Federal Public Service
Mobility and Transport
Air Accident Investigation Unit

Air Accident Investigation Unit (Belgium)
City Atrium
Rue du Progrès 56
1210 Brussels

Safety Investigation Report

Ref. AAIU-2013-02-EBNM

Classification: Accident

Level of investigation: Standard

Date and hour: 10 January 2013 at 11:02 UTC

Aircraft: Robinson R-22 Beta II, msn 3832. The helicopter was registered in Belgium and held a Certificate of Airworthiness and a valid Airworthiness Review Certificate (ARC)

Total flight time: 1690.2 FH

Type of engine: One Lycoming O-360-J2A, esn L-39949-36A

Accident location: On EBNM airfield

Type of flight: Training

Phase: Autorotation training

Persons on board: Two, a student pilot and an instructor.

Injuries: Minor

Abstract
During training flight, with a pilot and an instructor on board, the helicopter was performing autorotations. The helicopter was flying at 1600ft when the autorotation was initiated. The purpose of the exercise was to conduct the autorotation to the ground. The helicopter flared, but further contacted the ground violently, bounced back in a nose down attitude, then touched the ground again, sliding. The helicopter fell on the left side.

Cause
The accident was caused by the inadequate flare at the conclusion of an exercise of autorotation to the ground, leading to a brutal contact with the ground.

Contributing factors:
The instructor was late reacting to the inadequate flare.

Recommendations:
None

Hazard identified during the investigation [1]:
- Autorotation training

Consequence [2]:
Hard contact with the ground

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[1] Hazard – Condition or object with the potential of causing injuries to personnel, damage to equipment or structures, loss of material, or reduction of ability to perform a prescribed function.

[2] Consequence – Potential outcome(s) of the hazard

Factual Information

History of the flight

The pilot 2 had not flown regularly after the issue of his Private Pilot Licence.

As the due date of the type rating was coming near, he contacted Best in Sky, in order to get a support from an instructor for a refresher course. In December, he made 2 flights with an instructor, and he was about to make a third one with another instructor.

Before the flight, the pilot and the instructor sat down to determine the program. They decided to perform Circuit flights, Hover, Governor failure and some autorotation exercises.

They prepared the helicopter, and took off. The first part of the flight was uneventful.

Two autorotation exercises were initiated at 1600ft. The exercises were performed adequately. The instructor gave some indication pertaining to the particularities of the R22, as having low inertia.

They initiated the third exercise, from 1600ft. The instructor told the pilot to perform the landing (unlike the two first exercises that occurred with power recovery). The helicopter parameters were as expected.

The helicopter flared, then went in horizontal flight. Nevertheless, the vertical speed was still high, as the helicopter hit the ground violently, leaving two traces on the ground (10 cm deep on the RH side). The helicopter bounced, nose down. The LH skid left a trace on the ground, until the helicopter fell down again, and rolled over, on the LH side.

The two pilots climbed out, uninjured.

Injuries to persons.

Injuries	Pilot	Passenger	Others	Total
Fatal	0	0	0	0
Serious	0	0	0	0
Minor	2	0	0	2
None	0	0	0	0
Total	2	0	0	2

Damage to aircraft.

Both main rotor blade is broken.
The inspection of the helicopter revealed deformation on the horizontal and vertical firewall. tail boom deformed on both ends. LH door window broken.
The B223 yoke and A947-2 flexplate are deformed under torsion (transmission from V-belts to the tail rotor).

Pilot information

Instructor:	Male, 46 years old Holder of a Commercial Pilot Licence (Helicopter), first issued on 11 January 2008, valid until 11/04/2013 Ratings: Robinson R44, valid until 31/07/2013. Robinson R22, valid until 31/07/2013. Flight Instructor, valid until 31/05/2014 Flight experience: Total FH: 3094:57, PIC: 2586:07 FH, FI(H): 670 FH Types: Robinson R-22: (last 3 months): 11:36 FH. Robinson R44: (last 3 months): 23:06 FH. Other types: Alouette II, Agusta A109BA
Pilot:	Male, 42 years old Holder of a Private Pilot Licence(Helicopter), first issued on 15 February 2012, valid until 15 February 2017. Ratings: Robinson R22, valid until 28 February 2013. Total flight experience: 80:08 FH, PIC 17:30 FH, Dual: 62:48 FH (last 9 months): 02:12 FH

The helicopter

The R-22 is a single-engined helicopter with a semi-rigid two-bladed main rotor and a two-bladed tail rotor. The main rotor provides a teetering hinge and two coning hinges. The tail rotor provides only a teetering hinge.

