ACCIDENT

Aircraft Type and Registration:	Europa, G-PTAG
No & Type of Engines:	1 Jabiru Aircraft PTY 3300A piston engine
Year of Manufacture:	2000
Date & Time (UTC):	27 May 2006 at 1545 hrs
Location:	Wickenby, near Market Rasen, Lincolnshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to fuselage, nose gear leg, propeller and main gear fairings
Commander's Licence:	Private Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	555 hours (of which 532 were on type) Last 90 days - 14 hours Last 28 days - 5 hours
Information Source:	AAIB field investigation

Synopsis

After a normal touchdown, on both main wheels followed by the nosewheel, the nosewheel shimmied and departed the aircraft, together with the nosewheel fork. The lower cowl, propeller, nose gear leg, nose gear mount and main gear fairings were all subsequently damaged. The pilot and the passenger were uninjured.

A scroll pin which retained the nosewheel fork assembly had failed, although the precise cause of this failure could not be determined. One recommendation is made.

History of the flight

The aircraft was returning to Wickenby, having previously flown to Shobdon. The pilot reported a smooth touchdown on Runway 34 at Wickenby but, shortly after the nosewheel settled on the runway, it shimmied and detached, together with the nosewheel fork, and the propeller struck the tarmac. During the subsequent ground roll the nose gear leg, which is swept forward on this aircraft type, became angled rearwards thus allowing the aircraft to adopt an extreme nose down attitude, and the forward underside of the spats of the main wheels contacted the runway. The pilot recalled a long taxi on grass at Shobdon prior to the incident flight, with no problem.

The lower cowl, propeller, nose gear, nose gear mount and main gear fairings were all damaged. The pilot and the passenger were uninjured.

Description

The Europa is a two-seat aircraft sold in kit form. G-PTAG was a tri-gear version. The main component of the nose gear leg comprised a length of steel tube attached to the aircraft structure behind the engine compartment. The geometry was such that the leg was swept forward making an angle of approximately 30° to the horizontal, see Figure 1.

The nosewheel fork assembly was supplied as a pre-assembled unit and consisted of a pivot shaft and an aluminium alloy fork unit. The upper end of the pivot shaft fitted into a cylindrical housing welded to the lower end of the nose gear leg, see Figure 2.

The lower end of the pivot shaft fitted into a hole in the fork unit. The tolerances on the pivot shaft and the hole in the fork were such that for within-tolerance components there could be, at one extreme, a gap of 0.0016", and at the other extreme 0.0002" interference. Loctite adhesive was used to bond the two components. A 6 mm diameter scroll pin[1] was inserted into a hole through both the fork and the lower portion of the pivot shaft to locate the components positively and to take the relatively small load from tightening the shimmy damper nut, see Figure 3.

