

CCS PERFORMANCES AND SERVICES ON LARGE CONTAINER SHIPS

CCS
CHINA CLASSIFICATION SOCIETY
中国船级社

Overview

By sticking to the policy of "building first-class international classification society with own characteristics and with technology as the foundation and credibility as the cornerstone", CCS improves continuously its image and value of container ships through advanced technology and quality service and is widely and highly recognized by the industry.

Over the recent years, CCS has carried out further technical research on large container ships in terms of prescriptive rules, intelligent technology, direct calculation, vibration and noise, springing and whipping, container lashing, energy efficiency optimization and advanced NDT; meanwhile, various technologies are applied on board the ship and the technical service capability of large container ships is improved. A number of advanced large/very large container ships are classed with CCS.

By committing to the mission of "safety, environmental protection and creating value for clients and society" and based on over 90 offices across the world, CCS provides the ship owner with 7 X 24 hours of survey and technical support services. Relying on its highly efficient service system, CCS continuously provides comprehensive support for conducting survey activities, safeguarding ship safety and emergency response services. CCS has continuously achieved outstanding performance in three main MoUs and witnessed healthy and steady increase of its fleet size.

CCS container performance

CCS fleet of large/very large container ships convers all main ship types from 10,000 TEU to 20,000 TEU. At present it accounts for approximately 8.1% of the total number of large container ships globally. Shipowners include world renowned container shipping companies such as COSCO Shipping, Maersk Line, CMA CGM and MSC.

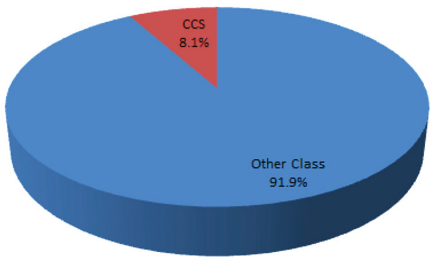


Figure 1 Percentage of large/very large container ships (number of ships)

Type of container ships classed with CCS

Classed Container Ships, Shiptype Fully Covered



Delivered Container Ships Recently



21,000TEU Container Ship MV COSCO Shipping Universe (IMO 9795610)



20,000TEU Container Ship MV COSCO Shipping Taurus (IMO 9783459)



19,150TEU Container Ship MV COSCO Shipping Aries (IMO 9783497)



15,500TEU Container Ship MV Evelyn Maersk (IMO 9321512)



14,500TEU Container Ship MV COSCO Shipping Himalayas (IMO 9757840)



13,500TEU Container Ship MV COSCO Shipping Peony (IMO 9785744)

Route and terminal

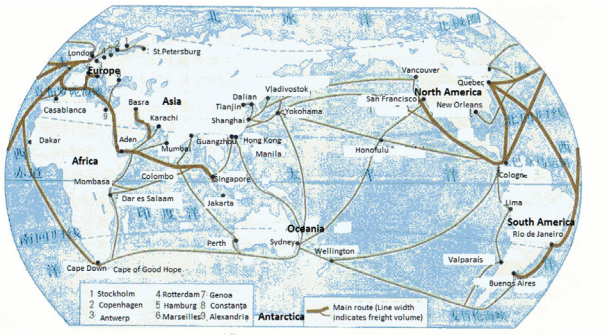
1. Main route of container ship

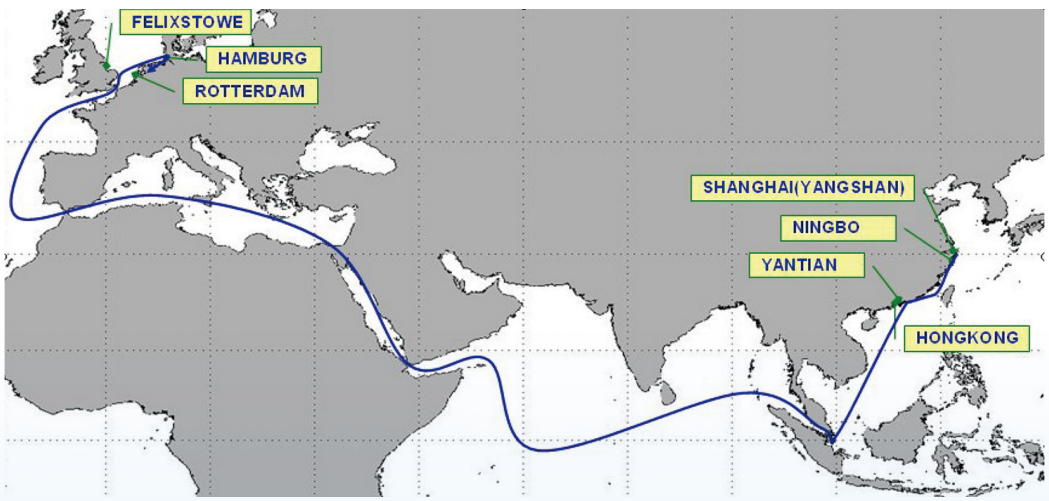
At present, main routes of container ships around the world include:

