Vibration Analysis of Rectangular Perforated Plates By COMSOL Multiphysics® Software

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Abstract

Vibration analysis of perforated plates is extremely important when designing structures where resonance is the possible mode of failure. This paper deals with the vibration analysis of rectangular perforated plates with three different types of perforations. Vibration analysis is to be carried out by both COMSOL Multiphysics and Experimental set-up. The applications of perforated plates range from light weight decorative items to structural components. These perforated plates are extensively used for Acoustic performance (Noise Control), Sunscreens, Heat Exchangers, Pressure vessels, Interior Design (Transparency), Radiation containment, HVAC, Ceilings, Furnishings, Screening and Fencing.

Many studies have been performed on rectangular and triangular array of holes on perforated plates, mainly [1] dealing with equivalent properties of material for perforated plate. By making use of these equivalent material properties, perforated plate is considered as a full solid plate. Shun Choi et al. [2] performed finite element modal analysis for the perforated pates having square and triangular hole patterns. Mali and Singru [3] formulated an analytical model to determine the fundamental frequency of free vibration of perforated plate by using unit step functions to express non-homogeneity in Density and Young's modulus. Boay [4] analyzed free vibration analysis by carrying a concentrated mass for rectangular isotropic plates. Comparison of COMSOL values [5] with Experimental and Analytical values for first few modes of rectangular perforated plates with circular perforations was carried out as shown in figures 1 &2. From the literature on vibration of perforated plates with different perforation patterns, various authors have discussed about perforated plates having square and rectangular perforated patterns, but the comparison between the vibration characteristics of practically used perforated plates with different types of perforations is not discussed in detail. This paper aims at finding the vibration of characteristics of perforated plates which are actually used in practice and compare the frequency response between these perforated plates. The vibration analysis of these perforated plates is being carried out by both COMSOL Multiphysics® and Experimental Analysis. Modal analysis was carried out on perforated plates by using COMSOL Multiphysics®. The boundary condition for the plate is clamped on all the four edges. The Experimental test setup consists of Accelerometer, FFT Analyzer, Shaper/Mill bed and an Impulse hammer. The frequency response function can be obtained from FFT Analyzer and mode shapes are drawn from the peak values of these readings. Experimental results have to be compared with the simulation results for all the three types of perforated plates.

Figures used in the abstract

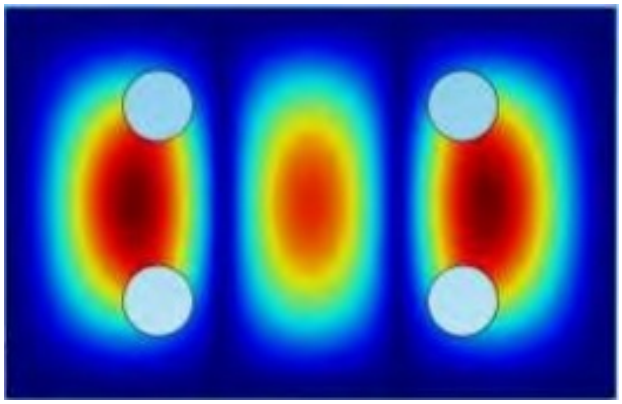

Figure 1: Fig 1.Mode Shape corresponding to 1574.6 Hertz.

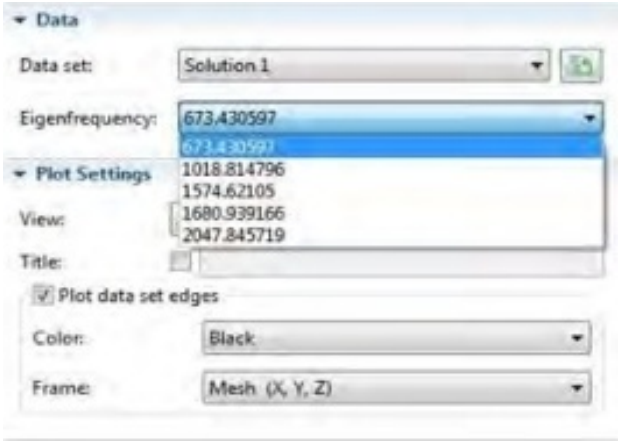

Figure 2: Fig 2.Values of first five Natural Frequencies.