NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Washington, DC
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Video Data Impact Speed Study (UA 175)

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A. ACCIDENT

Location:	New York, NY
Date:	September 11, 2001
Time:	Approximately 9:02 Local Time
Aircraft:	Boeing 767-200ER
Operator:	United Airlines Flight 175, Registration N612UA
NTSB#:	DCA-01-MA-063

B. GROUP

No Group was formed for this activity.

C. SUMMARY

On September 11, 2001 at approximately 9:02 AM local time, a Boeing 767-200ER, N612UA registered to and operated by United Airlines as flight 175 crashed into the South World Trade Center Tower. The aircraft had departed Boston Logan airport at approximately 8:14 AM enroute route to Los Angeles Ca. Visual meteorological conditions prevailed at the time of impact. The airplane was destroyed by impact forces and a post-crash fire. All aboard were fatally injured.

D. DETAILS OF INVESTIGATION

This report outlines the effort to calculate the speed of United 175 when it crashed into the South World Trade Center Tower from video data[1]. Speed calculations were made using distances measured using an image-processing tool (Adobe Photoshop), and using distances measured on prints of the video frames.

Distance from Prints Method

The video images for this study are shown below. These images consist of captured NTSC video fields. The fields were recorded in sequence, the lower field first then the upper field. Each field is 1/60 sec apart. These fields are interlaced to form a video frame.

[1] Impact speeds were also calculated in Radar Data Impact Speed Study (AA11 & UA 175) by Dr. Dan Bower, Feb, 7, 2002

Frame 3L

Frame 3U

Frame 4L

Frame 4U

Frame 5L

Frame 5U

Frame 6L

Frame 6U

Frame 7L

Frame 7U

Frame 8L

Frame 8U

Frame 9L

Frame 9U

Frame 10L

Frame 10U

Frame 11L

Frame 11U

Frame 12L

Frame 12U

Frame 13L

Frame 13U

Frame 14L

Frame 14U

Frame 15L

Frame 15U

The nose, the intersection of the right wing and the nacelle and the intersection of the right stabilizer leading edge and the fuselage were selected as points to track movement. For each sub frame, the distance from the emergenence point over the building on the left was established for the nose, the intersection of the right wing and the nacelle points. This was done using the known fuselage length to convert distance on the prints to feet. The distance from the intersection of the right stabilizer leading edge and the fuselage to the impact point on the World Trade Center was similarly established. These distances are plotted as a function of elapsed sub frame time in figure 1.

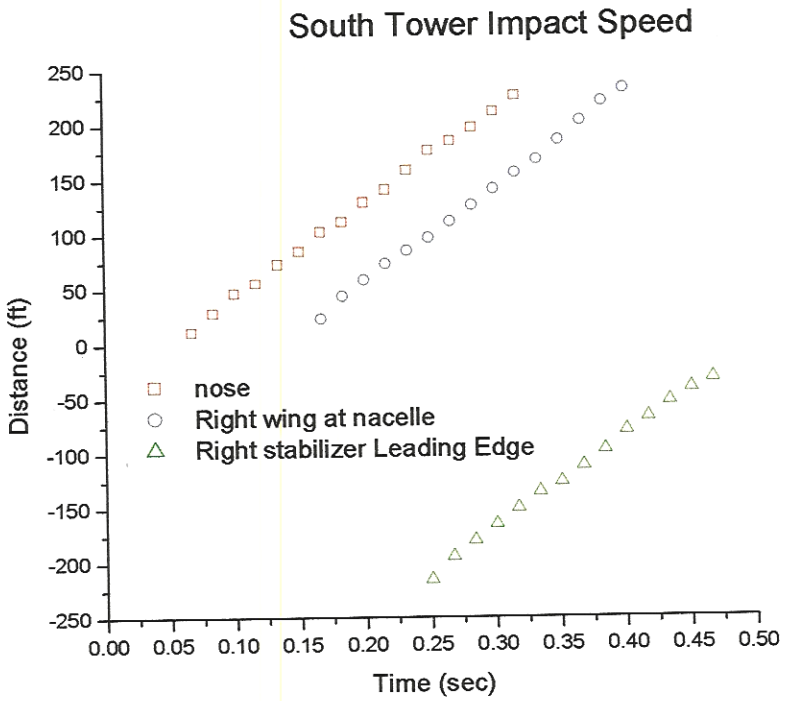

Figure 1: Positions vs. time

Since the position of the right wing at nacelle, and stabilizer leading edge at fuselage points are known relative to the nose of the aircraft, the time history of these positions can be transformed to positions on the nose. This is done in figure 2. The slope of distance vs. time on this graph shows an impact speed of 504 kts.

