

**NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF AVIATION SAFETY
WASHINGTON, D.C. 20594**

June 21, 2007

**VANS AIRCRAFT MODEL A SERIES AIRPLANE
NOSE-OVER ACCIDENT
PHOTOGRAPHS**

A. SUMMARY

Staff has examined data for 18 recent accidents and one incident in which Vans Aircraft series RV-6A, RV-7A, RV-8A, or RV-9A airplanes have become inverted during landing. Several involved hard landings such as hard touchdowns, bounced landings (six), or landing in a slip. Several others involved off-field landings in rough terrain, hitting a ditch, or going down an embankment.

Four of the accidents and one incident involved a touchdown and the start of a rollout on an unpaved runway, followed by the nose gear folding back. The airplanes would then slide for varying distances before nosing over. Staff also examined data for four additional incidents in which the nose gear collapse during taxi but the airplane did not nose over. These nine accidents and incidents occurred on various unpaved surfaces including gravel, turf, soft turf, hard surface with “washboard” bumps, and slight depressions. These nine cases involve the nose gear fork digging into the ground and the nose gear bending aft.

Photographs are provided that illustrate damage mechanisms.

B. PHOTOGRAPHS AND DOCUMENTS

Examination of photographs and several pieces of wreckage from several NTSB and FAA investigation revealed several consistent and pertinent pieces of evidence related to those airplanes that nosed over or were damaged during taxi.

Some accidents exhibit a long, narrow furrow through the ground and grass. The nose gear strut is bent to such a configuration that it can contact the ground and create a furrow. A disruption of the soil may be present at the end of the furrow and the airplane may lie inverted a short distance beyond the disruption of the soil. The long, narrow furrow varies in length for each accident, but the distance from the disruption to the airplane is only a matter of a few feet. ([Figure 1](#), [Figure 2](#), and [Figure 3](#))

The nose gear strut is bent aft. The bend usually has a smooth radius and there may be a sharper bend at the engine mount. The paint is worn off the front of the strut, about 9 to 15 inches above the fork. The furrow is the result of that portion of the strut contacting the ground. (Figure 4) The nose gear is bent much greater during the event and springs back after the loads have been removed. Photographs show several nose gear struts in a relaxed position after having been bent. (Figure 5, Figure 6 and Figure 7)

Grass and dirt are imbedded in the forward portions of the nose gear fork. Figure 8 shows grass and dirt on the front and top of the fork. This gear was fully bent aft with the fork pointed down. Figure 9 shows grass only at the lower portion of the fork. This gear was not bent fully aft during the taxi event. Figure 10, Figure 11, and Figure 12 show that the spinner is compressed in an aftward direction and the engine inlet is undisturbed.

The nose gear fairing has scrapes on the bottom, as if the fairing was level to the ground when the scrapes occurred. The fairing is normally separated from the fork. (Figure 13).

There have been several incidents in which the nose gear moved far aft or collapsed while the airplane was moving very slowly. In one case, the nose gear dropped into a tie down depression. The fairing was imprinted while the fork was digging into the side of the depression. In another case, it was reported that the airplane was moving very slowly and encountered a washboard area; the nose gear collapsed and dug in. In these cases, the fork is digging into the ground and initiating the sequence. Since the speed is low, the aft force on the gear is sufficient to bring the airplane to a stop. (Figure 14, Figure 15, Figure 16, and Figure 17).

C. EFFECTS OF TIRE PRESSURE ON GEAR STRUT AND FORK HEIGHT

The calculations are simplified but illustrate the effects of tire pressure on the resulting height of the strut and fork above the ground (tire shape and dynamics are very complicated). Figure 18 shows a new fork design profile. The height from the ground to the strut is about 5 inches when the tire is unloaded. The threaded area in the drawing is extended about 1 inch to be consistent with the 4-inch ground clearance of the original strut and fork design.

The weight on the nose gear at empty weight is about 370 pounds. At 30 psi tire pressure, the tire foot print would be 12.3 square inches (370/30). The tire is about 3.7 inches wide at the tread, thus the flat spot on the tire would be about 3.3 inches, when viewed from the side. In order to achieve a 12.3 square inch contact patch, the tire would compress about $\frac{1}{4}$ inch leaving the strut about 3.74 inches from the ground. See Figure 18. A 2X load (740 pounds) on the nose gear would require 6.7 inches of tire contact when viewed from the side. Because of the geometry, the compression is significantly

greater to get twice the tire footprint. In this case, the fork is now 2.9 inches from the ground (1/4 inch loss at 1X and 1.13 inch loss at 2X).

