CT Inspection of Welding Seam for Half-Axles of Maneuverable Aircraft’s Stabilizers

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Abstract
Half-axles of maneuverable aircraft’s stabilizers are important structural parts to guarantee the maneuverability and flight safety. Various defects, especially the crack and porosity in the welding area, may lead to structural fracture and serious flight accident. X-ray industrial computed tomography (CT) is a useful method for quality control and internal defect inspection, and this paper presents the CT inspection of welding seam for half-axles. Welding seam defects, including porosity, inclusion and cracks, were observed by CT images, proving the effectiveness of CT inspection for welding seam half-axles of maneuverable aircraft’s stabilizers.

Keywords: Industrial computed tomography, Welding seam, Half-axle, Maneuverable aircraft’s stabilizer

1. Introduction
Half-axles of maneuverable aircraft’s stabilizers are important structural part to guarantee the maneuverability, and minor defect such as crack and porosity may lead to structural fracture and serious flight accident.

Fatigue damage will accumulate with the increase of the flight time, and it is urgent to solve the health condition inspection problem. X-ray industrial computed tomography (CT) scanning can be a useful method for quality control and inspection because it will allow you to see any internal defects [1-3]. The objective of this study is to perform CT inspection for the half-axles of maneuverable aircraft’s stabilizers.

2. Experimental procedures
The half-axle of maneuverable aircraft’s stabilizer is shown in Fig.1. The main structure is composed of two cones and a cylinder by welding connection. After the fatigue test on the half-axle, the macroscopic fractography of the fractured half-axle of maneuverable aircraft’s stabilizer is shown in Fig.2. Fractographic analysis and metallographic studies of the metal structure were carried out, showing that the half-axle underwent a fatigue fracture. The fatigue zone is located near the welding point. Therefore, the key inspection zone is the welding seam area (see the red rectangles in Fig.1), and the defect type includes porosity, inclusion, and crack, etc.
The inspection instrument is ACTIS600/420KV ICT System by BIR Corp. USA. The density resolving power is about 0.1%. The inspection parameters used for the half-axle are as follows: Voltage 380kV, Electric current 5 mA, Time 2 minutes.

Fig.3 exhibits the CT inspection for the half-axle of maneuverable aircraft’s stabilizer. The half-axle is vertically placed on the swivel table of the machine. The inspection area covers the welding points, totally 15mm along the axle’s axes. The CT scanning span is 1mm, thus giving 15 CT images for each welding seam zone.
3. Results and discussion

Continuous CT scanning images of the half-axles are shown in Fig. 4. The scanning sequence is from bottom to top along the axle’s axes. The variation trends can be clearly distinguished from the images. In the beginning, an image of the axle’s wall is shown without welding point or defects. Subsequently, three welding points are observed. Then, the welding seam areas are observed piece by piece, which shows the internal structural information for the half-axle.

Figure 4. Continuous CT scanning images of the half-axle of maneuverable aircraft’s stabilizer

Fig. 5 exhibits the typical defects by CT testing for the half-axles. There are several kinds of defects including porosity, inclusion and crack, which may lead to structural fracture and flight accident of the aircraft.

Figure 5. Typical defects by CT inspection of the half-axle of maneuverable aircraft’s stabilizer
4. Conclusions

To resolve the non-destructive testing problem of the internal defects for the half-axles of maneuverable aircraft’s stabilizers, x-ray industrial computed tomography was studied to inspect the welding seam area. Welding seam defects, such as porosity, inclusion and crack, were observed by CT images, proving the effectiveness of CT inspection for welding seam of half-axles of maneuverable aircraft’s stabilizers. Although with high sensitivity and resolution, the CT technology still has some disadvantages, including that the x-ray testing method is not very appropriate for fatigue crack inspection. Therefore, it is necessary to add other methods such as Ultrasonic Testing, and relative investigations are in progress now.

References

