Kenneth Kuttler's letter on the Twin Towers collapse times

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Introduction

In May 2007, the Journal of 9-11 Studies published a letter by Professor Kenneth Kuttler on results from modeling the collapse times of the WTC Twin Towers, with particular emphasis on WTC1. The letter can be found at:

http://www.journalof911studies.com/l...lculations.pdf

Professor Kuttler's letter sets out to estimate the collapse times of the Twin Towers, then to establish lower limits for gravitational collapse times. This is in order to demonstrate that the collapse times observed are inconsistent with gravitational collapse, and hence the collapse must have been assisted by pre-planted explosives or thermite incendiaries, a commonly repeated assertion from the truth movement. Kenneth Kuttler is a Professor of Mathematics at Brigham Young and appears to have a respectable record as an academic and teacher. As mathematics is his speciality and the computation involved in this letter is all straightforward arithmetic, I shall assume that all his computed results are correctly derived from his assumptions, and shall focus primarily on the physical feasibility of his assumptions (more the province of a physicist or engineer than of a mathematician) and of the validity of his reasoning from results to conclusions.

The section numbering of the letter is a little idiosyncratic in that the hierarchy of section numbers does not reflect a logical arrangement of the paper into topics and sub-topics. I have tried to group my comments more rigorously by topic, so the organization of my comments will be grouped under specific sets of section numbers.

Sections 1.1 to 1.3 – establishing the methodology.

The first paragraph of section 1.1 refers to "the claim that the concrete of the floors was essentially all crushed to dust", and refers to the assertion that all the concrete in the Twin Towers was pulverized in his reference 10, an article by Morgan Reynolds. This in turn refers to a single comment by an un-named official taken out of context from an ABC news story which is no longer available but has been archived on a website dedicated to arguing the case for US government involvement in the 9-11 attacks. A less authoritative source would be hard to imagine. This quote of course contains no information about when in the

collapse the dust was created, the particle size distribution of the dust or whether larger fragments of concrete were present in other areas of the rubble pile than those in which the un-named official's workers were searching, and disagrees with a wealth of photographic evidence showing macroscopic concrete fragments present in very large quantities in the rubble pile. The date of the reference, September 16th, makes it clear that no significant clearance of debris could have taken place by this time, and that this quote therefore can at most only refer to the absence of large concrete fragments from the upper reaches of the debris pile. In particular, it does not state, or even suggest, that there was no concrete **dust** in the rubble pile. This will be of significance later in the article.

When Kuttler looks at the actual collapse times, some of the times quoted are not reasonable estimates. Kuttler starts by saying that the collapse time for WTC1 "looks like it came down in about 15 seconds", but then quotes times from the NIST report which are not estimates of the total collapse time but of the "elapsed times for the first exterior panels to strike the ground after the collapse initiated" [1]. Legge's estimate, also given as a reference, is an extrapolation without justification from the early moments of the collapse. In discussing his own estimate of the collapse time, Kuttler estimates that the collapse took about 12 seconds after the start of a specific video which he states begins "when the collapse of the top floors has been underway for a few seconds", but he rather misleadingly twice quotes the time "12 seconds" in a discussion which clearly indicates that the collapse time for WTC1 was significantly greater than 12 seconds. His actual estimate of the collapse time is never stated, which seems odd since it is a key part of the analysis.

Section 1.2 discusses different collapse modes, specifically what are referred to as "hard top" and "soft top" collapses. The "hard top" model is equivalent to that used by Greening, Bazant and others, and is commonly referred to as "crush-down/crush-up", in which the top part of the building initially destroys the bottom part and then is itself destroyed when it impacts the ground. The "soft top" collapse mode involves simultaneous crush-up and crush-down until the top portion has been destroyed, after which the rubble from the floors destroyed continues to collapse the lower floors. Kuttler argues with considerable justification that the latter model appears more physically reasonable, and then goes on to discuss both models in order to obtain valid comparisons with the work of others. This part of the analysis appears well thought-out and physically reasonable.

Section 1.3 sets out the basic physics involved in the collapse, which is generally correctly derived. One questionable statement from this section is that some energy sinks have been neglected and that therefore the modeled collapse time will be an underestimate. This will be further discussed in comments on section 1.4.3.

