Triton

tna

Naval Architects c.c.

IN COLLABORATION WITH AURECON

SPECIFICATION

FOR THE

"STURROCK DOCK FLOATING CAISSON"

Revision	Description	Date
1	Lloyds Rule references added to Corrosion Protection and Piping sections.	11 June 2020

	TNA 3501/007 Rev 1	DATE
PREPARED	B KINGWILL Barry Kingwill	MAY 2020

Triton Naval Architects
No. 8 Foregate Square Harbour Rd, Foreshore, CAPE TOWN
Tel +27 21 418 2090, Fax +27 21 425 2722
Web: www.triton.co.za, Email: triton@triton.co.za

	REVISION HISTORY			
REV No.	**DATE**	**DESCRIPTION**	**REQUESTED BY**	**COST IF APPLICABLE**
1	11 June 2020	Lloyds Rule references added to iping and Corrosion Protection Sections	MG	N/A

TABLE OF CONTENTS

PAGE

1. PROJECT DESCRIPTION

1.1 EMPLOYERS OBJECTIVE

Following a condition assessment of the aging floating Caisson in the Sturrock Dock, built in the 1940's, it was established that it needs replacement.

The floating caisson can fit into 3 slots within the Sturrock Dock, namely one emergency outer slot (outside of the main sliding caisson) and two operational slots within the centre section of the dock, so as to subdivide it to differing lengths, depending on what length ships are being docked in the fwd and aft sections.

This specification describes the design of a new replacement caisson, and should be read in conjunction with the design drawings, and the design report.

The existing floating caisson was designed to be level with the coping at the outer (emergency) slot.

The drydock is designed to be 4ft shallower at the outer emergency slot, compared to the depth at the two inner operational slots.

Hence the existing caisson, when fitted in the inner operational slots, has its road deck, some 4feet below the coping at those locations. (Units of feet used here, as the current caisson design dimensions are in feet)

The new caisson is designed to the height of the coping at the two inner slots (being its primary location of use) hence it will be 4ft higher than the existing caisson. However it can still be used in the outer slot, should maintenance be required, on the main sliding caisson, but will extend 4ft above the coping.

1.2 OVERVIEW OF PROJECT

Aurecon and Triton were contracted to design a replacement caisson, with Aurecon being the lead contractor and Triton offering the Naval Architectural design expertise.

The floating caisson is designed using LLoyds Rules for Floating Docks and Lloyds Rules for Steel Ships as reference, as suggested by Lloyds themselves, in light of the dedicated Floating Caisson Rules still being under development.

The caisson is thus designed almost entirely according to ship design principles, as if it were a floating ship/barge, however with additional exceptional lateral strength for acting as a dam wall in resisting a hydrostatic pressure (force) of some 7000tonnes.

The drawings are prepared in line with Class approve-able standards and methods, and although the caisson design nor build is being approved by Class, the selected fabricator should apply Class methods and standards in all aspects of construction and testing, as if it were a Class build. It is furthermore the designers suggest that bidding fabricators either be Class certified or have experience building ships or repairing ships, or refitting ships, to Class approval.

1.3 EXTENT OF WORKS

The extent of works include the detail design of the replacement caisson, to fabrication level detailing. This includes:

- 3D model for design layout and presentation purposes only.
- Structural Design Drawings with full 2D detailing for fabrication

- 2D Burning Templates (also referred to as workshop drawings, or cutting lists) for laser cutting of plates.
- Piping Drawings (inclusive of all bulkhead penetrations) and typical pipe clamp details, with location of supports determined during fitting.
- Drawings of all valves, vents, vent fans, cable ducts, manholes, hatches, stairways, ladders, gratings and landings, bollards, fairleaders, guard rails, watertight doors, etc
- Finite Element Analysis of all structures, for all applicable loadcases
- Weight and COG calculations
- Stability Calculations and reporting for floating, submerging, and grounded in the slot for different tides
- Electrical Design
- Mechanical Design in terms of selection of equipment
- Bill of Materials
- Costing
- Design Report
- Specification

This document only addresses the design for build specification.

2. CAISSON DESIGN DESCRIPTION

2.1 APPLICABLE REGULATIONS

The Caisson was designed using Lloyds Rules for Floating Docks and Lloyds Rules for Steel Ship Structures 2019.

The Caisson will NOT be classified as a vessel/ship hence will not be registered under Flag State (SAMSA).

The Caisson will also not be in Class with Lloyds, hence although being designed to meet Class requirements it will not be registered in Class, nor be built to Class.

However notwithstanding registration, fabrication should be performed in accordance with Lloyds and Regulations for the Classification of Ships, July 2019, and Lloyds Rules for the Manufacture, testing and Certification of Materials July 2019, as these regulations form the basis by which fabrication is measured and tested.

Having said that, it is still the designers recommendation that only experienced Shipbuilders / Ship Repair Yards who are either certificated by Class or have built marine structures to Class, be considered.

As the Caisson is a floating structure it was designed entirely along ship structural design methodologies, using Class rules as guidelines and references.

As SANS codes do not apply to floating structures, no SANS codes are applied to this design.

The structure is analysed for strength using FEA methods, with maximum stresses measured against Class requirements. See the FEA Structural Analysis Report.

The Stability of the Caisson is calculated according to international (IMO, IS 2008 Intact Stability) criteria, for both floating, and semi submerged / grounded load-cases. See the Stability Report.

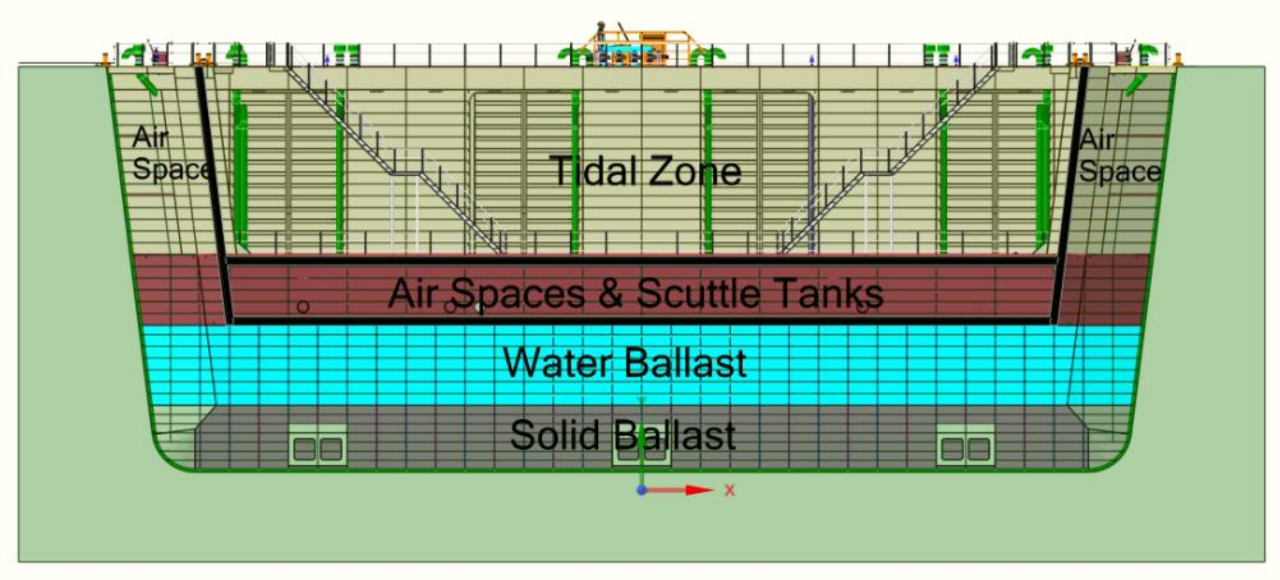
2.2 PRINCIPLE PARTICULARS

PRINCIPLE PARTICULARS		
Length Overall (measured over the keel)	46.989	m
Breadth Moulded	8.000	m
Depth to Wet Deck	10.000	m
Depth to Road Deck	17.983	m
Design Draft (floating)	9.900	m
Depth of Keel	0.914	m
Width of Keel	0.920	m
Displacement (at design draft)	2257	tonnes
Volume of Ballast Tank	1047	m3
Volume of Scuttle Tanks	258	m3
Draft at MLWS	14.338	m
Draft at MHWS	15.861	m
Grounding Force at MLWS	150.0	tonnes
Grounding Force at MHWS	115.4	tonnes
Grounding Force at 0.5m above MHWS	104.0	tonnes

2.3 ARRANGEMENT OF SPACES

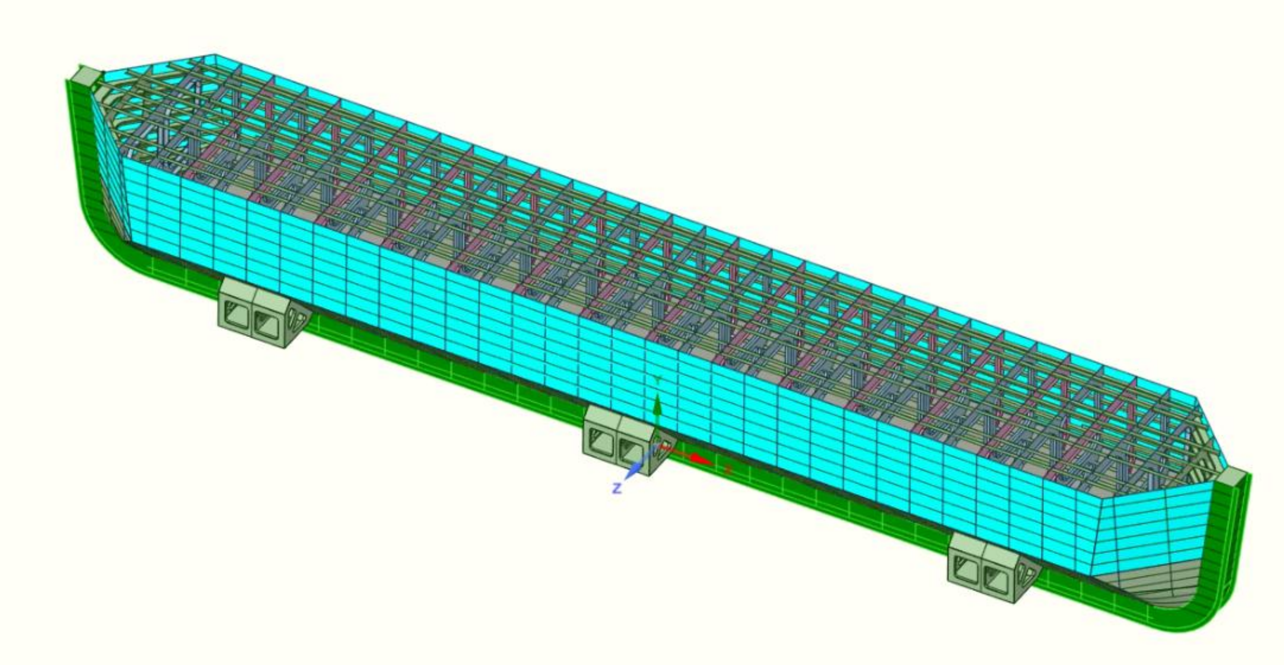
The Caisson is divided into a number of distinct spaces.

- Tidal zone
- Air Spaces (with scuttle tanks)
- Water ballast
- Solid ballast



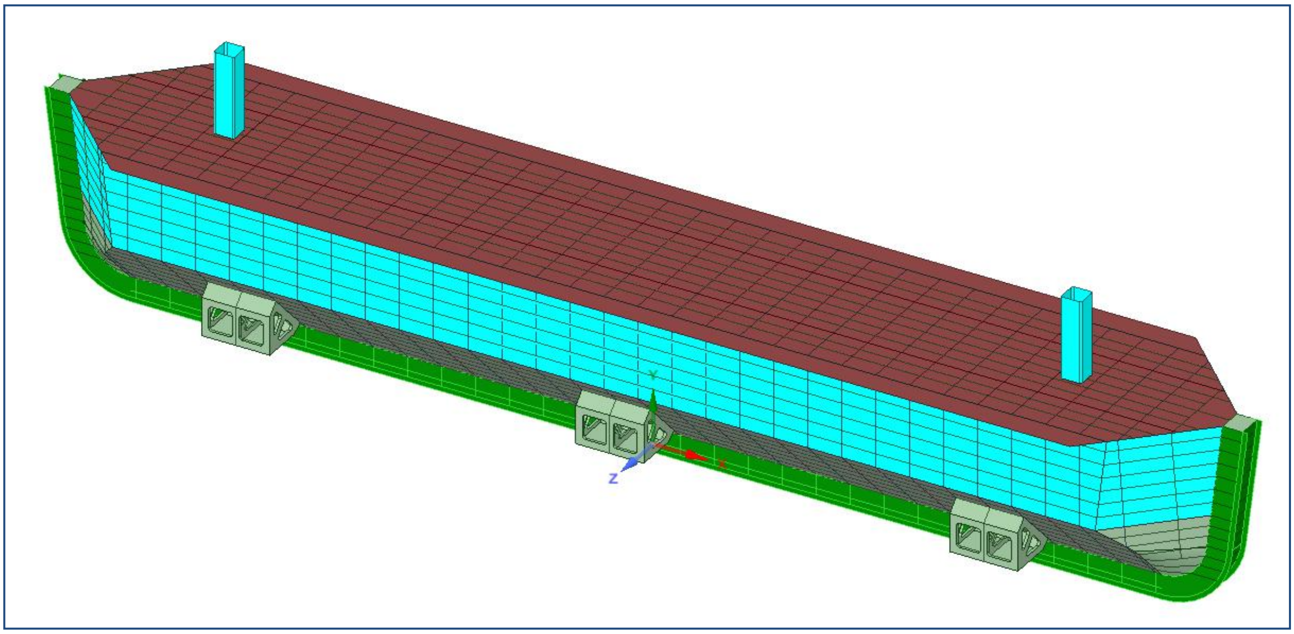
2.3.1 Water and Solid Ballast Space

The bottom section being the water ballast tank, which also contains solid (concrete ballast). This ballast being required to make the Caisson stable when floating and when being submerged in the process of slotting into the groove.



