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THEORETICAL CONSIDERATIONS ABOUT THE INFLUENCE OF THE NAVAL BULB'S PLATE THICKNESS OVER THE EXTREME VALUES OF THE MAXIMUM EQUIVALENT STRESS WHICH OCCUR IN IT DURING THE HYDRODYNAMIC IMPACT

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Abstract: *During the navigation in rough sea, the bow of the ship gets off the water and at the entrance suffers a hydrodynamic impact. The structural response of the ship it's a very destructive one. That way, the designers has tried to reinforce the bow structure at the most load point. In this paper, the author makes a short theoretical analysis about the influence of the plate thickness over the extreme values of the equivalent stress.*
Keywords: *slamming, hydrodynamic impact, structural optimisation*

A very good estimation of the forces acting on the bulbous bow during the hydrodynamic impact can be made using the added mass coefficient obtained by Katzuji Tanizawa.

The situation is the following:
Am semieliptical body is following into a fluid like in figure 1

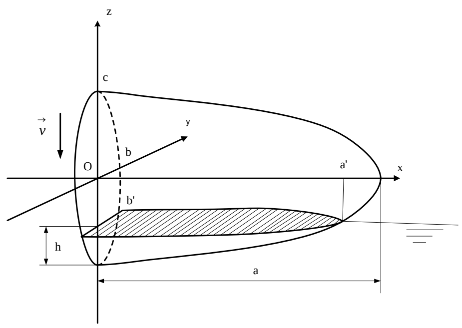

Figure 1. The semielliptical body diving into a fluid

The equation of the elliptical surface, defined by the intersection between the body and fluid (the hatched surface in the figure) is:

$$\left(\frac{x}{a}\right)^2+\left(\frac{y}{b}\right)^2+\left(\frac{z}{c}\right)^2=1 \qquad (1)$$

The origin of time, t=0 is the moment when the body touches the water.

At one moment, t, the depth is $h = v \cdot t$, where v is the initial speed of the body. At the time t, intersection between the body and the water surface is also semielliptical. The axes are:

$$a' = a\sqrt{\varsigma(t)},\ b' = b\sqrt{\varsigma(t)}\ , \qquad (2)$$

Where

$$\varsigma(t) = \frac{2v}{c}\cdot t - \left(\frac{v}{c}\right)^2 t^2 \qquad (3)$$

The added mass is:

$$m_a = \frac{1}{2}\rho\pi a' b'^2\ f_0(s) = \frac{1}{3}\rho\pi a b^2 \varsigma(t)^{3/2}\ f_0(s) \qquad (4)$$

ρ is the density and $f_0(s)$ is the added mass coefficient.

According to Taniyawa, $f_0(s)$ is:

$$f_0(s) = 1 - 0{,}094\cdot s - 0{,}9140\cdot s^2 + 0{,}9749\cdot s^3 - 0{,}3302\cdot s^4 \qquad (5)$$

The analyzed body have the length L=40cm, diameter D=20cm and different plate thickness.
Discrimination of the body is show in figure 2.

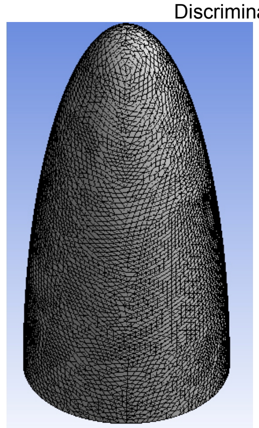

Figure 2 Discrimination of the semi elliptical body

The body has been considered to be rigid into his base and the force equally distributed over the whet surface. The surface is considered to be the wetted surface of the body when the force reaches its maximum. The variation of the added mass is shown in figure 3.

