Lloyd's Register Marine

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Extent of double continuous welding for special service craft

Guidance note

1. Introduction

1.1 It is the purpose of this note to provide guidance on the extent of the application of double continuous welding (DCW) required in high speed steel or aluminium hulled craft being built in accordance with the requirements of the Special Service Craft (SSC) Rules.

1.2 The areas requiring DCW for SSC vessels are outlined in Part 6, Chapter 2, Section 4.7.2 for steel and Part 7, Chapter 2, section 4.8.2 for aluminium hulled craft respectively. In addition to general guidance, this document provides specific guidance on the following clauses of the rule references:

- (e) The side, bottom shell and underside of the cross deck structure in the impact area of high speed motor craft
- The definition of "in way of end connections" in (j), (k) and (l) of the aforementioned rule references.

2. General information

2.1 Traditionally LR has always required DCW in areas subjected to impact as it was perceived that stop-start welds can lead to an increased number of weld defects, in addition the toes of these welds can act as geometric stress raisers (GSRs).

2.2 GSRs and weld defects are particularly harmful for aluminium structures which suffer from inherently low fatigue strength. However, recent research has indicated that the distortion and effect of heat input in thin plate aluminium structures is comparatively detrimental.

Further, a number of post weld treatments, such as weld profiling and de-burring, are available to limit the effects of GSRs.

2.3 Paragraph 2.2 highlights the fact that there is a trade-off between the structural benefits of DCW and intermittent welding.

2.4 It should be noted that DCW of plate down to a thickness of 5mm may be carried out satisfactorily providing the weld procedure and welder are suitably qualified and production welding distortion is controlled. The welding of thinner plates would require specific discussion with Lloyds' Register's Materials & NDE Department, which should be contacted at the earliest possible opportunity to prevent any delays to a project.

3. Pertinent Lloyds' Register Rule Requirements

3.1 The rule references designating the requirements for DCW are contained in Pt. 6, Ch.2, 4.7.2 and Pt.7, Ch.2, 4.8.2 for steel and aluminium hulls respectively. Specifically item (e) and items (j), (k), (l) in these references contain the clauses relating to 'impact area' and welding in way of end connections.

3.2 The current overriding rule minimum throat thickness for all continuous welds is 2.5mm (see Table 2.4.2 in Part 6, Chapter 2, section 4 and Table 2.4.4 in Part 7, Chapter 2, section 4 for steel and aluminium welding respectively).

3.3 The scantlings of end brackets are to be in accordance with Part 6, Chapter 3, Section 1.21 and Part 7, Chapter 3, Section1.21 for steel and aluminium structures respectively.

4. Double continuous welding "in way of end connections"

4.1 As per the rule requirements listed in 3.1, DCW is required in way of end connections as this is commonly the part of a member where shear stress and bending stress are largest and where out of plane loads can be expected.

4.2 The extent of the above is not clearly defined within the rules. As such, paragraph 4.3 has been formulated to define the extent of an end connection in relation to member arrangement.

4.3 The required length of DCW is calculated as follows:

"The length of double continuous welding required in way of end connections is to be greater than or equal to:

- The web depth of the smaller stiffening member extending either side of a stiffener crossing (DCW is required on both of the crossing members).
- Twice the height of the stiffening member extending from either end of the stiffener if the stiffener is sniped and / or un-bracketed at ends.
- The height of the stiffening member plus the leg length of the attached bracket if the stiffener is bracketed.
- However in no case is the length of double continuous weld to be taken as less than 10% of the stiffener span, or in the case of bracketed connections; the length in way of the bracket if that be greater.''

For further clarity, this requirement is illustrated in Figure 1.

