Arch 384_007 Bering Strait Competition for 1095

The diomede Bridge

Mark (Sung Jun) Kim / 20277308
in collaboration with Kristina Seo

initial concept design of the Diomede Bridge

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Bridges are highly symbolic by nature:
the physical act of connecting two separate distant places...

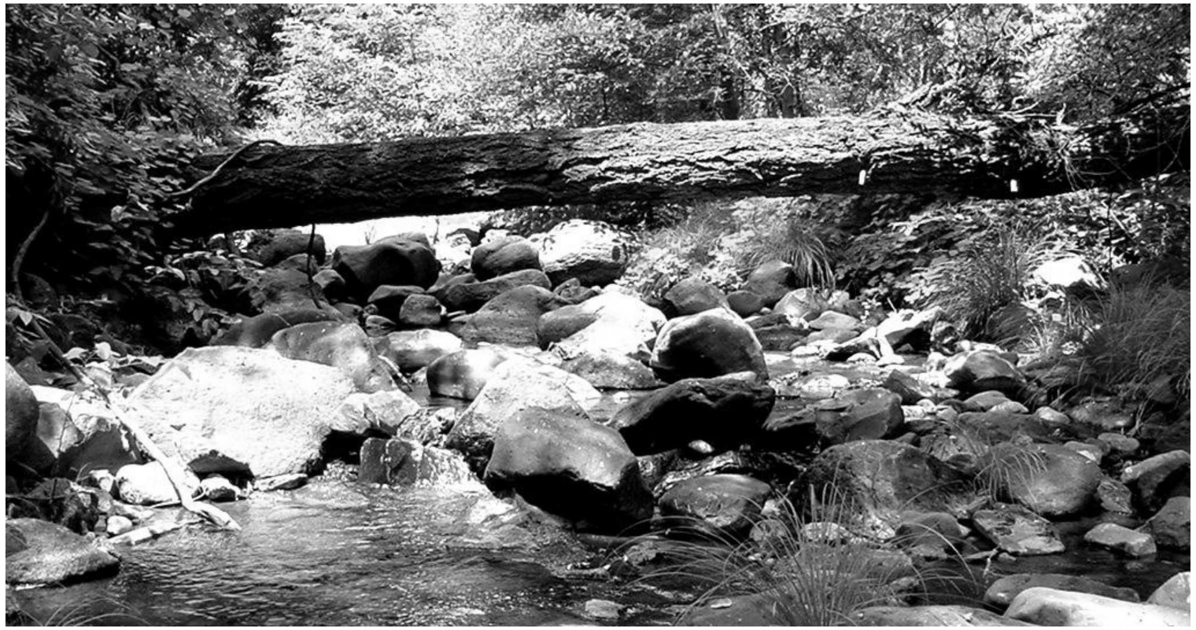


image credit: http://outdoors.webshots.com/photo/1046077367014427521cWELXf

image credit: http://www.bloggingwv.com/wp-content/uploads/2008/04/new_river_gorge_bridge.jpg

A bridge must conform to the site, function, and economy, which governs the form in the end.
Because bridges are not a source for profit, the design not only becomes rigorous in its structural aspect, but also has to be cost efficient.

image credit: http://minnesota.publicradio.org/display/web/2008/07/28/bridge_presser/

Site and climate conditions often challenge bridge builders to design the cheapest and most economical solution.

Bridges often appear to be devoid of design, and simply a formulation between cost and physics.

image credit: http://www.sxc.hu/browse.phtml?f=download&id=831868

However, it is the raw demonstration of economy and physics that makes bridges monumental and iconic; Thus, beauty of a bridge is often shaped by its site, climate, cost, and function.

Precident 1

The Confederation Bridge; Northumberland Strait,1997

The Confederation Bridge connects Prince Edward Island to New Brunswick. Harsh winter freezes the Northumberland Strait, creating ice shelves up to 1m thick. The distance being 12.9 km long, concrete box girder style bridge was used, utilizing 44 base piers that are 40m high and spaced around 200m apart. The piers have 'giant conical concrete skirts' that reduces the impact of ice shelves as it passes through the strait by breaking the ice up before it hits the base. The path of the bridge was 'deliberately designed with a bend approximately halfway along to reduce the danger of driver fatigue'. Studies have shown that accidents are more likely to happen on a straight horizontal roads where drivers can become bored and lose focus. Shifting of the horizon and views created by curved path can make drivers more alert.

Though perhaps the most economical style of bridge, due to the height of the two Diomede island being 300m above sea level, box girder bridges becomes excessive as it requires frequent placement of piers in closer distance when compared to suspension bridges or cable stayed bridges.

image credit: http://image55.webshots.com/55/7/21/48/2454721480065925426pGIlTF_fs.jpg

Precident 2

Helgeland Bridge; Alsten, Norway, 1991

Located near the Arctic circle, the site of Helgeland bridge shares a similar climate as the Bering Strait. Weather conditions include 'gales coming off the North sea gust' and 'strong currents combined with storm waves'. To harness the wealth from North Sea oil, investments have been made to lay down infrastructure to the city.

'The feasibility studies confirmed that wind loads would govern the design. Composite bridges combining steel and concrete were rejected, since a massive, monolithic concrete structure was shown to respond better to seismic loading and to be less prone to overturning. The scale of the crossing led to the consideration of cantilever and cable-stayed alternatives, of which a cable-stayed fan bridge with reinforced concrete towers and deck was found to be the least expensive and most durable option.'

