Letterhead of Civil Engineering Department Geotechnical Engineering Office

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4th Quarter, 1997

Quarterly Report No. 4/97 on Studies and Works Carried out under the Landslip Preventive Measures Programme

INTRODUCTION

This report is on the Landslip Preventive Measures (LPM) Programme and is produced by the Geotechnical Engineering Office (GEO) for general distribution. It is issued on a quarterly basis to provide information on the progress of Studies and Works carried out under this Programme. This report covers progress to 31 December 1997.

BACKGROUND

Although GEO has no maintenance responsibility for land, it has a responsibility for initial investigation of both public and private man-made slopes and retaining walls which were formed before GEO was established and could pose a risk to life or property. GEO also carries out some major slope upgrading works on behalf of other Government departments.

Since 1976, about $2.1 billion has been spent on studies and works to upgrade old (i.e. pre-GEO) slopes and retaining walls under a long-term programme, called the Landslip Preventive Measures Programme. The LPM Programme provides for the investigation in priority order of man-made slopes and retaining walls in existence when the GEO was set up in 1977. The designs of new slope works which have been built since then have been checked by the GEO to ensure that they conform with accepted standards of safety, as set down in the *Geotechnical Manual for Slopes.*

The GEO has a *Catalogue of Slopes*, which was prepared in 1977 and 1978. Its original purpose was to provide an inventory of all sizeable man-made slopes and retaining walls in existence when the GEO was established. These features, i.e. slopes registered in the 1977/78 *Catalogue of Slopes*, are being systematically investigated and sub-standard features are being upgraded to the standards set down in the *Geotechnical Manual for Slopes*. Since 1992, information from the *Catalogue of Slopes* has been made available for public consultation.

Slope owners have a particular interest in the data recorded in the *Catalogue of Slopes* because they are responsible for maintaining their slopes in safe condition. All slopes need to be maintained, including old slopes and new slopes which are built to current standards. Routine maintenance works to Government slopes are not carried out by GEO nor paid for under LPM funding. Government departments who are responsible for the maintenance of Government slopes allocated to them or under their charge have stepped up their programme of maintenance in accordance with the standard of practice promulgated in *Geoguide 5:*

Guide to Slope Maintenance. For example, funding to Highways Department for maintenance works to road-side slopes has been increased from $150 million in 1995/96 to about $240 million in 1997/98. Similarly, Architectural Services Department has also received increased funding from $38 million in 1995/96 to about $90 million in 1997/98 to cover the cost of maintenance works to slopes under its charge.

In 1978, the Government undertook to carry out an initial screening of slopes in the 1977/78 *Catalogue of Slopes* for both private and public features. There are two levels of study in the Programme, referred to in this report as Preliminary Studies and Detailed Studies.

PRELIMINARY STUDIES OF OLD SLOPES

A Preliminary Study nowadays essentially consists of a site reconnaissance during which the consequence of failure is assessed and a subjective judgement made of the likelihood of preventive measures being necessary. While the main purpose of a Preliminary Study is to identify features requiring a Detailed Study, they also allow features with immediate and obvious signs of distress to be identified, so that necessary works can be initiated immediately.

DETAILED STUDIES OF OLD SLOPES

A Detailed Study is a stability assessment of an existing slope or a retaining wall to decide whether or not upgrading works are necessary. Details of a stability assessment are given in Appendix B of the *Geoguide 5: Guide to Slope Maintenance*. It is based on a desk study, an interpretation of the general area from aerial photographs (API), site observations, stability analysis, and if necessary, ground investigation. For a privately-owned slope or wall, if ground investigation is required to confirm whether or not upgrading works are necessary, the requirement to carry out the ground investigation is normally passed to the private owners by a Statutory Order served on them by the Buildings Department.

A report on a Detailed Study may:

(a) recommend upgrading works for Government-owned features,

(b) recommend further investigation and/or upgrading works for privately-owned features by the service of a Statutory Order by the Buildings De partment on private owners,

(c) recommend other specified action (for which purpose a private owner is advised by an Advisory Letter issued by the Buildings Department), or

(d) conclude that immediate upgrading works are not required provided the slope maintenance practice recommended in *Geoguide 5: Guide to Slope Maintenance* is followed.

