CI-T 8
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Taper of Scantlings Outside the Midship 0.4L

Rule Section

8/1.2.1.3 Hull girder section modulus application to full length
8/1.4.1.2 Hull girder buckling application to full length
8/1.6 Tapering and structural continuity of longitudinal hull girder elements
8/3.1.3 Forward region structural continuity
8/4.1.3 Machinery space structural continuity
8/4.3.1 Machinery space tapering of side structure
8/5.1.3 Aft region structural continuity

Description

A procedure is developed for applying the structural tapering requirements outside of the midship 0.4 length for longitudinal strength, deck plating and shell plating thickness to address longitudinal strength and structural continuity.

Common Procedure

Longitudinal strength – the intent of the rules is to check that hull girder strength and structural continuity is maintained and properly tapered in way of changes in vessel section arrangement and vessel shape along the entire length taking into account the variation of hull girder loads. The hull girder section modulus taper is to be based on the larger of the required section modulus from 8/1.2.2 or 8/1.2.3. The tapered section modulus along the entire length of the vessel is to be in accordance with 8/1.2.1.3, 8/1.6.1.1 and 8/1.6.1.2. The structural ends of the hull girder are considered at 0.1L forward of the aft perpendicular and 0.1L aft of the forward perpendicular in accordance with Table 8.1.3 and Figure 8.1.9. The vertical and longitudinal extents of higher strength steel (e.g. the transitions between steels of different yield strength) along the entire length of the vessel are to comply with 8/1.6.2 and 8/1.6.3 regardless of which section modulus requirement governs. The hull girder buckling strength along the entire length of the vessel is to comply with 8/1.4.1.2 and the buckling calculations are to consider the actual material yield strength. If applicable, the hull girder plate thickness due to hull girder shear along the length of the vessel is to be in accordance with 8/1.6.4.

Deck plating – the tapering of the deck plate outside of the midship 0.4L is closely associated with the section modulus and buckling requirements. The deck plate thickness typically transitions from longitudinal strength considerations within the midship 0.4L to the local strength considerations toward the ends of the vessel, considered at 0.1L forward of the aft perpendicular and 0.1L aft of the forward perpendicular. The deck plating is to be maintained throughout the midship 0.4L or beyond the end of a superstructure located at or near the midship 0.4L point and then linearly tapered, according to the tapering procedure defined below, to the local strength requirements at the ends of the vessel, but also considering the actual hull girder properties and buckling considerations along the vessel length as noted above in longitudinal strength. Local increases to the deck plating in way of superstructure breaks, foundations, etc. are to be added after the tapering and continuity requirements are considered.

Shell plating – similar to the deck plating, the tapering of the shell plating outside of the midship 0.4L is closely associated with the section modulus and buckling requirements. The shell plating taper should provide a gradual transition, according to the tapering procedure defined below, from the midship 0.4L longitudinal strength considerations to the local strength

requirements at the ends of the vessel and also consider the actual hull girder properties and buckling considerations along the vessel length as noted above in longitudinal strength. The transition of the shell plating is somewhat complicated due to the presence of local increases due to local integrated deep tanks, sea chests, local buckling increases, tug pushing areas, hull girder shear increases, etc. including those items addressed in 9/2.4.5, these local considerations should be generally considered separately from the taper and added after the tapering and continuity requirements are considered.

Tapering procedure

To assist with the uniform application of the taper requirements to the side shell and to the deck, especially regarding 8/4.3.1.1 in way of the machinery space, the following straight line simple tapering procedure is to be used.

