Observations Of WTC1 Collapse, The Nist/Bazant Model And 2 Particulate Mass Models

The purpose of this treatise is to test both, the Model put forward for the collapse of WTC1 by NIST/BAZANT [1][11] and the Controlled Demolition hypothesis forwarded by Professor Steven Jones [3] and others, against the Empirical data taken from video evidence.

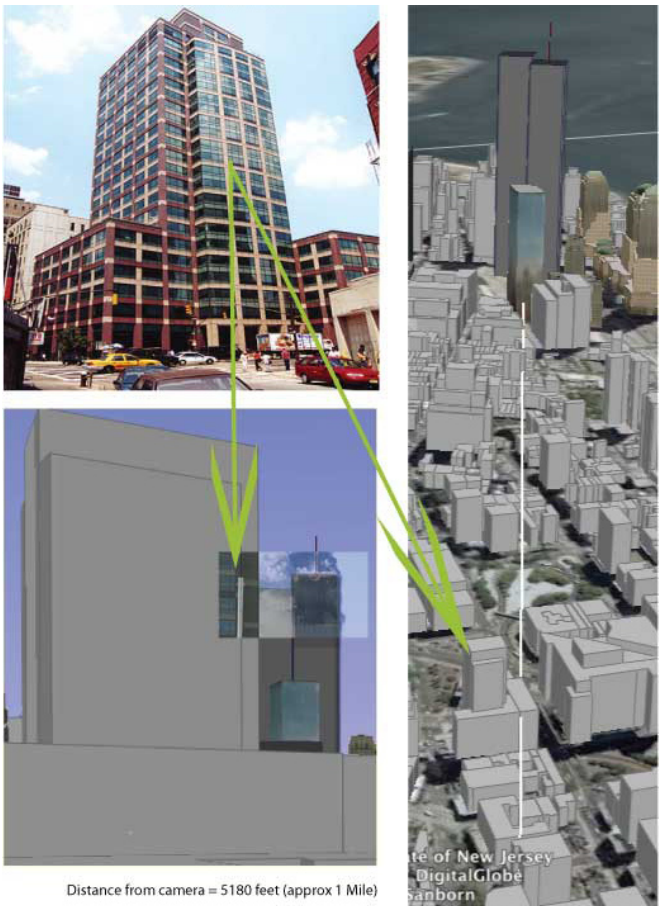
In their final report NIST take us to the moment of collapse initiation and then say global collapse ensues. NIST/BAZANT then give us a simple model for the collapse. An intact block of 12 floors falling a height of 12 feet or 3.7 meters builds up enough Kinetic Energy to overcome the “structure” of the floors below. The block remains intact and the masses of the floors the block is in collision with are added/accreted to the falling block and the collapse ‘progresses’.

Others have shown the inadequacy of this model with regard to constant Acceleration observed in the drop of the upper block, the lack of any support in the empirical evidence for a massive shock as the upper block collides with lower floors and Newton’s Third Law. [4][8][6] (See also Appendix C).

This treatise uses the basic premise of the NIST/BAZANT Model with a rigid block falling and destroying the tower below through the action of the Force of Gravity accelerating the rigid block.

This analysis uses the Mass calculations set out in Gregory Urich’s paper “Analysis of Mass and Potential Energy In the WTC” [10].

The video used in the analysis is the same video used by David Chandler[8], and Graeme MacQueen and Tony Szamboti [4] in their analyses. This video was shot from about a mile from the WTC site off 6th Avenue, between about 100 and 200 feet ASL. The camera is zoomed in and more or less facing the building so perspective distortions are at a minimum, despite being around 1000 feet lower than the section of the tower we see in the video.



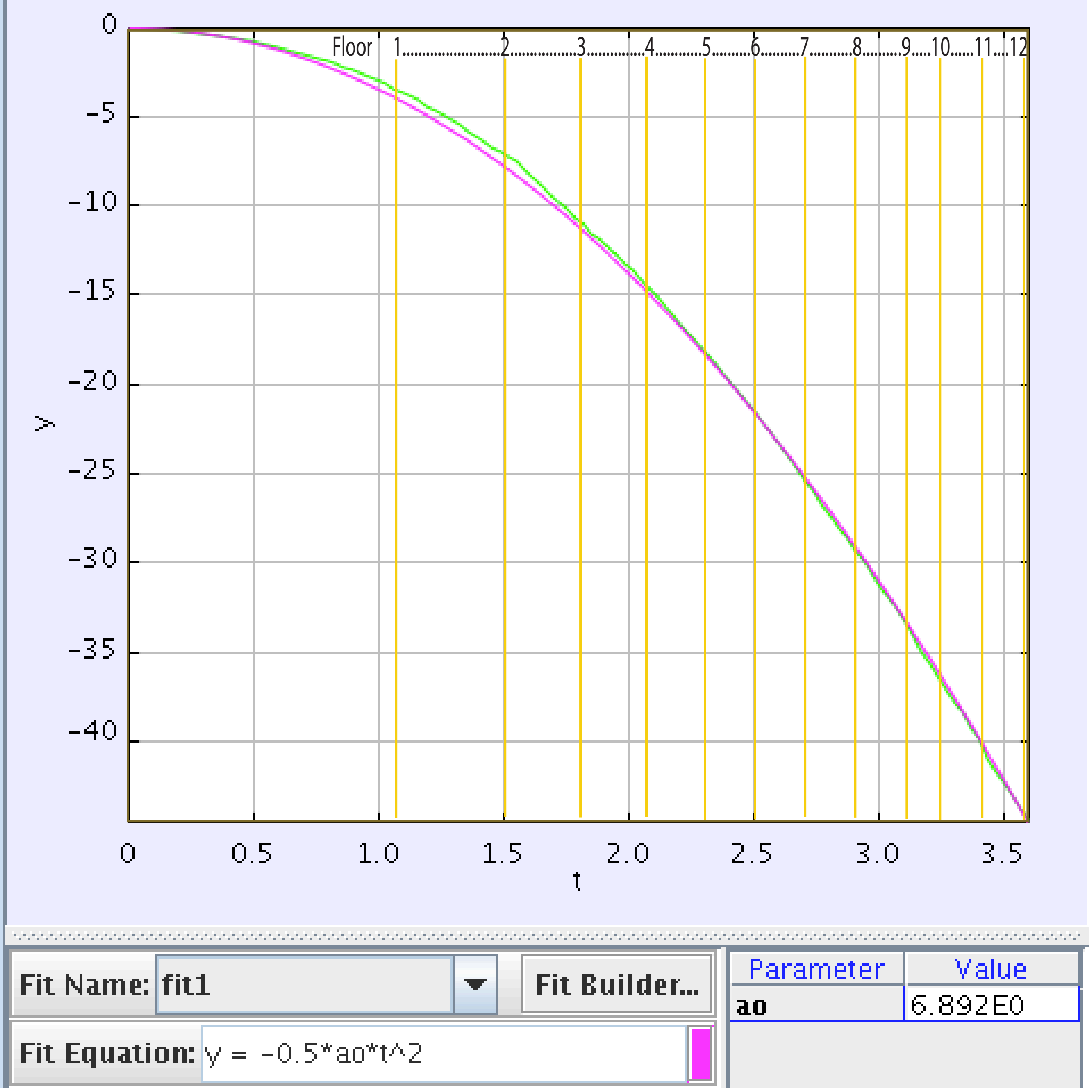
Distance from camera = 5180 feet (approx 1 Mile)

It is possible to see how much Energy the intact falling block loses in the collapse - that is we can empirically test simplified models of the collapse by measuring the rate of descent of the intact block. What a comparison of this measurement and what we'd expect to see in an object in free-fall gives us, is an insight into the Energy lost by the falling, intact block in driving the collapse.

Below is a plot of distance **Y** (green), the block has fallen over time (**t**) (measured from the East roof line). The best fit for this curve gives more or less constant Acceleration over the collapse of around 6.89 m/s/s. Data was taken from every frame of video (see Appendix A). Many 'tracks' were recorded and averaged. The track used throughout this analysis is the track that was closest to the average track and is shown here. Fig 1.

Floors are numbered in the sequence they are impacted, starting at time zero at floor 98. Therefore floor 97 becomes Floor 1 and so on, ending with the last floor impacted in the video, floor 86 (Floor 12).

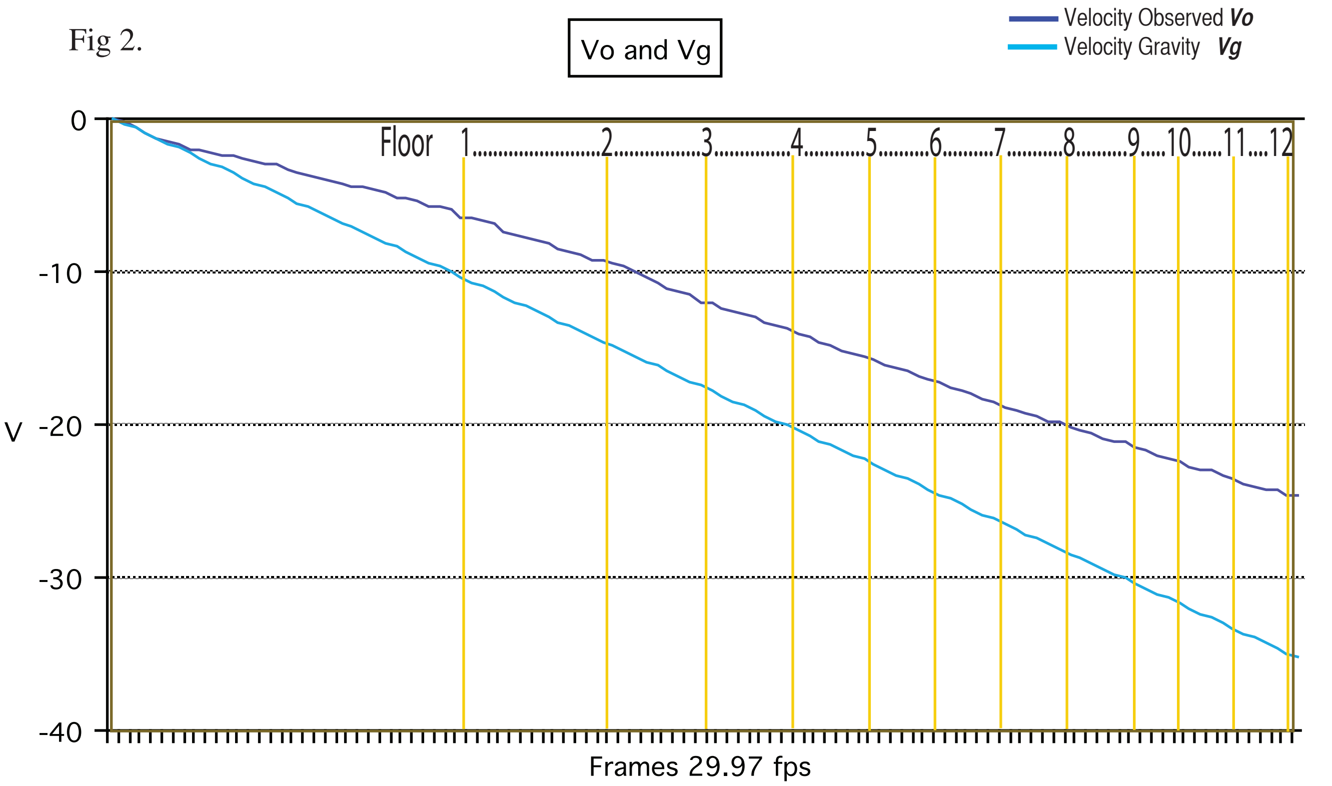
Fig 1. Observed Distance Fallen y (meters) in time t (seconds)



Using this data and data calculated for a free fall collapse we can calculate the Kinetic Energy lost by the falling block to the various Energy sinks we observe - pulverisation of concrete - ejection of Mass - overcoming inertia in masses of impacted stationary floors - structural sinks etc.

Fig 2. is a plot of observed Velocities ***Vo*** (dark-blue) and calculated free-fall Velocities ***Vg*** (blue), y-axis values are in meters per second.

Fig 2.



n.b. The observed collapse Velocity shows there are only small fluctuations in the Acceleration, (the negative trend just means the block is falling, Velocity unlike speed has a direction) which becomes more or less constant as the collapse progresses, again not what you'd expect in the NIST/BAZANT Model, where rapid deceleration is expected to occur. See Appendix C.

Fig 3.

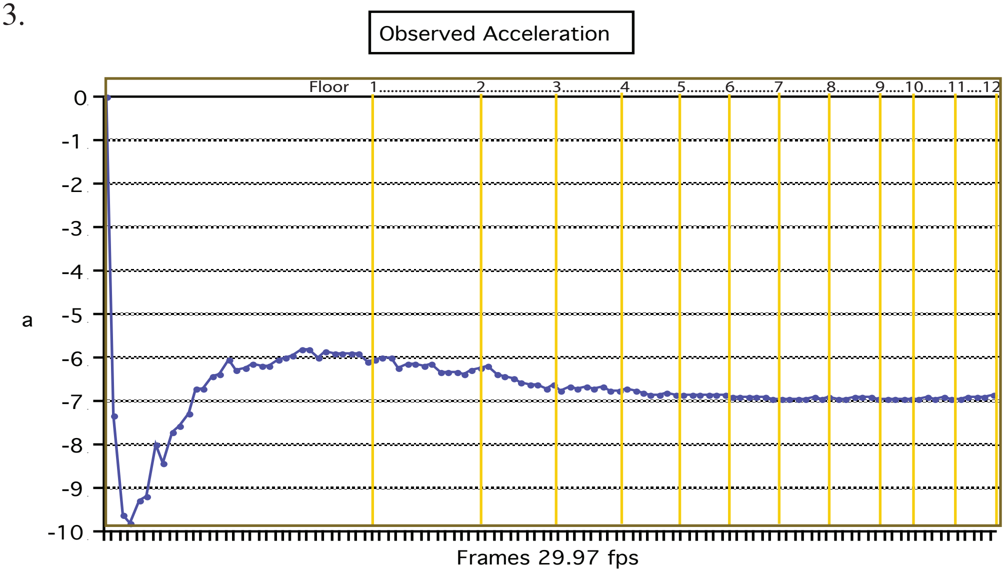


Fig 3. is a plot of observed Acceleration of the roof line. Often said to be 'near free-fall,' in-fact has this profile. There is a reasonably rapid Acceleration decrease over the first 0.6 of a second, (the Floor 1 line is at frame 34 1.033 seconds into the collapse) from here to Floor 1, Acceleration is constant around -6 m/s/s, Acceleration then begins to slowly increase before becoming constant at -6.9 m/s/s, or 70% free-fall shortly after Floor 4. It is noticeable that there are some short, low amplitude periods of relatively rapid Acceleration increase and decrease. The top block is always accelerating and never decelerating.

Energy Analysis

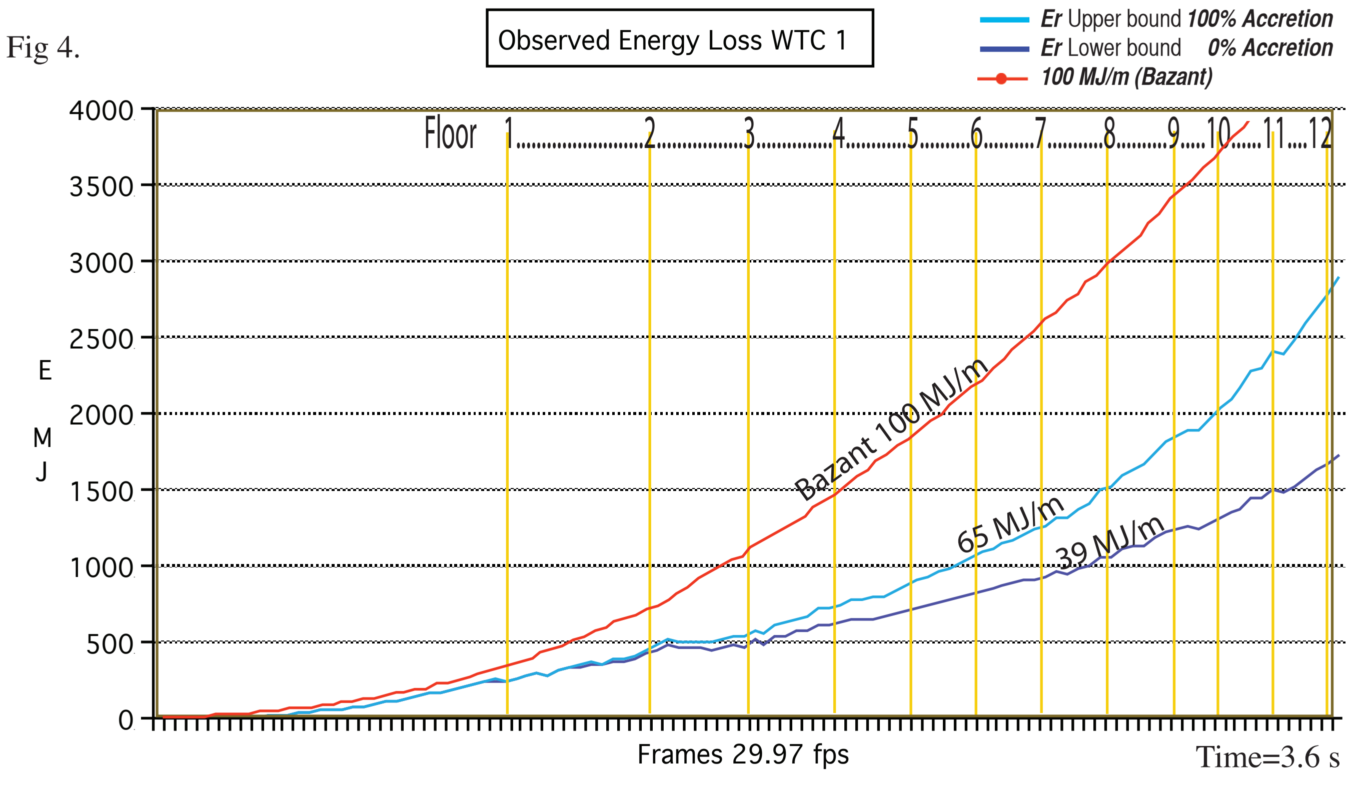
In Fig 2, the difference between the dark-blue line and the blue line is from the Conservation of Momentum, due to the total Kinetic Energy lost by the upper block to the various sinks in the course of the collapse.

By subtracting the Velocity we observe ***Vo***, from the Velocity calculated for free-fall ***Vg***, we get a Velocity difference ***Vr***, due to the resistance of the material the upper block is falling through. ***Vr=Vg-Vo*** *(Conservation of Momentum).*

This is useful because we can use ***Vr*** to get a measure of the total Energy lost to the various Energy sinks described above - ***Er***. This Energy depends on the Mass of the falling block (which is around 30 million kilos for a 12 floor block and roof), and its observed Velocity. (Some Mass is accreted after each collision which cannot be accurately estimated other than we know that after each 3.7 meter drop the block has encountered an average of 1.86 million kilos of Mass at rest, some of which will accrete)

Therefore two calculations for ***Er*** were made, one for 0% accretion and one for 100% accretion and are shown below in Fig 4, which is a plot of observed Energy loss ***Er*** with 100% Accretion (blue) and 0% Accretion (dark-blue). The red curve shows Energy absorption at 370MJ per floor due to an intact structure (given by Bazant). ***Er*** is calculated as shown in Appendix B.

Fig 4.



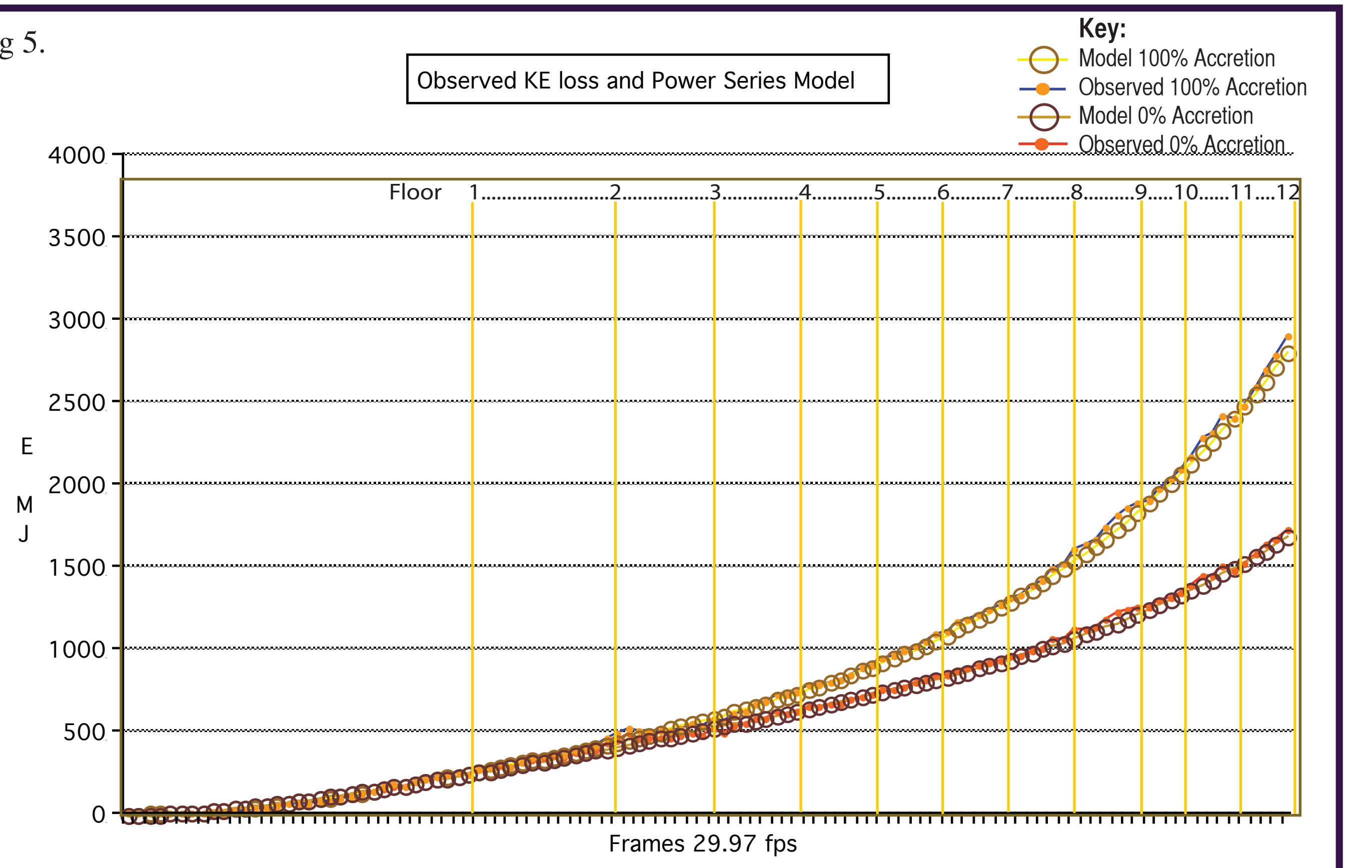
The actual Energy loss lies somewhere between these maxima (blue) and minima (dark-blue) bounds curves (referred to as The Observation in the text). The Observation is between 65% and 39% of Bazant's estimate. Bazant also wrote "*energy dissipation due to column buckling at the impact zone of the North Tower (96th story) = 510 MJ*" (Bazant and Zhou 2002) and "*..... the energy dissipation capability of D = 4.23 kJ per kg of structural steel. = 888.3MJ per floor*", all Bazant's estimates are higher than The Observation.

