MACCAFERRI

CASE HISTORY

Ref: CH/ INT/ SR007-IN, Rev 01, Oct 12

CONSTRUCTION OF NEW AIRPORT AT PAKYONG

SIKKIM, INDIA

REINFORCED SLOPES, RETAINING WALLS, HYDRAULIC WORKS, EROSION PROTECTION, ROCKFALL MITIGATION

Product: Terramesh® , Green Terramesh®, Paralink®, Gabions, Biomac®

Preamble:

Sikkim became a state of India in 1975. Due to its land locked situation, the state of Sikkim can only be approached by road. By virtue of its lush green topography, with a wide variety of flora, fauna and proximity to the Himalayas, it has always been a tourist attraction. The nearest rail terminus to Sikkim is at New Jalpaiguri and the nearest airport is at Bagdogra, 120km from Gangtok. Although Sikkim has ample scope for the development of tourism, direct access to this region does not exist, due to the lack of a commercial airport. Therefore, a new airport was proposed at Pakyong, situated approximately 33km from the capital, Gangtok.

Problem:

The site of the proposed airport with an acquired area of 200 acres, is in mountainous terrain. The runway strip was planned in a N-S orientation cutting into an existing hill with a natural slope from the West (uphill "cut" portion) to East (downhill "fill" portion). Since a 150m wide planar surface was required for the construction of the runway and airport structures, a vast "cut and fill" construction was determined to be the most efficient construction method (the uphill "cut" material providing the downhill "fill" material).

The project required that the cut and fill volume was balanced and would determine the level of the final runway. The range of cutting and filling heights are 4m-111m and 4m-72m respectively.

Sikkim experiences very high annual rainfall and drainage of storm water was a vital component of the project. Secondly, the local population use the water from the 11 Jhoras (natural streams) crossing the proposed runway alignment, to provide their daily water needs, from drinking to agriculture. This supply was not to be compromised by the airport works.

Location of Project

Aerial view of the proposed site

View of the airport site before construction

Client:

AIRPORTS AUTHORITY OF INDIA (AAI)

Main contractor:

PUNJJ LLOYD LTD.

Consultant:

MOTT MACDONALD INDIA PVT LTD.

Designer:

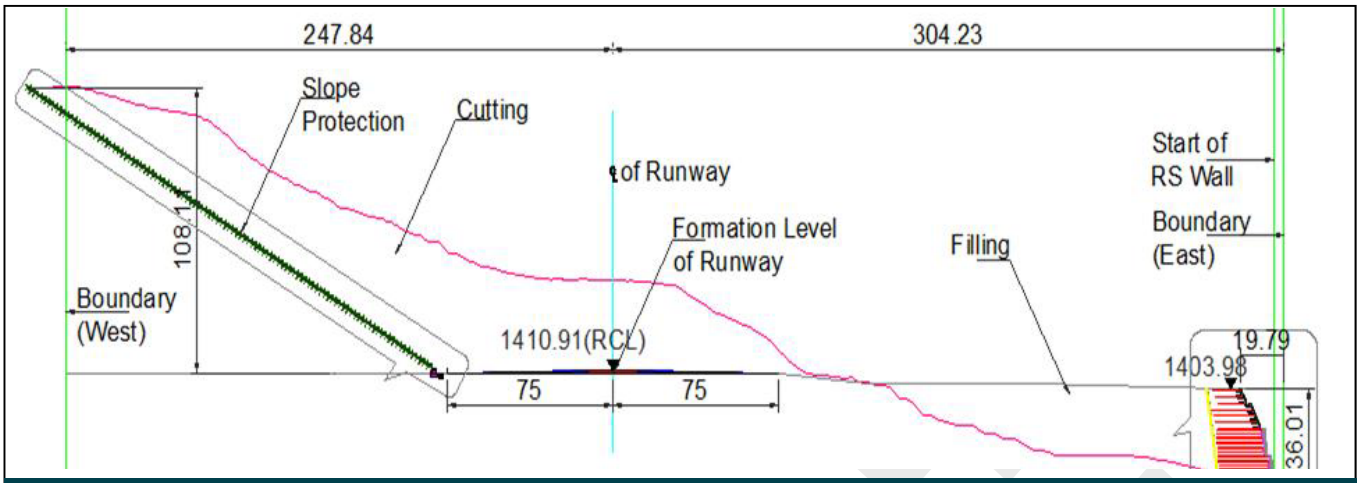
MACCAFERRI ENVIRONMENTAL SLNS. PVT. LTD

Products used:

Terramesh: Volume TBA
Green Terramesh: Volume TBA
Gabions: Volume TBA
Paralink: 200kN - 45,900m^2; 300kN - 41,900m^2; 400kN - 84,700m^2; 500kN - 368,000m^2; 600kN - 508,500m^2; 700kN - 432,600m^2; 800kN - 29,500m^2

Date of construction:

FEB 2009 - MID 2013



Cross section showing cut areas (at left) and fill areas (at right), supported by reinforced soil retaining structures up to 74m high

A specific requirement of the client, Airport Authority of India (AAI) was that the solution was environmentally friendly, limiting any impact on the local habitat. The cut and fill balance was ideally suited to this, by minimizing the quantity of construction or waste materials moved to and from the site.

Solution

Maccaferri Environmental Solutions Pvt. Ltd., India, working with project consultant Mott MacDonald India, proposed;

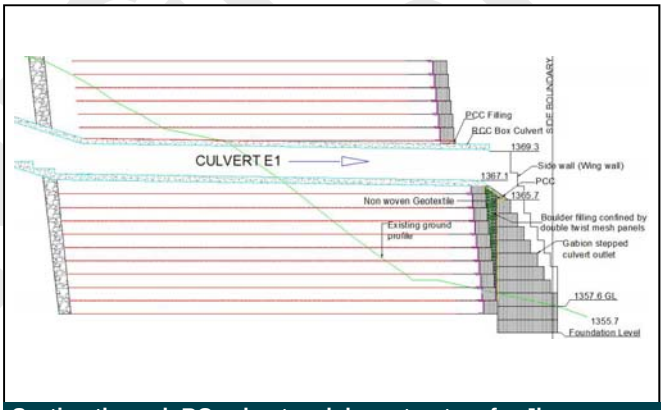
1. ParaMesh (Terramesh® and Paralink®) reinforced soil walls for stabilizing the "fill" valley side (4 to 72m High)
2. Gabion toe walls (3m high) at the uphill "cut" side to stabilize the slopes
3. Surface protection works for both cut and fill slopes with Biomac® C erosion control blankets
4. Drainage works for capturing and channelizing the surface water runoff and existing natural streams (Jhoras) using gabion cascades and RCC structures.

The site geology is a mixture of soil and rock; fragmented and highly weathered in the upper strata and with depth, the weathering decreased and soft to hard rock was encountered. Based on the required flying clearance required for the aircraft with respect to adjacent hills, the location, level and width of runway was determined.

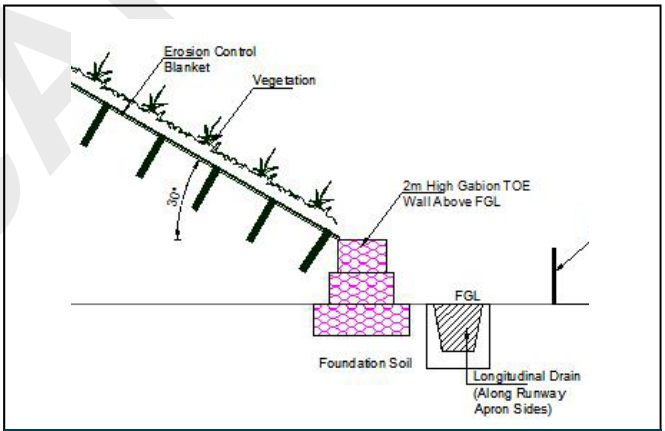
The material cut from the uphill slopes was then used for the downhill fill operations, thereby creating the platform for the runway. The toe of the uphill cut slopes were stabilized by 3m high gabion retaining walls, which being free-draining, also provided a drainage path for storm water. The vulnerable cut slopes were covered with erosion control blankets, Biomac® C, made of coir. The Biomac® C minimizes the surface erosion due to rain and surface run-off and additionally promotes vegetation re-establishment. Thus, the cut slope quickly stabilized and blended with the beautiful surroundings.