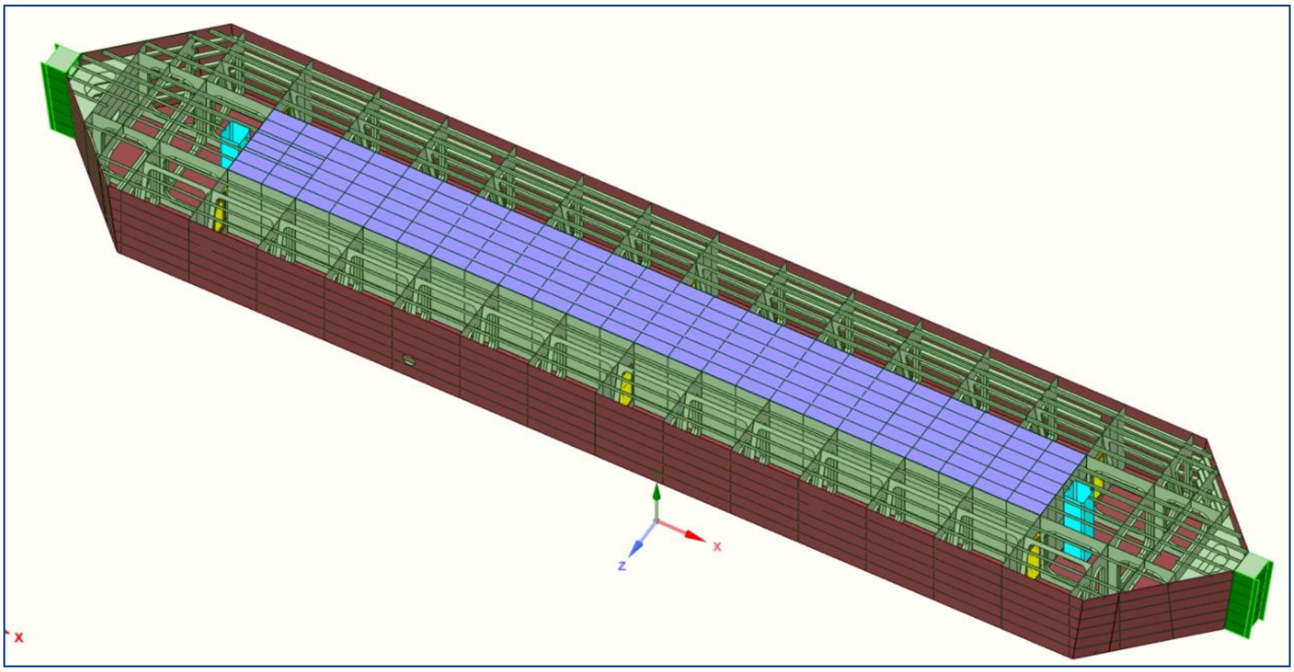
The waterballast tank does not have any piping or valves. It is filled through two permanently open ducts which extend to the wet deck (shown below). These duct is covered by a removal grating on wet deck and also serves as access points. These ducts also serve as vents. Other access (during maintenance) is via manholes from the air spaces above.

The ballast tank is drained (only in maintenance) by the use of docking plugs.



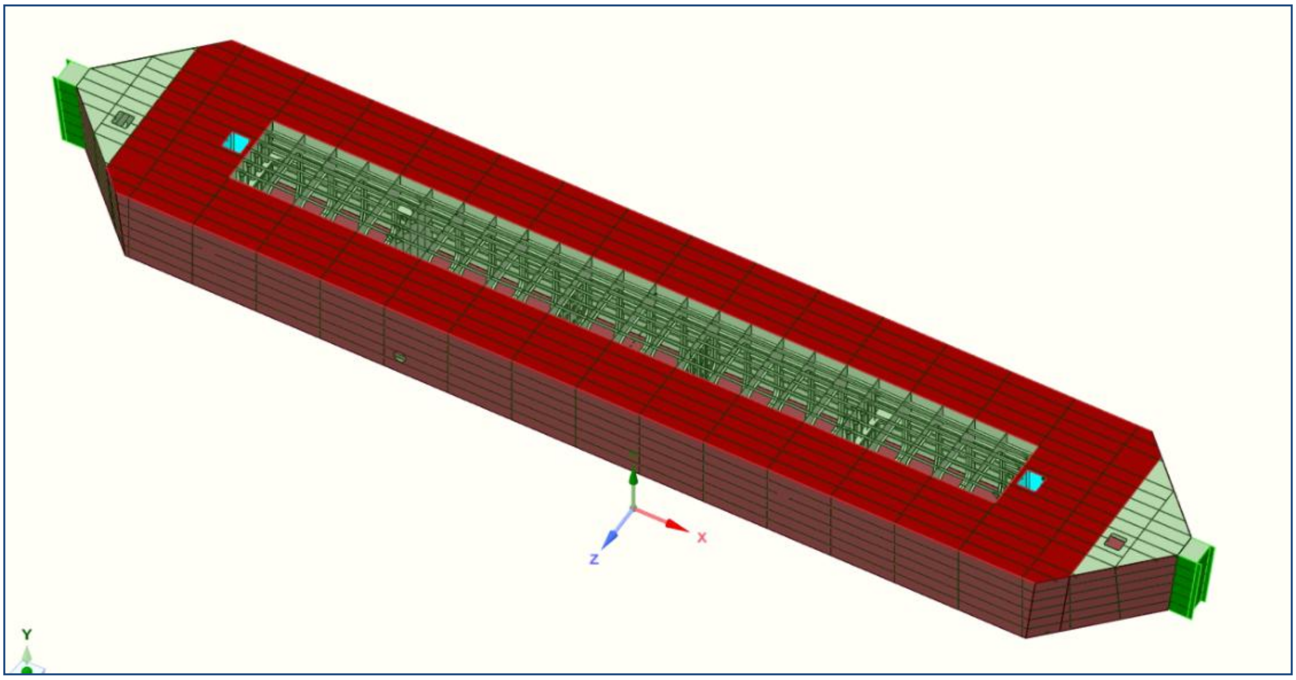
2.3.2 Air Spaces and Scuttle Tanks

The space above the water ballast space, is the Air Spaces around and including the Scuttle Tanks, which form the main buoyancy of the floating caisson. The scuttle tank is shown as the purple coloured section surrounded by dry spaces. All air spaces are individually ventilated (See section 11) and have lighting and oxygen monitoring (see Electrical Specification).

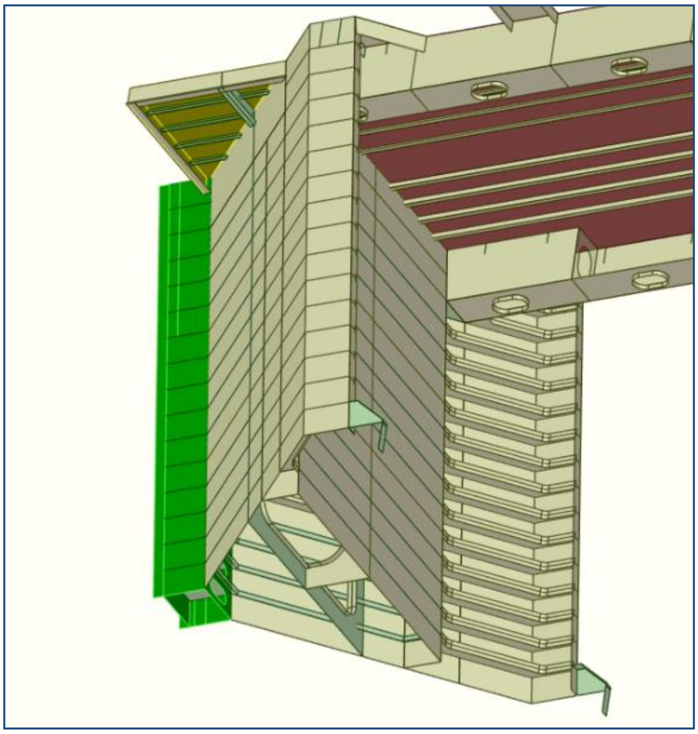


The dry spaces surrounding the scuttle tanks are subdivided into 6 spaces via watertight doors and watertight hatches. All spaces remain dry at all times. The doors and hatches are merely to contain flooding to one dry space, should the caisson ever suffer shell damage through impact.

The scuttle tank space is divided into three separate scuttle tanks, namely a large centre tank of 17.5m in length, and two smaller end tanks of 6.25m each.

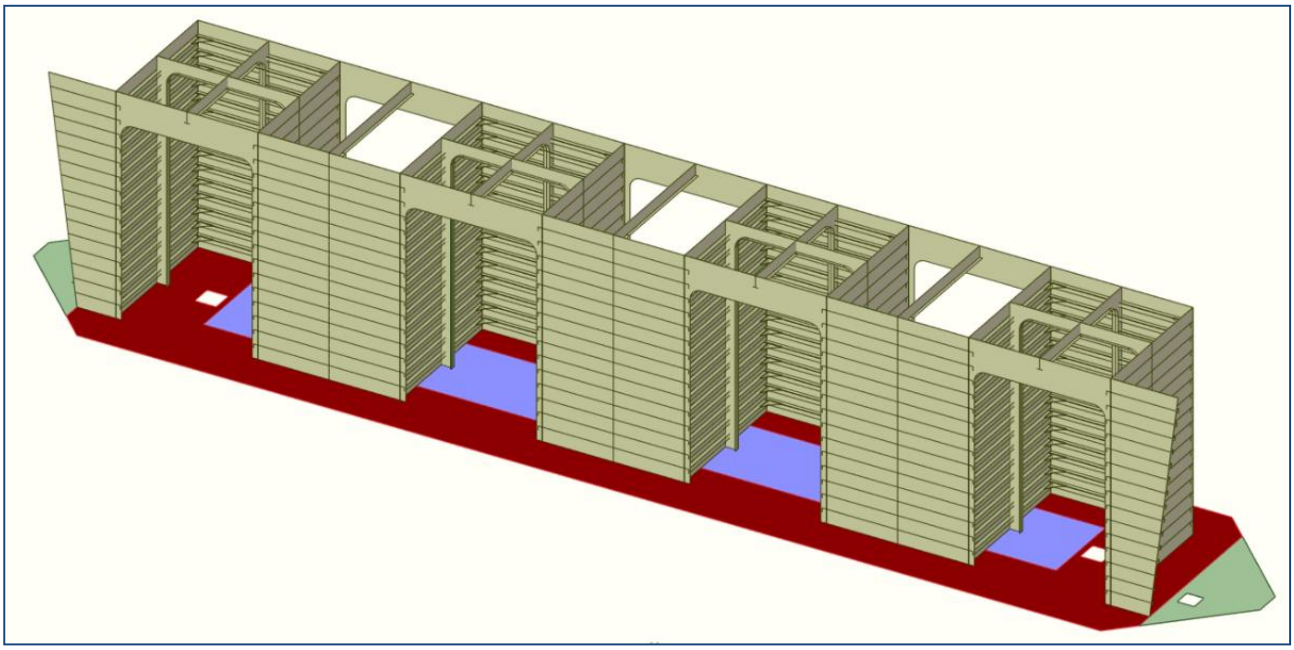


The end spaces are also air spaces, and serve as the buoyancy spaces which offer stability for when the caisson is being submerged. They also serve as the access route from the roaddeck above, down to the airspaces surrounding the scuttle tanks.



2.3.3 Tidal Zone

The space above the wetdeck and between the end columns (shown in image below) is a tidal zone, where there is no enclosed space or buoyancy, but is in fact a watertight bulkhead which acts as a dam wall, when the caisson is in the submerged position.



2.4 TANK AND SPACE CAPACITIES

Ballast Tank (including solid ballast)	1421 m^3
Scuttle Tank Centre	156 m^3
Scuttle Tank Ends	56 m^3 per tank

2.5 FITTINGS AND EQUIPMENT

This includes everything from the piping and valves, to the ventilation, to the handrails, the stairways and ladders, to the mooring equipment, to the electrical control equipment.

