COMMON STRUCTURAL RULES FOR BULK CARRIERS AND OIL TANKERS
Common structural rules for Bulk Carriers and Oil Tankers

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Common Structural Rules for Bulk Carriers and Oil Tankers
DNV GL offers state-of-the-art competence and services for Bulk Carriers and Oil Tankers
What is CSR BC & OT?

It is a comprehensive and consistent rule set which will set the standard for oil tankers and bulk carriers.

The new rule set consists of two main parts:
- The first is a common part covering general hull requirements applicable to both ship types, such as wave loads, hull girder strength, buckling and fatigue requirements. The second part covers ship-type specific requirements only applicable to bulk carriers or oil tankers.

The rule application has not changed from CSR-OT and CSR-BC. The rules will also comply with SOLAS II-1 Regulation 3-10 “Goal-based ship construction standards for bulk carriers and oil tankers” (GBS)

For which vessel types and sizes is the CSR BC & OT applicable?

CSR BC & OT applies to:
- Tankers for oil and oil product, with length 150m or above
- Bulk carriers with length of 90m or above

Excluded by the CSR are: Ore carriers, open hatch bulk carriers without hopper and top side tanks, OBOs, self-unloaders and some other specialized bulk carriers
Key features of the CSR BC & OT compared to CSR-OT and CSR-BC

- Extended verification scope, including FE analysis of all cargo holds
- More transparent and consistent requirements, including technical background
- Improved load model/formulations based on direct wave load analysis
- Enhanced fatigue standard, including detail design standard
- Hull girder buckling, also including lateral pressure and the combination with shear stress
- Hull girder ultimate limit state assessment, including damaged condition
- Compliance with IMO Goal Based Standards (GBS)
- Increased design grab weight for Panamax and Capesize vessels (Applicable only for Bulk Carriers)

The scope now covers the entire cargo hold region, including the transition to the fore body and the engine room. This will increase the number of cargo hold FE-models compared with the old CSR-BC and CSR-OT which basically cover only mid-ship region. The total required number of cargo hold FE-models can be in the range of 5-6 for Tankers and 5-9 for Bulk Carriers.

What are the consequences of the CSR BC & OT development?

The application of CSR BC & OT to existing designs shows that there will be some changes. Compared to CSR-BC and CSR-OT designs, increases of steel weight in the range of 1-3% may be expected. This is based on a simplified assessment without any redistribution of scantlings/design iterations. This means that, after iterations in a full design analysis, the actual impact may be reduced. The change in steel weight and scantlings also depends on the size of the vessel, structural arrangement, type of profiles and amount of high tensile material used.

A more detailed description of the practical consequences and scantling impact for each vessel type is given in page 6 and 8.
CONSEQUENCES OF CSR BC & OT ON BULK CARRIERS

In general, offered scantlings by CSR-BC satisfy yielding requirements of CSR BC & OT, with a few exceptions, such as the requirements for longitudinal stiffeners which are in general higher. This might lead to some increase of scantlings.

- The side shell plating both in the mid-ship area and in way of engine room and aft peak may need reinforcement or increase in thickness due to buckling check and higher minimum thickness requirements.
- The GRAB notation requirement has been modified. The minimum mass of unladen grab has been increased to 35 ton for Capesize vessels and 30 ton for Panamax vessels, in order to reflect the weights of the grabs currently used in some dry cargo terminals. Larger grab weight will give thicker inner bottom plating for vessels with length equal or greater than 200 m.
- Bottom plates and stiffeners in cargo hold 2 (and cargo hold 3 for large vessels) may need to be reinforced due to extended slamming reinforcement area.
- The increased scope for FE analysis has a significant scantling impact in the way of the foremost and aftermost cargo holds, and also primary members connected to collision bulkhead inside fore peak tank and structures attached to engine room bulkhead inside engine room. Typical areas of concern are shown in the figure.

- Some stiffeners in way of bottom, side shell and deck plate have fatigue life less than the required 25 years. Fatigue life can be increased by improving end connection details. CSR BC & OT requires standard structural details for fatigue concerned locations and alternative design is not acceptable unless direct analysis proves equivalent fatigue capacity to the standard details.
- It is further seen that hatch corner design and/or scantling in way of outside mid-ship region may need to be improved. Particularly for Handymax vessels, the size of hatch opening is relatively larger than for the bigger Bulk Carriers. This will lead to higher warping stresses due to hull girder torsion, so special attention is needed. In addition, oblique equivalent design wave (EDW) is added in CSR BC & OT to take into account warping stress correctly. It means more reliable results with respect to torsional deformation are now available.
- The hull girder ultimate strength (Intact condition) results are reviewed and in general this is expected to give some scantling increases. This is due to the double bottom effect which is added. Hull girder ultimate residual strength (damaged condition) does in general not show any scantling impact.
- The screening criteria for fine mesh local analysis in CSR BC & OT is more demanding than CSR-BC, which may lead to local reinforcements.
Typical areas of scantling increase due to FE analysis on a bulk carrier
CONSEQUENCES OF CSR BC & OT ON OIL TANKERS

- Normally scantling increases due to higher minimum thickness requirements will be found in way of keel, sheer strake plating and non-watertight stringers in the double hull.
- Some of the plate thickness in way of tank boundaries does not satisfy local plate requirement due to increased internal tank pressure, as the design vapour pressure is now added on top of the liquid pressure for seagoing conditions.
- Longitudinal stiffener section modulus requirements in way of deck and upper part of longitudinal bulkheads are generally higher due to updates in the buckling requirement. This leads to scantling increase in most ships.
- Offered scantlings generally satisfy the prescriptive fatigue assessment requirements in accordance with CSR BC & OT. Some longitudinal stiffeners located in the bottom shell and the side shell have fatigue life in the order of 20 to 25 years and increased scantlings or improved connection details will be necessary.
- Finite element yielding assessment has limited impact but finite element buckling assessment leads to scantling impact for some members, such as:
  - Hopper structure
  - Inner hull upper part
  - Longitudinal bulkhead upper part
  - Horizontal stringers in the double hull
  - Double bottom floors
- The Hull girder ultimate strength results for both intact and damaged condition were reviewed and no scantling increase was seen for the selected ships.
- The increased scope for FE analysis has a significant scantling impact in the way of the foremost and aftermost cargo holds, and also primary members connected to collision bulkhead inside fore peak tank and structures attached to engine room bulkhead inside engine room. Typical areas of concern are shown in the figure.
- CSR BC & OT requires standard structural details for fatigue critical locations and alternative design is not acceptable unless direct analysis proves equivalent fatigue capacity to the standard details. It is expected that this will result in more consistent quality of local detail design.
OIL TANKERS

Typical areas of reinforcement due to FE analysis on a tanker
WHAT CAN DNV GL OFFER TO OWNERS AND YARDS?

The merger of DNV GL means that we can bring greater technological expertise, experience and a broader range of classification services to our industry partners. As a leading classification society, we have over the years accumulated unique competence in both the tanker and dry bulk segments which we want to share with the maritime industry.

1. Global network of experts directly available for your support
   A more detailed description of the global network is given in page 12

2. Top-notch pre-contract services (Specification and Design review)
   A more detailed description of the pre-contract services are in page 14

3. Sophisticated modelling software
   A more detailed description of the Nauticus Hull software is given in page 16

4. Basic and Advanced training courses for our industry partners
   A more detailed description of the available training courses is given in page 18
1. Global network of experts directly available for your support

DNV GL’s global presence is complemented by our local networks - giving you a point of contact in your region who can rapidly respond with a targeted solution to best meet your individual needs.

DNV GL has expanded its activity world-wide to assist clients in implementing the CSR BC & OT. Central in these activities is the DNV GL networks of Ship Type Experts. Separate networks have been established for tankers and for bulk carriers, where the members represent DNV GL’s technical leaders for their respective ship types. The ship type experts combine detailed in depth technical knowledge with a broader experience.
2. Pre-contract services

Regulatory and third-party requirements are constantly developing, resulting in the emergence of the term «future proofing» of bulk carrier or tanker newbuildings. This implies that, for an owner, it is essential that the newbuilding specifications cover regulatory and third-party requirements that enter into force in the course of the building period and in the foreseeable future after delivery. DNV GL can assist owners with the above through reviews of technical specifications, as part of our free of charge pre-contract service.

Specification review

Specification review is a service where DNV GL utilizes its networks of Ship Type Experts to review the specification of the vessel. The main focus is to suggest possible improvements in the design and specifications of the vessel, but advice is also given on how to make the specification clearer to avoid possible misunderstandings. The typical input data for the review is the General Arrangement and the Outline Specification. The proposals for improvement are communicated through a specification review report, and very often followed up by a meeting to explain more in detail. A typical specification review report includes:

- Class & statutory requirements in force and relevant regional requirements (EU & USCG)
- Future known requirements
- Recommended class notations
- Evaluation of design and general arrangement
- Evaluation of technical specifications, capacities, choice of equipment, etc. based on experience from previous newbuilding
- Project execution and in-service experience.
- New technology such as alternative fuels
- Equivalent levels of safety for novel designs

The implementation of the IACS Common Structural Rules for Bulk Carriers and Oil Tankers is a topic commonly addressed in the specification review report.

