

STT



Sea Turtle Tetrapod

| Design Concept |

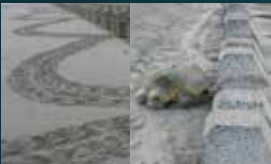
STT Sea Turtle Tetrapod is designed to allow sea turtles to pass through easily, featuring a bottom channel that helps them reach their nesting sites. Newly hatched sea turtles rely on the brightness of the horizon to navigate, but traditional tetrapods block natural light, causing disorientation and increasing mortality risks. To address this, the sea turtle tetrapod incorporates recycled glass, which reflects light to guide hatchlings back to the ocean. Its biomimetic reef design supports marine life attachment, making it suitable as an ecological reef that promotes ecosystem restoration.

| Design Background |



There are only seven species of sea turtles left in the world

According to statistics, only about 6.5 million sea turtles remain globally, placing them on the brink of extinction.



Tetrapods Preventing Sea Turtles from Reaching Nesting Sites

Tetrapods leaving Sea turtles them to wander along the beach without being able to nest.

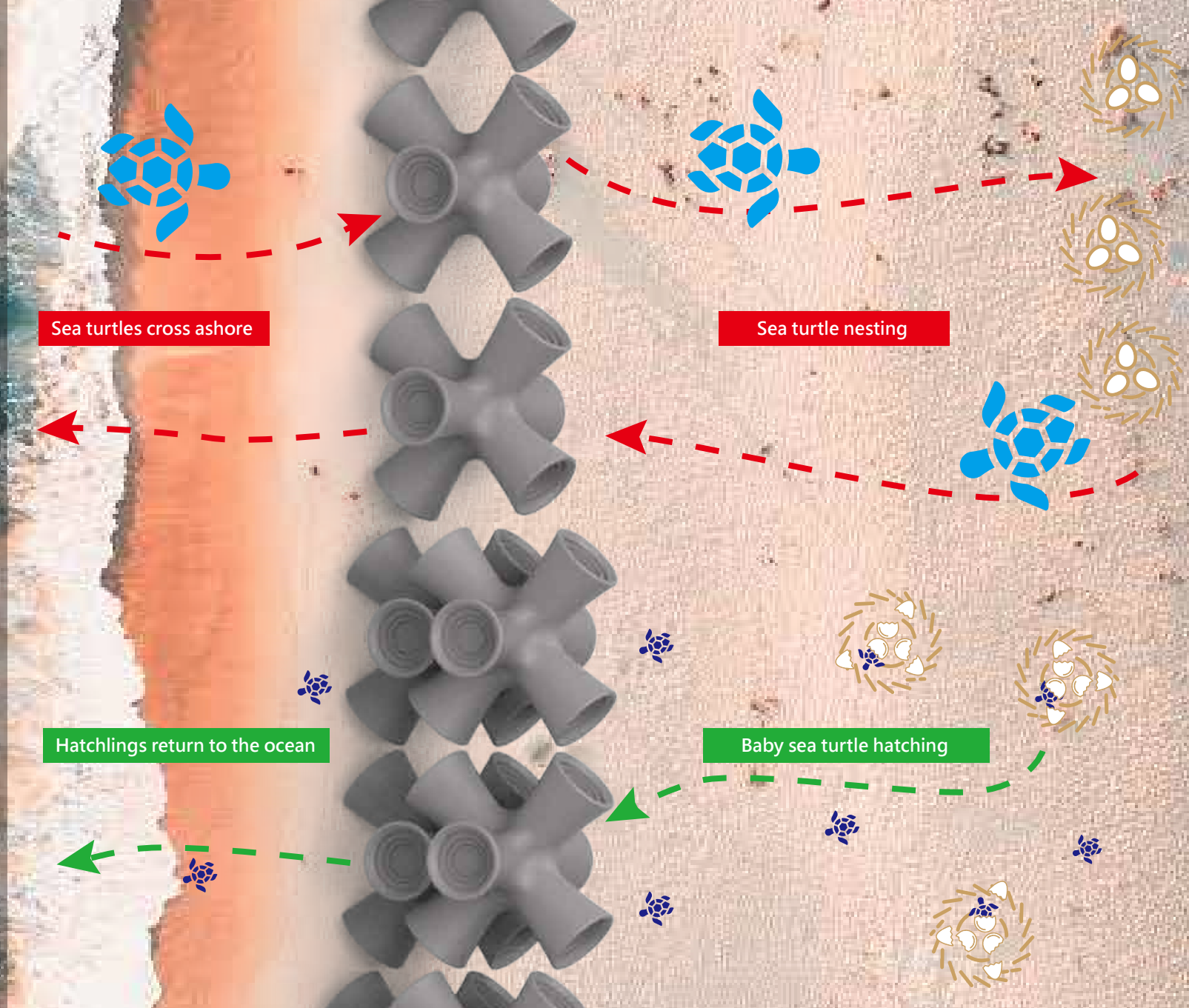


Severe Loss of Fine Sand in Sea Turtle Nesting Sites: To protect these beaches from vanishing, large numbers of tetrapods have been installed along the coastline.



Tetrapods Block Baby Sea Turtles from Returning Home:

Newly hatched sea turtles rely on the brightness of the horizon to guide their way, with the ocean typically being brighter than the land at night, serving as their navigation system.



Bottom channel design

Sea Turtle Tetrapod is designed to allow sea turtles to pass through easily, enabling them to reach their nesting sites safely without getting trapped and risking death.



Guiding baby sea turtles home

Sea Turtle Tetrapod contains recycled glass, which reflects light to guide baby sea turtles back to the ocean.

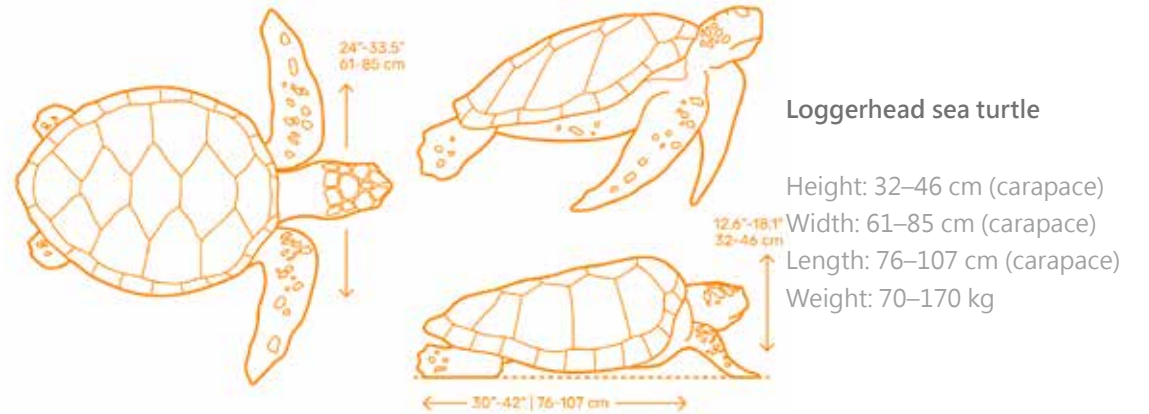
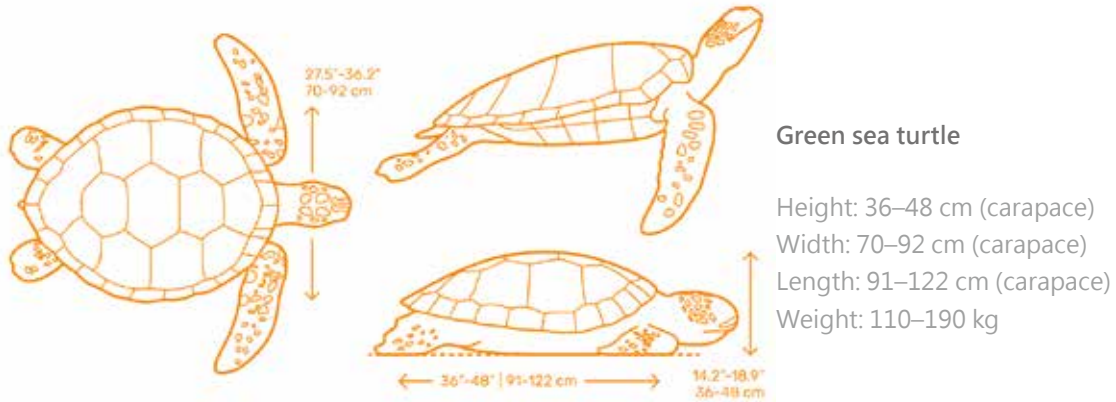


