

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

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ABSTRACT

To standardize JAXA-Non-adhesive DCB test fixture, experimental DCB tests were performed. Conventional DCB test standard requires adhesive procedure for connecting between specimen surface and test fixtures (load-blocks or piano-hinges). In test process, flat wise tension forces are occurred at bonded surfaces. However, it is predicted that these test methods will not be possible because of popularization of difficult-to-adhere material such as CFRTP. In this report, JAXA-Non-adhesive DCB test fixture, details of test setting up, and experimental results were introduced.

1 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).

Comparison between the current DCB test methods and the latest DCB test method, and merits of the latest DCB test method are reported in this document.

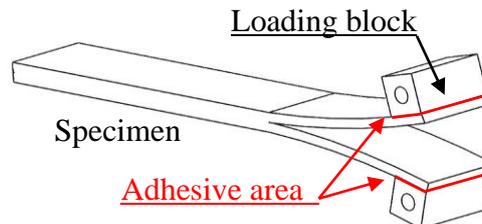


Figure 1 Typical DCB specimen with loading blocks

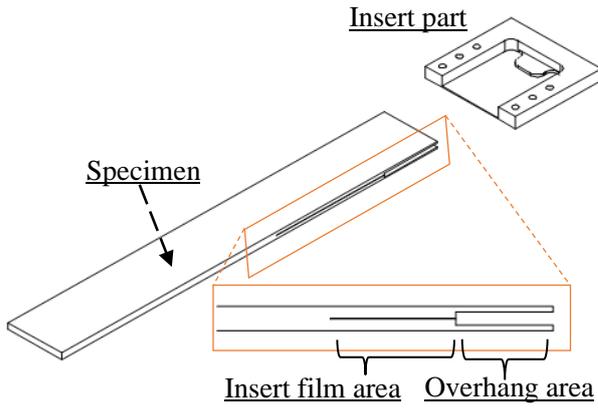


Figure 2 (a)

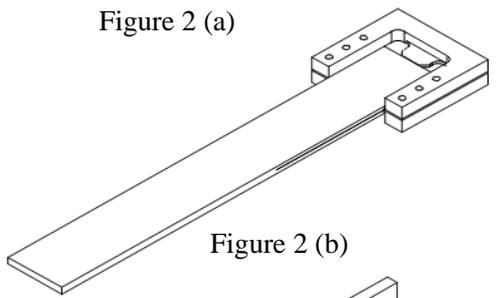


Figure 2 (b)

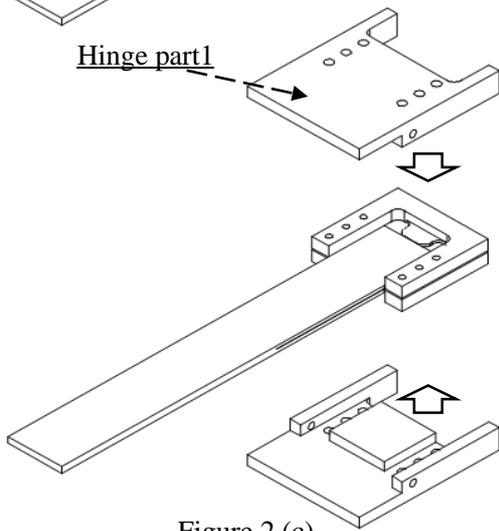


Figure 2 (c)

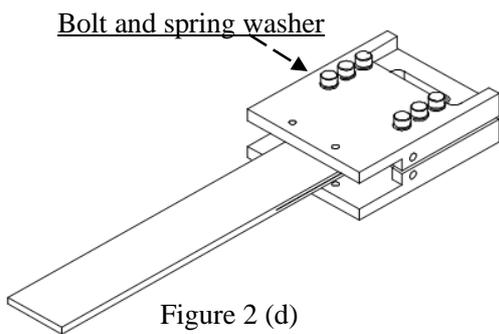


Figure 2 (d)