Clearly other Models need to be tried to see if they can predict The Observation.

It is possible to recreate the Energy loss plot using a pair of power series equations of the form $\sum_{m=0}^{\infty} c_m (x)^m$ for 0% and 100% accretion, where the coefficients with ***m*** > 4 are set to zero. see Fig 5. and Appendix B.

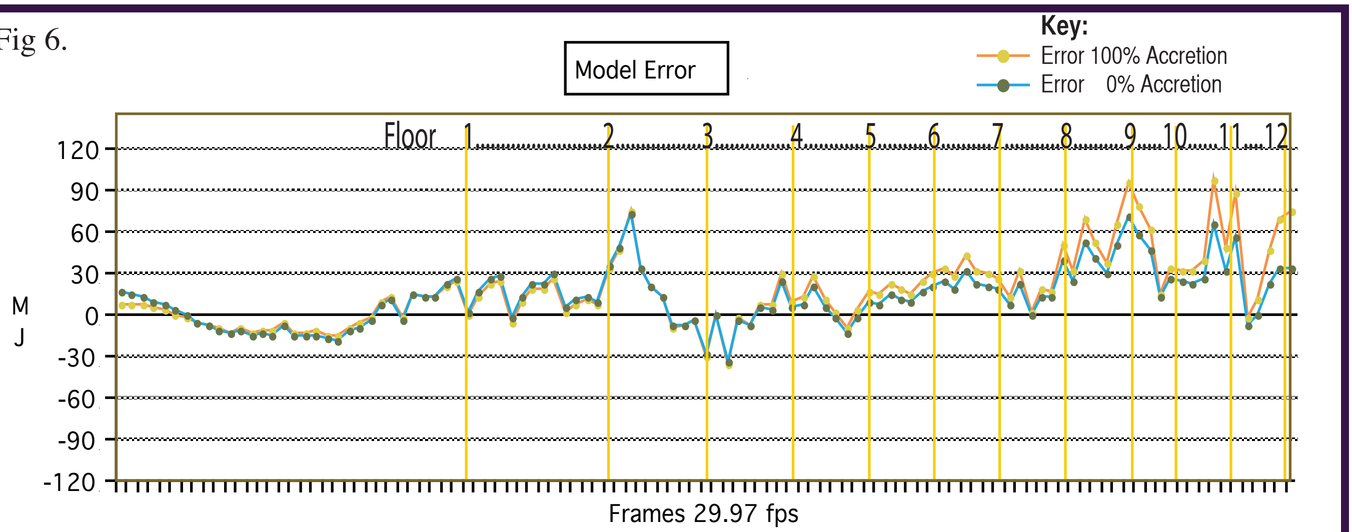
note: Fig 4 shows that accretion only begins to play a significant role after Floor 2
(Note: Upper block Mass accretion calculated with Mass distribution as for Model A. see Fig 8)

Fig 5.



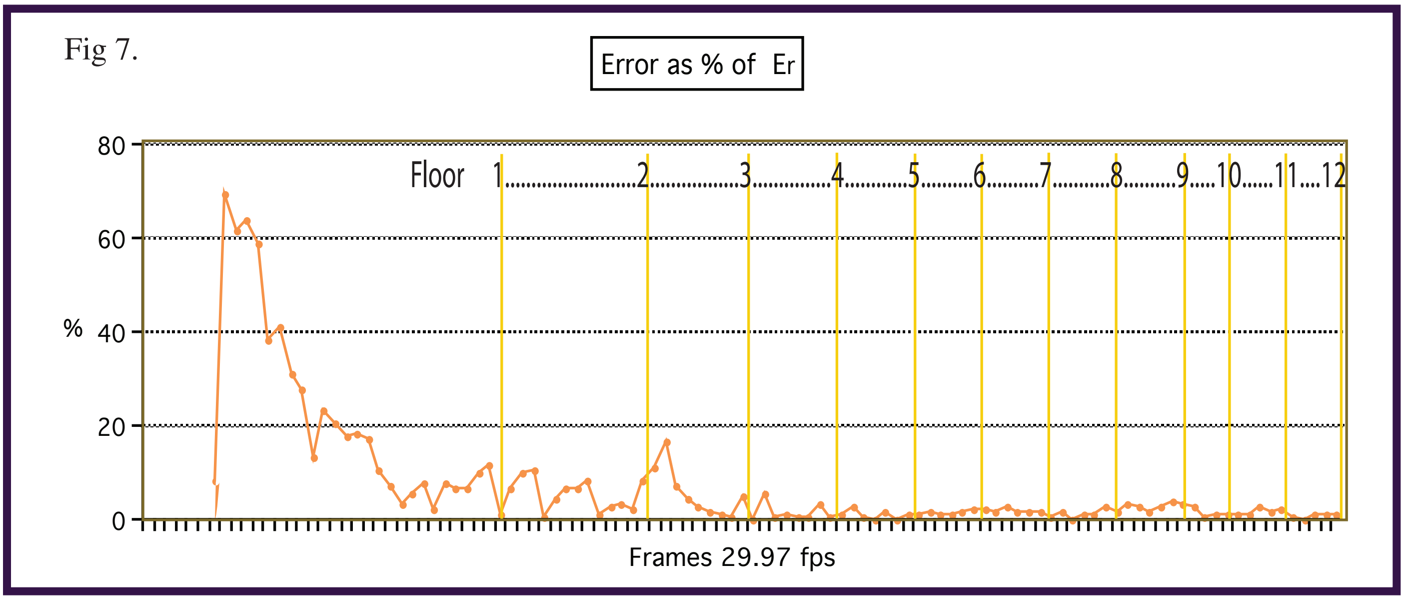
The model represents a smoothed version of reality and we can use the model to see the smoothness with which the collapse progressed by subtracting the model from The Observation. Fig 6. (un-weighted)

Fig 6.



The standard deviation from The Observation for the 100% Accretion power series model error is ± 24.1 MJ.
In Fig 6 positive MJ values on the y axis show Energy loss greater than the model in The Observation. One noticeable feature is the spike to +70 MJ recorded at Floor 2, it is visible as a slight bump in Figs 5, 4, 3 and is also seen in Figs 2 and 1. It represents 18% of the total Energy lost up to this time. As the collapse progresses and Velocity increases, more Energy is required to accelerate each floor Mass to the observed Velocity, therefore the deflections become less significant relative to the total Energy. Fig 7 illustrates this, the modulus of model error values from the 100% accretion curve of Fig 6 are shown as percentages of ***Er*** lost per frame of video.

Fig 7 shows the weighted error as a percentage of KE lost to that point in the collapse.



Due to the nature of the model the first 10 frames or so exaggerate the error and this is compounded by the very small movements of the block in this early stage of the collapse. The data was recorded assuming that the block was always moving downwards and never faster than Gravity in the first 5 or so frames.

Fig 7. is characterised with the a bumpy descent down to Floor 2 where a larger bump, already noted above occurs. Bumps become smaller with subsequent floors and decreasing height, this pattern is also seen in the Acceleration plot of Fig 3. There appears to be a *transition* from bumpy to smooth, starting after the event at Floor 2 and lasting until the start of Floor 4.

Leading up to and through Floor 1 we can see 3 ramps to +30 MJ above the power series model, followed by rapid increases in Velocity reminiscent of sliding in friction, with steady build up of the friction force and sudden jerks as the friction force is momentarily over come. There appears to be little evidence of an impact at Floor 1. The event at Floor 2, the +70MJ increase in Energy loss has characteristic shape of column buckling, but cannot represent more than a few remaining structural elements at the Velocity recorded at this point in the collapse. The 'spike' might also indicate an Acceleration of a single floor Mass from rest to the Velocity observed at this time (calculation shows 72MJ would be needed).

After floor 4 we have only minor bumps and a constant Acceleration, similar to what happens in air, only the Acceleration is 70% Gravity here, implying homogeneity of the material resisting the collapse. What material would cause this? There appears to be very little in the way of structural resistance, and what little there is has completely disappeared by Floor 5.

The smoothness with which the collapse occurred supports the Controlled Demolition Hypothesis, as does the paucity of evidence for any structural resistance, as does the evidence of constant Acceleration through a homogeneous medium.

That concludes the analysis, we have measured distance, and from there calculated Velocity and Acceleration. Using these data we measured the bounds of the Energy loss (The Observation). We also have an idea of the smoothness with which the collapse occurred by comparing The Observation with a pair of power series models. In the next section we construct two simple models for the collapse, **Model A** which resembles a 'natural' collapse based on the NIST/BAZANT Model and **Model B** which resembles a Controlled Demolition. We the test the models against The Observation i.e. the Empirical Energy loss data taken from the video. Bazant's column buckling is also modelled.

The measurement of the distance fallen has given us insight into what is going on behind the smoke and flying debris. Let us see if modelling can help us gain further insight into what at the moment, very strongly resembles a Controlled Demolition, in that the structure is destroyed, and the Mass becomes more homogeneous with lower density as the top block falls.

Two Simplified Energy Models of the Collapse.

Inherent in any model there are many sinks for the Kinetic Energy built up by the top block as it is accelerated by the force of Gravity. The total Energy lost by the falling block is a sum of all these Energy sinks, for example, three major sinks would be the buckling of steel structural components, overcoming the inertia of masses at rest and the pulverisation of concrete. From the Conservation of Energy the quantities of the various sinks occurring at any point in time in the collapse would be a polynomial sum, equal to the total Energy loss we observe at that time.

E1+E2+..... En =Total E lost. where ***E1*** etc. represent the various Energy sinks.

The values of ***E1 ..En*** are constantly changing and as the collapse progresses become more difficult to predict as the chaos increases, it is therefore highly improbable that the sum of these energies would increase in the way we see in the data, i.e. the smooth linear increase in Velocity - a straight line, or result in the therefore constant Acceleration. Clearly this has a very low probability of occurring - and yet this is what we observe in the collapse. The collapse can be modelled with two power series equations with five constant coefficients each, just ten numbers and time showing the remarkable smoothness with which events unfolded, could a natural collapse possibly produce these observations?

With this question in mind and for the purposes of gaining insight into the collapse two simplified models for Energy sinks due to inertial Mass are presented, **Model A,** similar to a 'Natural Collapse' in that the Mass is where it's expected to be and **Model B** representing the Demolition, where the Mass has been broken up and evenly re-distributed. A single structural sink is considered, singly and in conjunction with **Model A**, but the initial focus of this study is the inertial Mass sink, quantifying this sink will tell us by how much the other sinks are contributing to resisting the collapse. A further Demolition Model is formulated from the Mass models and a Structural Model.

Energy sinks are therefore categorised as follows, *Mass , Structure and Other*.

Mass sinks are the inertia of the Mass encountered by the top block as the collapse progresses. Mass also accretes to the top block as it falls, both models are compared with the maxima and minima accretion Energy sink curves of Fig 4. referred to as The Observation bounds.

Model A has all the Mass where it 'should' be, in two stratified bands per floor, with 85% occupying the last 4.5% of the floor drop. The density of the Mass cannot change in **Model A**'s Mass distribution (how could it?), but correction can be made to account for Other and Structural sinks by adding an offset. A value of 85% was chosen as conservative mean for possible values variously estimated at between 93% and 80%.

Model B is a model for an even distribution of floor Mass through each floor drop, after Floor 1. The density of the Mass can be adjusted and correction can be made to account for Other and Structural sinks in the same way as **Model A.**

Structural sinks are represented by a Model of the resistance due to hinging and buckling of columns given in the Bazant paper[11]. This single structural sink is also considered in conjunction with **Model A**. **Model B** assumes most of the structure is destroyed and is the reason for the collapse. In order to test the 'Natural Collapse' Hypothesis we need to see if there is any way a combination of the resistance of the structure, the inertia of the Mass and the other sinks can produce a 'Natural Collapse' from what looks like a Controlled Demolition in the Empirical evidence. If it can, then the 'Natural Collapse' Hypothesis can also be supported by the Empirical evidence. No other structural sink is considered here, therefore these sinks are categorised as Other for the purposes of the Modelling.

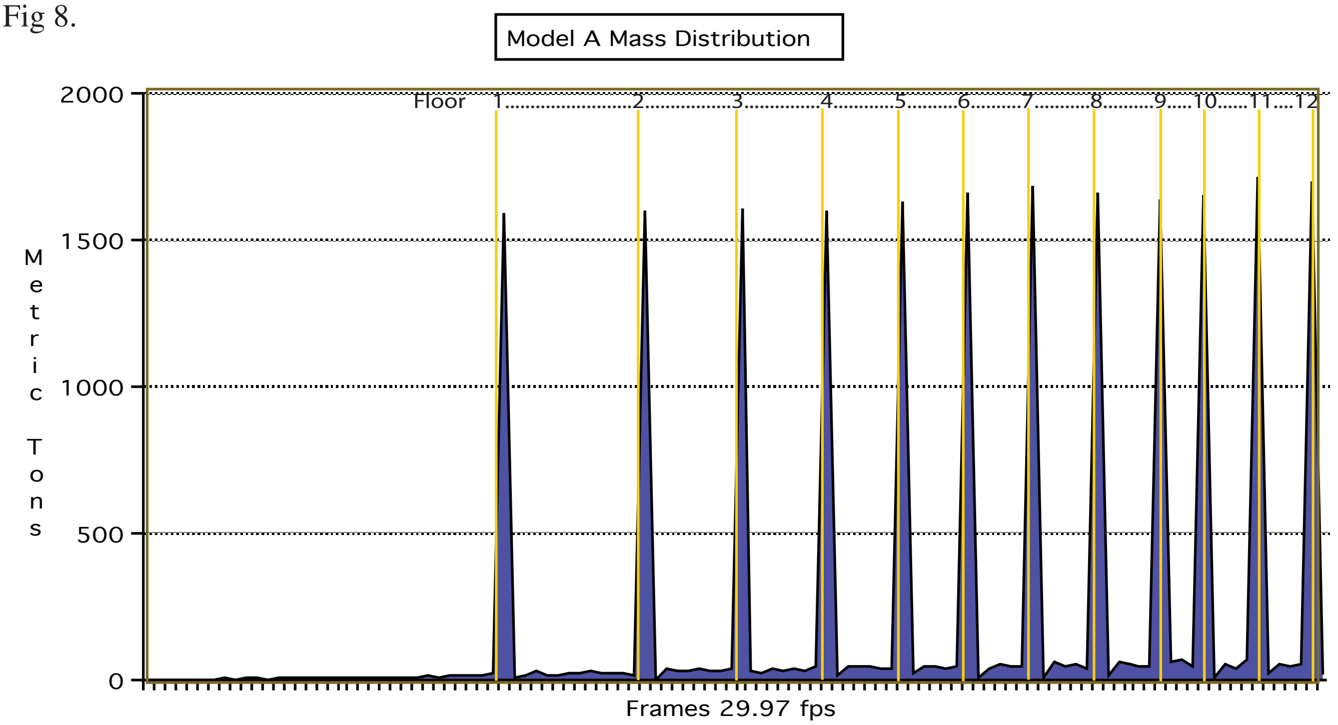
Other sinks are not considered here other than that they can be assumed to exist, these include friction and pulverisation etc. Our aim is to simply quantify these sinks by removing a knowable quantifiable sink (*Mass*) from The Observation. An estimate is made of the quantity of the Other sinks.

We compare (subtract) The Model from The Observation and get The Error. The Model, The Observation and The Error, are plotted. The Error represents the Other categories of sink not considered in The Model. In both these simplified models the upper block remains intact, with structure.

Model A Mass

Model A assumes that all 12 of the lower floor masses remain at rest until they are impacted and that the Mass is distributed so that 85% of the total Mass of a single floor occupies the last 4.5% of the floor height (3.7m). i.e. the Mass is where it should be and distributed as you might expect in a building. The distribution is calculated numerically from the distance measurements taken from the video and the Urich[10] Mass totals for each floor, the spikes appear where the upper block has encountered the 85% of a single floor Mass associated with the materials in the floor slabs. The Energy required to produce zero structural or other resistance is assumed to have already been supplied by the time of impact.

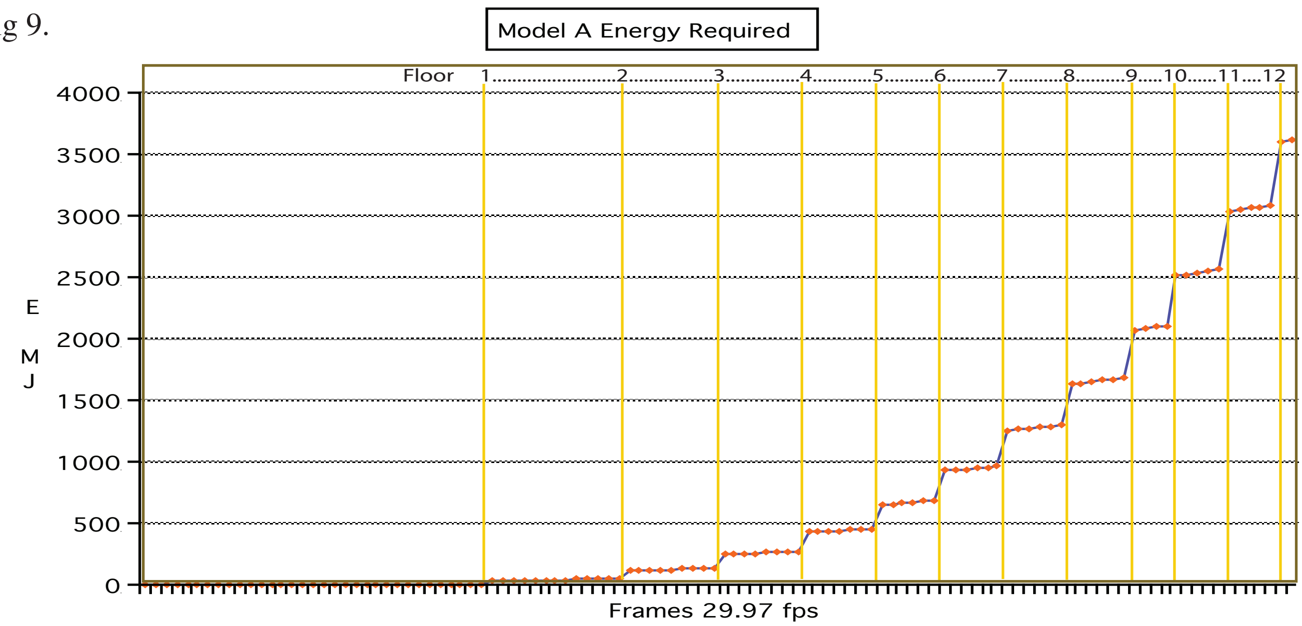
Fig 8.



In this Model, in the initial 44.4 meters of the collapse the upper 12 story block plus roof will collide and accelerate from rest the 12 single floor masses to the velocities we observe in the collapse. The block will have encountered 22,469 metric tons of Mass with an average of 1,860 metric tons per floor.

Fig 9. is a plot of the total Kinetic Energy required by Model A during the first 12 floor drop to accelerate each additional floor Mass to its observed Velocity with Model A Mass distribution.

Fig 9.



The offset for other sinks both Structural and Other, is set to zero in Fig. 9.

There are a few things to note in Fig. 9. The first is the fact that this model requires more total Energy (3700 MJ) than the total observed Energy loss seen in The Observation (3000MJ Maximum). This suggests that the Mass is not where it's expected to be in a 'Natural' collapse which is what The Observation is supposed to represent.

The other thing to note is the way the stratified distribution leads to discontinuities (steps) in the plot and in between these discontinuities, the slope of the plot becomes flatter as less Mass is encountered in the space between the floor slabs.

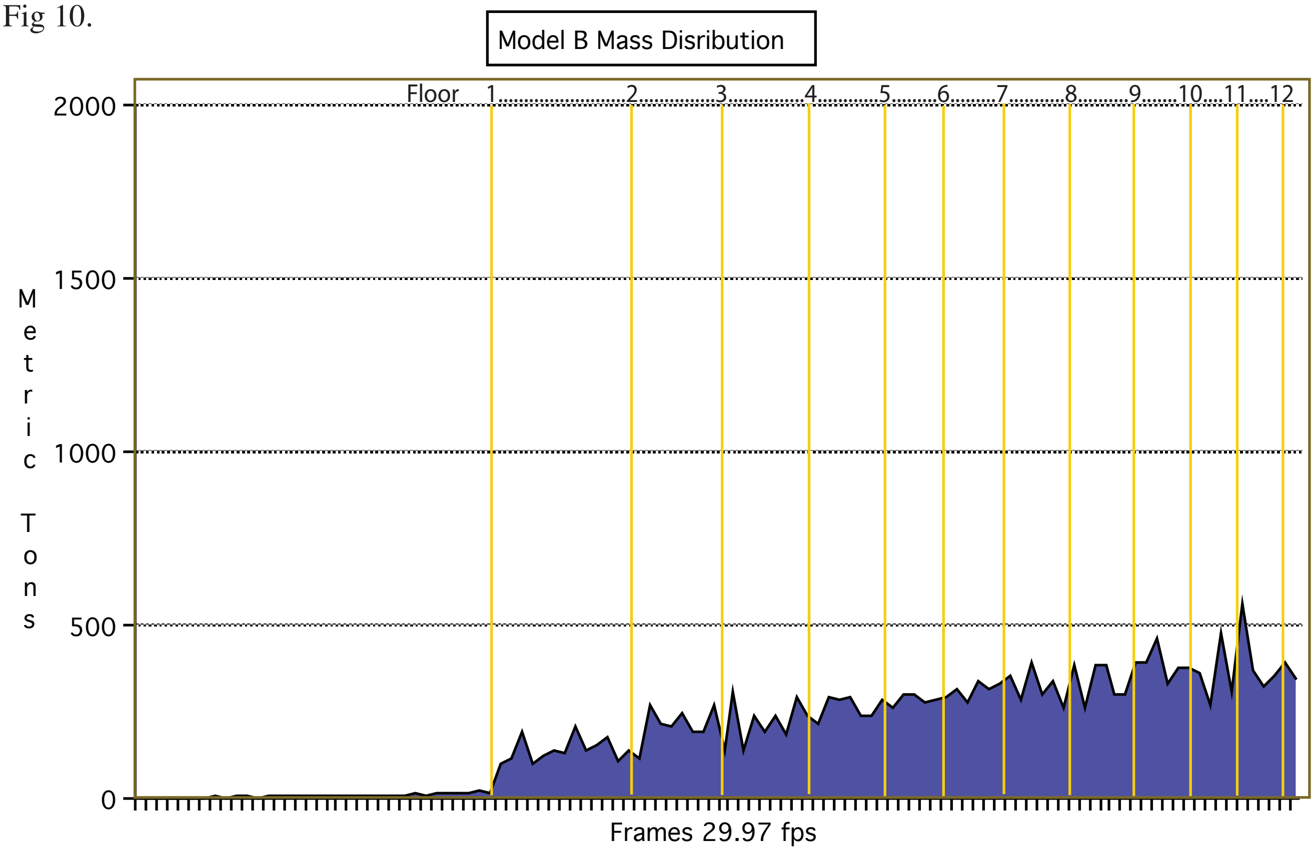
The steps get bigger as the collapse progresses and Velocity increases, reaching 500MJ+ at the end of the data.
The final thing to note is that we do not see much evidence for these discontinuities in The Observation (Fig 4.) after the Floor 2 event. (which looks similar in size and duration to what's happening in Model A at this time)

Model B Mass

This type of model was chosen because the observed constant Acceleration suggests that what is resisting the progress of the upper block is similar to a dense suspension of Mass floating in air. Observations of dense rapidly expanding dust clouds being ejected from the tower as it collapses and the fine dust which blanketed the area around the WTC post collapse, also support this choice of Model type.