The basic structure is welded chromoly steel tubing. The forward fuselage is made of fiberglass and aluminum with a Plexiglas canopy. The tailcone, vertical and horizontal stabilizers are aluminum. It has an enclosed cabin with side-by-side seating for a pilot and passenger. The doors may be removed for flight, and are often done so for photographic flights.

General characteristics

- **Crew:** 1
- **Length:** 8.7 m
- **Rotor diameter:** 7.7 m
- **Height:** 2.7 m
- **Empty weight:** 389 kg
- **Max. takeoff weight:** 635 kg
- **Powerplant:** 1 × Lycoming O-360 flat 4 piston engine,
- **Main tank total capacity:** 75 liters

Performance

- **Cruise speed:** 96 kts, (177 km/h)
- **Range:** 386 km
- **Service ceiling:** 14,000 ft (4,267 m)
- **Rate of climb:** 1,200 ft/min (6.1 m/s)
- **Endurance:** approx. 2 hours, with 30-minute reserve

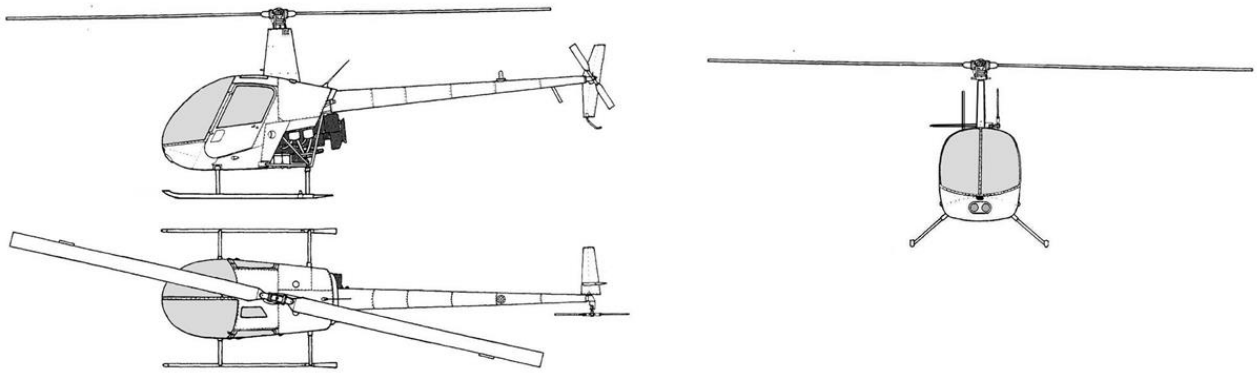


Figure 1: 3-view

1. **Airframe**
   - Manufacturer: Robinson
   - Type: R22 Beta II
   - Serial Number: 3832
   - Total Flight Time: 1690.2 FH
   - Built year: 2005

   Certificate of Registration: N°5480 issued by B.CAA on May 4th, 2012.
   Certificate of Airworthiness issued on June 7th, 2005. ARC last issued on June 6th, 2012, valid until June 12th, 2013
   Authorized flights: first flights, training, aerial photography, aerial surveillance.

2. **Engine**
   - Manufacturer: Lycoming.
   - Model: Lycoming O-360-J2A,
   - Serial Number: L-39949-36A
   - Total Flight Time: 1690.2 FH

Meteorological information

Situation at Namur airport (EBNM) 11:00 UTC

Wind Direction: 240

Visibility: 3000m

Temperature: 5°C

QNH: 1017 hPa

Airfield information

The Namur – Suarlée airfield (EBNM) is located near the city of Namur, at 50 km SE of Brussels and 60 km SW of Liege.

