LAMBDA Technologies Group

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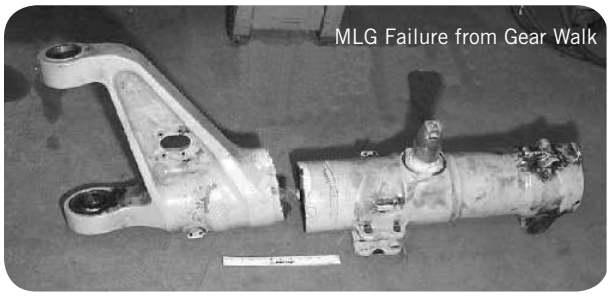
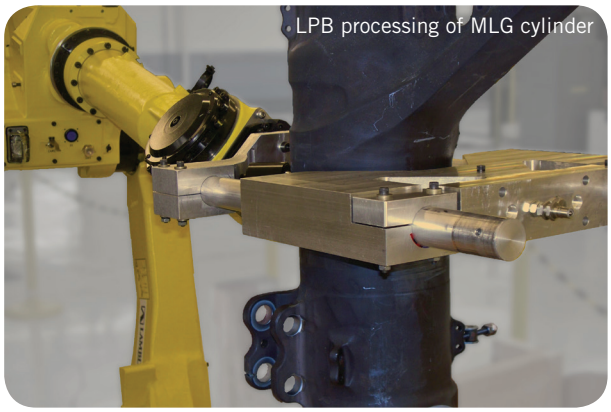
Improving Component Life and Performance

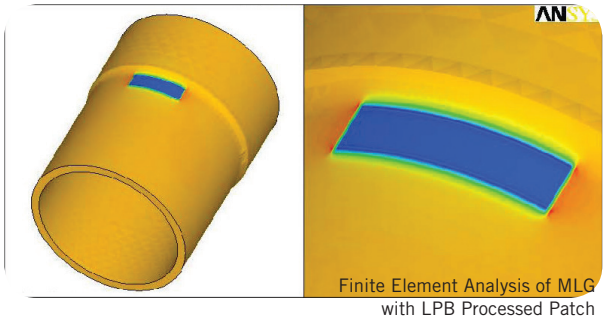
Landing Gear

High strength steel is used in landing gear because of its unique combination of extremely high strength with high fracture resistance. However, regular impact and braking during landing causes high hydraulic system induced vibratory stresses in the cylinders of some types of landing gear, referred to as “gear walk”, and can potentially lead to fatigue failure. Six fatigue failures of the MD-88 main landing gear (MLG) shock strut cylinder resulted in main gear collapse since 1995. An FAA Airworthiness Directive (AD) to install hydraulic brake line restrictors dampened the vibration and stopped further crack initiation, but propagation of existing small cracks led to continuing failures. A superseding AD mandated repetitive particle inspections, costing Delta Air Lines 5,500 man hours and over $1M annually to continue flying, not including income lost to downtime. Only total replacement of the cylinders at $80,000 each would stop mounting inspection costs.

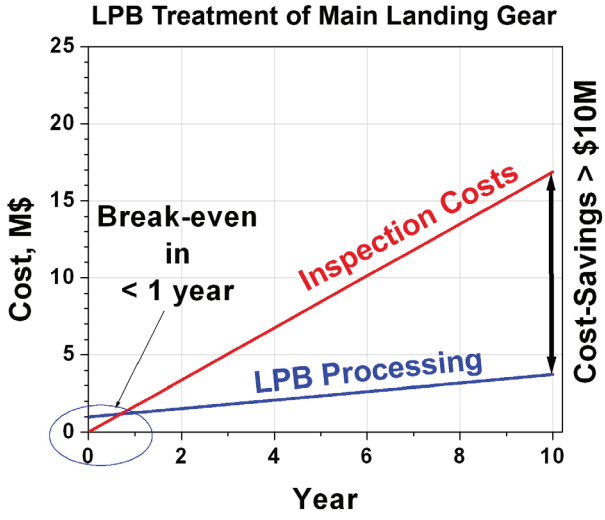

MLG Failure from Gear Walk


LPB processing of MLG cylinder

SOLUTION: The MLG cylinder was a good candidate for application of Lambda’s low plasticity burnishing (LPB®) technology to increase fatigue life and improve operational safety. A request for an Alternative Method of Compliance (AMoC) was submitted with detailed plans for testing and implementation. The FAA approved plan included LPB treatment, residual stress measurements and high cycle fatigue testing with specific goals required at each stage of the program. The goals were achieved and exceeded throughout each phase of the program, most notably in the high cycle fatigue testing. Based on these successes, a robotic implementation of LPB treatment to the crack-prone region made it possible for in situ processing during routine maintenance operations without the need to remove the MLG cylinder from the aircraft. This successful demonstration led to the approval of an AMoC for the AD in early 2013.


Finite Element Analysis of MLG with LPB Processed Patch

IMPACT: A total of 844 MD-88 aircrafts are reportedly in service. Of those, over 150 MLG cylinders have been LPB treated to date in maintenance, repair and overhaul facilities in Minneapolis, MN. Because LPB is applied in-situ during regularly scheduled maintenance, implementation has been easy and the process has proved to be a very cost-effective means of improving fatigue strength. It is estimated that this AMoC will save over $10 million in inspection costs alone for one major airline. The savings could be much larger if costs of grounded planes, scheduling, and replacement of cylinders were to be included in the cost-benefit analyses.



For more information on this and other LPB applications, visit our website at www.lambdatechs.com.

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