AIRBAGE

MODULAR BARGES FOR OFFSHORE INDUSTRY

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The concept: turning modular barges into submersible barges

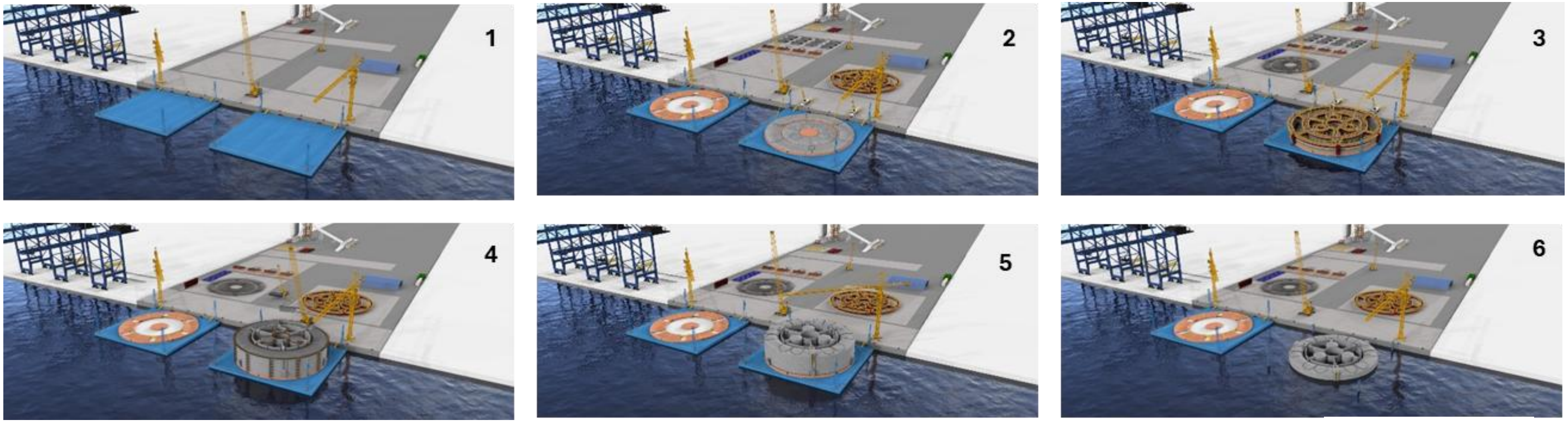
The patented AIRBARGE technology makes possible to cost-effectively turn conventional modular pontoons into submersible barges suitable for **floaters construction/assembly and float-off.**

AIRBARGE proposes a simple and economic retrofit of existing modules that will allow **using compressed air** as means to effectively **control the water ballast within each module**.

This retrofit turns them into modules that can be ballasted with water in a fully controlled manner, but with no need for any piping, valves, or water pumps.

The ballasting and de-ballasting of a large number of compartments will be effectively managed by simply regulating air flow & pressure in a limited number of control points along the barge perimeter.

This technology makes possible to emulate concrete caisson production and afloat construction/assembly for floaters of virtually any size in any port.



*Example of **afloat construction** sequence based on Airbarge technology for the Wheel.*
Minimal onshore yard (area less than 10Ha) and high production rates (3 units/month with 2 production lines).

