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Hydro-elastic Oscillations of the Bottom Membrane of a Rectangular Container Filled with Fluid

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The analysis of the hydro-elastic interactions of liquid-filled cavities or containers covered by an elastic membrane is important due to the solution of practical problems found in engineering applications. In this paper the dynamic behaviour of the bottom membrane of a rectangular container filled with a non-viscous and incompressible fluid is analyzed. The fluid velocity potential is obtained by applying a method of separation of variables and considering the momentum's linearized equation, the pressure field is obtained. Taking into account the deformation equation for the membrane in contact with fluid with the associated generalized work equation, and after a discretization process, a system for the calculation of the membrane frequencies of vibration is obtained. The influence of different geometrical parameters such as dimension, aspect ratio, container relative height, relative thickness as well as the fluid density on these frequencies is analysed. Validation of the method is made comparing the results with those obtained by other authors and theories.

[1] C.H.M. Jenkins and U.A Korde, Journal of Sound and Vibration, 295, 602 (2006).
[2] D.J. Laser and J.G. Santiago, Journal of Micromechanics and Microengineering, 14(6), 35 (2004).
[3] L.S. Pan, T.Y. Ng, K.H. Wu et al, Journal of Micromechanics and Microengineering, 13, 390 (2003).
[4] R. Shabani, F.G. Golzar, S. Tariverdilo, H. Taraghi, et al, International Journal of Engineering, 27, 643 (2013).
[5] X. Jin, I. Ladabaum et al, IEEE ASME Journal of Microelectromechanical Systems, 8 (1), 100 (1999).
[6] E. Defay, C. Millon, C. Malhaire et al, Sensors and Actuators, A 99, 64 (2002).
[7] Y.K. Cheung and D. Zhou, Journal of Fluids and Structures, 14, 339 (2000).
[8] F. Daneshmand and E. Ghavanloo, Journal of Fluids and Structures, 26, 236 (2010).
[9] H.F. Bauer, 1981, International Journal of Solid structures, 17, 639 (1981).
[10] H.F. Bauer, Journal of Sound and Vibration, 180, 689 (1995).
[11] M. Chiba, H. Watanabeand H.F Bauer, Journal of Sound and Vibration, 251, 717 (2002).
[12] S. Tariverdilo,M. Shahmardani, J. Mirzapour and R. Shabani, Applied Mathematical Modelling, 37, 228 (2013).
[13] S. Tariverdilo, J. Mirzapour, M. Shahmardani and G. Rezazadeh, Applied Mathematis and Mechanics, 33, 1167 (2012).
[14] C.Y. Wang and C.M. Wang, in Structural vibration: exact solutions for strings, membranes, beams and plates, (CRC Press, Boca Raton FL., 2014).
[15] B.R. Munson, et al, in Fundamentals of fluid mechanics (John Wiley & Sons, Hoboken, NJ., 2013).
[16] M.K. Kwak, Journal of Applied mechanics, 63, 110 (1996).
[17] M. Gascón-Pérez, International Journal of Applied Mechanics, 9 (5), (2017).
[18] M. Gascón-Pérez, International Journal of Applied Mechanics, 10 (2), (2018).