STRESS FRACTURE ON A BOEING 757 : OBSERVATIONS BY A GEOLOGIST

May 21, 2012

Richard R. Donofrio Oklahoma City, OK

As geologists we are accustomed to observing rock fractures in outcrops, cores, and elsewhere, but what about airplanes? It turns out that a fracture is a fracture regardless where it occurs and that our training and observations over the years really do help. Like joggers who develop stress fractures, aircraft likewise can develop fractures from the stresses and strains of flight. Here are some observations from a recent trip in a venerable Boeing 757.

Photos were taken using a first-generation (euphemism for old) 3.2 megapixel digital camera. The camera does not have optical zoom, and the lens makes images appear to be more distant from the camera than actual. Consequently, the relatively low pixel number and enlargements leave much to be desired. The unaided eye sees much more than the camera reveals.

Photo 1. Passenger's view of 757 wing

This is a passenger's view from a seat over the ~ 60 foot (18 meter) wing of a 757. The outboard and inboard flaps are starting to deploy for landing (outboard flaps are farthest on the wing). The eye clearly sees a fracture on the outboard flaps. Distance of the aircraft window to the closest segment of the fracture is about 26 feet (8m). A picture is taken, but the fracture cannot be recognized in the small viewing screen of the camera. When the photo is later enlarged and enhanced using a software imaging program, this picture emerges (next page).

Photo 2. Stress fracture on 757 outboard flap

A linear stress fracture parallel with the rivets can be seen extending virtually the entire length of the outboard flap, which is about 23 feet (7m)*. There are several sets/rows of rivets on the flap that are readily seen with the eye** but not with the camera. This stress fracture was positioned close to the last set. Another photo is on the following page.

* *Flap specifications for the 757 could not be found. The length is estimated from a Boeing schematic of the 757 to scale.*

** *Compared to a digital camera the pixel equivalent of the human eyes exceeds 500 million, depending on the field of view and other parameters. Under the best viewing conditions the color sensitivity of the eyes enables them to distinguish 10 million different color surfaces. (Guinness Book of World Records)*

Photo 3. Stress fracture on 757 outboard flap fully deployed for landing

Note that in this enlarged and enhanced photo the fracture, due to the lighting, does not appear as a black line as in the previous image. It appears as a distortion resembling a wrinkle. This subtle feature is best seen on a monitor screen and may not be evident when printed.

Photo 4. Fractured flap after landing

Here is another enlarged and enhanced picture of the same flap, this time after landing. Spoilers are up and flaps are down. The fracture is more distinct probably because of a reduction in surface glare caused by momentary cloud cover. The fracture width appeared to be in excess of 1/3 inch (> 8 millimeters). It was widest nearest the fuselage, and the fracture surface edge appeared to be metallic and shiny as when weathered aluminum is freshly torn. It was not oxidized/corroded like other areas of the aircraft. The possible point of origin appeared to have somewhat of a circular hole configuration and was nearest the fuselage (Photo 5 below). From here the fracture propagated essentially parallel with the rivets to the opposite ends of the flap. As previously mentioned this length is approximately 23 feet (7m).

Photo 5. Possible point of origin of fracture

While taxiing to the gate the spoilers were lowered and the flaps were retracted, the latter into the wing. This is undoubtedly standard operating procedure which, in this case, hides the stress fracture. Thus, it would not be seen by ground service personnel or by the pilot during a “walk around” inspection with flaps up prior to departure of the next flight. That procedure needs to be reviewed. But it is questionable if the damage could be seen from ground level looking up because of its high position on the flaps. Although readily visible from seats over the wing, at ground level one may need to step back a bit to view it, like geologists and geophysicists do when we are looking at seismic cross sections.