Contributor: sarens

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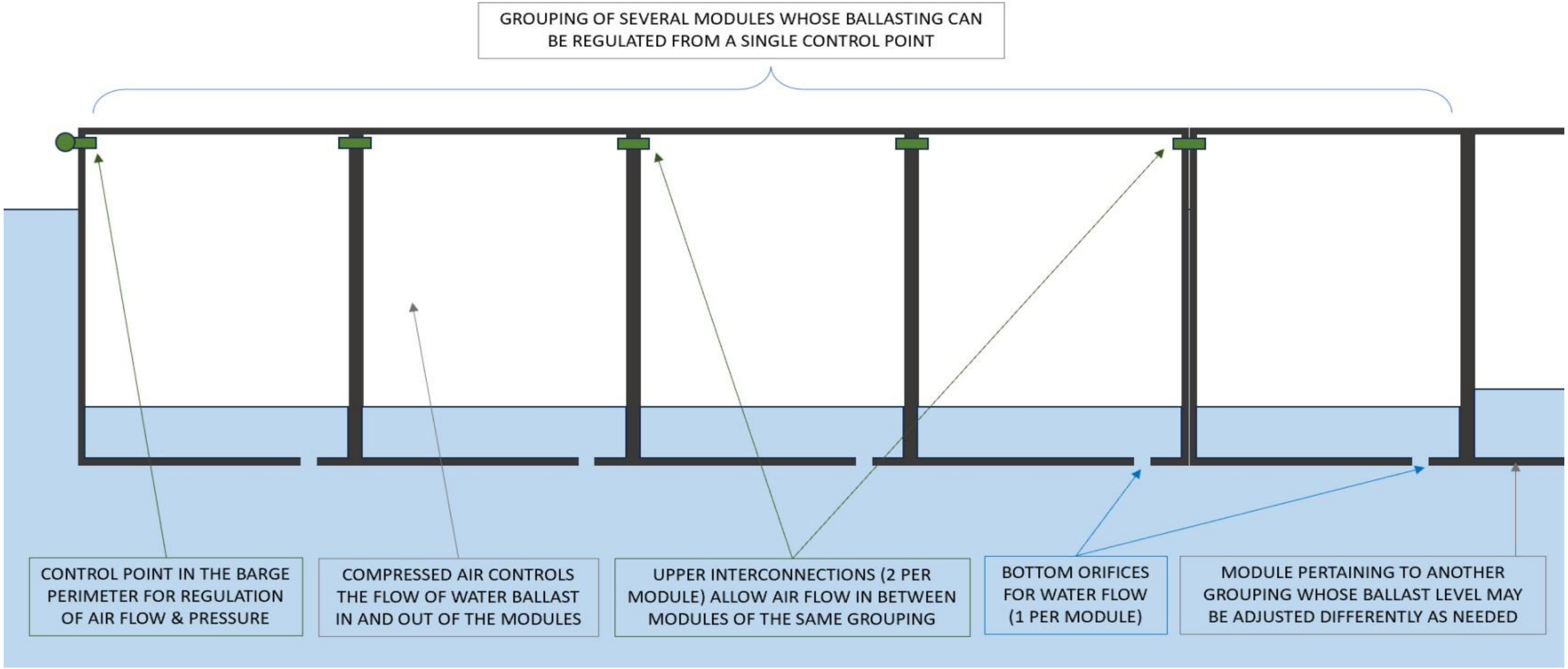
General working principles (1/3)

The modules are grouped and their inner air volume interconnected with upper airflow connections.

Waterflow openings are provided in the bottom of each module.

Water **ballasting** of many compartments **is managed by simply regulating air flow & pressure** in a limited number of control points along the barge perimeter, with no need for any piping, valves, or water pumps. The **upper deck remains free** and fully operative for construction works.



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General working principles (2/3)

Using **compressed air for ballast control** prevents increased forces on the immersed hull.

The Base Case considers organizing the modules into 8 groups, so that the ballast levels in the barge are controlled from 8 control points along the perimeter.

The 8 groups provide comfortable control of the "free surface effect" and also provide "damage stability" safety in case of accidental flooding of one of the groups.

The pneumatic equipment for control and regulation of air pressure is in the nearby quay (there is no need to locate it in the deck of the barge).

