Safety Spot
By Malcolm McBride

INSPECTION-TRIGGERING INCIDENTS, A COLLAPSING TITCH, HIDDEN DAMAGE & A TALE OF TWO REBELS…

The latest LAA Engineering topics and investigations

Hello again, and welcome to this mid-summer edition of *Safety Spot*, a hopefully agreeable viewing portal through which you can survey the continuing-airworthiness world of the LAA Engineering department, of which I'm proud to be a part.

Unusually, given the awful winter weather we all suffered, I'm now sat at my desk at our Turweston HQ and being distracted by lots of aircraft movements – there's a Robinson R44 practicing 'hovering over uneven ground' just outside my window. The student in question is making a better job of this quite difficult exercise than he did yesterday, perhaps demonstrating that 'practice makes perfect'. Mind you, there was quite a bit of wind yesterday, while it's now really calm on this sunny mid-May morning.

If you're a regular *Safety Spot* reader, you'll know that we tend to focus on certain areas of aircraft safety. Recently, LAA Engineering's attention has been cast towards the very great importance of including checks of components and structures which are normally hidden away in your *Tailored Maintenance Schedule* (*TMS*). You'll remember that we've been asking owners of SportCruiser aircraft to take their spats off regularly, to check the integrity of their noseleg spindle housings. Some owners have come across some near disastrous materials failures after getting their tools out to remove the spats. I've squeezed in a picture showing one such horror find (*shown at right*), just to emphasise the importance of checking things regularly.

While we're on the subject of checking things, during the LAA Engineering's assessment of quite a few recent *Permit Renewal* applications, we've noticed that many of the worksheets supplied detailing the work carried out fail to show a sign-off for both the initial and the duplicate inspections of any disturbed essential control systems (engine or airframe). If the worksheets don't describe these important checks, then we have to assume that they haven't been done and this can delay a *Renewal*. Remember, if you disconnect or disturb a control system in any way, initial and duplicate (first and second) inspections must be carried out and signatures made on the worksheets. It's a good idea to print your name against a signature and the qualification, eg LAA Inspector Number/owner/qualified pilot.

'INSPECTION-TRIGGERING INCIDENTS'

In the May edition of *Safety Spot*, we also explored problems which were hidden behind panels but, in a weird sort of way, 'in plain sight', by shining a light on issues with a wing connection on one de-riggable type. This time we'll look at a few examples where hidden damage to a structure was caused in an incident of one sort or another – I'll coin the term an 'inspection-triggering incident'.

(Above) **LAA Chief Engineer, Francis Donaldson, carrying out the duplicate inspection for LAA Inspector Graham Smith after an 'in the field' adjustment of an engine control. Whenever a flying or engine control is disturbed, for any reason, then it's essential that it's checked by a qualified second party before the aircraft is released for service.** *(Photo: LAA Engineering)*

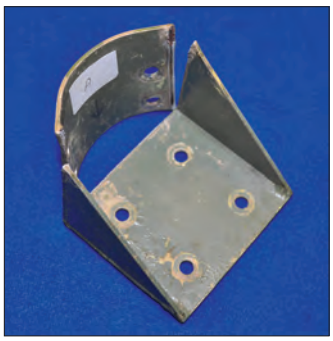
(Above) **Here's a horror which was lurking unseen behind a SportCruiser's spat. LAA engine specialist, Kevin Hyam, came across this cracked spindle housing after removing the spat on a friend's machine. The aircraft is nine years old, had completed roughly 350hr and been fitted with the 'Dover spindle modification'.** *(Photo: Kevin Hyam)*

Naturally, while scheduled maintenance tasks are designed to tease out any sign of trouble due to general usage (and, of course, the effects of ageing), it's absolutely essential that an aircraft is fully inspected after an incident, however minor.

At this point it might be worthwhile looking at how engineers might define the noun 'incident.' One dictionary I use defines the word as, 'Something dependent on or subordinate to something else of greater or principal importance.' Carefully steering clear of semantics, I'd suggest a clearer definition for owners/pilots to use as a maintenance trigger – how about, 'Any event where an aircraft has been operated outside its design limitations'?