Figure 2 Test set up of JAXA-DCB test fixture

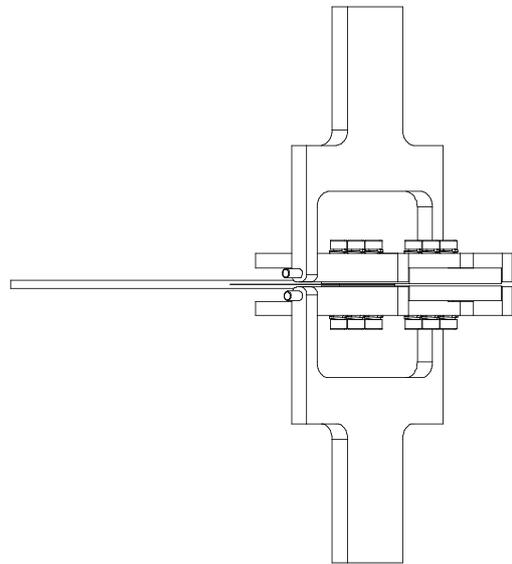


Figure 3 (a) Typical DCB specimen with JAXA-DCB test fixture before loaded

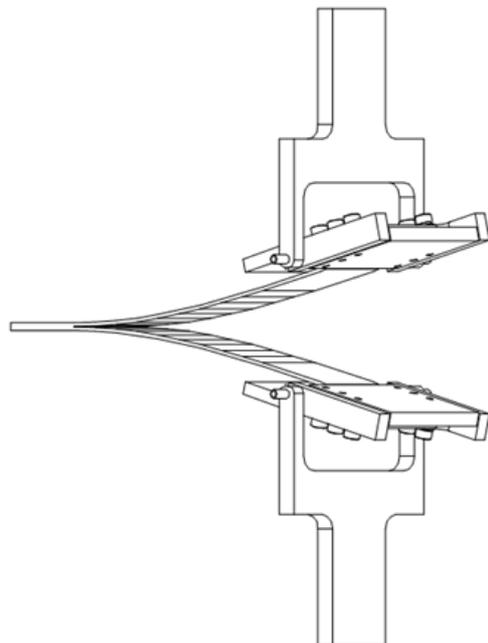


Figure 3 (b) Typical DCB specimen with JAXA-DCB test fixture under loaded

2 PROPOSED JAXA-NON-ADHESIVE INSERTING DCB TEST FIXTURE

DCB tests using flat insert hinge type with adhesive proposed by M. Matsushima, T. Ishikawa, et al. [5] were carried out from 1990. In later years, Urata, Kunoo, Uda et al. reported the results of a modified Ishikawa's DCB method [6]. Authors modified DCB test method using insert hinges without adhesive and investigated experimentally.

Figure 2 shows test set up of DCB test fixture. Figure 2(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 2(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 2(c) and Figure 2(d). DCB specimen is loaded as Figure 3 after setting on Test machine.

3 COMPARISON SETTING PROCEDURES BETWEEN PROPOSED JAXA-NON-ADHESIVE INSERTING DCB TEST FIXTURE AND CONVNTIONAL TEST FIXTURES

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 4.

