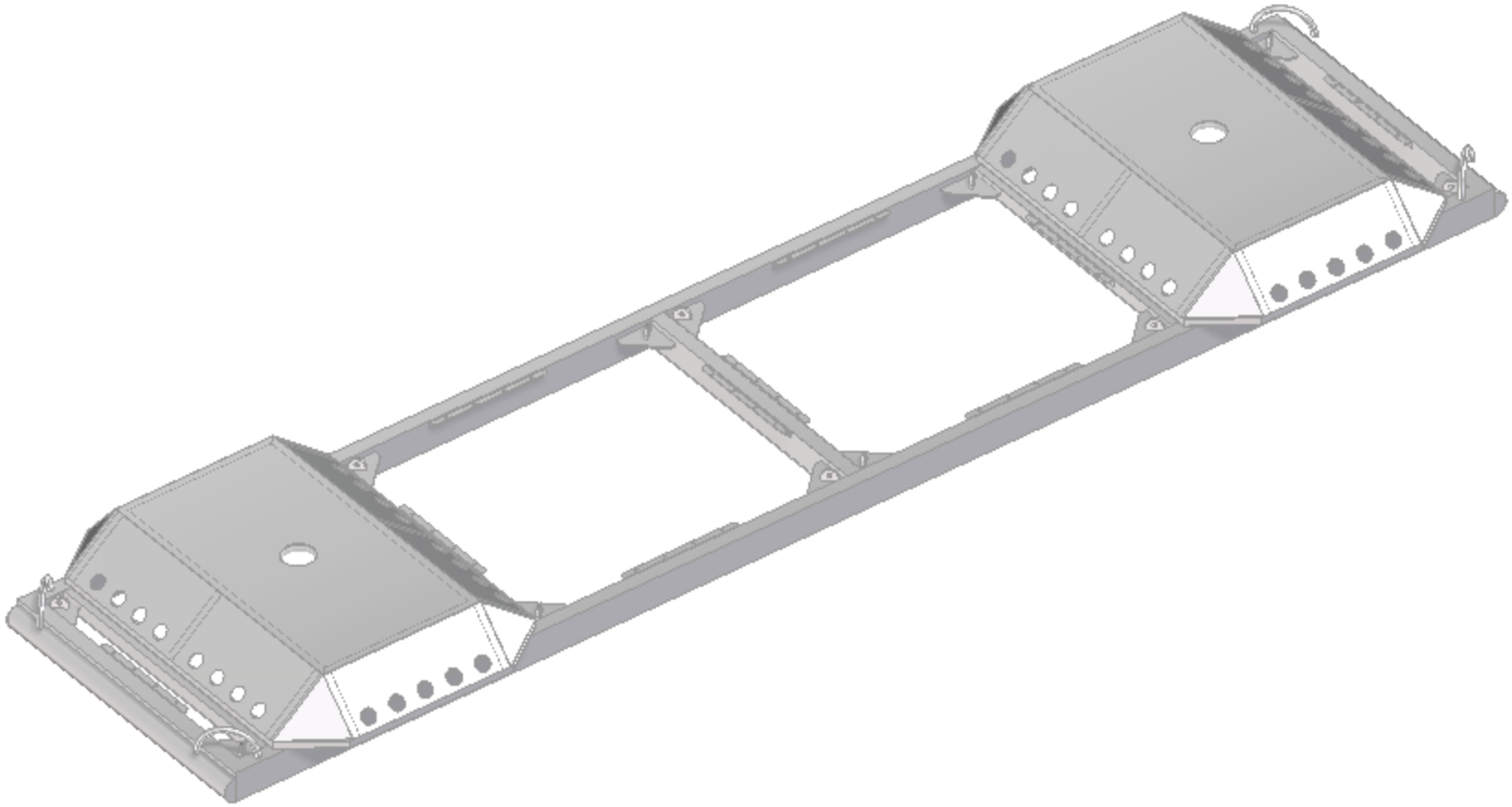
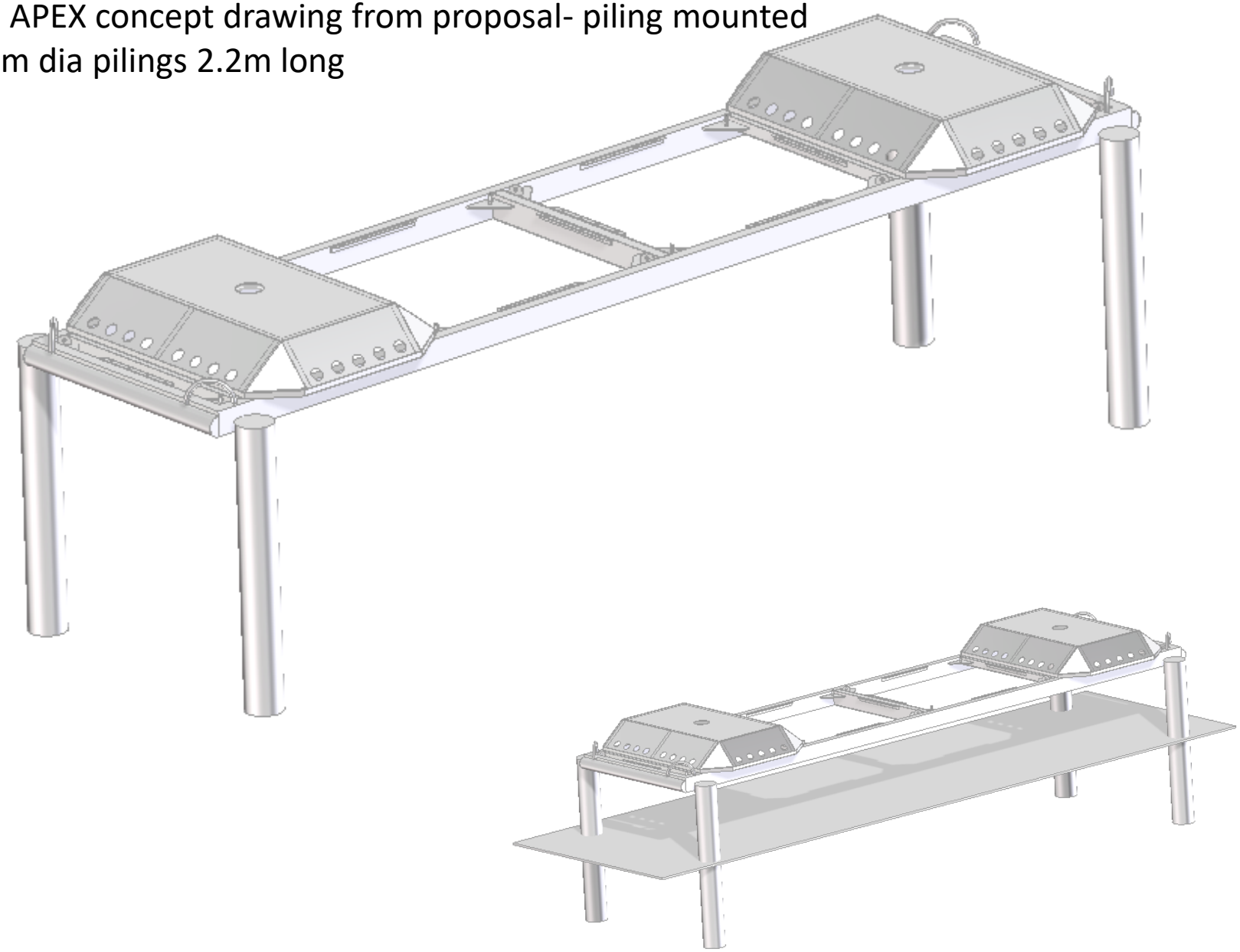
1:5 scale APEX as-deployed 2014

