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Introduction of Soil Creat System

Introduction

The Soil Creat System is to establish a rigid structure and vegetation to cover the soil or rock steep slope. During the installation work, fixing and tightening wild steel bars on the long anchors to form a series of square grid pattern of Creat. The wet spraying machine will be used to spray the readily mixed cement mortar on the structurally reinforcement bar in order to form a rigid structure of grid pattern. This can provide a structural protection of slope. Consequently, the spraying of Soil-Factor can provide the vegetation on the whole slope surface in order to achieve the full vegetation cover in the long run.

The performance is proven to be prominent that the Ministry of Transportation and Communications of Taiwan have specified the use of Soil Creat along the Cross-Island Highway (橫貫公路) for erosion control and also for planting vegetation so as to improve the visual appearance of slopes.

Various Vegetation Species

By spraying of 50 mm thickness of fiber soil, most of the shallow root species, such as grass species and creeper species will be established. Moreover, the Soil Creat System is applied on the in-situ surface with the contact of the in-situ soil. Most of the deep wood vegetation could develop the rooting system to achieve the adequate nutrient and moisture for the further development.

Surface Erosion Control

With the installation of high strength galvanized PVC coated wire mesh, which is fixed by an individual anchor at about 1,000 mm c/c and acting as the turf reinforcement mat, the sprayed layer of the organic fiber soil will be reinforced and self-sustained on the application surface. This permanent vegetation cover layer could prevent the underneath in-situ earth material from thermal weathering and surface erosion.

Prevent the Shadow Failure

The hardware components of the system consist of 2 numbers of mild steel bar which will be tightened onto the individual anchor. The cement sand mortar will be sprayed onto the mild steel bar to form a concrete crest that is a rigid structure to prevent the surface erosion.

Besides, the surface soil will be strengthened by connecting the 1meter to 1.5 meter anchor with the concrete bar.

Application on Steep Slope

The layer of the organic soil is made up of the natural vegetation fiber and is very light in weight, i.e. 350 kg/m³. It is proved that it can be self-sustained on the steep non-soil slope even under the heavy rainfall in Hong Kong.

Furthermore, the high porosity of the fiber soil could enhance the growth of rooting system of the plant and further reinforce the fiber soil to prevent erosion.

Besides, the system is designed to be fixed with individual small unit by individual anchor, such that the bulging effect and stress failure could be eliminated

Low Maintenance with Evergreen Performance

The fiber soil contains more than 95% of natural organic fiber that is a good moisture retaining agent. The moisture will be kept on the system for the growth and establishment of vegetation even in the dry season.

The layer of fiber soil consists of more than 50% of organic matter that is an enriched vegetation for the establishment. In the mature stage of the vegetation system, the dead tissue of the mature plant will be decomposed into the soil layer and become part of the nutrient cycle in the system itself. This could save up the annual application of fertilizer.

The layer of fiber soil consists of various types of organic and inorganic moisture retaining agent for the establishment of broad leaf vegetation. Once the vegetation system is established, the healthy and dense vegetation will fully protect the soil surface from intensive evaporation from the sunlight and strong wind. Normally, watering is not necessary in the summer time, or if there is no rainfall in dry winter for more than 30 days, once a month watering is required.

High Flexibility of the Material

The turf reinforcement mat is flexible that can be applied on any rough slope surface or the slope with high density of existing trees.

Application to High Level Location

The fiber soil was sprayed by the high powered air compressor, such that a long distance host, i.e. 50 meter in altitude or 100 meter in horizontal can be applied to the site location. Besides, wet spraying of the readily mixture fiber soil mortar is applied to minimize air pollution owing from the rebound of materials during the spraying work.

Particular Preambles for Standard Method of Measurement

Soil Creat System

The units of measurement should be:

- (i) Soil Creat System.....square meter
- (ii) Establishment Work.....square meter

The measurement of Soil Creat System should be the surface area of the slope vegetated. No allowance should be made for surface irregularities or other local peculiarities. No deduction should be made for opening of size one square meter or less.

Separate items should be provided for works in accordance with General Principles paragraphs 3 and 4 and the following:

Group	Feature
I	Soil Creat System
II	Establishment Work

The items for Soil Creat System should, in accordance with General Preambles paragraph 2, include:

- (a) Preparation of surface;
- (b) Supply and install 3-dimensional rhombus galvanized turf reinforcement mat with galvanized anchor in accordance with the Particular Specification and Drawing;
- (c) Supply and install fertilizer strip;
- (d) Supply and spray the fiber soil with grass seed mix in accordance with the Particular Specification and Drawing;
- (e) Supply and plant climber by sprigging;
- (f) Supply and install erosion control mat with U-shape pin.

