Engine mount joints using shape factor in aircraft design

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Abstract

Optimizations of power plant joints for modern and new types of aircraft jet engine have for a considerable time been applied successfully in the aerospace industry, but still has not become a mainstream technology for the design of universal aircraft mounts. The explanation for this is partly to be sought in the larger problem sizes and in the often quite complicated support and loading conditions for aircraft components and engine mounts. Also, aircraft components are often stability designs and the compliance based optimization using shape factor method.

Keywords: airframe design, engine mount, strength, engine installation, stress, strain member, joint of structure

1 Introduction

The question is how to deal with this 'more with less' mentality. The purpose of this research is to investigate and measure the changes of structure and strength for effects of optimization associated with taking a micro approach to stable aircraft design estimation.

Results show that there is a significant difference between estimating at the differing of assembly levels. However, from a practical standpoint, the difference in dollar terms is too small to be considered significant. As a result, engineer should allocate resources based on other constraints such as time allotted to complete the maintenance or required level of visibility into the inspections of jet engine joints.

2 The mating joints

Mounting jet engines on the airplane structure is somewhat simpler than in the case of reciprocating engines. The engine mounts must be designed to prevent airplane deflections from introducing loads into the powerplant, and must permit thermal expansion of the engine both axially and radially [1].

The major portio of the vertical loads is carried on two trunnions located near the engine C.G. Side loads are taken out on the trunnion on one side only, the other being free to move laterally to allow for thermal expansion. The forward mount (some design are located in the aft) is a universal joint capable of carrying vertical loads only. Since the trunnions are located near the C.G., therefore the major forces imposed on the front support arising from the gyroscopic couple caused by angular velocity in yaw and inertia moment caused by angular acceleration in pitch are small. Since the moving parts in a gas turbine have a simple rotary motion, and since combustion is continuous rather than intermittent, the unbalanced forces which might excite vibration are few in number and small in magnitude.

Detail design have two main concepts:

- Process Selection
- Materials Selection

We will concentrate on most important joints check calculation. In this case we have estimated section of cantilever of link design for engine axial expansion is shown in Figure 1.

Eliminate the free variables using each constraint in turn, giving a set of performance equations (objective functions) of the form: where σ and τ is adequate strength are expressions containing the functional requirements of geometry and materials indices J, S stiffness and dependent variables are Q, M mass loads.

If the beam is to meet both constraints then, for a given material, its dimensions are determined by the lowest of factor *F*. As a result of these assumptions it is needs to resolve multiple constraints equations:

$$\left.\begin{aligned} f1 &= \frac{Q \cdot S_{x\max}}{J_x \cdot s} - [\tau] \\ f2 &= \frac{M}{J_x} \cdot y_{max} - [\sigma] \end{aligned}\right\} F \rightarrow \min \quad , \qquad (1)$$

where

$$J_x = \frac{s \cdot (h-2t)^3}{12} + \frac{b \cdot (2s)^3}{12} \quad , \qquad (2)$$

$$S_{x\_\max} = b \cdot t \cdot \left(\frac{h-t}{2}\right) + (y_i \cdot s) \cdot \frac{y_i}{2} \quad . \qquad (3)$$

If the beam is to meet both constraints then, for a given material, its weight is determined by the lowest of f1 or f2 Figure (1).

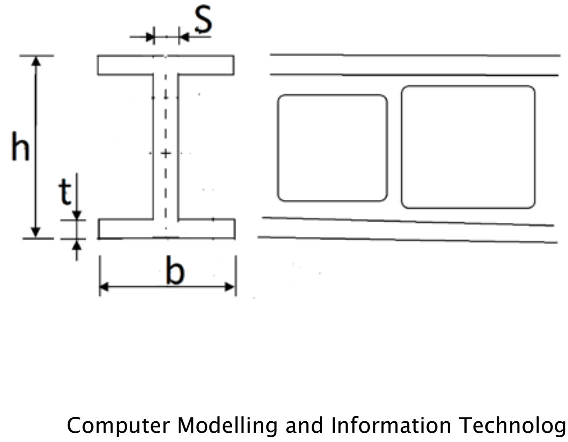

FIGURE 1 Cross-section of joint element

3 Structures estimations

All tail mount engines (inside fuselage as shown in Figure 1) are designed to withstand forward decelerations in those direction which would allow a less securely mounted engine.

An engine mount is a frame that supports the engine and holds it to the fuselage or nacelle. It may be made of built-up sheet metal, welded steel tubing, or some other suitable material. Engine mounts vary widely in appearance and construction, although the basic features of construction are similar and well standardized. They should be designed so that the engine and its accessories are accessible to inspection and maintenance. Engine mounts may be built as individual units which can be detached easily and quickly from the supporting structure. In many of the large transport aircraft, the engine mounts, the engine, and its accessories are removed and replaced as a single complete power-unit assembly, this makes maintenance and overhaul simpler as well as the time required for engine change much shorter. The bushings are often a part of the engine-mountings bracket and may be installed on the engine at the factory. The maximum vibration absorption is obtained when the mounting bolts are tightened so that the engine can move within reasonable limits from any fore-and-aft movement.

The torsional motion is damped by the restraining action of the pads or cushions and the friction of the metal surface held by the bolts. If these bolts are too tight, the mounts tends to vibrate with the engine, which is obviously undesirable. The typical turbojet engine tail mount installation is shown Figure 2.

The Fig 2 shows a detailed turbojet engine mount known as the QEC (QEC is an abbreviated notation for "Quick Engine Change"). It is a semi-rigid structure made up of frames, shear panels, and truss members [2].

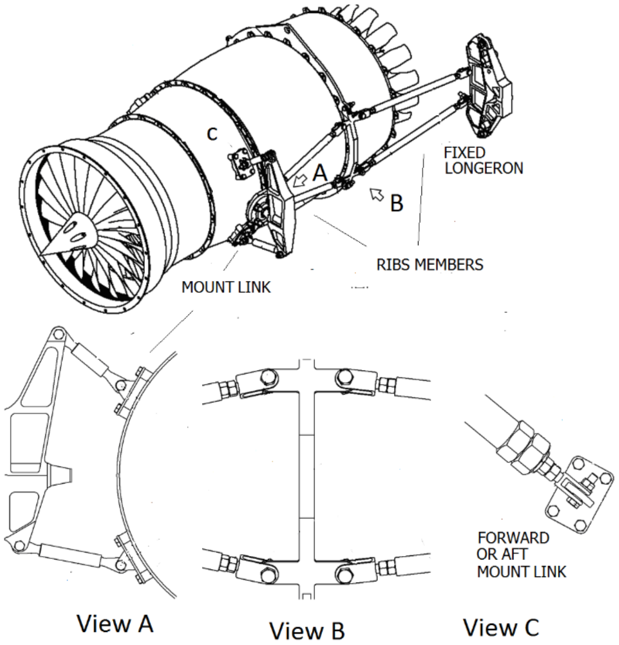

FIGURE 2 Detail configuration of QEC engine mount

4 Conclusions

At present, most jet engines are attached rigidly to the airplane structure. Some fuselage engine mounts for modern and new types of aircraft jet engine are shown in Figure 2 engine-mount supports virtually the entire power plant in the usual case, although for engines of large horsepower the engines mounts do not extend more than a few inches beyond rearmost accessory. It is a better engineering design to use tubular steel or titanium alloy supports which may be enclosed with a suitable cowling because of the necessity of gaining access to various parts of the engine and its accessories [2].

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References

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