At 20 psi, each footprint has to be 50% greater at each load factor. A load factor of 1X results in a fork to ground clearance of 3.4 inches. At a load factor of 2X, the ground clearance is 0.8 inches by calculation. However, the dynamics associated with a compressed tire and wheel diameter undoubtedly affect the actual height of the strut and fork.

A heavy engine/propeller combination will add to the tire compression. Seventy extra pounds has little effect on the ground clearance if the load factor is 1X and the tire is inflated to 30 psi. A 2X load factor would result in a ground clearance of 2.3 inches. A 2X load factor and 22 psi would result in the fork contacting the ground (by calculation).

Several scenarios are presented that show a calculated 1.5-inch ground clearance, which is the point at which the radius of the wheel would be at ground level.

D. OVERTURNING FORCES AND INERTIA

Drag forces from the landing gear/surface, in combination with all forces acting on an airplane, can cause an airplane to overturn. A high drag force on the nose gear can result in the airplane overturning. The magnitude of the drag force to create a positive overturning moment is variable and dependent on many factors. Such factors may include varying forces such as thrust, the aerodynamic drag of body, lift on the wings (or negative lift), and aerodynamic downloading on the horizontal stabilizer.

Figures 19 through 23 present a simplified explanation of overturning moments about the nose gear (other forces acting on the airplane are not considered). [Figure 19](#) depicts an aft force at the nose gear and an inertial reaction vector through the CG. [Figure 20](#) depicts the resultant vector that is the sum of the weight vector and inertial reaction vector. If the resultant vector falls behind the nose gear, the moment is not sufficient to overturn the airplane. [Figure 21](#) depicts a high aft force at the nose gear and the correspondingly high inertial reaction vector. [Figure 22](#) depicts a resultant vector that falls forward of the nose gear. Thus, a high drag load at the nose gear may produce a sufficient moment to overturn the airplane. The drag force would have to be about equal to or greater than the weight of the airplane. [Figure 23](#) shows the effect of the collapsed nose gear. The pitch-down attitude moves the CG forward and the contract point (nose gear strut) is much closer to the CG. Thus, the drag load at the strut or fork may only be 1/3 to 1/2 the weight of the airplane to produce an overturning moment. [Figure 23](#) also shows that aerodynamic loads on the wing and horizontal stabilizer resist the overturning tendency.

E. APPENDIX – ACCIDENT/INCIDENT DATA BASE ([see Appendix](#))

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Figure 1 – Narrow furrow in foreground created by nose gear strut.
(N448GM Source: FAA)



Figure 2 – Long narrow furrow created by nose gear strut. NTSB Case
No. ATLO6LA052



Figure 3 – Wider furrow created by nose gear fork followed by narrow furrow. NTSB Case No. MIA05LA021



Figure 4 – Nose gear strut that is polished by sliding on the ground. NTSB Case No. MIA05LA021



Figure 5 – Nose gear shown in relaxed position. It is bent much further aft during the event. NTSB Case No. ATL06LA052



Figure 6 – Nose gear shown in relaxed position. It is bent much further aft during the event. NTSB Case No. ATL06LA052



Figure 7 – Nose gear shown in relaxed position. It is bent much further aft during the event. NTSB Case No. MIA05LA021



Figure 8 – The forward and top portions of the nose gear fork exhibit evidence of having been imbedded in the turf. NTSB Case No. ATL06LA052



Figure 9 – The forward portion of the nose gear fork exhibit evidence of having been imbedded in the turf. (Source: owner of airplane)



Figure 10 – The propeller spinner is compressed aft and the engine inlet is essentially undamaged. (N448GM Source: FAA)



Figure 11 – The propeller spinner is compressed aft and the engine inlet is essentially undamaged. NTSB Case No. ATL06LA052



Figure 12 – The propeller spinner is compressed aft and the engine inlet is essentially undamaged. (N448GM Source: FAA)



Figure 13 – The bottom of the nose gear fairing exhibit scraping along the bottom. NTSB Case No. MIA06LA021



