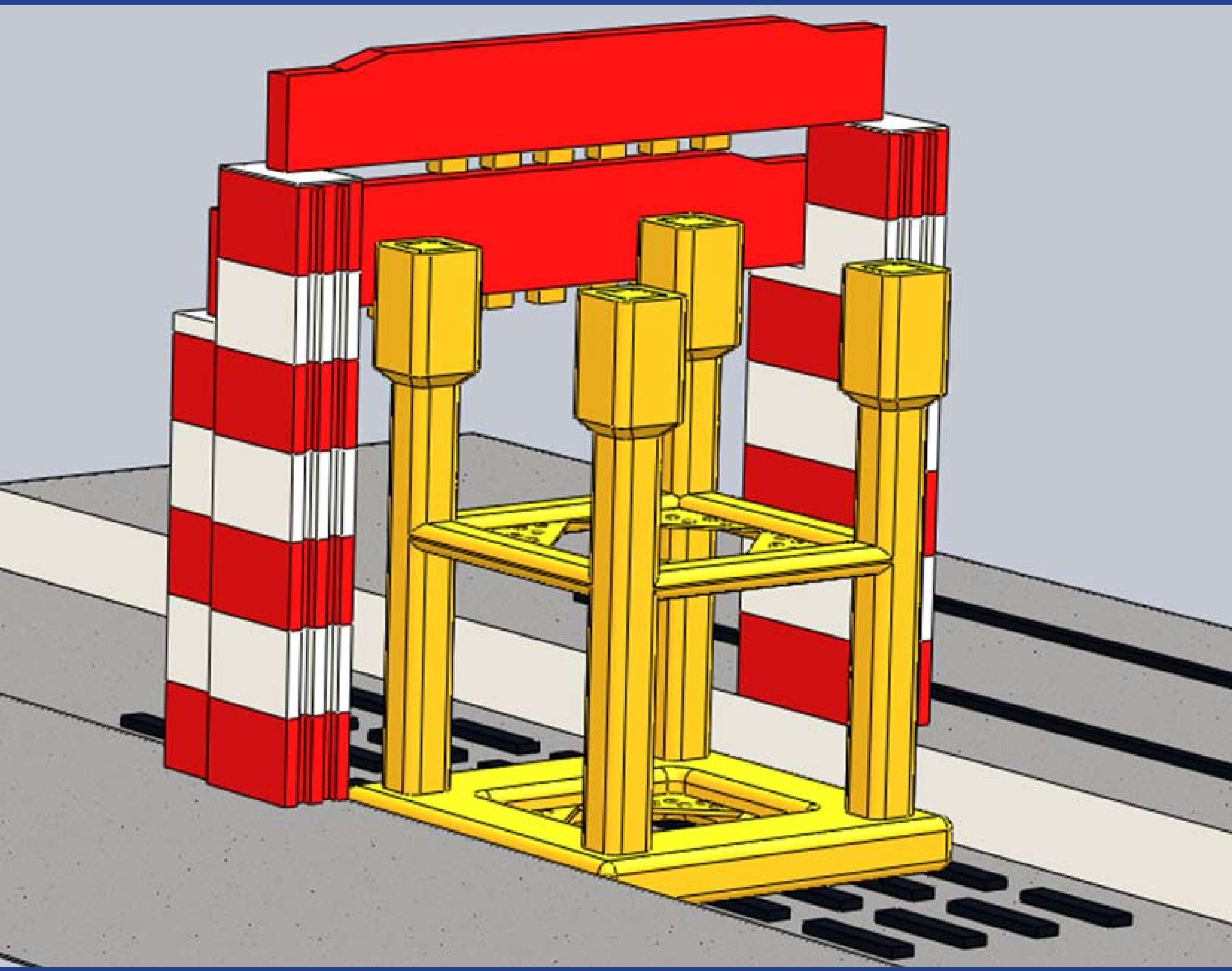
LEENAARS BV
MARINE & OFFSHORE DESIGN

Yantai Raffles
The Premier Shipbuilder

# SLOFO - Split Leg Float Over Platform



**The SLOFO concept is developed to make "float-over" possible for all major offshore locations and at the same time simplifying fabrication, transportation and installation.**

## SLOFO DEEP DRAFT FLOATER

The new platform concept is developed to reduce overall project cost. Estimates show significant cost reduction compared with a traditional SPAR. Preliminary designs were made and tank test performed. The main conclusions of the preliminary study are:

- The SLOFO platform can be installed in wave heights over 2 m. significant. This will guarantee a high workability for all offshore locations.
- The SLOFO floater allows heave motion compensation.
- The SLOFO construction is efficient in carrying topside weight it can support topsides of over 2 times its own weight.
- The reduction of project cost of the SLOFO concept is estimated between 20 to 40%.

## Design cost:

Design cost will be reduced by standardization based on 3 mother shapes whereby motions and loads are scalable by Froude law. These standard designs will cater for all carrying capacities required. It is the intention to select one of the mother shapes for further evaluation and then translate the results to benchmark projects of the participants and compare motions and cost.
The preliminary design is presently based on DNV requirements for permanent offshore units.
Corrosion allowance and anode protection should be designed to cover platform life.
Diffraction analysis shows that the harmonic components in the moments of the connection beams are very small. It is therefore easy to realize a long fatigue life. This is due to the deep draft and small diameter of the floater columns.

## Fabrication cost:

Design of the floater is focused on automation and simple erection procedures. YTR is further optimizing construction costs. The floater is fabricated at low wage area's.

## Transportation cost:

The design is made so that it can be simply transported on the classes of transport vessels (32, 40 and 63 m wide vessels or barges) For the transport there is no expensive cribbing required.

## Offshore installation cost:

For a reduction of cost it is important that the topside can be completely finished in or on shore. Therefore float over is considered for the offshore installation and analysis have shown that this is possible in wave heights of more than 2 meter significant. These calculations will be verified further in tank testing.

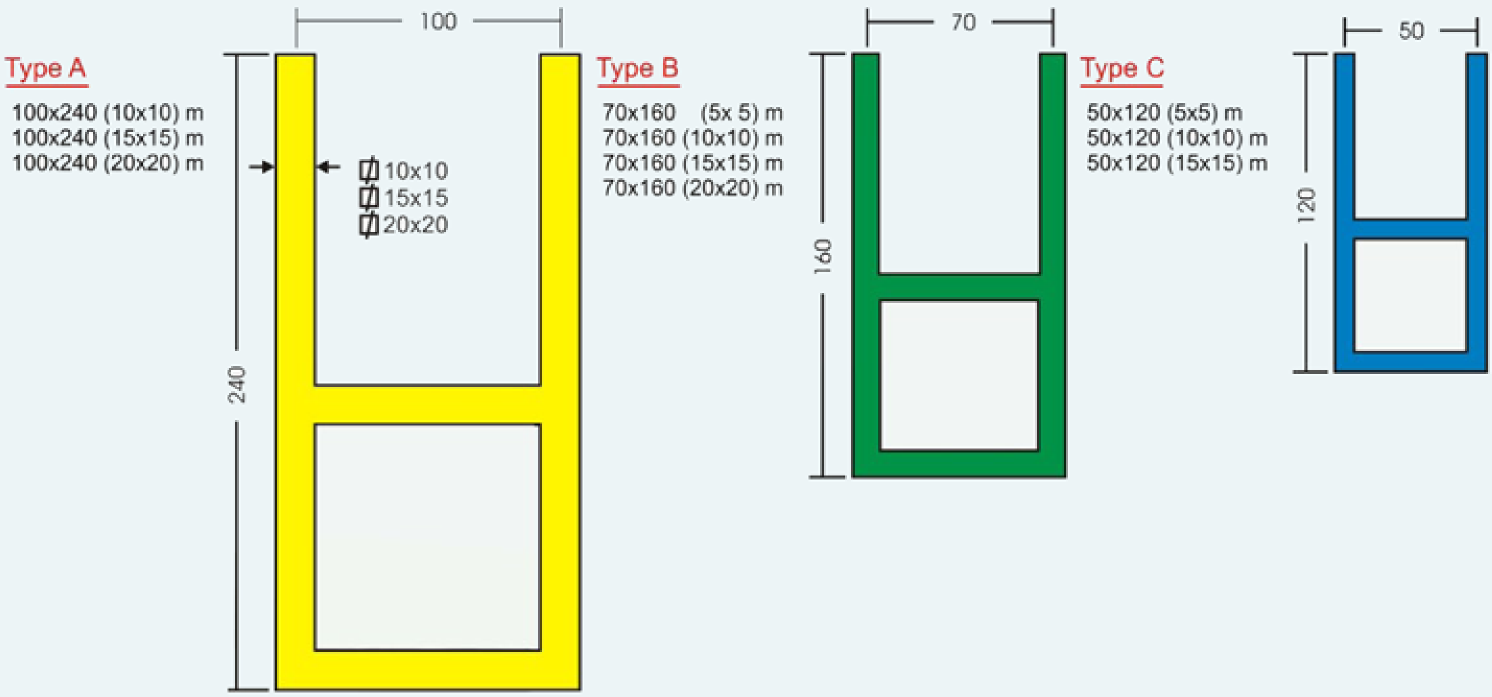
## Cost of mooring:

