MAK and KBWL LP Reports Data Analysis

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MAK – Interstate Aviation Committee
KBWL LP - Polish Air Incident Investigation Committee

Parts of presentation:

- First impressions
- Results of analysis:
  - horizontal trajectory
  - the likelihood of a roll to the left
  - TAWS #38
- Hypothetical two explosion - draft report

Properly secured air crash investigation site?

Two years later March, 2012

Photo from April 10, 2010

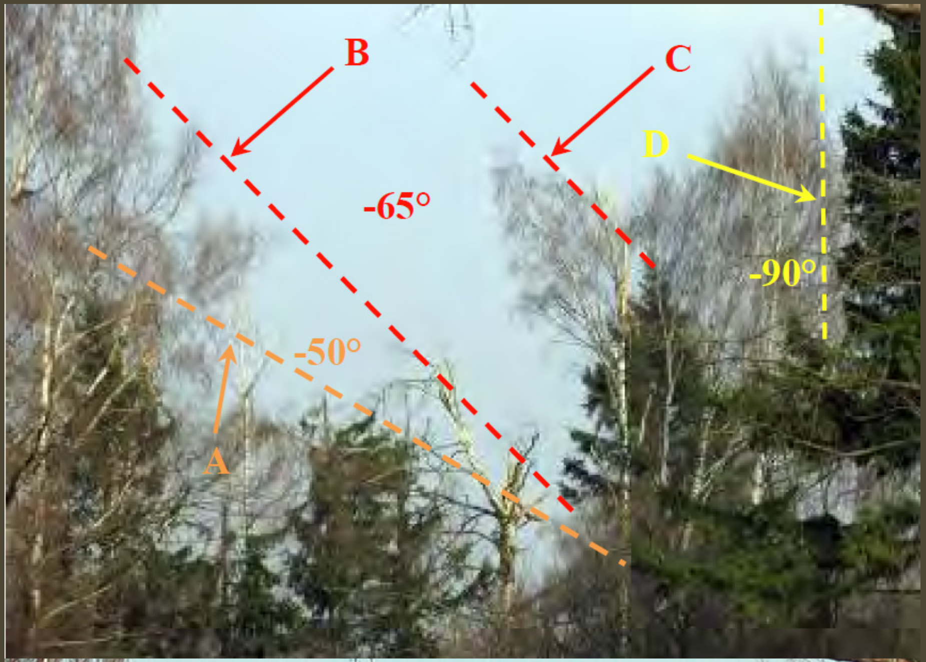

12
na żywo
MISJA
SPECJALNA

The plane's left horizontal stabilizer position on satellite pictures

The plane's left horizontal stabilizer position (33) in MAK Report identical to position on satellite picture from April 12, 2010

The final seconds of the flight analysis

KBWL Report



Russian amateur photographer Sergey Amelin

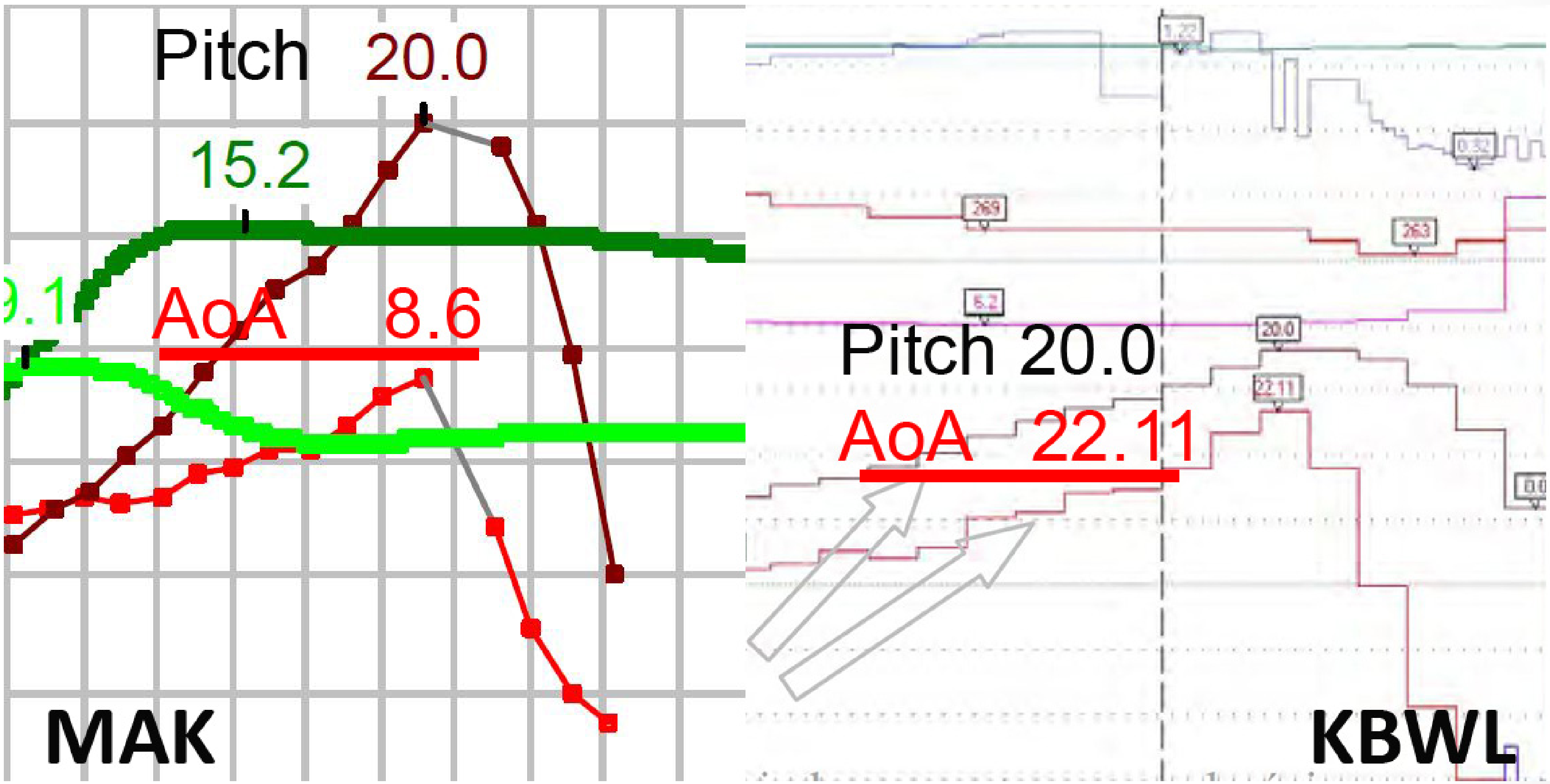
Flight Data Recorders:

1. Black Box MŁP-14-5 (Russia)

2. ATM-QAR Quick Access Recorder (Poland)

3. Flight Management System (FMS) (USA)
   Terrain Awareness and Warning System (TAWS)

Differences between MAK and KBWL reports
Angle of Attack



The angle-of-attack values are taken from a Russian and a Polish recorder, respectively. Both devices are merely data recorders and not measurement devices

Conclusions:

- The final reports of both MAK and Polish Air Incident Investigation Committee do not include any information as to the methodology of the analysis or provide any data which would make the analysis replicable.
- Data recovered from some of the aircraft's recording devices have been subject to arbitrary alterations and some of the data (FMS and TAWS logs) have not been included in the analysis.

