PREDICTING DUCTILE FRACTURE DURING TORSION TESTING USING ELLIPSOIDAL VOID MODEL AND ANALYTICAL MODEL

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Abstract
Research on ductile fracture under high stress triaxiality has been performed considerably, whereas research on ductile fracture under low stress triaxiality has not been performed sufficiently. In this paper, torsion testing of a bar which is prestrained by drawing is performed using a torsion testing machine, and ductile fracture during torsion testing is predicted using an ellipsoidal void model and an analytical model.

1. Introduction

It had been recognized for many years that the strain to fracture increases monotonically with decreasing the stress triaxiality. However, Bao and Wierzbicki [1] indicated that the strain to fracture increases initially, decreases temporarily, and increases afterward afresh with decreasing the stress triaxiality. It is well known that the stress triaxiality at which the strain to fracture is minimized is in the vicinity of zero. It goes without saying that the stress triaxiality is equal to zero during the torsion testing of a bar. In this study, the torsion testing of a bar which is prestrained by drawing is performed, and the strain to fracture calculated from the simulation is compared with the strain to fracture obtained experimentally.

2. Results

Since an exclusive torsion testing machine is large and expensive in general, a compact torsion testing machine which can be used in the universal testing machine is manufactured with reference to a patent [2]. Figure 1 shows the compact torsion testing machine. The length of the specimen of a bar is not fixed during torsion testing; the specimen of a bar is allowed to elongate during torsion testing so that the axial stress of the specimen is not generated. Figure 2 shows the relationship between the axial prestrain and the torsion strain at fracture. The material used is JIS S45C, which is equivalent to ISO C45. With increasing the axial prestrain due to drawing, the torsion strain at fracture decreases. The torsion strain at fracture calculated using an analytical model and that calculated using an ellipsoidal void model [3] are going to be compared with the torsion strain at fracture obtained experimentally.
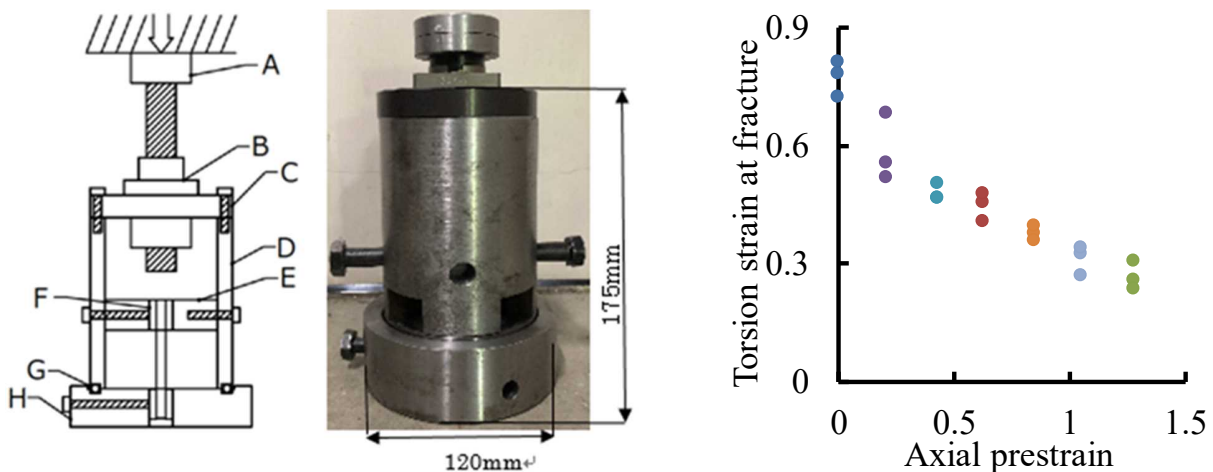

Fig. 1 Compact torsion testing machine.　　Fig. 2 Relationship between axial prestrain and torsion strain.

References
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