The wave forces act only on the top part (50 m.) of the columns and inertia forces of the remaining part of the floater resist these forces successfully. The diffraction analysis and tank test have shown that the motions of the floater and the wave induced mooring forces are very small, resulting in reduction of cost in the mooring system. The cost of the mooring will be mainly determined by wind loads and current loads not so much by wave loads.Mooring configurations will be evaluated during tank test and will be compared with benchmark projects. Further study is done to reduce current loads.

## Cost of risers:

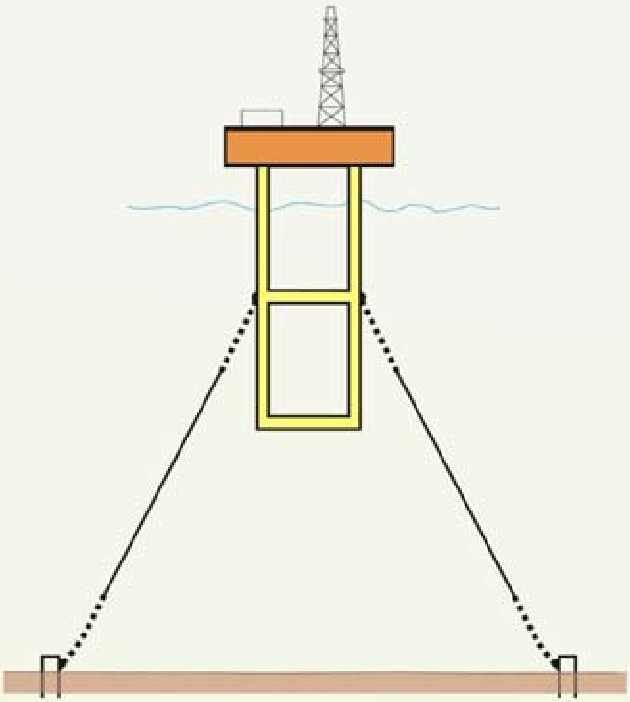
Due to the small motions of the floater it will be easy to realize a long fatigue life of the risers. We consider riser optimalisation important for further development and testing of this floater.

## Platform Configuration

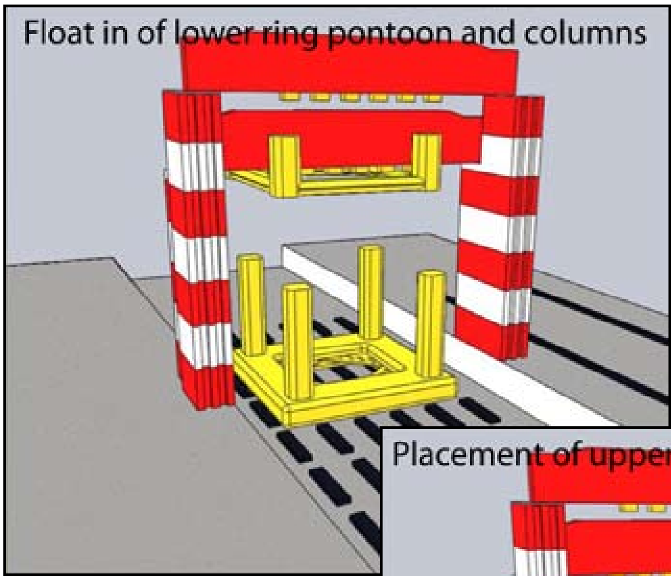



## Platform Mooring

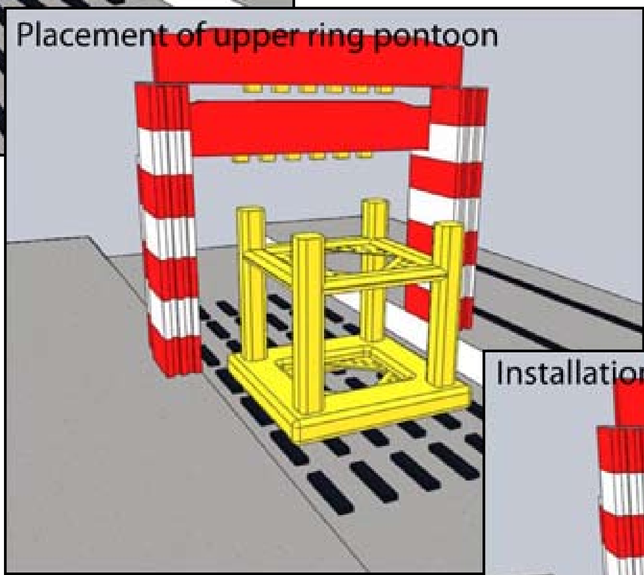
Taut rope mooring is suggested.



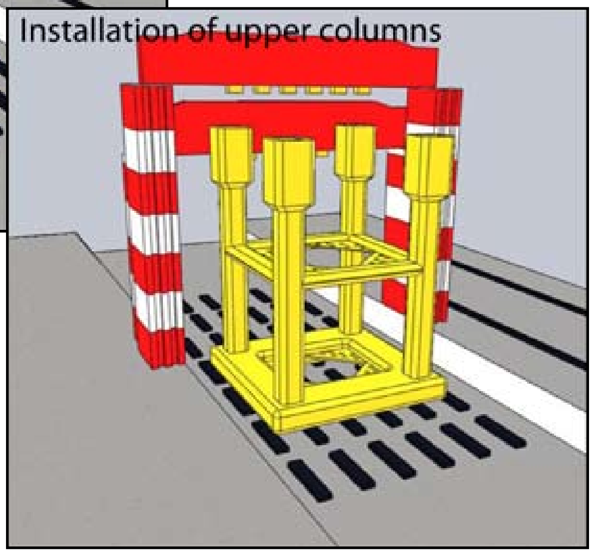
Assembly of the main components under the 20,000 crane at YTR.



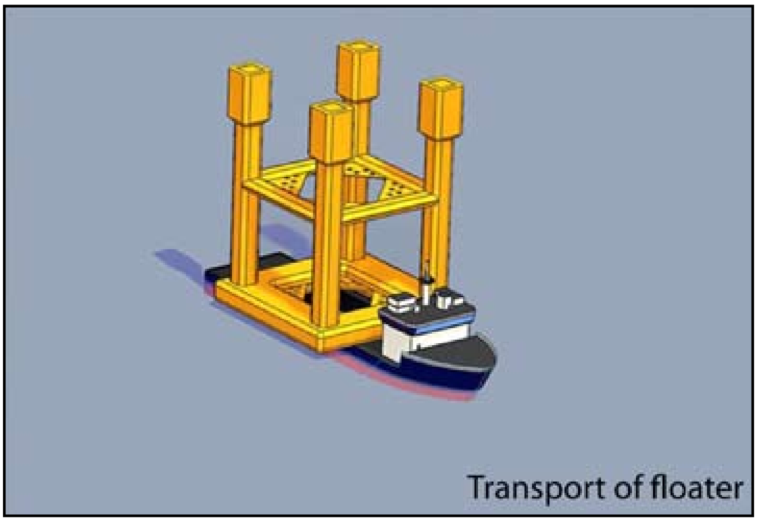
Float in of lower ring pontoon and columns