The items for establishment work should, in accordance with General Preambles paragraph 2, include :

- (a) Watering;
- (b) Fertilizing;
- (c) Insect and pest control;
- (d) Grass cutting;
- (e) Re-grassing where the grass fails to become established.

PARTICULAR SPECIFICATION of Soil Creat System

GENERAL

- General Requirement 1.01 (1) Soil Creat System is vegetation treatment to the slope of any rock or soil surface. It should be carried out at location as shown on the drawings or as directed by the Engineer.
- (2) The Hong Kong sole agent for this method is Toyo Greenland Company Limited at No. 58, South Section, Wah Shan Village, Sheung Shui, N.T.
(Tel. No.: 2639 9312 Fax No. 2377 2150)
- List of Approved Suppliers of Materials and Specialist Contractors 1.02 If the Contractor is not included in the “ List of Approved Suppliers of Materials and Specialist Contractors for Public Works” maintained by the Employer for :-
Landscaping Class II - Hydroseeding - Group II
- Then he should enter into written sub-contractors with approved listed contractors, in the relevant Group, for the execution of respective part of the Works.

MATERIALS & EQUIPMENT

- Turf Reinforcement Mat 2.01 It should be PVC coated rhombus galvanized wire mesh or equivalent with diameter 2.5 mm, 50 mm/50 mm rhombus opening and 30 mm thickness when it is spread.
- Auxiliary Anchor 2.02 It should be galvanized mild steel with 16 mm diameter and 400 mm length.
- Subanchor 2.03 It should be galvanized mild steel with 8 mm diameter and 200 mm length.
- Seeds 2.04 Grass seeds are imported in terms of species, variety and purity. The origin of seed and the name of the supplier should be stated on the container or packing.
- (1) The quality of grass seed should be gauged by purity, germination percentage and freedom from weeds. The total weed seed content should not exceed 0.5% by total mass and the total content of other crop seeds should not exceed 1% by total mass.
- (2) The application rate for the Toyo-Mulching work should be as follows :

Species

Application Rate

Bermuda grass (<i>Cynodon dactylon</i>)	15 gram/m ²
Bahia grass (<i>Paspalum notatum</i>)	10 gram/m ²
Other seed may be selectively added as requested	

Fiber Soil 2.05 (1) The fiber soil should be the Soil-Factor, or equivalent material, supplied by Toyo Greenland Company Limited. It should be excellent in gas permeability and water-retaining capacity, and can maintain fertilizer for a long period of time. Besides, it should be strong resistance to drought and rain erosion. High alkaline content material should not be used as bonding agent. The fiber soil consists of the following ingredients:

<u>Ingredients</u>	<u>Application Rate (per m³)</u>
(a) High grade peatmoss	600 litre
(b) Wood chip compost	400 litre
(c) Chemical fertilizer (N:P:K = 13:3:11)	0.36 kg
(d) Chemical fertilizer (N:P:K = 4:17:4)	1.19 kg
(e) Perlite powder	4.02 kg
(f) Acrylic polymer granules	0.05 kg
(g) Bonding agent	9.3 kg
(h) Germination stimulator	1 kg

(2) The properties of the fiber soil are:

(a) PH value	6.0 to 7.5
(b) Moisture content	30 % to 35 %
(c) Organic matter content (dry weight)	50 % to 90 %
(d) Organic Carbon content (dry weight)	40 % to 60 %
(e) Total Nitrogen content (dry weight)	0.1 % to 1.5 %
(f) Carbon: Nitrogen ratio	35:1 to 50:1
(g) Dry density	400 kg/m ³ to 450 kg/m ³
(h) Saturated density	350 kg/m ³ to 400 kg/m ³

Erosion Control Mat 2.06 Erosion Control Mat should be made with approved coir mesh or equivalent materials. It should be 100% natural organic coir fiber product and biodegradable within 5 years after application or until the specified grass cover has been established.

Fertilizer Strip 2.07 Fertilizer strip is supplied by Toyo Greenland Company Limited or equivalent material. It should be double layer of non-woven strip, which filled with approved

long lasting fertilizer and water retaining agent.