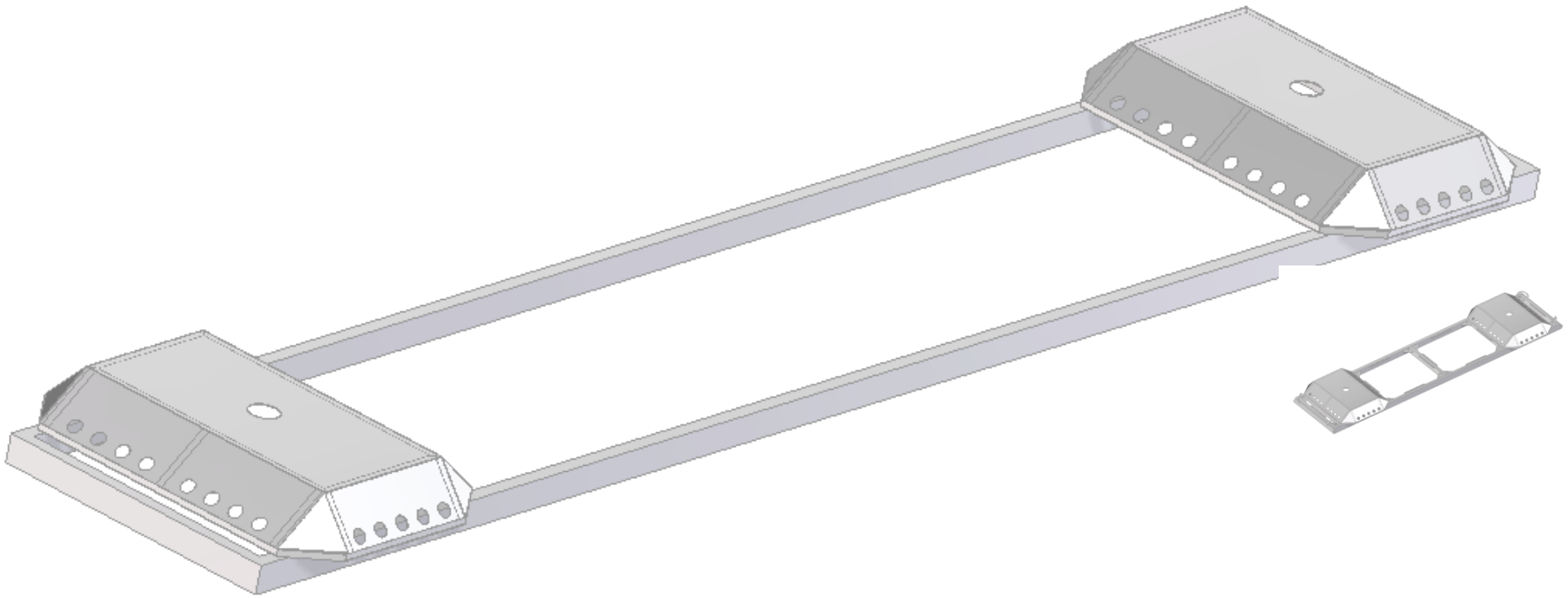


1:5 APEX concept drawing from proposal- piling mounted
0.3m dia pilings 2.2m long

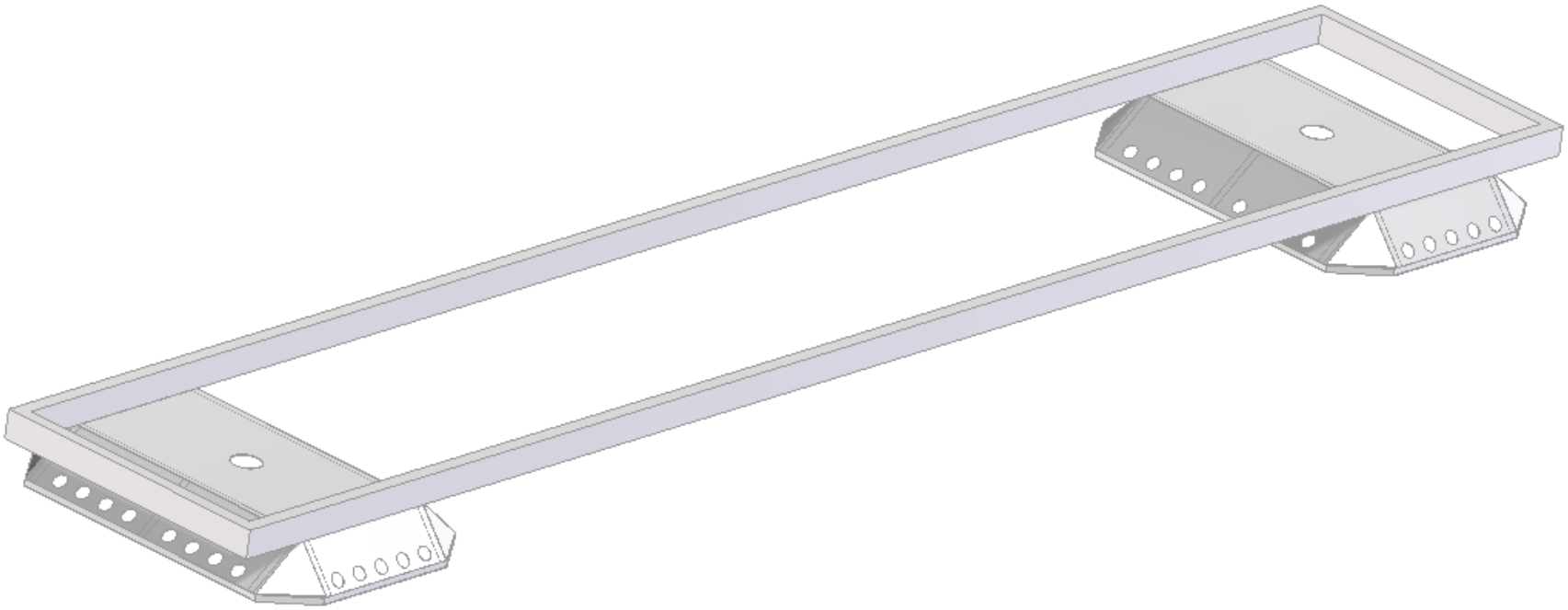


1:5 APEX concept drawing from proposal- spherical caissons
0.3m dia pilings 2.2m long