- Far East—North America Route
- Far East—Europe Route
- Far East—Australia Route
- North America/Mediterranean Route
- Australia—North America Route
- Europe, Mediterranean—West African, South Africa Route
- Round the World Route—the Pacific Ocean-Panama Canal-the Atlantic Ocean- the Mediterranean Sea-Suez Canal-the Indian Ocean- the Pacific Ocean

The busiest routes include Far East—Europe Route, Far East—North America Route and Europe—North America Route.







Far East——Europe Route

2. Main container ports

Very large container ships can berth at the main container ports of the Far East—Europe Route, Far East—America Route and Europe—America Route, including the following:

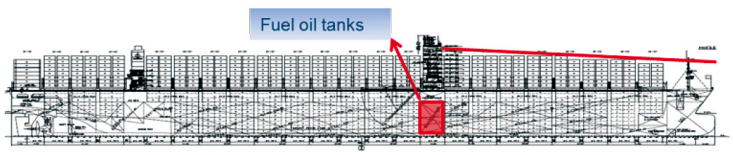
Main ports in Asia	Main ports in Europe	Main ports in America
Shanghai	Rotterdam	Los Angeles
Singapore	Antwerp	Long Beach
Busan	Hamburg	Auckland
Yokohama	Southampton	Vancouver
Kelang	Le Havre	Port of Prince Rupert

3. Characteristics of large container ships

◆ Characteristics of arrangement:

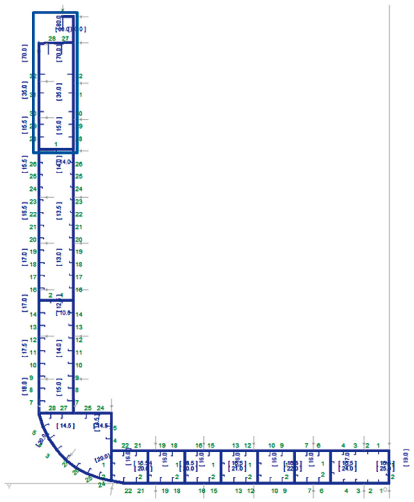
Twin-island arrangement is generally used on modern large container ships, with the following advantages:

- More containers can be carried on the deck provided that the visibility requirement is satisfied.
- The fuel oil tanks are arranged below the navigation bridge, so that it is easy to satisfy the fuel oil tank protection requirement.
- The area of deck opening is reduced by the twin-island structure, improving the torsional rigidity of container ships.
- The living area is far away from the engine room, so that it is easy to satisfy the requirement for cabin vibration and noise.



◆ Structural characteristic:

- Large deck opening: A large-opening design is used on container ships for the convenience of cargo loading and unloading. The breadth of opening in the strength deck of large container ships exceeds 0.9 of the moulded breadth.
- Torsion box structure: Large deck opening design of container ship results in structural small torsional rigidity. In order to improve the torsional rigidity of structure, the space between the double side skin and the strength deck and the upper deck is so designed as a torsion box structure extending from fore to aft.
- Continuous hatch coaming: The longitudinal hatch coaming is generally continuous from fore to aft, which is interrupted at the engine room area or a transition is made by an arc. The hatch coaming participates in the longitudinal strength calculation.



Hatch coaming and longitudinal torsion box structure

- Application of higher-strength hull structural thick steel plates: In order to improve hull girder bending strength and torsional strength, thick high tension plates with yielding limit of 460MPa and thickness of 100mm are used for longitudinal hatch coaming, upper deck, sheer strake and the area of inner hull close to the upper deck on container ships.
- Hatch corner structure: Under the combined effect of bending and torsional loads, the hatch corner is subject to large stress. Its fatigue strength is critical. In order to improve the fatigue strength of hatch corner, an elliptical negative corner type is generally used and the free edge is ground smooth.
- Lashing bridge structure: With the increase of number of containers loaded on the deck, the lashing bridge on the modern large/very large container ships becomes higher in order to improve the lashing efficiency and the safety of containers on the deck. Attention needs to be given to the strength of lashing bridge structure.