These are all described in detail under their own specific sections later in this document, with the exception of the electrical and control equipment which is described in a separate Electrical Specification Document.

3. CAISSON STRUCTURE

3.1 STRUCTURAL UNITS

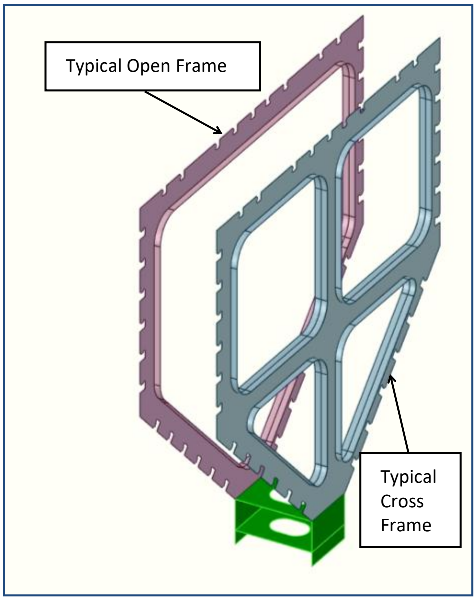
The Caisson is divided into 6 construction units, which include two identical End Columns that can be prefabricated at the contractors facilities and then transported to the port and assembled on site. See Construction Methodology section in the Design Report).

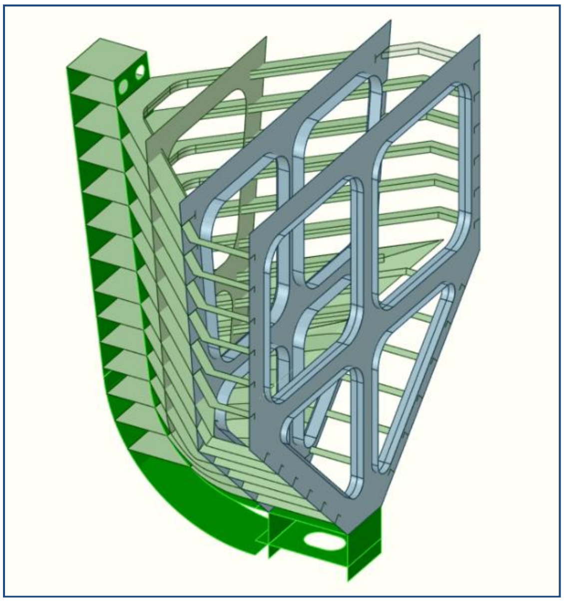
3.1.1 Ballast Tank

This unit, denoted UNIT 1, includes all structure up to the tank top at 7m (being the division between the ballast tank and the air compartments. It measures 44.243m in length and 6.3m wide.

The basic layout of UNIT 1 is shown as an image under 2.3.1 Ballast Space. The Keel and the Docking Feet are designed to be structurally integral parts of the Ballast Tank Structures.

The main body of this unit comprises principally of two types of deep transverse frames, alternating between cross frames and open frames at a spacing of 1250mm, throughout the entire parallel middle body of the unit.





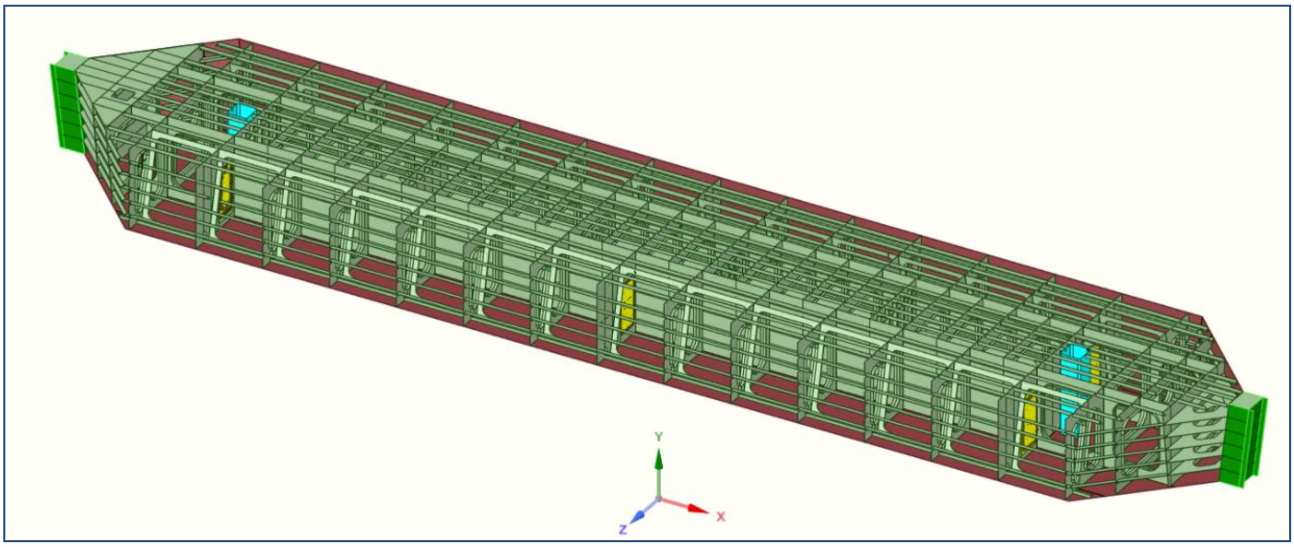
The fwd and aft end structure (as shown above) consists of horizontal framing tied into the keel as it slopes up at 82deg and to the longitudinal side stiffeners in order to ensure a fully integrated structure that will maintain continuity of strength.

This unit weighs 230 tonnes (raw steel weight) and could be transported from the fabricators facility to the syncrolift in either 1 or 2 pieces (depending on fabricator preferences and locations) using SPMT self propelled modular heavy lift transporters.

Refer to drawings 507343-0000-DRG-SS-101 (8 Sheets)

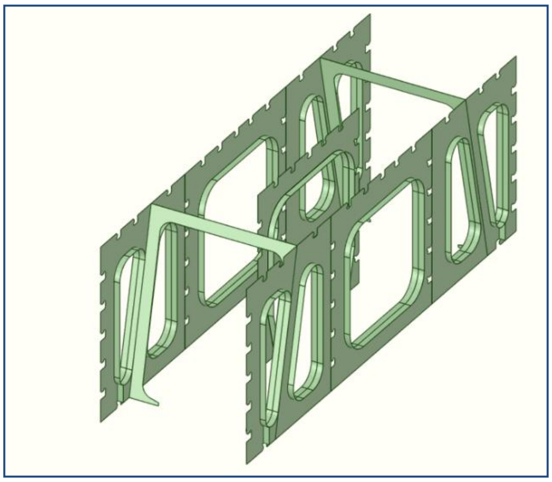
3.1.2 Air Spaces and Scuttle Tanks between level 7.000m and Level 10.000m

This unit, denoted UNIT 2, extends between the tank top at 7.0m and the wet deck at 10.0m and is 44.99m in length and 8.00m wide.



The 3D image above shows the typical framing both outside and inside the scuttle tanks (See 2.3.2 Air Spaces and Scuttle Tanks) for distinction between dry spaces and scuttle tanks).

The typical framing is a repetition of the framing set, extending over a distance of 2.5 meter, as shown in the image below. There is an intermediate open ring frame in the scuttle tank at 1250mm spacing, to offer closer support for the 125x75x12 Angle side longitudinal stiffeners, when the tanks are subjected to 2.5Bar design pressure.



This unit weighs 195 tonnes (raw steel weight) and could also be transported from the fabricators facility to the syncrolift in either 1 or 2 pieces (depending on fabricator preferences and locations) using SPMT self propelled modular heavy lift transporters.

As per the ballast tank, the fwd and aft ends are framed horizontally as shown in the main image above, and are fully integrated with the keel and the longitudinal side structures.

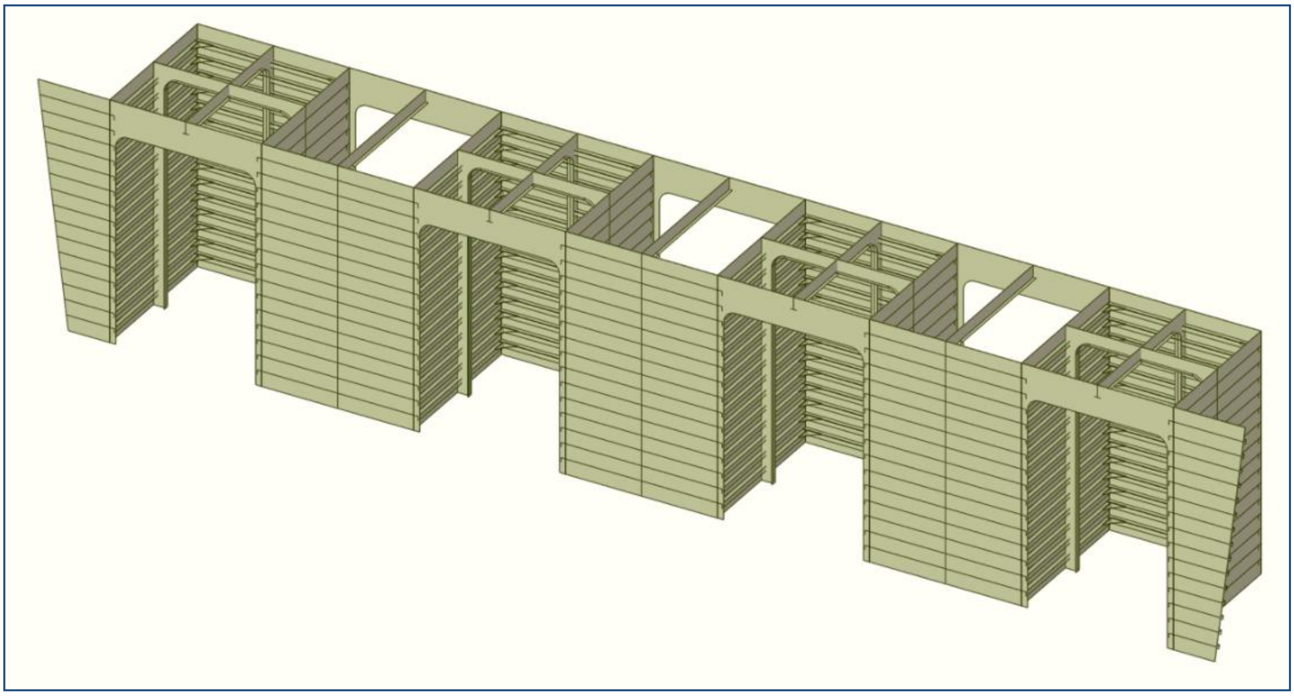
This unit would be joined to UNIT 1 at the Syncrolift, such that after solid ballast has been installed in the bottom of the Ballast Tank (Unit 1), the two units can be floated to the Sturrock Dock, for the installation of the remaining units.

Refer to drawings 507343-0000-DRG-SS-101 (8 Sheets)

3.1.3 Swedge Bulkheads

This unit, denoted UNIT 3, extends from the wet deck at 10.0m to the road deck at 17.983m. The swedge bulkheads are 12mm plate, single skin bulkheads arranged in a swedge form for strength, and are locally stiffened with 150x90 Angles (of varying thickness depending on vertical location, as shown on the applicable drawings.

This unit, measuring 39.7m in length, 5m wide and 8m high, weighing 107tonnes (raw steel weight only) would be transferred in one or more pieces (depending on location of fabricator) to the Sturrock dock, to be joined to the lower two units, already floated in from the Syncrolift.



The span of the 150x90 Angle stiffeners are broken by 400x200x12 T frames to a 2500mm span, and arranged both transversely and longitudinally as shown above.

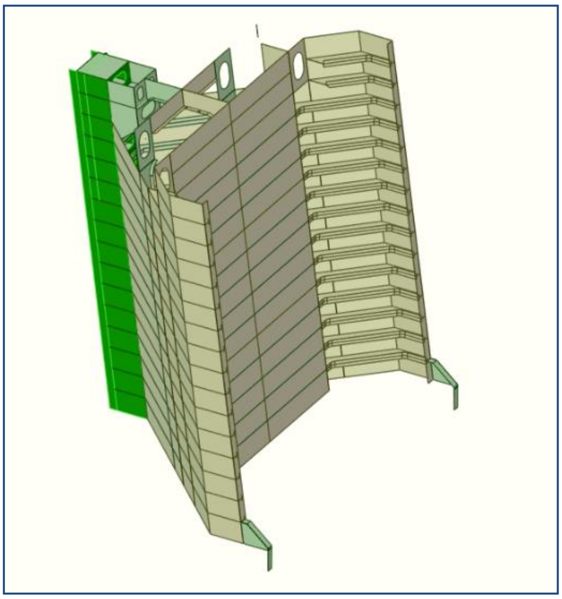
The 150x90 Angles range from 15mm thick at the bottom of the bulkheads where they are exposed to the greatest pressure to 10mm thick at the top, just below the Road Deck.

500x500x12 softnose brackets are located in the corners as shown.