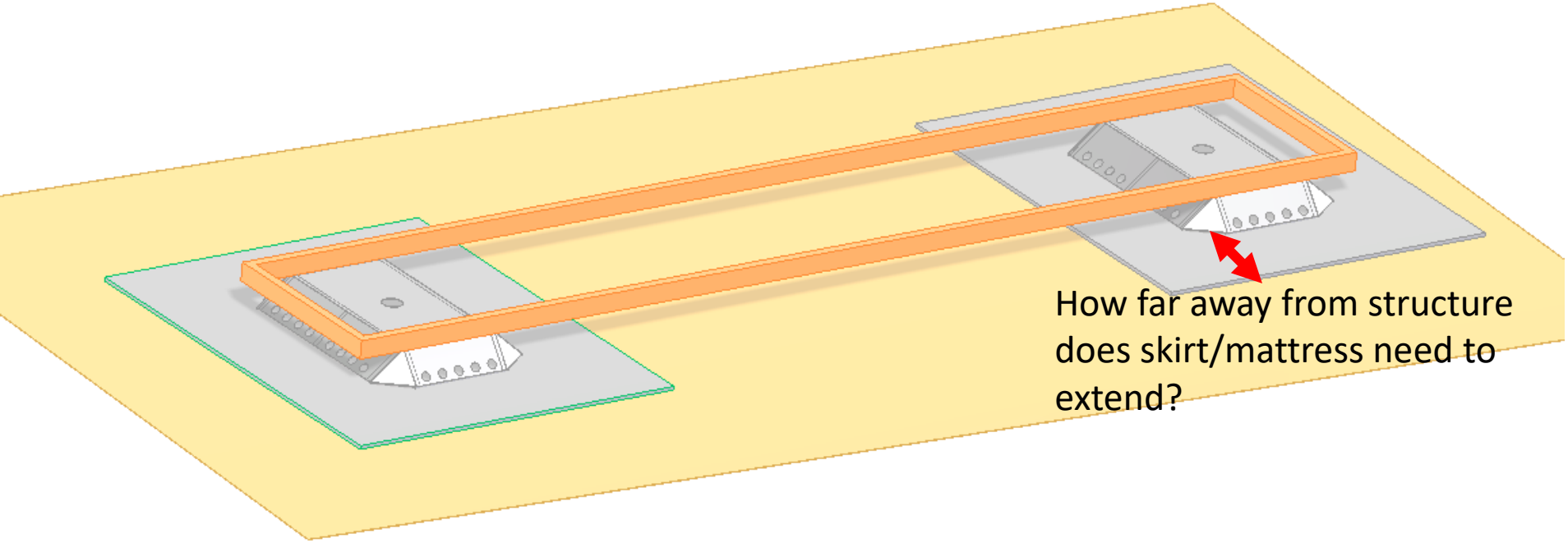
Baseline full-scale Standard APEX
Caisson rectangular top plate: 5m x 10m
Center-to-center length: 50m



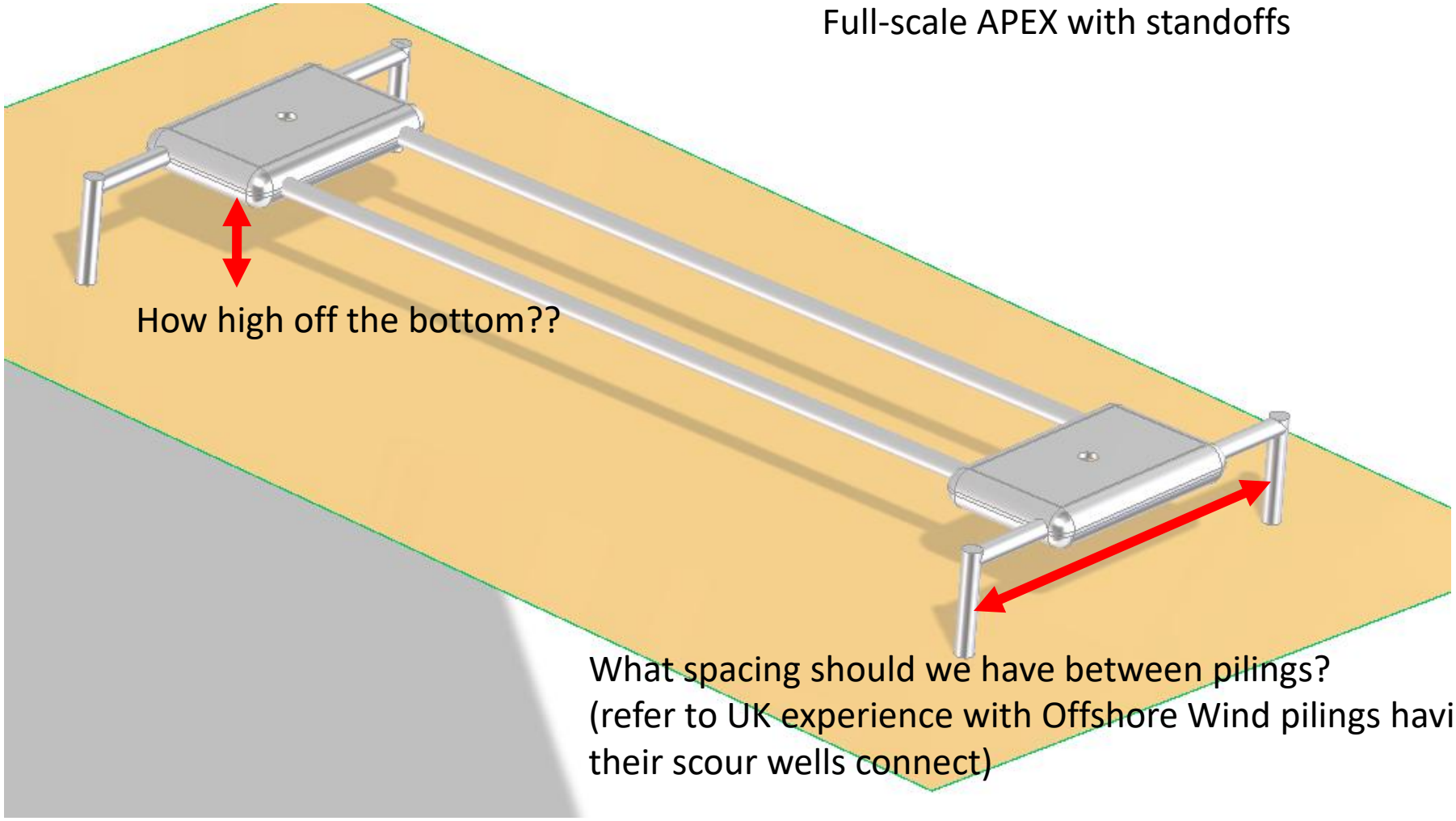
Baseline full-scale TopStrut APEX
Caisson rectangular top plate: 5m x 10m
Center-to-center length: 50m