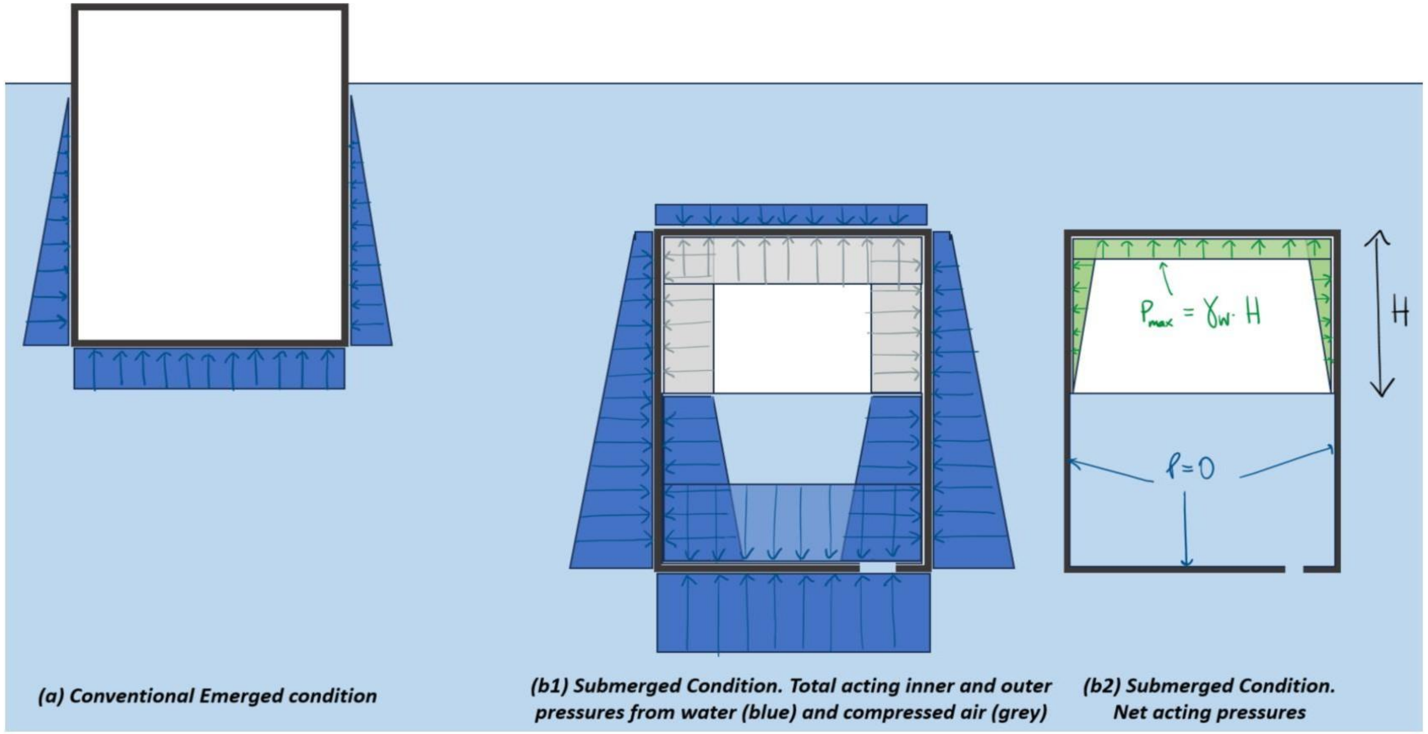
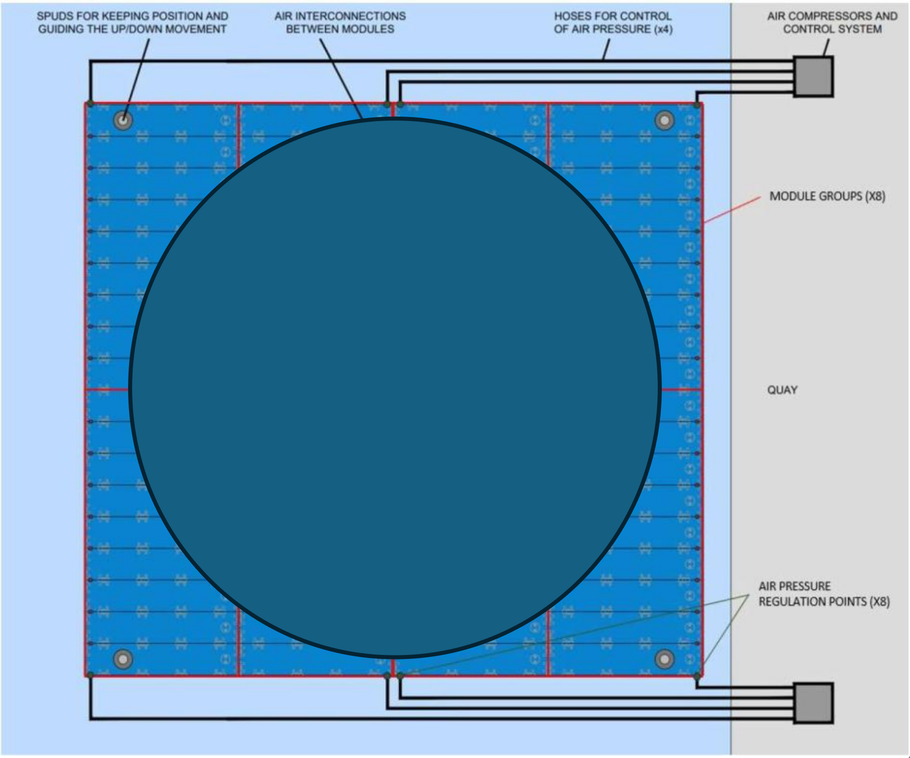


Figure 20: Acting pressures in the barge modules during Airbarge operation. Inner air pressures (b1) compensate increased outer water pressures, so that total net pressures acting on the module walls remain within design thresholds.