First determine t_{end} and t_m then,

For $t_{end} < t_m$:

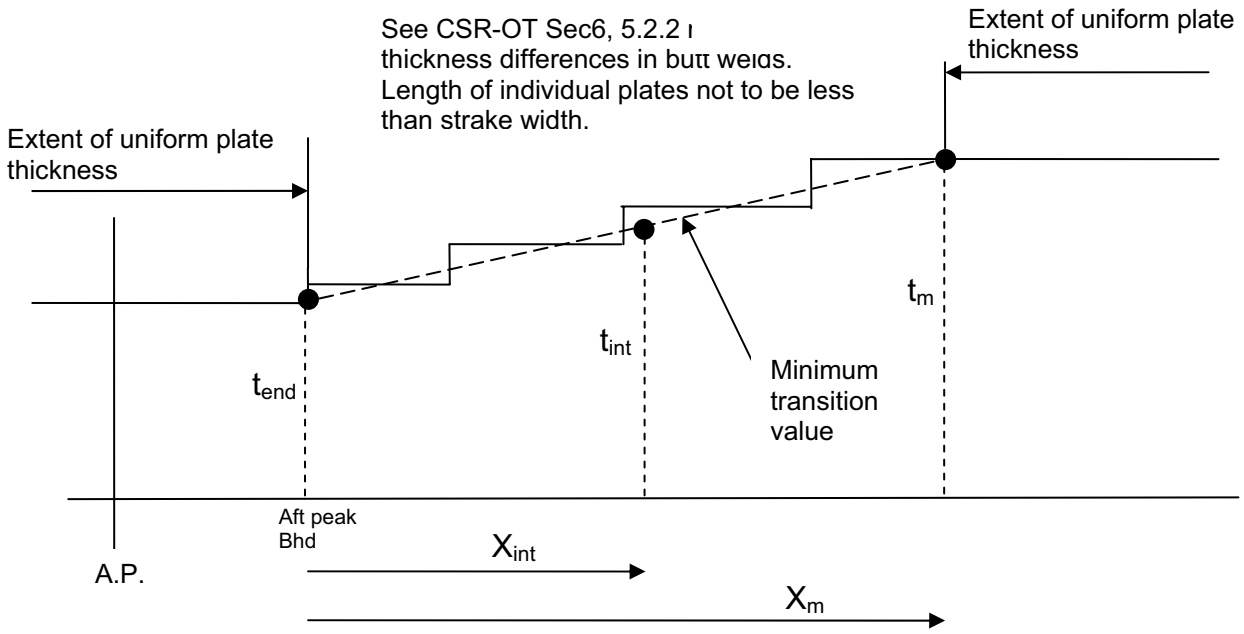
$$t_{int} = t_{end} + [(t_m - t_{end})\ X_{int}/X_m]$$

For $t_{end} > t_m$:

$$t_{int} = t_m$$

t_{int} = net required thickness as defined in Note 1, at the intermediate region (intermediate location being evaluated).
t_{end} = net required thickness as defined in Note 1, at the aft peak bulkhead or 0.1L from the FP
t_m = net required thickness as defined in Note 1, at midships.
X_{int} = distance from the aft peak bulkhead or 0.1L from the FP to the intermediate location being evaluated.
X_m = distance from the aft peak bulkhead or 0.1L from the FP to the corresponding aft or forward extent of the midship 0.4L.

Notes:
1. The tapering is to be based on the net required thickness, provided that this thickness comply with all requirements, including the minimum thickness, local scantlings, and thickness for quay zone. The net thickness requirements for local reinforcements such as local integrated deep tanks, tug pushing, sea chest opening compensation, vicinity of stern frame, breaks of super structure, buckling requirements and the hull girder shear requirements are to be excluded. These local reinforcement considerations are to be locally applied as necessary after the taper thickness requirement is determined.
2. For tapering, no local adjustment for the actual stiffener spacing and the plate material at the specific locations along the length of the vessel are to be applied. For example, if an area where the actual side frame spacing is different from the midships region between 0.4L amidships and the vessel ends, shell plate tapering in the area should be based on the straight thickness taper line drawn between two points, one end is the required side shell plate thickness at midships assessed based on the actual local spacing at the midship and the other end is the required side shell plate thickness at the vessel end based on the actual local spacing at the vessel end.
3. For tapering, the longitudinal location of the middle of the longitudinal extent of a strake and the vertical location at a line from midship to end region and parallel to baseline should be used to determine the required thickness for each plate that is located in the tapering region.
4. See CSR-OT Sec 6, 5.2.2 regarding thickness difference in butt welds, the length of individual plates is generally not to be less than the strake width.



