Escola Politécnica Superior

Trabajo Fin de Grado
CURSO 2019/20

Buque Portacontenedores Postpanamax 11000 TEUS

Grado en Ingeniería Naval y Oceánica

ALUMNA/O

Manuel García Pensado

TUTORAS/ES

Marcos Míguez González

FECHA

SEPTIEMBRE 2020

Resumen

En este trabajo se va a desarrollar el proyecto de un buque portacontenedores postpanamax con capacidad para 11000 TEUS.

Nuestro buque estará propulsado por un motor diésel directamente acoplado y dispondrá de generación eléctrica de gas en zonas portuarias con el fin de reducir la contaminación.

La tripulación estará formada por un total de 30 tripulantes y todos ellos dispondrán de camarotes individuales.

El buque no contará con sistemas de carga y descarga propios, a excepción de una pequeña grúa para el abastecimiento de víveres.

En sus cubiertas se dispondrán dos TEUS en sentido longitudinal, o un FEU si fuera el caso, porque las guías de nuestro buque estarán adaptadas a dicho propósito.

Resumo

Neste traballo irase desenvolvendo o proxecto dun buque portacontenedores postpanamax con capacidade para 11000 TEU´s.

O noso buque estará propulsado por un motor diésel directamente acoplado e disporá de xeración eléctrica de gas en zonas portuarias coa fin de reducir a contaminación.

A tripulación estará formada por un total de 30 tripulantes e todos eles disporán de camarotes individuais.

O buque non contará con sistemas de carga e descarga propios, a excepción dunha pequena grúa para o abastecemento de viveres.

Nas súas cubertas disporanse os TEU´s en sentido lonxitudinal, ou un FEU se fora o caso, porque as guias do noso buque estarán adaptadas a dito propósito.

Summary

In this work, the project of a post-Panamax container ship with capacity for 11000 TEUS will be developed.

Our ship will be powered by a directly coupled diesel engine and will have electric gas generation in port areas in order to reduce pollution.

The crew will be available for a total of 30 crew members and all of them will have individual cabins.

The ship does not have its own loading and unloading systems, with the exception of a small crane for supplying food.

On its decks two TEUS will be arranged longitudinally, or in FEU if applicable, because the guides of our ship are adapted to this purpose.

Escola Politécnica Superior

TRABAJO FIN DE GRADO

CURSO 2019/20

Buque Portacontenedores Postpanamax 11000 TEUS

Grado en Ingeniería Naval y Oceánica

Documento

CUADERNO 1: ELECCIÓN DE LA CIFRA DE MÉRITO Y SELECCIÓN DE LAS ALTERNATIVAS

ESCOLA POLITÉCNICA SUPERIOR

UNIVERSIDADE DA CORUÑA

GRADO EN INGENIERÍA NAVAL Y OCEÁNICA

TRABAJO FIN DE GRADO

CURSO 2.019-2020

PROYECTO NÚMERO 192024

TIPO DE BUQUE: BUQUE PORTACONTENEDORES POSTPANAMAX

CLASIFICACIÓN, COTA Y REGLAMENTOS DE APLICACIÓN: DNV-GL, SOLAS Y MARPOL.

CARACTERÍSTICAS DE LA CARGA: 11000 TEUS

VELOCIDAD Y AUTONOMÍA: Velocidad servicio 20 kn, 85% MCR, 10%MM, 14.000 millas de autonomía.

SISTEMAS Y EQUIPOS DE CARGA / DESCARGA: SIN GRUAS

PROPULSIÓN: Motor diésel directamente acoplado, Generación eléctrica a Gas en zonas portuarias

TRIPULACIÓN Y PASAJE: 30 tripulantes

OTROS EQUIPOS E INSTALACIONES: LOS HABITUALES EN ESTE TIPO DE BUQUE

Ferrol, 12 Setiembre 2020

ALUMNO/A: **Dª MANUEL GARCÍA PENSADO**

Tabla de contenido

1 INTRODUCCIÓN

En este cuaderno determinaremos las dimensiones principales de un buque portacontenedores postpanamax con capacidad para trasportar 11000 TEU´s, cumpliendo las RPA´s marcadas anteriormente en el proyecto.

Este tipo de buques comenzaron su andadura por los océanos en la década de 1950, cambiando por completo el comercio marítimo de mercancías. El transporte de contenedores comenzó con la adaptación de buques graneleros, lo cuales rápidamente daban lugar al nacimiento de los primeros portacontenedores capaces de transportar en torno a 500 contenedores. El crecimiento de este tipo de transporte fue exponencial, asi como las capacidades de los nuevos buques que pronto llegarían los 2000 TEU´s.

Sin embargo las capacidades de los buques tenían un techo de cristal que limitaba su crecimiento, y ese no era otro que las dimensiones de los canales y puertos por lo que transitaban, principalmente el canal de Panamá y el canal de Suez.

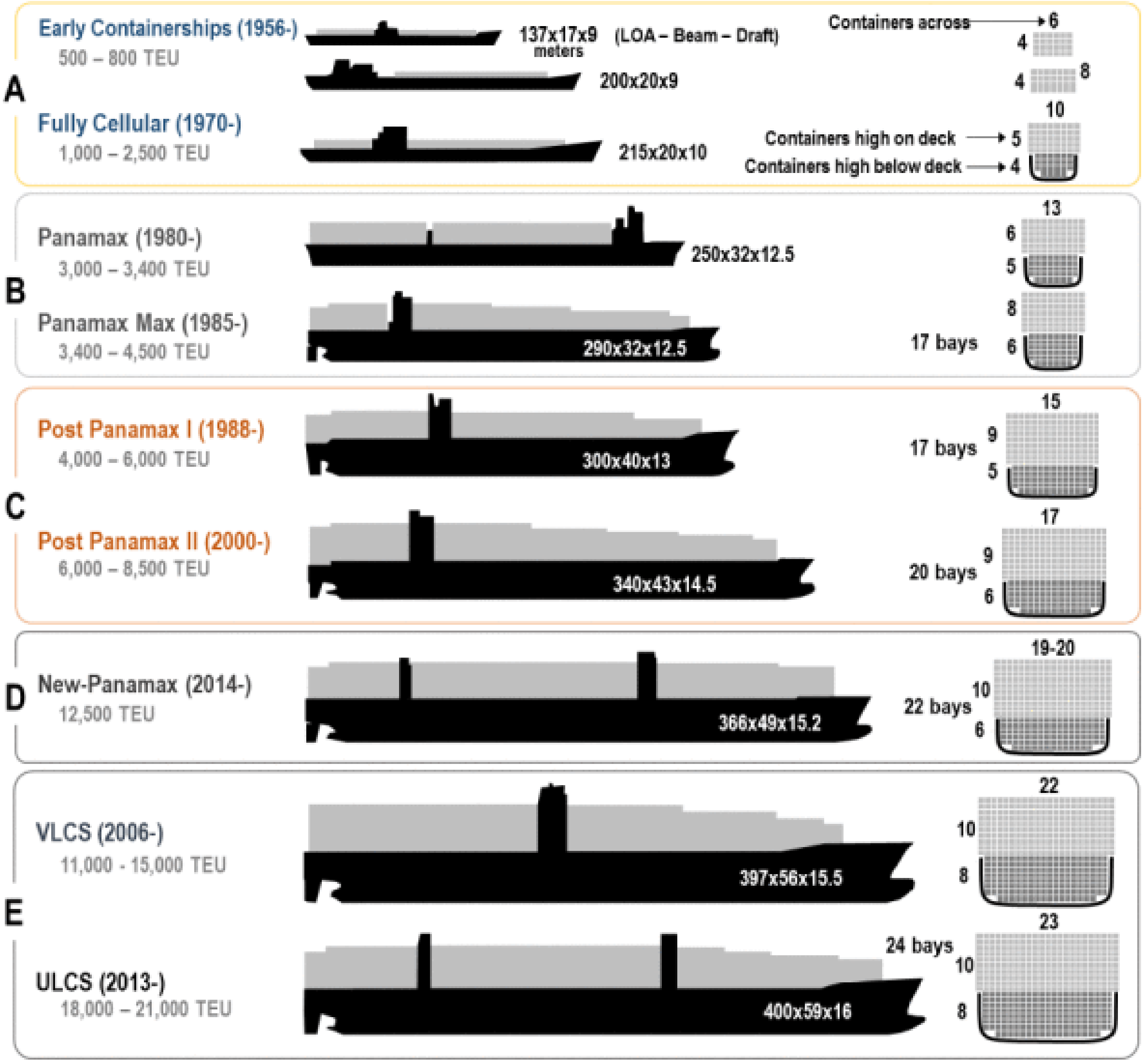
Nuestro buque proyecto transitara por rutas que conectan el sudeste asiático con el norte de Europa, conectando los puertos de Shangai (China) con Rotterdam (Países Bajos) y Hamburgo (Alemania), por lo que transitará a través del canal de Suez. El canal de Suez tiene una longitud total de 195 Km, con una anchura mínima en su fondo de 60 m y en la flotación de 170, permitiendo el transito para buques con un calado no superior a los 20 metros. En cuanto al canal de Panamá, sus dimensiones son las siguientes.

Dimensiones de las esclusas	**Canal de Panamá (Esclusas Neopanamax)**
Longitud	427 m
Anchura	55 m
Profundidad	18,3 m

Fuente: https://micanaldepanama.com/

A pesar de ello, las dimensiones de los buques no han parado de crecer con los años, durante los cuales las restricciones de puertos y canales han aumentado sus dimensiones, permitiendo asi el desarrollo de las economías a nivel mundial.

Los buques portacontenedores se suelen clasificar en función del número de TEU´s que pueden transportar, desde pequeños portacontenedores de 300 TEU´s (tránsito entre puertos Feeder) hasta los mayores construidos hasta la fecha que pueden llegar a los 23000 TEU´s. A continuación se muestra la denominación en función de su capacidad:



El transporte en contenedores, más conocidos como TEU (Twenty-foot Equivalent Unit), ha traído ventajas como:

- Mayor rapidez en operaciones de carga y descarga en puertos, con el consiguiente ahorro económico y tiempo.
- Las averías y perdidas en la carga se han reducido gracias a la protección que le otorga el contenedor.
- La mano de obra se ha reducido

Sin embargo, no todo son ventajas en con la implantación del contenedor, su aparición trajo consigo dificultades como:

- Los puertos deben de disponer de una infraestructura específica, con operarios cualificados para estibar la carga y grandes espacios donde almacenar los TEU´s
- El coste de los buques es más elevado que el de un buque de carga convencional equivalente

Como hemos dicho anteriormente, el uso de contenedor se ha generalizado con el paso de los años, por lo que pronto apremio la necesidad de estandirizar las dimensiones del contenedor. La ISO especifica las siguientes medidas para el TEU:

Dimensiones (en metros)	**TEU (Twenty-foot Equivalent Unit)**	**FEU (Forty-foot Equivalent Unit)**
Longitud (L)	6,096	12,192
Anchura (W)	2,438	4,876
Altura (H)	2,591	5,182

Con el fin de que la estiba de TEUS en las bodegas sea satisfactoria dispondremos de guías de carga verticales sustentadas en unos pilares que forman en la base celdas con el tamaño de un TEU. Esto nos permitirá disponer en las bodegas varias columnas de contenedores (“Tiers”).

El acceso a las bodegas de carga estará dotado de una compuerta tipo pontón, sobre la que estibaremos los contenedores sobre cubierta. Entre el ultimo TEU bajo cubierta y la compuerta se dejará una distancia de 0,5 m como mínimo, debido al pandeo que puede sufrir provocado por el peso de los contenedores en su parte superior.

En las RPA´s se especifica que el buque debe satisfacer una autonomía de 14000 millas náuticas a una velocidad de servicio de 20 nudos, dato que tendremos en cuenta en futuros cuadernos a la hora de seleccionar los equipos generadores y auxiliares a instalar.

2 DIMENSIONAMIENTO PRELIMINAR

Para el cálculo preliminar de las dimensiones del buque hemos realizado un estudio de los buques existentes similares al nuestro. Como resultado disponemos de una base de datos de 12 buque con capacidades comprendidas entre 6000 y 16000 TEUS. Todos los buques son posteriores al año 2010 y como fuente hemos utilizado la revista “Significant Ships”.

NOMBRE	**AÑO**	**FUENTE**	**$TEUS_{TOTAL}$**	**Δ (ton)**	**DW**	**P.Rosca**	**L_{OA} (m)**	**L_{PP} (m)**	**B (m)**	**D (m)**	**T (m)**
Charlotte Schulte	2014	SIGNIFICANT SHIPS	5466	84200	65120	19080	255	244	37,3	22	13,9
Maule	2010	SIGNIFICANT SHIPS	6589		81002		305,6	293,16	40	24,2	14
CCNI Iquique	2014	SIGNIFICANT SHIPS	6865	103160	80087	23073	270,9	258,4	42,8	24,6	14,55
MSC Altamira	2012	SIGNIFICANT SHIPS	8886	143761	112516	31245	299,18	286	48,2	24,8	14,5
Mol Bravo	2014	SIGNIFICANT SHIPS	10010	153111	114891	38220	337	320	48,2	27,2	15,2
Valparaíso Express	2016	SIGNIFICANT SHIPS	10593	160648	123587	37061	333,18	318	48,2	26,8	14
APL Southampton	2012	SIGNIFICANT SHIPS	10642		129240		347	331	45,2	29,7	15,5
HMM Promise	2018	SIGNIFICANT SHIPS	11167		134869		330	316,4	48,2	27,2	16
MSC Beryl	2010	SIGNIFICANT SHIPS	12967	182665	139418	43247	365,8	349,8	48,2	29,9	15,5
YM Window	2016	SIGNIFICANT SHIPS	14198		146072		368	351,55	51	29,85	16
CMA Washington	2017	SIGNIFICANT SHIPS	14414		148000		366	350	48,2	29,85	16
Marco Polo	2012	SIGNIFICANT SHIPS	16000		186470		396	378,4	53,6	29,9	16

NOMBRE	**L/B**	**B/D**	**L/D**	**T/D**	**L/T**	**L x B x D**	**V_{SERV} (Kn)**	**Vserv (m/s)**	**POT (Kw)**	**C_B**	**F_N**
Charlotte Schulte	6,54	1,69	11,09	0,63	17,55	200226,4	21,73	11,18	24680	0,65	0,2285
Maule	7,32	1,65	12,11	0,58	20,94	283778,9	25,3	13,01	57200		0,2427
CCNI Iquique	6,03	1,74	10,50	0,59	17,76	272064,2	21,31	10,96	27700	0,62	0,2177
MSC Altamira	5,93	1,94	11,53	0,58	19,72	341873	22	11,32	47430	0,70	0,2137
Mol Bravo	6,63	1,77	11,76	0,56	21,05	419532,8	23,8	12,24	51000	0,64	0,2185
Valparaíso Express	6,59	1,80	11,86	0,52	22,71	410779,7	21	10,80	40264	0,73	0,1934
APL Southampton	7,32	1,52	11,14	0,52	21,35	444347,6	23,4	12,04	54120		0,2112
HMM Promise	6,56	1,77	11,63	0,59	19,77	414813,1	22	11,32	42310		0,2031
MSC Beryl	7,26	1,61	11,70	0,52	22,57	504124,8	25,5	13,12	72240	0,68	0,2239
YM Window	6,89	1,71	11,78	0,54	21,97	535182,1	23,3	11,99	51823		0,2041
CMA Washington	7,26	1,61	11,72	0,54	21,87	503569,5	21,7	11,16	50190		0,1905
Marco Polo	7,06	1,79	12,65	0,53	23,65	606439	25,1	12,91	80080		0,2119

NOMBRE	**$TEUS_{TOTAL}$**	**$TEUS_{CUBIERTA}$**	**$TEUS_{BODEGA}$**	**% $TEUS_{CUBIERTA}$**	**% TEU_{BODEGA}**	**$TEU_{BODEGA}^{(1/3)}$**
Charlotte Schulte	5466	3484	1982	63,7	36,3	12,56
Maule	6589	3492	3097	53,0	47,0	14,58
CCNI Iquique	6865	4070	2795	59,3	40,7	14,09
MSC Altamira	8886	5056	3830	56,9	43,1	15,65
Mol Bravo	10010	5510	4500	55,0	45,0	16,51
Valparaíso Express	10593	6169	4424	58,2	41,8	16,42
APL Southampton	10642	5220	5422	49,1	50,9	17,57
HMM Promise	11167	6580	4587	58,9	41,1	16,62
MSC Beryl	12967	7053	5914	54,4	45,6	18,08
YM Window	14198	8034	6164	56,6	43,4	18,34
CMA Washington	14414	8420	5994	58,4	41,6	18,17
Marco Polo	16000	8600	7400	53,8	46,3	19,49

Una vez que tenemos los datos de buques similares llevaremos a cabo regresiones lineales, que nos permitirán obtener unas dimensiones principales de nuestro buque. A continuación, exponemos las relaciones empleadas en el estudio de las dimensiones, donde para cada dimensión del buque usaremos las ecuaciones que resultan de las regresiones.

Para conseguir una mayor fiabilidad en las dimensiones principales, nos apoyaremos en el estudio "Statistical Analysis and Determination of Regression Formulas for Main Dimensions of Container Ships based on IHS Fairplay Data" realizado por la Technical University of Denmark Hans Otto Kistensen. Las ecuaciones de dichas gráficas son la siguientes:

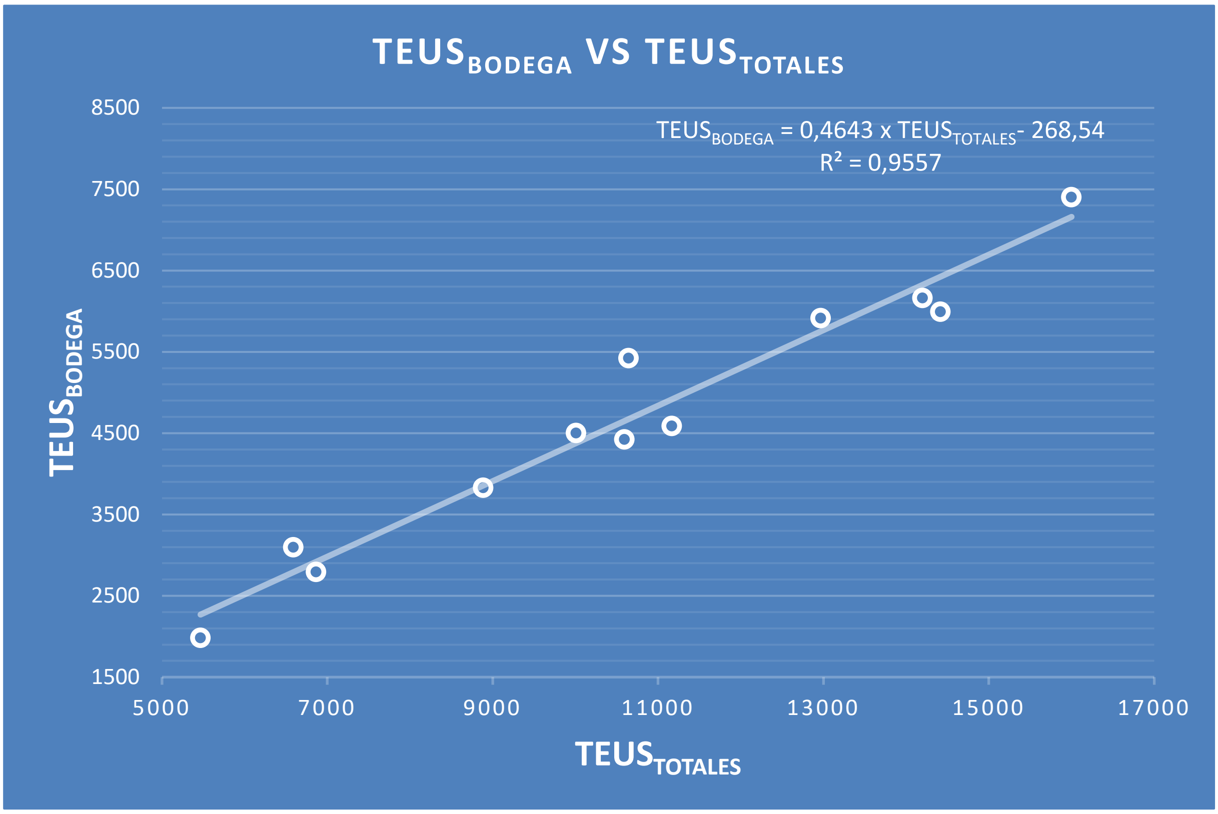
Appendix C – Post Panamax container ships (> 4000 TEU)

Length pp	$= 131.31 + 0.03012 * TEU – 0.00000099556 * TEU^2$ (<= 8000 TEU)
Length pp	$= 14.66 * TEU^{0.339}$ (> 8000 TEU)
Breadth	$= 32.51 + 0.0013 * TEU$
Depth	$= MIN(30.2,16.5 + 0.0011 * TEU)$
Draught	$= 12.73 + 0.0002 * TEU$
Lightweight/Lpp/B/D	$= MAX(0.09,0.104 – 0.00000115 * TEU)$
Dw/TEU	$= MAX(11.2;50.43 * TEU^{-0.16})$

A continuación realizaremos los calculo de cada una de las dimensiones principales mediante regresiones lineales empleando los buques de la base de datos

2.1 Cálculo de TEU´s en bodega y cubierta

En primer lugar, procedemos al cálculo de los contenedores que podemos transportar en bodegas. Relacionando los TEUS en bodega frente a los TEUS totales de los buques de la base de datos obtenemos una recta de regresión como se muestra en la figura. Con esa ecuación y sustituyendo los TEUS totales, que en nuestro caso son 11000, llegamos al siguiente resultado:

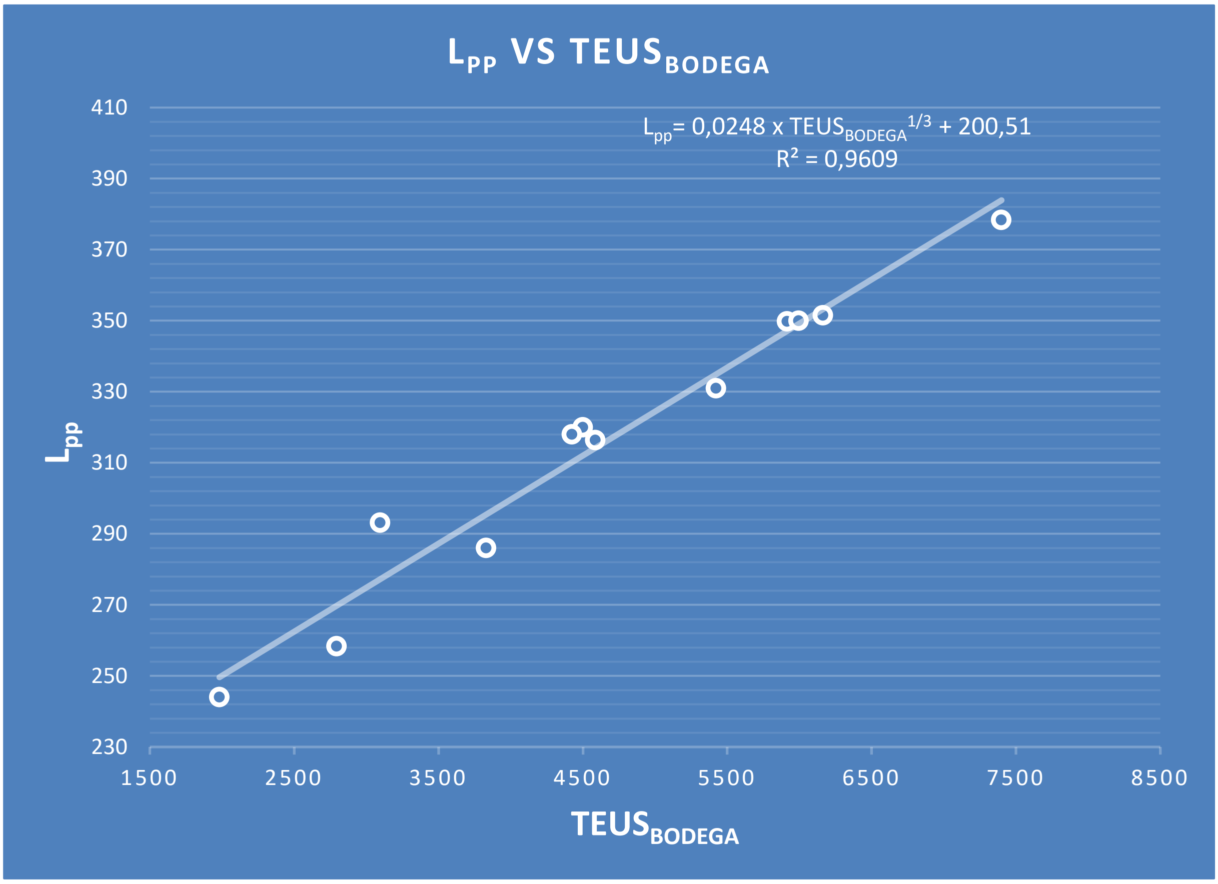


$$TEUS_{BODEGA} = 0{,}4643 \times TEUS_{TOTALES} - 268{,}54 = 4839\ TEUS_{BODEGA}$$

Esto supone que de los 11000 TEUS totales que transportamos, el buque alberga dentro de la bodega el 44% de la carga, frente al 66% que estaría dispuesto sobre la cubierta.

2.2 Cálculo de la eslora entre perpendiculares

Para el cálculo de la eslora entre perpendiculares empleamos el número de TEUS en bodega que obtuvimos con anterioridad. En este caso la regresión se obtiene relacionando la eslora entre perpendiculares frente al termino $TEUS_{BODEGA}^{1/3}$.



Sustituyendo el valor de $TEUS_{BODEGA}^{1/3} = 16,914$ en la ecuación obtendremos el siguiente resultado:

$$L_{pp} = 0,0248 \times TEUS_{BODEGA}^{1/3} + 200,51 = 320,51 \text{ m}$$

L_{pp} =320,51 m

Según las gráficas del estudio, para un buque de 11000 TEU´s:

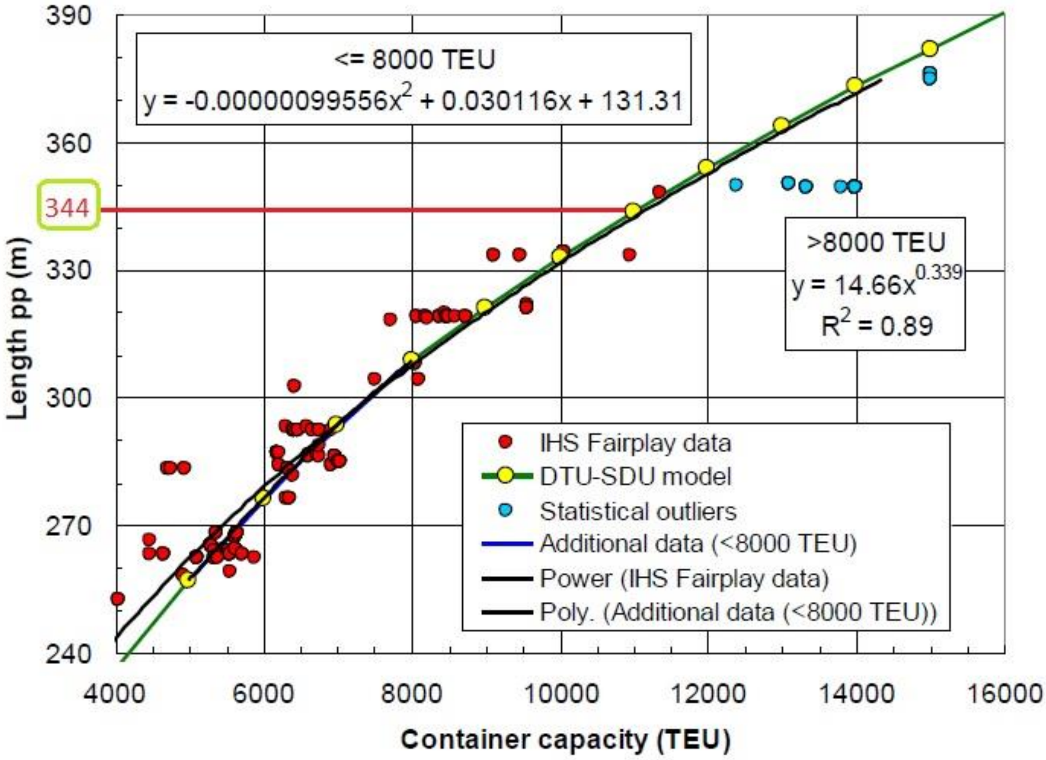
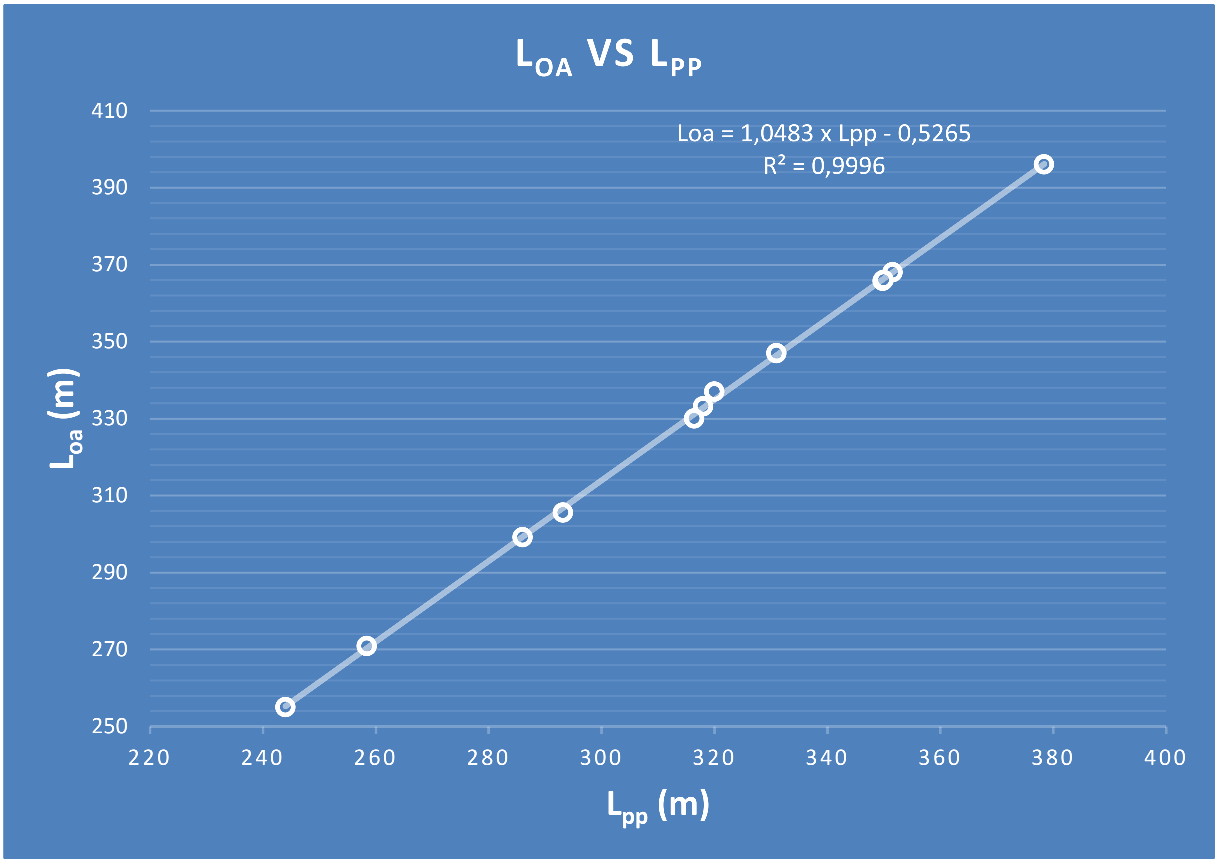


Fig. C1 Length between pp as function of TEU

El valor obtenido para la eslora entre perpendiculares es de 343,7 m

2.3 Cálculo de la eslora total

La eslora total estará directamente relacionada con la L_{PP}, que según se ha visto en el paso anterior era de L_{pp} = 320,51 m.



L_{OA} = 1,0483 x L_{pp} - 0,5265 = 335,465 m

El valor obtenido para la eslora total de nuestro buque será:

L_{OA} = 335,465 m

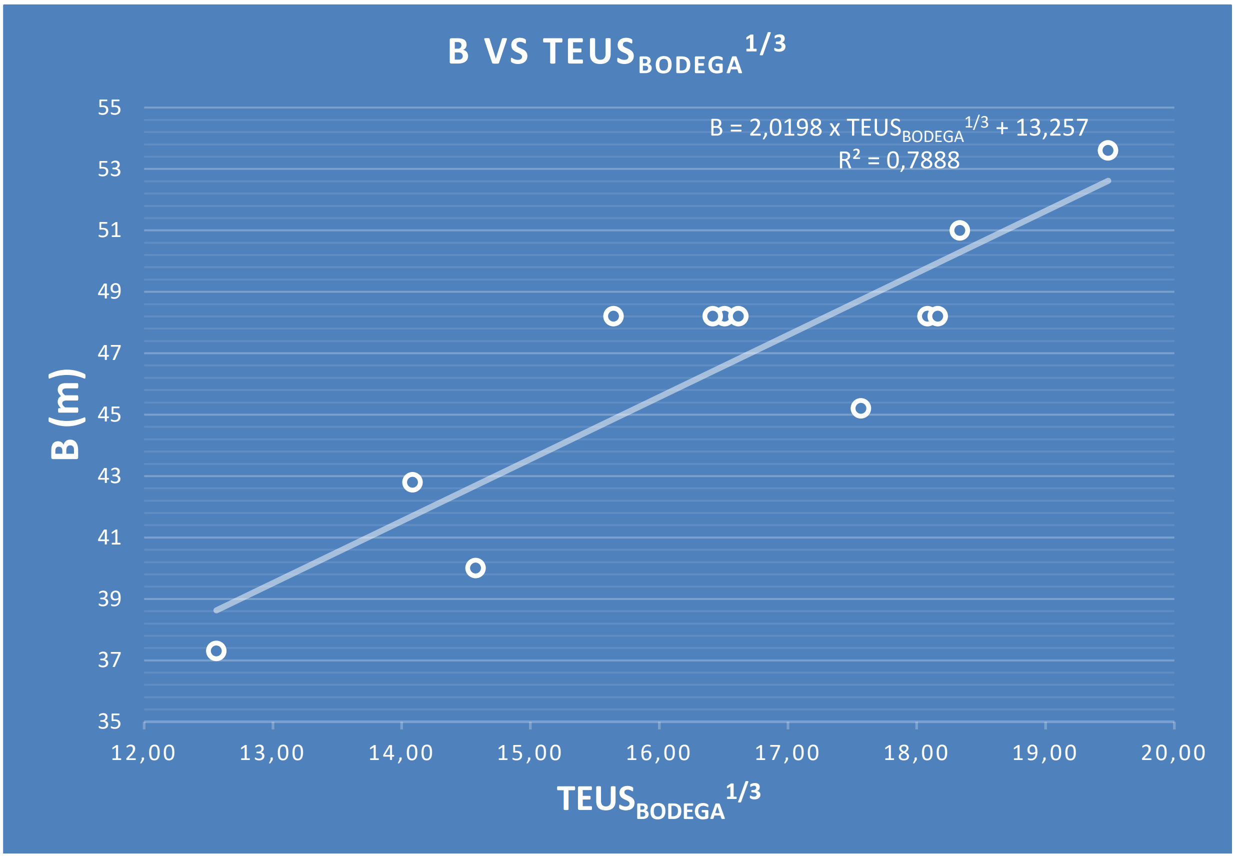
El estudio no dispone de ninguna grafica para el calculo de la eslora total, sin embargo podemos comprobar el valor obtenido si aplicásemos la ecuación anterior obtenida mediante regresiones al valor de L_{PP} devuelto por la gráfica.

Para una eslora entre perpendiculares de 343,7 m, el buque debería de tener una Loa = 360 m. Consideraremos este valor como el obtenido para la eslora total mediante las gráficas del estudio.

2.4 Cálculo de la manga

Para el cálculo de la manga emplearemos dos regresiones lineales relacionando la manga con los $TEUS_{BODEGA}^{1/3}$, y acto seguido obtendremos la relacion entre L_{PP}/B y la L_{PP}.

Recordemos que se obtuvo un valor de $TEUS_{BODEGA}^{1/3} = 16{,}914$.



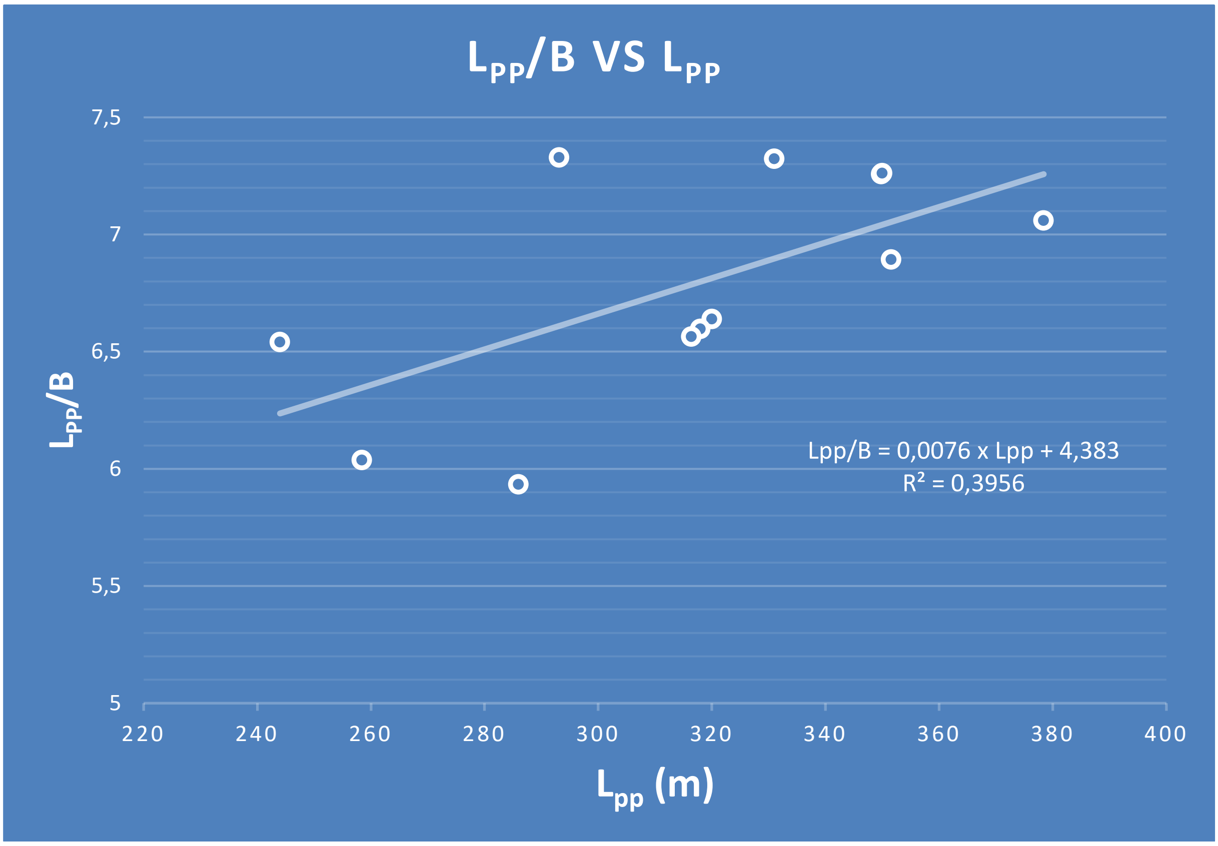
El primer valor que obtenemos para la manga de nuestro buque es de:

$$B_1 = 2{,}0198 \times TEUS_{BODEGA}^{1/3} + 13{,}257 = 47{,}42 \text{ m}$$

$$B_1 = 47{,}42 \text{ m}$$

A continuación obtendremos el segundo valor para la manga, que resulta de comparer la relación adimensional L_{PP}/B frente a la eslora entre perpendiculars.

Resordemos que el valor de la L_{PP} era de 320,51 m.



$$L_{pp}/B_2 = 0{,}0076 \times L_{pp} + 4{,}383 = 6{,}82$$

$$B_2 = 47 \text{ m}$$

El valor promedio de la manga será: $B = (B_1 + B_2) / 2 = 47{,}21$ m

B = 47,21 m

Según el estudio podemos obtener el valor de la manga a partir del número de TEU´s mediante la siguiente gráfica.

