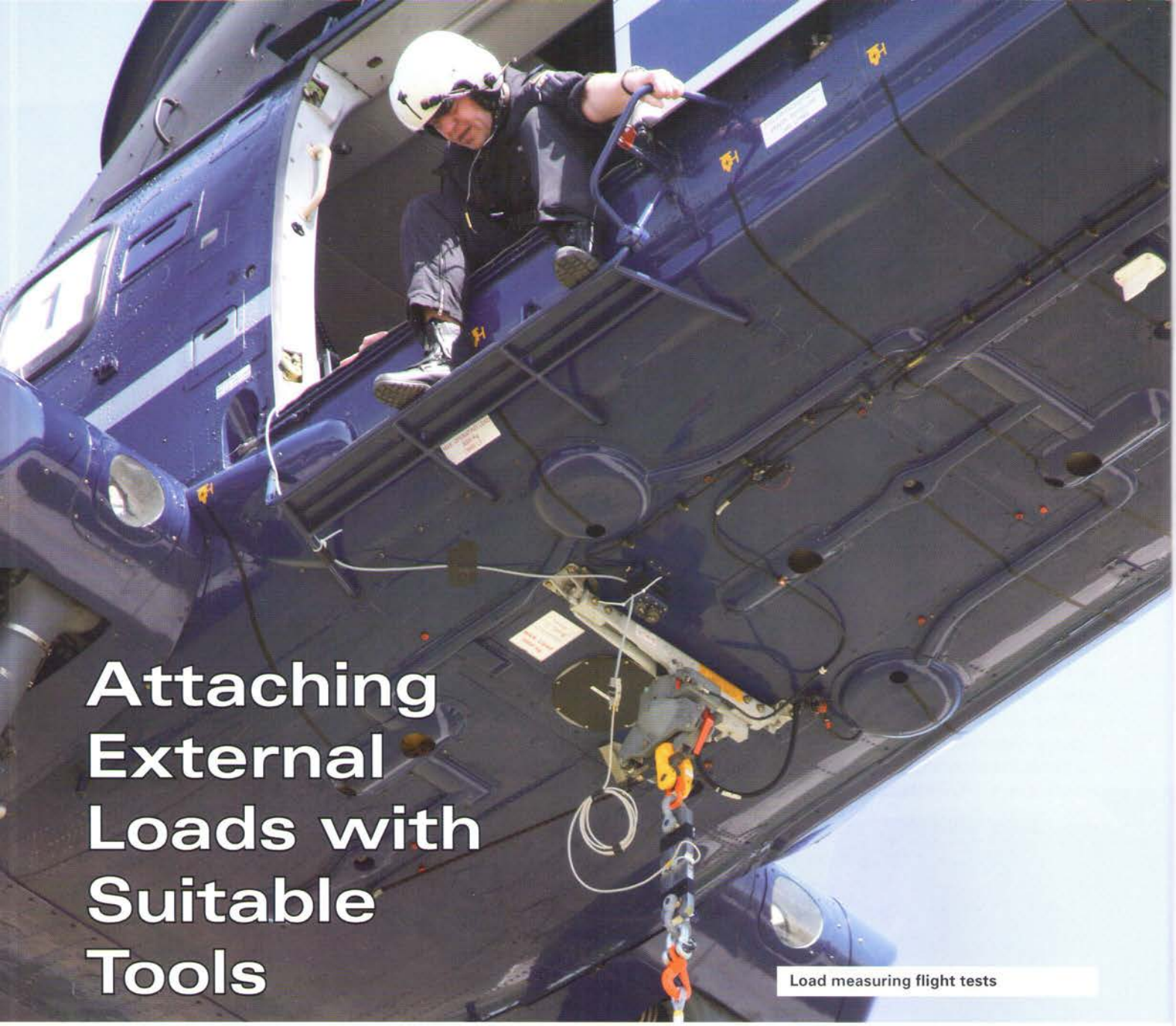


Attaching External Loads with Suitable Tools

Load measuring flight tests

Wherever use of a conventional (truck-mounted) crane is denied by geographical or other reasons, the helicopter becomes the crane of choice to transport loads. This requires specially trained personnel, but nevertheless, accidents continue to happen due to wrongly selected or unsuitable load-carrying equipment.

The cables used most during transport or construction flights are made of steel or synthetic materials. Under certain unloading conditions, e.g. breakage of the cable or dropping of the load, uncontrolled upward recoil may occur.

This is obviously a life-threatening danger, because should the cable or other elements of the load-carrying equipment enter into the main or tail rotor it could lead to the helicopter's crash. One such accident occurred during a forest re-cultivation project. Over a couple of days, the helicopter had already flown a number of missions carrying young trees. On the day of the accident, the flight plan was changed on short notice, and for the next flight, the load-carrying cable should have been removed from the helicopter. It was not. After take-off, the helicopter climbed vertically to a height of ca. 30m and then entered forward flight. After a short while, the cable got caught in a fence perpendicular to the helicopter' flight path and tore it apart. The relatively elastic cable that was suddenly relieved of an enormous stress, recoiled into the main-rotor disk and pretty much destroyed both the main and tail rotor. The helicopter crashed to the ground and was totally destroyed.

