Fatigue strength improvement by modifying the geometry of press fitted part of railway axle

Masataka YAMAMOTO
Assistant Senior Researcher, Vehicle and Bogie Parts Strength, Vehicle Structure Technology Division

1. Introduction

The fatigue strength of the press fitted parts of axles such as wheel seats and gear seats is lower than that of the axle bodies because of fretting damage. It is well known that fretting fatigue strength is improved by overhanging of wheel hubs to wheel seats or modifying the geometries of press fitted parts of axles. On the other hand, the relationship between fretting fatigue strength and the axle geometries has not been evaluated systematically. In this study, the relationship between the press fit geometries and fretting fatigue strength has been evaluated.

2. Fatigue tests of one-third scale axles

Fatigue tests with one-third scale axles were carried out. The axle specimens were made of SFA65 which has been used in Japanese conventional railway axles. Fig. 1 shows the fatigue limit of the specimens with different tangential angle θ. The fretting fatigue limit of specimens increased as the value of the tangential angle θ increased. Thus, the effect of the press fit geometries on fretting fatigue strength was able to be evaluated.

3. Fatigue tests of full-scale axles

Fatigue tests with full-scale axles were conducted to verify the fretting fatigue strength improvement by modifying wheel seat geometries. Two axle specimens were examined: one with the actual wheel seat geometry for a commuter train design (the “normal axle”), and the other (the “improved axle”) with improved geometry based on the fatigue testing results with the 1/3 scale axles. The fracture surfaces of the specimens after the full-scale fatigue tests are shown in Fig. 2 and Fig. 3. The maximum crack of 20 mm in circumferential length and 5 mm in depth developed in the improved axle. On the other hand large cracks regarded as fractures developed in the normal axle. These results indicate that crack growth was prevented by improving wheel seat geometry.

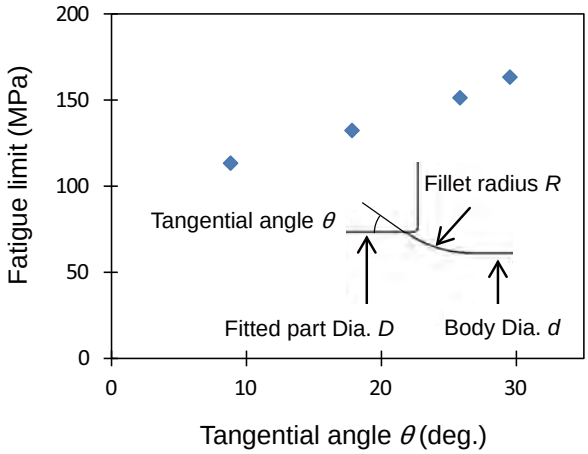

Fig.1 Relationship between fatigue limit and tangential angle θ

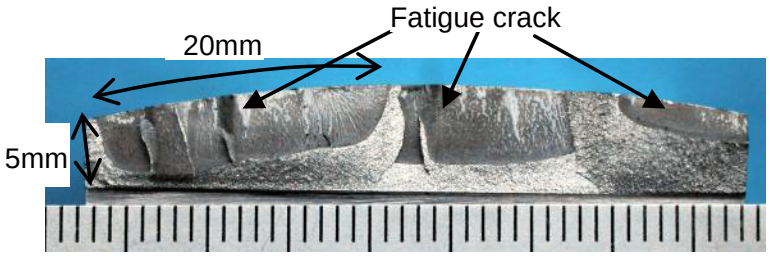

Fig.2 Fatigue testing results of full-scale axles - Maximum fatigue crack observed in the improved axle -

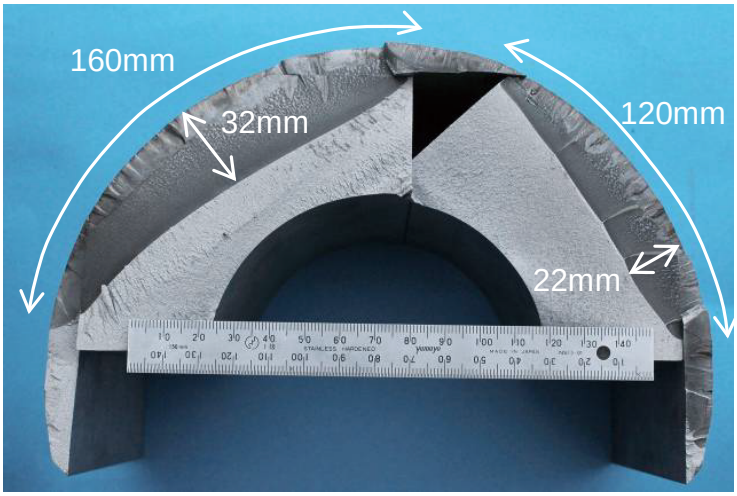

Fig.3 Fatigue testing results of full-scale axles - Fracture surface of the normal axle -