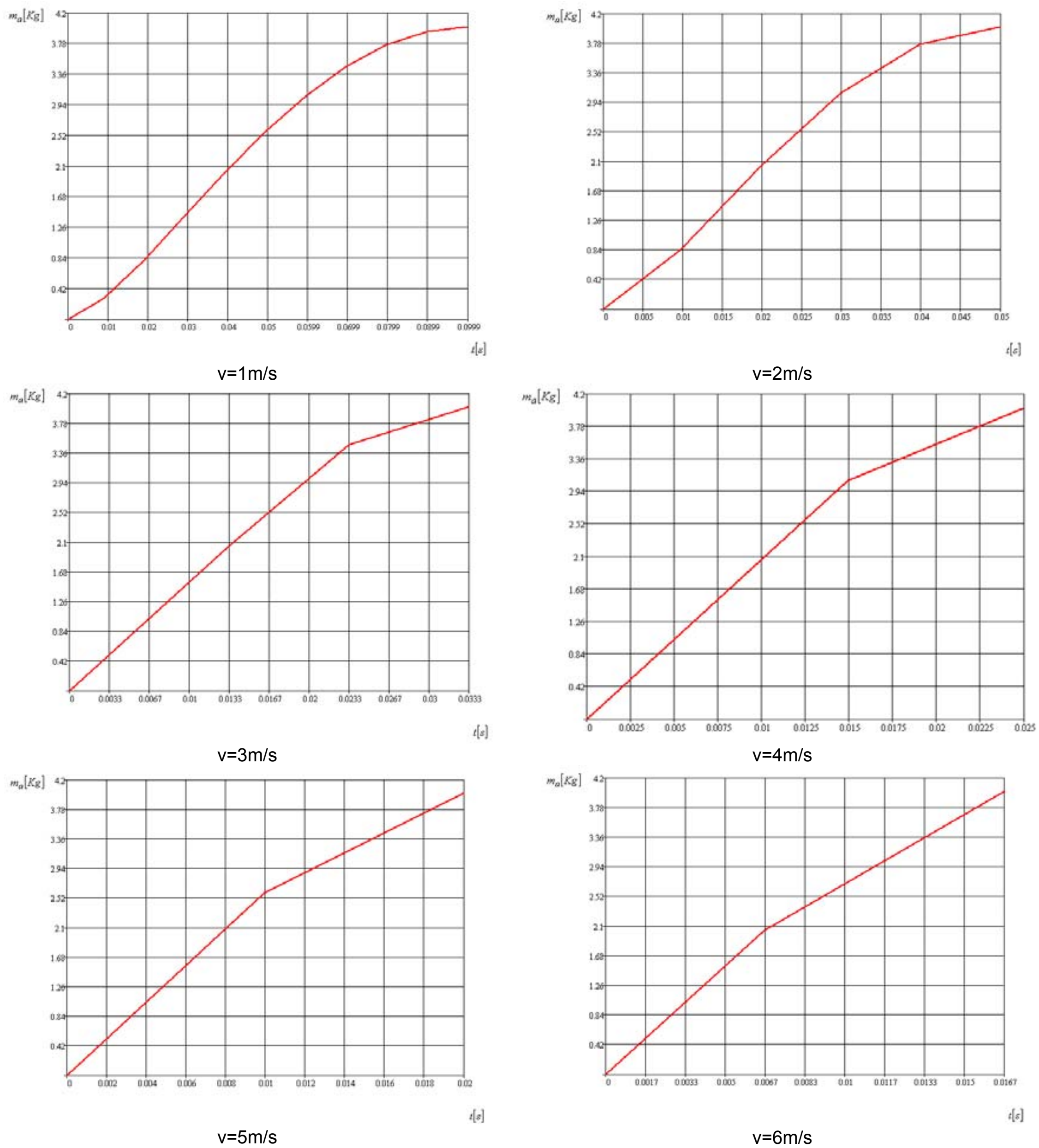

Figure 3 Variation of the added mass for different values of the initial impact speed