Photo 6. Shadows cast by 737 spoilers on undamaged flap

Another observation was noted. For this one we will use a Boeing 737 photo in lieu of an unavailable undamaged 757 in the file. This picture (also enhanced) was taken on another flight using the same camera. Specks are caused by dirt on the window. The outboard and inboard flaps on this smaller wing have been extended for landing. Note the straight shadows cast on the undamaged flaps by the spoilers (several spoilers are shown by blue dots). Compare this to another enlarged and enhanced photo (next page) of the fractured 757 flaps.

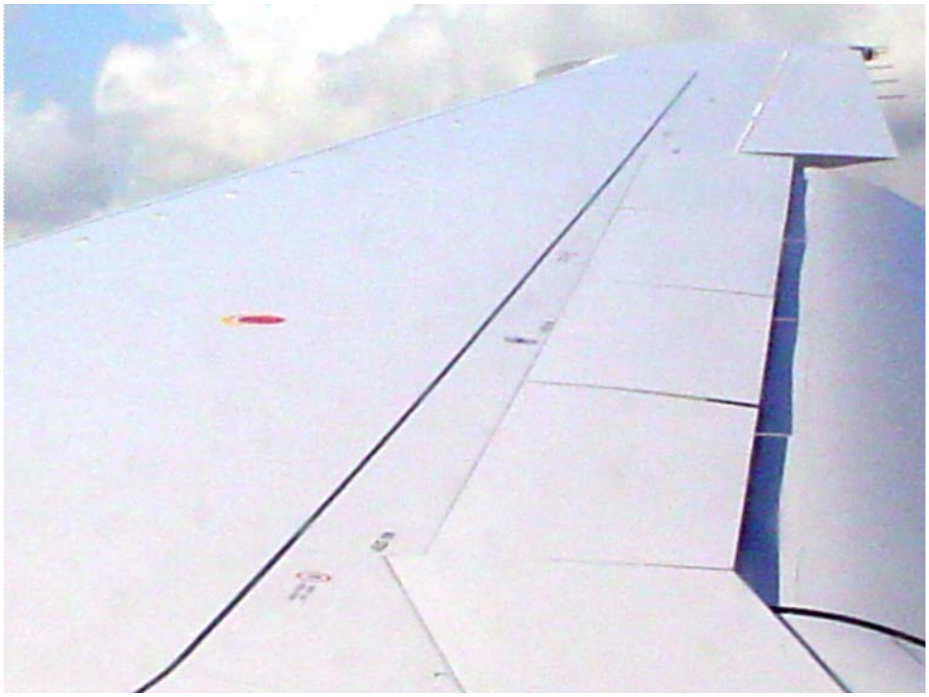

Photo 7. Shadows cast by 757 spoilers on damaged flap

The spoilers are straight but not the shadows (see also Photo 3). They are undulating (in waves). The most likely cause of this is a washboard or rippled-type surface on the flap (highs and lows in the aluminum skin), which is directly related to the damage resulting from the fracture. Indeed, some of the aluminum appeared to be torn and raised. These surface features could indicate a structural and/or mechanical problem with the flap.

So, you are a passenger with images of something wrong taken by an obsolete camera with a postage-sized viewing screen. You can't use it. What do you do to convey the information to the pilot after landing — sensibly and without possibly being detained and questioned by airport security and miss your connecting flight? You do what geologists are usually good at — you draw it, like you have done for years with structure and isopach maps. Then you take a chance and wait for other passengers to depart the plane and request to speak to the Captain. Always go right to the top if it is something you believe is critical. (Unlike other professions, damaged egos from being wrong are rarely a deterrent to geologists. We seldom hesitate because, despite all the technology, our success rate on rank exploration/wildcat wells is less than 15%. That's a lot of "dry holes", and we're used to taking chances). Be direct with the information, brief and to the point, and then leave. Fortunately, in this case the Captain, in the presence of another flight crew member, looked at the drawing (on a post-it note) as the fracture geometry was explained, listened intently, asked where it was, and then stated that the flaps would be pulled down [and checked].

This passenger departed with a sense of relief and is certain that the stress fracture was found and that the plane was removed from service for repairs. He also had a double scotch before boarding the next flight….

rrdono@aol.com