COCKPIT REMEDIES

The BGA safety team highlights steps we can take to lessen the impact in the event of a firm landing

■ Clubs can obtain printed copies of Safety Briefings from the BGA Office.

IN THE event of a firm landing or other impact, it is the glider cockpit and related systems that protect us. We train and plan to avoid such impacts, of course, but in case we hit something solid, modern gliders include various design features to enhance the crashworthiness; and, even with older models, there are some improvements that we may be able to make for ourselves.

Spinal protection

For over 45 years, the rate of serious injuries reported to the BGA has remained around one every 50,000 launches. Reports from the past 20 years show over half of such injuries to have involved fractures of the spine, predominantly the lumbar and sacral vertebrae of the lower back. These typically resulted from heavy landing, when the glider has a high rate of descent in a fairly level attitude.

When a glider hits the ground, its descent is arrested in the very short vertical distance

beginning only when the wheel first touches the earth. To achieve this deceleration, forces must be exerted upon all parts of the aircraft structure. First the undercarriage suspension and tyre are compressed, pushing in turn upon the fuselage, which carries the load through to the wing spars; and the wingtips continue to descend until the bend of the wing slows them too. If the glider touches down with too great a descent rate, the forces required for deceleration could exceed its structural strength, which is why after a heavy landing an inspector will check a number of load paths from the wheels to major masses such as the wings and tailplane.

The same is true of the pilot, who must be slowed by the same amount. First the undercarriage, then the seat, cushion and pilot's flesh are compressed, and they push in turn upon the body, where the skeleton in particular carries the load. Like the wingtips, the head, organs and torso will be slowed only indirectly as the body – particularly the spine – compresses and flexes. If the loads upon the spine from the upper body and head are too great, spinal injuries result.

A number of studies in recent decades have explored the vulnerability of the spine and how it might be protected in aircraft crashes and ejection seat operation [1]. The problem was championed for gliding by Dr Tony Segal, who outlined the key principles in a 1987 OSTIV presentation [2] and a series of articles in *S&G* [3]. Some of his suggestions relate to the glider design and are difficult to add to an existing aircraft, but two are readily addressed by the pilot/owner:

- *An energy-absorbing structure should be inserted between the pilot and aircraft, to allow the pilot to be decelerated more gently and without rebound.*
- *The pilot's back should be uniformly supported and held in its strongest shape.*

These can both be achieved using energy-absorbing foam.

Cushioning the impact

An appropriate seat cushion can reduce the deceleration the body undergoes during an impact and subsequent rebound. Segal, and later Jackson, Emck et al. [4], tested various types and brands of foam – a crucial property being that, unlike common upholstery materials, the foam absorbs the impact energy rather than simply storing it. It was found that 5cm was required to reduce spinal loads by a third, but even a thin cushion is considered useful and the BGA strongly recommends that cushions containing energy-absorbing foam be fitted in all gliders where space permits.

Jackson, Emck et al. [5,6] showed that such cushions need not be uncomfortable. Discomfort occurs when localised pressure prevents capillaries from flushing away metabolites, and a thin layer of a softer foam was found to spread the load without compromising the energy absorption. The most suitable foams are now available from gliding equipment suppliers and a BGA booklet provides helpful DIY details [7].

Cushions containing energy-absorbing foam can be tailored to fit individual pilots. It's essential that the cushions be secured so that they can't slip to foul the controls – Velcro can be effective – and, as airtight cushions are poor energy absorbers, the cover must be made of porous material.

Back support

Following suggestions by the German gliding team's doctor, Dr Teddy Stedtfeld, Segal [8] suggested that energy-absorbing foam, shaped to the pilot's back, could also serve as a lumbar support, potentially increasing by 50 per cent the load the spine can withstand. Such foam can also fill any gaps left by the parachute, ensuring that the pilot's back is supported uniformly.

In the last issue of *S&G*, Adrian Emck, who like Stedtfeld advocates a spine-shell, ascribed some of his soaring success to the comfort such support brings [9].

Leg and foot protection

The other major injury category, incurred in more than a third of serious injury accidents, is to the leg, foot or, commonly, ankle. These accidents typically occurred when the glider hit the ground, hill or obstacle nose-first.