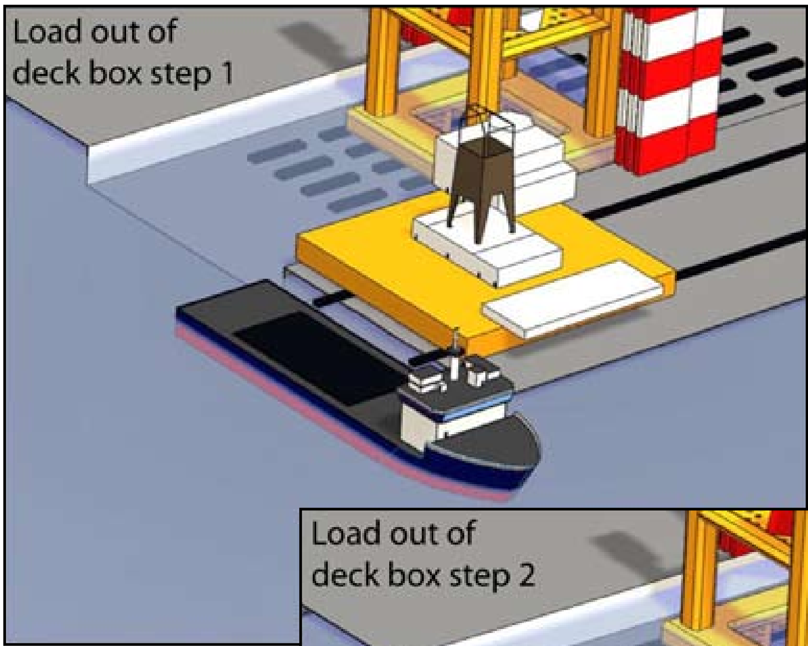
Placement of upper ring pontoon



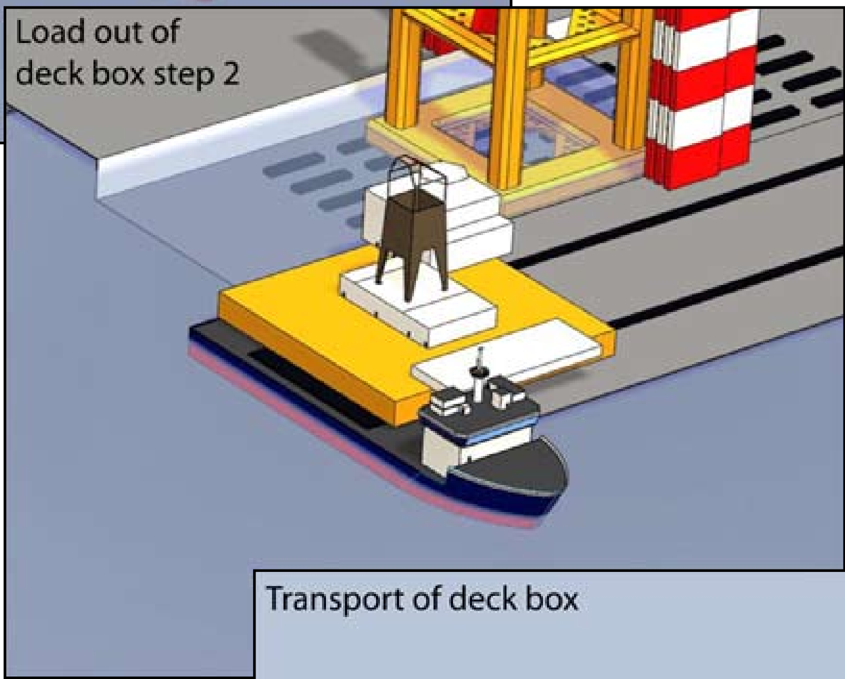
Installation of upper columns



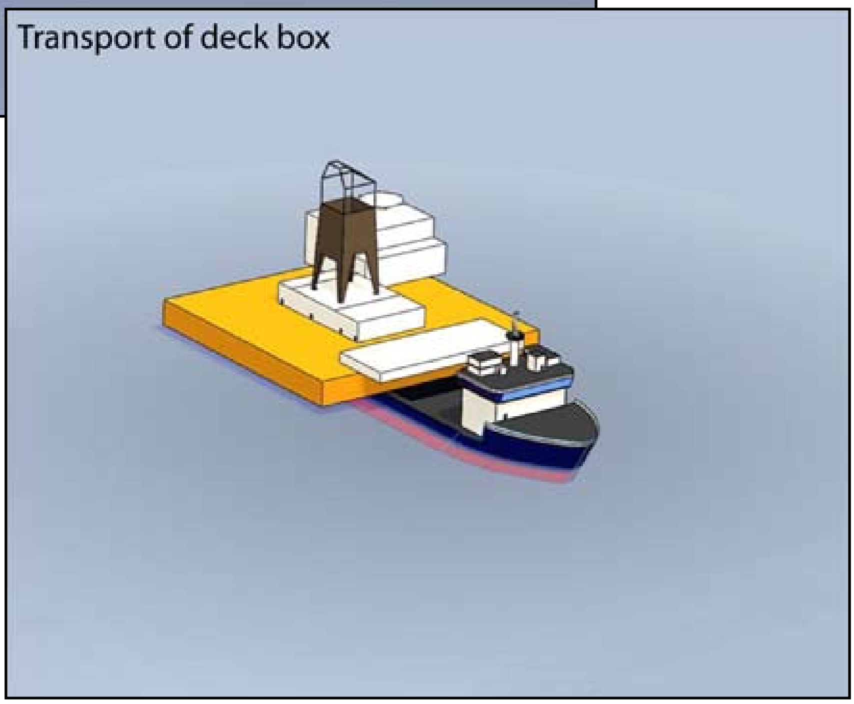
Transport of floater



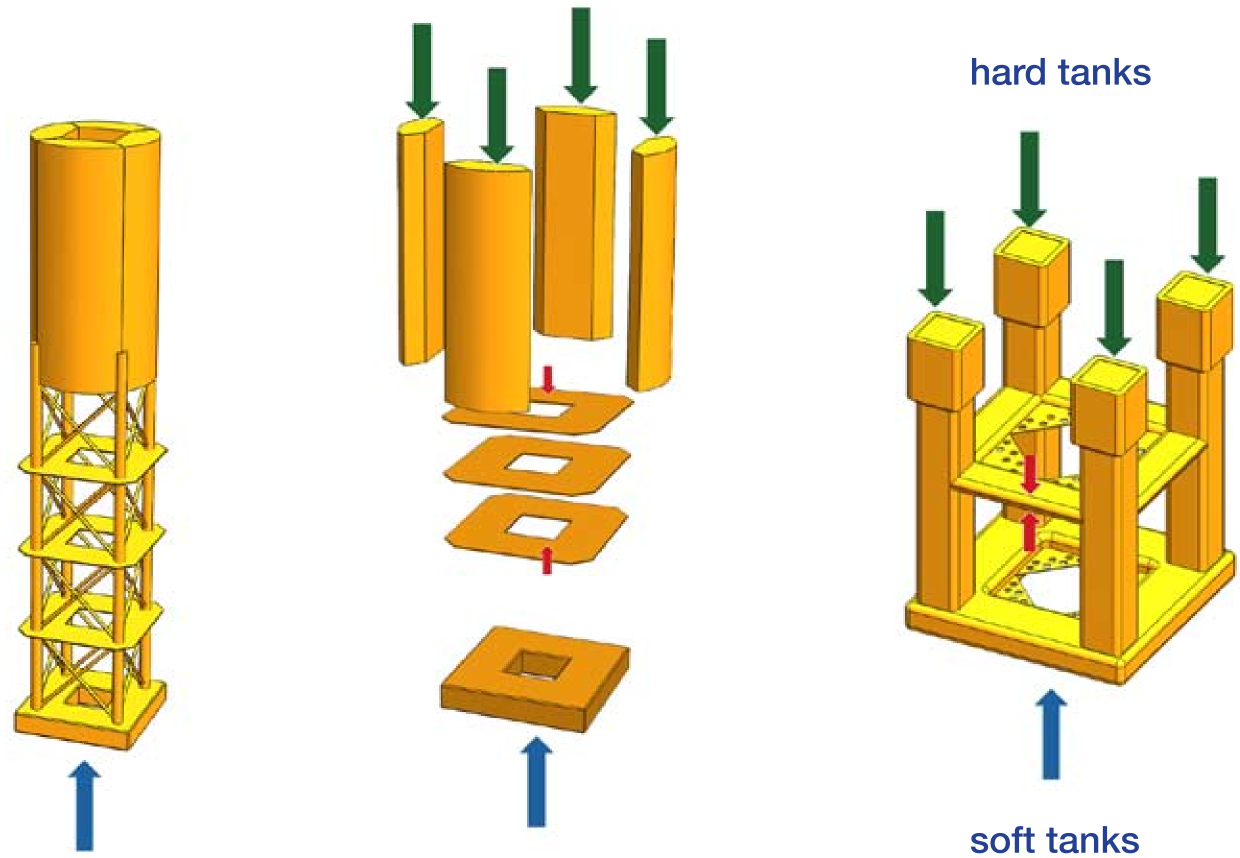