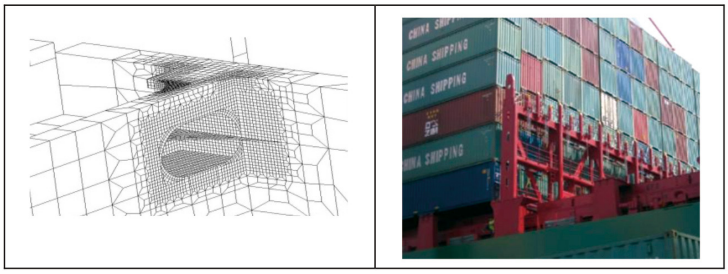
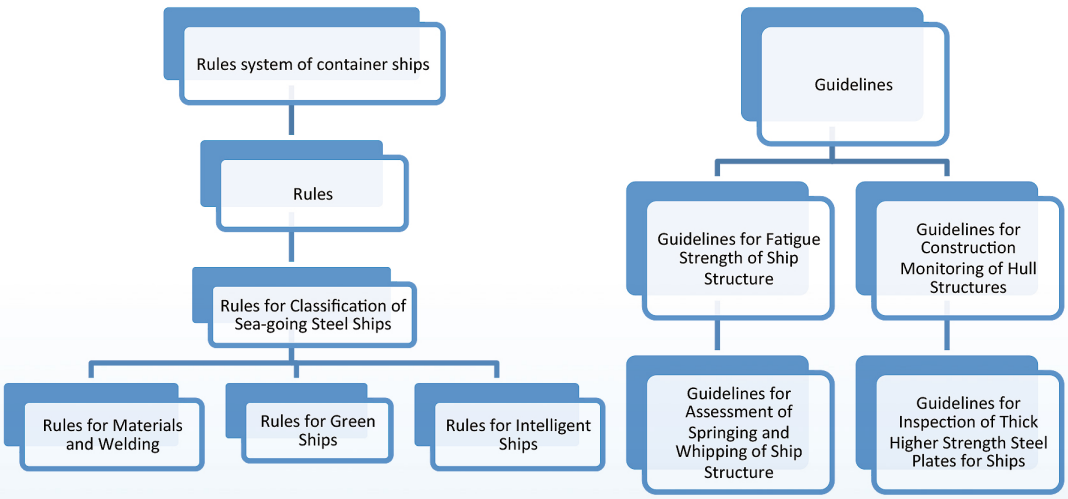


Figure 4 Hatch corner and lashing bridge structure

4. Rules system and calculation software

◆ Rules system



◆ Calculation software

CCS has released integrated calculation software characterized by efficiency, accuracy, friendliness and stability, provided fast and effective calculation tools for ship deign and strength assessment in order to safeguard the structural safety of ships.

- Container ship structure rules calculation software: NCSR-SDP
- Cargo hold FE analysis software
- Wave load calculation software: Compass-Walcs-Baisc
- Three dimensional linear frequency domain hydro-elasticity calculation software: COMPASS-WALCS-LE
- Three dimensional non-linear time domain hydro-elasticity calculation software: COMPASS-WALCS-NE
- Whole ship FE analysis software
- Spectrum fatigue analysis software

5. Typical characters of classification and class notations for container ships

CCS has released integrated calculation software characterized by efficiency, accuracy, friendliness and stability, provided fast and effective calculation tools for ship deign and strength check in order to safeguard the structural safety of ships.

★ CSA Container Ship; COMPASS(R, D, F); SOLAS II-2 Reg19; CM; SFA(25); FL (25); EPC2(SVS); Ice Class B; PSPC(B); Load Computer(S,I,D); CLC(V); In-Water Survey; i-Ship(N,M,E,I)

★ CSM AUT-0; OMBO; CMS; SCM; PMS; EAL;RSC; G-ECO(CDx, COM, BWM(T), BIO, VIB1, NOI1); G-EP(OIL2,IBTS,EAL,SC, GWC,NEC2,SEC,RSC2, INC,AFS, GPR);EFS(acc, fm); ESA; Cyber Security; Crew Accommodation (MLC); Natural Gas Fuel

At the request of the owner and upon plan approval and surveys by CCS, optional class notation(s) will be assigned by CCS if it is satisfied that the relevant requirements of CCS rules are complied with. Common optional class notations of container ships are as follows:

CCS Recommended Options

Class notation	Description
I-Ship(N,H,M,Es,C,I)	N：Route design and optimization H：Hull structure full-life-cycle management M：Condition monitoring of engine room equipment, failure diagnosis and assistant decision-making E：Energy efficiency parameter monitoring of main energy-consuming equipment, analysis and assessment, assistant decision-making Es：Ship speed optimization C：Intelligent liquid cargo management, including cargo and cargo hold monitoring alarm and assistant decision-making+ cargo stowage I：Intelligent integration platform
EGC Ready	Class notation for Exhaust Gas Cleaning system ready
DFDR (H,m,a,P,E,D)	Ships assigned the class notation for natural gas fuel ready system, where: H: the hull structures have been strengthened in accordance with the relevant requirements of natural gas fuel powered ships; m: main engine installed in ship construction stage which may be converted to a dual fuel engine in future
SWAF	Fatigue strength assessment taking both springing and whipping into consideration