Baseline full-scale TopStrut APEX
Caisson rectangular top plate: 5m x 10m
Center-to-center length: 50m
Caisson sediment skirt 5m all sides



Full-scale APEX with standoffs

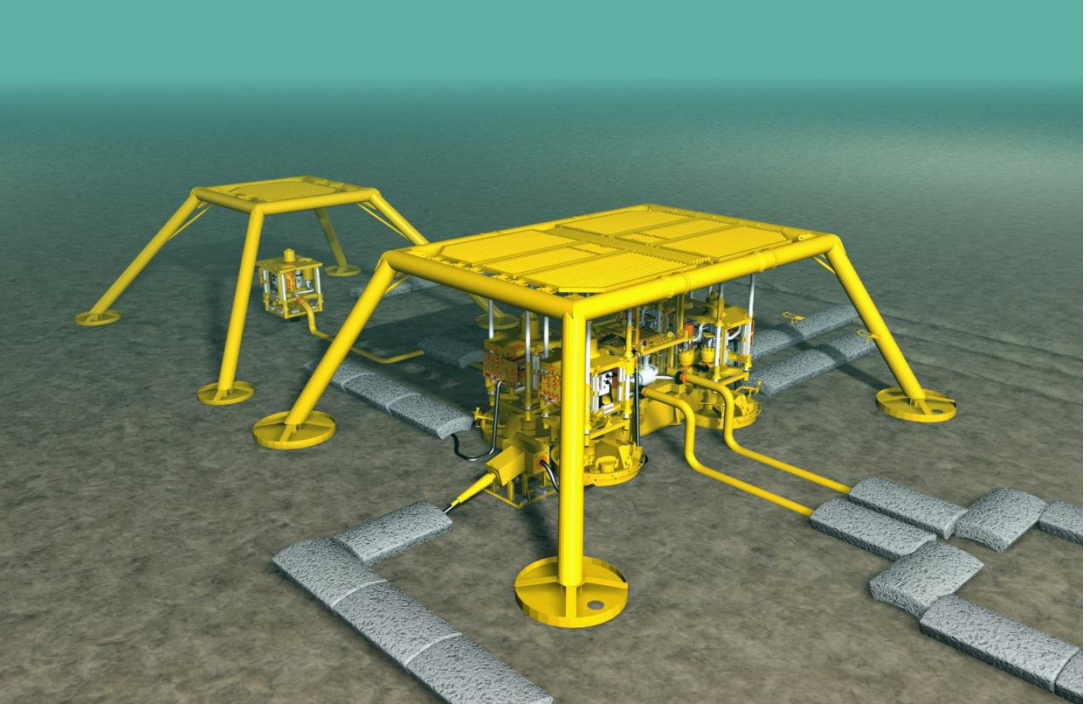


Pilings: 1m dia 5m tall as drawn

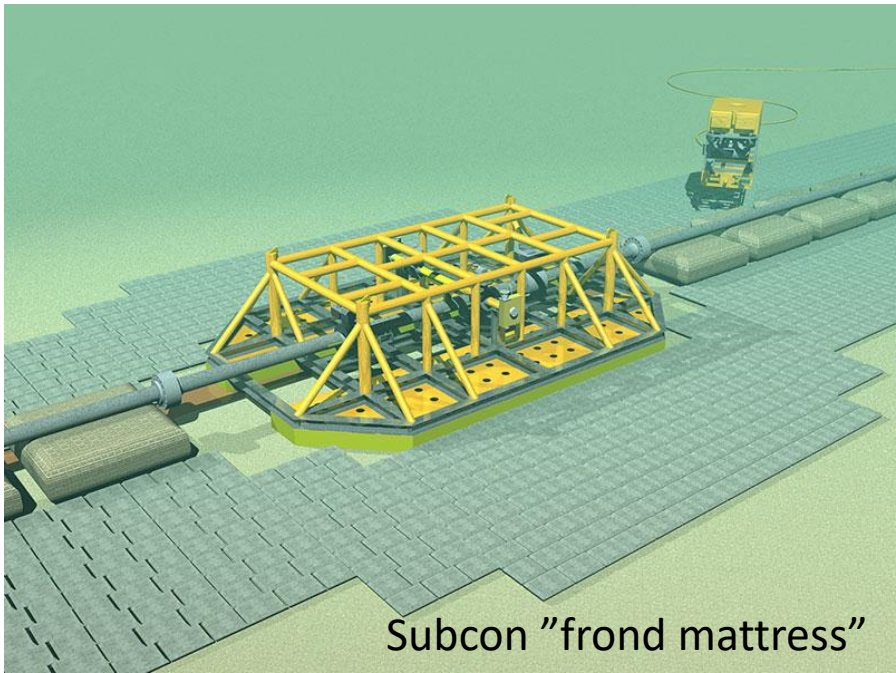
APEX: caissons 5m x 10m x 2m, open bottom. Center-to-center length: 50m

Coming soon:

Mattress/skirt variations



Are these scour inhibitors or pipe weights?



Subcon ”frond mattress”

Back up

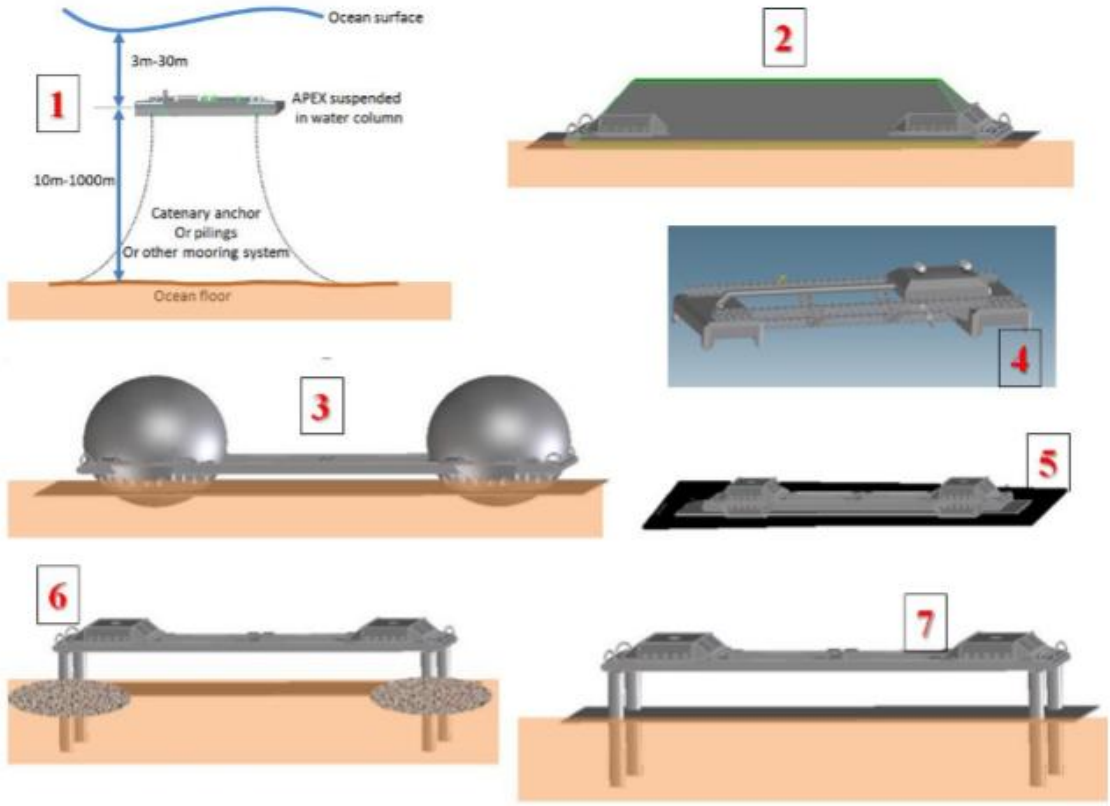
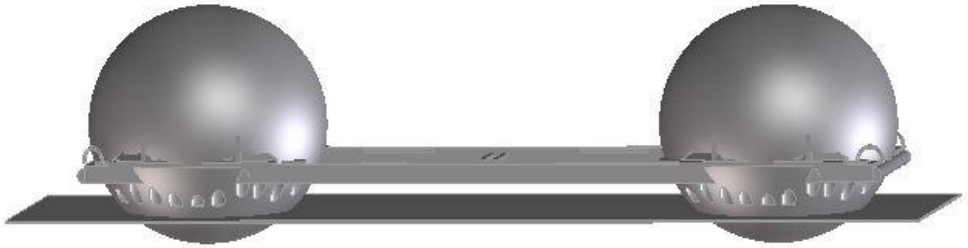