Load out of deck box step 1

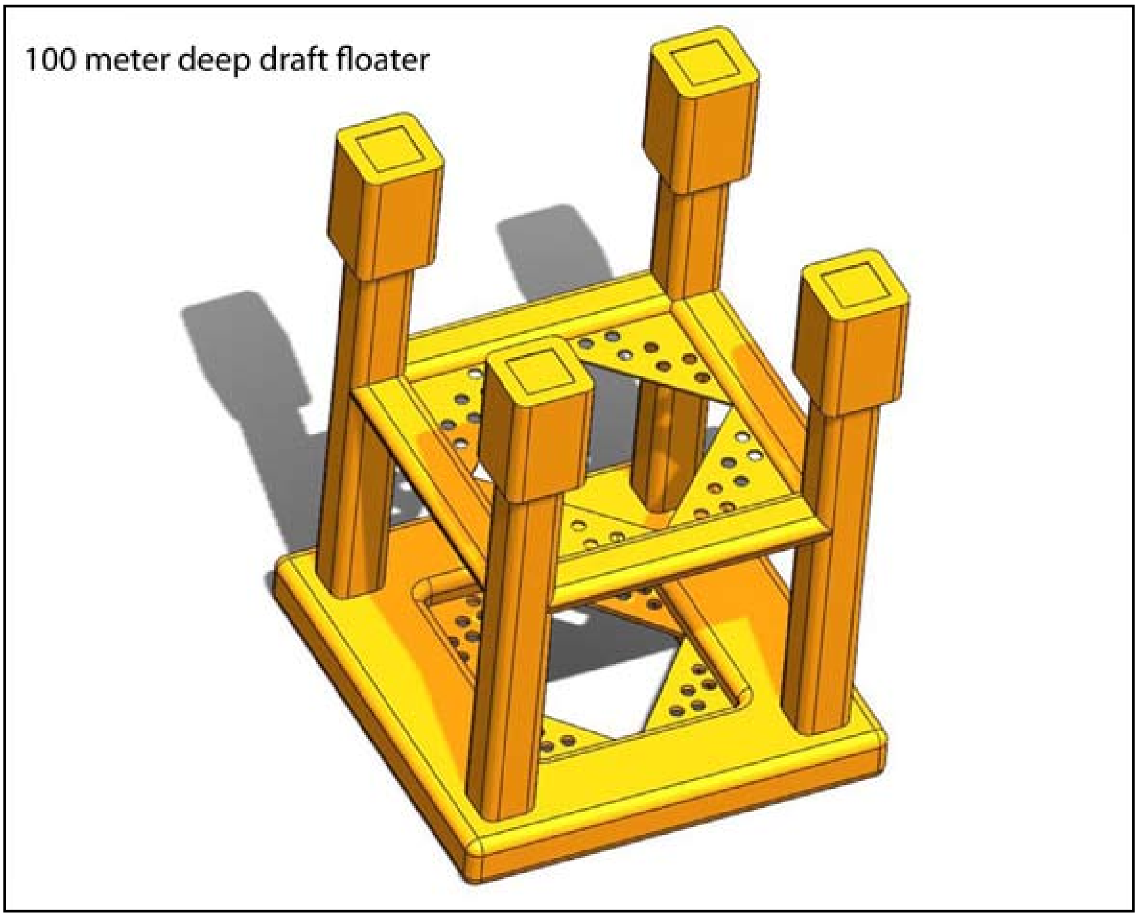


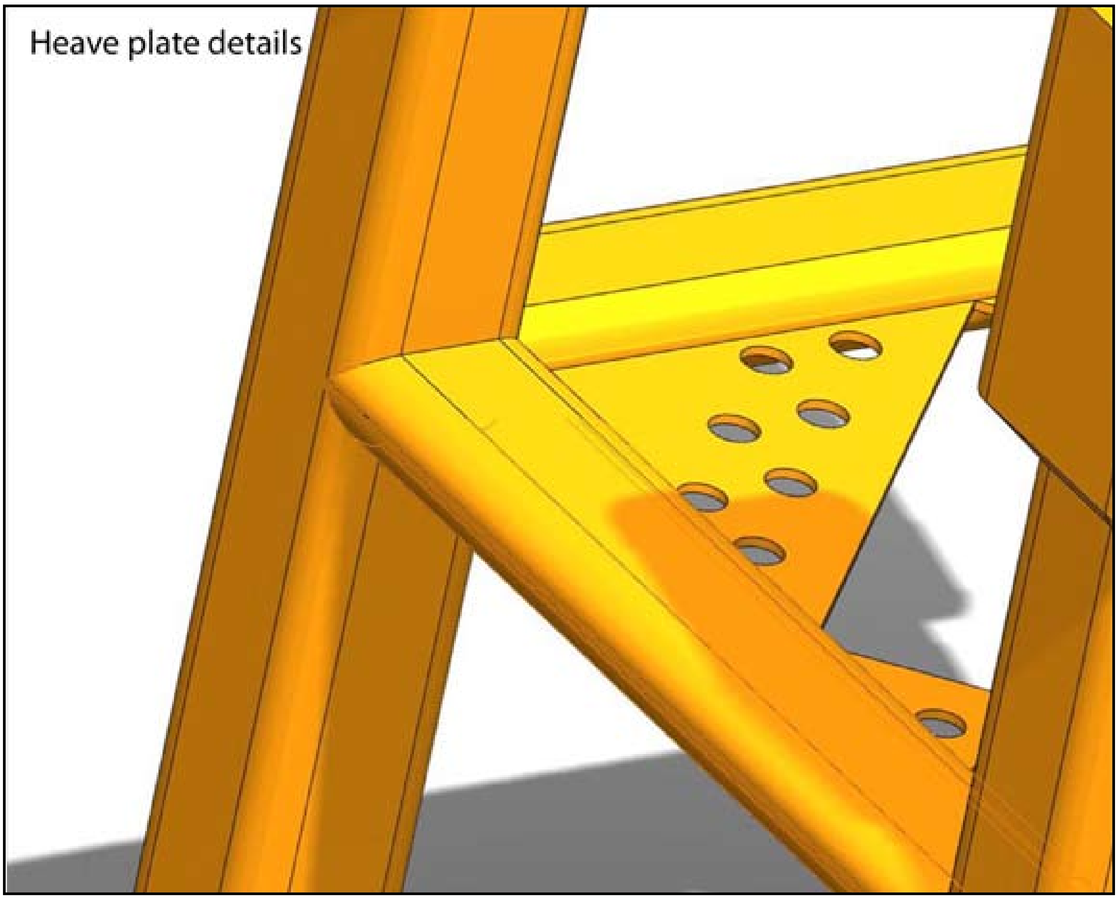
Load out of deck box step 2

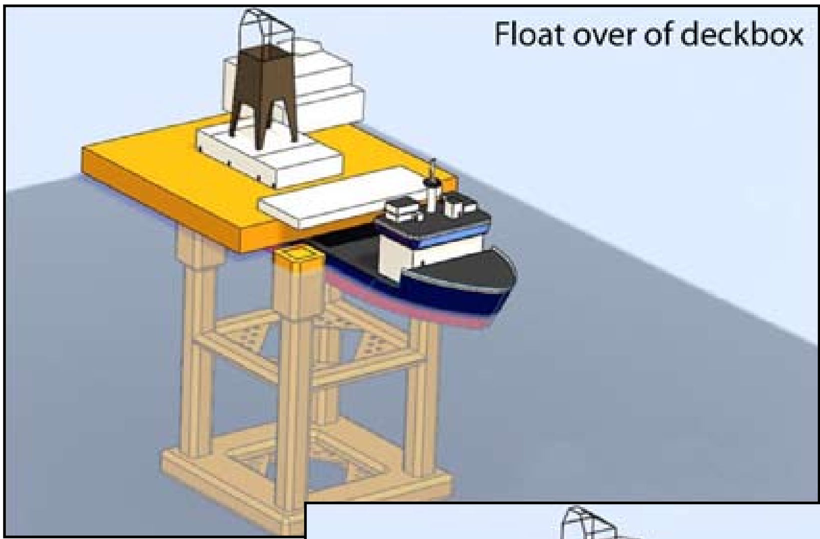


Transport of deck box

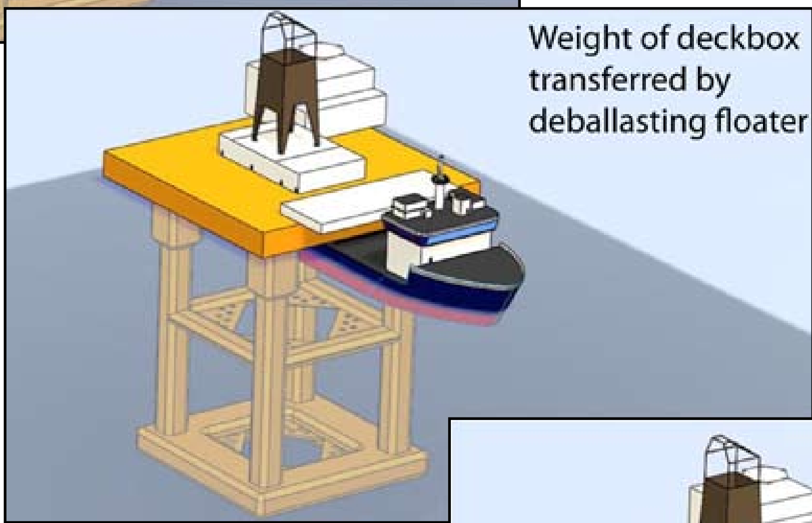

