Design and Research on the Hinged Cover of the Fuselage of Civil Aircraft

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Abstract. Due to the complexity of aircraft interior system, some systems need to design components installed in the fuselage, which will open in the fuselage on the formation, at the same time as the aircraft aerodynamic design requirements, the system must be in the form of the opening cover is closed, so in the design of the fuselage flap design system is particularly important. This paper mainly introduces a hinged cover in common design points and design points of cap shape.

1. Introduction
The flap is a common opening structure on the fuselage skin. Its opening angle is the main parameter to measure its structural function. How to design a flap with a simple structure and a large opening angle is the main design of the fuselage flap. This article studies the hinge design key points of a common hinged flap [1] and the key point of the flap panel shape design, compares different hinge design methods and flap panel design methods, and obtains an optimized design scheme for hinged flaps, which provides an important reference basis for the subsequent design of hinged flaps for fuselage skins.

2. Introduction of hinged flap structure
Common hinged flaps on civil aircraft are generally composed of a hinge and flap panel. The hinges fix the flap panel and ensure the flap panel to open and close, and the flap panel protects the internal system components [2] as well as ensures the function of the aerodynamic shape of the fuselage skin [3]. See Figure 1 for the typical structure.
2.1. Hinge structure
Hinges generally consist of two hinge surfaces and one hinge shaft. The two hinge surfaces are respectively connected with the internal system components and the flap panel, and one hinge shaft is connected through the holes on the two hinge surfaces. The typical structure is shown in Figure 2.

2.2. Structure of flap panel
The shape of the flap panel is generally designed according to the openings of the internal system components of the fuselage on the fuselage skin. It also includes a quick-release lock installation opening and a hinge installation opening. The typical structure is shown in Figure 3.
3. Key points of hinged flap design

3.1. Key points of hinge structure design
According to the structural characteristics of hinges, there are two design methods for hinges: a. Two hinge surfaces are installed in the same direction; b. Two hinge surfaces are installed in symmetrical directions. See Figure 4 for details.

Establish a 3D digital model[4] for motion analysis. Under the condition of ensuring the aerodynamic requirements of the fuselage shape, the influence of two different hinge design methods on the final hinged flap is shown in the limit opening angle of the flap panel, and the hinge surface is designed in the same direction. Bottom, the limit opening angle of the flap panel is about 153°, and the limit opening angle of the flap panel is about 92° under the symmetrical design of the hinge surface, as shown in Figure 5 and Figure 6.

Figure 4   Two hinge design methods

Figure 5  Hinge surface installation in the same direction
3.2. Key points of flap panel design

The shape of the flap panel is generally designed to be coordinated with the shape of the internal system components. Common flap panel shapes are round and square, as shown in Figure 7. Taking the hinge surface installation in the same direction as an example, a 3D digital model is established for motion analysis. After analysis, it is known that when the flap panel is opened to the limit position, the edge of the flap panel first contacts the fuselage skin, as shown in Figure 8. Therefore, the edge of the flap panel can be rounded, which can further increase the opening angle of the flap to about 161°. At the same time, since the contact area between the flap panel and the body skin is increased, the machine can be effectively reduced. The body skin is worn, see Figure 9 for details.
4. Introduction of hinged flap structure

After the above analysis, it can be seen that the design of the hinge surface in the same direction in the design of the fuselage hinged flap can increase the limit opening angle of the flap panel, which is conducive to the maintenance operation of the internal system components in the later period; the flap panel and the fuselage are aligned. The rounded corner design of the skin contact can further increase the opening angle of the flap panel and reduce the wear of the skin contact surface of the fuselage.

This paper analyzes the design of the hinged flap of the fuselage skin, and derives the design points of the general hinged flap. Also, through the analysis of different hinge layout forms and different flap shape design forms, a set of optimized design of the hinged flap of the fuselage skin is obtained, which provides an important reference for the subsequent design of the hinged flap.

References

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