

Reef Ball Designed Artificial Reefs Erosion Control & Tourism Enhancement



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Overview

- Reef Balls are prefabricated concrete modules used as a base for natural coral reefs to form.
- Reef Balls have been used in 55 countries in over 3,500 projects and ½ million modules are deployed.
- Reef Balls have been used in Mexico since 1995 throughout the Yucatan Peninsula



Reef Ball Near Isla Mujeres



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Organizations

- Reef Ball Foundation is a public non-profit organization that works to rehabilitate reefs.
- The Reef Beach Company is a division of the Foundation that specializes in erosion control uses of Reef Balls providing engineering and quality control services.
- Reef Ball Mexico is our local Authorized Contractor that can build and deploy Reef Balls for you.



What is a Reef Ball?

- A patented and copyrighted artificial reef technology using prefabricated artificial reef modules called “Reef Balls”

Featuring: A coral friendly surface texture with whirlpool creating holes, excellent stability, hollow for fish shelter and designed to last more than 500 years with a special pH neutral hi-tech concrete from Cemex. Includes attachment adapters for coral planting, prefabricated anchoring holes, interconnected holes for complexity and available in a large variety of styles and sizes to fit any reef building need.

What is a Reef Ball?

Right: Standard Style

Bottom: Layer Cake



Some Uses of Reef Balls

- To create scuba, fishing & snorkeling reefs
- To control beach erosion (as a submerged breakwater)
- For mitigation and coral reef restoration
- For coral propagation
- For guest conservation programs
- For research

Some Uses of Reef Balls

- To create scuba, fishing & snorkeling reefs

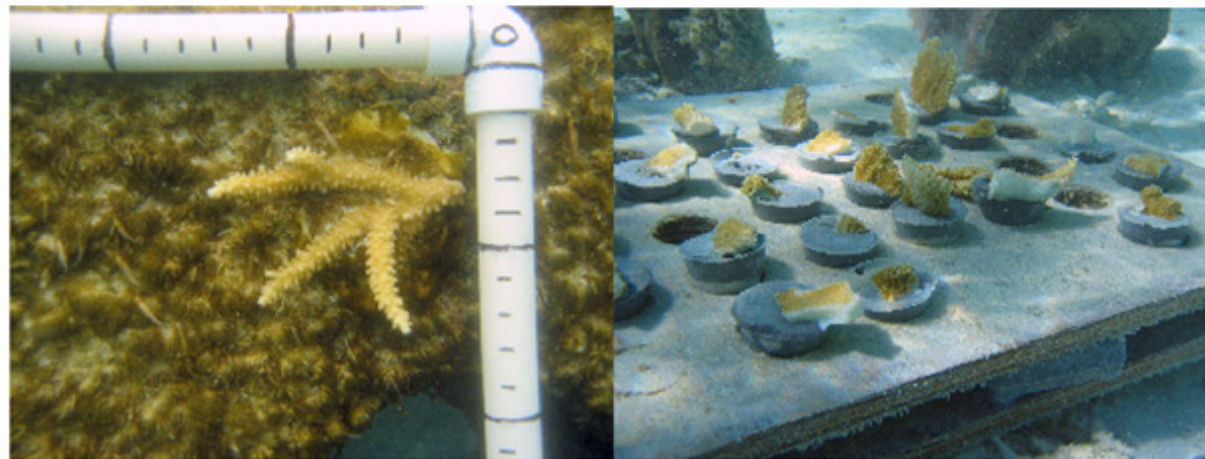


Some Uses of Reef Balls

- To control beach erosion (as a submerged breakwater)



Coral Propagation & Planting



Some Uses of Reef Balls

For guest conservation programs



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Research

- Reef Balls are considered the “standard” artificial reef modules worldwide for scientific study of reef systems. Replication in over 50 countries yields excellent comparative opportunities.



Figure 8. Coring donor corals for transplantation. Eighty coral cores were transplanted onto the Reef Ball modules (forty cores of each of two different species).



Figure 9. Transplant Reef Balls hold one core of each species (*Montastrea cavernosa* and *Meandrina meandrites*). Coral transplants were placed in empty pre-fabricated transplant holes adjacent to the settlement plates.

