How did the Three WTC Towers Fall?

a minimum time for "pancaking" collapse

Joshua Mitteldorf, PhD

Abstract—The three World Trade Center towers that fell on 9/11/2001 were observed to collapse from the top down. Questions have been raised whether the collapses could have been a natural result of fires within the buildings, or whether the manner of collapse suggests that the buildings had been prepared beforehand for controlled demolition. In the most popular version of natural collapse, the supporting members were weakened by fire throughout, such that the impact of each collapsing upper storey was sufficient to cause failure of the support members when it struck the next floor below. Here we present an idealized calculation of a minimum time for completion of the collapse in the scenario. The minimum time is computed on the assumption that as the floors are struck, the supporting members suddenly offer zero resistance to the fall. Nevertheless, there is the inertia of each floor's mass that was originally at rest that must be accelerated to catch up with the accumulated downward velocity of the mass falling from above. Based on inertia alone, with no structural force opposing collapse, we show that the time for the entire process cannot be less than √3 times the free-fall time. This minimum is inconsistent with the collapse times of all three towers, adding weight to the conclusion that the collapse of the towers was an engineered, and not a natural event.

1 Introduction

A common belief among the many alternative theories about the events of 9/11 is that the Twin Towers and also Building 7 were brought down by controlled demolition. Principal evidence in support of this hypothesis includes:

- Detection of nano-thermite in the WTC dust
- Molten metal seen pouring from the South Tower (with the color temperature of molten iron) and pools of molten iron/steel persisting weeks after the collapse
- Temperatures of kerosene fires would not have been sufficient to appreciably weaken steel support structure.
- Symmetry of the collapses
- Collapse rates close to free-fall speeds

Many people who believe the official account of events subscribe to a scenario dubbed "pancaking" by the National Institute for Standards and Technology (even after NIST has officially withdrawn support for this idea). The idea of "pancaking" is that the top floors collapsed onto the floors underneath, which succumbed to the impact. The floors were said to collapse one by one from the top down, each adding to the falling mass, which impacted each successive storey with increased impulse.

Here we present an idealized calculation of a minimum time for completion of the collapse in the "pancaking" scenario. Although realistically the supporting members would add considerable resistance and delay the collapse, we assume that the supporting members provided no resistance whatever, so that the collapse is slowed only by the inertia of each floor, as it is swept up into collapsing mass. Under this assumption, we show that a very conservative minimum time for the collapse is √3 times the free-fall time. This works out to 16.0 sec for the twin towers and 11.8 sec for WTC 7. The observed times for collapse were smaller than these minima.

The result is derived based on a contuum model, with the mass of each floor accumulating like snow before a snowplow. The resistance of structural supports is entirely neglected. This artificially requires that the beams and columns supporting each floor cease to exist when each floor crashes into the floor below it, so the supports offer no impulse to slow the collapse. Assuming a perfectly inelastic collision, the mass of each floor adds incrementally to the inertia of the mass above it. The net result is that the acceleration is reduced by a factor of 3, and thus the time is increase by √3.

2 Computation

In the limit as the building is much taller than one storey, the mass distribution may be approximated as continuous. Consider a mass M part-way through its descent, falling with instantaneous velocity v through a distance dz, then picking up a mass dm through an inelastic collision. Let g be the acceleration of gravity.

$$\text{As it falls, } v \rightarrow v + (g/v)\, dz$$

$$\text{As it collides, } v \rightarrow v\,(1 - dm/M)$$

Combining the two changes to v:

$$dv = (g/v)\, dz - v\, dm/M$$

Now we suppose that each storey has the same mass and the same height as the others. (In reality, the mass of lower floors is greater because supporting members are heavier, and this can only increase total time for the fall.) Then there is a constant mass per unit height, which we desig-

• *J. Mitteldorf is a consultant in computer simulation. E-mail: aging.advice@gmail.com.*

nate ρ, and we write the swept-up mass M as $M = \rho\, z$, with $\rho = dm/dz$.

Then ρ drops from the equation, leaving

$$dv/dz = g/v - v/z$$

With the boundary conditions $z=0$ and $v=0$ when $t=0$, the unique solution of this differential equation is:

$$v = gt/3, \quad z = gt^2/6$$

Thus the acceleration is exactly 1/3 of the free-fall result, and the time required to fall through a height h is $\sqrt{(6h/g)}$, which is $\sqrt{3}$ times the free-fall time. Substituting $g=9.8\text{m/s}^2$ and $h=416$ m for the Twin Towers gives a minimum time 16.0 sec, and substituting $h=226$m for WTC 7 yields 11.8 sec. These numbers ought to be strict minima for the pancaking scenario. However, in video clips, the North Tower collapsed in about 13-15 sec and WTC 7 collapsed in about 7 sec. (The fall of the South Tower was complicated by the tumbling of the top section.)

Chandler has measured acceleration for WTC 7 directly from video clips and concludes that the acceleration was essentially free-fall for the first 2.5 seconds of the collapse, a result that prompted NIST to modify their own measurement for their final report.

https://www.youtube.com/watch?v=rVCDpL4Ax7I

Note: Note: The approximation of continuous mass distribution substituting for discrete storeys makes the computation simpler, but it is the only assumption that is not assured to underestimate the time. Comparison with numerical simulation for 110 storeys suggests that the minimum time could be about 1 second less on this account.