Raw data from Study on the Influence of Mixed Mode I-Mode II Loading on Interlaminar Fracture of a Graphite Epoxy Tape Laminate

James G. Ratcliffe and William M. Johnston Jr.

INTRODUCTION

Mixed mode-I/II interlaminar fracture toughness over a mode mix range of $0.2 < G_{II}/G_T < 0.8$ of IM7/8552 unidirectional graphite/epoxy tape were characterized using the mixed-mode bend test method [1]. Fracture data arising from this test campaign were presented at the American Society for Composites 29th technical conference on composite materials [2]. While fracture toughness (and fatigue delamination growth rates) under the various mixed mode-I/II loading conditions studied were reported, the raw experimental data collected during each test were omitted from the technical proceedings since providing the data would have violated the conference paper length requirement and generally such data are not typically included in such conference proceedings. However, there is interest in the raw test data for verification and validation exercises of progressive damage analysis methods designed to predict mixed mode delamination growth. The purpose of this white paper is to make available the raw data from the interlaminar fatigue and fracture study reported in [2].

DATA SUMMARY

EXPERIMENTAL PROCEDURES

Quasi-static and fatigue mixed mode bending tests [1] were conducted on IM7/8552 unidirectional carbon/epoxy tape beam laminates at mixed mode ratios of G_{II}/G_T=0.2, 0.5 and 0.8. Interlaminar fracture toughness measured from this study are reported in [2]. Details of specimen designs and test procedures are also reported in [2]. The raw data from these tests are contained in .xlsx files accompanying this white paper.

RESULTS SUMMARY

Static Tests

Load-displacement responses typical of those observed during quasi-static MMB tests at the three mixed mode ratios, G_{II}/G_T = 0.2, 0.5, and 0.8, are presented in Fig. 1a. As expected, delamination growth stability decreases at higher values of G_{II}/G_T. Mixed mode interlaminar fracture toughness, G_c is plotted in Fig. 1b and shows the typical increase in G_c at higher mixed mode ratios. Results from pre-cracked (PC) and non-pre-cracked (NPC) specimens are included in Fig. 1b.

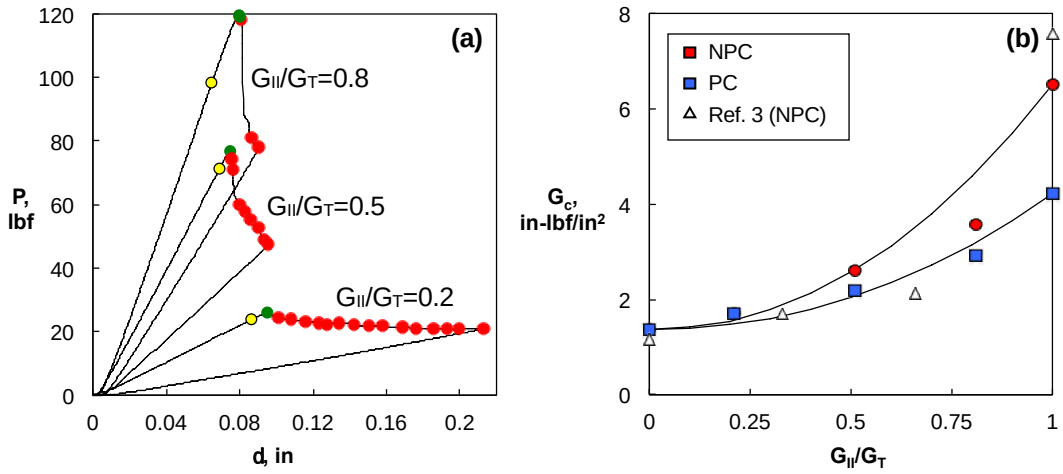

Figure 1 (a) Load-displacement responses at each mixed-mode ratio. (b) Mixed-mode delamination initiation criteria.

SUMMARY

Mixed-mode bending tests were conducted at three different mixed-mode ratios as part of a study to characterize delamination in IM7/8552 graphite/epoxy tape. In general, the fracture behavior of the material tested changes with mixed-mode ratio, G_{II}/G_T, in a manner that is consistent with fracture behavior during purely mode-I and mode-II loading conditions. A detailed summary of the test data is given in [2].

REFERENCES

1. ASTM D 6671- D 6671M-(04)13, Standard Test Method for Mixed Mode I-Mode II Interlaminar Fracture Toughness of Unidirectional Fiber-Reinforced Polymer Matrix Composites, in *Annual Book of ASTM Standards*. Vol. 15.03, ASTM International, 2014.
2. Ratcliffe, J, and Johnston, W. "Influence of Mixed Mode I-Mode II Loading on Interlaminar Fracture of a Graphite Epoxy Tape Laminate," Proceedings of the 29th American Society for Composites Annual Technical Conference, La Jolla, USA, 2014.
3. Hansen, P., and R., Martin. 1999. "DCB, 4ENF and MMB delamination characterisation of S2/8552 and IM7/8552," Materials Engineering Research Lab Report. European Research Office of the US Army.