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World Trade Center Fireproofing Tests Suggest a Wider Safety Problem

By JAMES GLANZ

Hundreds of buildings nationwide with fireproofing similar to that used in the World Trade Center could be far more prone to structural damage during major fires than previously thought, according to preliminary calculations by federal investigators.

The investigators are studying the precise causes of the World Trade Center collapse. Their work includes calculations of how heat moves through steel building components with small gaps or imperfections in fireproofing insulation. Their inquiry, which is still in its early stages, shows that during a fire such flaws can act as sluice gates for heat, allowing it to enter the steel, where it becomes trapped, weakening the structure.

Countless buildings put up since the 1960's have used the same type of lightweight, fluffy, spray-on fireproofing to protect their steel. Photographic evidence of the trade center suggests that this material, which is easily damaged, had gaps and possibly larger missing sections. Experts say similar problems are also found in ordinary high-rises.

The investigators want to examine the fireproofing in New York City buildings of similar vintage, and the city's Buildings Department has agreed to help identify them. Patricia J. Lancaster, the buildings commissioner, said that the use of spray-on fireproofing was extremely widespread in the city. "It's everywhere," Ms. Lancaster said. "It's easy to apply, and it's

light."

She said that because many fireproofing subcontractors do excellent work, she would be surprised if large variations in thickness, like gaps in the insulation, turned up in every building that was inspected. But, she added, not enough attention has been paid to concerns like the long-term durability of patches to fireproofing. Patches are applied after parts of the coatings are removed during work on ducts, wiring or sprinklers.

Investigators said their findings could have implications beyond the collapse of the towers themselves.

"When we entered into this investigation, there clearly was a concern with explaining why buildings that looked like they would stand forever came down," said Richard G. Gann, a senior research scientist at the Building and Fire Research Laboratory of the Commerce Department's National Institute of Standards and Technology in Gaithersburg, Md. That is where this \$16 million investigation into the sequence of structural failures that led to the collapse of World Trade Center — buildings that looked as if they would stand forever — is being conducted.

But, Dr. Gann said, "there are implications for other buildings, even if they are of different construction types, different styles, even conventional buildings."

S. Shyam Sunder, the leader of the investigation, cautioned that it was too soon to know if a formal bulletin or alert would be issued. He pointed out that no large-scale survey of fireproofing in high-rise buildings has been done, and that even with variations, it could turn out that in some cases fireproofing thicknesses are conservative, or sufficient for protection in all but the thinnest spots.

So far, he said, investigators have looked at only a small number of buildings in the Washington area, near their laboratories. In those buildings, they found substantial variations in fireproofing thickness.

He said they hoped that the inspections of the New York City buildings would yield closer parallels with the World Trade Center. Whatever the variations in the thickness of the fireproofing in the New York buildings turn out to be, he said, the team's calculations have so far focused only on individual steel components rather than on the overall building structure.

"We need to understand what the effect of this is on the performance of the components as a whole," Dr. Sunder said. "As we complete the work and can make definitive findings on fireproofing variability, then a recommendation can be made."

But other researchers are saying that the implications for ordinary buildings could be the most important outcome of the inquiry.

"When the investigation is over, this issue will radiate out to other buildings that have fireproofing in them," said Glenn P. Corbett, a member of the investigation's advisory committee and an assistant professor of fire science at the John Jay College of Criminal Justice. "We really have to decide whether it's appropriate to continue to use this type of material."

Whether the collapse of the twin towers was inevitable given the structural damage done by the hijacked planes, or whether the towers would have been able to stand with better fire protection is still not known. The exact sequence of failures that led to the towers falling has not yet been determined either. The federal investigation will try to answer these questions before a final report is released next fall.

Officials with the Port Authority of New York and New Jersey, which built the trade center, have claimed in the past that no matter how well the steel was protected, the planes probably knocked off much of the fireproofing where they struck. Other experts have disputed that contention, saying that poorly applied and maintained fireproofing could have played a role in the collapses.

Only the cores of the twin towers, which held the elevators and

escape stairwells, were built like traditional high-rises, with clusters of relatively heavy steel columns and beams linked together in a cagelike matrix. Beyond that, the 110 floors in each tower contained roughly an acre of open space each, uncluttered by vertical support columns.

Floor supports called trusses ran like bridges from the core to a dense palisade of columns within the towers' facades — 59 columns, each with relatively thin steel, per side of each tower. The trusses, a web of narrow steel bars and other components, were stouter versions of the supports used in the ceilings of many warehouses, supermarkets and sports installations like indoor tennis courts.

Spray-on fireproofing replaced the use of heavier materials, like terra-cotta blocks, after World War II, and became extremely common in the 1960's, when the World Trade Center went up. The fireproofing used on the trade center trusses was a mixture of mineral fibers and cement-like materials called binders.

Investigators at the Building and Fire Research Laboratory recreated the formula used at the trade center and applied it to mock-ups of the trusses in their laboratories. Dried and in place on the truss bars, the material is friable, even dusty to the touch. It tends to crumble under the slightest pressure.

Perhaps not surprising, there is extensive evidence that the trade center's fireproofing was missing in places. "We were looking at a lot of pictures of the World Trade Center, especially of the trusses," said Kuldeep Prasad, the investigator whose computer simulations produced the results on heat flow last month. "What we noticed was that there were gaps in the insulation. For some reason the insulation had just fallen off."

Investigators have also found that no fireproofing at all was applied to the sandwiches of metal and rubbery glue, called viscoelastic dampers, because the trade center plans did not call for it. The dampers were connected to the outer edges of the trusses, where they connected to the perimeter columns. The dampers, about 10,000 in each tower, acted like shock absorbers

to reduce the sway of the buildings in the wind.

The bare dampers "provide a heat input" to surrounding components, said Dr. John Gross, the leader of the structures group at the Building and Fire Research Laboratory. "It's steel that can heat up, connected directly to steel that is protected."

Even worse, investigators have found, there are indications that because workers had orders to avoid getting fireproofing on the dampers, they skimmed when spraying it on portions of the steel trusses in the same areas. Dr. Gross said that investigators were still trying to assess contradictory evidence about whether damaged and missing fireproofing was fixed.

In any event, Dr. Prasad decided to examine the effect of variations in the thickness of the fireproofing. His calculations showed that even random thickness variations of 20 percent in the fireproofing could cut in half the time it takes heavy vertical core columns to heat up to the point where they lose roughly half their strength and are prone to collapse.

On lighter members, like the thin steel bars of the trusses, gaps as narrow as an inch in the fireproofing could have catastrophic consequences, Dr. Prasad found.

"That bare steel gets hot very quickly," he said. "And when I say quickly, I mean a few minutes. Then, once it gets hot, it starts seeping energy in both directions."

As the intact fireproofing around the gap keeps the heat from radiating from the bar, he said, the heat travels even farther, compromising more and more of the steel.

Another fire expert, Philip J. DiNenno, president of Hughes Associates in Baltimore, cautioned against assuming that fireproofing gaps in ordinary buildings posed dangers before additional calculations and inspections have been completed.

