The Downward Motion of WTC Building 7 on 9/11/2001

(A kinematics lab studying an event with significant social and historical implications)

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(Both a pdf document and a Word document are included so instructors can easily make modifications of this lab to suit their particular needs.)

Introduction

The public is well aware that the North and South Towers of the World Trade Center in New York City (each 110 stories high) were hit by commercial Boeing 767 airliners on 9/11/2001. Less well publicized is that another tall building in the World Trade Center complex, Building 7 (or WTC 7), which was 47 stories tall, collapsed suddenly and completely seven hours later, at 5:20 pm on the same day, without being hit by an aircraft. The official explanation provided by the National Institute of Standards and Technology (NIST) in their *Final Report on the Collapse of World Trade Center Building 7* is that the collapse was due to fire alone.

A significant number of architects, engineers, and scientists (myself included), represented by Architects and Engineers for 9/11 Truth, Scientists for 9/11 Truth, and Scholars for 9/11 Truth and Justice, and other independent researchers, have challenged the correctness of the official explanation of the building collapses in the World Trade Center on 9/11. They believe there is a scientific basis to believe that the buildings were brought down as demolitions using pre-planted explosives, and that they could not have collapsed in the observed manner due to airplane impact, fire, and gravity alone.

One piece of evidence cited by these dissenting scientists is that the buildings came down far more rapidly than would be possible due to natural causes.

The roofline of WTC 1, the North Tower, accelerated downward the entire time it was visible above the cloud of debris. Furthermore, the television broadcasting antenna on top of the building, which was supported by the 47 core columns, was claimed to be the first thing to move downward. This could be seen as evidence that the core columns were simultaneously compromised at the very start of the collapse.

The motion of WTC 7, which was nearly half the height of the twin towers and came down at 5:20 in the evening of September 11, 2001 without being hit by a plane, is the most anomalous of the three building collapses. From even casual observation, Building 7's collapse looks very much like a classic controlled demolition. However, the National Institute of Standards and Technology (NIST, the government agency tasked with analyzing the building collapses) concluded that fires in WTC 7 caused the collapse. In their August 2008 draft for public comment of their WTC 7 summary report, NIST asserted that the time for the building to fall through the first 18 stories (the part of the collapse visible from the camera angle they used) took “40% longer than free fall time.” At a technical briefing conference in August of 2008, when challenged that measurements show the building came down very close to free fall, Shayam Sunder, the lead investigator for NIST stated:

“[A] free fall time would be an object that has no structural components below it. . . . the time that it took . . . for those 17 floors (*sic: 18 floors*) to disappear [was roughly 40 percent longer than free fall time], and that is not at all unusual, because there was structural resistance that was provided in this particular case. And you had a sequence of structural failures that had to take place, and everything was not instantaneous.”

In essence, NIST claimed the building could not have been in free fall because free fall of a building straight down through its structure would not be physically possible. The contrary claim was that one could verify by direct observation that free fall actually occurred. The downward acceleration of the building can be measured, and the question was how such a "publicly visible, easily measurable quantity" could be set aside.

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This brings us to the substance of this lab exercise.

The goal is to do the measurements for yourself. This would be a suitable activity for an introductory physics lab class, or a special student project, or a science fair project for a high school student that has taken introductory physics, or an exercise in self-education for a member of the general public.

[Note that the trz files are completed examples intended to be used as comparisons to the student work. Classroom teachers may want to remove these files until the student work is completed.]

Videos and associated data are provided in separate folders for WTC 1, several for WTC 7 from different perspectives, and two Verinage demolitions. The latter are true gravity-driven demolitions where no explosives are used. The columns are caused to buckle at the half-way point (using hydraulics) and the top half of the building is allowed to crash into the bottom half. Note that both halves demolish each other simultaneously, which is what one would expect according to Newton's third law of motion.

Watch my *Tracker* tutorial, and/or others available on YouTube, to get a feel for the basic features of the program. Import various videos into *Tracker* and experiment with them. Note that when you place marks on the video, you are referencing a position and a time. If you have the graphs set for x vs t or y vs t, you are tracking position as a function of time. If you set the graph for v_x vs t or v_y vs t, the program computes the velocity and plots it as a function of time. The slope of a position vs time graph is the velocity, and the slope of a velocity vs time graph is the acceleration. Plotting v_y vs t is of particular interest in studying the downward acceleration of the buildings.

