SK686, SPEED CALCULATION BASED ON DFDR DATA

Summary

On Monday, October 8, 2001, a Scandinavian Airlines System MD87 collided with a Cessna Citation during take off from Linate airport, Milano, Italy.

The MD87 was equipped with a Digital Flight Data Recorder (DFDR), which survived the crash without any damage to the recording. Data from this recorder was handed over from the Swedish Board of Accident Investigation.

Speed and Distance calculation.

After the collision the DFDR has continued to record data for about 16 seconds. Some of the data is erroneous or unreliable, but the acceleration data seems to be correct until the DFDR finally stops recording 16.5 seconds after collision, possibly in connection with final impact (into building).

The only speed registered is the IAS (Indicated Air Speed) which is unreliable or zero after the collision.

The acceleration is measured and registered in three directions;
Vertical – the direction of the aircrafts vertical axis.
Longitudinal – the direction of the longitudinal axis (where the nose is pointing).
Lateral acceleration – the direction perpendicular to the longitudinal axis (sideways acceleration).

The specified accuracy of these parameters is normally in the range ±0.05 G.

To make an accurate calculation of the deceleration it is therefore necessary to know the pitch, bank and yaw (heading) attitudes. Since these data are missing it is only possible to make an approximate calculation of speed and distance. Since however the distance could be checked on site (assuming collision with building 16.5 seconds after first collision), the speed accuracy is directly related to the error in distance.

The longitudinal and lateral acceleration is registered 4 times per second as can be seen in the appendix ("FDR speed"). For the first 10.25 seconds after collision the longitudinal acceleration is positive, indication the aircraft is increasing it's speed. Thereafter the longitudinal acceleration is negative indicating speed reduction.

The calculation starts using the IAS (Indicated Air Speed) registered at collision. During the acceleration phase only the longitudinal acceleration has been used. When the longitudinal acceleration is negative both the

longitudinal and lateral acceleration is assumed to decelerate the aircraft (using the square root of long + lat acc raised to second power).

Conclusion

The result of the calculation is that the aircraft speed is **139 kts** (71 m/s) and distance travelled **1329 m** after 16.5 seconds.

Enclosures;
FDR speed

Appendix FDR speed 13/01/2004 1[Pages])