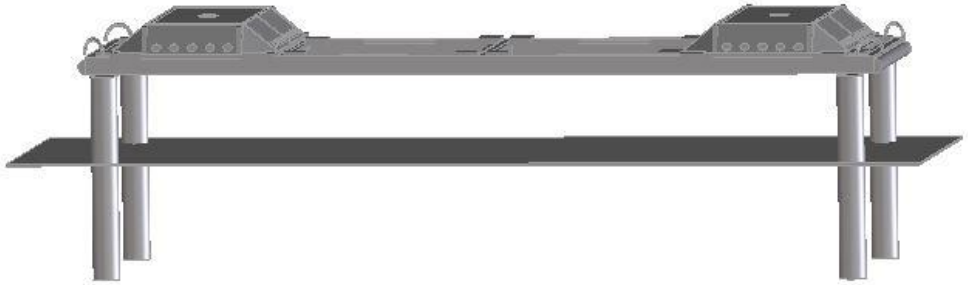
Figure 7: Examples of some of the numerous concepts that will be evaluated as part of this project (in most cases, the waterline is considerably above the device). 1] Mid-column SPD conventional mooring/anchoring; 2] Contiguous shell; 3] Symmetric caisson (several variations); 4] Integral embedment framework; 5] Sediment skirts (articulated and fixed, lattice and solid); 6] Piling support reinforced with rock, rubble, or engineered structures such as Dolos[7] ; 7] Jet-embedment integral temporary piling.



