TWENTY-THIRD INTERNATIONAL CONFERENCE ON COMPOSITE MATERIALS (ICCM23)

STANDARDIZATION OF NEW MODE-I INTERLAMINAR FRACTURE TOUGHNESS TEST OF CFRP LAMINATES WITH NON-ADHESIVE DCB TEST FIXTURE

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Introduction

The DCB(Double Cantilever Beam) test method for CFRP was first standardized as JIS K 7086:1993[1] in 1993. Later, ASTM D 5528:1994[2] and ISO 15024:2001[3] were standardized. All specimens of these test methods were loaded through loading blocks or piano-hinges bonded to specimen surface directly as shown in Figure 1. Current each DCB test method needs and depends on an adhesive process between specimen and test fixtures: load blocks and piano hinges. These current test fixtures were not enough to carry out the test for difficult to adhere material for example of thermoplastics CFRTP, or the test in high/low temperature tests where the adhesives cannot demonstrate their effectiveness. In order to overcome these problems, DCB tests with insert hinges will be modified and standardized as ISO 15024:2023 adding type c proposed by project leader [4] (corresponding author of this document).

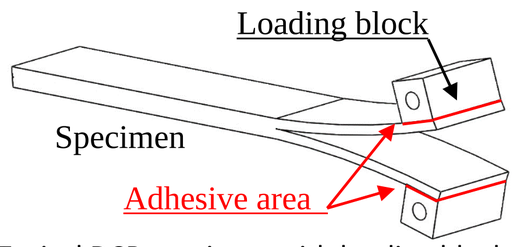

Figure 1 Typical DCB specimen with loading blocks required adhesive

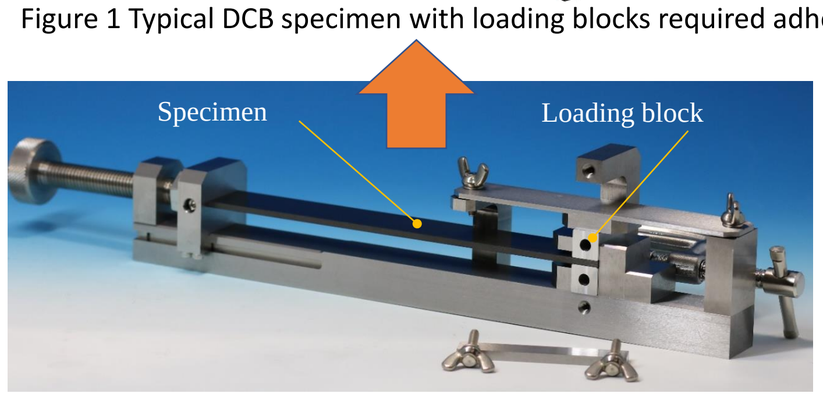

Figure 2 An example of adhesive fixture introduced in technical note of JIS K 7086 -1993

Proposed JAXA-Non-Adhesive Inserting DCB Test Fixture

As a more effective standard, the following conditions are required:
(1) Ensuring accuracy
(2) Test can be carried out easily by general engineers.
Conventional test requires the procedure of adhesive between specimen and loading blocks. Therefore, JIS K 7086 shows positioning fixture dedicated for adhesive procedure as shown in Figure 2.
On the other hand, Positioning specimen in test fixtures of JAXA-Non-Adhesive inserting DCB test is possible without special other tool since workability is taken into consideration. Figure 3 shows actual test set up procedure of JAXA-non-adhesive inserting DCB test fixture. Figure 3(a) shows DCB test specimen with overhang area for insert hinges and flat inserting parts. A flat inserting part prepared as a set of two parts is inserted into overhang area of the DCB specimen as shown in Figure 3(b). Then each insert hinge part for gripping overhang area is bolted to insert hinge part so as to grip cantilever of DCB specimen shown in Figure 3(c). DCB specimen is loaded as Figure 4 after setting on Test machine.

