木工程拓展署署長獻辭

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斜坡安全 三十載

30 Years of Slope Safety

香港地少山多，大部分城市發展依山而建，加上夏天時有大雨，山泥傾瀉便成為我們長期要面對的問題。香港在70年代經歷過多宗大型山泥傾瀉事故，導致很多人命及財物上的損失。政府在1977年成立了一個專責處理斜坡問題的土力工程部門，2007年正是該部門、即土木工程拓展署轄下的土力工程處30週年。自成立以來，我們採用的全方位「斜坡安全系統」，已盡可能將山泥傾瀉風險減至最低。

市民可從這小冊子，了解到香港斜坡安全系統在這30年來的成就。並希望能藉此提高市民對斜坡安全的認知，從而保持警覺，減低山泥傾瀉造成的影響。

Hong Kong has a hilly terrain with a substantial portion of urban development located near hillsides. Coupled with torrential summer rainfall, landslide becomes a long-term problem that we have to face. Year 2007 marks the 30th anniversary of the setting up of the Geotechnical Engineering Office (formerly called Geotechnical Control Office) of the Civil Engineering and Development Department to tackle the Hong Kong slope safety problems following a number of disastrous landslides in the 1970s. Since 1977, we have set up a comprehensive Slope Safety System to reduce landslide risk to as low as practically achievable.

This booklet presents the Hong Kong Slope Safety System and the achievements it has made in the past 30 years. It is hoped that it can also raise public awareness of slope safety so that people would sustain their vigilance in combating landslide risks.



山崩土淹的年代

THE ERA OF LANDSLIDE HAZARDS

山泥傾瀉災難的歷史及土力工程處的成立 The History of Landslide Disasters and the Setting Up of the Geotechnical Control Office

香港有慘痛的山泥傾瀉歷史，從1947年至今的60年間，山泥傾瀉造成的死亡人數就超過470人，當中大部分都是由人造削土坡、填土坡及護土牆的崩場所造成。

於1972年的同一日內更先後發生兩宗嚴重災難。6月18日，九龍秀茂坪一幅高40米的路堤填土坡倒塌，造成71人死亡。數小時後，香港半山區寶珊道亦發生山泥傾瀉，導致一幢12層高的住宅大廈塌下，釀成67人死亡。



1966年6月12日的一場暴雨，造成干德道遮打堂對下斜坡的大型山崩
A massive landslide occurred at Chater Hall, Conduit Road in the wake of the 12 June 1966 rainstorm



1972年秀茂坪山泥傾瀉事件
The 1972 landslide incident in Sau Mau Ping



▲ 社會福利署向受山泥傾瀉影響的災民派發熱飯
The Social Welfare Department distributing steamed rice to landslide victims



► 1972年寶珊道山泥傾瀉事件
The 1972 Po Shan Road landslide

Hong Kong has a history of tragic landslides. In the past 60 years since 1947, more than 470 people have died in landslides, mostly as a result of failures associated with man-made cut slopes, fill slopes and retaining walls.

Two major disasters took place on the same day in 1972. On 18 June 1972, a 40m high road embankment in the Sau Mau Ping Estate in Kowloon collapsed, killing 71 people. This was followed a few hours later by the collapse of the hillside at Po Shan Road in the Mid-Levels area of Hong Kong Island, triggering a landslide that demolished a 12-storey residential building and killed 67 people.



▲ 警員安慰一名在山泥傾瀉災難中失去愛子的母親
Policemen trying to comfort a woman who lost her son in the landslide disaster

► 港督麥理浩爵士巡視秀茂坪四周的山泥傾瀉及拯救情況
The Governor, Sir Murray MacLehose visiting Sau Mau Ping Estate to inspect the slope failure and the rescue operation



第九座最低數層被塌下的山泥淹蓋
The lower floors of Block 9 were inundated by the massive flow of mud



1984年土力工程處高級職員包括現任處長陳健碩先生、前處長白能達博士及麥隆禮博士
The senior members of the Geotechnical Control Office in 1984 showing the current Head of Geotechnical Engineering Office Mr Raymond K S Chan, previous office Heads Dr E W Brand and Dr A W Malone



《1976年8月25日秀茂坪山泥傾瀉報告》
Report on the Slope Failures at Sau Mau Ping, 25 August 1976

該獨立檢討委員會建議政府成立一個專責監管架構，規管本港的山邊發展，並管制斜坡的設計、建造及維修，因此政府在1977年成立了土力工程處這個岩土管制組織。土力工程處的主要職能是監管所有政府及私人岩土工程，確保所有新建斜坡均符合最高的安全標準。土力工程處採用了全方位模式，以減低山泥傾瀉的風險，並逐漸發展成一套全面的斜坡安全系統。

The independent review panel recommended the establishment of a control organization to regulate hillside developments and oversee the design, construction and maintenance of Hong Kong's slopes. This led to the formation of a government geotechnical control body, the Geotechnical Control Office (GCO), in 1977. Once established, the GCO's main function was to exercise geotechnical control over private and public works so as to ensure that all new slopes were constructed to high safety standards. The GCO adopted a holistic approach to reducing the risk of landslides, and gradually developed a comprehensive slope safety system.

In 1991, the GCO retitled itself as the Geotechnical Engineering Office (GEO), a name which better expressed the various engineering functions of the Office.

減低山泥傾瀉風險的策略

The Landslide Risk Reduction Strategy

隨著香港人口不斷增加，更多的山坡土地被開發作城市發展，因此製造了很多較陡峭的人造斜坡，令山泥傾瀉風險不斷增加。這些人造斜坡大都建於民居附近或一些基建設施如馬路旁邊，一旦發生山泥傾瀉，容易造成嚴重傷亡。在1977年土力工程處成立之前，香港缺乏岩土工程指引或斜坡安全標準，因此更加劇了山泥傾瀉的潛在危險。

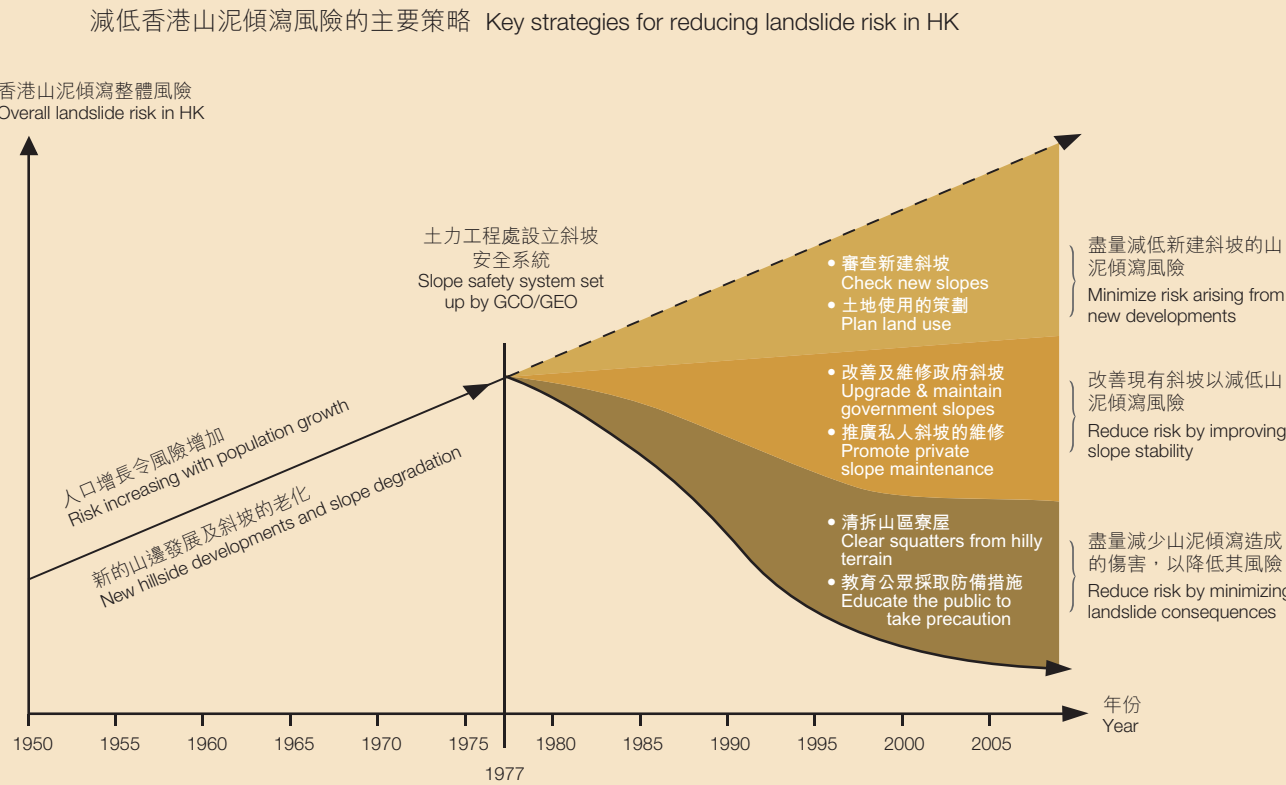
As Hong Kong's population has grown, more and more hillsides have been used for urban development. As a result, more relatively steep man-made slopes were built, and the risk of landslides increased accordingly. Many of these slopes were constructed close to buildings or infrastructure such as roads, and consequently the risks to human life associated with these man-made slopes are high. Before the establishment of the GEO in 1977, this risk was aggravated by a lack of geotechnical guidelines or slope standards.

2 改善現有斜坡以減低山泥傾瀉風險

Reduce Risk by Improving the Stability of Existing Slopes

香港政府制訂出一套持續的計劃，有系統地揀選及研究所有政府斜坡，然後對不合標準的斜坡進行維修及鞏固工程。至於私人斜坡方面，政府積極地鼓勵業主定期維修斜坡，及對不合標準的斜坡進行改善工程。

The government has developed an ongoing programme that involves systematically selecting and studying all government slopes, followed by maintenance and the upgrading of any that prove substandard. When it comes to privately-owned slopes, the government actively encourages their owners to maintain them regularly and upgrade them, if found necessary.



