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# Assessment of the Level of Uncertainty of the Ship's Hull Girder Shear Stresses

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ABSTRACT

The input data in hull girder shear strength calculation (shear forces, geometric and material properties) may have different levels of uncertainty. In most cases, the level of uncertainty of the shear stresses is unknown. It can be calculated if their probabilistic distribution is available. To derive this distribution, the composition of the distribution laws of the constituent variables is used. An example for the application of the method is given for a 25K DWT bulk carrier when all parameters are presented in a probabilistic format.

KEY WORDS: ship's hull girder shear strength; shear area

## INTRODUCTION

In traditional calculations of the hull girder shear strength, data for the shear forces, shear areas and mechanical properties of the material are used. All these parameters have, in general, different probabilistic distributions. So, when the numerical results for shear stresses are derived, a question may arise as to the *Level of Uncertainty* (L.O.U.) of the result. Calculation of this certainty/uncertainty can be performed when the probabilistic distribution of the result is determined. As to the hull girder shear stresses, to determine their probabilistic distributions, one should know the probabilistic distributions of the hull girder geometric properties (in this case – Shear Area) and the loads acting on it (still water, wave-induced and total shear forces).

## LEVEL OF CERTAINTY OF THE GEOMETRIC PROPERTIES

There are two major causes of the uncertainty in the hull girder geometric properties and its components – the manufacturing tolerances of steel plates and stiffeners and the corrosion wastage over time (the latter is the major contributor to this type of uncertainty).

### Plate Thickness

The initial plate thickness, $t_0$, is assumed to follow the Gaussian distribution (Vasilev and Gluskina, 1973) and the corrosion wastage, $\delta_T$ – Weibull distribution (Paik et al. , 1998, 2003). The corrosion wastage, $\delta_T$, is presented as (see Fig. 1):

$$\delta_T = T_e . C \tag{1}$$

where $T_e = T - T_t$ time after complete breakdown of coating, T = given time, $T_c$ = coating's life [years], $T_t$ = coating's life plus transition period (in the examples given here, $T_c$ = 3 years, $T_t$ = 5 years are assumed). They are treated as deterministic magnitudes but the methodology is a general one and can be applied when $T_c$ and $T_t$ are treated as random parameters once more reliable data is available.

The probabilistic distribution of the residual thickness, $t_T$, at any ship's age is calculated using the composition of the distribution laws of the constituent variables. Because the thickness cannot be negative, the integration starts from zero. Thus, the p.d.f. of $t_T$ is calculated by the formula (Livshits and Pugachev, 1963; Suhir, 1997):

$$f_{t_T}(t_T) = \int_0^\infty f_{\delta_T}(\delta_T) f_{t_0}(t_T + \delta_T) d(\delta_T) \tag{2}$$

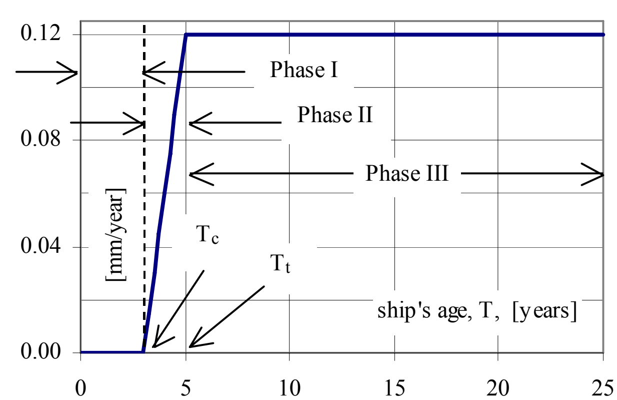


Fig. 1 Assumed phases for the corrosion rate, C

where $f_{t_T}(t_T)$ = p.d.f of $t_T$ , $f_{\delta_T}(\delta_T)$ = p.d.f of $\delta_T$,

$f_{t_0}(t_T + \delta_T)$ = p.d.f. of $t_0$ substituted by $t_T + \delta_T$

When Weibull distribution for the corrosion rate, C, is used, the p.d.f. of $\delta_T$ is calculated by the formula: