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Technical Report

Stability design of honeycomb sandwich radome with asymmetric shape

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ABSTRACT

The die radome, which is made of honeycomb sandwich structure, should be entirely refitted, for a big electronic observation facility is being fixed at the head section of an aircraft. In this work, the stability design of honeycomb sandwich radome is investigated. Initially, a local buckling failure is observed in the refitted radome during the preliminary calculation. Then design improvements are made to the existing radome, like some L-shaped stiffeners are added on the inner surface of metal faring in order to improve the stability of radome. In this way, the critical buckling load of radome increases more than 10 times. Different layout schemes for the stiffeners are studied during this work, and the best structure layout is obtained by discrete optimization method and also the relationship between stability and bar spacing is examined. Finally, the stability of radome under 45 load cases is calculated to validate the design. The result shows that the optimized design greatly improves the stability of radome. This method can be applied to structure design in preliminary assessment.

1. Introduction

As aviation control technology developing rapidly, more complex shapes and types of special materials are being used in making radomes for fighter aircrafts and helicopters, which makes the radome design multifaceted and complicated. A lot of research has been already carried out on shapes and materials of radomes to meet their increasing higher requirements, and different aspects are considered during this research, for example, strength, stiffness, stability and electromagnetic properties etc. [1–4]. As a secondary load-bearing structure, most researchers has been focusing on electromagnetic properties and bird striking [5] problems, rather than its mechanical properties [6–8]. Unfortunately, when the shape of a radome gets complex, the flow field around radome becomes disordered. Generally, the disordered flow will make the radome structure fail in static strength and buckling. Thus, it is necessary to analyze the strength and stability of radomes in early design stage.

In order to improve the observation and control abilities of the fighter aircraft, an electronic observation facility will be fixed at the head section of aircraft. As the volume of facility is large, the head radome should be entirely refitted. The configuration of refitted radome is shown in Fig. 1. There are five parts in the radome, main mask, metal faring, slung-pod, windscreen, and observation platform. The slung-pod, in which the electronic observation facility is fixed, is under the radome. The windscreen is installed in front of the slung-pod. Windscreen, made of special toughness glass which can resist thermal fatigue and solarization, is connected with slung-pod by sandwich structure whose panel is made of aluminum. Metal faring, which is almost flat, is installed below the slung-pod to improve the disordered flow field, which is generated by the large curvature of slung-pod. The refitted radome is asymmetrical with complex shape. So the flow filed distribution around radome is extremely disturbed and disordered. Mechanical properties such as strength, stiffness and stability are greatly influenced by the disordered flow field and plays very critical role in the radome design. In this paper, stability of refitted radome will be studied.

2. Finite element model

It is expensive and time-consuming to test the strength and stability of the whole radome. In the present study, finite element (FE) method [4] is used to evaluate mechanical properties in the early stage of structure design for its simple, fast and economical merits.

2.1. FE modeling

The FE model of radome is implemented in Patran/Nastran environment. Two dimensional (2D) triangular element is used to discretize the radome model. The FE model mesh has 69,438 2D triangular elements. The windscreen is connected with slung-pod through aluminum clamping plane. Based on this connecting method, the windscreen is dominated by small deformation. Multiple-point constraints (MPC) element can simulate not only the linear equation among multiple degrees of freedoms, but also the rigid constraints or the linear relations among specified nodes. So

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