hard tanks
soft tanks

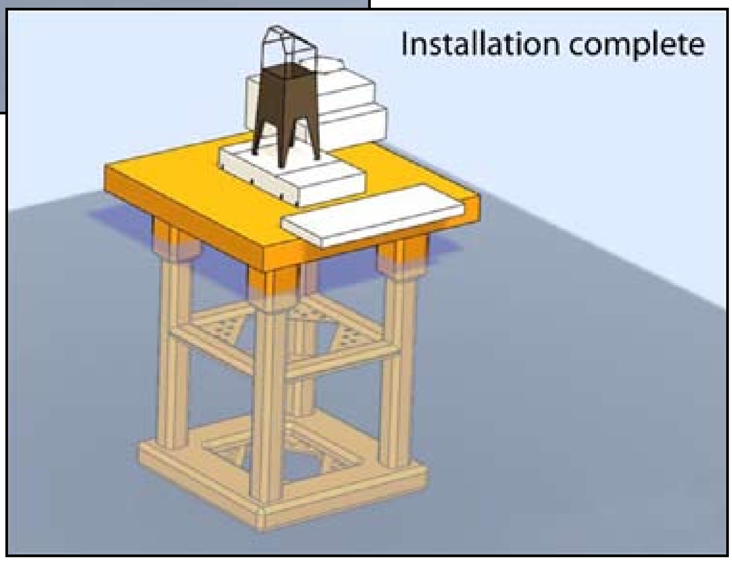

100 meter deep draft floater

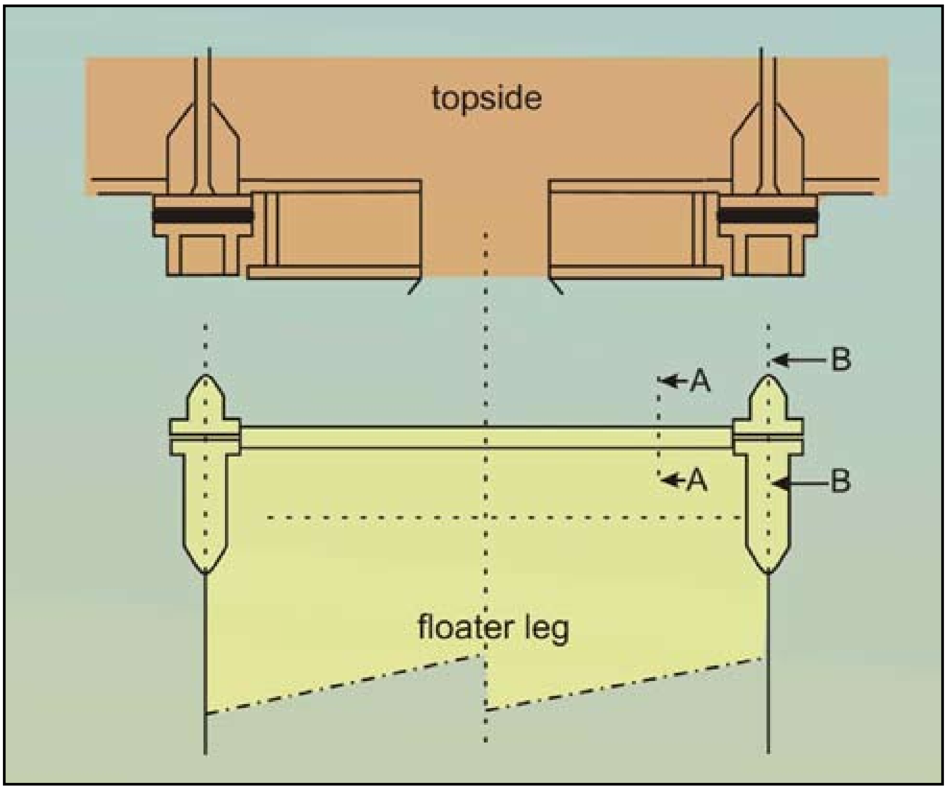

Heave plate details

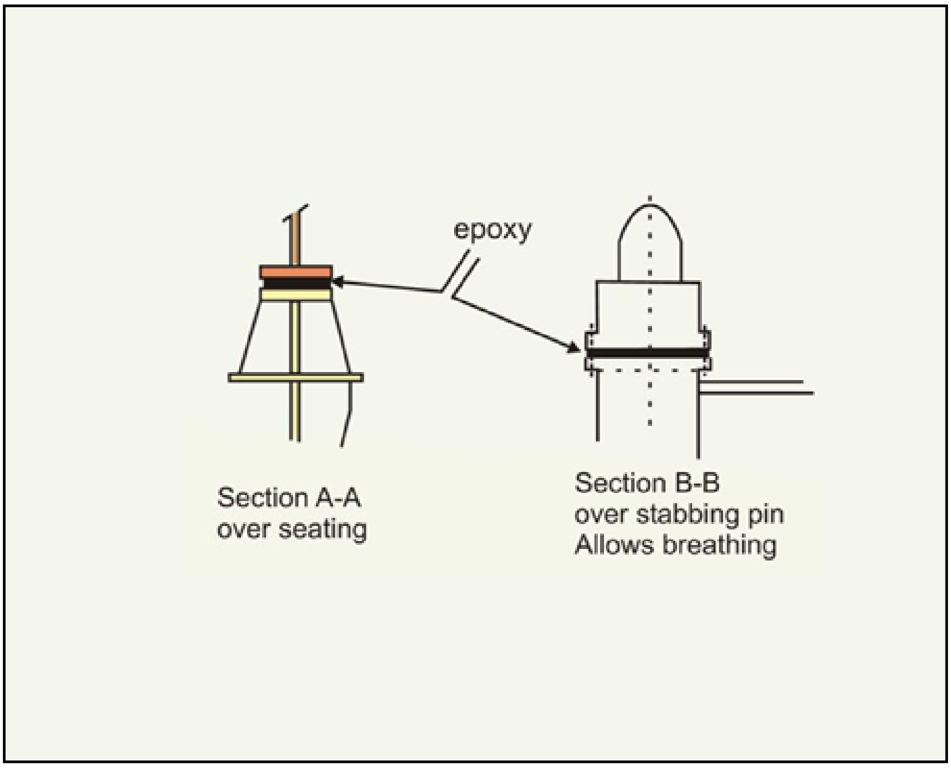



The float over of the topside by the transport vessel.



