# 1. DEFINITION OF HARD CORNERS

## 1.1. Structural members

The following structural areas are to be defined as hard corners:

(a) the plating area adjacent to intersecting plates

(b) the plating area adjacent to knuckles in the plating with an angle greater than 30 degrees.

(c) plating comprising rounded gunwales.

## 1.2. Size and extend

The size and modelling of hard corner elements is to be as follows:

(a) it is to be assumed that the hard corner extends up to s/2 from the plate intersection for longitudinally stiffened plate, where s is the stiffener spacing;

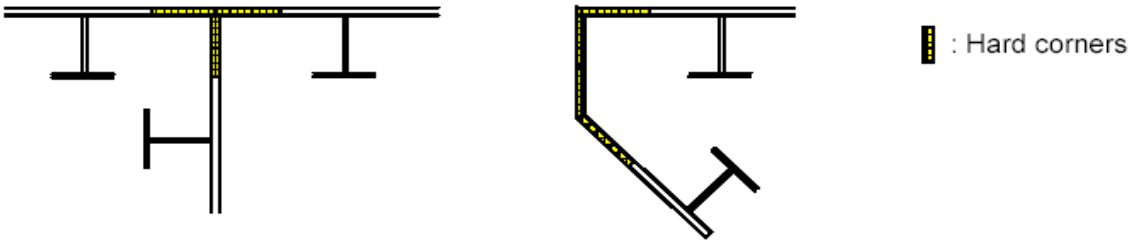


**Figure 1 : Different definitions of hard corners in longitudinal framing**

(b) it is to be assumed that the hard corner extends up to $20t_{gross}$ from the plate intersection for transversely stiffened plates, where $t_{gross}$ is the gross plate thickness.

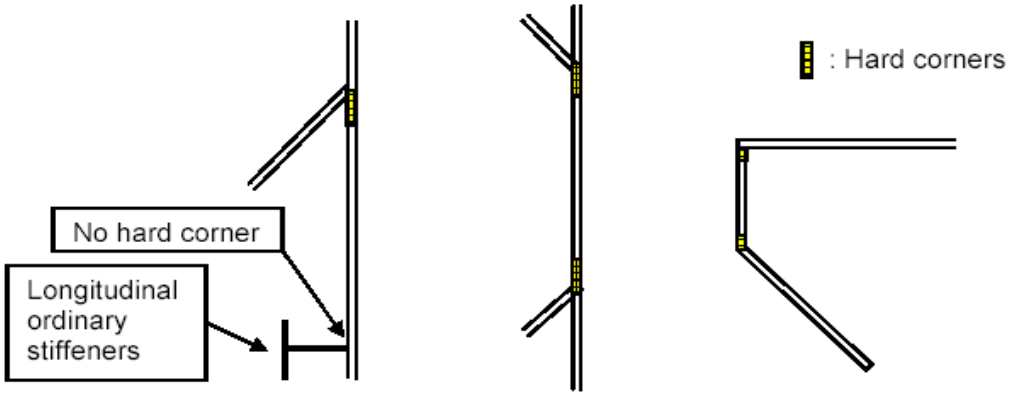


**Figure 2 : Different definitions of hard corners in transverse framing**

Nota: For transversely stiffened plate, the effective breadth of plate for the load shortening portion of the stress-strain curve is to be taken as the full plate breadth, i.e. to the intersection of other plates – not from the end of the hard corner if any.
The area on which the value of the buckling stress of transversely stiffened panels applies is to be taken as the breadth between the hard corners, i.e. excluding the end of the hard corner if any.

## 2. MODE OF FAILURE OF HARD CORNERS

Hard corners are sturdier elements composing the hull girder transverse section, which collapse mainly according to an elasto-plastic mode of failure. The relevant load-end shortening curve σ-ε is to be obtained according to the following formula, valid for both positive (shortening) and negative (lengthening) strains:

$$\sigma = \phi R_{eH}$$

where:

- $\phi$ : edge function:
$$\phi = -1 \quad for \quad \varepsilon < -1$$
$$\phi = \varepsilon \quad for \quad -1 < \varepsilon < 1$$
$$\phi = 1 \quad for \quad \varepsilon > 1$$
- $\varepsilon$ : Relative strain: $\varepsilon = \varepsilon_E / \varepsilon_Y$

  $\varepsilon_E$ : Element strain

  $\varepsilon_Y$ : Strain inducing yield stress in the element: $\varepsilon_Y = R_{eH} / E$

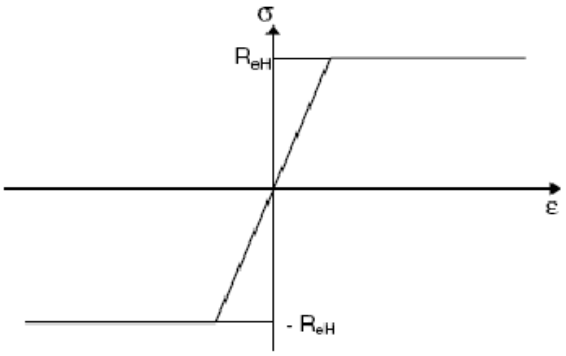


**Figure 3 : Load-end shortening curve $\sigma$- $\varepsilon$ for elasto-plastic collapse**

## 3. RULES REFERENCES

Common Structural Rules for Oil Tankers, edition October 2006
Appendix A, [2.2.2.3], [2.2.2.4], [2.3.2.1] and [2.3.3.1].