SPEED AND DISTANCE FROM DFDR DATA

Note	Time [s]	Ralt Coarse [feet]	IAS DADC [kts]	Vert Acc [G]	Long Acc [G]	Lat. Acc. [G]	Summ Acc[G]	Delta v [m/s]	Speed [m/s]	Dist [m]	
	-0,125		146	1,23					75,100		
impact	0,000			-3,37	-1,083	-1,083	error	0,300	75,400	0,000	Estimated acceleration
	0,250	-20		-3,37	-1,083	-1,083	error	0,300	75,700	18,925	Estimated acceleration
	0,500			-3,37	-1,083	-1,083	error	0,300	76,000	37,925	Estimated acceleration
	0,750			1,57	0,069	-0,203	0,069	0,169	76,169	56,967	Only long acceleration
	1,000			1,14	0,112	-0,049	0,112	0,275	76,444	76,078	Only long acceleration
	1,250	11		1,06	0,153	-0,016	0,153	0,376	76,820	95,283	Only long acceleration
	1,500			1,12	0,132	-0,006	0,132	0,324	77,144	114,569	Only long acceleration
	1,750			1,06	0,098	0,006	0,098	0,241	77,385	133,916	Only long acceleration
	2,000			1,04	0,102	0,051	0,102	0,250	77,635	153,324	Only long acceleration
	2,250	22		0,9	0,094	0,092	0,094	0,231	77,866	172,791	Only long acceleration
	2,500			0,8	0,098	0,075	0,098	0,241	78,106	192,317	Only long acceleration
	2,750			0,84	0,104	0,09	0,104	0,255	78,362	211,908	Only long acceleration
	3,000			0,79	0,098	0,09	0,098	0,241	78,602	231,558	Only long acceleration
	3,250	30		0,82	0,112	0,098	0,112	0,275	78,877	251,278	Only long acceleration
	3,500			0,9	0,126	0,108	0,126	0,309	79,187	271,074	Only long acceleration
	3,750			0,91	0,134	0,086	0,134	0,329	79,516	290,953	Only long acceleration
	4,000			0,99	0,136	0,086	0,136	0,334	79,849	310,916	Only long acceleration
	4,250	34		0,96	0,134	0,077	0,134	0,329	80,178	330,960	Only long acceleration
	4,500			0,89	0,094	0,061	0,094	0,231	80,409	351,053	Only long acceleration
	4,750			0,76	0,094	0,045	0,094	0,231	80,640	371,222	Only long acceleration
	5,000			0,75	0,079	0,01	0,079	0,194	80,834	391,431	Only long acceleration
	5,250	35		0,81	0,104	0,027	0,104	0,255	81,089	411,703	Only long acceleration
	5,500			0,89	0,124	0,027	0,124	0,304	81,394	432,052	Only long acceleration
	5,750			0,88	0,11	0,004	0,110	0,270	81,664	452,468	Only long acceleration
	6,000			1,22	0,108	0,002	0,108	0,265	81,929	472,950	Only long acceleration
	6,250	31		1	0,122	0,031	0,122	0,300	82,228	493,507	Only long acceleration
	6,500			1,07	0,138	0,016	0,138	0,339	82,567	514,149	Only long acceleration
	6,750			1,08	0,134	-0,014	0,134	0,329	82,896	534,873	Only long acceleration
	7,000			1,01	0,145	0,012	0,145	0,356	83,252	555,686	Only long acceleration
	7,250	27		0,98	0,094	0,006	0,094	0,231	83,483	576,556	Only long acceleration
	7,500			0,88	0,104	0,016	0,104	0,255	83,738	597,491	Only long acceleration
	7,750			0,77	0,067	0	0,067	0,164	83,903	618,467	Only long acceleration
	8,000			0,72	0,094	0,002	0,094	0,231	84,133	639,500	Only long acceleration
	8,250	19		0,8	0,086	0	0,086	0,211	84,345	660,586	Only long acceleration
	8,500			0,93	0,086	0,004	0,086	0,211	84,556	681,725	Only long acceleration
	8,750			0,93	0,082	0	0,082	0,201	84,757	702,914	Only long acceleration
	9,000			0,96	0,088	0,008	0,088	0,216	84,973	724,158	Only long acceleration
	9,250	9		1,03	0,09	0	0,090	0,221	85,194	745,456	Only long acceleration
	9,500			0,99	0,084	0,005	0,084	0,206	85,400	766,806	Only long acceleration
	9,750			0,93	0,029	0,002	0,029	0,071	85,471	788,174	Only long acceleration
	10,000			1,79	0,069	0,035	0,069	0,169	85,641	809,584	Only long acceleration
	10,250	0		1,12	0,016	0,132	0,016	0,039	85,680	831,004	Only long acceleration
	10,500			0,52	-0,024	-0,016	-0,029	-0,071	85,609	852,406	Long+Lat acceleration
	10,750			0,58	-0,081	0,049	-0,095	-0,232	85,377	873,751	Long+Lat acceleration
	11,000			2	-0,177	-0,085	-0,196	-0,482	84,895	894,974	Long+Lat acceleration
	11,250	-3		1,23	-0,089	-0,13	-0,158	-0,387	84,508	916,101	Long+Lat acceleration
	11,500			0,5	-0,075	0,02	-0,078	-0,191	84,317	937,181	Long+Lat acceleration
	11,750			0,79	-0,057	-0,128	-0,144	-0,355	83,963	958,171	Long+Lat acceleration
	12,000			1,24	-0,077	-0,094	-0,122	-0,298	83,664	979,088	Long+Lat acceleration
	12,250	-2		1,07	-0,124	0,016	-0,125	-0,307	83,358	999,927	Long+Lat acceleration
	12,500			0,68	-0,106	-0,132	-0,169	-0,416	82,942	1020,662	Long+Lat acceleration
	12,750			1,38	-0,161	-0,155	-0,223	-0,549	82,393	1041,261	Long+Lat acceleration
NG	13,000			2,11	-0,37	0,108	-0,385	-0,946	81,447	1061,622	Long+Lat acceleration
	13,250	10		0,11	-0,11	-0,169	-0,202	-0,495	80,952	1081,860	Long+Lat acceleration
	13,500			0,4	-0,177	-0,106	-0,206	-0,506	80,445	1101,972	Long+Lat acceleration
	13,750			1,34	-0,305	-0,085	-0,317	-0,777	79,668	1121,889	Long+Lat acceleration
	14,000			1,4	-0,393	0,057	-0,397	-0,975	78,693	1141,562	Long+Lat acceleration
	14,250	9		0,66	-0,228	-0,091	-0,245	-0,603	78,091	1161,085	Long+Lat acceleration
	14,500			1,08	-0,293	-0,083	-0,305	-0,748	77,343	1180,421	Long+Lat acceleration
	14,750			1,11	-0,299	0,134	-0,328	-0,804	76,539	1199,555	Long+Lat acceleration
	15,000			1,24	-0,25	0,041	-0,253	-0,622	75,917	1218,534	Long+Lat acceleration
	15,250	10		0,68	-0,183	0,067	-0,195	-0,478	75,438	1237,394	Long+Lat acceleration
	15,500			1,16	-0,354	0,161	-0,389	-0,955	74,483	1256,015	Long+Lat acceleration
	15,750			1	-0,372	0,077	-0,380	-0,933	73,551	1274,402	Long+Lat acceleration
	16,000			0,83	-0,256	0,073	-0,266	-0,654	72,897	1292,627	Long+Lat acceleration
	16,250	8		1,24	-0,238	0,132	-0,272	-0,668	72,229	1310,684	Long+Lat acceleration
	16,500			**1,05**	**-0,228**	**0,206**	**-0,307**	**-0,754**	**71,475**	**1328,553**	Long+Lat acceleration

Speed 139 kt

SK686.speed

SPEED AND DISTANCE FROM DFDR DATA

Note	Time [s]	Ralt Coarse [feet]	IAS DADC [kts]	Vert Acc [G]	Long Acc [G]	Lat. Acc. [G]	Summ Acc[G]	Delta v [m/s]	Speed [m/s]	Dist [m]

Distance 1329 m.

SK686.speed