In **Model B** instead of the banded distribution of Mass of **Model A**, the 85% floor Mass associated with the last 4.5% of each floor height is distributed evenly throughout the next lower floor drop, this models floor masses associated with the floor decks having been exploded into suspension and evenly re-distributed throughout the drop to the next lower floor. Again this distribution is numerically calculated from observed distances fallen by the upper block and that the Energy for this arrangement of Mass has already been supplied. Fig 10, shows this distribution of Mass.

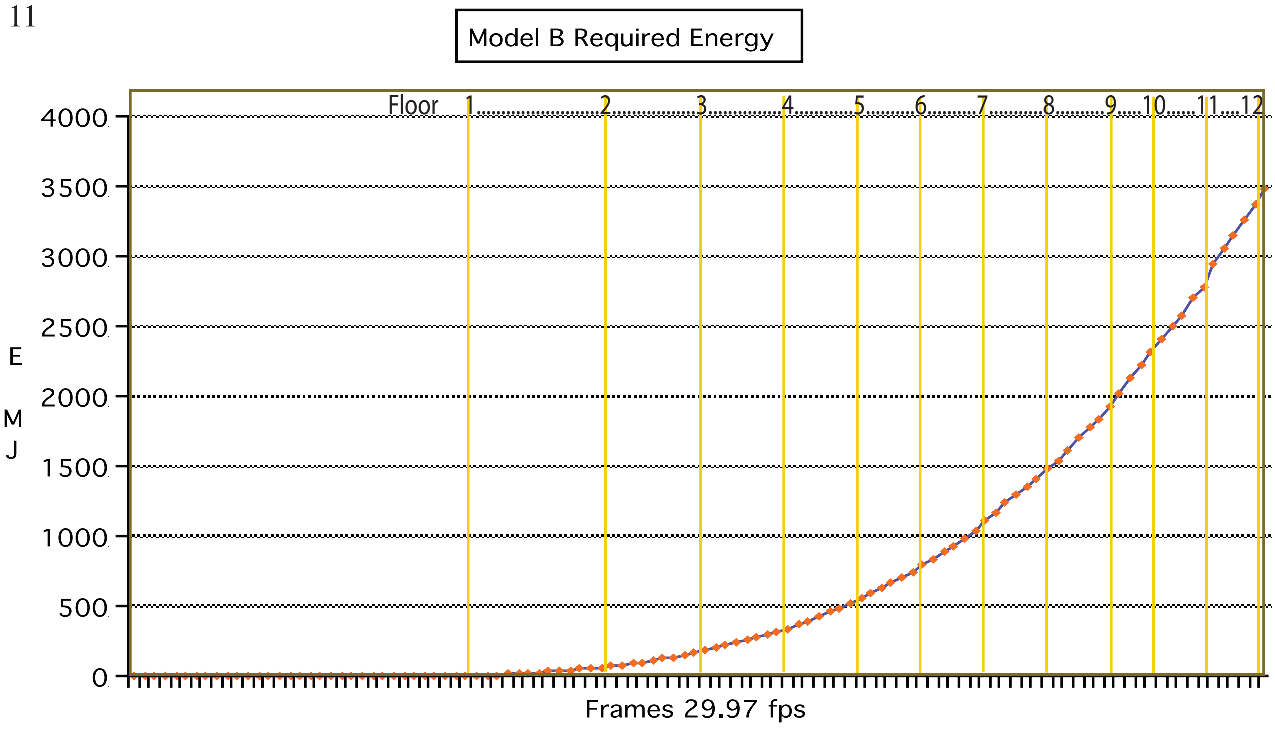
Fig 10.



Model B has an offset to allow for sinks other than the model as in Model A, but unlike Model A we can change the Density of the Mass throughout the collapse. Fig 10 shows Mass distribution with 100% density.

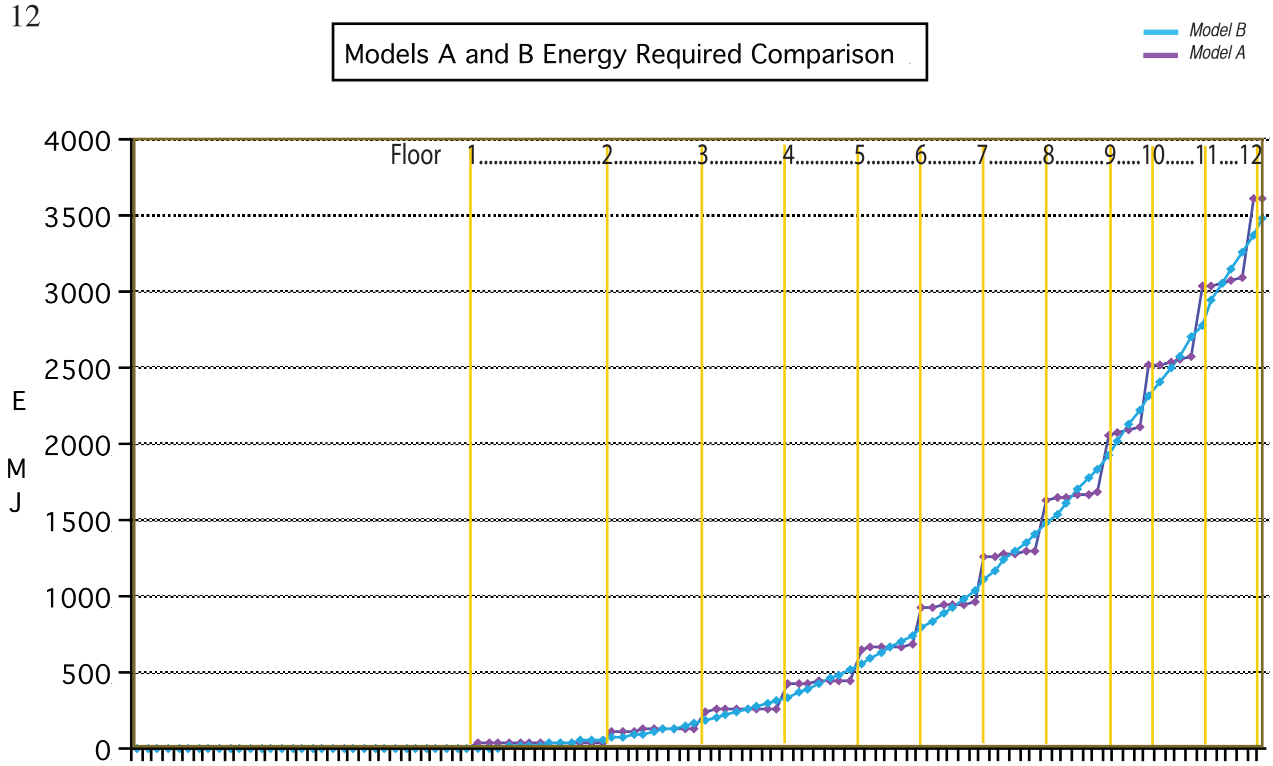
Fig 11. shows the Kinetic Energy required by Model B during the first 12 floor drop to accelerate additional Mass encountered to its observed Velocity with Model B Mass distribution, shown here with 100% Density and 0MJ offset.

Fig 11



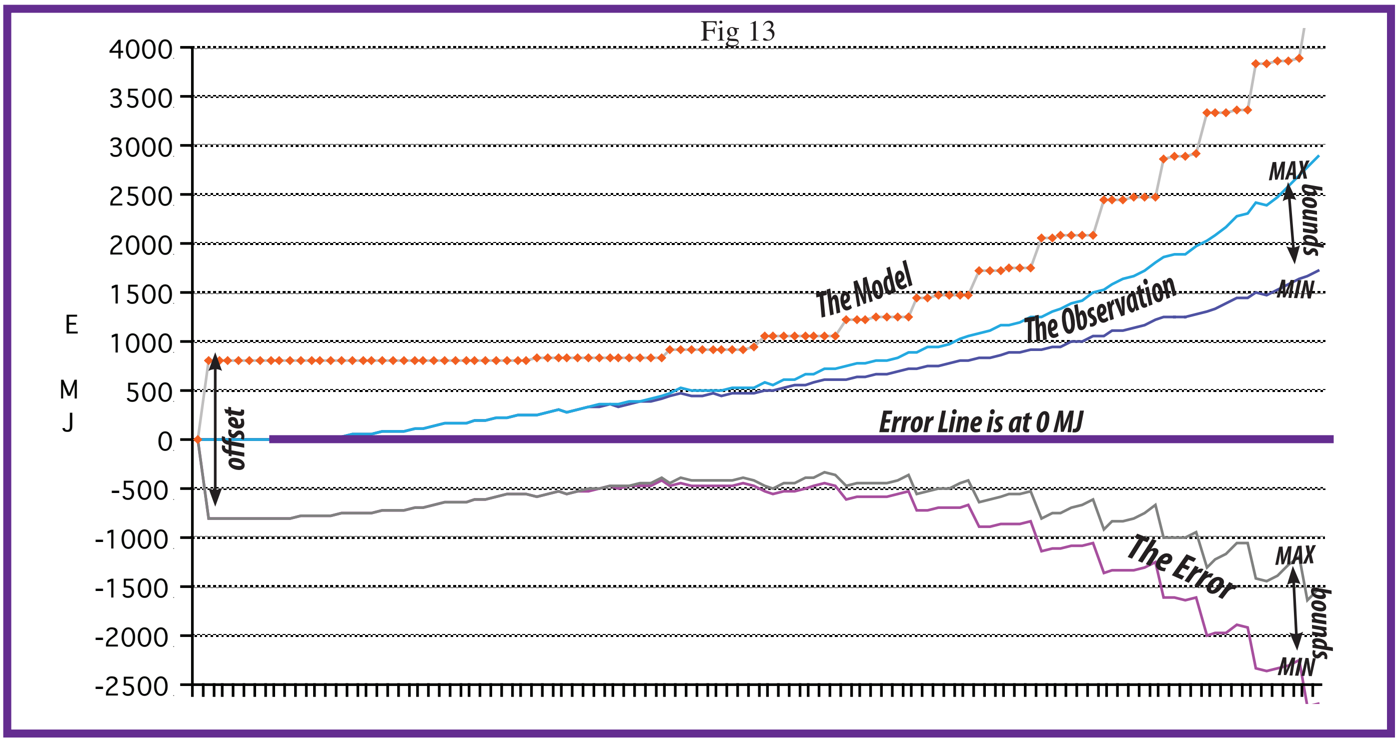
Model B also requires more Energy than The Observation, which is not surprising as this is the same Mass as Model A only distributed evenly, as the comparison in Fig 12 shows, but this distribution has a smoothness similar to that of The Observation.

Fig 12



Results

The Diagram Fig 13. below, shows how The Model is tested against The Observation to obtain The Error by subtraction. The offset is the only parameter common to both models and is used to adjust the vertical position of The Model. You can see if an offset is being added as the first data point is set to a constant 0 MJ.
The aim is to get The Error to converge with the Error Line at 0MJ on the y-axis, meaning The Model fits The Observation exactly (the orange diamonds line up within the bounds of The Observation). The Observation never moves, only The Model moves.



So three plots, both The Observation and The Error have maxima (***MAX***) and minima (***MIN***) to account for accretion and represent their ***bounds***. In all, when we add The Model (orange diamonds) there are a total of 5 traces representing 3 plots and the simple subtraction.

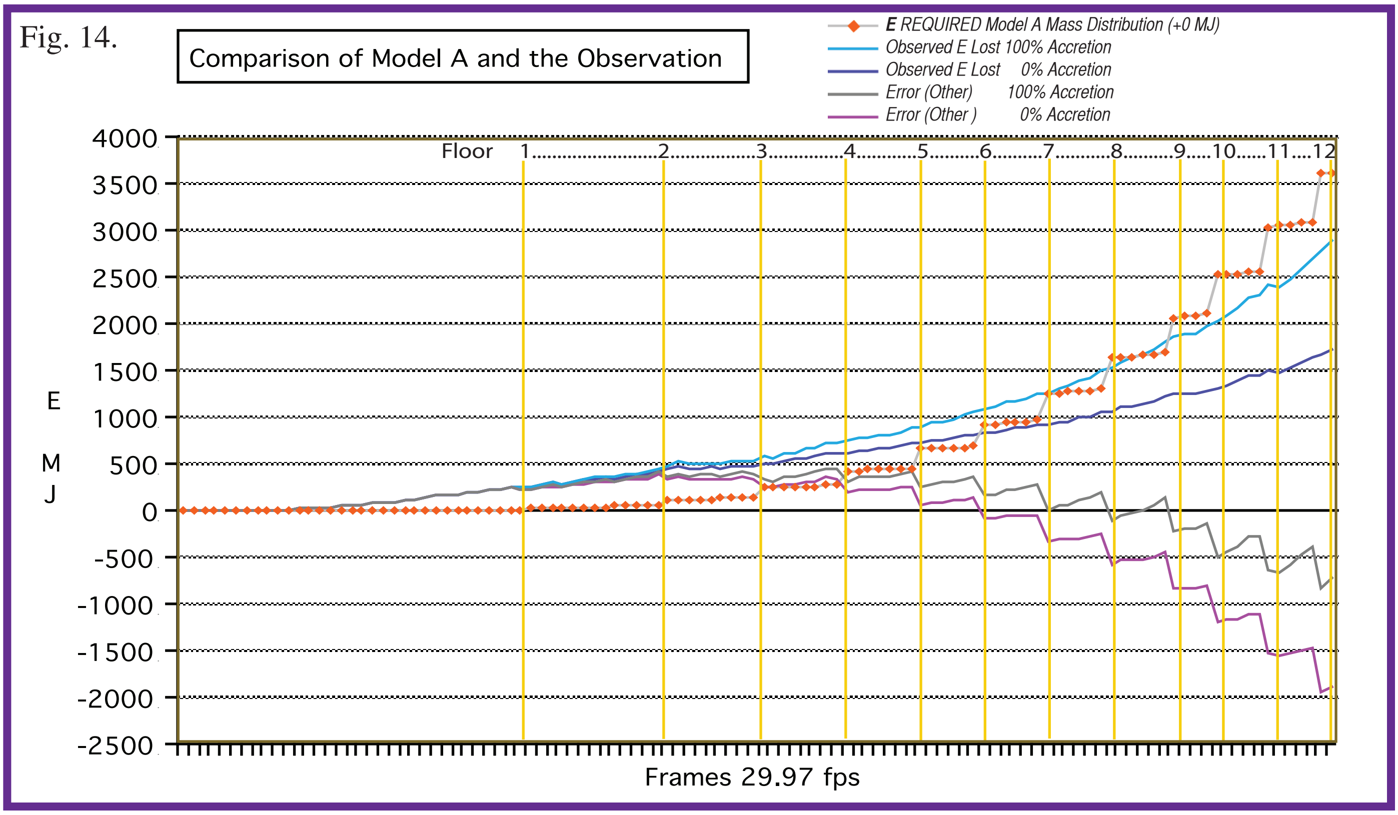
The Error=The Observation - The Model where *The Observation* is constant.

Either bound of The Error can converge with the Error Line. The Observation might appear to have a greater degree of freedom as the collapse progresses. i.e. as the ***bounds*** diverge, but the area between the ***bounds*** is filled with an infinite series of lines that share the same characteristics as the ***bounds***, each having a lower gradient as we move from ***MAX*** to ***MIN***. This is because the ***bounds*** are calculated using the scalar, Mass.

The Error thus represents sinks other than those represented in The Model, and gives insight into the scale of the other sinks and their rates of change over time. We can also see whether the other sinks are playing a greater or lesser role in determining the rate of Acceleration of the top block, and therefore tell if they are playing any role at all. If The Error is negative then The Observation's Energy loss is insufficient to supply The Model. The ***offset*** is the total amount of Energy being adsorbed by the Other sinks. The Error also tells use how well The Model is fitting The Observation, if either of The Error bounds has zero gradient the Model is moving in the same way as The Observation. This may seem like an over complication of a simple subtraction, but the clues given by The Error are crucial to gaining an Empirical understanding of the collapse.

Model A

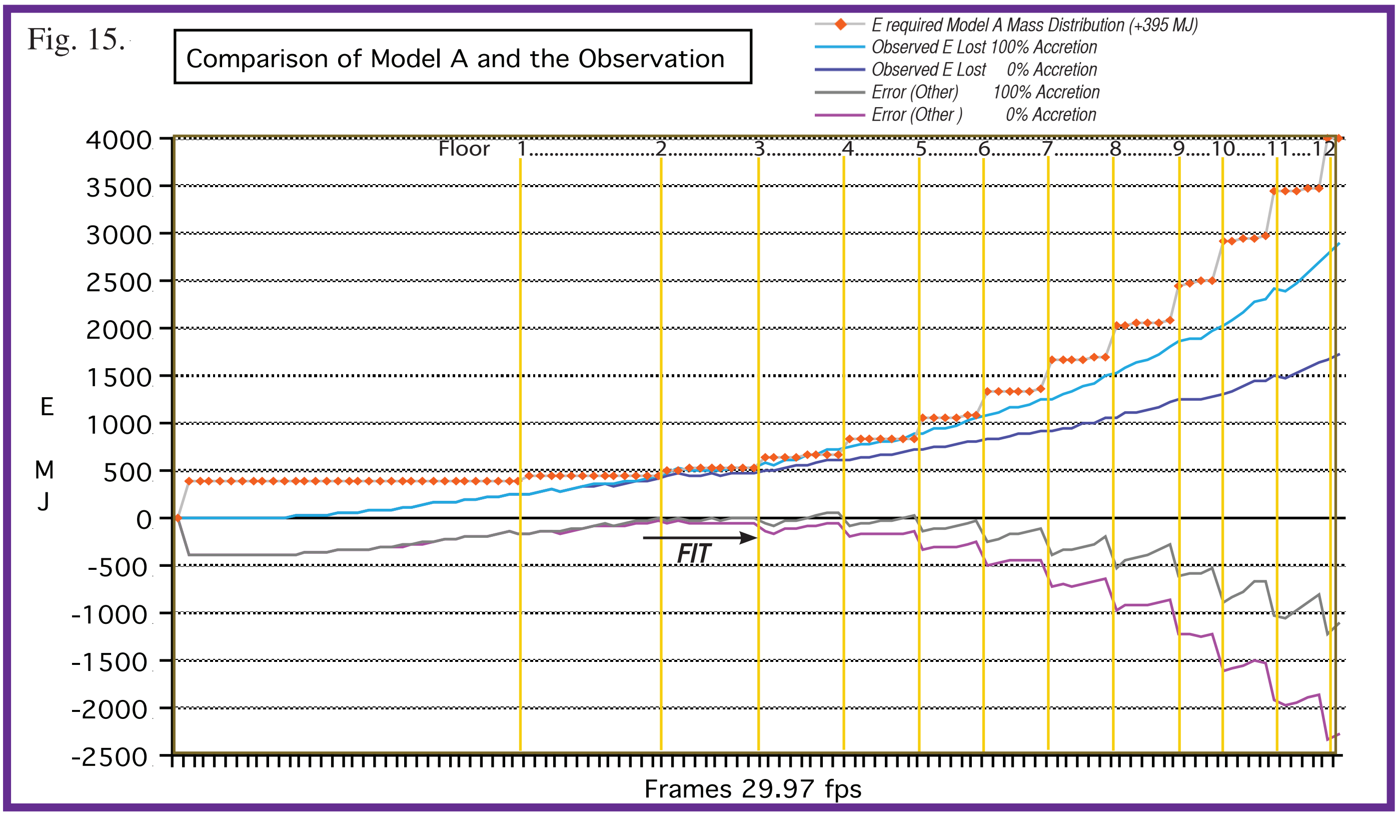
Fig. 14. Is the comparison of Model A with The Observation showing The Error (representing Other and Structural sinks). Offset = 0 MJ.



In Fig. 14. We can see that the Other sinks are responsible for around 400 MJ of the Energy loss in The Observation up to the event at the start of Floor 2.

Fig 15. is the same plot with the offset for non inertial Mass sinks set to 395 MJ. and is the plot referred to in the discussion below.

Offset = 395 MJ



Discussion of Model A

Fig 15. Model A

The Model A comparison with The Observation shows that the Mass is more or less where its expected to be up to Floor 2. After Floor 2 The Model remains within the bounds of The Observation (close to the 100% accretion bound) until Floor 4. From Floor 5 onwards The Observation cannot supply enough Energy to The Model, and The Error falls below the Error Line. The large discontinuities (steps) in The Error show that Mass is not distributed as it is expected to be and the slope of The Error shows that Mass has greater density than The Model's distribution. There is no evidence of an impact at Floor 1 instead we see a steady ramp up in Energy loss to the event at Floor 2. As The Error slope is level through Floor 2, (marked ***'FIT'*** with an arrow denoting the length of the fit on Fig 15) The Model has smoothed out The Error, suggesting that what causes the event at Floor 2 is similar to an encounter of the top block with a Mass roughly equivalent to a floor slab and that the density of the Mass is the same as The Models for this single floor.

The Model fits until the start of Floor 3 stays within the bounds until the start of Floor 5 and then diverges from The Observation. The Mass is not where its supposed to be and the Mass is not distributed as its expected to be from Floor 3 onwards. The Energy lost to other sinks totals 400MJ for the 12 floor drop recorded in The Observation, the equivalent of 9% of the expected structural resistance of 100MJ per meter (Bazant) or 4 meters of Structural resistance.

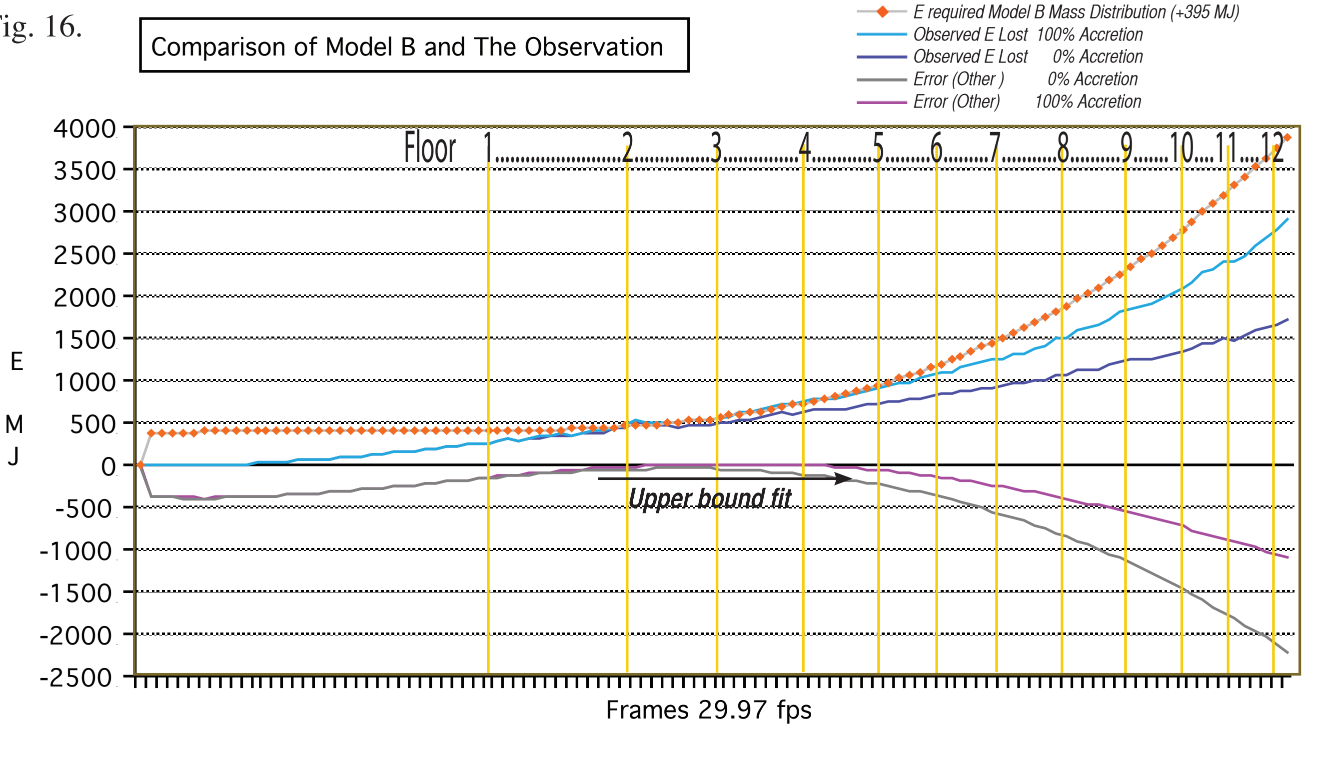
Model A that equates with the description of the collapse given by NIST and BAZANT (floors are impacted and accelerated from rest) does not fit with The Observed Energy Loss of Fig 4 from the start of Floor 3.

Model B

As the total Mass of Model B is the same as Model A, we get the similar results as for Model A without the discontinuities, Model B therefore has a better fit with the Observation. Model B has a parameter to change the density of the Mass by a constant factor through the collapse, to account for the effect of less Mass on Energy loss the offset is increased to compensate. As Model A fits The Observation up to Floor 3, Fig 16 has the same initial conditions as Model A Fig 15, but now the Mass is evenly distributed. The 'best fit' Model A offset is shown with additional offset and a total offset in MJ.

Offset = 395 + 0 = 395 MJ
Density =100 %

Fig. 16.



In Fig 16 we see the same ramp up to the event at Floor 2 and the MAX error bound fits The Observation through Floor 2 to half way through Floor 4. This means all the Mass is where its expected to be (but not in the right distribution see Model A). The Error diverges from The Observation at this time, meaning that not all the Mass is where it should be, and its density reduces through Floors 3 and 4. An exact fit of The Model can be achieved for both bounds by shifting the density of the Mass in The Model. We thus have a lower and upper limit on the density of the Mass encountered by the falling block depending on the amount of accretion. If more Mass accretes then the impacted Mass must be denser to fit The Observation. Figs 17 and 18 show exact fits of The Model with The Observation for both bounds.

Fig 17 fit with upper bound - 100% Accretion **Offset = 395 + 85= 480 MJ**
Density = 66 %

Fig. 17.

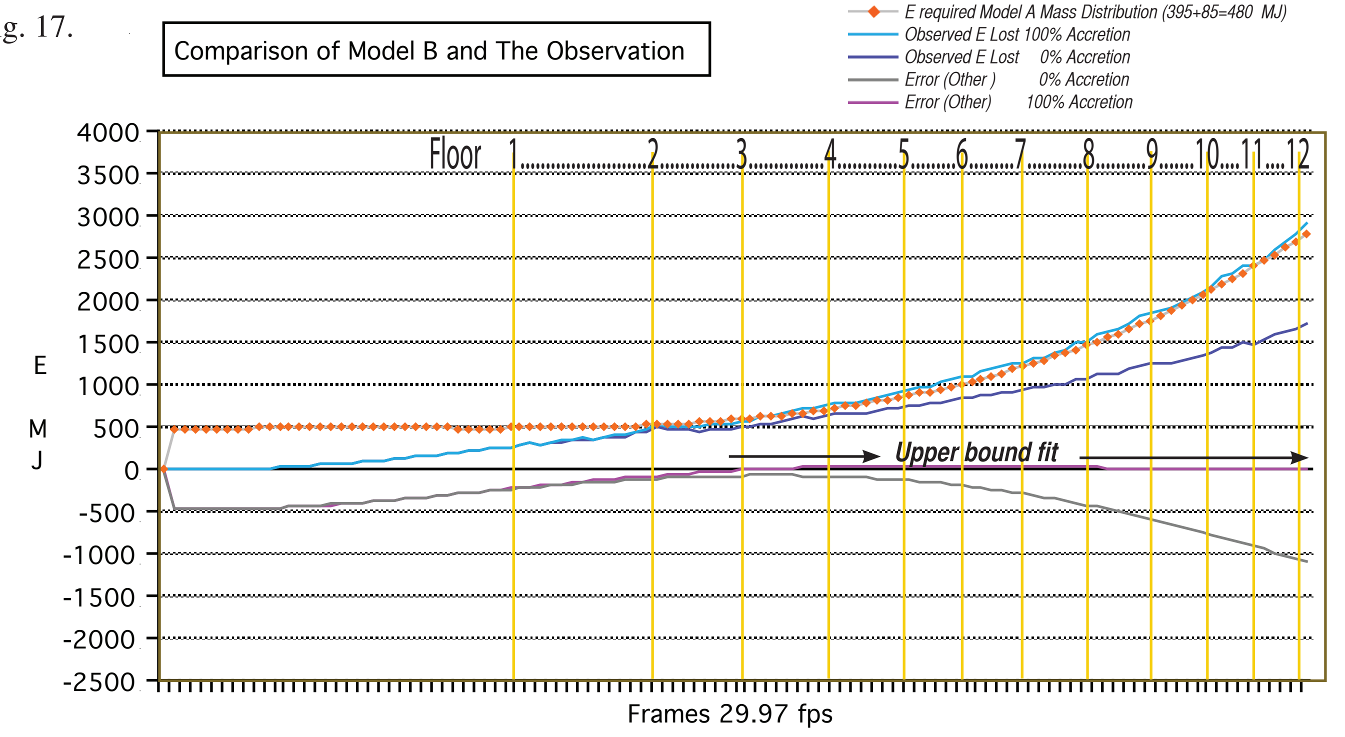
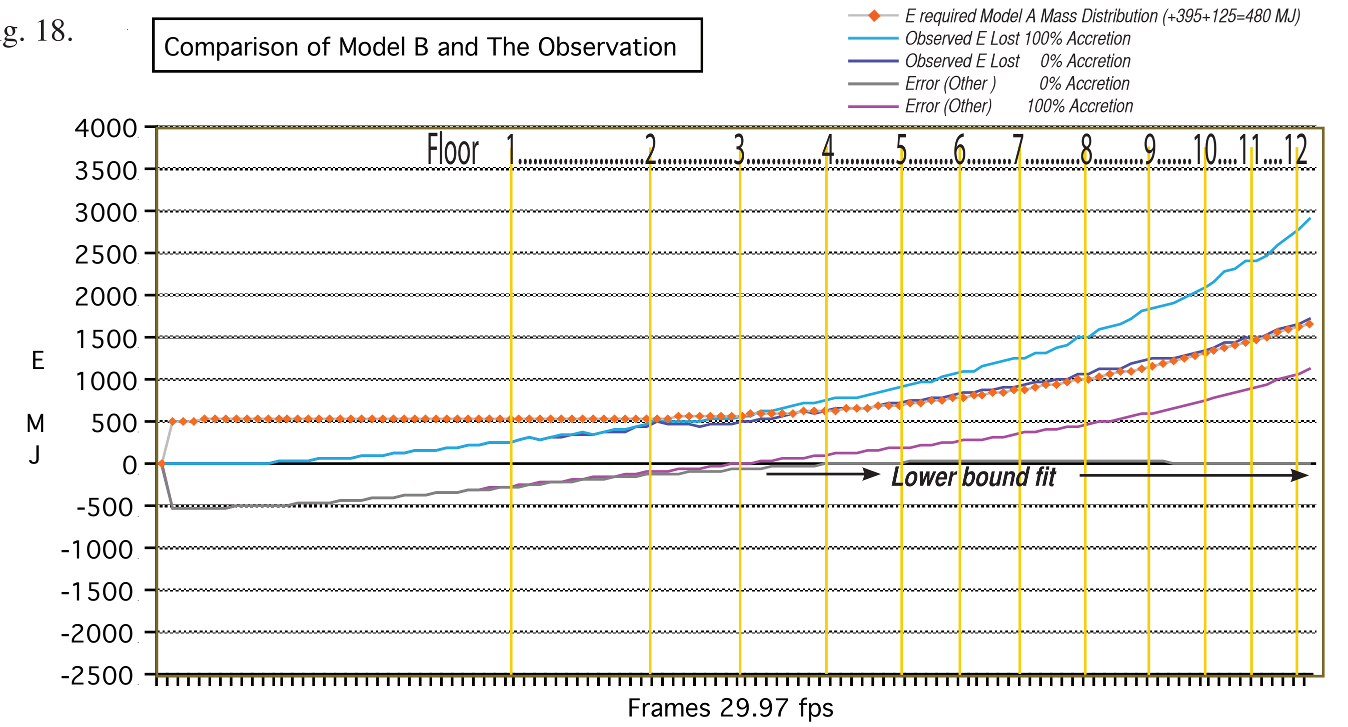


Fig 18 fit with lower bound - 0% Accretion **Offset = 395 + 125 = 480 MJ**
Density = 33 %

Fig. 18.



Discussion of Mass Distribution Models

All the Mass is where it should be and distributed more or less as expected until the start of Floor 3. Model A fits The Observation up to this point in the collapse then Model B takes over and the density of the Mass changes from 100% mid way through Floor 4 and ends with a range from 66% at the upper bound of The Observation to 33% at the lower bound.

By subtracting the Mass sink we have estimated the Energy loss in The Observation due to Structural and Other sinks to 400MJ, 9% of the expected total over 12 floors for an initially intact structure. We see the same event and transition noted in the comparison of The Observation with a smooth Power Series Model of the collapse. The transition from Model A, Mass where it should be, distributed as expected, to Model B, some of the Mass where expected, distributed evenly, occurs through Floors 3 and 4 and starts with the event at Floor 2. The collapse continues with a constant amount of missing Mass at a constant Acceleration from Floor 5 to the end of the data at Floor 12.

All the above observations support the Controlled Demolition Hypothesis. No evidence has been found to support the 'natural collapse' theory in The Observation after Floor 3.

It remains to be seen what the 400 MJ total for other sinks represents.

The Structural Model

In this section we discuss one structural sink model, that put forward by Bazant et al [11], the resistance of the columns.

The model is a simple, one dimensional opposition of the forces, ***F(u)*** and ***mg*** that act on the block and determine its acceleration and therefore its motion in the ***y*** axis. ***u*** is the distance between floors, (3.7 m) along the ***y*** axis. In the Bazant Model the force ***F(u)*** changes with distance, shown graphically below, Fig 22a.   ***mg*** is the force of gravity. The Bazant curve describes what may happen to the motion of the block in the ***y*** axis as it drops through a single floor. i.e the Fig 22a. curve is repeated for every floor encountered by the top block in its descent.

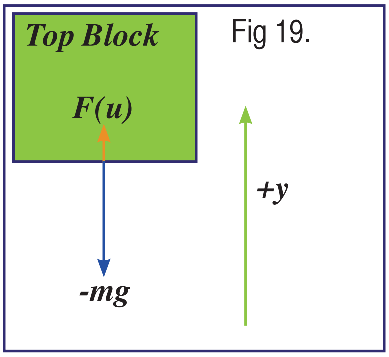
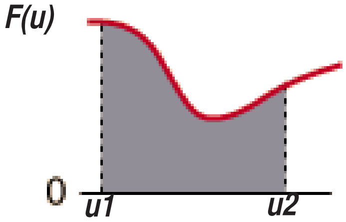


Fig 19.

The Bazant Curve in the time domain

The Bazant curve is explored as a function of force over distance in Appendix C. You'll find a fuller explanation of the Bazant curve there. In order to understand what happens in the Bazant Model in the time domain we need to take a brief detour into the physics of work.

Work is a force ***F(u)*** acting over a distance (***u2 - u1***) represented by the grey ***area*** below the red line in Fig 20.

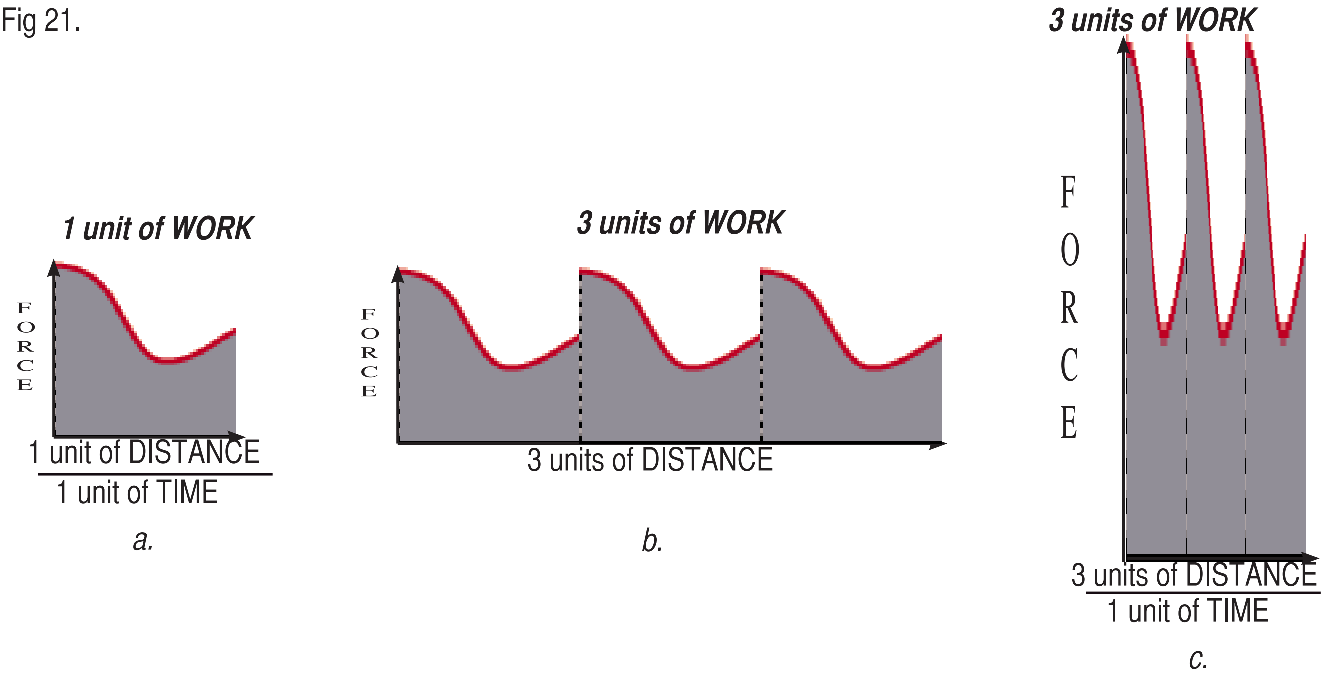


$$\text{Work} = \int_{u1}^{u2} F(u)du$$

Fig 20.

It's useful to think of ***work*** as an *area* and thinking in this way helps us see what happens in the Bazant model in the time domain. As discussed above the Bazant curve is cyclic, it repeats every floor, i.e when ***F(u)*** gets to the point ***u2*** in Fig 20 above, it continues from ***u1***, and the cycle repeats. We can determine the frequency of this cycle from the velocity of the block, and we can determine where in the cycle the top block is by taking the modulus of distance ***y*** divided by floor height ***u***. As we've already observed the block continuously accelerates, velocity is always increasing, therefore the frequency of the Bazant curve is increasing and so traces out a larger area under the graph in every unit of time.

Fig 21.



The area of b is 3 times a. and equal to c. b and c are two ways of representing the same amount of work.

Fig 21 shows what happens to a force when you have to squeeze more units of work into the same time. As the frequency of the unit of work increases the force increases to make the area under the graph (Fig 21*c)* equal to the area in (*Fig 21b*.) and 3 times as big as (*Fig 21a*.). As the unit of time is fixed the apparent force increases in direct proportion to the frequency. Velocity is a constant 11.1 m/s in *b* and *c* above and therefore there is zero acceleration, in the collapse however we have seen that Velocity is increasing throughout.

Fig 22 *a*.

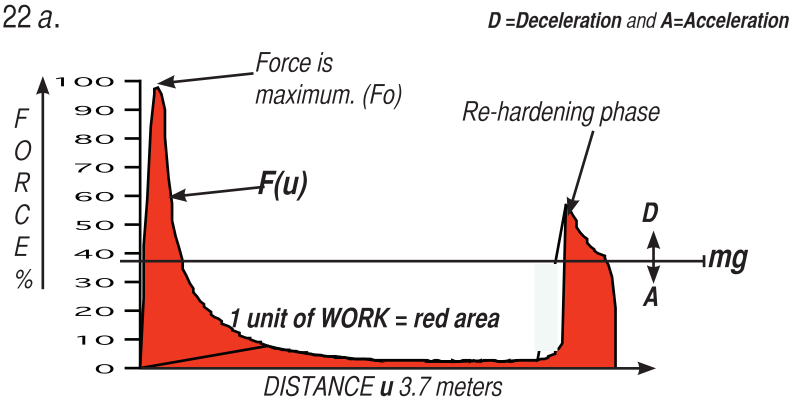
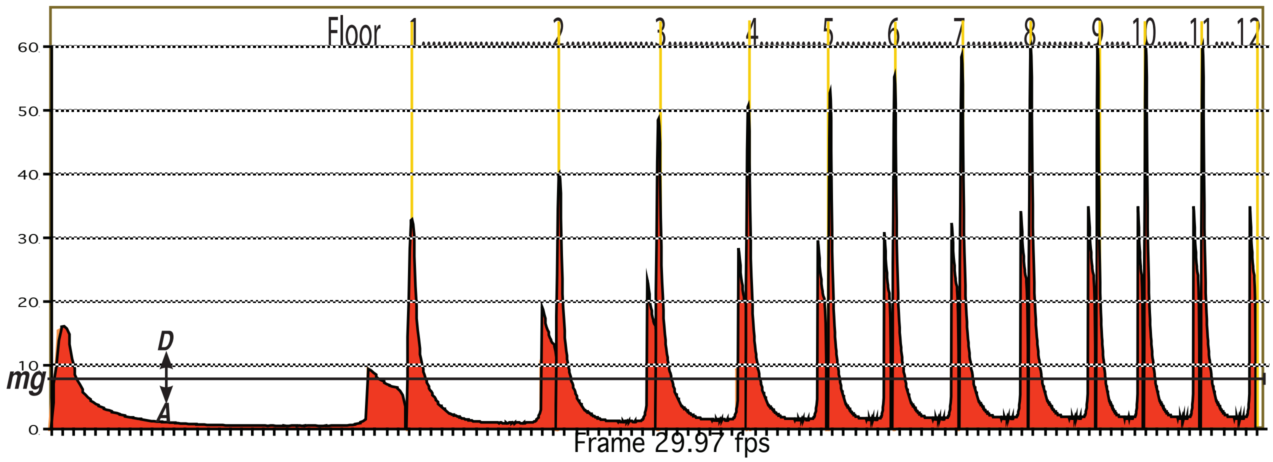


Fig 22 *a* shows the Bazant curve. The ***mg*** line represents an equilibrium between the two opposing forces, when ***F(u)*** is above ***mg*** deceleration occurs and when below the top block accelerates shown as ***D*** and ***A*** in the Figure. See Appendix C.

By ‘sampling’ the the value of ***F(u)*** over each small distance ***du*** we can transform the curve from the space domain to the time domain, using the observed velocity to calculate the total work per frame of video and using the observed distance measurement to find where top block is in the cycle.

Fig 22 *b* is a graphical representation of running the Bazant curve at the velocities seen in the collapse. The ***mg*** line is shown, ***D*** shows deceleration ***A*** shows Acceleration.

Fig 22 *b*. **Increasing resistance with increasing Velocity.**



By the end of the data the frequency is 6.67 floors a second and Velocity is 24.7 m/s. We would expect to see evidence of these large decelerations in the Velocity data. Fig 23 shows the actual measurement represented graphically in Fig 22. ***D*** shows deceleration (positive on the y-axis) ***A*** shows Acceleration (negative on the y-axis).

Fig 23.