FMS DATA EXTRACTION
FOR
NTSB IDENTIFICATION: ENG10SA025

ORIGINAL

APPROVALS:

Approved by: Frank Hummel
Vice President Engineering

Written by: Brian Eckmann
FMS Software Manager

Checked by: Thor Skaug
FMS Software Engineer

Status	Date
Original	June 25, 2010

Data Extraction conclusion:

The amount of raw binary data that was captured electronically is very large. UASC software engineering can convert additional parameters to human-readable format if they are needed for the investigation.

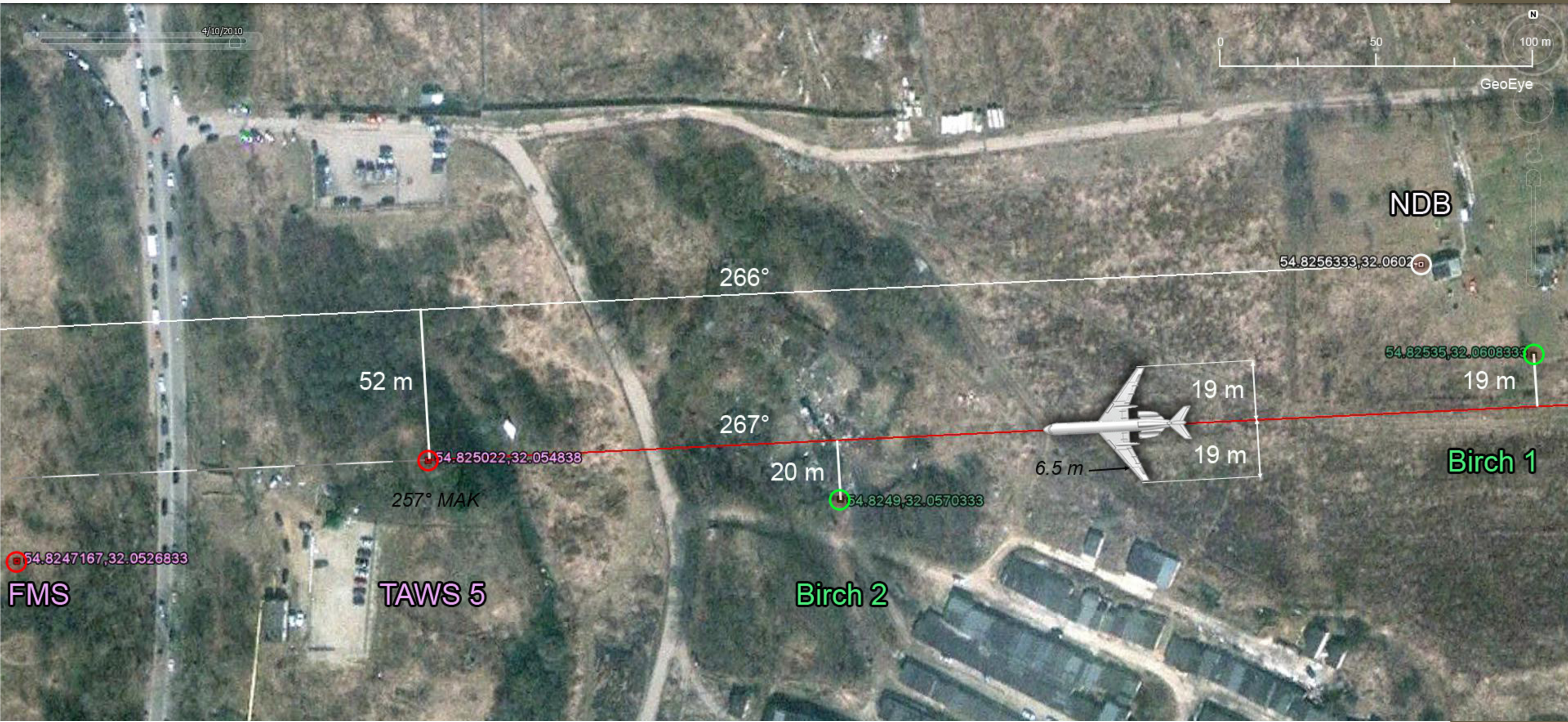
FMS (Flight Management System) and **TAWS** (Terrain Awareness and Warning System)

Table 1.

Event	UTC time	MAK synchronization +3 s	KBWL synchronization +6 s	Distance from the runway [m]
FMS	6:41:02	10:41:05	6:41:08	575
TAWS 38*	6:40:59	10:41:02	6:41:05	714
TAWS 37	6:40:43	10:40:46	6:40:49	1941
TAWS 36	6:40:36	10:40:39	6:40:42	2505
TAWS 35	6:40:29	10:40:32	6:40:34,5	3077
TAWS 34	6:40:03	10:40:06	6:40:09	5406

MAK added 3 seconds to real UTC time recorded in log files, the Polish investigating committee has added 6 seconds to most of the FMS and TAWS log times, both without releasing any further details

Horizontal Plane Trajectory Near the Birch Tree



According to TAWS #37 and #38 logs, the aircraft did not change its magnetic course 140 meters past the birch tree, which is inconsistent with information in both MAK and KBWL reports.

TAWS Alert Log #38 (Alert Type “Landing”)

Universal Avionics Systems Corporation — June 28, 2010
TAWS Data Extraction for NTSB Identification: ENG10SA025

APPENDIX C EXTRACTED ALERT LOG

April 10, 2010, Alert Log Extracted from NVRAM

```
------------------------------------------------------
Alert Record 38
------------------------------------------------------
Record CRC:                  0x849da809 (Computed: 0x849da809)
Record Size:                 394
Alert Record Type:           LANDING
Alert Date (M/D/Y):          04/10/2010
Alert Time (H:M:S):          06:40:59

True Track:                  -92.988281 deg
Track Rate:                  -0.064736 deg/sec
Cross Track:                 0.343750 nm
Terr Conflict Latitude:      54.825221 deg
Terr Conflict Longitude:     32.061042 deg
Terr Conflict Elevation:     813.648320 ft
Roll Angle:                  0.000000 deg
```

Track Rate Computed rate of change of true track, in degrees/sec.
Track rate is used to determine if the aircraft is turning.

Conclusions

The horizontal plane trajectory of Tu-154M, reconstructed from TAWS alert logs, does not change 140 meters after the birch tree which, according to MAK and KBWL, has impacted the aircraft's left wing .

Impacting the tree resulting in separation of part of the wing and an uncommanded roll would also have to result in altering the aircraft's horizontal plane trajectory. Such change in trajectory is inconsistent with TAWS Alert Log #38.

Uncontrolled Roll to the Left

1. Was there a possibility of a roll to the left after losing part of the wing?

2. Are flight parameters reported by MAK as evidence of an uncontrolled roll to the left consistent with what we know about the aerodynamics of this particular type of aircraft?

Literature:
В.П.Бехтир, В.М.Ржевский, В.Г.Ципенко
Практическая аэродинамика самолета Ту-154М , Москва 1997.

Пуминова Г.С.
Практическая аэродинамика самолета Ту-154В (Ту-154М), Санкт Петербуг 1995.

Critical flight phases of a Tu-154M aircraft in cruising configuration[1]

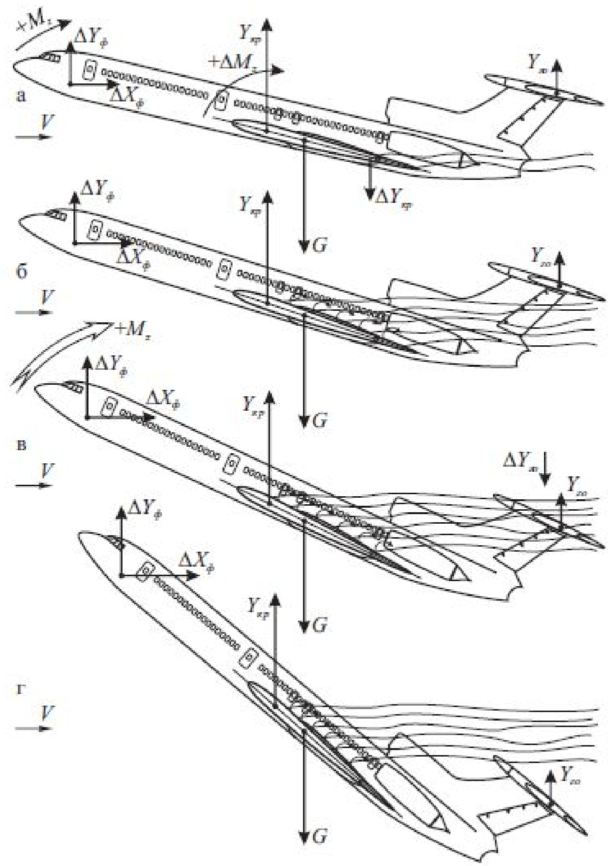


Рис. 7.24. Развитие срыва на стреловидном крыле у самолета с верхним расположением горизонтального оперения:
а – α = 15…17° – начало срыва у концов стреловидного крыла, падает устойчивость по перегрузке; б – α = 18…22° – распространение срыва по всему крылу; в – α = 22…35° – неустойчивый режим глубоково срыва; г – α = 40…45° – оперение выходит из мутной струи и попадает в невозмущенный поток; самолет балансируется на неустойчивом режиме глубокого срыва

Lift coefficient (C_y), and drag coefficient (C_x) of a TU-154M aircraft in landing configuration[1]

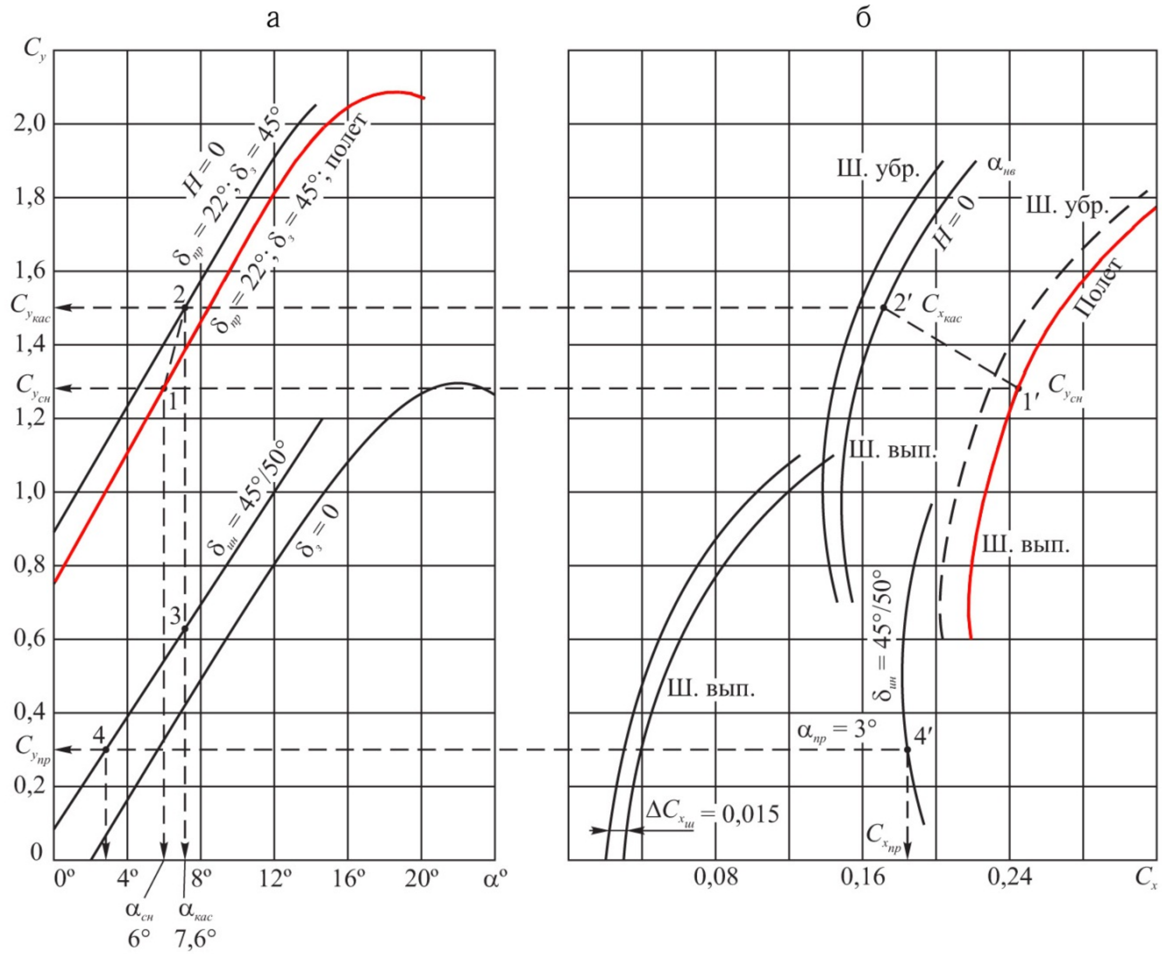
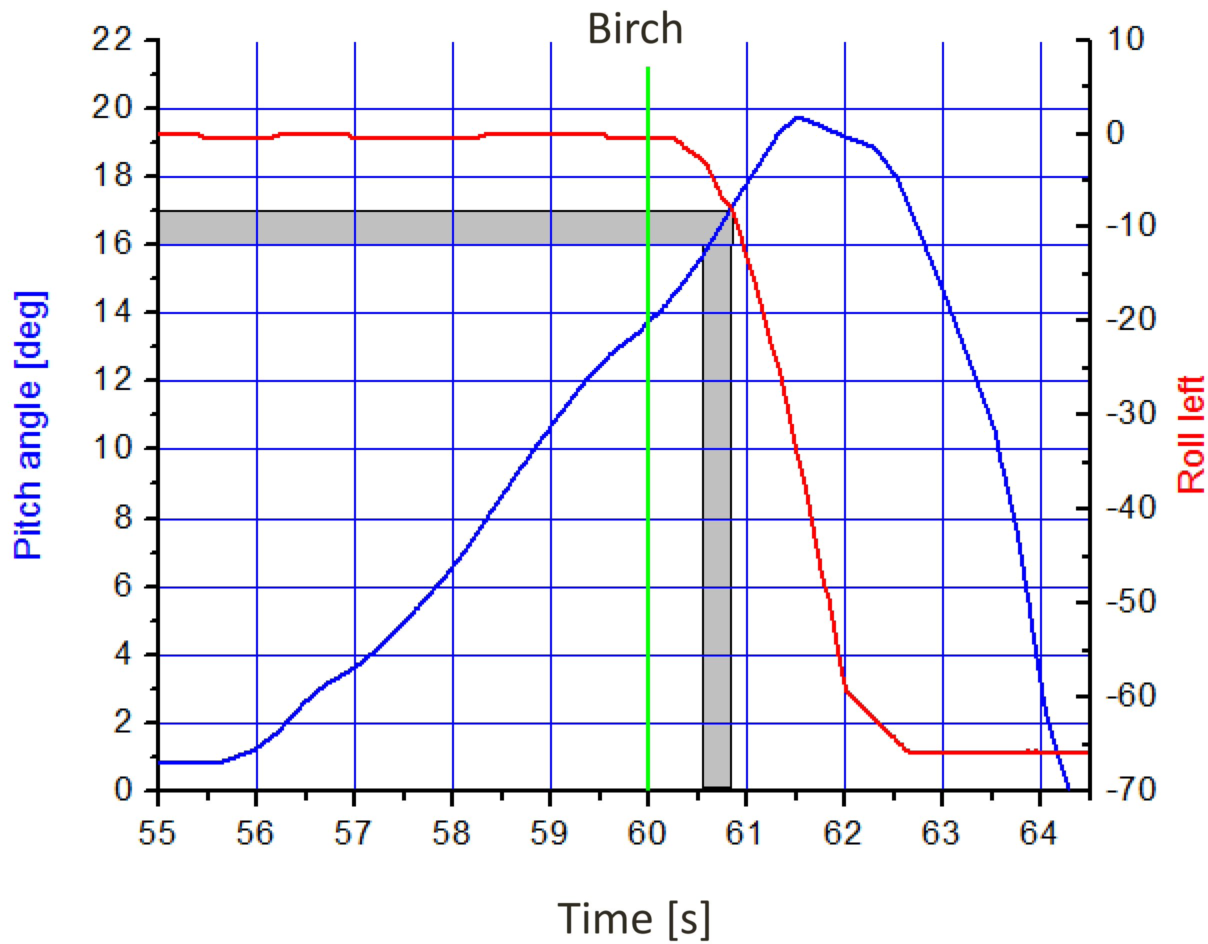


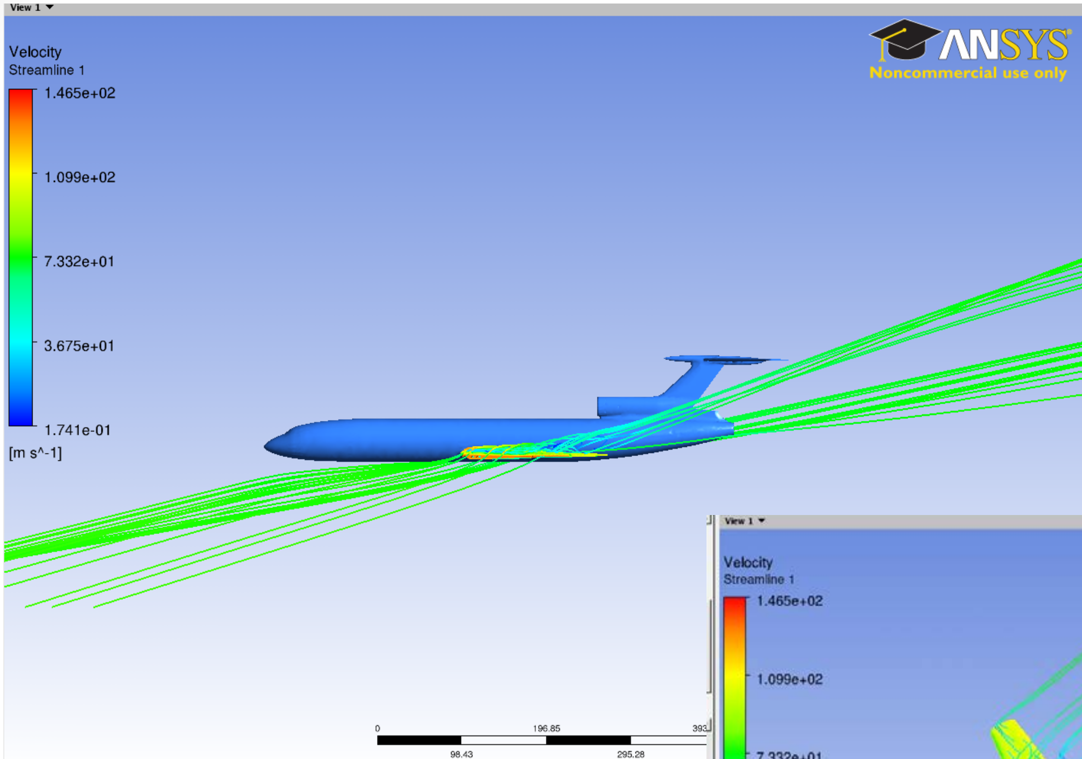
Рис. 6.5. Аэродинамические характеристики самолета Ту-154М при снижении и посадке: а – $C_y = f(\alpha)$; б – $C_y = f(C_x)$; ———— с влиянием земли; — — — без влияния земли

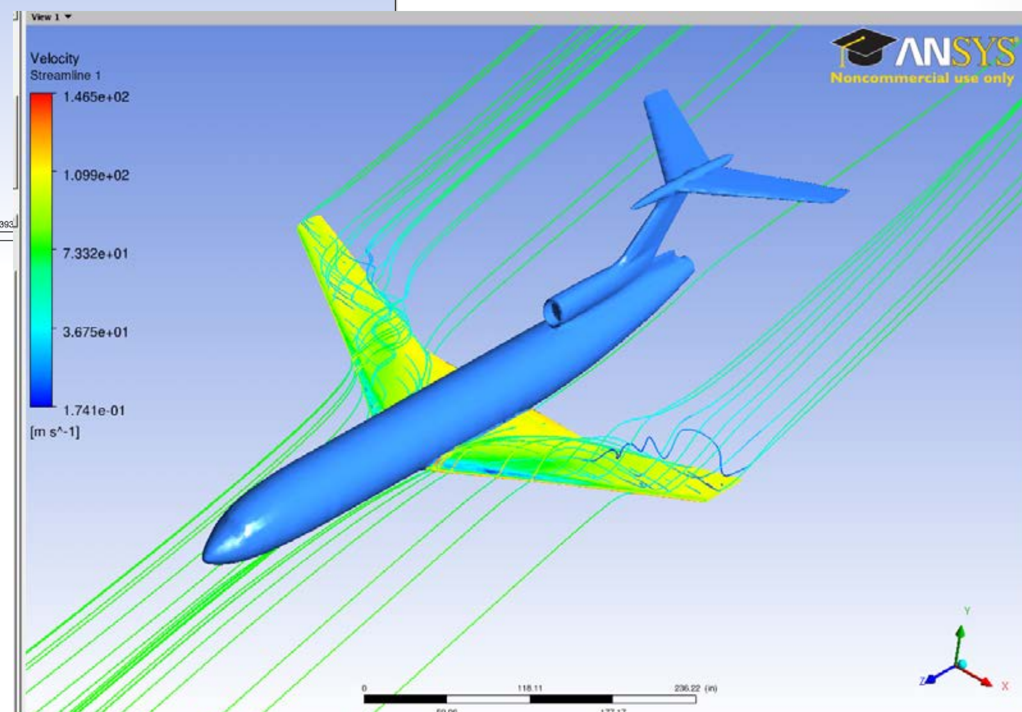
Pitch angle and Roll left parameters (MAK)



Taking into account the effects of the aircraft rolling to the left as well as losing a considerable amount of airfoil surface, we can conclude that the critical angle of attack would have been exceeded one second after left wing's impacting the birch tree.