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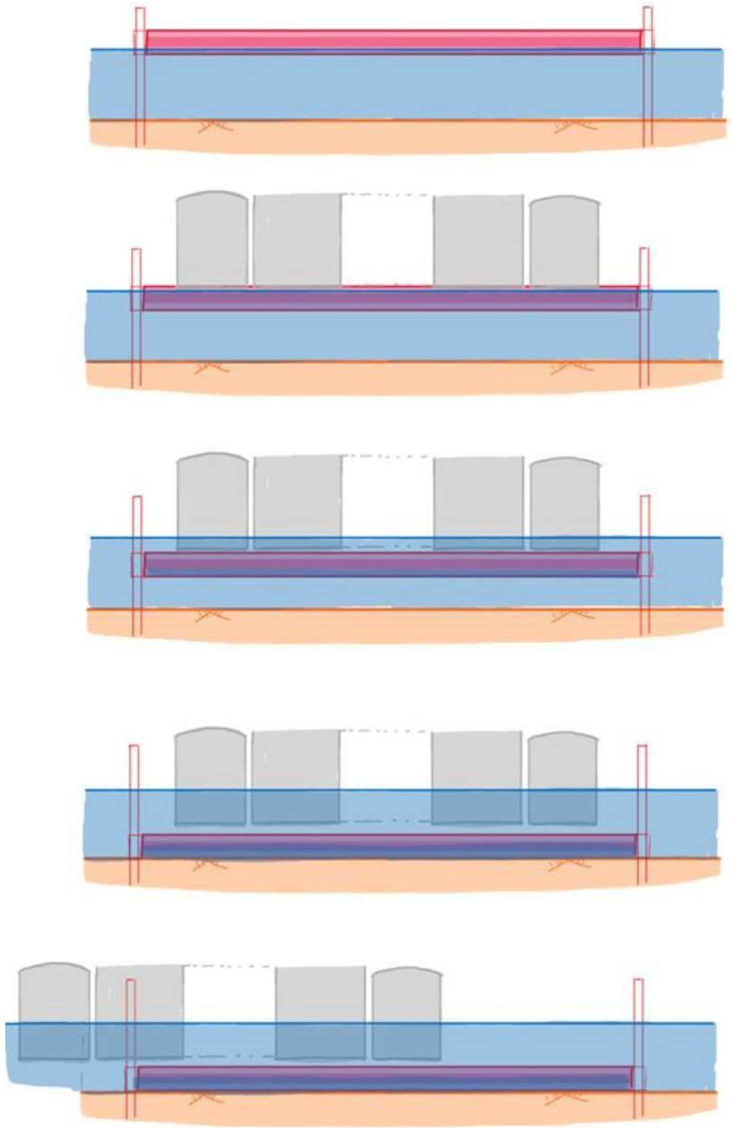
General working principles (3/3): the advantage of limited barge height

The limited height of modular barges can provide a decisive advantage thanks to the lower water depth required for the float-off operation. This is key regarding harbour selection and availability.

Depending on the harbour water draft, the barge may be grounded for the float-off operation. It can also be maintained above the seabed supported by spuds or by stability columns.

For example, in the case of combination with the floating substructure WHEEL, a **water depth of only 8m suffices** to perform the float-off, which is available in virtually any major port infrastructure.

Airbarge can be used for **afloat construction** of Offshore wind structures: GBS, slip forming concrete floaters; as well as for the **assembly, load out & float-off** of OW steel structures, support solutions for **marine industries**: aerospace, decommissioning, defence, salvage, and vessel drydocking.



Step 1: Modular pontoon platform ready to support the fabrication of the floater. The platform will use spuds to maintain position and serve as guides for vertical movement (but not as vertical load bearing elements). Platform draft due to its self-weight and will typically range between 0.4 and 0.5m depending on the type of module used.

Step 2: During the fabrication of the structure the draft of the barge will gradually increase as weight of the structure being built increases.

For most foreseen applications the construction can be completed maintaining a minimum freeboard, but it is also possible to partly submerge the structure before it is complete, thus reducing the total weight to be carried by the barge.

Such weight will remain well centred and will not require ballasting of the barge to compensate for eccentricities (which would in any case be possible if required). As a rule, the barge will remain unballasted during the whole construction process.

Step 3: The Airbarge is gradually ballasted in a controlled manner increasing the total draft until the concrete structure becomes self-floating (the WHEEL floater will become self-bouyant for drafts of approx. 4m and the ELISA GBS foundations for drafts of 5-6m approx.).

Step 4: The immersion of the barge continues until sufficient clearance between the barge and the self-floating concrete structure is reached. Submerged weight of the barge at this stage is near-zero. Reaching the seabed with the barge (as shown in the image) is only optional. The barge may also maintain a clearance with the seabed if deemed convenient.

Step 5: The floater is towed-out for wet storage.

The modular pontoon platform is deballasted and returns to the surface to initiate a new construction cycle.

