TETHYS SUPPORTER

Structural Analysis for the Ship Condition Assessment Program

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1. STRUCTURAL ANALYSIS

1.1. Analysis procedure

According to the procedure specified in /2/, the CAP structural analysis carried out for the ship under examination may be subdivided in the following steps:

- The as built scantlings have been assessed against the RINA Rules criteria in /1/. From the results of the above assessment, the rule required thicknesses have been derived to be used, as specified in /2/, when assigning a rating to any structural element on the basis of its corrosion diminution.
- The fatigue analysis results have been used to perform a screening of the longitudinal stiffener connections and identify the “hot spot” locations to be subjected to close-up inspection during surveys and to increase monitoring.
- The measured thicknesses have been used to check the as-gauged hull girder section modulus against the Rule criteria for existing ships, according to /2/.

1.2. Structural analysis based on the as-built scantlings

1.2.1. Analysis

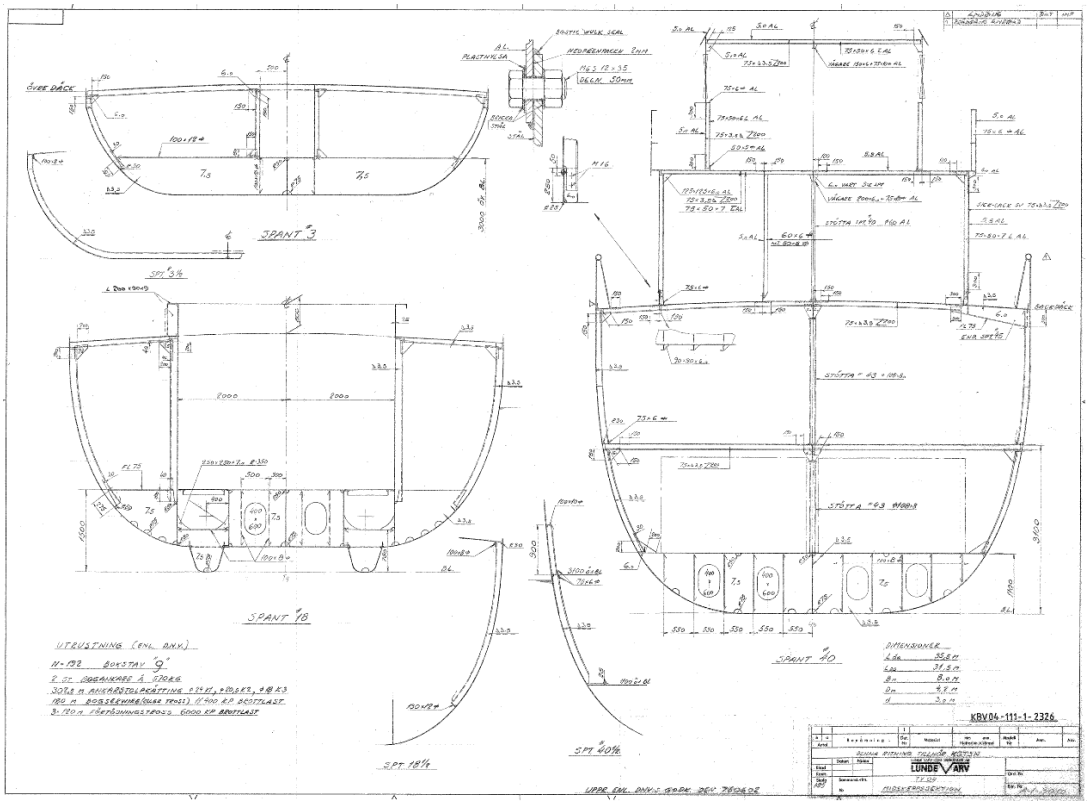
Structural analysis is carried out which assigns the loads and performs the strength checks in accordance with the RINA Rules criteria in /1/.

The analysis has considered all the plating and ordinary stiffeners belonging to the Midship Section, see Figure 1

The principal particulars are as below:

Lpp(m)	31.5
B(m)	8.0
D(m)	4.2
d(m)	3.0

Figure.1 Midship Section



1.2.2. Results

The results of the structural analysis based on the as-built scantlings are analyzed.

These results indicate that the strength of subjected vessel is in compliance with the Rule requirements presently in force

Fatigue analysis

1.2.3. Analysis

The Rule procedure for the fatigue analysis of structural details is based on the calculation of the fatigue damage originated by the fluctuating stresses induced in the detail by the hull girder and local wave loads, combined with the ballast and full load cargo conditions. From the fatigue damage, the fatigue life of the detail is calculated.

The loads considered for calculating the stress ranges in these connections are:

- hull girder vertical and horizontal bending moment,
- external wave pressures,
- internal pressures due to the inertial forces originated by the ship's longitudinal, transverse and vertical accelerations.

The nominal stress ranges induced in the considered connections by the hull girder and local wave loads in load cases "a", "b", "c" and "d" account for the following stress contributions:

- axial stresses due to the hull girder bending moments, both vertical and horizontal,
- bending stresses induced by the local wave loads supported by the stiffener, and
- for the connections with transverse bulkheads, additional bending stresses due to the relative deflections between the transverse bulkheads and the adjacent web frames (see Figure 2).