Airflow vectors

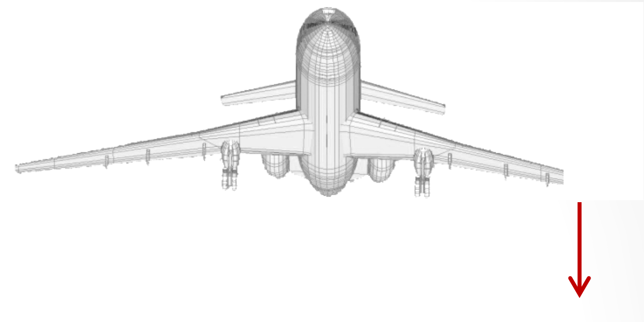




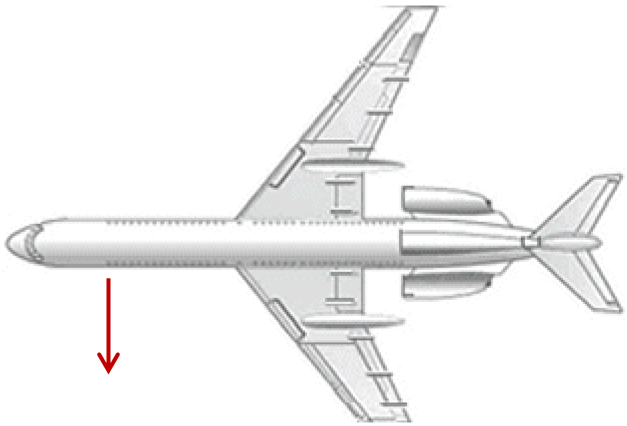
The behavior of the aircraft after losing part of the wing has also been analyzed by a team of researchers lead by prof. Brawn of the University of Akron.

As the aircraft loses part of its left wing, drag works to counteract roll with the force equivalent to air moving at 5 meters per second, applied to the top of the right wing and to the bottom of the left wing.

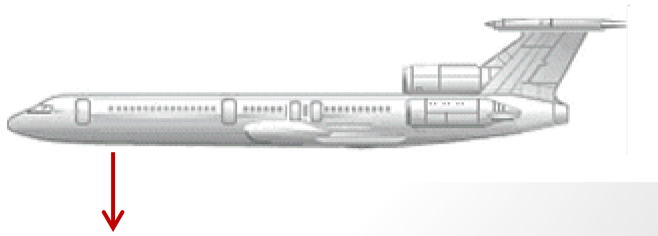
The left wing moves downwards with an initial acceleration of **-23.9,** which then decreases to **-2.5 deg/s^2** because of drag induced by the rolling motion



The net effect is that the aircraft is being rolled to the left
(**3.0** to **0.55 deg/s^2**)



The nose pitches down violently
(**1.3** to **6.1 deg/s^2**)



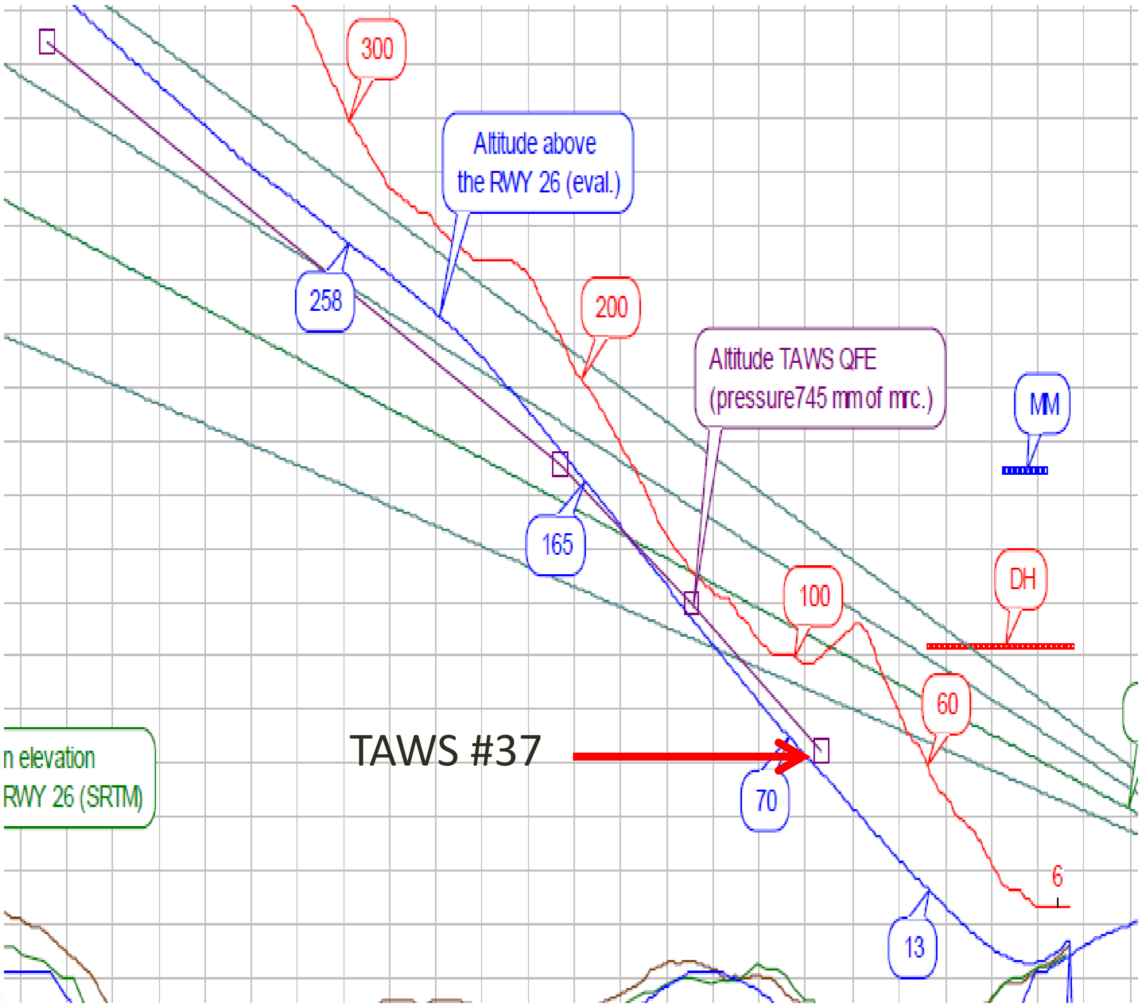
Conclusions

1. If Tu-154M 101 had lost part of its left wing on impact with the tree, it would have to roll to the left, pitch downwards, and impact the ground no later than one second after hitting the tree.

2. Flight parameters reported by MAK and KBWL describe a roll to the left event which is inconsistent with technical accounts of aerodynamic properties if this type of aircraft.

