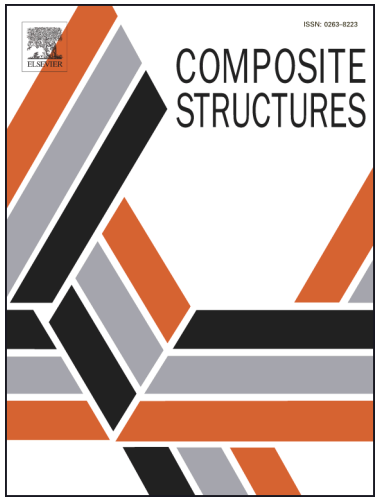

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Failure analysis of adhesively bonded steel corrugated sandwich structures under three-point bending

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Abstract: Failure modes and critical loads for adhesively bonded steel corrugated sandwich structure under three-point bending in both longitudinal and transverse direction are investigated. An analytical model considering both adhesive joint effects and classic beam theory is developed for predicting the failure modes and stresses in each member of the sandwich structure. Then the corresponding experiments and the numerical analysis by using cohesive zone model are also carried out. The experimental data, numerical results and the analytical predictions are all agree well with each other. Furthermore, based on the analytical expressions, the failure mechanism maps for three-point bending are constructed to get better understanding of failure modes and minimum weight design. Besides, the effects of adhesive parameters on failure modes and stress distribution are further studied by using the analytical model.

Keywords: corrugated sandwich structure; adhesive bonding; failure mechanism; three-point bending; analytical model.

1 Introduction

Sandwich structures are at least three-layer composite structures which are composed of two outside face sheets and one thick but low density core member between them. Sandwich panels and beams have been widely applied in many fields including shipbuilding, high-speed trains and construction due to their higher stiffness and strength to weight ratios compared to the thick homogeneous structures[1–3]. Among the key sandwich structures joining processes is the adhesively bonding process that can connect different materials while distributing the stress uniformly over bonded regions and better fatigue performance but with higher manufacture efficiency and lower price as compared to laser welding process[4,5].

A sandwich structure usually has several failure modes: face yielding, face buckling, core yielding, core buckling, indentation, delamination and joint failure. Various types of sandwich structures have been studied and analysed on their failures. Petras and Sutcliffe investigated the failure modes of honeycomb sandwich panels under 3-point bending by theoretical predictions and experiments[3]. Valdevit identified the failure mechanisms of the corrugated-core and diamond-core sandwich structures and derived their analytical expressions for critical loads[6,7]. Han carried out a combined analytical and numerical study on the stiffness and collapse strength of foam-filled corrugated sandwich beams under three-point bending[8]. Kazemahvazi and Dan developed an analytical model for the compressive and shear response of monolithic and hierarchical corrugated composite core sandwich structures[9] and tested them to obtain their failure modes then compared with the analytical model results[10]. However, the joint between

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