PROGRESS ON PRELIMINARY AND DETAILED STUDIES OF OLD SLOPES

An indication of the progress on Preliminary Studies and Detailed Studies over the last 13 years is illustrated in Figure 1.

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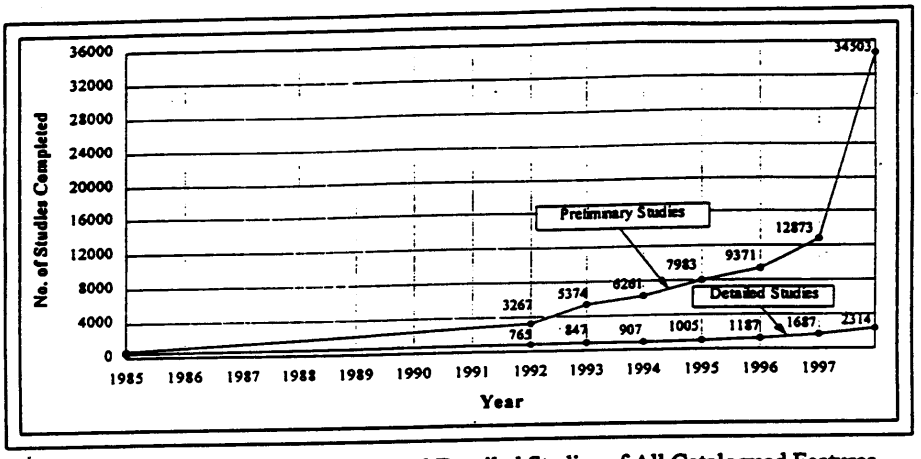

Figure 1 : Progress on Preliminary and Detailed Studies of All Catalogued Features including some features not in the 1977/78 Catalogue of Slopes

There are 10,840 slope features registered in the 1977/78 *Catalogue of Slopes*. A total of 9,723 Preliminary Studies and 1,779 Detailed Studies have been completed for features registered in the 1977/78 *Catalogue of Slopes*.

DANGEROUS HILLSIDE ORDERS SERVED ON PRIVATE OWNERS

Where found necessary as a result of a Preliminary Study or a Detailed Study, a Statutory Order is served by the Buildings Department on the owners of private features on the recommendation of the GEO. The Order requires the owner to carry out certain investigation and/or upgrading works to the feature. An Order may also be recommended to be issued after a slope failure has occurred, or as a result of other stability concerns brought to the attention of the GEO. The cumulative number of features on which Orders have been served by the Buildings Department is shown in Figure 2.

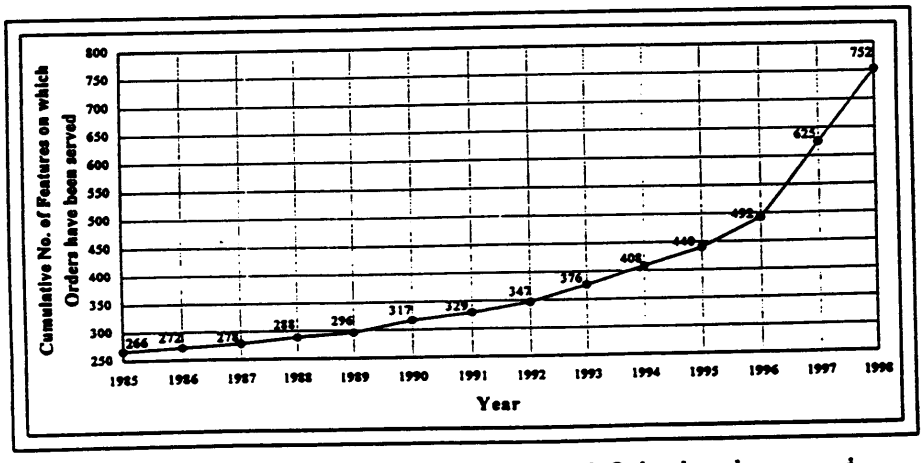

Figure 2 : Cumulative Number of Features on which Orders have been served

SPECIAL LPM STUDIES

From time to time, the GEO has been commissioned to carry out special studies related to LPM. These studies include:

(a) Mid-levels Studies (carried out between 1979 and 1981 and resulting in substantial LPM stabilization works),

(b) North Point Rock Slope Study (carried out between 1979 and 1981 and resulting insubstantial LPM stabilization works),

