

Mechanisms of Destruction and Collapse of the World Trade Center (WTC) Buildings on 9/11

An Analysis of Peer Reviewed Technical Literature 2001 - 2012

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The importance of understanding the mechanisms of collapse for the three World Trade Center buildings on September 11, 2001 cannot be over-estimated, for these unusual collapses and their disputed causes raise questions regarding all future steel-frame building design. A literature review was conducted to identify the evolving trend in research results in this area, which have become increasingly diverse over time. Recommendations for further research are presented.

Introduction

Over the past decade there have emerged two primary hypotheses regarding the mechanism of destruction for World Trade Center (WTC) buildings 1, 2 and 7, namely, the official fire-induced Progressive Collapse (PC) versus the alternate Controlled Demolition (CD). The question of which of these two hypotheses is correct is singularly important because its current lack of resolution leaves unmet the following critical needs (assuming PC):

- (1) Thousands of other structures may also be subject to such catastrophic destruction by office fires, and inspections and upgrades based on determination of what caused the WTC buildings to collapse may be needed to ensure public safety;
- (2) Significant structural design analysis tools and computer models need upgrades to account for the potential of such catastrophic destruction;
- (3) Major revisions to building codes for high-rise steel-frame buildings are critically needed (Bement, 2002).

Our goals here are to fully document the available peer-reviewed literature on this important question, and to promote more open and in-depth research by a broader community of scholars.

Although much relevant evidence from portions of the events of 9/11 remains unavailable to researchers as well as the general public, substantial evidence is available concerning the destruction of WTC 1, 2 and 7 that is relevant to resolving the key question of PC versus CD. Nevertheless, the diversity and complexity of the 9/11 events make it very difficult for most citizens, and even many researchers, to obtain the quality information needed to address and resolve the above questions.

In particular, information provided officially is notoriously incomplete; e.g., the official *9/11 Commission Report* (2004) makes no mention of destruction of the third high-rise steel-frame building, WTC 7. Further, relevant official reports produced by the National Institute of Standards and Technology (NIST) for the Twin Towers are incomplete in that they stopped their efforts at “collapse initiation” and could not explain total destruction. Finally, the same NIST reports have been surrounded by controversy that remains mostly unreported in mainstream media sources (see peer-reviewed papers referenced herein).

This controversy has been fueled in part because official investigations and reports on this topic have been very tightly controlled and not peer-reviewed.ⁱ Basic documentation of such work has not been made available to independent researchers in spite of repeated Freedom-of-Information-Act (FOIA) requests; e.g., most of the detailed documentation, coding, methodology and assumptions employed by NIST in their finite element analysis model of WTC 7. Related to these technical impediments to independent research, in addition to essentially no funding for such research, the “conspiracy theorist” or “truther” label has often been used to discourage or truncate debate on many critical questions, leaving the official theory as the default.

For the most part, and somewhat understandably, the science and engineering professional communities have stayed on the sidelines, perhaps in part to protect their reputations and in part to avoid putting their federal research grants at risk. This condition of obstructed research continues in spite of the fact that a “conspiracy” by definition is “*an agreement between two or more persons to commit a crime.*”

Thus, by definition, both the official PC hypothesis and the alternative CD hypothesis addressed here are necessarily associated with a conspiracy theory of one form or another. Setting such labels aside, the fundamental question remains, “which hypothesis is best supported by the evidence?” Unfortunately, this basic question and its resolution have been systematically subverted for the past decade.

Evaluating the Merits of Competing Hypotheses

Nevertheless, more than a hundred serious and independent researchers have taken up the question and are actively working to examine the available evidence and report their results to the broader research community. The subset of their research work that has been independently evaluated (i.e., peer-reviewedⁱⁱ) and published in scholarly journals, provides a critically important sample set for addressing key questions and, in particular, the following:

Key technical question: What is the mechanism of collapse for WTC 1, 2, and 7?

Was it through Progressive Collapse (PC) or Controlled Demolition (CD)?

We propose that one of the best available solutions to this critical question can be obtained through an evidence-based approach and a concentration on results derived from the available peer-reviewed technical literature. Although peer-reviewed papers are a small subset of the available literature on these topics, they generally (not always) represent higher quality, better argued, and better referenced materials than papers that lack such peer review. Thus, an analysis of the peer-reviewed literature over time should provide an excellent basis for evaluating the merits of the competing hypotheses that are here in

question.