Section 1.4 – the hard top model

Section 1.4 calculates collapse times for the hard top floating floor model. This section is broken down into a series of different sets of starting assumptions, as follows:

Section 1.4.1: Floating floor collapse times considering conservation of momentum only. Kuttler quotes his calculated 12.18 second collapse time as "longer than the official NIST figure of 11 seconds", despite having himself determined the collapse time to be longer than this. Since this letter purports to be a scientific analysis rather than a rebuttal to NIST, it seems inappropriate that he does not compare his results with his own observations. In any case, the figures from NIST are not total collapse times but "elapsed times for the first exterior panels to strike the ground after the collapse initiated" [1], so Kuttler gives the appearance of deliberately trying to find a shorter time than his calculation for comparison.

Section 1.4.2: Progressive loss of mass to dust. This section assumes 100% loss of concrete in every impact stage of the collapse. This assumes that, in the sequence of floor-to-floor impacts, the entire concrete content of the lower 94 floors has been lost by the time the top impacts the ground. This is a physically unreasonable and completely unjustified assumption. Even if there was no solid concrete remaining in the debris, this does not require that all the concrete involved in a floor-to-floor impact was expelled prior to impact with the ground, as Kuttler assumes; this would require that concrete was not even present as dust in the rubble pile, which the references in the letter do not support. As a result, the collapse times thus calculated will inevitably be unrealistically long. If we simply accept the possibility of dust in the rubble pile, then the requirement for pulverisation to precede the ground impact is removed, as the kinetic energy of the falling debris becomes available in its entirety for pulverisation. If we further accept that macroscopic concrete fragments were present then the energy requirement for pulverisation falls drastically.

Section 1.4.3: Kuttler neglects conservation of momentum and assumes 100% crushing of concrete to 100μm dust. This is physically unreasonable because (a) it has not been established satisfactorily that all the concrete was crushed (see above), and (b) the transfer of energy from kinetic to fracture energy must be limited by conservation of momentum otherwise Newtonian mechanics are violated. Indeed, it is the loss of kinetic energy due to the requirement that momentum is conserved in an inelastic collision that is the source of the fracture energy required for pulverisation, so by neglecting that effect Kuttler is failing to make any attempt at realistic modelling of the physics of pulverisation. The value of 100μm comes from Lioy et al, a paper concerning the sampling of airborne dust at remote sites downwind of the Twin Towers, a sampling technique which would automatically place an upper limit on the dust particle size collected; these samples were therefore in no way representative of the debris from the collapse as a whole, which could have a very much larger particle size distribution. In fact Kuttler himself comments that there was insufficient energy in the collapse to achieve the level of pulverisation he requires, which should alert him to the problems with his own modelling.

Sections 2.1 to 2.4 – the soft top model

Similar comments apply to sections 2.1, 2.2, and 2.3 as to section 1.4. The quantity and size of dust is not justified, hence the collapse times are unrealistically long. Kuttler does not calculate the collapse time for the soft top model without loss of mass or energy to pulverisation, which is a significant omission. Kuttler clearly defines his soft top model in

relation to the sequence of collisions, making no reference to pulverization, so a calculation without these factors would provide useful comparisons with section 1.4.1.

Section 2.4 seems to be arguing that the steel in the collapse did not contribute to the energy requirements for pulverising concrete but that it should be included as an unrealistic variant of the model to give a shorter collapse time. Quite what Kuttler is trying to say here, I can't really tell.

Section 2.5 – column resistance

In section 2.5, analysing the effect of column resistance on the collapse time, Kuttler states that each column exerts an average upwards force during the collapse of between 0.35 and 0.5 of its yield point, making no attempt to justify this figure either by reference or by calculation. This is a serious omission and a key weakness of the paper, as this value is critical to the remaining analysis. His discussion is limited to the following:

"Instead of the acceleration of gravity for g I will use

g = 32 - 2 x 32 x .35

The 2 in the above is a safety factor which should be somewhere between 2 and 5. A factor of 2 is the smallest reasonable safety factor. The .35 comes about because the column will not deliver its full force over the whole length of the interval. Thus it should be multiplied by some number between .35 and .5."

