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25 November 2015

Internal Report: Tecnam P92 ES (ZK-CDL)
Nose Leg Failure – 25/07/2015

Summary

On 25/07/2015 the nose leg on Tecnam P92ES, registered ZK-CDL, failed due to fatigue and collapsed whilst the aircraft was turning at the end of runway 07 (WAAP). The collapse resulted in a propeller strike and subsequent damage to propeller, engine and engine mount. The fork plates showed signs of extensive long term fatigue.

Owners of a Tecnam P2004 Bravo witnessed the incident involving ZK-CDL and decied to check their fork plates for cracks. A visual inspection did not clearly show any defects. Cracks were found on these fork plates.When checked off site.

The fatigue cracks were not easily detectable, visually, during preflight, nor during regular services.

The replacement fork plates were measured to be 33% thicker than the forkplates supplied as replacements at ~700 hours flight time. There are no known AD's or Service Bulletins regarding the nose leg on this model, or models using the same nose leg design (i.e all P92 models with tri-gear, the P96 Golf, the P2002 Sierra and the P2004 Bravo). Newer aircraft might be fitted with the thicker fork plates.

A procedure for checking and monitoring fork plates on any of these models used by the flying school has been implemented.This involves dimensionally checking and conducting die penetrant testing to expose cracks.

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Description of Incident

After returning from the second flight of the day (first training flight), the aircraft was being turned around at the end of the runway for a back track to the hangars. The radius of the turn increased as the aircraft slowed to near stand still and, as the PIC was about to apply throttle, the nose of the aircraft dropped and the propeller struck the runway, stopping the engine. The student applied shutdown procedures whilst the PIC notified traffic on final approach of the incident.

A nose wheel support plate (Fork Plate RH) on the aircraft failed during the turn at the end of the runway. This resulted in a collapse of the nose wheel and propeller strike on the runway.

The aircraft travelled a distance of ~30cm during the nose wheel collapse, of which ~10 cm during the propeller strike.

The engine was running at ~2200 rpm, fuel load estimated at 65 litres, pilot and student on board at ~83 kg and ~77 kg, respectively.

Investigation:

Aircraft:

Airframe TTIS: 2369.15 hrs

Since Last Inspection: 23.97 hrs

Nose Leg TTIS: ~1500 hrs (replaced ~700 hrs TTIS due to bent plates)

Loading at time of incident:

- *Aircraft: ~ 303 kg*
- *Fuel: ~65 lt (~47 kg)*
- *PIC: ~83 kg*
- *Passemger / Student: ~77 kg*
- *Shelf: ~5 kg*

Total Estimated Weight: ~515 kg.

Estimated Takeoff Weight: 526 kg (additional 15 lt of fuel)

Maximum Take-off weight for type: 544 kg

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Damage:

Propeller and nose leg damaged (see photographs 1 & 2). Nose Leg Fork Plate (RH) had broken at the shock absorber mounting bolt and the leg had collapsed backward (photgraph 2).

Later investigation by Leading Edge Aviation found the engine mount to be cracked and the engine crankshaft runout to be out of tolerance.

The aircraft left a skid mark and two divits (from the propeller blade strike) in the runway as shown in Photograph 3.

Photograph 1: Front View of Aircraft

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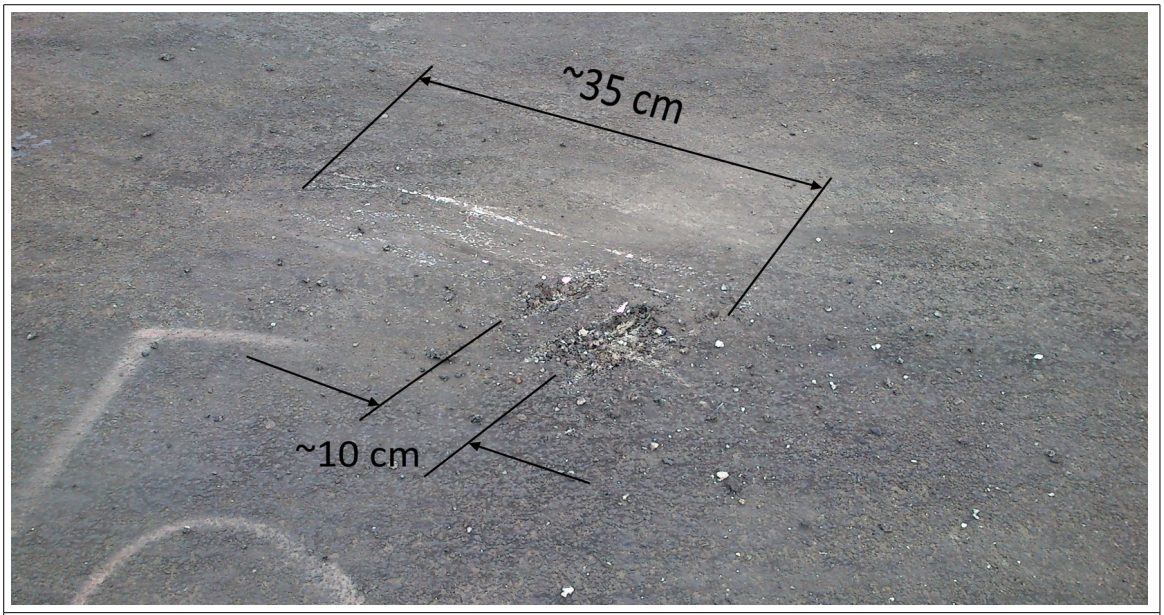
Photograph 2: Detail of Collapsed Nose Leg