We recognize that any conclusions are limited by the necessity for decisions between competing claims and hypotheses within that literature. Further, as stated in a recent study of the National Academy of Sciences, “*Research has deepened knowledge about the fallibility of human decision making, particularly the many cognitive biases to which people are subject.*” For example, “*People have a proclivity to ignore evidence that contradicts their preconceived notions (confirmation bias),*” (NRC, 2012, p. 57).

In scientific practice, a key methodology to compensate for such inevitable fallibility is to reproduce, when possible, the results for oneself. In the present case, the means for reproduction are available. Indeed, we encourage the reader to personally check results of this analysis of the peer-reviewed technical literature; e.g., spot checks can be easily done using scholar.google.com.

Resources and Methodology

For this analysis of available peer-reviewed technical literature relevant to the key question above, we have used two major databases, each accessing more than 3500 peer-reviewed journals worldwide:

(1) Academic Search Complete database, from EBSCO, 1965 to present (<http://www.ebscohost.com/academic/academic-search-complete>);

This database provides advanced search capability and full-text access for more than 5,100 peer-reviewed journals.

(2) The Thomson Reuters Web of Science database, similarly, provides advanced search and full-text access for more than 3500 notable peer-reviewed scientific and technical journals, 1956 to present.

In addition to these standard sources, we have searched the contents of a few additional journals which, at this time, are not included in the above databases.

Open Chemical Physics Journal, indexed by six services, among them Chemical Abstracts, the premiere world service for chemistry; also *Directory of Open Access Journals (DOAJ)*, *Open J-Gate*, *Genamics JournalSeek*, *MediaFinder®-Standard Periodical Directory*, *Astrophysics Data System (ADS)*.

Open Civil Engineering Journal, indexed in *Scopus*, *Compendex*, *Directory of Open Access Journals (DOAJ)*, *Open J-Gate*, *Genamics JournalSeek*, *MediaFinder®-Standard Periodical Directory*, *PubsHub*, *J-Gate*.
Journal of 9/11 Studies

Both the *Open Chemical Physics Journal* and the *Open Civil Engineering Journal* are open access, online journals of Bentham Open.ⁱⁱⁱ The *Journal of 9/11 Studies* is the primary peer-reviewed venue for the independent 9/11 research community, and has published papers on both sides of this question (e.g., Greening (2006) argues for the PC hypothesis). Since its initiation in 2006, articles published in this journal have always been subject to two independent peer-reviews.^{iv} Although papers prior to 2012 are not uniform in format, we have found this journal’s reviewing standard to be comparable overall to other journals

publishing on this topic.

For completeness, we have also included the *Journal of Debunking 911 Conspiracy Theories*.

Even though its submission guidelines make no reference to peer review, the phrase “Peer-Reviewed Papers” appears in its index of papers. Unlike all other journals used for our analysis, this journal’s title itself presupposes preferred study outcomes (to which all papers conform), and it did not provide sustained service to its research community (ten papers appeared in 2006, plus only one more in 2007). We encourage readers to judge the quality of peer review from this journal for themselves.

The methodology that we employed in this literature search was as follows:

- Systematic keyword selection based on index terms applied to known publications;
- Comprehensive search yielding 9,856 records, which is the sum of subtotals in columns 1, 3, 4, and 7 of Table 1;
- Clear specification of selection criteria;
- Manual check of all retrieved records (titles and abstracts); systematic identification of all cases that meet selection criteria;
- Compilation and recording of all publications meeting selection criteria (see Table 2).

The selection criteria were as follows: (1) paper’s title and abstract and, when available, its full-text content must support either the official (PC) hypothesis or the CD hypothesis; and (2) the associated paper must give some specific technical argument on behalf of that claim.

Results of the Literature Search

The search keywords and number of records obtained for the two databases are recorded in Table 1. A larger number of retrieved records were obtained with the EBSCO database because it included more non-technical journals. More specific keywords and search terms would have substantially expedited the searches; however, for this analysis, we considered it a high priority to avoid overlooking any relevant paper. As shown in Table 1, the aggregate number of records evaluated based on the EBSCO Academic Search Complete database searches was 6,404 records and, for the more technically-focused Web of Science database that we used, a total of 3,452 search records were obtained and analyzed.

The primary work in this analysis is that of reading and evaluating all titles and abstracts derived from search results given in Table 1. We effectively carried out our search-and-analysis process three times over: first, using only the EBSCO database for a preliminary study; second, using an independent set of search strategies by co-author Cole (applied to the latest version of EBSCO) to check the first analysis and to identify any additional papers (see “Cole” column in Table 1); and third, using both databases as a double-check and to assure comprehensive search and analysis.

