Surface Protection and Appearance of Slopes

Key Messages: It is Government policy to make slopes look as natural as possible to reduce their visual impact and improve the environment. Vegetation is used wherever possible as slope surface cover. A hard surface cover is used only as a last resort on slope stability grounds and as emergency repairs to landslide scars.

Introduction

Apart from maintaining the highest standard of slope safety, the Government is concerned about the appearance of the slopes. It has been a long-standing Government policy to make slopes look as natural as possible, blending them with their surroundings and minimizing their visual impact on the built environment. To pursue this policy, vegetation is used as slope surface cover and existing vegetation is preserved wherever possible in the formation of new slopes, in the upgrading of existing slopes and in the mitigation of natural terrain hazards under the Landslip Prevention and Mitigation Programme (LPMitP). A hard surface cover such as chunam or shotcrete is used only after other techniques for providing a vegetated surface cover have been explored and found not practical or inadequate on safety grounds. Where the use of a hard surface cover is unavoidable, landscape measures are taken to minimise its visual impact wherever practicable.

Choice of Surface Protective Cover

Surface protective covers on slopes are classified into two main types, namely vegetation cover and hard cover. The vegetation cover is basically provided by hydroseeding with planting of shrubs, seedlings and climbers on top where appropriate. As regards the hard cover, it is largely in the form of shotcrete, which has almost wholly replaced the less durable soil-lime-cement plaster called ‘chunam’ which was used extensively in the past. In choosing a suitable type of surface protective cover during the design of slope works, slope stability, maintenance requirements, and visual impact are the critical considerations.

There are both advantages and disadvantages in using a vegetation cover rather than a hard cover. A vegetation cover is visually and ecologically beneficial and less heat-reflective. Furthermore, a vegetation cover depletes water in the soil by root intake and transpiration, and its roots bind soil particles together, thus increasing the near-surface soil strength through root reinforcement effects. However, vegetation cover takes time to establish and is less effective than shotcrete in preventing water infiltration and surface erosion, both of which have an adverse effect on slope stability.

While shotcrete cover is visually unattractive, it is beneficial for slope stability where properly constructed and maintained because it virtually eliminates direct infiltration of water into a slope and provides reliable protection against surface erosion.
It is also generally effective as a cover to highly fractured or loosened rock slopes with high potential for local rockfalls. When properly applied, shotcrete cover is usually very durable. For cases where the groundwater level is expected to be high or where persistent seepage is observed, relief drains and raking drains in addition to weepholes are installed to release the water pressure behind the shotcrete cover.

In choosing a surface protective cover, it is also necessary to consider its practicability. It is quite safe and relatively easy to plant vegetation on soil slopes with a gradient up to 35°. On steeper soil slopes, vegetation can still be planted but the designer needs to consider carefully whether the rainwater infiltration and potential for increased surface erosion are acceptable. If the slope gradient is greater than 55°, it is generally more difficult and much more expensive to construct a stable vegetation cover by conventional methods. In Hong Kong, there is often little space available to cut back steep old slopes and a shotcrete cover is therefore sometimes necessary. In such cases, landscape measures are taken to minimize the visual impact of the shotcrete cover, such as applying subdued colour, masonry facing or decorative artwork to the shotcrete, and providing toe or berm planters and planting holes on the slope surface for screen planting.

Control of the Use of Hard Surface Cover

To control the use of hard surface cover, Vetting Committees on Slope Appearance have been set up in all the departments responsible for slope upgrading and maintenance works. First-time use or renewal of an existing hard surface cover on slopes in each project is critically reviewed and vetted by the committee to ensure compliance with the Government policy.

Emergency Works to Landslides

Public safety must always come first, and most notably in the case of emergency repairs to landslide scars on slopes in the high consequence-to-life category. Under such circumstances, shotcrete is generally used as a quick and secure method to remove the immediate danger posed to the public and to avoid prolonged closures causing inconvenience to the occupants of affected buildings and users of busy roads.

Slope Upgrading under the LPMitP

One of the basic types of works on Government man-made slopes is the upgrading of substandard slopes under a long-term LPMitP managed by the Geotechnical Engineering Office (GEO), Civil Engineering and Development Department (CEDD). In line with the Government policy, vegetation is used as a slope surface cover and existing vegetation is preserved wherever possible in the slope upgrading works. Unless there are severe site constraints, the gradient of the finished slopes is designed to be suitable for hydroseeding. Where it is not feasible to form relatively gentle slopes, hydroseeding is provided where possible with the aid of erosion control matting and steel wire mesh for slope surface protection. Where the use of a hard surface cover is unavoidable, visual impact mitigation measures are provided.
Natural Terrain Hazard Mitigation under the LPMitP

Besides the upgrading of substandard man-made slopes, the GEO will implement landslide risk mitigation measures to natural hillside catchments posing known hazards to buildings and major transport corridors. To reduce environmental disturbance to natural hillsides, the extent of mitigation works is minimised as far as practicable. The existing vegetation, including trees and shrubs, is also preserved where possible during the construction of landslide risk mitigation measures. Nevertheless, some ground cover will usually have to be removed. Landscape treatments similar to those for man-made slopes would be provided for the risk mitigation measures as appropriate to minimise their visual impact and blend them with their surrounding environment.