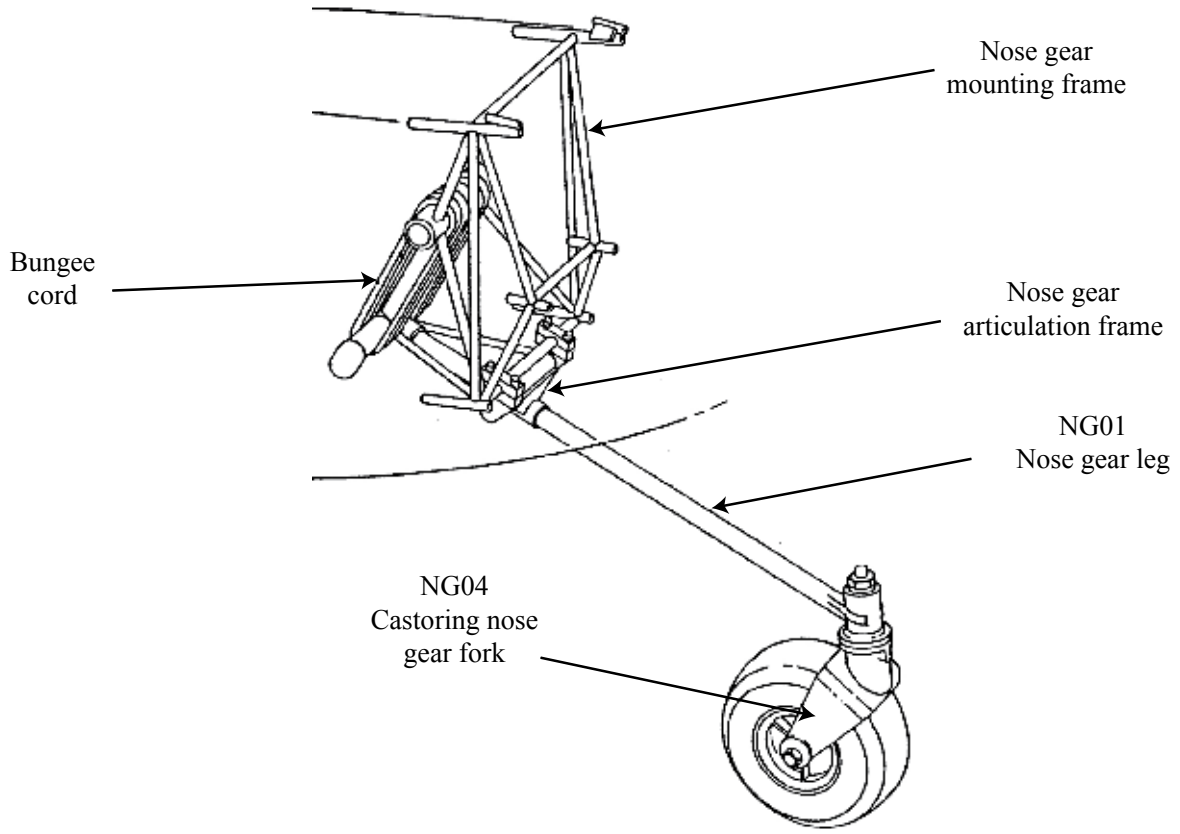

Figure 1

General arrangement of nose gear

Footnote

[1] A pin made from rolling a flat piece of metal with the appearance of a paper scroll

