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A warpage of printed circuit board (PCB) induced by reflow process became the one of the major concerns in the production of multilayer PCB. It is because the warpage can cause serious reliability problems in solder ball interconnection between the semiconductor chips and PCB layers. Moreover, the number of layers in one PCB is increased dramatically over the years for the high integration. Therefore, it is essential to predict the warpage of multi-layerd PCB to increase the reflow process reliability. However, it has been impossible to conduct the warpage analysis of PCB by using a convention full modeling in finite element analysis considering each of the patterns and their thermo-visco-elasticity due to long computing time and its complexity.
In this work, an equivalent visco-elastic modeling technique of several PCB patterns (line, square, and grid) was proposed to simplify a finite element model of the PCB for the cost-effective simulation based on the classical laminate plate theory. Also, an experimental verification was conducted using a beam-transfer vibration test. From the study, the visco-elastic properties of each PCB patterns with respect to time and temperature were measured compared to the equivalent model proposed in this work. As a result, good agreement between equivalent model and experimental results could be successfully achieved. The proposed visco-elastic properties modeling technique were successfully used in the finite element analysis for the warpage prediction of the multi-layerd PCB sturucture.

8085 | Failure mechanisms of sandwich beams with stainless steel mesh faces and aluminum foam core under static and dynamic loading conditions (2. Analysis of composite beams, plates and shells)

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The foamed aluminum panels and sandwiches manufactured using powder metallurgical technique represent new class of structural materials possessing enormous application potential in lightweight constructions, mainly as an alternative to wood, plastics or various expensive sandwiches. This paper investigates the collapse mechanisms of composite sandwich beams under static and dynamic loading conditions. Closed-cell aluminum foam AlSi10 with 400±10 kg/m^3 density was used as core material, while stainless steel mesh is the faces materials. In order to characterize these composite materials first were carried out a complete static and dynamic tests for both faces and sandwich core as follows: tensile and three point bending tests on steel mesh for two different directions; compression and three point bending tests on foam material respectively.
The compression tests of the sandwich core were carried out on cubic specimens (16.5 mm x 16.5 mm x 16.5 mm) without skin, while three point bending tests were carried out on rectangular bar samples with dimensions: thickness = 17 mm, width = 17 mm, span length = 75 mm. The tensile and bending tests of sandwich faces were tested in both cases: without metallic foam inside of the stainless steel mesh (before to be bonded to the foam structure) and with metallic foam inside of the stainless steel mesh (after the faces were bonded to the core structure), on rectangular specimens with dimensions: thickness = 2 mm, width = 15 mm, span length = 120 mm.
Static and dynamic three point bending tests were performed on sandwich beams using a Phantom v12.1 High Speed Camera and a Digital Image Correlation system ARAMIS for strain distribution. All experimental tests were performed at room temperature (23°C) with constant crosshead speed of 0.33*10^-4 m/s for static tests and 2 m/s for dynamic tests. All tested specimens were cut from the same plate.

Key words: composite sandwich beams, static and dynamic tests, surface strain mapping, closed-cell aluminum foam, steel mesh faces.

8095 | Local web-buckling of shear-deformable laminated composite beams under shear and uniaxial compressive loads using discrete plate analysis (2. Analysis of composite beams, plates and shells)

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Local web-buckling of shear-deformable laminated composite beams under shear and uniaxial compressive loads using discrete plate analysis

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This paper discusses a novel closed-form analytical approach for the local flange buckling analysis of thick-walled beams with close-profile cross-sections under shear and compression loads. The web and the flanges of the beams are assumed with symmetric stacking sequences. Based on a discrete plate analysis approach the flange under consideration is idealized as a plate that has two rotationally restrained edges wherein the rotational restraints depend on the properties of the web of the beam. For the restraint stiffness that is taken to represent the remainder of the beam’s cross-section, straightforward closed-form approximate solutions can be postulated. The buckling analysis as well as the calculation of the restraint stiffness is based on first-order shear deformation theory in order to account for transverse shear effects as they become relevant in moderately thick composite laminates. In order to derive a closed-form solution for the critical buckling load, adequate sets of shape functions are postulated for the buckling deflections as well as for the rotations of the laminate cross-section in the buckled state. The buckling condition is then derived from the principle of minimum elastic potential of the laminated plate in the buckled state. It will be shown that the employed shape functions allow for a very reliable determination of the local buckling modes of the flanges of composite beams and the corresponding critical buckling loads in a fully closed-form analytical approximate manner.

8171 | FE analysis of CFRP-strengthened timber finger-joint (2. Analysis of composite beams, plates and shells)

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The aim of this work was to study the mechanical behavior of timber beams externally reinforced using CFRP under bending test. Experimental and