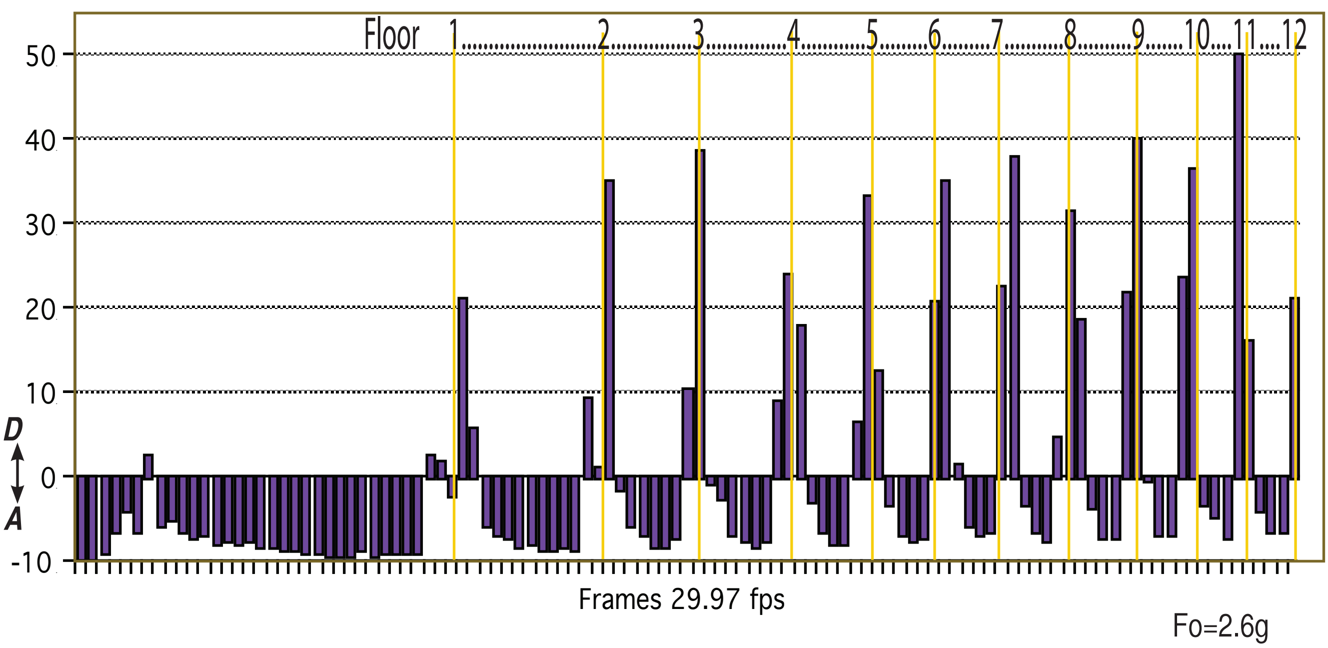


Fig 23. Shows that the top block will spend less and less time being accelerated by Gravity and experience increasing deceleration as Velocity increases through the data. The applied force (***mg***) increases linearly with accretion, ***g*** cannot exceed 9.8 m/s/s, ***mg*** is balanced by the increasing strength of the tower with decreasing height and so remains more or less constant if accretion is occurring at 100%. It's clear that there is an upper limit on how fast the collapse can progress. (Fig 29. shows this effect), if the structural resisting force is above a certain value. If the structure was doing what it's supposed to do, then the net force (total Acceleration) will drop to zero and Velocity will become constant. Figs 24 to 26 show what the magnitude of the deceleration would be at any point in the data and what kind of deflections we would expect to see in The Observation, should the structure be performing at 85% (core).

Fig 24 shows the magnitude of the Velocity shifts we are likely to see to the velocities observed in the collapse.

Fig 24.

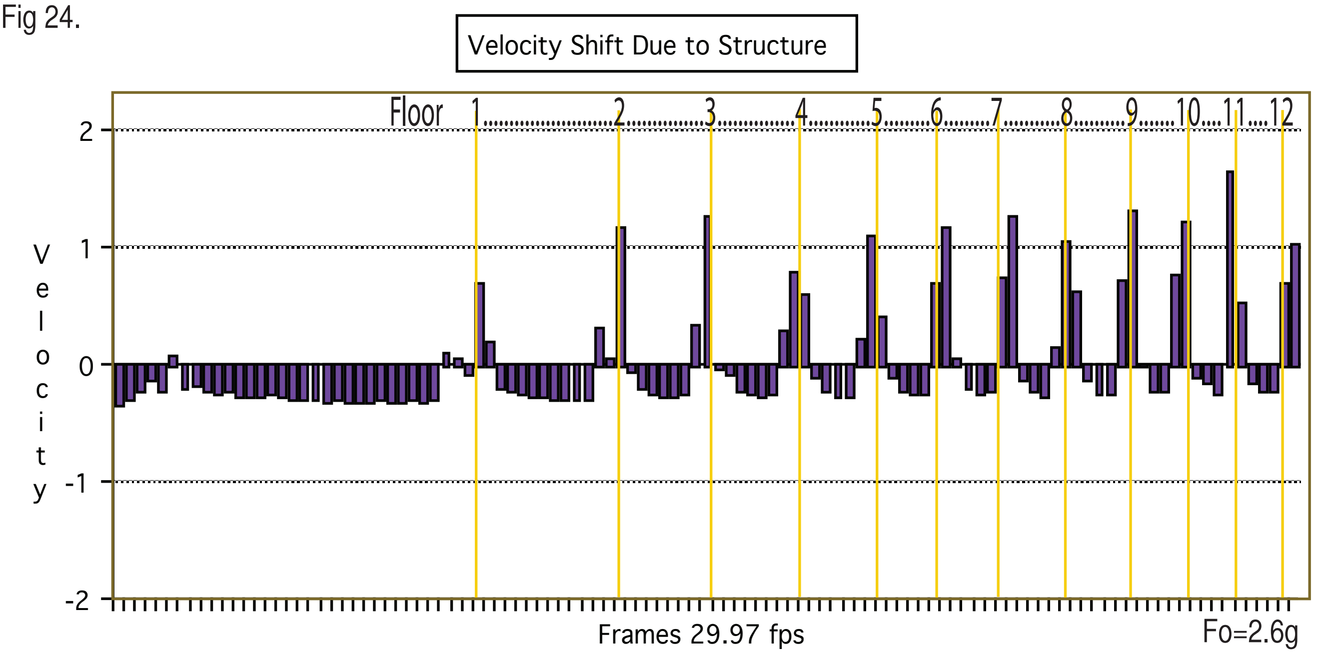
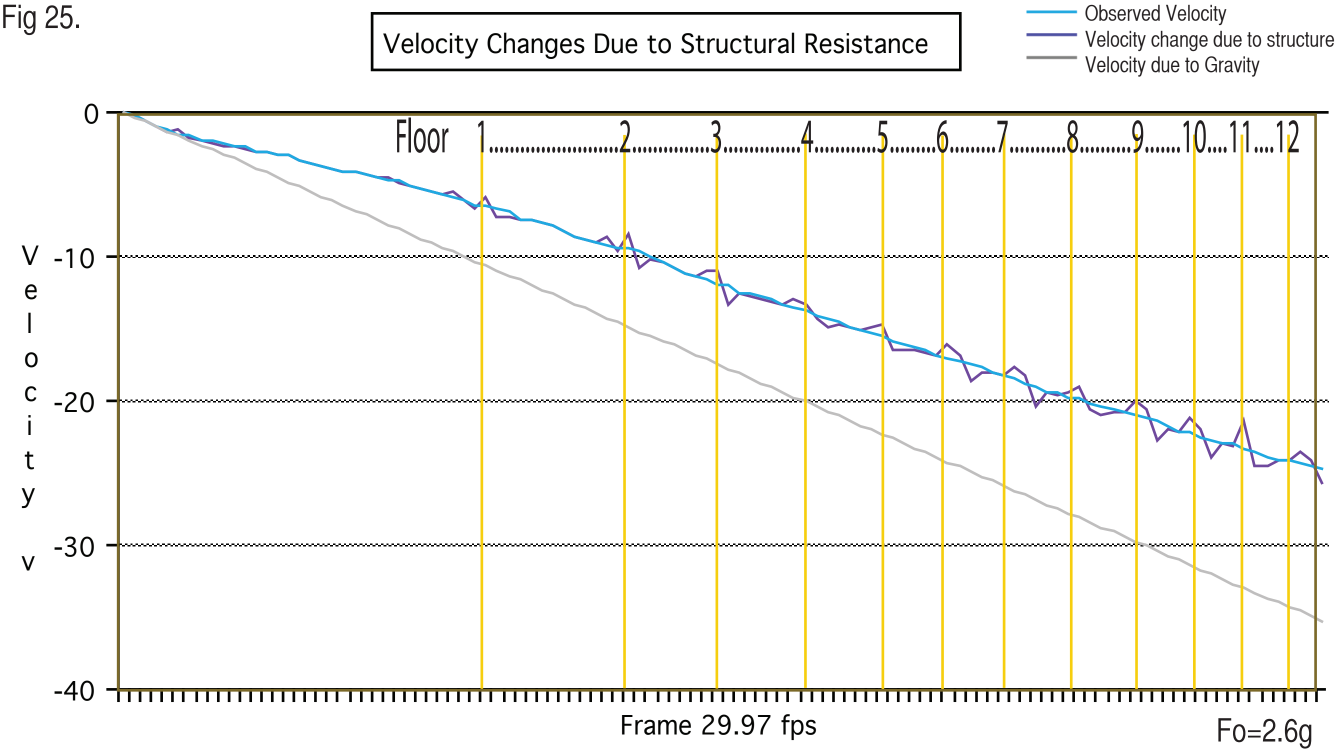


Fig 25 Shows the effect on the observed Velocity should the top block encounter a floor with 85% (core) structural integrity (Fo=2.6g) at the velocities observed.

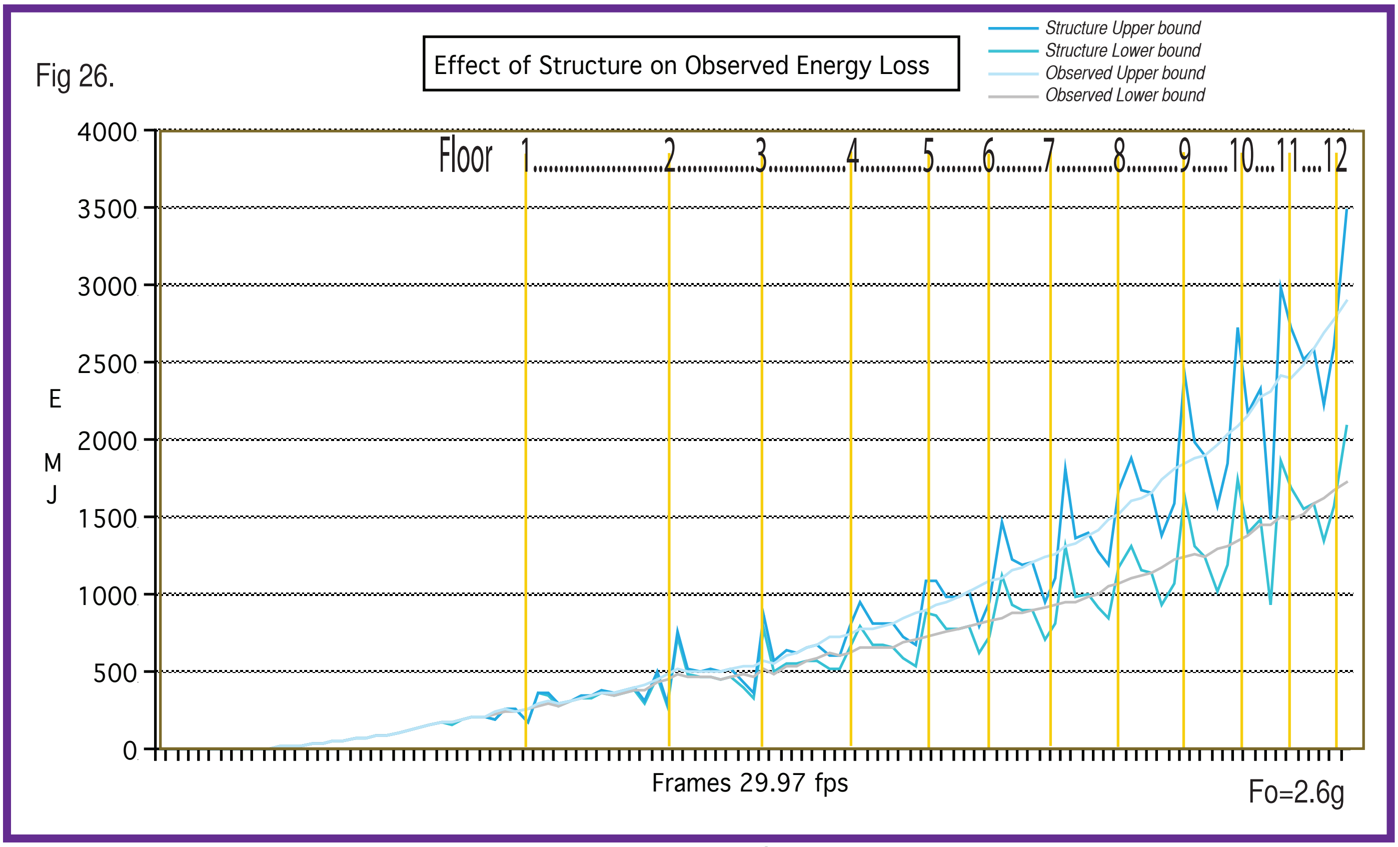
Fig 25.



Clearly the observed Velocity has no deflections of this magnitude and therefore there can be very little in the way of structure resisting collapse, which is more graphically illustrated in Fig 26 and modelled in Figs 28 and 29.

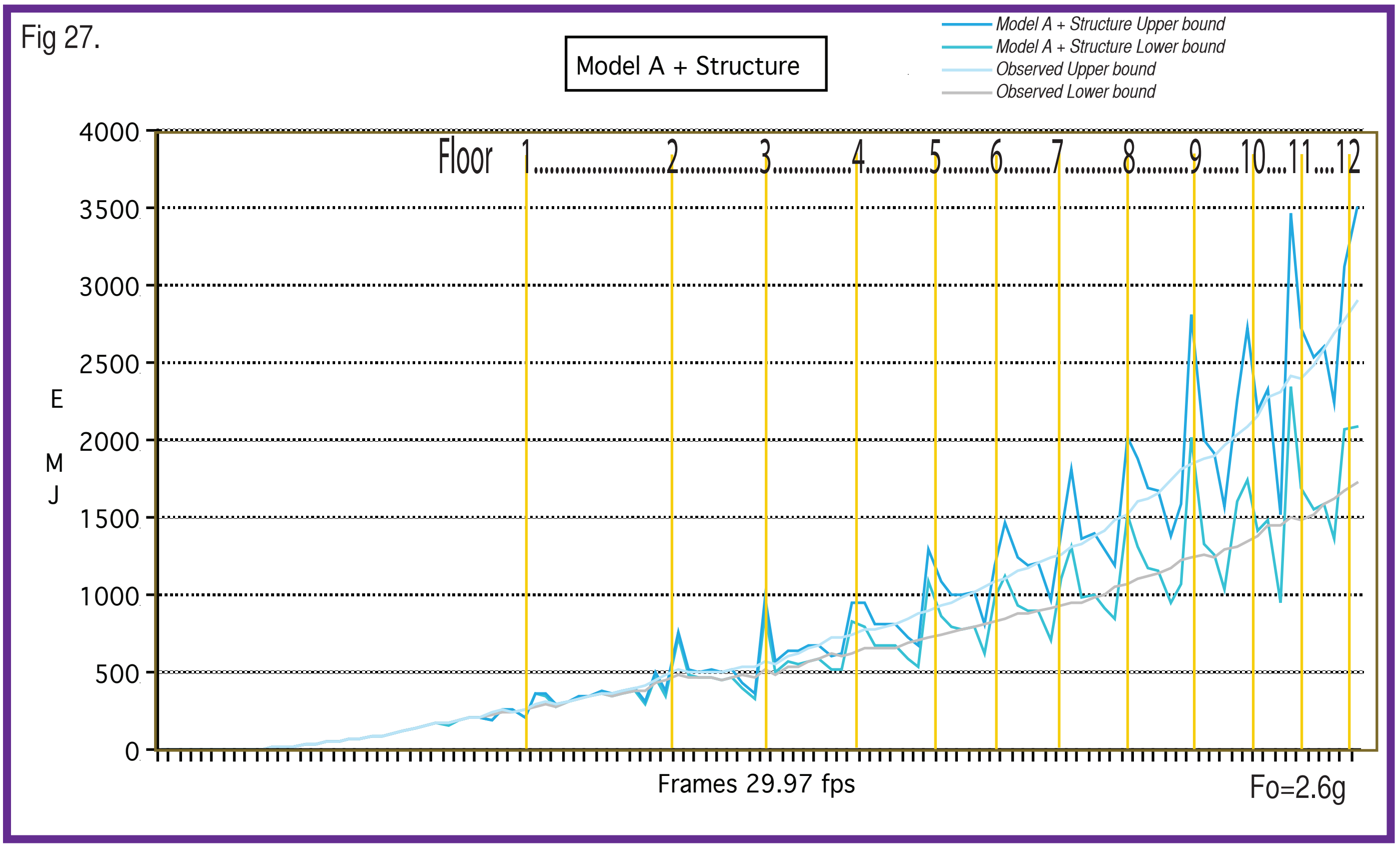
Only very large amounts of damping would reduce the magnitude of these deflections sufficiently so they would not appear in The Observation.

Fig 26 Shows the effect on the Energy Loss bounds should the top block encounter an 85% structurally intact floor at the velocities seen in the collapse, superimposed on a plot of The Observation.



The deflections expected at Floors 1 and 2 do not appear in The Observation, therefore the Floor 2 event is more like an impact with a floor slab sized Mass, as the fit of Model A at and through Floor 2 shows (Fig 15).

Fig 27. Shows the combined effect of Model A (Mass distributed and located where it should be) and structural resistance at observed velocities, superimposed on a plot of The Observation .



As you'd expect the deflections increase in magnitude and will do so even further if accretion is below 100%. (App. C)

Fig 28. shows how the collapse will reach a terminal Velocity (11.5 m/s) whatever the Velocity is when the top block begins to encounter structure that offers 85% (core) resistance or greater, which it will at some point. It's very clear that if there is structure from the start, average Acceleration drops to zero and Velocity will oscillate around terminal Velocity at values of Fo above 2.6***g***. In Figs 28 & 29 we assume 100% accretion and that the tower balances the increase in applied force due to accretion by virtue of its design. Structural strength increases with decreasing height in proportion to ***mg.*** The velocities observed in the collapse are shown for the first 6 floors at the time of impact with that floor (*F1 ..F6 on the y-axis*). In the collapse Acceleration becomes constant after Floor 5 and Velocity reaches 24.7 m/s by the time Floor 12 is encountered.

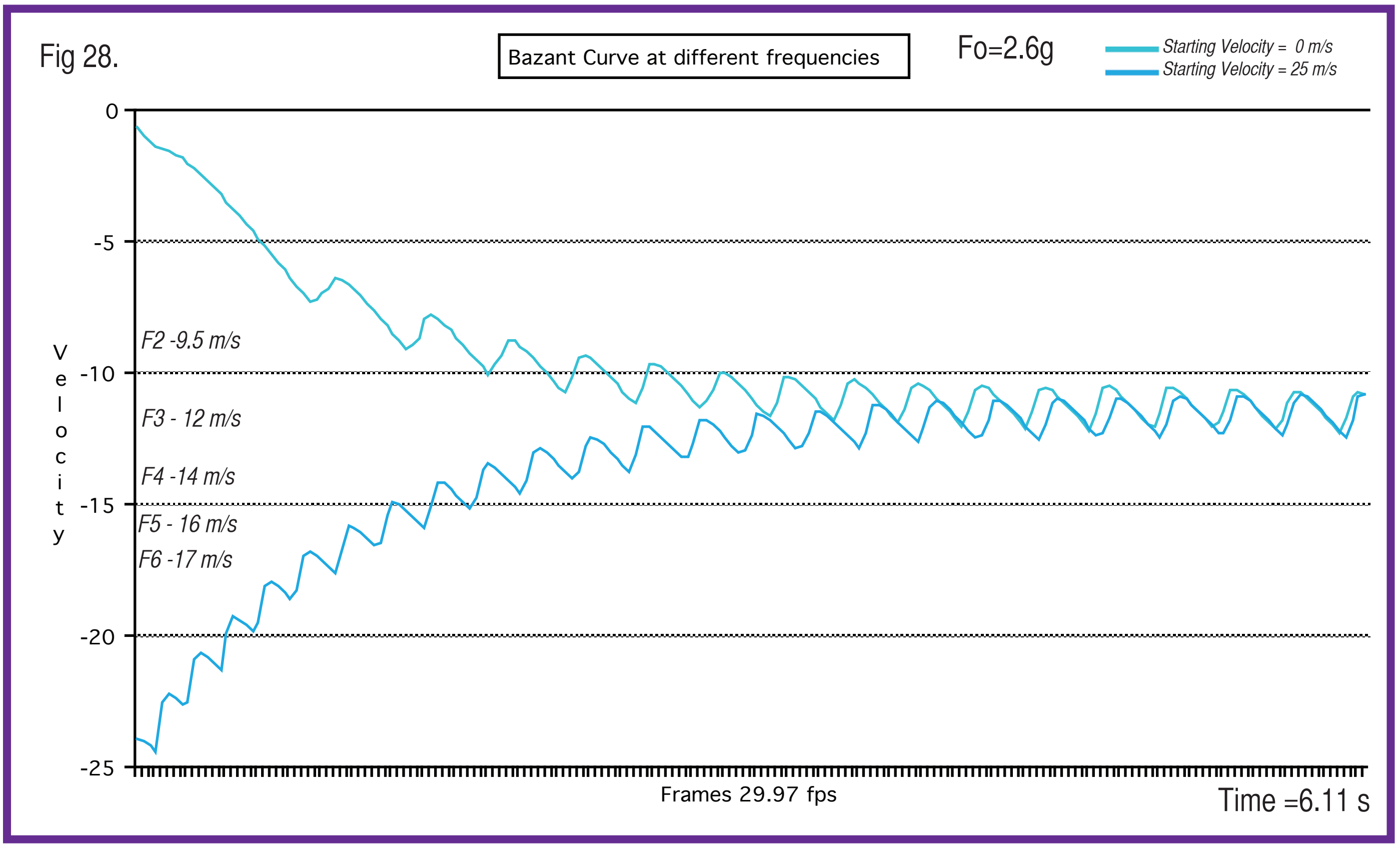
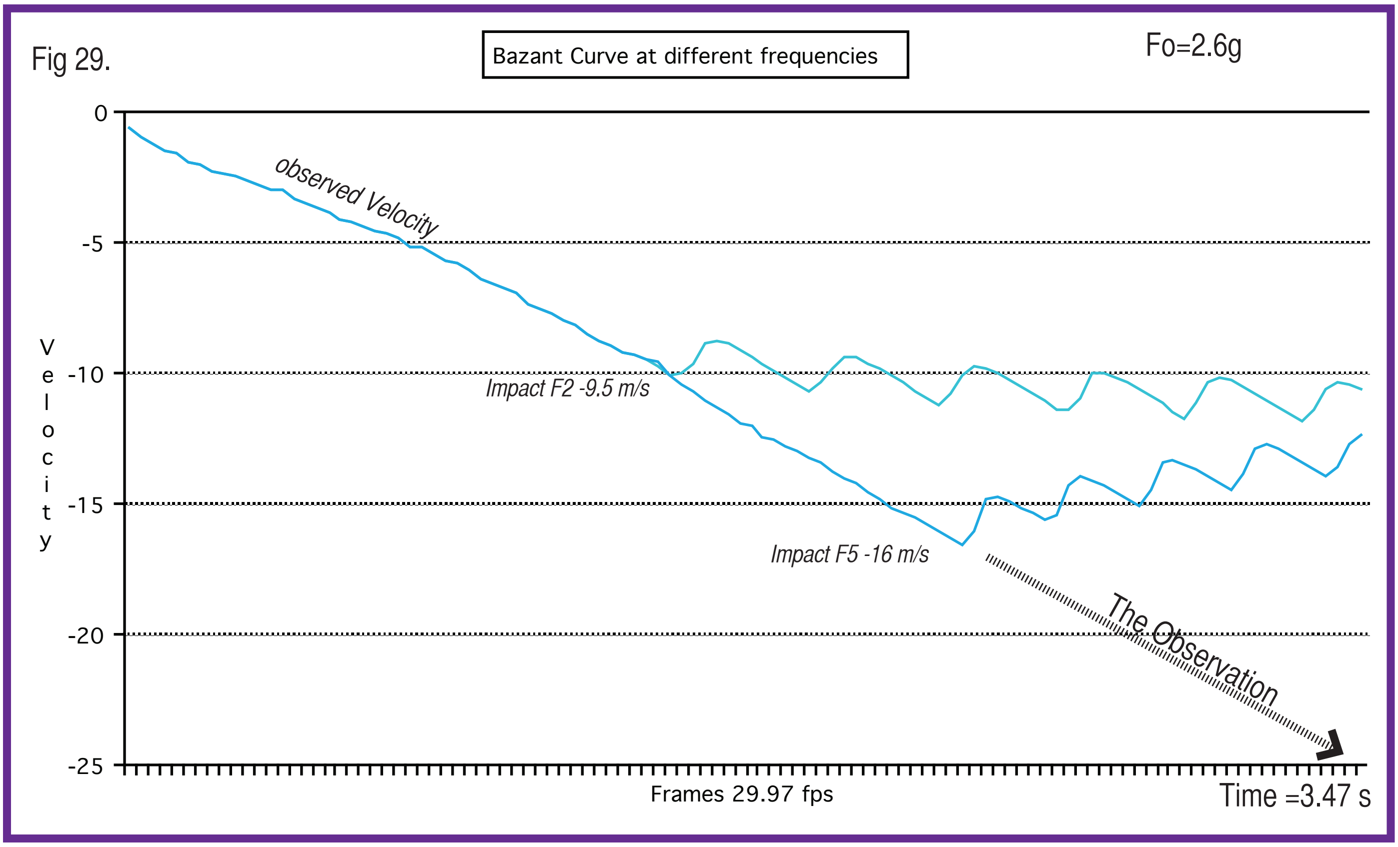


