Frank Greening's Challenge to David Chandler

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I note with amusement that someone who calls himself Reprehensor has posted the recent e-mail exchange between myself and Steven Jones on 9/11 Blogger. From the 40-plus comments Reprehensor's post has generated, I see that many researchers view my opinions on Chandler's "proof" that the collapse of WTC 1 must have been a CD, as evidence that I misunderstand the basic rudiments of Newtonian physics. Well, I beg to differ and will now go through Chandler's arguments to clarify my position on this issue.

Chandler's argument appears to be as follows: During the collapse of WTC 1, an upper portion of the building, (let's say the top 13 floors), started moving downward relative to the lower fixed portion of the building, causing the lower portion to be crushed. Let's call the (initial) mass of the upper block M(upper). For WTC 1, M(upper) was about 30,000 tonnes and the initiating drop distance was 3.7 meters or one story height. Measurements of the motion of the upper block, (while it was still visible), show it dropped about ten story heights during the first 3 seconds with an approximately constant acceleration of 6.31 m/s^2 or 64 % of g. From this observation Chandler concludes that the block was subject to a net force of 0.64M(upper)g. Prior to the collapse of WTC 1, the lower portion of the building was perfectly capable of holding up the upper block which we know exerted a downward force equal to M(upper)g. So why, once the collapse started, was the lower section of WTC 1 not able to support a load of 0.64M(upper)g?

Chandler's answer to this question: During the collapse of WTC 1, the only way the upper block could have accelerated at 64 % of g was for the lower section of the building to have continuously lost its load-carrying capacity, presumably through the occurrence of column failures ahead of the collapse front. The fact that the downward acceleration was not far below g shows that columns failed without significant resistance. This, concludes Chandler, proves that the destruction of WTC 1 was a controlled demolition.

This all sounds like a very nice exercise in Newtonian mechanics, …. so how could it possibly be incorrect? Well, the main problem with Chandler's analysis is that he is ignoring what <u>actually</u> happens to a building during collapse. In the collapse of WTC 1, the upper section is <u>not</u> the only part of the building that is set into motion. Evidently, the top of the lower section also started to move downwards, floor-by-floor. This means that some of the potential energy of the upper block was converted into kinetic energy of some portion of the lower block. Thus columns and beams at lower levels of the collapse front were set in motion as they were pushed downwards or sideways by a growing avalanche of debris. This means that we no longer have *two* distinct masses, M(upper) and M(lower). We have M(upper) = M(Initial upper) + dM/dt, and we have M(lower) = M(Initial lower) – dM/dt. And this is strictly true only in the absence of mass shedding.
Obviously this situation greatly complicates momentum transfer calculations because you have to include a dM/dt term as well as a dv/dt (acceleration) term. **I challenge David Chandler** to re-do his WTC 1 collapse analysis with inclusion of a dM/dt term.

I note too that Chandler gives no consideration to energy transfer in the collapse of WTC 1 & 2. Energy balance requires that:

a = g – E1/3.7M(upper), ……….. where E1 is the energy needed to collapse one floor

The fact that a is observed to be approximately constant means E1/M is also ~ constant. That E1/M should be more or less constant is consistent with the design of WTC 1 & 2, or indeed any tall building.

When I say that E1 is "the energy to collapse one floor" please note that E1 includes all the energy consumed during the descent of the upper block through one floor height (~ 3.7 meters). The E1 term therefore includes the energy to "fail" the columns, the energy to crush the floor trusses and office furniture, the energy to fracture and crush the concrete, etc. Because the value of a/g is 0.64 and (at the start of the collapse) M ~ 33,000 tonnes, we see that E1 ~ 0.5 GJ.

Now I fully realize that the core columns are "stronger" on the lower floors of the Towers, however, because the acceleration, a, is observed to be constant for the first 3 seconds of collapse, E1/M must also be constant over this time, namely for the first ten floors to collapse in WTC 1 – floors from approximately level 96 to level 86. The core column areas for these floors were approximately 2 m^2 for floor 96 and 3 m^2 for floor 86. The extra mass picked up over ten floors (ignoring any mass shedding) would be about 20,000 tonnes, so we have M increasing by a factor of 53,000/33,000 = 1.6; and E1, assumed to be directly proportional to the column areas, increasing by 1.5. Thus we see that E1/M is indeed approximately constant for the floors of interest.

On the question of energy transfer, deceleration and all that, I would say there is obviously a lot of energy transfer going on during the collapse of WTC 1 because the upper block is performing work on the lower section of the building by accelerating material such as steel columns and beams, concrete, etc, located at the collapse crush front. Thus some of the potential energy released by the downward motion of the upper block was converted into the "internal" kinetic energy of a layer of debris/rubble at the crush front. And some of the K.E. so created was "lost" through sideways ejections of material; nevertheless, calculations show that the overall velocity of the falling mass tends to *increase*. Furthermore, I believe it is quite realistic to consider the collapse not as a drop-bump-drop-bump, … motion, but as a s-m-o-o-t-h process of destruction leading to a continuous buildup of momentum. In this way the collapse of WTC 1 (and WTC 2) had a lot in common with a rockslide.

The collapse of WTC 1 is best studied by considering how potential energy was converted to kinetic energy and dissipated at the crush front and subsequently within the steadily growing debris/rubble layer. This debris layer was not only a sink for potential energy, but a source of random fluctuations in the motions of the individual debris particles. These fluctuations cannot exert a net resultant force against the downward motion of the upper block but rather serve to control the gravitational work rate. In fact, if this type of collapse should attain a state of dynamic equilibrium, there will be a balance between the production of fluctuation energy at the crush front and the conversion of this energy to heat within the debris layer through the dissipating effects of many random collisions of debris particles. It is considerations such as these that help to quantify the complexities of the WTC 1 collapse, not naïve applications of Newton's 3rd Law of motion.

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