Roll damping decay of a FPSO with bilge keel

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A B S T R A C T
The roll damping decay is investigated for a Floating Production Storage and Offloading (FPSO). For this purpose, a roll decay test of a middle section of FPSO with bilge keel is simulated by means of the numerical solution of the incompressible two-dimensional Navier–Stokes equations. The governing equations are solved using the finite volume method and the upwind Total Variation Diminishing (TVD) scheme of Roe–Sweby. The upwind TVD scheme resolves and captures the physics of the fluid dynamics without spurious oscillations in regions of the flow field with strong pressure gradients. The numerical results are compared with experimental data for validating the numerical scheme implemented. The simulations indicated the strong influence of the bilge radius in the damping coefficient of the FPSO section. Interesting results were obtained regarding the time series of the displacement of the body and vortex shedding around the bilge keel.

1. Introduction

The use of ships converted into FPSO (Floating Production Storage and Offloading) has been widely applied in the field of oil exploration by the advantages it offers, among them, the large load capacity and the reduction of cost and modification time of an existing structure. However, a disadvantage from the start of its application was the poor roll stability.

Wave radiation and viscous effects govern the roll damping of a FPSO. However, Downie et al. (1988) found that the viscous effects are stronger for rectangular hulls due to the generation of large vortices emitted from the sharp edges of the hull surface. The mechanism is non-linear and the intensity of the vortices depends on the amplitude of the roll motion.

It is well known that potential theory reproduces all degrees of freedom of the ship, except the behavior in roll motion because it does not take into account viscous effects on the roll damping, where they are predominant. For example, the study of elongated bilge keels to increase the roll stability proposed by Souza and Fernandes et al. (1998), undertaken by Pinheiro (2003), Fernandes and Oliveira (2009), Oliveira and Fernandes (2011), Oliveira (2011), Oliveira and Fernandes (2012) and Oliveira and Fernandes (2013).

The numerical simulation is another way to study the behavior of ship rolling. The Free-Surface Random-Vortex Method (FSRVM), nonlinear formulation by Yeung (2002) confirmed by computations

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