Thus, cable-stayed design was chosen for its excellent resistant to winds.

image credit: http://gallery.photo.net/photo/4284975-lg.jpg

Precident 3

Sunniberg Bridge; Klosters, Switzerland, 1998

Located in the mountains, The Sunniberg Bridge was designed to withstand the harsh mountain conditions and wide temperature swings. Some of the design features include:

'Expansion and contracts are accommodated by the deck springing into or out'

'The piers taper towards their bases so they can rock sideways without developing large bending forces'

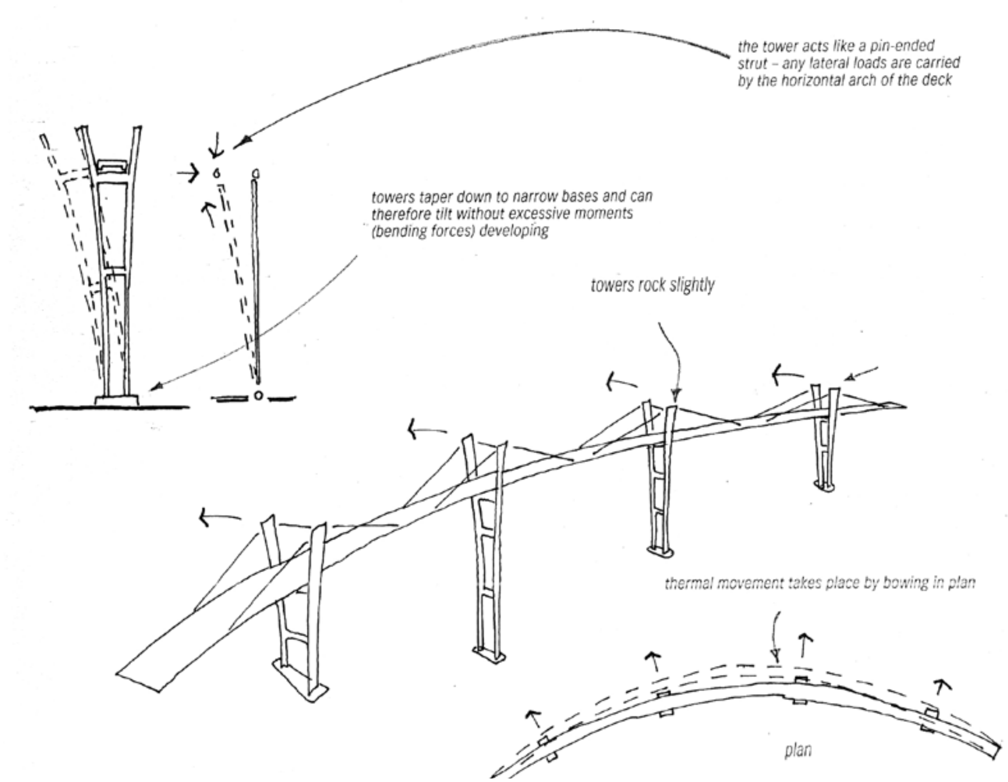


image credit: The Architecture of Bridge Design, page 127

image credit: https://fp.auburn.edu/heinmic/ConcreteHistory/images/Large/Christian%20Menn,%20Sunniberg%20Bridge.jpg

image credit: http://farm4.static.flickr.com/3239/3019948947_1fd6c17220.jpg?v=0

preliminary study of the Diomede Bridge

Precident 4

Le Grand Viaduc de Millau; Millau, France, 2004

In terms of the scale, the Millau Viaduct, designed by Norman Foster, comes close to the size and magnitude required for the Diomede Bridge. With seven slender pylon shaped piers piercing the sky, including one pylon which is taller than the Eiffel Tower, the bridge crosses the valley of the Tarn River.

With the total length of 2.8km, the designers deduced that the girder style bridge, like the ones used for the confederation bridge, would require a pier every 170m, resulting ‘ a cluttered look with too many piers...’ Thus, a cable stayed design was proposed, as it would allow longer spans between piers and thus less piers required.

‘350m is an optimal distribution for cable stayed spans. The location of the seven piers respects the site below and makes for an economical structural solution...’

The weather condition of Millau is much milder than the extreme climate of the arctic which the Diomede Bridge faces. Lengthening the span means less piers, but also means thicker decks, ‘which attracts high wind forces and becomes difficult to support on slender piers...’

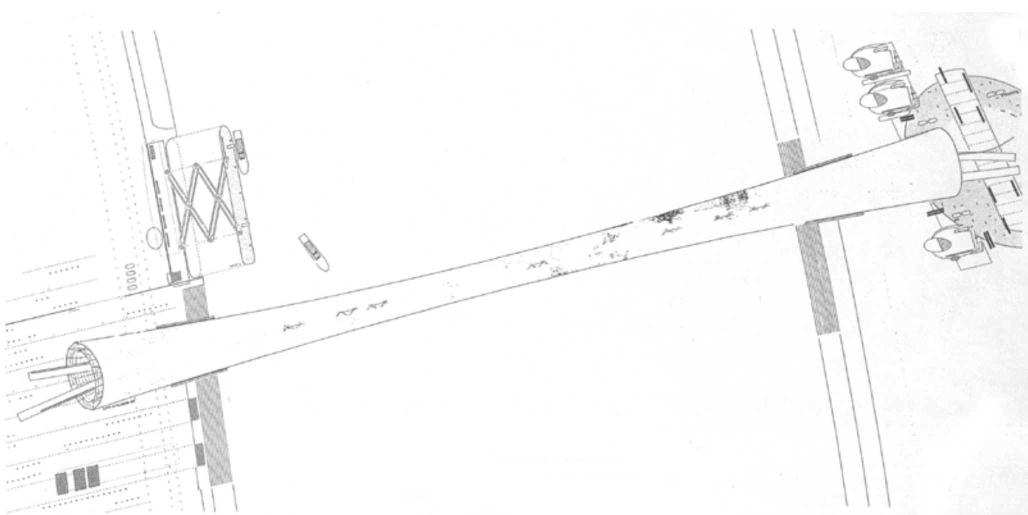
image credit: http://wemakesensemedia.files.wordpress.com/2009/04/millau_viaduct_1.jpg

Precident 5

The Great Arch Over the Danube; Budapest, Hungary, conceptual

As the Diomede Bridge will require a double deck, one for vehicles, and one for trains, the thicker decks will be a problem especially in the brutal arctic winds. The concept of capsulating the entire decks by a lattice truss system, inspired by the shapes of carbon nanotube, not only would reduce the wind drag, but also could strengthen the structure of the decks. Further, by covering the truss system with glazing and panels, it is possible to fully enclose the decks to prevent exposure to wind and snow for the vehicles and trains.