土力工程處成立後，隨即著手制訂整體的斜坡安全策略，減低人造斜坡的山泥傾瀉風險，並以三大目標配合連串相關措施推行工作：

Following its establishment, the GEO developed an overall landslide risk reduction strategy. It is made up of three main goals, with associated mechanisms for achieving them:

1 盡量減低新建斜坡的山泥傾瀉風險

Minimize Risk Arising from New Developments

土力工程處負責審查所有新建斜坡，確保斜坡符合現行的安全設計標準，同時在策劃土地發展的初期，亦會考慮到岩土工程的需要。這樣便能有效地控制新建斜坡的山泥傾瀉風險，大大緩減了整體的山泥傾瀉風險。

The GEO checks all new slopes formed to ensure that they are designed to current safety standards, and geotechnical considerations are now incorporated at the earliest stages of land use planning. In this way, risks associated with new developments are kept small, and this has helped substantially slow down the overall trend of growth in landslide risk.

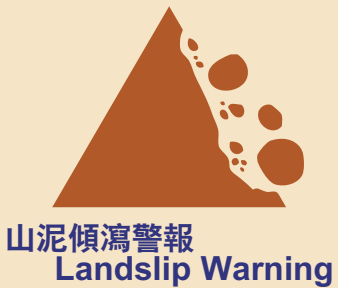
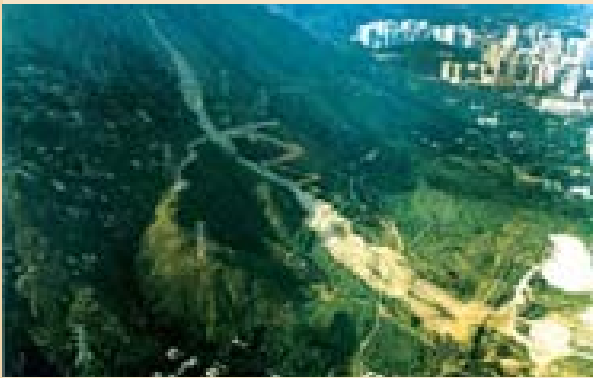
3 盡量減少山泥傾瀉造成的傷害，以降低其風險

Reduce Risk by Minimizing the Possible Consequences of Landslides



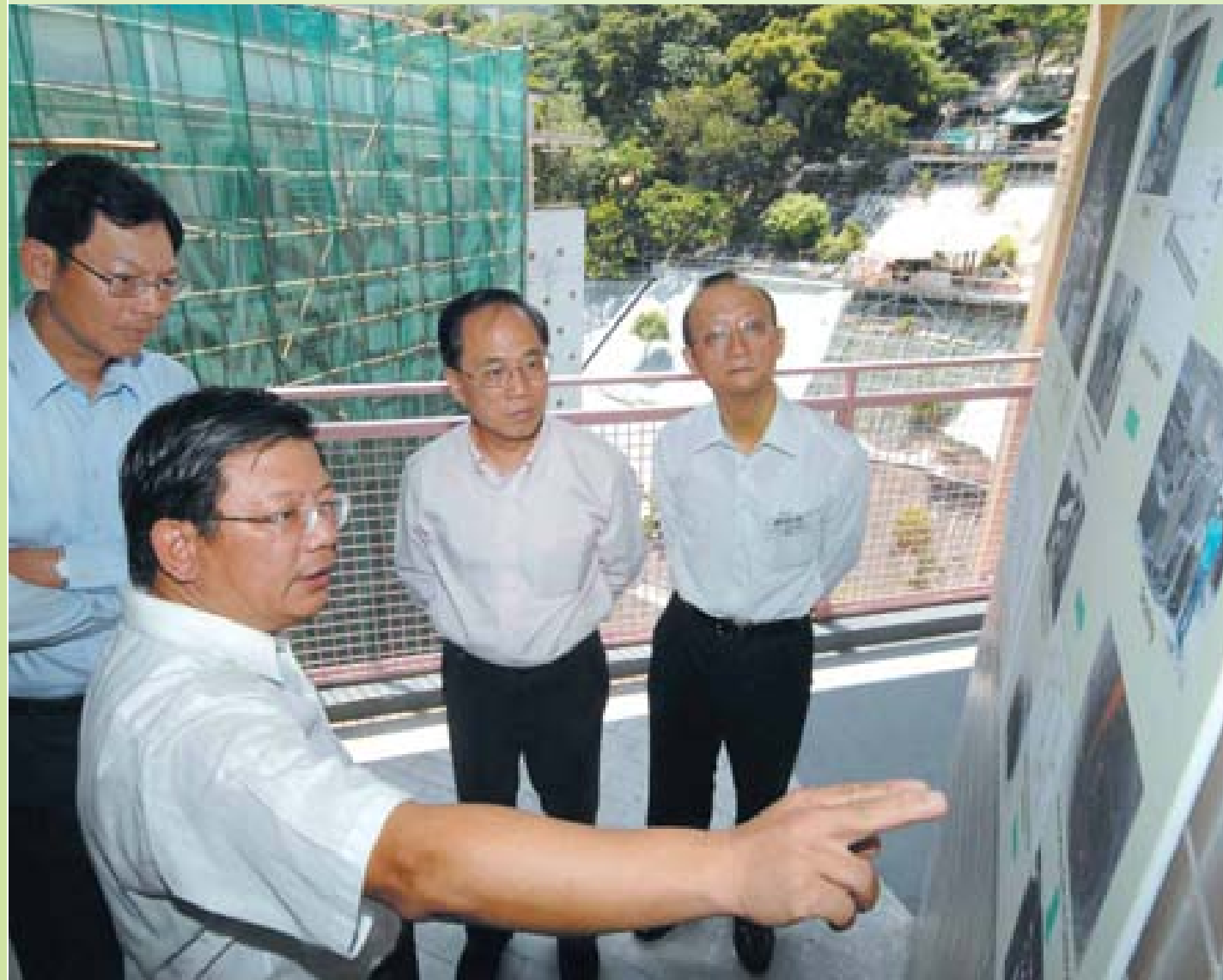
政府將建於山坡上的寮屋遷拆，以減少山泥傾瀉可能造成的傷害。並致力教育市民在暴雨來臨時應採取的防備措施，更設立山泥傾瀉警報系統，提醒市民山泥傾瀉的潛在風險。此外，土力工程處的24小時緊急服務，會在發生山泥傾瀉後立即為各政府部門提供岩土工程方面的意見，保障市民大眾，免受山泥傾瀉影響。

The government clears away squatter structures built on dangerous slopes in order to minimize any possible consequences of a landslide. It is also involved in educating the public about appropriate precautions to take during heavy rain. It has established a Landslip Warning System that alerts the public to any potential landslide danger. In addition, the GEO operates a 24-hour emergency service, providing geotechnical advice to various government departments on steps that should be taken after a landslide incident. The primary objective of this service is to protect the public from hazards associated with landslides.



全力以赴
確保斜坡安全

SLOPE SAFETY FOR ALL



◀ 土力工程處處長陳健碩在西環邨向行政長官曾蔭權、特首辦公室主任陳德森及土木工程拓展署署長蔡新榮講述斜坡工程
Head of Geotechnical Engineering Office, Mr Raymond K S Chan presenting the slope works at Sai Wan Estate to the Chief Executive Mr Donald Tsang, Director of Chief Executive's Office Mr Norman Chan and Director of Civil Engineering and Development Mr John S V Chai



盡量減低新發展項目帶來的風險 Minimize Risk Arising from New Developments

土力工程處於1977年成立時的其中一個主要目標，是透過改善香港所有新發展項目的岩土工程管制，盡量減低其可能造成的山泥傾瀉風險。這個目標得以達成，是通過審核新建斜坡及土地規劃這兩個主要機制。

One of the main objectives behind the establishment of the GEO in 1977 was to minimize landslide risks by improving geotechnical controls over all new development projects in Hong Kong. This has been achieved by two main mechanisms, namely, checking all new slopes & planning for land use.

審核新建私人斜坡 Check New Private Slopes

土力工程處透過法例賦予屋宇署的權力，對私人發展項目的岩土工程加以監管。在每個建築項目開展之前，發展商或其代理須向屋宇署呈交各工程項目的設計圖則，如場地勘察圖則、整體建築圖則，以及地盤平整圖則等，以供審批，土力工程處則在審批過程中提供岩土工程方面的意見。

The GEO exercises geotechnical control over private development projects through the statutory authority of the Buildings Department (BD). The BD approves design submissions made by developers or their agents before construction starts, such as ground investigation plans, general building plans, and site formation plans, and the GEO provides the BD with geotechnical input during the submission and approval process.



全力以赴 確保斜坡安全
SLOPE SAFETY FOR ALL

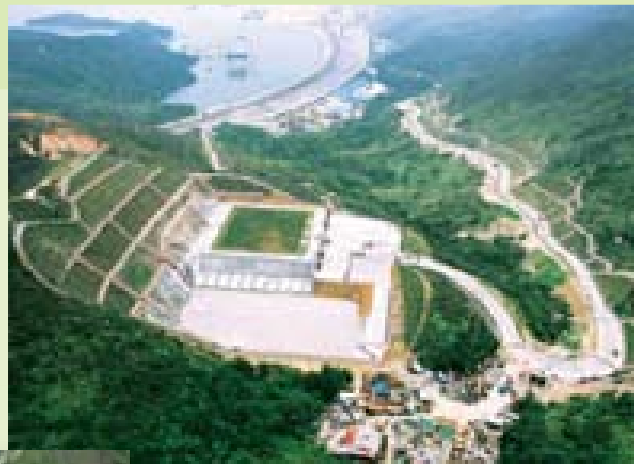


竹篙灣的地盤平整及配套基礎設施工程
Site formation and construction of associated infrastructure works for Penny's Bay development