Coordinates are N 50° 29' 17'' – E 4° 46' 08

The airfield is equipped with a 696 m long x 27 m wide grass runway, oriented 064°/244°.
Elevation is 594 ft above sea level.

Runway 24 for gliders shows a slight up slope, and is somewhat uneven.

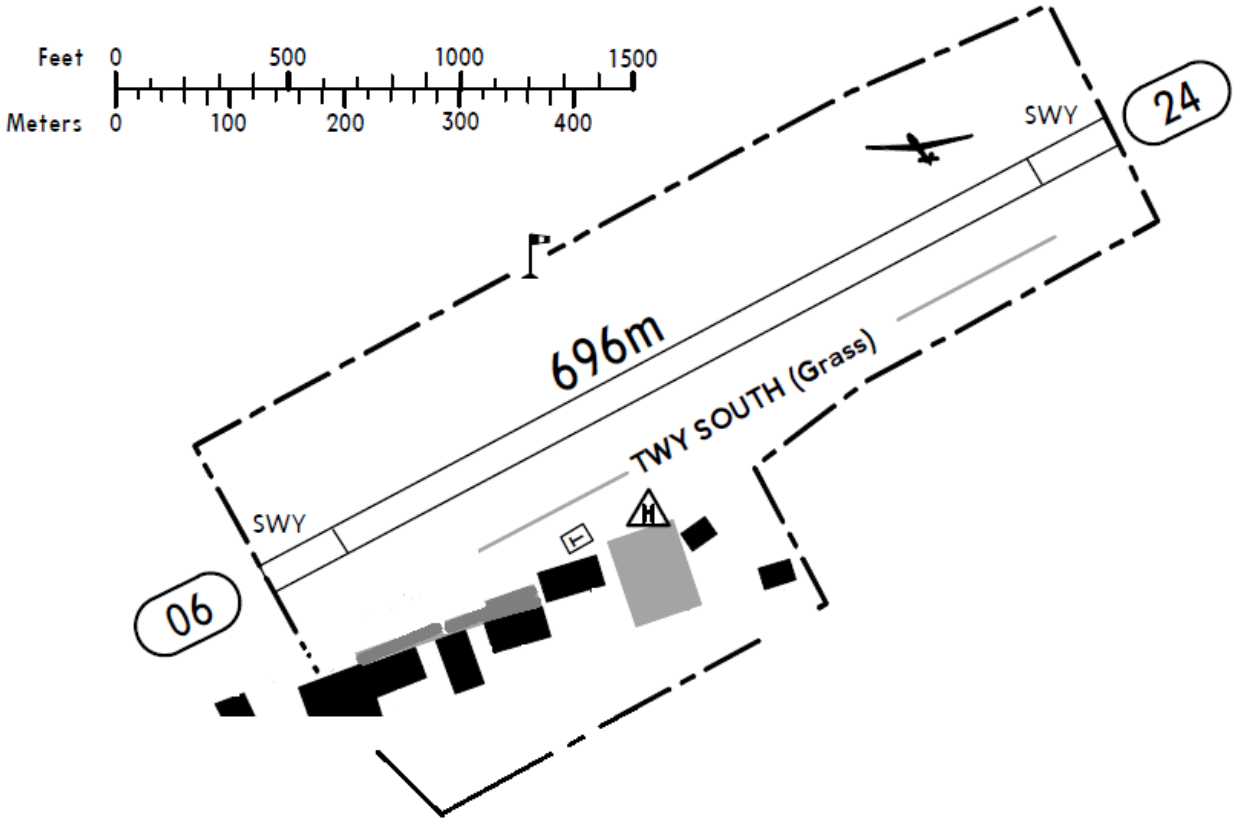


Figure 2: Airfield EBNM

Flight recorders.

The helicopter was not equipped with any flight recorder, nor was it supposed to.

Wreckage and impact information

The wreckage was inspected on the day of the accident.

Figure : Crash site

All damage consistent with a hard landing, followed by a rollover.

Main rotor blade broken.

Damage to the helicopter structure; vertical and horizontal firewall deformed. tail boom deformed on both ends. LH door window and windscreen broken.