Refer to drawings 507343-0000-DRG-SS-101 (8 Sheets)

3.1.4 End Columns

These Units, denoted UNITS 4&5, being identical mirror opposites, are 8m high, 6.3m wide and 6.3m long, weigh some 31 tonnes each (raw steel weight) and would typically be manufactured and transported in one piece from the fabrication yard, to the Sturrock Dock.



Again as applicable to all units, should the fabrication yard be located outside of the port and surrounds then, the units may be transported in smaller pieces due to bridge limitations etc.

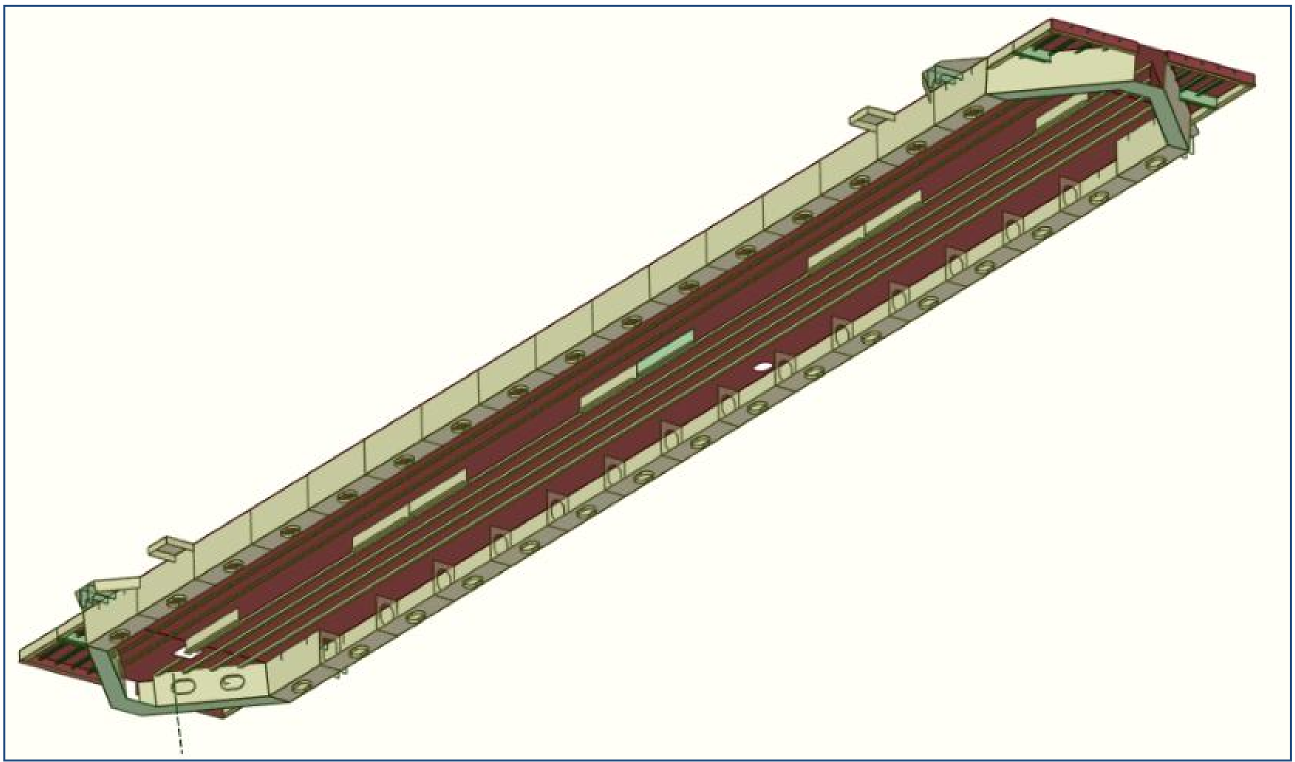
The end column units are essentially ring framed triangular structures, with 150x90x12 angle profiles for the frames, with a 400x200T girder breaking the span, both transversely and on the diagonal.

The non enclosed "wing" structures support the side fenders, and maintain width between the side fenders and the road deck above. They are framed with varying depth 12mm T frames webs, with 150x12 FB flanges, as shown.

Refer to drawings 507343-0000-DRG-SS-101 (8 Sheets)

3.1.5 Road Deck

This unit, denoted UNIT 6, is the Road Deck structure which is very much a strength member that holds the top of the bulkheads in place when subjected to side pressure. It also integrates into the structure of the end columns ensuring continuity of strength from the mid span into the keel.



It measures 45.3m in length, 6.3m in width (or 8.0m including the overhanging platforms), 0.98m deep and weighs 66 tonnes (raw steel weight), and would be the last unit to be added.

It is primarily made up of a 16mm deck plate with 90x75x10 longitudinal stiffeners. The sides of the deck are significantly reinforced with a 980mm deep x 650mm, 16mm plate, box girder (as shown above) which also serves as a servitude for cabling and piping.

Refer to drawings 507343-0000-DRG-SS-101 (8 Sheets)

4. FABRICATION METHODS, MATERIALS AND STANDARDS

4.1 REGULATIONS AND STANDARDS

The caisson was designed using Lloyds Rules for Steel ships and Lloyds Rules for Floating Drydocks as guidance and reference, however the caisson will not be classed.

The structure for all intensive purposes is seen as a ship, from a marine fabrication perspective, and construction should follow that of Class standards and requirements, including Class required extents of NDT testing, of welds.

Refer to Lloyds Rules for the Manufacture, Testing and Certification of Materials, July 2019.

4.2 STRUCTURAL MATERIALS

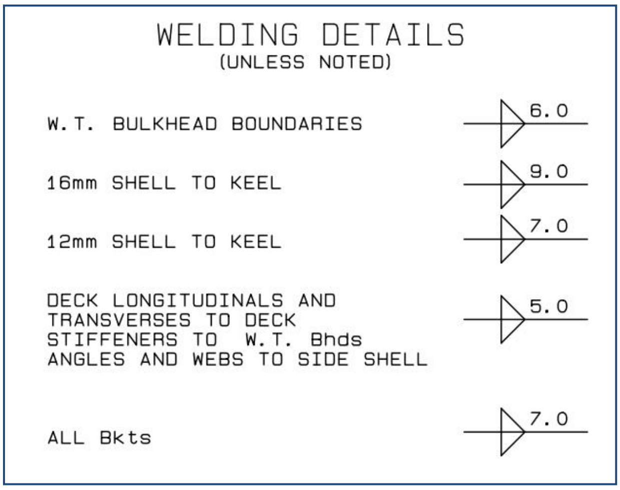
All steel plate structures are to be fabricated from EH36, and all steel sections are to be S355JR.

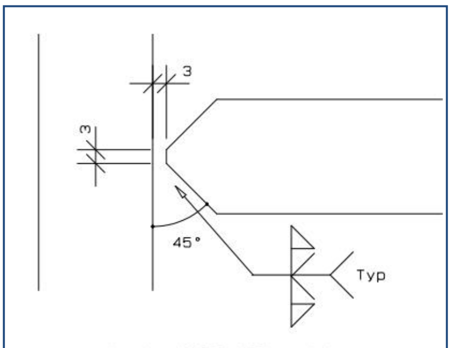
4.3 WELDING

The welds are designed according to the requirements of Lloyds Steel Ship Rules 2019, Part3, Chapter 10, *Welding and Structural Details*.

In summary they can be stated as double continuous welding of the following leg lengths, unless stated otherwise on the drawings.

Plates over 16mm thickness required edge preparation, as and where noted on the drawings, with typical example shown as follows:





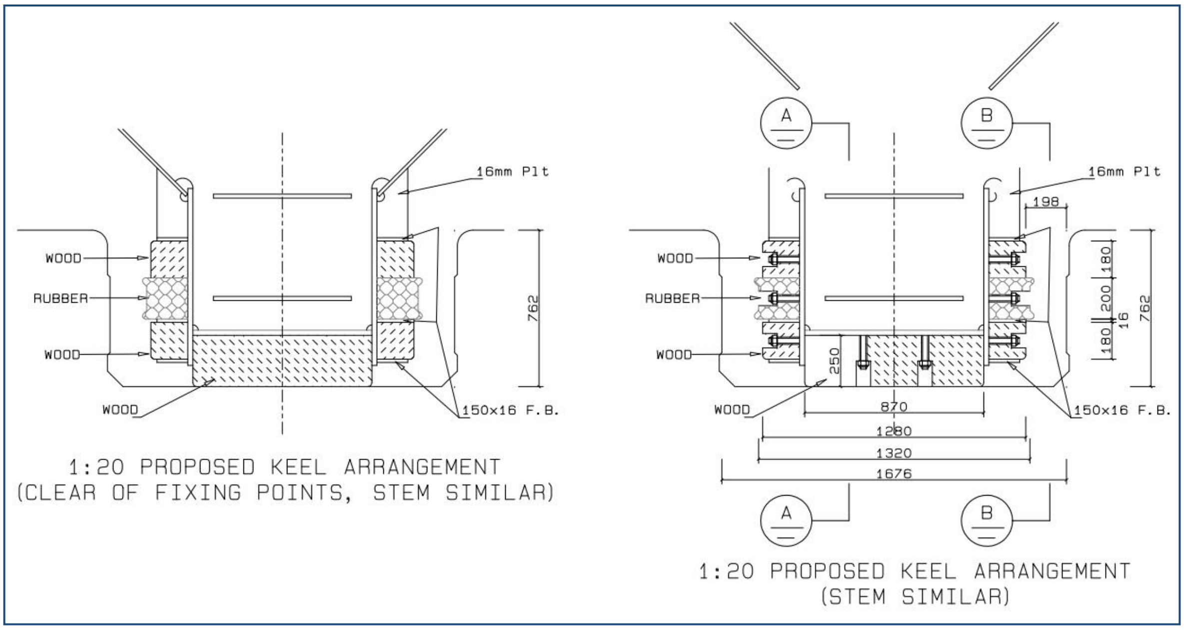
1:1 DETAIL 44
EDGE PREP FOR KEEL PLATE

Welding would be tested against the requirements of Lloyds Rules for the Manufacture Testing and Certification of Materials July 2019, Chapters 11,12 and 13.

5. FENDERING AND SEALING

5.1 KEEL FENDERING - GREEN HEART WOOD

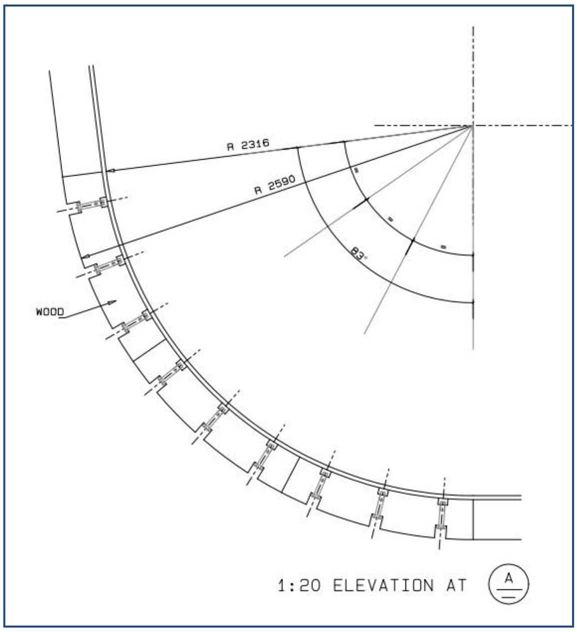
The primary keel fendering is Greenheart Wood. It is attached to the keel with studs as per the following detail.



The bottom slab of green-heart wood consists of a 870mm wide x 250mm high section, attached with a double row of studs at approx 900 spacing. *(Final spacing will be determined by the timber lengths supplied)*

There are two 180mm x 180mm sections on either side of the keel, adjacent to the rubber seal.

The curved section requires short segments, as shown below, and replacing the studs, with bolts into welded nuts. The reason for the bolts and welded nuts, vs studs in this region, is because one would not get the segments over the studs, due to the studs all projecting at a different angle.



See DWG No. 507343-0000-DRG-SS-102 for details.

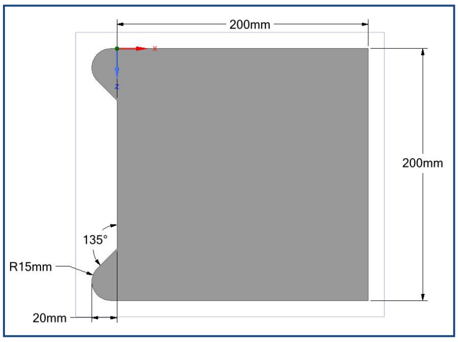
See Annexure 1 - Greenheart Wood Data Specification

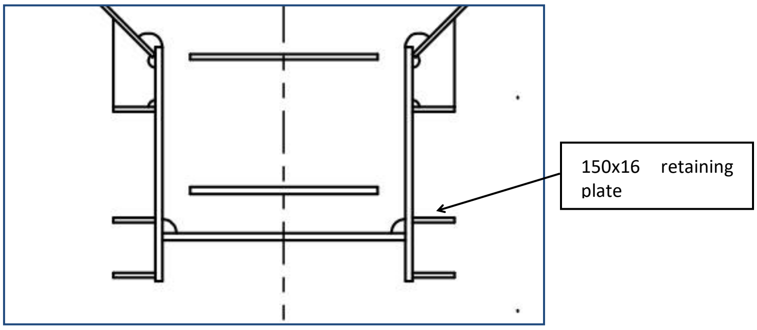
5.2 KEEL SEALING

As per the images above pertaining to the Green Heart Wood, the sealing rubber, sandwiched between two strips of timber, is a 200x200 solid rubber extrusion (with 20mm protruding ears). The rubber seal is also attached via studs, on the same spacing as per the timber. This rubber seal rests hard up against the side of the dock groove when the caisson is exposed to side pressure, with the ears compressing for an improved seal.