Ecological restoration

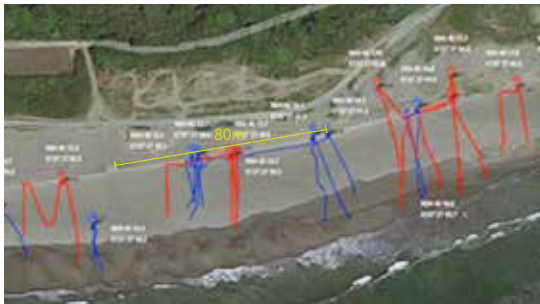
The biomimetic reef design facilitates organism attachment, making it suitable for use as eco-friendly bricks and promoting ecological restoration.



Sea Turtle Size Analysis



Sea Turtle Nesting Analysis



- Left image: GPS tracking route of a sea turtle coming ashore to nest on Japan's Omotegama Beach
- Species: Loggerhead turtle (*Caretta caretta*)
- Location of tetrapod installation: 35 cm from the average tide line
- Spacing between tetrapods: 80 meters
- Conclusion: Even with a spacing of just 80 meters, sea turtles can still become disoriented.



- Nesting near the water increases the risk of eggs being washed away
- Sea turtle eggs have only a 10% hatching success rate if submerged in water
- Without a suitable nesting site, sea turtles may be forced to return to the sea without laying eggs



- Sea turtles lack limbs suited for walking and can weigh up to 100 kilograms; prolonged movement on land may negatively impact their lifespan.

| Biomimicry design |

Issue

Newly hatched sea turtles rely on the brightness of the horizon to find their direction.

problem

Tetrapods can block light from the sea surface, causing hatchling sea turtles to become disoriented.

goal

How can we attract hatchling sea turtles toward the ocean?

Association

Glass sand is added to the road surface to enhance nighttime reflectivity and attract drivers' attention.

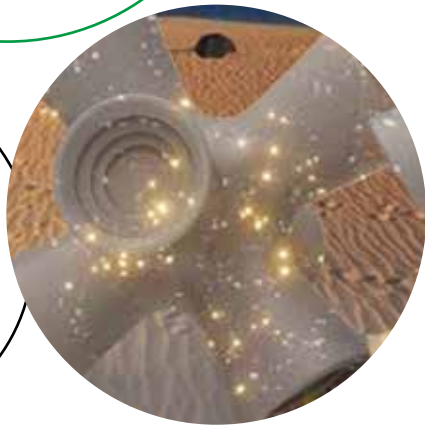
Biomimicry

Male peacock feathers reflect light to attract females. The cortex of the male peacock's feather barbs forms a photonic crystal structure that reflects specific wavelengths of light, drawing the attention of peahens.



Solution

The STT sea turtle tetrapod incorporates recycled glass to reflect light, guiding hatchling sea turtles toward the ocean.



Need

How can the passage space be increased to allow sea turtles to pass through?

Reduce weight

Reduce traction

Easily washed away

problem

Reduce material to increase passage space.

goal

How can traction be increased while reducing material?