Here are a few examples of inspection-triggering incidents: a heavy landing, an engine over-speed, a ground-loop, a manoeuvre overstress, an unexpected impact, exceeding in engine temperature limitations, going over the maximum (Vne) or flap-limiting

(Above) **Surely, there can be no better feeling than climbing into the cockpit of an aircraft you've built from plans with your own hands. This picture shows the owner and builder of this lovely Taylor Titch, Roy Newton, at just such a moment. Roy started building his aircraft in the late-seventies and it received its first flight test authorisation in 1986. In October last year, during a perfectly normal landing, the undercarriage gave way and the aircraft settled onto its belly. Luckily, the damage to the airframe was minimal and the Titch will soon be back in the air but Roy remembered that, some months previously, he'd landed rather more heavily than normal. It was possible that this landing began a crack in one of the undercarriage mounting brackets, and a closer look at the items themselves showed that the weld penetration was poor.** *(Photo: Roy Newton)*



(Above & above right) **The pictures above show the reason for the undercarriage collapse on Roy's Titch, namely a failed undercarriage bracket. As you can see, the bracket has failed completely along the welds, and a close examination showed that the weld itself, although looking very tidy from the outside, hardly penetrated into the supporting material. The second picture shows well-developed corrosion inside the joint, suggesting that the initial failure point occurred quite some time before the final incident, possibly during an earlier over-stress event.** *(Photos: Malcolm McBride)*

speed (Vfe). I'm sure that you could add to this already quite long list…

Some of the incidents described involve 'isolated' items in an aircraft, though care is needed as calling them such. Little on an aircraft actually operates completely independently, almost every component is part of a system in some way or another. For example, an engine temperature exceedance isn't likely to affect hidden attachments in the tailplane fitting, though it could disturb the engine mounting and associated structure. A ground-loop will very likely place the empennage structure under great strain, but the side-loads might also dislodge an engine cooling duct. Pilots must always remember that the aircraft they fly may, on the surface, appear structurally simple, but looking with an engineering eye, it's no such thing.

Aircraft designers work hard to make a structure as strong as possible using the minimum amount of material, in order to keep the weight down. Therefore, the design of an aircraft is a compromise between structural resilience and mass. Most aircraft aren't designed to land with the downward vector longer than the forward one, and it's always better to stop using the brakes than with a helping hand offered by a fence post or hay bale.

TAYLOR TITCH: LANDING-GEAR COLLAPSE

LAA builder and flyer, Roy Newton called to let us know that the undercarriage on his Taylor Titch had given way during a normal landing at his farm strip in Sussex. Roy felt that the associated damage was minimal, being limited to the lower cowl and, naturally, the wooden prop.

During our initial conversation, I asked Roy whether he'd recently suffered a heavier-than-usual landing and he said that he hadn't. However, after a short pause, Roy admitted that a year or so earlier he'd landed with a bit of a thump after being caught out by an unexpected gust of wind. He recalled that he was sufficiently worried about the 'heaviness' of the landing that he did complete a thorough check throughout the Titch's airframe.

Roy completed his Taylor Titch in the mid-eighties after an eight-year stint in his workshop, so he knows the aircraft very well – really, it's part of his family! At the end of our conversation, Roy said that he'd get back to me once he'd established the reason for the undercarriage failure.

Looking through our library of drawings here at LAA HQ, I discovered that there were three distinct types of undercarriage system used on the Titch – the first being a pair of single-spring steel legs, the second of a rather more elaborate sprung 'oleo' type and the third a one-piece 'Grove' undercarriage.

Being one of the first examples of the type built in the UK, Roy's aircraft was fitted with the two-piece sprung steel legs, each being mounted on a wooden plate in front of the main spar. Three steel reinforcing brackets transfer the landing loads from the undercarriage through its mounting plate into the main spar. The brackets are a simple right-angled plate, braced on each side by a web that's welded in place. They're arranged so that, when landing, the centre bracket assumes a tensile load, and the left and right outer ones take compressive loads.

