ACE Geosynthetics

CASE STUDY COLLECTION

Earthwork Construction

Retaining Walls

Slope Rehabilitation, Xihu Service Area, National Freeway No. 3 Miaoli, Taiwan, ROC

The Background

National Freeway No. 3, one of the most important north-south arteries in Taiwan, is famous for the scenery along its line. Because of the enormous demands of transportation, any slope instability that might endanger the traffic flow must be treated immediately. An 8m high slope was found to slip near the entrance of Xihu service area of the highway due to the results of a torrential rainfall. The deterioration was consequently jeopardizing the safety of the highway with time.

The Challenges

The highway authority required that the rehabilitation should be a sustainable solution to fully conform to an aesthetic and eco-friendly environment. In addition, the owner also required the construction to be completed within a limited schedule to minimize the traffic impact.

The Conventional Solution

To build a cast-in-place reinforced concrete (RC) frame in-filled with seeded soil bags. Such design is costly and the RC frame involves much more labor and materials for construction. It is also not a solution which favors sustainability. The completed surface also requires a relative longer time to develop sufficient vegetation to cover the RC frame.

ACE Innovative Application

To meet all the requirements of the project, a wrap-around reinforced earth structure (RES) containing ACEGrid®, soil bags, local soil, and drainage materials were chosen to restore the slope. There are five reasons for adopting this solution: (1) excellent quality and durability of ACEGrid® ensure the stability of the RES; (2) a well-designed integrated vertical and horizontal drainage system; (3) fast construction significantly reduces the traffic impact; (4) a flexible wrap-around facing system perfectly fits in-situ surrounding changing contours and also easily maintains a slope of 1:1.5-1:2 (H:V) identical to the original design; and (5) the porous surface structure of the RES provides a friendly environment for the development of local vegetation and an ecological system. The results proved the ACE system to be the novel solution to totally meet the demands of the site.

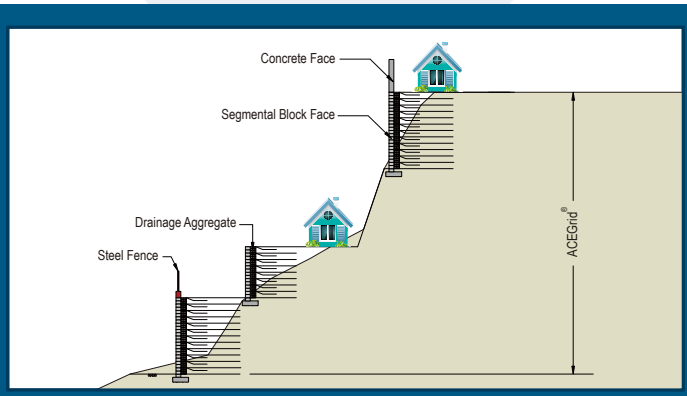
Retaining Walls

ACEGrid® Delivers Novel Solution for Difficult Site Preparation Chilpancingo, Mexico

2009 IFAI Outstanding Achievement International Achievement Awards

The Background

Our client planned to develop a residential housing complex in a mountainous area where rugged terrain is typical. Substantial levelling off the site was mandatory because of engineering safety. For conventional solution, multiple tiered retaining walls have to be built to accommodate different housing arrangements. However, such design not only introduces enormous amount of cut and fill earth construction but also makes foundations vulnerable to differential settlement. Cantilever retaining walls are costly and susceptible to seismic damage. Reinforced concrete structures also require longer time to complete.

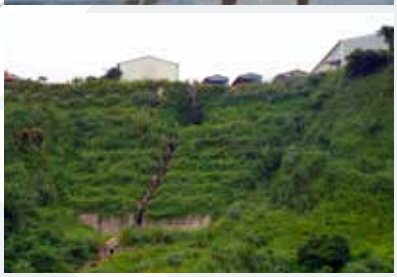


ACEGrid® Fits Challenging Conditions

By exploring the advantages of ACEGrid® mechanically stabilized earth (MSE) wall, the developer finally adopted it as the solution for the site. The ACEGrid® MSE wall allowed engineers to integrate cut, fill, and retaining structure into one step which made the site preparation much straightforward. Compacted fill reinforced with ACEGrid® satisfied both static and dynamic loads, and therefore becoming a perfect seismic-stable structure. Differential settlement also was not likely for such an engineered earth structure. The total length of the MSE walls was more than 300m and the height were varying from 7 to 12m to fit the terrain of the site. For aesthetic requirement, the designer specifically selected modular concrete blocks as the face of the MSE wall to match well with the appearance of the surrounding housing complex. Although the site condition was difficult, the final completed ACEGrid® MSE wall presented excellent result better than expected. The system has been proved totally meets the demands of the site and worthy of being considered as a model for future similar development.