審核新建政府斜坡 Check New Government Slopes

土力工程處亦根據政府行政規例，監管公共工程項目的岩土工程，同時為工程項目部門提供由發展計劃到詳細設計等各階段的專業意見。

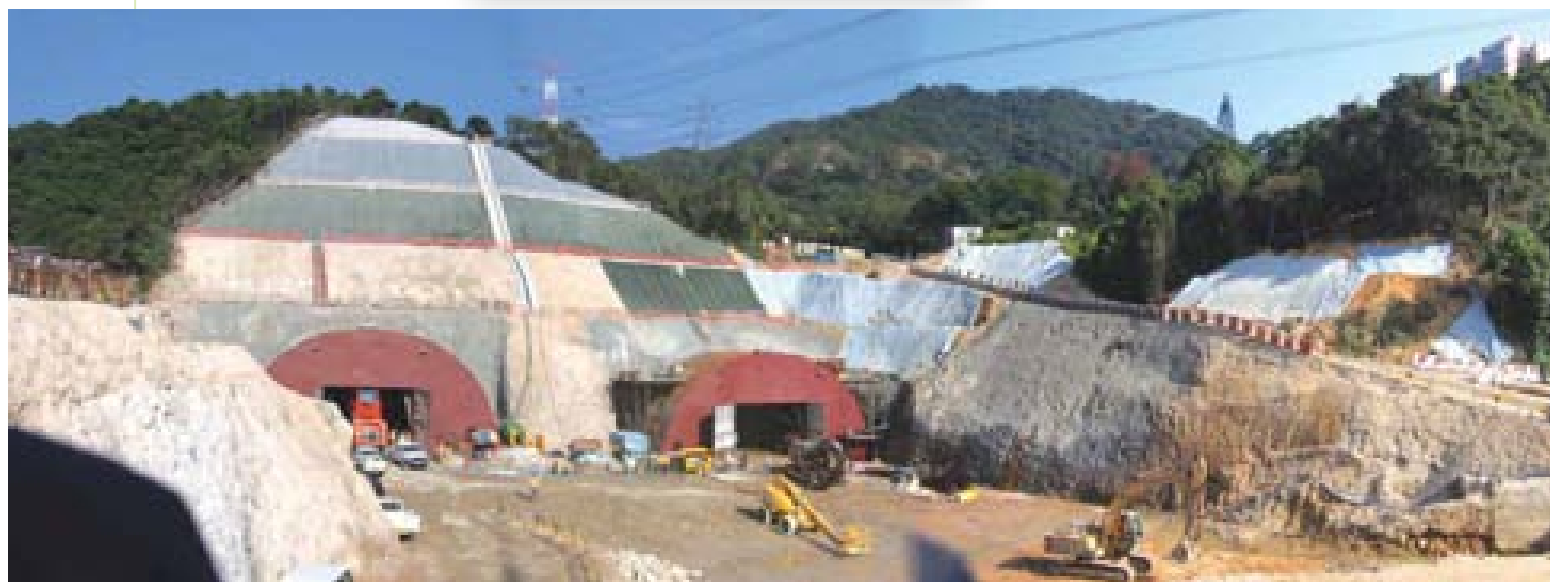
For public works, the GEO exercises geotechnical control according to government administrative regulations, providing expert advice to project departments at every stage from planning to detailed design.



欣澳食水配水庫 — 為香港迪士尼主題公園提供食水
Sunny Bay Fresh Water Service Reservoir – supplying water to Hong Kong Disneyland Theme Park



青衣北岸公路
Tsing Yi North Coastal Road



沙田大圍八號幹線隧道工程
Route 8 Tunnel Project at Tai Wai, Shatin

高空照片中可見的青山泥石流
The debris flow in Tsing Shan observed in an aerial photograph



1990年青山泥石流事件
The debris flow occurred in Tsing Shan in 1990

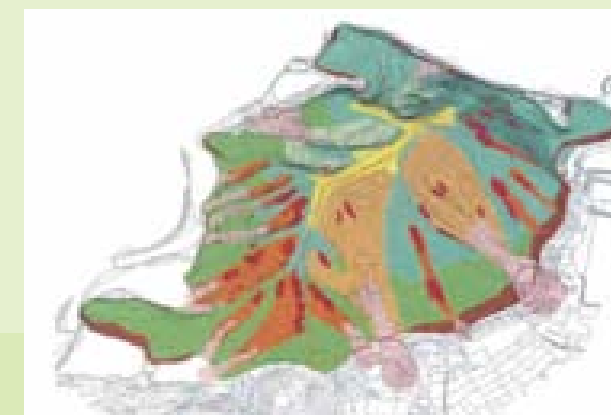
土地規劃 Plan for Land Use

土地規劃是減低山泥傾瀉風險的一個最符合成本效益的方法，在策劃新項目時，一併考慮天然災害的潛在影響，作為整體風險管理策略的一環。

土力工程處一向為規劃署及地政總署提供岩土工程方面的專業意見，在土地發展項目的初期，指出各種岩土工程限制，並對土地是否適合作特定用途提出意見。

One of the most cost-effective methods for reducing landslide risks is land use planning, in which the potential impact of natural hazards is taken into account in planning new developments as part of a wider risk management strategy.

The GEO provides the Planning Department and the Lands Department with geotechnical input at the early stages of land developments, identifying any geotechnical constraints and advising on the suitability of land for specific purposes.



改善現有斜坡以減低山泥傾瀉風險 Reduce Risk by Improving Slope Stability

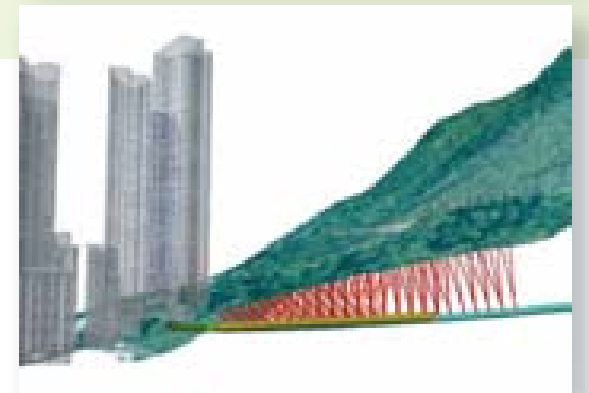
改善政府斜坡 Upgrade Government Slopes

土力工程處成立初期，政府面對如何處理大量不合規格的舊有人造斜坡及擋土牆的困難。在39,000政府斜坡中，約有10,500幅靠近建築物或主要道路。土力工程處自1976年起實行持續的防止山泥傾瀉計劃，旨在鞏固這些舊有的政府人造斜坡及擋土牆。

土力工程處採用量化風險評估所得的結果，發展了一套以風險為基礎的優先分級系統，並編訂了《斜坡紀錄冊》，記錄了重要的斜坡資料，以便有系統地處理風險較高的斜坡。



1994年觀龍樓山泥傾瀉事件
1994 Kwun Lung Lau failure



寶珊道地下水排水隧道工程
Po Shan Road groundwater drainage adit

加速及延續防止山泥傾瀉計劃 Accelerated and Extended Landslip Preventive Measures Programmes

自1994年發生觀龍樓山泥傾瀉事件後，土力工程處於1995年展開了為期5年的加速防止山泥傾瀉計劃，涉及的支出達29億港元。在其後的10年延續防止山泥傾瀉計劃(2000-2010)中，政府承諾鞏固2,500幅不合規格的政府斜坡及擋土牆，估計這項工程的成本，以1999年3月價格計算，約為90億港元。直至2007年1月，在計劃下鞏固的舊有政府斜坡已超過3,200幅。

A five-year accelerated LPM Programme was introduced in 1995 as a result of the 1994 Kwun Lung Lau failure, involving total capital expenditure of HK\$2.9 billion. In the extended 10-year LPM Programme (2000-2010), the government has committed to upgrading 2,500 substandard government slopes and retaining walls, with an estimated cost of around HK\$9 billion at March 1999 prices. Up to January 2007, over 3,200 old government slopes had been upgraded under the LPM programme.

安裝泥釘
Soil nailing



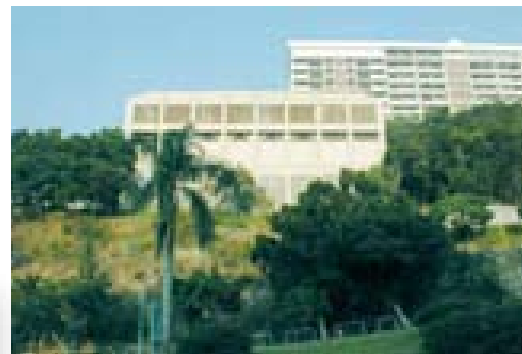
重新壓實填土坡工程
Fill slope recompaction



建造擋土牆
Retaining wall construction

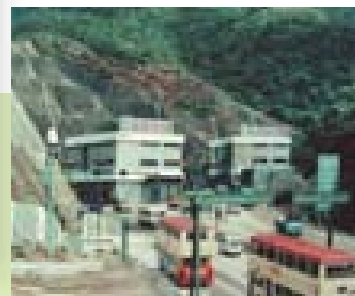


影響學校的斜坡
Slopes affecting schools



▲ 影響建築物的斜坡
Slopes affecting buildings

◀ 影響醫院的斜坡
Slopes affecting hospitals



影響隧道入口的斜坡
Slopes overlooking tunnel portals



影響主要道路的斜坡
Slopes affecting main roads



In the early days of the GEO, the government was faced with the problem of numerous old and substandard man-made slopes and retaining walls. About 10,500 of the 39,000 government slopes were close to building developments or major roads. Since 1976, the GEO has begun to implement an ongoing Landslip Preventive Measures (LPM) Programme with the objective of upgrading these old man-made government slopes and retaining walls.

To ensure that it selected the 'correct' slopes for upgrading, the GEO developed a risk-based priority classification system utilizing the results of Quantitative Risk Assessment, and created a Slope Catalogue containing essential information for the systematic selection of substandard slopes.