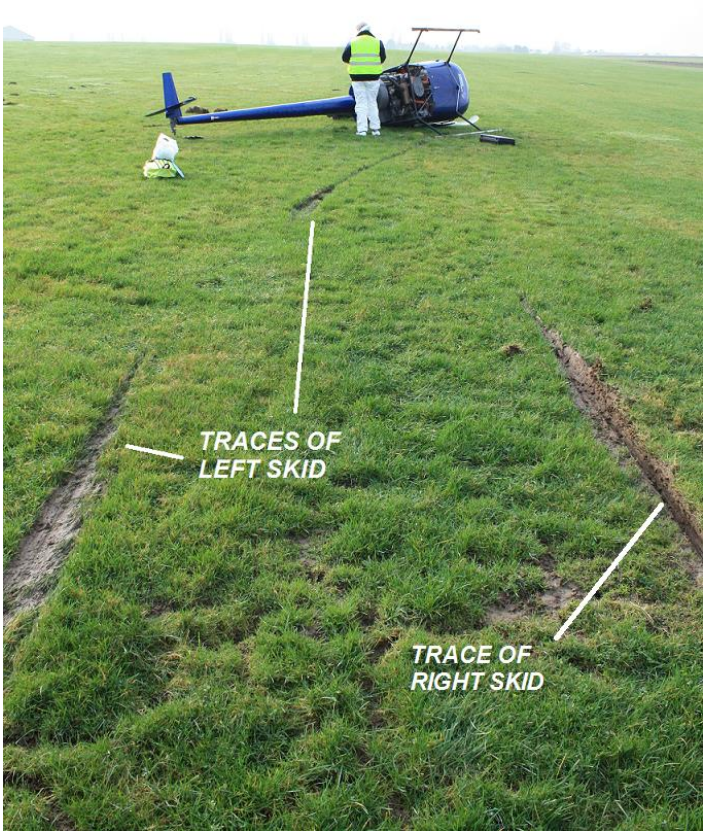
Damage on the upper and lower side of the tail boom-to structure attachment point, indicating the tail boom moved in the vertical plane (down during the hard landing, up, afterwards)

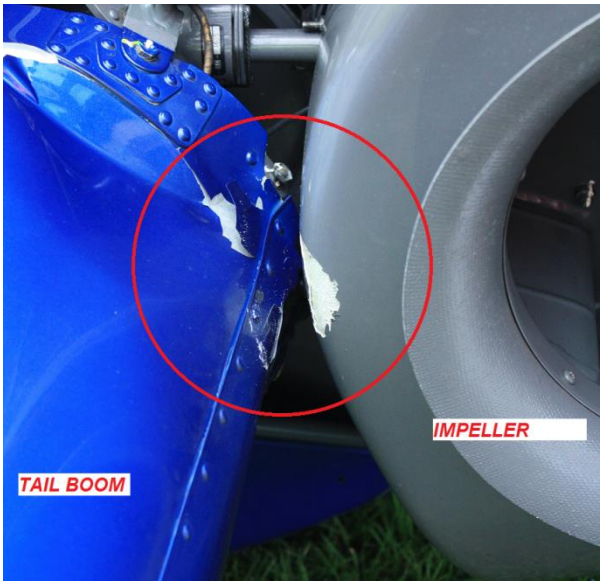
Engine power Transmission belts broken.

The B223 yoke and A947-2 flexplate are deformed under torsion (transmission from V-belts to the tail rotor).

There were no pre-impact defect technical defect found during inspection of the wreckage.

Skid traces


TRACES OF
LEFT SKID
TRACE OF
RIGHT SKID


IMPELLER
TAIL BOOM


TAIL
BOOM

Test and Research

General

Accident report database from NTSB, AAIB, BEA-fr and AAIU(Be) were consulted for accidents during helicopter flight training.