Structural continuity – the tapering of the scantlings of longitudinal members and the tapering of the hull girder properties in way of changes in vessel arrangements and shape along the length is closely related to the continuity and termination of structural members. It is important to provide continuity of strength and to avoid abrupt structural changes which tend to increase stress concentrations, by providing suitable scarphing arrangements and transition brackets to avoid abrupt changeover of stiffening from longitudinal framing to transverse framing and to properly compensate for openings in the structure. Various aspects of structural continuity are covered in 8/1.6.5., 8/1.6.6, 8/3.1.3, 8/4.1.3, 8/5.1.3.

Implementation date

The Common Interpretation is applicable for the original version of key drawings for approval with submission date 1 January 2010 or later.

Background

Longitudinal structural continuity along a ship's length is a vital aspect in ship design. There is to be sufficient continuity in longitudinal scantlings so as to have the hull girder strength criteria fulfilled all along the ship's length in line with the hull girder bending moments and shear forces.

Hull girder strength, local strength and other applicable rule requirements determine scantlings, which inevitably result in variation in scantlings along the vessel length. Good engineering practice, as well as the historic practice, which has been satisfactory, has been to require a gradual change in scantlings, for example in shell plating thickness between the midship and end regions of the vessel. The plate thickness along the ship is expected to change in a gradual manner, i.e. tapered from midship to the ends of the vessel.

Additionally, continuity and proper transition of longitudinal structure at breaks and changes in structural arrangement are equally important considerations.

In the current CSR for Oil Tankers continuity and proper tapering of scantlings are addressed in the following rule cites:

8/1.2.1.3	Hull girder section modulus application to full length
8/1.4.1.2	Hull girder buckling application to full length
8/1.6	Tapering and structural continuity of longitudinal hull girder elements
8/3.1.3	Forward region structural continuity
8/4.1.3	Machinery space structural continuity
8/4.3.1	Machinery space tapering of side structure
8/5.1.3	Aft region structural continuity
9/1.1.1	Application of hull girder ultimate strength
9/2.4.2	Application of scantlings to deck
9/2.4.5	Application of scantlings to side shell, longitudinal bulkheads and inner hull longitudinal bullheads.

1. Background and current application

Experience and feedback have highlighted that the rule text of the above rule sections is not clearly described in sufficient detail to facilitate a uniform application of these requirements. This could be attributed to the fact that tapering is mentioned only in general terms in the rules. The main objective of the CI is describing a tapering procedure in accordance with the CSR for Oil Tankers that all parties involved in the design and approval process can apply to ensure a uniform and consistent implementation of the general tapering criteria.

2. Tapering Procedure

To provide a common interpretation within the context of CSR for Oil Tankers on tapering of the shell envelope plating, the procedure in CI-T8 has been developed.

The procedure applies a linear taper using net scantlings at the midship and ends as the basis, since net scantlings form the foundation for scantlings in CSR.

Plating transitions are also complicated by local thickness increases stemming from compensation for openings, heavy plates in the vicinity of rudders and stern frames, local integrated deep tanks, tug pushing areas, compensation for hull girder shear stress, buckling etc. In addition material strength, framing system and spacing may vary along the vessel length.

In this tapering procedure, the following effects on local requirements are to be excluded from the calculation of the reference thickness t_{end} and t_m:

- Hull girder shear
- Tug pushing
- Sea chest opening compensation; heavy plates in way of stern frame; breaks of superstructure
- Buckling
- Local integrated deep tanks, except water ballast tanks in the midship location and peak tank at ends.
- Sloshing
- Bottom slamming
- Bow impact

These effects have to be applied after tapering thickness requirements have been met. No local adjustment for actual stiffener spacing and plate material strength is to be considered at the specific location for which the tapered thickness is being determined.

The required thickness is to be determined at the middle of the longitudinal extent of a strake on a line drawn at the vertical midpoint of the strake from midship to the ends and parallel to the baseline. Thickness difference in butt welds is to be in accordance with 6/5.2.2 of CSR for Oil Tankers and the length of an individual strake is not to be less than the strake width.