Retaining Walls

Riverbank Slope Rehabilitation, Proximity to National Freeway No. 4, East Sta.0+8k, Taichung, Taiwan, ROC



The Conventional Solution

Soil nailing together with shotcrete stabilization can usually be used for fast treatment of a steep slope such as this project. However, its appearance is totally not compatible with the local environment. Its impermeable surface will also create difficulties with the efficient draining of abounding groundwater, therefore increasing vulnerability to seepage damage. The disposal of piled rubble on site also will be extremely difficult for the contractor.

The Background

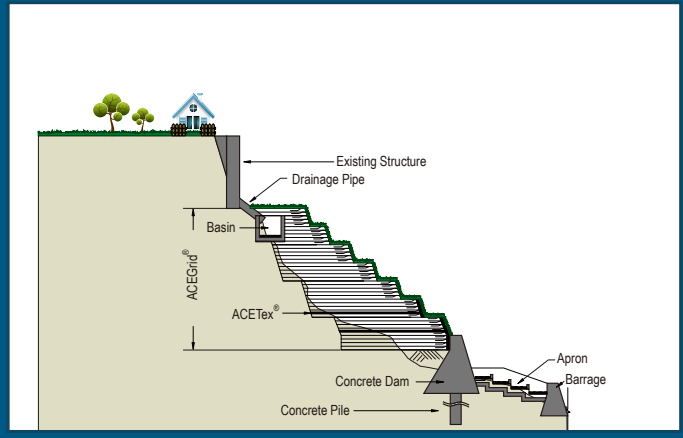
In September 21 1999, a devastating earthquake, dubbed the "Quake of the Century" by local media, struck the site and caused severe damage to the slope and its drainage system. Large amounts of gushing water subsequent to several heavy rainfalls led to severe surface erosion and further destruction of the slope. Although the managing authority conducted some mitigation measures, the sliding had never been accurately treated and condition was worsening with time. The safety of the industrial complex adjacent to the sliding zone thus is critically jeopardized, and the slope must be rehabilitated immediately.