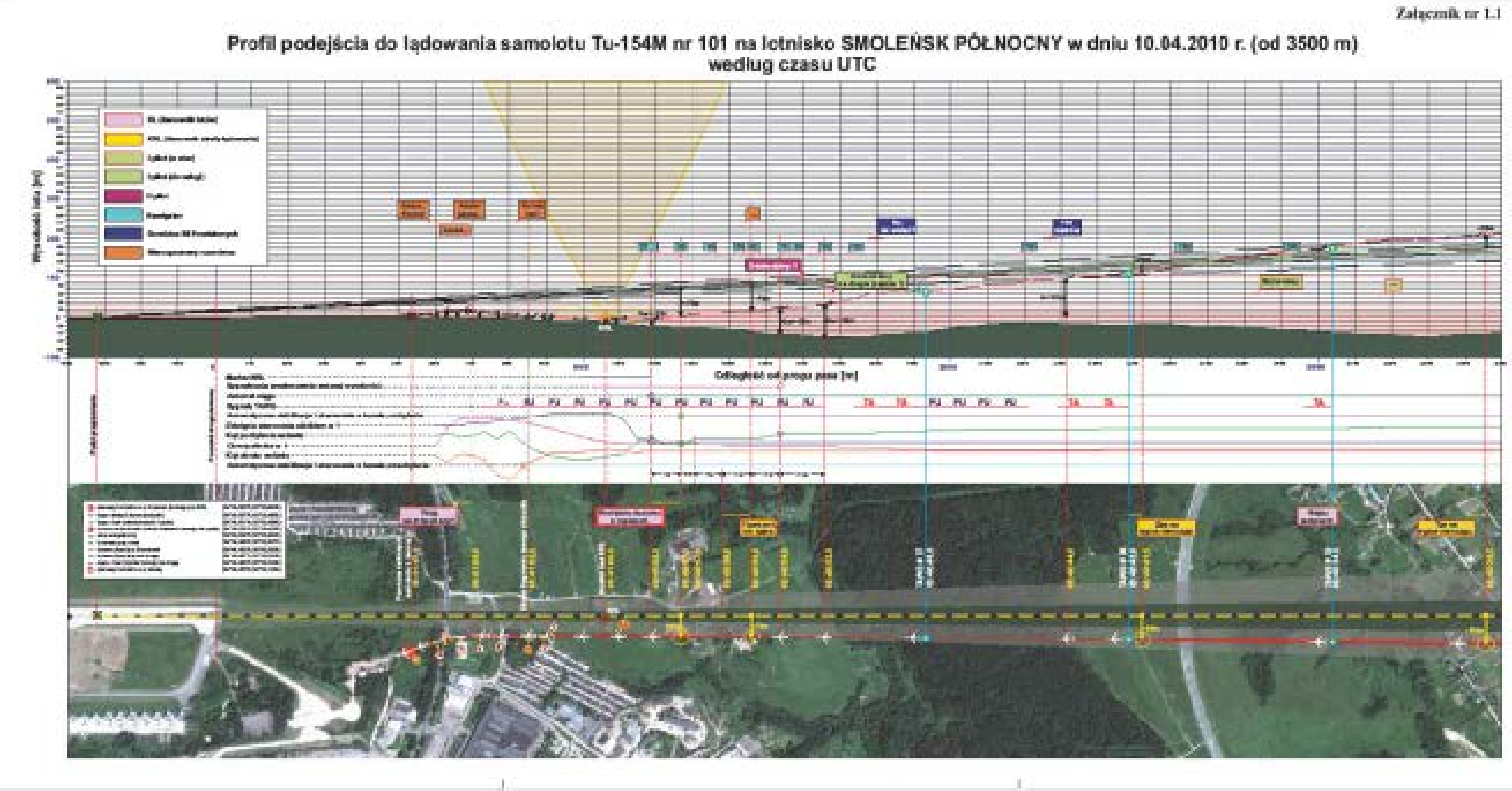
Satellite Images of the Area Where the Last TAWS Event Has Occurred (April and June 2010)

Fig. 46 of the MAK report, showing the aircraft's trajectory base on TAWS logs #34 through #37 *(purple line)* as well as a reconstruction of radio altitude *(blue line).*



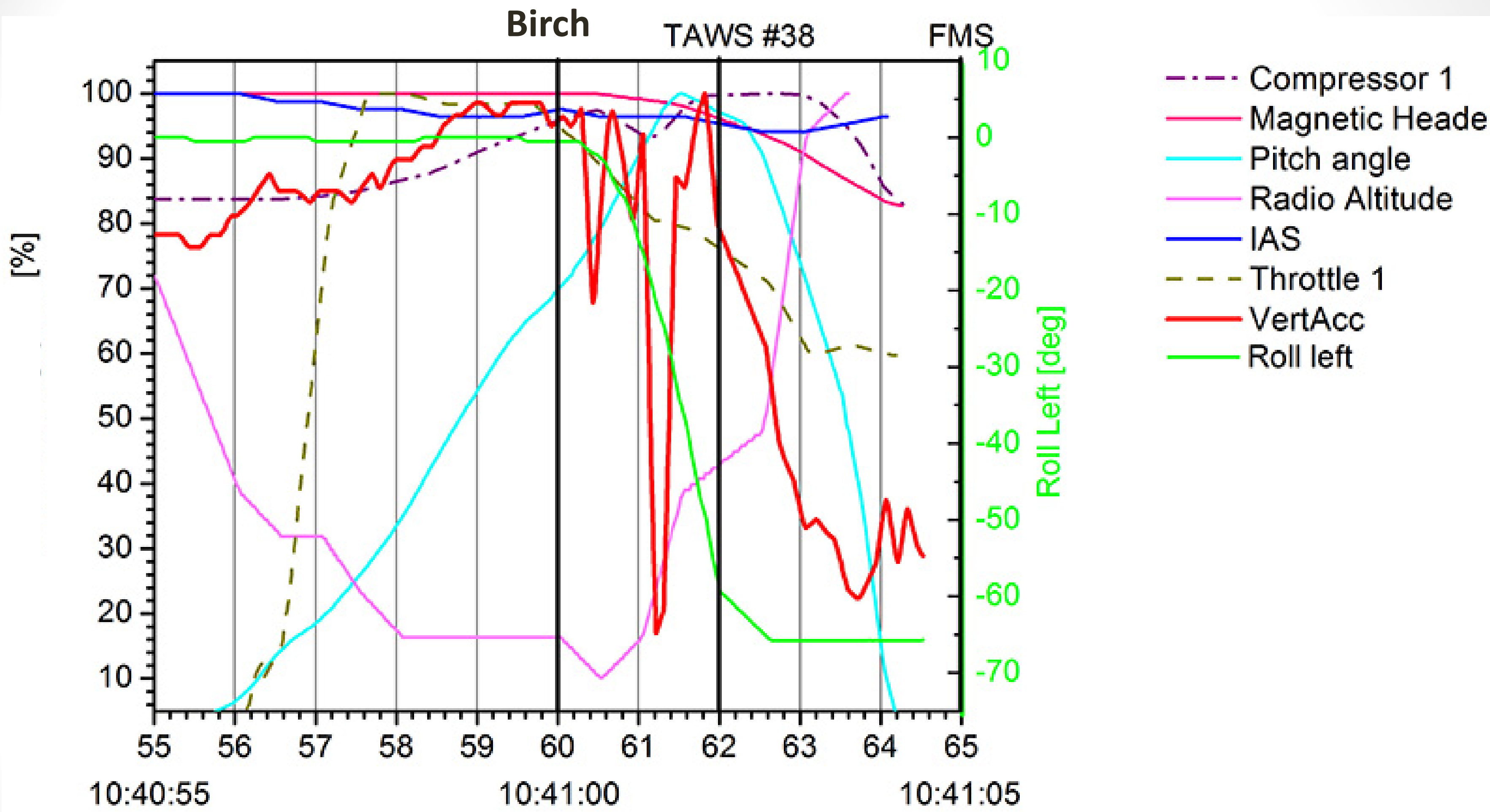
The blue line does not contain any explicit information from TAWS #38 or any of the FMS logs. We do see that the blue and purple lines cross at one point. All TAWS and FMS logs were known to both MAK and KBWL very early into their investigations.