Cancun Beach Coastal Engineering Options

- Sand Renourishment
- Perched Beach
- Groins
- Emergent Breakwaters
- Submerged Breakwaters

Coastal Engineering Options

Sand Filling

- Temporary restoration of beach function, and less stable than a natural beach.
- Sand filling disturbs corals and creates turbid waters so the activity should be limited as much as possible
- Expensive long term maintenance costs

Coastal Engineering Options

- Perched Beach

Basic concept is sand filled containers or concrete sea walls that contain the beach sand. The main disadvantage is the loss of the natural beach/water interface.

See appliedmarinetechnology.com for more details.

Coastal Engineering Options

- Groins

Groins hold sand updrift, but starve sand downdrift. Not suitable for areas with downdrift development such as Cancun except at the very south end of the beach.

Coastal Engineering Options

- Emergent Breakwaters

Work by reflecting wave energy back to sea, and are effective at holding sand, but prone to form a sand starving tomboli unless properly gapped.

Key disadvantages are loss of view, loss of beach access for nesting turtles, people and boats except at gaps. Often emergent breakwaters are the only option in high tidal range beaches or when the slope of the beach is steep.

Coastal Engineering Options

Submerged Breakwaters

Work to reduce wave energy by breaking the waves; porous designs also add friction. Additionally, they are used to refract waves to a more shore parallel track to slow littoral drift. Some designs also reflect some energy back to the sea. Key disadvantages is they must be very wide crested at the top to be effective and close to the surface. Generally more expensive than emergent breakwaters due the need for more material because of width requirements.

Materials Used

- Sand or water filled geotubes & containers
- Natural Rocks (typically 2-5 ton class)
- Engineered Concrete Modules
 - Army Corp Jacks, Beach Saver, Cast solid structures (cubes, pyramids, other shapes)
- Designed & Engineered Concrete Modules
 - Reef Balls, Fish Havens, Layer Cakes
- Experimentally
 - floating (plastics), geotextiles (surfing), dewatering, sand fences

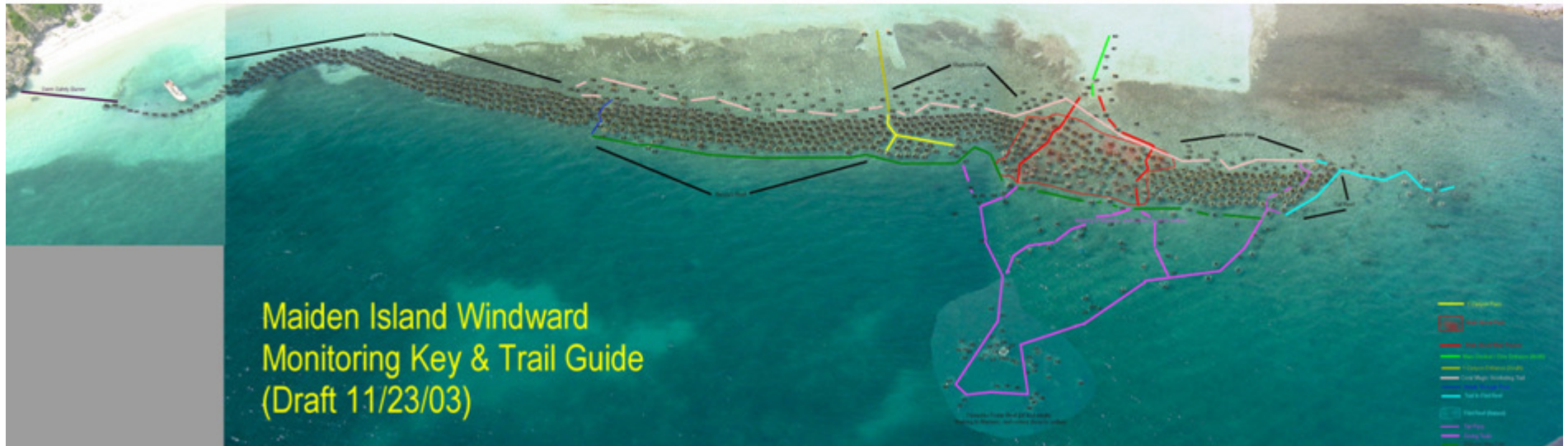
Reef Balls for Erosion Control

- Successfully used in 22+ projects as submerged breakwaters to protect beaches
- Allows turtle access for nesting
- No loss of view associated with emerged breakwaters or sand filled containers
- Used with or without sand renourishment
- Environmentally positive