Common Structural Rules for Bulk Carriers, edition January 2006
Chapter 5, Appendix 1, [2.1.2], [2.2.2], [2.2.3] and [1.3.3].

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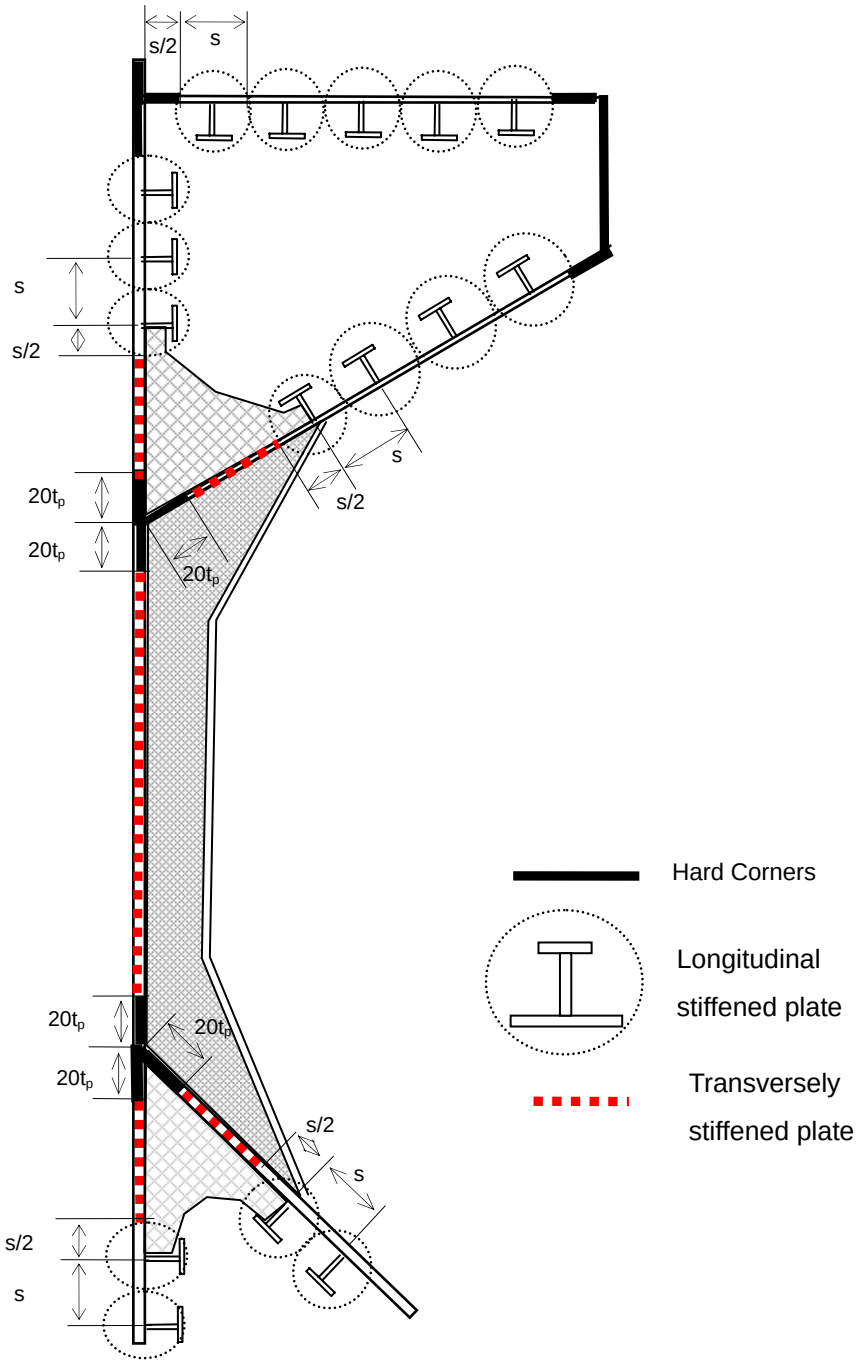
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Hard Corners
Longitudinal
stiffened plate
Transversely
stiffened plate