Photograph 3: Skid mark and damage to runway

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Due to the damage to the engine, propeller, engine mount and nose leg, the aircraft was written off by the insuring company. The airframe was sold for rebuild and installation of a new engine.

Failed Component/s

The Right Hand Fork Plate had failed through the bolt hole.

Failure was through progressive fatigue, evidenced by thumbnail crack formation over time, with leading "beach marks" (photograph 4). The whole of the trailing section of the fork plate (i.e. that section behind the shock absorber mounting bolt hole) had fatigued through.

This indicates a fatigue through torsional loading, with the highest loads being experienced by the material at the rear of the fork plate, around the mounting bolt hole.

Further metallurgical analysis was not conducted. However, the dimensional details of the fracture surface are recorded in Photographs 5 to 10. Features of the failure can be seen in these photographs. Final fracture of the fork plate occurred when approximately 70% of the available load bearing cross sectional area had already cracked through due to fatigue.

It is also possible to see the typical features of fatigue failure in these photographs.

Whilst the Fork Plate LH had bent as the wheel collapsed, it was possible to see fatigue cracks once the component was bent.

Other Information / Comments:

Preflight and Regular Inspection

Preflight inspection of the aircraft did not yield any sign of the defect cracks on the fork plate. The aircraft had been preflighted effectively three times on the day – before operations began, and then for each of the flights, where a full preflight was demonstrated by the PIC for both students who were new to the aircraft.

Additionally, a couple of the school's students are particularly pedantic about preflighting the aircraft, to the point that they get down on hands and knees and physically check out movement in each undercarraige leg.

After the incident, other pilots that had been using the aircraft reported haivng felt the nose leg felt "loose" during preflight inspection, but had not found anything untoward on closer examination.

To further underscore this, the owners of a Tecnam P2004 Bravo that was undergoing 100 hr check on the day of the incident, checked their side plates and found no cracks visually. As their aircraft had similar flight hours to ZK-CDL, they decided to strip the nose leg and have the plates checked for cracks off-site. Cracks were found in both plates and they have replaced their plates with new plates from Tecnam.