The KBWL Report Omits TAWS #38 and FMS Logs.



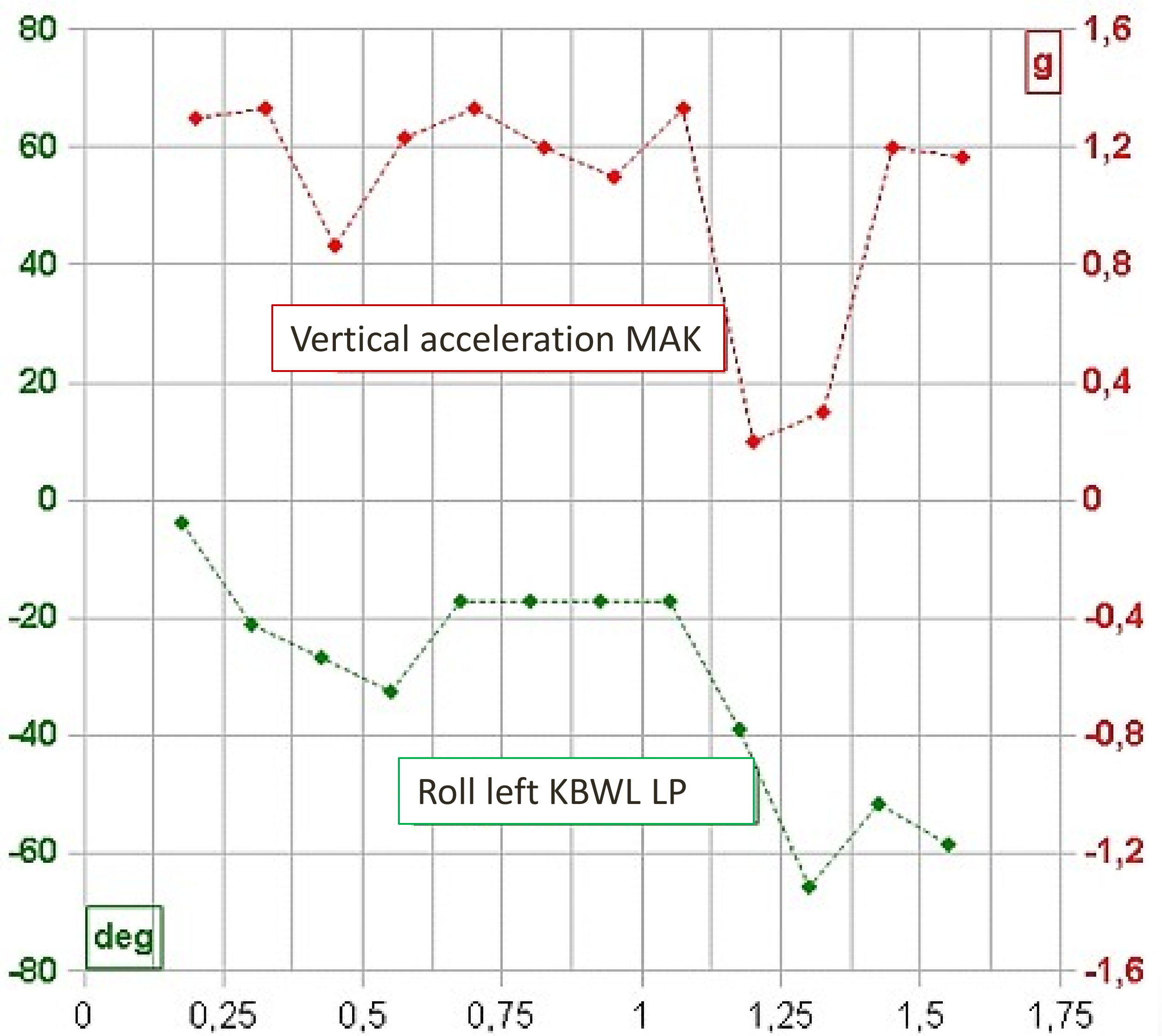
This slide shows the method used by KBWL to disguise the existence of this data. The fact of this disguise suggests that KBWL is fully aware of the fact that this data is inconsistent with their final conclusions.

MAK Report, FDR Parameters (Fig. 25 and 45, English Version)



Two sudden dips in the graph of vertical acceleration (red line) appear in graphs of both MAK and KBWL reports. Neither report mentions them in the analysis.