Final results of this search-and-analysis process, using both the EBSCO Academic Search Complete and Thomson Reuters Web of Science databases, are given in Table 2 (presented

at the end of this paper). This table provides, in order, each paper's date, title, author(s), journal name, journal volume and issue number. Finally, some notes are given as needed. Among the 9,856 records initially obtained via the keywords given in Table 1, and including papers from the four additional journals discussed above, a total of 84 papers were identified that are relevant to our focus. These papers include four by Cherepanov, who hypothesizes a propagating fracture hypothesis that does not easily fit within the PC/CD categories.

In the first column, these papers are designated "F" for the Fracture hypothesis. In some cases, a paper discusses related technical considerations about the towers but does not provide arguments for one of the two hypotheses; these cases are left as a blank in the first column (e.g., Newland, 2002). In some cases, a discussion, closure or commentary paper (e.g, Sivakumar, Nov. 2003; Gourley, 2007) either replicates arguments given in a previous paper (e.g., Sivakumar, July, 2003), or simply offers commentary on related points, but without arguing (as needed for the second criterion above) for a particular inferred hypothesis (e.g., Gourley, 2007; Flint, 2007). Several closure papers merely replicate arguments given in their associated base paper. Bazant's original paper of December 2001 was basically replicated, with the same title, in two journals and, with its Addendum of March, 2002, is treated here as simply one paper (Bazant and Zhou, 2002). These latter cases and the closure cases are represented with parentheses and are not here treated as distinct papers.

Table 1. Results of Keyword Search from Two Major Databases.

Keywords	Thomson Reuters Web of Science			EBSCO Academic Search Complete			
	10 Yrs	11 Yrs	Sept. 2011 - Dec. 2012	10 Yrs	11 Yrs	11 Yrs, Searches by Cole	Sept. 2011 - Dec. 2012
Progressive Collapse	1158	1319	193	245	298	427	76
World Trade Center	937	1022	87	4712	4894	6128	321
...collapse	201	212	12	116	118	129	4
...collapse analysis	65	70	6	7	8	7	1
WTC	427	473	52	399	439	659	60
...collapse	113	119	7	52	56	55	5
...mech. of collapse	9	9	0	0	0	81	0
...building 7	9	9	0	2	2	2	0
...demolition	2	2	0	0	0	2	0
Building mech. of collapse	311	368	64	4	5	1	2
World Trade Tower(s)	119	124	6	110	113	116	9
...demolition	0	0	0	1	1	1	0
Twin Tower(s)	90	95	8	413	442	591	53
...collapse	25	25	0	18	19	19	3
...progressive collapse	7	7	0	0	0		0
Totals	3042	3401	410	5883	6191	7922	521
Notes: "... " denotes addition to above keyword; "mech." = "mechanism; Cole's results are based on a newer version of the EBSCO database whereas other EBSCO results were accessed at the Library of Congress.							

Notes: "... " denotes addition to above keyword; "mech." = "mechanism; Cole's results are based on a newer version of the EBSCO database whereas other EBSCO results were accessed at the Library of Congress.

After applying these distinctions, a total of 60 distinct papers were identified that met both selection criteria above. These were given a designation (see first column) of either Progressive Collapse (PC) or Controlled Demolition (CD). In many such cases, the paper in question discusses only a mechanism of destruction for WTC 1 or 2. In cases where a paper

addresses a mechanism of destruction for WTC 7 as well, the designation “PC/7” or “CD/7” is given.

Summary of Analysis Results

In summary, important insights emerge from this literature search and analysis:

- (1) Within the first ten years after “9/11” (namely September 11, 2001 through September 11, 2011), the mainstream peer-reviewed literature, worldwide, contained no paper on WTC 7 that concludes with the Progressive Collapse (PC) hypothesis (Note: Two such PC papers appear in the short-lived *Journal of Debunking 9/11 Conspiracy Theories*);
- (2) Within the first ten years, there are 32 distinct CD papers (i.e., arguing for the Controlled Demolition hypothesis, including 15 that address WTC 7) versus 19 distinct PC papers (i.e., arguing for Progressive Collapse, including only 2 as noted immediately above that address WTC 7);
- (3) Overall, from 9/11/01 through 12/31/2012, there are 35 distinct CD papers versus 25 PC papers; among these, 16 of the CD papers address WTC 7 whereas only 4 PC papers do so, again indicating overall the importance of the CD hypothesis;
- (4) Although most CD papers (and one PC paper) derive from the *Journal of 9/11 Studies*, six qualified and distinct CD papers appear in mainstream journals.

