Numerical Simulation Study on Strain Rate Effect of Fiber Reinforced Composites

Hui Ye (✉ yehui@jlu.edu.cn)

Jilin University <https://orcid.org/0000-0002-3214-8566>

Chang Liu

Jilin University

Yanrong Zhu

Geely Automobile Research Institute

Original Article

Keywords: fiber reinforced composite, strain rate effect, constitutive model, VUMAT subroutine, simulation accuracy

Posted Date: June 18th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-35692/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

In order to study the effect of strain rate effect on the simulation precision of fiber reinforced composites, the dynamic enhancement factor (DIF) was introduced to modify the modulus and strength of the composite, and the modified Hashin failure criterion was used to establish a three-dimensional progressive damage constitutive model of composite materials which could consider the strain rate effect. The model is embedded into the Abaqus software by VUMAT subroutine, and the simulation of the projectile penetrating the fiberglass reinforced composite laminates is carried out. The simulation results are compared with the experimental results and the constitutive model simulation results without considering the strain rate effect. The results show that the constitutive model with strain rate established in this paper can accurately simulate the process of projectile penetrating the laminates. Compared with the simulation results without strain rate, the accuracy is increased in the model with strain rate, respectively by 14.1% at the penetration speed of 1.8 m/s and by 22.7% at 3 m/s. The errors, between the simulation results of without strain rate and that of the experiments, are increased with the increase of penetration speed, and increase from 28.7% of 1.8 m/s to 36.9% of 3 m/s. The simulation error of constitutive model with strain rate is relatively stable.

Full Text

This preprint is available for [download as a PDF](#).

Figures

Figure 1

Direction diagram

Figure 2

Finite element model of projectile penetrating composite laminates

(a) test^[5]

(b) simulation

Figure 3

The initial state of projectile penetrating laminate

(a) test^[5]

(b) simulation (+)

(c) simulation (-)

Figure 4

Intermediate process state of the model

Figure 5

Force-Displacement curves of projectile(0.4mm)

Figure 6

Force-Displacement curve of projectile(0.8mm)