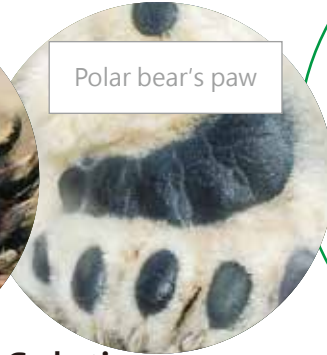
Biomimicry

Polar bear paw pads

The polar bear is the largest living bear species, yet it has smaller paw pads compared to other bears. However, the tiny bumps (papillae) on the surface of a polar bear's paw pads are about 1.5 times taller than those of other bear species, increasing friction and improving traction.

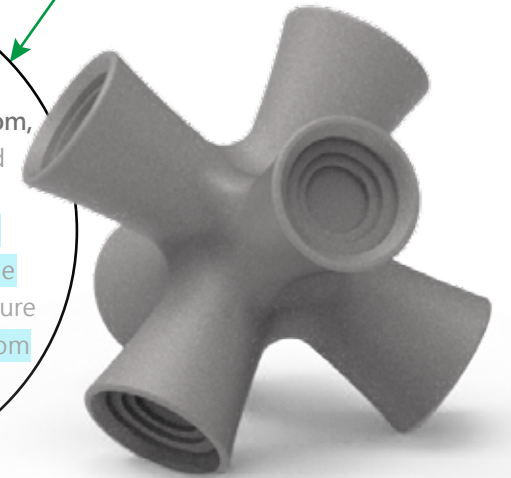
The paws of other bear species

Polar bear's paw



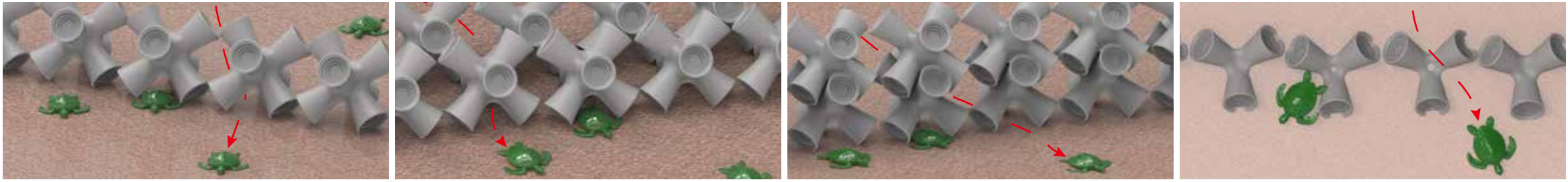
Solution

The STT features a polygonal protrusion structure at the bottom, allowing it to sink into the sand under its own weight, thereby effectively increasing traction. This design not only expands the passage space beneath the structure but also helps prevent the STT from being washed away by waves.



| Stacking test |

Perform an exploratory experiment on different methods of stacking.



| Sand retention capacity test |

Actual Environment (Tetrapod)

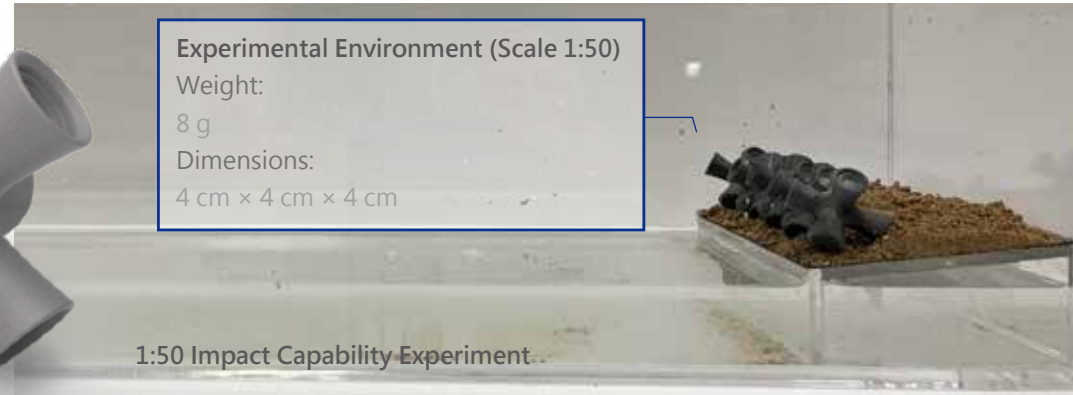
Weight:
1 metric ton
Dimensions:
2 meters × 2 meters × 2 meters



The estimated weight ranges from 1 to 2 tons. To ensure experimental accuracy, tests will be conducted using 1 ton as the standard.