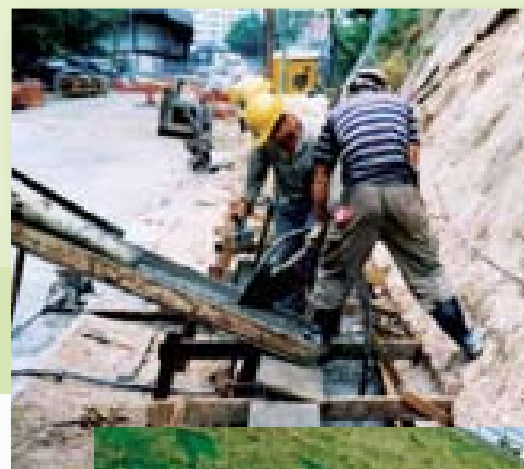


土力工程處為有關工程部門製作了一套《斜坡維修培訓手冊》
GEO produced a Training Kit on Slope Maintenance for maintenance departments

維修所有政府斜坡 Maintain all Government Slopes

人造斜坡與其他類型的工程結構一樣，須要定期維修。香港過去發生的山泥傾瀉，很多是因斜坡缺乏維修所致。在斜坡紀錄冊上登記有約57,000幅人造斜坡。政府透過有關的工程部門，如路政署及建築署等的維修斜坡計劃，致力維修所有的共39,000幅政府人造斜坡。土力工程處則為這些工程部門提供斜坡維修計劃指引，並進行審核，協助改善斜坡維修的工作。現時政府每年在維修斜坡上的開支約為6億港元。

As with other types of engineering structures, man-made slopes need regular maintenance, and lack of slope maintenance has been a major contributory factor to many of Hong Kong's landslides in the past. There are about 57,000 man-made slopes registered in the Catalogue of Slopes. The government systematically maintains all its 39,000 government slopes through the slope maintenance programmes of the relevant works departments, such as those of the Highways Department and the Architectural Services Department. The GEO provides these works departments with guidelines for the slope maintenance programme, and conducts slope maintenance audits to help them improve their slope maintenance works. The government's current annual expenditure on slope maintenance is about HK\$600 million.



推廣私人斜坡的維修 Promote the Maintenance of Private Slopes

土力工程處透過防止山泥傾瀉計劃，為私人斜坡進行安全篩選。如果發現斜坡有即時或潛在危險，土力工程處會建議屋宇監督發出「危險斜坡修葺令」，有關的私人業主必須對其斜坡進行勘測，並制訂鞏固工程計劃。直至2007年1月，經安全篩選的私人斜坡約有4,000幅。

為了確保所有人造斜坡安全，私人業主須承擔18,000幅註冊了的私人斜坡的責任。土力工程處於1992年起展開一系列的斜坡安全公眾教育計劃，鼓勵私人業主為其斜坡的安全負責，並成立了「社區諮詢服務組」，除了專責協助私人斜坡的業主履行維修斜坡的責任，還透過該組的社區外展諮詢服務，直接為斜坡業主提供所需的資訊。

The GEO carries out safety screening for private slopes as part of the LPM Programme. If any existing private slope is considered to be dangerous or liable to become dangerous, the GEO recommends the Building Authority to serve a Dangerous Hillside (DH) Order on the private owners. They must then investigate the slope and propose any remedial works. Up to January 2007, safety screening had been carried out on about 4,000 private slopes.

To ensure continued stability of all man-made slopes, the private owners have to take responsibility for the 18,000 registered private slopes. In 1992 the GEO began a systematic public education programme on slope safety to encourage private owners to take responsibility for the safety of their slopes. A dedicated "Community Advisory Unit" (CAU) has also been set up within the GEO, with the task of helping private slope owners undertake their slope maintenance responsibilities. The unit performs direct community outreach advisory services, and provides slope owners with all the relevant information they need.



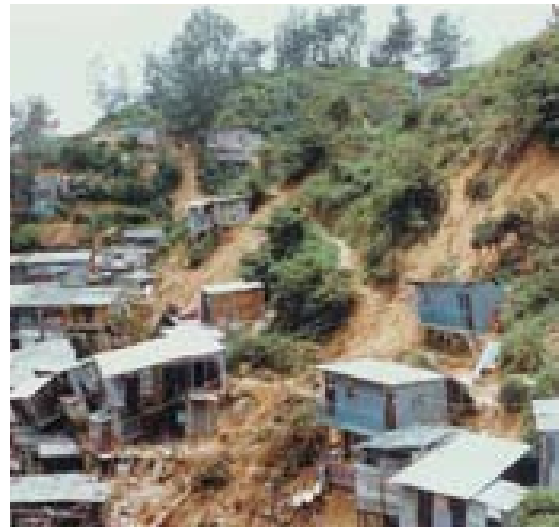
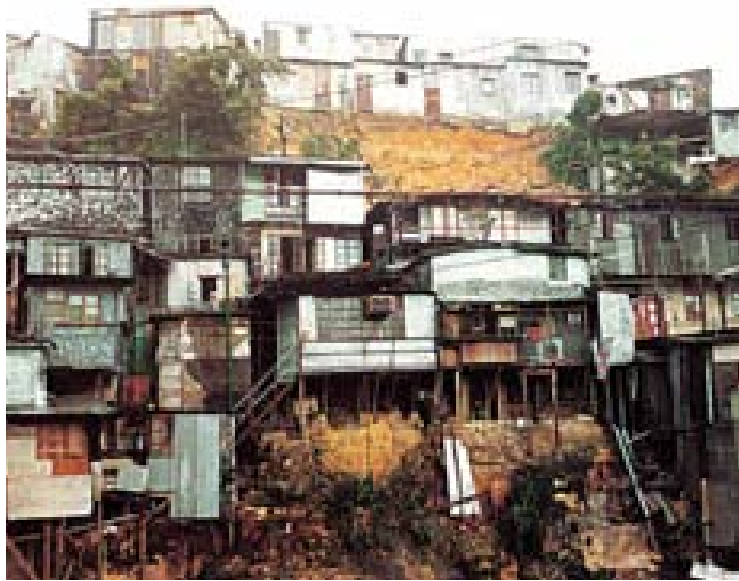
製作電視宣傳片推廣斜坡維修
Produce TV - Announcements of Public Interest (APIs) to promote slope maintenance

▼「社區諮詢服務組」為私人業主提供維修斜坡的意見
The "Community Advisory Unit" providing slope maintenance advice to private owners



印製斜坡維修指南及海報，製作錄像光碟，及向香港物業管理公司協會提供講座
Produce guidebooks, posters and VCDs on slope maintenance; deliver talks to the Hong Kong Association of Property Management Companies





山泥傾瀉警報 — 教育公眾採取預防措施 Landslip Warning - Educate The Public to Take Precautions

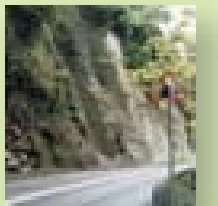
雖然政府已在斜坡安全工作上盡了很大努力，但每年平均仍接到約300宗山泥傾瀉報告。從1985年以來搜集到的數字顯示，九成以上的山泥傾瀉死亡事件都是發生在山泥傾瀉警報生效期間。可見山泥傾瀉警報是一個很可靠的預警系統，能及早提醒市民可能有山泥傾瀉危險。土力工程處採取一套完善及積極的策略，教導市民在山泥傾瀉警報生效時應採取的防備措施。並推動社區合作，透過公眾教育、宣傳活動及資訊服務，提高市民對斜坡安全的認知。

Despite the government's strenuous effort in slope safety work, there are still on average 300 reported landslides each year. A review of the landslide statistics since 1985 has indicated that more than 90% of the fatal landslides occurred when the Landslip Warning was in force. The Landslip Warning is therefore a reliable means in giving forewarnings of the potential landslide danger to the public. GEO has developed a comprehensive proactive strategy to educate the public to take the necessary precautions especially when the Landslip Warning is in force. It involves partnership with the community in promoting public awareness of slope safety through education, public campaigns and information services.

山泥傾瀉歷史展
Landslide History Exhibition



豎立山泥傾瀉警告牌，提醒路人及駕駛者
Erect Landslip Warning signs for pedestrians and motorists



盡量減少山泥傾瀉造成的傷害，以降低其風險 Reduce Risk by Minimizing the Consequences of Landslides

清拆山區寮屋 Clear Squatters from Hilly Terrain

1950年代至1980年代早期，有許多寮屋建於陡峭山坡地區，特別容易受到山泥傾瀉的影響。由1960至1980年代就曾在寮屋區發生多宗山泥傾瀉引起的傷亡事故。於1982年的兩場暴雨期間更收到至少三百宗發生在寮屋區的山泥傾瀉報告，造成23人死亡。

政府透過清拆寮屋及安置合資格的寮屋居民，以減低山泥傾瀉對寮屋居民構成的風險，而無須進行斜坡鞏固。1984年起，政府實行長遠的「非發展性清拆」計劃，截至2007年，約有75,000名寮屋居民獲得安置。從山泥傾瀉傷亡統計數字可見，寮屋居民面對的山泥傾瀉風險因此計劃已大幅下降。

Many squatter homes were built between the 1950s and the early 1980s on steep hillsides, which are particularly vulnerable to landslides. Numerous casualties arising from landslides in the squatter areas occurred from the 1960's through to the 1980's. In 1982, more than 300 landslides were reported to have occurred in squatter areas from two major rainstorms, resulting in 23 fatalities.

Landslide risks to squatters are reduced by clearing squatter structures and re-housing eligible squatters rather than by stabilizing slopes. An ongoing "Non-Development Clearance" (NDC) programme has been in place since 1984. By 2007, about 75,000 squatters have been re-housed. The landslide risks to squatters have been significantly reduced as a result, as is evident from landslide casualty statistics.