The concept bridge designed by Rodolphe Luscher and Fillippo Broggini for the '96 world expo in Budapest utilizes lattice structure that is 'capable of leaping across the 500m of legenday waters of Danube' without any piers supporting in the middle.



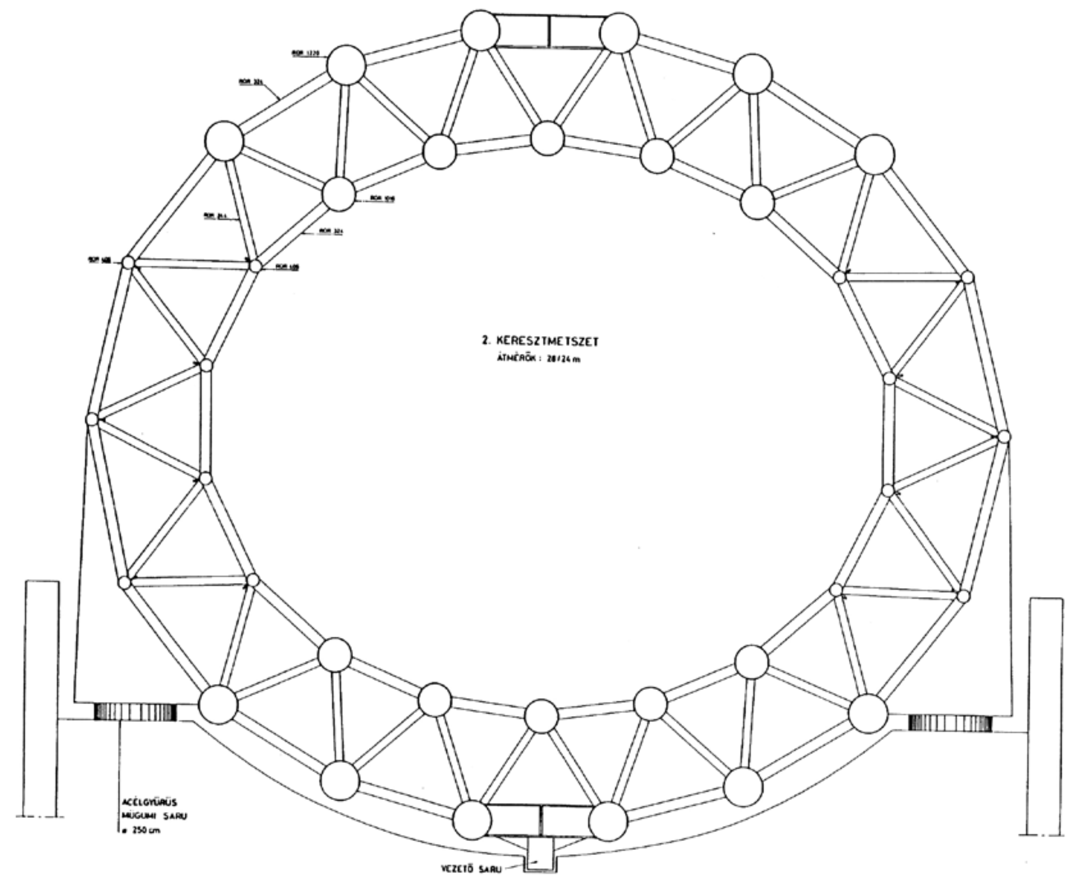


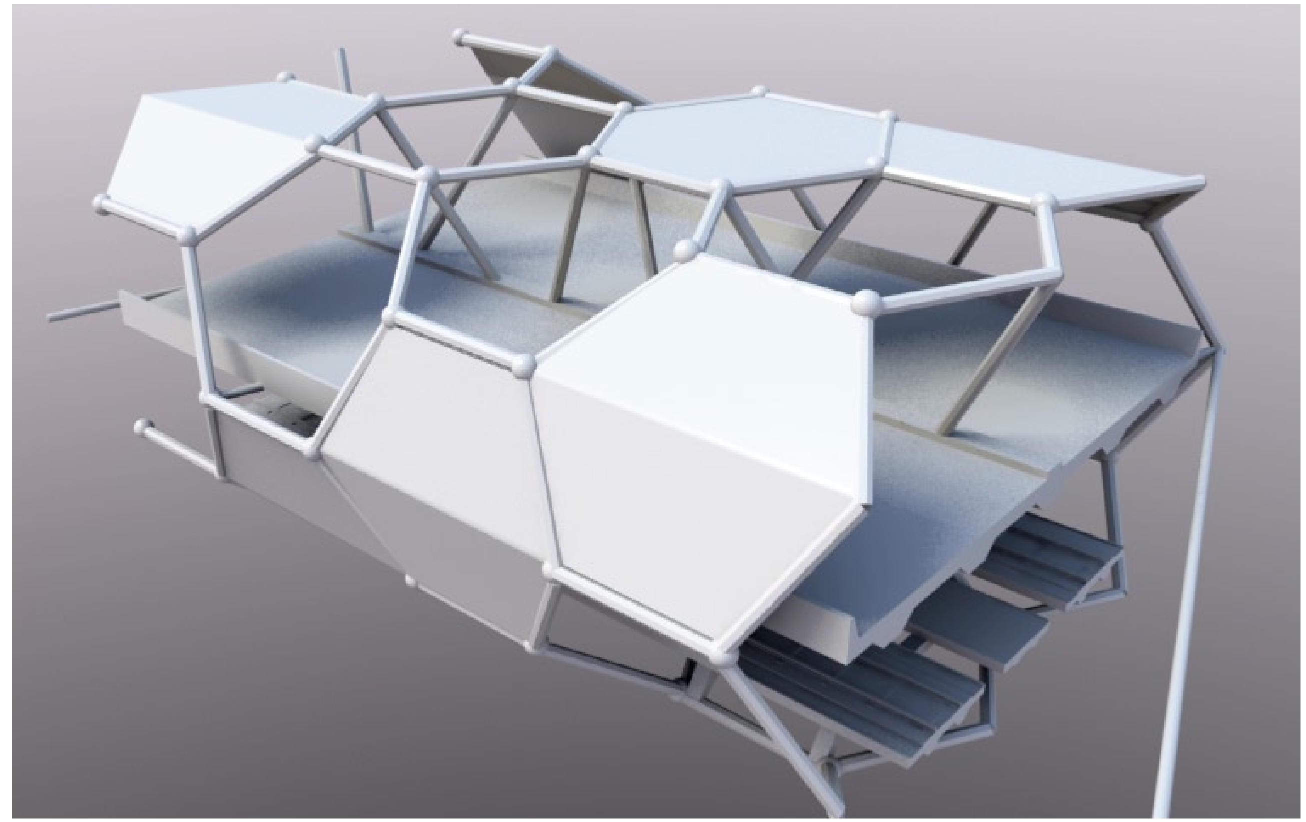
image credit: The Architecture of Bridge Design, page 84,85