The Cross Section of the Solid Rubber Extrusion (with ears) shown below.

There is a 150x16 retaining plate between the lower side of the rubber seal and the timber, for support, as shown below.





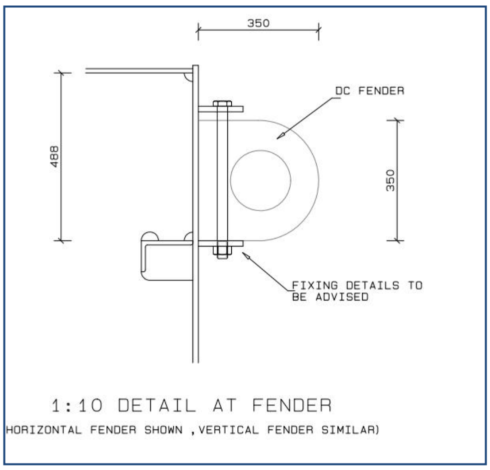
The rubber seal and side fendering (see Item 5.3) must be supplied by a PIANC accredited and certified manufacturer and supplier. *(PIANC is the international body which governs the fender standards for the marine and fendering industry)*

5.3 SIDE FENDERING

The side fendering, located as two horizontal strips on the side of the airspace compartments at levels just above 7m and just below 10m, as shown on the drawing No. 507343-0000-DRG-SS-110 made up by standard 350x350 (Ø150) DC Rubber Fender (150mm Hole).

There are also two vertical fenders of the same type, extending from a 7.0m level to the road-deck level, and supported by the outer wings of the end columns. These are thus located outboard of the 8m beam of the caisson.Should the caisson approach the quay at an angle it will impact on these fenders and the wood fendering on the bow and stern part of the keel, thus protecting the shell plate in between.

A total of 186m of DC 350x350 (Ø150) Fendering is required.



The fendering is located between two flatbars, and through bolted as shown in this extract.

For a DC350x350 (Ø150) fender the flatbars would typically be 120x12 and the bolts would typically be M30, however different fender suppliers might have different flatbar and bolt requirements.

Typical performance figures for 350x350DC (Ø150) fenders (per meter length):
Energy Absorption - 22.9kNm
Resultant Force - 549kN

Suppliers need to submit their performance figures for approval.

6. MOORING EQUIPMENT

6.1 BOLLARDS AND FAIRLEADERS

Six (6) in number bollards of Type DN 250 (ISO 3913_1977 EN) are arranged on road-deck for the purpose of mooring or towing the caisson.

The two bollards which are located on the centreline at the fwd and aft extreme are primarily used for towing.

The remaining four (4) bollards are fitted with associated four (4) panama type fairleaders so as to guide the mooring line (20mm wire) away from the handrailing, the stairs and the side of the caisson.

See details on Drawing 507343-0000-DRG-SS-110 (Fender, Bollard and Fairlead Details)

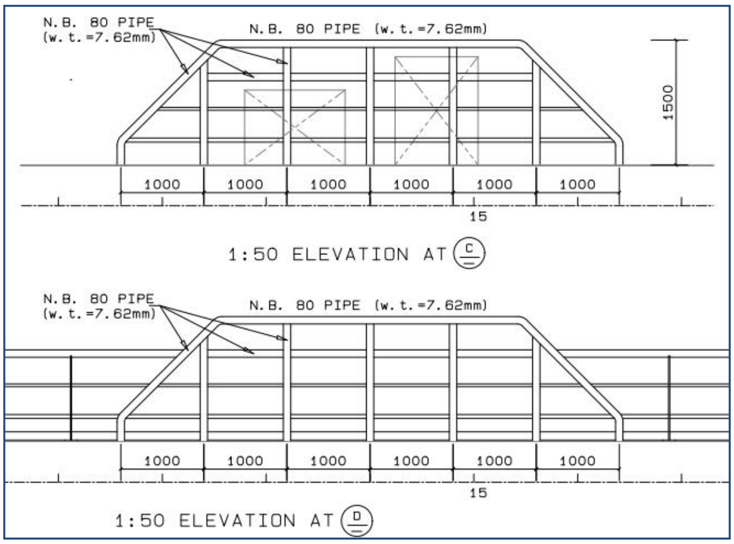
Welding would be tested against the requirements of Lloyds Rules for the Manufacture Testing and Certification of Materials July 2019, Chapters 11,12 and 13.

7. HANDRAILS, STAIRWAYS AND LADDERS

7.1 HANDRAILS ON ROAD DECK

The all welded steel handrails on road deck are a combination of a traditional safety handrail, and a deflector rail for the mooring lines when they are passed over the caisson.
The top pipe of the road-deck handrail is larger diameter NB 80 Sch 80 pipe, for the purpose of deflecting the 20mm wire mooring line over any deck equipment, including the control panel and distribution board at midships (centre of caisson).

In the area of the control panel and DB board, the railing is made higher, and an additional deflector frame is located inboard of the control panel / DB board, to protect it from being snagged by a mooring wire and to deflect such a wire over the top of the equipment.



See Drawing 507343-0000-DRG-SS-109-1 (Guard Rails and Stairs)

The remaining pipes are NB25 and NB32 Sch 40, with 65x16 F.B. Stantions.

7.2 HANDRAILS ON WET DECK

The handrails on wet-deck are GRP (Firebreglass) for improved durability in a wet environment, considering the wet deck is regularly submerged in sea water. These are to be sourced as a supplier item, per standard supplier offerings for these applications.

The supplier offering would then have to be reviewed and assessed by the client for approval.

7.3 STAIRWAYS FROM ROAD-DECK TO WET-DECK

The stairways between road-deck and wet-deck is a two stage, single landing stair constructed from GRP (fibreglass) for reduced corrosion effects due to the fact the stairway is largely submerged whenever the caisson is docked.

The steps and landings are to be from fibregrate, which inherently offers non slip properties.

As each supplier in this application has their own GRP mouldings, the stairway can only be specified in terms of the design layout, dimensions and purpose. The contractor would thus have to submit his supplier product specification and detail design, for client approval.

The design layout and dimensions is given by drawing 507343-0000-DRG-SS-109-1

7.4 LADDERS

Four (4) Vertical Ladders are arranged in each end of the caisson within the End Column and Air Spaces, acting as the main access down from road-deck to the inner compartments housing the valves. These ladders are 300mm wide, and fabricated from 65x10 FB's with a 20mm Solid Square orientated corner side up, with a rung spacing of 300mm.

They are welded in place by means of bracketing as detailed on Drawing 507343-0000-DRG-SS-101-8

8. ACCESS HATCHES AND DOORS

8.1 ACCESS HATCHES

Two (2) in number road deck hatches are located on the road deck acting as the access into the caisson. And a further two (2) in number hatches of the same design, are located on the wet-deck within the air spaces.

The four dog, watertight hatches have a 600mm high coaming (as per Ship's Loadline regulations) and are 780mm long by 780mm wide for ease of access.

The hinged covers are fitted with a fail safe open, safety catch, such that the lid acts as a handle when climbing in or out of the hatch.

The hatches are fitted with two internal rungs which act as the first two steps before stepping onto the ladder below.

The hatch seals watertight by way of the 4 dog cam lever system, compressing a neoprene rubber seal.

The hatch can be opened from above or below.

Detailed as per drawing 507343-0000-DRG-SS-106

Manholes are arranged into all enclosed spaces. All spaces are accessible for painting.

8.2 WATERTIGHT DOORS

Six (6) in number watertight doors are installed in the air spaces surrounding the scuttle tanks, between levels 7.0m and 10.0m, with clear doorway opening of 710mm x 1650mm.

These are custom constructed per drawing 50743-0000-DRG-SS-105-1 as a single handwheel 6 dog watertight hinged door, which can be opened from either side.

9. CORROSION PROTECTION

9.1 PAINT SPECIFICATION

The following paint spec's are prescribed for both internal and external surfaces. Other suppliers would need to submit their equivalent paint specifications for client approval.

New Steelwork (abrasive blasted) - Stonecor				
1	Carboweld 11 *Pink*	Sa $2^1/_2$	25µm	4hrs @ 25°C
2	Carbomastic 15 *Aluminium*		175µm	24hrs @ 25°C
3	Carbothane 134		40µm	3hrs @ 25°C
New Steelwork (abrasive blasted) - Jotun				
1	Muki Z 2001 *Red*	Sa $2^1/_2$	20µm	24hrs @ 23°C
2	Jotamastic 90 *Aluminium or tinted*		175µm	3hrs @ 23°C
3	Hardtop AS		40µm	5hrs @ 23°C

Due to the fact that the caisson spends a significant percentage of time, dry, when in the slot, it is found that retained marine growth is minimal, in that each time the underwater surfaces remain dry for any period of time, the marine growth dies.

Although the Caisson is not being built to Class, the requirements of Lloyds Rules for the Manufacture Testing and Certification of Materials July 2019, Chapter 15, Corrosion Protection,should be adhered to.

9.2 SACRIFICIAL ANODES

Sacrificial Zinc Aluminum Anodes, are arranged on the hull, as per the Anode Plan. The anode requirement is based on a 5yr replacement cycle.

These anodes are arranged with 50mm x 6mm galvanised steel mounting straps welded to the caisson, with anodes mounted bolt-on.

Zone 1 - Hull Surface up to Wet Deck
Zone 2 - Ballast Tank (internal)
Zone 3 - Scuttle Tanks (internal)

Zone 1 - Hull Surface up to Wet Deck					
Anode Type	**Weight**	**Zinc**	**Aluminum**	**Area - 1210m^2**	
				No. Of	Weight Zn
BN4 Bullnose 450x100x50	19.6kg	14kg	5.6kg	56	784kg
BN5 Bullnose 620x100x60	26.6kg	19kg	7.6kg	16	304kg

Zone 2 - Water Ballast Tank (internal)					
Anode Type	**Weight**	**Zinc**	**Aluminum**	**Area - 1910m^2**	
				No. Of	Weight Zn
BN3 Bullnose 440x100x40	14kg	10kg	4kg	240	2400kg

Zone 3 - Scuttle Tanks (internal)					
Anode Type	**Weight**	**Zinc**	**Aluminum**	**Area - 968m^2**	
				No. Of	Weight Zn
BN5 Bullnose 620x100x60	26.6kg	19kg	7.6kg	70	1330kg

10. PIPING AND VALVES

All pipe work and the installation of valves should be done in accordance with the requirements of Lloyds Rules for the Classification of Ships July 2019 and Lloyds Rules for the Manufacture, Testing and Certification of Materials, not limited to, but including pressure test requirements contained therein.

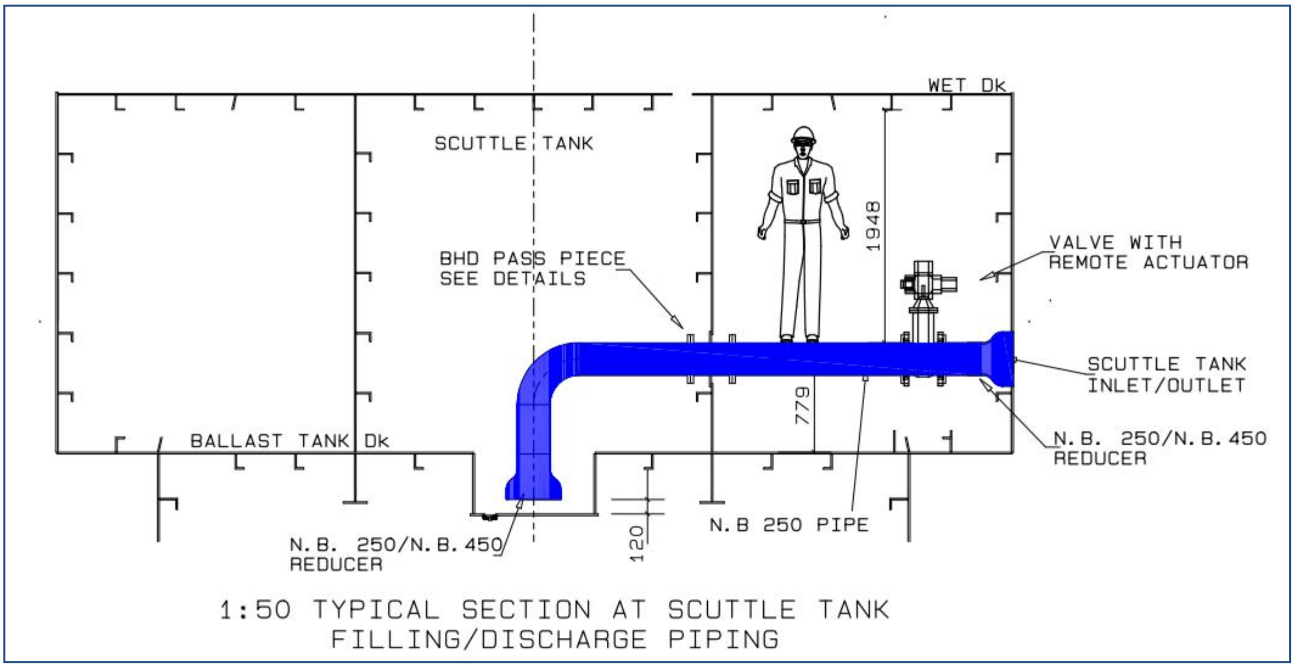
10.1 MAIN SCUTTLE TANK SEA WATER SYSTEM - PIPES AND VALVES

There are Six (6) in number scuttle pipes and associated valves, with two pipes per scuttle tank, one to portside and one to stbd.

