

Airbus A321, G-OOAI

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Aircraft Type and Registration:	Airbus A321, G-OOAI
No & Type of Engines:	2 CMF56 turbofan engines
Year of Manufacture:	1999
Date & Time (UTC):	3 June 1999 at 1631 hrs
Location:	Runway 24R at Manchester Airport
Type of Flight:	Public Transport
Persons on Board:	Crew - 7 - Passengers - 221
Injuries:	Crew - None - Passengers - None
Nature of Damage:	Skin and stringer damage over an area of 137 cm (4.5 feet) by 46 cm (1.5 feet) between frames 62 to 65
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	44 years
Commander's Flying Experience:	11,200 hours (of which 4,860 hours were on type) Last 90 days - 262 hours Last 28 days - 86 hours
Information Source:	AAIB Field Investigation

History of flight

The crew were on the second sector of the day in G-OOAI and returning to Manchester Airport. For the first sector, the commander had been the handling pilot and, for the return flight the first officer was designated as the handling pilot. There were no unserviceabilities noted in the Technical Log and the crew considered the aircraft fully serviceable. The weather at Manchester was reported as follows: surface wind of 270°/ less than 5 kt; visibility of 5,000 metres; scattered cloud at 800 feet agl; the runway was reported as wet.

G-OOAI was vectored by ATC to approximately 15 nm to the east of the airport before being turned inbound towards the ILS for Runway 24R. Throughout the approach, the commander considered that the cockpit workload was not particularly high and was satisfied with the first officer's handling of the aircraft. The first officer had briefed for a 'CONFIG FULL' landing using

automatic spoilers and medium autobrake from an ILS approach to Runway 24R. He stated that he was fully established on the ILS by 3,000 feet amsl, and that the landing checks were complete and the aircraft stabilised by approximately 1,200 feet agl. He recalled that ATC reported a surface wind of 280°/5 kt with the landing clearance. At about 400 feet agl, the first officer became visual with the runway and disconnected the autopilot. The approach appeared normal up to the point that the electronic voice called "50 feet"; as it did so, the first officer applied back pressure to his side-stick but suddenly became aware that the rate of descent was higher than normal. He heard the commander call for him to watch the sink rate and moved the side-stick further back. During this time, he also retarded the throttles on the activation of the automatic "Retard" call. As the aircraft contacted the runway hard on the main gear, the first officer felt that his side-stick was fully back. He thought that G-OOAI bounced and moved the side-stick forward to the neutral position to maintain aircraft attitude. About this time, the commander called: "I have control" and took control of the aircraft. There then appeared to be a second touchdown, which was firm but not as hard as the first one.

The commander recalled that light to moderate rain was falling during the approach and that he activated the windshield wipers at one stage. The PAPIs indicated that the aircraft was on the correct approach path and the autothrust was maintaining airspeed at about 3 to 5 kt above the lowest speed (V_{LS}) of 135 kt. There was no apparent windshear and the rate of descent seemed normal. However, at the point where the commander expected the flare to be initiated, there was no apparent aircraft attitude change and his perception was that the nosewheel might contact the ground before the main gear. He called urgently for the nose to be raised; this was done but the aircraft made a very firm touchdown and seemed to bounce. The commander could feel that the spoilers had deployed and called that he had control. He reduced the pitch attitude to recover the situation and selected thrust reverse once the aircraft was positively on the ground. While taxiing to the parking stand, the commander asked ATC if there had been any indication of a tail strike on landing and was advised in the negative. He also consulted with his cabin crew and ascertained that there had been an unusual noise at the back end of the aircraft on touchdown. Once on stand, some scrape marks were seen on the bottom of the rear fuselage of G-OOAI.

Flight recorders

Recorded information was available from the Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR) fitted to the aircraft. Both recorders used solid state recording technology and retained the whole of the accident flight including the landing.

Incident Landing

At 400 feet agl, having obtained landing clearance, the commander briefly operated the windshield wipers. The first officer stated that he was visual with the field and required no further calls. He disconnected the autopilot at 320 feet agl but left the autothrottle engaged which maintained a stable, managed airspeed of 140 kt. Final approach was made on the glideslope with an average barometric descent rate of 800 feet/min and aircraft pitch attitude of 2.8°. A selection of pertinent aircraft parameters recorded during the latter stages of the flight is shown in Figure 1.

Throughout the approach and landing phase, sidestick movements resulted in corresponding changes in elevator deflection. At 150 feet agl, the aircraft began to rise above the glideslope and the first officer applied a small amount of forward sidestick (1.5° out of 16° maximum travel each way from neutral); this lowered the nose of the aircraft to a pitch attitude of 2.1°. The ground closure rate, as derived from rate of change of radio altitude, was 900 feet/min at this time. By 100

feet agl the divergence in glideslope was arrested at a maximum of 0.6 dots and the first officer neutralised his sidestick. With an unchanged ground closure rate of 900 feet/min (15 feet per second) no further control inputs were made until 60 feet agl, when the first officer gradually began to move his sidestick aft (1° aft of neutral at this point). The pitch of the aircraft was unchanged at 2.1° by the time of the automatic "fifty" feet call and by 45 feet agl the sidestick had reached 2.5° aft of neutral. The commander told the first officer to "watch the sink rate... watch the sink rate" as the aircraft descended through 30 feet agl and the first officer had continued to move his sidestick to 5° aft of neutral. The pitch of the aircraft was still recorded as being 2.1° nose up. Just after the automatic call of "twenty ... retard" the first officer's sidestick was 10° aft of neutral. The aircraft had started to pitch up and achieved a pitch attitude of 3.1° by 15 feet agl, but still with a descent rate of 900 feet/min. One second later (half a second before touchdown), aircraft pitch had increased to 5.6°, the first officer had moved the sidestick further aft to 11.1° and the last airborne radio altitude of 2 feet agl was recorded as the rate of descent started to reduce.

