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Cracking in cargo aircraft main landing gear truck beams due to abusive grinding following chromium plating

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Abstract

While a wheel was being replaced on the subject aircraft, a crack was found on the rear axle bore of the left-hand main landing gear truck beam. This part had been overhauled 11 months earlier. One year later, while the subject aircraft was being parked, two loud bangs were heard coming from the right-hand main landing gear. Upon inspection, the right-hand truck beam was found cracked longitudinally at two locations on the rear axle bore. Microscopic examination revealed two crack origins, one on each side of the bore. Both cracks propagated from corrosion pits under the chromium plating in a stable intergranular mechanism. The final overload fracture produced quasi-cleavage features. Nital etch, following removal of the chromium plating, revealed areas of overtempered and untempered martensite indicative of heat damage incurred during abusive grinding. The hardness of the material in the heat-affected areas and in the areas adjacent to the origins was lower than that of the surrounding tempered martensite structure. These heat-affected areas were located in the chromium plating runout plateau adjacent to the counterbore transition radius and exhibited numerous thermally induced secondary cracks. It was concluded that the cause of failure was improper overhaul process, which left grinding burns and cracks beneath the chromium coating. Subsequently, electrolyte that penetrated through these cracks promoted the formation of pits beneath the coating, which served as preferred sites for failure initiation.

Keywords: Aircraft failures; Stress corrosion cracking; Non-destructive testing; Design; Landing gear

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1. Introduction

This paper is based on failure analyses of two truck beams from the main landing gear (MLG) of a cargo aircraft due to abusive grinding following chromium plating. The MLG consists of two struts to which four-wheel bogies are mounted. The landing gear is attached to the wing and is retracted inboard into the thickened juncture of the wing and fuselage. An illustration of the assembly is given in Fig. 1.

The landing gears are being overhauled once in 10 years according to the maintenance instructions of the manufacturer. The main stages in the overhaul process include:

(1) Sand cleaning to remove paint and rust.
(2) Removal of the chromium plating from marked areas, followed by stress relieve heat treatment.
(3) Use of non-destructive testing (NDT) by means of the magnetic particles technique [1].
(4) Shot peening.
(5) Chromium plating of the machined areas per MIL-STD-1501 (class 1, type II) [2], followed by grinding in accordance with MIL-STD-866B [3] to restore design dimensions and finish. The chromium plate runout plateau is that area of the chromium-plated surfaces where the chromium thickness changes from the required value to zero. The runout should be produced during the plating operation by use of special electrodes, current robbing, metal tape and shields, to provide a proper gradual runout (over a distance of about 2 mm) without formation of a bead or a square edge. The application of a solid film lubricant on top of chromium is recommended by the manufacturer, but is not considered as mandatory. Certain users prefer to apply corrosion prevention compounds (CPCs) to the interior of the truck beam after washing.
(6) Stress relieve heat treatment.
(7) Cadmium plating of the rest areas per MIL-STD-870 (type III) [4], followed by heat treatment to release hydrogen.

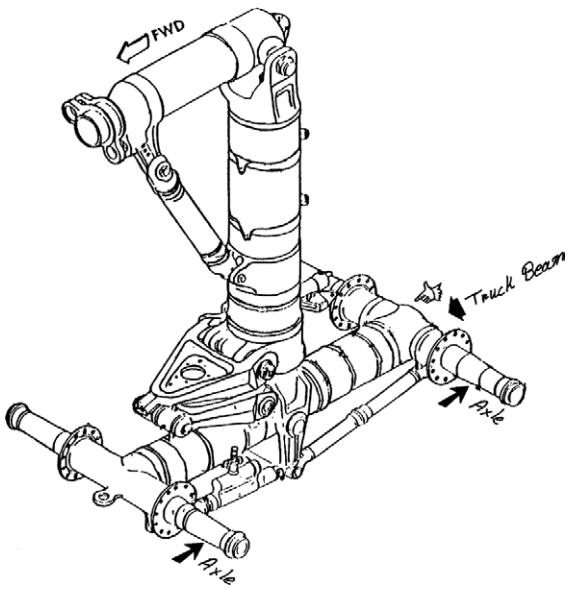

Fig. 1. Illustration of the main landing gear assembly on the subject aircraft. A finger marks the region of failure.