Conclusions

- What is most striking about our results is the fact that there is serious disagreement as to how the WTC structures fell on September 11, 2001. While precise sequences of every building component failure cannot be determined, the overall basic mechanism of destruction (i.e. some type of fire-induced natural gravitational collapse (PC), or some type of planned demolition CD) is clearly in dispute. There is no consensus. At this point, almost 12 years later, *there should not be any significant disagreement* about such a fundamental issue as to *how three buildings were destroyed so completely* given the magnitude of the event, the implications of the event, and repercussions for existing and future structural design.
- We note that in the early years, from 2001 to 2005, essentially all published papers supported the official narrative of some type of progressive collapse mechanism. Subsequent years, however, have generated numerous papers challenging the official narrative, and *a substantial number of peer-reviewed papers were published concluding that the failures were due to demolition.*
- The vast majority of independent investigations about other catastrophes narrow down and converge on the solution as more and better information is obtained. Theories that do not, or cannot, explain the additional information are discarded, resulting in a theory that earns general scientific consensus. Precisely the opposite has happened over the past decade with the study of how the WTC structures fell. That is, the more information that has been unearthed, the more unanswered questions have arisen with the official hypothesis, with more people questioning the initial theory. Thus, the demolition hypothesis is strengthened, and the hypothesis of fire-induced collapse is further weakened. Therefore, rather than converging on an answer, the study of 9/11 diverges over time as the scientific

rift has grown and the early consensus for the official story is undermined.

- If it is true that steel-frame buildings can collapse from fire alone, it is crucial for owners of existing structures and insurers to understand the risk of a sudden fire-induced collapse so that structural repairs and risk adjustments can be factored in. Given the official story, it is remarkable how little insurance premiums, or even design parameters and building construction codes,^{vi} have been modified (if at all) to address the possibility of catastrophic fire-induced progressive collapse. The fact that they have not been modified indicates that insurance companies do not accept the PC hypothesis.
- Given the fact that before September 11, 2001 no high-rise steel-frame building had ever collapsed from fire alone (Taylor, 2011), extraordinary claims require extraordinary proof. The NIST Reports did not address the total collapse of the Twin Towers, truncating their study at “collapse initiation.” *Overall, our peer-reviewed literature results collectively yield a very strong prima facie argument for CD.*
- Other than two papers appearing in the Journal of Debunking 9/11 Conspiracy Theories, the only papers that address WTC 7 and argue for PC are brief summaries by McAllister et al. (2012) of the non-peer-reviewed NIST report on WTC 7 (NIST, 2008). McAllister, it should be noted, was herself one of the co-project leaders for the NIST report. Thorough critiques of this paper and associated results of the NIST report are given in Legge (2009) and Brookman et al. (2012).
- When applying the scientific method, independent confirmation of an unexpected result is a very strong form of support. Such independent confirmation occurred twice with regard to 9/11 dust contamination. First, Harrit et al. (2009) published detailed evidence for active thermite material in relevant dust samples, thus supporting explosive demolition. This paper also appears to be one of the most extensively researched and professionally written of all 84 papers appearing in Table 2. Entirely independent of Harrit’s work, Wu et al. (2010) published a case report of lung disease in WTC responders. They reported an “unexpected” discovery of extremely fine carbon (nanotube) structures in responder lung tissue, which are associated with dust, thus independently confirming Harrit et al., who found the same such structures in 9/11 dust samples.
- Well-qualified scientists, including physicists, have pointed out inconsistencies and violations of basic physics contained in many PC papers. For example, Dr. Crockett Grabbe, Applied Physics Ph.D. from Caltech, has raised many such critical problems (see Grabbe, 2007, 2010, 2012). Physics teacher David Chandler and co-author Jonathan Cole also document many basic physics issues at their Website 911SpeakOut.org. And Architects & Engineers for 9/11 Truth (www.ae911truth.org), as of April, 2013, is comprised of 1,877 certified professionals who reject the PC hypothesis and jointly call for a new, independent investigation.
- The integrity of science itself is compromised when an argument that proceeds from authority alone is given precedence over the presentation of relevant, demonstrable facts (e.g., more than a hundred documented reports of explosions (MacQueen, 2012)), or even basic laws of physics (e.g., violations of conservation of energy and momentum, see Grabbe (2012)).
- Compiling all relevant peer-reviewed publications on this focused topic, as done here, enables a systematic, integrated analysis to address our key question in a way analogous to

how Paul Thompson's *9/11 Timeline* has served so effectively to help integrate a large range of 9/11-related issues (Thompson, 2004).^{vii}

- The first submitted draft paper on the mechanism of collapse is that by Bazant, submitted September 13, 2001 (see first entry of Table 2, including its footnote). It is our professional opinion that, by any measure, a responsible, professional research paper on this complex event that was not begun until September 11 could not have been completed and submitted by September 13.