CLC (V)	Reduction of acceleration for special route is considered based on CLC. CLC is assigned to ships with container lashing calculation program on board, which can carry out assessment of the lashing strength according to CCS rules for container securing
AMPS	The AMPS class notation may be assigned to a ship with a high-voltage shore connection system having rated alternating voltage above 1 kV and up to and including 15 kV for supplying shore power while in port so as to ensure normal operation of equipment intended to be used when generating sets of the ship are stopped

Other options

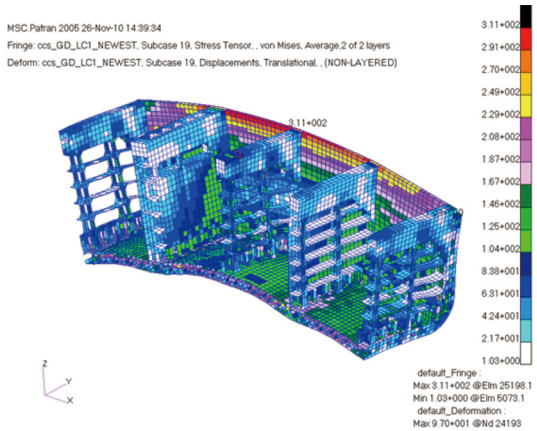
Class notation	Description
G-EP (X)	Environmental protectionWhere it is necessary to indicate further the level of environmental protection, " X" is used to represent the sub-elements as follows: OILx-- control of discharge of oil pollutants, where x is 1 or 2; EAL-- environmental acceptable lubricants; IBTS-- integrated bilge water treatment system; NLSx-- control of discharge of noxious liquid substances, where x is 1 or 2; SC-- control of discharge of sewage; GWC-- control of discharge of grey water; RC-- control of discharge of garbage; NECx-- control of NOx emission, where x is 1 or 2; SEC-- control of SOx emission; VCS/VCS-T-- VOC emission control; RSCx-- control of refrigeration system; INC-- emission control of incineration operation on board; BC20, BC70-- emission control of black carbon; AFS/AFS +-- anti-fouling systems; GPR/GPR+-- green passport; GPR (EU) /GPR (EU) + -- green passport (EU)
G-ECO (X)	Ecological protection Where it is necessary to indicate further the level of ecological protection, " X" is used to represent the sub-elements as follows: CD_x-- CO_2 emission design index, where "x" represents the percentage ratio of the ship's Attained EEDI value lower than the reference line value for that ship; COM-- CO2 emission operation management; BWM (T) -- ballast water treatment; BWM (Es) -- ballast water sequential method; BWM (Ef) -- ballast water flow-through method; BWM (Ed) -- ballast water dilution method; BWM (O) -- other management method of ballast water; BIO-- biofouling management; VIBx-- comfort onboard (vibration), where x is 1 or 2 or 3, and 3 means the highest grade; NOIx-- comfort onboard (compartment noise), where x is 1 or 2 or 3, and 3 means the highest grade; CLx-- comfort onboard (indoor climate), where x is 1 or 2 or 3, and 3 means the highest grade; UW-- underwater noise; RN-- ambient noise.
EFS (X)	Enhanced fire safetyOne or more suffixes X may be added to the EFS notation, where X stands for: acc: protection for accommodation, survival craft, embarkation stations and muster stations; fm: provision of deck fixed water monitor systems; fd: provision of temperature monitoring systems for container stowage areas; ws: provision of cargo hold water spraying systems
CMS	Where continuous survey system for machinery is adopted in lieu of special survey and items required in special survey are to be surveyed in regular rotation with uniform annual share within the five-year class period, this notation may be assigned
SCM	The class notation for screwshaft condition monitoring may be assigned to oil-lubricated or water-lubricated propeller shafts fitted with approved shaft seals
PMS	This class notation for planned maintenance scheme (PMS) for machinery may be assigned to ships for which CCS-approved PMS is adopted as an alternative to special or continuous survey of machinery and electrical installations

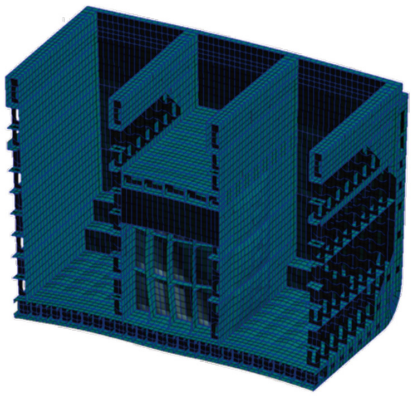
6. Key technologies of container ships:

◆ Structural safety technology

◎ Cargo Hold Model FE Analysis

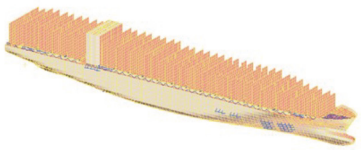
Based on the latest requirements of IACS URS11A and URS34, it is used to assess the yielding and buckling strength of primary members of cargo hold area and fuel oil tank area in typical loading conditions. Primary members include double bottom structure, transverse structure and side structure.