10.1.1 NB250 Pipe

The Scuttle Tank Sea Water Pipes are NB250 Sch 40 pipes, six in number, each consisiting of a suction bell mouth, an elbow, a bulkhead pass piece, an elctrically actuated remote controlled valve and an overboard discharge bell mouth.

The 450mm to 250mm bell mouths are designed to reduce the entrance and exit pipe losses.



On installation, and at each five (5) year maintenance period, the NB250 Scuttle Tank Pipes would be coated/flushed with marine Anti-Fouling paint.

10.1.2 Scuttle Tank Sea Water Valves

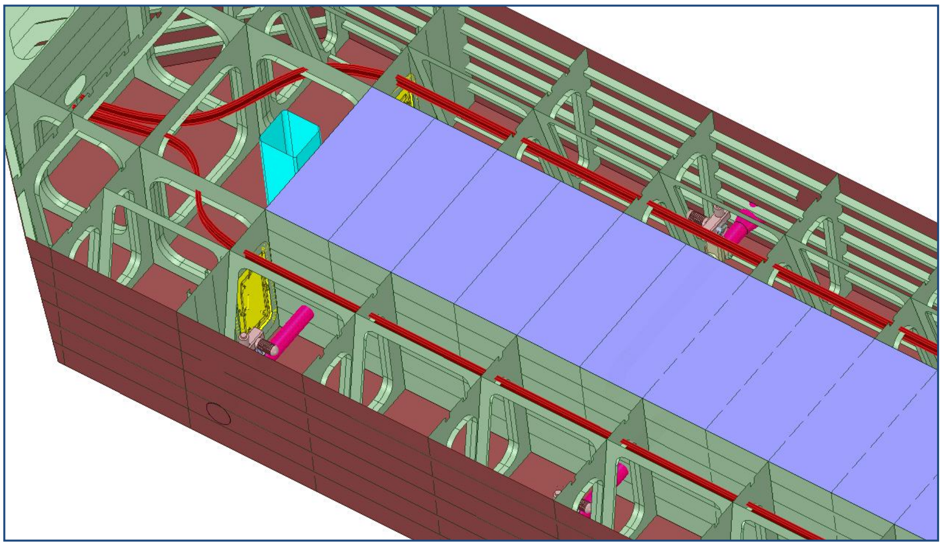
Sea Water Scuttle Tanks Valves				
Valve Category	**Quantity**	**Class**	**Material**	**Description**
NB250 variable flow electrically actuated , remotely controlled gate valves with failsafe CLOSED capabilities. Each fitted with an emergency handwheel manual override system.	6	PN10	Stainless 316	The sea water scuttle tank valves are located in the air space galleries outboard of the scuttle tanks, and have a crawl beam arrangement to facilitate the ease of removal and installation during maintenance. There are 2 valves per scuttle tank which are controlled from the Control Panel on Road Deck

*NOTE: The electrical actuator specification requirements are contained in a separate Electrical Specification Document.

10.1.3 Crawl Beam - For Installation and Maintenance of Valves

A crawl beam is arranged in the port and stbd outboard galleries. However the crawl beam terminates on either side of each watertight bulkhead and recommences on the other side. Thus when relocating a valve underslung from the travelling chainblock, it needs to be lowered at the bulkhead and then lifted by another travelling chain block on the other side of the watertight door, and then "walked" through that compartment, with the process repeated until reaching the hatch into the end column spaces, from where it is rigged up vertically through the end column space, until out on the road deck.

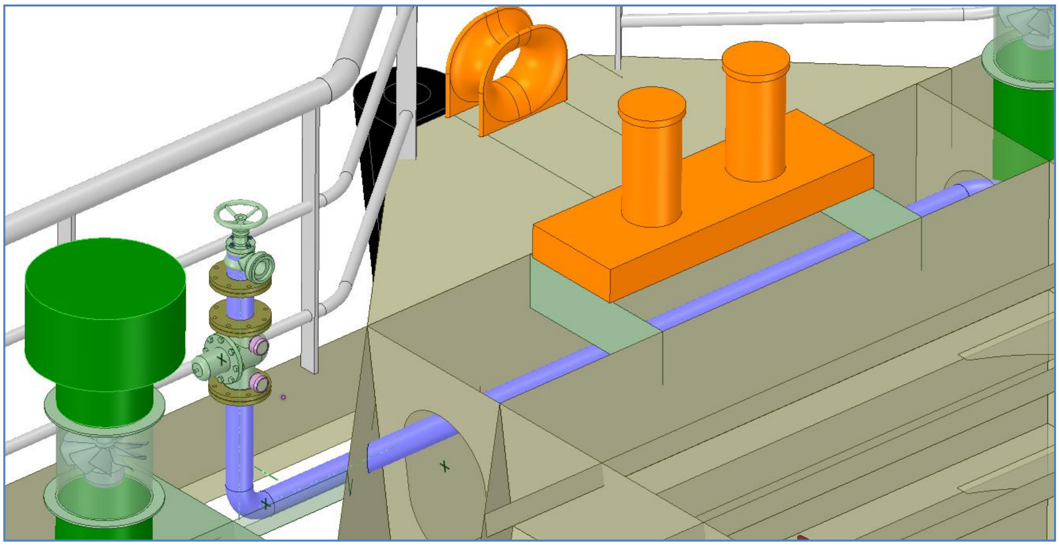
The size of the crawl beam is provisionally a 180x90 I Beam, but will be dependant on the supplier chain block trolley requirements.



10.2 SCUTTLE TANK COMPRESSED AIR SYSTEM - PIPES AND VALVES

10.2.1 Supply Line

The supply line is a NB80 pipe extending from both ends of the Caisson to the centrally located distribution point, namely the Manifold.
As the caisson is reversible, hose connections are accommodated at both ends.



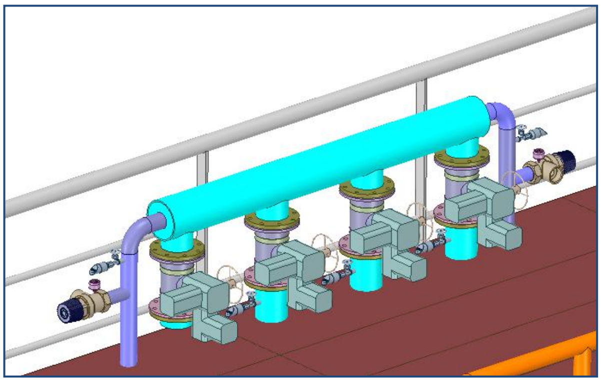
The supply line connection is located above deck (deck hidden for clarity in the image above) near the two ends of the caisson. The 3rd party air supply hose is connected to either of two NB80 hose connector diaphragm valves. The same valve on the opposite side that is not connected to the 3rd party supply hose must be closed, else the air would merely escape on the far side.

Immediately after the hose connector valve is a pressure reduction valve to reduce the pressure from 5.5bar to 2.0bar. This pressure reduction valve is to be fitted with mechanical pressure gauges on the high pressure side and on the low pressure side.

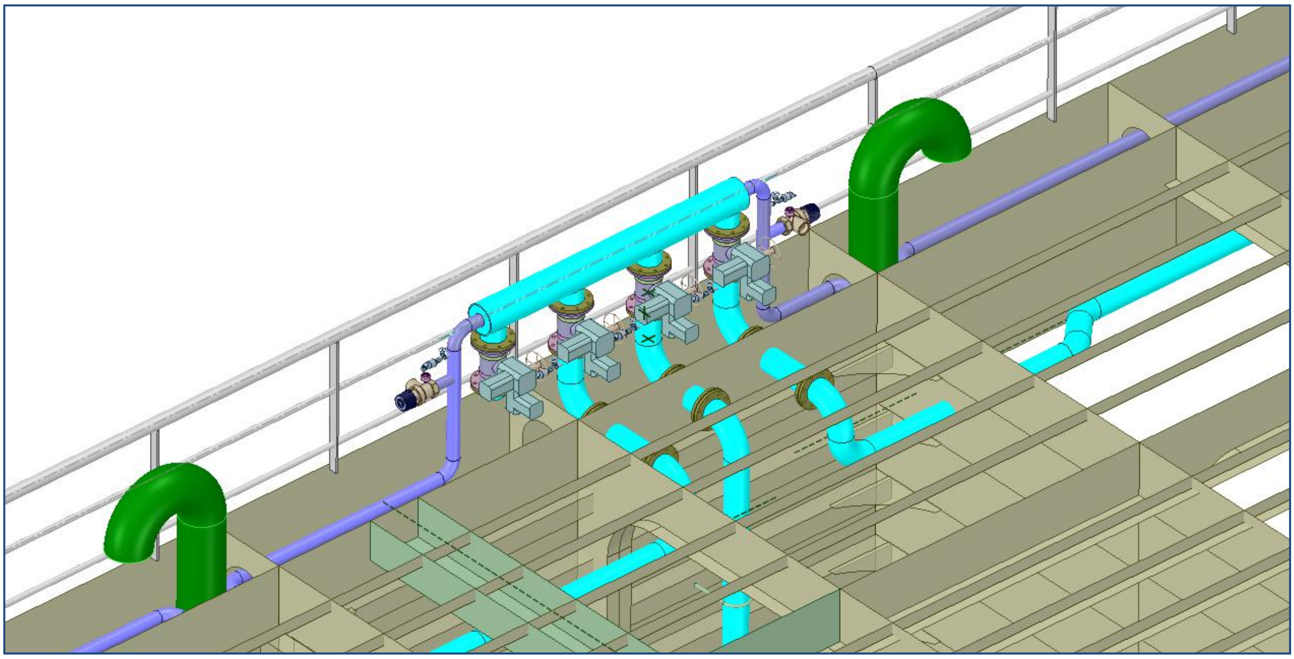
Per the images below, the supply lines run in the side box structures (which double as a servitude) and terminate at the manifold distribution point.

10.2.2 Manifold System

The compressed air manifold is a junction in the compressed air system, allowing for the supply of compressed air to come from either end of the reversible caisson and for the distribution of compressed air to each of the scuttle tanks, with the added capability of serving as scuttle tank vent pipes.
Thus the NB150 Scuttle Air pipes are used to supply compressed air to the scuttle tanks, when blowing the scuttle tanks empty, but are also used as vent pipes for when filling the scuttle tanks with sea water during the scuttling process. Note: The 4th NB150 Valve vents to atmosphere.



As can be seen in this image, the manifold is essentially a NB 200 Pipe, located above deck, close to midships, allowing for easy access for the supply lines and scuttle pipes and their valves.

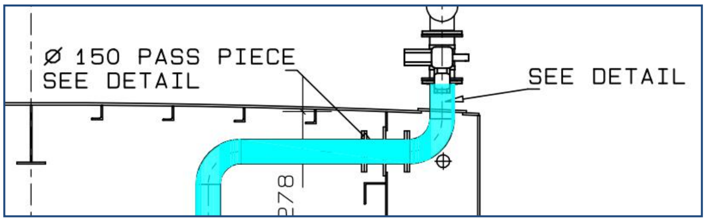


10.2.3 Scuttle Tank Lines

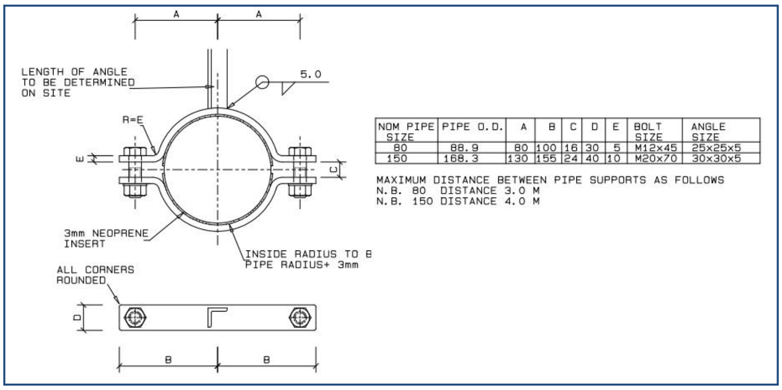
The scuttle tank air lines lead off the electrically actuated remotely activated valves located above deck at the manifold, down to each of the three scuttle tanks. Just beyond each of the valves a pressure transducer so as to give the Scada control system feedback as to the pressure being experienced by each scuttle tank.