This last sentence, on closer examination, seems a bizarre assertion. It is to be assumed that Kuttler is implying that the yield point of each column is between twice and five times the design loading, an entirely reasonable estimate, although not backed up here by reference to any information on the design of WTC1. Since, by definition, at no time can the column exert a significantly greater force than its yield point [2], this suggests that either the columns were delivering their full strength up to a compression of 35%, or - this is more likely Kuttler's basis for calculation - that their strength declined continuously throughout the collapse in such a way that they were always exerting an upward force whose average value over the collapse was 35-50% of the yield point. This presumes that the support columns were, in effect, slowly bent during the collapse rather than breaking. Since this has no resemblance to the behaviour of steel columns under compressive strain beyond their yield point, his resulting collapse times have no physical meaning whatsoever, and are necessarily a gross overestimate.

In an attempt to understand why Kuttler makes his assertion about the column strength during collapse, I would comment that a linear decrease in strength over the collapse interval would give a factor of 0.5, and a quadratic decrease would give a factor of 0.33.

This may be the origin of these factors, but if so this does not suggest that they are derived from any attempt at realistic analysis of the failure of steel in compression.

It is instructive to consider the implications of Kuttler's model to the feasibility of controlled demolition using explosives, a technique he claims must have been used to bring about the collapse of WTC7. Taking the expression above as the starting point:

$$g = 32 - 2 \times 32 \times .35 \qquad (1)$$

Equation (1) can be trivially simplified to:

$$a = g\,(1 - F1 \times F2) \qquad (2)$$

where a is the acceleration of the falling block, g is the acceleration due to gravity, F1 is the safety factor which according to Kuttler is between 2 and 5, and F2 is the fraction of the column force delivered on average over the interval, and according to Kuttler is between 0.35 and 0.5.

On inspection, this reveals an immediate problem with Kuttler's assumptions. If the product of F1 and F2 is greater than unity, the acceleration becomes negative. Clearly this is physically unrealistic; if the column is capable of exerting an upward force greater than the weight it supports, collapse will simply stop. Therefore, equation (2) becomes:

$$a = \mathrm{MAX}((g \times (1 - F1 \times F2)), 0) \qquad (3)$$

What values, then, will give a null result for acceleration? From Kuttler's values, the product of F1 and F2 varies between 0.7 and 2.5, and only if it is less than 1 is collapse possible. In particular, a structure with a safety factor of 3 cannot collapse under any circumstances, and if the proper value for F2 is 0.5 then no structure can collapse. Note that this is independent of the initiation mechanism, and is therefore valid for explosive demolitions no less than for collapse due to fire and impact damage. In attempting to prove that WTC7 was demolished using explosives, Kuttler has therefore used a set of assumptions which strongly suggest that demolition of a steel structure using explosives is itself almost impossible.

Conclusions

In summary, Kuttler in this letter does two things which preclude meaningful analysis.

Firstly, he makes invalid or physically unreasonable assumptions which will lead to greatly increased collapse times. There are four major invalid assumptions amongst those on which the analysis is founded:
(1) There was no concrete in the rubble piles within the footprint of either of the Twin Towers, not even in the form of dust.
(2) The entire concrete content of both towers was pulverised into fragments of 100 microns or less.
(3) Conservation of momentum is not a necessary factor in analysing inelastic collisions.
(4) Collapsing steel columns continue to support significant fractions of their design loads after failure in compressions.
Of these assumptions, (1) is not supported even by the flimsy anecdotal evidence advanced in its support, (2) is based on misinterpretation of airborne dust sampling data, (3) is patently absurd, and (4) is asserted in a highly disguised form and never discussed.

Secondly, either by misinterpretation or veiled implication, he suggests in two places that the collapse time was shorter than his own observations indicate.

While the former could simply be interpreted as an inability to visualise complex situations accurately, the latter - quite blatantly carried out - appears willfully dishonest. This is the type of propaganda technique of which the truth movement frequently accuses government and media sources, so it is ironic to see it in a scientific communication which purports to seek the truth concerning the 9-11 attacks.

This letter is therefore, in my opinion, primarily a mixture of fatal fallacies and deliberate attempts to mislead. Since its fundamental assumptions are grossly unrealistic, its conclusions are of no value whatsoever, and it therefore offers no plausible evidence that the collapse of WTC7 was in any way assisted by pre-planted explosives.

References:

[1] NIST's Investigation of the Sept. 11 World Trade Center Disaster – Frequently Asked Questions, http://wtc.nist.gov/pubs/factsheets/faqs_8_2006.htm. The times given are "elapsed times for the first exterior panels to strike the ground after the collapse initiated" (section 6), rather than overall collapse times.

[2] Wikipedia definition of yield point: http://en.wikipedia.org/wiki/Yield_point