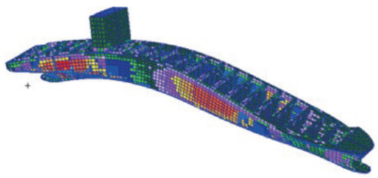


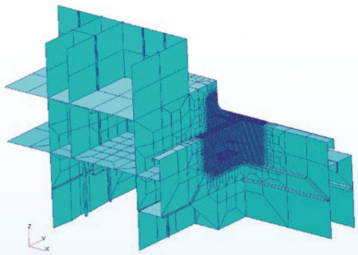


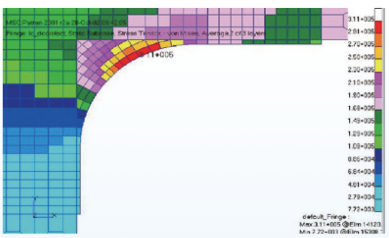
◎ Whole Ship Model FE Analysis

Based on the latest requirements of IACS URS11A and URS34 and combined with three-dimensional wave load calculation software to transfer a series of design wave load to the whole ship model. It is used to assess the global strength of hull primary members and fatigue strength of critical locations such as hatch corners under the combined bending and torsional loads.







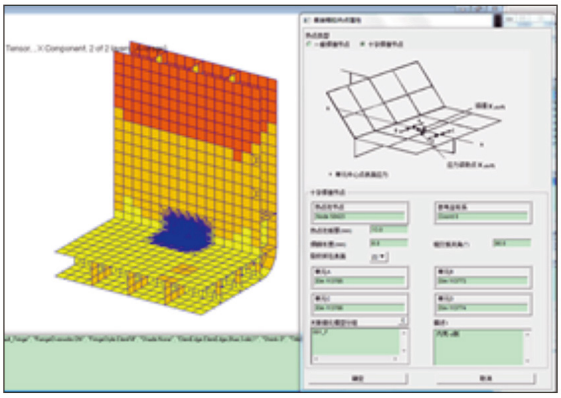


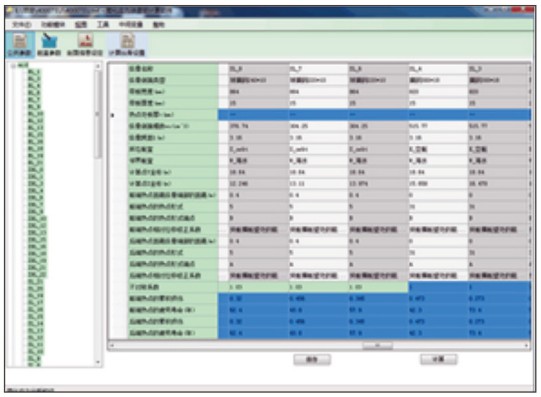
◎ **Springing and Whipping Assessment**

Springing is global vertical resonant hull girder vibration due to oscillating wave loads. Whipping is transient vibration of hull girder due to bow or bottom impact. Both springing and whipping might affect the fatigue life of hull structures while whipping might also lead to the increase of hull girder extreme load.

◇ Class notations for springing and whipping:

- **SAF- fatigue assessment with springing effect**
- **SWAF- fatigue assessment with both springing and whipping effects**





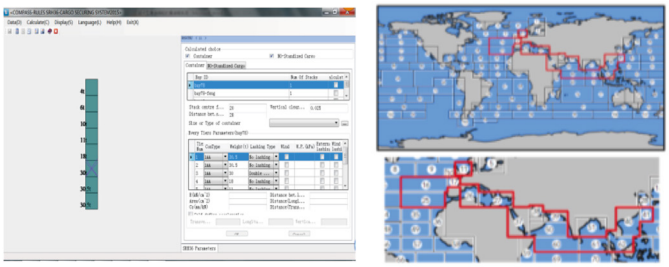
◎ **Structural detail optimization of large container ships**

CCS has published the guidelines for structural arrangement and detail optimization based on the experiences of container ship design and the case study of real ship structure failure, which could be used to guide designers and shipowners on ship structural arrangement and detail optimization. CCS has successfully provided the value-added service of "structural arrangement and detail optimization" to series of large container ship projects, which helped shipyard and owner balance the light weight with safety.



