Geophysical Research Abstracts
Vol. 12, EGU2010-2583, 2010
EGU General Assembly 2010

The interaction of extreme waves with hull elements

Shamil Galiev (1) and Richard Flay ()

(1) Department of Mechanical Engineering, The University of Auckland, Auckland, New Zealand (s.galiyev@auckland.ac.nz),
(2) Department of Mechanical Engineering,The University of Auckland, Auckland, New Zealand (r.flay@auckland.ac.nz)

The problem of the impact of a rogue wave onto a deformable marine structure is formulated in a few publications (see, for example, a short review in *http://researchspace.auckland.ac.nz/handle/2292/4474*). In this paper the results from numerical and experimental investigations of the effect of cavitation on the deformation of a hull element, loaded by a wall of water, generated by an extreme ocean surface wave are considered. The hull element is modelled as a circular metal plate with the edge of the plate rigidly clamped. The plate surface is much smaller than the surface of the wave front, so that at the initial moment of the interaction, the pressure is constant on the plate surface. At the next instant, because of the plate deformation, axisymmetric loading of the plate occurs. The influences of membrane forces and plastic deformations are ignored, and therefore, the equation of plate motion has the following classical form

$$Eh^3(w_{rrrr} + 2r^{-1}w_{rrrr} - r^{-2}w_{rr} + r^{-3}w_r) = -121 - \nu^2)[\rho h w_{tt} + \delta(r,t)(p + \rho_0 a_0 w_t)].$$

Here w is the plate displacement, subscripts t and $r$indicate derivatives with respect to time and the radial coordinate,

is the plate material density, $h$is the plate thickness, $E$is Young's modulus,

is Poisson's ratio and p is the pressure of the incident surface wave measured on the wall,

is the water density,

is the speed of sound in water, and

is the normal velocity of the plate. The term

takes into account the effect of the deformability of the plate. Obviously, the hull of a vessel is not rigid like a solid wall, but starts to deform and to move. This motion produces a reflected pressure wave, which travels from the hull into the water wave with a magnitude equal to

. The normal velocity is positive so the reflected pressure

is negative (tensile wave). If the fluid pressure drops below some critical value $p_{k,}$ the wet plate surface separates from the water, and cavitation may be generated. The function $\delta(r,t)$ takes into account the effect of the hull cavitation. The function

or 0, and is determined during the numerical calculations. Case

is valid for the case with *no* cavitation, and the case $\delta(r,t) = 0$ corresponds to the case with *hull* cavitation.

The results from these calculations allow us to draw the following conclusions.

1) The pressures generated depend greatly on the irregularity of waves. In particular, the shock pressures are affected by this irregularity, making the prediction of their magnitude almost impossible.

2) In the majority of cases, the elastic deformation of thin hull elements by a short duration water wave pressure pulse is accompanied by hull cavitation. The effect of cavitation may be important, provided that the time of loading by the water wall pressure is less than the period of the fundamental frequency of the hull element oscillations.

3) The cavitation zones can enclose practically the whole wet surface and thus completely change the water loading onto the hull element, compared to the pressures that would be developed in the absence of cavitation.

4) The hull element deformation generates surface pressure and cavitation waves.

5) Cavitation interaction of extreme water waves with structures, and hull response, are complex topics, which are not well understood and are expected to be important in the design of advanced ships in the future.

6) The existence of rogue waves makes it important to re-examine some of the ideas developed earlier which are fundamental to merchant ship design.