Fig 29 shows what happens to Velocity if 85% structure is encountered at floors 2 & 5 at observed velocities.



In the above examples ***Fo*** (the maximum resisting force) is set to 2.6***g*** which was the value estimated from the Bazant curve found in Fig 3 of the Bazant et al paper[11] described in Appendix C. This value is about 85% of the factor of safety in the core of 3, but what if the maximum resistance force is higher or lower than 2.6***g***?

If the maximum resistance force is higher than 85% then the terminal Velocity approaches zero as the resisting force increases and as is clear from The Observation the average resisting force for each of the 12 impacted floors must be less than 85% (core). Figs 30 - 32 show what happens if the resistance is a constant 75% (core) or 2.283***g***. The block reaches around 24 m/s Velocity at around 44.5 meters, and ostensibly looks like a good fit with the observed distance fallen and Velocity reached by the end of the data, but these fits (Figs 30 - 32) are only produced if the tower has no Mass.

Key Fig 30 *Distance*
Observed Distance y
Structural Model - Accretion =100%
Structural Model - Accretion = 0%

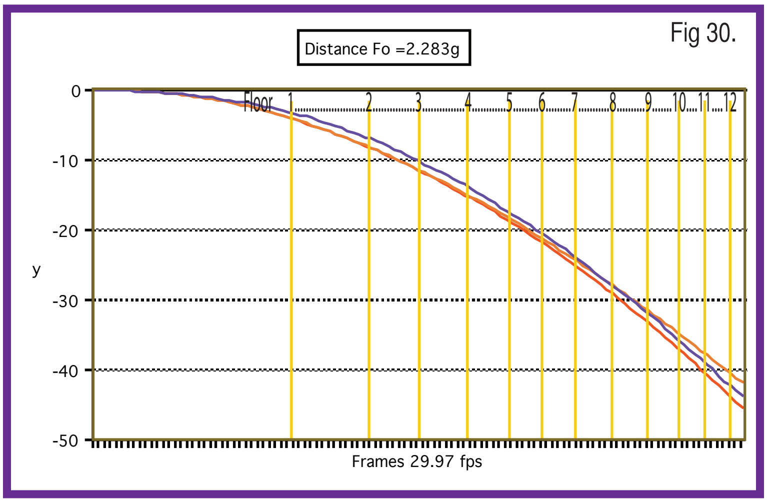


Fig 30.

As noted above the upper and lower bounds of the structural model differ from those in the Mass models, the structural model bounds are reversed with respect to accretion, as structural strength increases with decreasing height in proportion to increasing ***mg.***

Fig 30 shows that The Observation is within the bounds of The Model i.e. the Model has fallen roughly the same distance in the same time as the top block. i.e. 44.4 m in 3.6 s.

Key Fig 31 *Velocity*
Structural Model - Accretion =   0%
Structural Model - Accretion = 100%
Observed Velocity
Vg

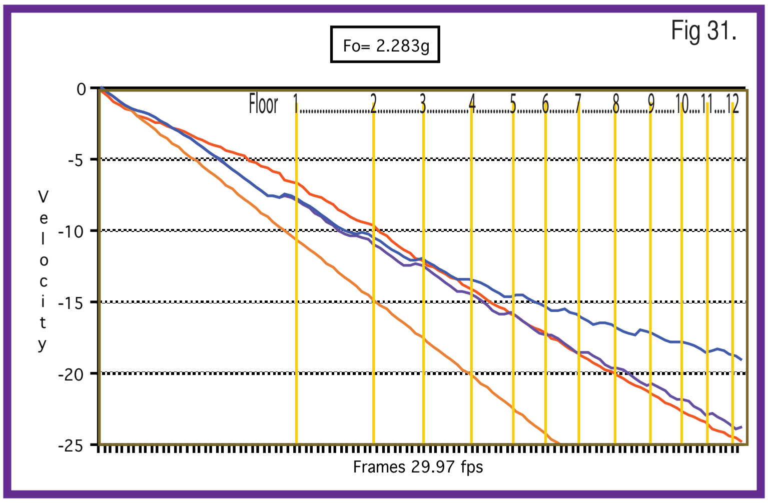


Fig 31.

Fig 31. Here Velocity in the structural model matches the observed Velocity from about floor 5, and ends the data with the same Velocity as the observed Velocity. It is clear that accretion must remain close to 100% or the top block's Velocity will be retarded more and will fall outside the Observation. The discontinuities introduced by the structure are clear and are amplified in the Energy plot of Fig 32.

Key Fig 32 *Energy*
Structural Model -
Observation
Error
Offset = 185 MJ

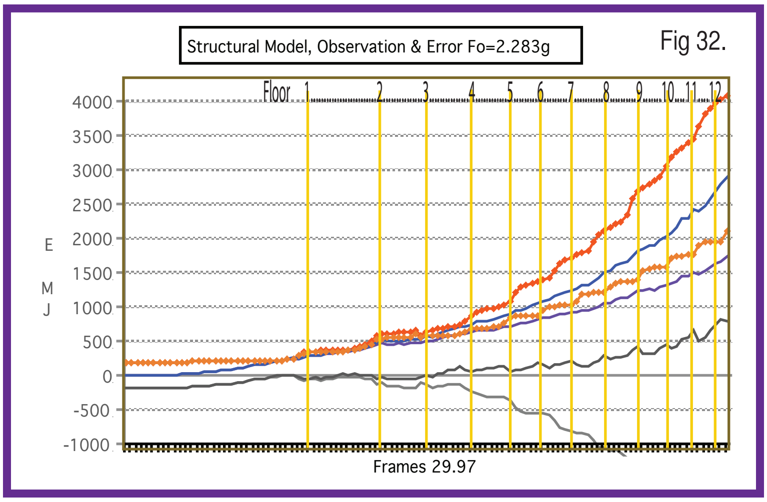


Fig 32.

Fig 32 has an offset of 185 MJ added to the model in the same way as the Mass models, to allow for the other sinks. Though here it looks as though there is a fit of The Model to The Observation, The Error shows that the bounds of The Model don't have the same characteristics as The Observation. i.e. the upper bound of The Model is close to the lower bound of the Observation. Discontinuities are again in evidence, but there is a fit up to the end of Floor 2. What happens when Mass is reintroduced is shown in Fig 33.

***Key Fig 32** Energy with Mass*
Structural Model + Mass
The Observation
The Error
Offset = 185 MJ

When the Model A Mass distribution is added to the structural model, The Error quickly falls away showing that The Observation cannot supply both the Mass sink and the structural sink. Again we see larger discontinuities as the position of the floor slabs lies between the re-hardening and buckling phases of the structural Model. Clearly, The Observation cannot supply the sinks we might expect, and the Energy for supplying other sinks such as pulverisation is non-existent from Floor 2 onwards.

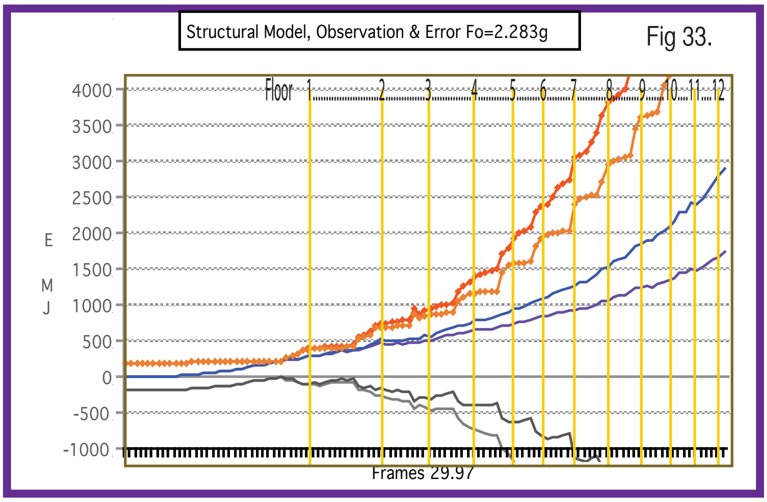


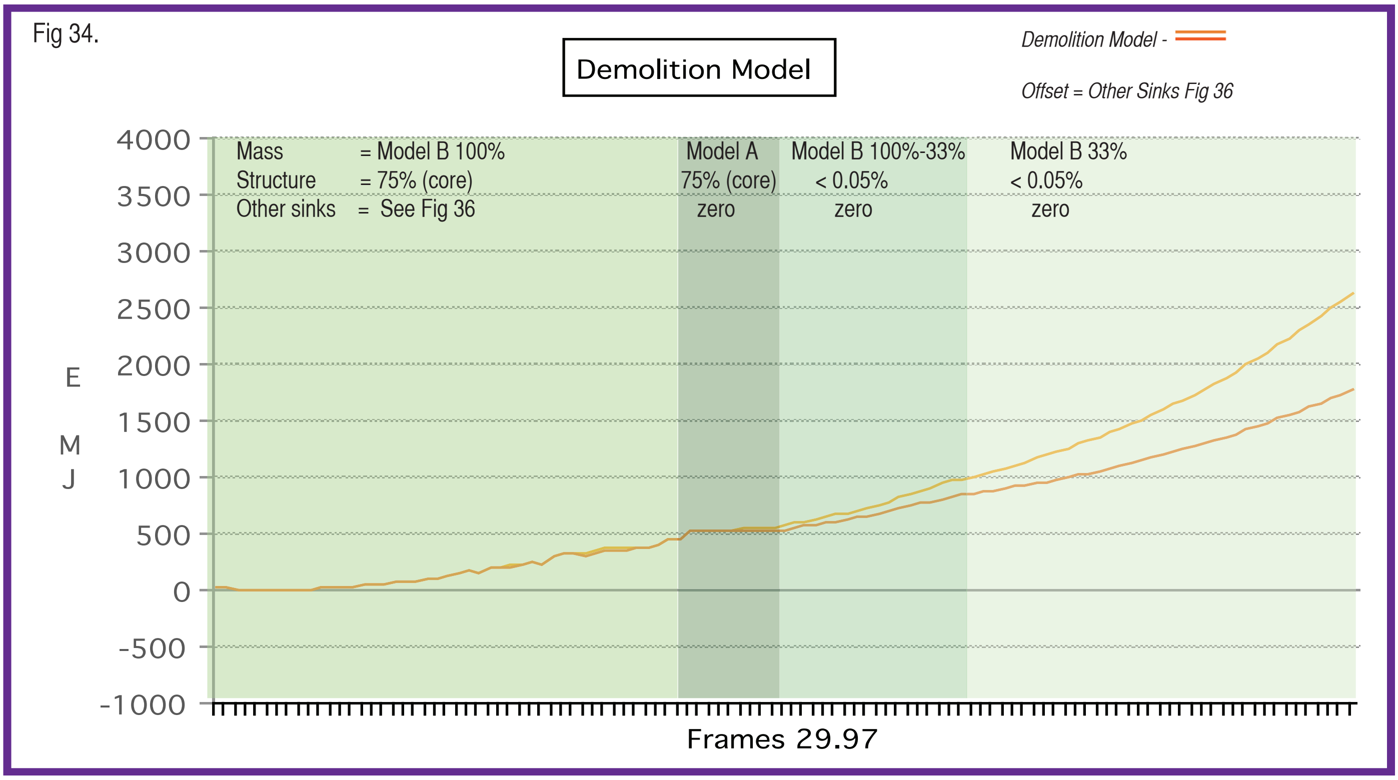
Fig 33.

Fig 33. Shows the structure resisting at 75% (core), which represents the about half of the offset of 400 MJ we saw when modelling the Mass (over the first 3 Floors). The Model fits for the first 2 and a half floors, leaving around 185 MJ for other sinks such as friction, but as the block approaches impact with the Floor 3, The Observation's ability to supply all expected sinks falls further and further behind. The situation may be ameliorated if the structural resistance falls close to zero, but this would mean that floors not damaged by the aircraft and fire, have somehow lost most of their structural strength which presents us with another highly improbable scenario. In order to supply the structural sink, the Mass sink must fall close to zero, and in order to supply the Mass sink the structural sink must fall close to zero. Fig 33. highlights the *transition* from a collapse characterised in its initial stages by; some structural, most of the Mass and a small amount of other resistive sinks, to a collapse characterised after Floor 2 by; virtually no structure, at most 66% Mass and no Energy available for other sinks, or if the structure is still resisting after Floor 2 then most of the Mass needs to disappear.

We have seen what happens if the resistance force climbs towards 2.6***g***, a terminal oscillating Velocity is reached and it is clear from The Observation that this level of structural resistance is never reached, which means that floors undamaged in the initial 'plane impact have somehow lost almost exactly equal structural integrity as the damaged floors above, another highly improbable scenario.

Fig 34. represents a Demolition Model which allows for Mass to change density arrangement and allows near zero structural integrity. The Model is created out of the 2 Mass Models, the structural Model and offset as shown.

Fig 34.



The Demolition Model produces this exact fit (Fig 35.) with The Observation.

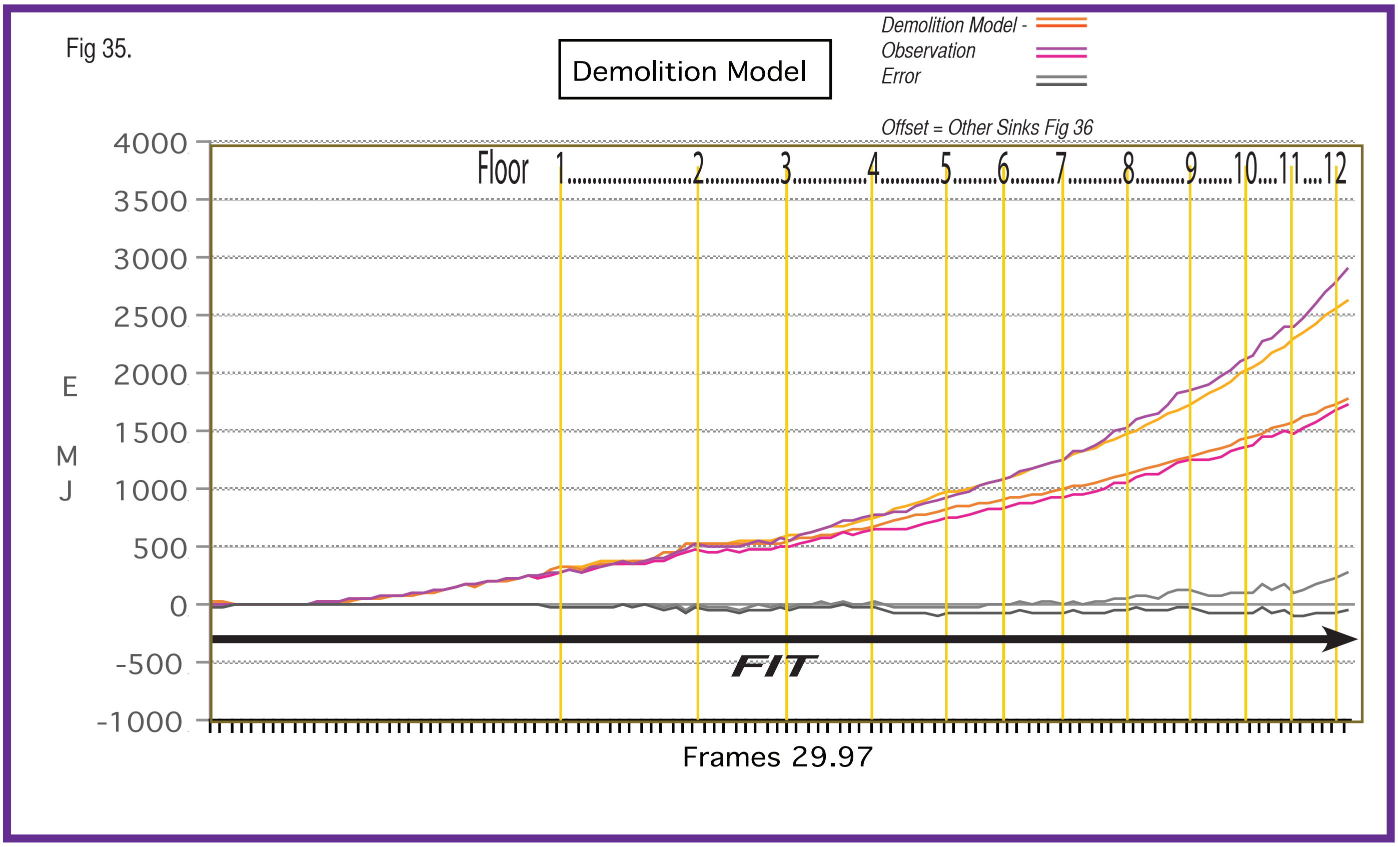
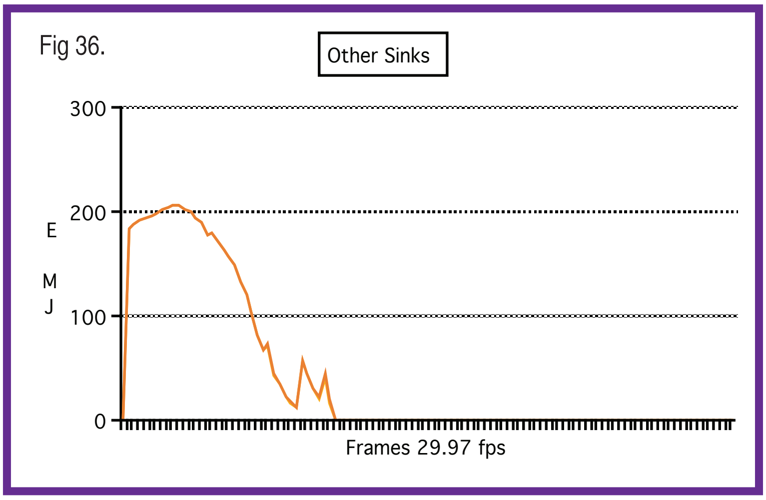


Fig 36 shows Other sinks used in the Demolition Model calculated by subtracting Model A Mass and the 75% structural model from The Observation.

The Other sinks fall to zero at Frame 39 i.e. just after expected impact with Floor 1, and peak at +200 MJ.



Discussion.

That concludes our look at the Bazant et al [11] structural model none of the phenomena that the model predicts are present in The Observation after Floor 2. If in the Bazant structural model, the maximum force is = 2.6g the collapse will tend to balance at a frequency of just over three floors a second as the resisting force balances the applied force. We have shown that if significant structural resistance is met, it will cause the collapse to proceed with velocities approaching a terminal Velocity, which for the model of the Bazant wave we've used is 11.5 m/s, oscillating ±0.5 m/s around the terminal Velocity. If Mass is not accreting at 100% then the terminal Velocity falls as the stronger structure in subsequently lower floors will increase the resisting force relative to the applied force. As we see no evidence of this behaviour in The Observation, therefore *all* 12 floors impacted have an average structural resistance < = 75% (core).

Comparing the Bazant wave model with The Observation it is clear that there is no evidence of any structural resistance at any time after Floor 2 during the collapse.

We have also shown that if Mass is distributed as you'd expect in a building, then further discontinuities are introduced and added to the discontinuities caused by the structure, a 'Natural Collapse' is bumpy through out and the bumps get bigger the greater the Velocity. The Observation on the other hand has a smoothness that can be accurately modelled by a 4th order power series equation (a very smooth curve) with a standard deviation of ± 24.1 MJ (a very very smooth collapse).

