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Delamination failure of steel single angle sections

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ABSTRACT

Delamination is one of the most important material irregularities which affect the strength of materials under any type of loading. Delamination can be described as the separating of layers from each other or the formation of unconnected layers. Delamination irregularity can be formed during the manufacturing stage of a structural element, service loads and other effects such as corrosion. Delamination in materials is an irregularity which can be formed suddenly (by impact) or slowly over time (by corrosion fatigue). In this study, the delamination effects on single angle sections are examined, which are commonly used in engineering structures because of their geometrical properties. Delaminations are studied in single angle sections under bending and axial loads. After the experiments and examinations, it is concluded that delamination crack width is very effective on the strength of steel single angle section structural members.

1. Introduction

Production mistakes, corrosion, temperature and delamination are basic irregularities which affect the strength of materials. Delamination irregularity, which is seen in most materials, affects the strength of elements or the whole structural system negatively (Fig. 1). To minimize the effects of these irregularities, precautions must be taken during the manufacturing stage and service life. For example, to prevent a metal from corrosion, it must be painted properly at proper time intervals.

It was found from the literature that delaminations are more effective on layered materials. Technological causes of the delamination can be grouped into two categories. The first category includes delamination due to curved sections, such as curved segments, tubular sections, cylinders and spheres, and pressure vessels. In all of these cases, the normal and shear stresses at the interface of two adjacent plies can result in the loss of adhesion and the initiation of an interlaminar crack. The second category includes abrupt changes to the section, such as ply drop-offs, unions between stiffeners and thin plates, free edges and bonded and bolted joints. During service, delamination may arise under various circumstances, such as in the case of transverse concentrated loads caused by low velocity impacts. Interlaminar cracks can originate from internal damage in the interface between adjacent plies as a consequence of impact, from the drop of a tool during production, mounting or repairing, or from ballistic impacts in military planes or structures [1]. According to Bolotin, two types of delamination can be considered: internal delamination and near-surface delamination. Internal delamination originates in the inner ply interfaces of the laminate and can be due to the interaction of matrix cracks and ply interfaces. Internal delamination considerably reduces the load-capacity of composite structures. In particular, when compression loads are applied, the overall flexural behaviour of the laminate is significantly affected. After initiation, internal or near-surface delaminations can propagate under either static or fatigue loads. In both cases, the reduction in strength and stability of the composite part to flexural loading is considerable [2]. During the hot-forming of steel members, non-homogenous laminated material structures can be formed with layers of different strengths. The effects of delaminations on the buckling strength of the layered composite shells lower by decreasing the delamination crack width. But if a limited delamination crack width value is exceeded

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