(c) Studies of slopes affecting squatters (ongoing since 1982),

(d) Study of slopes along some Water Supplies Department catchwaters (carried out in 1984, and resulting in substantial LPM stabilization works and squatter clearance),

(e) Studies of slopes affecting the Kowloon Canton Railway (carried out between 1984 and 1990, and resulting in substantial LPM stabilization works),

(f) Studies of Seymour Cliffs above Conduit Road (carried out in 1991 and 1992, and resulting in substantial LPM stabilization works),

(g) Study of slopes affecting bus shelters (carried out in 1994),

(h) Masonry Wall Studies (completed in March 1996),

(i) New Priority Classification Systems (completed in August 1996),

(j) Quantitative Risk Assessment (on going since mid-1994),

(k) Systematic Inspection of Slopes in the Territory (SIFT), (Paragraph 2 of Page 7 refers) and

(l) Systematic Identification and Registration of Slopes in the Territory (SIRST), (Paragraph 4 of Page 7 refers).

UPGRADING WORKS TO OLD GOVERNMENT-OWNED FEATURES

Where old Government-owned features are found to be below current standard they are recommended for upgrading works. The programme of Government slopes selected for detailed studies and upgrading works is referred to an interdepartmental committee, the Landslip Preventive Measures Committee (LPMC) for consideration, advice and agreement. The LPMC also considers nominations for upgrading works by Government departments responsible for slope maintenance. Figure 3 shows the number of Government slope features upgraded by GEO on behalf of other Government departments.

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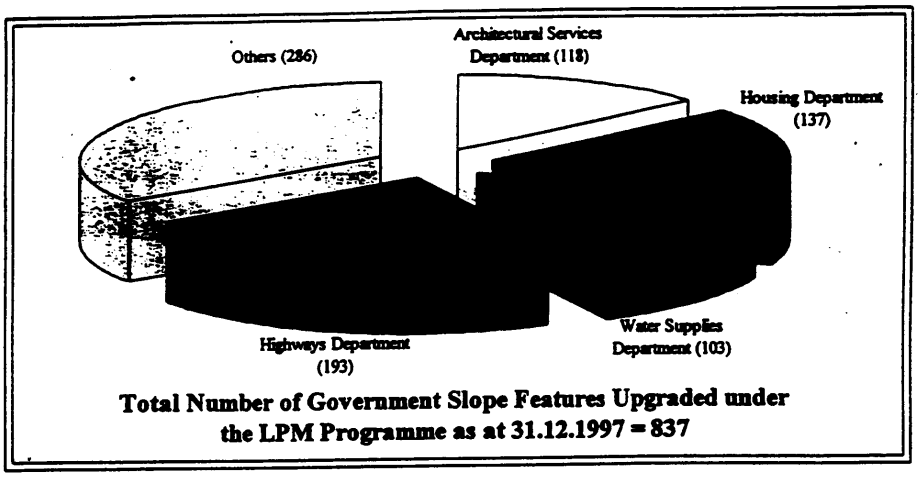

Figure 3 : Numbers of Government Slope Features Upgraded by GEO on behalf of other Government departments as at 31.12.1997

Government slopes are included in the LPM Programme under several different categories. These include:

(a) slopes categorized as having high consequence-to-life (high consequence with respect to loss of life in the event of failure). These are generally slopes close to occupied buildings,

(b) slopes categorized as having high economic consequence. These are slopes where a failure would cause significant disruption to the public, and they include slopes on major transport routes, and, since 1995, selected slopes affecting busy roads and footpaths,

(c) slopes affecting cul-de-sac roads. These are slopes along roads where, in the event of a failure, access for essential services, would be totally interrupted because there is no other access available, and

(d) slopes categorized as having high indirect consequence to life (high consequence with respect to loss of life in the event of failure). These are slopes affecting the access to hospitals, fire stations, airport navigational facilities and the like. The number of features in each of these categories that have been upgraded under the LPM Programme is shown in Figure 4 below.