The pictures above clearly show that the weld has failed on the centre bracket. This weld holds the strengthening side webs in place – once they failed, the bracket couldn't sustain the landing loads. Upon examination, it was clear that the penetration of the weld was very poor, which rather miffed Roy as he remembered sub-contracting it to an 'approved' welder, at great expense.

Lessons learnt? Well, this is an example where perhaps following a heavy landing, the undercarriage and its brackets should've been removed for inspection, which would've revealed the cracking in ›

(Above) **This is an example of fracture damage, most likely caused by the bursting effect of a compressive overstress, in the plywood skin of the Jodel's main spar. Because this aircraft has a section of false rib over the spar, to maintain wing top surface profile, this damage would be difficult to spot without close examination.** *(Photo: Alan James)*

the bracket. That said, in fairness, judging whether this type of check seemed in order would rather have depended on just how hard the initiating thump had been.

JODEL D120: HIDDEN DAMAGE AFTER TAXYING INCIDENT

I often remark about the strange way that, under normal circumstances, distinctly separate events appear to conspire to land, often simultaneously, on my desk, where they present a common theme. When that happens I almost feel obliged to share the event with the readers of this column – it's a sort of 'hairs on the back of the neck' thing. If you aren't sure what I mean by this, chat to one of the more experienced pilots or engineers in your local Strut, they'll remind you that you should never ignore a moment which prompts a neck rubbing!

Anyway, as you know, we've been focusing our attention on the importance of looking 'deeper' into structures, not only as part of your *TMS* but also if you've been unlucky enough to have been involved in an inspection-triggering incident. Well, our Chief Engineer, mindful of this 'safety push', collared me the other day and suggested that I read through an AAIB report about a Robin DR400 aircraft which had suffered an in-flight structural failure back in the summer of 1996. It sounded like a good tip, so I printed the report off and tucked it into my lunchbox for a bit of bedtime reading. It proved to be quite a harrowing read…

We don't have any DR400s on our books – there are 157 examples flying in the UK, most under a *Certificate of Airworthiness* – but the basic structure of this type is very similar indeed to our very own Jodel machines, so the sad story of this in-flight structure failure resonated somewhat. I resolved to somehow point readers of *Safety Spot* to this AAIB report.

A couple of days later, we received a *Repair Application* from LAA Inspector, Alan James, who's just bought a Jodel D120 rebuild project which had been sitting about for a while, rather unloved. With the *Repair Application*, Alan posted a couple of pictures showing some damage he'd found after removing the plywood covering from a portion of the wing's main spar. He'd proposed a scarf repair, which is being looked at by our design chaps, probably as you read this. As the story of the Robin was still resonating with me, I decided to look a little more closely at the cause of the damage that led to this *Repair Application*.

Time and space limitations don't allow me to go into great detail about the two incidents, both of which perhaps had a similar trigger event, but I'll try to precis how contrasting management of these situations led to very different outcomes.

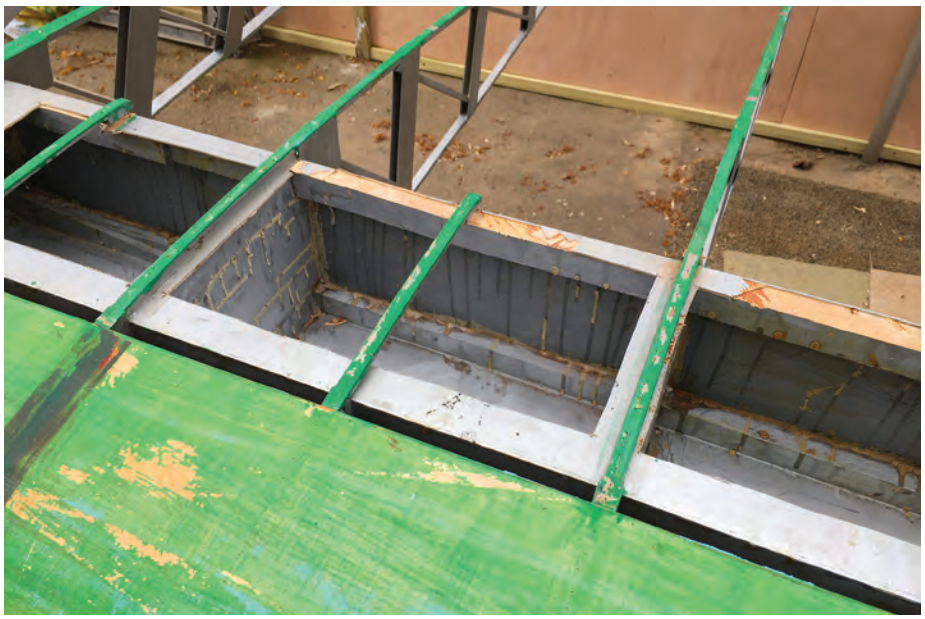
The Robin's pilot was flying a pal on a return from Cornwall to Kemble. The weather was, in the view of the passenger and the post-incident meteorological evaluation, very turbulent.