Other hot topics have been related to air-emission legislation for SOx and NOx and associated technologies, as well as the future ballast water treatment requirements, where the choice of technology and location and USCG compliance issues are important. In terms of new technology, alternative fuels are of course an important issue. DNV GL has significant experience with gas-fuelled installations and can assist owners in assessing the feasibility of the proposed solutions and highlight potential challenges that need to be addressed in the specifications.

Design review

Design review is a service focusing more on the formal rule requirements of the vessel's scantlings and arrangement. The minimum scope is typically to carry out a mid-ship cross section analysis. The analysis scope may be extended if required, for instance cross section analysis of the whole cargo hold, FE cargo hold analysis, or fatigue calculations. In addition other technical disciplines than hull may be included.
EXPERTISE IS KNOWING WHICH DETAILS MAKE ALL THE DIFFERENCE
Common structural rules for Bulk Carriers and Oil Tankers

3. SOFTWARE - Nauticus Hull

The Common Structural Rules for Bulk Carriers and Oil Tankers (CSR BC & OT) are based on physics’ first principles, instead of on empirically based models. This will provide a better answer to the conditions the ship will experience in reality. However, it also means a shift towards more computerisation of the rule formulations and structural assessment and good support from rule calculation tools will be essential in the structural design process.

As a response to this, DNV GL has invested heavily into its rule calculation tools to provide efficient support for the new rules. Nauticus Hull is updated to support the latest version of the CSR BC & OT rules for prescriptive and Finite Element Method calculations. Main priorities during development have been to improve efficiency and quality by introducing better modelling capabilities, automation of calculation tasks and improved reporting functionalities. In addition it has been important to improve interface to other design and FE systems for exchange of models. The changes in Nauticus Hull addresses the needs of the designer, who will be working with new demands for an increased number models and load cases.

Nauticus Hull

For prescriptive calculations, Nauticus Hull Cross Section Analysis is updated to support the CSR BC & OT rules including buckling, yielding, fatigue and hull girder ultimate strength analyses. In addition a new Rule Calculator is introduced for local scantling checks of primary supporting members and individual assessment of plates and stiffeners.

On the FEM side, there are improvements to the functionality for modelling the non-parallel fore and aft part of the cargo area, including the import of the hull shape from stability software. Ship-specific modelling features, such as adding longitudinals to the outer shell, have been significantly improved. It is also possible to reuse finite element models from other software systems. It includes powerful algorithms to automatically generate mesh according to various requirements. For further improved mesh control, the software has been updated with functionality for partial meshing and state of the art tools for manual mesh adjustments.

Based on the FE model the user can automatically apply corrosion additions, loads and boundary conditions according to CSR BC & OT. In addition the software is updated with tools for doing automatic yield- and buckling check according to the rules. Acceptance criteria for different structural components are automatically accounted for.

The new rules also require a number of local models for assessment of critical details. Nauticus Hull has new functionality for screening of the model to identify critical areas as well as improved efficiency for generation of local fine mesh FE models and to run local fatigue assessment.
1. Aftermost cargo hold FE model yield and deformations assessment
2. FE buckling check
3. Local fine mesh model of lower stool for detailed stress assessment
4. Local fine mesh model of lower stool for detailed stress assessment
4. Training courses

DNV GL has activities world-wide to assist clients in implementing the CSR BC & OT. An extensive training program has been initiated for all approval units enabling our staff to be well prepared to provide efficient and local support to the industry. We have also been running workshops and training for yards, designers and owners, and together we have performed extensive consequence assessment of existing designs. We want to ensure a smooth transition to CSR BC & OT for our clients.

Training and presentation packages are among the activities to assist clients. The presentations are available with different detail levels, ranging from brief overview presentations to workshop material going in detail on specific technical subjects.

Both the presentation and training packages may be tailor made to accommodate the customer’s needs.

Basic 1-day training course

The standard training package consists of a one day introduction course, with an optional 2 days course going in more details.

The introduction course covers the following subjects:
- Concept and structure of the rules
- Difference between CSR BC & OT and the old CSR-OT and CSR-BC on technical requirements and design scope
- Scantling impact
- Software

Advanced 2-day training course

The optional 2 days course is aiming at understanding the detailed technical background of CSR BC & OT, and includes hands on experience with CSR BC & OT software.