The variation of the maximum force is shown in figure 4

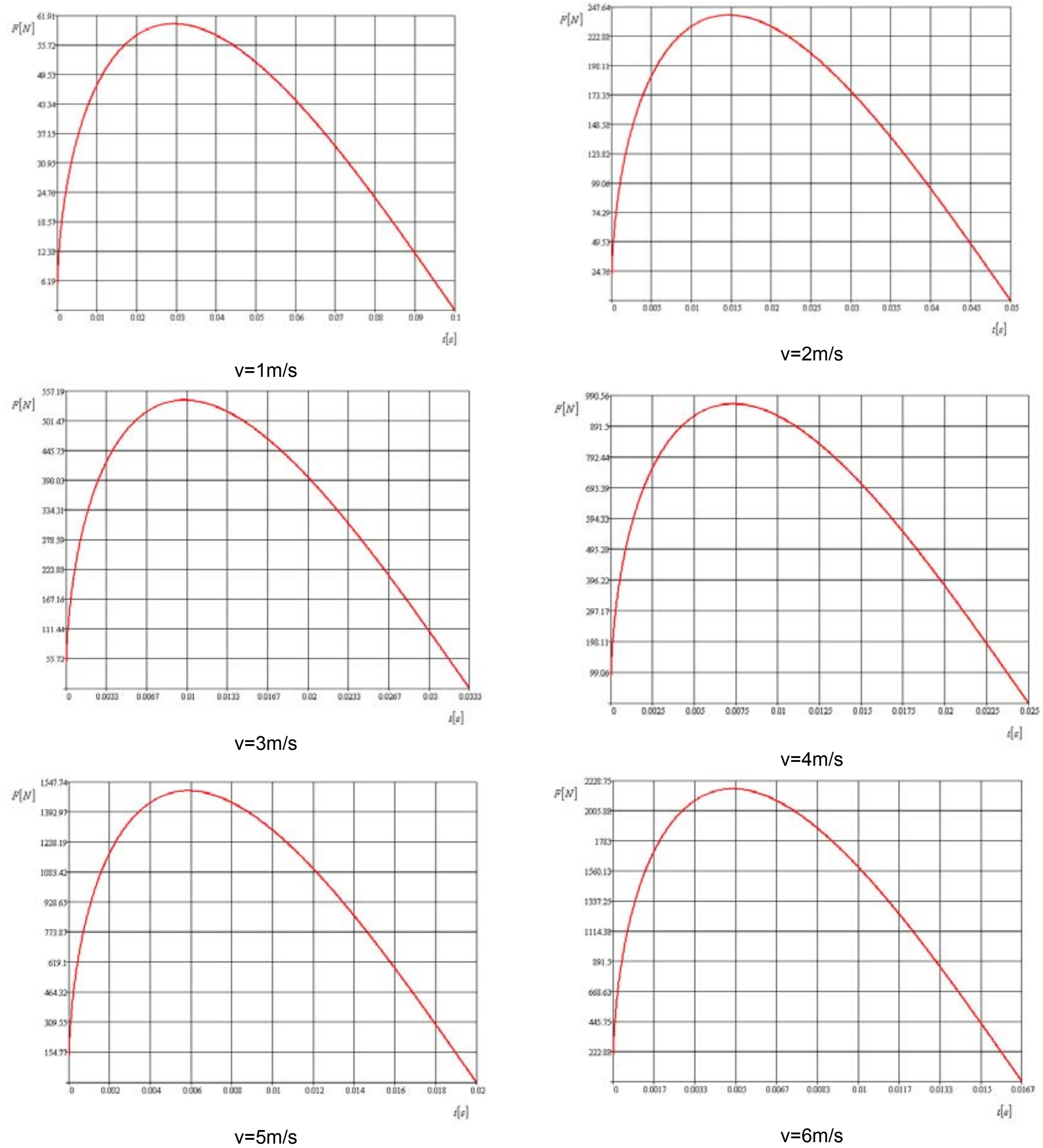

Figure 4 Variation of the maximum force for different values of the initial impact speed

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The variation of the extreme values of the equivalent stress for a plate thickness equal with 6mm is shown in figure 5.