The folder entitled WTC1 contains a video clip showing the north face of the North Tower and a document that gives the spacing of the floors.

Several video clips are provided that show the collapse of WTC 7. The "Dan Rather" video is a famous CBS video that contains Dan Rather's spontaneous comment on how much the collapse looks like a controlled demolition. A second similar-looking video was taken with a tilted camera, a spare camera that was not being manned. The advantage for us is that the camera was untouched for the entire duration of the collapse. You can compare the reliability of this video and the Dan Rather video by "tracking" a point on a stationary building near WTC 7. (There is a little variation in the position of even a "fixed" point due to atmospheric turbulence, but tracking a fixed point can tell you whether and how much the camera may have moved.) On the two videos rows of windows on the building mark the floors.

A document is included that gives the spacing of the floors. Note that not all of the floors are the same spacing, so be careful.

The Verinage demolitions are interesting to compare with the WTC collapses. Note that the demolition is started at the middle and both halves demolish each other simultaneously, which is what one would expect according to Newton's third law of motion. Note in particular how the acceleration (the slope of the v vs t graph) changes when the two sections of the building actually meet. Track the motions of the rooflines of these known gravity demolitions to compare with the claim that the WTC buildings were gravity-driven collapses.

The frame rates of the cameras vary. The US standard is 29.97 (~30) frames per second. The two Verinage demolitions follow the European standard, 25 fps. Camera 3 uses 15 fps. If you use every frame, the amount of motion in a single frame will be small compared with the resolution of the video pixels, so measurement error will tend to overwhelm the measurements themselves. We would say the data is "noisy." Try setting the video controller in Tracker (the icon in the menu bar that looks like a short strip of film) to step through the video at 0.1 or 0.2 seconds per step. (For example, 30 frames/sec x 0.2 sec = 6 frames, so if you want to use 0.2 sec intervals, set the video controller to a step size of 6 frames. For the 25 fps footage use a step size of 5 frames, and for 15 fps use a step size of 3 frames.)

For all of the videos, but particularly for the tilted camera video, you should display the coordinate axes and rotate the axes to align with a vertical edge of a building. A small mark indicates the positive x-axis. You can rotate the axes by dragging any point on the positive x-axis. All *x* and *y* positions computed by the program are relative to the current coordinates.

The vertical distance for a given number of floors can be used to calibrate the video. Identify two floors (reasonably far apart) and compute the distance between them based on the documents provided with each video. Convert the distance from feet to meters by multiplying the number of feet by 0.3048. In *Tracker*, create a calibration stick (or calibration tape), move the endpoints to two chosen floors (making sure the calibration stick is aligned with the vertical coordinate axis) and change the number at the center of the calibration stick/tape to the real-world distance in meters.

Use the "Create" function to create a marker with a suitable "footprint" to use for tracking the chosen point. (The markers are called "Point Masses" in *Tracker*.) If you decide to track more than one point, create multiple markers and use different colors and/or marker shapes.

To mark the video, choose the mass you have created then go to the desired point and do Shift-Click. While placing the marks, it is best to turn off the trail of previous marks. (There is a button in the toolbar that controls the length of the trail. Another one turns the numbering of the marks on or off.) Use the magnifying glass tool (or the mouse wheel) to zoom in to precisely position the points. After a first pass at placing the points the positions can be adjusted under magnification to get better precision. If you plot more than one track of points, select which track is displayed in the Plot panel using the pull-down menu above the graph.

Alternatively, read the documentation and learn how to let the program automatically position the points for you.

On the Plot panel (usually on the upper right side of the screen), click on the vertical axis label and select v_y , the *y*-component of velocity, and select time on the horizontal axis. (You might also want to study relationships among other variables. You can change the variables being graphed even after the data is taken.)

Given the position as a function of time, when you select a velocity variable to graph, an approximation of the instantaneous velocity is computed and recorded by the program in the data table at the bottom right and plotted in the Plot panel.