At touchdown, a normal acceleration of 1.95 g was recorded with the aircraft pitch attitude at 6.0° and wings level. Both left and right main gear 'weight on wheels' switches closed. The sampling rate of normal acceleration was eight times per second and, with the sharp rise and fall of the 'g spike', it is possible that the peak value was slightly higher than that recorded. The first officer's sidestick was recorded as being 12.4° aft of neutral at touchdown. At the point of touchdown the aircraft pitch attitude remained constant for one sample (a quarter of a second) due to the reaction moment of the main gear compression against the runway surface.

Pitch attitude was still increasing as the aircraft became light on the oleos, opening the left main gear 'weight on wheels' switch but not that of the right main gear. This momentary opening of the left main gear switch was also apparent on recordings from previous uneventful landings. Ground spoilers started to deploy and the first officer moved his sidestick forward momentarily to 1.4° aft before pulling it back to 11.2° aft. However, pitch attitude continued to increase through 8.8° and the commander stated "I have control". The first officer's sidestick neutralised as the aircraft sank on the main gear, registering a normal acceleration of 1.64 g at a pitch attitude of 9.5°. The commander applied full forward movement on his sidestick and arrested the pitch up at an attitude of 9.84°. The aircraft began to pitch down rapidly and, at a pitch attitude of 6.7°, the commander applied full aft movement on his sidestick until the nose gear contacted the runway. The maximum rate of pitch down achieved was 7 degrees per second and, although not detectable on the recording of normal acceleration, the contact of the nose gear with the runway was very distinct on the CVR.

Comparison with other landings

The incident landing was compared with the previous landings made by G-OOAI that were recorded on the FDR. There were no major differences noted in the CG positions of any of the flights compared to the incident flight. However, the rate of descent in all the uneventful landings had been reduced earlier by increasing the pitch attitude of the aircraft. Typical of such landings was the start of reduction in descent rate at heights between 60 feet agl and 100 feet agl. This resulted in typical descent rates in the order of 600 feet/min by 30 feet agl and less than 300 feet/min at touchdown.

A different operator, flying the same type of aircraft (G-MIDA), had a very similar event ten months before the date of the incident to G-OOAI. The data from that earlier event showed a descent rate in the order of 900 feet/min during the final seconds before touchdown and a high pitch attitude of the aircraft during the flare; that event also resulted in a tail strike.

Engineering information

Damage to the aircraft was limited to abrasion damage to skin, frames and stringers over an area of 4.5 feet by 1.5 feet between frames 62 to 65. A post-flight Heavy Landing Inspection found no other damage. Inspection of the runway also revealed no evidence of surface marking resulting from the tail strike.

A post-flight readout of the Electronic Centralised Aircraft Monitoring System (ECAMS) showed that there had been no relevant system fault detected during the subject flight.

Operational information

The first officer had recently completed his line training, with his final line check on 29 May. He had then flown two line sectors on 30 May before flying G-OOAI on 3 June. At the time of the incident, he had a total of 5,200 hours of which 60 hours were on Airbus A320/321; during his line training, he had flown 12 of the 16 sectors on the Airbus A321. His training records indicated a competent pilot who had fully completed his conversion training to a satisfactory standard.

The aircraft manuals include the following relevant information about landing the A320/321:

'For the A321, a tail strike occurs if pitch attitude exceeds 11° (9.5° with the landing gear compressed). For the A320, a tail strike occurs if the pitch attitude exceeds 13.5° (11.5° with the landing gear compressed). For both models, there is a pitch-up tendency with ground spoiler extension.'

Passenger and baggage weights were based on standard European charter flight figures; the CG and total weight had been calculated accurately on the manual load sheet. Additionally, a manual calculation of V_L s and V_{app} based on the aircraft weight and surface wind confirmed that the speeds used for the approach and landing of G-OOAI at Manchester were accurate.

Discussion

The aircraft was fully serviceable during the flight, the CG position was within limits and the approach speed had been correctly calculated. The commander was satisfied with the way the first officer was handling G-OOAI; the approach was well controlled and the cockpit workload was at a normal level. Around 400 feet agl, the first officer stated that he was visual with the runway and that he required no further calls. The aircraft was fully configured for landing and was stabilised on the correct 3° glideslope at the correct speed of 140 kt at a pitch attitude of 2.8° ; in accordance with company procedures, autothrottle was engaged.

The approach appeared normal until 150 feet agl when the aircraft went slightly above the glideslope. The first officer countered this movement with a forward movement of his sidestick and reduced the pitch attitude to 2.1° . There was no subsequent change in aircraft attitude until under 30 feet agl; the rate of descent remained at 900 feet/minute. At this point, the commander made his warning call to the first officer and the right side stick was moved back. Touchdown was firm and, after initial ground contact, the aircraft 'bounced' slightly; the first officer moved his sidestick forward momentarily to 1.4° aft of neutral before moving it back to 11.2° . During this time, the pitch attitude of the aircraft continued to increase until it was arrested by a positive movement of the side stick by the commander. However, the pitch attitude achieved was at a level just sufficient to cause a tail strike.

In summary, the sequence of events appeared to start when the flare was initiated late and with too slow sidestick demand. The damage to the aircraft was minimised by the positive control movements made by the commander once he had taken control.