鑽石山寮屋區清拆前後的剪影
Snapshots of the Diamond Hill squatter area, before and after clearance

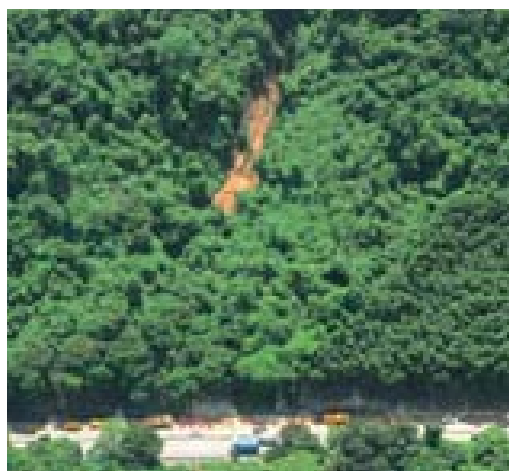


在香港科學館舉辦大型斜坡展覽
Major slope safety exhibitions at the Hong Kong Science Museum



巡迴斜坡安全展覽
Roving exhibitions on slope safety





2005年獅子山隧道公路上天然山坡山泥傾瀉事件
A landslide occurred at the natural hillside above the Lion Rock Tunnel Road in 2005



就土力工程處的建議，路政署進行緊急修葺工程
Urgent repair works recommended by GEO were carried out by Highways Department

土力工程處緊急事故系統 GEO Emergency System

香港每年約有300宗山泥傾瀉報告。自1980年代初，土力工程處設立了一套緊急系統，全年每天24小時為其他政府部門提供資訊及應付山泥傾瀉威脅的專業意見。每當土力工程處收到山泥傾瀉報告，便會派出岩土工程師到現場視察，並就所需的緩解措施或緊急維修向有關部門提出建議。

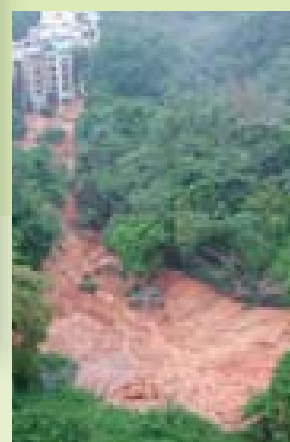
There are around 300 reported landslides in Hong Kong each year. Since early 1980s, the GEO has set up an emergency system providing year-round 24-hour information to government departments on what to do when landslide dangers develop. When the GEO receives reports of a landslide, its geotechnical engineers carry out site inspections and give advice to the responsible maintenance departments on any necessary mitigation measures, or urgent repair works.



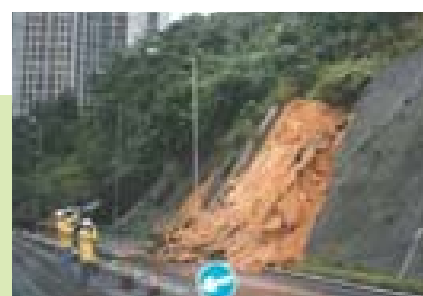
土力工程處的緊急控制中心正在運作中
The GEO Emergency Control Centre in operation



2005年發生在沙田畢架山引水道的山泥傾瀉
A landslide occurred at Sha Tin Beacon Hill Catchwater in 2005



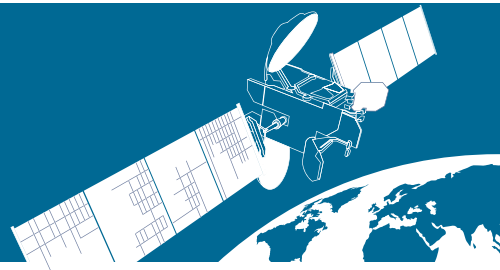
2005年沙田嶺山泥傾瀉事件
A landslide took place at Sha Tin Heights in 2005



土力工程師到達塌泥現場視察
Geotechnical Engineers carrying out emergency inspections



專業技術 綽綽領先
EXCELLENCE IN GEOTECHNICAL
ENGINEERING



提供指引，制定標準 Provide Guidelines and Set Standards

70年代以前，香港在斜坡設計及施工方面的岩土工程資料不多。土力工程處一直致力研究岩土技術的發展，以制訂有關斜坡工程先進科技的岩土指引刊物及技術報告。其所編訂的《斜坡岩土工程手冊》(1979年及1984年版)相信是香港在推廣優質斜坡工程作業方面的重要里程碑。至2006年底，土力工程處已相繼出版了超過220份有關的技術刊物。

此外，土力工程處轄下的工務試驗所，除了為公共工程項目提供可靠快捷的測試服務外，亦制定有關測試的技術標準，其編印的《泥土測試的標準規格》，已成為本地的泥土測試標準。同時，試驗所亦配備各種先進設施，以進行如泥土三軸應力路徑試驗及隧道挖掘效能評估試驗等的特別岩土測試。



工務中央試驗所的技術主任正進行泥土三軸剪壓試驗
A technical officer of the Public Works Central Laboratory conducting a Triaxial Soil Compression test



Before the 1970s there was very little in the way of input from geotechnical engineers into the processes of slope design and construction. The GEO has been putting tremendous effort on the technical developments that lie behind the production of new geotechnical guidance documents and technical reports. Perhaps the most important milestone in collecting the state-of-the-art geotechnical knowledge about slopes and promoting good slope engineering practices in Hong Kong came with the publication of the Geotechnical Manual for Slopes (1979 & 1984). By the end of 2006, GEO had released more than 220 publications on many different aspects of slope engineering.

Apart from providing reliable, efficient and effective testing services for public works projects, the GEO's Public Works Laboratories (PWL) also publish technical standards for use in laboratory soil testing. Its Geospec 3: Model Specification for Soil Testing has been adopted as the local standard. The laboratories are also equipped with advanced facilities for carrying out specialized soil and rock tests, such as Stress Path Triaxial tests on soil samples and Cherchar tests on rock cores.

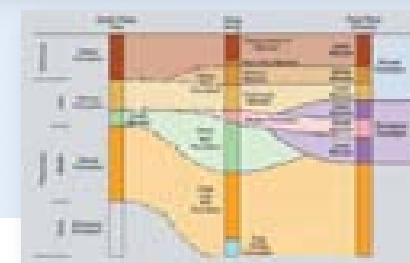
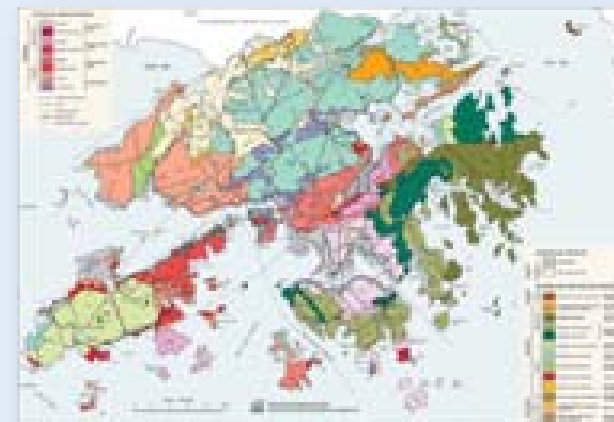


在工務中央試驗所進行的泥土壓縮固結試驗
An Oedometer Soil Test being carried out at the Public Works Central Laboratory



自1982年土力工程處成立香港地質調查組以來，已為香港建立了一套獨有及完善的地質資料庫。到了1996年，本處共出版了6份備忘報告及15份比例為1:20,000的地質圖。於2007年初更推出了香港地質圖的網上版本，公眾可隨時登入香港斜坡安全網站(<http://hkss.cedd.gov.hk>)瀏覽。

此外，土力工程處亦研究及制定土地勘察的技術標準，並出版了《場地勘察指南》及泥土腐蝕性評估等指引。



土力工程處另一項顯著成就，就是發展了一套對風化岩石特性的深入見解，並對地質泥土作出正確的判釋，這是斜坡工程設計的首要條件。香港的山泥傾瀉問題主要與岩石受熱帶風化逐漸變成泥土有關。因此土力工程處負起了為香港制定合適的岩土分類系統及標準的重任。1988年出版的《岩土描述指南》便是其中的研究成果。

Another GEO's most notable technical achievement has been the development of an improved understanding of the characteristics of weathered rock, which is an essential pre-requisite for successful slope engineering. Many of the landslide problems that affect Hong Kong are related to tropical patterns of weathering, which gradually change rock into soil. From the outset, the GEO worked on developing appropriate systems and standards for Hong Kong, and its research led to the publication of the Guide to Rock and Soil Descriptions in 1988.



In 1982, the Hong Kong Geological Survey was established within the GEO. Since then, it has built up the single most comprehensive archive of geological information in Hong Kong. By 1996, it had published a total of six memoirs and fifteen 1:20,000 scale geological maps. It also published an on-line map version of the geology of Hong Kong in 2007, which is accessible via the Hong Kong Slope Safety website (<http://hkss.cedd.gov.hk>).

The GEO also develops and publishes technical standards for ground investigation. These include the Guide to Site Investigation, and guidelines for assessing soil corrosivity.

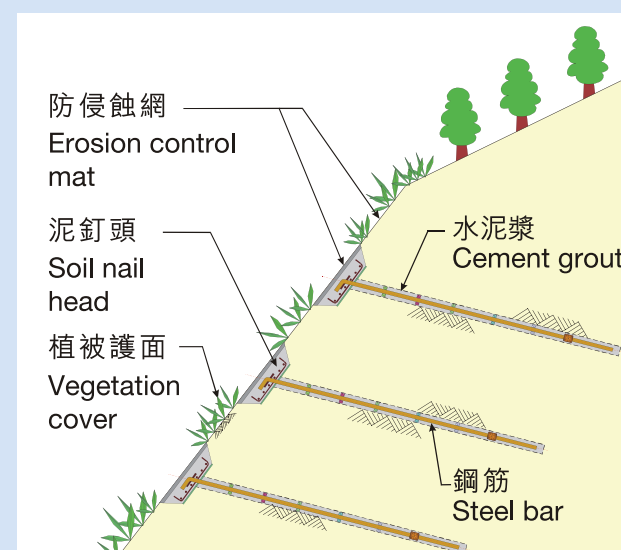


提昇業界的岩土工程知識 Advance Geotechnical Knowledge for the Industry

泥釘 Soil Nails

「泥釘法」是利用插放於泥土的鋼筋(即泥釘)以增強泥土抗剪力的技術。土力工程處是香港使用這項技術的先驅者，自90年代起，香港逐漸廣泛使用泥釘法來鞏固削土坡。由於它不易受到不利的地質條件及地下水情況影響，因此更為堅穩，亦合乎成本效益。至目前為止，從沒有施用泥釘法的斜坡出現過嚴重的山泥傾瀉事故。土力工程處在對泥釘技術進行了有系統的研究後，現已將其用途擴大至鞏固擋土牆和填土坡上。

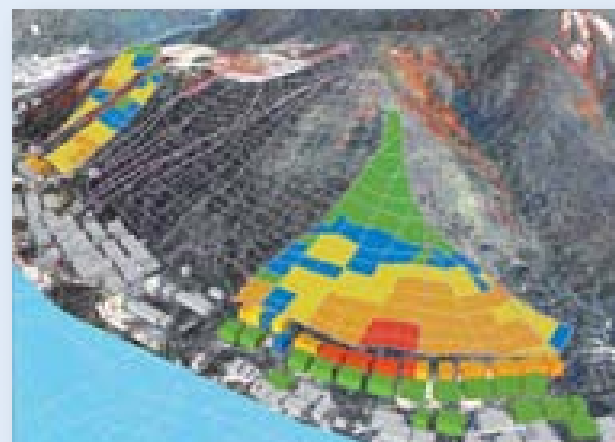
“Soil nailing” is a technique used to improve the strength of a soil mass by insertion of steel bars (soil nails) into predrilled grouted holes. The GEO was one of the pioneers in the use of soil nailing in Hong Kong. Since the 1990s, soil nailing has been widely used in Hong Kong to stabilize soil cut slopes. This has proven to be not only more cost-effective but also more robust than older methods, because it is less sensitive to unforeseen weak geological materials and adverse groundwater conditions. So far, no significant failures have ever occurred on a slope that has been soil nailed. After carrying out systematic research into soil nailing technology, the GEO has now extended its use to retaining walls and fill slopes.



