Modal Analysis of a Steel Sandwich Plate System (SPS) Floor

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Abstract

The application of Steel Sandwich panels as a floor increasing in various industries. Steel Sandwich plate system (SPS) floors are using in buses, industrial Platforms and elevator floors etc. In this work Modal analysis of corrugated steel sandwich plate with all Edges clamped are carried out in ANSYS Workbench. The SPS floor Natural frequencies are compared with traditional steel plate of with same weight, same area with same boundary conditions

1. Introduction

A **sandwich structure** is a fabricated material that consists of two thin, stiff **facing sheets** joined to either side of a low density **core material or structure**. The separation of the facings by a lightweight core acts to significantly increase the second moment of area (and hence the bending stiffness) of the material cross-section with only a small increase in weight. This construction is often used in lightweight applications such as aircrafts, marine applications, wind turbine blades, industrial platforms and floors. The face sheets of sandwich panels provide structural stiffness and protect the core against damage and weathering. During loading, the face sheets take compressive and tensile loads and core is subjected to shear loads between the faces, thus providing high bending stiffness. Sandwich structures are used in applications requiring high stiffness to weight ratios, since for a given weight, the sandwich structures has a much higher moment of inertia compared to solid or I-beam structures.

1.1Classification of Sandwich Structures

A wide range of materials can be used for sandwich facings and cores. Common facing materials include metals (e.g. Steel or Aluminium) and composites. Common core materials or structures include metallic stiffeners, foams (polymeror metallic), honeycombs and balsa wood. The core-to-facing joint is normally achieved through adhesive bonding or welding. 1

1.2 All-Metal Sandwich Structures

All-metal, hybrid metal, and composite sandwich structures are most commonly used for industrial applications. This section details all-metal sandwich structures. An **all-metal** sandwich structure is defined as one in which both the facings and the core are formed from metallic materials. In the marine industry, this normally means steel or aluminum. Aside from the constituent materials, all-metal sandwich structures can be further classified by the geometry of the core. Some typical examples are shown in the table 1.2.The table 1.3 highlights the main differences in various types of all-metal sandwich structures.

1.3Steel Sandwich panels

Metallic Sandwich panels with top and bottom plates as well as the core made up of steel are called steel sandwich panels. The core structures are of different types according to core structures the steel sandwich structures are divided some of them are I-

core, O- core with rectangular beams, Vf/V- core with hat or corrugated sheets as a core, web core, round O-core and X-core with two hats as a core

2. Modal Analysis

Modal Analysis of a Steel Sandwich Plate System A 3D model of sandwich floor is generated using Pro-E by assembling 4 sandwich panels as shown in figure. The specifications of the sandwich panel are Face sheets and Core Material - Stainless steel 304 Thickness of the face sheets – 18 gauge,Core shape – V,Core Height - 20 mm,Panel shape – Rectangular - 250 mm × 500 mm. The floor assembly is modeled in Pro-E and the model in igs format is imported to ANSYS Workbench as shown in figure 1. The solid element is considered for meshing as shown in figure2

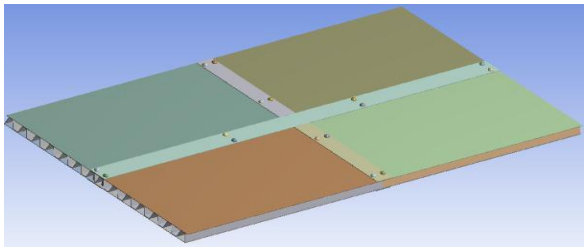


Figure1 : Floor designed using optimized sandwich panels

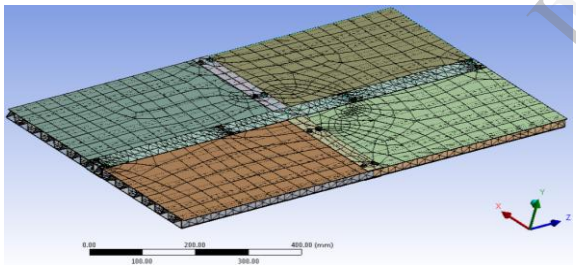
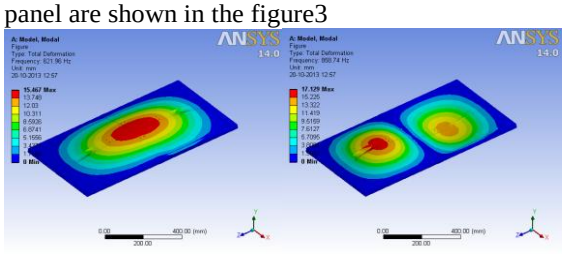