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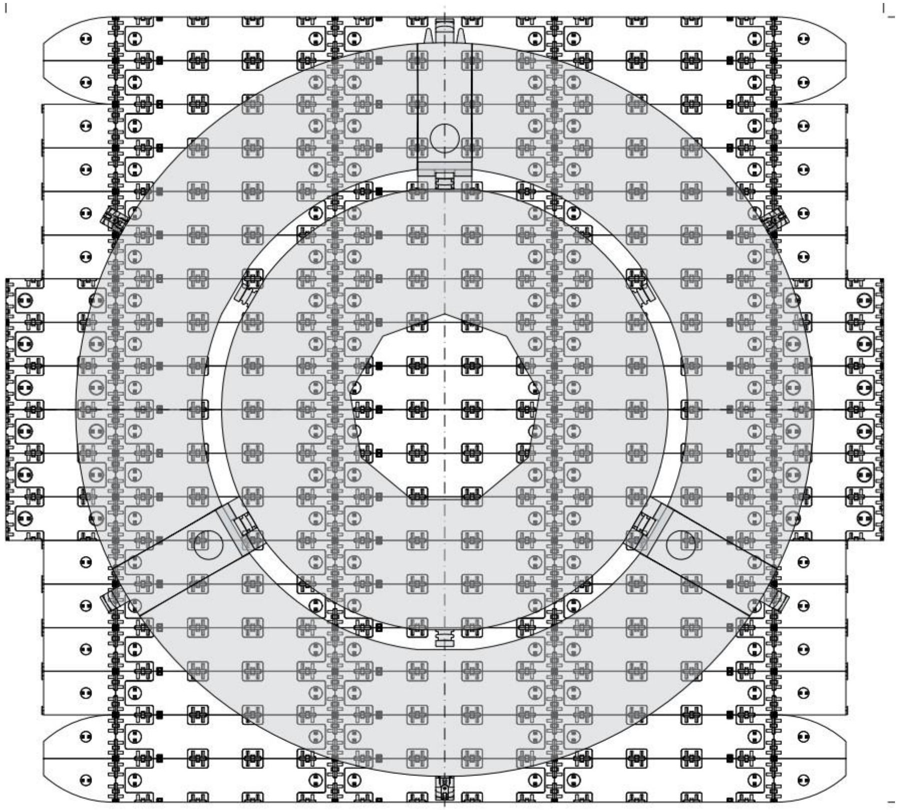
Application: fast Industrialized Afloat Construction

Contributor:

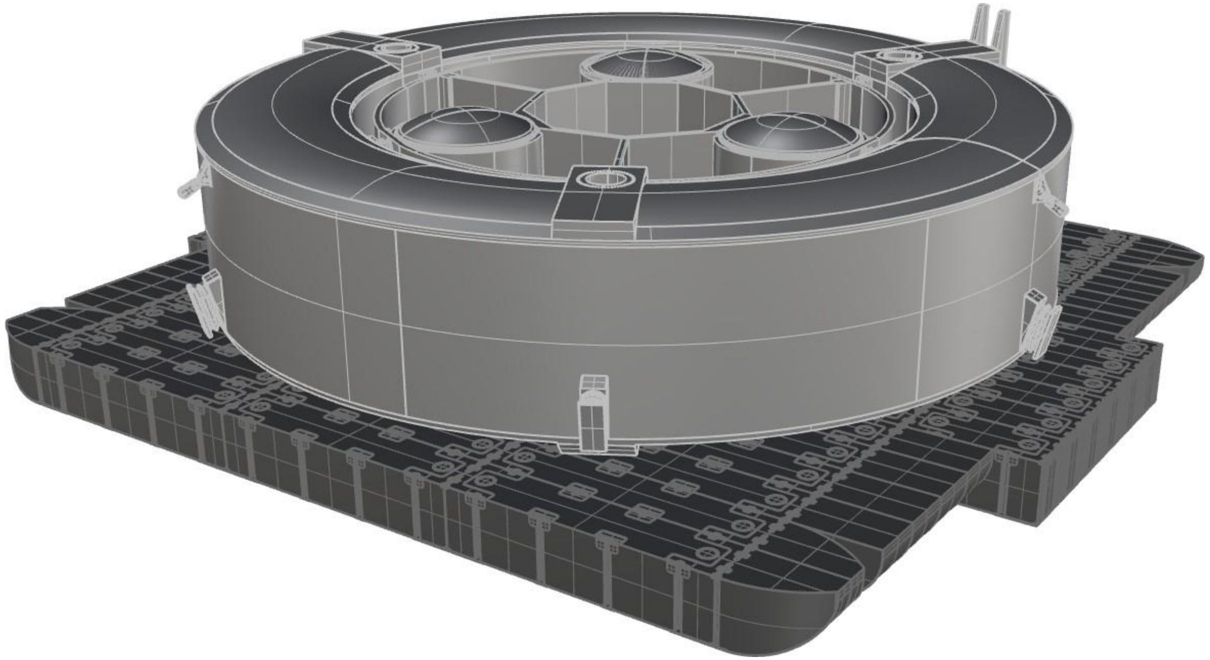
Esteyco and Sarens have already signed the contract for the use of the Airbarge technology applied onto existing SMB (Sarens Modular Barges) to deliver submersible capabilities.