The Challenges

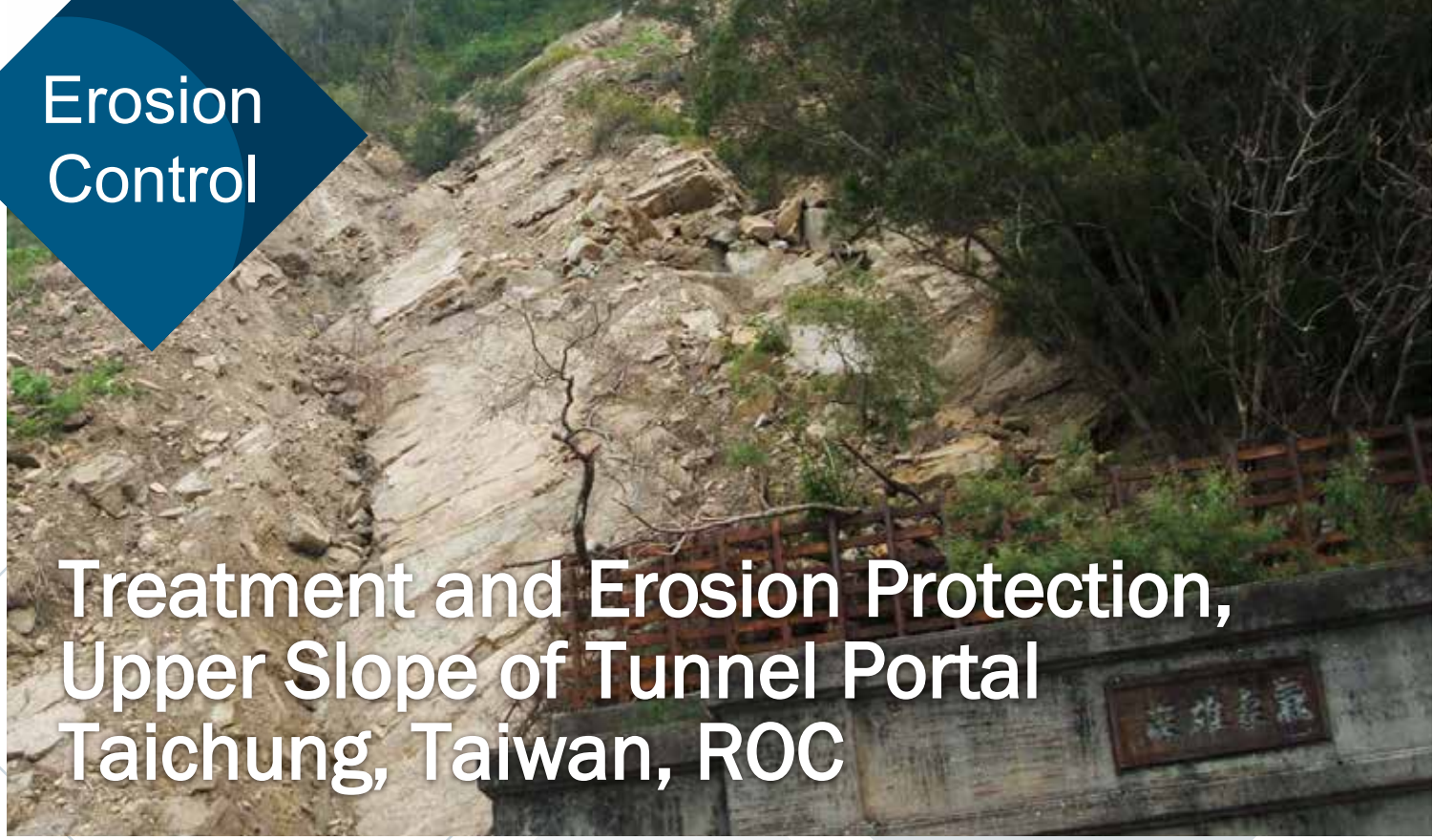
The height of the collapsed slope was about 30m and the averaged inclination was over 70°. The geological formation at the site was red clayey silt intermixed with gravel. This is a typical difficult formation in Taiwan as it is very sensitive to the variation of its water content. The rehabilitation should not only stabilize the slope and protect it from future seismic damage, but should also prevent surface run-off and groundwater seepage softening the silty gravelly formation. The managing authority required that the restoration should be completed with a sustainable solution within a limited schedule. The construction should try to utilize all the collapsed rubble and the site should be as green as possible to match well with the surrounding environment.

ACE Innovative Application

Considering safety, durability, and sustainability, the designer finally adopted ACE reinforced earth slope (RES) composite system for the rehabilitation. Based on the stability analysis, secant piles and toe berm, reinforced concrete structural members with stronger stiffness, were installed at the toe to provide sufficient base support. Then, 11 tiers of reinforced earth slope using ACEGrid® and the on-site collapsed rubble were placed in sequences up to the crest. The RES was constructed with geogrid wrap-around facing with each tier at a height of 3m and an inclined ratio of 1:2(H:V). ACE drainage board, pipe, and geotextile (ACETex®) were arranged elaborately as intercept system in the RES for prompt seepage dissipation. Longitudinal and horizontal trench systems were also installed to facilitate the drainage of surface run-off. Soil-filled and hydro-seeded ACEBag™ was stacked for slope face protection. Since installation, the project has visually integrated into the environment through the growing of vegetation. The aesthetic appearance, together with a variety of local species observed on site, has demonstrated the eco-friendly capabilities of the ACE system. In addition, the completed ACE reinforced earth slope has remained in good condition through the deadly Typhoon Morakot in 2009. It is indeed a safe, durable, aesthetic, and sustainable solution for similar projects.



Erosion Control



Treatment and Erosion Protection, Upper Slope of Tunnel Portal Taichung, Taiwan, ROC

The Background

This project took place at the portal area of tunnel No.9 of an abandoned railway (currently remodeled as a scenic bike path) in Taichung. The surface of the upper slope at the portal area has been covered by a layer of completely weathered and fractured sandstone with a thickness of 1 to 2m. According to the environmental geological studies given by the Central Geological Survey, the site has been classified as debris sliding zone. It appeared to be very unstable and risky upon any disturbance.