量化風險評估 Quantitative Risk Assessment (QRA)

量化風險評估自90年代中起正式被採用於山泥傾瀉的風險評估及管理。土力工程處在發展和應用量化風險管理上擔當著領導角色，我們不但制定了整體斜坡安全策略，亦在具體層面上就個別場地進行山泥傾瀉風險管理。

Since the mid 1990s, QRA has been formally applied to the process of assessing and managing landslide risks. The GEO has played a leading role in developing and applying quantified risk management, both at the general strategic level of formulating overall slope safety strategies, and at the specific functional level of managing landslide risks posed by individual sites.



山泥傾瀉勘測 Landslide Investigation

土力工程處自1997年起開展了有系統的山泥傾瀉勘測計劃，這項計劃使我們加深了對山泥傾瀉的認識，並且對其成因及機理有著更深入的瞭解，有效改善斜坡工程技術。過去10年間，經調查的山泥傾瀉事件約有2,800宗，並進行了共180項山泥傾瀉的勘查和研究，我們亦有將勘查得出的寶貴經驗及教訓向業界發放。

In 1997, the GEO introduced a systematic landslide investigation programme. This programme has since played a key role in advancing our state of knowledge about landslides, and in improving slope engineering practices by providing a better understanding of the causes and mechanisms of slope failures. Over the past 10 years, the programme has examined some 2,800 landslide incidents and carried out 180 landslide investigations and studies, with lessons learnt being disseminated amongst the industry.



1995年翡翠道山泥傾瀉事件
Fei Tsui Road landslide in 1995



2005年中峽道山泥傾瀉事件
Middle Gap Road landslide in 2005



技術人員正收集泥土樣辦以供測試
A soil sample being collected by a technical officer for testing



1997年呈祥道山泥傾瀉事件
Ching Cheung Road landslide in 1997

應用新資訊科技 Apply Advanced Information Technology

斜坡資訊系統 Slope Information System

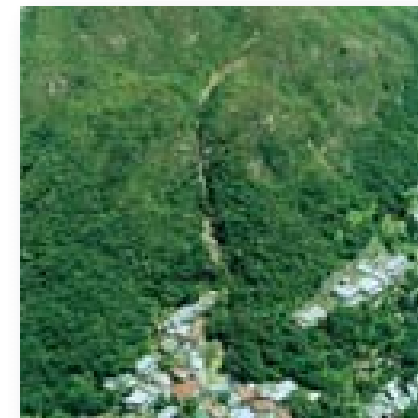
掌握資訊，才能防患未然。土力工程處應用資訊科技來收集和發放斜坡資料，大大加強了香港促進斜坡安全的工作。這套斜坡資訊系統載有全港57,000幅登記了的人造斜坡的資料。工程師以至市民大眾，都可從斜坡安全網站(<http://hkss.cedd.gov.hk>)取得最新的斜坡資料。在2003年，這套系統獲鷹圖公司頒發「地理空間成就獎」的「優越表現證書」。其後又於2006年獲得由香港工程師學會舉辦，香港特區政府資訊科技總監辦公室贊助的「香港資訊及通訊科技獎2006：電子政府(最具環保意識獎)」。

Landslide prevention begins with information. The GEO's work in improving slope safety in Hong Kong is greatly enhanced by the use of information technology to collect and disseminate slope information. Containing information on 57,000 registered man-made slopes, the Slope Information System (SIS) provides engineers as well as the general public with updated slope information through the slope safety website (<http://hkss.cedd.gov.hk>). In 2003, the System was awarded the "Geospatial Achievement Award - Certificate of Merit" by the Intergraph Corporation. In 2006, it also received an award in the "Hong Kong ICT Awards 2006 : e-Government (Most Environmental Conscious) Award" organized by the Hong Kong Institution of Engineers and supported by the Office of the Government Chief Information Officer."

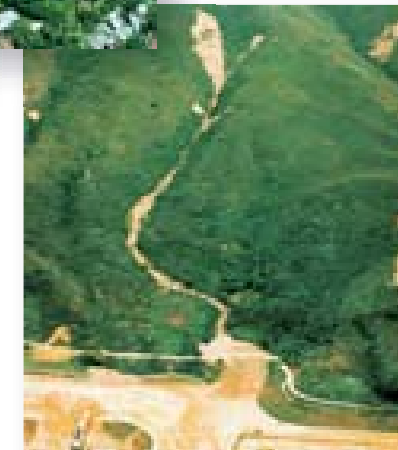
土力工程處處長陳健碩從主持手中接過「最具環保意識獎」
Head of GEO Mr Raymond K S Chan received the "Most Environmental Conscious Award"



市民可隨時在家中瀏覽及下載斜坡安全資訊
The public can browse through and download slope information any time at home.



1999年深井新村泥石流
The 1999 Sham Tseng San Tsuen debris flow



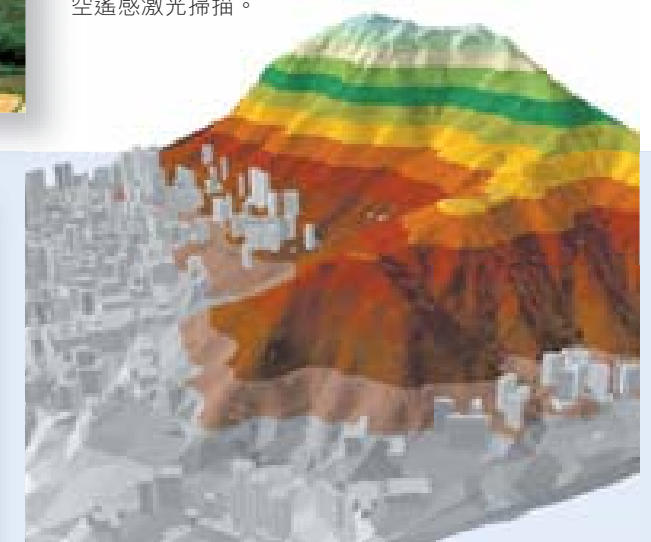
現今東涌新市鎮對上的山坡曾發生泥石流
A debris flow near the present Tung Chung new town



天然山坡山泥傾瀉風險管理 Natural Terrain Landslide Risk Management

全港約有百分之六十面積的土地為較陡峭的天然山坡，一旦發生山泥傾瀉，其規模可以很大，覆蓋範圍亦非常廣闊。1990年及1999年分別發生於青山及深井新村的泥石流便是例證。土力工程處自90年代初以來，進行了大量的研究及發展，為應付天然山坡山泥傾瀉的風險作好準備。

過去多年，土力工程處在使用新數碼資訊科技方面也有顯著進展，藉以提升了天然山泥傾瀉的管理能力。其中包括利用地理信息系統，應用在空間分析及三維工程模擬上。而採用的新科技包括數碼攝影測量、合成孔徑雷達干涉測量技術、三維雷射遙感掃描及影像處理以及航空遙感激光掃描。



About 60% of Hong Kong's total land area consists of relatively steep natural terrain. Landslides occurring in natural terrain can be very large and travel long distances, such as those occurring in Tsing Shan in 1990 and Sham Tseng San Tsuen in 1999. The GEO has carried out numerous research and development activities since the early 1990s to help it prepare for the risks posed by natural terrain landslides.

Over the years, the GEO has also made significant advances in applying new digital and information technology in ways that have expanded its ability to manage natural terrain landslides. Geographic Information System is used in spatial analysis and 3-D engineering modeling. Some of the new technologies adopted have included digital photogrammetry, Interferometric Synthetic Aperture Radar (InSAR), remote sensing using 3-D laser scanning and image processing and air-borne Light Detection and Ranging (LiDAR).



