Log 2550

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: July 3, 1995
In reply refer to : A-95-68 through -70

Honorable David R. Hinson
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On November 3, 1994, a McDonnell Douglas MD-83, French registration F-GHED, operated by Air Liberte Airlines, Tunisia, was involved in an accident while landing at Kajaani Aerodrome, Kajaani, Finland. The airplane reportedly touched down firmly about one-third of the way down the 8,202-foot runway. The pilot reported that the wheel brakes were ineffective and that the main landing gear (MLG) vibrated during the landing roll. The pilot had steered the airplane to the right side of the runway to avoid the approach lights at the runway end. The airplane subsequently yawed to the right and went off the right side of the runway. The left main landing gear (LMLG) collapsed into the wheel well as the airplane departed the runway. The 164 passengers and seven crew aboard the flight evacuated the airplane; one passenger was injured during the evacuation. The airplane received substantial damage; however, there was no postcrash fire.

Examination of the tire marks on the runway indicated that the LMLG made "serpentine" marks on the runway, indicating heavy vibration. These marks were followed by heavier spiral marks, indicating that the LMLG was rotating horizontally (castoring) as the airplane travelled down the runway. Serpentine marks from the right main landing gear (RMLG) were also observed on the runway for a short distance.

Postaccident examination of the wreckage was conducted by the Finish Civil Aviation Administration (CAA) and the Douglas Aircraft Company (DAC) in Kajaani, Finland. The examination of the wreckage showed that the LMLG shimmy damper remained attached to the landing gear structure, and the shimmy damper reservoir had separated along with the upper and lower torque links. The RMLG upper and lower torque link arms had also separated. The RMLG's shimmy damper remained attached to the upper torque link, but the reservoir had separated. Threads on the right apex bolt were found stripped, and both the right and left apex nut were found on the runway with bolt threads stripped.

The McDonnell Douglas MD-80 and earlier DC-9 series airplanes are configured with shimmy dampers, which provide torsional/lateral vibrational stability to the landing gear during the landing roll (see Figure 1). The upper torque link is connected to the main stationary strut, and the lower torque link is connected to the compressible strut. Both the upper and lower torque links are connected to a shimmy damper with a single apex bolt. The upper torque link remains stationary, and the lower torque link moves laterally along with the apex bolt to provide a lateral damping movement.