The Problem

In July 2006, a torrential rainfall attacked the site and totally saturated the decomposed slope surface. A typical shallow plane failure was then triggered and caused the surface to slide off the bedrock. The movement further loosened the cementation of the weathered sandstone and thus seriously jeopardized the traffic safety of the portal area. The managing authority called for an immediate rehabilitation not only to stabilize the upper slope but to resurface the portal area for scenic improvement as well.

The Solution and Innovation

3D diamond-shaped high-tensile steel wire mesh was first secured onto the bare slope using grouted rock nails. A base layer consisted of mixed seeds, fertilizer, and water-bearing material was hydro-sprayed on top of the wire mesh networks. High tensile strength ACEMat™ R, a 3D cellular confinement material, was then fixed together with the steel wire mesh using rock nails.

The Contribution

The composite slope protection system not only secures the weathered sandstone, it gives a fresh green looking at the portal area as well. ACEMat™ R offers spaces for vegetation to grow. It is also attractive for a variety of local species to stay. Although the site has experienced several challenges of strong typhoons and torrential rainfalls, it remains stable with richly grows vegetation. The design scheme has proved such composite slope protection system with ACEMat™ R totally meets the demands of an eco-friendly environment with sound stability.

Erosion Control

One Ecological Landscape Park with ACEMat™ R – Taichung Pinglin Forest Park

The Background

Taichung Pinglin forest park covering about 11.7 hectares, is located opposite the Taichung Armed Forces General Hospital, near to the National Chin-Yi University of Technology. This park sits on the land originally reserved for military use. In recent years, due to the decrease of the military, reducing the demand of land, and the governments urban plan policy, the government intended to reconstruct this area as a multifunction ecological park providing recreational space, a scenic environment and a water-detention basin.

The Problem

In this case, in order to achieve the government's policy objectives and improve the greening rate, the owner intends to plan a forest area exceeding 3.7 hectares, plus a water-retention basin of 32,000m². It not only provides the function as a detention basin, water collection during the flood but also offers a pleasant forested place for the residents to enjoy their time in normal period, moreover promotes the development of this area.

The Solution

In this case, the area start up to construct the green park and ecological water-retention basin, in order to make a green landscape, using the rectangular pyramidal geomat, ACEMat™ R to do the green work. The area covered by the ACEMat™ R is about 8,000m². ACEMat™ R manufactured by polypropylene yarns, with the three-dimensional structure can closely integrated with the soil which supporting vegetation. Furthermore, thanks to the increase of the surface roughness, surface soil eroded by the rainfall can be avoided. ACEMat™ R can protect slope and also prevent the erosion rill formed naturally to expand. In addition, ACEMat™ R with the flexibility characteristic can be adapted to the local terrain condition and be installed easily.

The Contribution

The construction of the Pinglin forest park provides an environment which can not only conserve water, adjust temperature, provide a biological habitats but also maintain the current landscape. The use of the green materials ACEMat™ R avoid the visual oppressive of concrete and form a multifunctional ecologically sustainable green park to adjust the temperature in the near region and effectively decrease the air pollution.

Erosion Control

Slope Rehabilitation, Renai Access Road Nantou Taiwan, ROC

The Background

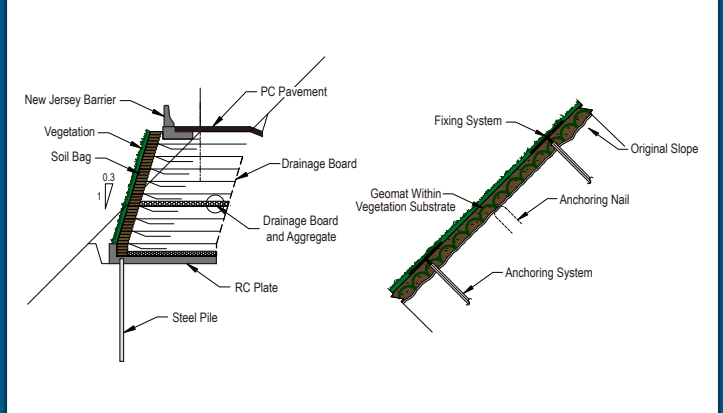
Renai Township is a mountain indigenous village in Nantou County, Taiwan. It is famous for its aboriginal culture products and beautiful nature scenery. The site is located in Renai Township. The slope disrupted during an attack of torrential rainfall due to its poor geological and hydrological conditions. The slope was damaged seriously with a collapsed depth over 30m and led to a total loss of the road structures and thereafter the interruption for the local traffic.

