ANSV AGENZIA NAZIONALE PER LA SICUREZZA DEL VOLO

Prot. **1724/INV/419/7/07**
Rome, July 26th, 2007

SAFETY RECOMMENDATION

Subject: Boeing 737/8AS, registration marks EI-CSN. Accident occurred on June 25th, 2007, at Treviso airport (Italy).

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Synopsis

On June 25th 2007, at 15.46 UTC, the aircraft B737/8AS, registration marks EI-CSN, operating flight FR 9513 from Gerona (LEGE) to Treviso Sant'Angelo (LIPH), suffered the NLG left wheel separation during the landing roll.

Cockpit and cabin crew members reported a loud "bang" three to five seconds after the nose wheel touched the runway, at an aircraft speed of approximately 100 kts. After that, the aircraft yawed slightly to the left, but no difficulties were reported in keeping the centreline. The subsequent actions were carried out uneventfully till the stand, when the separation was observed.

Upon notification, the Agenzia Nazionale per la Sicurezza del Volo (ANSV) opened an investigation and immediately required the acquisition of the broken component.

Although the part was early sent to a specialized laboratory for further metallurgical analyses, based on the results of preliminary macrofractographic examination (visual exams, Photo n. 1), some key elements have already been identified and the following considerations have been made.

Photo n. 1: EI-CSN as landed at LIPH.

Findings

The separation of the wheel was due to the structural failure of the NLG axle, part of the assy inner cylinder P/N 162A1120-2, s/n 5018.

The component, made of high strength steel, AISI 4340M or 300M (UTS 1860÷2070 MPa) failed on its left side (scheme in Figure 1), where the wheel was installed, at 15.309 Cycles Since New (CSN), about 1/5 of its life (75.000 cycles).

Based on the maintenance history of the component, this part was manufactured in 2000 and consequently did not undergo any overhaul inspection (OH), scheduled at ten years.

With respect to the 1C inspection, scheduled every 4.000 cycles, the last one was recently accomplished at a certified facilities in UK on June 06th 2006 at 15.205 CSN.

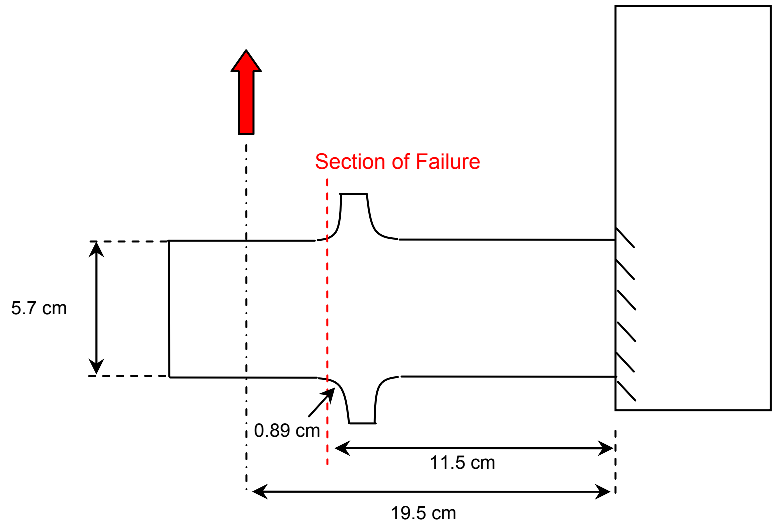

Figure 1: structural scheme of the axle.

Analysis

The fracture surface (Photo n. 2) appears exempt from plastic deformation, in agreement with the high strength and consequently brittle nature of the material.

On the fracture surfaces two main areas can be highlighted:

- Area A, dark brown and semi-elliptical or fan shaped, which covers about 5% of the whole fracture surface. This area is located at 6 o'clock position, therefore in the lower part of the axle, where the highest tensile stresses, due to the flexional behaviour imposed by the weight, are concentrated (see scheme in Figure 1). This area is associated to the progressive crack that developed till the final breakage occurred;
- Area B, light grey and plenty of chevron marks, typical of dynamic failures of brittle materials, which covers the remaining 95% of the fracture surface. It is associated to the final and instantaneous breakage of the axle.