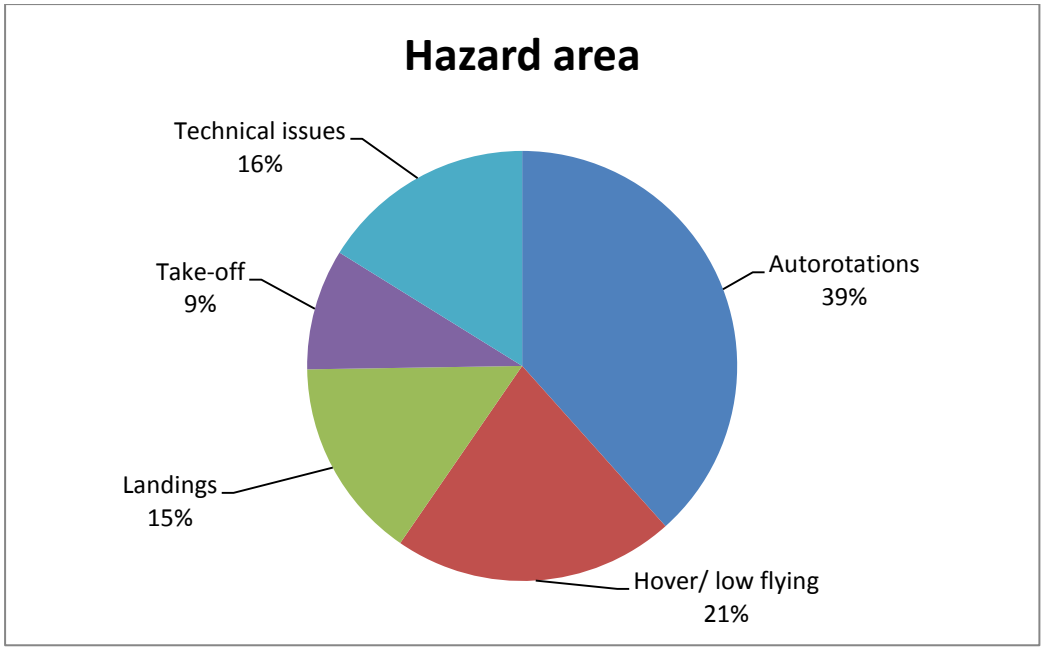
The combined database showed 151 helicopter training accident reports filed for the period 2000-2012. Helicopter flight training accidents were accounting for 25 % of all helicopter accidents.

Out of the these accidents;

- 71% occurred during basic training,
- 19% occurred during refresh course, flight review exams and check rides.
- 10% occurred during advanced training (conversion, type training)

- 5% were fatal accidents.
- 7% involved serious injuries.
- 87% involved only material damage and minor injuries.

Breaking down the hazard area,



Autorotations constitute the most important hazard in helicopter accident, and constitutes 50% of the total helicopter flight training fatal accidents.
The accident distribution in function of the type of autorotation is;

- 40% of autorotations to the ground
- 47% of autorotations with power recovery.
- 12% of autorotations from hover.

The causes identified in the reports are:

- 44% of pilot's inadequate input (50% of the cases concern flight reviews, advance training and examination flights).
- 38% Flight instructor / examiner late response
- 35% Pilot's failure to maintain rotor rpm
- 19% Instructor/ examiner improper supervision

Note: Causes here above are sometimes combined for a given accident.

European Helicopter Safety Team
Launched on November 2006, the European Helicopter Safety Team (EHEST) brings together manufacturers, operators, research organizations, regulators, accident investigators and a few military operators from across Europe. EHEST is the helicopter branch of the ESSI, and also the European component of the International Helicopter Safety Team (IHST).

EHEST is committed to contribute to the goal of reducing the helicopter accident rate by 80 percent by 2016 worldwide, with emphasis on improving European safety.

EHEST has published an analysis of 2000-2005 European helicopter accidents and regularly publishes leaflet on various subjects regarding helicopter operations. In March 2013, EHEST published the Safety Leaflet "HE5 – Risk Management in Training for Helicopter Pilots and Instructors". The document was developed in partnership with major stakeholders and provides tools and methods to improve risk management in training. Training for autorotation is used as a practical example to illustrate the process (EHEST website).