Erosion Control-features

- Broad flat crested submerged breakwater.
- Porous, no ponding or water channeling.
- Anchoring options for any level of stability.
- Hard and soft corals can be planted with built in coral attachment adapters.
- Snorkeling trails & features easily added in clearwater environments.
- Long term solution to beach erosion problems.

Recreational Enhancement- Snorkeling Trail Guides



Example Breakwater Projects

- Dominican Republic (4)
- Cayman Islands (2)
- Antigua (3)
- Miami Beach (1)
- Mexican Projects (4)
 - Porto Progresso
 - Yalkubul lighthouse
 - Federal Highway Campeche
 - Mayan Palace

Approved Anchoring Options

- Prefabricated pilings for use on sand bottom over hard bottom (Antigua)
- Fiberglass rebar anchors for use on hard bottoms (Cayman Islands)
- Articulated Concrete Mats for unstable sand bottoms (Miami Beach)
- Cones and spikes for use over seagrass beds (Antigua)
- Dead Weight Solutions for mixed firm bottoms. (Dominican Republic)

Anchoring

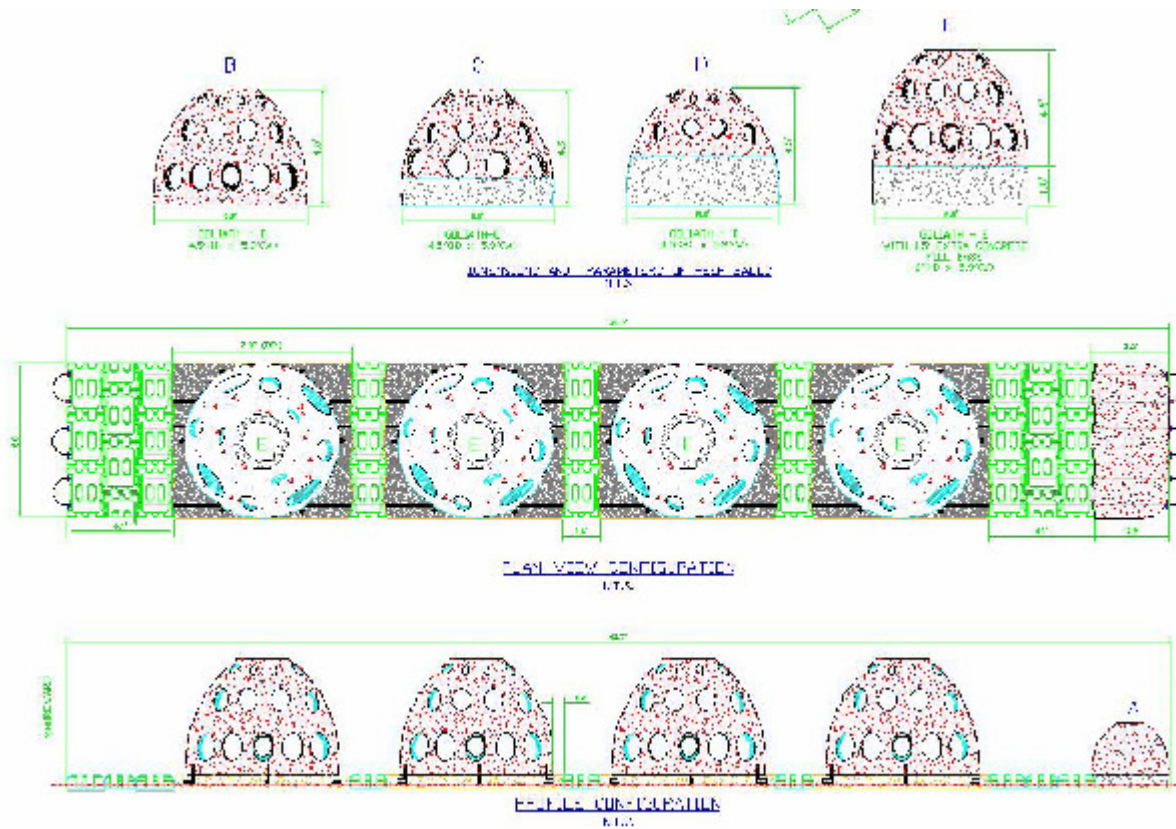


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Anchoring-Articulated Concrete Mat