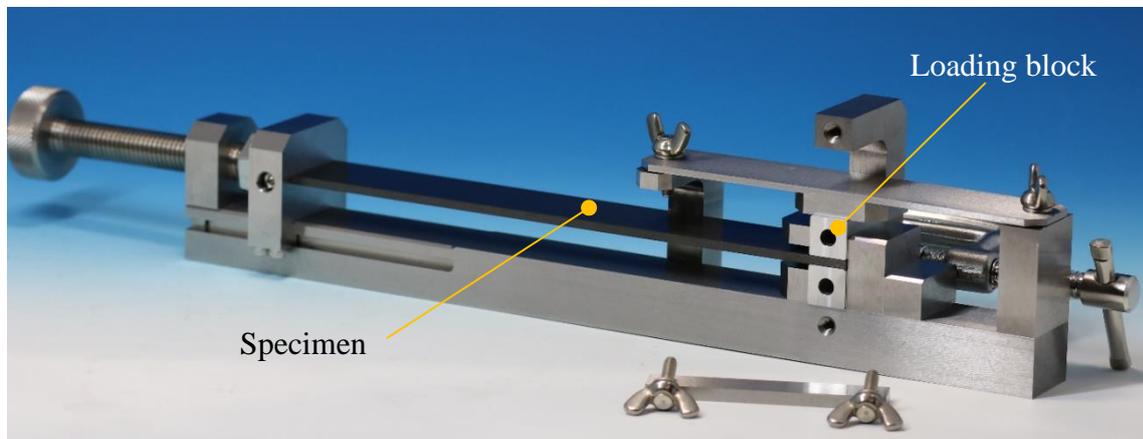


Figure 4 An example of adhesive fixture introduced in technical note of JIS K 7086 -1993 Testing methods for interlaminar fracture toughness of carbon fibre reinforced plastics.

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 5 shows actual test set up procedure of JAXA-non-adhesive inserting DCB test fixture.

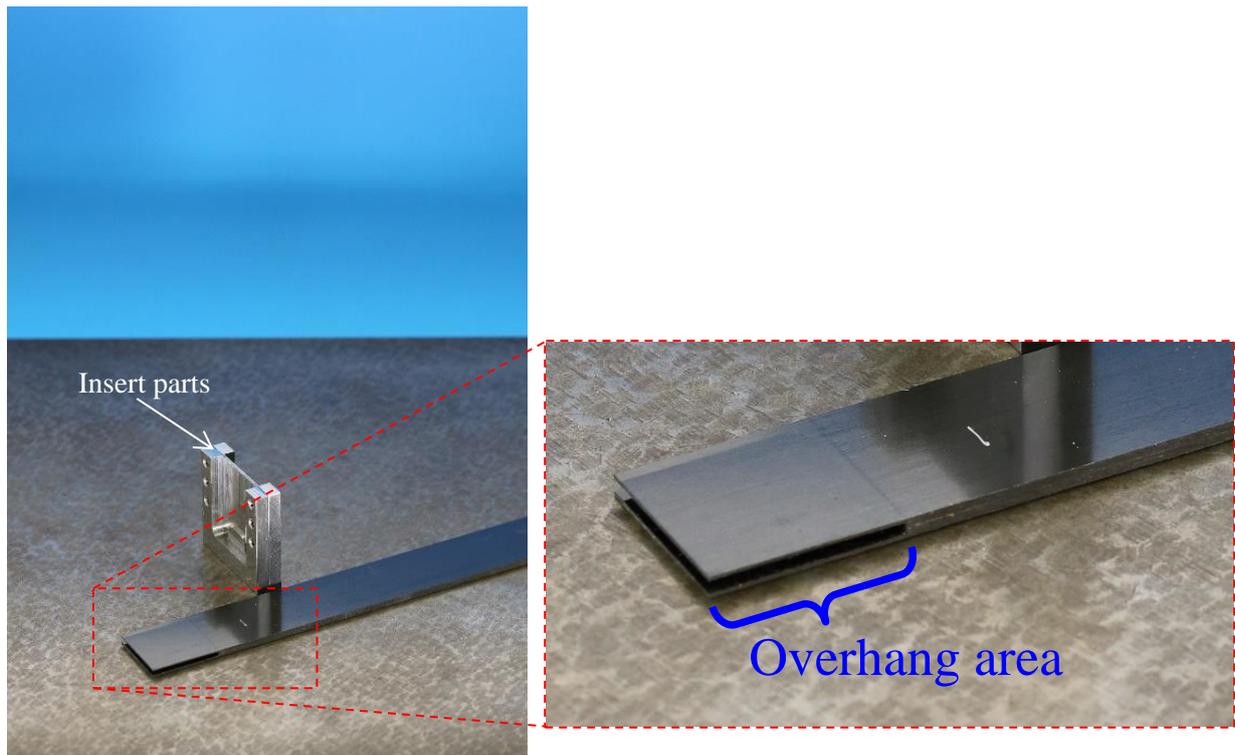


Figure 5 (a) Setting insert parts of test fixture with their backs to each other on surface plate and preparing specimen with overhang area

