Fatigue Strength Improvement of Friction Stir Welding

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1. Introduction

In recent years, FSW (Friction Stir Welding) attracts attention as welding of aluminum alloys. FSW is characterized by low power consumption compared with conventional joining methods. However, there are few data on the mechanical properties and fatigue strength of the joint material. In this study, therefore, the effect of welding conditions on the fatigue strength of FSW joints using aluminum alloys was investigated.

2. Test piece and production method

The specimen material used for the test is A5052 with a plate thickness of 1.0 mm. As shown in Fig. 1, FSJ bonding was performed on the flat part of the U-shaped test piece, and an H-type test piece was manufactured. There are four types of tool shapes, as shown in Fig. 2, with the pins being cylindrical and threaded, and the shoulders being flat and recessed. The indentation amount was 1.2 mm and 1.4 mm, the rotation speed was 1645 rpm and 2240 rpm, the joining time was 30 s, and the tool indentation load was 4.0 kN.

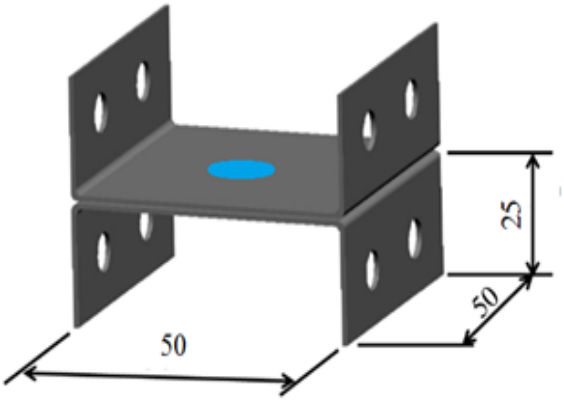

Fig.1 Shape and dimensions of H type specimen

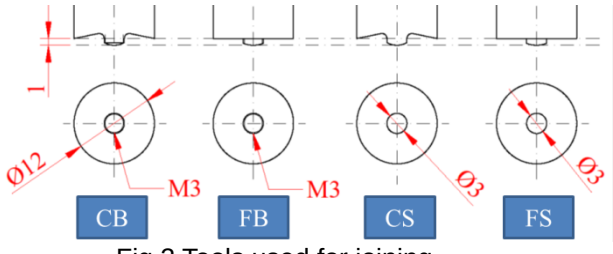

Fig.2 Tools used for joining

3. Result

Table 1 summarizes the number of cycle to failure obtained from fatigue test.

Table 1 Fatigue life of FSW specimen manufacturing using 4 types of tools and 2types of tool insert depth and 2 types of rotation rates

Tool type	Tool insert depth[mm]	Rotation rates[rpm]	Fatigue life[cycle]
FS	1.2	1645	10266
		2240	5073
	1.4	1645	2994
		2240	2700
CS	1.2	1645	14959
		2240	12304
	1.4	1645	4517
		2240	9635
FB	1.2	1645	12047
		2240	3573
	1.4	1645	15983
		2240	18774
CB	1.2	1645	2441
		2240	1841
	1.4	1645	3318
		2240	3912

As shown in Table 1, in the case of tool insert depth 1.2mm, fatigue life of joint specimen which was made using tool CS was longer than those of other specimens. In the case of tool insert depth 1.4mm, fatigue life of joint specimen which was made using tool FB was longer than those of other specimens. It was found that fatigue life of joint specimen depends on the tool shape and insert depth.

On the other hand, the case of tool insert depth 1.2mm, fatigue life of specimen which was made under low rotation rate 1645rpm was longer than those of specimen under high rotating rate 2240rpm. In the case of tool insert depth 1.4mm, fatigue life made under high rotation rate was longer than those of specimen under low rotation

rate. It was found that rotation rate significantly influenced on the fatigue life of joint specimens.

Finally, fatigue life of joint specimen which was made using FB under rotating rate of 2240rpm and tool insert depth of 1.4mm was longest than those of other specimens.

4. Conclusion

It was found that fatigue life of FSW joint specimen depends on various tool parameters (tool shape, tool rotation rate and tool insert depth).

References

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