

DESIGN AND STRESS ANALYSIS OF SWEEPED BACK WING WITH NASTRAN AND PATRAN

T J Prasanna Kumar¹, G Rajagopal², P Rohith Sai³, S Anvesh⁴, S Durga Das⁵

¹Assistant Professor, Dept of Aeronautical Engineering, PVPSIT, Andhra Pradesh, India

^{2,3,4,5}Dept. of Aeronautical Engineering, PVPSIT, Andhra Pradesh, India

Abstract - A wing is a type of fin that produces lift while moving through air or some other fluid. As such, wings have streamlined cross-sections that are subject to aerodynamic forces and act as airfoils. A wing's aerodynamic efficiency is expressed as its lift-to-drag ratio. The lift generated at a given speed and angle of attack can be one to two orders of magnitude greater than the total drag on the wing. A high lift-to-drag ratio requires a significantly smaller thrust to propel the wings through the air at sufficient lift.

In this article an attempt was made to bring out the challenges associated with the design of a Swept Back Wing for aircraft. A swept wing is a wing that angles either backward or, occasionally, forward, from its root rather than in a straight sideways direction. Wing sweep has the effect of delaying the shock waves and accompanying aerodynamic drag rise caused by fluid compressibility near the speed of sound, improving performance. The objective is to design and perform structural analysis of Swept Back Wing for aircraft with different load conditions and load factors. The Swept Back Wing is designed in CATIA tool and the linear static structural analysis is performed through MSC NASTRAN PATRAN software with satisfactory factor of safety.

Key Words: Swept Wing, CAD, CAE, FE Modelling

1. INTRODUCTION

Wings develop the major portion of the lift of a heavier-than-air aircraft. Wings structures carry some of the heavier loads found in the aircraft structure. The particular design of a wing depends upon many factors, such as size, weight, speed, rate of climb, and use of the aircraft. The wing must be constructed so that it holds its aerodynamic shape under extreme stresses of compact maneuvers or wing loading.

Wing construction is similar in most modern aircraft. In its simplest form, the wing is a framework made up of spars and ribs and covered with the metal.

Spars are the main structural members of the wing. They extend from the fuselage to the tip of the wing. The entire load carried by the wing is taken up by the spars. The spars are designed to have great bending strength. Ribs give the wing section its shape, and they transmit the air load from the wing covering to the spars. Ribs extend from the leading edge to the trailing edge of the wing.

In addition to the main spars, some wings have a false spar to support the aileron and flaps. Most aircraft wings have a removable tip, which streamlines the outer end of the wing.

II. DESIGN CONSIDERATIONS

2.1 WING DESIGN PARAMETERS



$$\begin{aligned} R &= \text{Wing span} \\ \Lambda &= \text{SWEPT RATIO} = \frac{b \sin \Lambda}{b} = \frac{R}{b} \\ \Lambda &= \text{SWEPT OR SWEEP ANGLE} \\ R &= \text{wing width (ft)} \end{aligned}$$

2.2 SELECTION OF WING SPAN

Selecting the wing span is one of the most basic decisions to be made in the design of a wing. The span is sometimes constrained by contest rules, hangars, tie, or ground facilities but when it is not we might decide to use the largest span consistent with structural dynamic constraints (flutter). This would reduce the induced drag directly. However, as the span is increased, the wing structural weight also increases and at some point the weight increase offsets the induced drag savings. This point is rarely reached, though, for several reasons.

1. The optimum is quite flat and one must stretch the span a great deal to reach the actual optimum.
2. Concerns about wing bending as it affects stability and flutter mounts as span is increased.
3. The cost of the wing itself increases as the structural weight increases. This must be included

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