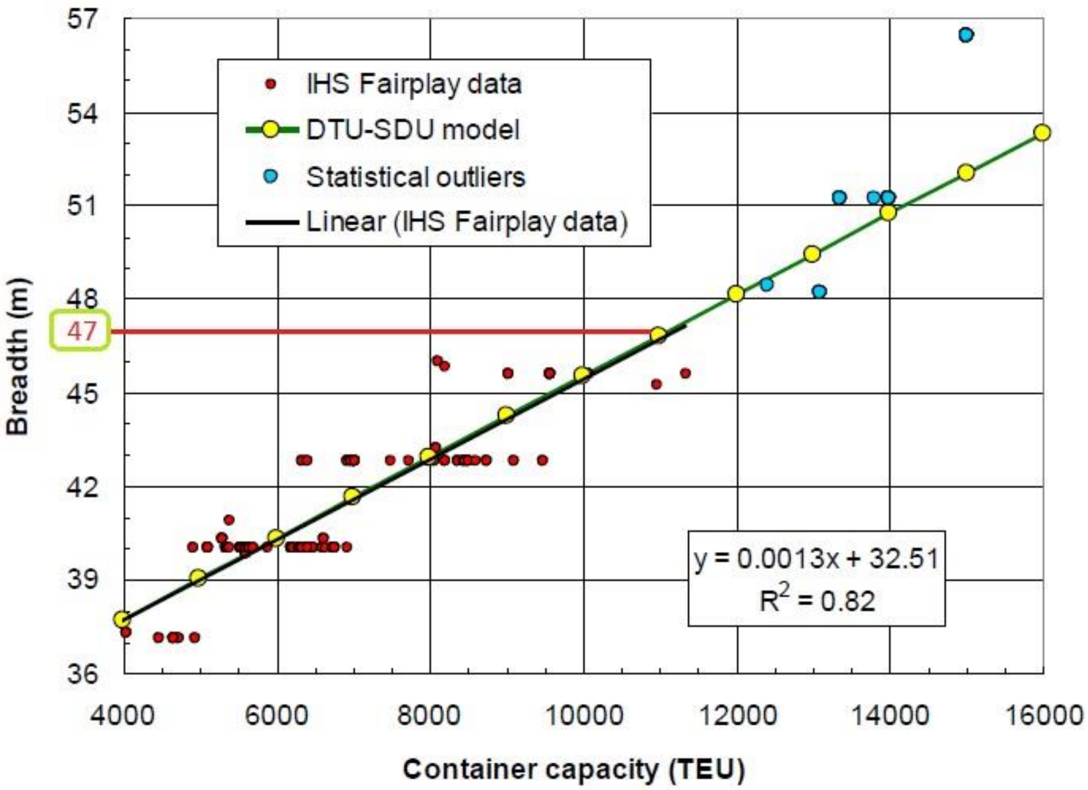


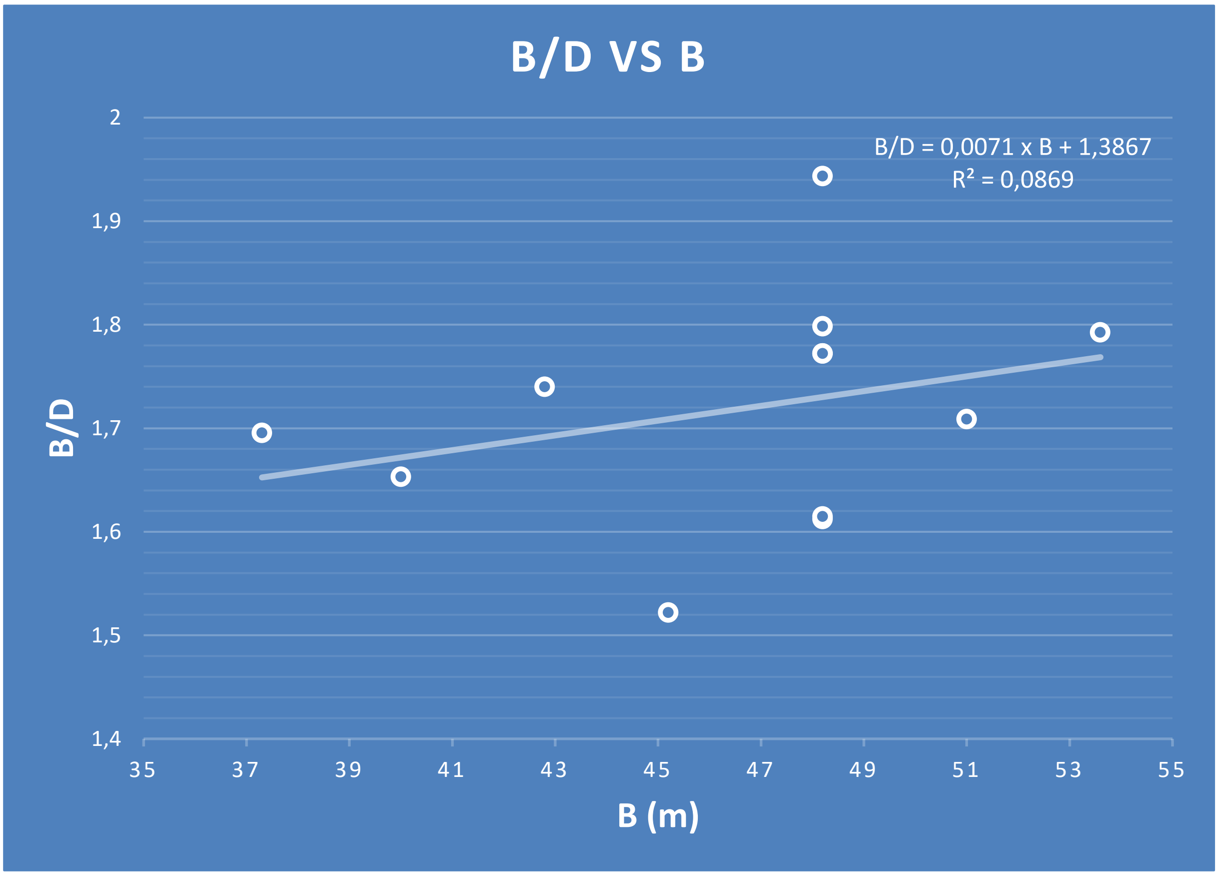
Fig. C2 Breadth as function of TEU

El valor obtenido para la manga será de B = 46,81 m.

2.5 Cálculo del puntal

Para buques de volumen, el puntal prima antes que el calado, por lo que en este cálculo obtendremos tres regresiones diferentes.

En primer lugar, tenemos la relación B/D frente a la manga, recordando que en nuestro caso la manga era de 47,21 m.

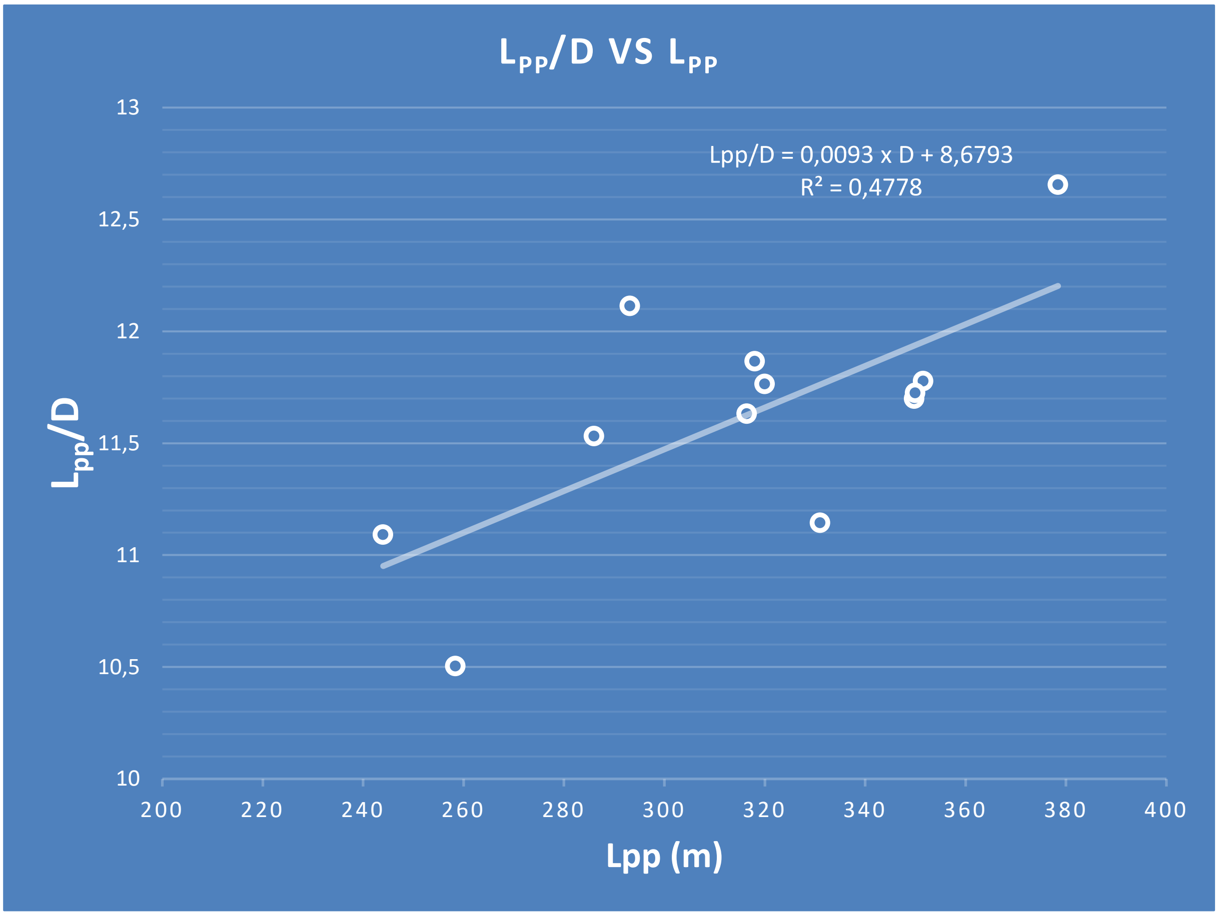


$$B/D_1 = 0,0071 \times B + 1,3867 = 1,72$$

$$D1 = 27,42 \text{ m}$$

Acto seguido la regresión que relaciona LPP/D frente a LPP nos proporciona el segundo valor de nuestro puntal.

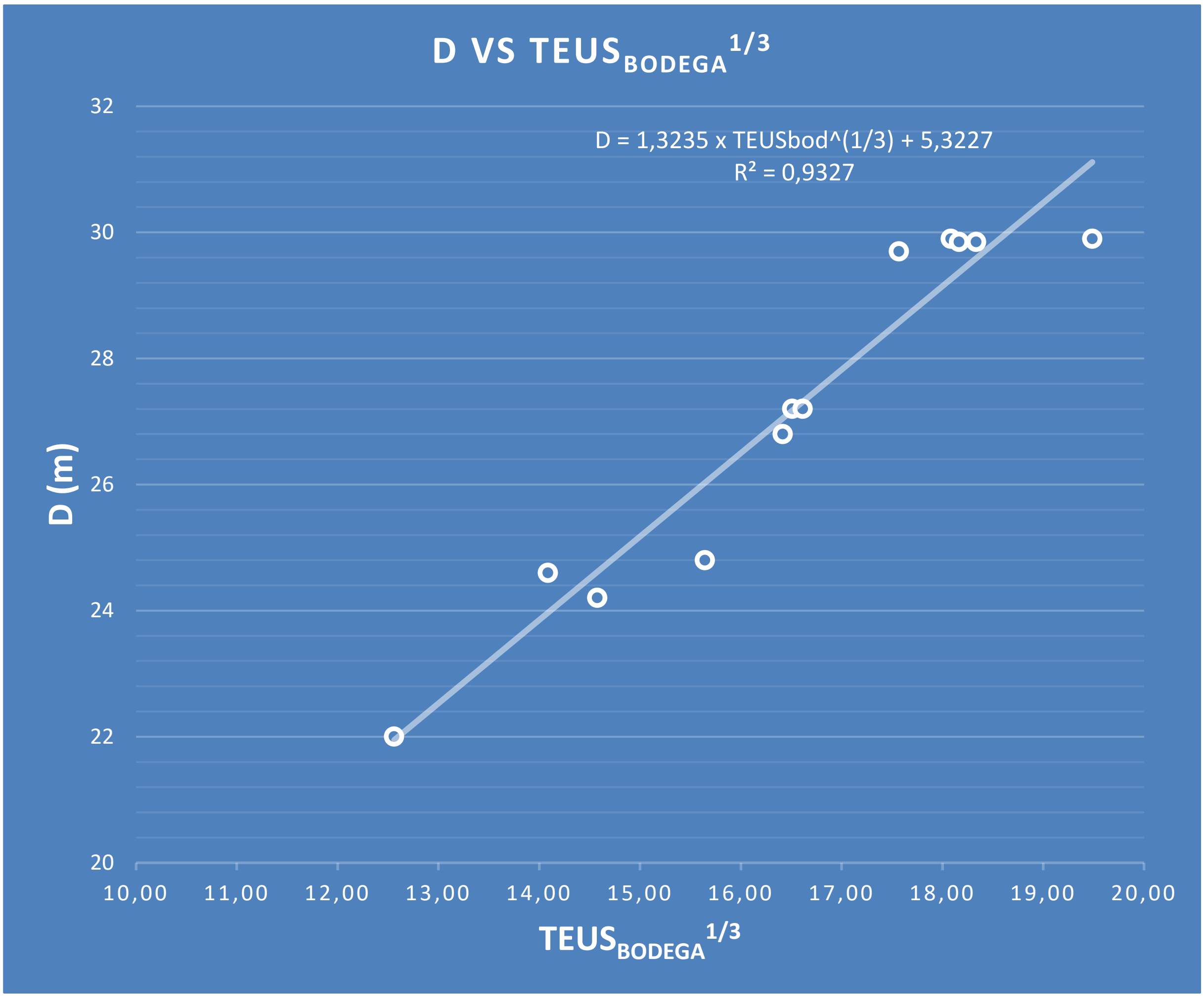
El valor que obtuvimos antes de la L_{PP} era de 320,51 m.



$$L_{pp}/D_2 = 0{,}0093 \times L_{pp} + 8{,}6793 = 27{,}5 \text{ m}$$

$$D_2 = 27{,}5 \text{ m}$$

Por último, el valor del tercer calado surgirá de relacionar D frente a $TEUS_{BODEGA}^{1/3}$. Recordemos que el valor de $TEUS_{BODEGA}^{1/3}$ era 16,9.



$$D_3 = 1,3235 \text{ x } TEUS_{BODEGA}^{1/3} + 5,3227 = 27,7 \text{ m}$$

El calor promedio del puntal será: $D = (D_1 + D_2 + D_3)/3 = 27,54$ m

D = 27,54 m

Según las gráficas del estudio:

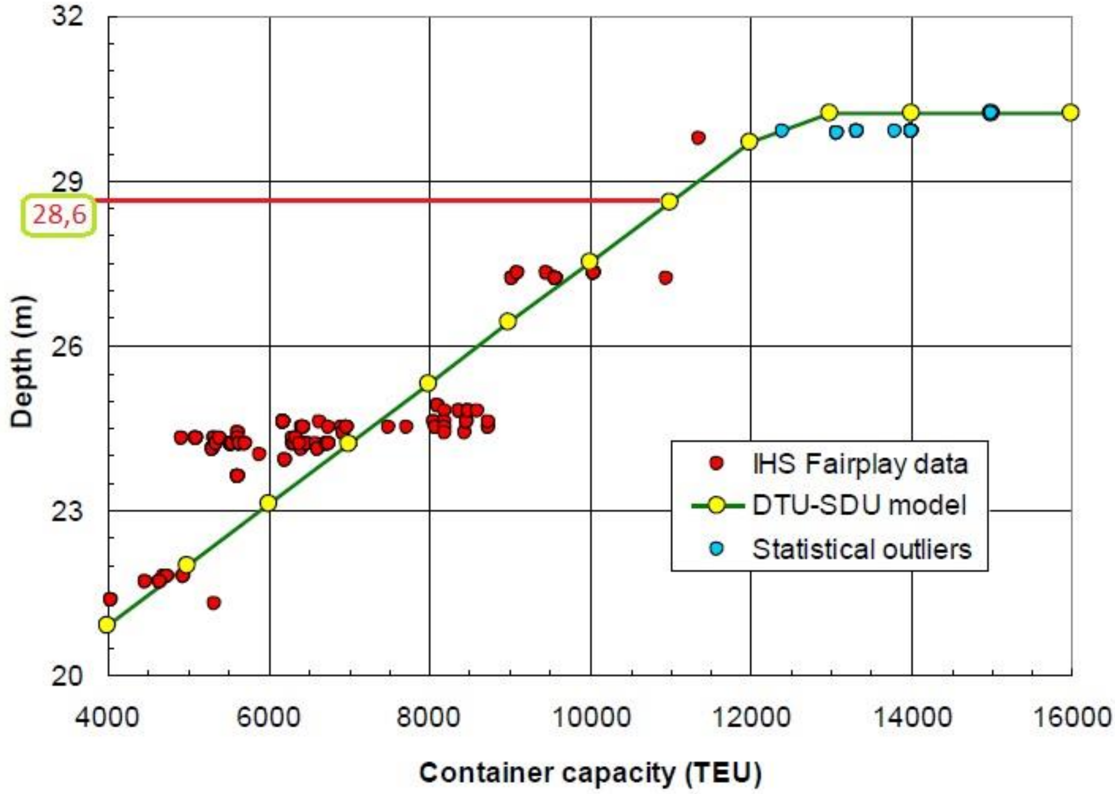


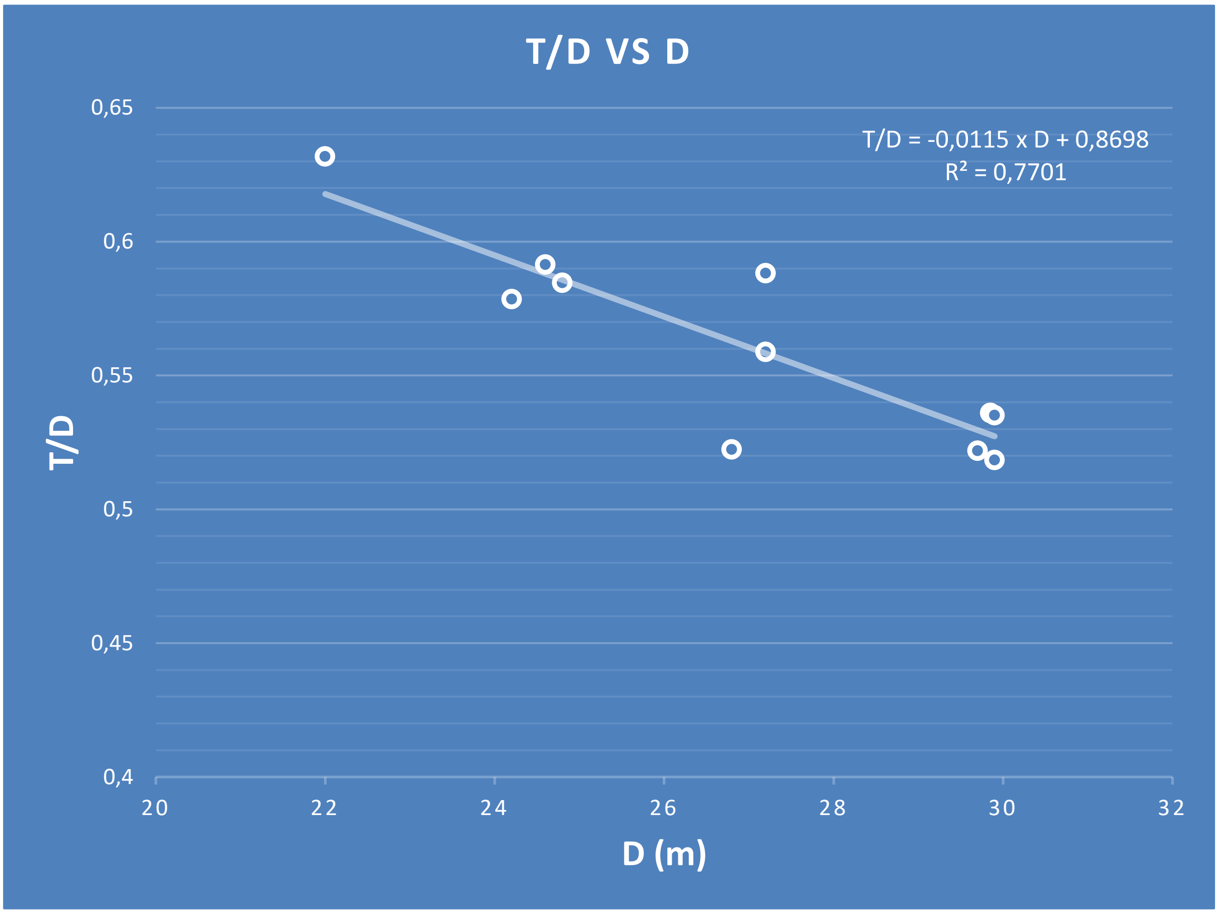
Fig. C3 Depth as function of TEU

El valor del puntal será D = 28,6 m.

2.6 Cálculo del calado

Al igual que en el cálculo del puntal, para dimensionar el calado del buque usaremos tres regresiones diferentes, con lo que se busca una mayor precisión en los resultados.

La primera de las regresiones se obtiene relacionan T/D frente a D, donde emplearemos el valor obtenido para el calado donde D = 27,54 m.

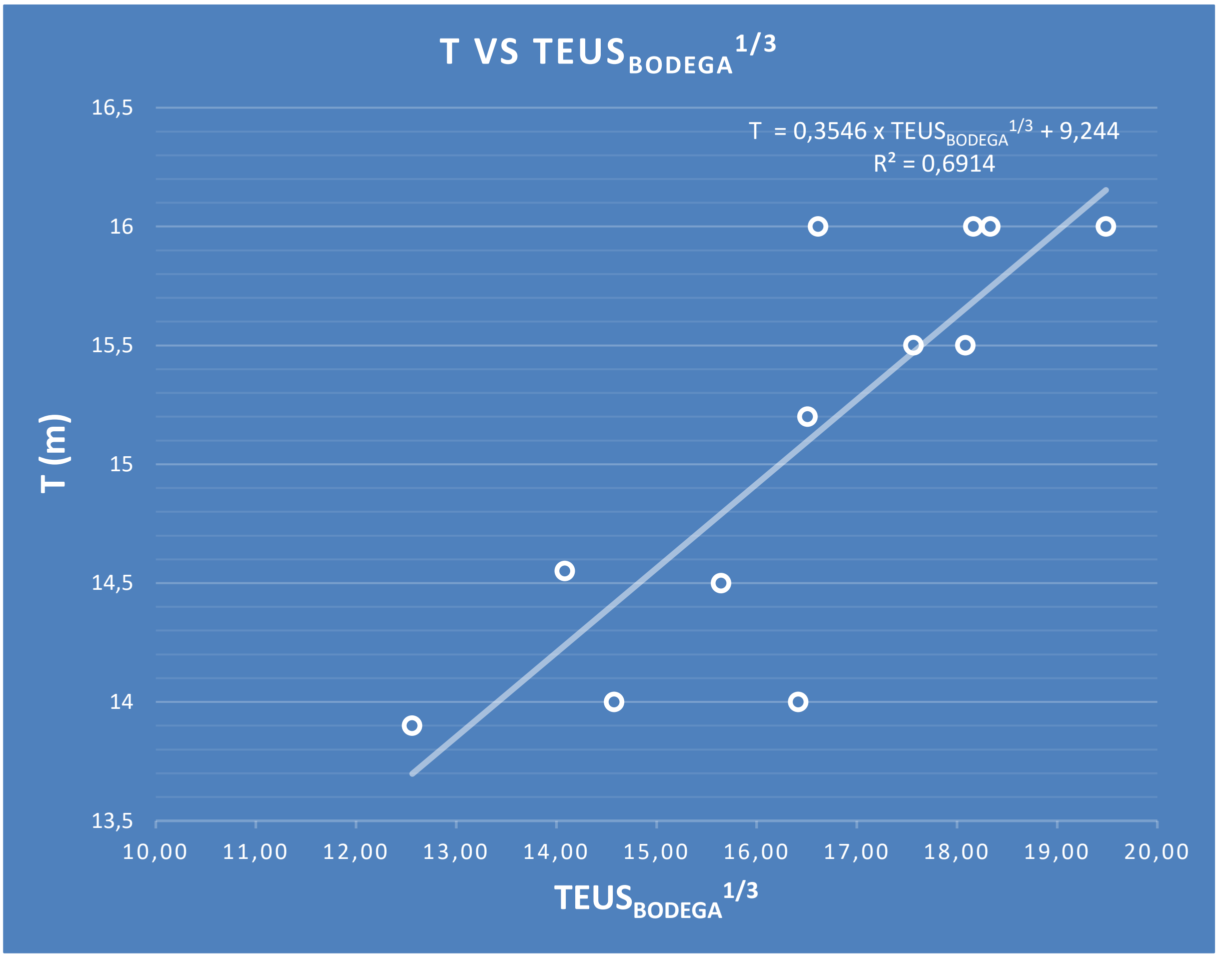


El resultado de aplicar la ecuación de la recta a calado se muestra a continuación:

$$T_1/D = -0{,}0115 \times D + 0{,}8698 = 0{,}55311$$

$$T_1 = 15{,}2317 \text{ m}$$

El siguiente paso será relacionar el calado frente a los $TEUS_{BODEGA}^{1/3}$, que según hemos visto anteriormente era de 16,9.

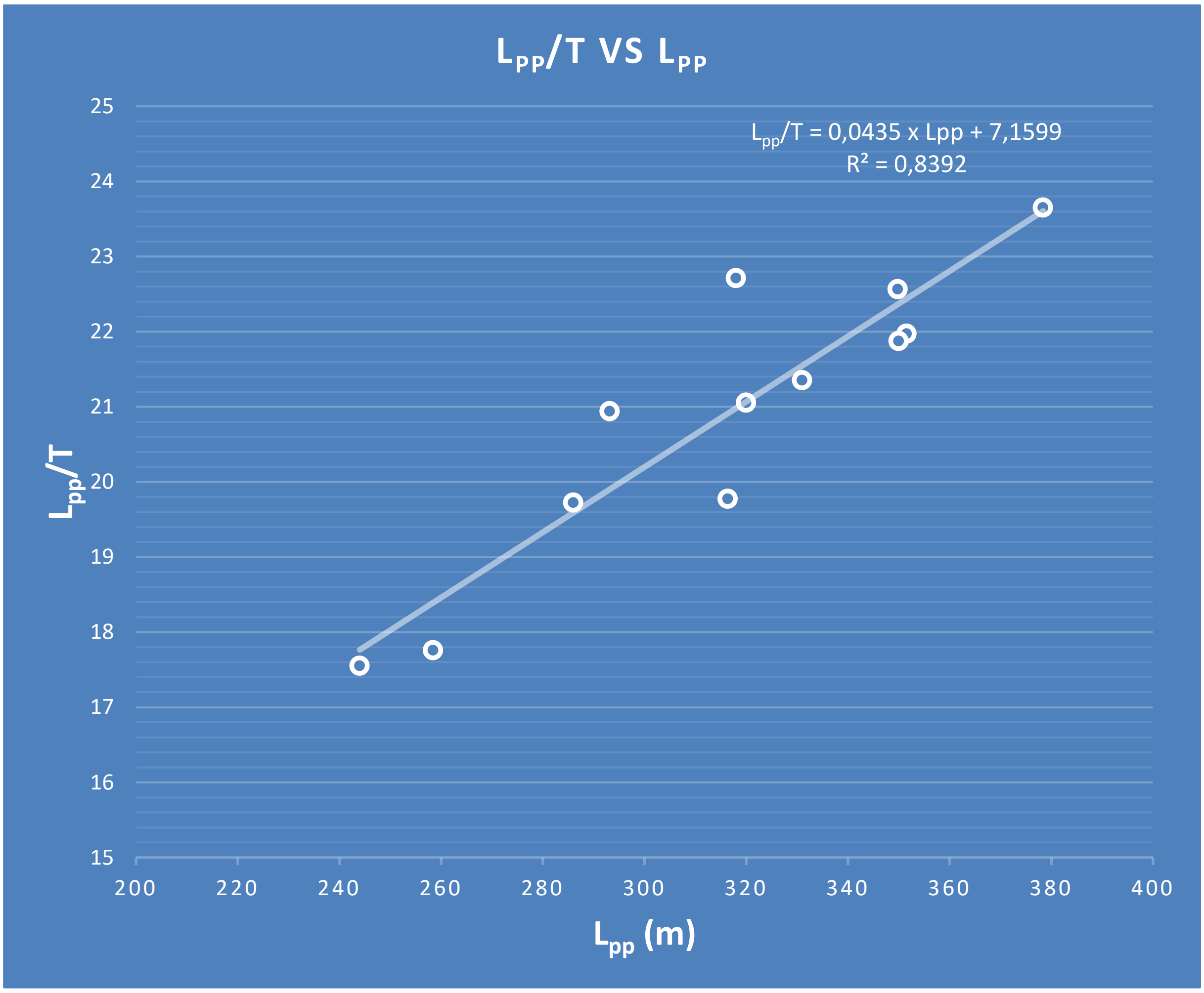


$$T_2 = 0,3546 \times TEUS_{BODEGA}^{1/3} + 9,244 = 15,24 \text{ m}$$

$$T_2 = 15,24 \text{ m}$$

Por último, la regresión resultante de enfrentar L_{PP}/T y L_{PP} nos lleva al tercer valor para el calado.

Recordemos que el valor de la L_{PP} era de 320,51 m.



$$L_{pp}/T_3 = 0,0435 \times L_{pp} + 7,1599 = 21,1021$$

$$T_3 = 15,1886 \text{ m}$$

El valor promedio del calado será: $T = (T_1 + T_2 + T_3)/3 = 15,22$ m

T =15,22 m

Según el estudio el calado que debería tener nuestro buque será el siguiente.

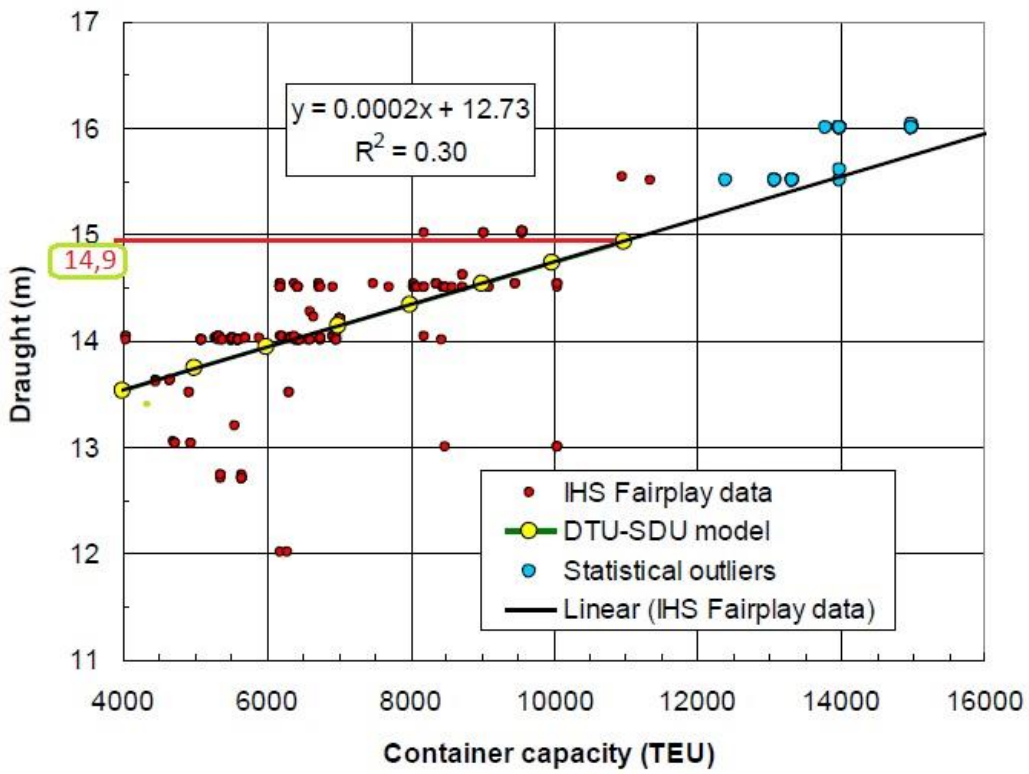


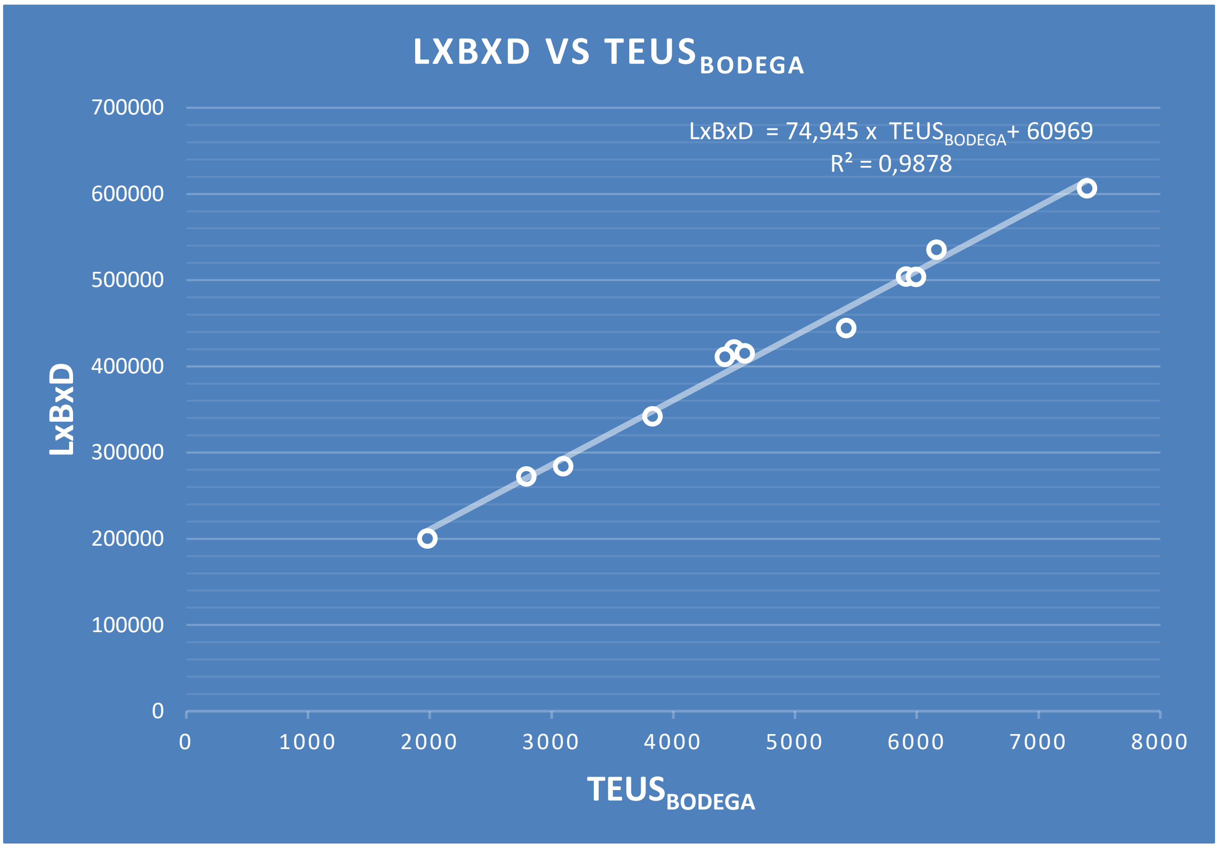
Fig. C4 Maximum draught as function of TEU

El calado del buque es de 14,93 m.

2.7 Cálculo del factor LxBxD

El factor LxBxD nos aporta información relativa a la capacidad de carga de nuestro buque, que en el caso de un portacontenedores cobra mas relevancia si cabe.

Dicho factor se obtiene relacionando los diferentes factores LxBxD de la base de datos frente a $TEUS_{BODEGA}$



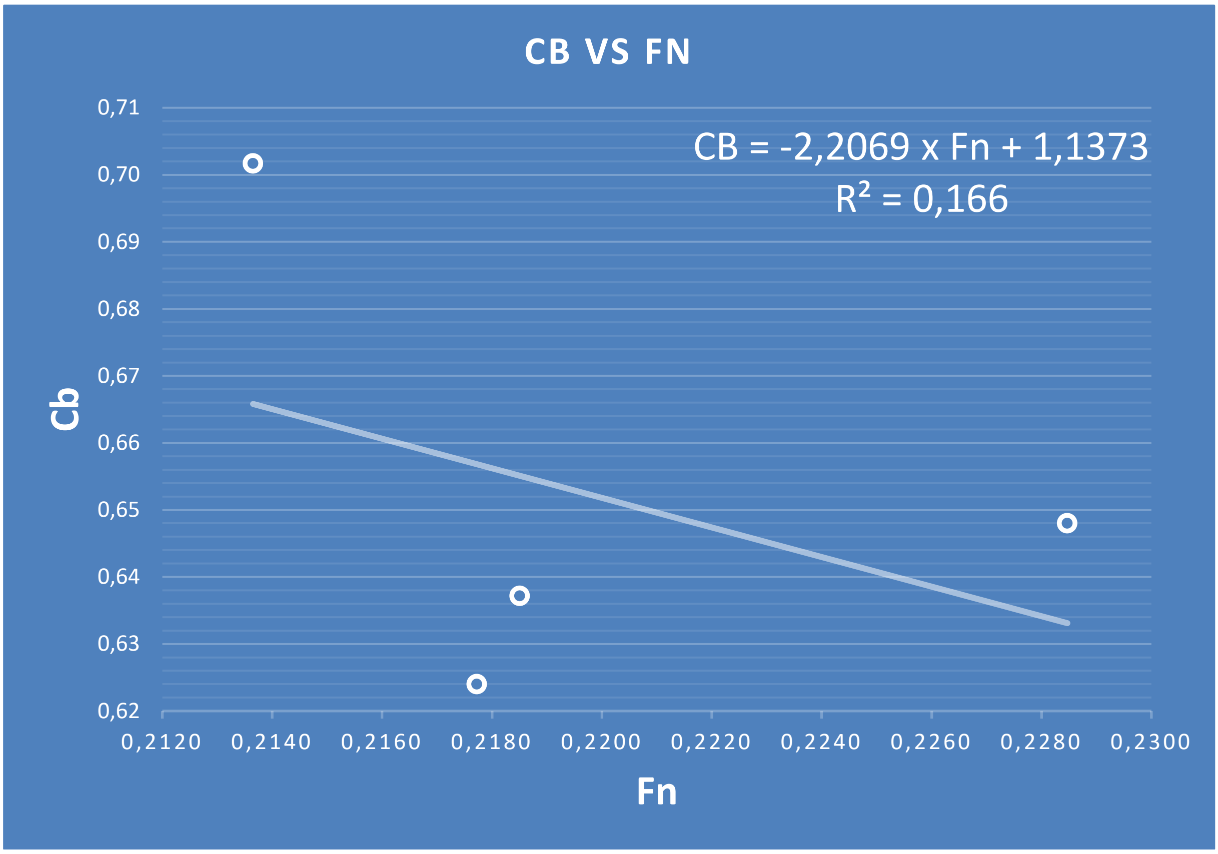
Aplicando los datos calculados anteriormente a la ecuación de la recta obtenemos:

$$LxBxD = 74{,}945 \times TEUS_{BODEGA} + 60969 = 423610$$

LxBxD = 423610

2.8 Cálculo del coeficiente de bloque

El cálculo del coeficiente de bloque se realizará relacionando los C_B frente a los F_N.



$$F_N = \frac{v}{\sqrt{g \times Lpp}}$$

F_N = 0,18347

C_B = (-2,2069 x F_N) + 1,1373 = 0,7324

C_B = 0,7324

Este valor es demasiado elevado para este tipo de barco, por lo que obtendremos nuestro coeficiente de bloque analizando los datos obtenidos en un estudio de la Technical University of Denmark. En dicho estudio se expone la relación entre el número de TEU´s y las diferentes dimensiones del buque, con lo que para 11000 TEU´s se corresponde con un C_B = 0,67.

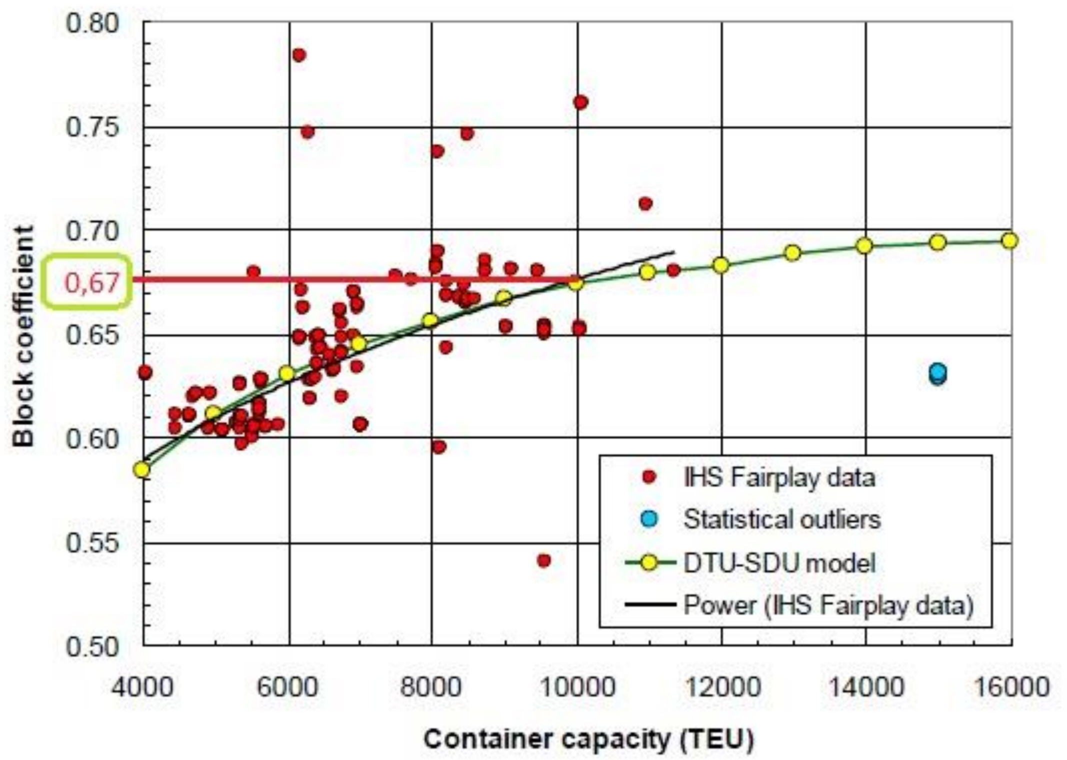


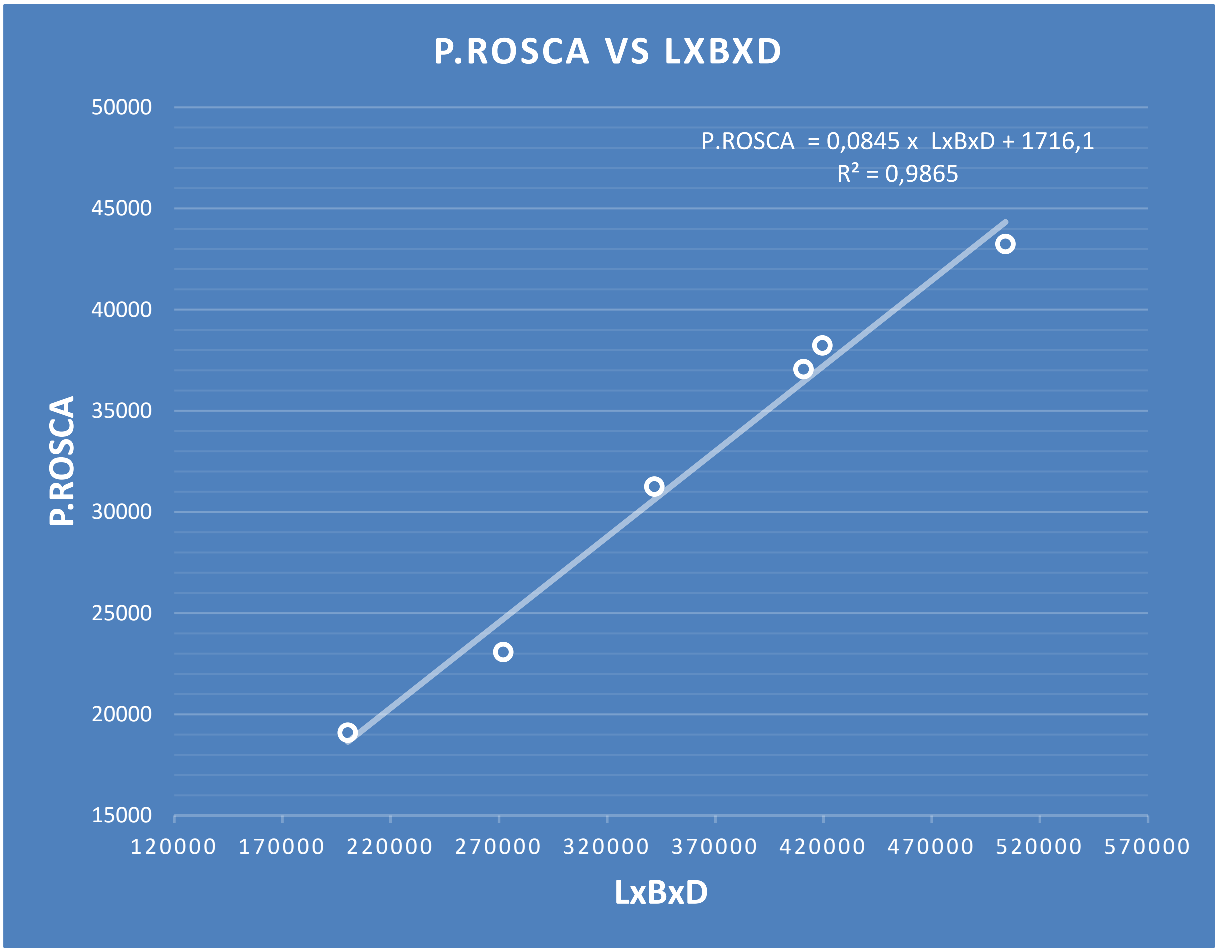
Fig. C5 Block coefficient as function of TEU

Este valor se ajusta mucho más al de otros buques de similares características.