Ground Cover Sprig	2.08	The ground cover sprig should not be more than 150 mm long, but with more than 1 number of healthy nodes.
Concrete Creat	2.09	It should be a mixture of cement and sand at ratio of 1:4 by volume.
Creat Bar	2.10	It should be mild steel with 8 mm in diameter.
Spraying Machinery	2.11	The machinery should be a wet spraying machinery that should be verified by the material supplier in order to facilitate the spraying of fiber soil. Water and fiber soil ingredients should be readily mixed before loading into the spraying machine.

MATERIALS SUBMISSION

Submission	3.01	The following particulars of the proposed materials for Soil Creat System and establishment works should be submitted to the Engineer, not less than 14 days before the commencement of works.
Particulars of Seed Mixture	3.02	A certificate or a numbered seed analysis report for each seed mixture issued within 6 months before the date of use of the seed showing the species and variety of the seed, the date of testing and including results of tests for: (a) Percentage of germination of pure seed in a fixed period of time under standard laboratory conditions (b) Percentage of composition by weight, including details of impurities
Test Report of Fiber Soil	3.03	A test report of fiber soil issued within 6 months before the date of use should include details of the composition and results of test: (a) PH value (b) Moisture content (c) Carbon/nitrogen ratio (d) Dry density (e) Saturated density
Particulars of Other Materials	3.04	The following particulars of the proposed materials and method statement of Soil Creat System should be submitted to the Engineer.

- (a) Species and rate of application of grass seed and ground cover sprig
- (b) Type and rate of application of water retaining agent, fertilizer and bonding agent
- (c) Details of turf reinforcement mat, galvanized anchor and galvanized subanchor
- (d) Type and detail of erosion control mat
- (e) Details of the company employed to carry out the hydromulching works. The company should provide at least 3-year local job reference of projects, which proved to be successful with all year round self-sustained vegetation
- (f) Details of the equipment to be used

Samples of Materials 3.05 (1) Samples of the following proposed materials should be submitted to the Engineer at the same time as particulars of the material are submitted:

Samples	<u>Quantity</u>
(a) Fiber Soil	100 litre
(b) Fertilizer Strip	500 mm
(b) Turf Reinforcement Mat	1 sq. feet
(c) Auxiliary Anchor	1 no.
(d) Subanchor	1 no.
(e) Mild Steel Bar	300 mm
(f) Erosion Control Mat	1 sq. feet

(2) Samples of materials for Soil Creat System and the program of establishment works should be inspected and checked by the Engineer before the delivery of material to the site.

METHOD STATEMENT

Preliminary 4.01 The method statement and procedure of work should be read in conjunction with the detail of the drawing or as requested by the Engineer. All provisional works should be scheduled according to the different gradients and surface conditions of slopes according to the instruction of Engineer.

Ground Cleaning 4.02 Weeds, rubbish, litter, stones exceeding 50 mm diameter and all deleterious material should be removed from the surface of the ground. Vegetation should be cleared without using herbicide unless permitted by the Engineer. If permitted, the herbicide should be a proprietary type approved by the Engineer and should be applied in accordance with the manufacturer's recommendation.

Fixing of Turf Reinforcement Mat	4.03	<p>(1) Fixing of turf reinforcement mat, anchor and subanchor.</p> <p>(2) The auxiliary anchor should be fixed at a minimum of 1,200 mm c/c along the top of the slope.</p> <p>(3) Minimum 50 numbers of subanchors should be fixed in every 100 m² of area</p>
Installation of Fertilizer Strip	4.04	<p>(1) The double layer non-woven fertilizer strip filled with slow-released fertilizer and water retaining agent.</p> <p>(2) The fertilizer strip should be inserted horizontally into wire mesh at approximate 500 mm c/c.</p>
Extension of Weep Hole	4.05	The weep hole should be extended 100 mm further with plastic pipe to avoid blocking after hydromulching.
Installation of Crete Bar	4.06	<p>(1) The anchors will be installed at the 1,300 mm c/c to form the grid pattern.</p> <p>(2) Two number of 8 mm diameter mild steel bar will be tied by wire between the anchors vertically and horizontally in order to form the square pattern of Crete Square.</p>
Spraying of Cement/Sand Mortar	4.07	<p>(1) The crete square surface will be covered with plastic sheet.</p> <p>(2) The cement/sand mortar will be sprayed by using the wet spray machine onto the mild steel bars in order to form a semi round Crete with approximately 150 mm thickness and 350 mm width.</p>
Hydromulching	4.08	<p>(1) The fiber soil should be mixed with seed and water in an appropriate proportion.</p> <p>(2) The mixture will be sprayed by wet spraying machinery onto the surface until reaching sufficient thickness of 50 mm or covering the thickness of turf reinforcement mat.</p> <p>(3) Walking on the area that have been hydromulched should be restricted to access unless fixing protective material or for patching up.</p>
Installation of Erosion Control Mat	4.09	The Erosion Control Mat should be laid and fixed with iron u-shape pin on the surface of fiber soil layer with anchor at 1,000 mm c/c.
Planting of Ground	4.10	Ground cover sprig will be planted at 500 mm c/c if no planter tubes are installed.

