様式例：課程博士用　　　　　　　　　　　　　　　　　　　　19年　1月　16日

機械．構造 システム工学		学籍番号	049102
申請者氏名	Shirley Savetlana		

指導教員氏名	本間　寛臣 上村　正雄 河村　庄造

論　文　要　旨(博士)

論文題目	An approach to dynamic fracture toughness of GFRP from the aspect of viscoelastic and debonding

(要旨 1,200字程度)

Abstract

Nowadays Glass Fiber Reinforced Plastics (GFRP) is widely used because of its properties. The important issues regarding the loading rate effect on the fracture in the application of GFRP are to understand the behavior of not only the constituents in the composites but also the completed end product in the way they respond to an applied load. Hence, the research regarding to the dynamic response of GFRP can answer the uncertainty in the design using GFRP materials. From the literatures survey, mechanical properties of GFRP are affected by the loading rate. Fracture toughness increases with fiber volume fraction. Hence high fracture toughness of GFRP under dynamic loading is suggested because of the transition of the failure mode. The damping properties also lowered or delayed the intensity factor overshoot ahead of the crack tip. Debonding mode and the viscoelastic effect are underlined as two important factors that determine the fracture toughness of GFRP regarding the strain rate effect. Hence the objective of this research is to investigate the dynamic fracture mechanism of GFRP from the aspects of viscoelastic and debonding.

Young's modulus of GFRP and pure polyester were tested over a wide range of strain rate. Based on the Young's modulus curve, the viscoelastic parameter of GFRP is identified by finite element method. Then experimental fracture toughness test using the strain gauge method was carried out. The stress and strain intensities at the crack tip were calculated numerically by finite element method. In order to investigate the roles of the debonding in determine the fracture toughness of GFRP, intermediate debonding test of single fiber bundle was carried out. Finally the numerical analysis of debonding failure mode ahead the crack tip was carried out to investigate the stress and the strain distributions in the debonding process ahead of the crack tip.

Fracture toughness based on the strain can explain the fracture behavior of viscoelastic materials, but the loading rate effect cannot be fully explained from the aspect of viscoelastic property. Interfacial bonding strength under different loading rates is considered to fully understand the loading rate effect on the dynamic fracture toughness of GFRP. Debonding test on the single fibre bundle shows that the debonding initiation strain over the wide range of loading rate is proportional to the strain intensity factor at the crack tip of fracture toughness test.

The three point bend model with a single fibre bundle at the crack tip is successfully model by considering the viscoelastic property and the criterion of the initiation of the debonding. Based on the static fracture toughness by strain gauge method in the experiment, the fracture toughness of GFRP which is independent with the loading rate can be calculated using the model.