Figure 14 – Encounter with depressed tie-down. The airport manual depicts the depth of the depression. (N994W Source: public web site)



Figure 15 – The airplane nose gear was not permanently deformed.
(N994W Source: public web site)



Figure 16 – The cap on the nose gear fairing exhibits the impression from the fork and nut. (N994W Source: public web site)



Figure 17 – Damage from a slow speed taxi event. (Source: owner of airplane)



Figure 18

Effects of Tire Pressure, Load Factor and Static Weight on Strut Clearance

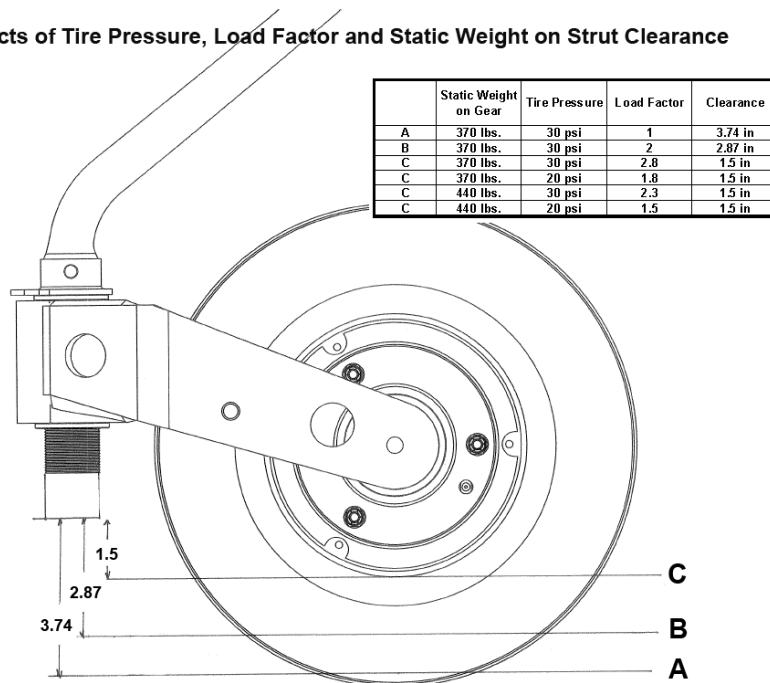


Figure 19

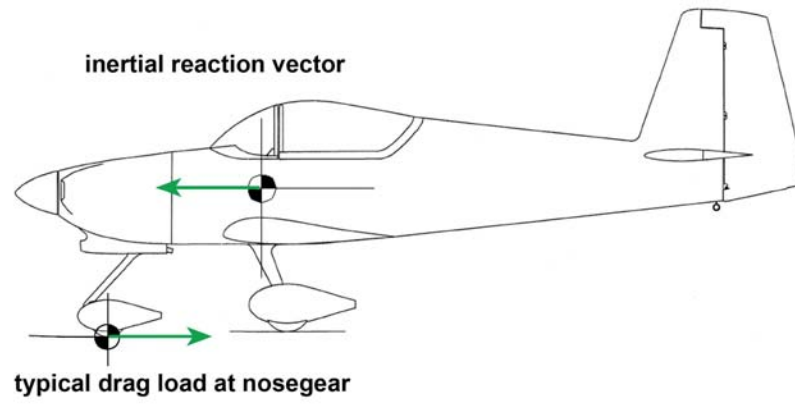


Figure 20

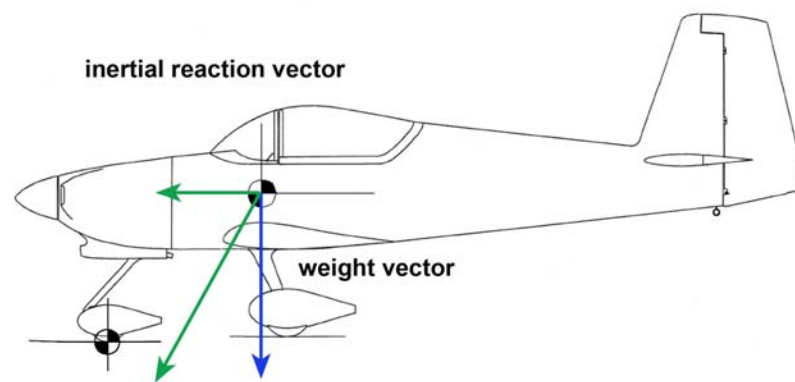


Figure 21

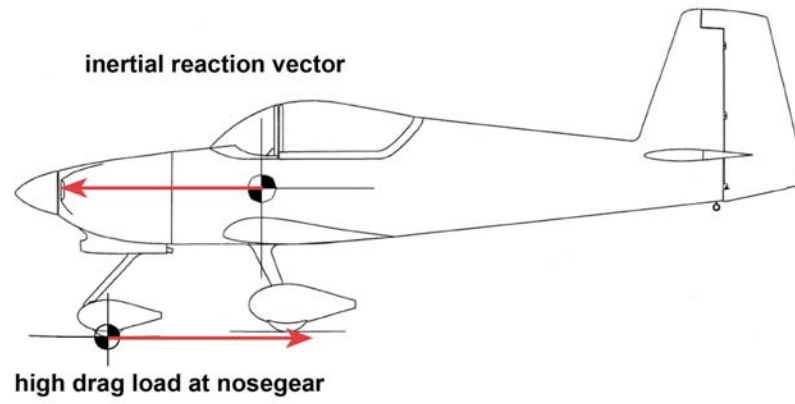


Figure 22

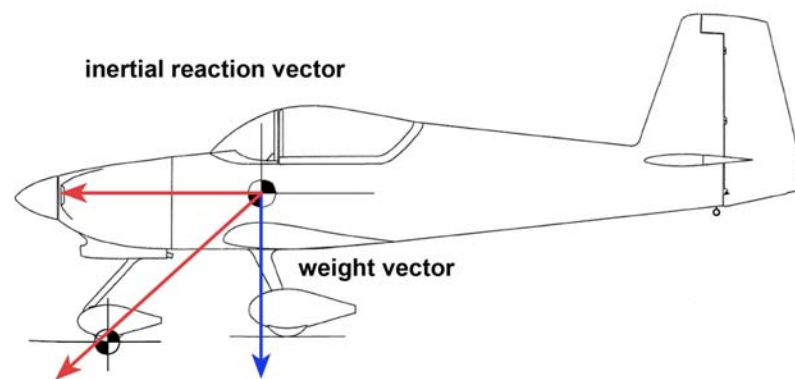
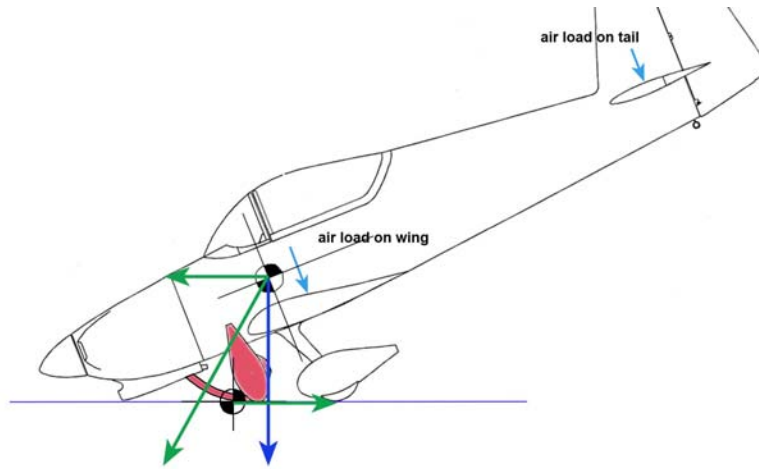