Figure 2: Floor designed using optimized sandwich panels

All the edges of the SPS plate is clamped and modal analysis is perfomed. Six mode shapes of sandwich panel are shown in the figure3



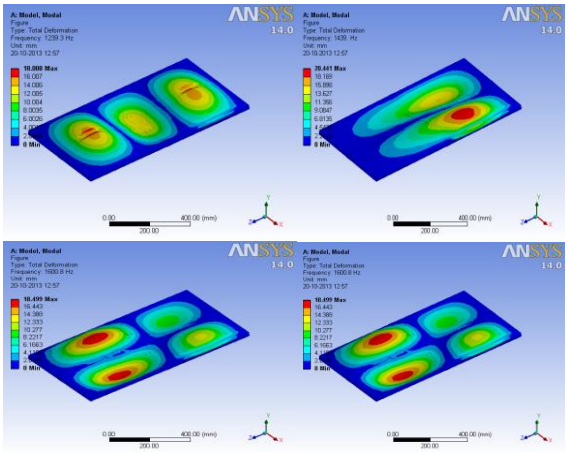


Figure 3: Six mode shapes of SPS floor

2.1.Modal Analysis of a Steel Sandwich Plate System

A 3D model of a rectangular SS plate with surface area dimensions as that of sandwich floor but with thickness chosen such that the weight of the plate is equal to that of the sandwich floor is created in Pro/E. This plate model is then imported into Ansys. FEA is then performed on this model to study its behavior under the same boundary conditions as that of the SPS floor. A traditional steel plate of same weight and area, with is considered for the analysis.

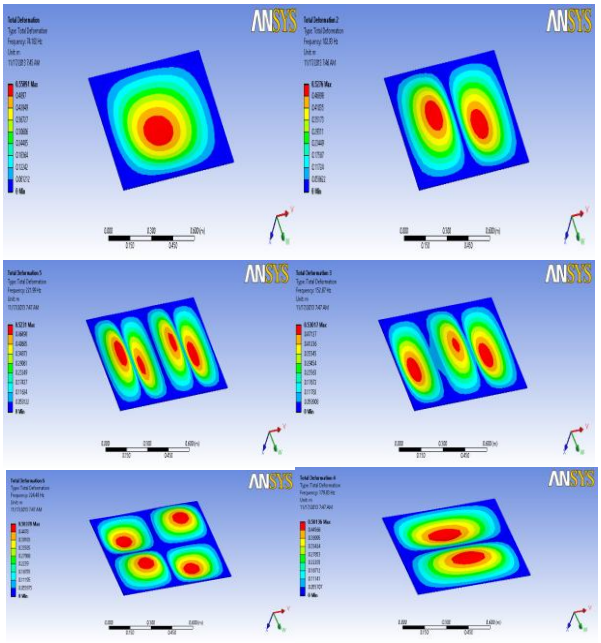


Fig4: Six mode shapes of steel plate floor

5. Comparison of Natural Frequencies of SPS floor and Plate Floor

Modal Analysis is performed to study the natural frequencies of both plate floor and SPS floor. Comparison of natural frequencies of SPS floor and Plate floor is given in figure 3. Figure 4 shows mode shape for SPS floor with their corresponding natural frequencies. From figure 5, it can be seen that the natural frequencies of the SPS floor are more than plate floor which is a desirable design characteristic.

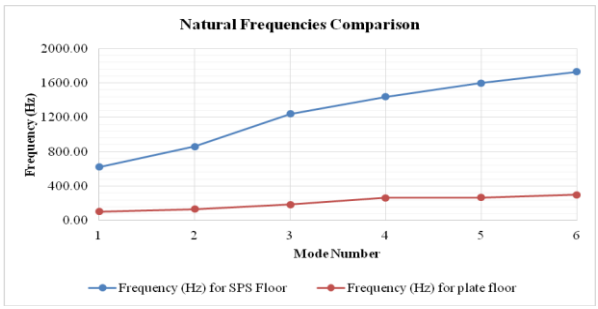


Figure 5: Comparison of natural frequencies of SPS floor and Plate floor**.**

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6. Conclusion: Modal analysis is performed to calculate its natural frequencies on SPS floor These are compared with that of a simple plate with same length, width and weight. Simulation results showed that the SPS floor had higher natural frequencies with its first natural frequency to be around 6 times more than that of simple plate floor.

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