Engineering Failure Analysis 18 (2011) 1605–1612

Contents lists available at ScienceDirect

Engineering Failure Analysis

journal homepage: www.elsevier.com/locate/engfailanal

Short communication

Experimental and macroscopic investigation of dynamic crack patterns in PVB laminated glass sheets subject to light-weight impact

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ARTICLE INFO

Article history:
Received 24 March 2011
Accepted 10 May 2011
Available online 17 May 2011

Keywords:
Windshield
Dynamic experiment
Light-weight impact
Crack propagation

1. Introduction

PVB laminated windshield has long been a standard component in both vehicular transportation tools [1] and building structures [2], which plays a critical role in human protection and structure integrity [3,4]. As a composite structure, it is inevitable to different types of impact from foreign objects. Stones and pedestrian heads are two major potential impactors to vehicles [5], while stones and birds are among the main sources of impactors to PVB windshields in various buildings [2]. A typical impact scenario involves a foreign object, which is small-sized and light-weighted (compare with that of the windshield), collides with a composite plate which consists of a PVB interlayer sandwiched by two brittle glass sheets. Cracks are the most obvious traces left on the windshield plate after impact [6], thus attracting growing interests for studying the cracking behaviors which may contain abundant information about material property and impact history [5,7–9].

Unlike quasi-static cracking problem, dynamic fracture is more complex and challenging [10]. Although numerical simulations such as those based on probabilistic damage mathematical model [11], continuum damage mechanics [4,8,12,13], explicit finite element method [14–16], and extended finite element method [7] may provide useful insights for the foreign object impact resistance of windshield or glass, these studies often neglected the important PVB layer and most of them did not involve explicit crack growth and pattern analysis; moreover, the validation of simulations will critically rely on experiments. Unfortunately, for laminated glass plates, the previous experimental studies were focused on the damage evolution in cracked plates and interface debonding [17–19], and the direct experimental investigation of the impact fracture charac-

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1350-6307/$ - see front matter
doi:10.1016/j.engfailanal.2011.05.004