◆ Lashing and Securing Assessment

Lashing calculation instrument is now being installed on large container ships and this instrument may be used to carry out container stowage evaluation and lashing strength assessment according to CCS rules for container securing.



◎ Class notations for lashing and securing:

- **CLC:** Container lashing calculation program is provided on board, capable of carrying out assessment of lashing strength according to CCS rules for container securing.
- **CLC(V):** Reduction of acceleration for special route is considered based on **CLC**.
- **CLC(W):** Reduction of acceleration due to seasonal and weather factor for special route is considered based on **CLC(V)**.

◎ CCS container securing and lashing service

- By the application of onboard lashing computer, a more flexible container stowage and lashing plan on the deck can be provided, so as to substantially improve loading capacity or average stack weight of containers and comprehensively improve the operational efficiency of container ships and operational benefits;
- Reduction factor of acceleration is developed for multiple special routes (e.g. domestic coastal route, route from Asia to the east of South America and route from Asia to Australia) and for special seasons, so that loading and transport efficiency and economy are improved provided that lashing safety is guaranteed.

◆ Construction technology: welding and inspection of thick plate

◎ Thick plate welding technology

A large number of thick higher strength steel plates are used on large container ships, which raises higher requirements for welding technology and procedures. By means of welding experiment and research on welding procedures, CCS strictly controls the pre-heating of members and the inter-pass temperature during welding in order to guarantee the welding quality.

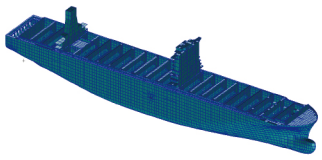
◎ Combined Inspection of Time-of-Flight Diffraction (TOFD) Technique and Phased Array Ultrasonic Testing (PAUT)

With regard to the inspection of very thick plates and welds, CCS has introduced the combined inspection of Time-of-Flight Diffraction (TOFD) Technique and Phased Array Ultrasonic Testing (PAUT). As compared to common ultrasonic testing technique, it has stricter acceptance criteria for defects and more accurate testing results. Such testing technique is applicable to NDT of very thick plates and welds of very large container ships.

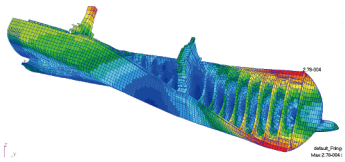
7. Hotspot technology of container ships

◆ Vibration and Noise Assessment Services

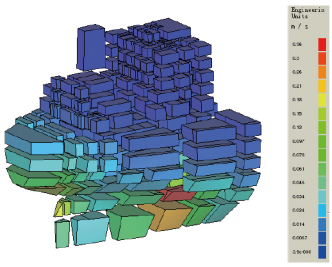
The hull structural rigidity is reduced due to the hull girder increase in size of large container ships. On the other hand, due to the large propulsion power of main engines, the large container ship is prone to have vibration and noise problems. In order to better control the harmful vibration on board ships, CCS is committed to the research on technology of controlling the shipboard vibration. Based on the research results and experience, the "guidelines for shipboard vibration control" was published for use by the industry. CCS can provide global and local vibration assessments for container ships, deliver solutions for harmful vibration as per clients' request.



FE model of container ship



Global vibration assessment



Noise assessment

IMO's Code on noise levels on board ships took effect on 1 July 2014, which raises higher requirements for ship design, construction, operation and marine products. To facilitate effective implementation of the Code, CCS provides technical service of noise control on board ships based on its own technology advantages, with an aim to assist ship designers to develop comfortable ship types with lower noise level. Following services can be provided:

- Introduction of the requirement on cabin noise control;
- Design evaluation of noise optimization on board ships;
- Prediction of cabin noise;
- Solutions for excessive cabin noise.

◆ Emission Control (Sox & Nox Tier III)

As international conventions and relevant nations and regions specify stricter requirements for emission control of air pollution from ships, CCS has always been committed to research on various technologies and methods to effectively reduce Sox/NOx emission from ships.