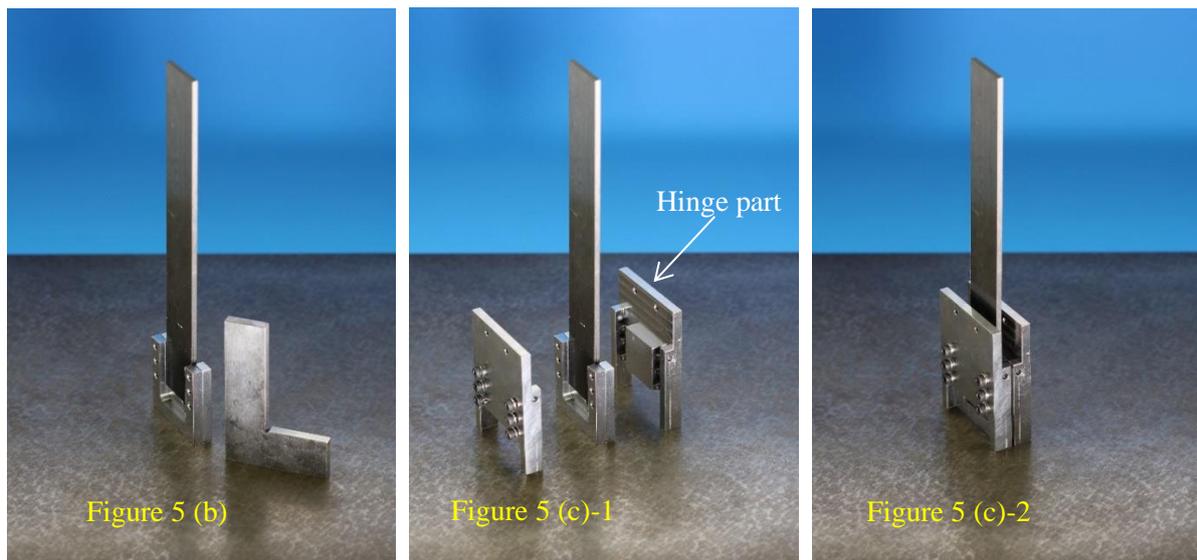


Figure 5 (b) Inserting specimen vertically into inset parts of test fixture with steel square

Figure 5 (c) Gripping overhang area of specimen by fastening each hinge part to the insert part with bolts.

4 EXPERIMENTS

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 6 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 6.

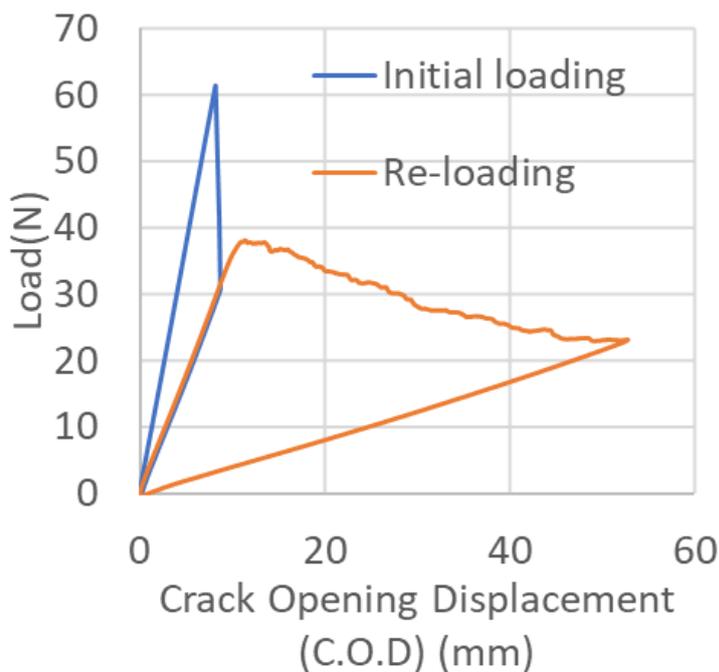


Figure 6 Load-Crack Opening Displacement of DCB test with flat inserting fixture.

5 DISCUSSION AND CONCLUSION

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.

REFERENCES

- [1] JIS K 7086 (1993) (in Japanese / in English)
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