C_B = 0,67

2.9 Cálculo del peso en rosca

Para el cálculo del peso en rosca del buque hemos realizado la regresión empleando los diferentes pesos en rosca frente al factor LxBxD de la base de datos y aplicando a la ecuación de la recta el valor obtenido anteriormente de LxBxD = 423610.

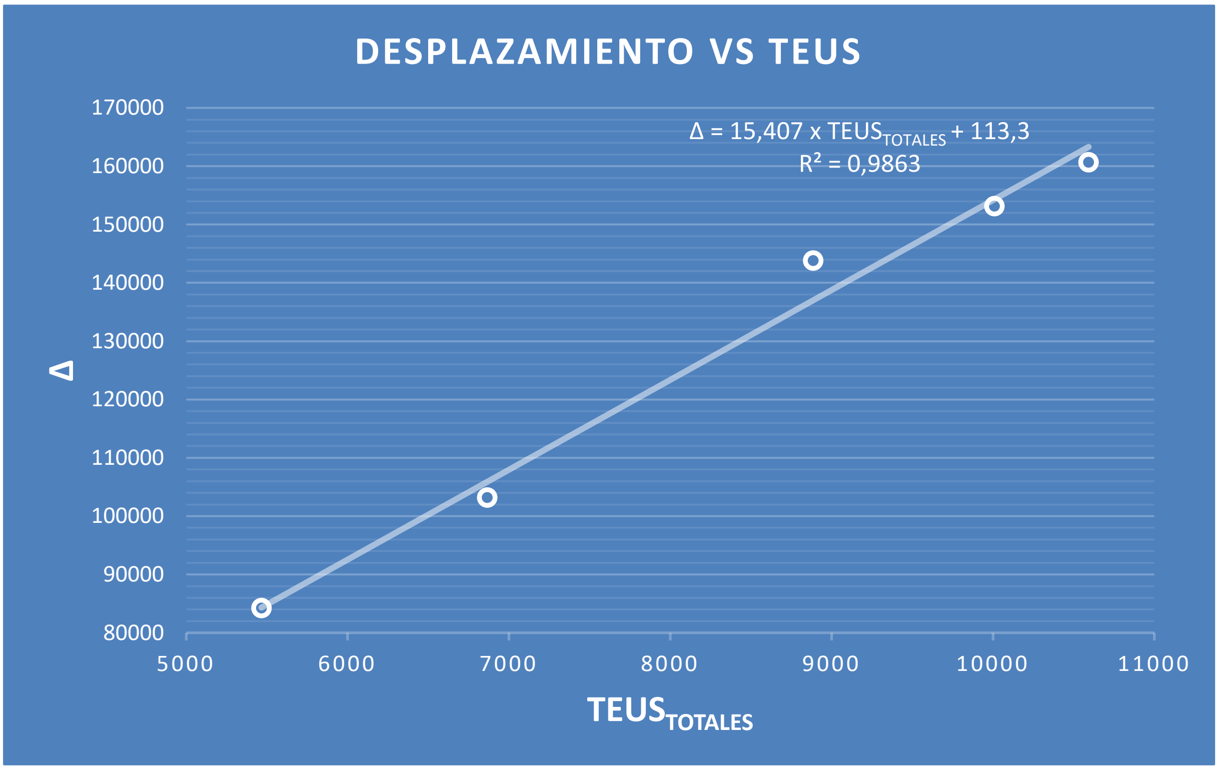


Peso en Rosca = (0,0845 x LxBxD) + 1716,1 = 37511,1 t

Peso en Rosca = 37511,1 t

2.10 Cálculo del desplazamiento

En este apartado calcularemos el desplazamiento de nuestro buque en función de la capacidad de contenedores totales que puede transportar. En este caso no disponemos de todos los desplazamientos de los buques de nuestra base de datos.



Recordando que nuestro buque tiene capacidad para transportar 11000 TEUS, los resultados serán los siguientes:

$$\Delta = (15{,}407 \times TEUS_{TOTALES}) + 113{,}3 = 169590 \text{ t}$$

$$\mathbf{\Delta = 169590 \text{ t}}$$

En el estudio no se relaciona directamente el número de TEU´s con el desplazamiento, si no que en el eje de ordenadas se introduce un factor resultante de dividir la LPP entre el valor del desplazamiento elevado al cubo, como se muestra en la figura.

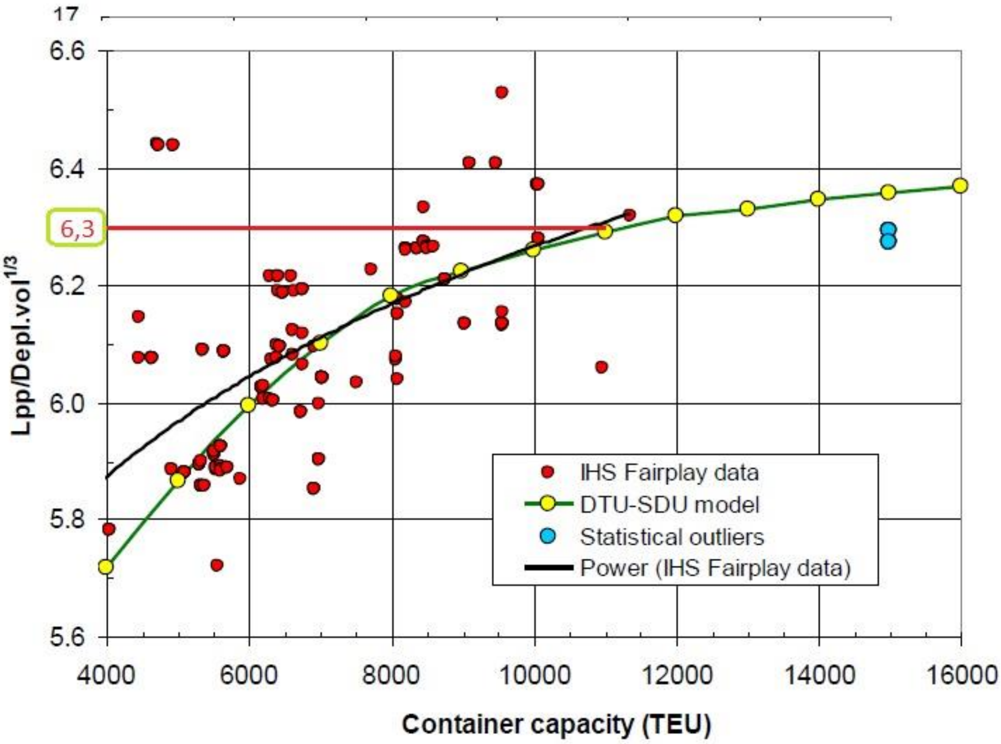


Fig. C6 Length displacement ratio as function of

$$\frac{Lpp}{\sqrt[3]{\Delta}} = 6{,}3$$

Donde sabemos de apartados anteriores que L_{PP} = 343,7 m.

El valor obtenido para el desplazamiento es de 162375 t.

2.11 Cálculo de coeficientes

2.11.1 Cálculo del coeficiente de bloque

Otra forma de obtener los coeficientes de bloque, coeficiente de la maestra y el coeficiente prismático seria mediante formulación:

- Towsin:

$$C_B = 0,7 + 0,125 * Arctan\,[\,25 * (0,23 - F_N)\,] = 0,8$$

- Minorsky

$$C_B = 1,22 - 2,38 * F_N = 0,78$$

- Van Lammeren: Este valor difiere un poco del resto posiblemente debido a que en esa época todavía no existían o era usuales los buques portacontenedores.

$$C_B = 1,37 - 2,02 * Fn = 0,999$$

Los valores obtenidos mediante formulación nos devuelven un CB demasiado elevados, como podemos ver al compararlos con los valores calculados anteriormente mediante regresiones lineales.

Por tanto el valor de nuestro coeficiente de bloque será de CB = 0,67.

2.11.2 Cálculo del coeficiente de la sección media

Para los cálculos tomaremos el valor C_B obtenido en las regresiones, donde **C_B = 0,67.**

- Kerlen

$$C_M = 1,006 - 0,0056 * Cb^{-3,56} = 0,9826$$

- El HSVA

$$C_M = \frac{1}{(1+(1-Cb)\text{^}3,5)} = 0,9797$$

- J.Torroja

$$F_N = 0,18347 \rightarrow C_M = 1 - 2 * Fn^4 = 0,9977$$

- M.Meizoso

$$C_M = 1 - 0,062 * F_N^{0,792} = 0,9838$$

El valor medio obtenido para el C_M es:

C_M = 0,985

2.11.3 Cálculo del coeficiente prismático

- Coeficiente prismático (C_{PL}):

  $C_{PL} = C_B / C_M = 0,68$

- Troost:

  $C_{PL} = k_1 - 2,12 * F_N$

  k_1 (1 hélice) = 1,2 → *$C_{PL} = 0,811$*

El valor medio que obtenemos para el coeficiente prismático es:

C_{PL} = 0, 7864

2.12 Dimensiones principales del buque

DIMENSIONES PRELIMINARES	**REGRESIONES**	**ESTUDIO**	**VALOR MEDIO**	
ESLORA TOTAL (L_{OA})	335,46	360	**347,6**	m
ESLORA ENTRE PERPENDICULARES (L_{PP})	320,51	343,7	**332**	m
MANGA (B)	47,21	46,81	**47**	m
PUNTAL (D)	27,54	28,6	**28**	m
CALADO (T)	15,22	14,93	**15**	m
VELOCIDAD DE SERVICIO (Kn)	20	20	**20**	nudos
VELOCIDAD DE SERVICIO (m/s)	10,29	10,29	**10,29**	m/s
NUMERO DE FROUDE (F_N)	0,18	0,18	**0,18**	-
TEUS TOTALES	11000	11000	**11000**	TEUS
TEUS EN BODEGA	4839	4839	**4839**	TEUS
TEUS EN CUBIERTA	6161	6161	**6161**	TEUS
COEFICIENTE DE BLOQUE (C_B)	0,67	0,67	**0,67**	-
COEFICIENTE DE LA SECCION MEDIA (C_M)	0,985	0,985	**0,985**	-
COEFICIENTE PRISMATICO (C_{PL})	0,68	0,68	**0,68**	-
PESO EN ROSCA	37511,13	36975	**37234**	t
PESO MUERTO	132079	125400	**128740**	
DESPLAZAMIENTO (Δ)	169590,3	162375	**165974**	t
LxBxD	423610	-	**423610**	-

3 ELECCIÓN DE LA CIFRA DE MÉRITO

A continuación, realizaremos una evaluación económica preliminar, adoptando con cifra de mérito el coste de construcción del buque, dado que es la partida que mayor interés despierta en los intereses del astillero. Para dicho análisis se han utilizado las fórmulas expuestas en “Proyectos de buque y artefactos. Criterios de evaluación técnica y económica del proyecto de un buque” del profesor Fernando Junco.

Coste de construcción: CC = CMg + CEq + CMo + CVa

Coste de materiales a granel (CMg):

$$CMg = cmg * PS = ccs * cas * cem * ps * PS$$

Donde:

- ccs: coeficiente de coste ponderado de chapas y acero de distintas calidades (1,05 < ccs < 1,1 hasta 1,5). En nuestro caso ccs = 1,3.
- cas: coeficiente de aprovechamiento del acero (1,08 < cas <1,15). En nuestro caso cas = 1,08.
- cem: coeficiente de incremento por equipo metálico incluido en la estructura (1.03 < cem < 1,1). En nuestro caso cem = 1,03.
- ps: precio unitario de acero. En nuestro caso obtenemos un valor aproximado expuesto en los apuntes de la asignatura, ps = 450€/ton.
- PS: peso de aceros del buque. Para calcular el peso de aceros utilizaremos la siguiente expresión

Donde:

K = 0,03
L_{PP} = 332 m
B = 47 m
D = 28 m

Formula de Miller:

$$PS = 8400 * (L * B * D/10^5)^{0,9} * (0,675 + Cb/2) * [0,00585 * (L/D - 8,3)^{1,8} + 0,939]$$

PS (MILLER) = 29450,6 ton

Sustituyendo los valores obtenidos en la fórmula obtenemos:

CMg = 19164955 €= 19,1 M€

Coste de los equipos (CEq) y de su montaje (CMe):

CEq + CMe = CEc + Cep + CHf + CEr

Donde:

- CEc: coste de equipos de manipulación de la carga. En nuestro caso será nulo dado que el buque no posee medios propios para manipulación de la carga.
- CEp: coste de equipos de propulsión y auxiliares.

*CEp = cep * BP*

Donde:

- cep: coste por unidad de potencia de los equipos de propulsión y auxiliares (300 < cep < 400€/kW). En nuestro caso tomaremos cep = 350€/kW.
- BP: potencia propulsora total. Para la estimación de la potencia utilizaremos la formulación de Watson:

$$BP = (0,889*(\Delta^{2/3})*(40-(Lpp/61)+400*(k-1)^2-(12*C_B))/(1500-181*N*raiz(Lpp))$$

$$K = C_B+((0,5*V)/raiz(3,28*Lpp)) = 0,973$$

$$\Delta = \rho*C_B*L*B*T = 160740\ ton$$

Donde:

N = 88 rpm (Base de datos)
L_{PP} = 332 m
B = 47 m
T = 15 m
V = 20 nudos
CB = 0,67

Sustituyendo los valores obtenemos una potencia de 53967 BHP, o lo que es lo mismo *BP = 40243 kW*.

CEp = 14085184,15 €

- CHf: coste de habilitación y montaje.

$$CHf = chf * nch * NT$$

Donde:

- chf: coeficiente unitario de la habilitación por tripulante (32000 < chf < 35000 €/tripulante). En nuestro caso tomaremos chf = 33000 €/tripulante.
- nch: coeficiente de nivel de calidad de la habilitación (0,9 < nch < 1,2). Nuestro valor será de nch = 1,1.
- NT: número de tripulantes. En las RPA se especifica que habrá 30 tripulantes.

Sustituyendo obtenemos que *CHf = 1089000€*

- CEr: coste de equipo restante instalado.

$$CEr = ccs * ps * Per$$

Donde:

- Per: peso de equipos restantes

$$Per = K * L^{1,3} * B^{0,8} * D^{0,3}$$

Per = 4481

K=0,04

Sustituyendo los valores *CEr = 2621385 €*

El coste de equipos será **CEq= 17795569 €**

<u>Coste de mano de obra (CMo):</u>

$$CMo = CMm + Cme = chm * csh * PS$$

Donde:

- chm: coste horario medio del astillero (21/25<chm<10/40€/hora). En nuestro caso chm = 30 €/hora.
- csh: coeficiente de horas por unidad de peso (20/30<csh<80/100 h/ton). En nuestro caso csh = 40 h/ton.
- PS (MILLER) = 29450,38 ton

Sustituyendo los valores obtenemos que **CMo = 35340460 €**

<u>Costes varios aplicados (CVa):</u>

$$CVa = cva * (CMg + CEq + CMo)$$

Donde cva =7,5% (5<cva< 10% CC), el valor obtenido será **CVa = 5422574 €**

El coste total de construcción de nuestro buque será:

CC = 77723558 € = 77,7 M€

4 ESTUDIO DE ALTERNATIVAS

A continuación realizaremos un estudio las dimensiones alternativas a nuestro buque inicial, seleccionando la mas favorable para el astillero. Para ello variaremos las dimensiones iniciales de eslora entre perpendiculares, manga y puntal, añadiendo y disminuyendo uno y dos contenedores en cada dimensión. Asi mismo variaremos para cada alternativa el coeficiente de bloque, aumentando y disminuyendo un 1,5% y un 3%.

Mediante este procedimiento obtenemos una hoja de Excel con 625 alternativas, entre las cuales seleccionaremos aquellas que cumplan con las restricciones siguientes, sacadas de la base de datos:

MÍNIMO	RELACIÓN	MÁXIMO
5,934	L_{PP}/B	7,329
10,504	L_{PP}/D	12,656
1,522	B/D	1,944
0,518	T/D	0,632
17,554	L_{PP}/T	23,65
423610	LxBxD	-

La siguiente tabla muestra las dimensiones de partida de nuestro buque, calculadas en apartados anteriores. A dichas medidas iniciales se le han sumado y restado las dimensiones correspondientes a 1 y 2 contenedores, con el fin de obtener los máximos y mínimos entre los cuales oscilarán las alternativas estudiadas.

	Lpp	B	D	Cb
MAXIMO	344,12	51,88	33,84	0,690
	338,06	49,44	30,92	0,680
INICIAL	332,00	47,00	28,00	0,670
	325,94	44,56	25,08	0,660
MINIMO	319,88	42,12	22,16	0,650

Para la selección de la alternativa mas favorable, se han combinado las dimensiones del buque dentro de los rangos mínimo y máximo detallados anteriormente. De entre todas las posibles combinaciones, un total de 625, escogeremos la que tenga un coste de construcción más bajo, dado que será la mas favorable para el astillero.

L_{PP}	326 m
B	47 m
D	28 m
T	16 m
C_B	0,67
Δ	168475 t
F_N	0,1817
C_M	0,9978
C_P	0,67
C_F	0,77
PS	30862 t
CMg	20083650 €
CMo	37034548 €
BP	35903 kW
C_{EP}	12565937 €
CHf	1089000 €
P_{ER}	4374,9 €
C_{ER}	2559316
CC TOTAL	78832385 €
CC TOTAL	79 Milloes de €

A continuación, se muestra una tabla real donde podemos observar que el precio de nuestro buque tiene un precio cercano al de buques de similares características en el mercado actual.

La siguiente tabla de precios ha sido extraída del Nº 989 de la revista especializada “Ingeniería naval” correspondiente al mes de marzo de 2020.

Tabla 2. Precios de Nuevas construcciones en MUS$

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Petroleros										
VLCC (300.000 tpm)	102/105	99/100	92/93	94/95	97/98	93/94	84/85	81/82	92 / 93	92
Suezmax (150.000 tpm)	65/66	60/61	56/57	61/62	64/66	63/64	54/55	54/55	60 / 61	61
Aframax (110.000 tpm)	55/57	52/53	47/48	52/53	53/54	52/53	44/45	43/44	48 / 49	48
Panamax (70.000 tpm)	45/46	44/45	41/42	42/43	46/47	36/37	41/42	41/42	43 / 44	45
Handy (47.000 tpm)	36/37	35/36	33/34	34/35	37/38	34/35	32/33	33/34	36/37	36
Graneleros										
Capesize (170.000 tpm)	55/57	48/49	46/47	53/54	54/55	46/47	41/43	43/44	49 / 50	50
Kamsarmax* (82.000 tpm)	34/36	29/30	25/26	29/30	29/30	25/26	24/25	25/26	27 / 28	27
Handymax (60.000 tpm)	31/32	26/28	24/25	26/27	27/28	24/25	22/23	23/24	25 / 26	25
Handy (35.000 tpm)	26/27	22/23	20/21	22/23	23/24	20/21	19/20	21/22	23 / 24	23
Portacontenedores										
1.000 teu	20/22	19/20	17/18	18/19	19/20	14/15	15/16	15/16	18 / 19	19
3.500 teu	49/50	48/49	36/37	37/38	39/40	37/38	32/33	32/33	37 / 38	40
6.700 teu**	79/80	64/65	56/57	60/61	67/68	66/67	60/61	60/61	68 / 69	72
8.800 teu***	96/97	85/86	72/73	78/80	88/89	88/89	82/83	82/83	89 / 90	89
13.000 teu***	S/D	S/D	100/102	105/106	115/116	115/116	108/110	107/108	114 / 115	
120.000 teu					151/152	151/152	151/152	147 / 148	145	145
Gaseros										
LNG 174.000 m³*	202/202	202/202	200/202	200/210	200/210	199/205	192/193	181/182	182 / 182	186
1LPG 82.000 m³	72/73	72/73	70/72	73/74	78/79	77/78	72/73	70/71	70/71	71
Ro-Ro										
3.500-4.000	38/39	36/37	52/53	55/56	56/57	49/50	46/47	50/51	60 / 61	59
2.300-1.700	57/58	54/55	68/69	69/70	67/68	59/60	58/59	62/63	49 / 50	48
Multipropósitos										
17.200 tpm									23 / 24	25

LNG: antes 160.000 m³. (**) Antes 6.200. (***) Antes 8.000. (****) Antes 12.000. (*) Antes Panamax 70.000 tpm. Datos de fin de diciembre 2019. Fuente: Clarkson Research, AHSB, Baltic Exchange, Fearnleys. Sube mes. Baja mes. Igual mes anterior-

5 ESTUDIO PRELIMINAR DE PESOS

A continuación, se realizará un estudio preliminar de los pesos de buque, para la cual emplearemos las dimensiones seleccionadas en el apartado anterior.

Para los cálculos utilizaremos el libro “El proyecto básico del buque mercante”, donde se expone la siguiente formulación:

5.1 Cálculo del peso en rosca

5.1.1 Peso de acero

Para el cálculo del peso de acero empleamos la formulación de Miller:

$$PS = 8400*(L*B*D/10^5)^{0,9}*(0,675+C_B/2)*[0,00585*(L/D-8,3)^{1,8}+0,939]$$

Donde:

PS: peso de aceros del buque

L: eslora del buque. L = 326 m

B: manga. B = 47 m

D: puntal. D = 28 m

C_B: coeficiente de bloque. C_B = 0,67

El peso de aceros obtenido es **PS = 24001 t**

5.1.2 Peso del equipo y habilitación

$$PEH = Ke*Lpp*B$$

Ke = 0,33 t/m^2

Lpp = 326 m

B = 47 m

El peso del equipo y habilitación será de **5056 t**

5.1.3 Peso de maquinaria propulsora

5.1.3.1 Peso del motor propulsor

En esta fase inicial estimaremos el peso del motor en base a la potencia anteriormente obtenida. Para ello hemos recurrido al catálogo de Wärtsila y escogeremos un motor con una potencia ligeramente superior.

Wärtsilä X82DF	IMO Tier III in gas mode
Cylinder bore	820 mm
Piston stroke	3375 mm
Speed	65–84 rpm
Mean effective pressure at R1	17.3 bar
Stroke / bore	4.12

Rated power, principal dimensions and weights						
Cyl.	Output in kW at				Length A mm	Weight tonnes
	84 rpm		65 rpm			
	R1	R2	R3	R4		
6	25 920	21 600	20 070	16 710	11 045	805
7	30 240	25 200	23 415	19 495	12 550	910
8	34 560	28 800	26 760	22 280	14 055	1 020
9	38 880	32 400	30 105	25 065	16 500	1 160

Como todavía no hemos escogido el motor propulsor y la tabla anterior es orientativa, la primera estimación del peso de maquinaria propulsora la fijaremos en **1200 t.**

5.1.3.2 Peso del resto de maquinaria

El peso del resto de maquinaria lo obtenemos aplicando la siguiente formulación:

$$PM_2 = Km*BHP^{0,7}$$

Donde:

Km = 0,63 (portacontenedores)

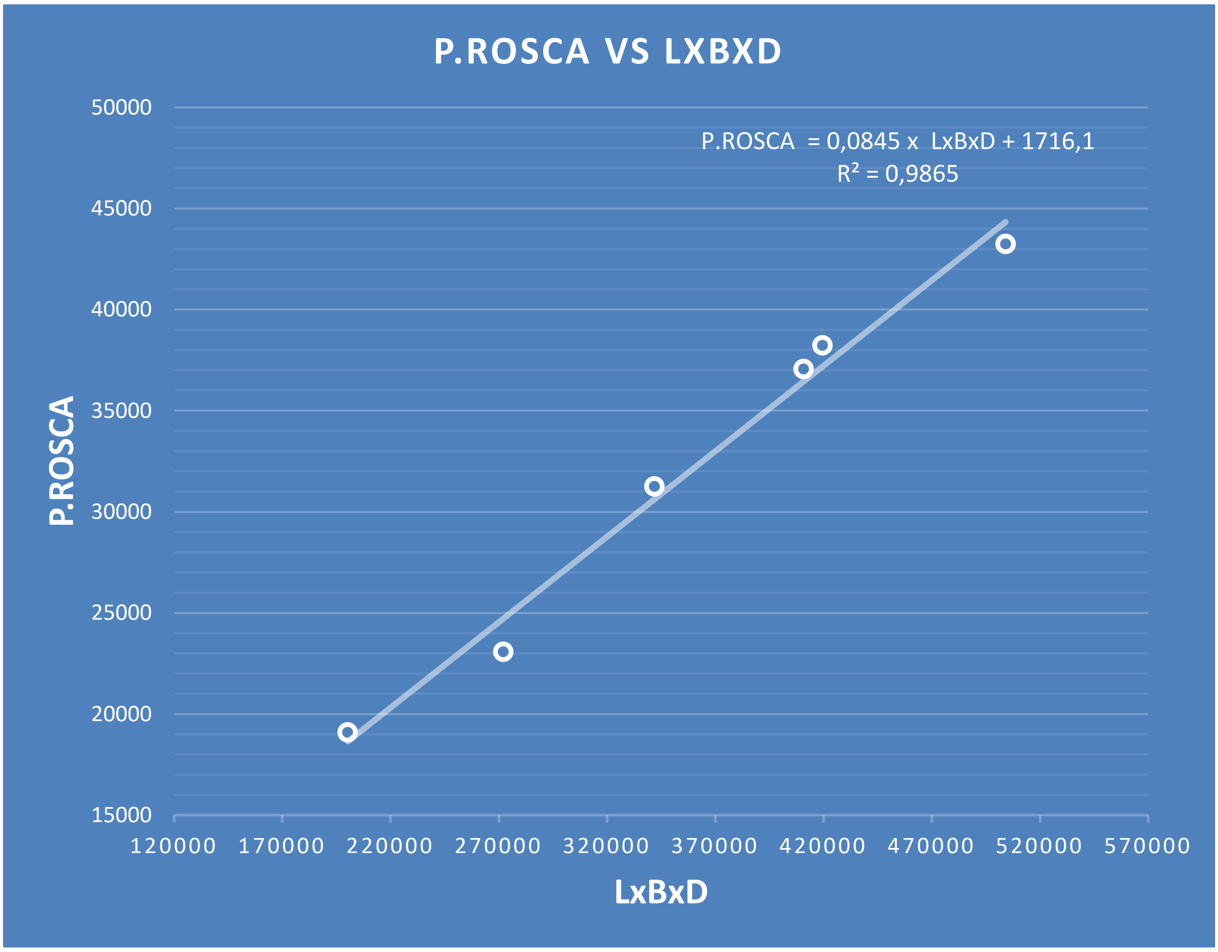
BHP = 38880 kW (potencia asociada al motor anteriormente seleccionado)

El peso de maquinaria restante será de **1028 t**

Por lo tanto, el peso en rosca de nuestro buque será:

Peso en Rosca = PS + PEH + (PM_1 +PM_2) = 31285 t

Con el fin de comprobar si este valor del peso en rosca se ajusta al valor real, recordaremos el valor anteriormente obtenido mediante rectas de regresión.



Aplicando la ecuación de la recta de regresión obtenemos el siguiente valor:

Peso en Rosca = (0,0845 x LxBxD) + 1716,1 = 37511,1 t

Peso en Rosca = 37511,1 t

Si comparamos los valores del peso en rosca obtenido por ambos métodos se aprecia una diferencia considerable, que puede ser debida a la estimación preliminar varios de los pesos. En cuadernos posteriores ajustaremos estas diferencias para obtener el valor definitivo de los pesos a bordo.

5.2 Cálculo del peso muerto

5.2.1 Carga útil

Estimaremos que los contenedores estan al 70% de su capacidad y el peso de cada uno de los 11000 contenedores a bordo se aproxima a 14 t. Por lo tanto el peso de la carga util será de **107800 t**

5.2.2 Consumos

5.2.2.1 Consumo de combustible

En las RPA se especifica que el buque deberá de tener una autonomía de 14000 millas náuticas y una velocidad de 20 nudos.

La potencia que emplearemos para el cálculo será la del motor anteriormente seleccionado.

Potencia = 38880 kW

Consumo = 181 g/kW*h

Velocidad = 20 kn

Autonomía = 14000 millas

Margen = 5%

Por tanto, el consumo de combustible se obtendrá mediante la siguiente formula:

$$CM = \frac{(Autonomía \times Consumo \times Potencia)}{Velocidad \times 1000000} \times 1{,}05$$

CM = (14000*181*38880*1,05)/(20*1000000) = 517 t

El peso de consumo de combustible será de **517 t**

5.2.2.2 Consumo de aceite

Estimaremos un 4% del consumo de combustible, por lo que el consumo de aceite será de **20,7 t**

5.2.2.3 Consumo de agua dulce, agua de alimentación y agua potable

Para el cálculo del agua a bordo se estimarán un valor de 200 l/persona al día para cada uno de los 30 tripulantes que se especifican en las RPA.

Peso agua = (200*30*14000)/(20*24) = 175000 Kg = 175 t

El peso de agua necesario a bordo será de **175 t**

5.2.3 Peso de víveres

Considerando 5 Kg/persona al día para cada uno de los 30 tripulantes obtenemos el siguiente resultado.

Peso de víveres = (5*30*14000)/(20*24) = 4375 Kg = 4,375 t

El peso de víveres a bordo será de **4,375 t**

5.2.4 Tripulación y pasaje

Se estimarán 150 Kg/persona para cada uno de los 30 tripulantes, con lo que obtendremos un peso de **4,5 t**

5.2.5 Pertrechos

Estimaremos para el peso de pertrechos un 1% del peso en rosca, por lo que el peso de pertrechos será de **480 t**

Sumando los pesos anteriores obtendremos una primera estimación del peso muerto de nuestro buque

Peso Muerto= 109000 t

5.3 Cálculo del desplazamiento

Por último, comparamos la suma de los pesos frente el valor obtenido mediante formulación del desplazamiento.

$$\Delta = PM + PR = \mathbf{146513{,}1\ t}$$

$$\Delta = L_{PP} * B * T * C_B * \rho = 326{,}57 * 47{,}21 * 14{,}36 * 0{,}744 * 1{,}025 = \mathbf{168808{,}8\ t}$$

La diferencia entre ambos resultados es considerable y puede deberse a que los cálculos son preliminares y a las estimaciones presentes durante el proceso.

6 BUQUE DE REFERENCIA

En esta primera fase del proyecto adoptaremos como buque base el "Valparaiso Express", dado que sus características son similares a la de nuestro buque.

El buque presenta las siguientes características principales:

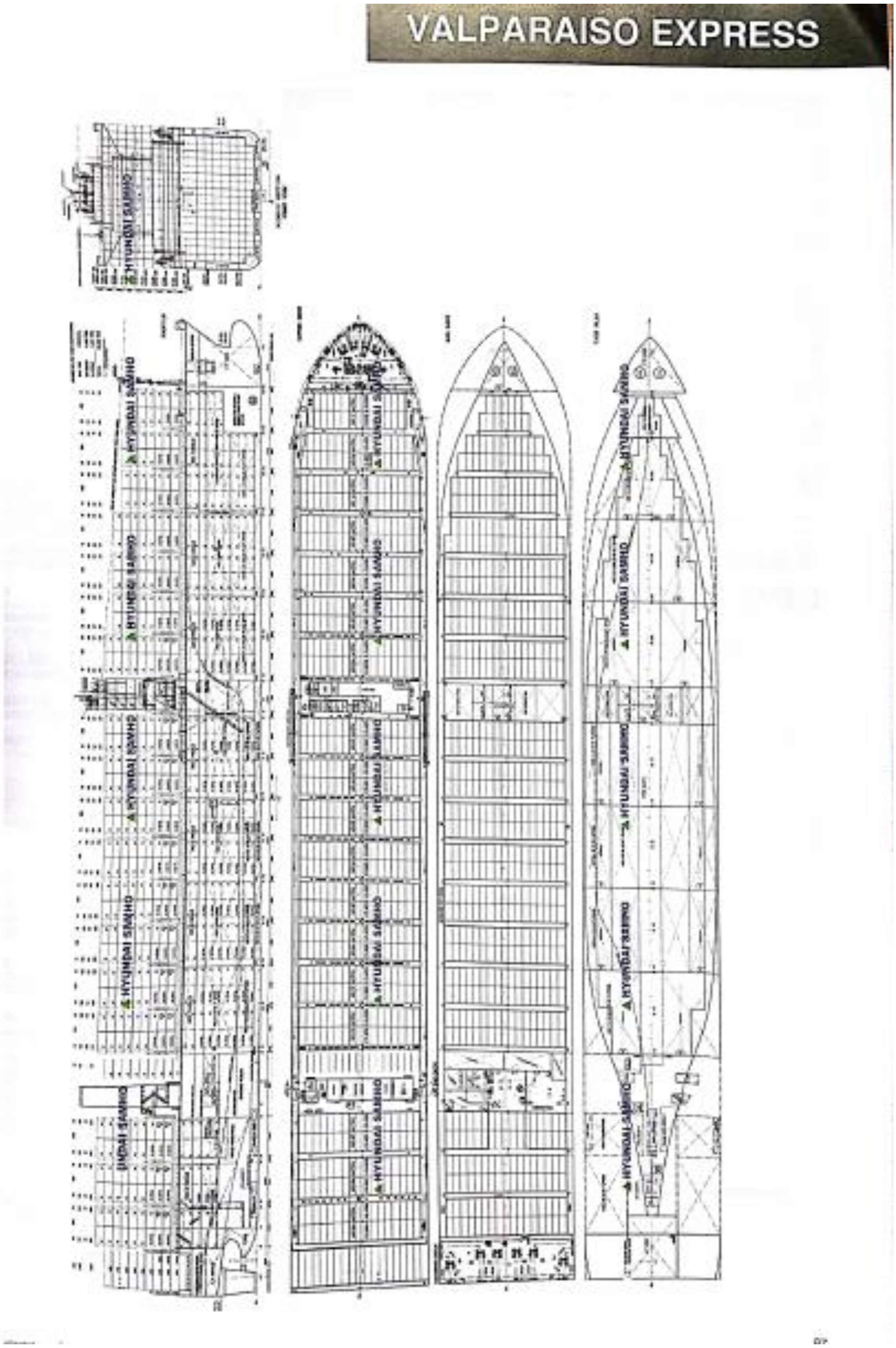
L_{OA}	333,18	m	
L_{PP}	318	m	
B	48,2	m	
D	26,8	m	
T	14	m	
Desplazamiento (Δ)	160.648	t	
Peso Muerto	123.587	t	
Peso en Rosca	37.061	t	
Coeficiente de bloque (C_F)	0,7286		
Velocidad de servicio	21	Nudos	
Capacidad de los tanques			
FUEL	9.380	m^3	
DIESEL	710	m^3	
LASTRE	31.100	m^3	
Motor principal	40.264	kW	
Motores auxiliares	5 x 4480	kW	
Capacidad de carga	10.500	TEU´s	

Este buque está habilitado para transportar productos perecederos como fruta, vegetales, carne o productos farmacéuticos. Además, posee equipamiento para transportar cargas peligrosas.

Los tanques de combustible son de gran capacidad, pueden almacenar hasta 10000 m3 de combustible, entre diésel y fuel pesado, lo que le permite disfrutar de una autonomía de 30000 millas náuticas en sus travesías.

A continuación, se muestra una imagen del buque acompañada de los planos.


The new class:
"Valparaíso Express"
At a glance: the most important features of the five new 10,500-TEU ships Hapag-Lloyd will be bringing into operation as of fall 2016
LENGTH: 333 meters
WIDTH: 48 meters
These Post-Panamax vessels are able to transit the expanded Panama Canal.
CAPACITY: 10,500 TEU
SIDE BY SIDE: max. 18 rows of containers
TIERS: max. 18 containers (max. 9 below and 9 above deck)
CARGO HOLDS: 8 in total
HEIGHT: 63.5 meters (from keel to top of superstructure)
MAX. LOAD CAPACITY: 123,490 metric tonnes
MAX. DRAUGHT: 14 meters
SHIPYARD: Hyundai Samho Heavy Industries (South Korea)
CLASS: DNVGL
DANGEROUS GOODS
On principle, all hatches are prepared to carry this special kind of cargo – providing more flexibility during loading.
NEW LASHING AND LOADING SYSTEM
The new system means there are now up to four hatch covers – instead of the usual three. This provides greater flexibility during loading and unloading. Also: the lashing bridges are now three-tiered (container layers).
OUT-OF-GAUGE CARGO
Oversized cargo that does not fit into a container is often stored below deck.
LIFEBOATS
At the side of the superstructures.
TWIN ISLAND
The separation of superstructure and engine room improves the stability and provides more loading capacity while maintaining visibility.
FREQUENCY CONTROLLED PUMPS
These increase energy savings at lower speeds.
GERMAN FLAG
All five newbuilds will fly the German flag.
HOME PORT HAMBURG
Hapag-Lloyd
LANDSIDE SHORE CONNECTION
All ships of the "Valparaíso Express" class are prepared for an environmentally friendly landside shore connection – the auxiliary diesels on board can then be switched off in port. A special container will be provided at the stern.
MAIN ENGINE
A 7S90ME-C10.5 from MAN Diesel & Turbo – a highly efficient, economical 7-cylinder diesel engine with electronic, emission-reducing valve control, providing an output of 34,224 kW (around 46,530 hp). Also: five auxiliary engines with a total output of 21,270 kW (28,920 hp).
BALLAST WATER
Ballast water treatment units purify the ship's ballast water without the use of chemicals before it is pumped into and out of the ballast water tanks; filtration and UV light treatment prevent organisms from inadvertently entering foreign ecosystems via the ballast water tanks.
TANKS
Situated inboard with no contact to the outer shell, the tanks hold a total of 10,000 cubic meters of fuel, in particular MDO (Marine Diesel Oil for Emission Control Areas).
RUDDER BULB
Reduces fuel consumption.
PROPULSION
The five-blade propeller can accelerate the ship to speeds of up to 21 knots – during slow steaming the vessel sails much slower. The range is around 30,000 nautical miles (around 55,000 km).
BOW THRUSTER
The thruster with around 2,500 kW (circa 3,400 hp) facilitates manoeuvers in narrow waterways like port basins.
OPTIMIZED SHIP'S HULL
Optimized for special loading cases and speed profiles in South American trade lanes.
SLOTS FOR REFRIGERATED CONTAINERS
A total of 2,100 sockets – of which around 1,250 are above and 850 are below deck – make these ships particularly suited to the transport of perishable goods like fruit, vegetables, meat or pharmaceutical products.
Infographic: Volker Rörner


VALPARAISO EXPRESS

7 COMPROBACIÓN DEL FRANCOBORDO

En este apartado se realizará una estimación del francobordo del buque en base a un cálculo simplificado empleando el “Convenio internacional de líneas de carga de 1966 y protocolo de 1988”, con el objetivo de cerciorarnos de que cumplimos con la reserva mínima de flotabilidad. Asimismo, en dicho procedimiento emplearemos el documento Excel facilitado por el profesor Vicente Diaz.

El primer paso será definir el tipo de buque según el convenio, donde se especifican dos tipos:

CAPÍTULO III. FRANCOBORDOS

Regla 27. Tipos de buques

1) Para el cálculo del francobordo los buques se dividirán en dos tipos: ‘A’ y ‘B’.

Buques de tipo ‘A’

2) Buque de tipo ‘A’ será el que:

a) haya sido proyectado para transportar solamente cargas líquidas a granel;

b) tenga una gran integridad en la cubierta expuesta y sólo pequeñas aberturas de acceso a los compartimientos de carga, cerradas por tapas de acero u otro material equivalente, estancas y dotadas de frisas; y

c) tenga baja permeabilidad de los espacios de carga llenos.

3) Un buque de tipo ‘A’ de eslora superior a 150 m al que se haya asignado un francobordo inferior al de los buques de tipo ‘B’, cuando esté cargado de acuerdo con las prescripciones del párrafo 11) habrá de poder soportar la inundación sufrida en uno o varios compartimientos cualesquiera, de una permeabilidad supuesta de 0,95, a raíz de las averías hipotéticas que se especifican en el párrafo 12), y permanecer a flote en un estado de equilibrio satisfactorio que se ajuste a lo especificado en el párrafo 13). En tal buque, el espacio de máquinas se considerará como compartimiento inundable, pero con una permeabilidad de 0,85.

4) A los buques de tipo ‘A’ se les asignarán francobordos no inferiores a los basados en la tabla 28.1.

57

Buques de tipo 'B'

5) Los buques que no se ajusten a lo dispuesto para los buques de tipo 'A' en los párrafos 2) y 3) se considerarán buques de tipo 'B'.

6) A los buques de tipo 'B' que en emplazamientos de clase 1 lleven tapas de escotilla que la Administración permita que cumplan lo prescrito en la regla 15 (con excepción de lo prescrito en el párrafo 6), o que estén provistos de medios para asegurar la estanquidad a la intemperie aceptados con arreglo a las disposiciones de la regla 16 6), se les asignarán francobordos basados en los valores que figuran en la tabla 28.2, aumentados en los valores indicados en la tabla 27.1:

Tabla 27.1

En el caso de nuestro buque, según el reglamento se enmarcará en buque tipo B.

A continuación debemos establecer las dimensiones principales del buque para los cálculos como se establece en la Regla 3:

Regla 3. Definiciones de los términos usados en los anexos

1) *Eslora*

a) Se tomará como eslora (L) el 96% de la eslora total medida en una flotación cuya distancia al canto alto de la quilla sea igual al 85% del puntal mínimo de trazado, o la eslora medida en esa flotación desde la cara proel de la roda hasta el eje de la mecha del timón, si esta segunda magnitud es mayor.

b) En los buques sin mecha de timón, se tomará como eslora (L) el 96% de la flotación correspondiente al 85% del puntal mínimo de trazado.

En nuestro caso la mayor de las esloras que se reflejan en la norma será de 326 m, por lo que ese será el valor de la eslora de francobordo:

L = 326 m

4) *Manga*. A menos que se indique expresamente otra cosa, la manga (B) será la manga máxima del buque, medida en el centro del mismo hasta la línea de trazado de la cuaderna, en los buques de forro metálico, o hasta la superficie exterior del casco, en los buques con forro de otros materiales.