ESTABLISHMENT WORKS

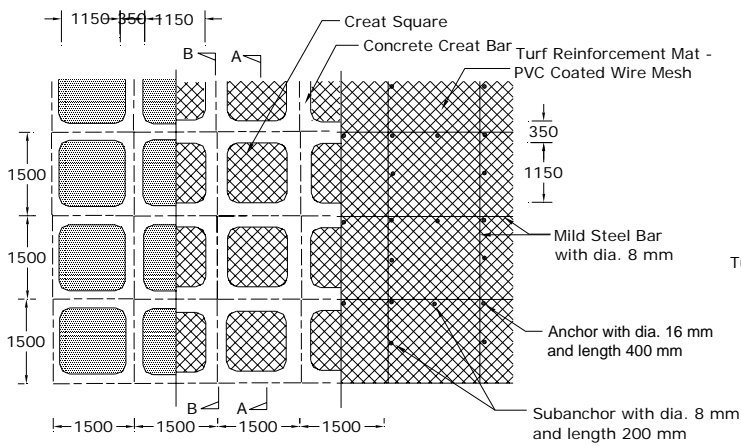
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|-----------------------------------|------|-----|---|
| Establishment Works | 5.01 | (1) | Establishment works should be carried out for the period stated in the Contract and in accordance with Clauses 5.04 to 5.06. |
| | | (2) | All necessary measures should be taken to ensure that grass and ground cover become well established and to keep the area tidy and free from litter and rubbish. |
| Inspection of Establishment Works | 5.02 | | An inspection of Soil Creat System and the establishment works should be carried out jointly by the Contractor and the Engineer at monthly intervals when required. The Engineer should instruct the Contractor to carry out establishment works when necessary; the work instructed should be completed within 14 days after the date of the Engineer's instruction. |
| Replacement of Vegetation | 5.03 | | Vegetation coverage of 95% of the area should be achieved at the end of the period for establishment works. The vegetation should be healthy and free from weeds. Areas that are considered unsatisfactory by the Engineer should be reseeded by hydroseeding as stated in General Specification. |
| Watering | 5.04 | (1) | Fresh water should be used for watering for Soil Creat System. Water should be applied by using a hose or any type of sprinkler agreed by the Engineer and in such a manner that compaction, washout of loosening material will not be caused; any damage caused should be made good immediately. |
| | | (2) | After spraying, watering should be carried out every 7 days. The minimum requirement for watering should be 10 litres/m ² . The Contractor may apply for the Engineer's agreement for relaxation of the requirements in the event of heavy rainfall. |
| | | (3) | Watering should be conducted until the vegetation is satisfactorily established. |
| Grass Cutting | 5.05 | (1) | The inspection of grass cutting should be carried out twice a year at 5th month and 11th month after completion of work. |
| | | (2) | Grass should be trimmed along the boundary of hydromulched area, if the climber spread outside the hydromulched area more than 500 mm. |

- (3) Grass shall be reduced by cutting to a height of 100mm when it reaches 300 mm height.

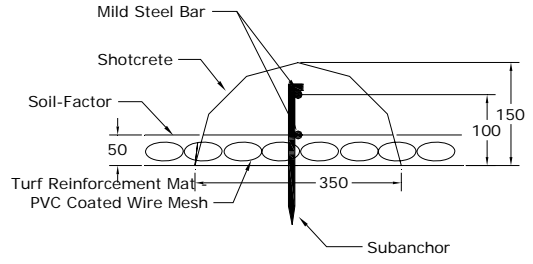
Control of Pests and Disease	5.06	Pesticide or fungicide should be applied in accordance with the manufacturer's recommendations to control pests and disease.
Completion of Work	5.07	Immediately before the end of the period for establishment works: <ol style="list-style-type: none">(a) All planted and grassed areas should be free from litter;(b) All replacement and patching up of vegetation should be completed;(c) All vegetation edges should be trimmed.

