Accepted Manuscript

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PII: S1359-8368(18)32542-3

DOI: 10.1016/j.compositesb.2018.08.110

Reference: JCOMB 5940

To appear in: *Composites Part B*

Received Date: 10 August 2018

Accepted Date: 23 August 2018

Please cite this article as: Jia Z, Yuan G, Feng X, Zou Y, Numerical study on the mechanical behavior of a polyurethane adhesive under high strain rate, *Composites Part B* (2018), doi: https://doi.org/10.1016/j.compositesb.2018.08.110.

Numerical study on the mechanical behavior of a polyurethane adhesive under high strain rate

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Abstract

The cohesive parameters of a polyurethane (PU) adhesive are experimentally tested under different strain rate conditions. As the strain rate of this adhesive is constantly changing under the actual impact conditions, this paper proposes a method, called weighted average strain rate method, to determine the effective strain rate of the adhesive under the high strain rate condition for numerical simulation. Based on this method, the relationship between cohesive parameters and the determined effective strain rate is established and a strain rate-dependent cohesive constitutive model of the adhesive is developed and implemented into commercial finite element analysis software via a subroutine. The model is calibrated and verified against experimental data for double cantilever beam (DCB), end notched flexure (ENF) tests and thick adherend shear tests (TAST). Finally, impact tensile shear test and numerical analysis on composite single-lap joints at high loading rates are carried out to validate the reliability of the subroutine. By comparing the FEA results with experimental results, a good agreement is achieved which proves the effectiveness of the strain rate determination method and the subroutine.

Keywords: high strain rate; cohesive zone model; adhesive numerical simulation;