Experimental Environment (Scale 1:50)

Weight:
8 g
Dimensions:
4 cm × 4 cm × 4 cm



1:50 Impact Capability Experiment



The weight at a 1:50 scale is approximately 8 grams.



Add screws to the wave dissipation block to increase its weight.

No Tetrapod

Stacking method 1

Stacking method 2

Stacking method 3

Stacking method



Sand Loss amount



66g

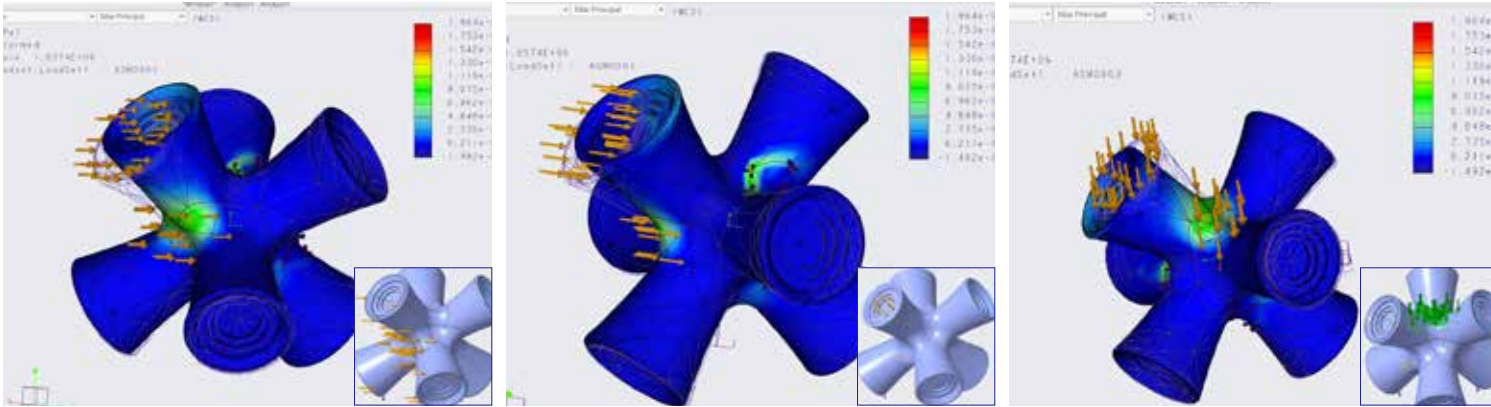
26g

18g

39g

Regardless of the stacking method of the breakwater, the sand loss amount is significantly lower than when no breakwater is installed. The sand loss amount in Stacking Method 2 is even only 27% of that without a Tetrapod.

| Stress Analysis |



Analyzing the force of 16m high waves from different directions.



None of them exceeded the material's load capacity.

Wave height (m)	Impact velocity (cm/sec)	Impact force (N)
1	31.4	4.93
5	157.1	24.49
9	282.7	43.13
11	345.6	52.41
16	502.7	80.23

| Mold Design |

From mold design to real mold casting

| Model making |



| Material Description |



Made from a mixture of oyster shell powder and ash derived from incinerated sludge.

- **Environmental Sustainability**

By using oyster shell powder, we are repurposing waste materials.

- **Reducing Carbon Footprint**

Tetrapods made from oyster shell powder reduce material carbon footprints by 50% compared to those made from cement.

- **Reducing Cement Usage**

Why choose oyster shells?