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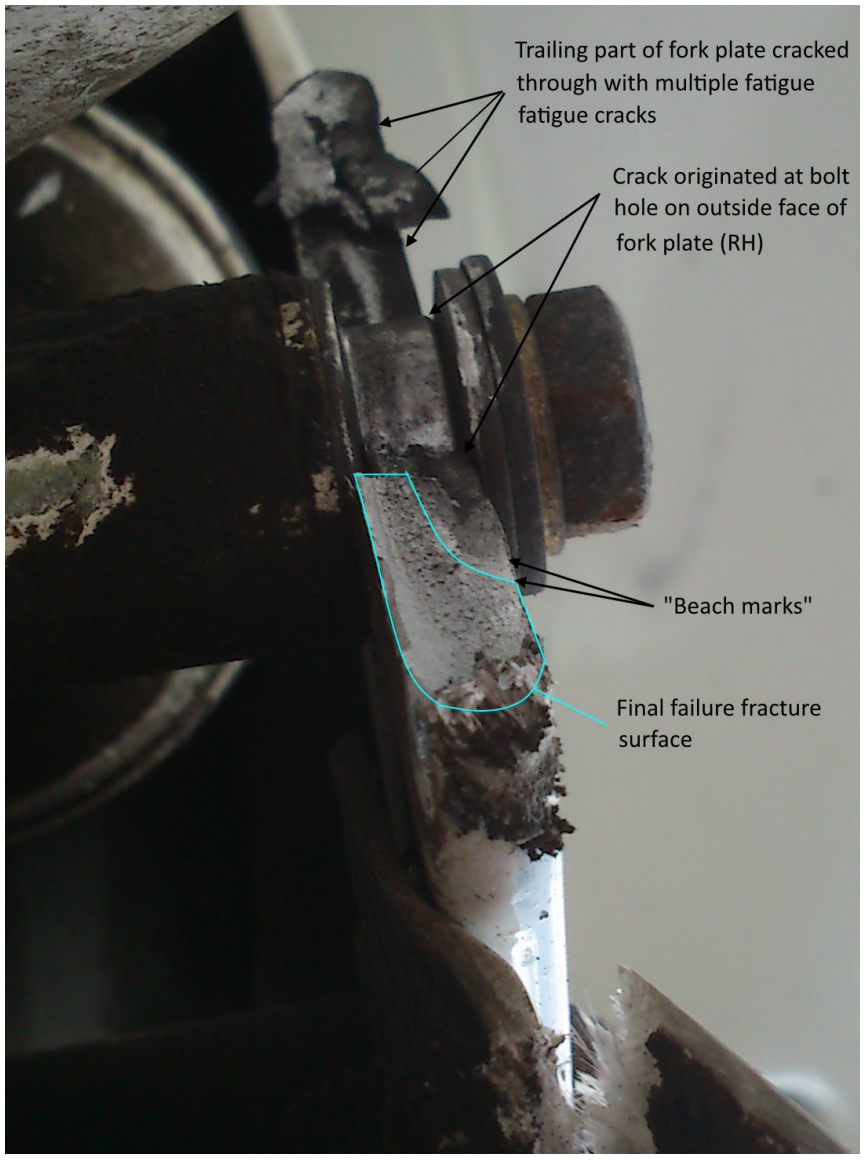

Photogaph 4: Fracture Features on Failed Fork Plate (RH)

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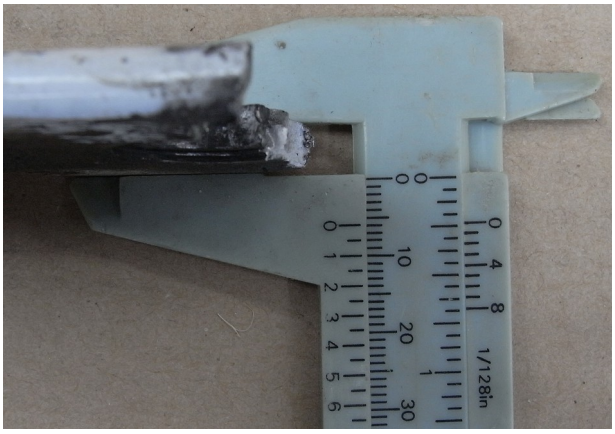	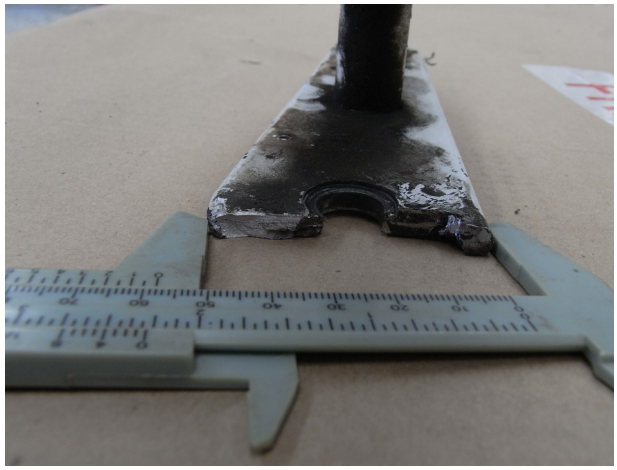
Photograph 5: Thickness of failed Fork Plate (~6.1 mm)	Photograph 6: Total Width of Fork Plate – note fracture surface features
	
Photograph 7: Leading Section Width (Final failure section)	Photograph 8: Trailing Section Width (this section was fatigued completely prior to final failure)