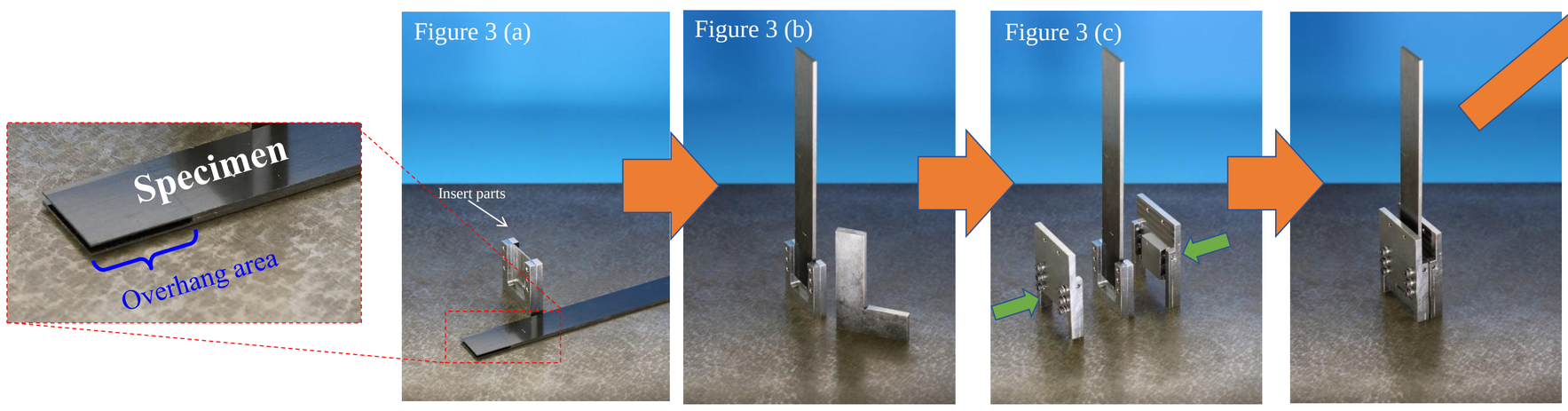

Figure 3 Test set up of JAXA-Non-adhesive inserting DCB test fixture : ISO 15024:2023 type c

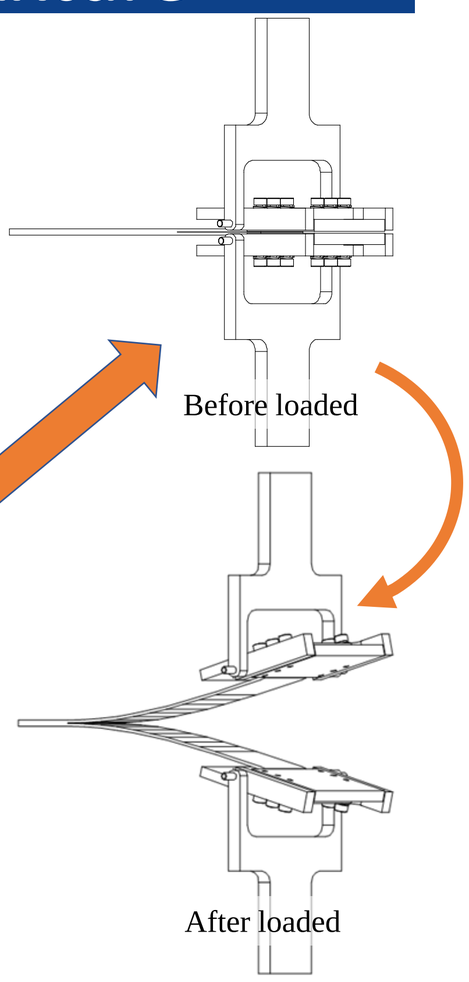

Figure 4 Typical DCB specimen with JAXA-Non-adhesive inserting DCB test fixture before/after loaded

Experiments, Discussion and Conclusion

DCB tests with insert test fixture were carried out at room temperature. CFRP plates for specimen were fabricated from a unidirectional reinforcing fiber (T800S) and an epoxy matrix (3900-2B; supplied by TORAY, Japan). Unidirectional laminate was chosen as DCB specimen. Polyimide film was also laminated at midplane of specimen. Overhang parts were fabricated as part of the specimen. width of specimen was chosen to 25mm. According to ISO 15024:2001, initial-loading and re-loading process was carried out. Figure 5 shows an example data of load-C.O.D (Crack Opening Displacement). It was confirmed that returned C.O.D curve closed to the 0 point after DCB test as shown in Figure 5.

New DCB test method can be expected following merits:
(1) Test for difficult to adhere material
(2) Skipping the bonding process
(3) Test in high/low temperature conditions
It was confirmed that the introduced test was successfully performed.

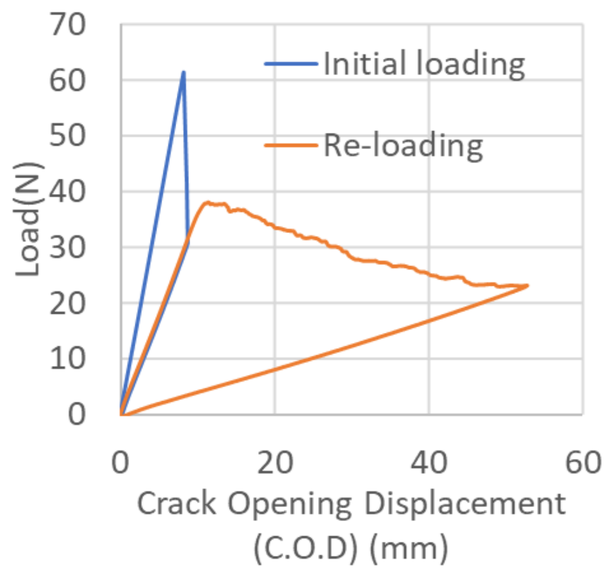

Figure 5 Load-Crack Opening Displacement of DCB test with flat inserting fixture.

[1] JIS K 7086 (1993) (in Japanese / in English)
[2] ISO 15024:2001 (2001)
[3] ASTM D 5528:2021 (2021)
[4] ISO 15024:2023 https://www.iso.org/standard/84263.html, (2023)
[5] M. Matsushima, T. Ishikawa, Y. Hayashi, S. Kobayashi, Technical Report of National Aerospace Laboratory TR-1096, (1991). (in Japanese)
[6] S. Urata, K. Kunoo, N. Uda, K. Ono, T. Nagayasu ". J. of the Japan Society of Composite Materials, Vol.31, No.4, (2005). (in Japanese)