Time correlation between peaks of vertical acceleration (MAK) and roll left KBWL



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Report No. 456

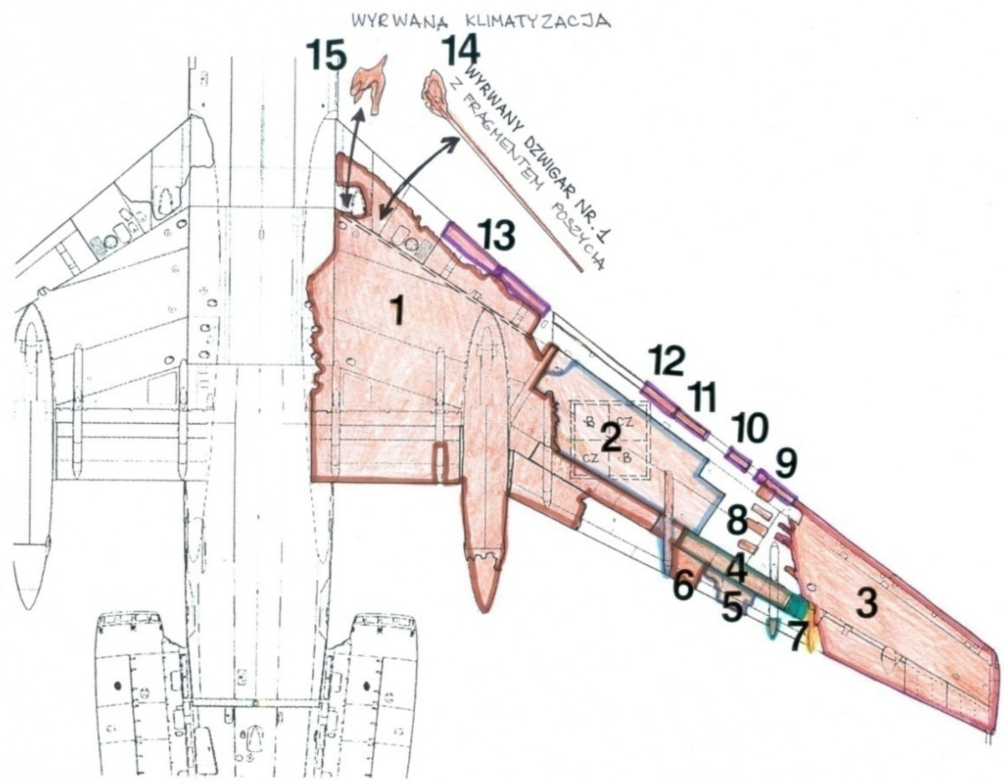
SOME TECHNICAL AND STRUCTURAL ASPECTS OF THE SMOLENSK PLANE CRASH

Author: Dr Gregory Szuladzinski

Independent Technical Advisor
of the Parliamentary Team of Antoni Macierewicz

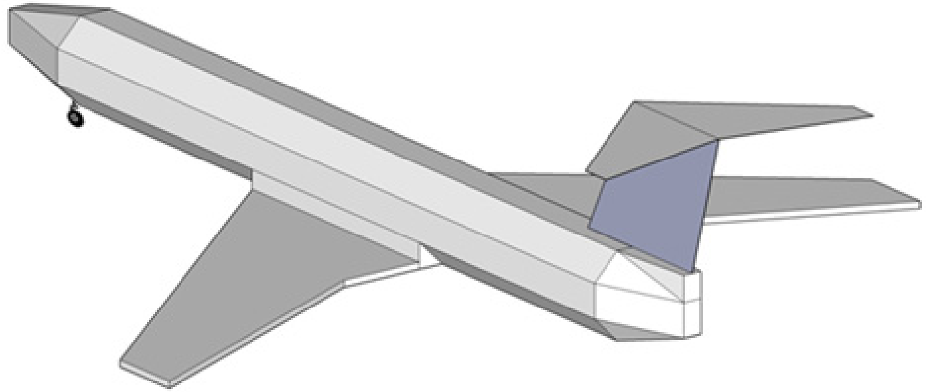
Dr Gregory SZULADZINSKI received his Masters Degree in Mechanical Engineering from Warsaw University of Technology in 1965 and Doctoral Degree in Structural Mechanics from University of Southern California in 1973.
From 1981 until present, he has been working in Australia in the fields of aerospace, railway, power, offshore, automotive and process industries, as well as in rock mechanics, underground blasting and military applications. Especially since the early 90'ties he has been doing computer simulations of such violent phenomena as rock breaking with the use of explosives, fragmentation of metallic objects, shock damage to buildings, structural collapse, fluid-structure interaction, blast protection and aircraft impact protection. He has done a number of state-of-the-art studies showing explicit fragmentation of structures and other objects.
He is a Fellow of the Institute of Engineers Australia, member of its Structural and Mechanical College, a member of the American Society of Mechanical Engineers and a member of the American Society of Civil Engineers.

Data for analysis has been submitted by the Parliamentary Commission

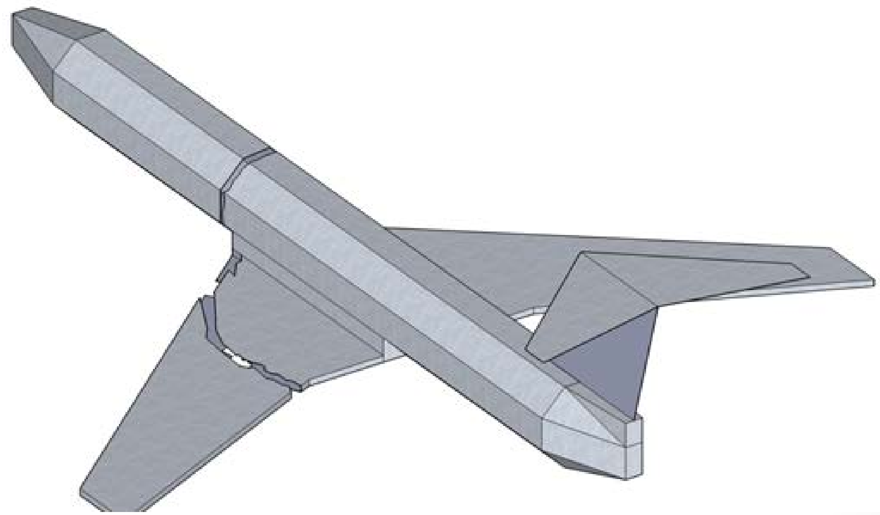


The left wing, view from the bottom. The parts are pieced together based on images from the day of the incident.

Phase I
Internal or external explosion in front of the left wing



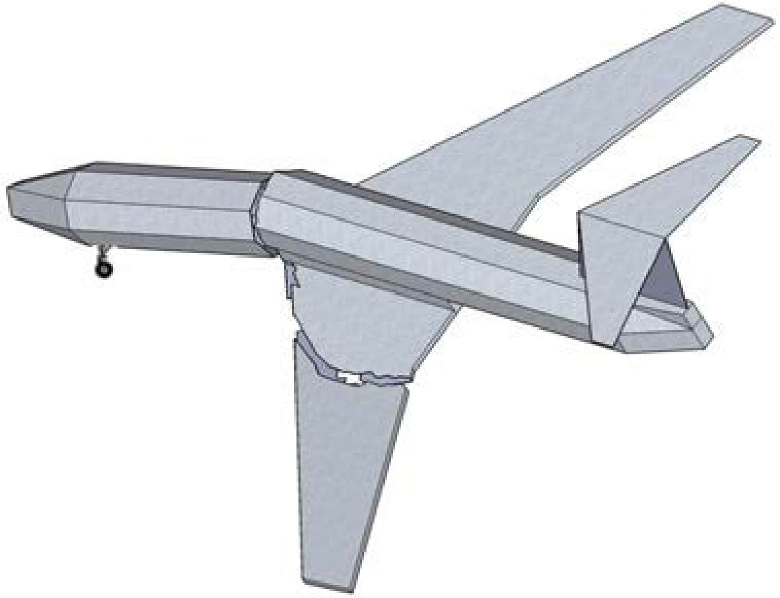
Phase II
Internal explosion in central position in airframe



The loss of the wing's leading edge near the fuselage and the entire left-most part of the wing had two aerodynamic effects: loss of lift on the left side and increase of drag. The first effect induces roll to the left, while the second one induces a change in magnetic heading.

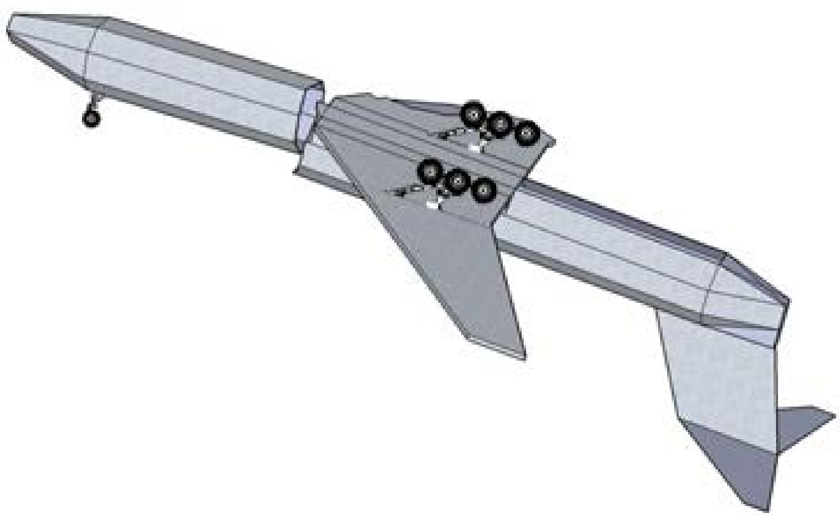
Phase III

The rear part of the airframe with wings and vertical stabilizer rolls to the left independently of the front part which stays in its natural position



Phase IV

Impact with the ground: only the rear part of the fuselage is inverted.



Angular momentum about the roll axis breaks the fuselage apart completely, separating the front of the fuselage from the rear, with the rear continuing to roll to the left.

Cokpit and front part of fuselage are not inverted

Rear parts of the fuselage in inverted position

Summary of Results

- The main causes of the crash were two explosions taking place just before landing.
- One of them impacted the left wing near its mid-point and caused an extensive damage, effectively breaking the wing in two. The other, inside the fuselage, caused an profound damage and dismemberment of the latter, as well as loosening the connection of the left wing and fuselage. The landing in a woody area, no matter how unfortunate and at what angle, was incapable of causing the documented fragmentation of the structure.