La manga máxima del buque es de 47 m, por lo que la manga de francobordo será:

B = 47 m

6) *Puntal de francobordo (D)*

a) El puntal de francobordo (D) será el puntal de trazado en el centro del buque más el espesor de la cubierta de francobordo en el costado.

b) El puntal de francobordo (D) en un buque con trancanil redondeado de radio superior al 4% de la manga (B) o en el que la parte alta de los costados tenga una forma fuera de lo normal, será el puntal de francobordo correspondiente a un buque que tuviera una cuaderna maestra con costados verticales en la obra muerta y con la misma brusca del bao, y el área transversal de la parte superior igual a la correspondiente a la cuaderna maestra del buque real.

7) *Coeficiente de bloque*

a) El coeficiente de bloque (C_b) vendrá dado por la fórmula:

$$C_b = \frac{\nabla}{LBd_1}$$

donde:

∇ será el volumen del desplazamiento de trazado del buque, excluidos los apéndices, en un buque con forro metálico, y el volumen de desplazamiento de la superficie exterior del casco en los buques con forro de cualquier otro material, ambos tomados a un calado de trazado d_1; siendo

d_1 el 85% del puntal mínimo de trazado.

b) Para calcular el coeficiente de bloque de una nave multicasco, se utilizará la manga máxima (B) definida en el párrafo 4), y no la manga de un solo casco.

En cuanto al puntal de francobordo el valor que utilizaremos será el del puntal de nuestro buque, dado que todavía desconocemos los espesores de las chapas en esta fase inicial de trabajo. Por tanto, el puntal de francobordo será:

D = 28 m

Por lo tanto el valor del coeficiente de bloque será el siguiente:

$$Cb = \frac{\nabla}{L \times B \times D}$$

CB = 0,67

Como hemos dicho, para el cálculo del francobordo utilizaremos el documento Excel facilitado por el profesor Vicente Díaz, en el cual al introducir las dimensiones principales se nos devuelve el volumen de carena de nuestro buque, que será:

∇ = 292731 m^3

El siguiente paso será comprobar qué francobordo tabular le corresponde a nuestro buque según su eslora, que recordemos era de L = 326 m.

Para ello consultaremos la Tabla 28.2 del reglamento correspondiente a los buques tipo B.

Tabla 28.2

Tabla de francobordo para buques de tipo 'B' *(Continuación)*

Eslora del buque (m)	Francobordo (mm)	Eslora del buque (m)	Francobordo (mm)	Eslora del buque (m)	Francobordo (mm)
282	4420	310	4736	338	5035
283	4432	311	4748	339	5045
284	4443	312	4757	340	5055
285	4455	313	4768	341	5065
286	4467	314	4779	342	5075
287	4478	315	4790	343	5086
288	4490	316	4801	344	5097
289	4502	317	4812	345	5108
290	4513	318	4823	346	5119
291	4525	319	4834	347	5130
292	4537	320	4844	348	5140
293	4548	321	4855	349	5150
294	4560	322	4866	350	5160
295	4572	323	4878	351	5170
296	4583	324	4890	352	5180
297	4595	325	4899	353	5190
298	4607	326	4909	354	5200
299	4618	327	4920	355	5210
300	4630	328	4931	356	5220
301	4642	329	4943	357	5230
302	4654	330	4955	358	5240
303	4665	331	4965	359	5250
304	4676	332	4975	360	5260
305	4686	333	4985	361	5268
306	4695	334	4995	362	5276
307	4704	335	5005	363	5285
308	4714	336	5015	364	5294
309	4725	337	5025	365	5303

Los francobordos correspondientes a esloras intermedias se obtendrán por interpolación lineal.
Los francobordos de los buques de más de 365 m de eslora serán determinados por la Administración.

El **francobordo tabular** en nuestro caso será de **4909 mm.**

7.1 Correcciones por eslora menor a 100 m

Regla 29. Corrección al francobordo para buques de eslora inferior a 100 m

El francobordo tabular para buques de tipo 'B', de eslora comprendida entre 24 m y 100 m con superestructuras cerradas de una longitud efectiva de hasta el 35% de la eslora, se incrementará en la siguiente cantidad:

$$7{,}5(100 - L)\left(0{,}35 - \frac{E_1}{L}\right) \quad \text{mm}$$

No se aplica ya que nuestro buque tiene una eslora superior a 100 metros.

7.2 Corrección por coeficiente de bloque

Regla 30. Corrección por coeficiente de bloque

Cuando el coeficiente de bloque (C_b) sea superior a 0,68, el francobordo tabular especificado en la regla 28, después de ser modificado, si procede, por las reglas 27 8), 27 10) y 29, se multiplicará por el factor.

$$\frac{C_b + 0{,}68}{1{,}36}$$

El coeficiente de bloque no se supondrá superior a 1,0.

Recordemos que el CB = 0,67, por lo que al ser menor de 0,68 no aplicaremos corrección alguna por coeficiente de bloque.

7.3 Corrección por puntal

La corrección por puntal no indica lo siguiente:

Regla 31. Corrección por puntal

1) Cuando D exceda de L/15, el francobordo se aumentará en $\left(D - \frac{L}{15}\right) R$, mm, siendo $R = \frac{L}{0{,}48}$ para esloras inferiores a 120 m y 250 para esloras de 120 m o mayores.

2) Cuando D sea menor que L/15 no se hará reducción alguna, excepto en buques con superestructuras cerradas que cubran al menos una longitud igual a 0,6L en el centro del buque, o bien con un tronco completo, o una combinación de superestructuras cerradas separadas y troncos que se extiendan de manera continua de proa a popa, en cuyo caso el francobordo se reducirá en la proporción prescrita en el párrafo 1).

3) Cuando la altura de la superestructura o del tronco sea inferior a la normal que corresponda, la reducción calculada se corregirá con la relación entre la altura real de la superestructura o del tronco y la altura normal aplicable definida en la regla 33.

El valor de L/15 es de 21,77 m. Recordemos que nuestro puntal tiene un valor de 27 m, por lo que excede el valor de L/15 y deberemos de aplicar corrección por puntal.

La corrección que aplicaremos será $\left(D - \frac{L}{15}\right) \times R$, donde R vale 250 para esloras superiores a 120 m, como es nuestro caso.

Es decir, la corrección por puntal tendrá un valor de 1567 **mm**.

7.4 Corrección por superestructuras

En primer lugar, definiremos lo que el reglamento considera como superestructura.

10) *Superestructura*

a) Una superestructura será una construcción provista de techo y dispuesta encima de la cubierta de francobordo, que se extienda de banda a banda del buque o cuyo forro lateral no esté separado del forro del costado más de un 4% de la manga (B).

b) Una superestructura cerrada será aquella:

i) que tenga mamparos de cierre de construcción eficiente;

ii) cuyas aberturas de acceso, si existen en estos mamparos, estén provistas de puertas que satisfagan las prescripciones de la regla 12;

iii) en la que todas las demás aberturas, en los costados o en los extremos de la superestructura. estén dotadas de medios eficientes de cierre, estancos a la intemperie.

Por otra parte, un puente o una toldilla no se considerarán superestructuras cerradas, a menos que estén dotados de acceso para que la tripulación, a partir de cualquier punto de la cubierta completa expuesta más alta, o desde un punto más alto, pueda llegar a la maquinaria y demás lugares de trabajo situados en el interior de estas superestructuras, por otros medios que puedan utilizarse en todo momento cuando estén cerradas las aberturas de los mamparos.

c) La altura de una superestructura será la altura mínima vertical medida en el costado desde el canto alto de los baos de la cubierta de la superestructura hasta el canto alto de los baos de la cubierta de francobordo.

d) La longitud de una superestructura (S) será la longitud media de la parte de superestructura situada dentro de la eslora (L).

e) Puente. El puente será una superestructura que no se extienda hasta la perpendicular de proa, ni tampoco hasta la perpendicular de popa.

f) Toldilla. La toldilla será una superestructura que se extienda en dirección a proa desde la perpendicular de popa hasta un punto situado a popa de la perpendicular de proa. La toldilla puede empezar un punto que se encuentre a popa de la perpendicular de popa.

g) Castillo de proa. El castillo de proa será una superestructura que se extienda en dirección a popa desde la perpendicular de proa hasta un punto a proa de la perpendicular de popa. El castillo de proa podrá comenzar en un punto que se encuentre a proa de la perpendicular de proa.

h) Superestructura completa. Una superestructura completa será aquella que se extienda como mínimo desde la perpendicular de proa a la de popa.

i) Cubierta de saltillo. La cubierta de saltillo será una superestructura que se extienda hacia proa desde la perpendicular de popa, que por lo general tenga una altura inferior a la de una superestructura normal y que disponga de un mamparo proel intacto (portillos fijos con ojos de buey eficientes y tapas de registro empernadas) (véase la figura 3.4). Cuando el mamparo proel no esté intacto por incluir puertas y aberturas de acceso, la superestructura se considerará una toldilla.

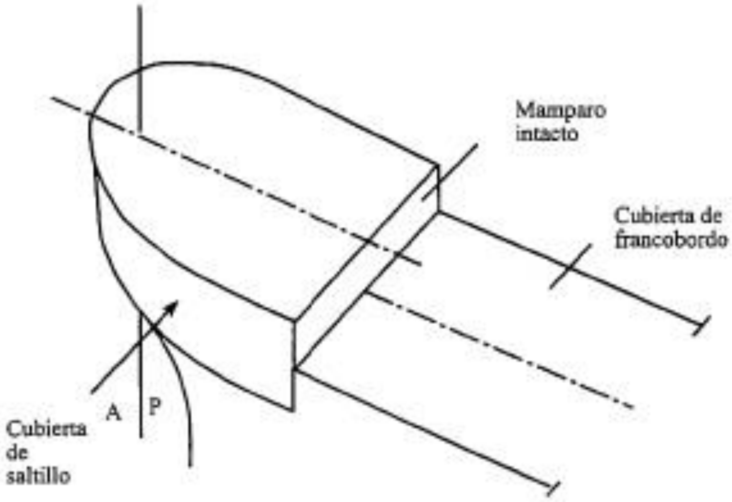


Figura 3.4

Se consideran superestructuras aquellas estructuras sobre la cubierta principal cuyos extremos distan de babor y estribor menos de un 4% de la manga.

En nuestro buque las superestructuras que disponemos no cumplen con tales requisitos, por lo que no tendremos corrección alguna por superestructuras.

7.5 Corrección por arrufo

El reglamento establece en la Regla 38 una corrección por arrufo, así como su proceso de calculo que seguiremos a continuación.

Nuestro buque no presenta arrufo, por lo tanto, el cálculo de la corrección por arrufo lo realizaremos de la siguiente manera.

Curva de arrufo normal

8) Las ordenadas de la curva de arrufo normal se dan en la tabla siguiente:

Tabla 38.1.
Curva de arrufo normal
(L en m)

	Situación	Ordenada (en mm)	Factor
Mitad de popa	Perpendicular de popa	25 (L/3+10)	1
	1/6 L desde la P. de Pp.	11.1(L/3+10)	3
	1/3 L desde la P. de Pp.	2,8 (L/3+10)	3
	Centro del buque	0	1
Mitad de proa	Centro del buque	0	1
	1/3 L desde la P. de Pr.	5,6 (L/3+10)	3
	1/6 L desde la P. de Pr.	22,2(L/3+10)	3
	Perpendicular de proa	50 (L/3+10)	1

POSICIÓN	**FACTOR**	**NORMAL**	**REAL**	**NORMAL X FACTOR**	**REAL X FACTOR**
P_{PP}	1	2971,25	0	2971,25	0
1/6	3	1319,23	0	3957,7	0
1/3	3	332,78	0	998,34	0
0	1	0	0	0	0
0	1	0	0	0	0
1/3	3	665,56	0	1996,7	0
1/6	3	2638,47	0	7915,41	0
P_{PR}	1	5942,5	0	5942,5	0

∑Normal Popa = 7927,3

∑Normal Proa = 15854,61

∑Real Popa = 0

∑Real Proa = 0

Exceso/Defecto popa = (∑Real Popa - ∑Normal Popa)/8 = -990,9

Exceso/Defecto proa = (∑Real Proa - ∑Normal Proa)/8 = -1981,82

Exceso/Defecto Arrufo = $\frac{(\text{Exceso/Defecto popa} + \text{Exceso/Defecto proa}}{2}$ = **- 1486,36 mm**

Los resultados obtenidos en el cálculo preliminar del francobordo son los siguientes:

R-40 Minimum freeboards						*Applicable*	
	Minimun freeboard without R-32			50	mm		
	R-28	4909	mm	Freeboard in Salt Water		7589	mm
	R-29		mm				
	R-30		mm	*Minimun Summer Freeboard*		*7589*	*mm*
	R-31	1567	mm	*Maximun Summer Draught*		*20411*	*mm*
	R-32.1		mm				
	R-37		mm	Maximun Scantling Draught		14360	mm
	R-38	1113	mm	Maximun Stability Draught		14360	mm
	Sum	**7589**	**mm**				
	R-39.1	0	mm	***Summer Freeboard***		***13640***	***mm***
	R-39.2	0	mm	***Summer Draught***		***14360***	***mm***
	Sum	**7589**	**mm**	***Tropical Freeboard***		***13640***	***mm***
				Winter Freeboard		***13940***	***mm***
	R-32	0	mm	***Winter N. Atlantic Freeboard***		***13940***	***mm***
				Fresh Water		***7290***	***mm***
Displacement at 14,36 m			ton				
TPCM at 14,36 m			ton/cm				

En futuros cuadernos se realizará un cálculo más detallado en relación al francobordo que debe tener nuestro buque aplicando el reglamento.

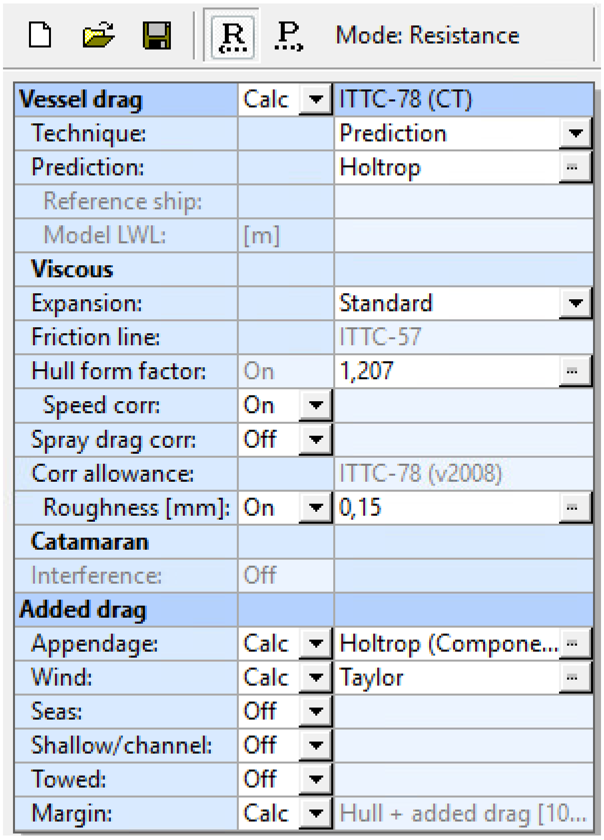
8 ESTIMACIÓN DE POTENCIA

En este apartado expondremos la primera estimación de la potencia que requerirá nuestro buque para poder navegar en condiciones normales a la velocidad de 20 nudos. Para ellos emplearemos el programa Navcad, donde introduciendo los datos de nuestro buque calcularemos tanto la resistencia al avance como la resistencia a la propulsión, y de esta forma poder seleccionar el motor que debemos instalar.

A continuación, se describe el proceso completo, así como los resultados obtenidos para el estudio de una hélice de 4, 5 y 6 palas.

8.1 Cálculo de la resistencia al avance

Para el cálculo emplearemos el método de predicción de Holtrop, con una rugosidad de 0,15 mm



En primer lugar, introduciremos los datos de nuestro buque L_{PP} = 326 m, Δ=168894,4 t y buque monocasco. La línea de fricción que emplearemos será la ITTC-78, para la cual seleccionamos agua salada.

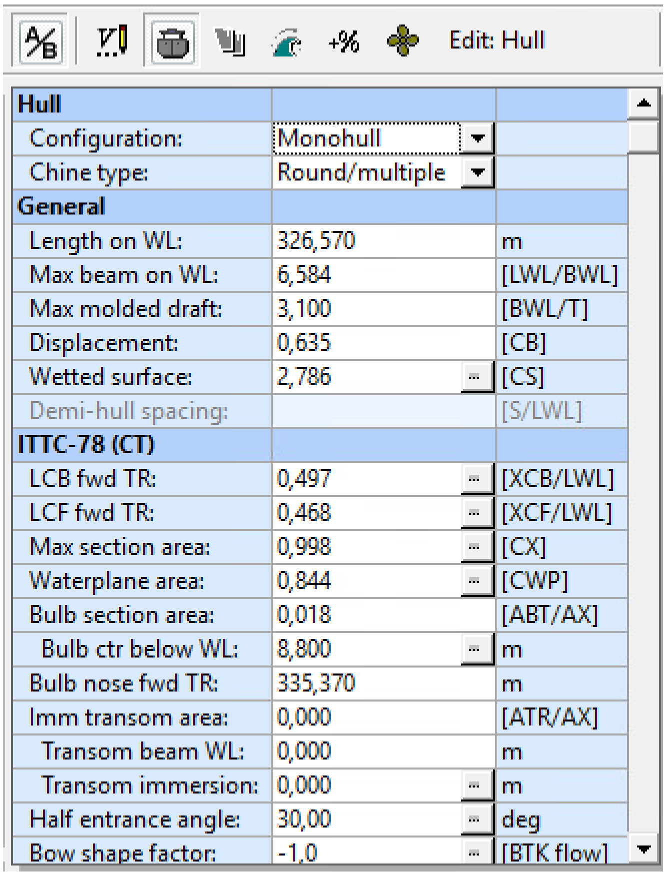
Edit: Condition

Project		
Project ID:	Proyecto septiem...	
Description:	Portacontenedore...	
Summary		
Scope:	ITTC-78 (CT)	
Configuration:	Monohull	
Chine type:	Round/multiple	
Length on WL:	326,000	m
Displacement:	168475,00	t
Propulsor type:	Propeller	
Count:	1	
Water properties		
Water type:	Salt	
Density:	1026,00	kg/m3
Viscosity:	1,18920e-6	m2/s
Speeds		
Speed [01]	12,00	kt
Speed [02]	13,00	kt
Speed [03]	14,00	kt
Speed [04]	15,00	kt
Speed [05]	16,00	kt
Speed [06]	17,00	kt
Speed [07]	18,00	kt

Como se nos especifica en las RPA´s la velocidad para la que hemos de diseñar nuestro buque será de 20 nudos, por lo que debemremos introducirla en el progrma de la siguiente manera:

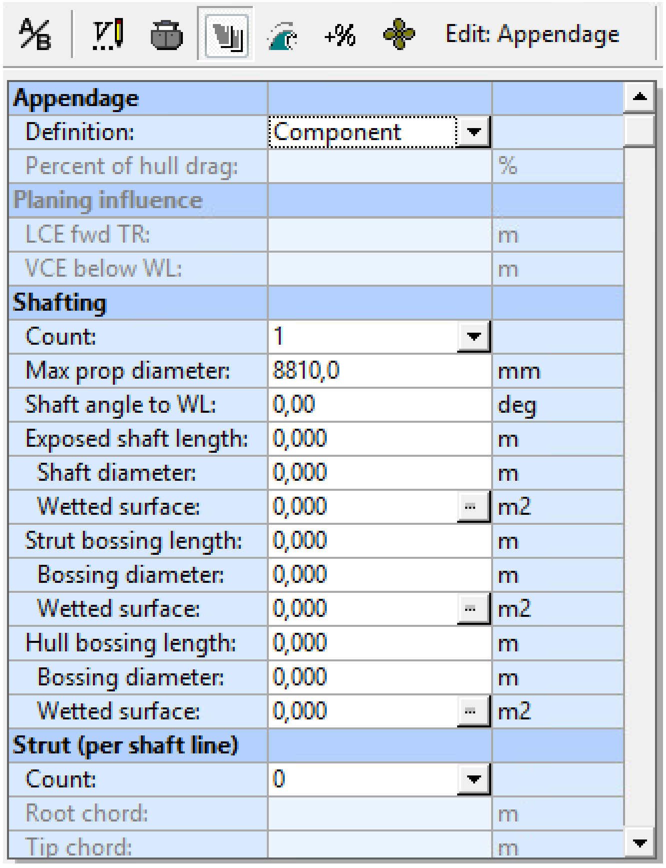
Speeds		
Speed [01]	12,00	kt
Speed [02]	13,00	kt
Speed [03]	14,00	kt
Speed [04]	15,00	kt
Speed [05]	16,00	kt
Speed [06]	17,00	kt
Speed [07]	18,00	kt
Speed [08]	19,00	kt
Speed [09]	20,00	kt
Speed [10]	21,00	kt
Design condition		
Design speed:	20,00	kt

A continuacion introduciremos los coeficientes que obtuvimos en apartados anteriores, como el C_F = 0,77 y C_M=0,9978. Tambien introduciremos los factores de popa y proa en funcion de la forma de las cuadernas en esas secciones.



Hull		
Configuration:	Monohull	
Chine type:	Round/multiple	
General		
Length on WL:	326,570	m
Max beam on WL:	6,584	[LWL/BWL]
Max molded draft:	3,100	[BWL/T]
Displacement:	0,635	[CB]
Wetted surface:	2,786	[CS]
Demi-hull spacing:		[S/LWL]
ITTC-78 (CT)		
LCB fwd TR:	0,497	[XCB/LWL]
LCF fwd TR:	0,468	[XCF/LWL]
Max section area:	0,998	[CX]
Waterplane area:	0,844	[CWP]
Bulb section area:	0,018	[ABT/AX]
Bulb ctr below WL:	8,800	m
Bulb nose fwd TR:	335,370	m
Imm transom area:	0,000	[ATR/AX]
Transom beam WL:	0,000	m
Transom immersion:	0,000	m
Half entrance angle:	30,00	deg
Bow shape factor:	-1,0	[BTK flow]

En la sección de apéndices, como todavía no conocemos el diámetro de nuestro propulsor, nos basaremos en el buque base para obtener dicho valor, por lo que estimaremos un diámetro de propulsor de 8,81 m.



Para el componente del viento consideramos en estos primeros cálculos como nulo, y en cuanto a las áreas transversales estimaremos su valor en función del buque base.

Edit: Environment

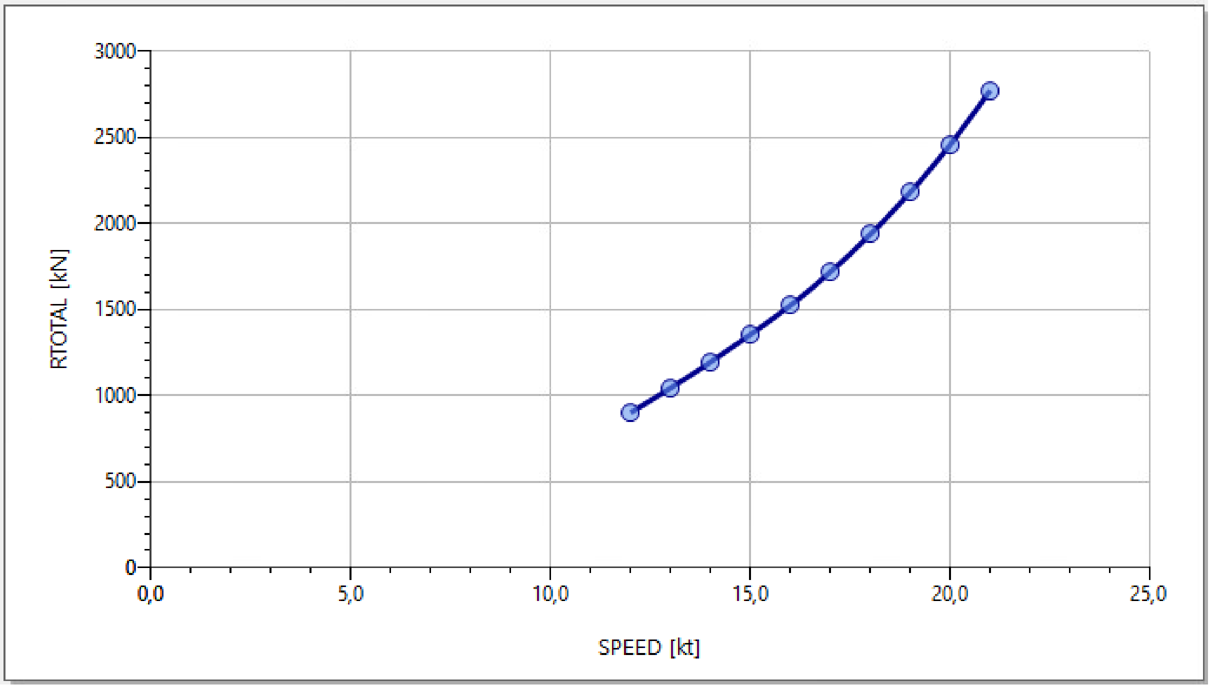
Wind		
Wind speed:	0,00	kt
Angle off bow:	0,00	deg
Gradient correction:	Off	
Exposed hull		
Transverse area:	719,200	m2
VCE above WL:	14,500	m
Profile area:	4814,000	m2
Superstructure		
Superstructure shape:	Container ship	
Transverse area:	1132,860	m2
VCE above WL:	14,500	m
Profile area:	44307,640	m2
Seas		
Significant wave ht:	0,000	m
Modal wave period:	0,0	sec
Shallow/channel		
Water depth:	0,000	m
Type:	Shallow water	
Channel width:		m
Channel side slope:		deg
Hull girth:		m

El margen de mar considerado será del 10%.

Edit: Margin

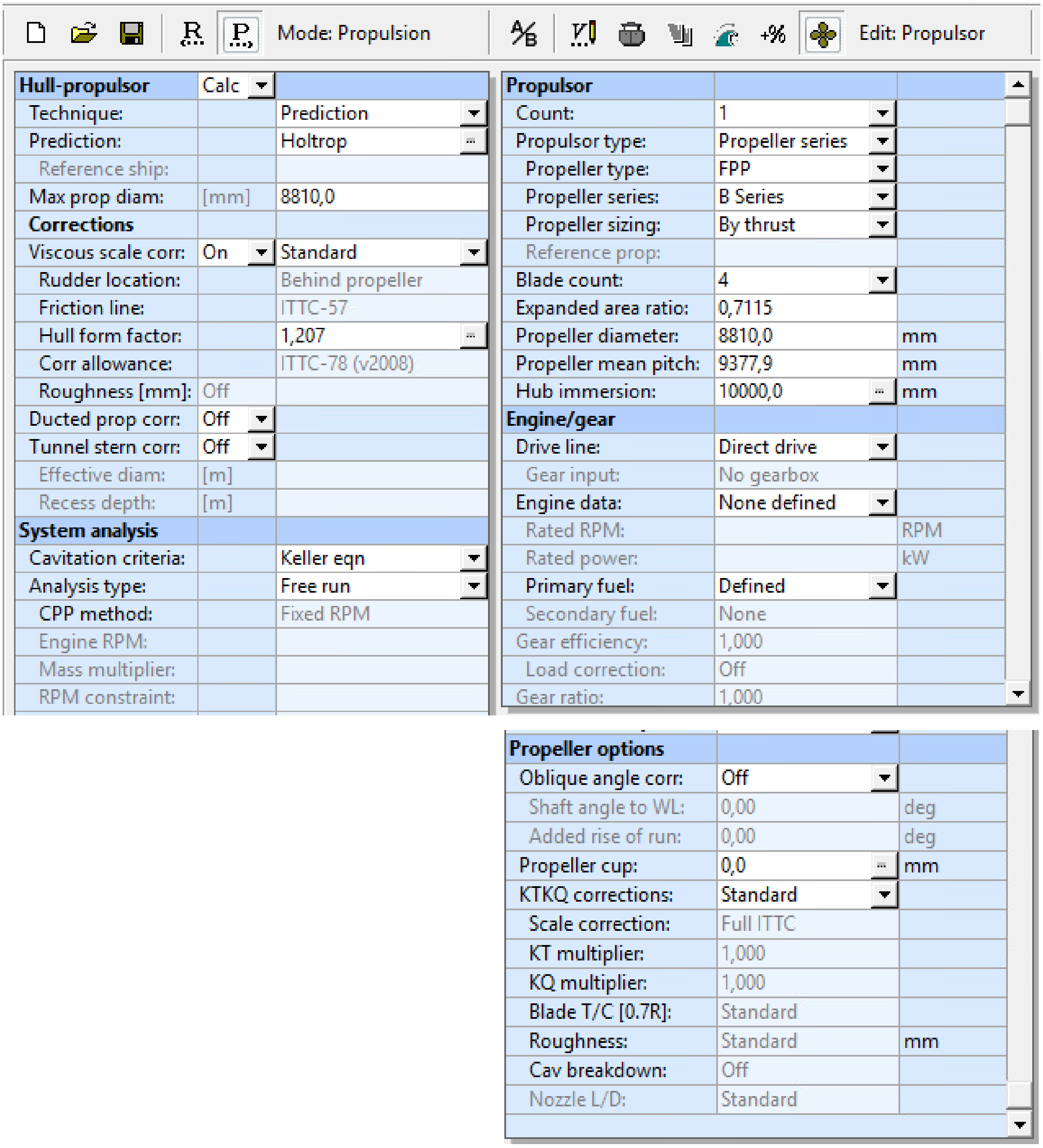
Margin		
Design margin:	10	%
Basis:	Hull + added dr...	

La gráfica que resulta del cálculo de la resistencia al avance es la siguiente:



8.2 Cálculo de la resistencia a la propulsión

A continuación, pasaremos a calcular la resistencia a la propulsión que debe vencer el buque, en el cual usaremos el método Holtrop igualmente y el método de Keller para cavitación. Nuestra hélice será de paso fijo y debemos indicar que emplearemos la serie B para los cálculos. Al igual que el diámetro del propulsor, la inmersión de la hélice también ha sido estimada a partir del buque base.

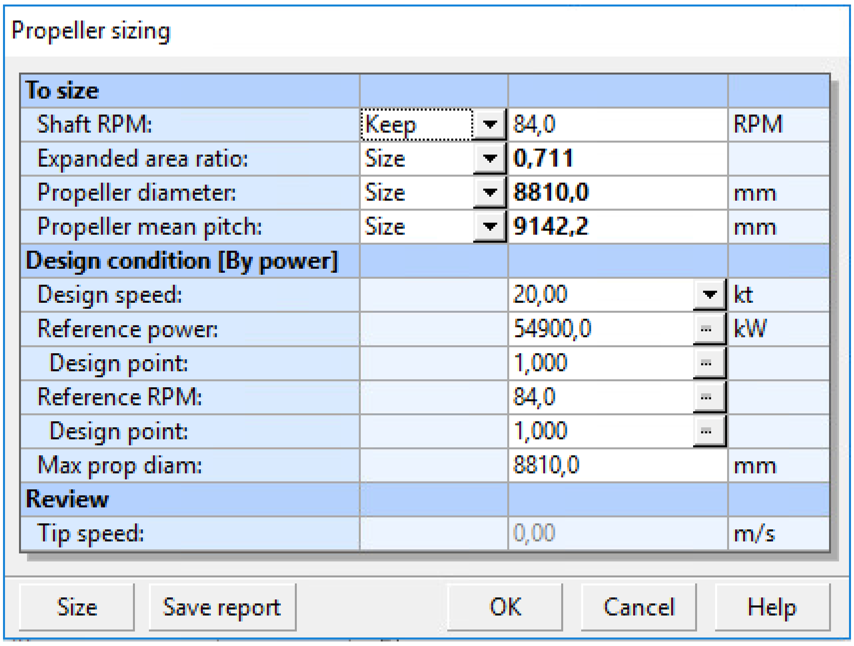


Hull-propulsor	Calc	
Technique:		Prediction
Prediction:		Holtrop
Reference ship:		
Max prop diam:	[mm]	8810,0
Corrections		
Viscous scale corr:	On	Standard
Rudder location:		Behind propeller
Friction line:		ITTC-57
Hull form factor:		1,207
Corr allowance:		ITTC-78 (v2008)
Roughness [mm]:	Off	
Ducted prop corr:	Off	
Tunnel stern corr:	Off	
Effective diam:	[m]	
Recess depth:	[m]	
System analysis		
Cavitation criteria:		Keller eqn
Analysis type:		Free run
CPP method:		Fixed RPM
Engine RPM:		
Mass multiplier:		
RPM constraint:		

Propulsor		
Count:	1	
Propulsor type:	Propeller series	
Propeller type:	FPP	
Propeller series:	B Series	
Propeller sizing:	By thrust	
Reference prop:		
Blade count:	4	
Expanded area ratio:	0,7115	
Propeller diameter:	8810,0	mm
Propeller mean pitch:	9377,9	mm
Hub immersion:	10000,0	mm
Engine/gear		
Drive line:	Direct drive	
Gear input:	No gearbox	
Engine data:	None defined	
Rated RPM:		RPM
Rated power:		kW
Primary fuel:	Defined	
Secondary fuel:	None	
Gear efficiency:	1,000	
Load correction:	Off	
Gear ratio:	1,000	

Propeller options		
Oblique angle corr:	Off	
Shaft angle to WL:	0,00	deg
Added rise of run:	0,00	deg
Propeller cup:	0,0	mm
KTKQ corrections:	Standard	
Scale correction:	Full ITTC	
KT multiplier:	1,000	
KQ multiplier:	1,000	
Blade T/C [0.7R]:	Standard	
Roughness:	Standard	mm
Cav breakdown:	Off	
Nozzle L/D:	Standard	

Una vez que hayamos introducido todos los datos, debemos ejecutar el programa a través de la ventana que se muestra a continuación:

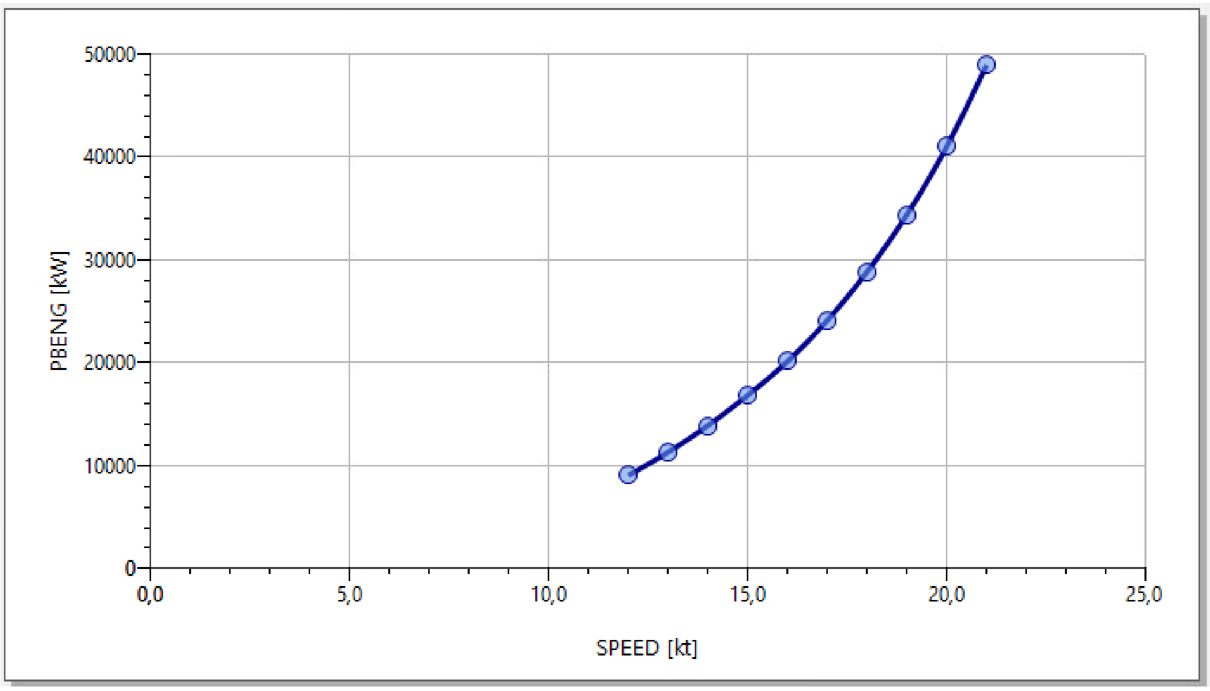

Propeller sizing

To size			
Shaft RPM:	Keep	84,0	RPM
Expanded area ratio:	Size	**0,711**	
Propeller diameter:	Size	**8810,0**	mm
Propeller mean pitch:	Size	**9142,2**	mm
Design condition [By power]			
Design speed:		20,00	kt
Reference power:		54900,0	kW
Design point:		1,000	
Reference RPM:		84,0	
Design point:		1,000	
Max prop diam:		8810,0	mm
Review			
Tip speed:		0,00	m/s

Size | Save report | OK | Cancel | Help

Debemos presionar “Size” y acto seguido “Ok”.

La gráfica referente a la resistencia a la propulsión será la siguiente



A su vez, el programa también nos devuelve un valor para la potencia necesaria que debemos instalar a bordo, que en nuestro caso será de 42295,7 kW.

El motor que seleccionemos debe satisfacer la siguiente potencia:

$$Potencia = \frac{PBTotal}{N^{a}motores \times Regimen\ motor}$$

Donde:

PBTotal = 41040 kW

N.º Motores = 1

Régimen del motor = 0,85

No hemos dispuesto de PTO acoplada al motor, por lo que el resultado será:

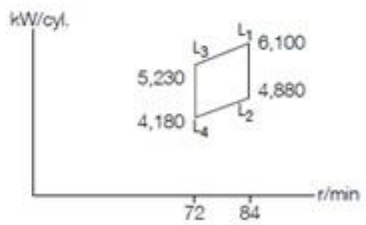
Potencia mínima = 47000 kW

Con este valor de potencia buscaremos en el catálogo de motores MAN un modelo que satisfaga dicha potencia. Nosotros nos hemos decantado por el modelo MAN B&W S90ME-C10.5-GI-TII de 9 cilindros que entrega una potencia de 54900 kW.

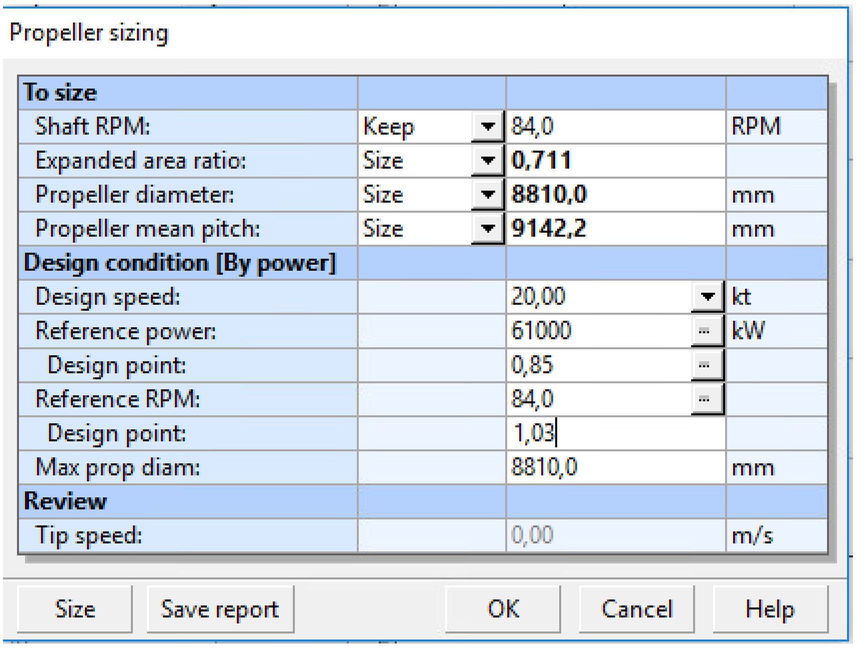
MAN B&W S90ME-C10.5-GI-TII

Stroke: 3,260 mm/L_1 MEP: 21.0 bar

Cyl.	L_1 kW
5	30,500
6	36,600
7	42,700
8	48,800
9	54,900
10	61,000
11	67,100
12	73,200



Por último, volvemos a realizar el cálculo de la potencia en Navcad, pero esta vez introduciendo en la casilla “Propeller sizing: By Power” e introducir las rpm y potencia de nuestro motor. También deberemos considerar una ligereza de 1,03 y un punto de diseño de 0,85.