The Solution

The designer introduced a composite engineering system for the rehabilitation. First, a reinforced concrete mat foundation with steel H toe piles were installed as base support. Then, a mechanics stabilized earth wall (MSEW), 5m high and 6m wide, was built to serve as the embankment for the access road. The MSEW was constructed in compacted layers which consisted of in-situ soils and the ACEGrid®. They were piled up with 0.5m increments until reaching the design height. Stacked soil-filled ACEBag™ with geogrid wrap-around facing was used for face protection. A step back inclined ratio of 1:0.3 (V:H) was maintained to allow for the most possible width of the access road. ACE drainage board and geotextile (ACETex®) were arranged within the MSEW as intercept system for prompt seepage dissipation. For damaged slope below the MSEW, traditional solution such as shotcrete or cross concrete structural bars are commonly applied. They are fast, strong and effective to protect a weathered rock slope. However, their awkward appearance and impermeable surface ruled out their possibilities for this project. The designer selected an eco-friendly and green system for the downslope protection. 3D diamond-shaped high-tensile steel wire mesh was first secured onto the bare slope using grouted rock nails. A base layer consisted of mixed seeds, fertilizer, and water-bearing material was hydro-sprayed on top of the wire mesh networks. Finally, high tensile strength ACEMat™ R, a 3D cellular confinement material, was then fixed together with the steel wire mesh using rock nails. In addition, longitudinal and horizontal trench systems also were installed to facilitate the drainage of surface run off.

The Contribution

ACEMat™ R offers sufficient spaces for vegetation to grow. It is also attractive for a variety of local species to stay. The eco-system not only provided stabilization for the fractured slope but also improved the appearance of the site. Since the completion of the project, the composite system has been through a number of typhoons and severe rainfalls, however, the installed system stays functional and the slope presents sufficient stability. The strategy of using ACE green system to substitute traditional gray structures has awarded numerous compliments because of the success of this project.



Slope Stablization

Landscape Engineering of the Maple Garden – Taichung, Taiwan

The Maple Garden project is the first and only recreational park below ground level in Taiwan. It is a local landmark on the busy Taiwan Boulevard in Taichung City. With a land area of 30,000m², it was the proposed site for the Taichung International Expo Center; however, for some reasons the project was ceased and cancelled after excavation. As a result, a huge and dangerous boomerang-shaped ground opening, with a depth of about 20m, was left on site. The opening was seriously affecting the city's appearance, threatening citizen's safety, and limiting the usage of the land, landform-wise and budget-wise. The local government was under the pressure of the general public. Something had to be done in a short time and within the budget.

A creative, exciting, and feasible idea was proposed to solve all concerns with given constraints and conditions. The idea was to make use of such landform to build a multifunctional park below ground level; serving the functions of flood detention, exhibition, recreation, park, and regulation of air quality of the city. Environmentally-friendliness and concrete reduction were the main foci of the landscape engineering concept for the project. This idea was adopted by the Taichung City Government, and hence the land was re-planned accordingly.