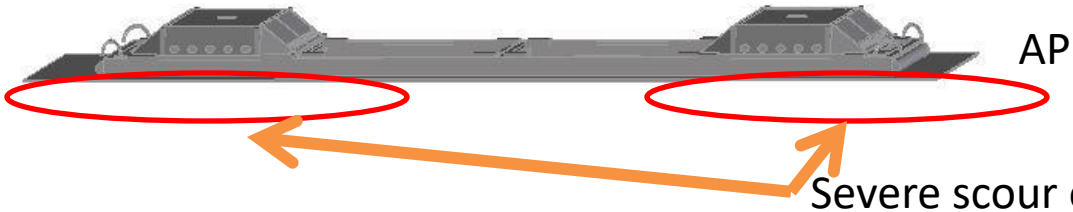
Spherical concept

Symmetric caisson concept

Contiguous shell concept



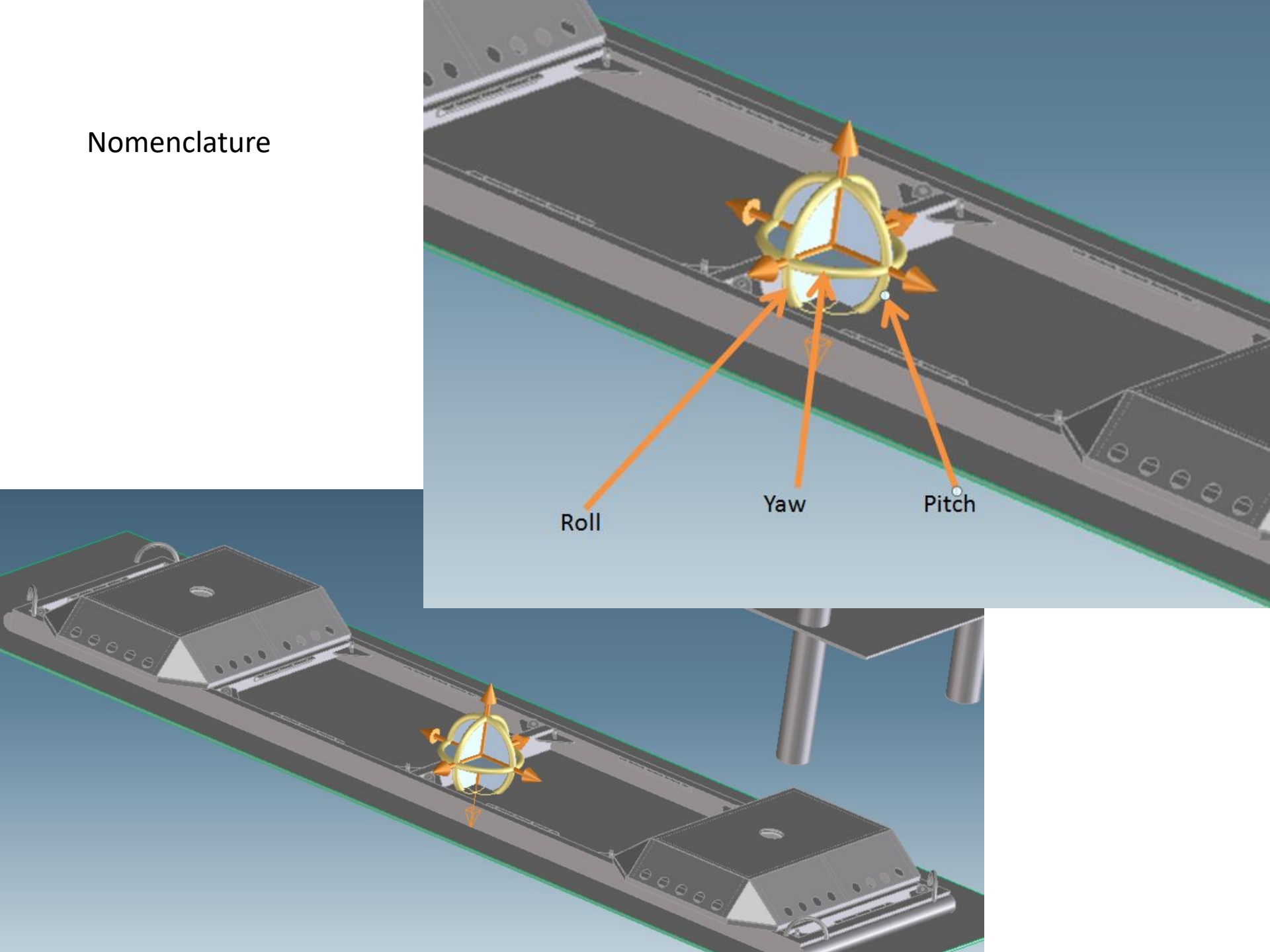
Jet-embedment temporary piling concept



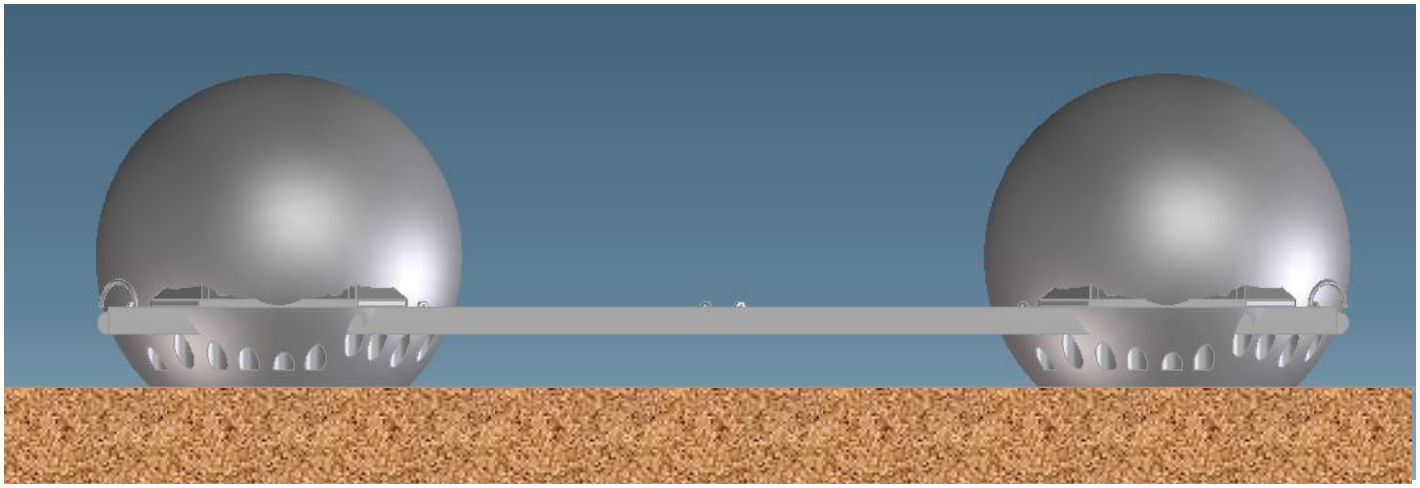
APEX as deployed 2014

Severe scour observed under these areas

Nomenclature

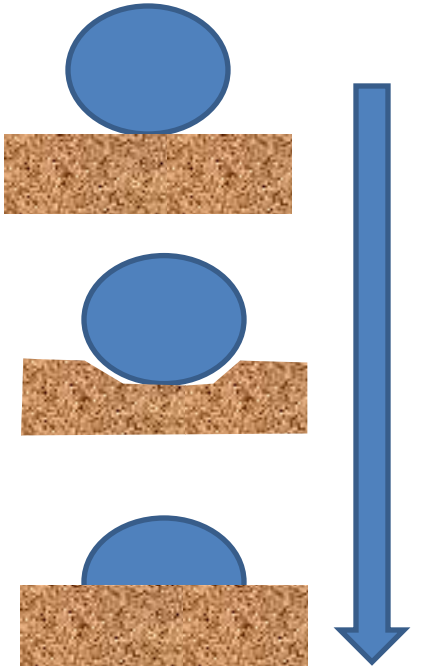


Symmetric Caisson- Spherical Concept

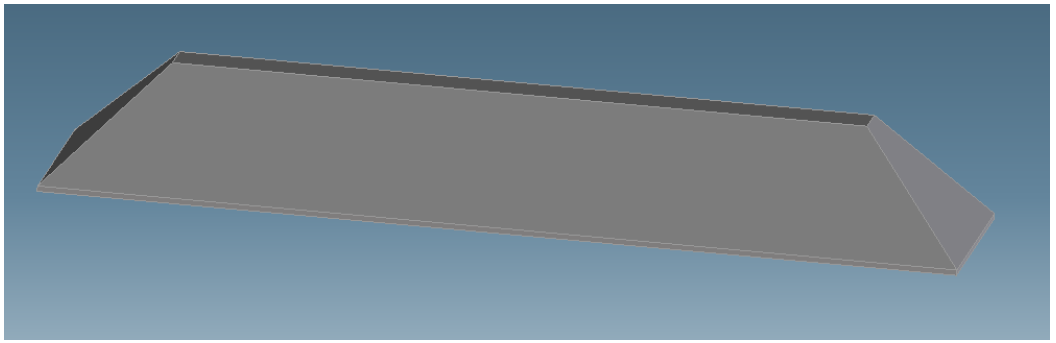


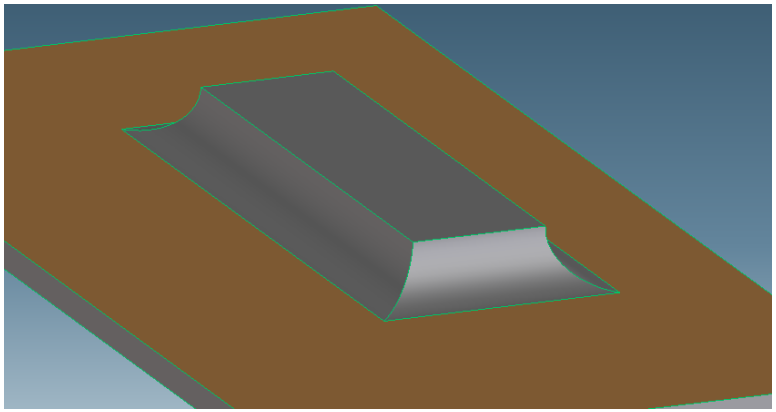
Idea: as sediment accretes or scours, system reaches a stable balance.
Cross structure TBD (design flexibility)

Issues:
Different scour on each end could lead to pitch
Manufacturability



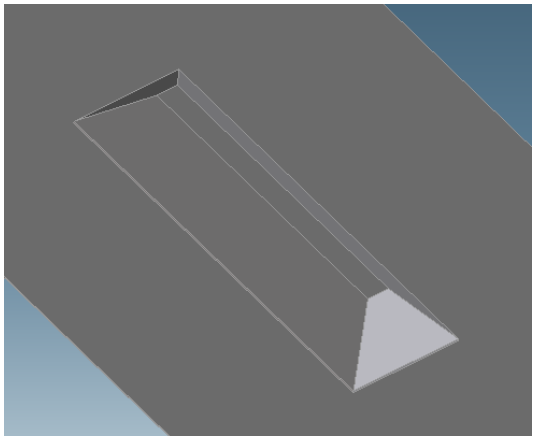
Contiguous Shell
Idea: reduce/eliminate localized regions of accelerated flow under or around device.