To quote the AAIB report: *'Due to the strong crosswind and turbulence, the pilot experienced considerable difficulty in making an approach [into Kemble] and had to work hard to maintain wings-level during the touchdown and subsequent landing roll. Witnesses reported hearing a prolonged squeal of the tyres, and a brief but large increase in engine power, suggesting that the pilot was having difficulty in controlling the aircraft at this stage, and may have inadvertently landed with the toe brakes applied.'*

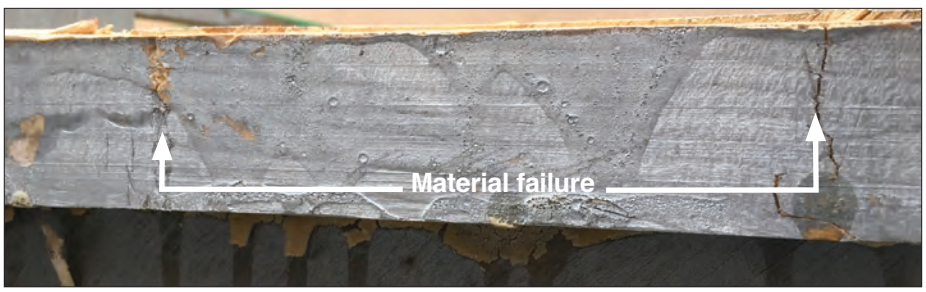
That sounds like a pretty hairy landing and later examination of the runway surface revealed rubber tyre marks indicating that the pilot had indeed locked-up the brakes. Further investigation showed that the aircraft had run off the paved runway surface onto the grass and, worse, the Robin's wing had very likely hit the top of a circular hay bale. Afterwards, it looked like the wing had ridden over the bale, probably lifting it a few inches.

Certainly, the pilot checked the aircraft very thoroughly before departing again – a witness stated that they'd seen him 'tugging' the wings during his pre-flight, in a way consistent with being worried about damage having been caused by hitting the hay bale.

After making his inspection and saying his goodbyes to his passenger, the pilot then left for home. The report then moves onto



(Above) **The Jodel D120 has a wood-and-fabric wing built around a thin-walled wooden box spar, comprising plywood side, bottom and top panels, bonded to corner elements of rectangular-section timber. A simple form of construction, this confers excellent bending and torsional rigidity when intact, but very little stiffness in the event of loss of integrity of the timber corner elements of the box. This picture shows the wing structure with the fabric off and the spar's top plywood panel removed so you can easily see the damage. Unless this type of damage is very severe, it just wouldn't be apparent without removing the fabric.** *(Photo: Alan James)*



(Above) **Once the plywood skin was removed, the completely unexpected damage to the main spar's corner timber could be seen. Compression failures like this are notoriously difficult to spot, and to imagine one occurring in wood it's important to understand how the material is made up. During the failure, the wood fibres have buckled (like squashed drinking straws) and, therefore, lost all of their tube-like integrity. Fortunately, this simple structure can be repaired by cutting out the damaged timber and scarfing-in a new piece, though naturally a thorough design evaluation of any proposed repair will need to be made by professionals.** *(Photo: Alan James)*

the radio communications history, which ends with the pilot explaining to ATC that he was having trouble controlling the aircraft – the transmission ended abruptly with a single statement: “Oh, God”.