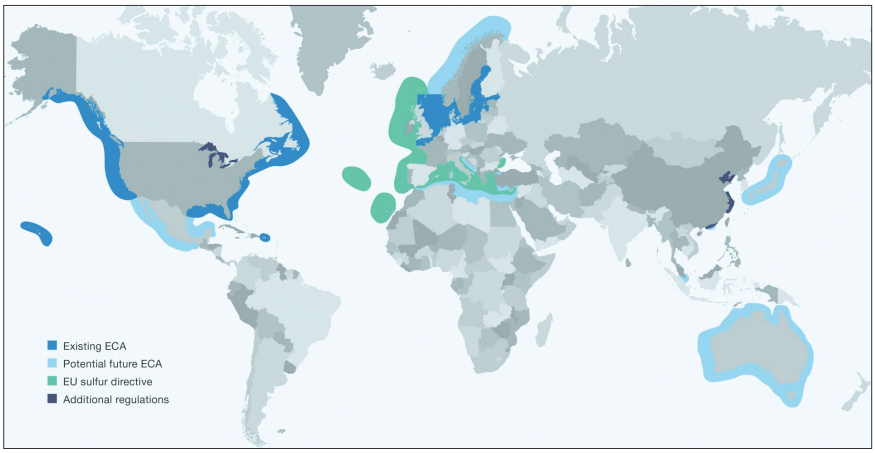
◎ **With regard to SOx emission requirements, the following may be used:**

- Low Sulphur content fuel oil;
- Dual fuel power system;
- Exhaust gas cleaning (EGC) system

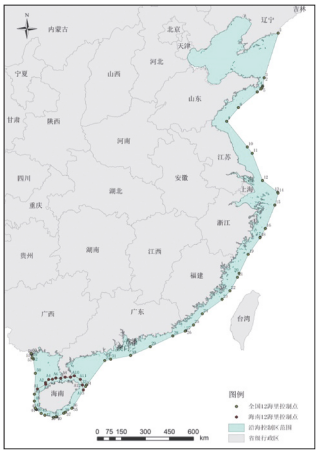
◎ **With regard to NOx Tier III requirements, the following may be used:**

- Low pressure dual fuel power system;
- Selective catalytic reduction (SCR) system;
- Exhaust gas recirculation (EGR) system.

In accordance with ship type characteristics and route, CCS can provide shipowners with individual or combined emission control solutions and carry out economic analysis.



a) Global ECAs



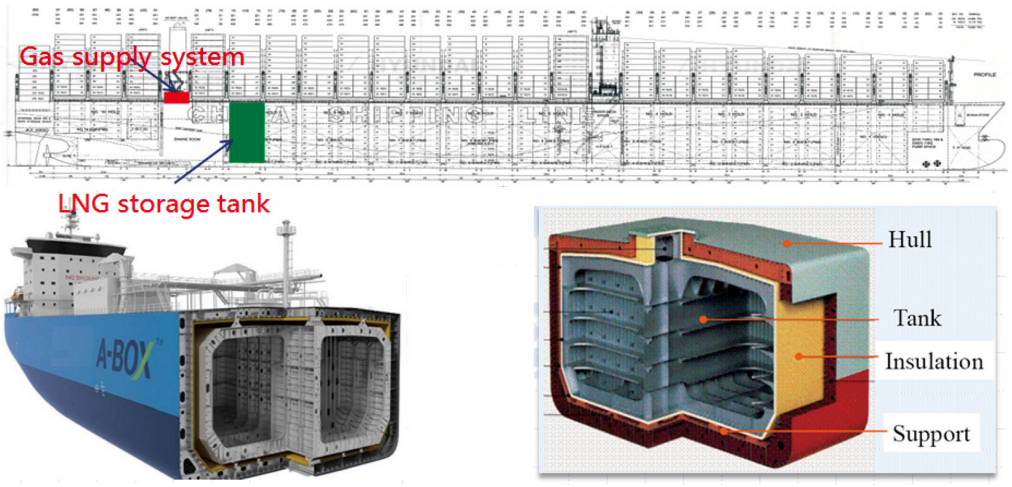
b) China ECAs

◆ LNG Ready scheme

The new applicable SOx and NOx Emission Control increases the level of challenge to ship system and arrangement. LNG Ready scheme is a reliable solution to coordinate both SOx and NOx emission control systems. CCS has complete and thorough experience in LNG Ready schemes for container ships.

◎ LNG Ready solution for 19,000TEU Container ship

- Type A/B independent tank
- 418 TEU lost for cruising range 11,500 nautical miles (single voyage)
- 205 TEU lost for cruising range 5,000 nautical miles (LNG for ECA only)
- Recommended class notation: **DFDR (H, m, a, E, P, D)**



◆ Ship energy efficiency technology

Due to the double pressure of environment and operational cost, the shipbuilding and shipping industries have focused their attention on ship's energy saving and emission reduction. By means of evaluation of ship's resistance reduction and efficiency improvement technology based on experience, test and CFD, CCS can provide guidance on ship's weight control technology and carry out evaluation of comprehensive energy efficiency in full load and/or ballast and/or partial load conditions in accordance

with ship type, logistics and route characteristics, including optimization of power system, propulsion system, electrical system and application of new energy and energy-saving technology, so that ships can satisfy or exceed the requirements of MARPOL convention, for the purpose of improving ship's energy efficiency, saving energy and operational cost.