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	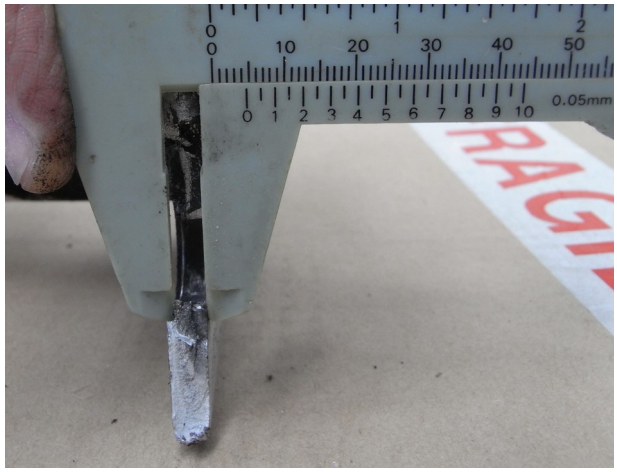
Photograph 9: Thumbnail Crack Width	Photograph 10: Thumbnail Crack Thickness

ZK-CDL is regularly maintained, every 50 hours, by Leading Edge Aviation and a LAME. Whilst the undercarriage requires regular inspection during these checks, this is merely a physical inspection, of components on the assembled undercarraige. No defects had been detected recently during these checks.

Loads on the Fork Plates

Bending stresses are applied to both fork plates during takeoff (application of right rudder as power is introduced) and during taxiing, particularly in cross winds and during turning, as the turning forces are primarily applied through the displacement of the nose wheel. The crack originated at the bolt hole, which could have been a source of a defect to start the cracking under such loads.

Replacement Fork Plates & Tecnam AD's

The replacement fork plates ordered to repair the damaged nose leg on ZK-CDL are 2 mm thicker (i.e. 8mm instead of 6mm) and the bushes for the shock absorber attachment bolt have been re-engineered (Photographs 11 & 12). Given the same load bearing width, this would increase load carrying area by 33%, or reduce the stress due to normal operations by a similar degree.

The change in dimension of the fork would indicate that Tecnam are aware of potential problems with the fork plates.

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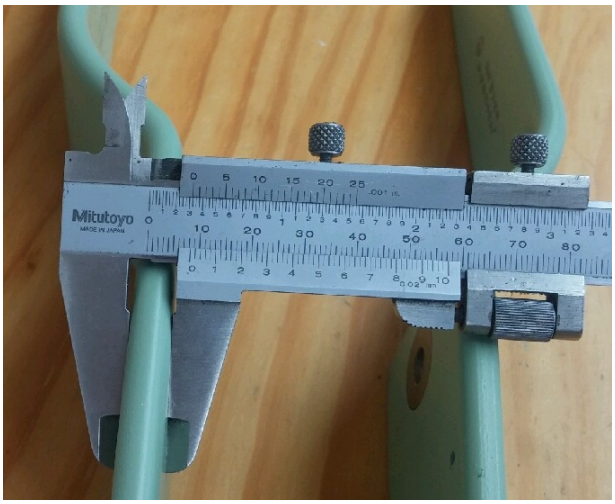	
Photograph 11: Replacement Fork Plate Thickness (~8.1 mm)	Photograph 12: Replacement Fork Plate General View – Note Bushing in Central Hole on new plates

The same nose leg design, and thus forks, are used on other aircraft such as the P92 series (J, Echo, Super Echo, Echo Super, Eaglet), P96 (Golf), P2002 (Sierra), P2004 (Bravo).

There are no current Service Bulletins or AD's regarding the fork plates on P92's on the Tecnam Australasia websites.

Conclusions

- *The damage caused to Tecnam P92 ES was as a result of fatigue failure of the fork plate (RH) on the nose leg.*
- *Cracks were not easily identified by visual inspection of the nose leg assembly and may not be detected visually during preflight or regular service inspections.*
- *The fatigue cracks possibly developed due to continued training use primarily on sealed runways, with a normal cross wind component.*
- *The replacement fork plates issued by Tecnam are 33% thicker than OE supplied with the aircraft. This would reduce the stress on the plates by a similar degree.*

Actions

Any Tecnam aircraft entering service with FlyWest will be evaluated for nose leg fork side plate

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revision and safety.

- *If the side plates are 8mm thick, a die penetrant test of the plates will be required. If no cracks are found, then no further testing will be required.*
- *If the plates are 6mm thick, then a die penetrant test of the side plates will be conducted – this can be done whilst the nose leg is still assembled to the aircraft. If cracks are detected, then the following will apply:*
    - *Cracks detected less than 15mm long (sum of all cracks along a load line): Notify owner (if applicable) and use die penetrant testing every 50 hours of flying time.*
    - *Cracks 15mm long or more (sum of all cracks along a load line): Notify owner (if applicable) and take the aircraft off line until the side plates have been replaced.*

This is to be applied immediately.

Richard Seymour-Wright
Manager