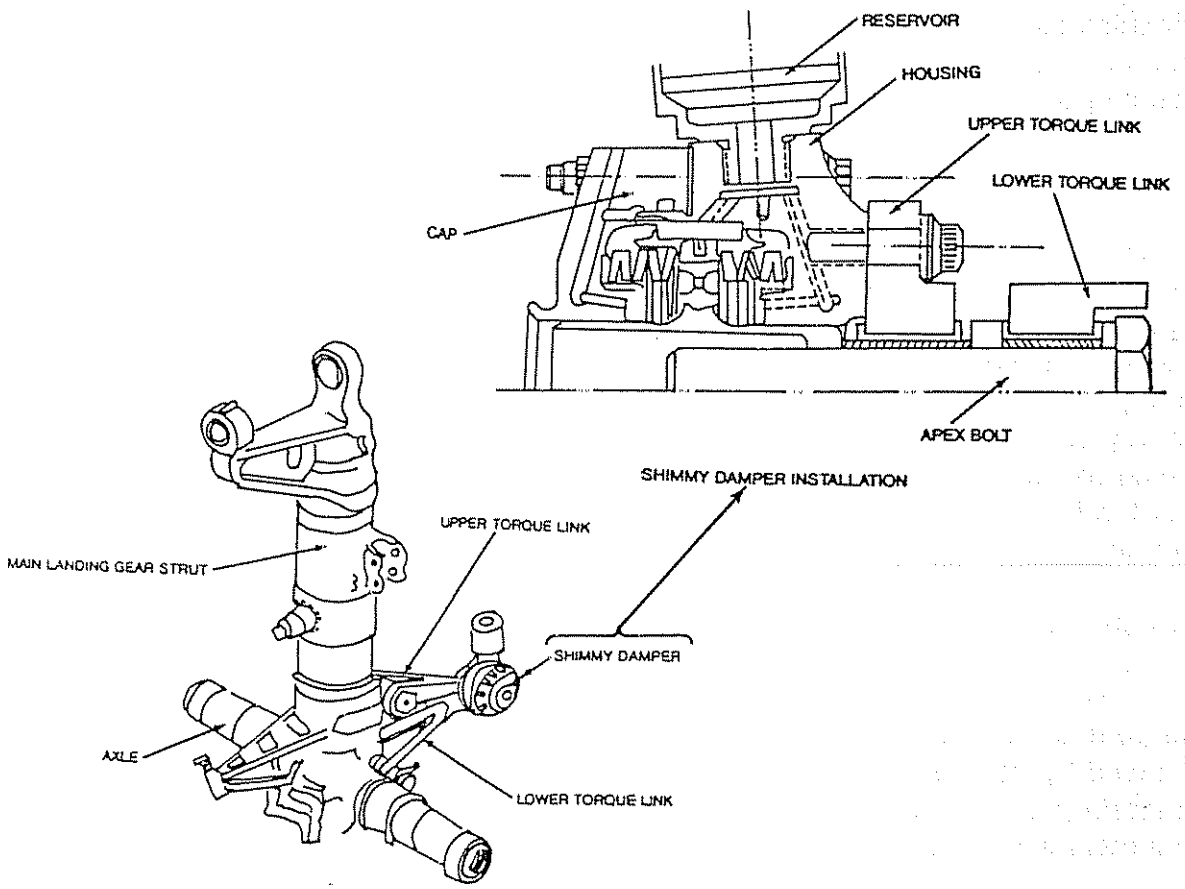

FIGURE 1. MAIN LANDING GEAR SHIMMY DAMPER ASSEMBLY

DAC records indicate that, before the Kajaani accident, a total of five MD-80 series accidents/incidents had occurred since 1989, involving MLG vibration and

subsequent failure of torque links, side braces, and shimmy dampers.[1] The Safety Board has investigated four in-service MD-80 accidents/incidents -- three involving Continental Airlines at Denver, Colorado, and one involving USAir at LaGuardia Airport, New York. The landing parameters of each of these occurrences were very similar. In each case, auto brakes were not armed, and moderate-to-light braking was applied during the landing roll. Moderate-to-severe MLG vibrations were experienced after touchdown, with structural damage to the MLG and shimmy damper components. Each airplane touched down with spoilers armed and at higher-than-normal ground speed. Although the pilots reported that the spoilers were armed, they did not deploy automatically after touchdown and were not deployed manually by the flightcrew members. Following the fourth in-service incident, the DAC issued All Operators Letter (AOL) FO-AOL-9-043, on September 30, 1994, which advised MD-80 operators' Flight Operations Departments of the four in-service incidents and recommended operating procedures to reduce MLG vibration during the landing roll. As a result, the DAC evaluated possible improvements to brake control/MLG stability in the MD-80. The AOL recommended flying a stabilized approach using appropriate approach speeds, avoiding unnecessary heavy braking during landing roll, and using the thrust reversers in accordance with the Flight Crew Operating Manual (FCOM). The AOL specifically recommended:

> (1) Ground spoilers should be used for all landings, and should be deployed (manually, if necessary) prior to brake application, runway permitting.
>
> (2) Fly a speed stabilized approach, using appropriate approach speeds and maximum flaps to reduce landing speeds/distance.
>
> (3) Avoid landing long to reduce the need for maximum braking.
>
> (4) Use the thrust reverser in accordance with the Flight Crew Operating Manual (FCOM) to reduce wheel braking energy required during landings and aborted takeoffs.
>
> (5) Avoid unnecessary heavy braking during the landing, if possible, to further reduce braking loads. When the autobrake system is used, select the MINIMUM or MEDIUM position when possible.

[1]This includes one production flight test airplane and four in-service airplanes. An incident involving a production flight test aircraft occurred at Long Beach, California, during a maximum brake functional check at normal landing speed. The aircraft experienced MLG vibrations and failure of the torque link. The landing parameters of this airplane are not similar to those of other accidents/incidents, and is therefore not considered for analysis.

(6) Autobrakes, if installed, should be armed for takeoff and used per FCOM procedures in the event of a rejected takeoff (RTO). It is important that the crew ensure that the spoilers are deployed during an RTO.

(7) If a substantial main gear vibration is felt (may appear as a heavy shudder or low frequency vibration) above approximately 50 knots during deceleration, momentarily release the brakes and reapply them smoothly to a lower braking level as soon as the vibration stops. If conditions warrant, however, maximum braking should be utilized.

According to the DAC, the procedures recommended in the AOL will reduce the likelihood of encountering MLG vibration and will minimize exposure time if vibration is encountered in the MD-80 series airplanes.

