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Tensile Test of Welding Joint Parts for a Plate-type Fuel Assembly

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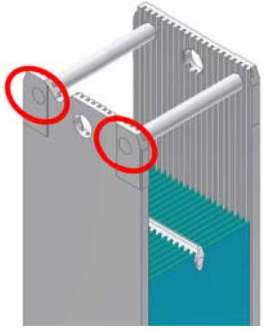
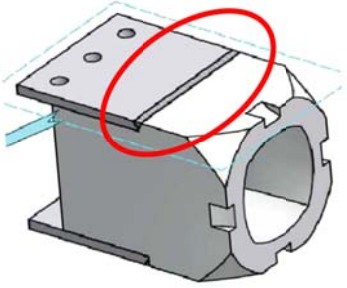
1. Introduction

These tensile tests of joint parts for a plate-type fuel assembly (FA) have to be executed to evaluate the structural strength. For the tensile test, joint parts of a FA used in the test are made of aluminum alloy (Al6061-T6). The tensile tests were performed using the INSTRON 4505 (universal tensile) testing machine.

These welding joints are composed with two parts for the soundness of the fuel assembly; one is the side plate with fixing bar and the other is side plate with end fitting, which is shown in Fig. 1. These two joint parts are fabricated by TIG welding method.



(a) Upper welding joint



(b) Lower welding joint

Fig.1 Schematic drawing of the welding joints for a plate-type FA.

2. Tensile test

2.1 Test machine

The test will be performed in the INSTRON 4505 testing machine [1]. The INSTRON 4505 (Fig. 2) consists of the main frame, crosshead controller, environmental chamber and signal conditioning unit. The measuring range of an upper load cell is 100 kN, the upper and lower fixtures are made of the same aluminum alloy. This machine is controlled with displacement, strain rate and moving direction. Electromechanical or universal testing machines are most commonly used for static testing in a tensile or compression mode within a single frame. They are also referred to as pull testers. Additional test types include tensile, compression, shear, flexure, peel, tear, cyclic, and bend tests. Capacities for these systems range from low-load forces of 1 kN up to high-capacity 100 kN test frames. This system is frequently configured for automated testing. In addition to the testing equipment, specimen preparation is an extremely important factor to consider when evaluating the repeatability of results. Specimens with nicks, cuts, and non-parallel edges will have an adverse impact on repeatability of results.

The tensile test for the joint parts will be carried by ASTM E8 (Standard test methods for tension testing of metallic materials) [2].

Fig.2 Schematic drawing of the tensile testing machine INSTRON 4505.

2.2 Test specimen and fixture configurations

The test specimens for tensile test are designed and fabricated by reflecting weld depth and angle used in actual fabrication process of FA. These welding joint specimens have non-standard geometry; therefore the special holding fixtures are designed. The holding fixtures of the specimen are designed for aligning the upper and lower crossheads. The specimen fixture stands on the upper crosshead of the main frame with hexagonal head bolts.

2.3 Test condition

The test is performed at the room temperature and air condition. Considering the maximum attainable load, the displacement used for test may be stopped to protect the testing machine. The defined crosshead moving speed is 0.5 mm per minutes, the sampling rate for data acquisition is 5 points per second, and the lower crosshead will be moved downward direction.

2.4 Test results

2.4.1 Side plate and fixing bar case

The maximum load and extension results of the upper welding joint are summarized in Table 1 and Fig. 3. A little discrepancy among the test results occurred due to the misalignment between the upper and lower fixture. The average value is about 2.86 kN.

Table 1. Maximum load and extension of fixing bar welding specimens.