Furthermore, Mass is not where it should be or at a density it should have from Floor 3 onwards.

There is nothing in the Empirical Evidence to support the NIST/ BAZANT Natural Collapse Hypothesis, therefore this is not a 'Natural Collapse'.

Does that make it a Controlled Demolition?

All the Empirical evidence in The Observation supports the Controlled Demolition Hypothesis. There's no structure after Floor 2 and Mass changes both density and arrangement following the Floor 3 encounter, which is what explosives do to concentrated Mass, density reduces further in the course of the descent, until Acceleration becomes constant after Floor 4, which is a phenomena that can only be explained by the presence of homogeneous Mass. There is not enough Energy available for the pulverisation of concrete on such a scale. Bazant gives a "*dissipation of about 865 J per kg of pulverized concrete, = 1,029.35MJ per floor*".

Clearly, Empirically and obviously the demise of WTC 1 was due to Controlled Demolition and was not a "Natural Collapse".

Many news reporters and eye witnesses said that it "looked like a controlled demolition". The Empirical Evidence endorses these first intuitive responses to the horrific destruction they witnessed. It was a controlled demolition.

Notes

1. Since this paper first appeared further evidence to support the controlled demolition hypothesis has emerged in a paper published in an open access peer reviewed journal. Evidence of 'nano thermitic' materials have been found in samples of dust taken from the area around WTC.
http://www.bentham-open.org/pages/content.php?TOCIEJ/2008/00000002/00000001/35TOCIEJ.SGM

References

[1] http://wtc.nist.gov/NISTNCSTAR1CollapseofTowers.pdf
[2] http://www.journalof911studies.com/volume/200704/NISTandDrBazant-SimultaneousFailure-WTCCollapseAnalysis2.pdf
[3] http://www.journalof911studies.com/volume/200609/Why_Indeed_Did_the_WTC_Buildings_Completely_Collapse_Jones_Thermite_World_Trade_Center.pdf
[4] http://www.journalof911studies.com/volume/2008/TheMissingJolt7.pdf
[5] http://www.journalof911studies.com/volume/200704/GrabbeExplosionsEvidence.pdf
[6] http://www.journalof911studies.com/volume/2007/Ryan_HVBD.pdf
[7] http://www.journalof911studies.com/volume/200704/SzambotiSustainabilityofControlledDemolitionHypothesisForDestructionofTwinTowers.pdf
[8] http://911blogger.com/node/19053
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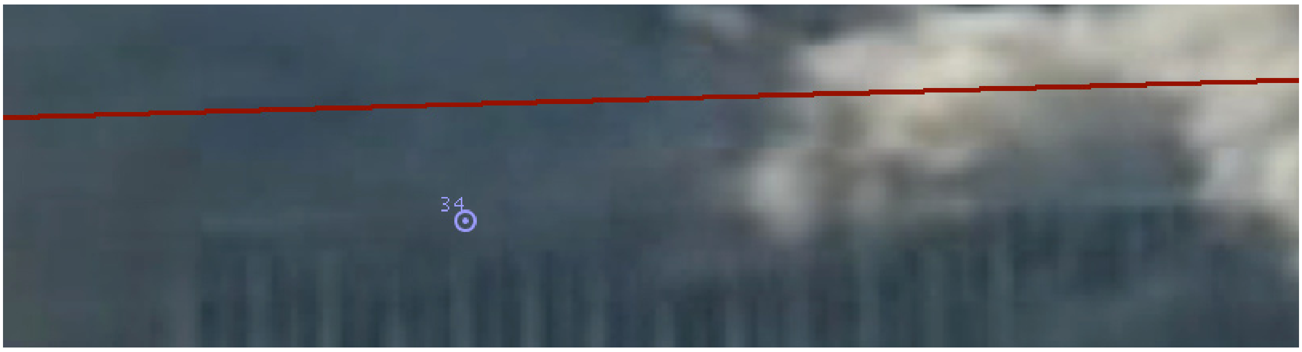
[10] http://www.journalof911studies.com/volume/200703/GUrich/MassAndPeWtc.pdf
[11] Mechanics of Progressive Collapse, Learning from World Trade Center and Building Demolitions Zdenek P. Bazant and Mathieu Verdure Report No. 06-06/C605t

<u>**Apendix A.**</u>

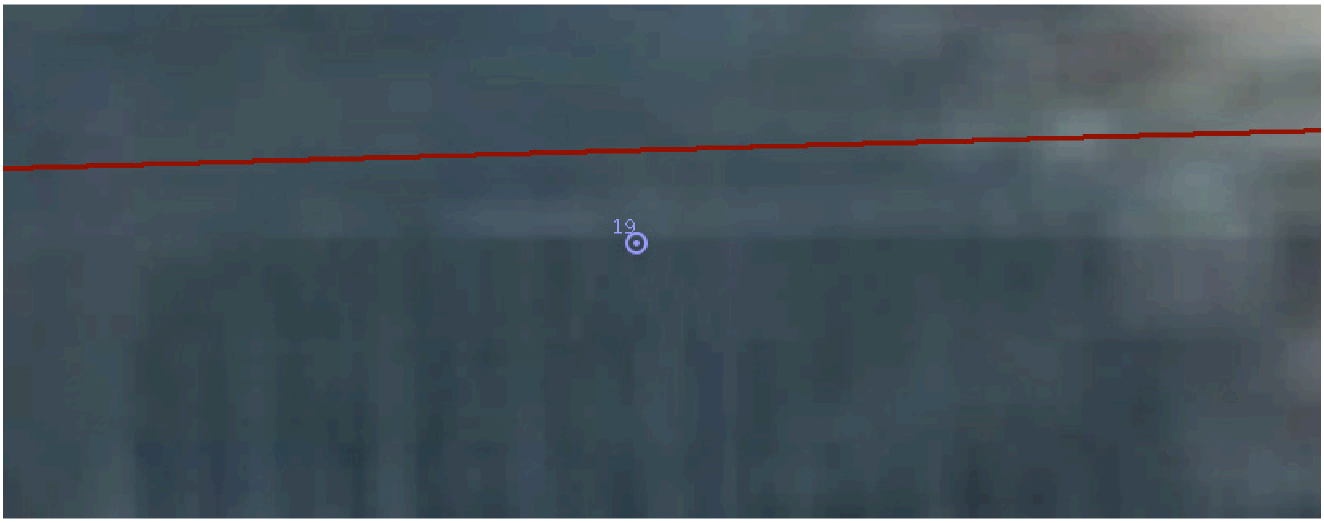
Notes on placing the data points

At whatever scale chosen the job of plotting data points is one of judgement, at higher magnification the video quality is blocky and compression artifacts are more obvious.

Below: although the roof line is obscured by smoke, it can still be seen on either side of the obscured portion, a judgement can be made where to place the data point. (The red line is the x-axis rotated so the y axis is pointing straight down, the data point is the dot inside the numbered circle)



In the frame below we can see an averaging artifact created in the camera or by a compression algorithm The artifacts are ‘blocky’ horizontal bands which merge with the roof line, this can lead to errors in plotting, in the example below the data point is set slightly too low and needs to be adjusted upwards.



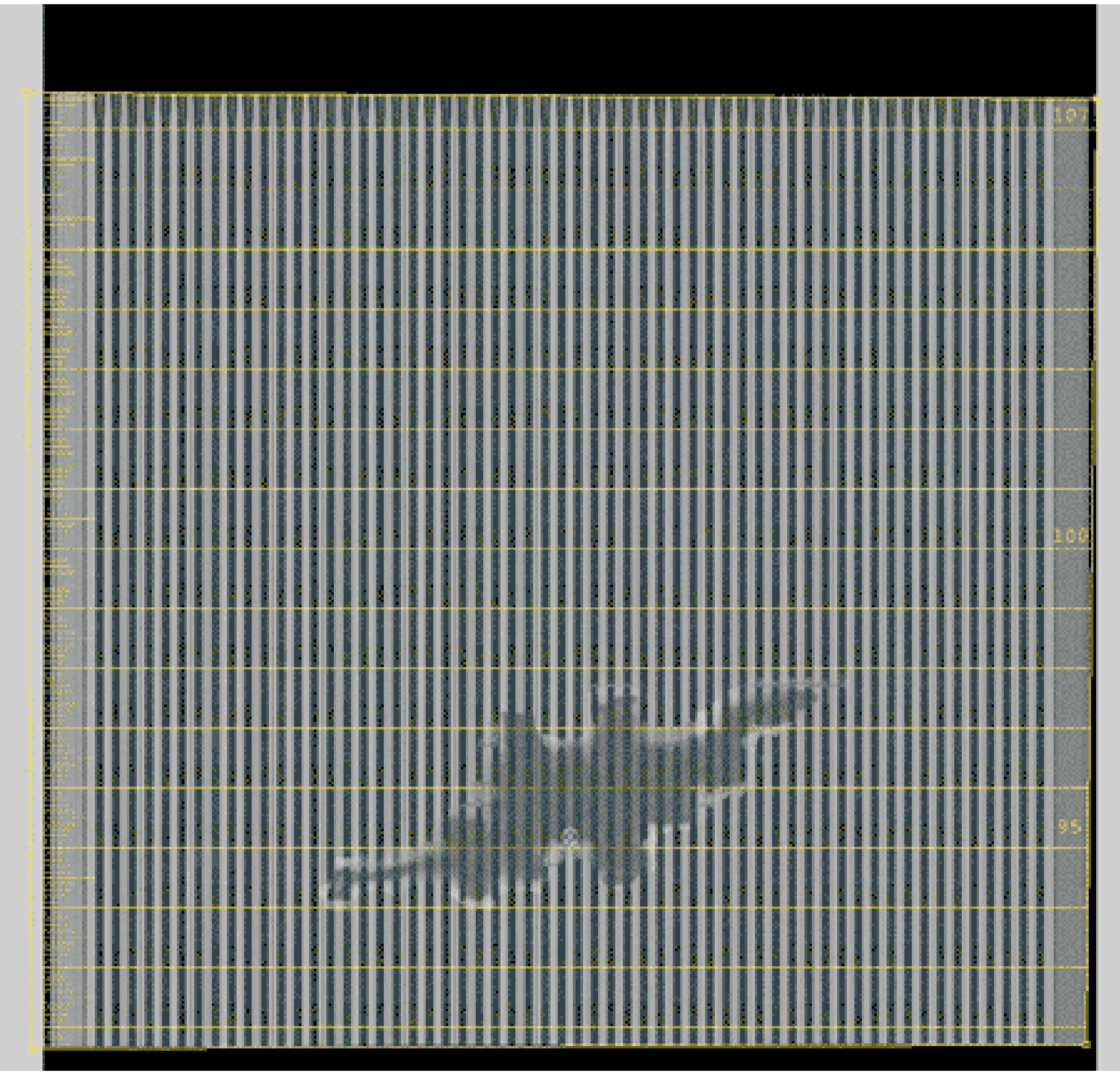
note : The analysis in Apendix C used an edge detection algorithm to aid the task of data plotting.

It is possible to scale the video by a factor of 8 in Tracker to make plotting the data points easier. Though the resolution of the video is not improved by scaling the resolution of the scale is, and as the job of inputting data points requires judgement, at whatever scale the data is collected, increasing the scale resolution in this way allows us to plot data for every frame of video. The Video was scaled by a factor of 4, cropped and saved without compression before being imported into Tracker.

Setting the Scale

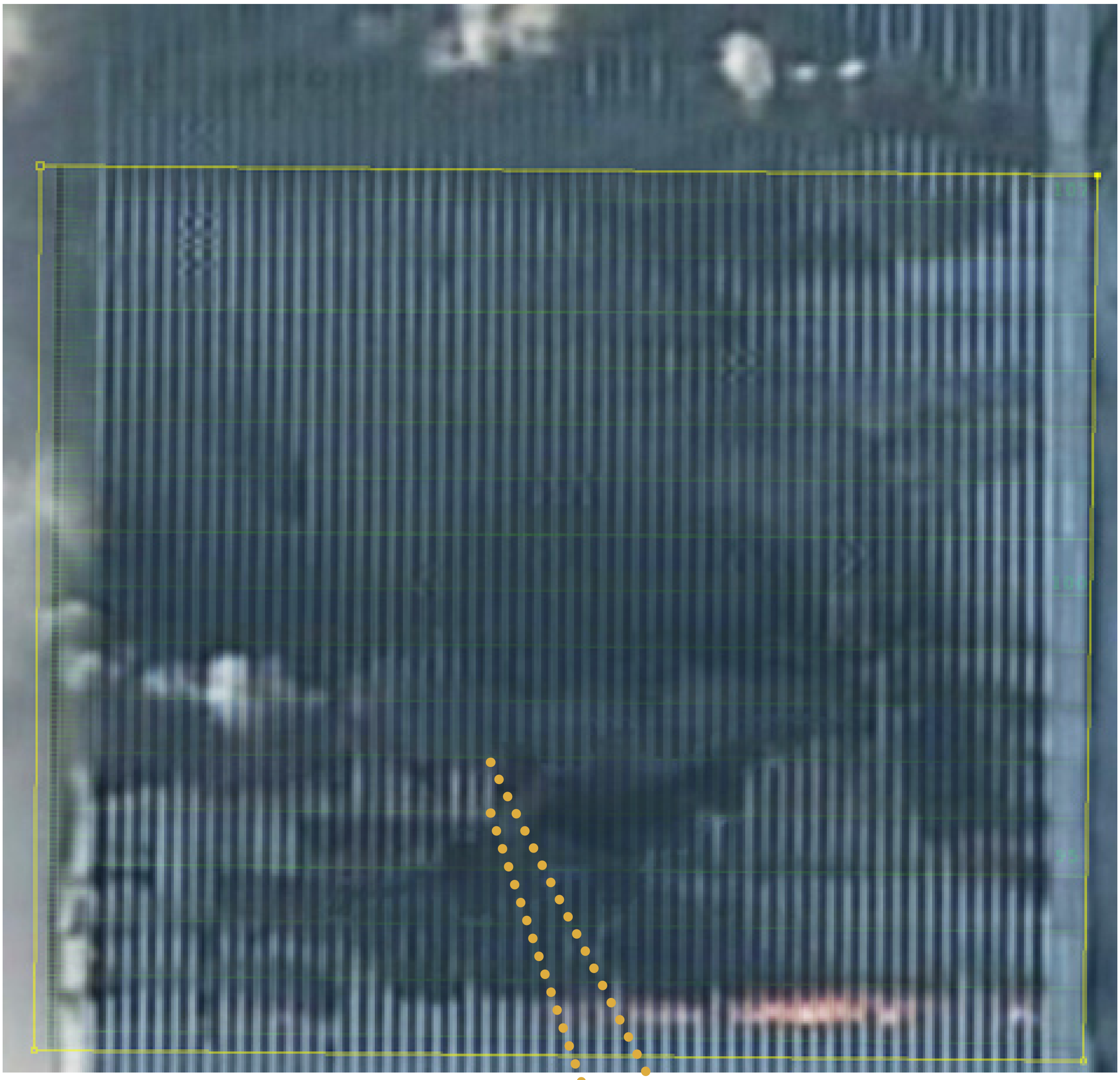
The intention was to use a scale of 1.5 inches per pixel .

Below. This (scaled down here) to scale graphic was created marking the various 'land marks' on the face of the building (the full scale version was 96 pixels per floor or 1.5 inches per pixel). This was done in order to facilitate setting a scale in Tracker. The yellow rules are 1 pixel wide at full scale..



The graphic was imported as a 3D object into a video editor, the video was then scaled to closely match the graphic and the graphic was then rotated in the x axis by -0.6 degrees to match the perspective of the video. +1.0 degrees y rotation as the West side of the tower is slightly closer to the camera than the East, and 0.4 degrees in the z axis to cancel a rotation in the camera.

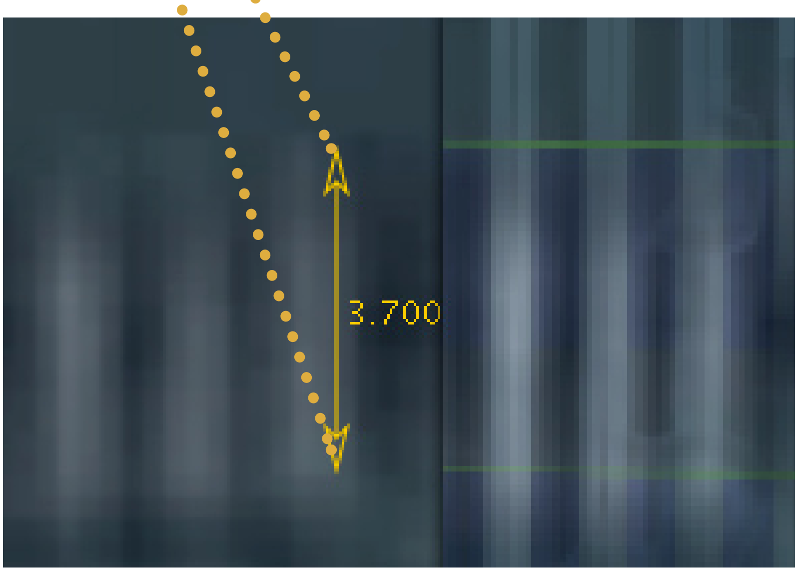
Below the graphic, rotated with 50% transparency and overlaid on the video. The graphic is defined by a yellow mask border. The vertical bands between the perimeter columns were used as a guide in setting the rotations and the dark bands apparent on the corner cladding were used as the main guide to floors. Unfortunately the un-compressed video was too large (2GB) to run on the java virtual machine that Tracker needs. So the ruler was set in Tracker using this graphic as a guide only. (Note. The video and graphic have an additional rotation of +1.3 degrees [clockwise] in the image below)



Right and Above

Setting the 'ruler" in Tracker.

This feature was chosen as it was the most central and prominent feature on the building.



Appendix B

Determining Energy loss ***Er*** from Velocity difference ***Vr=Vg-Vo***
(i.e We're looking for the Energy Er that accounts for the Velocity difference Vr)

From

$$E = \tfrac{1}{2} mv^2 \qquad \text{Eq 1}$$

Velocity has this relation to Energy

$$v = \sqrt{\frac{2E}{m}} \qquad \text{Eq 2}$$

Let ***Vr*** equal the difference between ***Vg*** and ***Vo (Conservation of Momentum)***

$$v_r = v_g - v_o \qquad \text{Eq 3}$$

From Eq 2

$$v_r = \sqrt{\frac{2E_r}{m}} \qquad \text{Eq 4}$$

ditto

$$v_g = \sqrt{\frac{2E_g}{m}} \qquad \text{Eq 5}$$

ditto

$$v_o = \sqrt{\frac{2E_o}{m}} \qquad \text{Eq 6}$$

Expressing Eq 3 In terms of ***Er***

$$\sqrt{\frac{2E_r}{m}} = \sqrt{\frac{2E_g}{m}} - \sqrt{\frac{2E_o}{m}} \qquad \text{Eq 7}$$

Therefore

$$E_r = m\frac{\left(\sqrt{\frac{2E_g}{m}} - \sqrt{\frac{2E_o}{m}}\right)^2}{2} \qquad \text{Eq 8}$$

Simplifying from Eqs 5 and 6

$$E_r = \frac{1}{2} m(v_g - v_o)^2 \qquad \text{Eq 9}$$

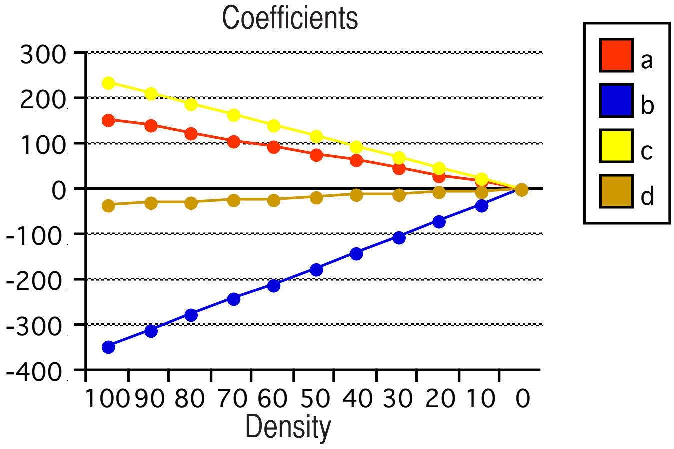
Substituting from Eq 3

$$E_r = \frac{1}{2} mv_r^{\,2} \qquad \text{Eq 10}$$

Model B Mass Distribution Model.

The Model outputs MJ values for Model B Energy Requirements per frame

$$y = at^3 + bt^2 + ct + d \qquad dt = 0.033s$$



Multiply these coefficients by Density percentage

a	b	c	d
1.544	-3.49	2.36	-0.353

D=Density, Table of pre-calculated Densities

Coefficients

D %	a	b	c	d
100	154.3	-348.7	235.8	-35.26
90	138.9	-313.8	212.3	-31.74
80	123.4	-278.9	188.6	-28.02
70	108	-244.1	165.1	-24.68
60	92.68	-209.5	141.7	-21.18
50	77.24	-174.6	118.1	-17.65
40	61.828	-139.78	94.56	-14.128
30	46.416	-104.96	71.02	-10.606
20	31.004	-70.14	47.48	-7.084
10	15.592	-35.32	23.94	-3.562

Power Series Model of the collapse

Outputs Energy Lost per frame of video in MJ

$$y = at^4 + bt^3 + ct^2 + dt + e \qquad dt = 0.033s$$

Upper Bound	Lower Bound
$a = 32.46$	$a = 20.9$
$b = -155.1$	$b = -123.7$
$c = 365.1$	$c = 294.1$
$d = -7.711$	$d = 39.9$
$e = -8.11$	$e = -16.82$

Appendix C. Why the Bazant model is wrong, where the Theoretical meets the Empirical.

In their paper Bazant et al say....

> *"The equation of motion of Mass m(z) during the crushing of one story (or one group of stories, in the case of multistory buckling) reads as follows:"*
> $$\ddot{u} = g - F(u)/m(z) \qquad Eq\ (2).$$

Where $\ddot{u}$ is the downward Acceleration of the top block and $m(z)$ its Mass at any point z in the descent. *note: u and z, in the Bazant one dimensional model are the same dimension as y in this paper, u denotes the vertical displacement of the top floor relative to the floor below.*

In their paper Bazant et al also say....

> *"If the complete function F(u) is known, then the calculation of motion of the upper part of tower from Eq (2) is easy"*
> Though Bazant adds in parentheses
> *"to calculate this function precisely is a formidable problem"*

The 'complete function ***F(u)***' can be known, and its calculation is straight forward.

