Large geotextile containers for coastal storm protection

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ABSTRACT: The central coast of Vietnam is regularly ravaged by typhoons which develop in the South China Sea and move westwards during a typhoon season which extends from September to November each year. At Hoi An there have been several attempts at shore protection for beach front hotel developments using gabion structures and sand filled geotextile tubes (geotubes). These have failed to provide adequate protection mostly due to construction difficulties in the constant wave environment which prevails even outside of the storm season. In June 2009 work commenced on the construction of a seawall and groynes using large sand filled geotextile containers that when filled with sand weigh around 4.5 tonnes each. They are filled on land and used like large bricks to take advantage of the interlock and the high interface friction between the non-woven geotextile used for the geotextile containers. Wall construction commenced in July 2009 and the seawall was partially complete when some minor damage was sustained by the first storm in early September 2009. In late September the site was struck by typhoon Ketsana which made landfall very close to Hoi An with reported wind speeds of up to 140 km/hr. There was widespread damage to property in the area but the partially built seawall has escaped relatively unscathed. The paper describes the concepts behind the containers, discusses the design issues, describes the filling and construction processes and provides some detail of the impact of typhoon Ketsana.

1 INTRODUCTION

Hoi An is an ancient shipping and trading city in Central Vietnam about 30 km south of Da Nang. The old town is on the Thu Bon river and is a listed world heritage site which attracts many tourists. This tourist traffic has lead the Hoi Anh Tourism Authority to foster development of resorts along the sand dunes at the surf beach.

The surf beach faces eastwards directly to the South China Sea and has consistent wave action all year and is buffeted by regular typhoons in the typhoon season from September to November each year.

Various attempts to provide shore protection to the resort structures have failed due largely to inappropriate solutions and difficulties with construction in the wave environment.

Figure 1 shows the state of the beach and structures in early 2009 with debris from previous work with gabions and geotubes evident.

Figure 1 – Early 2009

2 CONCEPT

The concept of the large geotextile containers is to create the largest sand filled geotextile containers that can be readily filled and handled at site with regular construction equipment.

The geotextile containers used at Hoi An were nominally 2.5m x 1.8 m and when filled were about 0.6 m thick with a total mass of around 4.5 tonnes.

They were based on a heavy duty non-woven geotextile (unit mass 1000 g/sqm) and some of the geotextile containers used a geotextile that was over needled with additional coarse fibres (total unit mass 2000 g/sqm) to provide additional long term durability in the high energy wave climate and extreme UV conditions.

These large geotextile containers can be filled with sand on the beach and placed in position using cranes or excavators with little impact from wave action during construction.

3 DESIGN

The geotextile containers were configured into a seawall, similar to that in Figure 2, seven rows of geotextile containers high with a double row of geotextile containers for the first four rows and an additional base geocontainer at the toe with a geotextile hinge to facillitate articulation resulting in protection from toe erosion.

Since the geotextile containers are made from non-woven fabric they generate high levels of interface friction between individual units and stability is enhanced by steeper walls with greater contact area between geotextile containers.

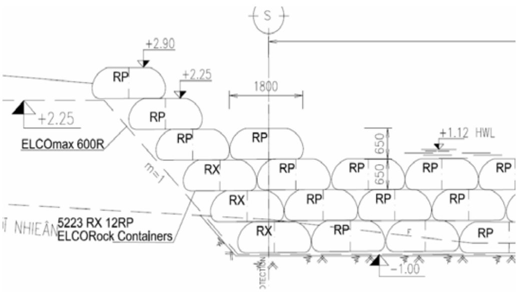

Figure 2 Typical section of Geocontainer wall

4 GEOTEXTILE CONTAINER FILLING

The geotextile containers were filled using local clean beach sand with a generous supply of water to help distribute and compact the sand, and achieve a nearly 100% full geocontainer. They were filled in a frame based on standard formwork components with a special hopper overhead. This can be seen in Figure 3.

These geotextile containers were fitted with geotextile tubes which help to facilitate filling and achieve a more secure closure after filling is complete.

Figure 3. Filling Frame

5 PLACEMENT

The geotextile containers were placed in position using both excavators and cranes with advantage being taken of the crane reach to facilitate placement of the geotextile containers without the machinery needing to enter the water. Figure 4 shows a geocontainer being placed in shallow water.

Figure 4 A geotextile container being placed in shallow water. Note poor slinging without a spreader frame which results in geotextile container being squashed.

Placement of geotextile containers to form the seawall commenced in late July 2009 and by late August it had been built up to row 5. The partially built wall can be seen in Figures 5 and 6 – note the rapid colouration of the geotextile containers as the geotextile encourages marine plant growth.

Figure 5. Partially built wall – up to row 5

Figure 6 An early storm

Figure 7. Map showing track of Ketsana

6 TYPHOON KETSANA

Typhoon Ketsana is typical of the seasonal typhoons that originate in the South China Sea east of the Philipines and track west and north as they build strength.

Ketsana caused widespread flooding and damage in the Phillipines on 26th and 27th September and then it tracked west to cross the Vietnamese coastline some 80 km south of Da Nang late afternoon on the 29th September. Figures 7 and 8 show its path.

It was reported by the Denverpost and Vietnam News to have wind speeds over 140 km/hr and offshore waves were said to be 6 m high. Destruction to property was widespread as was the resultant flooding as shown in Figure 9.

More than 250 people were reported dead in the Philipines and more than 50 dead in Vietnam.

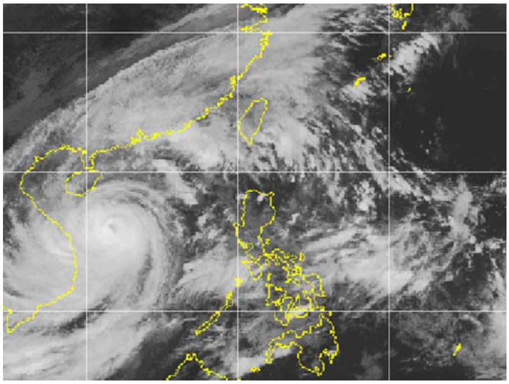

Figure 8 IR Map showing eye of storm approaching Da Nang

Figure 9 Flooding in Hoi An (AFP/Getty Images)

7 STORM DAMAGE AND REPAIRS

Generally the partially complete geocontainer wall stood up very well with only a few geotextile containers shifting and no rupturing of geotextile containers. The geotextile containers that have shifted are able to be easily repositioned. The majority of this movement was due to overtopping of the partially completed wall.

Figure 10. Partly built wall before typhoon

Figure 11. Partly built wall on the morning of the typhoon.

Figure 12. Partly built wall two days after typhoon. Note shifting of a few containers.

Figure 13. Collapse of structures in locations not protected by wall.

8 SUMMARY

A partly built seawall using large geotextile containers filled with local sand has survived a direct hit by a full scale typhoon with minimal damage.

This has resulted in growing confidence in the ability to build shore protection structures with these large geotextile containers that can be filled, handled and placed with locally available equipment and labour. In the event of partial damage or movement the wall can be repaired or reconstructed using the original geotextile containers.

Most importantly the staff and families of the companies involved with the development are safe and well after the typhoon.

9 ACKNOWLEDGMENTS

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