The following comes straight from the report: *‘At about this time, a witness who lived in the vicinity reported that while working in his garden he noticed a light aircraft flying overhead at about 2,000 feet. Shortly afterwards, he heard a sound which he compared to that of a stout piece of timber breaking, followed by the engine throttling back and then power being reapplied. Other witnesses in the area reported hearing a ‘dull crack’, similar to the noise made by a leather hammer. A number of witnesses saw the aircraft descending in a spiral similar to that of a ‘falling sycamore leaf’ and observed that one wing was damaged, if not missing altogether.’*

Although it’s pretty harrowing read for pilots and my summation highlights the key points, if you’d like the very detailed report into this incident, *AAIB Ref: EW/C96/7/10*, you can download it as a PDF from *www.tinyurl.com/AAIB-DR400*

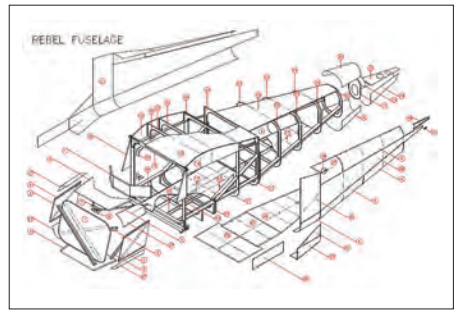
Clearly, the DR400’s pilot was worried that the structure of the aircraft might’ve been compromised by the events during the landing. However, despite taking time to give the aircraft a thorough external inspection, he wasn’t able to spot that, under the fabric, one of the webs of the spar box had split away from the corner members. This joint failure would’ve substantially reduced the torsional stiffness of the wing. It’s likely that the resultant twisting of the wing was the reason why the pilot reported difficulty in controlling the aircraft to the ATC.

If you take a look at the pictures on the opposite page, which show the damage to the Jodel D120’s wing, I hope you’ll see the similarity to that suffered by the DR400. In the case of the D120, the keen eye of LAA Inspector Chris Turner spotted the tell-tale sign of severe overstress in the buckling failures of the wing’s trailing-edges, even though no impact had been suffered in those areas.

There’s no AAIB report into the incident which led to the damage uncovered on the D120, though by chatting to a few LAA members who were around at the time, an accurate enough story materialised. After a perfectly normal landing, the Jodel began to taxi back to the hangar at Breighton when its starboard wing hit a fence post, apparently quite gently, near the wingtip. This swung the aircraft quite rapidly around and the port wing leading-edge hit another fence post. The damage to the leading-edge was more severe on the port side, where the fence post had hit between the ribs. On the starboard side the impact had been taken square on by one of the ribs and the leading-edge appeared bruised but basically intact.

Once the fabric was removed, the structural damage was easily seen. Both of the thin wooden trailing-edge members had given way and there was a compression/shear failure of the thin upper plywood web of the box spar. Worse, once this plywood facing had been removed, severe damage to two of the four spar caps was revealed – a number of transverse compression failures were present which would’ve robbed these components of almost all of their strength. These are a box spar’s principle load-bearing elements.

(Above) **The Murphy Rebel is a two-seat, high-wing, all-metal monoplane which is available in kit form for amateur construction from Murphy Aviation Ltd, British Columbia, Canada. The Rebel is of conventional, riveted 6061-T6 sheet aluminium alloy, semi-monocoque construction and has a reputation for being a good short-field performer. A number of engine options are available – this example, one of the aircraft discussed in the main feature, is powered by the ubiquitous Lycoming O-320. The LAA has a total of 24 of these aircraft on our books, eight currently flying and ten of which are still under construction.** *(Photo: Tom Cole)*



(Above & above right) **The sketch above shows the numerous panels which go into a metal aircraft, and the one that’s showing cracking and needs either replacing or repairing can be seen in above right. It may be that the cracking along the rivet line is due to an overstress event at some time in the past, perhaps a heavy landing, possibly the recorded ground-loop, but both the repair and the replacement options will require the airframe to be completely stripped out and the fuselage held in a jig during the work. Fuselage structures lose their rigidity very quickly when panels are removed and it’s easy to damage unsupported structures, which is why a repair process needs much planning before any work begins.**
(Photos: Murphy Aircraft Manufacturing Ltd/Ronald Pols)

(Left) **Owner Pete Hyde and his Rebel – he tells me that he’s made quite a bit of progress since this picture was taken. Pete began the build in the late-nineties, although what might be described as the ‘normal turbulence’ of life has meant a rather protracted project timeline.** *(Photo: Pete Hyde)*

Perhaps most soberingly, this very serious spar damage was on the starboard side of the wing, where the leading-edge damage looked relatively inconsequential. That just shows however minor the external damage might be, it’s essential to look under the skin.