view of the Diomede bridge exciting from the cliff of Big Diomede island

The Design

The Diomede Bridge Proposal

The bridge that links the two islands was designed to be the major iconic structure for the entire project and symbolize peace. The bridge was inspired by the shape of carbon nano-tube, which has a high strength-to-material ratio, enclosed within a truss tube which is fully encapsulated by glazing and panel system to protect the inside from various weather conditions, but still allow further structural integrity. The façade of the bridge consists of combination of glazing and metal panels that constantly changes along the bridge. Glazing materials to be proposed is a thin stretched sheet of ETFE fitted within the hexagonal shape. Because the bridge portion do not need to be insulated, pneumatic panels should not be necessary. Due to the extreme lightness of ETFE, the glazing portion will not contribute to the weight. Such pattern contributes to a better driving experience by reducing the repetitiveness of the road and providing interesting patterns through out the driving experience. For structural stability, the enclosure is tubular shaped to minimize the snow build up and the triple cable stayed system is used to allow more stability under extreme weather conditions. And the 'Y' shaped concrete pylons provide a lateral support to the bridge, and the tapered lower half allows piers to sway with the wind without excessive movement.



A segment of the deck and the lattice truss system


Big Diomede
C H U K O T
Diomede
Little Diomede
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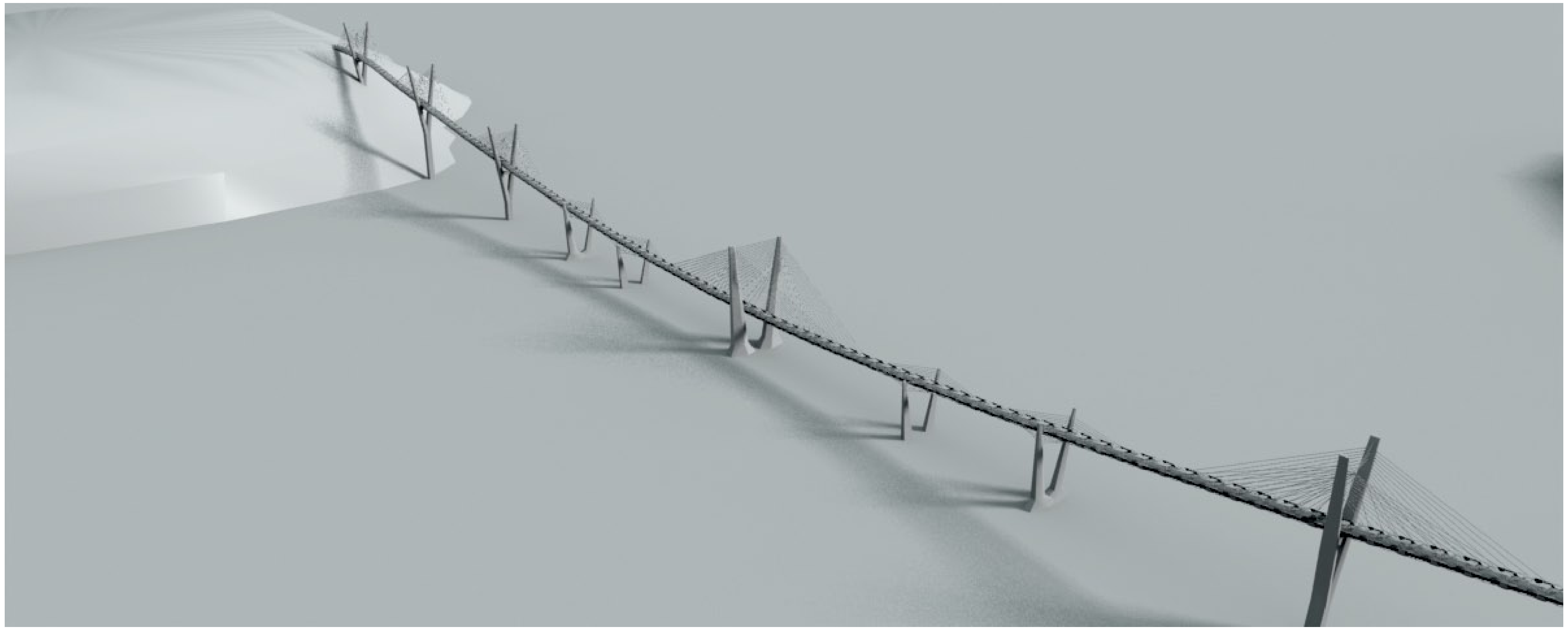
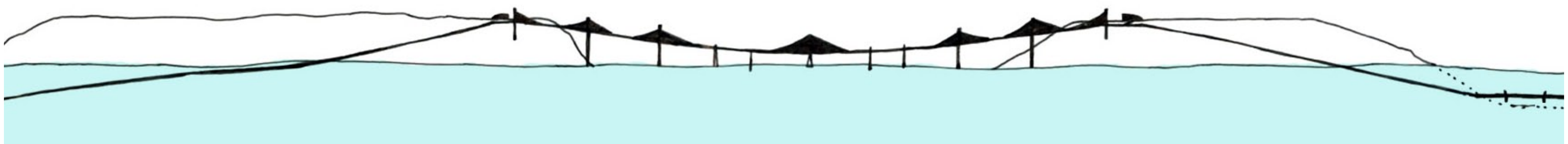
SITEPLAN