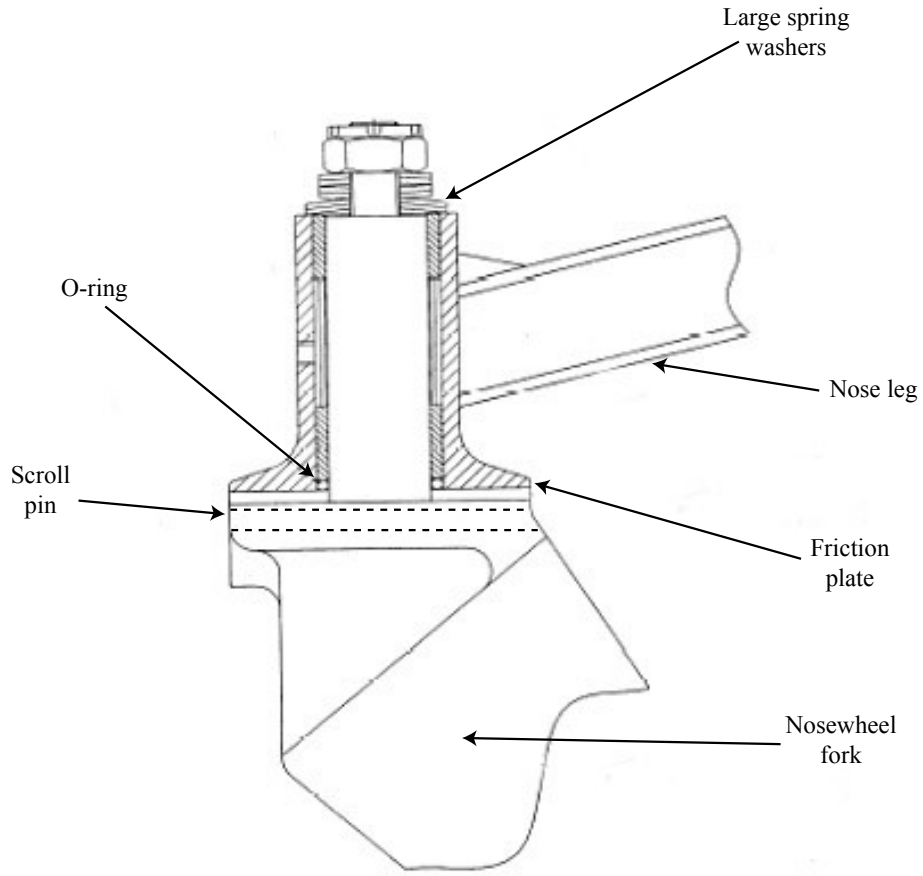

Figure 2
Details of attachment of nosewheel fork to leg

The threaded upper end of the pivot shaft was inserted through a bushed hole within the cylindrical housing and was secured by means of a nut, which tightened down onto a stack of spring washers. These, in conjunction with a friction plate between the fork and the housing, allowed the nosewheel to castor. The spring washers provide shimmy damping, with the level of damping being adjusted by tightening or loosening the nut.

Recent maintenance on the nose gear

The owner, who was also the pilot, had adjusted the shimmy-damper nut on 4 April 2006. Fifteen flights were made between then and the incident flight.

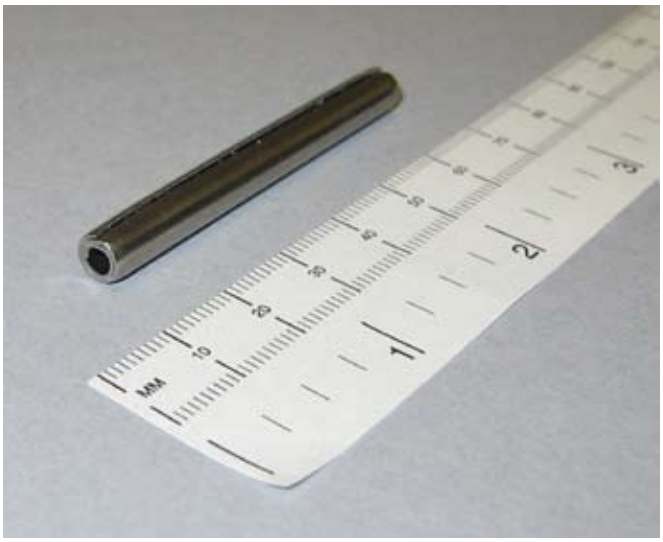

Figure 3
Detail of a scroll pin

Runway marks

The pilot took a series of photographs after the incident to record the ground marks on the runway. There was good physical evidence of the following having taken place (in chronological order):

a) the nosewheel shimmied, approximately 20 m after the nosewheel touched down;

b) the nosewheel fork departed the airframe;

c) the propeller struck the runway, approximately 30 m after the nosewheel touched down;

d) approximately 45 m after the nosewheel touched down, the nose gear leg scraped along the runway for a further 45 m;

e) the nose gear leg entered a small, pre-existing pot hole on the runway;

f) at the same distance along the runway as e), the front underside of the main wheel fairings scraped along the runway;

g) the aircraft stopped 105 m along the runway from the start of the shimmy marks.

The aircraft remained within a few metres of the runway centre line throughout its ground roll.

Examination of the nose gear

The nose gear leg and fork assembly were transported to the AAIB headquarters for detailed inspection. A consultant metallurgist examined the damaged surfaces.

The nose gear leg had deformed plastically downwards, in the opposite direction to that which would normally be expected from loads applied during landing (which, due to the forward rake of the nose leg, would normally deflect the leg forwards and upwards). This deformation probably occurred when the nose gear leg struck the pot hole, causing the gear leg attachment structure in the fuselage to fail and the leg to then rotate rearwards. This is supported by the runway marks near the pot hole which indicated that the aircraft had nosed forward causing the forward underside of the main gear fairings to contact the runway.

The underside of both the pivot shaft and the front of the pivot shaft housing had worn to a 'chisel edge', see Figure 4. This was consistent with the aircraft having rolled along the runway without the nosewheel and nosewheel fork, but with the gear leg swept forward in its normal position.

Figure 4

Pivot shaft housing and nose gear leg

The scroll pin in the pivot shaft had failed in shear due to overload, see Figure 5. The hole in the pivot shaft for the scroll pin had not been drilled accurately across a diameter, see Figure 6. There were also burrs present on the internal surface of the pivot shaft next to the hole for the scroll pin. The hole was not perpendicular to the axis of the pivot shaft, hence the scroll pin was aligned slightly nose down. The off-centre and

Figure 5

Pivot shaft
Note failed scroll pin

Figure 6

Detail of failed scroll pin in pivot shaft

non-perpendicular hole for the scroll pin, and possibly the presence of the burrs, would have compromised the effective strength of the scroll pin.