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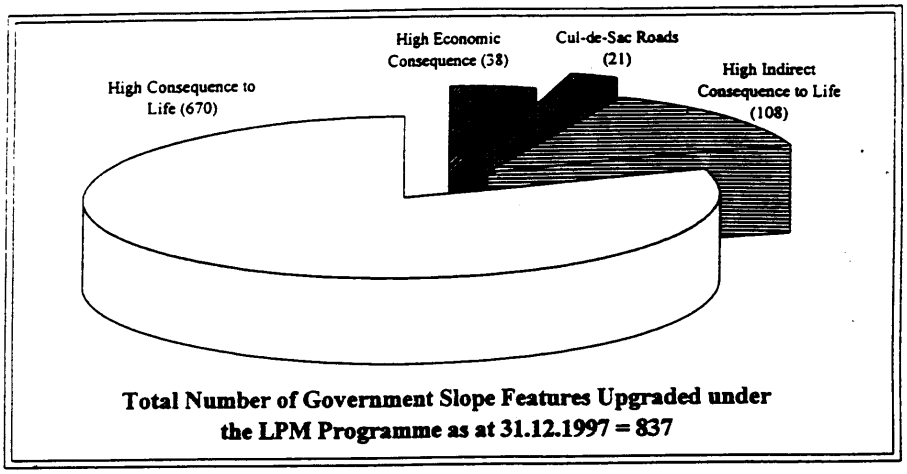

Figure 4 : Different Categories of Slopes Upgraded under the LPM Programme

Year-by-year information on the number of features upgraded under the LPM Programme and on LPM expenditure is given in Table 1 below.

Financial Year	# Expenditure under the LPM Programme ($ Million)	* No. of Features Upgraded under the LPM Programme
1977/78 - 1984/85	475	176
1985/86	56	41
1986/87	62	39
1987/88	63	32
1988/89	63	56
1989/90	75	27
1990/91	69	37
1991/92	62	34
1992/93	64	39
1993/94	69	77
1994/95	110	73
1995/96	194	51
1996/97	393	72
1997/98 +	423	83
Total	2178	837

Table 1 : Expenditure and Numbers of Features Upgraded under the LPM Programme

\# Figures include cost for urgent repair works to slopes on Government land and other special studies

* These figures include some features not in the 1977/78 *Catalogue of Slopes*

\+ Figures up to 31.12.1997

ACCELERATION OF LPM PROGRAMME

In 1991 streamlined procedures were introduced to boost the output of Preliminary and Detailed Studies (see Figure 1) and in 1992 a programme commenced to use private sector resources to improve progress of the LPM Programme.

As part of the implementation of the recommendations of the Slope Safety Review Report issued by the Works Branch and endorsed by the Executive Council in February 1995, the GEO received increased resources to further accelerate the LPM Programme. The target is to complete the investigation and the necessary upgrading works on as many substandard slopes in the 1977/78 *Catalogue of Slopes* over five years commencing on 1 April 1995 as is reasonably practicable by increasing the number of in-house staff and engaging more consultants. Features identified in the current recataloguing exercise as presenting an immediate and obvious danger are also investigated and upgraded under the LPM Programme.

NEW CATALOGUE

The 1977/78 *Catalogue of Slopes* has been used by the GEO as an information database for the LPM Programme. However, many slopes existing in 1977/78 were not included in the original slope cataloguing exercise. In addition, many new slopes have been formed since the completion of the Catalogue in 1978. In mid-1992, the GEO initiated a project entitled 'Systematic Inspection of Slopes in the Territory' (SIFT) to systematically search for slopes not previously included in the Catalogue. The information held in the Catalogue is checked against aerial photographs to identify features needing to be included in a new catalogue. The Government holds an extensive library of historical aerial photographs, dating back to 1924, and these are studied by a team of expert interpreters to identify the additional features. To date, the search has been completed for the urban area of Hong Kong and Kowloon and work is in progress for the New Territories.

Once sizeable features are identified they need to be registered in the catalogue. Registerable features comprise:

(a) cut slopes, including any associated retaining walls, and retaining walls greater than 3m high,

(b) fill slopes, including any associated retaining walls, greater than 5m high, and

(c) fill slopes, including any associated retaining walls, less than 5m high which pose a direct consequence to life in the event of failure.

In order to accelerate the work of slope registration, since July 1994 the GEO has been carrying out the 'Systematic Identification and Registration of Slopes in the Territory' (SIRST) project. To date, 53,000 slope features have been registered in a new catalogue. The new catalogue will be available for public use in March 1998.

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CKW/KYC/KTS