Specimen #	maximum load(kN)	Extension (mm)
1	3.01	0.46
2	3.28	0.40
3	2.28	0.35

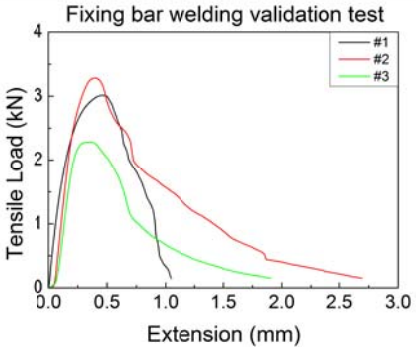


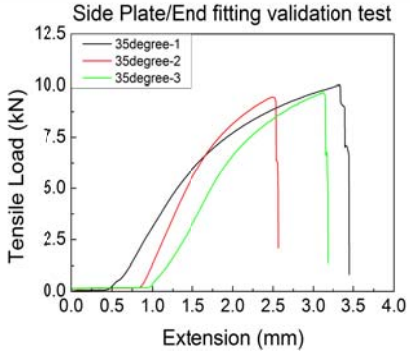
Fig. 3 Test results of the upper welding joint by tensile test.

2.4.2 Side plate and end fitting case

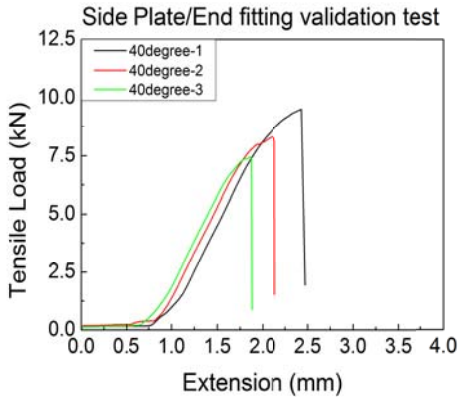
The maximum load and extension results of the lower welding joint are summarized in Table 2. In this case, the butting joint designs have two cases, one is the 35 degree and the other is 40 degree case. The former case is shown in Fig. 4 and the latter case is shown in Fig. 5. The average values of the lower welding joints by surface degree are about 9.72 and 8.41 kN, respectively. Therefore the 35 degree case result is larger than those of the 40 degree case.

Table 2. Table Maximum load and extension of side plate/End fitting welding specimens.

Specimen #	maximum load(kN)	Extension (mm)
35-1	10.02	3.33
35-2	9.46	2.49
35-3	9.68	3.11
40-1	9.50	2.43
40-2	8.31	2.10
40-3	7.43	1.85



(a) 35 degree case



(b) 40 degree case

Fig. 4 Test results of the lower welding joint by tensile test.

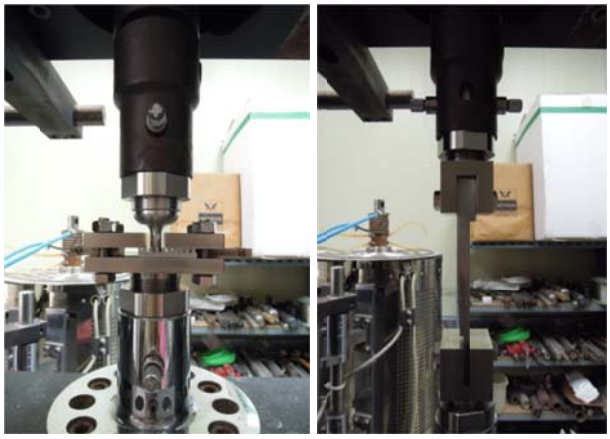


Fig. 5 Test photograph of the welding joints by tensile test.

4. Conclusion

The tensile tests of the welding joints of a plate-type FA are executed by tensile test. The fixture configurations for the specimen are very important to obtain the strict test results. The maximum strength has the approximately linear correlation with the bonding area of the welding joints. In spite of those results, the maximum strengths of the welding joints are satisfied according to the minimum requirement.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Operating Instructions, “INSTRON universal testing instruments”, INSTRON Manual, 1987.
[2] ASTM E8, “Standard Test Methods for Tension Testing of Metallic Materials”, 2000.