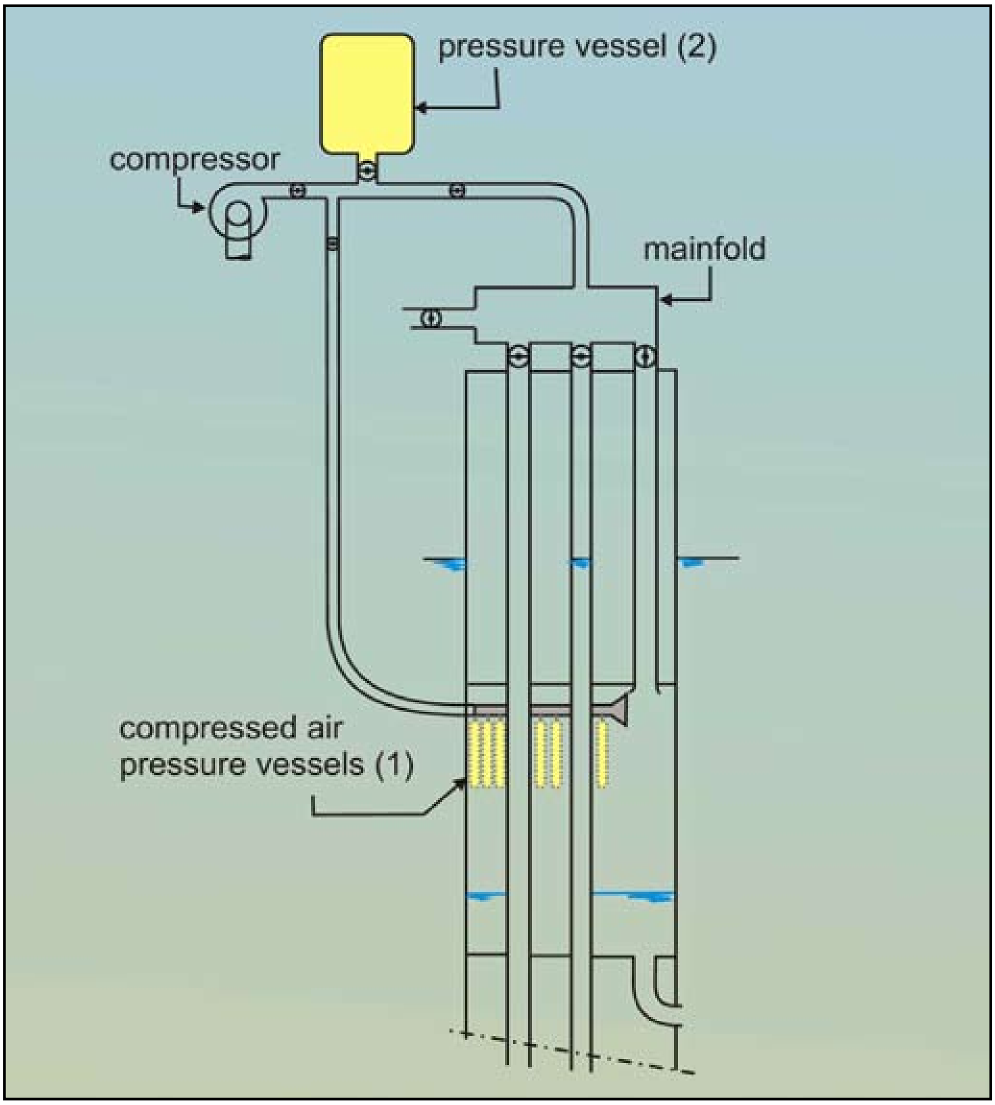

topside
A
A
B
B
floater leg


epoxy
Section A-A
over seating
Section B-B
over stabbing pin
Allows breathing

## Stabbing of the legs

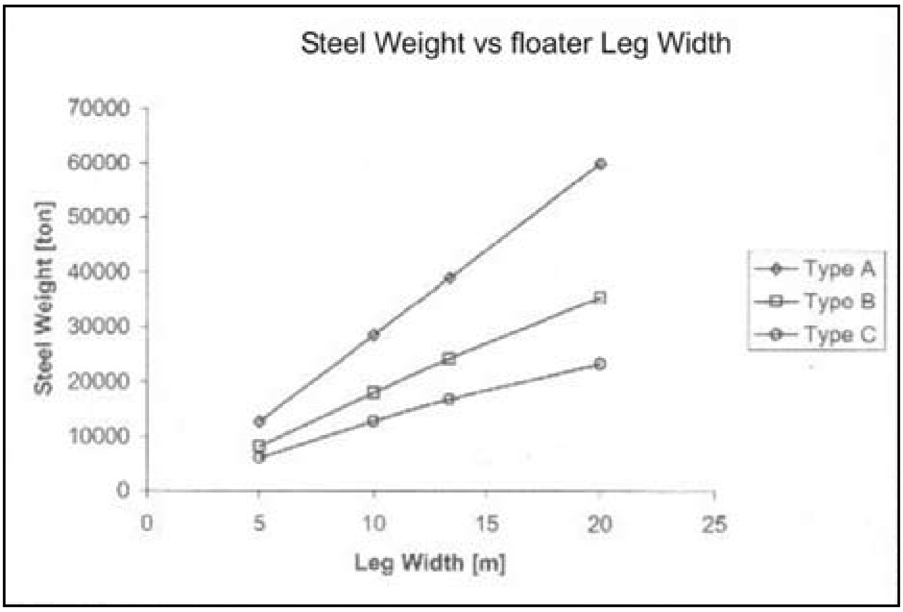
For stabbing of each leg the floater is provided with a compressed air system inside the ballast tank (1) or outside the ballast tank (2).

By releasing the compresses air into the stabbing tanks the legs move into receiving cones on the topside in a couple of seconds. This is done to prevent hammering between floater and topside.



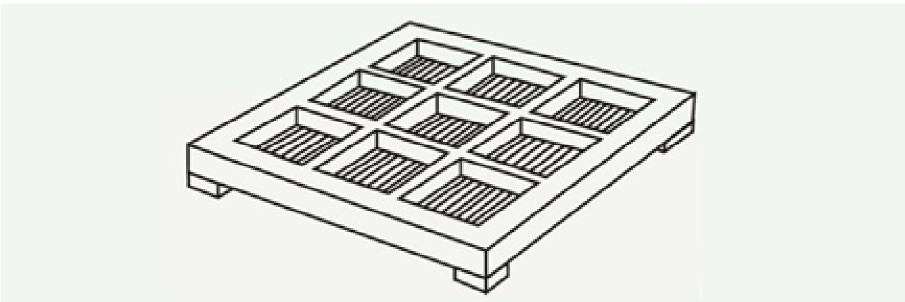

## ADOB tank

Detailed tank tests have been done on the dynamic behaviour of an An Air Driven Open Ballast tank.



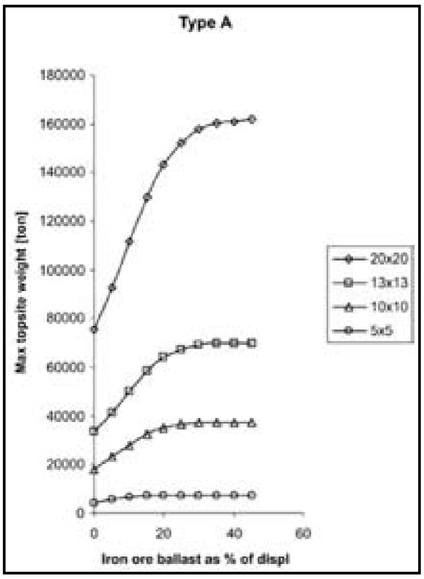

A standard floater construction is designed for each floater based on DNV requirements.

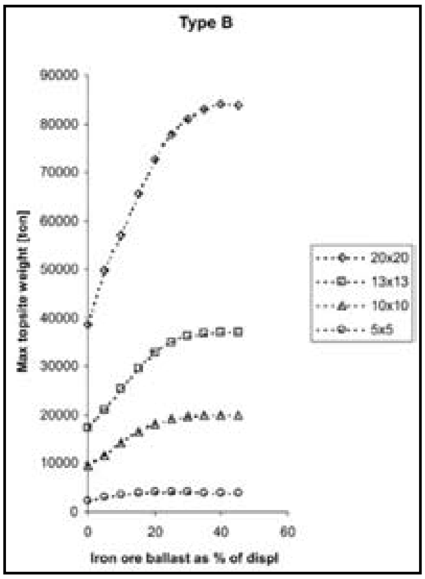
Due to the fact that most of the load is taken in compression and due to the application of soft tanks the floater is relatively light.