1. Oysters are found in large numbers in areas where sea turtles are commonly found.

The top areas in the world where sea turtles are commonly found include:

Oaxaca, Mexico

Ostional National Wildlife Refuge in Costa Rica

Oysters are produced in the surrounding areas.

2. Millions of tons of waste oyster shells are generated globally each year, causing serious environmental pollution.



Add Recycled Glass

Reflects light to guide baby sea turtles back to the ocean.

- **Environmental Sustainability**

- **Reflects light**

The glass can reflect light, guiding baby sea turtles back to the ocean.

- **The glass has high hardness.**

| Material Experiment |

Exploring materials using different ratios of silt, oyster shell powder, and glass.



| Design Iteration |

1st Generation



2nd Generation



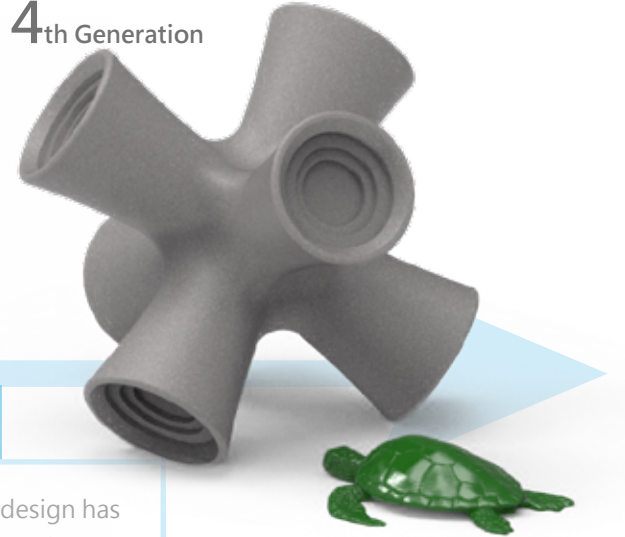
The structure is unstable and has low wave resistance.

3rd Generation



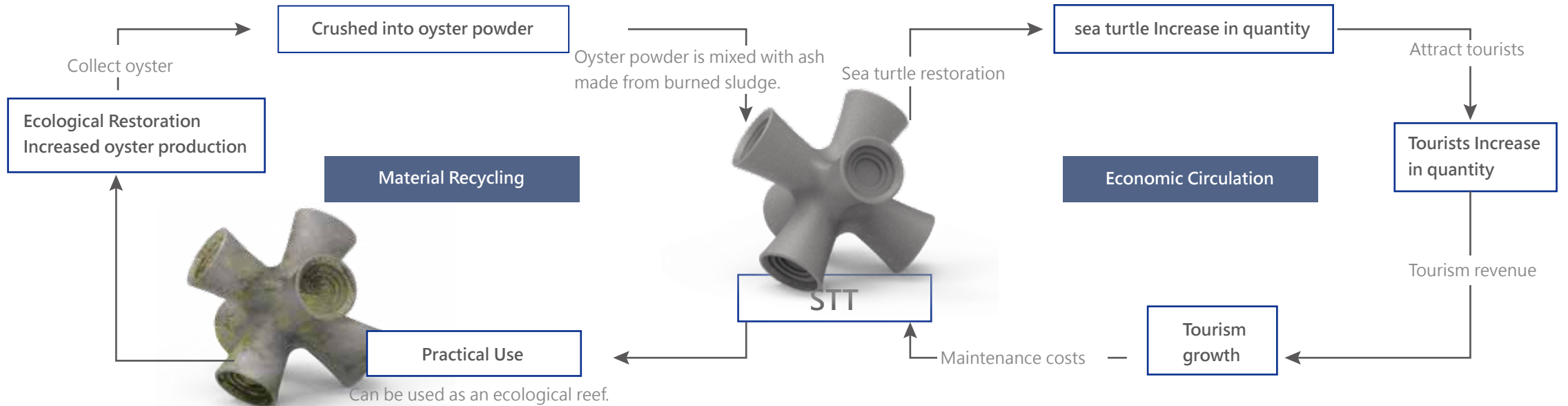
- Fully glass construction is expensive
- Asymmetrical design is not conducive to construction

4th Generation



- The hollow design has poor impact resistance.

| Stress Analysis |



| Carbon emission analysis |

STT integrates innovative carbon sequestration technology by injecting a precise dose of captured CO₂ into concrete during the mixing process, causing it to mineralize. This can enhance the compressive strength of concrete, optimize the mixture, and significantly reduce the carbon footprint.