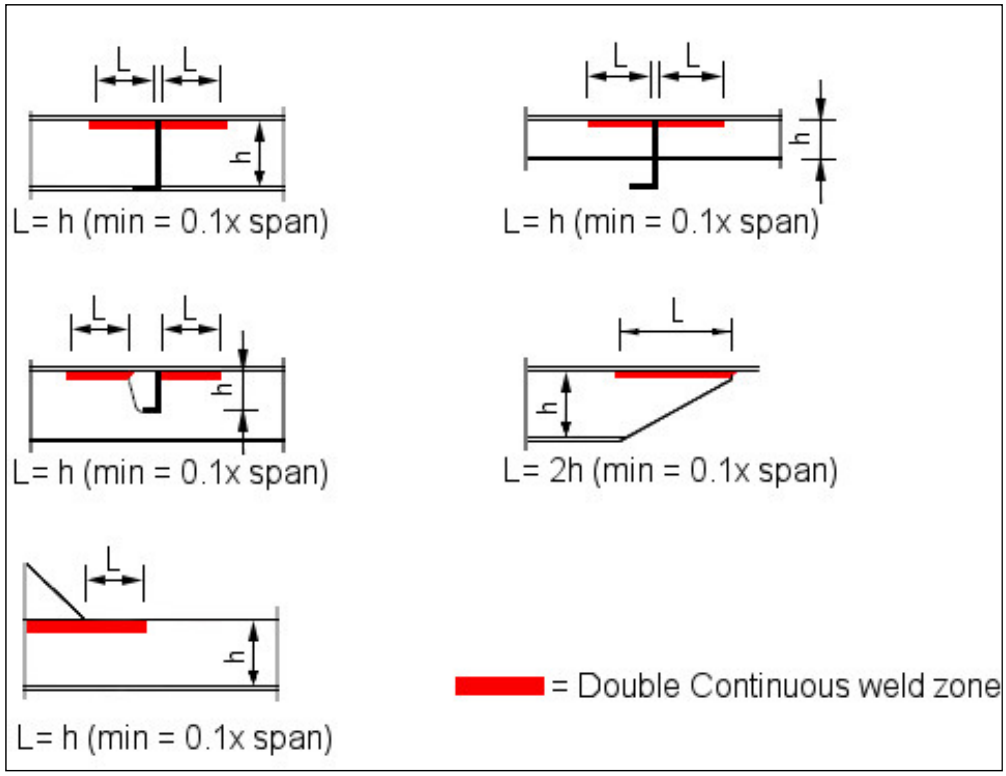

Figure 1: Example stiffening members required double continuous weld zones

5. The extent of DC welding in the impact area of high speed motor craft

5.1 Care should be taken not to confuse the 'Impact area' in paragraph 5.3 with the 'Slamming Zone' mentioned elsewhere throughout the rules. Note that the primary purpose of the identification of the slamming zone is to enable slamming zone specific stress factors to be applied to hull scantlings.

5.2 The 'Impact area' of any high speed motor craft is subject to the high pressures and fatigue loadings associated with regular slamming impacts.

5.3 The 'Slamming Zone' of any high speed motor craft is subject to occasional high pressure loadings associated with incidental slamming events.

5.4 As presently no definition exists, the following definition of 'Impact area' as referred to in the rule reference listed in 3.1, has been formulated:

"The area of the hull that, in normal design operation of the craft, will be subject to loads of sufficient magnitude and velocity for slamming to occur on a regular basis (An average slamming frequency of 0.3 Hz shall be considered as regular)."

Areas where conditions for slamming occur incidentally are not considered as impact areas.

5.5 As presently no textual definition exists, the following definition of 'Slamming Zone' has been formulated:

"The Slamming Zone is the region where the operational non-displacement mode pressures exceed the operational displacement mode pressures."

5.6 It is to be noted that calculation of the extent of the slamming zone provides a useful indication of the relative distribution of pressure. However the slamming zone quasi-static pressures will not necessarily result in an impact (slam). Therefore the extent of the slamming zone is rarely representative of the 'impact area' as a number of other important parameters are associated as with whether an impact event will be experienced. These include, but are not necessarily limited to; trim, dead-rise and relative velocity. The rules do not consider these parameters collectively.