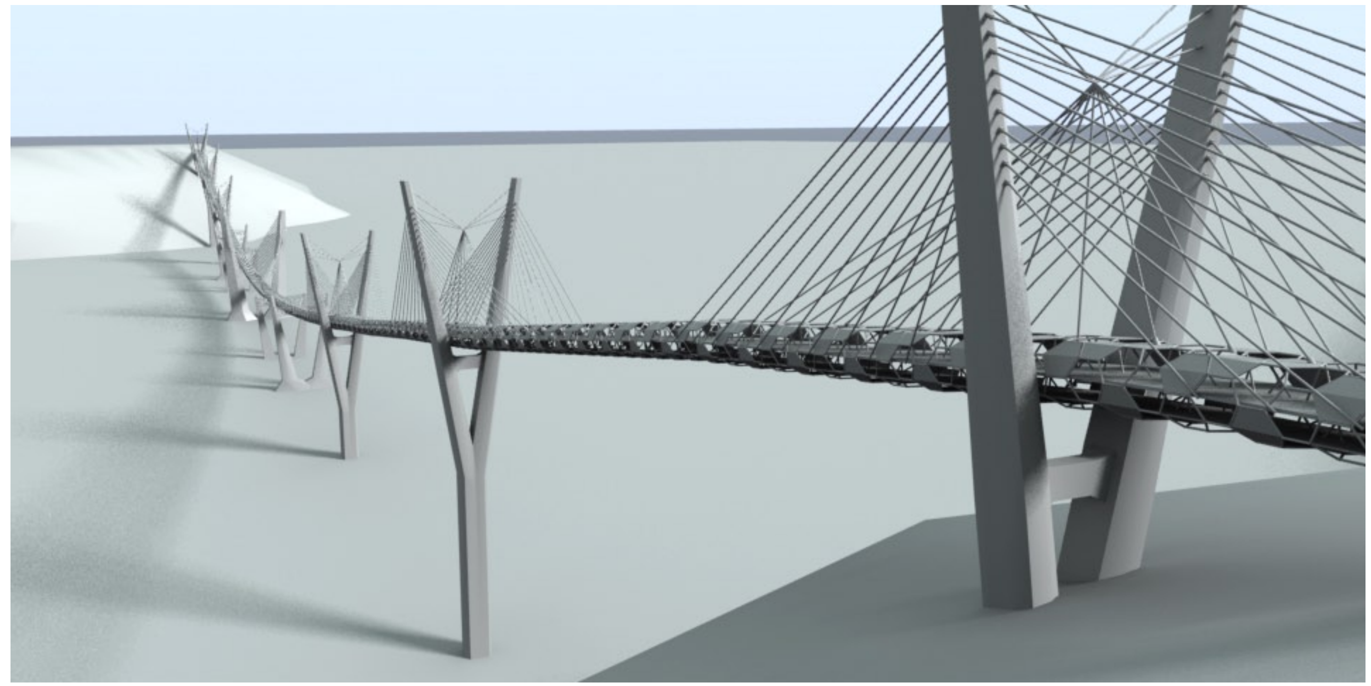
AERIAL VIEW

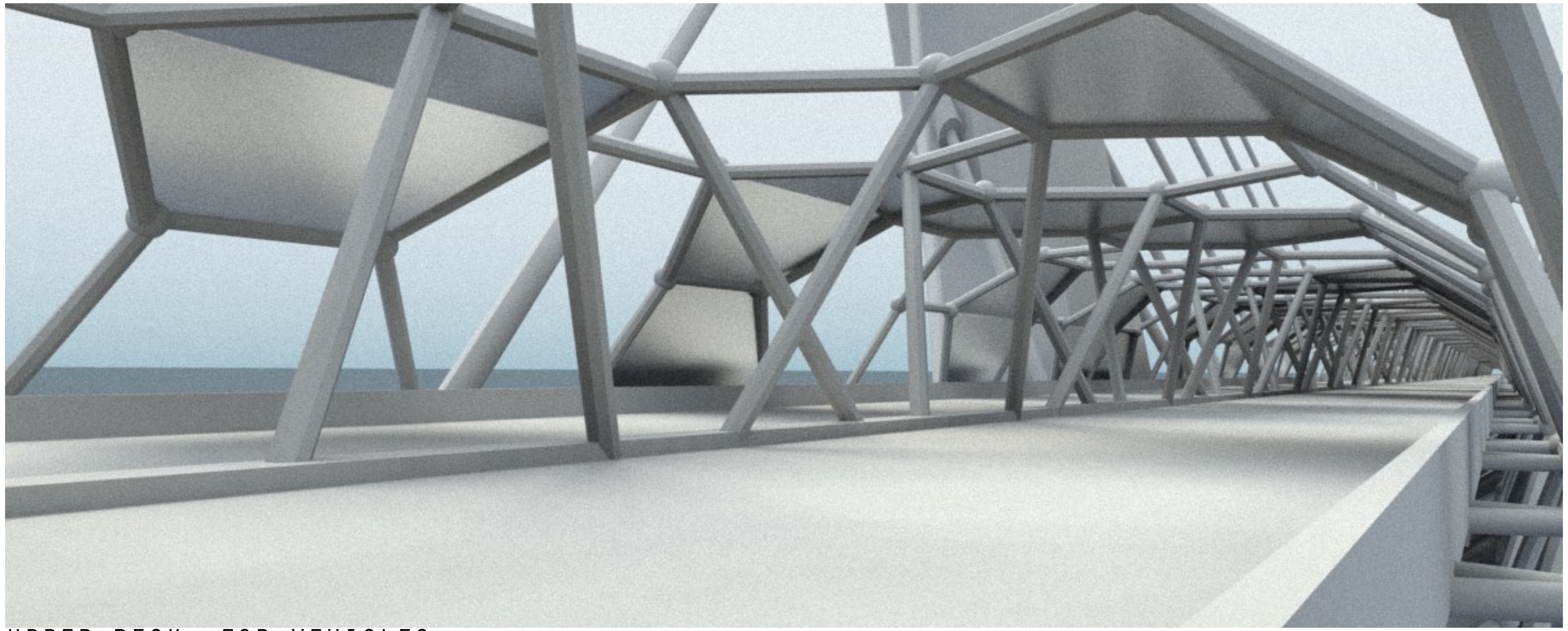


SECTION

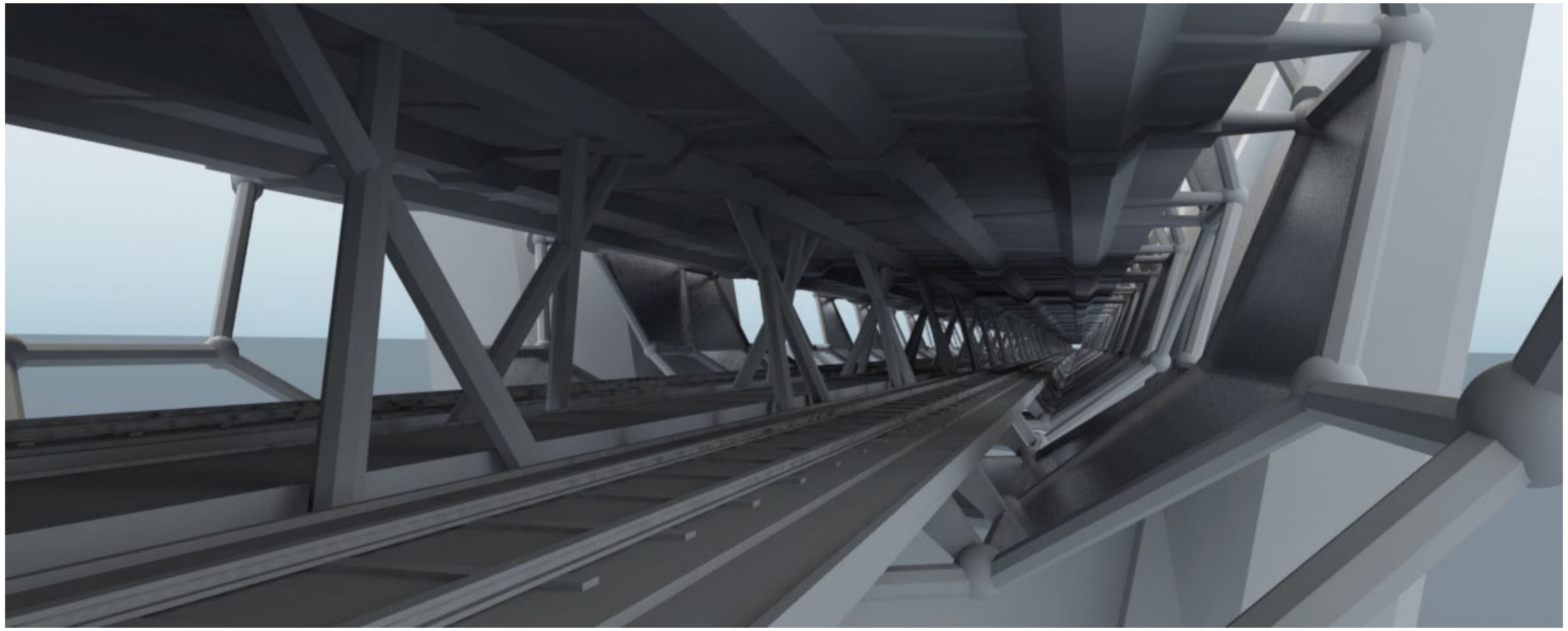
PLAN

To reduce the cost but increase the structural stability under high wind, the bridge is designed such that it dips down as it reaches the centre (between the two island). Not only dipping the bridge reduces the length exposed to high velocity air above the sea, but also allows smaller and shorter piers and pylons to be used. Thus, the bridge makes a graceful inverse arch as it reaches the US and Russian boarder, as well as the International Date Line, where the bridge appears to be just skimming off the surface of the water.