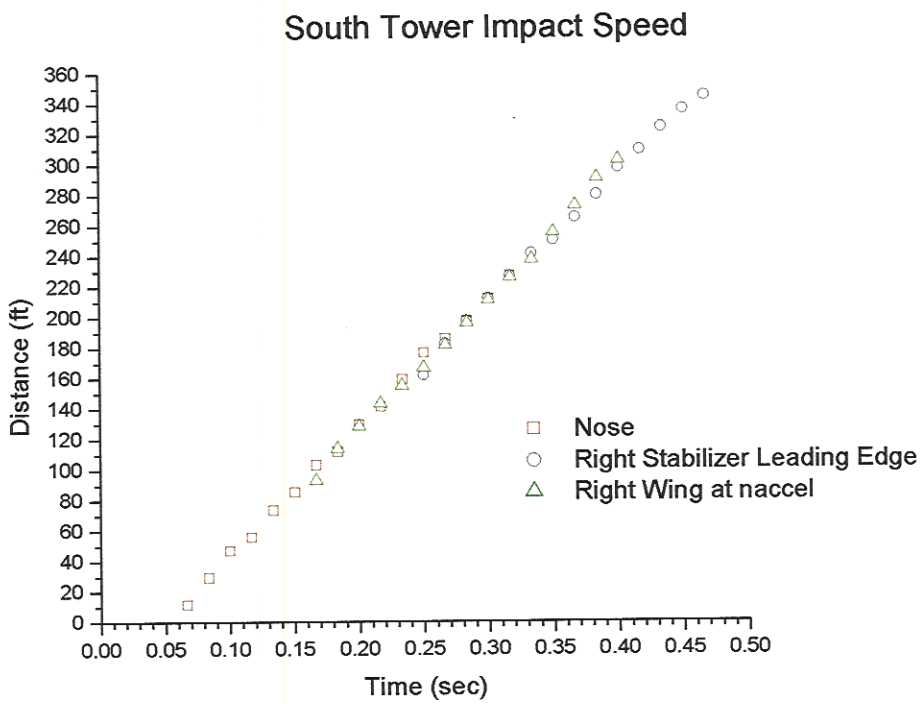

Figure 2: Transformed positions vs. time

With the resolution of the photographs it was difficult to see the nose and tail cone of the airplane precisely for scaling. Accordingly, the exercise was repeated using the distance between the wing leading edge fuselage intersection and the tail leading edge fuselage intersection as the basis for scaling. Since the lines forming the intersection points could be determined from multiple pixels, this was thought to be more accurate. The resulting distance vs. time plot, with positions transformed to the aircraft nose, is presented in figure 3. The slope of distance vs. time on this graph shows an impact speed of 507 kts.

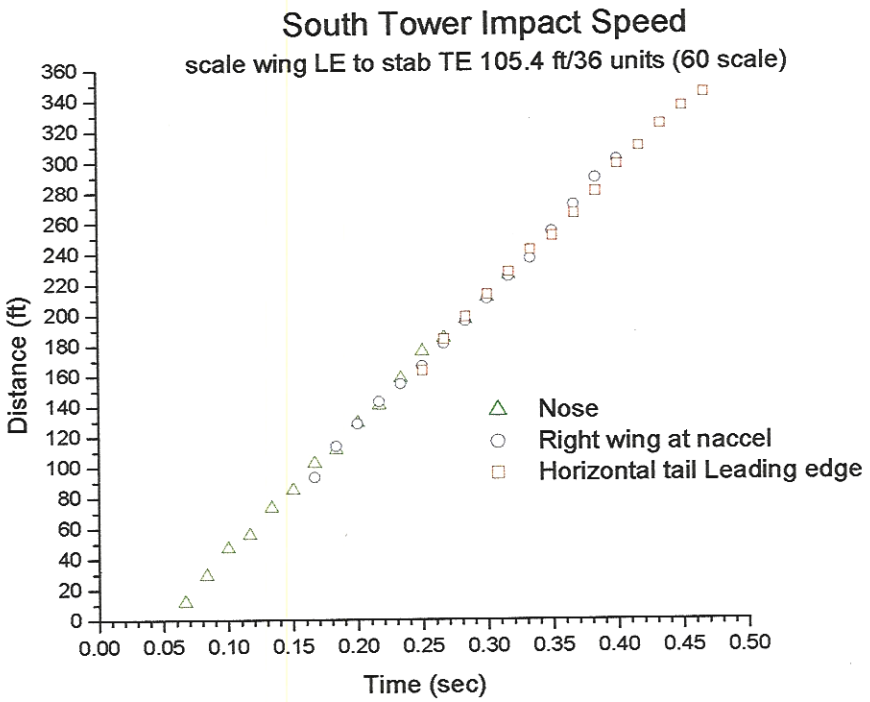

Figure 3: Transformed position vs. time (second scale)

Distance from Video Screen Method

The vehicle recorders division received videotape containing news footage of the airplane as it approached and crashed into Tower 2 of the World Trade Center. Using still images extracted from of one of the views of the videotape, measurements were taken to determine the relative position of the airplane as a function of time.

A total of 27 consecutive still images (NTSC video fields) were used in the evaluation, each 1/60th of a second apart. In each image, a distance was measured from a fixed landmark in the view to two separate points located on the airplane (the nose, and tail). These measurements were plotted, and a least squares method was used to calculate a best-fit straight line through specific sections of the data. The scale of the video images was evaluated using the known airplane length of 155 feet (nose to tail cone). Based on the scale, and the least squares method relationship of units/second, the airplane's groundspeed was then calculated in feet/sec and Knots.

Based on the recorded video information provided, the groundspeed of the airplane was calculated to be between 473 and 477 Knots (544 and 549 Miles Per Hour) just prior to the collision with the building.

Associated data files:
Measurements/calculations: *wtc_video_measurements.xls*
Still images captured from video: *page01.jpg – page16.jpg*

Summary

Using distances taken directly from the video screen, flight 175's groundspeed was calculated to be between 473 and 477 Knots just prior to the collision with the building. Using distances taken from video screen prints, groundspeeds at impact of 504 Knots and 507 Knots were calculated. This compares to an impact speed of 510 Knots calculated from radar data in the Radar Data Impact Speed Study (AA11 & UA175).

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