ABSTRACT

Different numerical methods exist to treat the non-linear wave body interaction problem. These methods go from very complex CFD simulations (VoF, SPH…) to simpler potential flow based methods. Within the potential flow methods, different types of numerical approaches also exist, going from very complex fully nonlinear time domain methods to simpler hybrid frequency-time domain methods. In this paper, only the hybrid frequency-time domain potential flow methods are of concern.

The basic principle of these methods is to use the linear frequency domain data and transfer them to the time domain (Cummings-1962, Ogilvie-1964) using the inverse Fourier transforms. Once in the time domain, all kinds of nonlinearities can be added on top of the linear solution. This method showed to be very computationally efficient for global behavior of the floating bodies. However, in the context of the body structural response, it is not trivial to make the load transfer from the 3D hydrodynamic panel model to 3DFE model of the structure. One of the main problems concerns the radiation part of the potential which comes into the play through the well-known convolution integral of the impulse response functions. Within the hydro-structure interaction problem which is of concern here, the straightforward application of the Cummings principles leads to the convolution integral for every pressure point (either on hydrodynamic or structural mesh) which can lead to very expensive numerical simulations.

Previous study by Tuitman, Sireta, Malenica and Bosman (2009) proposed the use of the fast Fourier transform (FFT) to compute the radiated wave loads at each point of the structural model, as a post-processing of the seakeeping calculations.

In this way the CPU time is significantly reduced but the slight unbalancing of the 3DFE model remains. In this paper, we propose the direct use of the local radiated pressure impulse response functions and we show that a good numerical implementation of such method can result in acceptable CPU time with perfect balance of the 3DFE model.

INTRODUCTION

Different numerical methods exist to treat the non-linear wave body interaction problem. These methods go from very complex CFD simulations (VoF, SPH…) to simpler potential flow based methods. Within the potential flow methods, different types of numerical approaches also exist, going from very complex fully nonlinear time domain methods to simpler hybrid frequency-time domain methods. In this paper, only the hybrid frequency-time domain potential flow methods are of concern.

The basic principle of these methods is to use the linear frequency domain data and transfer them to the time domain (Cummings-1962, Ogilvie-1964) using the inverse Fourier transforms. Once in the time domain, all kinds of nonlinearities can be added on top of the linear solution. This method showed to be very computationally efficient for global behavior of the floating bodies, as shown by previous study by Derbanne, Malenica, Tuitman, Bigot and Chen (2010).

However, in the context of the body structural response, it is not trivial to make the load transfer from the 3D hydrodynamic panel model to 3DFE model of the structure. One of the main problems concerns the radiation part of the potential which comes into the play through the well-known convolution integral of the impulse response functions. Within the hydro-structure interaction problem which is of concern here, the straightforward application of the Cummings principles leads to the convolution integral for every pressure point (either on hydrodynamic or structural mesh) which can lead to very expensive numerical simulations. Previous study by Tuitman, Sireta, Malenica and Bosman (2009) proposed the use of the fast Fourier transform (FFT) to compute the radiated wave loads at each point of the structural model, as a post-