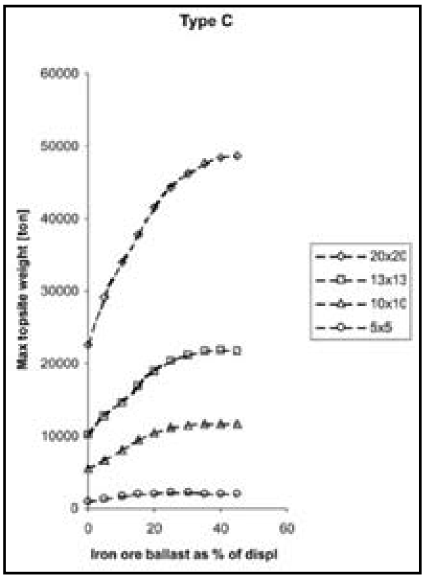


The topside construction consists of the 4 box sections that connect with the legs with 2 intermediate bulkheads.

## The effect of fixed ballast on allowable topside weight.

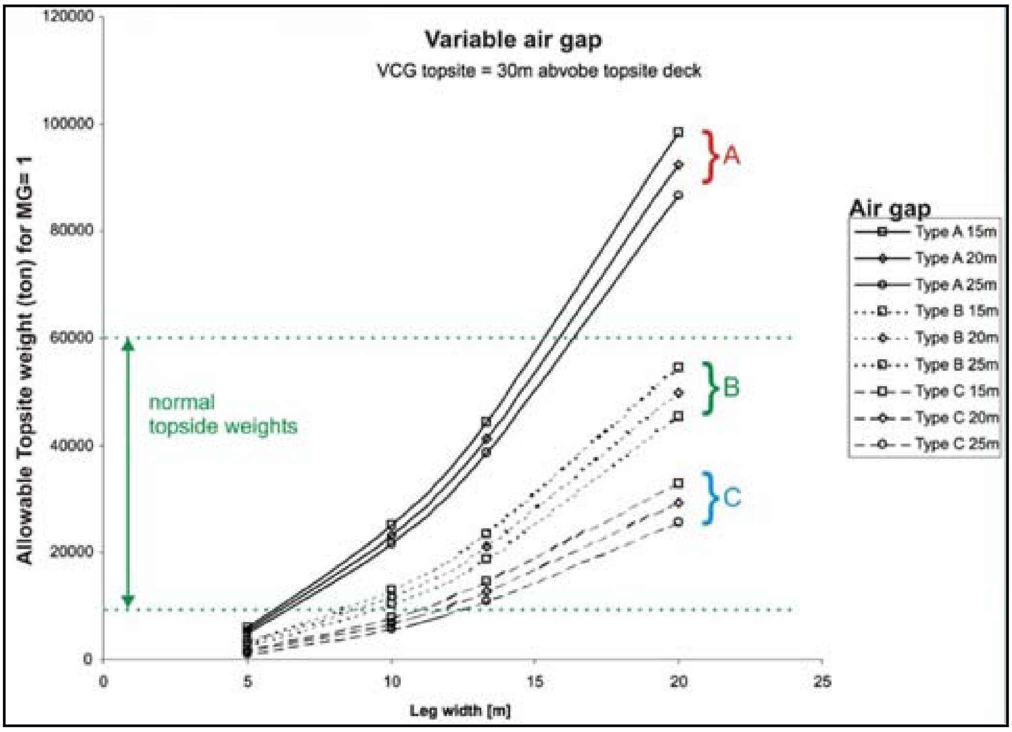


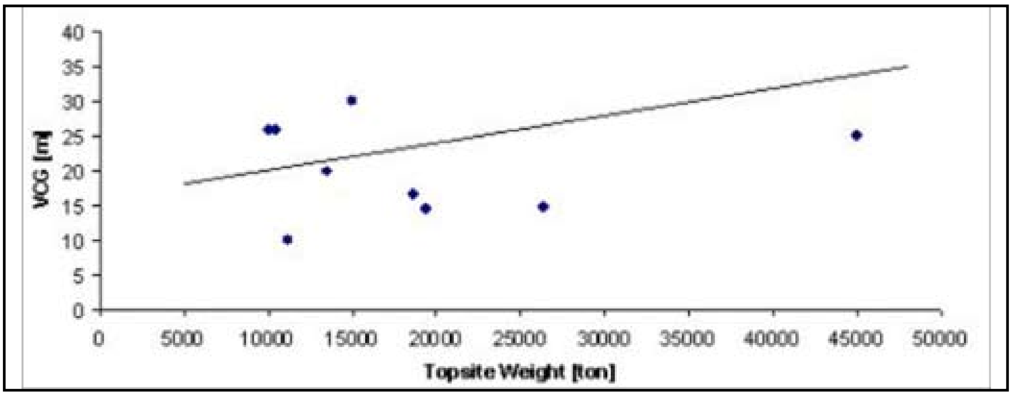




10 to 15% fixed ballast is effective

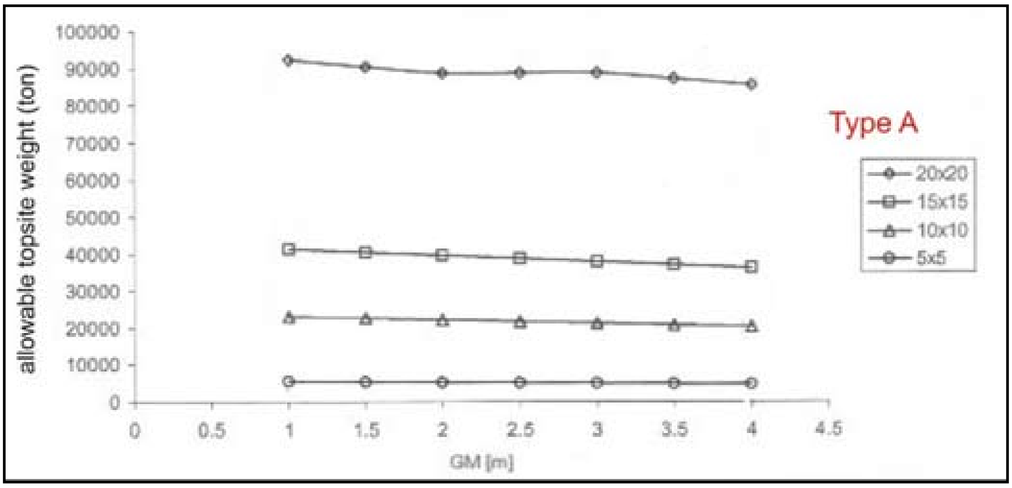
## Variation of air gap and VCG topside between 45 and 5m above water level.