5.7 Due to the fact that defining the extent of a vessel's impact area from plans only is complex (as noted in paragraph 5.6 variables include hull geometry, floating position and vessel velocity) and unique to each design, it is not practical for class to provide a method for derivation of the impact area. Hence, it is to be defined by the designer/ builder from one or more of the following sources which are to clearly detail which areas of the hull would be subject to regular impact pressure during normal design operation:

- In-service experience.
- Seakeeping reports.
- Direct calculations.
- Model test data

The attending surveyor may wish to verify the defined impact area by inspecting the sources used in the definition.

5.8 If it is preferred, in lieu of the information listed in 5.7, the following historical approach may be applied. Requiring DCW for a non-displacement hard-chined monohull craft in the following areas:

i. Aft of L/2 from AP: Any shell area below a line 150 mm above the chine or the tangential point.
ii. Forward of 2L/3 from AP: Up to the deck (or chine if pronounced), see also 4.2
iii. Between L/2 and 2L/3: Linear interpolation between 150mm above chine and the deck, or to a line 150mm above the chine if pronounced in the bow region.

The above is illustrated in Figure 2 for clarity.

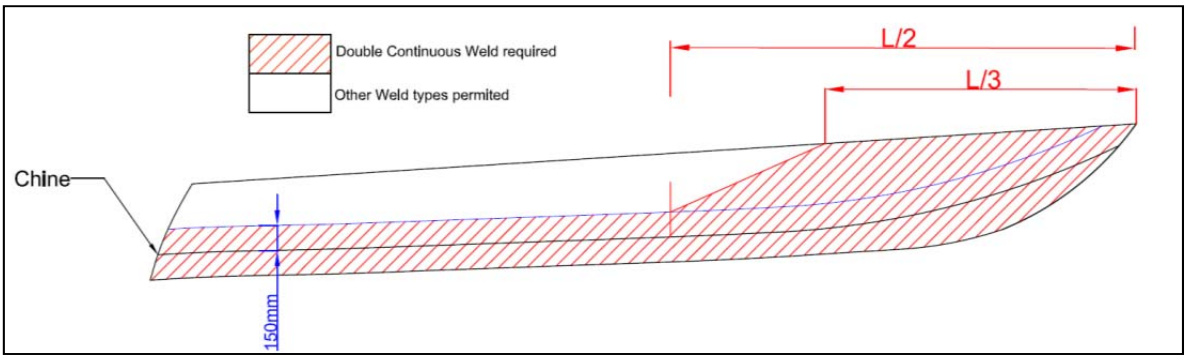

Figure 2: Defined area of double continuous welding (vessel without pronounced Bow Chine)

5.8.1 It is noted that for vessels with large forward freeboard or beamy wide bodies the above interpretation could lead to an excessive amount of DCW required. This is also the case if one considers that vessels may be operating at high speed but would only be doing so in flat water. If this is the case requirement (ii) may be replaced by ''Any shell area with a deadrise angle less than 70 degrees.''

5.8.2 For craft operating in displacement mode and with shallow draft, bottom slamming may occur and DCW is to be considered as per 5.7

6. The extent of double continuous welding in the impact area of high speed motor craft: Special considerations for multihulls

6.1 Craft such as SWATHS and wave-piercing catamarans will not generally experience slamming in the demi-hulls. The underside of the crossdeck ('wet deck') region forward should however be considered as an area which may require the same double continuous extents as detailed for the impact area.

6.2 Likewise, in concave areas of all multihull hull forms where significant stresses can occur in the plane of the plating, for example the transition between wet deck and inside shell, consideration must be given to application of DCW due to the presence of out of plane loads.

7. Conclusions

7.1 It has been noted that it is not practical to create a "one-size, fits-all" requirement to determine the impact area, and the extent of DCW must be clearly defined at the point of plan submission and supported by evidence as detailed in 5.7. Such evidence is also to be made available to the attending surveyor.

7.2 The length of double continuous weld required in way of end connections has been clearly defined and linked to member geometry and span, see paragraph 4.3.

7.3 Both impact area and slamming zone have been described and defined see paragraphs 5.3 and 5.4 respectively.

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