The NB150 air pipes serve as both the compressed air supply lines to the scuttle tanks and also as the vent lines from the scuttle tanks.

Where air pipes penetrate the bulkheads and decks, double flanged bulkhead and deck penetration pieces are used, as detailed on drawings



The air pipes are supported from the bulkhead and deep frames, by means of pipe clamps (extract shown below) with spacing to be determined during installation.



NOM PIPE SIZE	PIPE O.D.	A	B	C	D	E	BOLT SIZE	ANGLE SIZE
80	88.9	80	100	16	30	5	M12x45	25x25x5
150	168.3	130	155	24	40	10	M20x70	30x30x5

Where pipes span two adjacent bulkheads, the pipe path is kinked through a double 45deg elbow, to avoid the pillaring effect.

See piping drawings 507343-0000-DRG-SS-109-3 & 4 for details.

10.2.4 Valves & Fittings

Compressed Air Valves and Fittings				
Valve Category	**Quantity**	**Class**	**Material**	**Description**
NB150 (open/closed) electrically actuated remotely activated ball valves with no failsafe capabilities, with handwheel manual override	3	PN10	Stainless 316	These valves are fitted to the central manifold and are used for directing airflow to each of the scuttle tanks, in order to "blow them out" when emptying them. They are controlled from the Control Panel on Road Deck
NB150 (open/closed) electrically actuated remotely activated ball valves with no failsafe capabilities, with handwheel manual override	1	PN10	Stainless 316	This valve is fitted to the manifold and when opened in conjunction with one or all of the scuttle tank air valves, serves to vent these tank/s to atmosphere, when being filled from outside water level, under gravity fill. This valve is controlled from the Control Panel on Road Deck
NB80 Mechanical Relief Valves	2	PN10	Stainless 316 Or Brass	These valves are fitted to the incoming compressed air feed lines, before they feed into the manifold. Although located on each incoming lines, they are in fact common to each other, hence serve as redundancy should one fail. They serve to avoid over pressure in the scuttle tanks, should the supply pressure from the 3rd party compressed air be higher than the prescribed 2 Bar.
NB80 Pressure Reduction Valves	2	PN10	Stainless 316 Or Brass	These valves are located at the ends of the caisson, near the hose connection points, and serve to reduce the air pressure from about 5.5Bar (3rd party supply pressure) to 2Bar (the scuttle tank working pressure). These valves are also to be supplied with mechanical pressure gauges on both the high and low pressure sides.
NB80 Hose Connection Globe or Diaphragm Valves	2	PN10	Stainless 316 Or Brass	These valves are located at the ends of the caisson. As the caisson is reversible, either end would be connected to the external air hose, with the other connection valve closed, such that the air supply does not escape at the other end
Mechanical Pressure Gauges	2	Max Pressure 5 Bar	Stainless 316 Or Brass	There are 2 mechanical pressure gauges located on the two NB80 incoming supply lines into the manifold. As they are common to each other the one offers the other redundancy.

For all electrical and electronic monitoring systems, refer to the Electrical Design Specification.

10.3 FILLING PIPES AND VALVES

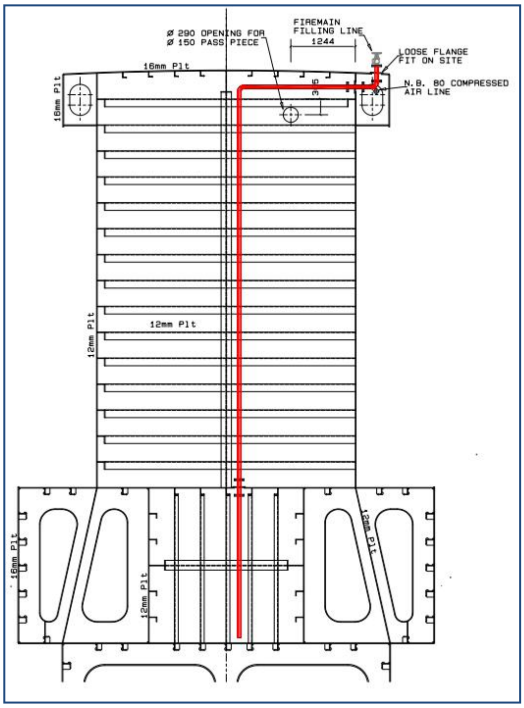
The scuttle tanks have NB65 dedicated filling lines, which are only used for initial filling, and for refilling after maintenance.

These valves need to remain tightly closed at all times during normal operation, else the scuttling process with compressed air will either not work, or will be slowed through leakage of air.

The filling pipes are sized at NB65, as that is the size of the shore-side fire hoses, which would be used for this purpose.

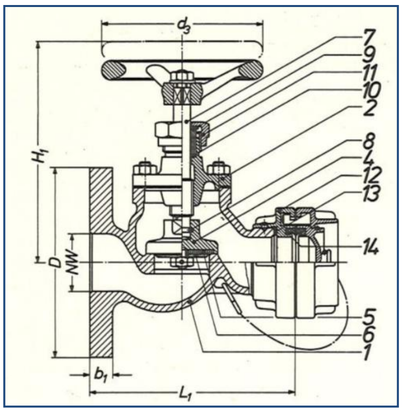
The valves/connector points are located on deck, against the handrail and opposite each scuttle tank below.

Scuttle Tank Filling Valves				
Valve Category	**Quantity**	**Class**	**Material**	**Description**
NB65 Hose Connection Globe or Diaphragm Valves	3	PN10	Stainless 316 Or Brass(see below)	The filling lines have Fire Hose quick connectors, for initial filling of the scuttle tanks.



See drawings 507343-0000-DRG-SS-109-3 & 4 for details

Brass Material Example Shown Below: Suppliers to submit material for approval.



Teil Rep. Part	Werkstoff nach DIN Matière svt. DIN Material acc. DIN
1	G - Cu Sn 5 Zn Pb
2	G - Cu Sn 5Zn Pb
3	G - Cu Sn 5 Zn Pb
4	G - Cu Sn 5 Zn Pb
5	Perbunan
6	G - Cu Sn 5 Zn Pb
7	Cu Zn 35 Ni F 45
8	Cu Sn 6
9	Cu Zn 39 Pb 2 F 37
10	Cu Zn 39 Pb 2 F 37
11	Cu Zn 39 Pb 3 p
12	Cu Zn 39 Pb 3 p
13	Perbunan
14	Weichgummi

Application : For fire fighting and deck washing especially on board of ships

11. VENTILATION

All pipe work and the installation of valves should be done in accordance with the requirements of Lloyds Rules for the Classification of Ships July 2019 and Lloyds Rules for the Manufacture, Testing and Certification of Materials, not limited to, but including pressure test requirements contained therein.

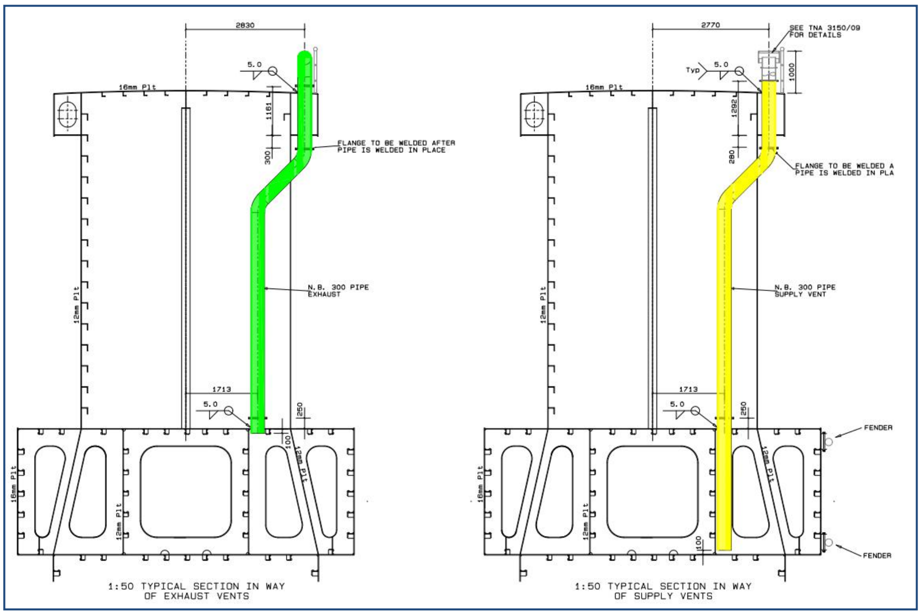
The caisson is divided into 8 dry air spaces, all of which offer access routes to the scuttle tank valves below decks. These 8 spaces (described under section 2 above) all have individual lighting, ventilation and oxygen monitoring. The oxygen monitoring and lighting is covered in the Electrical Specification.

11.1 PIPING (DUCTING)

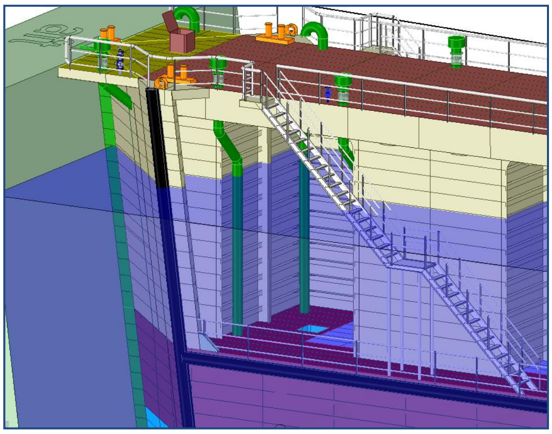
Due to the nature of the ventilation ducting being exposed to external hydrostatic water pressure, it needs to be constructed from a structural pipe NB300Sch 40, rather than a traditional thin walled duct.

Each compartment is fitted with a supply side and exhaust side duct, extending from the compartment in question, and terminating above the road deck.

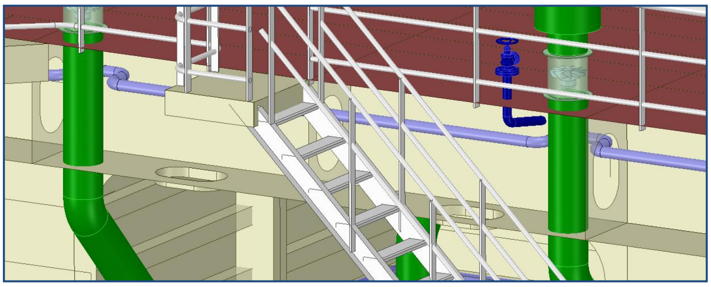
The supply side ducts (shown in yellow in the image below), extend to the bottom of each compartment, whilst the exhaust side (shown in green in the image above) extend from the top (deck head) of each compartment and generally from opposite sides of the compartments where possible, to ensure good flow.



The supply side at road deck level are fitted with mushroom vents coupled to inline axial fans. The exhaust side are fitted with goosenecks, to avoid the ingress of rain or sea spray. Neither are close-able.



As can be seen on the image to the left and below, the vent pipes (shown in green) are first routed through the road deck edge box girders (servitudes) then kinked inboard so as to tuck into the swedge bulkhead cavities, and run down the bulkheads or in the corners.



11.2 AXIAL IN LINE FANS

Inline axial fans of 315mm diameter are used for the air supply, to achieve at least 5 air changes per hour. These are fitted directly below the mushroom vents, located above the road deck, next to the port and stbd hand rails.

The volume of the largest air space is 117m^3, hence the minimum supply rate is 587m^3/hr or 0.16m^3/s

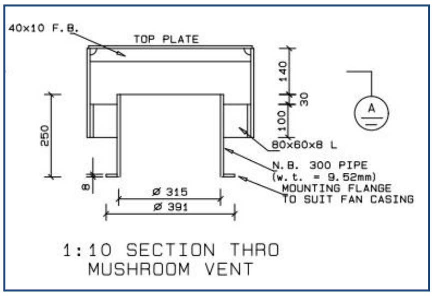
The fans are 380V, 4 Pole, 50Hz, IP66.

Typical inline axial fan.

Category	Qty	RPM	kW	Voltage	Volume [m^3]	Pressure	Material
315mm Inline Axial Fan	8	1385-1500	0.1-0.37	380	0.16 to 0.40	50Pa	Stainless 316

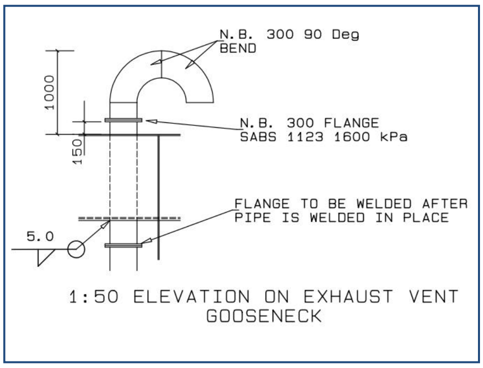
11.3 MUSHROOM VENTS

The eight (8) steel (EH36) non closeable mushroom vents, are fabricated items, per drawing 507343-0000-DRG-SS-107, with section extract below.