We know y, the distance fallen in time t, we therefore can calculate $\ddot{u}$ from the video data:

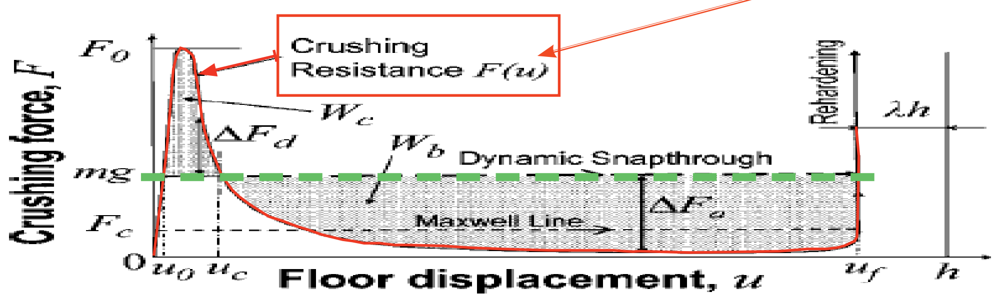
as $y = \frac{1}{2}\ddot{u}t^2$

therefore $\ddot{u} = \frac{2y}{t^2}$

and therefore the crushing force $F(u)$ can be calculated by re-arranging Eq (2)

$$-F(u) = (\ddot{u} - g) * m(z) \qquad \text{Eq.(3)} \ [*1]$$

Here is Fig 3 from Bazant's paper; a plot of among other things theoretical $F(u)$ [red] for a single floor.[*2]



note: *This graphic has been stretched to fit the page. The 'mg' line [green] was used to estimate the vertical scale i.e. mg= 300 MN for the top block Mass of 30 million kilos. The red and green lines have been added to highlight the original.*

Looking at the Bazant curve for *F(u) [red]* we see the crushing force rise rapidly to a peak at *Fo*. then fall to near zero, this is the buckling phase of the failure and occurs within the first 0.4 m of the downward movement, between points *uo* and *uc* on the x-axis. The top block is decelerating when above, accelerating when below the *mg [green]* line and Acceleration is zero when *F(u)* equals *mg* (*mg* represents the applied force and its value increases as we move down the tower by accretion of Mass). Note also the 're-hardening' phase at point *uf,* where again the top block should experience further rapid deceleration. The location of *uf* and the value to which *F(u)* rises at *uf* are variable and depend on the value of λ*h*, but there is no doubt that the effect of re-hardening is rapid deceleration. We've chosen to place *uf* where Bazant places it in Fig 3 above.

**1One thing to note from Eq 3 is that F(u) depends on m(z) and m(z) will increase when the Mass it has encountered accretes, but as the structure gets stronger the further down we go (see Fig a), then at Mass accretion rates of 100% the F(u) curve should produce more or less similar Acceleration in each cycle , but if less than 100% Mass accretes then the Acceleration will be lower and the deceleration higher for each cycle (see Fig b.).*

**2 Bazant shows other versions of this curve in Fig 4, of his paper, but as we only see Acceleration during the collapse we examine the curve "Fig 4, a) Front Accelerates" here.*

In Bazant's Fig 3. the distance along the x-axis, 0 - *h* represents a single floor drop of 3.7 m so we can roughly estimate where each phase of the crushing theoretically begins and ends. We can also simply estimate *Fo* using the value of *mg* and a factor of safety in the core of 3, (Bazant uses 2.6 in Fig 3 and so we do the same), and we give *F(u)* a typical value of a constant 480 MN in the re-hardening phase. Acceleration is expected to rise to close to *g (F(u)* is close to zero*)* between these two deceleration events.

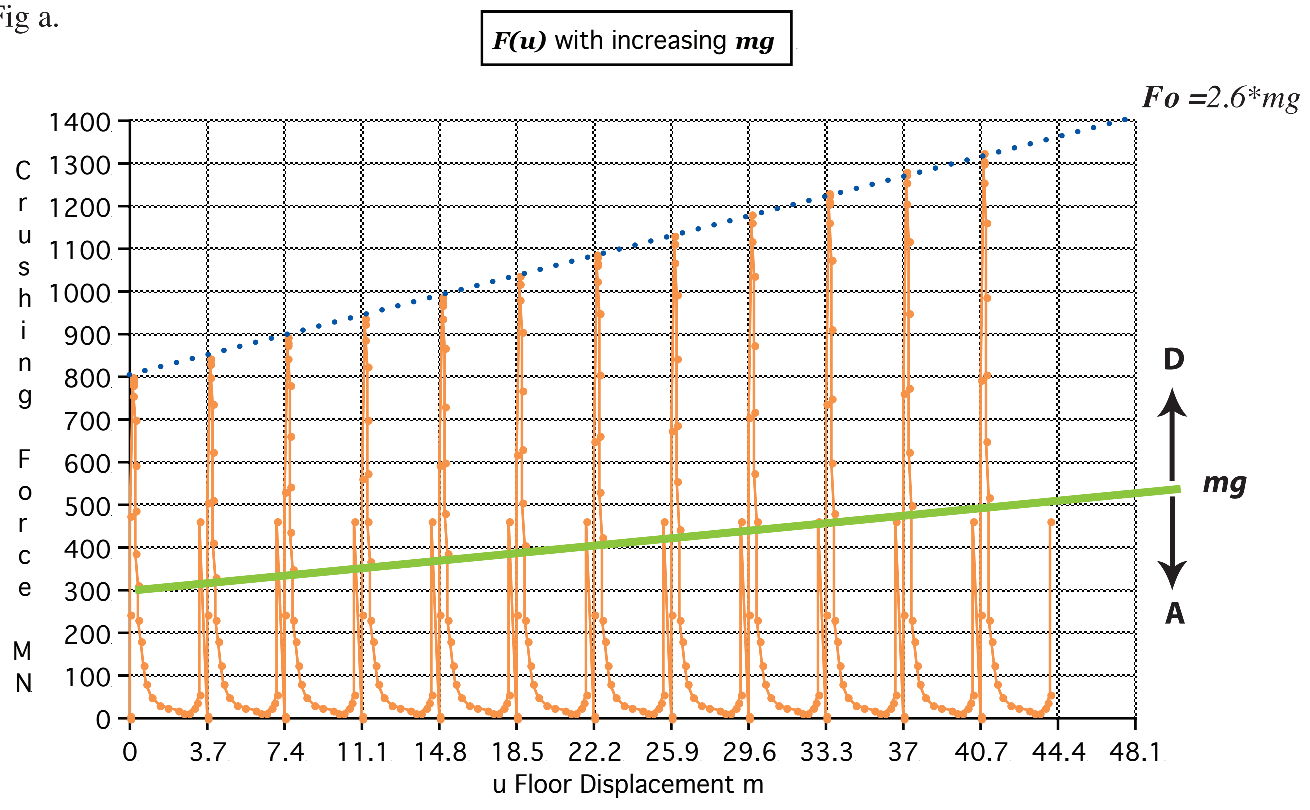
This typical cycle is repeated for each floor in the graph in Fig a. Although this might not be exactly what happens in the real collapse, we would expect to see some evidence of this structural resistance in a plot of observed *F(u)*.

The Fig a. plot shows us how much, and the kind of structural resistance that would be needed to be overcome in an intact structure for a collapse to occur. We should see rapid deceleration in the first half meter or so of a floor drop followed by a return to Acceleration close to free-fall and a final abrupt deceleration as impact with the next lower floor begins in the 're-hardening' phase. *Fo* is plotted at 2.6 times *mg,* the value taken from the Bazant curve. We would expect however *Fo* to be above the factor of safety (*fos)* of 3 for the core, so these values for *Fo* should be considered as minimum values. Further study is needed to show how the actual design coped with increasing *mg*.

The arrows marked 'D' and 'A' in Fig a. show deceleration and Acceleration along the *mg* (equilibrium) line. *mg* has an initial value of 303 MN and rises to 523 MN at floor 12, The *mg* line is for illustrative purposes and is not intended to be a model for the Mass distribution.

Fig a. is a plot of the 'typical' theoretical *F(u)* curve for each floor in the drop, with increasing *mg (100% Accretion)*

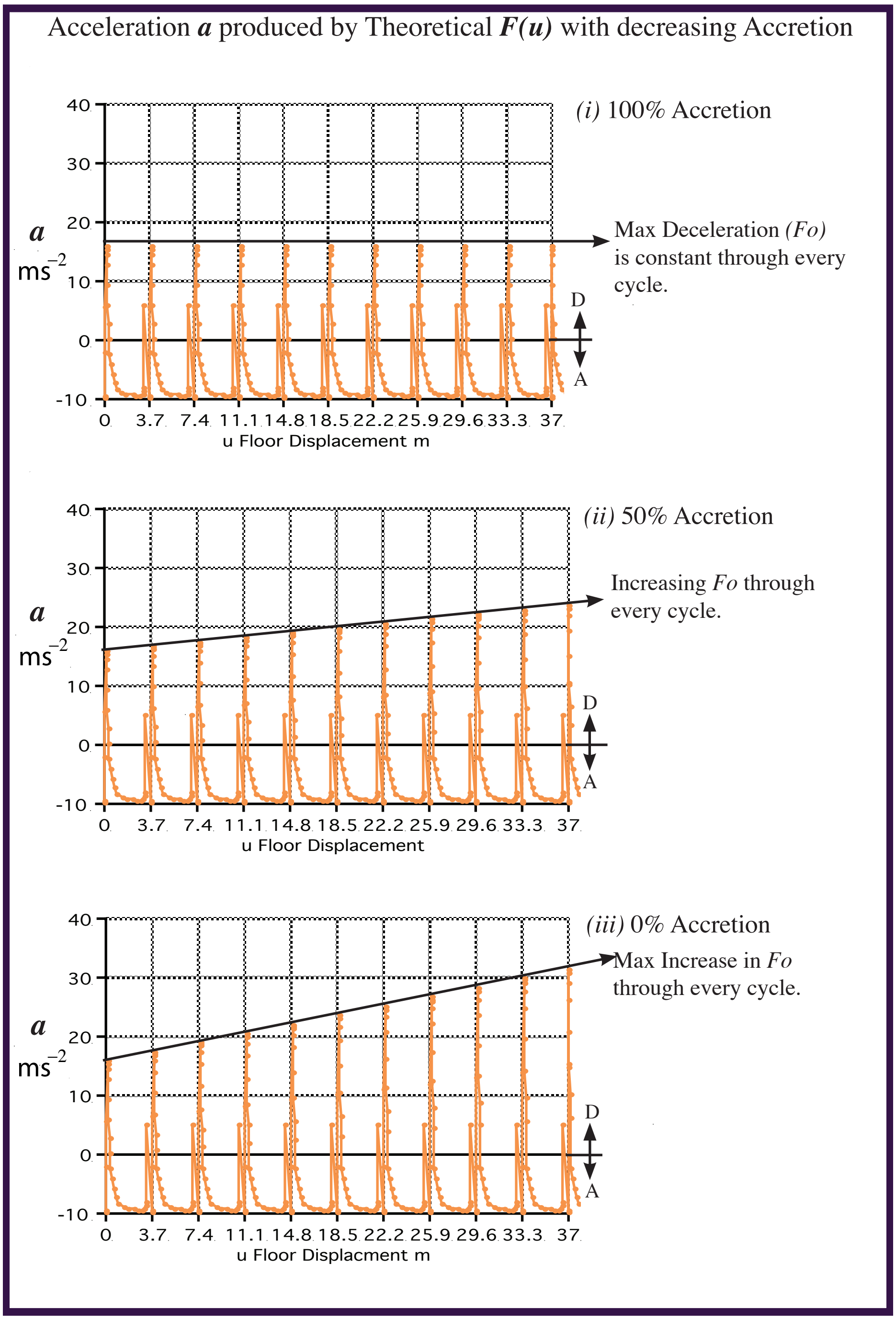
Fig a.



We can see that even with 100% accretion the top block will experience deceleration all the way to the ground, as structure that is designed to support increasing *mg* with decreasing height is overcome, although around floor 9 (33.3 m) the re-hardening phase will cease to cause deceleration with the constant value we've selected here, actual deceleration due to re-hardening is variable and may not cause deceleration, but is expected to cause an abrupt positive change in *F(u)*.

Each floor is designed to support the Mass above it, e.g. the structure of floor 99 is designed to hold up the 10 floors and roof masses above it times the *fos*. If floor 99 is then accreted to the upper block thus becoming 11 floor masses and roof, and falls onto floor 98 then, as floor 98 is designed to support 11 floor masses and roof times the *fos* we should theoretically see identical Acceleration and deceleration through each cycle of the Bazant *F(u)* curve. The effect of accretion on the Bazant curve is shown in fig b.

Fig b.



note: the values here are calculated using Bazant's Eq 2. and masses from Gregory Urich's Mass calculations, and thus show actual theoretical values for WTC1. With these values we should expect to see a minimum deceleration of 16 m s^{-2} *at Fo.*

As its clear from the video and the distribution of mass in the debris pile, accretion to the top block is lower than 100% during the collapse, therefore some evidence of this increasing deceleration during the buckling phase should be observable in the plot of Observed *F(u)*.

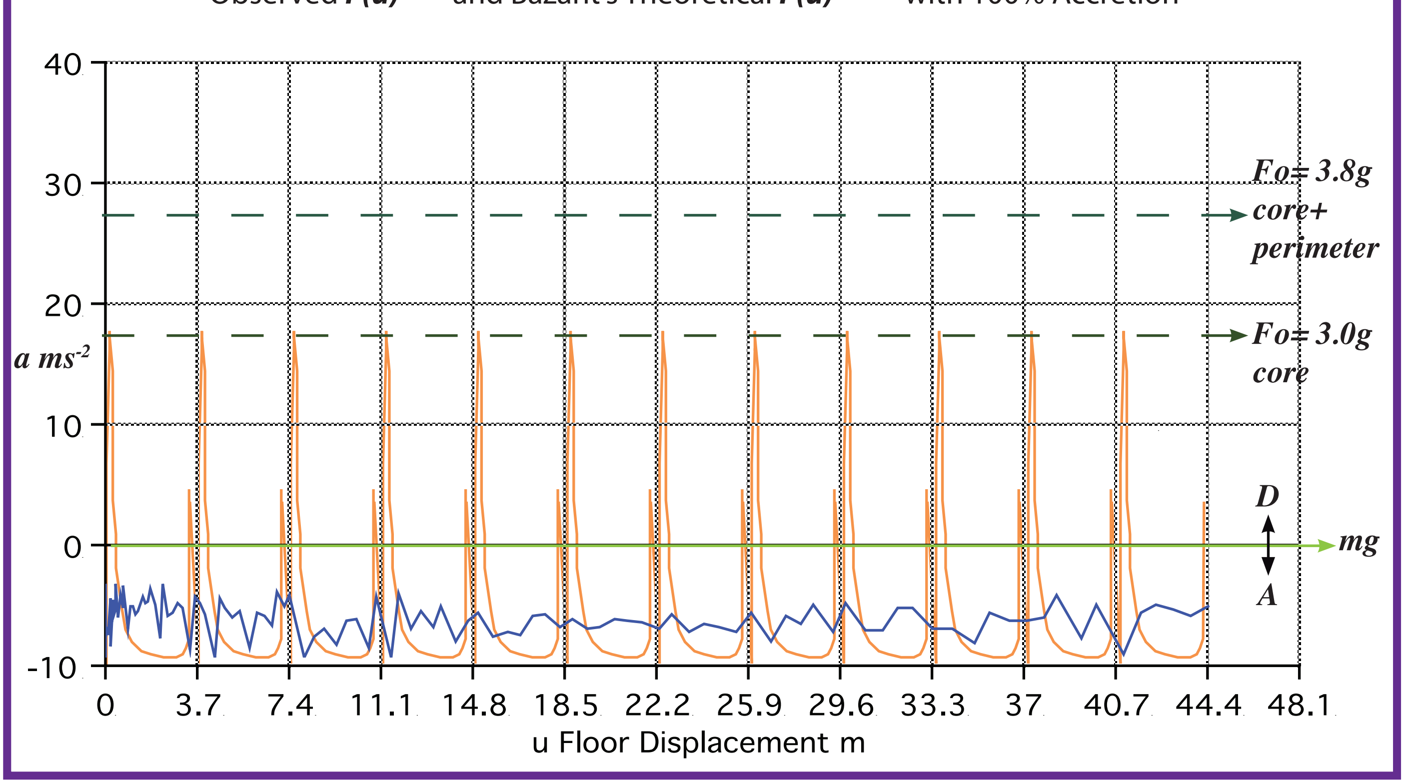
That then is the theory, the top block should theoretically experience at least one phase of deceleration and an additional, abrupt reduction in Acceleration per floor, during the collapse. The top block should then accelerate close to free-fall between these two decelerating phases. If the Mass accreted by *m(z)* causes *mg* to rise above *F(u)* in either of the decelerating phases no deceleration will occur, but this should never happen in the first phase (buckling) as the structure is designed to cope with increasing *mg* with decreasing height.

We are now in a position to compare the Bazant theoretical model with Empirical reality. Using Eq 3. and the observed Acceleration we can plot Observed *F(u)*.

note: no consideration is given to overcoming the inertia of impacted Mass in this analysis.

Below Fig c. A comparison of Bazant's theoretical (for an intact structure) $F(u)$[orange] and real world $F(u)$ [blue] for the first 44 m of the collapse.

Fig c.

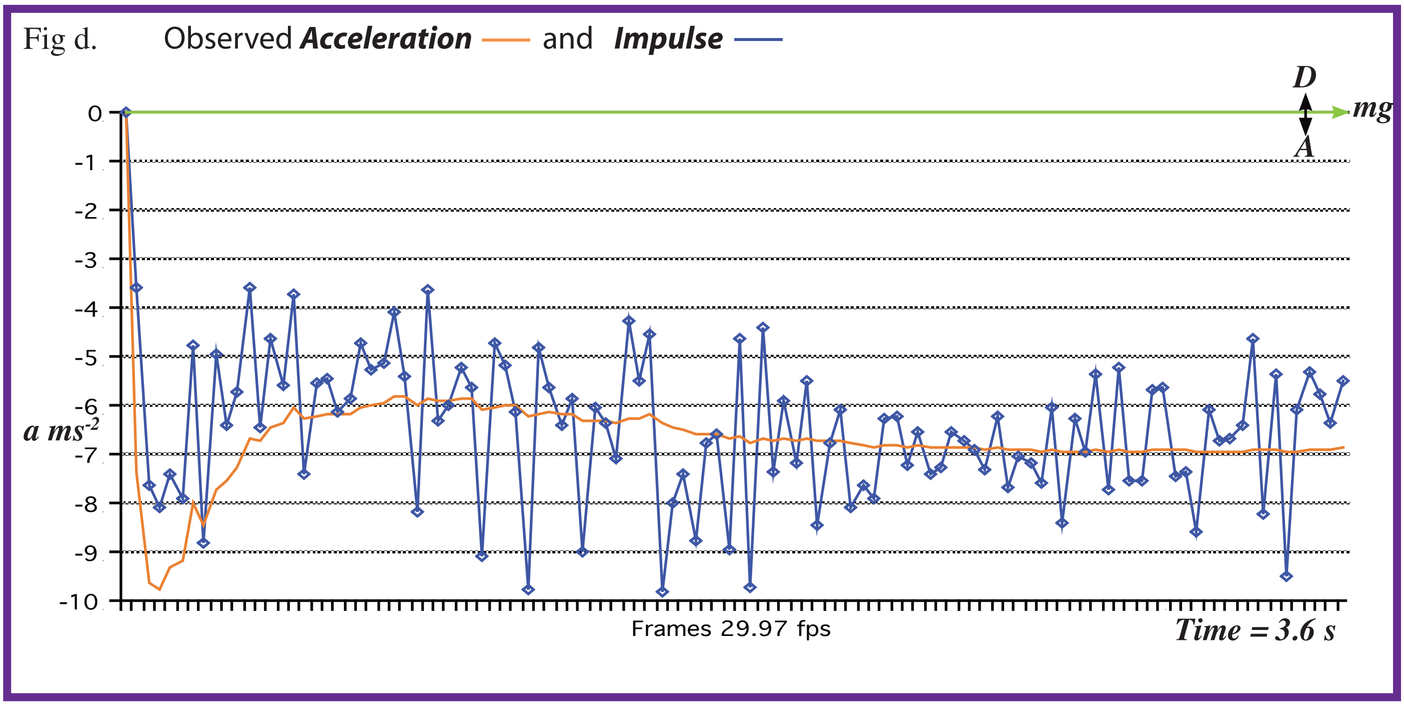


Observed Fu has an average value of 0.33***g***, 9% of the expected performance of the intact core and perimeter columns, 0.33***g*** gives an average acceleration of -6.52 ms^{-2} over the descent. The observed *F(u) [blue]* plot shows that at no time during this initial 44 m of the collapse is the top block experiencing the deceleration predicted in the Bazant model and is continuously accelerating. There is little indication of any structural resistance being present at any time. The Bazant curve shows us what we might expect in a 'normal' collapse and evidentially this is nowhere near a 'normal' collapse. Even if the damaged floors offered little structural resistance we should see a change as the top block begins to encounter intact floors after 4-6 floors of the drop, but we see no change whatsoever in the plot.

Further there can be very little accretion going on because if *m(z)* were increasing then it would be very unlikely that the Acceleration we observe in the collapse would remain constant, it would mean that somehow the resisting force would have to increase to balance exactly the increasing downward force caused by chance encounters with other masses accreting to *m(z)*.

F(u) was calculated using the observed impulse, setting mass =1Kg, so force=acceleration. The actual force in Newtons, is obtained by multiplying the acceleration by the top block mass, ***m(z).*** Velocity deltas were calculated as; ***dv=dy/dt,*** per frame and used to calculate the Impulse=***dv/t***. (change in Momentum) see Fig d.

Fig d. is a plot of Observed Acceleration and Impulse.



We see only Acceleration in the Impulse plot, no Deceleration.

We've seen 'The Missing Jolt', this is 'The Missing Jolts', 'The Missing Accretion' and 'The Missing Structure' all rolled into one. Clearly 12 floors of the structure have been destroyed and not by the falling block or 'plane impact and fire. Bazant's theoretical model does not match or predict Empirical reality and therefore the Bazant model is wrong for this collapse.

Bazant's theory follows this erroneous logic; The tower collapsed, when towers collapse it's normal for columns to buckle, this is how columns buckle and therefore that's what happened. The Empirical data (which Bazant should and could have easily checked his theory against) shows that this is not what happened in this collapse.

Further, this comparison shows that at no time during at least the first 44 m of the collapse is there any evidence of any structural resistance of the kind that Bazant or any other structural engineer might expect, there appears to be no hinging and buckling of columns and no 're-hardening' as the impacted masses compact.

This comparison supports the controlled demolition hypothesis which supposes that all of the structure is destroyed so the block is free to accelerate in a predictable (constant) way through structure-less Mass.