Los resultados obtenidos para 4, 5 y 6 palas se muestran en el anexo situado al final del documento. A continuación, muestra un resumen de los resultados:

N.º palas	Potencia (kW)
4	41146,4
5	40359,7
6	40327,4

9 ANEXO I: RESULTADOS DE LA ESTIMACIÓN DE POTENCIA (NAVCAD)

9.1 Resultados de Resistencia al avance

Resistance

31 jul 2020 04:35

HydroComp NavCad 2018

Project ID **Proyecto septiembre 2020**

Description **Portacontenedores 11000 TEUS**

File name **PROYECTO SEPTIEMBRE 2020.hcnc**

Analysis parameters

Vessel drag	ITTC-78 (CT)	Added drag	
Technique:	[Calc] Prediction	Appendage:	[Calc] Holtrop (Component)
Prediction:	Holtrop	Wind:	[Calc] Taylor
Reference ship:		Seas:	[Off]
Model LWL:		Shallow/channel:	[Off]
Expansion:	Standard	Towed:	[Off]
Friction line:	ITTC-57	Margin:	[Calc] Hull + added drag [10%]
Hull form factor:	[On] 1,207	**Water properties**	
Speed corr:	[On]	Water type:	Salt
Spray drag corr:	[Off]	Density:	1026,00 kg/m3
Corr allowance:	ITTC-78 (v2008)	Viscosity:	1,18920e-6 m2/s
Roughness [mm]:	[On] 0,15		

Prediction method check [Holtrop]

Parameters	FN [design]	CP	LWL/BWL	BWL/T	Lambda
Value	0,18	0,64	6,57	3,10	0,72
Range	0,06--0,40	0,55--0,85	3,90--14,90	2,10--4,00	0,01--1,07

Prediction results

	SPEED COEFS		ITTC-78 COEFS						
SPEED [kt]	FN	FV	RN	CF	[CV/CF]	CR	dCF	CA	CT
12,00	0,109	0,266	1,69e9	0,001435	1,207	0,000001	0,000000	0,000238	0,001971
13,00	0,118	0,289	1,83e9	0,001422	1,206	0,000001	0,000000	0,000227	0,001943
14,00	0,127	0,311	1,97e9	0,001409	1,206	0,000001	0,000000	0,000217	0,001917
15,00	0,136	0,333	2,12e9	0,001398	1,206	0,000001	0,000000	0,000207	0,001893
16,00	0,146	0,355	2,26e9	0,001387	1,205	0,000001	0,000000	0,000197	0,001870
17,00	0,155	0,377	2,40e9	0,001377	1,204	0,000020	0,000000	0,000188	0,001867
18,00	0,164	0,400	2,54e9	0,001368	1,204	0,000051	0,000000	0,000179	0,001877
19,00	0,173	0,422	2,68e9	0,001359	1,203	0,000093	0,000000	0,000171	0,001898
+ 20,00 +	0,182	0,444	2,82e9	0,001351	1,201	0,000146	0,000000	0,000163	0,001932
21,00	0,191	0,466	2,96e9	0,001344	1,200	0,000211	0,000000	0,000155	0,001979

	RESISTANCE							
SPEED [kt]	RBARE [kN]	RAPP [kN]	RWIND [kN]	RSEAS [kN]	RCHAN [kN]	RTOWED [kN]	RMARGIN [kN]	RTOTAL [kN]
12,00	787,18	0,00	32,47	0,00	0,00	0,00	81,96	901,61
13,00	910,73	0,00	38,10	0,00	0,00	0,00	94,88	1043,71
14,00	1042,06	0,00	44,19	0,00	0,00	0,00	108,63	1194,88
15,00	1181,00	0,00	50,73	0,00	0,00	0,00	123,17	1354,90
16,00	1327,35	0,00	57,72	0,00	0,00	0,00	138,51	1523,57
17,00	1496,21	0,00	65,16	0,00	0,00	0,00	156,14	1717,50
18,00	1686,57	0,00	73,05	0,00	0,00	0,00	175,96	1935,58
19,00	1900,41	0,00	81,39	0,00	0,00	0,00	198,18	2179,98
+ 20,00 +	2142,92	0,00	90,18	0,00	0,00	0,00	223,31	2456,41
21,00	2419,86	0,00	99,43	0,00	0,00	0,00	251,93	2771,22

	EFFECTIVE POWER		OTHER		
SPEED [kt]	PEBARE [kW]	PETOTAL [kW]	CTLR	CTLT	RBARE/W
12,00	4859,5	5565,9	0,00002	0,03997	0,00048
13,00	6090,7	6980,1	0,00002	0,03940	0,00055
14,00	7505,2	8605,8	0,00002	0,03887	0,00063
15,00	9113,4	10455,3	0,00002	0,03838	0,00071
16,00	10925,6	12540,7	0,00002	0,03791	0,00080
17,00	13085,2	15020,5	0,00041	0,03785	0,00091
18,00	15617,6	17923,4	0,00104	0,03806	0,00102
19,00	18575,5	21308,1	0,00188	0,03849	0,00115
+ 20,00 +	22048,3	25273,8	0,00295	0,03917	0,00130
21,00	26142,5	29938,4	0,00428	0,04012	0,00146

Report ID20200731-1635 HydroComp NavCad 2018 18.04.0073.0539.U1002

Resistance

31 jul 2020 04:35
HydroComp NavCad 2018

Project ID	**Proyecto septiembre 2020**
Description	**Portacontenedores 11000 TEUS**
File name	**PROYECTO SEPTIEMBRE 2020.hcnc**

Hull data

General		
Configuration:		**Monohull**
Chine type:		**Round/multiple**
Length on WL:		**326,000 m**
Max beam on WL:	[LWL/BWL 6,573]	**49,600 m**
Max molded draft:	[BWL/T 3,100]	**16,000 m**
Displacement:	[CB 0,635]	**168475,00 t**
Wetted surface:	[CS 2,792]	**20425,819 m2**

ITTC-78 (CT)		
LCB fwd TR:	[XCB/LWL 0,498]	**162,467 m**
LCF fwd TR:	[XCF/LWL 0,468]	**152,697 m**
Max section area:	[CX 0,998]	**791,854 m2**
Waterplane area:	[CWP 0,770]	**12450,600 m2**
Bulb section area:		**14,000 m2**
Bulb ctr below WL:		**8,800 m**
Bulb nose fwd TR:		**345,230 m**
Imm transom area:	[ATR/AX 0,000]	**0,000 m2**
Transom beam WL:	[BTR/BWL 0,000]	**0,000 m**
Transom immersion:	[TTR/T 0,000]	**0,000 m**
Half entrance angle:		**30,00 deg**
Bow shape factor:	[BTK flow]	**-1,0**
Stern shape factor:	[WL flow]	**1,0**

Planing		
Proj chine length:		*0,000 m*
Proj bottom area:		*0,000 m2*
LCG fwd TR:	*[XCG/LP 0,000]*	*0,000 m*
VCG below WL:		*0,000 m*
Aft station (fwd TR):		*0,000 m*
Deadrise:		*0,00 deg*
Chine beam:		*0,000 m*
Chine ht below WL:		*0,000 m*
Fwd station (fwd TR):		*0,000 m*
Deadrise:		*0,00 deg*
Chine beam:		*0,000 m*
Chine ht below WL:		*0,000 m*
Propulsor type:		*Propeller*
Max prop diameter:		*8810,0 mm*
Shaft angle to WL:		*0,00 deg*
Position fwd TR:		*0,000 m*
Position below WL:		*0,000 m*
Transom lift device:		*Flap*
Device count:		*0*
Span:		*0,000 m*
Chord length:		*0,000 m*
Deflection angle:		*0,00 deg*
Tow point fwd TR:		*0,000 m*
Tow point below WL:		*0,000 m*

Report ID20200731-1636 HydroComp NavCad 2018 18.04.0073.0539.U1002

Resistance

31 jul 2020 04:35
HydroComp NavCad 2018

Project ID: Proyecto septiembre 2020
Description: Portacontenedores 11000 TEUS
File name: PROYECTO SEPTIEMBRE 2020.hcnc

Appendage data

General		**Skeg/Keel**	
Definition:	Component	Count:	0
Percent of hull drag:	0,00 %	Type:	Skeg
Planing influence		Mean length:	0,000 m
LCE fwd TR:	0,000 m	Mean width:	0,000 m
VCE below WL:	0,000 m	Height aft:	0,000 m
Shafting		Height mid:	0,000 m
Count:	1	Height fwd:	0,000 m
Max prop diameter:	8810,0 mm	Projected area:	0,000 m2
Shaft angle to WL:	0,00 deg	Wetted surface:	0,000 m2
Exposed shaft length:	0,000 m	**Stabilizer**	
Shaft diameter:	0,000 m	Count:	0
Wetted surface:	0,000 m2	Root chord:	0,000 m
Strut bossing length:	0,000 m	Tip chord:	0,000 m
Bossing diameter:	0,000 m	Span:	0,000 m
Wetted surface:	0,000 m2	T/C ratio:	0,000
Hull bossing length:	0,000 m	LE sweep:	0,00 deg
Bossing diameter:	0,000 m	Wetted surface:	0,000 m2
Wetted surface:	0,000 m2	Projected area:	0,000 m2
Strut (per shaft line)		Dynamic multiplier:	1,00
Count:	0	**Bilge keel**	
Root chord:	0,000 m	Count:	0
Tip chord:	0,000 mm	Mean length:	0,000 m
Span:	0,000 m	Mean base width:	0,000 m
T/C ratio:	0,000	Mean projection:	0,000 m
Projected area:	0,000 m2	Wetted surface:	0,000 m2
Wetted surface:	0,000 m2	**Tunnel thruster**	
Exposed palm depth:	0,000 m	Count:	0
Exposed palm width:	0,000 m	Diameter:	0,000 m
Rudder		**Sonar dome**	
Count:	1	Count:	0
Rudder location:	Behind propeller	Wetted surface:	0,000 m2
Type:	Balanced foil	**Miscellaneous**	
Root chord:	0,000 m	Count:	0
Tip chord:	0,000 m	Drag area:	0,000 m2
Span:	0,000 m	Drag coef:	0,00
T/C ratio:	0,000		
LE sweep:	0,00 deg		
Projected area:	0,000 m2		
Wetted surface:	0,000 m2		

Environment data

Wind		**Seas**	
Wind speed:	0,00 kt	Significant wave ht:	0,000 m
Angle off bow:	0,00 deg	Modal wave period:	0,0 sec
Gradient correction:	Off	**Shallow/channel**	
Exposed hull		Water depth:	0,000 m
Transverse area:	719,200 m2	Type:	Shallow water
VCE above WL:	14,500 m	Channel width:	0,000 m
Profile area:	4814,000 m2	Channel side slope:	0,00 deg
Superstructure		Hull girth:	0,000 m
Superstructure shape:	Container ship		
Transverse area:	1132,860 m2		
VCE above WL:	14,500 m		
Profile area:	44307,640 m2		

Report ID20200731-1635 HydroComp NavCad 2018 18.04.0073.0539.U1002

9.2 Resultados de propulsión (By Thrust)

Propulsion

31 jul 2020 04:35
HydroComp NavCad 2018

Project ID	Proyecto septiembre 2020
Description	Portacontenedores 11000 TEUS
File name	PROYECTO SEPTIEMBRE 2020.hcnc

Analysis parameters

Hull-propulsor interaction			System analysis	
Technique:	[Calc]	Prediction	Cavitation criteria:	Keller eqn
Prediction:		Holtrop	Analysis type:	Free run
Reference ship:			CPP method:	
Max prop diam:		8810,0 mm	Engine RPM:	
Corrections			Mass multiplier:	
Viscous scale corr:	[On]	Standard	RPM constraint:	
Rudder location:		Behind propeller	Limit [RPM/s]:	
Friction line:		ITTC-57	**Water properties**	
Hull form factor:		1,207	Water type:	Salt
Corr allowance:		ITTC-78 (v2008)	Density:	1026,00 kg/m3
Roughness [mm]:	[Off]	0,15	Viscosity:	1,18920e-6 m2/s
Ducted prop corr:	[Off]			
Tunnel stern corr:	[Off]			

Prediction method check [Holtrop]

Parameters	FN [design]	CP	LWL/BWL	BWL/T
Value	0,18	0,64	6,57	3,10
Range	0,06--0,80	0,55--0,85	3,90--14,90	2,10--4,00

Prediction results [System]

	HULL-PROPULSOR				ENGINE			FUEL PER ENGINE	
SPEED [kt]	PETOTAL [kW]	WFT	THD	EFFR	RPMENG [RPM]	PBENG [kW]	LOADENG [% rated]	VOLRATE [L/h]	MASSRATE [t/h]
12,00	5565,9	0,3239	0,2153	1,0022	55	8849,7	0,0	---	---
13,00	6980,1	0,3234	0,2153	1,0022	59	11060,8	0,0	---	---
14,00	8605,8	0,3229	0,2153	1,0022	63	13593,8	0,0	---	---
15,00	10455,3	0,3224	0,2153	1,0022	68	16466,0	0,0	---	---
16,00	12540,7	0,3220	0,2153	1,0022	72	19694,1	0,0	---	---
17,00	15020,5	0,3215	0,2153	1,0022	76	23585,9	0,0	---	---
18,00	17923,4	0,3212	0,2153	1,0022	81	28190,7	0,0	---	---
19,00	21308,1	0,3208	0,2153	1,0022	86	33619,2	0,0	---	---
+ 20,00 +	25273,8	0,3205	0,2153	1,0022	91	40065,8	0,0	---	---
21,00	29938,4	0,3202	0,2153	1,0022	96	47768,0	0,0	---	---

	EFFICIENCY			THRUST	
SPEED [kt]	EFFO	EFFOA	MERIT	THRPROP [kN]	DELTHR [kN]
12,00	0,5574	0,6289	0,57243	1148,99	901,61
13,00	0,5598	0,6311	0,57043	1330,07	1043,71
14,00	0,5620	0,6331	0,56855	1522,71	1194,87
15,00	0,5640	0,6350	0,56676	1726,65	1354,90
16,00	0,5660	0,6368	0,56504	1941,59	1523,57
17,00	0,5664	0,6368	0,5647	2188,73	1717,50
18,00	0,5658	0,6358	0,56524	2466,64	1935,57
19,00	0,5643	0,6338	0,56652	2778,10	2179,98
+ 20,00 +	0,5619	0,6308	0,56859	3130,37	2456,41
21,00	0,5585	0,6267	0,57147	3531,55	2771,21

	POWER DELIVERY							
SPEED [kt]	RPMPROP [RPM]	QPROP [kN·m]	QENG [kN·m]	PDPROP [kW]	PSPROP [kW]	PSTOTAL [kW]	PBTOTAL [kW]	TRANSP
12,00	55	1502,01	1502,01	8584,2	8849,7	8849,7	8849,7	---
13,00	59	1740,30	1740,30	10729,0	11060,8	11060,8	11060,8	999,0
14,00	63	1994,07	1994,07	13186,0	13593,8	13593,8	13593,8	875,4
15,00	68	2262,99	2262,99	15972,1	16466,0	16466,0	16466,0	774,3
16,00	72	2546,71	2546,71	19103,3	19694,1	19694,1	19694,1	690,5
17,00	76	2871,33	2871,33	22878,3	23585,9	23585,9	23585,9	612,6
18,00	81	3235,10	3235,10	27345,0	28190,7	28190,7	28190,7	542,7
19,00	86	3641,46	3641,46	32610,6	33619,2	33619,2	33619,2	480,4
+ 20,00 +	91	4099,31	4099,31	38863,8	40065,8	40065,8	40065,8	424,3
21,00	96	4618,62	4618,62	46334,9	47768,0	47768,0	47768,0	373,7

Report ID20200731-1635
HydroComp NavCad 2018 18.04.0073.0539.U1002

Propulsion

31 jul 2020 04:35
HydroComp NavCad 2018

Project ID **Proyecto septiembre 2020**
Description **Portacontenedores 11000 TEUS**
File name **PROYECTO SEPTIEMBRE 2020.hcnc**

Prediction results [Propulsor]

	CAVITATION								
SPEED [kt]	SIGMAV	SIGMAN	SIGMA07R	TIPSPEED [m/s]	MINBAR	PRESS [kPa]	CAVAVG [%]	CAVMAX [%]	PITCHFC [mm]
12,00	22,41	6,05	1,19	25,23	0,385	29,69	2,0	2,0	6325,7
13,00	19,06	5,20	1,02	27,22	0,414	34,37	2,0	2,0	6337,0
14,00	16,41	4,52	0,88	29,19	0,445	39,35	2,1	2,1	6347,7
15,00	14,28	3,97	0,78	31,16	0,478	44,62	2,5	2,5	6357,8
16,00	12,53	3,51	0,69	33,12	0,512	50,18	3,0	3,0	6367,5
17,00	11,09	3,11	0,61	35,18	0,552	56,57	3,6	3,6	6369,4
18,00	9,88	2,77	0,54	37,32	0,597	63,75 !	4,5	4,5	6366,4
19,00	8,86	2,46	0,48	39,54	0,647	71,80 !!	5,6	5,6	6359,1
+ 20,00 +	7,99	2,20	0,43	41,85	0,704	80,90 !!	7,0	7,0	6347,4
21,00	7,24	1,96	0,38	44,29	0,768	91,27 !!	8,9	8,9	6331,2

	PROPULSOR COEFS								
SPEED [kt]	J	KT	KQ	KT/J2	KQ/J3	CTH	CP	RNPROP	
12,00	0,5197	0,2237	0,03319	0,82831	0,2365	2,1093	3,7758	4,92e7	
13,00	0,5223	0,2225	0,03305	0,81565	0,23191	2,077	3,7025	5,31e7	
14,00	0,5248	0,2215	0,03292	0,80393	0,22769	2,0472	3,635	5,70e7	
15,00	0,5272	0,2204	0,03279	0,79301	0,22377	2,0194	3,5724	6,08e7	
16,00	0,5295	0,2194	0,03267	0,78274	0,2201	1,9932	3,5139	6,46e7	
17,00	0,5299	0,2192	0,03265	0,78069	0,21937	1,988	3,5022	6,87e7	
18,00	0,5292	0,2195	0,03268	0,78391	0,22052	1,9962	3,5205	7,28e7	
19,00	0,5275	0,2203	0,03277	0,79159	0,22326	2,0158	3,5643	7,72e7	
+ 20,00 +	0,5248	0,2215	0,03292	0,80422	0,22779	2,0479	3,6366	8,17e7	
21,00	0,5210	0,2231	0,03312	0,82218	0,23428	2,0937	3,7403	8,64e7	

Report ID20200731-1635 HydroComp NavCad 2018 18.04.0073.0539.U1002

Propulsion

31 jul 2020 04:35
HydroComp NavCad 2018

Project ID **Proyecto septiembre 2020**
Description **Portacontenedores 11000 TEUS**
File name **PROYECTO SEPTIEMBRE 2020.hcnc**

Hull data

General		
Configuration:		Monohull
Chine type:		Round/multiple
Length on WL:		326,000 m
Max beam on WL:	[LWL/BWL 6,573]	49,600 m
Max molded draft:	[BWL/T 3,100]	16,000 m
Displacement:	[CB 0,635]	168475,00 t
Wetted surface:	[CS 2,792]	20425,819 m2
ITTC-78 (CT)		
LCB fwd TR:	[XCB/LWL 0,498]	162,467 m
LCF fwd TR:	[XCF/LWL 0,468]	152,697 m
Max section area:	[CX 0,998]	791,854 m2
Waterplane area:	[CWP 0,770]	12450,600 m2
Bulb section area:		14,000 m2
Bulb ctr below WL:		8,800 m
Bulb nose fwd TR:		345,230 m
Imm transom area:	[ATR/AX 0,000]	0,000 m2
Transom beam WL:	[BTR/BWL 0,000]	0,000 m
Transom immersion:	[TTR/T 0,000]	0,000 m
Half entrance angle:		30,00 deg
Bow shape factor:	[BTK flow]	-1,0
Stern shape factor:	[WL flow]	1,0

Planing		
Proj chine length:		0,000 m
Proj bottom area:		0,000 m2
LCG fwd TR:	[XCG/LP 0,000]	0,000 m
VCG below WL:		0,000 m
Aft station (fwd TR):		0,000 m
Deadrise:		0,00 deg
Chine beam:		0,000 m
Chine ht below WL:		0,000 m
Fwd station (fwd TR):		0,000 m
Deadrise:		0,00 deg
Chine beam:		0,000 m
Chine ht below WL:		0,000 m
Propulsor type:		Propeller
Max prop diameter:		8810,0 mm
Shaft angle to WL:		0,00 deg
Position fwd TR:		0,000 m
Position below WL:		0,000 m
Transom lift device:		Flap
Device count:		0
Span:		0,000 m
Chord length:		0,000 m
Deflection angle:		0,00 deg
Tow point fwd TR:		0,000 m
Tow point below WL:		0,000 m

Propulsor data

Propulsor			
Count:		1	
Propulsor type:		Propeller series	
Propeller type:		FPP	
Propeller series:		B Series	
Propeller sizing:		By thrust	
Reference prop:			
Blade count:		4	
Expanded area ratio:		0,6347	[Size]
Propeller diameter:		8810,0 mm	[Size]
Propeller mean pitch:	[P/D 0,9238]	8138,5 mm	[Size]
Hub immersion:		10000,0 mm	

Propeller options		
Oblique angle corr:	Off	
Shaft angle to WL:	0,00 deg	
Added rise of run:	0,00 deg	
Propeller cup:	0,0 mm	
KTKQ corrections:	Standard	
Scale correction:	Full ITTC	
KT multiplier:	1,000	
KQ multiplier:	1,000	
Blade T/C [0.7R]:	Standard	
Roughness:	Standard	
Cav breakdown:	Off	

Engine/gear	
Drive line:	Direct drive
Gear input:	No gearbox
Engine data:	
Rated RPM:	0 RPM
Rated power:	0,0 kW
Primary fuel:	Defined
Secondary fuel:	None
Gear efficiency:	1,000
Load correction:	Off
Gear ratio:	1,000
Shaft efficiency:	0,970

Design condition [By thrust]		
Max prop diam:	8810,0 mm	
Design speed:	20,00 kt	
Reference thrust:	3179,70 kW	
Design point:	0,850	
Reference RPM:	84,0 RPM	
Design point:	1,030	
Shaft RPM:	84,0 RPM	[Keep]

Report ID20200731-1635 HydroComp NavCad 2018 18.04.0073.0539.U1002

9.3 Resultados de Propulsión (By Power)

9.3.1 Resultados para 4 palas

Propulsion
30 jul 2020 06:00
HydroComp NavCad 2018

Project ID **Proyecto septiembre 2020**
Description **Portacontenedores 11000 TEUS**
File name **PROYECTO SEPTIEMBRE 2020.hcnc**

Analysis parameters

Hull-propulsor interaction		
Technique:	[Calc]	Prediction
Prediction:		Holtrop
Reference ship:		
Max prop diam:		8810,0 mm
Corrections		
Viscous scale corr:	[On]	Standard
Rudder location:		Behind propeller
Friction line:		ITTC-57
Hull form factor:		1,207
Corr allowance:		ITTC-78 (v2008)
Roughness [mm]:	[Off]	0,15
Ducted prop corr:	[Off]	
Tunnel stern corr:	[Off]	

System analysis	
Cavitation criteria:	Keller eqn
Analysis type:	Free run
CPP method:	
Engine RPM:	
Mass multiplier:	
RPM constraint:	
Limit [RPM/s]:	
Water properties	
Water type:	Salt
Density:	1026,00 kg/m3
Viscosity:	1,18920e-6 m2/s

Prediction method check [Holtrop]

Parameters	FN [design]	CP	LWL/BWL	BWL/T
Value	0,18	0,64	6,57	3,10
Range	0,06--0,80	0,55--0,85	3,90--14,90	2,10--4,00

Prediction results [System]

	HULL-PROPULSOR				ENGINE			FUEL PER ENGINE	
SPEED [kt]	PETOTAL [kW]	WFT	THD	EFFR	RPMENG [RPM]	PBENG [kW]	LOADENG [% rated]	VOLRATE [L/h]	MASSRATE [t/h]
12,00	5565,9	0,3239	0,2153	0,9950	50	9092,1	0,0	---	---
13,00	6980,1	0,3234	0,2153	0,9950	54	11361,4	0,0	---	---
14,00	8605,8	0,3229	0,2153	0,9950	58	13960,3	0,0	---	---
15,00	10455,3	0,3224	0,2153	0,9950	62	16906,8	0,0	---	---
16,00	12540,7	0,3220	0,2153	0,9950	66	20217,7	0,0	---	---
17,00	15020,5	0,3215	0,2153	0,9950	70	24212,0	0,0	---	---
18,00	17923,4	0,3212	0,2153	0,9950	75	28940,7	0,0	---	---
19,00	21308,1	0,3208	0,2153	0,9950	79	34518,4	0,0	---	---
+ 20,00 +	25273,8	0,3205	0,2153	0,9950	84	41146,4	0,0	---	---
21,00	29938,4	0,3202	0,2153	0,9950	89	49071,3	0,0	---	---

	EFFICIENCY			THRUST	
SPEED [kt]	EFFO	EFFOA	MERIT	THRPROP [kN]	DELTHR [kN]
12,00	0,5465	0,6122	0,56119	1148,98	901,61
13,00	0,5489	0,6144	0,55935	1330,07	1043,71
14,00	0,5511	0,6164	0,55761	1522,71	1194,87
15,00	0,5533	0,6184	0,55596	1726,64	1354,90
16,00	0,5553	0,6203	0,55438	1941,59	1523,57
17,00	0,5557	0,6204	0,55407	2188,73	1717,50
18,00	0,5551	0,6193	0,55456	2466,63	1935,57
19,00	0,5536	0,6173	0,55574	2778,10	2179,98
+ 20,00 +	0,5511	0,6142	0,55765	3130,37	2456,41
21,00	0,5476	0,6101	0,5603	3531,55	2771,21

	POWER DELIVERY							
SPEED [kt]	RPMPROP [RPM]	QPROP [kN·m]	QENG [kN·m]	PDPROP [kW]	PSPROP [kW]	PSTOTAL [kW]	PBTOTAL [kW]	TRANSP
12,00	50	1661,01	1661,01	8819,3	9092,1	9092,1	9092,1	---
13,00	54	1924,12	1924,12	11020,6	11361,4	11361,4	11361,4	972,5
14,00	58	2204,24	2204,24	13541,5	13960,3	13960,3	13960,3	852,4
15,00	62	2501,01	2501,01	16399,6	16906,8	16906,8	16906,8	754,1
16,00	66	2814,06	2814,06	19611,1	20217,7	20217,7	20217,7	672,6
17,00	70	3172,63	3172,63	23485,6	24212,0	24212,0	24212,0	596,8
18,00	75	3574,78	3574,78	28072,4	28940,7	28940,7	28940,7	528,6
19,00	79	4024,37	4024,37	33482,8	34518,4	34518,4	34518,4	467,8
+ 20,00 +	84	4531,39	4531,39	39912,1	41146,4	41146,4	41146,4	413,1
21,00	89	5107,02	5107,02	47599,1	49071,3	49071,3	49071,3	363,7

Report ID20200730-1800 HydroComp NavCad 2018 18.04.0073.0539.U1002

Propulsion

30 jul 2020 06:00
HydroComp NavCad 2018

Project ID **Proyecto septiembre 2020**
Description **Portacontenedores 11000 TEUS**
File name **PROYECTO SEPTIEMBRE 2020.hcnc**

Prediction results [Propulsor]

	CAVITATION								
SPEED [kt]	SIGMAV	SIGMAN	SIGMA07R	TIPSPEED [m/s]	MINBAR	PRESS [kPa]	CAVAVG [%]	CAVMAX [%]	PITCHFC [mm]
12,00	22,41	7,11	1,38	23,27	0,385	24,92	2,0	2,0	6858,0
13,00	19,06	6,11	1,19	25,10	0,414	28,85	2,0	2,0	6870,2
14,00	16,41	5,31	1,03	26,93	0,445	33,03	2,0	2,0	6881,8
15,00	14,28	4,66	0,90	28,74	0,478	37,45	2,1	2,1	6892,7
16,00	12,53	4,13	0,80	30,55	0,512	42,11	2,5	2,5	6903,2
17,00	11,09	3,66	0,71	32,45	0,552	47,48	3,0	3,0	6905,3
18,00	9,88	3,25	0,63	34,42	0,597	53,50	3,6	3,6	6902,0
19,00	8,86	2,90	0,56	36,47	0,647	60,26	4,5	4,5	6894,2
+ 20,00 +	7,99	2,58	0,50	38,61	0,704	67,90 !	5,6	5,6	6881,5
21,00	7,24	2,31	0,45	40,85	0,768	76,60 !!	7,0	7,0	6863,9

	PROPULSOR COEFS								
SPEED [kt]	J	KT	KQ	KT/J2	KQ/J3	CTH	CP	RNPROP	
12,00	0,5634	0,2629	0,04314	0,8283	0,24124	2,1093	3,8792	5,43e7	
13,00	0,5663	0,2616	0,04295	0,81565	0,23651	2,077	3,8031	5,86e7	
14,00	0,5690	0,2603	0,04277	0,80393	0,23215	2,0472	3,733	6,29e7	
15,00	0,5716	0,2591	0,04259	0,79301	0,22811	2,0194	3,668	6,71e7	
16,00	0,5740	0,2579	0,04243	0,78274	0,22433	1,9932	3,6073	7,13e7	
17,00	0,5745	0,2577	0,04240	0,78069	0,22358	1,988	3,5952	7,58e7	
18,00	0,5737	0,2580	0,04245	0,78391	0,22476	1,9962	3,6142	8,04e7	
19,00	0,5719	0,2589	0,04257	0,79159	0,22759	2,0158	3,6596	8,52e7	
+ 20,00 +	0,5689	0,2603	0,04277	0,80422	0,23226	2,0479	3,7347	9,01e7	
21,00	0,5648	0,2623	0,04305	0,82218	0,23895	2,0937	3,8423	9,53e7	

Report ID20200730-1800 HydroComp NavCad 2018 18.04.0073.0539.U1002

Propulsion

30 jul 2020 06:00
HydroComp NavCad 2018

Project ID **Proyecto septiembre 2020**
Description **Portacontenedores 11000 TEUS**
File name **PROYECTO SEPTIEMBRE 2020.hcnc**

Hull data

General			Planing		
Configuration:		**Monohull**	Proj chine length:		0,000 m
Chine type:		**Round/multiple**	Proj bottom area:		0,000 m2
Length on WL:		**326,000 m**	LCG fwd TR:	[XCG/LP 0,000]	0,000 m
Max beam on WL:	[LWL/BWL 6,573]	**49,600 m**	VCG below WL:		0,000 m
Max molded draft:	[BWL/T 3,100]	**16,000 m**	Aft station (fwd TR):		0,000 m
Displacement:	[CB 0,635]	**168475,00 t**	Deadrise:		0,00 deg
Wetted surface:	[CS 2,792]	**20425,819 m2**	Chine beam:		0,000 m
ITTC-78 (CT)			Chine ht below WL:		0,000 m
LCB fwd TR:	[XCB/LWL 0,498]	**162,467 m**	Fwd station (fwd TR):		0,000 m
LCF fwd TR:	[XCF/LWL 0,468]	**152,697 m**	Deadrise:		0,00 deg
Max section area:	[CX 0,998]	**791,854 m2**	Chine beam:		0,000 m
Waterplane area:	[CWP 0,770]	**12450,600 m2**	Chine ht below WL:		0,000 m
Bulb section area:		**14,000 m2**	Propulsor type:		Propeller
Bulb ctr below WL:		**8,800 m**	Max prop diameter:		8810,0 mm
Bulb nose fwd TR:		**345,230 m**	Shaft angle to WL:		0,00 deg
Imm transom area:	[ATR/AX 0,000]	**0,000 m2**	Position fwd TR:		0,000 m
Transom beam WL:	[BTR/BWL 0,000]	**0,000 m**	Position below WL:		0,000 m
Transom immersion:	[TTR/T 0,000]	**0,000 m**	Transom lift device:		Flap
Half entrance angle:		**30,00 deg**	Device count:		0
Bow shape factor:	[BTK flow]	**-1,0**	Span:		0,000 m
Stern shape factor:	[WL flow]	**1,0**	Chord length:		0,000 m
			Deflection angle:		0,00 deg
			Tow point fwd TR:		0,000 m
			Tow point below WL:		0,000 m

Propulsor data

Propulsor				Propeller options		
Count:		1		Oblique angle corr:	Off	
Propulsor type:		Propeller series		Shaft angle to WL:	0,00 deg	
Propeller type:		FPP		Added rise of run:	0,00 deg	
Propeller series:		B Series		Propeller cup:	0,0 mm	
Propeller sizing:		By power		KTKQ corrections:	Standard	
Reference prop:				Scale correction:	Full ITTC	
Blade count:		4		KT multiplier:	1,000	
Expanded area ratio:		0,7563	[Size]	KQ multiplier:	1,000	
Propeller diameter:		8810,0 mm	[Size]	Blade T/C [0.7R]:	Standard	
Propeller mean pitch:	[P/D 1,0358]	9125,5 mm	[Size]	Roughness:	Standard	
Hub immersion:		10000,0 mm		Cav breakdown:	Off	
Engine/gear				**Design condition [By power]**		
Drive line:		Direct drive		Max prop diam:	8810,0 mm	
Gear input:		No gearbox		Design speed:	20,00 kt	
Engine data:				Reference power:	54900,0 kW	
Rated RPM:		0 RPM		Design point:	0,850	
Rated power:		0,0 kW		Reference RPM:	84,0 RPM	
Primary fuel:		Defined		Design point:	1,030	
Secondary fuel:		None		Shaft RPM:	84,0 RPM	[Keep]
Gear efficiency:		1,000				
Load correction:		Off				
Gear ratio:		1,000				
Shaft efficiency:		0,970				

Report ID20200730-1800 HydroComp NavCad 2018 18.04.0073.0539.U1002

9.4 Resultados para 5 palas

Propulsion

30 jul 2020 06:02
HydroComp NavCad 2018

Project ID: Proyecto septiembre 2020
Description: Portacontenedores 11000 TEUS
File name: PROYECTO SEPTIEMBRE 2020.hcnc

Analysis parameters

Hull-propulsor interaction		
Technique:	[Calc]	Prediction
Prediction:		Holtrop
Reference ship:		
Max prop diam:		8810,0 mm
Corrections		
Viscous scale corr:	[On]	Standard
Rudder location:		Behind propeller
Friction line:		ITTC-57
Hull form factor:		1,207
Corr allowance:		ITTC-78 (v2008)
Roughness [mm]:	[Off]	0,15
Ducted prop corr:	[Off]	
Tunnel stern corr:	[Off]	

System analysis	
Cavitation criteria:	Keller eqn
Analysis type:	Free run
CPP method:	
Engine RPM:	
Mass multiplier:	
RPM constraint:	
Limit [RPM/s]:	
Water properties	
Water type:	Salt
Density:	1026,00 kg/m3
Viscosity:	1,18920e-6 m2/s

Prediction method check [Holtrop]

Parameters	FN [design]	CP	LWL/BWL	BWL/T
Value	0,18	0,64	6,57	3,10
Range	0,06--0,80	0,55--0,85	3,90--14,90	2,10--4,00

Prediction results [System]

	HULL-PROPULSOR				ENGINE			FUEL PER ENGINE	
SPEED [kt]	PETOTAL [kW]	WFT	THD	EFFR	RPMENG [RPM]	PBENG [kW]	LOADENG [% rated]	VOLRATE [L/h]	MASSRATE [t/h]
12,00	5565,9	0,3239	0,2153	0,9904	50	8915,2	0,0	---	---
13,00	6980,1	0,3234	0,2153	0,9904	54	11142,4	0,0	---	---
14,00	8605,8	0,3229	0,2153	0,9904	58	13693,5	0,0	---	---
15,00	10455,3	0,3224	0,2153	0,9904	62	16586,2	0,0	---	---
16,00	12540,7	0,3220	0,2153	0,9904	66	19837,2	0,0	---	---
17,00	15020,5	0,3215	0,2153	0,9904	70	23757,3	0,0	---	---
18,00	17923,4	0,3212	0,2153	0,9904	74	28395,6	0,0	---	---
19,00	21308,1	0,3208	0,2153	0,9904	79	33864,4	0,0	---	---
+ 20,00 +	25273,8	0,3205	0,2153	0,9904	83	40359,7	0,0	---	---
21,00	29938,4	0,3202	0,2153	0,9904	88	48120,8	0,0	---	---

	EFFICIENCY			THRUST	
SPEED [kt]	EFFO	EFFOA	MERIT	THRPROP [kN]	DELTHR [kN]
12,00	0,5599	0,6243	0,57497	1148,98	901,60
13,00	0,5623	0,6264	0,57299	1330,07	1043,71
14,00	0,5645	0,6285	0,57112	1522,71	1194,87
15,00	0,5666	0,6304	0,56933	1726,64	1354,89
16,00	0,5686	0,6322	0,56763	1941,59	1523,57
17,00	0,5690	0,6322	0,56729	2188,74	1717,50
18,00	0,5684	0,6312	0,56783	2466,63	1935,57
19,00	0,5669	0,6292	0,5691	2778,10	2179,98
+ 20,00 +	0,5644	0,6262	0,57116	3130,38	2456,41
21,00	0,5610	0,6221	0,57402	3531,55	2771,21

	POWER DELIVERY							
SPEED [kt]	RPMPROP [RPM]	QPROP [kN·m]	QENG [kN·m]	PDPROP [kW]	PSPROP [kW]	PSTOTAL [kW]	PBTOTAL [kW]	TRANSP
12,00	50	1630,21	1630,21	8647,7	8915,2	8915,2	8915,2	---
13,00	54	1888,67	1888,67	10808,1	11142,4	11142,4	11142,4	991,7
14,00	58	2163,85	2163,85	13282,7	13693,5	13693,5	13693,5	869,0
15,00	62	2455,43	2455,43	16088,6	16586,2	16586,2	16586,2	768,7
16,00	66	2763,04	2763,04	19242,1	19837,2	19837,2	19837,2	685,5
17,00	70	3115,19	3115,19	23044,6	23757,3	23757,3	23757,3	608,2
18,00	74	3509,94	3509,94	27543,8	28395,6	28395,6	28395,6	538,8
19,00	79	3951,08	3951,08	32848,5	33864,4	33864,4	33864,4	476,9
+ 20,00 +	83	4448,36	4448,36	39148,9	40359,7	40359,7	40359,7	421,2
21,00	88	5012,62	5012,62	46677,2	48120,8	48120,8	48120,8	370,9

Report ID20200730-1802 HydroComp NavCad 2018 18.04.0073.0539.U1002

Propulsion

30 jul 2020 06:02
HydroComp NavCad 2018

Project ID **Proyecto septiembre 2020**
Description **Portacontenedores 11000 TEUS**
File name **PROYECTO SEPTIEMBRE 2020.hcnc**

Prediction results [Propulsor]

	CAVITATION								
SPEED [kt]	SIGMAV	SIGMAN	SIGMA07R	TIPSPEED [m/s]	MINBAR	PRESS [kPa]	CAVAVG [%]	CAVMAX [%]	PITCHFC [mm]
12,00	22,41	7,19	1,39	23,14	0,407	22,60	2,0	2,0	6896,2
13,00	19,06	6,18	1,20	24,97	0,440	26,16	2,0	2,0	6908,1
14,00	16,41	5,37	1,04	26,78	0,474	29,95	2,0	2,0	6919,3
15,00	14,28	4,71	0,91	28,59	0,511	33,96	2,0	2,0	6929,9
16,00	12,53	4,17	0,81	30,38	0,550	38,19	2,0	2,0	6940,0
17,00	11,09	3,70	0,72	32,27	0,594	43,05	2,2	2,2	6942,1
18,00	9,88	3,29	0,64	34,24	0,644	48,52	2,6	2,6	6938,9
19,00	8,86	2,93	0,57	36,27	0,700	54,65	3,2	3,2	6931,3
+ 20,00 +	7,99	2,61	0,51	38,40	0,764	61,58	4,0	4,0	6919,0
21,00	7,24	2,33	0,45	40,63	0,836	69,47 !	5,1	5,1	6901,9

	PROPULSOR COEFS								
SPEED [kt]	J	KT	KQ	KT/J2	KQ/J3	CTH	CP	RNPROP	
12,00	0,5665	0,2659	0,04282	0,8283	0,23546	2,1092	3,8037	4,76e7	
13,00	0,5694	0,2645	0,04262	0,81565	0,23088	2,077	3,7298	5,14e7	
14,00	0,5721	0,2631	0,04244	0,80393	0,22666	2,0472	3,6617	5,52e7	
15,00	0,5747	0,2619	0,04227	0,793	0,22275	2,0194	3,5985	5,89e7	
16,00	0,5771	0,2607	0,04211	0,78274	0,2191	1,9932	3,5394	6,26e7	
17,00	0,5776	0,2604	0,04207	0,7807	0,21837	1,988	3,5277	6,65e7	
18,00	0,5768	0,2608	0,04213	0,78391	0,21951	1,9962	3,5461	7,06e7	
19,00	0,5750	0,2617	0,04225	0,79159	0,22225	2,0158	3,5903	7,47e7	
+ 20,00 +	0,5720	0,2632	0,04245	0,80422	0,22677	2,0479	3,6633	7,91e7	
21,00	0,5679	0,2652	0,04272	0,82218	0,23324	2,0937	3,7679	8,37e7	

Report ID20200730-1802 — HydroComp NavCad 2018 18.04.0073.0539.U1002

Propulsion

30 jul 2020 06:02
HydroComp NavCad 2018

Project ID **Proyecto septiembre 2020**
Description **Portacontenedores 11000 TEUS**
File name **PROYECTO SEPTIEMBRE 2020.hcnc**

Hull data

General		
Configuration:		**Monohull**
Chine type:		**Round/multiple**
Length on WL:		**326,000 m**
Max beam on WL:	[LWL/BWL 6,573]	**49,600 m**
Max molded draft:	[BWL/T 3,100]	**16,000 m**
Displacement:	[CB 0,635]	**168475,00 t**
Wetted surface:	[CS 2,792]	**20425,819 m2**
ITTC-78 (CT)		
LCB fwd TR:	[XCB/LWL 0,498]	**162,467 m**
LCF fwd TR:	[XCF/LWL 0,468]	**152,697 m**
Max section area:	[CX 0,998]	**791,854 m2**
Waterplane area:	[CWP 0,770]	**12450,600 m2**
Bulb section area:		**14,000 m2**
Bulb ctr below WL:		**8,800 m**
Bulb nose fwd TR:		**345,230 m**
Imm transom area:	[ATR/AX 0,000]	**0,000 m2**
Transom beam WL:	[BTR/BWL 0,000]	**0,000 m**
Transom immersion:	[TTR/T 0,000]	**0,000 m**
Half entrance angle:		**30,00 deg**
Bow shape factor:	[BTK flow]	**-1,0**
Stern shape factor:	[WL flow]	**1,0**

Planing		
Proj chine length:		0,000 m
Proj bottom area:		0,000 m2
LCG fwd TR:	[XCG/LP 0,000]	0,000 m
VCG below WL:		0,000 m
Aft station (fwd TR):		0,000 m
Deadrise:		0,00 deg
Chine beam:		0,000 m
Chine ht below WL:		0,000 m
Fwd station (fwd TR):		0,000 m
Deadrise:		0,00 deg
Chine beam:		0,000 m
Chine ht below WL:		0,000 m
Propulsor type:		Propeller
Max prop diameter:		8810,0 mm
Shaft angle to WL:		0,00 deg
Position fwd TR:		0,000 m
Position below WL:		0,000 m
Transom lift device:		Flap
Device count:		0
Span:		0,000 m
Chord length:		0,000 m
Deflection angle:		0,00 deg
Tow point fwd TR:		0,000 m
Tow point below WL:		0,000 m

Propulsor data

Propulsor				Propeller options		
Count:		1		Oblique angle corr:	Off	
Propulsor type:		Propeller series		Shaft angle to WL:	0,00 deg	
Propeller type:		FPP		Added rise of run:	0,00 deg	
Propeller series:		B Series		Propeller cup:	0,0 mm	
Propeller sizing:		By power		KTKQ corrections:	Standard	
Reference prop:				Scale correction:	Full ITTC	
Blade count:		5		KT multiplier:	1,000	
Expanded area ratio:		0,8340	[Size]	KQ multiplier:	1,000	
Propeller diameter:		8810,0 mm	[Size]	Blade T/C [0.7R]:	Standard	
Propeller mean pitch:	[P/D 1,0159]	8950,3 mm	[Size]	Roughness:	Standard	
Hub immersion:		10000,0 mm		Cav breakdown:	Off	
Engine/gear				**Design condition [By power]**		
Drive line:		Direct drive		Max prop diam:	8810,0 mm	
Gear input:		No gearbox		Design speed:	20,00 kt	
Engine data:				Reference power:	54900,0 kW	
Rated RPM:		0 RPM		Design point:	0,850	
Rated power:		0,0 kW		Reference RPM:	84,0 RPM	
Primary fuel:		Defined		Design point:	1,030	
Secondary fuel:		None		Shaft RPM:	84,0 RPM	[Keep]
Gear efficiency:		1,000				
Load correction:		Off				
Gear ratio:		1,000				
Shaft efficiency:		0,970				

Report ID20200730-1802 HydroComp NavCad 2018 18.04.0073.0539.U1002

9.5 Resultados para 6 palas

Propulsion

30 jul 2020 06:02
HydroComp NavCad 2018

Project ID	Proyecto septiembre 2020
Description	Portacontenedores 11000 TEUS
File name	PROYECTO SEPTIEMBRE 2020.hcnc