11.4 GOOSENECKS

The eight (8) steel goosenecks are fabricated items, using two standard 90deg NB 300 Sch 40, bends, as per the extracted view below. See piping drawing 507343-0000-DRG-SS-109-4



12. SOLID BALLAST

The caisson is designed to have up to 500 tonnes of solid CONCRETE ballast installed in the bottom of the ballast tank. The final amount of ballast would be determined from the Inclining Experiment conducted after fabrication.

A specific density of 2.6t/m^3 has been assumed, but up to 2.8t/m^3 is achievable from some suppliers. The higher the better.

Initially 330 tonnes of concrete would be poured into UNIT 1, once UNIT 1 and UNIT 2 have been joined at the Syncrolift. This allows the bottom two units to be floated in a stable manner from the Syncrolift to the Sturrock Dock, where it would be drydocked, for further assembly of the upper units. It is docked on its docking feet on standard ship docking blocks, keeping its keel accessible for the fitting of the timber and rubber seal.

While Units1 and Units 2 are being floated across from the Syncrlift to the Sturrock dock, freeboards would be taken so as to accurately determine their combined weight. This weight will be compared with the theoretically calculated weight and would serve to advise on the required remaining ballast to be poured so as to achieve a 9.9m floating draft, when complete.

Prudence would dictate that slightly less than the required ballast be poured at this time, so that the final ballasting can be determined by the Inclining Experiment, following which a third and final pour would be undertaken. This would also allow for any longitudinal or transverse inbalance (resulting in trim or heel) be countered by association of the distribution of the final pour.

13. INCLINING EXPERIMENT AND FINAL STABILTY DOCUMENATION

A Stability Report has been drawn up which details the buouancy and stability characteristics of the caisson, both floating and during scuttling, based on the calculated weight and centres of gravity.

However the Final Trim and Stability Book (as applicable to all floating structures) would be drawn up following an inclining experiment conducted after completion with the caisson afloat at Freddy’s Quay.

This inclining experiment determines the overall weight (displacement) of the caisson as well as the position of the centre of gravity, in terms of VCG (vertical distance from underkeel), TCG (transverse distance from centreline) and LCG (longitudinal distance from midships).

The inclining experiment will also determine the amount and location of the final ballast pour to achieve a 9.9m draft, floating level. This additional added weight and its position, will be calculated into the overall Incline Result to determine the LIGHTSHIP weight and COG.

From the LIGHTSHIP, and COG, coupled to the hydrostatic model of the caisson, with consideration of the calculated water ballast and scuttling tank weights when filled, determine the final Conditions of Loading. The stability parameters are then determined and documented for all such conditions of loading (following the same format as the Stability Report).

ANNEXURE A - GREEN HEART WOOD DATA SPECIFICATION

GREENHEART

Family: LAURACEAE (angiosperm)
Scientific name(s): Chlorocardium rodiaei
Ocotea rodiaei (synonymous)
Commercial restriction: no commercial restriction
Note: In Surinam, the name GROENHART is also used for IPE squared timber and square edged boards.

WOOD DESCRIPTION

Color: yellow brown
Sapwood: clearly demarcated
Texture: fine
Grain: straight
Interlocked grain: absent
Note: Very thick sapwood, heartwood yellow brown to dark olive brown, with sometimes irregular darker veins.

LOG DESCRIPTION

Diameter: from 80 to 100 cm
Thickness of sapwood:
Floats: no
Log durability: good

PHYSICAL PROPERTIES

MECHANICAL AND ACOUSTIC PROPERTIES

Physical and mechanical properties are based on mature heartwood specimens. These properties can vary greatly depending on origin and growth conditions.

	Mean	Std dev.
Specific gravity *:	0,97	
Monnin hardness *:	19,8	
Coeff. of volumetric shrinkage:	0,36 %	
Total tangential shrinkage (TS):	8,2 %	
Total radial shrinkage (RS):	7,5 %	
TS/RS ratio:	1,1	
Fiber saturation point:	40 %	

Stability: moderately stable to poorly stable

	Mean	Std dev.
Crushing strength *:	98 MPa	
Static bending strength *:	217 MPa	
Modulus of elasticity *:	30400 MPa	

(*: at 12% moisture content, with 1 MPa = 1 N/mm²)

Musical quality factor: 160,5 measured at 2931 Hz

NATURAL DURABILITY AND TREATABILITY

Fungi and termite resistance refers to end-uses under temperate climate. Except for special comments on sapwood, natural durability is based on mature heartwood. Sapwood must always be considered as non-durable against wood degrading agents.
E.N. = Euro Norm

Funghi (according to E.N. standards): class 1 - very durable
Dry wood borers: durable - sapwood demarcated (risk limited to sapwood)
Termites (according to E.N. standards): class D - durable
Treatability (according to E.N. standards): class 4 - not permeable
Use class ensured by natural durability: class 4 - in ground or fresh water contact
Species covering the use class 5: Yes
Note: This species is listed in the European standard NF EN 350-2.
This species naturally covers the use class 5 (end-uses in marine environment or in brackish water) due to its high specific gravity and hardness.
According to the European standard NF EN 335, performance length might be modified by the intensity of end-use exposition.

REQUIREMENT OF A PRESERVATIVE TREATMENT

Against dry wood borer attacks: does not require any preservative treatment
In case of risk of temporary humidification: does not require any preservative treatment
In case of risk of permanent humidification: does not require any preservative treatment

 26/03/2012

GREENHEART

DRYING

Drying rate: slow
Risk of distortion: slight risk
Risk of casehardening: no
Risk of checking: slight risk
Risk of collapse: no

Possible drying schedule: 5

M.C. (%)	Temperature (°C) dry-bulb	wet-bulb	Air humidity (%)
30	42	41	94
25	42	39	82
20	48	43	74
15	48	43	74

This schedule is given for information only and is applicable to thickness lower or equal to 38 mm.
It must be used in compliance with the code of practice.
For thickness from 38 to 75 mm, the air relative humidity should be increased by 5 % at each step.
For thickness over 75 mm, a 10 % increase should be considered.

SAWING AND MACHINING

Blunting effect: fairly high
Sawteeth recommended: stellite-tipped
Cutting tools: tungsten carbide
Peeling: not recommended or without interest
Slicing: not recommended or without interest
Note: Sawdust may cause allergies.

ASSEMBLING

Nailing / screwing: good but pre-boring necessary
Gluing: correct
Note: Gluing must be done with care (very dense wood).

COMMERCIAL GRADING

Appearance grading for sawn timbers: According to NHLA grading rules (January 2007)
Possible grading: FAS, Select, Common 1, Common 2, Common 3

FIRE SAFETY

Conventional French grading: Thickness > 14 mm : M.3 (moderately inflammable)
Thickness < 14 mm : M.4 (easily inflammable)

Euroclasses grading: D s2 d0
Default grading for solid wood, according to requirements of European standard EN 14081-1 annex C (April 2009). It concerns structural graded timber in vertical uses with mean density upper 0.35 and thickness upper 22 mm.

END-USES

Hydraulic works (seawater)
Ship building
Bridges (parts in contact with water or ground)
Heavy carpentry
Sleepers
Poles
Hydraulic works (fresh water)
Cooperage
Bridges (parts not in contact with water or ground)
Industrial or heavy flooring
Turned goods

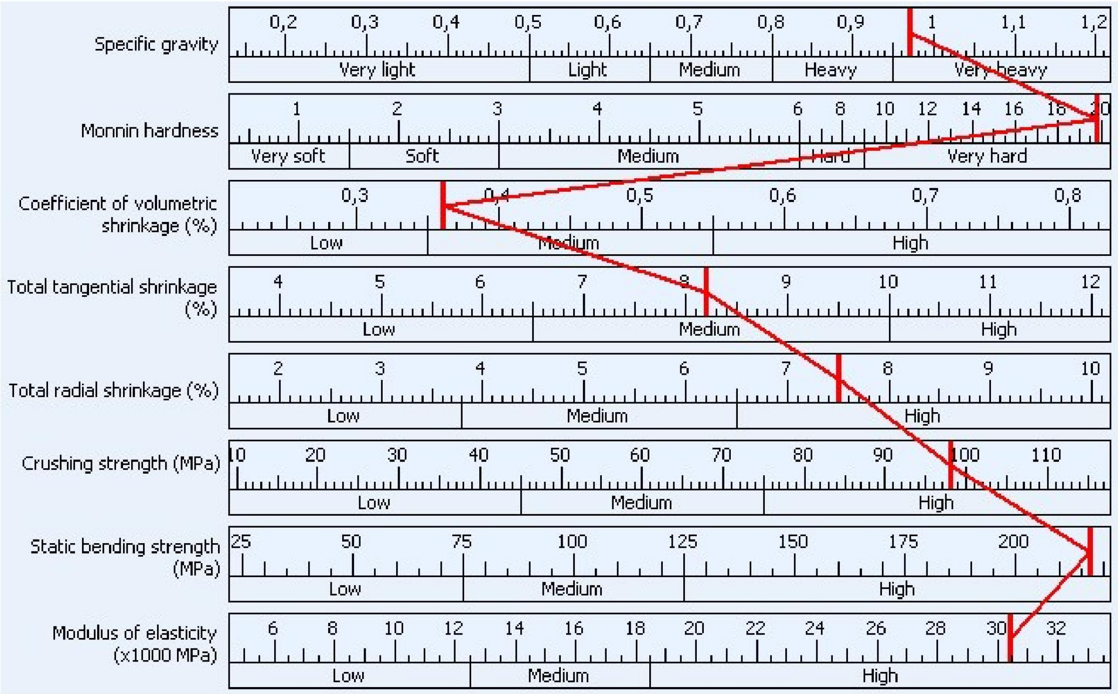
Note: Although not very used in France, GREENHEART is one of the most suitable species for end-uses in marine environment.
Species resistant to acids. GREENHEART is also used for billiard cue.

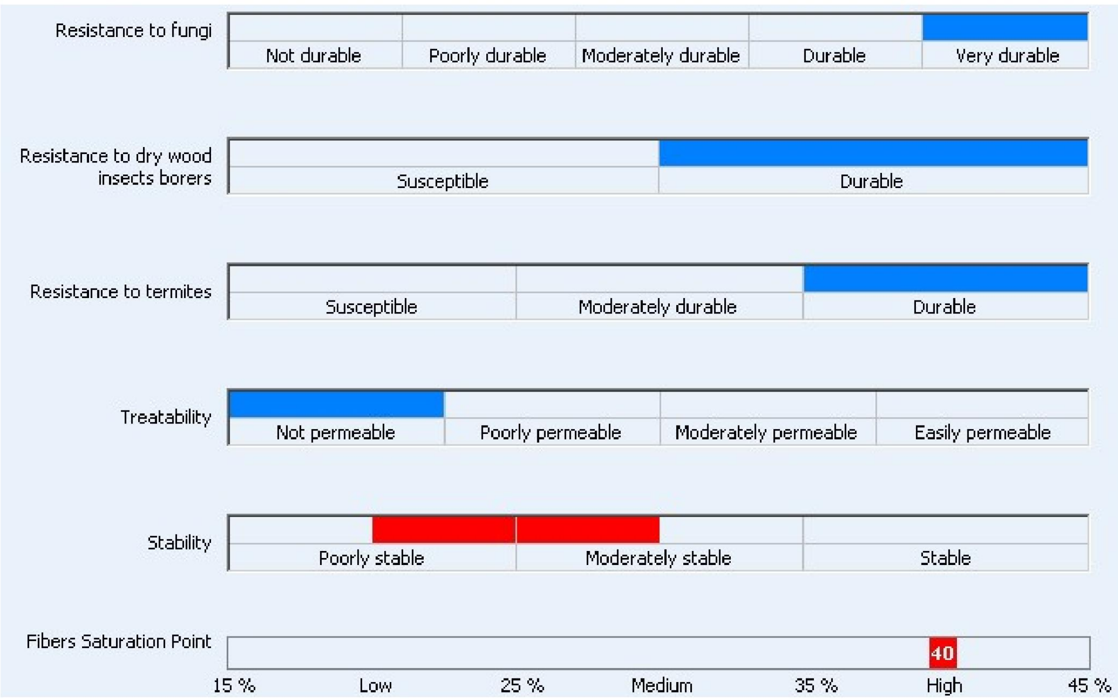
GREENHEART

MAIN LOCAL NAMES

Country	Local name	Country	Local name
Brazil	BIBIRU	Brazil	ITAUBA BRANCA
Guyana	BIBIRU	Guyana	DEMERARA
Guyana	GREENHEART	Suriname	BEEBEROE
Suriname	GROENHART	Suriname	SIPIROE
Venezuela	VIRUVIRU		

GREENHEART





 26/03/2012