

Reef Surface material system is aiming for creating a large scale 3d surface composed of small linear fragments working as a new type of breakerwave forming series intermitted mobile islands. This creation of man-made islands is a part of comprehensive coastal management strategies deployed on the coastal line along Thailand Andaman Sea. It will be as an infrastructure not only for tsunami mitigation to safeguard Thai Phangnga Province coastal line and restore the tourism industry but also as a long term running for regeneration of mangrove forests. These mangrove forests will provide a favorable environment to local fauna and flora for aquaculture farming in order to help local fishing industry which was heavily affected by 2004 Asian Tsunami. It is aiming this man-made system embedded with nature environmental system and as incubators for the local culture and economy to achieve sustainable socio-ecosystem in a very similar way to how a reef becomes a life centre for the fish that inhabit it. (Project is still undergoing and it is trying to explore the porosity characteristic of fabric-formed casting concrete.)

General Characteristics of Fabric Forms for HYDROTEX Linings and Mats and HYDROCAST Armor Units

HYDROTEX fabric forms are constructed of high-strength, synthetic, yarn formed into woven, double-layer fabric. Textured yarns comprise a minimum of 50% of the fabric weight for improved adhesion to the aggregate concrete and better friction characteristics. The yarns are woven into a network mesh that provides uniform coverage and stability.

The fabric forms are designed to serve as filters as well as concrete forms with a permeability selected to permit egress of excess concrete mixing water while retaining the cement paste. The fabric forms are designed to be flexible, durable, and long-lasting.

After the fabric forms are woven and inspected, each roll of fabric is factory assembled either into panels designed to fit project dimensions and topography or into forms of specific dimensions.

The design of the fabric forms and their woven construction provide HYDROTEX fabric forms with a range of important benefits including:

- High Strength: enabling the fabric forms to perform effectively under concrete pumping pressure.
- High Elongation: to resist tear and puncture failure and to reduce form contraction.
- Excellent permeability: to expel excess mixing water.
- Lightweight: for ease of installation, and
- Uniformity in dimensions: to assure consistent performance characteristics.

The fabric forms are designed to adhere to the fine aggregate concrete fill. Through it is assumed that the top layer of the fabric form may eventually be set to abrasion and ultrasonic degradation, the bottom layer is expected to still maintain its strength and to provide a low modulus fracture mechanism.

There are two primary types of HYDROTEX fabric-formed concrete systems - HYDROTEX Linings and Mats (Fig. 1-5) and HYDROCAST Armor Units (Fig. 6). (See <http://www.geacorporation.com/hyform.htm>.)

Reef Surface Mobile Islands

Over most of the last century, coastal protection has been developed into major two strategies - "hard protection" and "soft protection". The advanced soft protection are the appearance of the natural materials used and their compatibility with natural coastal processes. In many cases the cost is below hard construction, however longevity is sometimes a problem. (Daini 2002) My research aim to develop a hybrid system which is taking both of their advantages as well as looking possibility of utilize this infrastructure as fishery or other alternative programming within local social and ecosystem.

Reef Surface material system is aiming for creating a large scale 3d surface composed of small linear fragments working as a new type of breakerwave forming series intermitted mobile islands. It is embedded with nature environmental system and as incubators for the local culture and economy to achieve sustainable socio-ecosystem. The creation of a Reef Surface Mobile Islands as part of a comprehensive coastal management strategy is on behalf of the Thai Government. The aim of the Reef Surface is not only to protect Phangnga Province area coastline in order to safeguard its population and restore the tourism industry, but also simultaneously to provide an infrastructure for the regeneration of the local environment and fishing industry heavily affected by the December 2004 Tsunami.

The surface shall consist of a single module built using the local skills, which will be combined to create different configurations which will serve 3 main purposes:

- 1) Protecting the coastal line of Phangnga Province coastline.
- 2) Regenerating a wide Mangrove forest which grows in muddy, chiefly tropical, coastal swamps and has tangled roots that grow above ground, in order to upgrade the protective power of the surface (front) and to make a healthy environment for the recreation of the local marine life (back).
- 3) The formation of pools within the surface shall be used as aquaculture forms in order to help promote the heavily degraded fishing industry and provide local forms of alternative rather than depending solely on humanitarian aid. (34)

These Reef Surface Islands along the coastline through its series of crests and pockets simultaneously as protecting Phangnga Province coastline from potential Tsunami like a coral reef would do, ends up creating an ecosystem which nourishes protects and generally sustains the local creature and plants including humans, in a way similar way to how a reef becomes a life centre for the fish that inhabit it.