The limited height of modular barges provide **a decisive advantage** thanks to the **low water depth required** for the float-off operation.

This advantage can be key regarding **harbour selection** together with the reduced construction yard area (<10Ha). This technology enables **low-cost concrete construction strategies (barge-based) for a serialized production** (3 units/month with 2 production lines) and overcomes the expected bottlenecks in floaters supply chain (steel and concrete) and the harbour infrastructure availability.



Airbarge Plan View for the DemoWHEEL



Airbarge 3D View for the DemoWHEEL

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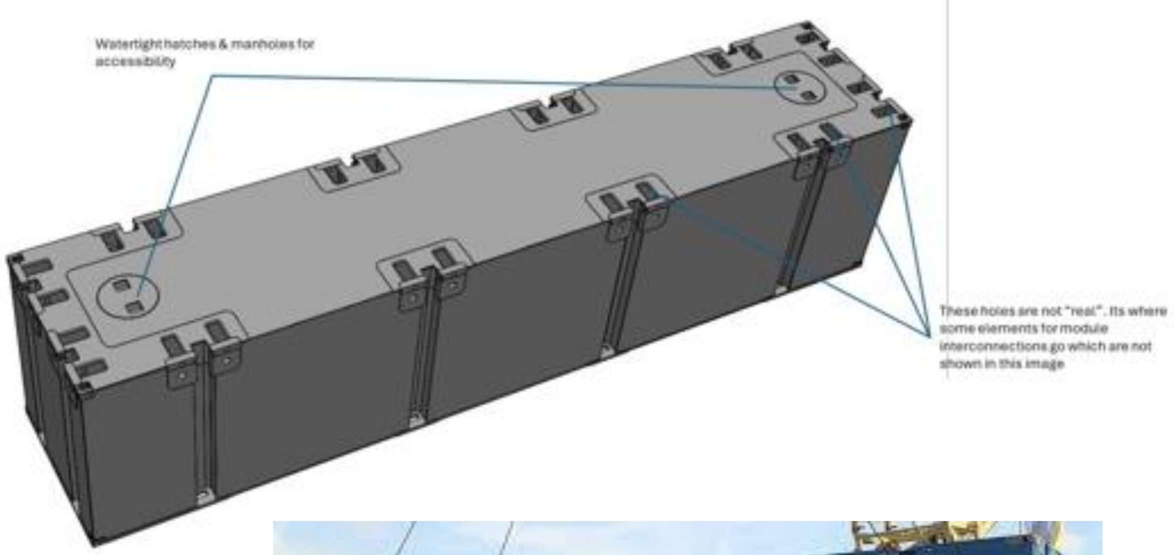
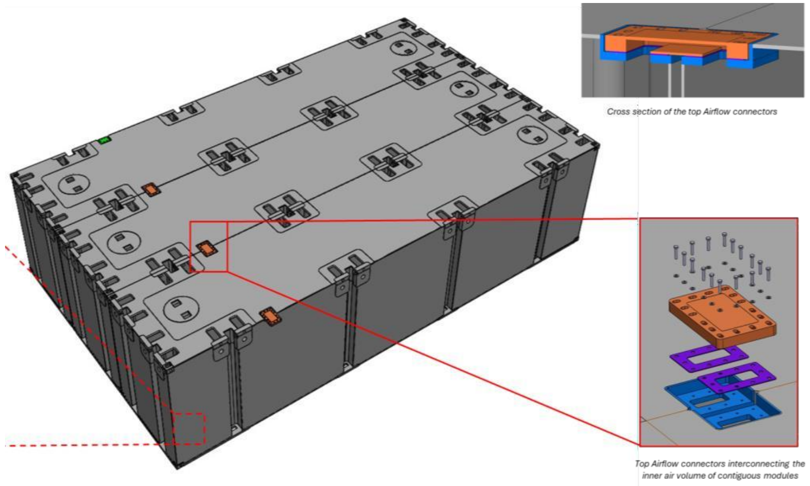
Application: retrofitting of modules