The leaflet "HE5 – Risk Management in Training for Helicopter Pilots and Instructors" is available at:
https://easa.europa.eu/essi/ehest/category/publication-type/

Belgian CAA initiatives
The Belgian CAA organised a Helicopter Safety Day in June 2012, inviting Belgian helicopter pilots to attend a series of presentations from industry, aviation authorities and AAIU(be) on helicopter safety.

FAA Advisory Circular

The FAA issued the Advisory Circular AC 61-140 on 23 May 2013 on autorotation training. The document describes guidelines for autorotations during rotorcraft/helicopter flight training.

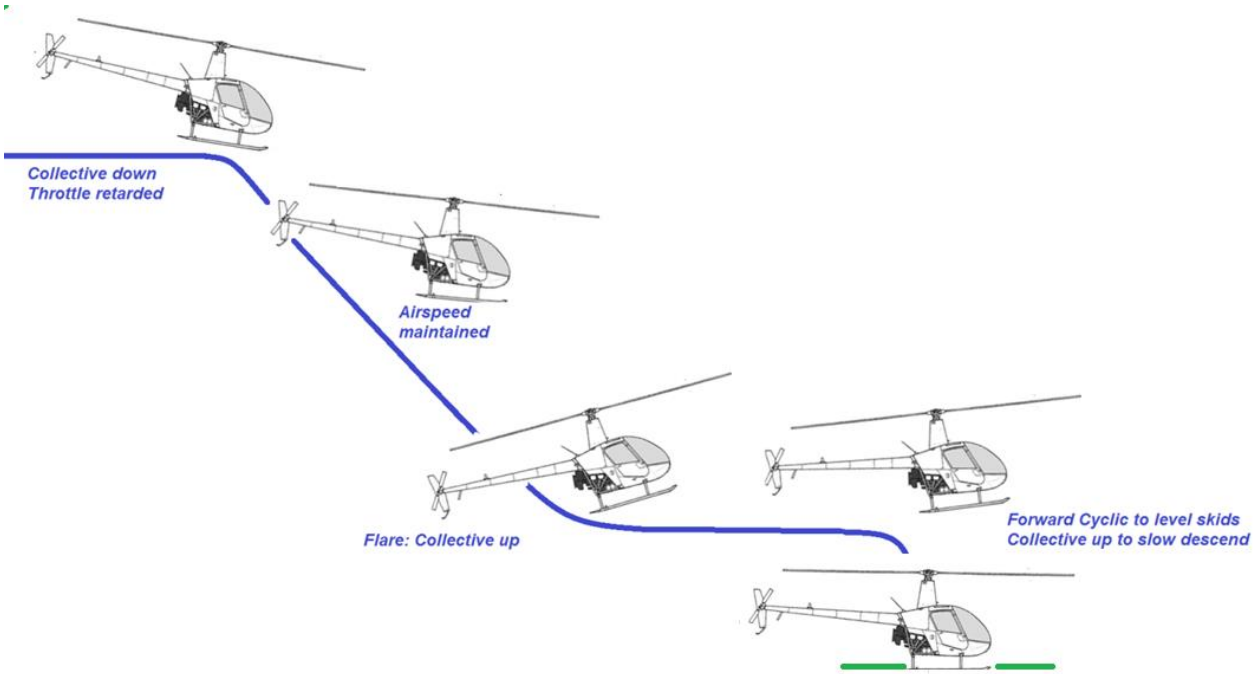
The document defines the common errors made during autorotation:

1. Entering the maneuver at an improper altitude or airspeed.
2. Entering the maneuver without a level attitude (or not in coordinated flight).
3. Entering the maneuver and not correcting from the initial deceleration to a steady state attitude (which allows excessive airspeed loss in the descent).
4. Improper transition into the descent on entry.
5. Improper use of anti-torque on entry.
6. Failure to establish the appropriate cross-wind correction, allowing the aircraft to drift.
7. Failure to maintain coordinated flight through the turn.
8. Failure to maintain rotor rpm within the POH recommended range.
9. Excessive yaw when increasing collective to slow rate of descent during power recovery autorotations.
10. During power recovery autorotations, a delay in reapplying power.
11. Initial collective pull either too high or too low.
12. Improper flare (too much or not enough).
13. Flaring too low or too high (AGL).
14. Failure to maintain heading when reapplying power.
15. Not landing with a level attitude.
16. Landing with aircraft not aligned with the direction of travel.
17. Insufficient collective cushioning during full autorotations.
18. Abrupt control inputs on touchdown during full autorotations.