CCS has successfully provided technical service and recommended plan with regard to resistance optimization, optimized provision of main and auxiliary engines and application of energy-saving appendage to VLCC, 1100 TEU, 176,000 ton bulk carrier and 180,000 ton bulk carrier projects.



Boss cap fin



Rudder bulb

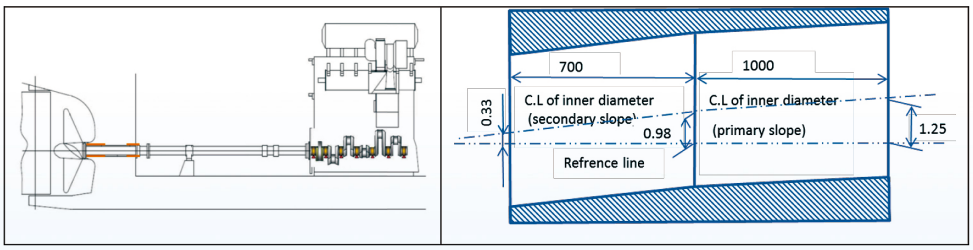


Twisted rudder

◆ Shafting vibration and alignment

The main engine of large container ships is generally arranged at the mid and aft part with a large line due to the small stern line and large size of main engine, giving rise to a long shafting. Generally the distance from the propeller to the main engine of very large container ships is 40 to 50 m, giving rise to the problem of shafting vibration.

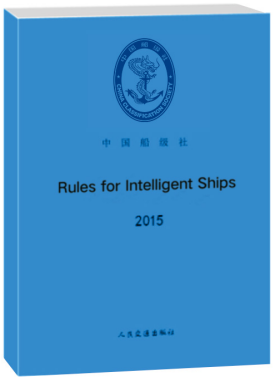
By means of analysis and assessment of shafting vibration and alignment characteristics, CCS provides technical support to construction technique plan of shafting arrangement and alignment, which can effectively avoid shafting damage and over-heating. For shafting damage on board ships, CCS can provide cause analysis of failure and put forward solutions.



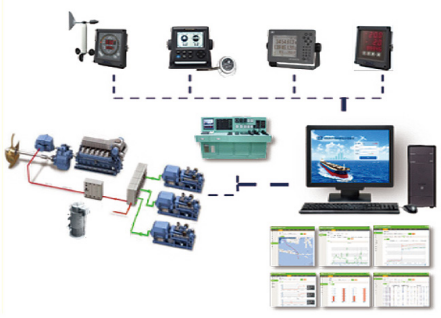
◆ Intelligentization

Intelligent ships are those ships which automatically perceive and obtain information and data on ship itself, marine environment, logistics and port by making use of sensors, communication, the Internet of Things, the Internet and other technical means, and achieve intelligent operation in terms of ship navigation, management, maintenance and cargo transportation based on computer technology, automatic control technology and big data processing and analyzing technology, so that ships can become safer, more environmentally friendly, economical and reliable.

CCS can provide shipowners with intelligent technology application service such as intelligent route optimization, hull structure full-life-cycle management, condition monitoring of engine room equipment and assistant decision-making, energy efficiency parameter monitoring and assistant decision-making, ship speed optimization, optimal trim and stowage, intelligent integration platform etc.







Up to now, large container ship projects which have applied for and are assigned CCS Intelligent Ship notation include 13,500TEU, 14,500TEU, 191,500TEU, 20,000TEU and 21,000TEU.

8. CCS Additional Services

◆ Joint development of ship type

Ship type is jointly developed in conjunction with the shipyard and designer. By making use of CCS advantage in information and technology, based on comprehensive information such as route, port and channel and by means of advanced technical rules, technical economic analysis and structural and performance calculation analysis, effective technical solutions are provided in order to jointly develop top quality ship type.

◆ Optimization and upgrading of ship type

Reliable structural optimization and upgrading solutions are provided by means of scientifically reasonable quantitative and qualitative analysis and research based on current characteristics of ship type, so as to provide strong support for ship type upgrading, making the ship safer, more environmentally friendly, more economical and more efficient.

◆ Approval of ship type

Compliance evaluation is carried out on ship types provided by the shipyards and designers in accordance with agreed rules and conventions, and ship type approval certificate is issued to lay the foundation for ship type promotion and plan approval in the future.

◆ Recommendation of ship type

Excellent and reasonable ship type is recommended in accordance with the basic needs of the client and based on CCS ship type performance accumulation and advantage in technical experience, covering main scantling, structural arrangement, type selection of main engine, energy efficiency indicator, emission scheme and intelligent scheme.

◆ Technical training of clients

Based on the needs of the clients, CCS can provide comprehensive and customized technical training service related to rules, software and technical solutions.

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