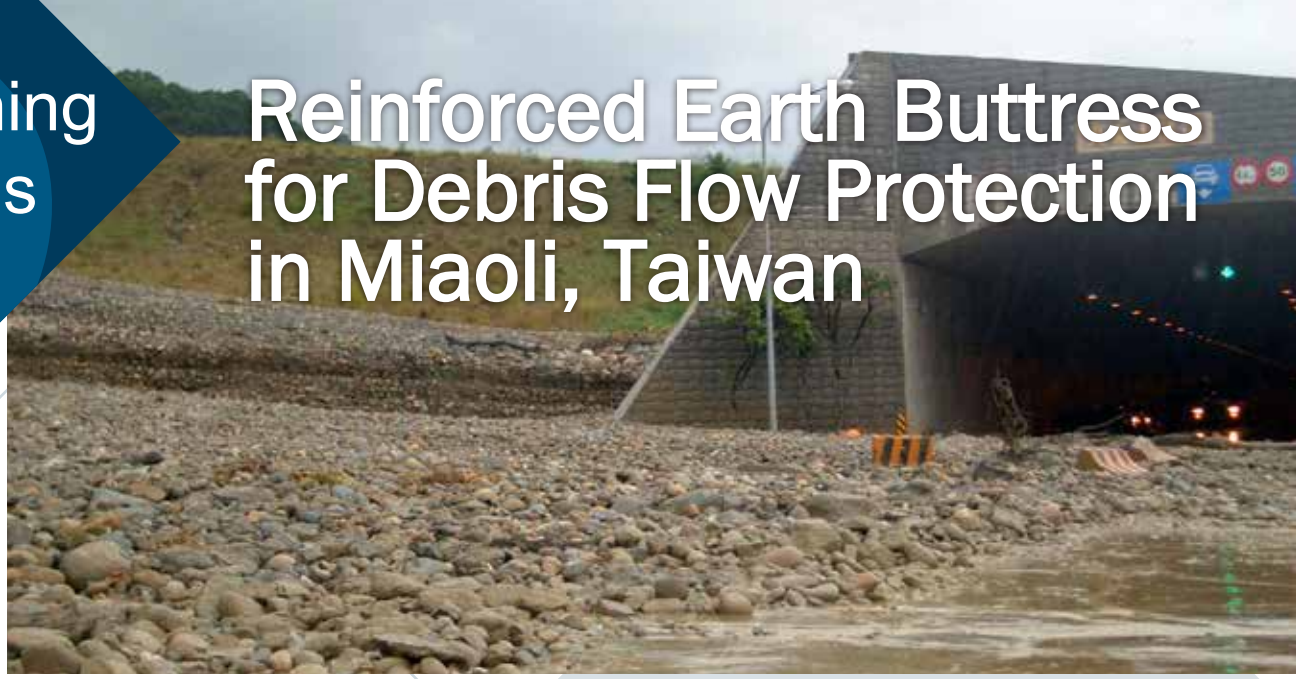
Considering the overall project requirements in cost-efficiency, construction convenience, environmental friendliness, and landscape beautification, the applications of geosynthetic products and relevant engineering methods were the most suitable and feasible approach to carry out the work. The project largely adopted the various geosynthetic products such as flexible woven geogrid (ACEGrid®), geotextile fabric (ACETex®), soil bag, vegetation mat (ACEMat™), geomembrane, etc. in reinforcing and enhancing the landscape. Rather than building traditional RC retaining wall, the surrounding wall and slope of the opening were built with wrap-around reinforcing method with geogrid (ACEGrid®), geotextile (ACETex®), and soil bag forming mechanically stabilized earth wall (MSEW) and reinforce soil slope (RSS), to support the loading coming from the road and sidewalk above and around the Maple Garden, and to provide rooms for vegetation on the wall and slope surface. This method took advantage of in-situ soil to cut down the construction time and cost, and greatly reduced the use of concrete. Moreover, geomat (ACEMat™) and gabion were incorporated in the green landscape building, to serve as a medium for vegetation and erosion control and shape the outline of the landscape. Various trees and shrubs were planted to further beautify and enrich the appearance of the park.

Furthermore, a detention pond of 200,000m³ was to be constructed and connected to the city drainage for regulation of flood. In order to merge with the landscape naturally, geomembrane, soil bag, and gabion were used to construct an ecological detention pond to fulfill this demand. A restaurant with a circular design front was built at the inner corner, merging with the reinforced wall and facing the pond; an artistic exhibition center was built at the entrance of the park beside the Taiwan Boulevard; these building structures not only enhanced the function of the park, but also added some elements of civilization and culture to the atmosphere. Walkways were constructed with different methods at different sections in the park. Crushed aggregate, timber, and wood chips were used in permeable pavements beside the pond. The perimeter sidewalk built around the pond was about 388m. All these artificial, but natural, settings built up the beauty and spirit of the Maple Garden.

Geosynthetic product applications play a major role in building the park, and significantly contribute to the concrete reduction and environmental friendliness demand of the Maple Garden project; and the use of in-situ materials and geosynthetic products brings convenience to the construction and brings down the cost at the same time. Reshaping by the ecological engineering methods, the project has successfully converted a problematic ground opening to an attractive and environmentally-friendly scenic site. It not only provides a recreational place for the general public, but also serves as an urban drainage regulator in case of flood. Moreover, the vegetation planted throughout the garden has increased the city's green coverage by 28,000m², and contributed to lowering the urban heat island effect. This creative thought and construction of turning a problem into an achievement has gained many awards and recognitions from the construction and geosynthetic industries in Taiwan. And it further wins the 2013 FIABCI Prix d'Excellence Award in the Public Infrastructures/Amenities Category at the 65th FIABCI World Congress (2014), Luxemburg. Started as a remedy and ends up with glory, the Maple Garden project is beyond construction, it is in fact a meaningful and remarkable art.