The "hot spot stress ranges" have been calculated by multiplying the nominal stress ranges by the SCF's defined by the Rules for this specific type of connections. They are indicated in Table 1, which is an extract from the RINA Rules, together with the other relevant Rule requirements.

Figure 2: Bending stress from relative deflections between transverse bulkhead and adjacent web frame

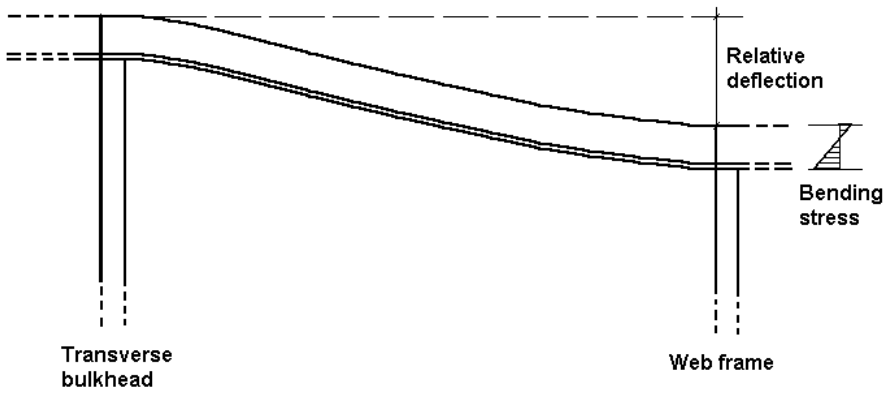
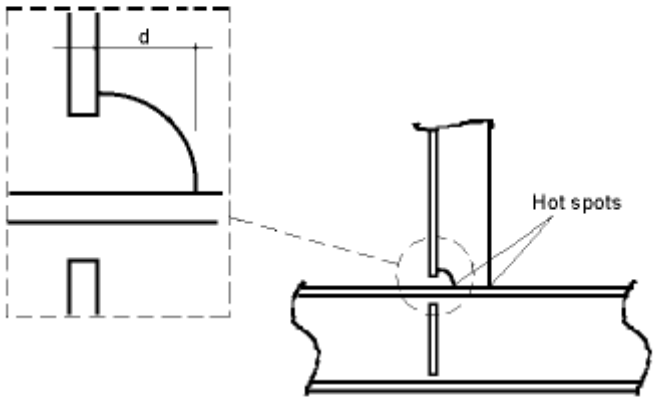


Table 1 : Connection of ordinary stiffeners with transverse primary supporting structures

AREA 1: Side between $0,7T_B$ and 1,15T from the baseline	Connection of side longitudinal ordinary stiffeners with stiffeners of transverse primary supporting members - No bracket	Sheet 1.7 *(1/1/2001)*



t = minimum thickness between those of:
- web of side longitudinal,
- stiffener of transverse primary supporting member.

SCANTLINGS:	FATIGUE:
d to be as small as possible, maximum 35 mm recommended.	Fatigue check to be carried out for L ≥ 150 m: $K_h = 1,3$ $K_f = 1,65$
CONSTRUCTION:	**NDE:**
Misalignment (measured between the outer edges) between longitudinal and web stiffener to be in general equal to or less than 0,7 t. For bulbs, a misalignment equal to 0,8 t may generally be accepted.	Visual examination 100%.

WELDING AND MATERIALS:

Welding requirements:

- continuous fillet welding,
- throat thickness = 0,45 t_w , where t_w is the web stiffener thickness,
- weld around the stiffener's toes,
- fair shape of fillet at toes in longitudinal direction.

1.2.4. Results

For this subjected vessel, as the structures are transversely framed, there is no potential hot spot items requirement for this subjected vessel.

But we bring to your attention the following items that shall be considered during survey on this vessel:

- End connections of the intermediate side transverse stiffener

- End connections between the side transverse stiffener with deck stiffener and bottom floor

- Other elements could deserve a close up survey depending on the actual ship conditions (corrosion, damage, excessive deformations)

1.3. Structural re-assessment based on the measured thicknesses

The analysis has been carried out for the girth belt which is the one showing the greatest corrosion wastages, according to the results of the thickness measurements taken during the CAP survey.

The measured thicknesses and scantlings have been checked against the hull girder strength criteria for ships in-service.

The results indicate that the hull girder section modules calculated with the thicknesses measured on the considered girth belt are greater than 90% of the as-built values. This check is therefore fulfilled.

1.4. Conclusions

The results of the structural analyses carried out according to the CAP procedure have indicated that:

1. The strength of subjected vessel is in compliance with the Rule requirements presently in force
2. The results of the structural analysis based on measured scantlings indicate that the hull girder section modules calculated with the thicknesses measured on the considered girth belt are greater than 90% of the as-built values. This check is therefore fulfilled.

For this subjected vessel, as the structures are transversely framed, there is no potential hot spot items requirement for this subjected vessel.

But we bring to your attention the following items that shall be considered during survey on this vessel:

- End connections of the intermediate side transverse stiffener

- End connections between the side transverse stiffener with deck stiffener and bottom floor

- Other elements could deserve a close up survey depending on the actual ship conditions (corrosion, damage, excessive deformations)

2. REFERENCES

/1/ RINA – Rules for the Classification of Ships – Part B “Hull and Stability”

/2/ RINA – Guide for the Ship Condition Assessment Programme (CAP)