HYPOTHETICAL COLLISION OF TU-154M WITH BIRCH TREE VERSUS FULL-SCALE CRASH DYNAMIC TESTS OF DC-7 AND LC-1649

Porównanie hipotetycznej kolizji Tu-154M z brzoza z testami dynamicznymi zderzen w pełnej skali przy użyciu samolotów DC-7 oraz LC-1649

Professor Jacek F. Gieras, PhD, DSc, Fellow IEEE
University of Technology and Life Sciences, Bydgoszcz, Poland

E-mail: jacek.gieras@utp.edu.pl
Full-Scale Crash Dynamic Tests of DC-7 and LC-1649

What?
Full-scale dynamic crash tests of DC-7 and Lockheed Constellation 1649 (LC-1649) passenger aircraft conducted by the Federal Aviation Agency in April 1964.

Why?
These test programs were designed to simulate typical crash conditions during survivable take-off and landing accidents and collected considerable data on crash loads, accelerations, and fuel containment.

How?
The test site has been designed in such a way as to obtain the desired impact conditions for accelerating the test aircraft to approximately the climbout velocity, controlled guidance of the aircraft to the initial impact point, and appropriate location of earthen barriers and pole barriers (telephone poles).
The runway was built of two soil-cement strips 4.57-m wide and 5.49-m apart laid over the desert soil to support the main landing gear wheels. The length of strips from release point to the impact barriers was 1219 m. The aircraft was guided along a single track made of standard 41-kg railroad rails laid on a continuous reinforced concrete base.
The rock, earthen and pole barriers were erected to break the nose landing gear, propellers of engines and wings, respectively.
In 1964 full-scale dynamic crash tests on DC-7 and Lockheed 1649 Constellation (LC-1649) were performed by the Federal Aviation Agency, AZ, USA.
The objective of these experiments was exploration of the manner in which large aircraft are damaged in survivable accidents and accurate measurement of the crash loads.

In the case of the DC-7, after collision with telephone poles, the tip of right wing finally fell off. This fact is frequently cited by supporters of the crash official reports as a proof that the collision of the Tu-154M No 101 with the trunk of a birch tree on April 10, 2010 near Smolensk North Military Air Base severed the tip of the left wing and finally caused fatal collision of the Tu-154M No 101 with the ground.

It is necessary to point out the following differences in:

- weight and volume envelope of the Tu-154M, DC-7 and LC-1649 aircraft;
- construction of aircraft and their wings;
- kinetic energy and linear momentum of aircraft;
- height at which the wing hit the pole or tree;
- properties of timber/wood;
- how the telephone poles and birch tree have been anchored to the ground.


**Full-Scale Tests**

Conditions prior to crash or full-scale tests

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Tu-154M 101</th>
<th>DC-7</th>
<th>LC-1649</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross weight of airliner at the time of crash/test. kg</td>
<td>78,600 (estimated)</td>
<td>49,010</td>
<td>72,245</td>
</tr>
<tr>
<td>Velocity prior to contact with barrier, km/h</td>
<td>approx. 270.0 (birch tree)</td>
<td>257.4 (gear barrier)</td>
<td>207.6 (gear barrier)</td>
</tr>
<tr>
<td>Linear momentum, MNs</td>
<td>5.896</td>
<td>3.504</td>
<td>4.166</td>
</tr>
<tr>
<td><strong>Kinetic energy, MJ</strong></td>
<td><strong>221.1</strong></td>
<td><strong>125.3</strong></td>
<td><strong>120.1</strong></td>
</tr>
<tr>
<td>Leading edge sweep of wings, degree</td>
<td>approx. 37</td>
<td>approx. 5</td>
<td>approx. 6</td>
</tr>
<tr>
<td>Material of wooden barriers</td>
<td>birch tree</td>
<td>processed pine</td>
<td>processed pine</td>
</tr>
<tr>
<td>Height of impact point measured from the ground level, m</td>
<td>approx. 5.1</td>
<td>approx. 3.2</td>
<td>approx. 2.0</td>
</tr>
<tr>
<td>Diameter of pole/tree, m</td>
<td>0.3 to 0.4</td>
<td>0.305</td>
<td>0.305</td>
</tr>
<tr>
<td>Distance of impact point measured from the center axis of the fuselage, m</td>
<td>12.675</td>
<td>13.83</td>
<td>unknown</td>
</tr>
<tr>
<td><strong>Wing sweep angle, degree</strong></td>
<td><strong>37</strong></td>
<td><strong>5</strong></td>
<td><strong>6</strong></td>
</tr>
<tr>
<td>Length of the tip wing being cut off, m</td>
<td>6.1</td>
<td>3.66</td>
<td>unknown</td>
</tr>
</tbody>
</table>
The LC-1649 was made from higher-strength, low-elongation aluminum similar to modern aircraft.