Example of a Training Course Agenda:

Basic 1-day training course
- Concept and structure
- Gap between CSR BC & OT versus CSR OT and CSR BC
- Consequence of CSR BC & OT
- Scope increase
- Software

Advanced 2-day training course
- Understanding detail technical background
  - Loads
  - Prescriptive local plate and stiffener
  - Hull girder strength
  - FE analysis
  - Buckling
  - Fatigue
- Hands on experience with CSR BC & OT software
FREQUENTLY ASKED QUESTIONS / INDUSTRY CONCERNS

The questions and answers you find below are provided with the purpose to clarify issues related to the implementation of CSR BC & OT.

1. **Bulk carriers and tankers are different vessel types, so why make a common rule set?**

   Tankers and Bulk carriers are different ship types, but also have much in common. For example, both ship types are constructed of stiffened steel plate panels with similar yielding, buckling and fatigue properties, both ship types have to withstand the same wave loads, etc.

   The common requirements are given in Part 1 of the rules, while the ship type specific requirements are given in Part 2.

2. **What should be the biggest concerns in the industry for application of CSR BC & OT?**

   Due to the extended scope, more resources and time will be required in the design phase unless better tools are available. However in case of good/smart tools, repetitiveness of design and approval will be improved.

3. **Will ship designed to the new rules be heavier than the existing CSR-BC or CSR-OT designs?**

   The new rules shall ensure that vessels designed according to these rules will be at least as safe and robust as the existing vessels. It is introduced new hull girder ultimate limit state criteria, and the FE-analysis scope has been extended. Based on this we expect a 1-3 % increase in steel weight if CSR BC & OT is applied on top of an existing CSR-BC or CSR-OT compliant design. However, if a vessel is designed from scratch applying CSR BC & OT criteria, the impact might be minimised.

4. **Will it be possible for an existing CSR approved vessel to comply with the new CSR BC & OT criteria?**

   Yes, but an existing design would most likely require some modifications of the existing scantlings.

5. **What is the rationale behind increasing the analysis scope?**

   With respect to extending the FE scope to cover the entire cargo area, IACS has recognized that the existing method of extrapolating results from mid-ship to fore and aft hold do not provide the transparency and consistency in results as IMO GBS requires. In addition the computerization capabilities have developed significantly, meaning with today’s tools it is feasible to do these analyses within a reasonable timeframe.
6. **What measures are taken to ensure consistent interpretation of the rules amongst the IACS societies?**

A Rule Maintenance Team has been established in IACS, consisting of 5 technical experts from the Classification societies with the assistance from the staff in IACS permanent secretariat. This project teams will answer questions and conduct the technical assessment of potential inconsistent interpretations, which may eventually draw up recommended Rule changes for approval by the IACS Hull Panel.

7. **Will DNV GL do approval of a vessel if she is already approved according to CSR BC & OT by another IACS society?**

If a Memorandum of Understanding (MoU agreement) is signed between shipowner, yard and DNV GL accepting another IACS society’s approval, there will be a limited review and comparison. In this case no comments with respect to CSR BC & OT are expected.

If there is no MoU in place, DNV GL is obliged to do a full plan approval. However, we do not anticipate significant changes in scantlings.

8. **How to handle a contract signed prior to 1st of July 2015 where construction will not commence until 2016?**

The general rule is that ships or series of ships signed for construction prior to 1st of July 2015 are not subject to CSR BC & OT even if the construction is taking place later than 1st of July 2015.

However, if the delivery is on or after 1st July 2020, SOLAS II-1 Regulation 3-10 “Goal-based ship construction standards for bulk carriers and oil tankers” (GBS) applies. CSR BC & OT have to be applied for vessels with delivery on or after 1st July 2020, no matter when the building contract is signed.

9. **A ship building contract signed prior to 1st of July 2015 includes options for additional ships. To which rules should the optional ships be constructed?**

Options included in contracts signed prior to 1st of July 2015 are not subject to CSR BC & OT if the option is exercised within a year of the initial contract signing, except if delivery is on or after 1st July 2020.

10. **A ship building contract signed before 1st of July 2015 is amended. To which rules should the additional ships be constructed?**

Amendments are subject to the Rules in force at the date of signing the amendment. If the amendment is signed on or after 1st of July 2015, the ships are subject to CSR BC & OT.
THE POWER OF INFORMATION
THE APP
The new DNV GL - Maritime app is packed with features and information, including NEWS & EVENTS, CONTACTS, VESSELS, MARKET INSIGHT and TRAINING COURSES. There have never been so many ways to interact with us and stay informed about the latest developments at DNV GL.

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Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries.

Combining leading technical and operational expertise, risk methodology and in-depth industry knowledge, we empower our customers’ decisions and actions with trust and confidence. We continuously invest in research and collaborative innovation to provide customers and society with operational and technological foresight. With our origins stretching back to 1864, our reach today is global. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping customers make the world safer, smarter and greener.