即時雨量資料傳送至控制中心
Real-time rainfall data is transmitted to the control centre

即時雨量分布
Real-time rainfall distribution

雨量計及山泥傾瀉警報系統 Raingauge and Landslip Warning System

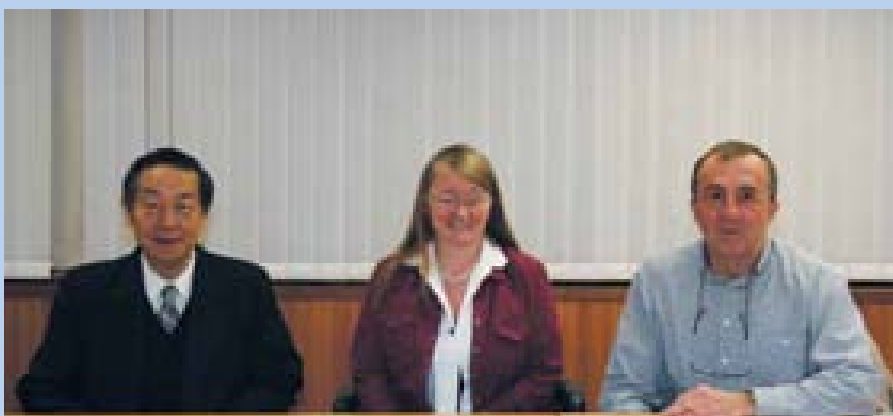
土力工程處管理的自動雨量計系統採用了現代化和先進的數據記錄及處理設備。此系統設有一個覆蓋範圍廣闊、包含110個自動雨量計的網絡，為山泥傾瀉警報系統的運作提供即時的雨量數據。斜坡資訊系統提供了斜坡的分佈。土力工程處整合了過往多年的數據，研發了一個山泥傾瀉頻率和雨量的關係模型。從以上的資料，便可估計每一場雨可能帶來的山泥傾瀉數字。加上香港天文台的預計雨量數字，政府便可作出發出或取消山泥傾瀉警報的決定。

The GEO operates a raingauge system utilizing advanced data logging and processing equipment and software. It comprises an extensive network of 110 automatic raingauges providing real-time rainfall data to the operation of the Landslip Warning System. The SIS provides the distribution of slope features across the territory. Based on the historical data, GEO has developed a landslide frequency - rainfall correlation model. With the above information, the estimated total number of potential landslides can be estimated for a certain rainstorm. By combining this with the rainfall forecasts from the Hong Kong Observatory, the government is able to make a decision on issuing or canceling of the Landslip Warning.



土力工程處在善用地理信息系統上亦獲得嘉獎。在2002年，憑著研發的流動勘測應用系統，獲得環境系統研究所ESRI頒予「地理信息特別成就獎」。

The GEO has also been honoured for its innovative use of Geographic Information System (GIS) technology. In 2002, the GEO received the "Special Achievement in GIS" from Environmental Systems Research Institute (ESRI) with its developed Mobile Mapping Application System.



新一屆斜坡安全技術檢討委員會
The current Slope Safety Technical Review Board

中國科學院王思敬教授
Professor Wang Sijing of the Chinese Academy of Sciences

挪威岩土工程學院蘭卡斯博士
Dr Suzanne Lacasse of the Norwegian Geotechnical Institute

英屬哥倫比亞大學享格教授
Professor Oldrich Hungr of the University of British Columbia

國際基準評價 International Benchmarking

斜坡安全技術檢討委員會自1995年5月獲委任以來，一直就斜坡安全的技術事項向政府提出意見。

土力工程處透過斜坡安全技術檢討委員會為香港的斜坡安全系統作定期檢討並進行國際基準評價。在回答1996年5月新聞發佈會的一個關於香港防治山泥傾瀉水平的問題時，委員會就曾讚揚土力工程處及香港岩土工程界在瞭解斜坡崩塌原理、斜坡建造的質量、成本效益及減低山泥傾瀉風險方面作出了領導性的貢獻。

Since its appointment in May 1995, the Slope Safety Technical Review Board (SSTRB) has advised the Government on the technical aspects of slope safety.

The GEO's Slope Safety System is regularly reviewed and benchmarked internationally through the SSTRB. In response to a question at a press conference in May 1996 on the standards of landslide mitigation in Hong Kong, the SSTRB stated that the GEO and the wider geotechnical community had made leading-edge contributions to the understanding of slope failure mechanisms, to the quality and cost-effectiveness of slope construction, and to the reduction of landslide risks.

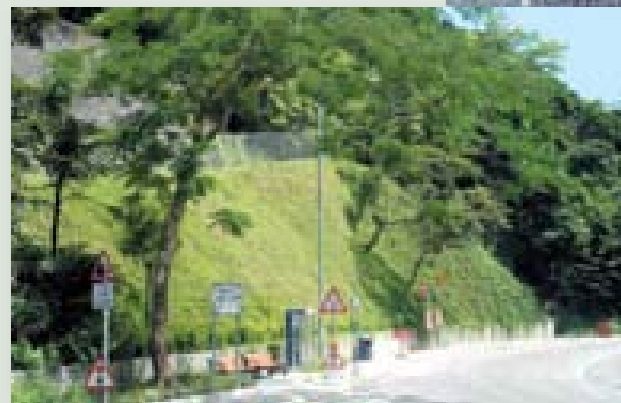


綠化斜坡 美化環境 GREENING SLOPES FOR A BETTER ENVIRONMENT



美化斜坡和擋土牆 Enhance the Appearance of Slopes and Retaining Walls

斜坡和擋土牆在香港隨處可見，因此它們的外觀對我們的生活環境及市容有直接的影響。土力工程處不單要確保斜坡的安全，且在美化人造斜坡和擋土牆方面，也扮演著領導的角色，務求使它們的外觀變得自然，盡量與四周環境融合。



斜坡上的植被
Vegetation cover on slopes

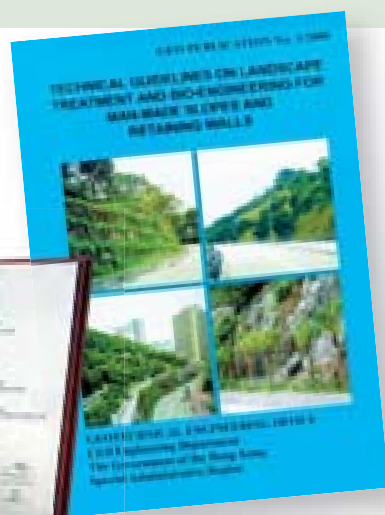


石牆上樹木的保育
Preservation of wall trees

Slopes and retaining walls can be seen everywhere in Hong Kong, and their appearance has a direct visual impact on our city and living environment. Apart from keeping our man-made slopes and retaining walls safe, the GEO has taken a leading role in making them look as natural as possible, blending them with their surroundings and minimizing their visual impact.

土力工程處於1984年在《斜坡岩土工程手冊》第二版內率先推介有關使用植物作為斜坡護面的技術指引。其後在2000年出版了一本《人造斜坡及擋土牆的園境美化及生物工程技術指引》，廣受業界推崇，並榮獲由香港園境師學會、康樂及文化事務署及園藝學會合辦的「2000年傑出綠化項目大獎」的金獎和銀獎。

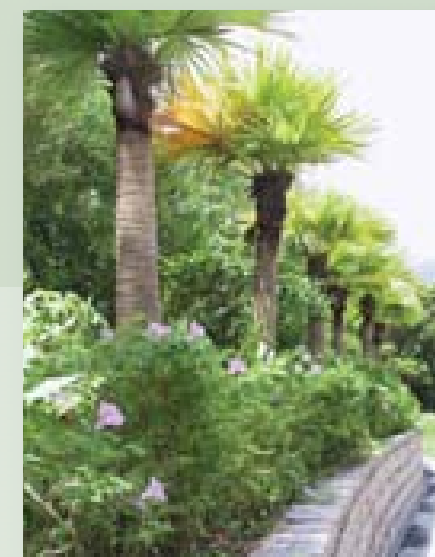
In 1984, the use of vegetation for the protection of slope surfaces was first introduced in the second edition of the Geotechnical Manual for Slopes. GEO also published in 2000 the Technical Guidelines on Landscape Treatment and Bio-engineering for Man-made Slopes and Retaining Walls and won the Grand Award and the Silver Award in the "Outstanding Green Project Awards 2000" jointly organized by the Hong Kong Institute of Landscape Architects, the Leisure and Cultural Services Department, and the Society of Horticulture.



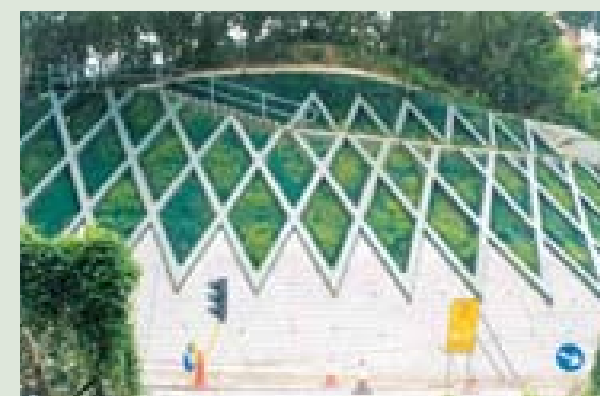
一幅加上了美術設計的路政署擋土牆
A Highways Department's retaining wall with artistically designed panels

多年來，處方一直與本地大學及有關機構，如嘉道理農場及植物園等合作，研究人造斜坡及擋土牆的園境設計及生物技術。研究結果亦制訂了一系列建議，有助在不同環境的人造斜坡培植茁壯的、符合成本效益及配合生態環境的植被。除了植被外，其他常用的美化斜坡護面包括砌石、條紋或其他圖案的表面修飾，沿斜坡底部設置植物槽及在斜坡表面預留孔洞栽種植物等。有時也會採用新穎的設計，如在斜坡或擋土牆表面加上美術設計或壁畫，避免原有的混凝土護面損害外觀。

Over the years, the GEO has been a pioneer in research into landscape treatments and bio-engineering measures for man-made slopes and retaining walls in collaboration with local universities and related organizations, such as the Kadoorie Farm and Botanic Garden. Recommendations have been developed with a view to establishing robust, cost-effective and eco-friendly vegetation cover for man-made slopes in different conditions. Besides vegetation cover, other commonly used measures include masonry block facing, ribbed or other patterned finishes, and the provision of toe planters and planter holes. In some cases, innovative measures such as graphic designs or paintings are adopted to minimize the adverse visual impact of their original shotcrete cover.



常用的斜坡園境設計及生物技術
Commonly used landscape treatment methods and bio-engineering measures for slopes





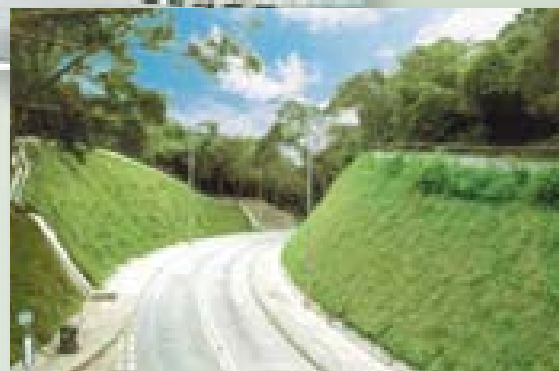
美化政府斜坡 Provide Landscape Treatment to Government Slopes

現時，經防止山泥傾瀉計劃下鞏固的，或由政府負責維修的斜坡，都會加入美化的元素。

Landscape treatment has now been applied on all government slopes upgraded under the LPM Programme and maintained by maintenance departments.