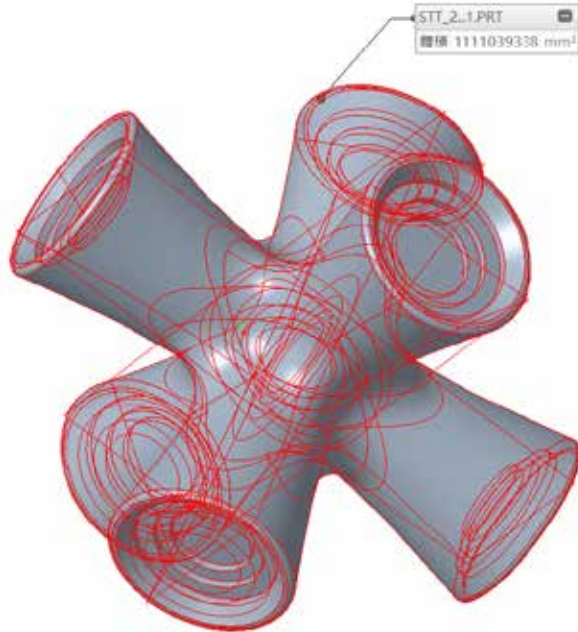


Reduces 7–11 kg CO₂ per m³

STT volume = 1.111 m³

One STT can sequester approximately 7.8–12 kg of CO₂,

≈ the amount absorbed by one tree in a year.



| Business Value |



- The market size for sea turtle ecotourism has reached 500 million visitors.
- Sea turtle ecotourism is more profitable than consumption.

| Estimated number of sea turtles to be saved |

How many baby sea turtles can a rescued adult female sea turtle give birth to in a year?

Rescue a female sea turtle	Each female sea turtle can lay 3 to 7 clutches of eggs in a nesting season.	Each clutch contains approximately 100 eggs.	The average hatching rate of sea turtle eggs is 70%.	Currently, there are approximately 6.5 million sea turtles globally.
↓	↓	↓	↓	
01	X	03	X	21
		∩		∩
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| Expected Benefits |



- Increase the chances of newly hatched sea turtles safely crawling to the ocean.



- Reduce the risk of sea turtles getting trapped in the gaps of wave-dissipating blocks.



- Allow sea turtles to reach suitable nesting sites.



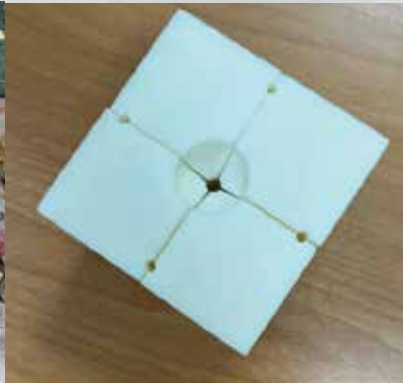
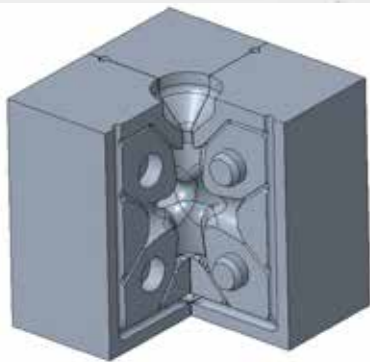
- Sea turtles benefit the ecosystem by effectively controlling the jellyfish population.



- STT is injected with steam and carbon dioxide during the manufacturing process, enabling effective carbon sequestration.



- STT recycles waste oyster shells, glass, and sludge into cement, promoting waste reutilization.







STT



Sea Turtle Tetrapod