TESTING OF VEGETATION COVERAGE

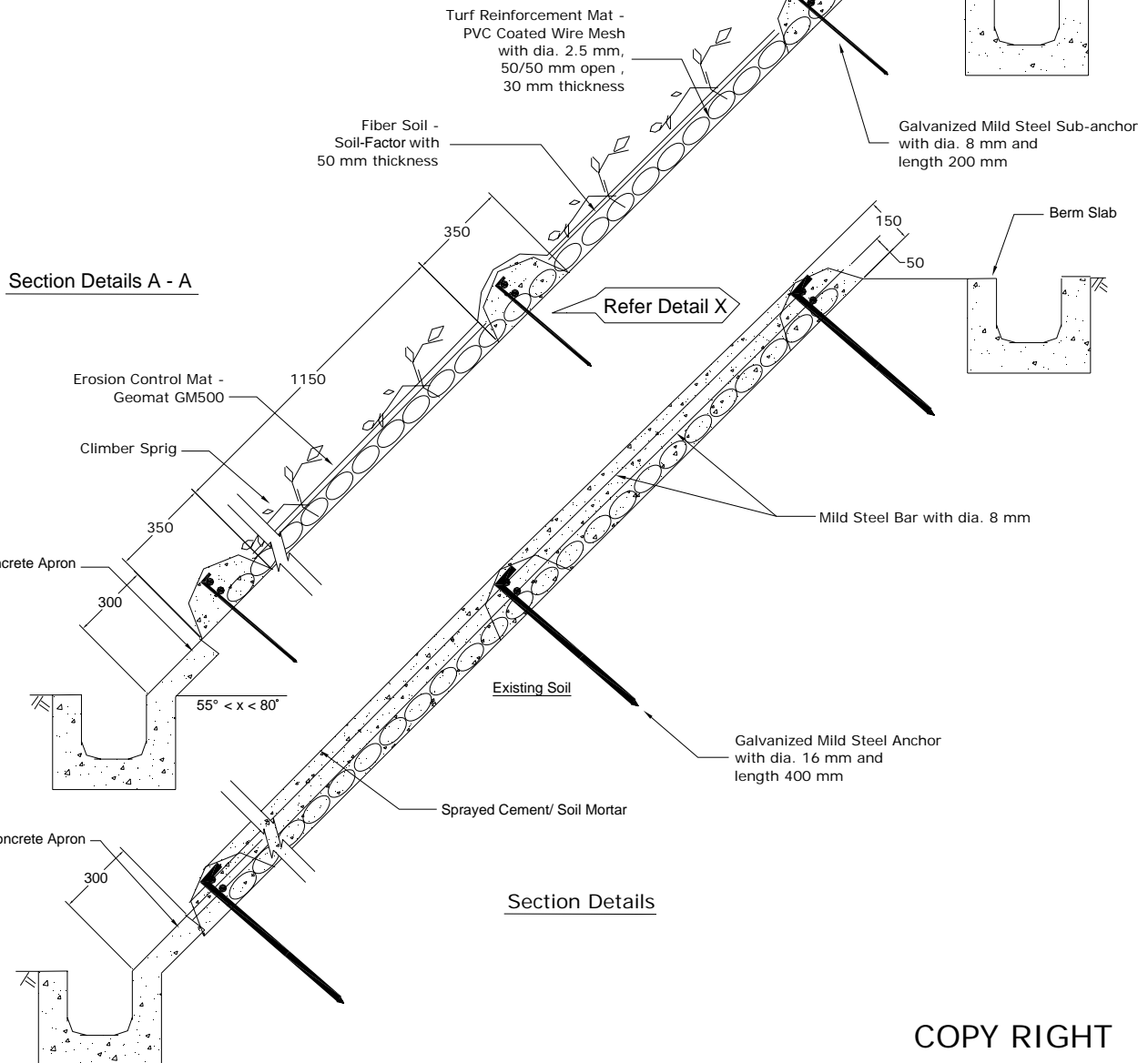
Testing of Vegetation Coverage	6.01	<ol style="list-style-type: none">(1) Tests should be carried out to determine the vegetation coverage. The tests should be carried out 100 days after grassing and at the end of the period for establishment works. The vegetation should be cut to a height of 300 mm if necessary over the parts of the area to be tested.(2) The number of tests should be instructed by the Engineer.(3) Tests should be carried out at location that is chosen by the Engineer to represent the grassed area as a whole. At each test location an approximate area of 10 m² should be marked.
Compliance Criteria of Vegetation Coverage	6.02	At least 95% of each test area should be covered with vegetation unless the existing gradient of the slope is greater than that from design, or it is a shaded area that is not suitable for vegetation growth.
Non-compliance of Vegetation Coverage	6.03	If the result of any test for vegetation coverage of Soil Creat System works does not comply with the specified requirements for vegetation coverage, the area should be re-hydroseeded or reseeded as stated in General Specification, depending upon the size of the defective area, as instructed by the Engineer.