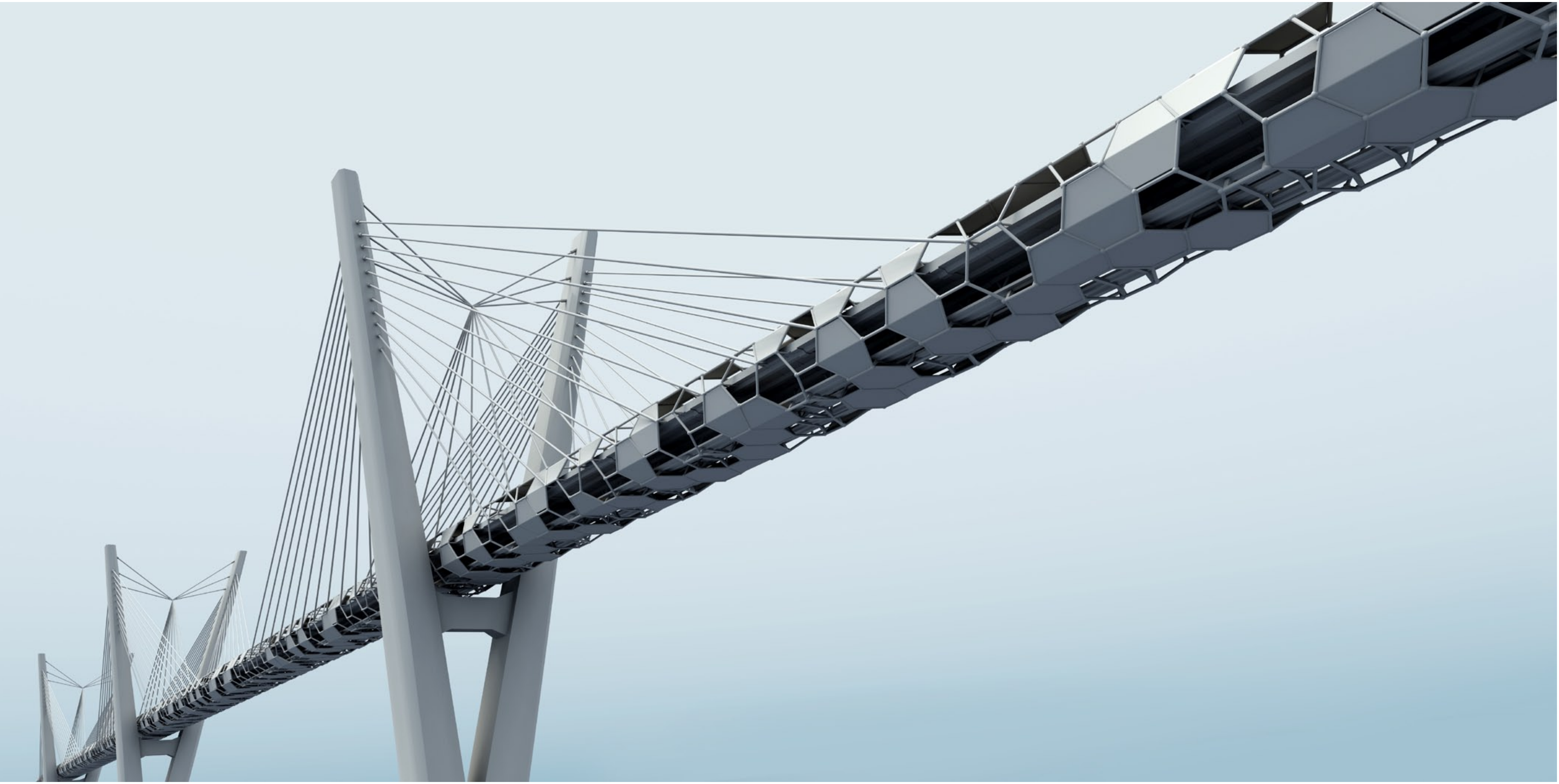


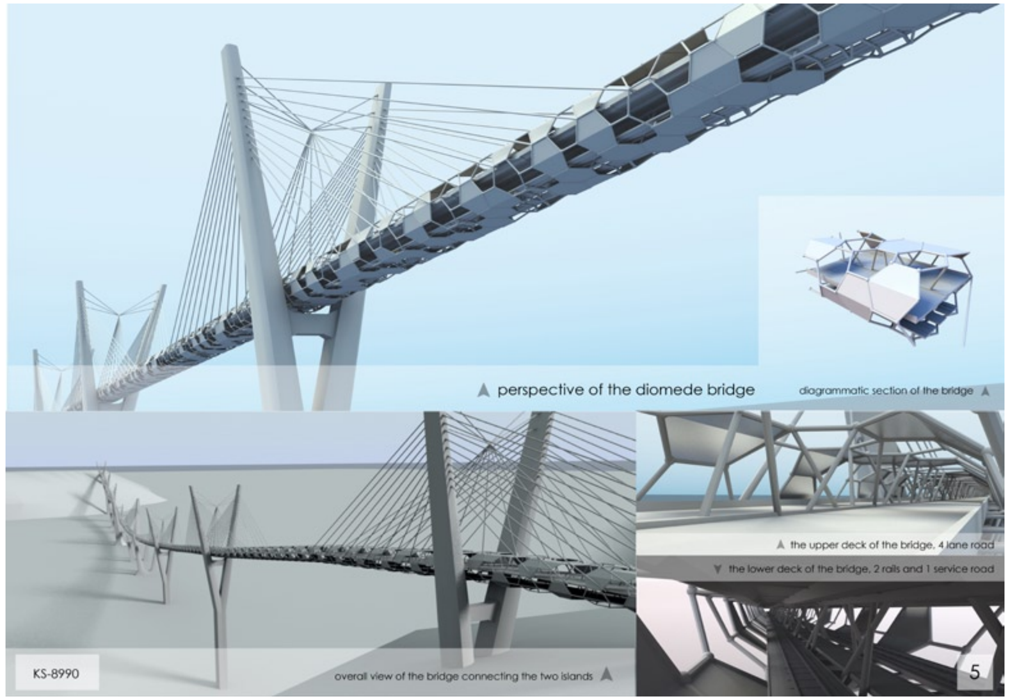


UPPER DECK, FOR VEHICLES



LOWER DECK, FOR TRAINS




perspective of the diomede bridge
diagrammatic section of the bridge
the upper deck of the bridge, 4 lane road
the lower deck of the bridge, 2 rails and 1 service road
KS-8990
overall view of the bridge connecting the two islands
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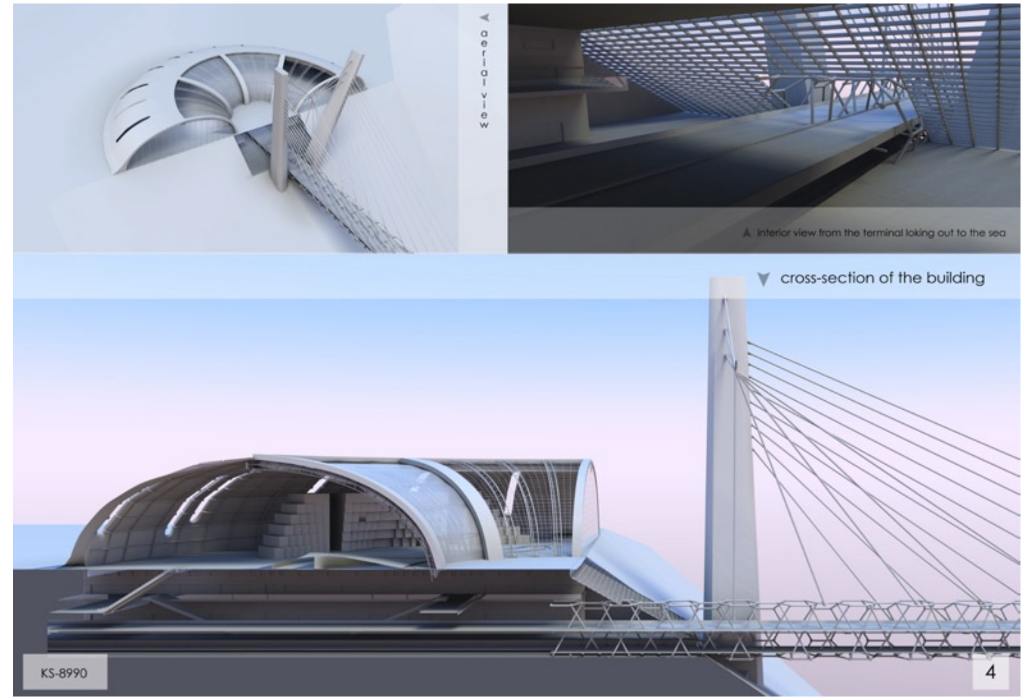
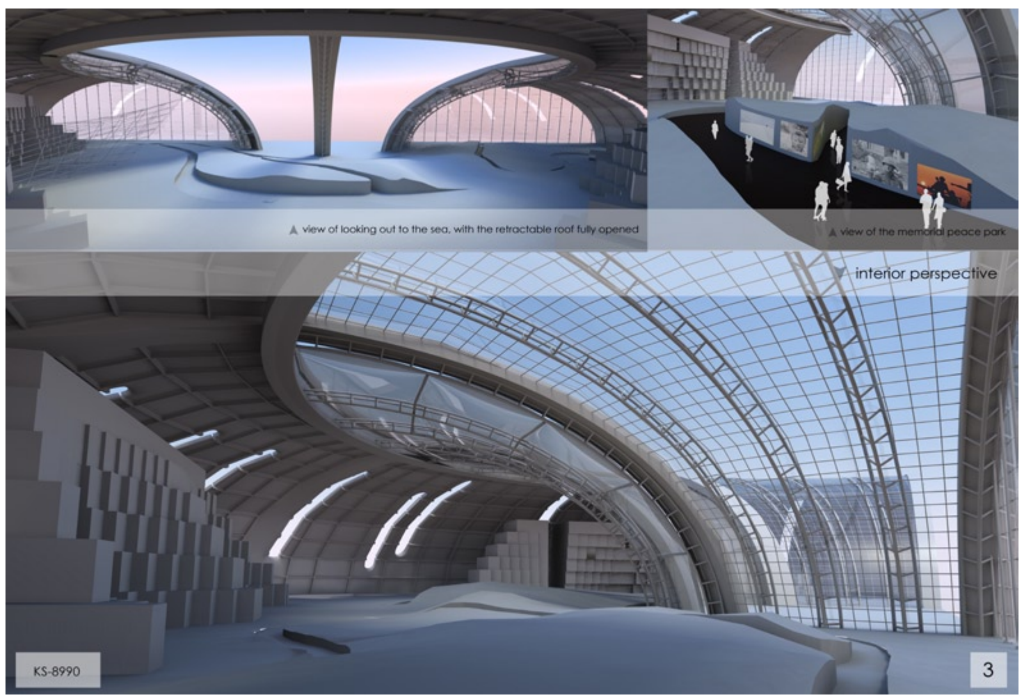

aerial view
interior view from the terminal loking out to the sea
cross-section of the building
KS-8990
4