The document is available at:
http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentid/1021176

Analysis

Autorotation exercise



The intended exercise was to conduct an autorotation to the ground.

This would involve getting to a suitable altitude, retarding the throttles and moving the collective down. The helicopter will begin an immediate descent, thus producing an upward flow of air through the rotor system ensuring a lifting force throughout the descent.

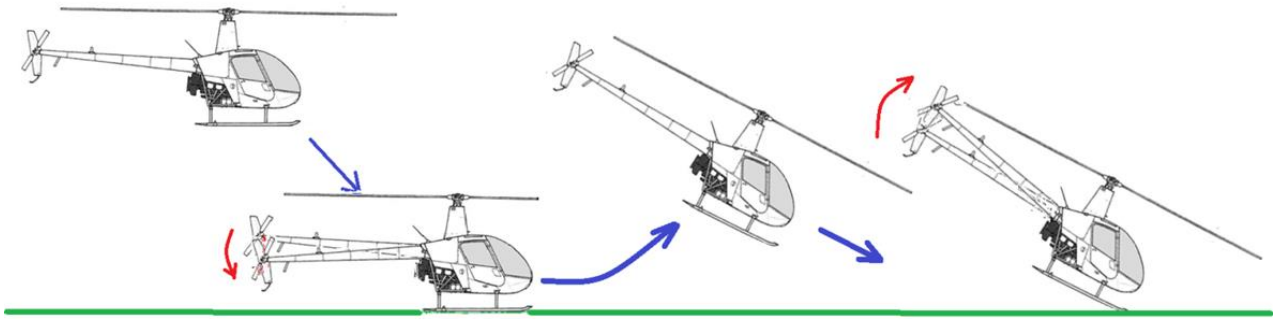
The pilot needs to adjust the cyclic controls to achieve the best (autorotation) airspeed. Rotor rpm is kept within limits by using the collective.

A flare autorotation enables the pilot to land a helicopter.
The speed at touchdown and the resulting ground run will depend on the rate and amount of the flare - the greater the degree of flare and the longer it is held, the slower the touchdown speed and the shorter the ground run.

The flare is initiated by moving the cyclic controls to the rear. As forward motion decreases to the desired groundspeed, the cyclic controls is moved forward to place the helicopter in preparation for landing attitude. The throttle is retarded towards the closed position.

The altitude at this time should be approximately 10 feet. The helicopter is then allowed to descend vertically and collective pitch is applied, as necessary, to control the descent speed. The throttle is held in the closed position so the rotor will not re-engage.

Impact



The helicopter after the flare had residual vertical and forward speed in excess.

The skid traces on the ground indicate the first contact was brutal, the skid made a 10cm deep groove in the ground. The tail boom swung downwards, making a print on the rear fan.

There was a residual forward speed, and the helicopter bounced forward and the nose pointed downwards. .

The left skid touched the ground, and forced the helicopter, losing its balance, to a right turn. The main rotor impacted the ground and the helicopter rolled over its left side.

Note: the instructor would normally expect the helicopter to be brought in hover at 10ft, before lowering the collective to land the helicopter. In this case, he was not able to detect the problem during the flare, and was late reacting.

Conclusions

Cause

The accident was caused by the inadequate flare at the conclusion of an exercise of autorotation to the ground, leading to a brutal contact with the ground.

Contributing factors:

The instructor was late reacting to the inadequate flare.

Safety Recommendations

None

About this report

As per Annex 13 and EU regulation EU 996/2010, each safety investigation shall be concluded with a report in a form appropriate to the type and seriousness of the accident and serious incident. For this occurrence, a limited-scope, fact-gathering investigation and analysis was conducted in order to produce a short summary report.

It is not the purpose of the Air Accident Investigation Unit to apportion blame or liability. The sole objective of the investigation and the reports produced is the determination of the causes, and, where appropriate define recommendations in order to prevent future accidents and incidents.