NUMERICAL STUDY OF WATER SLOSHING IN PERFORMANCE OF FULL AND SEMI-FULL RESERVOIRS IN EARTHQUAKE CONDITION

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Water reservoirs are the important structures which shall be operated in catastrophes such as earthquake. Since the main section of mass of such structures is located at a considerable distance to foundation, their function under influence of lateral forces for further efficiency during earthquake shall be analysed. During earthquake, water in reservoir sways and imposes considerable hydrodynamic forces to the lateral walls which will destruct the reservoir walls. Moreover, some researches have been performed on dynamic analysis of fluids in reservoir. This problem was first solved by Westergard (1933) by ignoring the effects of water compression and effect of surface waves. Then, Housner (1957) presented a simple dynamic analysis based on the range of reply for air reserves by using mass- spring model. In the next research, Chalhoub (1987) suggested fluids equations for measuring hydrodynamic pressures and fluctuation of water surface for cylindrical reserve.

In this research, three prevalent shapes of reservoirs was simulated by using Flow 3D software which that using VOF[1] and FAVOR[2] techniques in order to simulate water surface and solid surfaces. The purpose of simulating numerical model was to compare η (sloshing wave height) and ξ (damping) in these shapes to suggest advantages and disadvantages of each shape. Also the effect of hydrodynamic pressure thereon was analysed. For validation, the numerical model was first simulate the experimental data from Goudarzi & Sabbagh Yazdi (2012) investigation. The shape of the reservoir in this investigation was rectangular which having dimensions of 1m×0.96m×0.4m (height×length×width) with 0.624 m water depth. The surge motion is given as Eqs. (1).

$$X_{(t)} = D\sin(\omega t) \qquad (1)$$

Where D is maximum horizontal amplitude which was considered to 0.005 mm and ω is horizontal forced frequency which was considered 5.615 rad/sec. Changes in the height of sloshing waves in distance of 25 mm from the edge of the wall of reservoir was plotted in figure 1. The result of this simulation was compared with five different mesh size. This comparison was shown maximum 3% error between height of sloshing in numerical results with 8mm mesh size and experimental results. Therefore the mesh size was chosen 8 mm.

1 Volume Of Fluid
2 Fractional Area-Volume Obstacle Representation

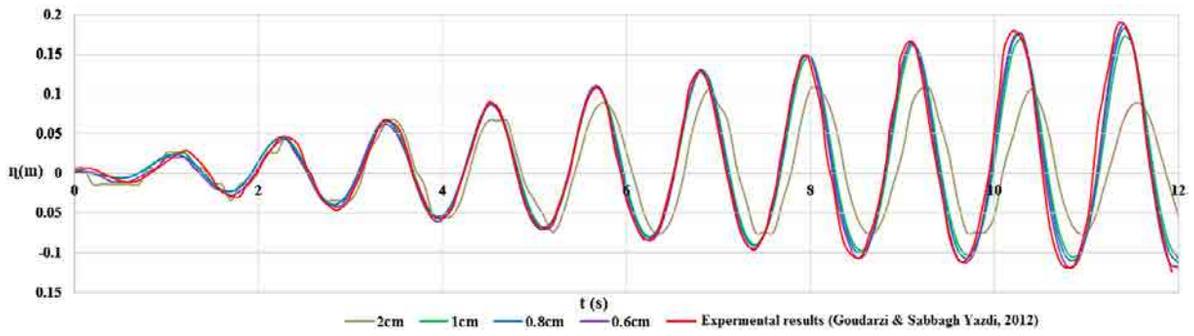

Figure 1. Validation of numerical model and mesh analyze

After validation three reservoirs shapes were simulated in the software in order to compare and evaluation. This three shapes are shown in table 1.

Table 1. Geometrical specifications of considered shapes

Shape 3(cylindrical)	Shape 2(sphere)	Shape 1(cubic)	Shape number
			3D view
1	1	1	Volume (m3)
1.09	1.24	1	Height (m)
1.08	1.24	1.41	Diameter (m)

Finally the effect of hydrodynamic pressure of earthquake on reservoirs was analysed. The surge motion is given as Eqs. (1) where magnitude was considered to 0.05 and frequency was considered to 4 rad/sec in all simulations. Figure 2 is shown the comparison of the results after 3.5 seconds.

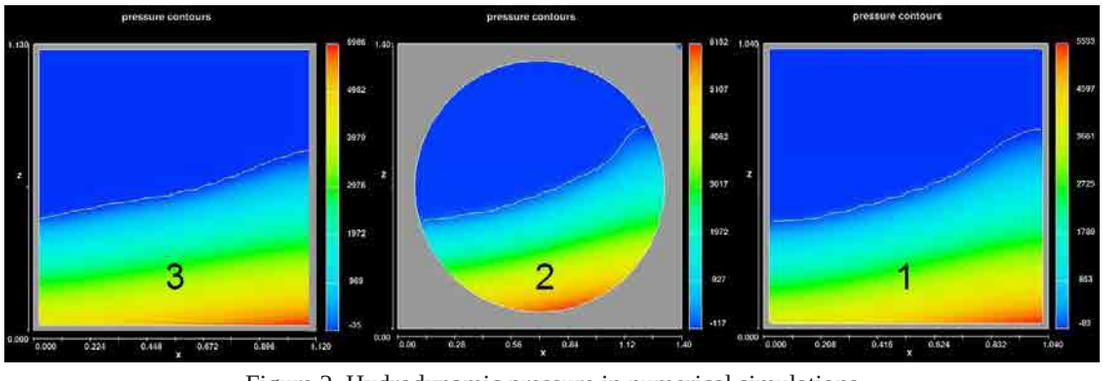

Figure 2. Hydrodynamic pressure in numerical simulations

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