Retaining Walls

Reinforced Earth Buttress for Debris Flow Protection in Miaoli, Taiwan



The Background

This project was located at the toe of the Houyan Mountain, between the western portal of the Houyan Mountain Tunnel and the nature conservation area. The geologic situation of the mountain was naturally unstable. Over the years, extreme torrential rain had made the area even more vulnerable; debris flow became a threat to the environment and the road close by. A debris basin was found beside the tunnel portal as a protective measure. However, frequent typhoon invasion and concurrent of debris flow broke the protective barrier between the existing road and the debris basin again and again.

The Problem

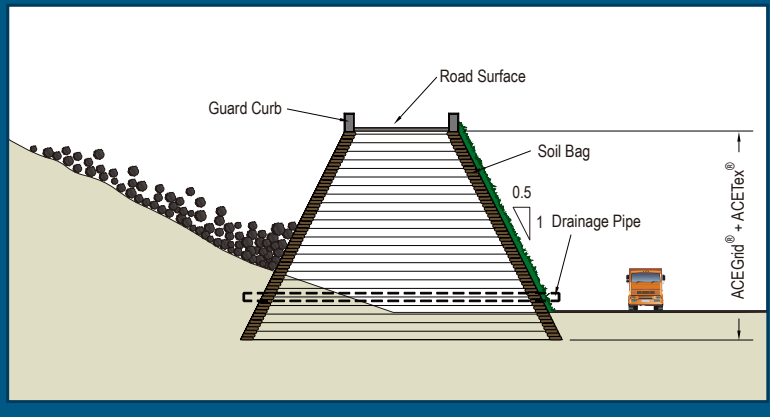
The boundary of the conservation area was close to the proposed site of construction, which limited the available working space and the size of structure to be built. According to the construction history of the site, gabion and earth dyke were practically proven ineffective. Therefore, the Miaoli County Government wanted a different and effective structure to keep the debris in the basin; and access for debris cleaning must be considered in the design.

The Contribution

Natural propagation has vegetated and enhanced the appearance of the MSE buttress. Over the years, the structure has experienced more than fifteen (15) typhoons and the debris flow caused by them. Its overall performance and current status proves itself an adequate and effective protection for debris flow.

The Solution

A mechanically stabilized earth (MSE) buttress was determined for this project; the geogrid wrap-around reinforcing method was used. The design concept was to use in-situ materials to deal with in-situ problem. The designed buttress should function as a retaining wall, a training levee, an access road, and an environment keeper. The overall MSE buttress structure had a width of 20m at the foundation and 6.6m at the crest, on which a 6m wide PC pavement was constructed as debris cleaning access. With an average slope of 7.96%, the total length of the structure was 177m; the buttress extended and shielded 15m of the tunnel portal in length, and the end point of the buttress was 4.3m higher than the tunnel roof.



ACE Geosynthetics, established in 1996, is a leading geosynthetics manufacturer and solution provider headquartered in Taiwan. We develop, manufacture and supply a wide range of reliable geosynthetic products that are approved and certified by CE, BBA, NTPEP. We also customize products to meet clients' various needs. In our company are more than 40 experts in civil, geotechnical, marine, hydraulic and environmental engineering who provides professional technical service and cost-effective solutions that help clients realize projects with success and efficiency.

What We Offer

Structure design and analysis

Our experienced engineers design and conduct analysis with professional engineering software such as MSEW, ReSSA, Reslope, Stedwin and GeoCoPS, and provide drawings or advice to help clients install materials properly.

Technical Consultation

We work closely with clients and provide advice in every stage throughout the entire process, including selecting optimal products, proposing solutions and giving advice on material installation.

Product customization

We customize products for clients. Many of our products including ACEGrid®, ACETex®, ACETube®, ACEFormer™ and ACEBag™ can be made according to individual specifications to fulfill particular requirements.

Construction Assistance

We offer on-site technical support on request during construction to ensure proper installation of products and structural stability.

Our experience and achievements:

- Reinforced walls and slopes
- Soil stabilization
- Ground stabilization
- Pavement reinforcement
- Erosion control
- Sewage and sludge dewatering
- Shoreline remediation
- River / wetland remediation
- Coastal protection
- Harbor dredging

ACE Geosynthetics

www.geoace.com sales@geoace.com

2016/08