The first version of the **Tu-154M** was designed in 1964, while the **DC-7** was designed before 1953 and **LC-1649** before 1943. The **turbofan** engines of the **Tu-154M** are mounted in the rear of the fuselage. The **piston engines** of the **DC-7** and **LC-1649** are buried in wings.
Length of Aircraft

Comparison of length of aircraft: (a) **Tu-154M**; (b) **DC-7**; (c) **LC-1649**

(a) Tu-154M: Length = 11.4 meters
(b) DC-7: Length = 47.9 meters
(c) LC-1649: Length = 29.53 meters

Total length:
- **Tu-154M**: 11.4 meters
- **DC-7**: 47.9 meters
- **LC-1649**: 29.53 meters

Total: 88.83 meters
Comparison of wing span: (a) **Tu-154M**; (b) **DC-7**; (c) **LC-1649**
Sweep Angle of Wings

Leading edge sweep of wings of (a) **Tu-154M**, (b) **DC-7** and (c) **LC-1649** aircraft.

The **leading edge sweep** is the angle between a constant percentage chord line along the semispan of the wing and the lateral axis perpendicular to the aircraft center line.

- **Tu-154M**: 37°
- **DC-7**: 5°
- **LC-1649**: 6°
## Specifications of Aircraft

### Specifications of Tu-154M, Douglas DC-7 and LC-1649 aircraft

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Aircraft</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tu154M</td>
<td>DC-7</td>
<td>Lockheed LC-1649</td>
</tr>
<tr>
<td>Dimensions:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wing span, m</td>
<td>37.55</td>
<td>34.98</td>
<td>45.72</td>
</tr>
<tr>
<td>Length, m</td>
<td>47.90</td>
<td>29.53</td>
<td>35.41</td>
</tr>
<tr>
<td>Height, m</td>
<td>11.40</td>
<td>8.75</td>
<td>7.54</td>
</tr>
<tr>
<td>Wing area, m²</td>
<td>201.5</td>
<td>188.3</td>
<td>171.87</td>
</tr>
<tr>
<td>Weights</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Empty weight, kg</td>
<td>55,300</td>
<td>37,785</td>
<td>41,969</td>
</tr>
<tr>
<td>Loaded weight, kg</td>
<td>max 100,000</td>
<td>57,200</td>
<td>72,575</td>
</tr>
<tr>
<td>Performance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. speed, km/h</td>
<td>950</td>
<td>650</td>
<td>606 at 5669 m</td>
</tr>
<tr>
<td>Cruising speed, km/h</td>
<td>560</td>
<td></td>
<td>466</td>
</tr>
<tr>
<td>Service ceiling, m</td>
<td>11,100</td>
<td>6850</td>
<td>7223</td>
</tr>
<tr>
<td>Max range, km</td>
<td>5200</td>
<td>9000</td>
<td>9945 + 3628 payload</td>
</tr>
<tr>
<td>Range max payload, km</td>
<td>3900</td>
<td>7400</td>
<td>7950 + 8845 payload</td>
</tr>
<tr>
<td>Power plant (engines)</td>
<td>3 x D-30KU turbofan rated at 108 kN (24,270 lb) each</td>
<td>4 x R-3350 988TC-DA turbo radial rated at 2420 kW (3250 hp)</td>
<td>4 x R-3350-988TC-18EA-2 turbo rated at 2535 kW (3400 hp) each</td>
</tr>
</tbody>
</table>
LC-1649 Dynamic Crash Test

