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Wave Impact on a Vertical Baffle

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Abstract

A fluid-structure interaction phenomenon is an important consideration in several engineering fields. When a tank truck is braking, turning or in collision, the liquid in the partially-filled tank will slosh or even splash due to the oscillating of the unrestrained free surface of the liquid. The study of the pressure impulse on the baffles and walls can provide data on the impacts acting on the tank and baffles which can be used for simulating handling stability, especially for planes, rockets and spacecraft. We consider the wave impact against a vertical baffle in four cases: (i) A vertical baffle at free surface; (ii) A vertical baffle in front of a wall; (iii) A vertical baffle at a deck in front of a seawall; (iv) A vertical baffle on the seabed in front of a wall. The mathematical formulation and the boundary conditions for four cases of baffles which have different positions are presented using the pressure impulse theory. We used a basis function method to solve the mathematical formulation, and total impulse and moment impulse are investigated for each problem. The influence of the depth of baffle penetration and the size of the impact region is also studied. We can see different of impact pressure impulse for different case of baffle. We note that pressure impulse on the baffles almost same for case (i),(ii) and (iii) for different length of baffles with same size of impact. However the pressure impulse behind the baffles decreases when the length of baffle increases for case (ii) and (iii). For case (iv), the pressure impulse on the wall and behind the baffles increases when the length of baffle on the seabed increases.

Mathematical Formulation

We consider a rectangular model with wave impact with a fraction □ of the baffle. Note that we have baffle with H_b, the depth of penetration. On the right hand side of the baffle for all four cases we have the free surface, y □0. The pressure impulse P (see equation (1)) satisfies Laplace's equation throughout the fluid and is zero on the free surface. Since the wave comes from the right, the normal derivative of P at the back of the baffle is zero.

$$P(x,y) = \int_{t_b}^{t_a} p(x,y,t)\,dt \qquad (1)$$

Results and Discussion

From Figure 1, we can see that pressure impulse on the baffles is almost same for cases (i), (ii) and (iii) for different length of baffles with same size of impact. However the pressure impulse behind the baffles decreases when the length of baffle increases for case (ii) and (iii). For case (iv), the pressure impulse on the wall and behind the baffles increases when the length of baffle on the seabed increases. The total impulse in front of baffles is greater than those on the back of baffle for case (i) and (ii). In contrast, for problem (iii) the total impulse behind the baffle is greater than the total impulse in front of the baffle. The total impulse on the seabed for problem (iii) is high compared to the other cases. Case (iv) has the highest total impulse on the wall. The total impulse on the wall for case (iii) is higher than case (ii) and in the seaward direction. This is somewhat counter-intuitive result arises from high pressure impulses behind the baffle being trapped beneath a rigid free surface.