Analysis parameters

Hull-propulsor interaction		
Technique:	[Calc]	Prediction
Prediction:		Holtrop
Reference ship:		
Max prop diam:		8810,0 mm
Corrections		
Viscous scale corr:	[On]	Standard
Rudder location:		Behind propeller
Friction line:		ITTC-57
Hull form factor:		1,207
Corr allowance:		ITTC-78 (v2008)
Roughness [mm]:	[Off]	0,15
Ducted prop corr:	[Off]	
Tunnel stern corr:	[Off]	

System analysis	
Cavitation criteria:	Keller eqn
Analysis type:	Free run
CPP method:	
Engine RPM:	
Mass multiplier:	
RPM constraint:	
Limit [RPM/s]:	
Water properties	
Water type:	Salt
Density:	1026,00 kg/m3
Viscosity:	1,18920e-6 m2/s

Prediction method check [Holtrop]

Parameters	FN [design]	CP	LWL/BWL	BWL/T
Value	0,18	0,64	6,57	3,10
Range	0,06--0,80	0,55--0,85	3,90--14,90	2,10--4,00

Prediction results [System]

	HULL-PROPULSOR				ENGINE			FUEL PER ENGINE	
SPEED [kt]	PETOTAL [kW]	WFT	THD	EFFR	RPMENG [RPM]	PBENG [kW]	LOADENG [% rated]	VOLRATE [L/h]	MASSRATE [t/h]
12,00	5565,9	0,3239	0,2153	0,9863	50	8904,0	0,0	---	---
13,00	6980,1	0,3234	0,2153	0,9863	54	11131,0	0,0	---	---
14,00	8605,8	0,3229	0,2153	0,9863	58	13682,6	0,0	---	---
15,00	10455,3	0,3224	0,2153	0,9863	62	16576,6	0,0	---	---
16,00	12540,7	0,3220	0,2153	0,9863	66	19829,8	0,0	---	---
17,00	15020,5	0,3215	0,2153	0,9863	70	23749,5	0,0	---	---
18,00	17923,4	0,3212	0,2153	0,9863	74	28384,5	0,0	---	---
19,00	21308,1	0,3208	0,2153	0,9863	79	33845,7	0,0	---	---
+ 20,00 +	25273,8	0,3205	0,2153	0,9863	83	40327,4	0,0	---	---
21,00	29938,4	0,3202	0,2153	0,9863	88	48065,7	0,0	---	---

	EFFICIENCY			THRUST	
SPEED [kt]	EFFO	EFFOA	MERIT	THRPROP [kN]	DELTHR [kN]
12,00	0,5629	0,6251	0,57808	1148,98	901,60
13,00	0,5652	0,6271	0,57595	1330,07	1043,71
14,00	0,5673	0,6290	0,57394	1522,71	1194,88
15,00	0,5693	0,6307	0,57202	1726,64	1354,89
16,00	0,5712	0,6324	0,57019	1941,59	1523,57
17,00	0,5715	0,6325	0,56982	2188,73	1717,50
18,00	0,5709	0,6315	0,5704	2466,64	1935,57
19,00	0,5695	0,6296	0,57177	2778,10	2179,97
+ 20,00 +	0,5672	0,6267	0,57398	3130,38	2456,41
21,00	0,5640	0,6229	0,57705	3531,55	2771,21

	POWER DELIVERY							
SPEED [kt]	RPMPROP [RPM]	QPROP [kN·m]	QENG [kN·m]	PDPROP [kW]	PSPROP [kW]	PSTOTAL [kW]	PBTOTAL [kW]	TRANSP
12,00	50	1621,70	1621,70	8636,8	8904,0	8904,0	8904,0	---
13,00	54	1879,12	1879,12	10797,1	11131,0	11131,0	11131,0	992,7
14,00	58	2153,27	2153,27	13272,1	13682,6	13682,6	13682,6	869,7
15,00	62	2443,79	2443,79	16079,3	16576,6	16576,6	16576,6	769,1
16,00	66	2750,34	2750,34	19234,9	19829,8	19829,8	19829,8	685,8
17,00	70	3100,97	3100,97	23037,0	23749,5	23749,5	23749,5	608,4
18,00	74	3493,75	3493,75	27532,9	28384,5	28384,5	28384,5	539,0
19,00	79	3932,42	3932,42	32830,4	33845,7	33845,7	33845,7	477,1
+ 20,00 +	83	4426,56	4426,56	39117,5	40327,4	40327,4	40327,4	421,5
21,00	88	4986,85	4986,85	46623,8	48065,7	48065,7	48065,7	371,3

Report ID20200730-1802 HydroComp NavCad 2018 18.04.0073.0539.U1002

Propulsion

30 jul 2020 06:02
HydroComp NavCad 2018

Project ID Proyecto septiembre 2020
Description Portacontenedores 11000 TEUS
File name PROYECTO SEPTIEMBRE 2020.hcnc

Prediction results [Propulsor]

	CAVITATION								
SPEED [kt]	SIGMAV	SIGMAN	SIGMA07R	TIPSPEED [m/s]	MINBAR	PRESS [kPa]	CAVAVG [%]	CAVMAX [%]	PITCHFC [mm]
12,00	22,41	7,19	1,40	23,14	0,429	20,87	2,0	2,0	6897,3
13,00	19,06	6,18	1,20	24,96	0,465	24,16	2,0	2,0	6908,6
14,00	16,41	5,37	1,04	26,78	0,504	27,66	2,0	2,0	6919,4
15,00	14,28	4,71	0,91	28,59	0,544	31,37	2,0	2,0	6929,6
16,00	12,53	4,17	0,81	30,39	0,587	35,27	2,0	2,0	6939,3
17,00	11,09	3,70	0,72	32,28	0,637	39,76	2,0	2,0	6941,2
18,00	9,88	3,29	0,64	34,24	0,692	44,81	2,0	2,0	6938,2
19,00	8,86	2,93	0,57	36,27	0,754	50,47	2,5	2,5	6930,9
+ 20,00 +	7,99	2,61	0,51	38,40	0,824	56,87	3,1	3,1	6919,1
21,00	7,24	2,33	0,45	40,62	0,904	64,15 !	3,9	3,9	6902,7

	PROPULSOR COEFS							
SPEED [kt]	J	KT	KQ	KT/J2	KQ/J3	CTH	CP	RNPROP
12,00	0,5666	0,2659	0,04261	0,8283	0,23419	2,1092	3,7989	4,30e7
13,00	0,5695	0,2645	0,04242	0,81565	0,22969	2,077	3,726	4,64e7
14,00	0,5721	0,2631	0,04224	0,80394	0,22555	2,0472	3,6588	4,98e7
15,00	0,5746	0,2618	0,04207	0,793	0,22171	2,0194	3,5964	5,32e7
16,00	0,5770	0,2606	0,04190	0,78274	0,21811	1,9932	3,5381	5,65e7
17,00	0,5775	0,2604	0,04187	0,78069	0,2174	1,988	3,5265	6,00e7
18,00	0,5767	0,2608	0,04192	0,78391	0,21852	1,9962	3,5447	6,37e7
19,00	0,5750	0,2617	0,04204	0,79159	0,22121	2,0158	3,5883	6,74e7
+ 20,00 +	0,5720	0,2632	0,04224	0,80422	0,22565	2,0479	3,6604	7,14e7
21,00	0,5680	0,2652	0,04251	0,82218	0,23201	2,0937	3,7636	7,55e7

Report ID20200730-1802 HydroComp NavCad 2018 18.04.0073.0539.U1002

Propulsion

30 jul 2020 06:02
HydroComp NavCad 2018

Project ID Proyecto septiembre 2020
Description Portacontenedores 11000 TEUS
File name PROYECTO SEPTIEMBRE 2020.hcnc

Hull data

General		
Configuration:		Monohull
Chine type:		Round/multiple
Length on WL:		326,000 m
Max beam on WL:	[LWL/BWL 6,573]	49,600 m
Max molded draft:	[BWL/T 3,100]	16,000 m
Displacement:	[CB 0,635]	168475,00 t
Wetted surface:	[CS 2,792]	20425,819 m2
ITTC-78 (CT)		
LCB fwd TR:	[XCB/LWL 0,498]	162,467 m
LCF fwd TR:	[XCF/LWL 0,468]	152,697 m
Max section area:	[CX 0,998]	791,854 m2
Waterplane area:	[CWP 0,770]	12450,600 m2
Bulb section area:		14,000 m2
Bulb ctr below WL:		8,800 m
Bulb nose fwd TR:		345,230 m
Imm transom area:	[ATR/AX 0,000]	0,000 m2
Transom beam WL:	[BTR/BWL 0,000]	0,000 m
Transom immersion:	[TTR/T 0,000]	0,000 m
Half entrance angle:		30,00 deg
Bow shape factor:	[BTK flow]	-1,0
Stern shape factor:	[WL flow]	1,0

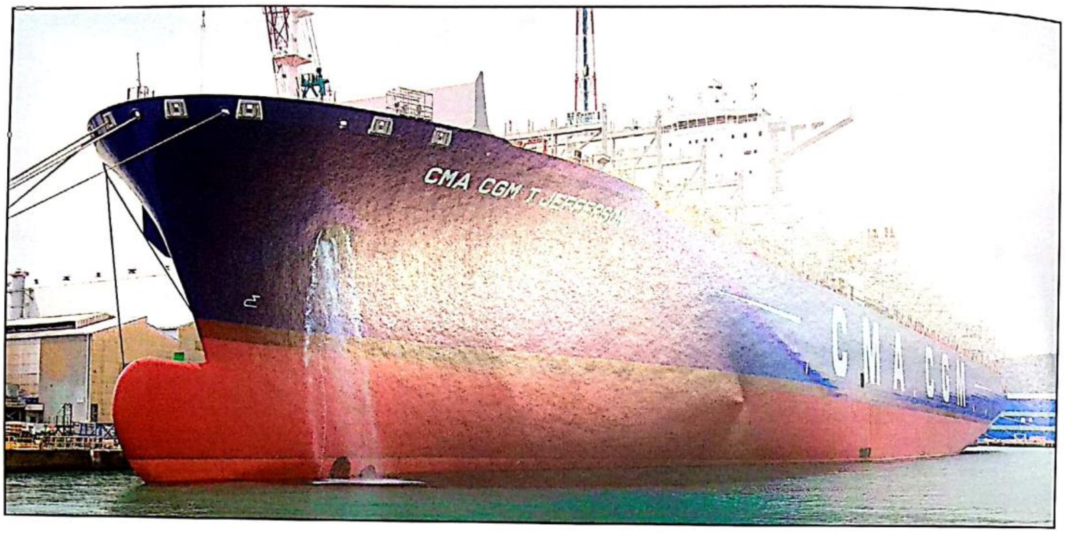
Planing		
Proj chine length:		0,000 m
Proj bottom area:		0,000 m2
LCG fwd TR:	[XCG/LP 0,000]	0,000 m
VCG below WL:		0,000 m
Aft station (fwd TR):		0,000 m
Deadrise:		0,00 deg
Chine beam:		0,000 m
Chine ht below WL:		0,000 m
Fwd station (fwd TR):		0,000 m
Deadrise:		0,00 deg
Chine beam:		0,000 m
Chine ht below WL:		0,000 m
Propulsor type:		Propeller
Max prop diameter:		8810,0 mm
Shaft angle to WL:		0,00 deg
Position fwd TR:		0,000 m
Position below WL:		0,000 m
Transom lift device:		Flap
Device count:		0
Span:		0,000 m
Chord length:		0,000 m
Deflection angle:		0,00 deg
Tow point fwd TR:		0,000 m
Tow point below WL:		0,000 m

Propulsor data

Propulsor			Propeller options		
Count:	**1**		Oblique angle corr:	**Off**	
Propulsor type:	**Propeller series**		Shaft angle to WL:	**0,00 deg**	
Propeller type:	**FPP**		Added rise of run:	**0,00 deg**	
Propeller series:	**B Series**		Propeller cup:	**0,0 mm**	
Propeller sizing:	**By power**		KTKQ corrections:	**Standard**	
Reference prop:			Scale correction:	**Full ITTC**	
Blade count:	**6**		KT multiplier:	**1,000**	
Expanded area ratio:	**0,9030**	**[Size]**	KQ multiplier:	**1,000**	
Propeller diameter:	**8810,0 mm**	**[Size]**	Blade T/C [0.7R]:	**Standard**	
Propeller mean pitch:	[P/D 0,9944] **8761,0 mm**	**[Size]**	Roughness:	**Standard**	
Hub immersion:	**10000,0 mm**		Cav breakdown:	**Off**	
Engine/gear			**Design condition [By power]**		
Drive line:	**Direct drive**		Max prop diam:	**8810,0 mm**	
Gear input:	**No gearbox**		Design speed:	**20,00 kt**	
Engine data:			Reference power:	**54900,0 kW**	
Rated RPM:	**0 RPM**		Design point:	**0,850**	
Rated power:	**0,0 kW**		Reference RPM:	**84,0 RPM**	
Primary fuel:	**Defined**		Design point:	**1,030**	
Secondary fuel:	**None**		Shaft RPM:	**84,0 RPM**	**[Keep]**
Gear efficiency:	**1,000**				
Load correction:	**Off**				
Gear ratio:	**1,000**				
Shaft efficiency:	**0,970**				

Report ID20200730-1802 HydroComp NavCad 2018 18.04.0073.0539.U1002

10 ANEXO II: BASE DE DATOS



CMA CGM G. WASHINGTON: Container vessel

Shipbuilder: .... **Hyundai Heavy Industries**
Vessel's name: .... ***CMA CGM G. Washington***
Hull No: **2855**
Owner/Operator: .... **CMA CGM**
Country: .... **France**
Designer: .... **Hyundai Heavy Industries**
Country: .... **Republic of Korea**
Model test establishment used: .... **Hyundai Maritime Research Institute (HMRI)**
Flag: .... **UK**
IMO number: **9780847**
Total number of sister ships already completed (excluding ship presented): **4**

The first in a series six container vessels named after US presidents, *CMA CGM G. Washington* was built by Hyundai Heavy Industries to conform specifically with the owner's requirements. In particular, the hull form has been optimised to provide efficient fuel consumption when at the intended operating profile.

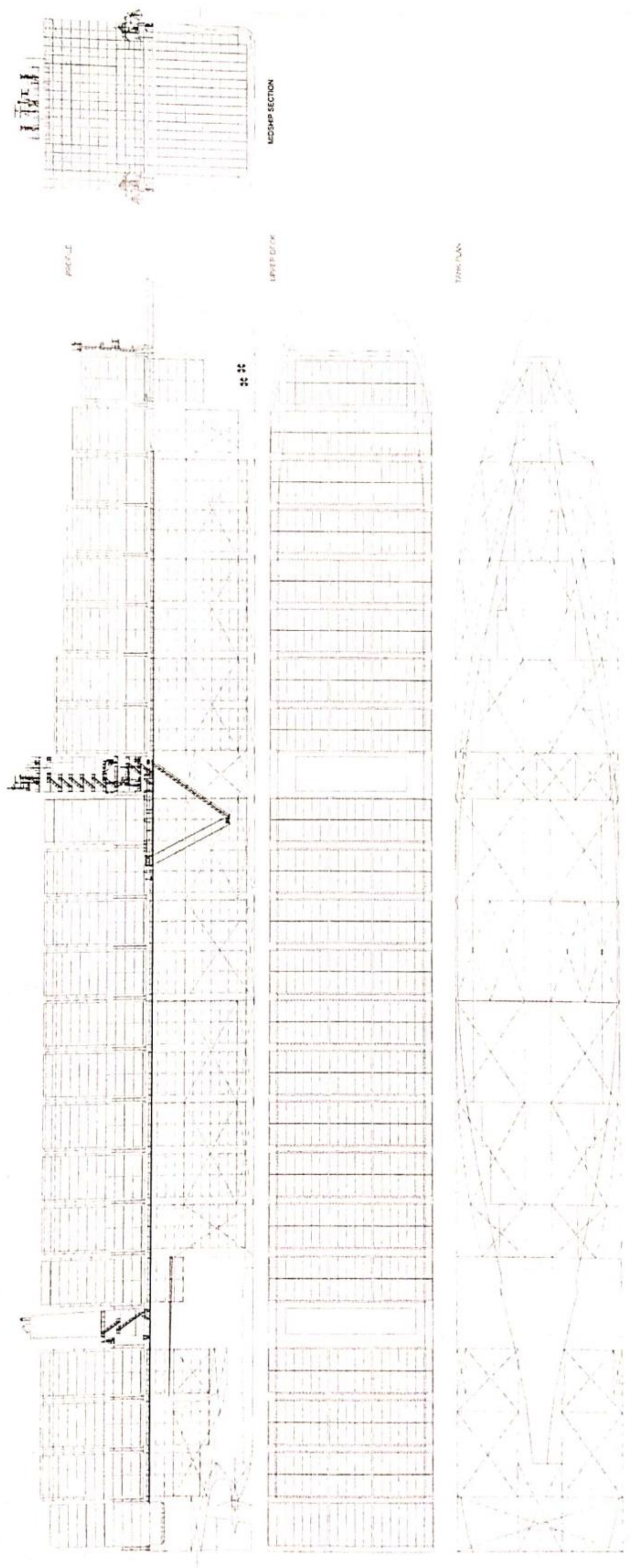
At 14,414TEU, the 149,000dwt vessel and its sisters (such as *CMA CGM T Jefferson*, pictured) have nominally more capacity than the neo-Panamax container ships of previous generations, which typically offered around 13,000TEUs. In September 2017, *CMA CGM Theodore Roosevelt* became the largest vessel to date to traverse the Panama Canal. *CMA CGM G. Washington* is UK registered and built under the auspices of Bureau Veritas.

TECHNICAL PARTICULARS

Length oa: 366m
Length bp: 350m
Breadth moulded: 48.2m
Depth moulded
To main deck: 29.85m
Draught
Scantling: 16m
Design: 14.5m
Gross: 140,830gt
Deadweight
Design:
Scantling: .... abt. 148,000t
Speed, service: 21.7knots
Bunkers (m^3)
Heavy oil: .... ca. 9,200
Diesel oil: .... ca. 1,500
Water ballast (m^3): .... ca. 32,900
Classification society and notations: ....BV I, +HULL, +MACH, Container ship, ESA, WhiSp2, Unrestricted navigation, ALP, +AUT-UMS, +AUT-PORT, +VeriSTAR-HULL DFL 25 years, CLEANSHIP, CPS(WBT), FORS, GREEN PASSPORT, INWATERSURVEY, LASHING-WW, LI-HG-S2, MON-SHAFT, SDS.
Main engine
Design: .... Hyundai-WinGD
Model: 10X92
Manufacturer: .... Hyundai Heavy Industries
Number: 1
Type of fuel: ....HFO, ULSFO and MGO
Output of each engine: .....50,190 kW (MCR)
Propeller(s)
Designer/Manufacturer: ....Hyundai Heavy Industries
Number: 1
Fixed/Controllable pitch: .... Fixed
Diesel-driven alternators
Number: ....4 (3 + 1)
Engine make/type: .... Hyundai, 9H32/40 and 6H32/40
Type of fuel: .... HFO or ULSFO or MGO
Output/speed of each set: ....4,500kW x 720rpm / 3,000kW x 720rpm
Alternator make/type: ....Hyundai
Output/speed of each set: ....4,320kW x 720rpm / 2,880kW x 720rpm
Boiler
Number: 1
Type: .... Automatic, forced draft, marine
Make: ....Kangrim
Output: 4,500kg/h
Cargo cranes/cargo gear: ....Hose-handling crane / Provision crane
Number: 2
Make: .... DMC
Type: .... Electro-hydraulic
Performance: .... 4t SWL
Other cranes
Number: 1
Make: ....Oriental Precision
Type: .... Electric motor-driven
Tasks: ....Monorail hoist
Performance: .... 12.5t SWL
Mooring equipment
Number: ....2 windlass, 10 mooring winch
Make: .... NOV-BLM
Type: .... Electric
Special lifesaving equipment
Number of each and capacity: .... 2, 35 persons each
Make: .... Hatecke
Type: .... Conventional
Hatch covers
Design: .... SMS
Manufacturer: .... Marintech
Type (upper deck/other decks): ...... Pontoon, non-sequential operation type
Containers
Total TEU capacity: 14,414
On deck: 8,420
In holds: 5,994
Reefer plugs: 1,400TEU
Tiers/rows (maximum)
On deck: .... 11 / 19
In holds: .... 11 / 17
Ballast control system
Make: .... Kongsberg
Type: .... K-Chief 600 (PC type)
Water ballast treatment system
Make: .... BIO-UV
Capacity: .... 2,000m^3/hr
Complement
Officers: 19
Crew: 16
Suez/Repair Crew: ...1 cabin for 6 Suez crew and 1 cabin for Suez electrician
Bow thrusters:
Make: .... Kawasaki
Number: 2
Output: .... 2,500kW each
Bridge control system
Make: .... Kongsberg
Type: .... Auto Chief 600
Is bridge fitted for one-man operation? ...Yes
Fire detection system
Make: .... Consilium
Type: .... Salwico Cargo (Addressable type)
Fire extinguishing systems
Cargo holds:
Make/Type: ....NK / CO_2
Engine room:
Make/Type: ....NK / CO_2
Radars
Number: .... 3 (one for S-band and two for X-band)
Make: .... Sperry
Models: ....Visionmaster FT
Integrated bridge system: ....Yes
Make: .... Sperry
Model: .... Visionmaster FT ECDIS
Waste disposal plant
Sewage plant
Make: .... Il Seung (Biological type)
Model: ISB-11
Contract date: .... 29 May 2015
Launch/float-out date: ....7 October 2016
Delivery date: ....20 April 2017

34 SIGNIFICANT SHIPS OF 2017

CMA CGM G. WASHINGTON



HMM PROMISE: Container ship

Shipbuilder: ....**HHIC-Phil Inc.**
Vessel's name: ....***HMM Promise***
Hull No: **NCP0117**
Owner/Operator: .....**Hyundai Merchant Marine Co.,Ltd**
Country: ....**Republic of Korea**
Designer: ....**HHIC-Phil Korea / HHIC-Tech Inc**
Country: ..**Republic of Korea / Republic of the Philippines**
Model test establishment used: ....**KRISO**
Flag: ....**Marshall Islands**
IMO number: **9742168**
Total number of sister ships already completed (excluding ship presented): **1**
Total number of sister ships still on order: .....**nil**

Initially ordered by Greek interests in 2014 from HHIC-Philippines, *HMM Promise* and *HMM Blessing* have been built to a standard HHIC 11,000teu design and has earlier sisters operated by Greek and other interests.

HMM Promise was originally floated out in 2016 and tentatively named *Caravaggio* while its sister was initially named *Monet*. The two ships were sold to Hyundai Merchant Marine (HMM), South Korea's largest ocean carrier, in August 2017 in a deal that was said to be worth around $162M for the pair. HMM said at the time that the price for the vessels was 10% lower than the then current market price. *HMM Promise* also represents the first large container ship delivered to HMM after its ownership was shifted into the hands of state-run Korea Development Bank in August 2016.

Ordinarily that start in life would not qualify the vessel for inclusion in this publication but before putting the vessels into service HMM had decided that its strategy for meeting the 2020 sulphur cap of 0.5% would involve installing scrubbers. Consequently, the two vessels were sent for a scrubber to be fitted immediately.

That on *HMM Promise* was completed first, allowing the ship to become the first container ship of 11,000teu to be fitted with an exhaust gas cleaning system. There are in fact two scrubbers fitted to each ship. Both are Wärtsilä open-loop types; a 34MW unit is fitted for the main engine and a smaller 15MW version to cater for the auxiliaries and boiler.

As with other ships of the type built by HHIC, *HMM Promise* is fitted with a single MAN B&W 8G95ME C9.5 main engine rated at 42,310kW at 77rpm. The drive is to a 9.7m propeller to give a service speed of 22knots at 80% MCR. The auxiliaries are a quartet of HiMSEN H32/40 engines of which two are 9-cylinder versions and the other two 8-cylinder models.

With hull dimensions of 330m length and 46.2m beam and a draught of 16m, the ship can enjoy worldwide trading using the new Panama Canal locks. *HMM Promise* was put into service in July 2018 serving the Asia/East Coast of South America trade while its sister will be employed on the Asia West Coast South America route.

Nominal cargo capacity of the vessels is 11,167teu with 4,587 under deck and 6,580 on deck. At 14tonnes homogenous, the maximum capacity would be 8,300teu. *HMM Promise* has a fairly high reefer capacity with 1,453 plugs capable of accepting standard 40' reefer boxes.

TECHNICAL PARTICULARS

Length oa: 330m
Length bp: 316.4m
Breadth moulded: 48.2m
Depth moulded
To main deck: 27.2m
To upper deck: 27.2m
Width of double skin
Side: 2.37m
Bottom: 2.2m
Draught
Scantling: 16.0m
Design: 13.0m

Gross: 114,000gt
Deadweight
Design: 94,800dwt
Scantling: 134,869dwt
Speed: 22knots
Bunkers
Heavy oil: 7,600m³
Marine gas oil: 640m³
Water ballast: 30,800m³
Water ballast in loaded condition: .... 8,050t at 14t/TEU loaded in summer draught

Daily fuel consumption
Main engine only: 163.99t/day
Auxiliaries: .... 19.65t/day (9Cyl.) / 17.47t/day (8Cyl.)
Classification society and notations:.......Korean Register
KRS1 CONTAINER SHIP LS(CL) SeaTrust(DSA2, FSA3) CLEAN2 IWS ERS CDG IHM LG LI UMA3 BWT STCM DPS(1)
Heel control equipment: .....Anti heeling system
Roll-stabilisation equipment: .... Bilge keel
Main engines
Design: .... MAN Diesel Turbo
Model: 8G95ME C9.5
Manufacturer: ....Hyundai Heavy Ind.
Number: 1
Type of fuel: ....HFO or MGO
Output of each engine: .... 42,310kW at 76.9rpm

Propellers
Material: ....Ni-Al-Bronze
Designer/Manufacturer: ....HHIC-Phil Korea / HHI
Number: 1
Fixed/controllable pitch: .... Fixed
Diameter: 9,700mm
Speed: 76.9rpm

Diesel-driven alternators
Number: 4
Engine make/type: ....Hyundai HiMSEN 9H32/40 (2) / 8H32/40 (2)
Type of fuel: ....HFO or MGO
Output/speed of each set: .... 4,500kW / 4,000kW at 720rpm
Alternator make/type: ....Nishishiba / NTAKL / 89/90A1A
Output/speed of each set: .... 4,320kW 720rpm x 2 / 3,840kW 720rpm x 2

Exhaust-gas scrubbing equipment
Manufacturer: .... Wärtsilä Venturi(V-SOx)
Type: .... Open loop
On main engines?: ..34MW(Scrubber unit for ME-EGC1)
On auxiliary engines?: .... 15MW (Scrubber unit for GE&Boiler-EGC2)

Boilers
Number: 2
Type: ....Vertical smoke tube
Make: ....Kangrim
Output, each boiler: ....EGB 2,500kg/h / Aux. boiler 3,500kg/h

Mooring equipment
Number: 9
Make: ....Flutek
Type: .... Electric motor driven

Special lifesaving equipment
Number of each and capacity: .... 2 x 30
Make: ....DSB Eng.
Type: ....Hinged gravity type

Hatch covers
Design: ....MacGregor
Manufacturer: ....HHIC-Phil Inc.
Type: ....Lift-away

Containers
Lengths: 20ft, 40ft, 45ft
Heights: ....20ft & 40ft, 45ft
Cell guides: ....Fixed (150 x 150 x 15mm angles)
Total TEU capacity: 11,167
On deck: 6,580
In holds: 4,587
Homogeneously loaded to 14t: ..8,300TEU
Reefer plugs: ....1,453FEU [948FEU on deck + 452FEU in hold + 53FEU socket only]
Tiers/rows (maximum)
On deck: 10/19
In holds: 10/17

Ballast control system
Make: ....Emerson
Type: ....Electro-hydraulic

Water Ballast Treatment System
Make: ....Erma First
Capacity: 1,000m³/h

Complement
Officers: 13
Crew: 15
Stern appendages: ....Rudder bulb

Bow thrusters
Make: ....Kawasaki
Number: 1
Output (each): 3,000kW

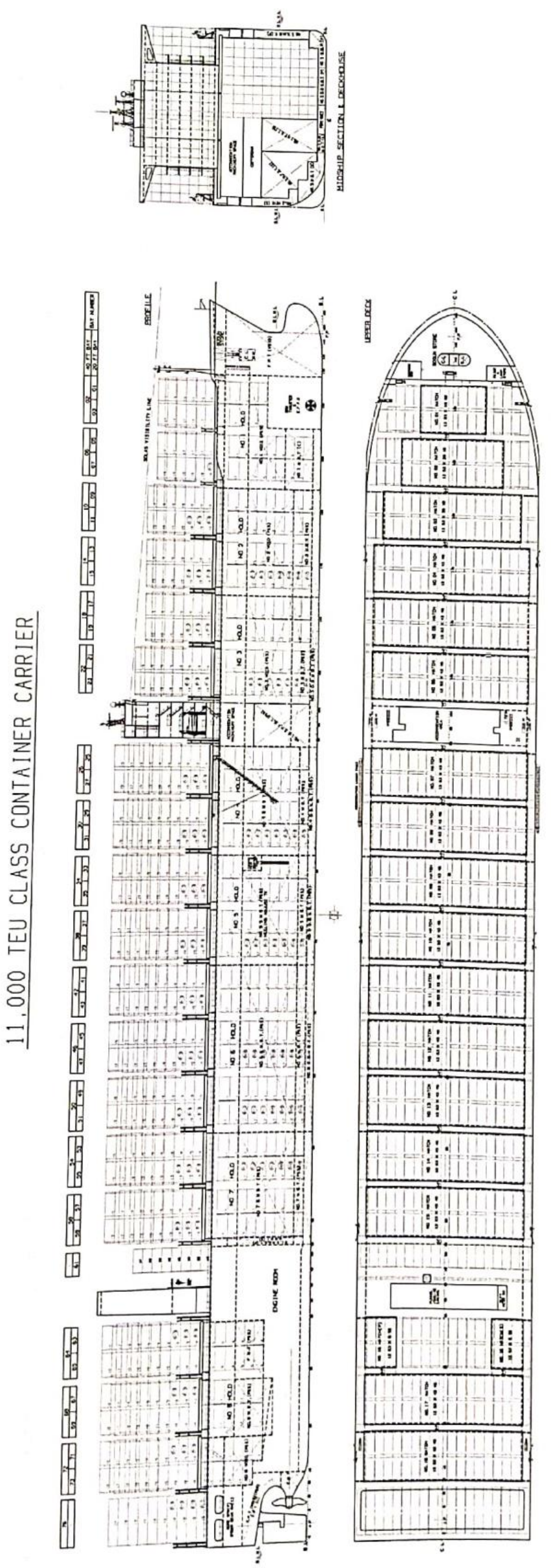
Bridge control system
Make: ....Hyundai Electric
Type: ....Integrated bridge console
One-man operation: ....No

Fire detection system
Make: .... Consilium
Type: ....Salwico Cargo

Fire extinguishing systems
Cargo holds: ....CO_2
Make/Type: .... NK / Fixed high pressure
Engine room: ....CO_2
Make/Type: .... NK / Fixed high pressure
Contract date: ....27 March 2014
Launch/float-out date: ....5 October 2016
Delivery date: .... 23 June 2018

36 SIGNIFICANT SHIPS OF 201

HMM PROMISE



CHARLOTTE SCHULTE: Wide-beam boxship

Shipbuilder: .... **HHIC-Phil**
Vessel's name: .... ***Charlotte Schulte***
Hull No: **NCP0087**
Owner/operator: .... **Bernhard Schulte**
Country: .... **Germany**
Designer: .... **Hanjin Heavy Industry & Construction**
Country: .... **Korea**
Model test establishment used: .... **MOERI**
Flag: .... **Singapore**
IMO number: **9665657**
Total number of sister ships already completed (excluding ship presented): **3**
Total number of sister ships still on order: ...... **nil**

CHARLOTTE Schulte is the first vessel in a series of five 5,400TEU containerships that are being constructed at HHIC-Phil for German shipowner Bernhard Schulte. *Charlotte Schulte* was delivered in January 2014.

With the development of the Panama Canal, both owners and yards are looking at how to optimise vessels for the new dimensions of the canal. Because of this, vessels such as *Charlotte Schulte*, a containership with Post-Panamax dimensions, are starting to come on to the market. *Charlotte Schulte* has a 37.30m beam for the expected new expanded Panama Canal and has a 22m depth with a scantling draught of 13.90m, and weighs in at 65,000dwt.

These wide-beam box ships are starting to become more popular with owners. HHIC-Phil has explained the philosophy of this emerging vessel type has come about from the recession in the world shipping market and the rise in bunker prices, which caused shipping companies to have an interest in container vessels with optimum trims for slow-speed steaming that will reduce operational costs, rather than container vessels that are optimised for high-speed steaming.

To satisfy shipowners' needs and IMO requirements, the lightweight and hull steel weight need to be minimised, which can be achieved by the wide beam design for container vessels. In addition, the benefit of the wide beam design enables more load capacity than other, same-class vessels and facilitates fuel cost reduction by adopting low-speed engines.

In addition, owners are expecting substantial savings from this vessel type, which has been said to be around the US$17,000/day mark compared to older 5,500TEU Panamax designs.

The vessel has been fitted with a G-type super long stroke engine that meets with IMO Tier II NOx emission standards and the Phase III of IMO EEDI index. The engine has an output of 24,680kW SMCR at 72rpm, to give a service speed of 21knots at NCR (22,212kW at 69.5rpm) with a 15% sea margin and design draught, which is designed to optimise the daily fuel consumption. The vessel runs on ultra-low sulphur marine gas oil (ULSMGO) and can be cooled by an ULSMGO cooler to increase the viscosity of the fuel to increase the performance of the main engine's allowable operational range.

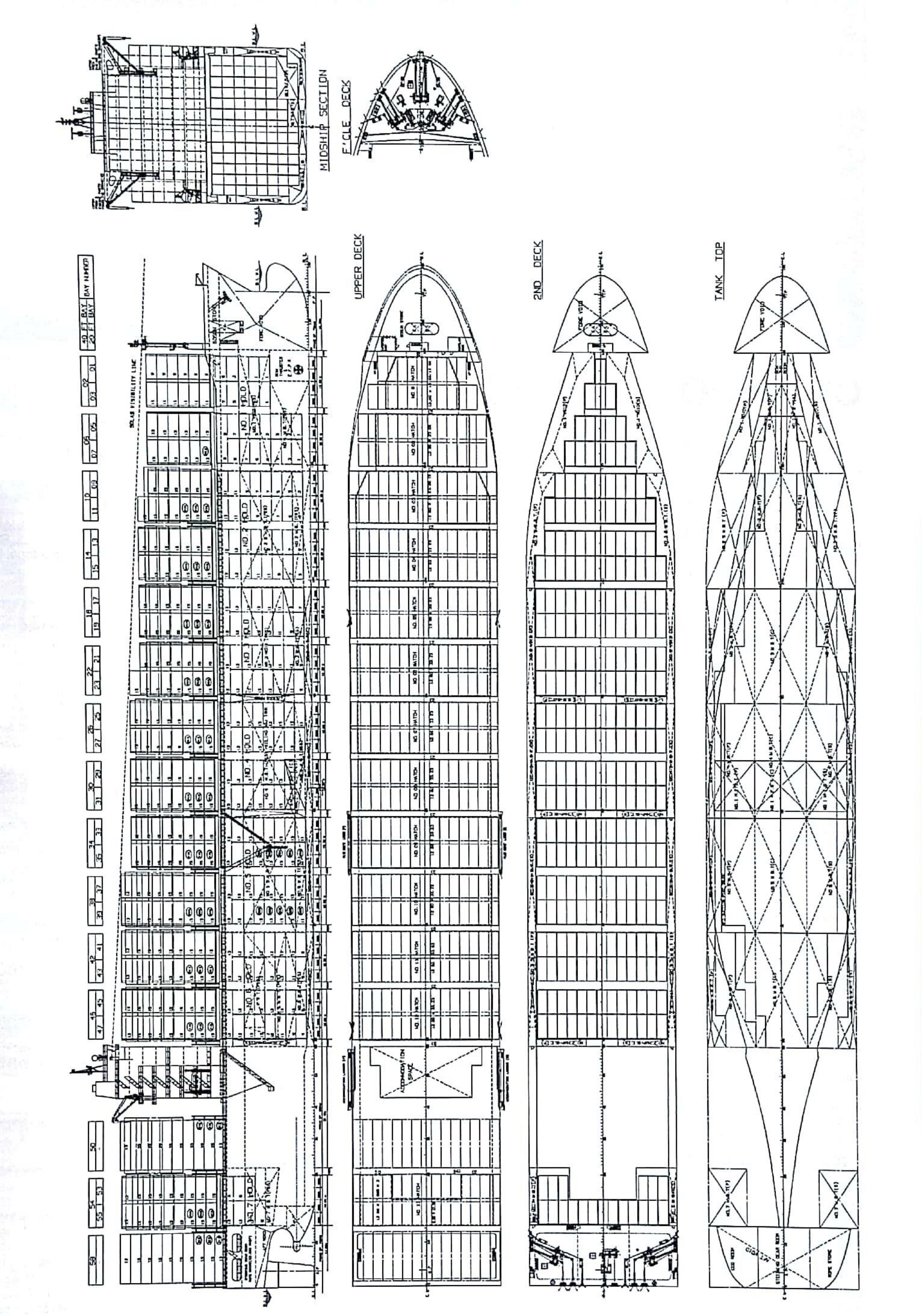
Charlotte Schulte is fitted with a fixed pitch five-bladed propeller that was designed and manufactured by HHIC and has been optimised to reduce the cavitation effects. Both the vessel's hull and propeller optimisation were carried out by HHIC with DNV to give the vessel optimum performance parameters.

TECHNICAL PARTICULARS

Length oa: 255.00m
Length bp: 244.00m
Breadth moulded: 37.30m
Depth moulded
  To main deck: 22.00m
Width of double skin
  Side: 2.35m
  Bottom: 1.90m
Draught
  Scantling: 13.90m
  Design: 12.00m
Gross: 51,870gt
Displacement: 84,200tonnes
Lightweight: 19,120tonnes
Deadweight
  Design: 50,060dwt
  Scantling: 65,120dwt
Block co-efficient: 0.6482
Speed, service: 21.73knots
Bunkers
  Heavy oil: .... 3,930m^3
  Diesel oil: .... 170m^3
Water ballast: .... 19,550m^3
Daily fuel consumption
  Main engine only: 86.6tonnes/day
  Auxiliaries: 7.5tonnes/day
Classification society and notations: ...... DNV+1A1, Container Carrier, DG-P, E0, BIS, BWM-T, TMON, NAUTICUS (Newbuilding), ERS, CLEAN
Main engine
  Design: .... MAN Turbo Diesel
  Model: 6G80ME-C9.2
  Manufacturer: .... Hyundai Heavy Industries Co., Ltd
  Number: 1
  Type of fuel: .... HFO
  Output of each engine: 24,680kW
Propellers
  Material: .... Ni-Al-Bronze
Designer/manufacturer: .... Hanjin Heavy Industries & Construction /Hyundai Heavy Industries
Number: 1
Fixed/controllable pitch: .... Fixed
Diameter: 8.7m
Speed: 72rpm
Diesel-driven alternators
  Number: 4
  Engine make/type: .... Hyundai/Himsen 3 x 7H25/33
  1 x 6H25/33
  Type of fuel: .... HFO
  Output/speed of each set: .... 2,200kW x 900rpm
Alternator make/type: .... HHI-EES/ HFC7 714-84K-EH (HFC7 636-84K)
Output/speed of each set: .... 2,090kW x 900rpm
Boilers
  Number: 1
  Type: .... Composite boiler
  Make: .... Alfa Laval – Aalborg
  Output, each boiler: 3,000/2,500kg/h 7bar
Mooring equipment
  Number: 6
  Make/Type: .... Towimor/Electric motor driven
Special lifesaving equipment
  Number of each and capacity: ... 2 x 25 persons
  Make/Type: .... DSB/Hinged gravity type
Hatch covers
  Design: .... MacGregor
  Manufacturer: .... Hanjin Heavy Industry & Construction
  Type: .... Lift-away type
Containers
  Lengths: 20ft/40ft
  Cell guides: .... Fixed type
  Total TEU capacity: 5,466TEU
    On deck: 3,484TEU
    In holds: 1,982TEU
    Homogenously loaded to 14tonnes: 3,685TEU
  Reeder plugs: 650
  Tiers/rows
    On deck: 10/15
    In holds: 8/13
  Hold refrigeration system: .... Air type
Ballast control system
  Make: .... Pleiger Far East
  Type: .... Electro-hydraulic type
Water ballast treatment system
  Make: .... Alfa Laval
  Capacity: .... 750m^3/h
Stern appendages/special rudders: .... Full spade type
Bow thruster
  Make: .... Hyundai Heavy Industries
  Number: 1
  Output: 1,600kW
Bridge control system
  Make: .... Hyundai Heavy Industries & Construction
  Type: .... Integrated navigation console
Fire detection system
  Make/Type .... Autronica/Autoprime
Fire extinguishing systems
  Cargo holds/engine room: .... Fain/CO_2
Radars
  Number: 2
  Make: .... Japan Radio
  Model: JMA-9172-SA/ 9122-9XA
Integrated bridge system
  Make: .... Japan Radio
  Model: JAN-901B, JAN-2000-CON1
Contract date: .... 31 May 2012
Launch/float-out date: .... 16 September 2013
Delivery date: .... 17 January 2014

30 SIGNIFICANT SHIPS OF 2014

CHARLOTTE SCHULTE



:ANT SHIPS OF 2014 31

MAULE: Taiwan-built 6600TEU class container vessel

Shipbuilder: **CSBC Corporation, Taiwan Kaohsiung shipyard**
Vessel's name: ***Maule***
Hull No: **HNo.896**
IMO number: **9400069**
Owner/operator: **Compania SudAmericana de Vapores S.A.**
Designer: **CSBC Corporation, Taiwan**
Model test establishment used: **HSVA, Germany**
Flag: **Liberia**
Total number of sister ships already completed (excluding vessel presented): **4**
Total number of sister ships still on order: **1**

CSBC's 6600TEU class container vessel series were ordered by the Chile Compania SudAmericana de Vapores S.A. company in 2006. Due to the global financial crisis, the ship's delivery date was moved back over a couple of months. *Maule* is the second vessel of a series of five vessels that was delivered in April.

The hull form and arrangement derives from CSBC's former 5500TEU design, but has a cargo hold length of parallel mid-body added.

The model tests carried out by HSVA were found to be much more productive than HSVA statistical data. The lashing bridge has been raised by one tier for convenient lashing by stevedores than on the previous 5500TEU class ships. Meanwhile, seven tiers of containers on deck can be arranged with the same deck house height and the SOLAS visibility requirements. As a result, the total container number can be increased to 6589TEU.

A total of 1162 sets of reefer plugs are available on deck and in the hold. The reefer containers of 834FEU are stowed in the first three tiers above the hatch cover and 328FEU in three cargo holds.