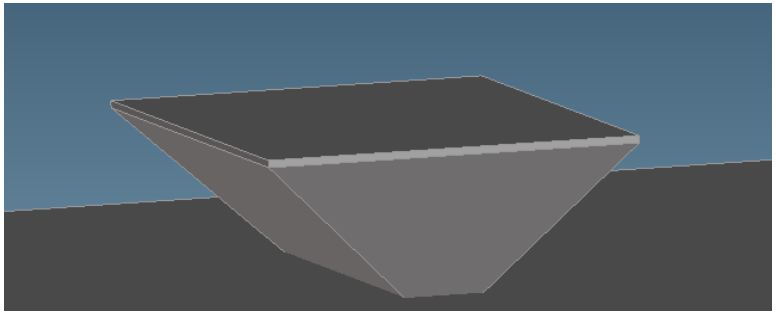


Blended edges

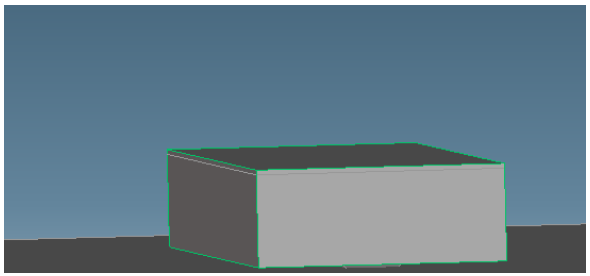
Beveled Contiguous shell
“Pyramid”



Beveled Contiguous shell
“Reverse Pyramid”