When apparently minor damage occurs away from the home airfield, ‘get-home-itis’, shock and self-denial kick in strongly and it’s ever so tempting to attempt a return flight for repair back at base. The best advice in such circumstances is to stop, pause and seek qualified independent advice.

Fortunately, the D120 received the appropriate in-depth scrutiny at the incident site, and both the owner of the machine and indeed, the aircraft itself, lived on to fly another day.

MURPHY REBEL: LOSS OF CONTROL DURING LANDING

Coincidence, as I suggested in the tale of the Robin and the Jodel, is something which is only ignored by the unwary, and aviators – at least the long-lived ones – could never be described as that. So, having described one story where a fortuitous temporal convergence illuminated a safety issue, I’m rather surprised that I’ve another uncanny tale where a past event coalesced with something more recent.

Worryingly, this story also involves two similar aircraft, an AAIB report, airframe skin damage requiring repair approval, and a good spot by an LAA member. So, we have one coincidence, backed up by another, which definitely isn’t something to be ignored. ›

SAFETY SPOT

This is a story about two Murphy Rebel aircraft, both of which entered the UK as kits in the late-nineties. One aircraft was completed quite quickly, receiving its first *Permit* in 2001, the other, due to a complex set of reasons, is just closing in on a final inspection point.

The first aircraft ended up having a ground-loop incident after landing, here's the synopsis from the 2001 AAIB report into the runway departure: *'After a satisfactory three-point landing, the aircraft completed about half its expected ground roll but then started to turn left. The pilot was unable to correct the turn with full right rudder and full right brake. During the subsequent ground-loop the right landing gear leg collapsed and the aircraft came to rest after turning through approximately 120°. No-one was injured in the accident. It wasn't possible to determine with confidence the cause of the ground-loop but the most likely reason appeared to be a stiff main wheel bearing.'*

Now the pilot in this incident was a very experience tailwheel pilot and well used to the Murphy Rebel as a type, so it was generally agreed that there was a technical issue somewhere. Even though the stiff wheel bearing seemed a rather questionable reason, no other cause could be found. The aircraft was repaired and new brakes of a different make were fitted.

We saw this first aircraft again, some 400 flying hours and seventeen years later, when the new owner supplied us with a *Repair Proposal* because he was worried about some skin damage to the underside of the fuselage. Incidentally, although a patch repair was considered, it was decided that the best repair option is a replacement of the complete skin.

Now, what about its 'sister-ship'? Well, as its builder, LAA'er Pete Hyde, reached the final stages of his build, he started looking closely at the brakes, as supplied by the kit manufacturer. We're pretty certain that this type of brake was fitted to our 'other' aircraft though, as stated earlier, these were changed during the repair after the ground-loop incident. Well, I hope you can see from the pictures, when looking at the clearances between the various components in the brake system, there's a very great possibility that they could've jammed in service.