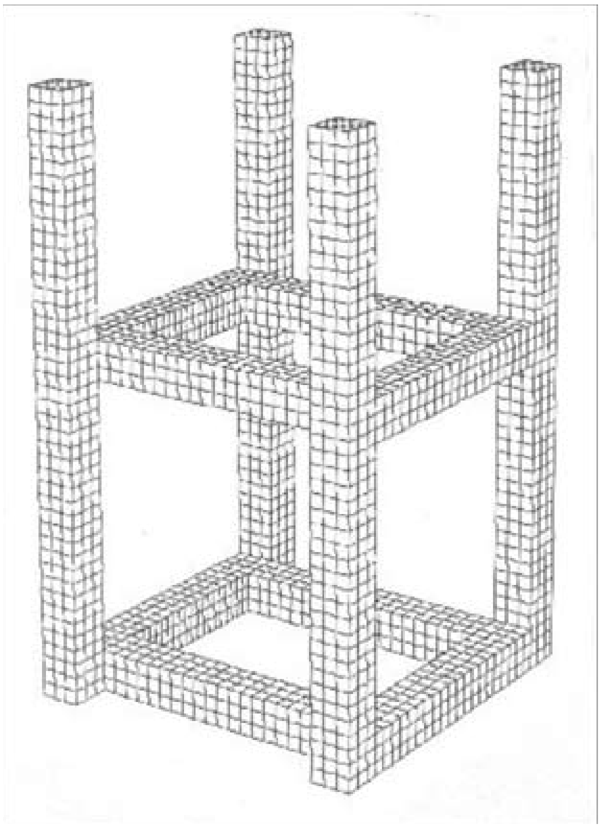



## Variation in topside weight for actual build topside.

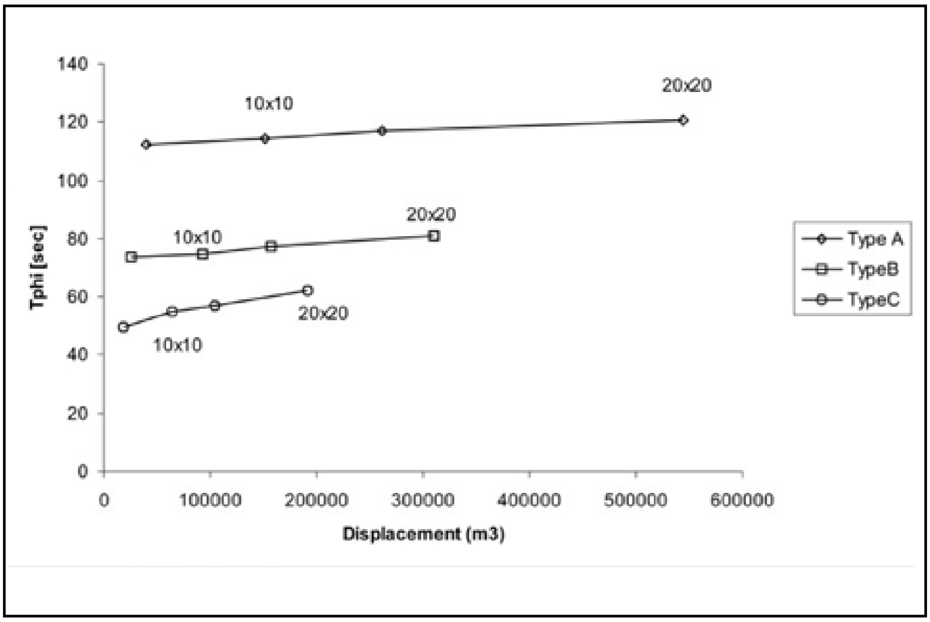



## Effect of variation in MG on allowable topside weight.





The motions are calculated by means of diffraction calculations at the University of Delft calibrated with a 1:200 scale model.




The theoretical rolling and pitching period is mainly determined by leg distance.

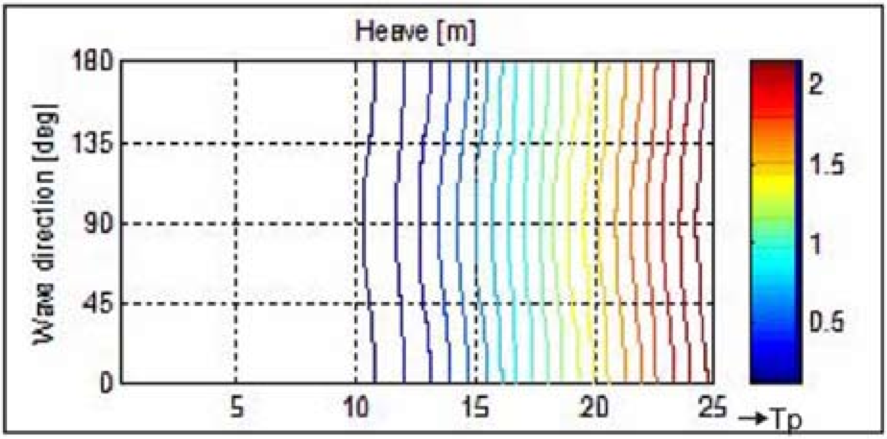
The periods from a decay test are for type A 15x15:
sway/surge 533 sec.
pitch/roll 292 sec.
heave 52 sec.

The horizontal motions are lowest at the location where the mooring is applied.

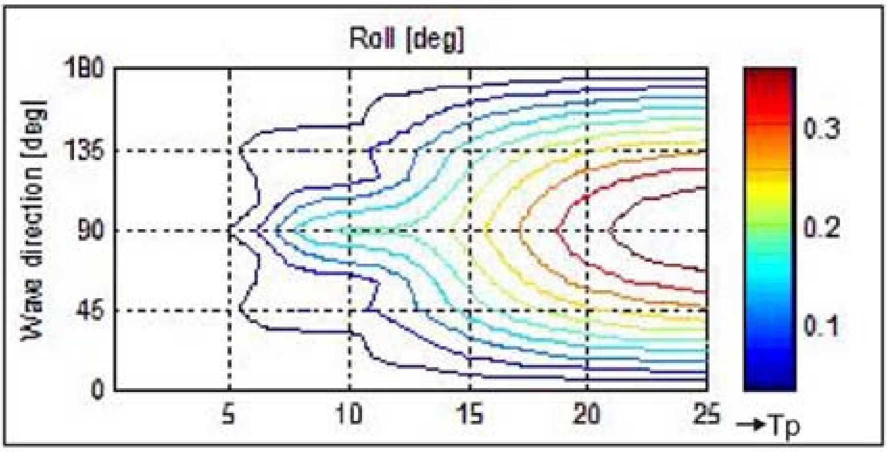
The heave is not affected by wave direction.

Roll and pitch are extremely smalland lowest at diagonal settings.

Hs= 10 m




Hs= 10 m




## For survival conditions Hs=10m and Tp=12 taut/rope mooring from:

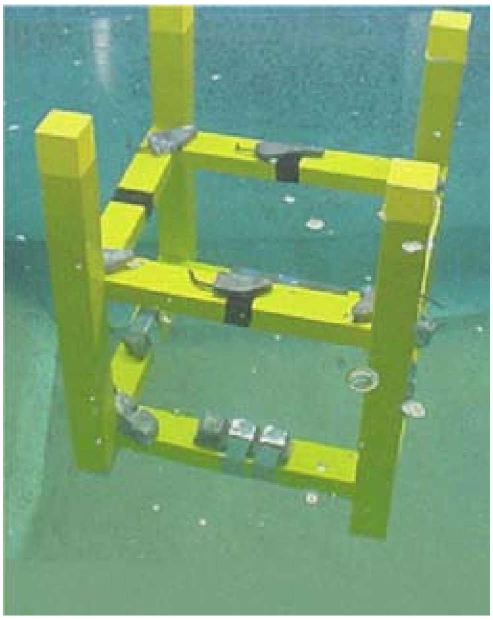
| motions at C.O.G. | top | middle | bottem |
|---|---|---|---|
| standard deviation horizontal (m) | .9 | 1,0 | 1,2 |
| max. horizontal motion (m) | -5,1 | -5,3 | -5,6 |
| st. deviation mooring line load (kN) | 20,5 | 12,6 | 12 |
| max. vertical heave motion (m) | 1,5 | 1,5 | 1,5 |
| max. roll/pitch angle (degrees) | 1,0 | 1,0 | 1,0 |

Values include 1st and 2nd order drift forces and motions

Risers can be best fixed to the bottom with taut wire mooring to the bottom of the platform.

Splitting forces between the legs are very small, in survival conditions.

Most important motions are in horizontal plane and offsets are created by wind load and current.



- The SLOFO platform can be installed in wave heights over 2 m. significant.
  This will make float over possible for all offshore locations.

- The SLOFO's simple construction will make fabrication possible at sites that have simple shipbuilding capabilities in low wage countries.

- The SLOFO concept has superior motion compensation to eliminate all motions except horizontal shift.

- The SLOFO concept is suitable for all platform sizes.

- The SLOFO design can support topsides with over 2 times its own weight.

- The SLOFO concept can considerably reduce overall project costs.

*"SLOFO : a cost effective solution for your offshore project."*


**LEENAARS BV**
MARINE & OFFSHORE DESIGN

Pascalweg 19
3225 LE Hellevoetsluis
The Netherlands
t +31 (0) 181-316305
w www.leenaars-bv.nl

MGMT.SYS.
RvA C 010

**Yantai Raffles**
The Premier Shipbuilder

No. 70 Zhifu East Road
Zhifu Island, Yantai 264000
Shandong Province China
t +86 535 6801451-2033
f +86 535 6828419
e mike.amtmann@yantai-raffles.net

**Longways Marine Ltd.**

Xinggang Street 207-10
Zhifu District, Yantai
Shandong Province China
t +86 535 6743910
e lzd76529@163.com