Recommendations

- Greater recognition is needed for the importance of evidence-based scholarly analyses (e.g., MacQueen's detailed analysis of eye-witness accounts of explosions), in addition to more in-depth technical analyses and scholarly works that reveal the broader context of 9/11 events;

- We stress the importance of scientific, technical and scholarly research on these questions, followed up with peer-reviewed publications; lacking this, the discussion

tends to be dominated by essays driven mostly by advocacy-based thinking. In contrast, the best of science is evidence-based with systematic testing of alternative hypotheses, falsification, and model-making (where appropriate);

- In contrast to current conditions that have suppressed research and dialogue on these world-changing collapses, achieving improved understanding of these critical questions requires transparency, avoidance of cognitive bias (especially confirmation bias), peer-review, checks and balances, and efforts to reduce research misconduct.^{viii}

Challenge to the Reader

Although every reasonable effort was made to locate all relevant papers, we fully acknowledge that some papers or publications meeting the criteria herein may have been overlooked in our search. Accordingly we challenge the reader (especially professional engineers and scientists) to leverage the resources referenced in Table 2, and then perform for themselves such a synthesis and, if appropriate, submit the results of such a study to a peer-reviewed journal, especially if they conflict with our conclusions.

Such a check simply requires access to at least one of the relevant databases, which are available through most major universities and research libraries. Indeed, anyone can do spot checks using Google Scholar (scholar.google.com); e.g., keywords "controlled demolition" WTC returns 436 results, and "progressive collapse" WTC returns 920 results.

Acknowledgments

We are thankful for all the independent researchers throughout the years who have courageously stepped forward providing evidence, research, testing and analysis concerning this catastrophic event, especially when such works contradicted official claims. In particular, we gratefully acknowledge detailed technical and editing inputs provided by David Ray Griffin, Tod Fletcher and two independent reviewers. Finally, we respectfully acknowledge the open access available through the internet and public libraries, both critical infrastructures for democracy, which makes this research possible.

[CLICK HERE TO ACCESS TABLE 2: Peer-reviewed Publications Focused on Mechanism of Collapse for WTC 1, 2, and 7 \(PDF FORMAT\)](#)

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ENDNOTES

i On December 16, 2004, the Office of Management and Budget (OMB) formally issued its "Final Information Quality Bulletin for Peer Review." Section II of the Bulletin "requires each agency to subject "influential" scientific information to peer review prior to dissemination." Official reports on the destruction of the WTC buildings (NIST, 2012) were among the most "influential" such reports to appear in the last decade and yet, contrary to requirements of this OMB Bulletin, they were not peer reviewed.

ii Scholarly peer review is the process of subjecting research papers to critical analysis by experts in the same or related field to help enhance the quality, value and objectivity of any final publication (see "Peer review" in Wikipedia.org). With the exception of the *Journal of Debunking 9/11 Conspiracy Theories*, journals included in our database represent publication venues that are recognized by their associated research communities as providing a valuable, and sustained peer-reviewed service.

iii The online journals of Bentham Open are described at <http://www.benthamscience.com>.

iv Information on the *Journal of 9/11 Studies* is available at its website (<http://www.journalof911studies.com>), and confirmed by co-editor K. Ryan (private communications, 2013).

v JEM author guidelines provide for the submission of both Discussion papers and a final Closure paper by the original author(s), both limited to 2000 words.

vi Chemist Kevin Ryan (2012) has shown that building code changes, traceable to basic causes cited by NIST for the destruction of WTC buildings, have never been adopted, whether by the international building community, or even New York City.

vii The History Commons website is an experiment in open-content civic journalism (www.historycommons.org), providing dynamic timelines with summaries of over twenty thousand events.

viii In considerable detail, David Ray Griffin has shown that "the NIST report on WTC 7 should be exposed by the scientific community for committing scientific fraud in the strict sense." (Griffin, 2010).

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