You will probably be most interested in the v_y measurements as a function of time. In introductory physics we learn that the slope of a velocity vs time graph gives the acceleration. If the building is falling with a constant downward acceleration, the velocity vs time graph would be linear, and the slope of the linear portion of the graph would give the acceleration. This can be compared with the acceleration of gravity, which in New York City is 9.803 m/s^2. To compute the slope of the linear portion of the graph, right click the Plot view and select Analyze to bring up the Data Tool, which is a companion program. In Data Tool, select the Analyze tab and check the box for Curve Fits. At the bottom left select Line and be sure the Autofit box is checked. Now when you click and move the mouse over a selection of data points, a "best fit" regression line will be shown and the equation of the line will be shown in a box at the bottom. The equation is given as vy=A*t+B. A is the slope, which in this case is the acceleration. The numbers will be displayed in scientific notation with the digits following the E representing the power of 10. (If the number is in the form 1.23E4 the E stands for the power of 10, so this number would be 1.23×10^4, or 12300.)

All of the materials needed to perform this lab (apart from the *Tracker* program itself) have been collected together as a "kit" and are available for download: *WTC-911-Motion-Lab.zip*.

The program *Tracker* is part of the *Open Source Physics* project. It can be downloaded from https://www.cabrillo.edu/~dbrown/tracker/ or search for "OSP Tracker." It is free and cross platform, written in *Java*. The appropriate version of Java is bundled with the program installer, so you don't need to install Java separately.

Interpreting Your Results

- Over what range of time does each building undergo essentially constant downward acceleration? For the buildings with known calibration data, what is that acceleration? Note the amount of variation in the result that occurs as different ranges of data points are selected for the regression calculation.

- By what percent does the measured acceleration differ from g? (The acceleration of gravity is 9.803 m/s^2 in New York City.)

- Is the term "free fall" justified for WTC 1? For WTC 7? See the article at http://journalof911studies.com/volume/2010/ChandlerDownwardAccelerationOfWTC1.pdf for a discussion of the implications of uniform downward acceleration at some rate other than free fall.

- 40% less than free fall acceleration is 5.88 m/s^2. Read the NIST report to see how they came up with this value. Is this a valid method for determining the downward acceleration of the building?

- What are the implications of free fall for a building falling through its own structure? What do you make of NIST's initial claim that the building fell 40% slower than free fall? What do you make of Shayam Sunder's statement about why the building could not fall at free fall acceleration?

- For WTC 7: What *distance* of fall corresponds with the *time* it is observed to be in free fall? Considering the distance between floors, how many stories failed to offer any support before it started meeting resistance? For WTC 1, convert the distance the roofline is observed to move with a downward acceleration into a number of floors.

- What do you think are the implications of the free fall of WTC 7 and the downward acceleration of WTC 1 for interpreting the events of the day of 9/11?

Follow-up

NIST changed their final report after being confronted on the issue of the measured free fall of WTC 7. Several of us submitted "requests for correction," which are included with excerpts from the NIST documents in the Documents folder. Videotaped excerpts of the technical briefing conference can be seen here, along with commentary: http://www.youtube.com/view_play_list?p=206C1F5EDFC83824 .

- The Documents folder included with this lab kit contains the summary versions of the NIST Building 7 report, both the final draft version issued in August and the final version issued in November 2008. [The most relevant pages are p. 40-41 of the draft document (pdf pages 78-79) and p. 44-46 of the final version (pdf pages 86-88)] Read the sections of the draft and final summary reports dealing with the free fall of WTC 7 and the three included requests for correction. Compare these with Shayam Sunder's statements at the technical briefing conference. Is the analyses in the final summary report self-consistent with respect to free fall?

- The final report acknowledges that WTC 7 fell at free fall for ~2.25 seconds. Then the report concludes, "*The three stages of collapse progression described above are consistent with the results of the global collapse analyses discussed in Chapter 12 of NIST NCSTAR 1-9.*" *NIST NCSTAR 1-9* (797 pages) is the full NIST report on WTC 7. You can find the full report on the NIST website here: https://ws680.nist.gov/publication/get_pdf.cfm?pub_id=861611. What is your assessment of NIST's conclusions?

- What is the role of a science educated citizen in a democracy?