Rapid Prototype RSM-01

RSM-01 Front spongy surface
Why Phangnga
Water, 200m
Volume: 0.1 liter
Porosity: 125%

Micro Scale
A differentiated spongy surface as a type of breakerwave armor strengthens its hydraulic stability and structural integrity performance. Scale and porosity ratios will be according to its location (island to island) and wave energy propagation.

Fabric-formed Concrete Reference

1. **Filter Point (FP) Linings**
Filter Point Linings (Fig. 1) with filtering points (dots) provide erosion resistance, permeable concrete walls for drainage, and protected port and harbor areas. Filter Point Linings have a cobble surface and a relatively high coefficient of hydraulic friction in order to achieve lower flow velocities and to reduce wave setup. The filter points provide for the need of hydraulic uplift pressure, increasing the system stability.

2. **Filter Band™ (FB) Linings**
Filter Band Linings (Fig. 2) are similar to Filter Point, providing an effective and high quality concrete lining that resists erosion. Unlike Filter Point, the concrete is cast in a continuous, interconnected, tubular concrete segments that are separated by large, narrow, filter bands. The Filter Point provides for greater reduction of uplift pressure than Filter Band Linings. Also, the band alignment in a linear sequence creates a series of hydraulic uplift pressure, increasing the system stability.

3. **Uniform Section (US) Linings**
Uniform Section Linings (Fig. 3) are similar to traditional concrete masonry blocks. They create a solid, high quality concrete lining with a relatively uniform resistance and uniform cross section. These linings are used to reduce the infiltration and exfiltration of aggressive fluids into or out of open channels and basins. They are also used to reduce erosion and to stabilize slopes where open channels and basins require exterior linings.

4.1 **Enviromat™ (EL and EB) Linings**
Enviromat Linings (EL Fig. 4.1) and EB (Fig. 4.2) are installed to provide protection against surface erosion. They are often used to stabilize slopes and to provide a more natural appearance. Enviromat Linings are used in concrete ditches and in upper slopes of embankments, bridge piers, seawalls, rivers, and other water courses as well as for embankments subject to heavy runoff.

5. **Articulating Block (AB) Mats**
Articulating Block Mats (Fig. 5) form cable-reinforced concrete blocks that serve as a flexible armor. They are often used to stabilize slopes and to provide a more natural appearance. All Mats are typically used to protect coastlines, canals, rivers, lakes, reservoirs, embankments, bridge piers, and other marine structures from regular wave, ship strikes, wind waves, currents, and high velocity flows. They are also used in environmental construction for landfill caps, down drains, and culverts.

6. **Hydrocast™ Armor Units**
Hydrocast Armor Units (Fig. 6) are monolithic concrete structures which include layers of fabric. They are often used to stabilize slopes and to provide a more natural appearance. All units are typically used to protect coastlines, canals, rivers, lakes, reservoirs, embankments, bridge piers, and other marine structures from regular wave, ship strikes, wind waves, currents, and high velocity flows. They are also used in environmental construction for landfill caps, down drains, and culverts.

Reef Ball

Why Built Reefs
Mangrove islands are natural islands that are built by nature. They are located about 13 km away between Bala Oa and Ta Bala Oa. They are located about 8 km west of the Bala Oa. They are located about 8 km west of the Bala Oa.

Macro Scale

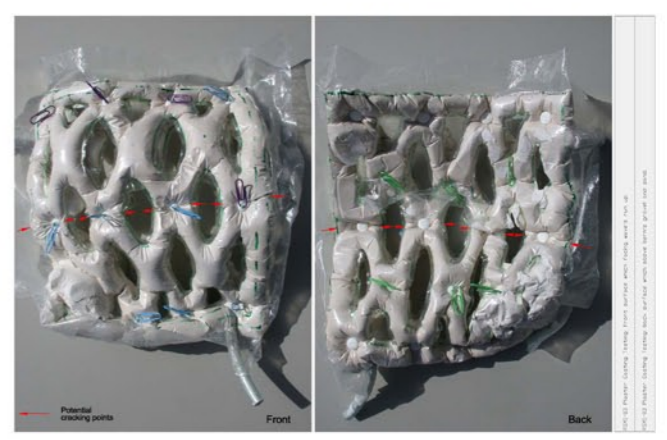
A zigzag-stagger organisation of islands is to introduce interference and turbulent flows when giant waves come thus the wave energy is reduced by its destructive interference waves. Underneath front spongy surface will be filled with earthbound and planted mangrove trees which will further dissipate the wave energy. Fish farm will be located on the wave shallow zone - back pond.

Above existing 8 types fabric-formed Concrete Systems developed by Geac Corporation

Below three new types of systems have been developed in order to provide more porosity characteristic for mangrove tree planting and also better hydraulic performance

Planar pattern Scale 1:2

Cover buttons 11mm for nodal points
Front block pattern and back block pattern are the same but different scale.
Area which bottom layer of front block and top layer of back block welded together.