view of looking out to the sea, with the retractable roof fully opened
view of the memorial peace park
interior perspective
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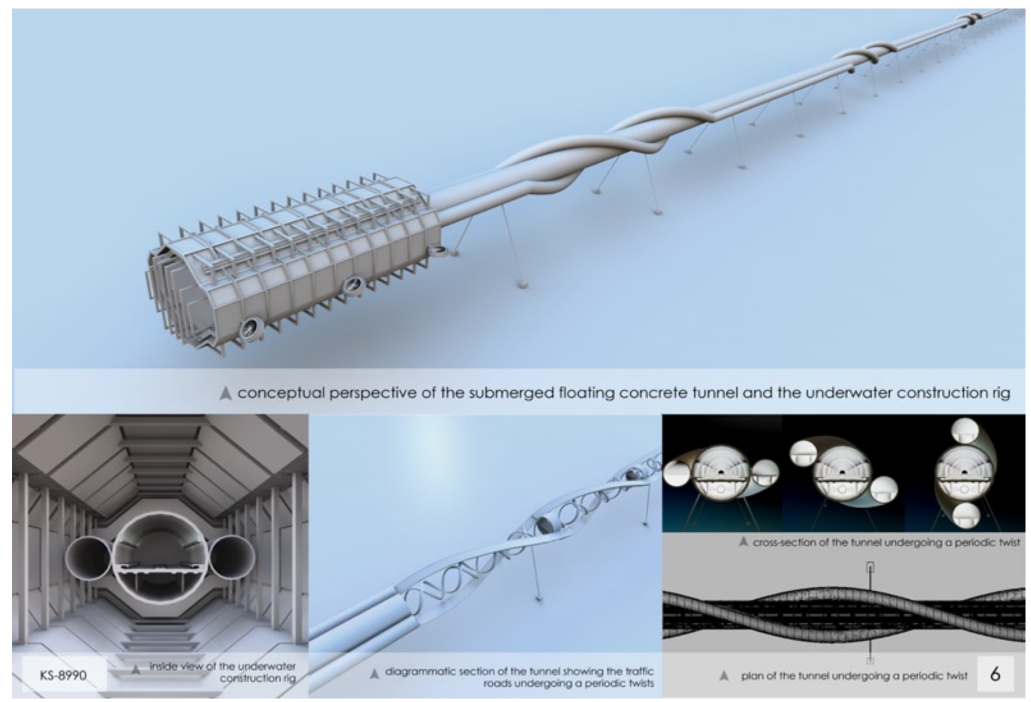
3


conceptual perspective of the submerged floating concrete tunnel and the underwater construction rig
cross-section of the tunnel undergoing a periodic twist
KS-8990
inside view of the underwater construction rig
diagrammatic section of the tunnel showing the traffic roads undergoing a periodic twists
plan of the tunnel undergoing a periodic twist
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