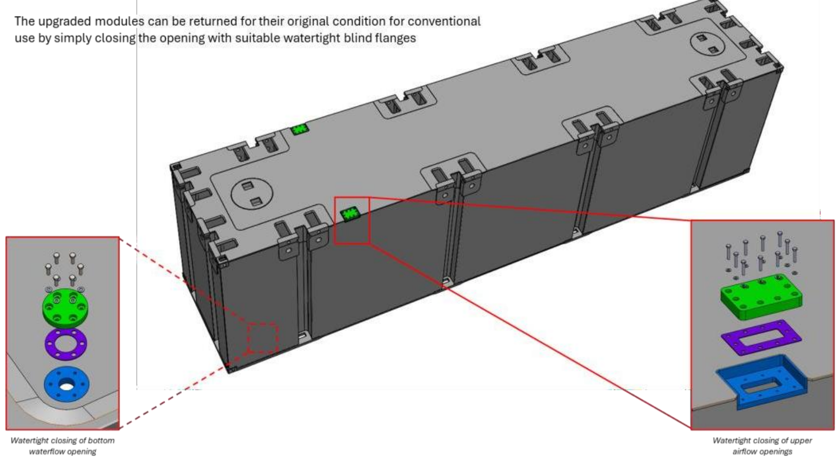
The retrofitting of modules is already fully engineered and manufactured by Esteyco (in this case, approved by Sarens): only 60kg of new steel per module suffice to retrofit the existing SBM into the Airbarge application.

It has already been confirmed with the certification body that such minor retrofit will not affect the current certification of the existing SMB modules

This kind of modules are commercially **available at global scale**, with well known logistics and **cost certainty**. These modules are already prepared internally with coating for water ingress, and present high structural capacity, stiffness and robustness on the connections.



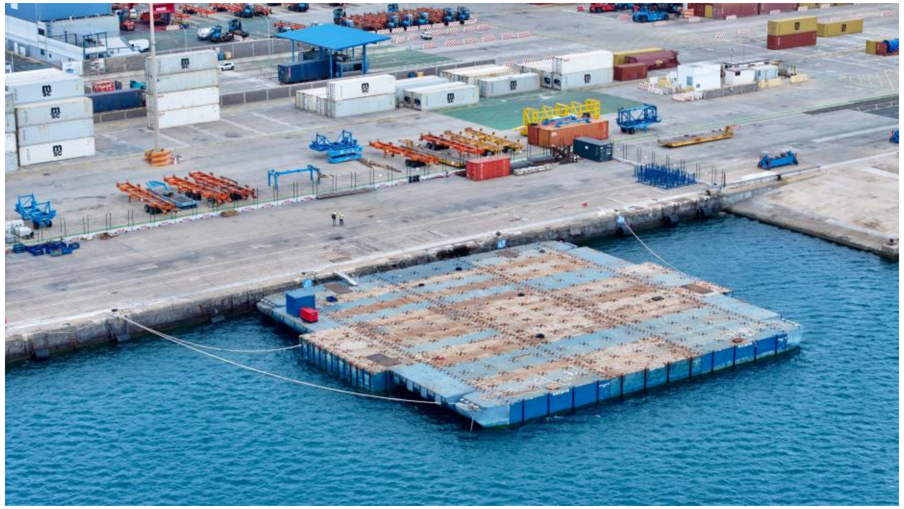




AIRBARGE Gran Canarias Demo

Retrofit and assembly demonstration

Contributor: sarens



AIRBARGE Gran Canarias Demo

Ballast Control Module and system overview(2/3)