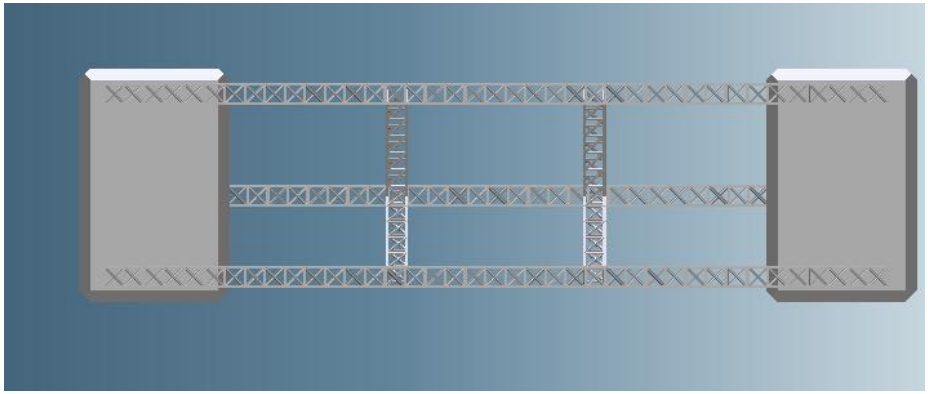


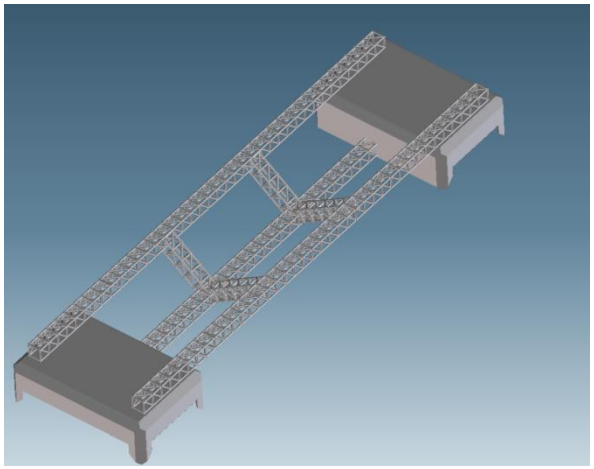
Solid Block

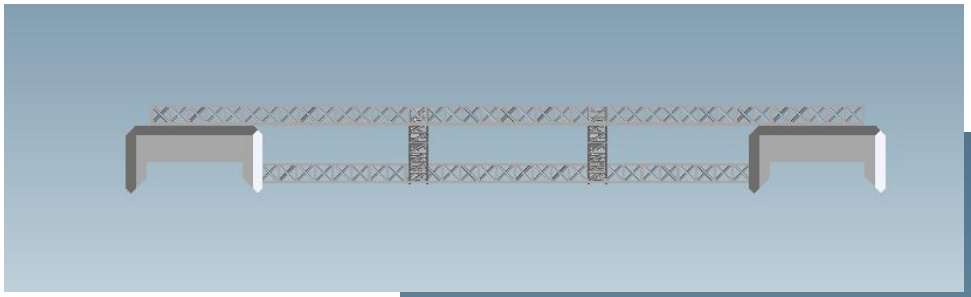


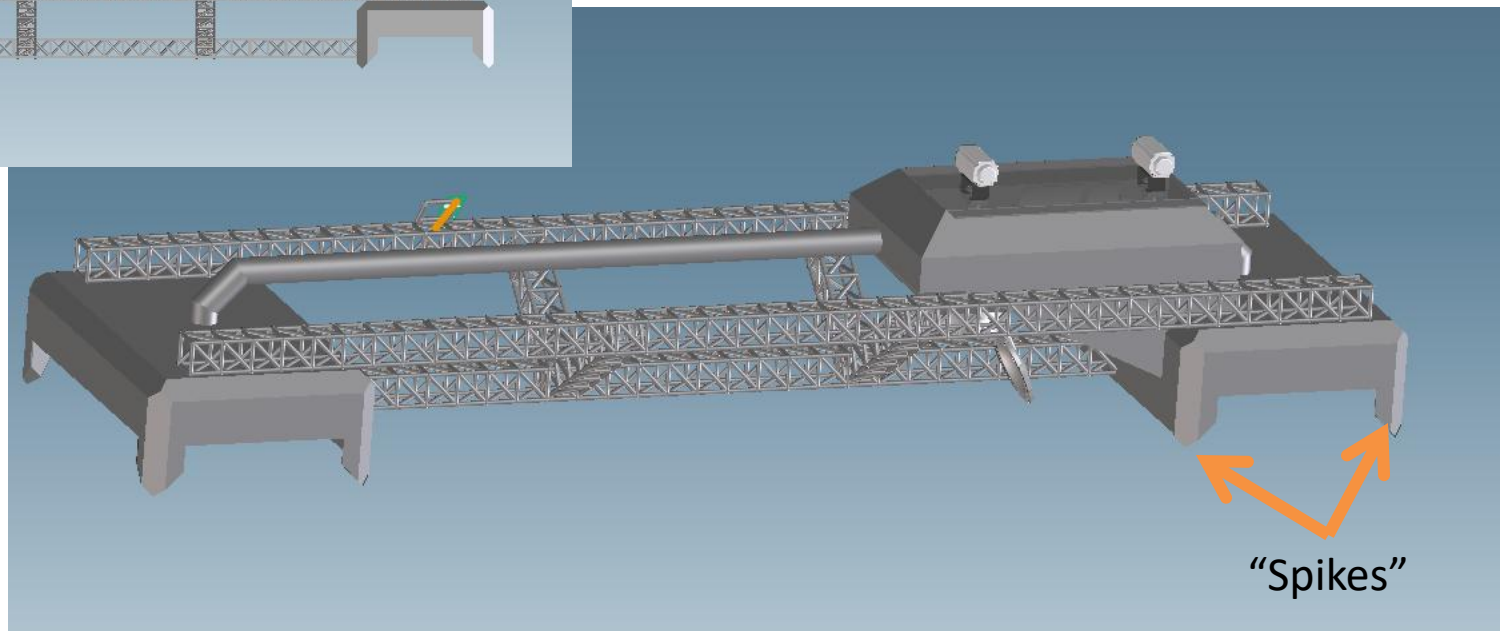
Integral Embedment Framework.

Idea: Caissons have corner “spike” structures that embed into sediment. Cross-structures between caissons are made from structural materials that allow particle pass-thru (lattice structures).

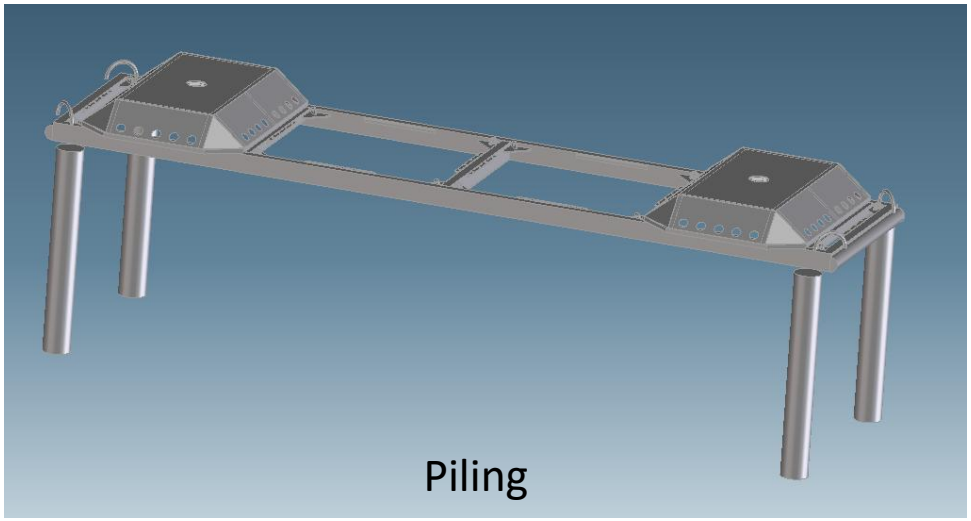






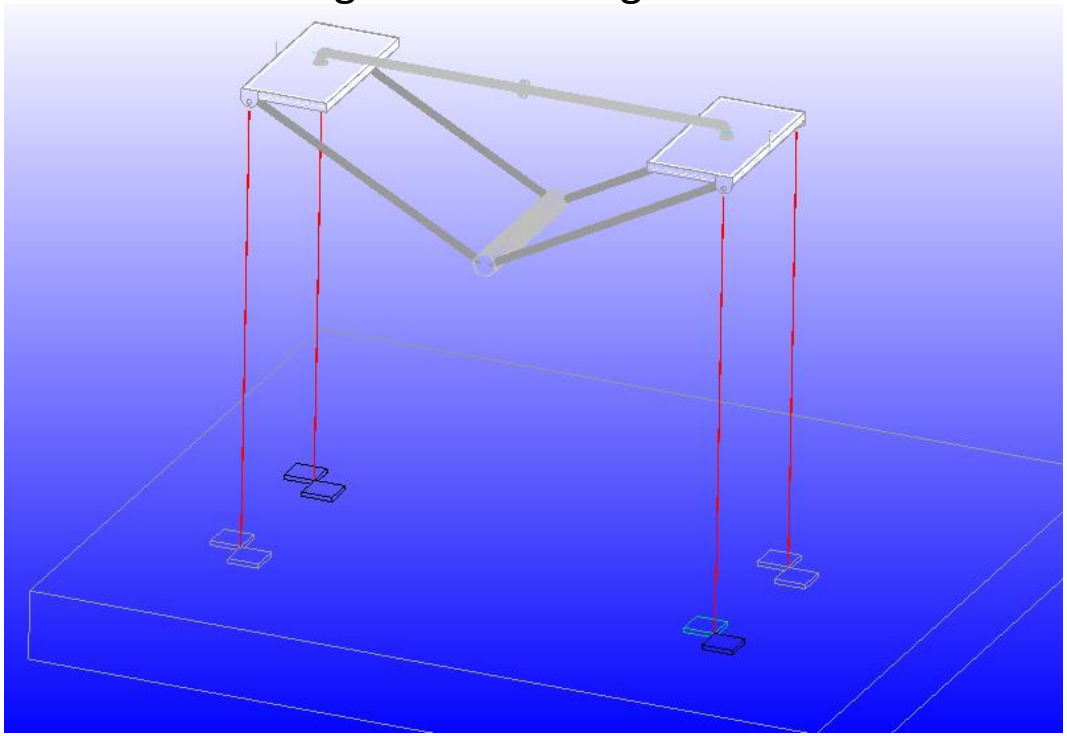


Mid-column Concepts



Piling

Submerged Tension Leg Platform



Is it better to have more pilings of smaller diameter or fewer larger ones?

How far off the floor do we need to be to allow sediment to “pass through?”

More Ideas:

A. Snow fence. Structures around APEX serve to disrupt the fluid/particle flow, causing accretion or scour at these “sacrificial” structures to prevent those phenomena at APEX.
    A. What happens when structure “loads up” with sediment? Does it clear or does it merely delay the inevitable.
B. Cobble skirt. Coarser gravel or rock material is situated around APEX to minimize particle motion.
C. Caissons are independent structures with no rigid connection. Essentially acting as two nearby (100 yards apart) discrete structures.
    A. Challenge: elevation delta between caissons must be controlled.
    B. If one shifts relative to the other, an effective pitch shift can be induced.