經美化後的政府斜坡
Selected examples of completed government slopes with different landscape treatment



推廣私人斜坡的美化 Promote Beautification of Private Slopes

政府通過推行公眾教育及與社區的緊密合作，鼓勵私人業主改善他們的斜坡外觀。土力工程處於2002年出版了《美化斜坡及擋土牆簡易指南》，同年又分發了《美化斜坡資料集》給業主立案法團、互助委員會及物業管理公司。

為了引起大眾興趣，土力工程處於2003年舉辦「最佳斜坡美化獎」，並獲得私人斜坡業主的熱烈回應，比賽收到55份報名表格，共90個斜坡及擋土牆參選。



「最佳斜坡美化獎」由土力工程處與環保建築專業議會、香港物業管理公司協會及香港園境師學會合辦，冠軍斜坡位於赤柱龍德苑

The "Best Landscaped Slope Awards" scheme was jointly organized by the GEO with the Professional Green Building Council, the Hong Kong Association of Property Management Companies, and the Hong Kong Institute of Landscape Architects. The Champion went to a slope at Lung Tak Court, Stanley

The government also encourages private owners to enhance the appearance of their slopes through public education and partnership with the community. In 2002, the GEO published the Layman's Guide to Landscape Treatment of Man-made Slopes and Retaining Walls, and also distributed a Slope Landscaping Information Kit to Owners' Corporations, Mutual Aid Committees and Property Management Companies.

To stimulate public interest, the GEO organized the "Best Landscaped Slope Awards" scheme in 2003, which was overwhelmingly received by slope owners, with 55 entries involving 90 slopes and retaining walls.



「最佳斜坡美化獎」頒獎典禮
"The Best Landscaped Slope Awards" Prize Presentation Ceremony

石礦場復修工程 Quarry Rehabilitation

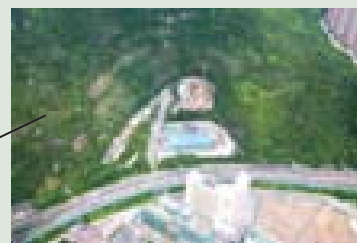
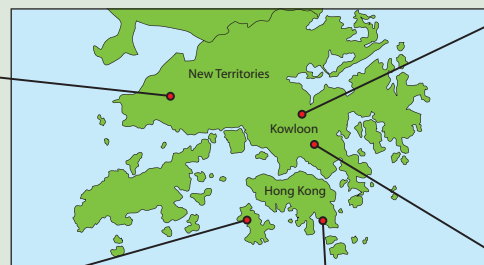
土力工程處的礦務部專責監管香港所有石礦場的運作。1989年的「市區週邊及海岸區域城市環境美化策略」把石礦場列為須要修復的受損景觀地區，政府因此開始批出石礦場復修合約。

石礦場復修工程一般牽涉大規模的地形重塑，防止侵蝕護面及大面積的綠化工程，以美化採石後的岩面，並與四周的自然環境融為一體。亦有採用特別方法，例如建造人工湖泊、池塘及鳥類築巢地點，讓原生的動植物可以重新生長，回復原來的生態環境。



藍地石礦場
Lam Tei Quarry

石礦場的位置分佈
The locations of quarries



女婆山石礦場
Turret Hill Quarry



南丫石礦場
Lamma Quarry



石澳石礦場
Shek O Quarry



安達臣道石礦場
Anderson Road Quarry

The Mines Division of the GEO controls the operation of quarries in Hong Kong. In 1989, the Metroplan Landscape Strategy for Urban Fringe and Coastal Areas identified quarries as areas of degraded landscape that required rehabilitation, and consequently the government began to issue quarry rehabilitation contracts.

Quarry rehabilitation works typically involve major re-contouring, erosion control, and extensive greening to beautify the final slope face so that it blends with the surrounding natural environment. Special measures are also adopted to enhance the ecology of the area, such as the creation of lakes, ponds and nesting sites, which provide habitats that encourage native plants and animals to re-colonize.



修復後的南丫石礦場
Lamma Quarry after rehabilitation



卓越成就 有目共睹
OVERALL ACHIEVEMENTS

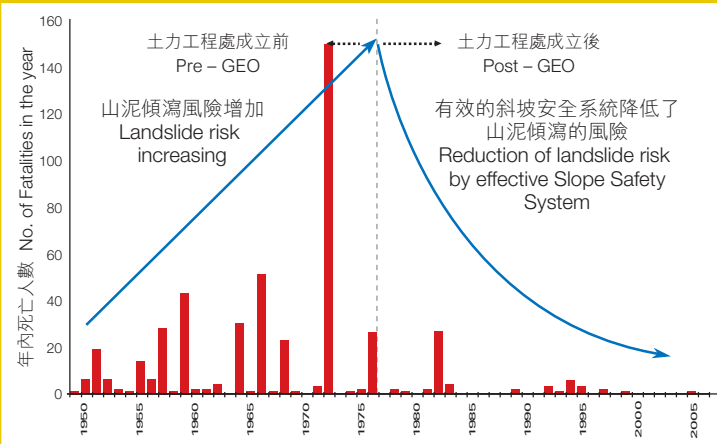


山泥傾瀉死亡人數大大減少 Major Reduction in Landslide Fatality

至2007年1月為止，土力工程處已為3,200多個舊有政府斜坡進行鞏固工程，並就4,000多個私人斜坡進行了安全篩選。這些已被鞏固的斜坡成功率高於99.8%。我們的防止山泥傾瀉計劃採用以風險為基準的優先次序，揀選出較高危的斜坡作優先處理，已成功於2000年時把人造斜坡的整體山泥傾瀉風險減至1977年的50%水平，並預計於2010年前將這水平進一步降低至25%以下。斜坡安全系統的成效，可反映於近年來驟降的傷亡率。

By January 2007, the GEO had upgraded over 3,200 old government slopes, and carried out safety screening on some 4,000 private slopes. The success rate for slopes upgraded under the LPM Programme has been higher than 99.8%. By first upgrading the high priority slopes following a risk-based priority system, the GEO had successfully reduced, by 2000, the level of landslide risk from man-made slopes to less than 50% of the 1977 level. It is anticipated that the landslide risk level will be further reduced to less than 25% by the year 2010. The effectiveness of the Slope Safety System is also demonstrated by a casualty rate which has fallen sharply over the years.

香港山泥傾瀉死亡人數 Landslide Fatalities in Hong Kong



南韓文化廣播公司訪問土力工程處處長
Head of GEO was interviewed by the Munhwa Broadcasting Corporation of South Korea

山泥傾瀉風險管理譽滿全球 World Leader in Landslide Risk Management

香港的斜坡安全系統在岩土工程界已贏得崇高的國際地位。世界各地很多機構，包括政府組織，大學和私人公司都曾到土力工程處拜訪，分享斜坡安全方面的知識和經驗。他們有些來自鄰近地區，如台灣、馬來西亞、新加坡、韓國、日本和中國內地各省，有些則來自歐美以及南美洲，包括加拿大、美國、英國、挪威、巴拿馬和巴西。

有些海外國家在發生嚴重山泥傾瀉後，當地政府派出官員來土力工程處，學習香港減低山泥傾瀉風險的策略。此外，2006年7月，南韓在颱風吹襲後發生多宗山泥傾瀉。當地的文化廣播公司特別派員訪港參觀土力工程處，並訪問處長及製作了一個關於斜坡安全的新聞特輯。

The Hong Kong Slope Safety System has won high international regard within the geotechnical field. Many organizations, including government bodies, universities and private companies from all around the world, have visited the GEO to exchange knowledge and experience in slope safety. Delegations have arrived from nearby countries and regions such as Taiwan, Malaysia, Singapore, Korea, Japan, and various provinces of the Mainland, as well as from further afield, from countries such as Canada, the US, the UK, Norway, Panama, and Brazil, to name a few.

Some overseas government officials have been sent to the GEO to learn about Hong Kong's strategies for landslide mitigation following major landslide disasters that have occurred in their home countries. The Munhwa Broadcasting Corporation of South Korea made a special trip to Hong Kong after a large number of landslide failures in South Korea caused by a typhoon that hit the country in July 2006. They toured the GEO and interviewed the Head of the GEO, subsequently producing a news feature story on slope safety.



加拿大在2005年發生致命山泥傾瀉後，北溫哥華市長於2006年4月率領代表團來港取經
A delegation led by the Mayor of North Vancouver visited GEO in April 2006 following a fatal landslide in Canada in 2005



在過去30年，因山泥傾瀉引致的人命及財物損失數字已大大減少，這反映出山泥傾瀉風險已持續降低。但由於香港本身的天然地理及氣候問題，我們是不可能將山泥傾瀉風險完全減滅，所以我們不能自滿。政府會繼續致力斜坡安全工作，私人業主亦應處理他們的斜坡，如有需要，政府可給予協助。政府亦會持續推行公眾教育，提醒市民保持警覺，在暴雨期間保障個人安全。

相信在政府和市民的合作下，定能齊心將香港提升為一個更安全的地方，獅子山下盡是綠化美好的居住環境。

In the past 30 years, there has been a continual reduction in landslide risk as reflected by the substantial decrease in the loss of life and property resulted from landslides. Due to the inherent problems with the natural geographical and climatic settings of Hong Kong, landslide risk can never be completely eliminated. Therefore, we must not be complacent. The government will carry on with the slope safety work and private owners should also look after their own slopes with necessary assistance from the government. The government will also continue to educate the public to be vigilant and take personal safety precautions during heavy rainstorms.

With the concerted efforts from the government and private slope owners, and the support and participation of the community, we will create a safer and better living environment below the Lion Rock, for the people of Hong Kong.