Ballast Control Module

Control Room

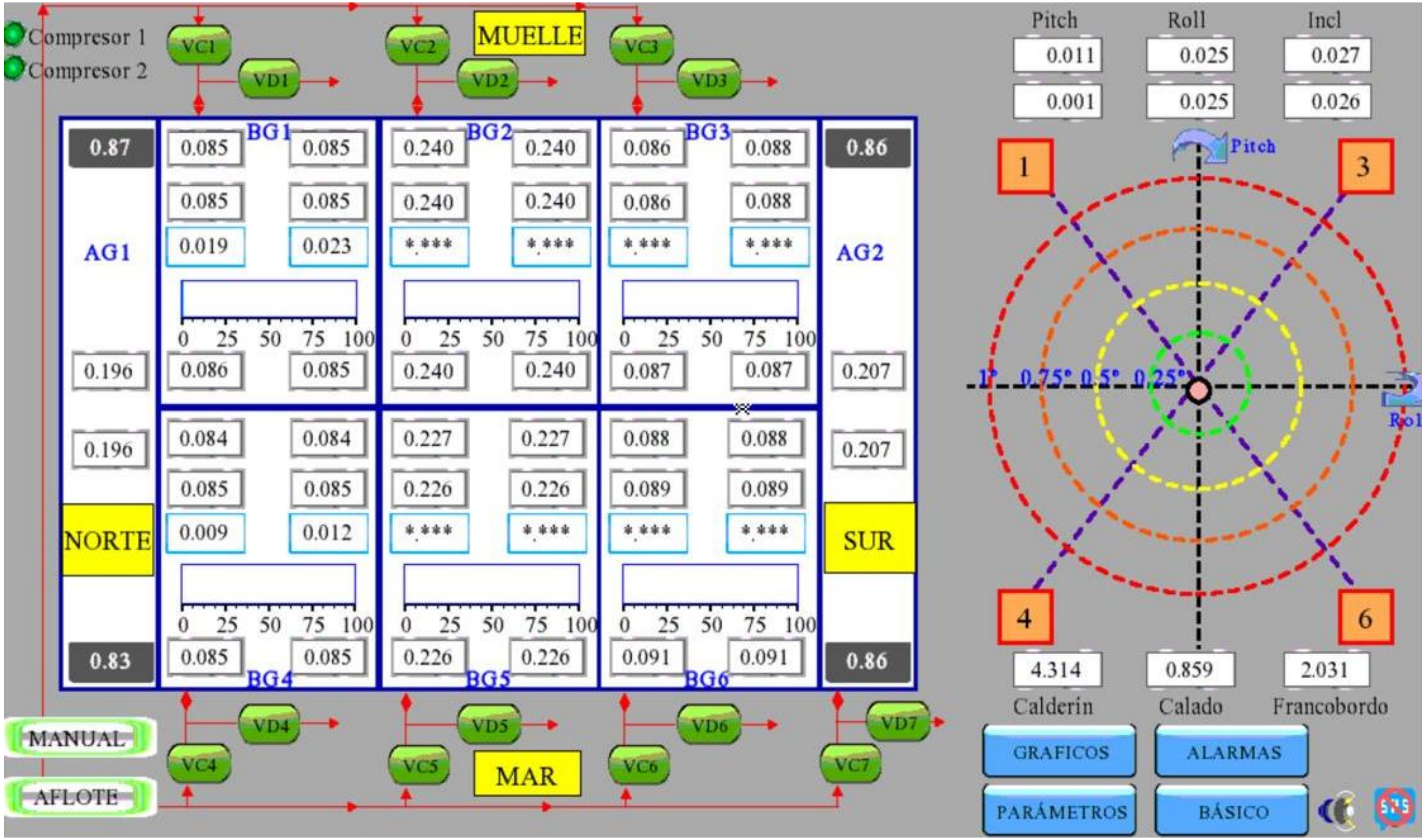
Pneumatic hoses routed along the barge perimeter

Regulation points (x6) on the barge perimeter for control of air inflow / outflow<

Top Airflow Connectors integrated on the barge deck

AIRBARGE Gran Canarias Demo

Ballast Control Module and system overview(3/3)



The PLC allows operation and monitoring (local & remote) of the whole system.

It integrates redundant sensors for monitoring of barge draft & tilt, and air pressure / ballast levels in each of the 6 ballast groups.

Designed for a manual mode for loading / unloading operations, and an automatic mode for unattended stationary conditions (automatic correction of any air leakage)

AIRBARGE: the future

Route to market: potential applications

Potential user cases for the Offshore Wind Industry:

Afloat construction of Offshore wind sub-structures.

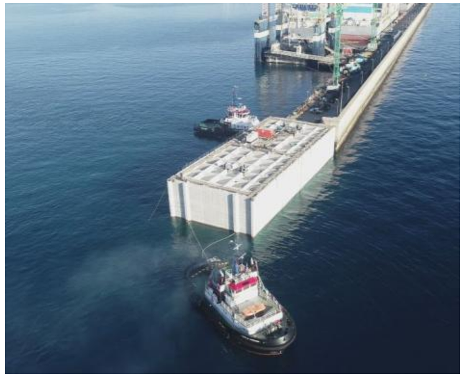
- ✓ ELISA technology (or any other GBS) manufacturing
- ✓ WHEEL technology (or any other floating substructure)
- ✓ Slip forming concrete substructures (i.e. caissons)

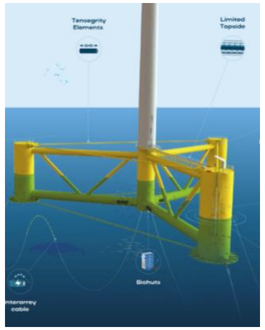
Assembly, load out & float-off of OW steel structures

- ✓ Steel floaters based on welded panels or bolted connections
- ✓ ATOMS O&M Platform final assembly and float off
- ✓ Offshore Wind Farms in inner seas (i.e. Black Sea & Caspian)

Potential applications to the Marine Industries in general:

- ✓ Aerospace, defence and salvage
- ✓ Decommissioning
- ✓ Vessel drydocking



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