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Optimum first failure load design of one/two-core sandwich plates under blast loads, and their ultimate loads

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Abstract: For sandwich plates with facesheets made of unidirectional fiber-reinforced composite having either glass, or carbon or aramid fibers and balsa wood core loaded by a blast pressure, we find optimal geometries and materials for maximizing the first failure load. We assume that the areal density is fixed and use the Nest-Site Selection optimization algorithm, a third-order shear and normal deformable plate theory, a one-step stress recovery scheme, and the Tsai-Wu failure criterion. We also delineate the effect on the first failure load of inertia forces and uncertainties in values of various parameters, and find the ultimate load by progressively degrading elasticities of failed elements. We find that the optimal single-core sandwich designs are symmetric about the mid-surface with thick facesheets and the optimal two-core sandwich designs have a thin middle facesheet, and thick top and bottom facesheets. The first failure load of the optimal clamped single-core (two-core) design is approximately 20% (30%) more than that of the corresponding simply-supported plate. We find that the first failure occurs in a facesheet (core) due to the in-plane transverse axial stress (transverse shear stress) exceeding its critical value. The collapse load of a clamped (simply-supported) sandwich structure is approximately 15%-30% (0%-17%) higher than the first failure load.

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