To retain the fill within the airport boundary on the valley side, retaining structures of heights varying from 4 to 72 m were proposed. Tried and tested throughout the world, Maccaferri's ParaMesh reinforced soil system was used for these elements. ParaMesh consists of two components;

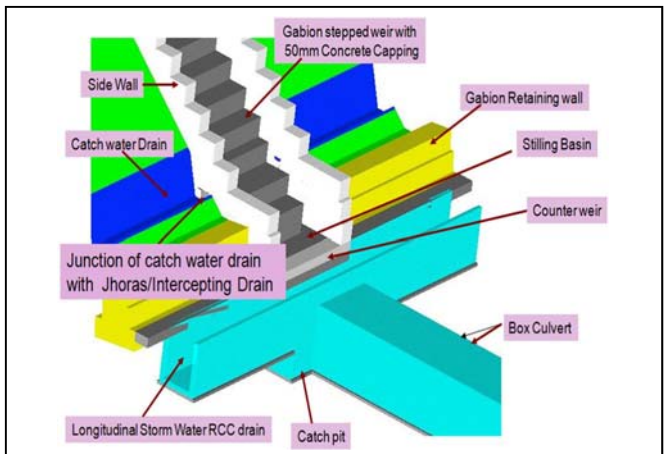
- Paralink® geogrids as a primary reinforcement with strengths ranging from 200 to 900kN/m
- Terramesh® and/or Green Terramesh® fascia units and secondary reinforcement.



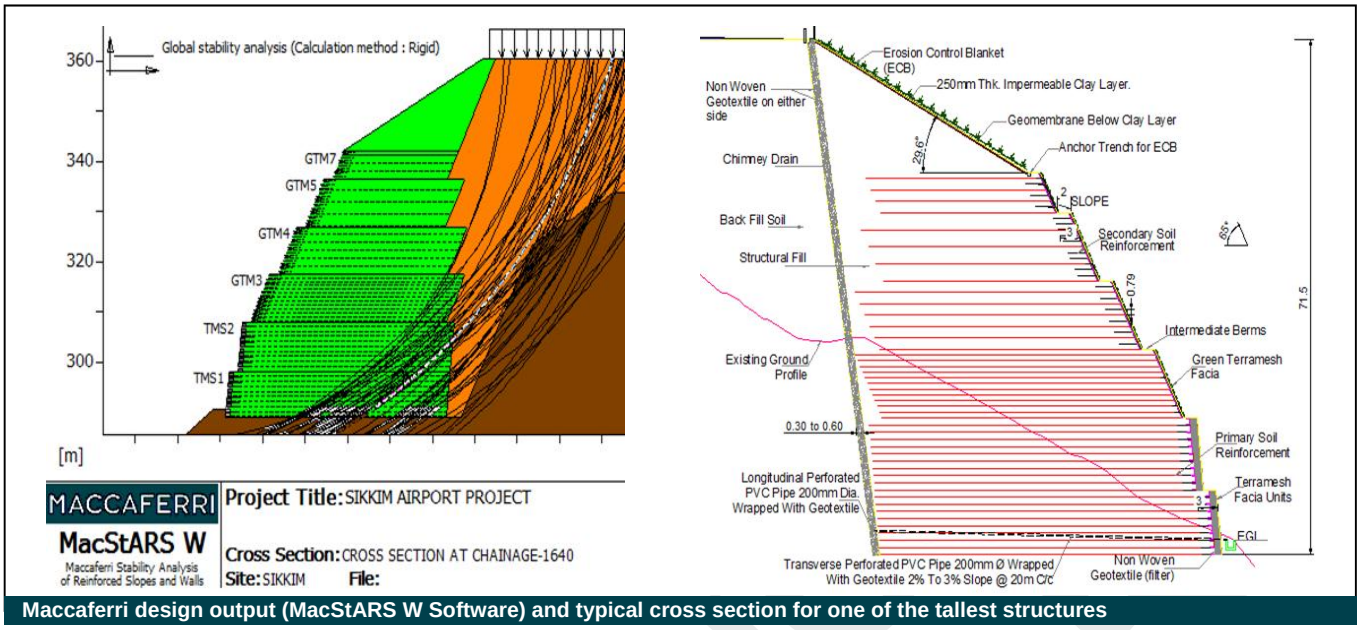
Section through RC culvert and drop structure for Jhoras