RSMI - 03 Plaster Casting Test

Model aiming:
RSMI - 03 is aiming for easy lodging geometry to ground (semi) Diamond shape is the best and it is very easy for differentiating patterns and also good for lodging the ground condition. However, the zig-zag porosity effect has been demonstrated so it will be less efficient for dissipating wave energy.

Lessons
We can easily find out the weakest point and it is possible the structure will follow the linking points to be disconnected when it gets wave impact.

Reef Ball mild system diagram (RSM-01)

Reef Ball mild system diagram (RSM-01) is developed further from Reef Ball system which invented by Reef Ball Group.

Material and longevity

A variety of surface textures that enhance the settlement of marine life are essential. Marine friendly concrete for Reef Ball construction will be developed further. The concrete used to make Reef Balls features W.R. Grace's Ferro 10,000 micro silica to create a super high strength, abrasion resistant, concrete that has a pH similar to natural sea water. This is unlike regular concrete which has a surface pH as high as 12. This high pH (the sea has a natural pH of 8.3) can inhibit the settlement and growth of many species of marine life including some larval corals. Micro silica gives Reef Balls an expected life of 500 or more years.

Schematic section BB

Area which bottom layer of front block and top layer of back block welded together before separately.
It is called together into two blocks unlike RSM-02 was casted twice separately.

Planar pattern Scale 1:2

Nodal connection with front block and middle block
Middle block pattern Red color
Front block pattern Blue color
Nodal connection with middle block and back block
Back block pattern Blue color



RSMI - 04 Plaster Casting Test

Model aiming:

RSMI - 04 is aiming for producing differentiating differentiation surface block which then has more structure rigidity and integrity. These hidden order of stagger relationship is based on stagger shape which is differentiated.

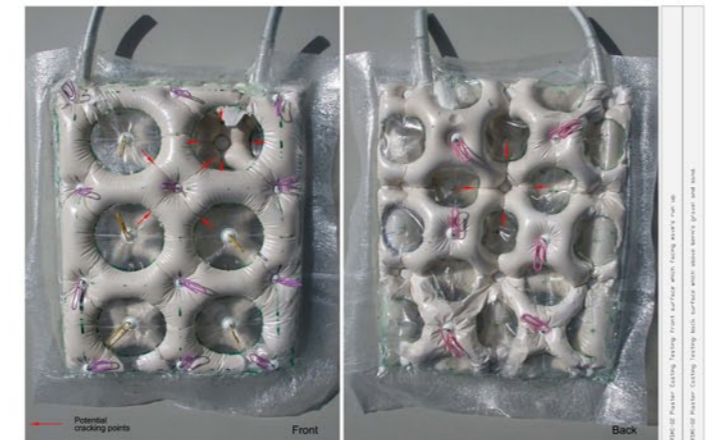
Lessons
It becomes more critical how to maintain or lose the parameter for differentiated differentiation pattern with relevant performance required. Comparing RSMI-04 to previous prototypes, perhaps it is most efficient and easy lodging geometry for new type of breakerwave for mangrove trees. It certainly has similarity with organization of mangrove root structure.

Polythene sheet injection plaster casting

Model aiming:
Polythene sheet injection casting is aiming to simulate the fabric-formed casting technique. It is aiming to find the geometry relationship in the pattern designs rather than actual fabric design. There are two fundamental important things need to exist: easy and a polythene can not join together by weaving due to thermal welding character so it is delay joined when two layers meet, so polythene sheet is not inflatable for air and water so it has an bubble effect if it is not casted well.

Planar pattern Scale 1:2

Nuts and bolts for hanging weight
Cover buttons 11mm for nodal points
Front view pattern
Back view pattern



RSMI - 02 Plaster Casting Test

Model aiming:

RSMI - 02 is continuing to find the similar solution as RSMI - 01, part of front circle infiltrate the wave energy and part of back circle reflect the incoming waves. This two layers combination can be applied to more layers if wave impact increases thus structural density required.

Lessons
Advancing 1 layer finally cast RSMI-02 successfully, its nodal points are structurally weak points because there are too many bars intersecting together. Also its adaptability of fitting the ground condition is not feasible enough. So next generation approach will be focusing on attaching to the ground and less nodal points. However, it might reflect and dissipate wave energy more efficiently.

Schematic section AA

Plywood frame board
Polythene sheet with Black pattern
Waving patterned rubber 3mm thick
Front block and back block are injected separately thus back block surface becomes a negative imprint of front block.

Planar pattern Scale 1:2

Actual front view pattern size is enlarged by 125%
Actual back view pattern size is enlarged by 140%

Concept generic regular pattern
Differentiated difference pattern