Segal suggested that lower limb injuries might be the price to pay for surviving a high energy crash, if the nose of the glider were designed to collapse as a 'crumple zone', absorbing energy while slowly decelerating the rest of the glider. Calculations by Prof Loek Boermans showed that extending the nose to give better protection would have little effect upon the glide performance. Such structures are, however, difficult to retrofit. Without buying a new glider, you can only hope to have the presence of mind to draw back your legs before impact and aim for something forgiving. Segal demonstrated that a five-point harness would prevent 'submarining' forward – and that a six-point harness would do so less painfully.

A crumpling cockpit can bring the instrument panel edge against the pilot's legs, where a sharp edge can cause nasty injuries. The BGA recommends replacing any metal instrument panels that have unprotected edges with fibreglass designs [10].

Current designs

Many of Tony Segal's suggestions [11], along with innovations from OSTIV colleagues such as Martin Sperber and Prof Wolf Röger, as well as the glider manufacturers, are now within the CS22 design code implemented in modern glider designs. A sacrificial nose structure in front of a protective cockpit shell; energy-absorbing undercarriages that fail progressively under extreme loads; headrests to reduce whiplash; cockpits free from dangerous protrusions. Röger hooks may be an available option, and can sometimes be retrofitted to older gliders – as can headrests and fibreglass instrument panels.

Research continues, and future designs will doubtless contain further enhancements but, regardless of the age of your glider, there are some improvements you can make yourself. If you're wondering what to buy your glider for Christmas, maybe some suitably sculpted energy-absorbing foam, stitched into a smart personal cushion that can be secured to the seat pan – and a firm foam pad to fill gaps between your back and the parachute pack – could be just the thing.

Tim Freegarde and the BGA safety team

PREVIOUS 'FLY RIGHT' ARTICLES

The Perils of Distraction (Apr/May 19)
Keeping Safe in Thermals (June/July 19)
Why It Is Good to Think Ahead (Aug/Sep 19)
The Effects of Wind Gradient (Oct/Nov 19)
A Fun but Safe Introduction (Dec19/Jan20)
Stop the Drop (Feb/Mar 20)
Avoiding Upset (Apr/May 20)
Backroom Boys (June/July 20)
Cockpit muddle (Aug/Sep 20)
Safe rotation (Oct/Nov 20)

■ For more information, see the BGA booklet *Why you should fly with an energy-absorbing cushion* [7] and BGA advice on metal instrument panels [10]. Many of Tony Segal's papers are collected in a special issue of *Technical Soaring* [11].

[1] See e.g. J W Coltman, Tech Report FAA-AM-83-3 (1983) *https://tinyurl.com/flyright2035*
[2] A M Segal, Tech Soaring **12** (4), 111 (1988) *https://tinyurl.com/flyright2036*
[3] A M Segal, *S&G* Dec 1991/Jan 1992, Feb/Mar 1992, Apr/May 1992 *https://tinyurl.com/flyright2037* *https://tinyurl.com/flyright2038* *https://tinyurl.com/flyright2039*
[4] C Jackson et al., Tech Soaring **33** (2), 47 (2009) *https://tinyurl.com/flyright2040*
[5] C Jackson et al., ASEM 80 (6), 565 (2009) *https://tinyurl.com/flyright2041*
[6] C Jackson, *S&G* p50 (Feb/Mar 2010)
[7] BGA, *Why you should fly with an energy-absorbing safety cushion* (2017) *https://tinyurl.com/flyright2042*
[8] A M Segal, *S&G* p12 (Feb/Mar 1985) *https://tinyurl.com/flyright2043*
[9] A Emck, *S&G* p14 (Oct/Nov 2020) *https://tinyurl.com/flyright2044*
[10] BGA TNS 02/05 *https://tinyurl.com/flyright2045*
[11] A M Segal, Tech Soaring **32** (1/2) 272 (2008) *https://tinyurl.com/flyright2046*

OVER HALF OF SERIOUS INJURIES INVOLVE FRACTURES OF THE SPINE