Up to the 2006, different steel and synthetic cables' recoil behaviors upon sudden unloading were relatively nebulous, despite the fact that this is of greatest importance when selecting suitable cables.

The Technical Oversight Service of the Accident Prevention and Insurance Association for Transport and Traffic Management (Technischer Aufsichtsdienst der Berufsgenossenschaft für Transport und Verkehrswirtschaft, (BG Verkehr)) that is among others responsible for helicopter operations focused on this

topic. Systematic research into this specific behavior of cables meant entering unknown territory; the first brainstorming quickly evolved into a full-fledged research project. After initial theoretical research practical tests soon followed. On the premises of a large shipyard in Hamburg, Germany, BG Verkehr and the project partners carried out the first trials on the recoil behavior of load-carrying equipment. For these trials they used a gigantic crane.

Very quickly, it became apparent that many of the load-carrying equipment used in commercial as well as in military aviation was unsuited for the task. Some of the cables–made of various materials and of different construction–that were tested behaved almost like rubber bands and in a real world scenario could have damaged the helicopter's fuselage or rotor(s). Data and results were accumulated in 230 individual tests that proved among other things that:

- steel cables without rotational freedom and woven polyamide cables as well as
- meshed cables with great extension of their construction (e.g. polypropylene and polyamide nettings, cross mesh)

are unsuitable as load carrying or fixing cables.

The static tests were followed by helicopter flight-tests in 2011 and 2012. Project leader Stephan Elfert developed special equipment to measure and record the dynamic influences and forces that take effect on the load-carrying devices during load transport.

Data were collected during special measuring flights as well as during regular day-to-day helicopter operations. Already after only a few flights surprising and unexpected data became apparent. It was known that when picking up a load or putting it down , peaks in the load can occur. What was surprising was the intensity and duration of the oscillations' loads already during normal flight maneuvers. The loads that were induced into the cables were multiple that of the static loads. The unexpectedly high load peaks coupled with the remarkable duration they take effect (of up to a few seconds) can reduce the operating life of the load-carrying equipment.

As a consequence, an increase in the dimensioning factors of load-carrying equipment and the safety of the materials/tools used is unavoidable.

Another result of the trials is an answer to the question whether or not a damper can be effectively applied. Utilizing a damper (in principle a coil spring with more elasticity than the cable) can be useful, but the following must be considered:

- Dampers must be placed between helicopter and load-carrying equipment.
- Placing dampers at the lower end of the cable is not advised (handling difficulties, intensified recoil).
- Using a damper with very short cables is problematic with regard to the recoil.

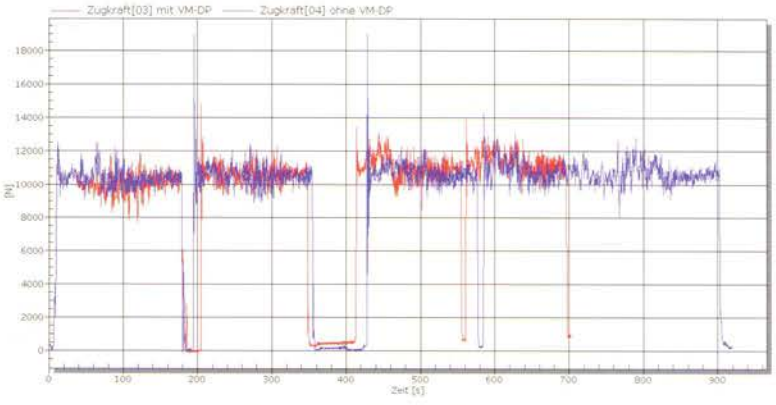
A correctly dimensioned damper has been proven to reduce load peaks by more than 30%. All project partners agree that lower load peaks will not only have a positive effect on any kind of cable's life time, but also on the maintenance effort for the helicopters.

The trials and their results were introduced and explained in info sessions, seminars and at expos, e.g. ILA Berlin Air Show. Interest among the helicopter industry is immense, and the next flight trials are already scheduled for 2013.

We would like to thank the German Federal Police's Air Support Service and their squadron at Blumberg and the Swiss company AirWork & Heliseilerei GmbH for their efforts. Thanks are also due to Eurocopter Germany and the Berner Fachhochschule (University for Applied Sciences) Burgdorf who participated in the trials in 2012.

Stephan Elfert

Links: www.bg-verkehr.de, www.air-work.com, www.bazl.admin.ch



Dynamic forces acting on load-carrying equipment (Newton vs. time)

Shipyard crane used for static tests