By adding cargo holds, the required equipment number also increases. The grade of anchor and anchor chain is also higher than the previous 5500TEU design, therefore, the hawser pipe and windlass arrangement of the forecastle deck have had to be re-designed.

The cargo hold can accommodate eight tiers of normal containers plus one tier of high cubes. Dangerous goods can be loaded in No. 2 to 3 cargo holds.

The ship is propelled by a Wärtsilä electrical Flex type engine with low load tuning function for fuel saving in low & medium speed range. The electric power is supplied from four sets of diesel generator each develops 3690kW which can match up the large reefer requirements. One set of bow thrusters with 2000kW capacity is also installed.

The bridge and navigation system has one man bridge operation. An integrated control and monitoring system (ICMS) has been installed on the vessel to integrate the ballast system, diesel / fuel oil system, power management system, bilge piping high level alarm, draught gauges and the loading computer.

Although the main engine power is higher, the sea trials confirm that the vibration performance is much better than the previous 5500TEU designs.

TECHNICAL PARTICULARS

Length, oa: 305.60m
Length, bp: 293.16m
Breadth, moulded: 40.00m
Depth, moulded: 24.20m
Gross: 75,752gt
Deadweight
- Design: 61,175dwt
- Scantling: 81,002dwt

Draught
- Design: 12.00m
- Scantling: 14.00m

Speed, at 90%mcr, 15%sea margin, design draft, BF3: 25.30knots
Bunkers
- Heavy oil: 7813m^3
- Diesel oil: 385m^3

Water ballast: 18,846m^3
Fuel consumption
- Main engine only: 206 tonnes/day

Classification society and notations: LR +100A1, "Container Ship", *IWS, +LMC, UMS, ShipRight (SDA, FDA, CM), LI, SCM
Heeling control system: Auto control, 700m^3/h
Main engine
- Design: Wartsila
- Model: 10RT-flex96C
- Manufacturer: Doosan Engine Co. Ltd.
- Number: 1
- Type of fuel: HFO
- Output of each engine: 57,200 kW x 102rpm

Propeller
- Material: Nickle-aluminium-bronze
- Design/Manufacturer: CSBC/Nakashima
- Number: 1
- Fixed/controllable pitch: Fixed
- Speed: 102rpm

Diesel-driven alternators
- Number: 4
- Engine make/type: Daihatsu /8DC-32
- Type of fuel: HFO
- Output: 3844kW x 720rpm
- Alternator make/type: Nishishiba/FEK63B-10
- Output: 3690kw x 720rpm

Boilers
- Number: 1
- Type: MA06AAR22, Vertical oil fired boiler
- Make: Kangrim industries Co., Ltd
- Output: 4000kg/h

Mooring equipment
- Number: 2 x mooring winch/windlass, 6 x mooring winch
- Make: Rolls-Royce
- Type: ElectricHatch covers
- Design: MacGregor
- Make: CSBC
- Type: Pontoon type

Containers
- Lengths: 20ft/40ft
- Total TEU capacity: 6589
  - on deck: 3492
  - in hold: 3097
- homogeneously loaded to 14tonnes: 4963
- Reefer plugs: 1162FEU

Tiers/rows (maximum)
- on deck: 7/16
- in hold: 9/14

Ballast control system
- Make: InterSchalt Maritime Systems
- Type: Vista Automation

Complement
- Officers: 15
- Crews: 14
- Suez Canal crew: 6

Bow thruster
- Make: KHI
- Number: 1
- Output: 2000kW

Fire detection system
- Make: Consilium Marine
- Type: Salwico CS4000

Fire extinguishing system
- Cargo hold/Engine room: Fixed CO_2 NK Co., LTD

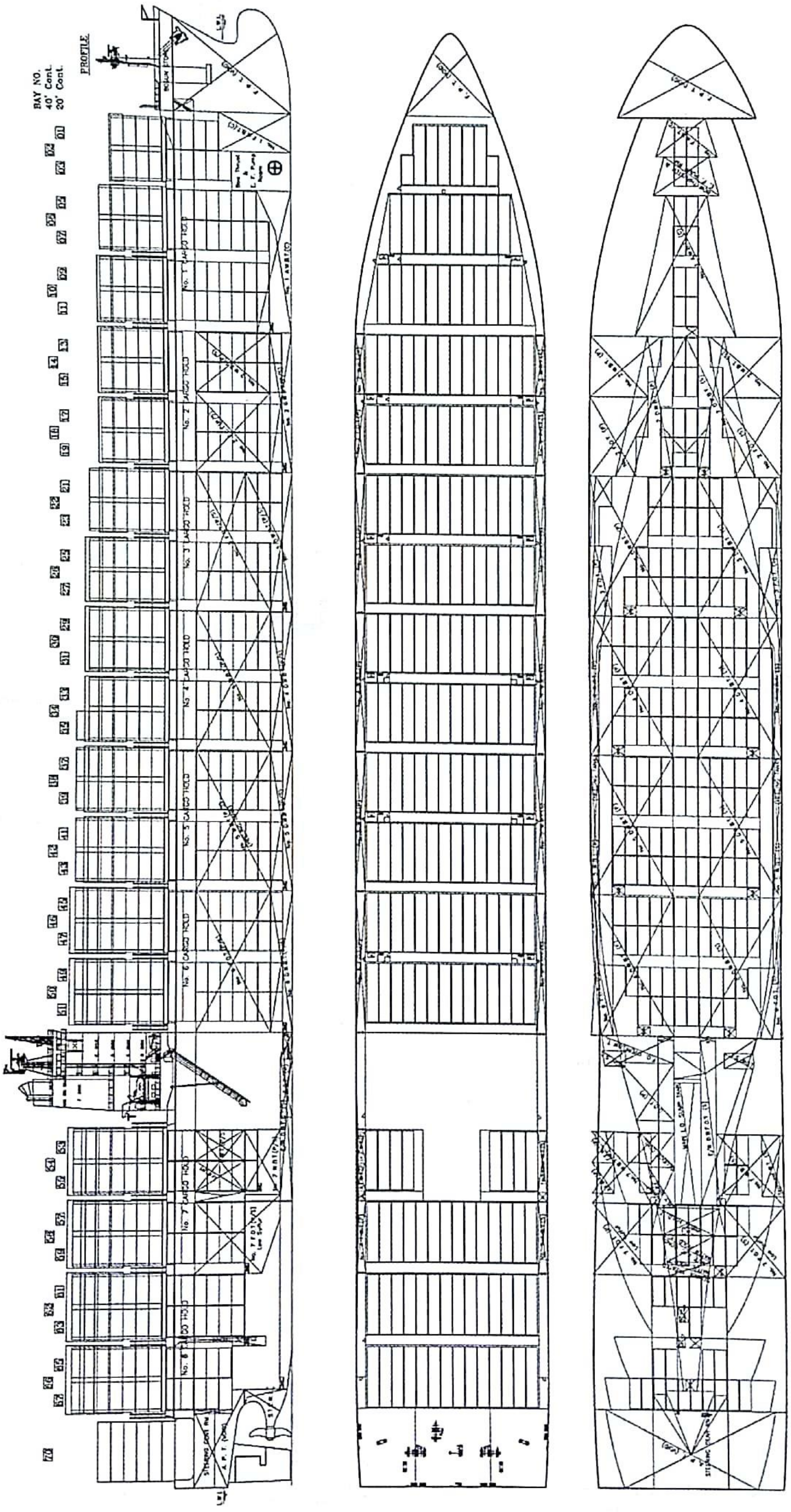
Radars
- Number: 3
- Make: Sperry Marine
- Model: B1418C01-02/B1417B01

Waste disposal plant
- Incinerator: Sunflame KFB-100
- Sewage plant: Hamworthy ST-2A

Contract date: May 2006
Launch/float-out date: July 2009
Delivery date: April 2010

66 SIGNIFICANT SHIPS OF 2010

MAULE



CCNI IQUIQUE: Next generation 6,800TEU container ship

Shipbuilder: ....**HHIC-Phil**
Vessel's name: ....***CCNI Iquique***
Hull No: **NCP0095**
Owner/operator: .....**Paxi Maritime Corporation**
Country: ....**Greek**
Designer: ....**Hanjin Heavy industry & Construction**
Country: ....**Korea**
Model test establishment used: .... **MOERI**
Flag: ....**Liberia**
IMO number: **9679555**
Total number of sister ships already completed (excluding ship presented): .... **nil**
Total number of sister ships still on order: ...... **nil**

CCNI *Iquique* is the first vessel of HHIC's second generation of 6,800TEU class container carriers which was constructed at HHIC-Phil for Paxi Maritime Corporation and was delivered in August.

Compared with HHIC's previous vessel, the major change has been focused on the enhanced energy efficiency and environmentally-friendly design. A reduction of about 7% in fuel consumption by the main engine at NCR power has been achieved through the use of the Wärtsilä 7RT-flex82T-B that has been delta tuned and complies with the IMO Tier II NOx emissions standards.

Trim optimisation model tests have also been carried out on the design with the results expected to provide favourable trims for actual operating conditions in order to reduce ship resistance to gain an even better fuel efficiency.

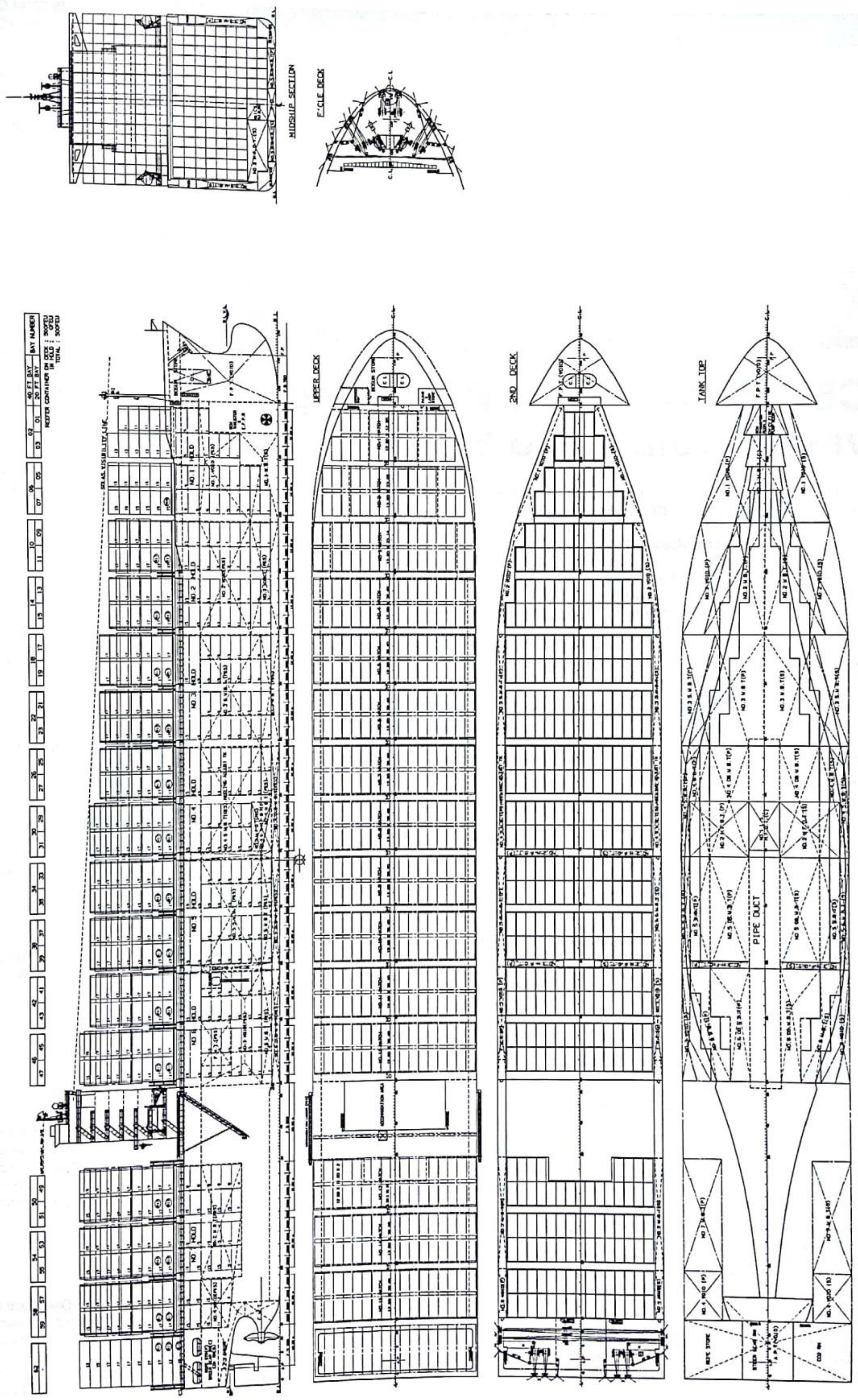
Further environmental gains can be seen through the classification of ABS with the application of notations such as ENVIRO and GP. The vessel also meets with the phase III of IMO EEDI index. Furthermore, the extensive spectral-based fatigue analysis according to ABS 'SFA(25)' notation has been applied to the vessel's structural systems based on the design target fatigue life of 25 years for North Atlantic operation.

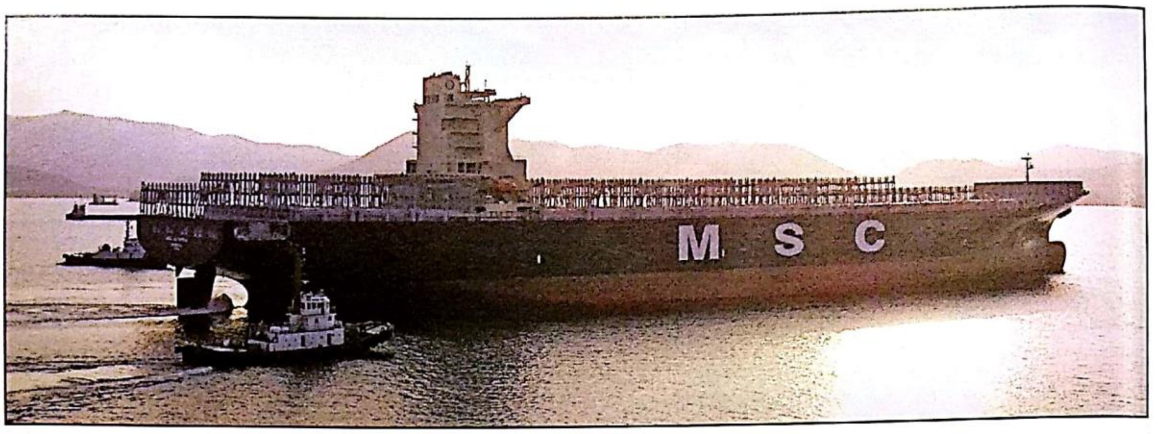
TECHNICAL PARTICULARS

Length oa: 270.90m
Length bp: 258.40m
Breadth moulded: 42.80m
Depth moulded
 To main deck: 24.6m
 To upper deck: 24.6m
Width of double skin
 Side: 2.79m
 Bottom: 2.10m
Draught
 Scantling: 14,550m
 Design: 13,000m
Gross: 70,262gt
Displacement: 103,160tonnes
Lightweight: 23,073tonnes
Deadweight
 Design: 65,625dwt
 Scantling: 80,087dwt
Block co-efficient: 0.6240
Speed, service: 21.31knots
Bunkers
 Heavy oil: 4,942m³
 Diesel oil: 325m³
Water ballast: 21,779m³
Container ships – water ballast in loaded conditions: ....6,232tonnes at 14tonnes homogenously loaded 50% consume condition
Classification society and notations: .... ABS +A1(E), Container carrier, +AMS, +ACCU, SH, SHCM, UWILD, TCM, CSC, BWT, ENVIRO, GP, CPS, SH-DLA, SFA(25), FL(25) and RW, CLP-V
% high-tensile steel used in construction: ... 64%
Main engines
 Design: .... Wärtsilä
 Model: 7RT-flex82T-B
 Manufacturer: ....Hyundai Heavy Industries
 Number: 1
 Type of fuel: ....HFO
 Output of each engine: 27,700kW
Propeller
 Material: ....Ni-Al-Bronze
Designer/manufacturer: ....Hanjin Heavy Industry & Construction/ Hyundai Heavy Industries
Number: 1
Fixed/controllable pitch: .... Fixed
Diameter: 8.70m
Speed: 84rpm
Diesel-driven alternators
 Number: 4
 Engine make/type: ....Hyundai Heavy Industries/ Trunk piston
 Type of fuel: ....HFO
 Output/speed of each set: 1,540kW
 Alternator make/type: ....Hyundai/HFC& 636-08P
 Output/speed of each set: .... 1,450kW x 900rpm
Boilers
 Number: 1
 Type: ....Aux boiler
 Make: ....Kangrim
 Output, each boiler: ....3,000kg/h @ 7bar
Other cranes
 Number: 1
 Make: ....Haean Machinery Ind.
 Type: .... Electric motor driven monorail type
 Tasks: ....Provisions & Engine part handling
 Performance: ....10tonne SWL
Mooring equipment
 Number: 6
 Make: .... TTS
 Type: ....Electric motor driven type
Special lifesaving equipment
 Number of each and capacity: .... 2 x 28 persons
 Make: ....Hyundai Lifeboat
 Type: ....Hinged gravity type
Hatch covers
 Design: ....SMS
 Manufacturer: ....Hanjin Heavy Industry & Construction
 Type: ....Lift-away type
Containers
 Lengths: 20ft, 40ft, 43ft, 54ft
 Heights: .... 20 & 40ft, 48 & 53ft
 Cell guides: .... Fixed
 Total TEU capacity: 6,865
  On deck: 4,070
  In holds: 2,795
  Homogenously loaded to 14tonnes: .... 4,970TEU at half bunker condition
Reefer plugs: 730
Tiers/rows
  On deck: 10/17
  In holds: 9/15
Ballast control system
 Make: ....Hanla IMS
 Type: ....Electro-hydraulic
Water ballast treatment system
 Make: .... Panasia
 Capacity: 750m³/h
Complement
 Officers: .... 13 persons
 Crew: .... 15 persons
Stern appendages/special rudders: .... Semi spade rudder
Bow thruster
 Make: ....Hyundai Heavy Industries
 Number: 1
 Output: 2,150kW
Bridge control system
 Make: ....Hyundai Heavy Industries & Construction
 Type: ....Integrated navigation console
Fire detection system
 Make: .... Consilium
 Type: ....Salwico FDA-A Cargo
Fire extinguishing systems
 Cargo holds: ....Fain/ CO_2
 Engine room: ....Fain/CO_2
Radars
 Number: 2
 Make: .... JRC
 Model: JMA-9132-SA, JMA-9122-9XA
Integrated bridge system
 Make: .... JRC
 Model: JAN-901B
Waste disposal plant
 Incinerator: ....Hyundai-Atlas/ MAXI NG 150SL WS
 Sewage plant: ....Il Seung/ ISS-35N
Contract date: .... 15 October 2012
Launch/float-out date: .... 30 April 2014
Delivery date: .... 30 October 2014

26 SIGNIFICANT SHIPS OF 2014

CCNI IQUIQUE





MSC ALTAMIRA: modern 8,900TEU box ship from Hyundai Samho

Shipbuilder: Hyundai Samho Heavy Industries Co., Ltd
Vessel's name: *MSC Altamira*
Hull No: S592
Owner/operator: Ofer Ships Holding Ltd/ Bernhard Schulte
Country: Israel
Designer: Hyundai Samho Heavy Industries Co., Ltd
Country: Korea
Model test establishment used: Hyundai Maritime Research Institute (HMRI)
Flag: Hong Kong
IMO number: 9619426
Total number of sister ships already completed (excluding ship presented): 1
Total number of sister ships still on order: 4

MSC Altamira is the latest design from Hyundai Samho Industries Co., Ltd that has an increased capacity from 8,800TEU to 8,900TEU for joint owners Ofer Ships Holding and Berhard Schulte that was delivered in September, and which will be oprated by MSC. *MSC Altamira* is the first in a series of six container carriers ordered by the companies.

Apart from the increased container capacity the vessel also has an applied wide breadth of 48.2m compared to that of an 8,600TEU container ship. With the expansion of the Panama Canal there is a trend for wider vessels, allowing ships to have an increased capacity, but also giving them more stability. The vessel design also offers a higher reefer container intake.

The ship is powered by an HHI-EMD 9S90ME-C8.2 that has a power output of 47,430kW that gives the vessel a service speed of 22knots. Another advantage of this vessel is that is also is capable of slow steaming, bringing its emission levels down.

MSC Altamira is also keeping up with the initiatives to prevent seawater contamination with the installation of an Alfa Laval ballast water treatment system (BWTS) that has a capacity of 1,000m^3/h, which is the first installation of this type for the shipyard that meets the rules and regulations aimed at the protection of marine environment.

The vessel is designed as an ocean going, single screw, which is directly driven by a Hyundai Wartsila 6RT-flex82T that has a total output of MCR 23,600 kW marine diesel engine, giving the vessel a speed of 14.95 knots. It has a bulbous bow, transom stern and a continuous deck with a forecastle deck.

Two electro hydraulic cargo cranes manufactured by Oriental Precision & Engineering Co., Ltd., each with a loading capacity of 4tonnes, can handle cargo. Total capacity is 8,886TEU including 1,000FEU of reefer containers and the homogenous intake, based on the unit weight of 14tonnes/TEU, is about 7,260TEU.

The vessel is classed to Korean Register of Shipping: +KRS1, Container Ship, Sea trust (DSA2, FSA3, HCM), IWS, ERS, CDG, ENV(IBWM, IAFS, IOPP, ISPP, IGPP, IAPP, IIHM), PSPC, EDD, OHIMP, CHA LI.

TECHNICAL PARTICULARS

Length oa: 299.18m
Length bp: 286.00m
Breadth moulded: 48.20m
Depth moulded
- To main deck: 24.80m
- To upper deck: 24.80m
- To other decks: 20.14m

Width of double skin
- Side: 48.20m
- Bottom: 2.00m

Draught
- Scantling: 14.50m
- Design: 12.50m

Gross: 94,017gt
Displacement: 143,761tonnes
Lightweight: 31,245tonnes
Deadweight
Design: 88,997dwt
Scantling: 112,516dwt
Block co-efficient: 0.6996
Speed, service: 22knots
Bunkers
- Heavy oil: 9003.1m^3
- Diesel oil: 485.4m^3

Water ballast: 28,465m^3
Daily fuel consumption
- Main engine only: 159.7tonnes/day
- Auxiliaries: 3.9tonnes/day

Classification society and notations: KR, +KRS1-Container Ship, IWS, Sea Trust (DSA2, FSA3 and HCM), CDG, ENV (IBWM, IAFS, IOPP, ISPP, IGPP and IAPP), PSPC, LI, CHA + KRM1-UMA, STCM
Heel control equipment: Anti-heeling pump
Main engine
- Model: 9S90ME-C8.2
- Manufacturer: HHI-EMD
- Number: 1
- Type of fuel: HFO, MDO
- Output of each engine: 47,430kW x 78rpm

Propellers
- Material: Ni-Al-Bronze
- Designer/manufacturer: HHI-EMD
- Number: 1
- Fixed/controllable pitch: Fixed
- Diameter: 9.5m
- Speed: 76.1rpm

Diesel-driven alternators
- Number: 4
- Engine make/type: HHI-EMD/7H23/40
- Type of fuel: HFO, MDO
- Output/speed of each set: 3,500kW x 720rpm
- Alternator make/type: HHI-EES/ HJ 807-10P
- Output/speed of each set: 3,360kW

Boilers
- Number: 1
- Type: Pin tube type, oil fired buring
- Make: Kangrim
- Output, each boiler: 5,500kg/h

Other cranes
- Number: Monorail crane
- Make: Dongham Marine Crane
- Type: Electric motor driven sliding type
- Tasks: Engine room service
- Performance: SWL 10tonnes

Mooring equipment
- Number: 2 x Windlasses, 7 x winches
- Make: Towimor
- Type: Electric hydraulic and electric driven

Special lifesaving equipment
- Number of each and capacity: 2 x 30 persons, 2 x 6 persons, 4 x 16 persons
- Make: Schat-Harding , Viking Life Saving
- Type: Lifeboat: totally enclosed, Liferaft: throw over type

Hatch covers
- Design: Cargotec
- Manufacturer: Marine Tech Inc
- Type: Pontoon, non-sequencial operation

Containers
- Lengths: 20ft/40ft/45ft
- Heights: 8ft 6inches/ 9ft 6inches
- Total TEU capacity: 8,886TEU
  - On deck: 5,056TEU
  - In holds: 3,830TEU
  - Homogenously loaded to 14tonnes: 7,260TEU
- Reefer plugs: 1,000FEU
- Tiers/rows
  - On deck: 10 tiers/19 rows
  - In holds: 9 tiers/ 17 rows

Ballast control system
- Make: Pleiger Far East
- Type: Electro hydraulic type

Water ballast treatment system
- Make: Alfa Laval
- Capacity: 1,000m^3/h

Complement
- Officers: 11
- Crew: 16

Stern appendages/special rudders: Semi-balance stream line
Bow thruster
- Make: Hyundai Heavy Industries Co., Ltd
- Number: 1
- Output: 3,000kW

Bridge control system
- Make: Hyundai Heavy Industries Co. Ltd
- Type: Self standing
- One-man operation: Yes

Fire detection system
- Make: NK
- Type: Smoke detecting type

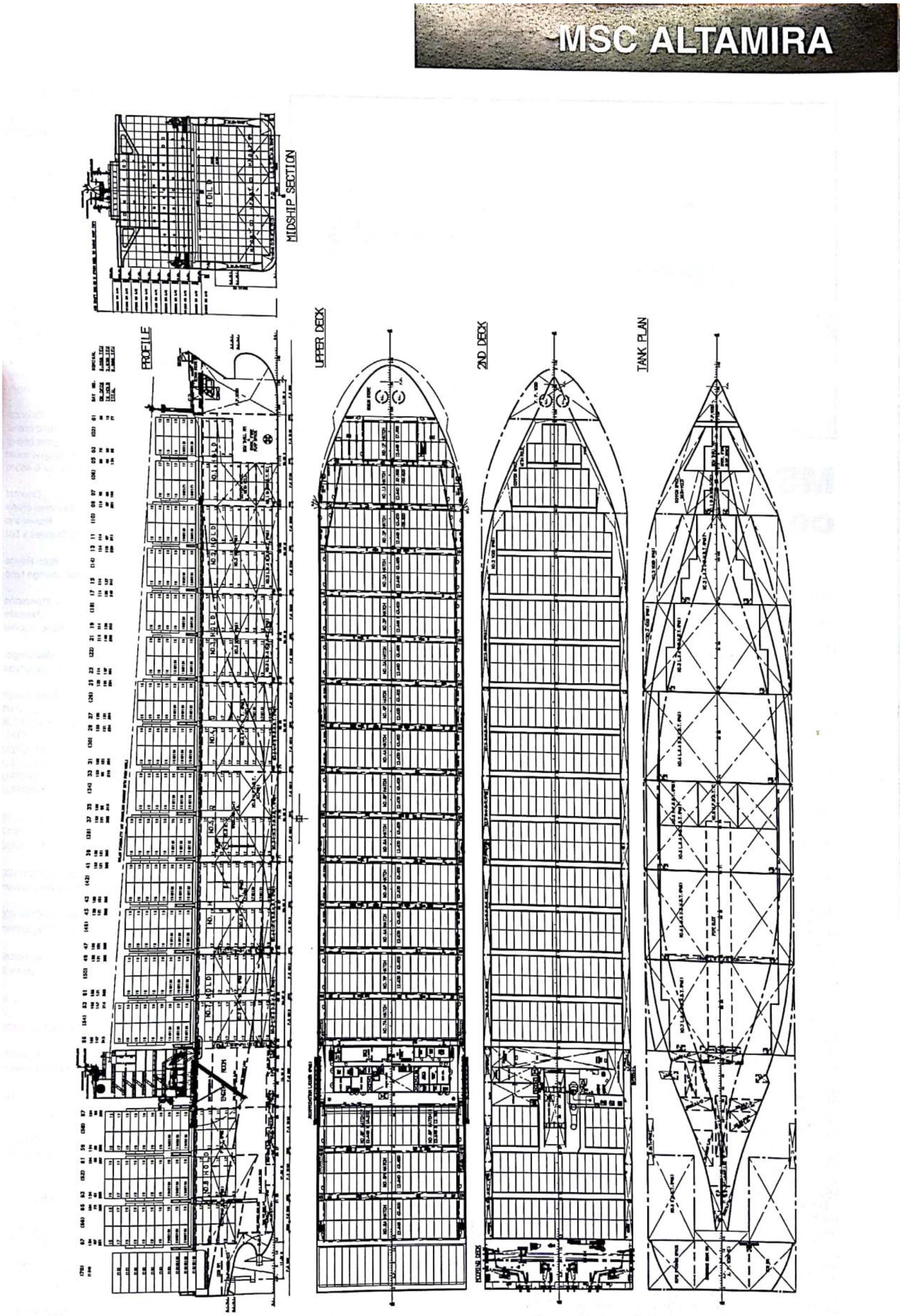
Fire extinguishing systems
- Cargo holds: NK/ CO_2
- Engine room: NK/ CO_2
- Cabins: Sea water
- Public spaces: Sea water

Radars
- Number: 2
- Make: JRC
- Model: JMA-9132-SA, JMA-9122-6XA

Waste disposal plant
- Sewage plant: Jonghap Machinery Co., Ltd/ Biological

Contract date: 1 February 2011
Launch/float-out date: 27 July 2012
Delivery date: 28 September 2012

74 SIGNIFICANT SHIPS OF 2012



SIGNIFICANT SHIPS OF 2012

75

MOL BRAVO: SAVER 10000 containership design

Shipbuilder: .... **Jiangsu Yangzi Zinfu Shipbuilding**
Vessel's name: .... ***MOL Bravo***
Hull No: **1006**
Owner/operator: .... **Seaspan**
Country: .... **Hong Kong**
Designer: .... **Marine Design and Research Institute of China (MARIC)**
Country: .... **China**
Model test establishment used: .... **MARIN**
Flag: .... **Hong Kong**
IMO number: **9685322**
Total number of sister ships already completed (excluding ship presented): **3**
Total number of sister ships still on order: **6**

THE shipping industry has been under pressure to reduce its carbon emissions, in response to this pressure Seaspan has designed and developed the SAVER 10000 series, which balances cost effectiveness and client acceptability with energy efficiency measures. The vessel, *MOL Bravo*, is the first in the second series constructed at Jiangsu Yangzi Zinfu Shipbuilding and delivered to Seaspan in July.

The SAVER 10000 breaks with the traditional method of optimising for a design point of one speed and draught that is very seldom seen during the ship's operation. The SAVER 10000 is instead optimised to operate over a range of speeds and draughts, based on Seaspan's extensive experience with this vessel type. Seaspan has suggested this is a paradigm shift in the container industry rather than an iterative improvement, as prior to the design of the SAVER 10000 this approach of optimising for the anticipated operational profile was uncommon.

Through numerous model tests, the hull lines and bulbous bow have been optimised and matched to the engine and propeller to ensure maximum energy efficiency over the range of speeds and draughts the vessel is likely to see in service. The efficiency of the vessel has been further improved with the installation of a full spade rudder with twisted leading edge, Propeller Boss cap fins and the use of high-performance low friction anti-fouling paint. Installation of a trim and draught optimisation module as part of the loading software, will allow the vessel to gain further efficiencies on each voyage. Later sister vessels in this series will also have Becker Twisted Fins which will decrease the fuel consumption even further.

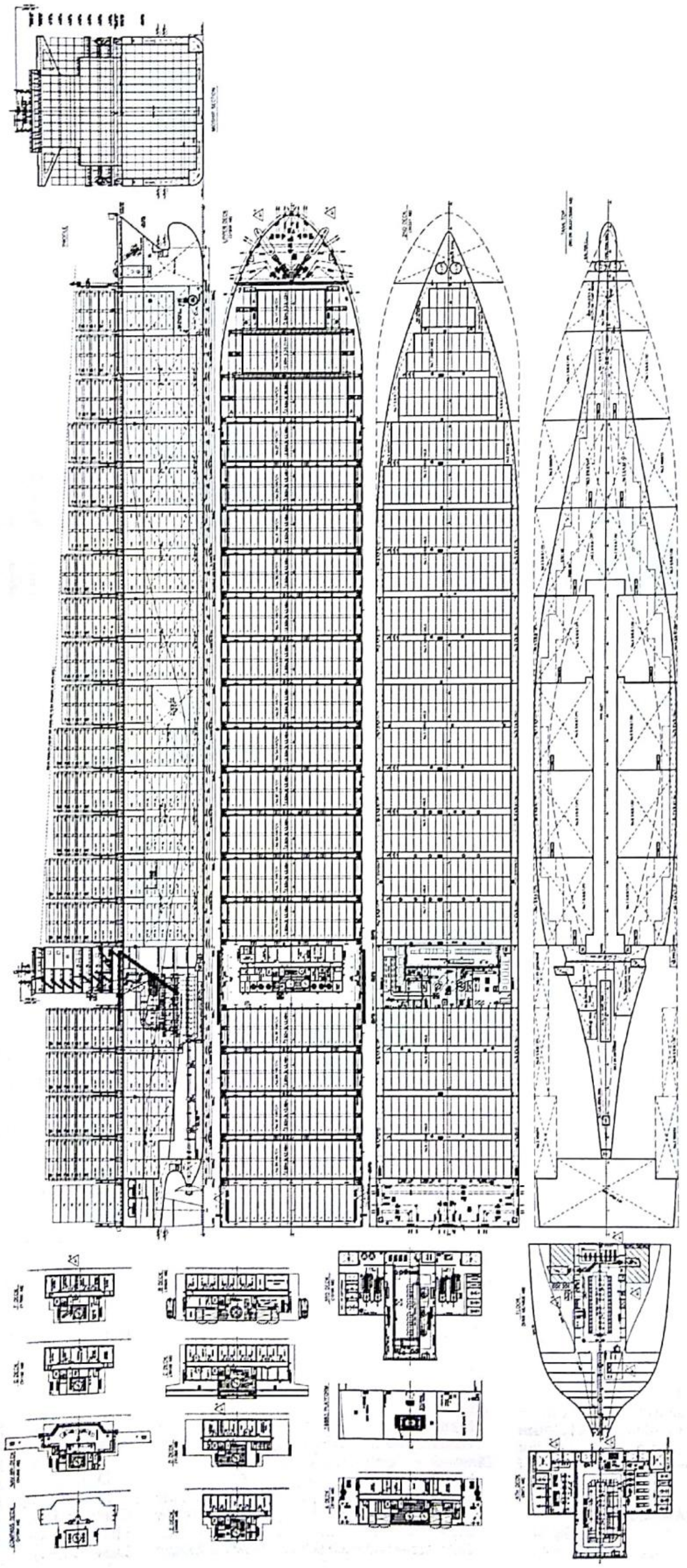
The main engine is a MAN B&W 10S90ME-C9, an efficient super long-stroke slow-speed engine. The engine is derated and has exhaust gas bypass with low load tuning, allowing greater fuel savings at lower loads where the vessels are more often operating. The addition of PMI auto tuning will ensure the engine is always optimised. The load on the auxiliary engines has been reduced by the installation of frequency controlled sea water pumps and engine room fans.

The SAVER 10000 has also been designed to reduce other environmental impacts; the vessel has a Tier II engine to reduce its NOx emissions, it has an RWO CleanBallast ballast water treatment system. An Inventory of Hazardous Materials certificate will assist in the safe and environmental recycling of the vessel at the end of its life and it has DNV Clean Notation to validate the vessel's design and equipment are in compliance with or are more extensive than those found in international standards currently in force.

TECHNICAL PARTICULARS

Length oa: 337m
Length bp: 320m
Breadth moulded: 48.20m
Depth moulded
  To main deck: 20.33m
  To upper deck: 27.20m
Width of double skin
  Side: 2.36m
  Bottom: 2.20m
Draught
  Scantling: 15.20m
  Design: 13m
Gross: 112,083gt
Displacement: 153,111.7tonnes
Lightweight: 38,220tonnes
Deadweight
  Design: 86,000dwt
  Scantling: 114,891.7dwt
Block co-efficient: 0.635
Speed, service: 23.8knots
Bunkers
  Heavy oil: .... 10,066.9m^3
  Diesel oil: .... 517.1m^3
Water ballast: .... 31,530.1m^3
Daily fuel consumption
  Main engine only: 179.2tonnes/day
  Auxiliaries: .... 5.5tonnes/day (in port, no temperature controlled containers) 9.5tonnes/day (at sea, no temperature controlled containers)
Classification society and notations: .... DNV +1A1 Container Carrier, Nauticus (Newbuildings), E0, TMON, BIS, DG, BWM-(T), CLEAN, NAUT-OC, COMF (3) C (3), COAT-PSPC (B), SafeLash
% high tensile steel used in construction: 75%
Heel control equipment: .... Heeling tanks
Roll-stabilisation equipment: .... bilge keels
Main engine
  Design: .... MAN B&W
  Model: 10S90MEC9.2
  Manufacturer: .... CSSC-MES Diesel Co Ltd
  Number: 1
  Type of fuel: .... HFO, MDO
  Output of each engine: .... SMCR 51,000kW
Propellers
  Material: .... Ni-Al-Bronze
  Designer/manufacturer: .... Nakashima
  Number: 1
  Fixed/controllable pitch: .... Fixed
  Diameter: 9.5m
  Speed: 84rpm
  Special adaptations: .... Propeller boss cap fin
Diesel-driven alternators
  Number: 4
  Engine make/type: .... 2 x Daihatsu 8DC-32e 2 x Daihatsu 6DC-32e
  Type of fuel: .... HFO, MDO
  Output/speed of each set: 3860kW/ 2895kW
  Alternator make/type: .... Nishishiba NTAKL
  Output/speed of each set: 3690kW/ 2760kW
Boilers
  Number: 1
  Type: .... MOS-T C1
  Make: .... Alfa Laval
  Output, each boiler: 5,500kg/h
Mooring equipment
  Number: .... 8 x mooring lines forward 8 x mooring lines aft
  Make: .... Hatlapa Marine Equipment
  Type: .... Electric hydraulic driven
Special lifesaving equipment
  Number of each and capacity: .... 2 x 35 persons
  Make: .... Jiangyinshi Neihai LSA
  Type: .... Totally enclosed life/rescue boat
Hatch covers
  Design: .... TTS
  Manufacturer: .... TTS
  Type: .... Upper deck hatches, non-sequential, pontoon type
Containers
  Lengths: 20ft, 40ft, 45ft
  Heights: .... 8',6" and 9',6"
  Total TEU capacity: 10,010
    On decks: 5,510
    In holds: 4,500
    Homogenously loaded to 14tonnes: 8,060
  Reefer plugs: 1,000FEU
  Tiers/rows
    On deck: 9/19
    In holds: 10/17
Ballast control system
  Make: .... Hoppe
  Type: .... Valve remote control system
Water ballast treatment system
  Make: .... RWO CleanBallast
  Capacity: .... 1,000m^3
Complement
  Crew: 14
Stern appendages/special rudders: .... Full spade rudder with twisted leading edge
Bow thruster
  Make: .... Nakashima
  Number: 1
  Output: 3,000kW
Bridge control system
  Make: .... Nabtesco
  Type: .... M-800-V M/E remote control system
  One-man operation: .... Yes
Fire detection system
  Make: .... Consilium
  Type: .... Conventional system
Fire extinguishing systems
  Cargo holds: .... Seaplus/ CO_2
  Engine room: .... CO_2
  Cabins/public spaces: .... Fire extinguisher / fire hose
Radars
  Number: 3
  Make: .... Furuno
  Model: FCR-2829
Waste disposal plant
  Incinerator: .... Teamtec/ GS1000CX
  Sewage plant: .... Hamworthy/ ST3A-C
Contract date: .... 13 August 2014
Launch/float-out date: .... 13 February 2014
Delivery date: .... 13 July 2014

MOL BRAVO



VALPARAISO EXPRESS: 10,500TEU containership

Shipbuilder: .... **Hyundai Samho Heavy Industries Co. Ltd**
Vessel's name: .... ***VALPARAISO EXPRESS***
Hull No: **S832**
Owner/Operator: .... **Hapag-Lloyd**
Country: .... **Germany**
Designer: .... **Hyundai Samho Heavy Industries Co. Ltd**
Country: .... **Republic of Korea**
Model test establishment used: .... **HSVA**
Flag: .... **Germany**
IMO number: **9777589**
Total number of sister ships already completed (excluding ship presented): .... **One**
Total number of sister ships still on order: .. **Five**

VALPARAISO EXPRESS, a post-panamax containership, has a number of innovative features which not only improve the vessel's operational and environmental performance but also provide more flexibility during loading. The ship is built to the twin islands type design where the separation of superstructure and engine room improves stability and provides more loading capacity while maintaining visibility.

The ship complies with the IMO's Cargo Stowage & Securing (CSS) Code and has a total of 2,100 sockets – of which around 1,250 are above and 850 are below deck – making this class of ship particularly well suited to the transport of perishable goods like fruit, vegetables, meat or pharmaceutical products. Oversized cargo that does not fit into a container can be stored below deck. The ship is fully equipped for the carriage of dangerous goods and the lashing and loading system means there are up to four hatch covers – instead of the usual three. This provides greater flexibility during loading and unloading. The lashing bridges are three-tiered (container layers).

Valparaíso Express is fitted with a bow thruster of around 2,500kW (circa 3,400hp) which facilitates manoeuvring in narrow waterways like port basins. The main engine was designed by MAN Diesel & Turbo with a highly efficient, economical 7-cylinder diesel engine with electronic, emission-reducing valve control, providing an output of 34,224kW (around 46,530hp). There are five auxiliary engines with a total output of 21,270kW (28,920hp); however, all ships of the Valparaíso Express class are equipped for landside shore connection, which enables the onboard auxiliary engines to be switched off in port.

The ship's hull has been optimised for special loading cases and speed profiles in South American trade lanes, while the ship's five-blade propeller can increase the ship's speed to 21knots and features an applied rudder bulb for energy saving.

Valparaíso Express' range is around 30,000 nautical miles (around 55,000km). Tanks hold a total of 10,000m^3 of fuel, including marine diesel oil for use in Emission Control Areas.