The Safety Board notes that the AOL only addresses MD-80 (DC-9-80) series airplanes. Since the MD-80 series airplanes are derivatives of earlier DC-9 models, the design, performance, and operational parameters of the two airplanes are very similar. The Safety Board is concerned that other DC-9 series airplanes might also encounter MLG vibrations during the landing roll. Safety Board and DAC records identified just one earlier DC-9 model airplane incident involving MLG vibrations during the landing roll and that incident was initiated by excessive clearance between the LMLG torque link pins and their bushings. Although the Safety Board was unable to identify previous incidents involving MLG vibrations during the landing roll due to operational factors in earlier DC-9 models, the Safety Board believes that the DAC should issue an AOL, or modify the current MD-80 AOL, to address earlier DC-9 series airplanes and to ensure that those operators are aware of the lessons learned from the MD-80 incidents.

The examination of the MLG components (including antiskid control, spoiler control, brakes, and shimmy damper) of the Continental Airlines and Air Liberte accident/incident airplanes led the DAC to conduct extensive flight, simulator, mathematical model, and laboratory testing of the components. As a result of these tests, the DAC issued three service bulletins (SBs) applicable to all MD-80 series airplanes to reduce the potential for MLG vibration during landing roll. The DAC has flight-tested the MD-80 airplane extensively in an effort to duplicate the MLG instability experienced in the MLG vibration accidents/incidents. The DAC was unable to duplicate the gear instability in these tests. Nevertheless, DAC analytical simulations and laboratory tests of the MLG components indicate that the three SBs will improve the stability margins of the MLG.

SB A32-275, effective January 4, 1995, recommends removing shims between the hydraulic damper cap and hydraulic damper assembly housing, and increasing the torque on the bolts holding the cap and the housing. These changes allow higher preload on the internal metal-to-metal seal of the damper chamber components and

reduce internal fluid leakage from the damping chamber to the reservoir, thus decreasing the possibility of reduced damping efficiency due to cavitation. The recommended compliance time is 12 months after receipt of the SB.

SB 32-276, effective March 31, 1995, recommends adding or replacing filtered orifices/restrictors in the brake lines down stream of the antiskid control valves, which act to reduce brake control and gear motion coupling by altering the brake control antiskid cyclic frequencies away from the natural frequency of the landing gear. The restrictors alter the antiskid cyclic frequencies by slowing the fill rate of the brake cylinders. The recommended compliance time is 2 years.

SB 32-278, effective March 31, 1995, recommends installing new or reworking existing hydraulic dampers to improve internal damper chamber flow characteristics. The improvements increase the refill capability of the damper chamber under high velocity cyclic loading by enlarging and/or unblocking internal passages between the damper reservoir and the damping chamber. The result is sustained power absorption capability. The recommended compliance time is 3 years.

The Safety Board believes that the previous MD-80 accidents/incidents resulting in MLG vibration during the landing roll indicate inadequate performance of MLG components. The Safety Board has reviewed SBs A32-275, 32-276, and 32-278 and believes that mandating the accomplishment of the SBs would reduce the potential of MLG vibration, failure, and of an accident during landing roll.

The Safety Board notes that the shimmy dampers on the MD-80 and earlier DC-9 models are similar in design and function. Due to this similarity, the Safety Board believes that any change in design or modification made to the shimmy dampers of the MD-80 may also be appropriate to the shimmy dampers installed in earlier DC-9 series airplanes. The Safety Board recognizes that the landing/takeoff weight, speeds, and other factors/issues need to be considered before effecting any change to the design of the DC-9 series airplane's shimmy damper, and therefore believes that the FAA should, in conjunction with the DAC, evaluate whether implementing design changes or modifications to earlier model DC-9 series airplanes' shimmy dampers, as specified in SBs A32-275 and 32-278 for MD-80 series airplanes, would be appropriate.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Issue an airworthiness directive to require compliance with the Douglas Aircraft Company's MD-80 Service Bulletins A32-275, 32-276, and 32-278 within the recommended compliance time to reduce the potential for landing gear vibration and resultant failure during the landing roll. (Class II, Priority Action)(A-95-68)

In conjunction with the Douglas Aircraft Company (DAC), evaluate the possibility of implementing modifications to DC-9-10, -20, -30, -40 and -50 series airplane shimmy dampers as specified in the DAC's SBs A32-275 and 32-278 for the MD-80 series airplane to enhance the performance of the shimmy damper and to reduce the potential for landing gear vibration and failure during the landing roll. (Class II, Priority Action)(A-95-69)

Require McDonnell Douglas to issue an "All Operators Letter," similar to FO-AOL-9-043, dated September 30, 1994, to all DC-9 operators, to recommend operating procedures that would reduce the likelihood of encountering main landing gear vibrations during landing and to minimize exposure time if vibration is encountered. (Class II, Priority Action) (A-95-70)

Chairman HALL, Vice Chairman FRANCIS, and Member HAMMERSCHMIDT concurred in these recommendations.

By: Jim Hall
Chairman