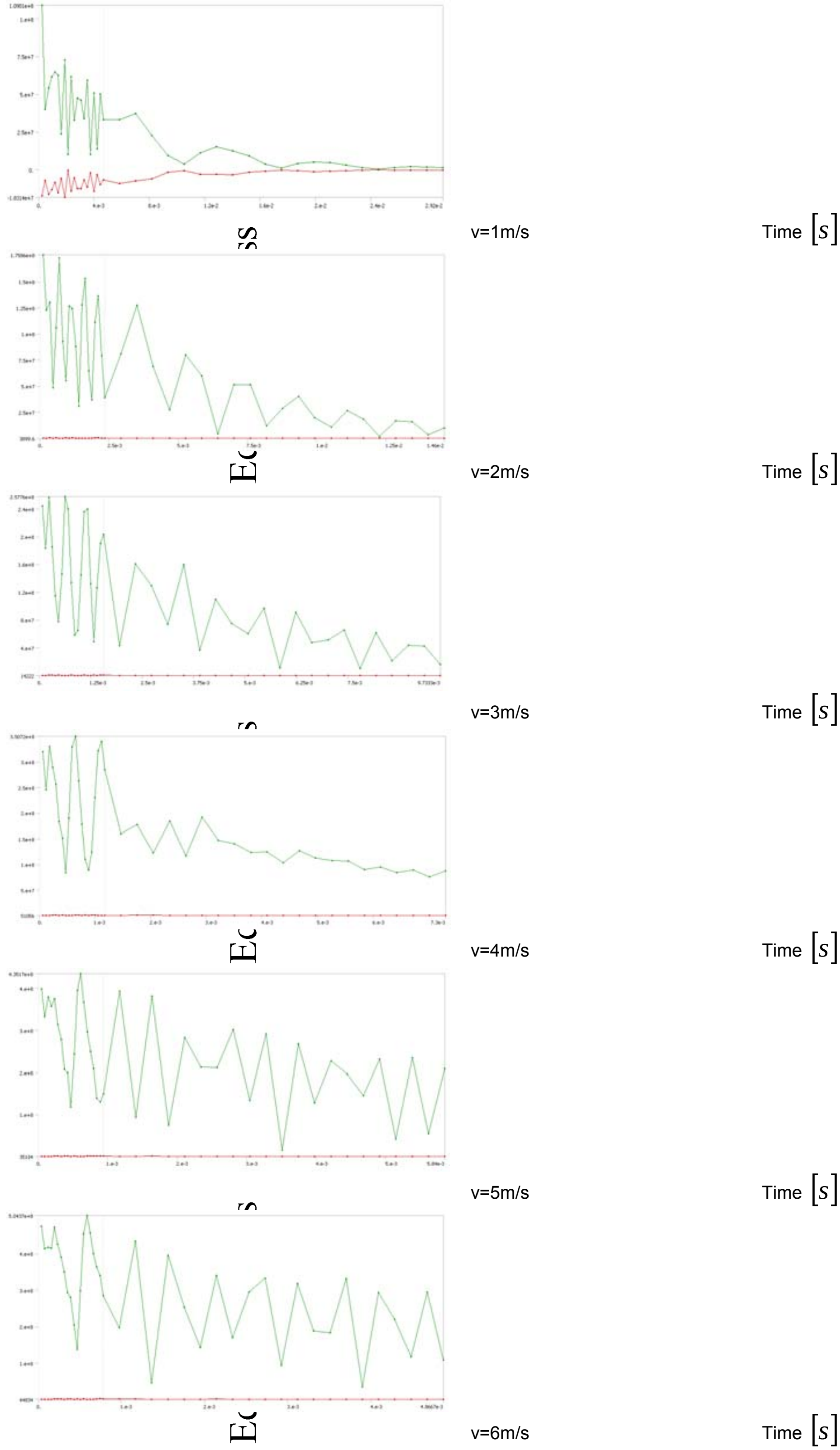

Figure 5 Variation of the equivalent stress for the plate thickness equal with 6mm, for different values of the impact speed

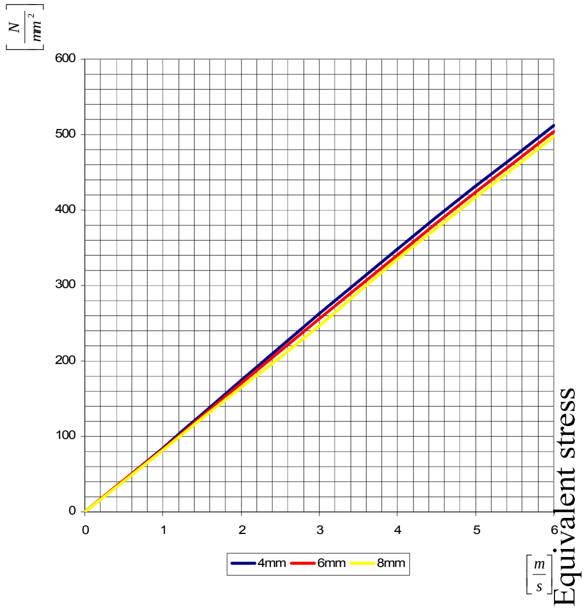

Figure 6 Variation of the extreme value of the equivalent stress for different plate thickness, and different impact speeds

CONCLUSIONS:

As it's shown in figure the values of the extreme equivalent stress are decreasing while the plate thickness is increasing (as it should be). Also, from the diagram in the figure 6, we can see the phenomena can be aproximated to be quasy liniar for this tipe of bulb (having the ratio L/D equal with 2).

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