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Exploring joint strength and energy absorption across various clinching configurations of steel and aluminum alloy sheets

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Abstract
The quality and mechanical characteristics of clinched joints using the extensible die with different dissimilar materials (steel sheets and aluminum alloy), various thicknesses, and different combinations and orientations (vertical, horizontal, and quantity) of the joints were investigated in this paper. Tensile shear testing was performed to obtain the mechanical characteristics of different clinched joints with combinations of dissimilar metal sheets allowing the examination of specimens under different categories of conventional and hybrid joints. In addition, the pull-out test was considered for different clinched joints. Results showed that almost all mild steel-coated, non-coated sheets and galvanized sheets joined with aluminum sheets using clinched joints failed at the neck rejoin of the joint (neck fracture mode). Moreover, the location of the thin sheet affects the joints' quality, whereas the results indicate that joint failures occur during forming of the joint with thin sheets located at the punch side provided that the softer material is located at the die side. In general, the location of the aluminum sheets influences the load bearing capacity which has lower load capacity than when located at the die location. Hybrid clinched joints show that the curing time and thickness of the adhesive affect the strength of the joints, whereas long curing time causes lower strength, at the same time, thick adhesive layers show lower strength than a thin adhesive layer with less curing time. © The Author(s), under exclusive licence to Springer-Verlag London Ltd., part of Springer Nature 2025.

Author Keywords
Adhesive; Clinching; Dissimilar materials; Energy absorption; Experimental; Strength

Index Keywords
Adhesive joints, Aluminum coated steel, Aluminum coatings, Aluminum sheet, Galvanized metal, Galvanizing, Steel sheet, Tensile testing; Adhesive layers, Aluminium-alloy sheets, Clinching, Curing time, Energy, Experimental, Joint strength, Mechanical characteristics, Strength, Thin sheet; Aluminum alloys

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