Landscape Design under the LPMitP

The GEO ensures that landscape design is treated as an integral part of the design of upgrading works for man-made slopes and natural terrain hazard mitigation works. Input by professional landscape architects is provided at the early stage of the design process to ensure that landscaping input is integrated with geotechnical input. In this regard, all consultants undertaking LPMitP projects are required under the terms of their agreements to provide landscape input during the design of slope works. Landscape consultants are employed to provide professional landscape services for in-house LPMitP projects, to supplement the technical support services provided by in-house landscape architects.

Maintenance Works on Slopes

In general, the GEO is not responsible for routine maintenance of slopes. Various other Government departments are required to regularly inspect and maintain slopes under their responsibility. In line with the Government policy, maintenance departments should aim to progressively replace any existing hard surface covers on slopes that pose negligible risk to life, if geotechnically acceptable, with a vegetation cover. Aesthetic aspects of slope works are included in the scope of slope maintenance audits conducted by the GEO.

Technical Guidelines and Research

The role of vegetation was first promoted in 1984 when technical guidelines on the use of grass, shrubs and trees for slope surface protection were published in the second edition of the Geotechnical Manual for Slopes. In 1999, the GEO stipulated a set of interim guidelines in GEO Report No. 56 for prescriptive use of vegetation for soil cut slopes. The guidelines were subsequently updated in 2009 to cover the prescriptive use of vegetation for both cut slopes and fill slopes. The updated guidelines are given in GEO Publication No. 1/2009.

To provide comprehensive guidelines which include the various sources of technical knowledge and cover the aesthetic aspects of slope works in a broader sense, a
much expanded set of technical guidelines is given in the GEO Publication No. 1/2000. The Publication provides practical guidelines for use by professionals in the planning, design, construction and maintenance of slope works, for enhancing the appearance of new and existing slopes. In recognition of its contribution to enhancement of the built environment, the Publication won the Grand Award in the ‘Outstanding Green Project Awards 2000’ organized by the Leisure and Cultural Services Department in association with the Hong Kong Institute of Landscape Architects and the Society of Horticulture, Hong Kong.

To improve the technology in greening slopes, the GEO has been researching into the use of vegetation in slope works and experimenting with new techniques of providing erosion control measures and vegetation covers to steep slopes, with due regard to safety, cost, aesthetic quality, and long-term maintenance requirements. Since 2002 the GEO has set up a database called ‘Greening Methods on Slopes’ to co-ordinate updates of the information on the different new greening techniques that have been tried on Government slopes. Studies have been undertaken to assess the performance of different greening techniques and to identify vegetation species that can successfully establish and self-sustain on steep slopes. In collaboration with the Kadoorie Farm and Botanic Garden, the GEO has carried out a planting trial of native small tree and shrub species on steep slopes. The results of the studies and the planting trial provide useful information for further research into the establishment of robust, cost-effective, and eco-friendly vegetation covers on man-made slopes. Further studies on the application of various vegetation species for greening of man-made slopes were completed in 2007 and 2011 respectively, which have expanded the range of suitable vegetation species for landscape use on man-made slopes.

As part of the continuous improvement initiatives for achieving sustainable slope greening, the GEO has completed a study of masonry walls with trees. Under the study, a more rigorous methodology is formulated for assessing the effects of trees on the stability of old masonry walls and appropriate methods are proposed for upgrading substandard masonry walls to the required safety standards whilst preserving the constituent trees on the walls as well as preserving the wall fabric where warranted. In addition, a study has been carried out to look into the functions of degradable and non-degradable erosion control mats on exposed soil slope surface and to improve the associated specifications.

In the light of this advancement in knowledge, a review of the GEO Publication No. 1/2000 has recently been carried out in order to promulgate the latest best practice and expand the scope to include landscape treatments for natural terrain mitigation works and landslide repairs. The review has culminated in the new GEO Publication No. 1/2011 “Technical Guidelines on Landscape Treatment on Slopes”, which supersedes GEO Publication No. 1/2000.

Public Education

As part of the public education initiatives, the GEO published in 2002 the Layman’s Guide to Landscape Treatment of Man-made Slopes and Retaining Walls for use by the general public. Currently, the Layman’s Guide is being updated to include the new recommendations given in GEO Publication No. 1/2011. To arouse the
public’s interest in enhancing slope appearance, the ‘Best Landscaped Slope Awards’ competition was organized jointly by the then Civil Engineering Department (now renamed as Civil Engineering and Development Department), the Professional Green Building Council, the Hong Kong Association of Property Management Companies, and the Hong Kong Institute of Landscape Architects in 2003.

Public Opinion

Since 1998 the GEO has commissioned local universities to undertake annual opinion surveys on various aspects of slope safety. Results of the year 2011 survey by the Chinese University of Hong Kong showed that about 75% of those interviewed expressed general satisfaction with slope appearance. The GEO welcomes feedback from members of the public on slope appearance and acknowledges that there is opportunity for continuous improvement.