The lower end of the pivot shaft had expanded the upper part of the hole in the fork by working within it. This probably occurred during the ground roll after the scroll pin had failed. Thus it was not possible to determine the precise dimensions of the diameter of the pivot shaft and the hole in the fork due to damage sustained in the accident.

The spring washers from G-PTAG were inspected and compared with a set of new parts supplied from the manufacturer. Wear on the faces of the washers from G-PTAG was found. The washers were stacked in pairs and their respective heights measured. The height of both the large and small pairs of washers from G-PTAG were over 10% lower than the respective pairs of new parts. This could have been due to overloading of the spring washers.

The metallurgist concluded that the scroll pin had fractured in overload in shear and that the load was applied by tightening the pivot shaft nut during adjustments made to prevent nosewheel shimmying.

Manufacturer's testing

As a result of the incident the manufacturer tested a nosewheel assembly to determine if a scroll pin could fail under the typical loads encountered during maintenance. They reported that 17 ft lbs of torque completely compressed the washers (ie a much higher torque than that required to prevent shimmy), and that the scroll pin withstood 40 ft lbs of torque without being marked.

Previous heavy landing

The aircraft had landed heavily, nosewheel first, approximately three years ago. The nose gear leg was deformed downwards and was subsequently replaced. The fork was inspected by the owner and a PFA inspector, and subsequently fitted to the new gear leg.

Other incidents

On 7 June 2005 a tri-gear Europa, registration G-PUDS, suffered a failure of the scroll pin in shear; ie in overload from a load vertically downwards (see AAIB Bulletin 11/2005). Whilst the pivot shaft was recovered,

the investigation was hindered since the nosewheel and nosewheel fork were never found. Such was the distortion in the lower end of the pivot shaft that an overload from a heavy landing or striking an obstruction was considered to be the most likely cause. Also of note was that the lower end of the pivot shaft had an additional hole which would indicate that the pivot shaft had been removed from the fork at some stage.

Analysis

The scroll pin in both this accident and the accident to G-PUDS failed in shear from a load applied downwards on the fork, relative to the pivot shaft.

The source of such a load could be from:

a) Over-tightening of the anti-shimmy nut. The manufacturer's tests indicated that over-tightening of the nut would be unlikely to fail a scroll pin. However the hole for the scroll pin was significantly off-centre, which would have introduced some degree of asymmetric loading;

b) A heavy nosewheel first landing, possibly combined with an uneven surface dragging the nosewheel rearwards (as was probably the case with G-PUDS). G-PTAG had a nosewheel first landing approximately three years ago and this could have caused some damage to the scroll pin;

c) Nosewheel shimmy, and hence high loads in the nose gear components.

The pilot reported that the landing was normal, with no abnormal forces on the nose leg prior to the nosewheel shimmy. The nosewheel shimmy could have been as a result of the nosewheel fork rotating about the pivot shaft, and this could happen if the scroll pin had failed prior to or during the incident landing.

The precise cause of the failure of the scroll pin could not be determined. However there is evidence from this and the G-PUDS incident that the design and manufacture of the fork assembly could be more robust, particularly when the three possible sources of downwards loads described above are considered. As a result of this a recommendation is made to prevent reoccurrence:

Safety Recommendation 2006-146

It is recommended that Europa Aircraft Limited review the design, manufacture and recommended maintenance of the nose gear fork assembly of the tri-gear Europa to improve the integrity of the nosewheel fork attachment.

Safety actions

Prior to finalising this report for publication, and following the distribution of a draft to various parties, including Europa, for comment, Europa has advised the AAIB that the design of the pivot shaft has been revised. It has been modified to increase the length of insertion in the casting and thereby reduce the load on the scroll pin. Also, the tolerances of the shaft and casting bore will be reviewed, and a new material has been specified for the casting. No change to the maintenance requirements was considered necessary by Europa.

In view of this response to the draft report, the AAIB considers that the intent of Safety Recommendation 2006-146 has now been met.