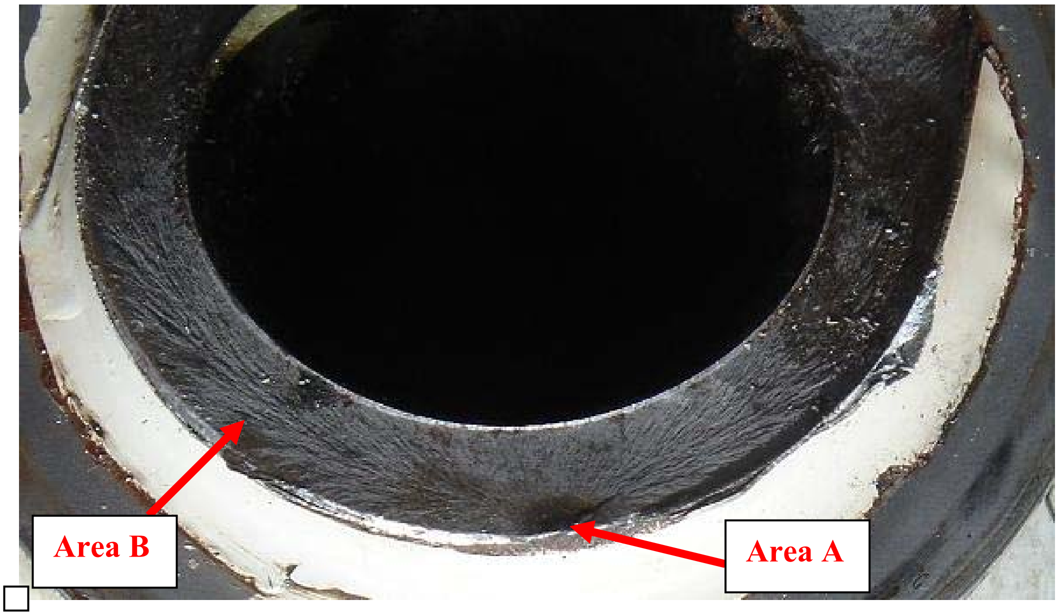

Photo n. 2: fracture surface of the axle connected to the wheel, areas A e B

This facts show that the axle failure proceeded in two different steps: the first when the progressive crack developed from the high stress region till covering a reduced section of the axle, and the second, covering a much wider area when the final instantaneous breakage took place. During this final breakage, the association of the impact forces due to the landing explains the pattern of the upper part of the fracture surface, that doesn't appear flat and in-plane with the lower part.

With respect to the progressive crack in Photo n. 2, the brown colouration of the area is likely due to a corrosion phenomenon taking place.

This evidence supports the deduction that the structural failure was probably due to a Stress Corrosion Cracking (SCC) phenomenon initiated from general corrosion taking place on the external surface of the axle.

As a matter of fact, when observing the external surface of the component near the crack initiation region, the presence of an uniform corrosion process, accompanied by some pitting, was found (arrow in Photo n. 3).