Fuel tank and engine locations

(a) DC-7
(b) LC-1649
The aircraft were released for full-scale dynamic tests under the following arrangements:

• Normal take-off configuration;
• Flaps positioned full-up to reduce lift and drag;
• Upon release, the throttles advanced to pre-determined take-off position (for DC-7 3050 bhp (2.275 MW) per engine);
• Smooth and continuous acceleration of the aircraft during the 1292 m run until the impact with the propeller and landing gear barriers;
• Velocity of 257.4 km/h (139 knots) for DC-7 and 207.4 km/h (112 knots) for LC-1649.

The tests were conducted by the FAA at Deer Valley Airport north of Phoenix, AZ, USA.

Photo on left shows the DC-7 wheels clipped off and one wing struck by a telephone pole. Photo on the right shows the DC-7 begins to explode into flames apparently unplanned.

http://www.arizonawrecks.com/images/460_DC-7a.jpg

LC-1649 destroyed in the test at Deer Valley. Photo taken by C. Baird.
http://www.arizonawrecks.com/images/460_Constellation_N7307C_FAA_crash_web_pic.jpg
1. The first barrier was the landing gear barrier.
2. All four propellers were broken as a result of hitting the propeller barriers. All four engine mounts failed.
3. The gear barrier tore out the right main landing gear.
4. The outer pole cut off the right wing approximately 3.66 m (12 feet) from the tip.
5. The aircraft hit the second inner pole approximately 0.15 s after the first pole impact. The inner pole struck the right wing between engines No 3 and No 4. The wing leading edge structure back to the forward spar was crushed. Then, the inner pole broke.
Famous “Armored” Birch Tree

Which photograph is authentic?
Famous “Armored” Birch Tree

Recent photographs. The most important portion has been cut off.

Famous “Armored” Birch Tree

Recent photographs. Dr Bodin’s lot with “armored” birch tree

Source: www.google.com

Source: http://imgsru.ru/para-moto1/30127119.html
The wing has been cut off while the front edge **slat is intact**

How is it possible?

http://vfl.ru/fotos/aa582e8c473661.html
Conclusions

(a) The **Tu-154M** is much longer (47.9 m versus 29.53 m and 35.41 m) and heavier (empty weight 55.3 t versus 37.785 t and 41.969 t) aircraft than the **DC-7** and **LC-1649**.

(b) The construction of the **Tu-154M**, **DC-7** and **LC-1649** aircraft and their wings is very different, e.g., leading edge sweep. The **turbofan engines** of the **Tu-154M** are mounted in the rear of the fuselage. The **piston engines** of the **DC-7** and **LC-1649** are buried in wings.

(c) The kinetic energy prior to impact of the **Tu-154M** was 221.1 MJ versus 125.3 MJ for **DC-7** and 120.1 for **LC-1649**.

(d) It is easier to cut a pole/tree barrier by a wing with large **sweep angle** (**Tu-154M**) than by a wing perpendicular to the center line of the fuselage (**DC-7**, **LC-1649**).

(e) The physical parameters of the "live" birch tree are different than those of telephone poles made of processed timber (yellow southern pine).

(f) The height of impact point measured from the ground level is different for each case, i.e., approx 5.1 m for the **Tu-154M**, approx 3.2 m for the **DC-7** and approx 2 m for the **LC-1649**.

(g) The birch tree grew probably in **swampy ground**, while the telephone poles were buried approximatelay 1.22 m in the ground. It is unknown if a concrette has been used.

(h) Research performed at the University of Akron and University of Maryland, photographs of the birch taken immediately after crash, lack of damage to the slat and lack of detailed investigation of the birch tree and wing immediately after crash testify that there was rather no collision of the **Tu-154M** Nr 101 with a birch tree.

Therefore, the separation of the tip of wings in full-scale dynamic tests using the **DC-7** and **LC-1649** aircraft can not be a proof that the tip of the wing of the **Tu-154M** was cut off as a result of collision with a birch tree trunk.
Questions & Answers