Figure 23



APPENDIX

RV NOSE LANDING GEAR ACCIDENTS/INCIDENTS

NTSB ID/LOCATION	DATE	N-NUM	MODEL	ENG	ESTIMATED SPEED (mph)		GROUND COND	REMARKS
NYC00LA107 East Liverpool, OH	4/1/2000	565BW	8A	320	20+	off runway	asphalt first, soft dirt second	On landing, nose wheel engaged runway first, airplane veered right, nosewheel dug into soft ground, nosed over
NYC02LA182 Oxford, OH	9/5/2002	945D	9A	320	30+	off runway	road, field	Fuel starvation, night, followed cars to land on road, bounced 5-6 times, hit sign, veered into soy field, nosed over
CHI02LA278 Brodhead, WI	9/10/2002	54LF	8A	360	10-20?	rollout	grass/turf	Touched down on turf r/w, held nose off, nose gear touched small bump, bent aft, nosed over
NYC04LA012 Deshler, OH	10/19/2003	786HL	9A	SUB	30+	bounce	turf r/w	Touched down on turf runway, bounced, then bounced 2 more times, nosed over
FTW04LA109 Borger, TX	4/15/2004	82LS	8A	CHEV V6	30+	off runway	short of runway	Losing engine power, impacted 100 ft short of rw, nose gear folded, nosed over, slid for 100 ft to r/w threshold.
CHI04CA141 Ft. Scott, KS	6/6/2004	369RV	9A	SUB	30+	off runway	off airport, field, ditch	Lost power, landed in field, hit ditch, nosed over
CHI04LA011 Augusta, MO	10/13/2004	707DD	7A	SUB	20+	off runway	off airport, soft soil	Lost power. Landed on dirt road, nose gear dug into soft sandy soil, nosed over
MIA05LA021 Weirsville, FL	11/1/2004	955DC	6A	320	30+	bounce	turf, soft	Bounced, fork dug in, then main nose strut, then kicked sideways and over
DFW05CA042 Gordonville, TX	12/17/2004	207TP	7A	SUB	20+	bounce	grass strip, uphill slope, soft in landing area	Impacted hard, nose gear dug into soft ground and nosed over
ANC05CA031 Panacea, FL	2/12/2005	429WD	7A	360	20+	bounce	paved runway	Taxi test, airborne, high rate of descent, bounce, landed on nose gear, collapsed and nosed over
Beaumont, KS	8/1/2005	311TW	7A	SUB	4-5+/-	taxi	turf runway	Slow taxi, wash board surface, started bouncing, nose gear folded. (See photos)
ANC05LA123 Palmer, AK	8/12/2005	63EB	9A	360	10-20?	rollout	gravel runway, 1200 ft	500 ft after touchdown, nose gear began scuffing runway, fork dug in, bent aft, nosed over
DFW06CA009 Reklaw, TX	10/23/2005	555YF	7A	360	30+	rollout	turf	Landed on turf, nosed over.
Australia	10/29/2005	VH- RMV	7A	UNK.	UNK.	off runway	off end of asphalt, into grass	Off end, into ditch, fence; clumps of dirt/grass on fork, nosed over
Hollister, CA	11/5/2005	994W	9A	320	2-3+/-	taxi	turf runway, hard.	Taxi in, nose gear into depresses tie down (10X2 in.), fork dug in, gear bent back, but rebounded. (See photos)
ATL06LA052 Mooreville, NC	3/13/2006	57ME	6A	320	30+	rollout	turf, soft, wet,	Hit rabbit on touchdown, pilot stated stick full aft, nosed over
ANC06LA035 San Diego, CA	3/27/2006	428BC	6A	360	50	bounce	asphalt	Landed fast, bounced 3 times, did not go around, nose gear folded on third bounce
MIA06CA095 Live Oak, FL	4/19/2006	8117Q	6A	320	50	xwind	turf	Landed in crosswind and crab, bent nose strut, slid 30 feet & flipped over
Endicott, NY	4/20/2006	448GM	8A	UNK.	UNK.	rollout	turf, thick grass	Fork dug in, then main nose strut, nosed over
A06O0119 (TSB Canada) Brampton, Ontario	5/19/2006	C- FEQP	7A	UNK.	UNK.	xwind	paved runway, but went off side into soft dirt	During touch down in x-wind, landed hard on nose gear and it collapsed, slid to side of runway where remaining portion of gear dug into the soft dirt, nosed over
Boone County, TX	6/17/2006	UNK.	7A	360	5-10 mph	taxi	sod	During taxi, collapsed nose gear, hit prop
WAS06SA019 Rostraver, PA	8/13/2006	6699	9A	320	3 mph	taxi	turf to asphalt taxi way	While moving at 2-3 mph taxied from grass to asphalt, heard bang & felt small bump, fork hit asphalt, tire 26 psi
United Kingdom Croft Farm	6/9/2007	G- CDRM	7A	UNK.	30+	bounce	landing on turf	Video on web. Bouncing at start and end, speed about 40+ mph at start (uncorrected for camera speed)