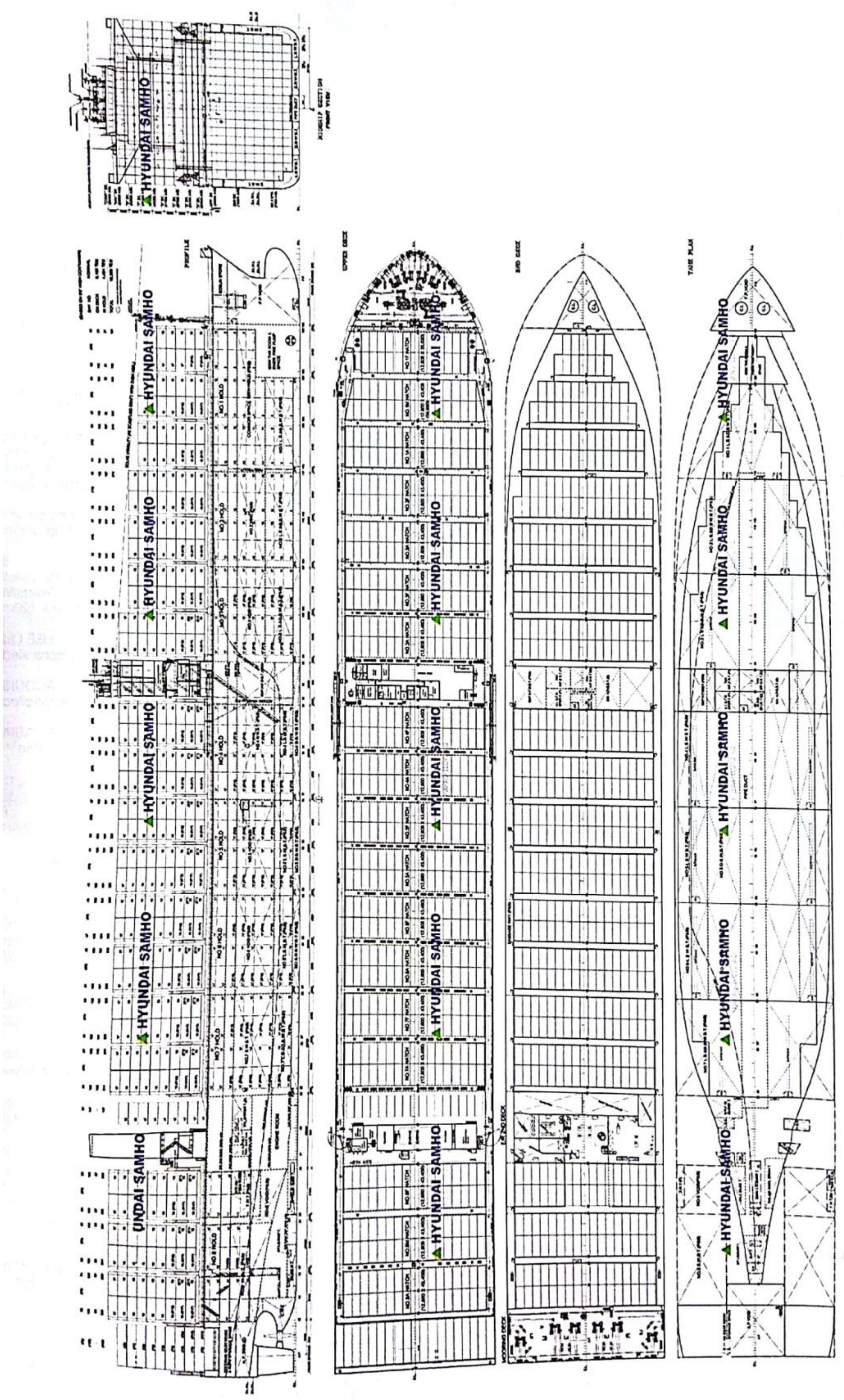
Frequency controlled pumps increase energy savings at lower speeds and ballast water treatment units purify the ship's ballast water without the use of chemicals before it is pumped into and out of the ballast water tanks using filtration and UV light treatment.

TECHNICAL PARTICULARS

Length oa: 333.18m
Length bp: 318m
Breadth moulded: 48.2m
Depth moulded
  To main deck: 26.8m
  To upper deck: 26.8m
Width of double skin
  Side: 2.4m
Bottom: 2.2m
Draught
  Scantling: 14m
  Design: 12.5m
Gross: 118,945gt
Displacement: ..... 160,648tonnes (at scantling)
Lightweight: 37,061tonnes
Deadweight
  Design: 103,057tonnes
  Scantling: 123,587tonnes
Block co-efficient (please state relevant draught): .... 0.7286 (at scantling)
Speed, service (-- %MCR output): .... 21knots at scantling at NCR with 15% SM
Bunkers
  Heavy oil: .... 9,380m^3
  Diesel oil: .... 710m^3
Water ballast: .... 31,100m^3
Daily fuel consumption (tonnes/day)
  Main engine only: .... 161.6g/kWh + 5% at NCR
Classification society and notations: .... DNV-GL, +100A5 E, CONTAINER SHIP, DG, IW, BWM(D2), +MC E, AUT, RSD, EP-D, NAV, LC, CM-PS, RCP 1700/25
Main engine(s)
  Design: .... HYUNDAI-MAN B&W
  Model: 7S90ME-C10.5
  Manufacturer: .... HHI-EMD
  Number: .... One
  Type of fuel: .... HFO/MDO
  Output of each engine: .... 40,264kW x 83.8rpm (Two stroke, Crosshead, Turbocharged)
Propeller(s)
  Material: .... Ni.Al.Bronze
  Designer/Manufacturer: .... HHI-EMD
  Number: .... One
  Fixed/Controllable pitch: .... Fixed pitch
  Diameter: 9.3m
Diesel-driven alternators
  Number: .... Five sets
  Engine make/type: Daihatsu/8DE-33/6DE-33
  Type of fuel: .... HFO/MDO/MGO
  Output/speed of each set: .... Abt. 4,670 kW@720rpm, abt. 3,530kW@720rpm
Alternator make/type: .... HHI-EES/Marine Design IP44 enclosure brushless
  Output/speed of each set: .... Abt. 4,480kW @720rpm, abt. 3,350 kW@720rpm
Boilers
  Number: .... One set
  Type: .... Automatic, forced draft, Heavy Fuel Oil burning, marine boiler
  Make: .... SAACKE
  Output, each boiler: .... 4,500kg/h x 1set (oil fired section), 3,800kg/h x 1set (exhaust gas section)
Other cranes
  Number: .... One set
  Make: .... Oriental Precision & Engineering Co. Ltd
  Type: .... Electric motor driven system
  Tasks: .... Monorail crane
  Performance: .... 12.5tonnes x 5m/min
Other cranes
  Number: .... Two sets
  Make: .... Oriental Precision & Engineering Co. Ltd
  Type: .... Electric motor driven system
  Tasks: .... Provision crane
  Performance: .... 4tonnes x 10m/min, 2.5tonnes x 10m/min
Mooring equipment
  Number: .... Twelve sets
  Make: .... TTS Marine GMBH
  Type (electric/hydraulic/steam): .... Electric
Hatch covers
  Design: .... Non-tight, pontoon non-sequential operation type
  Manufacturer: .... MacGregor
  Type (upper deck/other decks): ...... Upper Deck
Containers
  Lengths: ..... 40ft container of 40'(L) x 8'(W) x 9'6"(H) ISO container
  Heights: ...... 40ft container of 40'(L) x 8'(W) x 9'6"(H) ISO container
  Cell guides: .... 40ft container of 40'(L) x 8'(W) x 9'6"(H) ISO container
Total TEU capacity
  On deck: 6,169TEU
  In holds: 4,424TEU
  Homogeneously loaded to 14tonnes: 7,798TEU
  Reefer plugs: .... 1,254FEU reefer container socket on deck/hatch covers
  Tiers/rows (maximum)
    On deck: .... 9 Tiers/19 rows
    In holds: .... 9 Tiers/17 rows
Ballast control system
  Make: .... HOPPE
  Type: .... Hydraulically operated and remotely controlled
Water Ballast Treatment System
  Make: .... MAHLE
  Capacity: .... Filter + UV type (800m^3/h)
Complement
  Officers: .... 12 persons
  Crew: .... 16 persons
  Suez/Repair Crew: .... 6 persons
Bow thruster(s)
  Make: .... Kawasaki
  Number: .... One set
  Output (each): .... 2,500kW x 880rpm
Bridge control system
  Make: .... HHI-EES
Fire detection system
  Make: .... Consilium Marine
  Type: .... Analogue addressable optical smoke detector
Fire extinguishing systems
  Cargo holds: .... High pressure CO_2, sea water
  Make/Type: .... NK CO. LTD.
  Engine room: .... CO_2, sea water, PFE
  Make/Type: .... NK CO. LTD.
  Cabins: .... Sea water, PFE
  Make/Type: .... NK CO. LTD.
Radars
  Number: .... Two sets
  Make: .... Furuno
  Model(s): .... S-BAND (FAR-3230S-BB), X-BAND (FAR-3220-BB)
Integrated bridge system? .... No
Waste disposal plant
  Sewage plant
    Make: .... DVZ
    Model: .... Biological type
Contract date: .... 20 April 2015
Launch/float-out date: .... 10 September 2016
Delivery date: .... 2 November 2016

86 SIGNIFICANT SHIPS OF 2016

VALPARAISO EXPRESS



APL SOUTHAMPTON: eco-box ship

Shipbuilder: **Daewoo Shipbuilding & marine Engineering Co., Ltd**
Vessel's name: ***APL Southampton***
Hull No: **4191**
Owner/operator: **Neptune Orient Lines**
Country: **Singapore**
Designer: **Daewoo Shipbuilding & marine Engineering Co., Ltd**
Country: **Korea**
Model test establishment used: **HSVA**
Flag: **Singapore**
IMO number: **9462017**
Total number of sister ships completed (excluding ship presented): **nil**
Total number of sister ships still on order: **3**

In a time where saving money counts and fuel costs are a major part of shipowner expenditure, Neptune Orient Lines latest vessel *APL Southampton* was built with lower fuel consumption in mind. Daewoo Shipbuilding & Marine Engineering delivered the vessel to its owner in April 2012.

The container carrier, APL, plans to reduce its carbon emissions by 30% by 2015 from its global shipping operations. The Singapore-based line will be gaining an influx of new vessels, which will run at a reduced speed and will put the target within reach claim the company.

By 2015, APL says that its fleet will produce 130 grams of carbon exhaust for every TEU of cargo transported one nautical mile. Going by that calculation the company would expect a 30% reduction in emissions levels from the 2009 levels.

APL will be deploying 32 new vessels over three years, which will be significantly more fuel efficient than its existing fleet.

The APL designs include optimised vessel trim, speed and routing; improved maintenance on vessel hulls to reduce drag in the water; and, to aid turn around times, upgrading of cargo handling equipment at APL terminals.

To give *APL Southampton* better fuel consumption it has been fitted with a derated electronically-controlled MAN B&W 12K98ME-C7.1 that has 54,120kW at 97rpm, giving the vessel a service speed of 23.3knots at a design draught of 13.5m on an even keel at 85% MCR. The vessel's hull has been optimised for its future operational profile and as such is expected to consume significantly less fuel. Further, it has been optimised for a range of speed/draft conditions, known as the 'off-design', which the vessel is likely to encounter in its daily operation.

The vessel can carry 10,640TEU including 800FEU of reefer containers and the homogenous intake, based on the unit weight of 14tonnes/TEU, is more than 7,700TEU. The vessel has 10 double skinned cargo holds that have 21 bays, which can carry 40ft containers with 20 hatches.

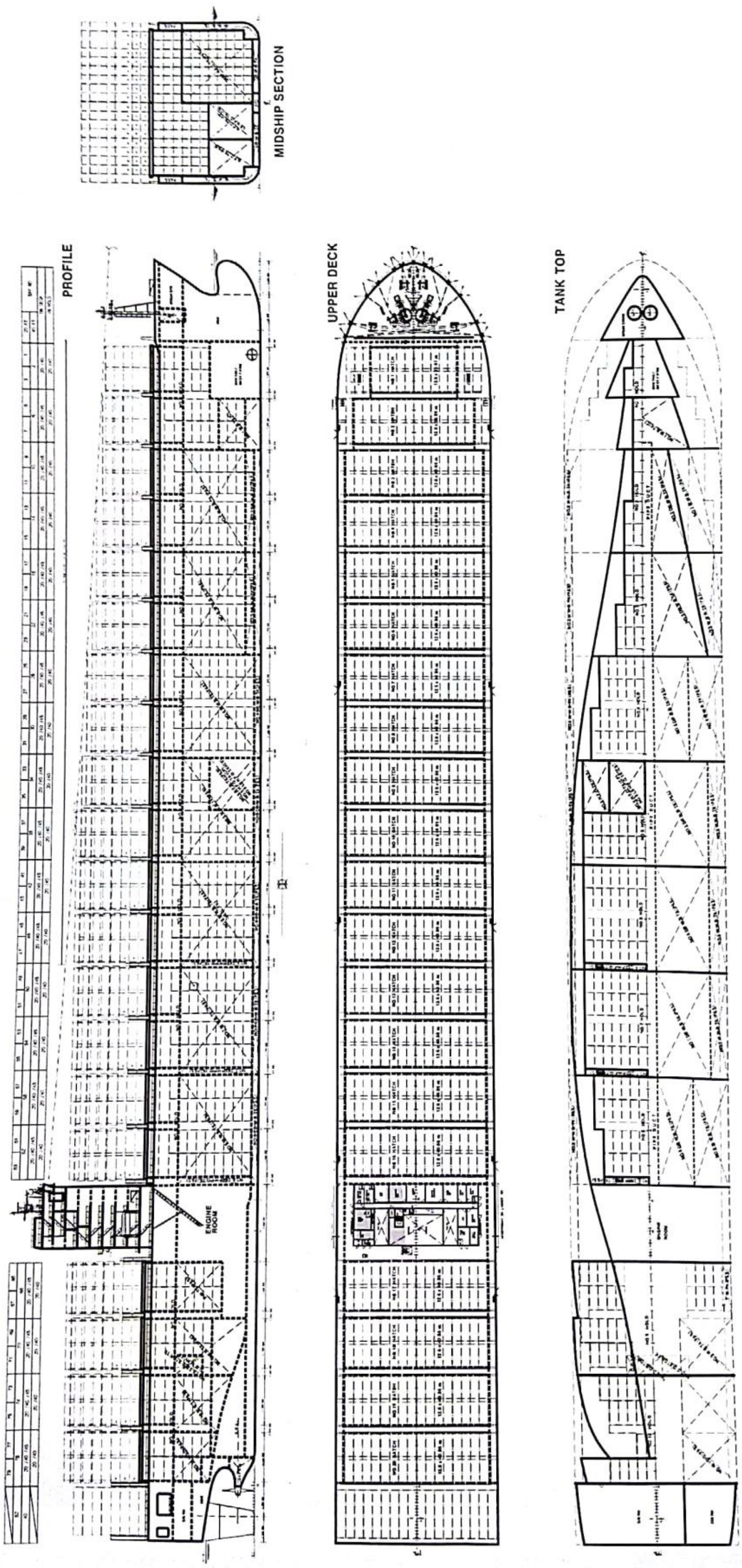
APL Southampton is fully welded with a flush deck and bulbous bow, a transom stern with an open water type stern frame. Fixed cell guides have been fitted on the transom end to ensure that heavier containers can be loaded higher. *APL Southampton* also has an enlarged grey water holding tank and full double hull protection of the oil tanks. Provisions for anti-piracy have also been catered for with a protection cover for the lower accommodation deck, security doors, net securing fittings and crew shelter.

APL has also taken the step of installing ballast water treatment technology on its ships in line with the framework provided in the IMO's Ballast Water Management Convention. *APL Southampton* has been fitted with a Techcross system that has a capacity of 1,000m³/h.

TECHNICAL PARTICULARS

Length oa:	347.0m
Length bp:	331.0m
Breadth moulded:	45.2m
Depth moulded	
To freeboard deck:	22.59m
To upper deck:	29.7m
Width of double skin	
Side:	2.17m
Bottom:	2.0m
Draught	
Scantling:	15.5m
Bottom:	13.5m
Gross:	128,929gt
Deadweight	
Design:	102,140dwt
Scantling:	129,240dwt
Speed, service:	23.4knots
Bunkers	
Heavy oil:	12,300m³
Classification society and notations:	GL + 100A5E, Container Ship, +MC E, AUT, IW, DG, NAV-O, RSD, STAR, EP, CM (shaft monitoring)
Heel control equipment:	One pair of anti-heeling tanks
Main engines	
Design:	1 x MAN B&W
Model:	12K98ME-C7.1
Manufacturer:	Doosan Engine Co., Ltd
Type of fuel:	HFO, MDO
Output of each engine:	54,120kW x 97rpm
Propeller	
Material:	Ni-Al-Bronze
Designer/manufacturer:	1 x DSME/MMG
Fixed/controllable pitch:	Fixed
Diameter:	8.9m
Diesel-driven alternators	
Engine make/type:	4 x Hyundai HiMSEN 7H32/40
Type of fuel:	HFO, MDO
Output, speed of each set:	3,500kW x 720rpm
Alternator make/type:	Hyundai
Output/speed of each set:	3,300kW
Boilers	
Type:	1 x vertical, water tube
Make:	Kangrim
Output, each boiler:	5,500kg/h
Other cranes	
Make:	1 x DMC
Type:	Monorail
Tasks:	Provisions
Performance:	SWL 13tonnes
Mooring equipment	
Make:	12 x Rolls-Royce
Type:	Electric
Hatch covers	
Manufacturer:	DSME/MacGregor
Type:	Pontoon
Containers	
Cell guides:	Arranged in holds
Total TEU capacity:	10,642
On deck:	5,220
In holds:	5,422
Homogenously loaded:	7,760TEU
Reefer plugs:	800 units
Tiers/rows	
On deck:	8 tiers
In holds:	11 tiers/16 rows
Water ballast treatment system	
Make:	Techcross
Capacity:	1,000m³/h
Complement	
Officers:	18
Crew:	12
Bow thrusters	
Make:	1 x HHI
Output:	3,000kW
Bridge control system	
Make:	Sperry
One-man operation:	Yes
Fire detection system	
Make:	Consilium
Type:	Addressable
Fire extinguishing systems	
Cargo holds:	NK/ CO_2
Engine room:	NK/ CO_2
Radars	
Make:	2 x Sperry
Contract date:	17 July 2007
Launch/float-out date:	11 February 2012
Delivery date:	30 April 2012

APL SOUTHAMPTON



MSC BERYL: 13,000TEU post panamax containership from STX

Shipbuilder: .... **STX Offshore & Shipbuilding**
Vessel name: .... ***MSC Beryl***
Hull No:... **S3011**
Owner/operator:............**Niki Shipping Co. Inc**
Country: .... **Greece**
Designer: ....**STX Offshore & Shipbuilding Co.Ltd**
Country: .... **Korea**
Model test establishment used:...**Maritime and Ocean Engineering Research Institute**
Flag: .... **Panama**
IMO number:..................................... **9467392**
Total number of sister ships already completed (excluding ship present):............ **0**
Total number of sister ships still on order:..... **8**

MSC Beryl is the first large container vessel of its type to be built at STX Offshore & Shipbuilding, designed to fit the new post Panamax Canal dimensions. The vessel was delivered to its owner Niki Shipping on the 30 September. There are a further eight sister vessels of this 13,000TEU design on order for the same owner.

MSC Beryl has been certified by Germanischer Lloyd to the latest International Maritime Organisation (IMO) regulation to comply with the Energy Efficiency Design Index (EEDI) in the area of 13,000TEU class and larger. Adding to the design she can also carry 1150FEU self-contained reefer containers can be arranged on deck, along with carrying dangerous good in containers.

The vessel has a service speed of 25.5knots at MCR rating with 15% sea margin at design draft in response to various circumstances for customers, with a maximum speed of 27.5knots. *MSC Beryl* can cruise for more than 20,600 nautical miles at a service speed of 25.20knots.

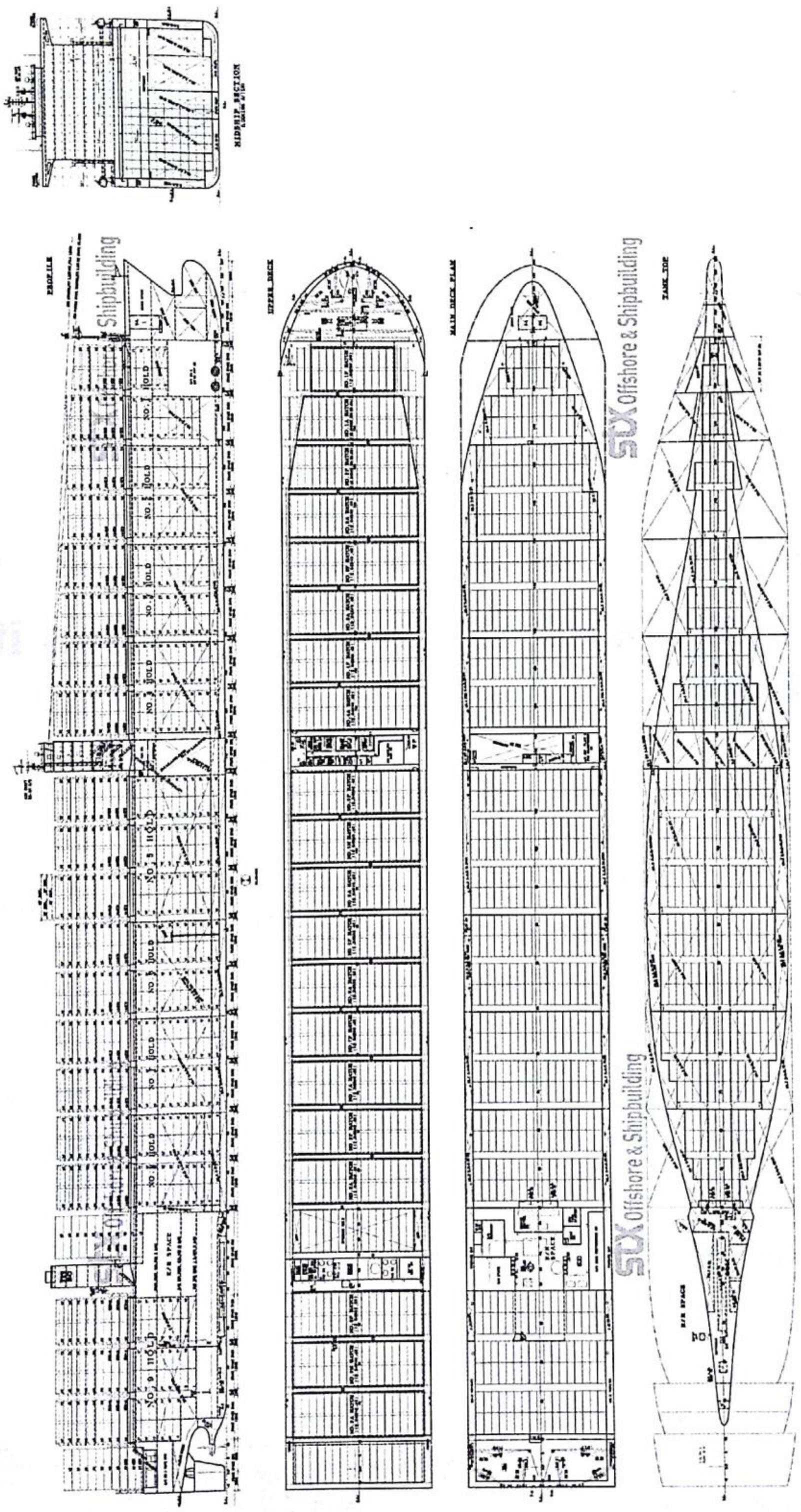
MSC Beryl is powered by a STX MAN B&W 12K978MC-C7 with an output of 98,280bhp at 104rpm, which is accompanied with a 9.3m diameter propeller that has also been designed by STX. It has also been fitted with a twisted full spade rudder for increased energy efficiency of about 2-3%, along with four diesel driven alternators with the performance of 3800kW x 720rpm each. For efficient maneuovrability two stem bow thrusters with 2000kW powered at 880rpm have also been fitted.

The wheelhouse is equipped with an individual workstation to allocate the primary bridge functions and to allow close cooperation between the various workstations that incorporate with the main engine manoeuvring and navigating based on the requirements of one man bridge control in accordance with the classification society notation NAV-O.

TECHNICAL PARTICULARS

Length oa: 365.80m
Length bp: 349.80m
Breadth moulded: 48.40m
Depth moulded
To main deck: 22.94m
To upper deck: 29.90m
Width of double skin
Side: 2.49m
Bottom: 2.20m
Draught
Scantling: 15.50m
Design: 13.50m
Gross: 140,096gt
Displacement: 182,665tonnes
Lightweight: 43,246tonnes
Deadweight
Design: 109,794dwt
Scantling: 139,418dwt
Block co-efficient: 0.6775
Speed, service: 25.5knots
Cargo capacity
Bale: 13,000TEU
Refrigerated cargo: 1150TEU
Bunkers
Heavy oil: ....$10{,}516m^3$
Diesel oil: ....$716.9m^3$
Water ballast: ....$44{,}965m^3$
Water ballast in loaded conditions: ....$37{,}610m^3$
Daily fuel consumption
Main engine only: 268.288tonnes/day
Auxiliaries: 17.808tonnes/day
Classification society and notations:.... Germanischer Lloyd (GL) +100A5 Containership, SOLAS II-2 Reg.19, +MC, AUT, BWM-F, IW, NAV-0, RCP 1000/45, Environmental Passport
% high-tensile steel used in construction: 70%
Main Engine
Design: ....MAN B&W
Model: 12K98MC-C7
Manufacturer: ....STX Engine
Number: 1
Type of fuel: ....HFO
Output: 72,240kW
Propellers
Material: ....Ni-Al-Bronze
Designer/Manufacturer: ....Nakashima
Number: 1
Fixed/Controllable pitch: ....Fixed
Diameter: 9.3m
Speed: 104rpm
Diesel-driven alternators
Number: 4
Engine make/type: ....STX Engine/ MAN B&W Holeby 8L32/40H
Type of fuel: ....HFO
Output/speed of each set: ....3800kW x 720rpm
Boilers
Number: ....1+1
Type: ....Vertical, cylindrical type + smoke tube type
Make: ....Kangrim
Output: ....6000kg/h x 7kg2G
5000kg/h x 7kg/cm2G
Other cranes
Number: 2
Make: .... Oriental Precision & Engineering Co., Ltd
Type: ....Electric motor driven
Tasks: ....Provision handling
Performance: ....4tonnes SWL
Mooring equipment
Number: 10
Make: ....Rolls-Royce OY AB
Type: ....Electric motor driven enclosed gear
Special lifesaving equipment
Number of each and capacity: ....2 x 32 persons
Make: ....Fassmer-Marland Ltd
Type: ....Totally enclosed
Hatch covers
Design: ....MacGregor
Manufacturer: ....MacGregor
Type: ....Lift away
Containers
Lengths: 6.058m
Heights: 2.591m
Cell guides: .... Applicable for 20ft & 40ft
Total TEU capacity: 12967TEU
On deck: 7053TEU
In holds: 5914TEU
Homogeneously loaded to 14tonnes: 8702TEU
Reefer plugs: 1150
Tiers/rows
On deck: 9
In holds: 11
Complement
Officers: 18
Crew: 14
Suez/Repair crew: 6
Bow thrusters
Make: ....KTECo., Ltd
Number: 2
Output: ....2000kW x 880rpm
Bridge control system
Make: ....KTE
Type: ....One man bridge T-Sharp
One-man operation: ....Yes
Fire detection system
Make: ....Consilium
Type: ....Addressable smoke detection type
Fire extinguishing systems
Cargo holds: ....CO_2
Engine room: ....CO_2
Radars
Number: 3
Make: ....Furuno
Model: .... Up-mast type, FAR-2837/FAR-2827
Integrated bridge system
Make: ....Furuno
Model: FEA-2807
Waste disposal plant
Incinerator: .... HMMCO MAXI 1200SL WS
Sewage plant: ....Hamworthy ST4A
Contract date: ....09 August 2007
Launch/float-out date: ....29 April 2010
Delivery date: ....30 September 2010

MSC BERYL



IFICANT SHIPS OF 2010

77

YM WINDOW: 14,000TEU container vessel

Shipbuilder: .... **CSBC Corporation, Taiwan**
Vessel's name: .... ***YM Window***
Hull No: **1036**
Owner/Operator: .... **GC Intermodal XIII, LTD**
Country: .... **Marshall Islands**
Designer: .... **CSBC Corporation, Taiwan**
Country: .... **Taiwan, R.O.C.**
Model test establishment used: .... **HSVA, Germany**
Flag: .... **Hong Kong**
IMO number: **9708435**
Total number of sister ships already completed (excluding ship presented): **2**
Total number of sister ships still on order: **2**

YM WINDOW has been designed and built by CSBC. The vessel is equipped with an energy saving bow that has superior performance, including at different draughts or trims, as well as a high efficiency propeller and twist rudder with rudder bulb. Combined with all energy saving equipment, the performance of this vessel can reach the highest standard of container vessel design. The vessel also meets IMO EEDI requirements for 2025 (phase III), with greatly reduced carbon emissions.

Its 3-tier lashing bridge design enhances lashing ability, and container stacks on deck follow the Russian stowage model which can also upgrade homogeneous container loading and make the arrangement of containers more flexible. It also improves the operation of loading and unloading containers. Moreover, the ship has obtained Lloyd's Register's BoxMax notation that enables operators to load more cargoes with more flexibility according to different weather and routes.

Fatigue and ultimate strength were assessed by whipping and springing analysis, which can substantially improve the reliability of the hull structure.

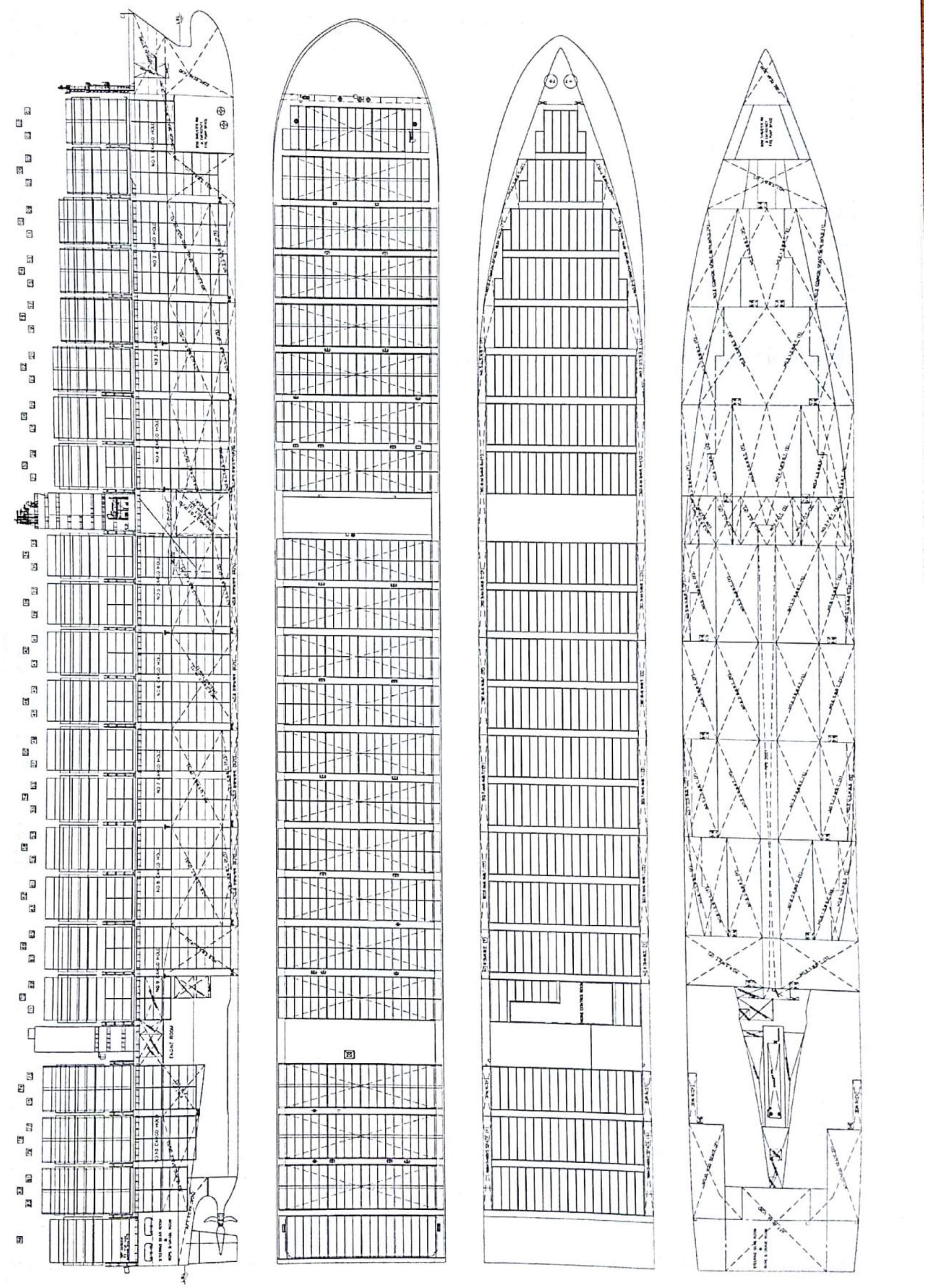
This vessel applies the smart ship design concept, and is fitted with a Remote Maintenance System that remotely links to the equipment onboard, including the main engine and auxiliary system, in order to inspect, analyse, conduct troubleshooting or determine what actions should be taken. The vessel is also equipped with a MGO cooler, mobile container type AMP system, variable frequency control for main sea water pumps for example, and energy saving and environmental protection equipment.

TECHNICAL PARTICULARS

Length oa: 368m
Length bp: 351.55m
Breadth moulded:...................................... 51m
Depth moulded
To main deck: .... Nil
To upper deck: 29.85m
To other decks: .... 20.47m (2 Deck)
Draught
Scantling: 16m
Design: 14.5m
Gross: 145,136tonnes
Deadweight
Design: 123,038.65tonnes
Scantling: 146,072.65tonnes
Speed, service (85%MCR output): 23.3knots
Cargo capacity
Refrigerated cargo: 800FEU
Bunkers
Heavy oil: ....abt. 10,050m³
Diesel oil: ....abt. 930m³
Water ballast: ....abt. 42,380m³
Daily fuel consumption
Main engine only: 167.7tonnes/day
Auxiliaries: ....abt. 210.6 (50%MCR) tonnes/day
Classification society and notations:.............LR: +100A1, CONTAINER SHIP, LI, *IWS, SHIPRIGHT(SDA, FDA, CM, ACS(B)), +LMC, UMS, NAV1, ECO(BWT, EEDI, IHM) BOX MAX(V, M) WITH DESCRIPTIVE NOTES PART HIGHER TENSILE STEEL, SHIPRIGHT(BWMP(T,S) SERS, SCM)
% high-tensile steel used in construction:..........................abt.63%
% aluminium used in hull/superstructure: ..... Nil
Heel control equipment: .... Anti-Heeling Control System
Roll-stabilisation equipment: .... Nil
Main engine(s)
Design: .... MAN B&W
Model: 11S90ME-C10.2
Manufacturer: ....Hyundai Heavy Industries
Number: 1
Type of fuel:................................. HFO, MGO
Output of each engine: ....51,823kW x 78.5rpm
Propeller(s)
Material: ....NI-AL-Bronze
Designer/Manufacturer: ...... CSBC / Hyundai Heavy Industries
Number: 1
Fixed/Controllable pitch: .... Fixed Pitch
Diameter: .... N/A
Speed: .... N/A
Special adaptations: .... N/A
Diesel-driven alternators
Number: ....2+2
Engine make/type: .... STX Engine Co. Ltd./ 8L32/40 & 6L32/40
Type of fuel: .... HFO, MGO
Output/speed of each set: ....4,000kW x 720rpm / 3,000kW x 720rpm
Alternator make/type: ..STX Engine Co., Ltd / HCM434F1
Output/speed of each set: 1
Boilers
Number: 1
Type: ....Vertical oil fired
Make: ....Kangrim
Output, each boiler: ....365kg/hr x 4 bar
Mooring equipment
Number: 8
Make: ....Nippon Pusnes Co. Ltd
Type (electric/hydraulic/steam): ..... Electrica/ Hydraulic
Special lifesaving equipment
Number of each and capacity: ..2 x lifeboats
Make: ....Beihai Shipbuilding Heavy Industry Co.Ltd
Type: BH-E670
Hatch covers
Design: ....MacGregor
Manufacturer: .... CSBC
Type (upper deck/ other decks): .... Non-Weather Tight, Pontoon Type (upper deck)
Containers
Lengths: .... 20ft / 40ft
Heights: ....8.6ft & 9.6ft
Cell guides: 865mm
Total teu capacity: 14,198TEU
On deck: 8,034TEU
In holds: 6,164TEU
Homogeneously loaded to 14tonnes: 9,534TEU
Reefer plugs: ....1,000 sets
Tiers/rows (maximum)
On deck: ....10/20 In holds: 11/18
Hold refrigeration system: .... Nil
Ballast control system
Make: .... HHI-EES
Type: .... Nil
Water Ballast Treatment System
Make: .... Headway
Capacity:............................... 2 x 1,000m³/hr
Complement
Officers: 12
Crew: 19
Suez/Repair Crew: 6
Bow thruster(s)
Make: .... Nakashima
Number: 2
Output (each): 1,800kW
Bridge control system
Make: .... HHI-EES
Type: .... Nil
Is bridge fitted for one-man operation? .... Yes
Fire detection system
Make: .... Consilium
Type: .... Nil
Fire extinguishing systems
Cargo holds: Make/Type: ....NK Co. Ltd/ CO_2
Engine room: Make/Type: ....NK Co. Ltd/ CO_2
Cabins: Make/Type: ....FAIN/ Portable Fire Extinguisher
Public spaces: Make/Type:.......FAIN/ Portable Fire Extinguisher
Radars
Number: 3
Make: .... JRC Radio Co Ltd
Contract date: ....22 August 2013
Launch/float-out date: .... 15 September 2015
Delivery date: .... 6 May 2016

90 SIGNIFICANT SHIPS OF 2016

YM WINDOW



CMA CGM MARCO POLO: mega container ship from DSME

Shipbuilder: **Daewoo Shipbuilding & Marine Engineering Co., Ltd**
Vessel's name: ***CMA CGM Marco Polo***
Hull No: **4161**
Owner/operator: **CMA CGM**
Country: **France**
Designer: **Daewoo Shipbuilding & Marine Engineering Co., Ltd**
Country: **Korea**
Model test establishment used: **HSVA**
Flag: **France**
IMO number: **9454436**
Total number of sister ships already completed (excluding ship presented): **nil**
Total number of sister ships on order: **2**

THE challenge to the container shipping industry by Maersk's Emma class ships has been met by CMA CGM with an order for its own 16,000TEU environmentally friendly ships.

Unfortunately for CMA CGM no sooner do they catch up with the Danes, Maersk move on to the next stage. Consequently Marco Polo's reign as the world's largest container ship will last only into summer 2013 when the first of Maersk's 18,000TEU Triple E Class vessels is delivered.

Nonetheless, CMA CGM's ships will be constructed at Daewoo Shipbuilding & Marine Engineering and the first of these vessels, *CMA CGM Marco Polo*, was delivered in October with the other two vessels expected in 2013.

These orders were originally for three 13,800TEU ships, but CMA CGM increased the capacity to 16,000TEU in June 2011. A further three 12,500TEU vessels also under construction have had their capacity increased to 16,000TEU.

The vessel has a fully welded flush deck and a bulbous bow, a transom stern with an open water type stern frame. The 186,000dwt vessel has a double skin surrounding its eights cargo holds that have 24 bays for 40ft container with 22 hatches.

The new vessels are also designed with the latest technology to give better levels of performance, safety and environmental protection. Other features of the vessel include a mid-ship deckhouse, an electronic-injection engine that will reduce the oil and fuel consumption, fuel tanks that are protected by a double hull and a Fast Oil Recovery System.

CMA CGM Marco Polo is fitted with two bow thrusters that afford the vessel better manoeuvrability when berthing, a full spade rudder and a fixed pitch propeller that is directly driven by a Wärtsilä 14RT-flex96C engine that has a maximum rating of 80,080kW at 102rpm, giving the vessel a speed of 25.1knots at a scantling draught of 16m at 90% MCR. A pre swirl stator has also been fitted for increased energy savings and thereby improving fuel efficiency.

CMA CGM Marco Polo also has a chemical-free ballast water treatment system from Heinrich Behrens Pumpenfabric that will protect the marine ecosystems by limiting the transfer of micro-organisms from ocean to ocean.

The vessel will operate in CMA CGM's FAL1 Asia – Europe trade where it is expected that volumes will increase. Although there are larger vessels on the horizon CMA CGM has opted for the 16,000TEU vessels as at the moment they are better adapted to current port infrastructure and can operate in all of the major ports between Asia and Northern Europe.

TECHNICAL PARTICULARS

Length oa: 396.0m
Length bp: 378.4m
Breadth moulded: 53.6m
Depth moulded
To main deck: 29.9m
Width of double skin
Side: 2.59m
Bottom: 2.2m
Draught
Scantling: 16.0m
Design: 14.0m
Gross: 153,022gt
Deadweight
Design: 149,470dwt
Scantling: 186,470dwt
Speed, service: 25.1knots
Bunkers
Heavy oil: 14,500m^3
Diesel oil: 450m^3
Water ballast: 52,000m^3
Daily fuel consumption
Main engine only: 288.5tonnes/day
Classification society and notations: BV I, +HULL, +MACH, Container Ship, Unrestricted Navigation, VERISTAR HULL, +AUT-UMS, +AUT-PORT, Inwatersurvey, MON SHAFT, ALP, LASHING, CLEANSHIP(C), Green Passport
% high tensile steel used in construction: 66.2%
Main engine
Design: Wärtsilä 14RT-flex96C
Manufacturer: Doosan Engine
Type of fuel: HFO, MDO
Output of each engine: 80,080kW x 102rpm
Propeller
Material: Ni-Al-Bronze
Designer/manufacturer: DSME/ Hyundai
Fixed/controllable pitch: 9.1m
Diesel-driven alternators
Engine make/type: Hyundai HiMSEN
Type of fuel used: HFO, MDO
Output/speed of each set: 2 x 3,840kW, 2 x 3,300kW
Alternator make/type: self-excited/brushless
Output/speed of each set: 720rpm
Boilers
Type: Vertical
Make: Alfa Laval Aalborg
Output: 5,500kg/h
Cranes
Make: Oriental
Type: Electric
Tasks: Provisions, Suez mooring boats and FO hose handling
Mooring equipment
Number: 2 x windlasses, 10 x mooring winches
Make: Rolls-Royce
Type: Electric
Special lifesaving equipment
Number of each and capacity: 2 x 40 persons
Make: 2 x 40 person Hyundai Lifeboat Conventional
Hatch covers
Design: Cargotec Finland
Manufacturer: DSME
Type: Pontoon type
Containers
Lengths: 40ft
Heights: 8ft 6in or 9ft 6in
Cell guides: Fixed cell guide
Total TEU capacity: 16,000
On deck: 8,600
In holds: 7,400
Homogenously loaded to 14tonnes: 12,000TEU
Reefer plugs: 800 units
Tiers/rows
On deck: 9/21
In holds: 11/19
Ballast control system
Make: Heinrich Behrens Pumpenfabric
Type: Centrifugal, vertical, self-priming
Complement
Officers: 15
Crew: 14
Bow thruster
Make: Kawasaki Heavy Industry
Output: 1,800kW
Fire extinguishing systems
Cargo holds/Engine room: CO_2
Cabins: Seawater from fire main
Radars
Number: 1
Models: Radar and integrated navigation system
Contract date: 6 July 2007
Launch/float-out date: 6 June 2012
Delivery date: 16 October 2012

CMA CGM MARCO POLO