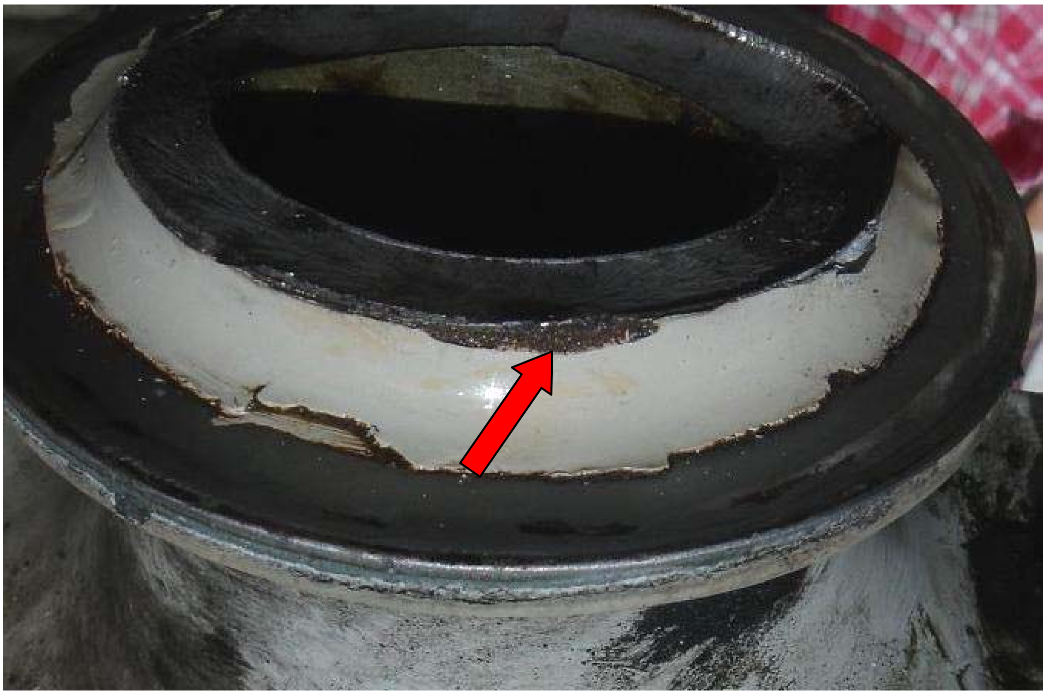

Photo n. 3: presence of uniform corrosion on the external surface, right where the progressive crack initiation.

Considerations

The observed failure shows the same characteristics of the similar event occurred on June 15th 2006 at another B737, registration marks EI-COI, flight AP 2843, while taking-off from Catania Fontanarossa airport to Rome Fiumicino (LIRF).
In that event, the subsequent metallurgical analyses had confirmed the SCC nature of the failure and identified a critical depth for the external pitting to promote such a phenomenon.
Based on those observation, ANSV issued a safety recommendation (**ANSV-17/341-06/1/A/06**) which required a revision of the current Corrosion Prevention Task Card, explicitly calling out

removal of the spacer and visual check for corrosion on the area beneath it, with particular attention to be focused at the 6 ‘o clock position.

Up to now a review task has been recently completed by the manufacturer and a specific task requiring removal of the spacer and a corrosion inspection every "C" check will be added. The AMM and MPD will also be revised to reflect the same requirement and the 737 NG and Classic versions will also have identical requirements, and these changes are expected to be available by October 2007.

In the meanwhile, the proactive campaign carried out by the Italian operator that suffered the previous failure, showed that 2 out of 18 of the aircraft inspected for corrosion showed presence of surface degradation, determining the axle replacement.

Conclusions

The failure was due to a crack that progressively extended till the critical size for the material, when the instantaneous breakage of the part occurred.
Currently, stress corrosion cracking is thought as the most probable failure mechanism, since an uniform corrosion attack was observed in the region of the external surface where the highest stresses are concentrated.
Similarly to a previous event the component recently underwent a 1C inspection where the phenomenon, most likely already present, could not be individuated due to a lack of the suitable inspection procedures.

Recommendation

Based on the previous considerations, pending the maintenance manual revision, ANSV recommends European Aviation Safety Agency (EASA) and Federal Aviation Administration (FAA) to:

> **perform an** *una tantum* **visual inspection on the NLG axles installed on all the 737 models currently equipped with similar component. The inspection should be accomplished by preliminary removal of the spacer and then particularly focused on verifying any presence of corrosion at the 6 o’clock position after removal of the spacer. If corrosion is detected in that specific area an additional NDT for cracks (dye penetrants or MPI) has to be implemented.**
>
> **As a matter of fact, when not correctly found and removed, the corrosive attack seems able to promote an instantaneous failure of the axle, also when it has a short accumulated life with respect its original time limit.**
> **(ANSV-8/419-7/1/A/07).**

Original signed

Prof. Bruno Franchi

ANSV President