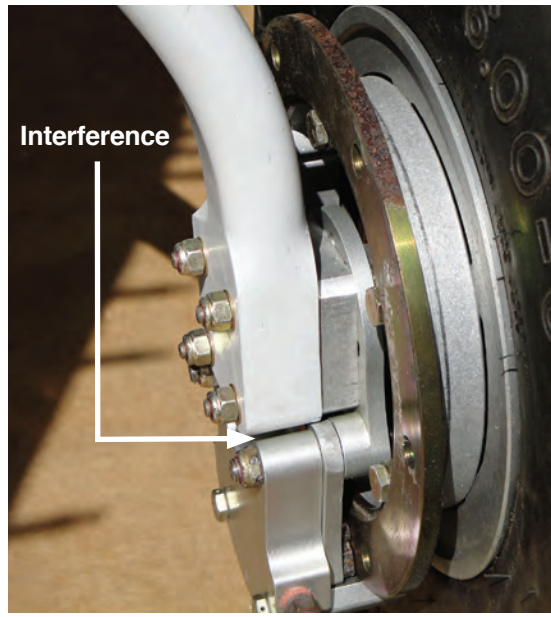
(Above) **The main 'gripping' components of an aircraft braking system. When assembled, the inside pad carrier must be able to move freely along the guide pins without contacting any fixed structure, but there mustn't be enough freedom for it to jam sideways. Pete intends to trim about a sixteenth of an inch from the carrier, which should prevent it from contacting the undercarriage leg. Note that these pads are held onto their carriers using copper rivets, which is quite normal with aircraft brakes.**

Some brake pads are fixed to their carriers using adhesive, and the LAA has become aware that some pads used on Rotorsport gyroplanes have been coming loose in service and this has, on more than one occasion, caused complete brake failure. If you've suffered an event like this, please get in touch with LAA Engineering so that we can establish if there's a fleet issue.
(Photo: Pete Hyde)

Pete suggests that the clearances can be increased quite easily by opening them up using a file, although he's going to inspect the system's operation very closely before opening the throttle for his aircraft's first flight.

Upon discovering the potential brake issue on his aircraft, Pete was reminded of the past incident involving the other Rebel and thought that a brake jam was a more likely explanation for the ground-loop. A past issue bumping into the future…

Brakes are an oft-forgotten area of an aircraft, but when you think about the work you're asking them to perform, they shouldn't be. Perhaps it isn't a coincidence that I've two other incident/accident reports on my desk, both yet to be evaluated fully but still involving braking systems.



(Above) **A point of possible interference between the pad carrier and the bottom of the undercarriage leg. Braking systems are particularly sensitive to issues with clearance between moving components and their stationary supporting structures – too tight or loose and they can have a jam potential.**
(Photo: Pete Hyde)

One concerns a Jabiru runway departure – the aircraft's owner serviced his brakes just before a flight, during which he lost directional control and hit a hedge, though nobody was hurt in either incident, thank goodness. The other is a report from a gyro pilot where there seems to be an issue with fairly regular failures of some bonded brake pads – in the couple of days since receiving the original report, of a very near-miss by a gyro pilot while taxying, I've heard about this happening to a couple of other flyers. However, the right-hand lower corner of *Safety Spot*'s final page is appearing so I'd better get off the keyboard…

I'm away on leave for a couple of days now so I'm hoping that I'll get some nice weather – after all, with all these coincidences about, surely it would be fitting! Fair winds. ■

LAA ENGINEERING CHARGES – PLEASE NOTE, NEW FEES HAVE APPLIED SINCE 1 APRIL 2015

LAA Project Registration	
Kit Built Aircraft	£300
Plans Built Aircraft	£50
Issue of a *Permit to Test Fly*	
Non-LAA approved design only	£40
Initial *Permit* issue	
Up to 450kg	£450
451-999kg	£550
1,000kg and above	£650
***Permit Renewal* (can now be paid online via LAA Shop)**	
Up to 450kg	**£155**
451-999kg	**£200**
1,000kg and above	**£230**
Factory-built gyroplanes (all weights) *Note: if the last Renewal wasn't administered by the LAA an extra fee of £125 applies*	**£250**
Modification application	
Prototype modification	minimum £60
Repeat modification	minimum £30

Transfer	
(from *C of A* to *Permit* or *CAA Permit* to *LAA Permit*)	
Up to 450kg	£150
451- 999kg	£250
1,000kg and above	£350
Four-seat aircraft	
Manufacturer's/agent's type acceptance fee	£2,000
Project registration royalty	£50
Category change	
Group A to microlight	£135
Microlight to Group A	£135
Change of G-Registration fee	
Issue of *Permit* documents following G-Reg change	£45
Replacement Documents	
Lost, stolen etc (fee is per document)	£20
Latest SPARS – No 17 April 2018	