Limitations

- Must be placed in less than 3 meters of depth
- Tops of modules can be exposed during some low tide events
- Must use top quality concrete with microsilica and appropriate anchoring or hurricanes can damage the units.
- May not prevent all erosion, especially from hurricanes with a large storm surge.

Benefits

- Hotels get long term property value enhancement and additional guest benefits.
- Aids in coral reef restoration.
- Modular / can be reconfigured
- Not solid so less problems with subsidence
- Easy to construct and can be deployed by hand
- World standard in designed reefs, fully scientifically documented with a proven track record

Sizes & Specifications

Style	Width	Height	Weight	Concrete Volume	Surface Area	# Holes
Goliath	6 feet (1.83 m)	5 feet (1.52 m)	4,000-6,000 lbs. (1,818-2,727 kg.)	1.3 yard ³ (1.19 m ³)	230 ft ² (21.4 m ²)	25-40
Super Ball	6 feet (1.83 m)	4.5 feet (1.37 m)	4,000-6,000 lbs (1,818-2,727 kg.)	1.3 yard ³ (1.19 m ³)	190 ft ² (17.6 m ²)	22-34
Ultra Ball	5.5 feet (1.68 m)	4.3 feet (1.31 m)	3,500-4,500 lbs. (1,591-2,045 kg.)	0.9 yard ³ (0.76 m ³)	150 ft ² (13.9 m ²)	22-34
Reef Ball	6 feet (1.83 m)	3.8 feet (1.16 m)	3000-4200 lbs. (1364-1,909 kg.)	0.75 yard ³ (0.57 m ³)	130 ft ² (12.1 m ²)	22-34
Pallet Ball	4 feet (1.22 m)	2.9 feet (0.88 m)	1500-2200 lbs. (682-1,000 kg.)	0.33 yard ³ (0.25 m ³)	75 ft ² (7.0 m ²)	17-24
Bay Ball	3 feet (0.91 m)	2 feet (0.61 m)	375-750 lbs. (170-341 kg.)	0.10 yard ³ (0.08 m ³)	30 ft ² (2.8 m ²)	11-16
Mini-Bay Ball	2.5 feet (0.76 m)	1.75 feet (0.53 m)	150-200 lbs. (68-91 kg.)	less than 4 50 lb. bags		8-12
Lo-Pro	2 feet (0.61 m)	1.5 feet (0.46 m)	80-130 lbs. (36-59 kg.)	less than 2 50 lb. bags		6-10
Combo	6 Feet 4 "	5.5-7.5 Feet	9000 lbs+	1.3 Yards +		

Pricing

- Biological uses of Reef Balls typically cost between USD \$60-\$300 per module
- Submerged Breakwater uses typically cost USD \$600-\$1,000 per module due to larger sizes, anchoring and engineering.
- Our grant program can provide assistance in the form of large discounts for biological uses.
- Assistance is available for planting corals on Reef Balls of any type.

Permitting

- Reef Balls have a long history of being permitted in Mexico
- Reef Ball use has been encouraged by both federal and local Mexican authorities due to environmental enhancement
- The Reef Beach Company has enacted more stringent quality control for erosion control projects, particularly in regard to anchoring due to Mayan Palace experience.

Next Steps?

- Engineering feasibility assessment of your property
 - Dr. Lee Harris of Florida Institute of Technology
- Working with your local contractor, we will then provide a custom site proposal.

For More Information

- Erosion Control with Reef Balls

WWW.REEFBEACH.COM

- Foundation Grant Support
www.reefball.org

Or e-mail reefball@reefball.com