Section through uphill "cut" gabion retaining structure



3D view of drainage scheme at junction of cutting & toe wall



Maccaferri design output (MacStARS W Software) and typical cross section for one of the tallest structures

The unique ultra-high performance, Paralink® is laid horizontally and is then sandwiched between layers of compacted backfill, reinforcing it and dramatically improving the properties of that fill material. Terramesh® and Green Terramesh® units consisting of a continuous horizontal panel of woven steel-wire mesh geogrid with an integral fascia unit. This makes the system efficient and economical to construct as there is no connection between grid and facia element. Installation is quicker and there is less potential risk of errors and omissions during construction; important with the local work-force and the need for quality construction in these tall structures.

The Terramesh® fascia unit is filled with either durable rock-fill (in the same manner as a gabion), or in the case of Green Terramesh®, with topsoil to enable revegetation of the slope. The selection of Green Terramesh®, Terramesh® or a combination of both, was determined depending on space constraints and the location of the Jhora concrete culverts.

Once completed at nearly 74m high, these ParaMesh structures will be amongst the tallest reinforced soil walls and slopes in the world.

Laying ParaLink primary soil reinforcement geogrids

Erosion protection mat Biomac C, placed on cut-slopes

Assembling Terramesh fascia units, ready for stone fill

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Green Terramesh soil reinforcement under construction

Green Terramesh soil reinforcement after vegetating

With incredible annual rainfall, management of storm water run-off on the project was vital. Constraining the natural passage of water in any way could cause a build up of pore-water pressure within the reinforced soil walls (potentially affecting stability) or reduce the water supply to the population downstream of the airport. Of the 11 Jhoras (natural streams) identified within the site boundary, 9 crossed the runway alignment and had to be canalized. Water control structures ultimately fed 4 concrete culverts running perpendicular to the runway which discharge through the face of the reinforced soil ParaMesh structures.

Primary construction halted for the monsoon 2011 and then in September 2011, Sikkim was struck by a magnitude 6.8 earthquake. While most other infrastructure in the area was damaged by the quake, the ParaMesh structure stood firm due to its flexibility and inherent robustness of these Paralink® reinforced soil structures.

Since then the structure has been awarded the Ground Engineering “International Project of the Year 2011” and Airports Authority of India were awarded the ‘Greentech Corporate Social Responsibility CSR Award 2011’ in the Gold Category for the project, due to the minimization of environmental impact and reduction in carbon footprint compared to the traditional solutions considered.

Combined Terramesh / Green Terramesh wall

Completed Jhora culvert and gabion drop-structure

Main reinforced soil structure nearing full height

Officine Maccaferri S.p.A. Global Headquarters
Via JF Kennedy 10, 40069 Zola Predosa (BO) - Italy
T: (+39) 051 6436000 F: (+39) 051 236507
E: comes@maccaferri.com
www. Maccaferri.com

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