Plan Details of Soil Cret System



Detail X



Section Details A - A

Section Details

COPY RIGHT

Project:

Toyo Greenland Co., Ltd.

Drawing Title: Soil Cret System on Soil Slope

Check : Daniel Ho

Scale : N.T.S.

Ref.:

Date : 20 January 2005

TOYO GREENLAND COMPANY LIMITED

Tel : 2639 9312 Fax : 2377 2150

Soil Creat System Job Reference

<u>No.</u>	<u>Project</u>	<u>Main Contractor</u>	<u>Client/Consultants/Landscape Architect</u>	<u>Completion Date</u>
1	Contract No.: HY/94/20 Smithfield Road Extension Slope No.: S-2 50 m ²	Paul Y. Construction Co., Ltd	Highways Department Pypun Engineering Consultants Ltd. Team 73 Ltd.	September 1998
2	Contract No.: HY/94/20 Smithfield Road Extension Slope No.: S-4 50 m ²	Paul Y. Construction Co., Ltd	Highways Department Pypun Engineering Consultants Ltd. Team 73 Ltd.	September 1998
3	Chinese University of Hong Kong Slope No.: 7NE-C/C2 50 m ²	Campus Development Offices	The Chinese University of Hong Kong	February 1999
4	Chinese University of Hong Kong Slope No.: 7NE-C/C 9 50 m ²	Campus Development Offices	The Chinese University of Hong Kong	April 1999

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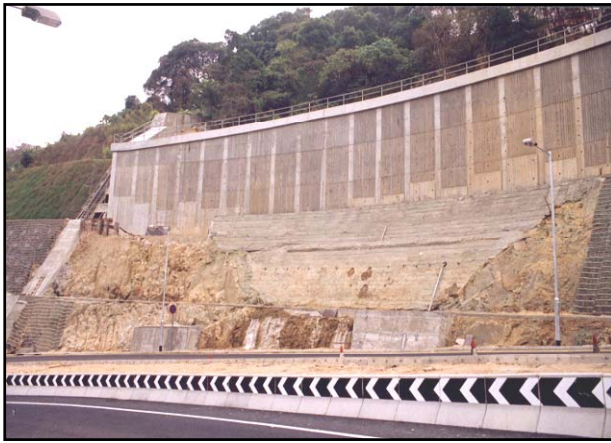
Soil Cret System Job Reference

<u>No.</u>	<u>Project</u>	<u>Main Contractor</u>	<u>Client/Consultants/Landscape Architect</u>	<u>Completion Date</u>
5	Contract No.: 1/WSD/00 Maintenance Term Contract Tai Tam Reservoir Road, Tai Tam Slope No.: 11SE-C/C684 600 m ²	Chun Wo Construction Co., Ltd.	Water Supplies Department	December 2000

Contract No.: HY/94/20

Smithfield Road Extension, Sai Wan – Slope no.: S-2

Soil Cret System on rock slope with rock fragment, no fines concrete, gradient 50° – 60° , completed in September 1998



Date : 24 May 1998



Date : 10 July 2001

Contract No.: HY/94/20

Smithfield Road Extension, Sai Wan – Slope No.: S-4

Soil Cret System on rock slope with shotcrete cover with gradient 75° , completed in September 1998



Date: 5 May 1998



Date : 10 June 2001

Residence Road, Chinese University of Hong Kong – Slope No.: 7NE-C/C2

Soil Cret System on shotcrete slope with gradient 60° , completed in February 1999



Date: 2 February 1999



Date : 21 June 2001

Chung Chi Road, Chinese University of Hong Kong – Slope no.: 7NE-C/C9
Soil Creat System on soil slope with chunam cover, gradient 50⁰, completed in May 1999



Date: 28 April 1999



Date: 19 April 2001

Contract No.: 1/WSD/00
Tai Tam Reservoir
Soil Creat System on shotcrete slope, completed in December 2000



Date: 15 October 2000



Date: 25 September 2001