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CSCE member in the "Experts Team" studying the collapse of the World Trade Center

The September 11th, terrorist attacks on the World Trade Center and the Pentagon caused significant damage and destruction to buildings and infrastructure in the vicinities of the World Trade Center and the Pentagon. In the aftermath of these terrorist incidents, civil engineers have assumed prominent roles and are leading the efforts to evaluate not only the performance of the affected buildings, but also the vulnerability of the infrastructure to future attacks.

The American Society of Civil Engineers (ASCE), together with the Federal Emergency Management Agency (FEMA), have established a tea of experts to investigate the performance of buildings and infrastructure in the vicinity of WTC. Representing a coalition of leading engineering organizations, the Building Performance Study Team (BPAT) will be led by ASCE and FEMA. Partnering organizations on the study include the American Institute of Steel Construction Inc. (AISC), the American Concrete Institute (ACI), the Council on Tall Buildings and Urban Habitat (CTBUH), the International Code Council (ICC), the National Fire Protection Association (NFPA), the Society of Fire Protection Engineers (SFPE), the Structural Engineers Association of NY (SEAoNY), the Masonry Society (TMS), the National Council of Structural Engineering Associations (NCSEA), the Structural Engineers Institute (SEI) of ASCE and the New York Department of Design and Construction (DDC). The BPAT team comprises of experts in tall buildings, steel structures, connections, fire engineering, blast effects, and structural investigations. Dr. Venkatesh Kodur, MCSCE, is the only member from outside of the U.S.A. invited to join the experts team. Dr. Kodur, Research Officer at the Institute of Research in Construction, National Research Council of Canada, is a world expert in the areas of fire resistance and the effect of fire on building materials.

The main objective of BPAT is to investigate the factors that led to the collapse/ damage of the buildings in the vicinity of the World Trade Center. The team will also make recommendations relating to research needs for designing and constructing safer buildings. The BPAT members visited Ground Zero (WTC) for six days in the beginning of October, and collected a significant amount of data. The team visited the collapsed/ damaged WTC buildings and collected data relevant to building performance under extreme conditions. Significant damage occurred in the WTC complex, comprising seven buildings, and to a number of high-rise buildings in the WTC vicinity (about 1 km radius): four buildings (Towers 1 and 2, Buildings 3 and 7 of WTC) had completely collapsed, four buildings around the Towers had partially collapsed (beyond any repair), nine buildings had major damage and 18 other buildings had moderate damage. After the events, the city had to carry out structural assessments of about 400 high-rise buildings.

At present, the BPAT is analysing data to determine what parts of the building were destroyed upon the initial impact, what columns were destroyed, and how the fire grew and contributed to the collapse of the towers and the surrounding buildings.

The studies' findings will be published in spring 2002 in a joint ASCE / Federal Emergency Management Agency (FEMA) report. Further details, including the names of the experts assigned to the WTC Building Performance Study team, are listed on ASCE's Web site at www.asce.org/ emerg_document _pub.cfm.

Dr. Venkatesh Kodur, MCSCE, is a Research Officer at the Institute of Research in Construction at the National Research Council of Canada, Ottawa. He received his M.Sc. and Ph.D. degrees from Queen's University at Kingston, Canada. His expertise includes laboratory testing and numerical modeling for the evaluation of fire resistance of structural members, and nonlinear design and analysis of structures. He has published over 90 papers in the areas of structural and fire resistance. He is an adjunct Professor at Queen's University, Canada; Chairman of ASCE Committee on Structural Fire Protection; member of ACI Fire Protection Technical Committee, and a member of CSA Standard on FRP for Structural Components for Buildings.

Venkatesh Kodur outside the Column furnace at the NRC/ IRC's M-59 building in Ottawa.

Dr. Kodur's expertise in fire resistance and on the effect of fire on building materials is recognized worldwide. He has led international collaborative research projects with Taiwan, U.K., Belgium and U.S.A. He has been invited to deliver keynote presentations at international conferences in Canada, U.S.A, Taiwan, Malaysia and Spain and has won awards including "NATO Award for Collaborative Research" with Building Research Establishment, U.K. He was invited to write a chapter for the "SFPE Design Manual on Fire Protection Engineering", the most widely used handbook by fire protection engineers around the world.

Simply put Dr. Kodur's research consists of putting building elements under tremendous stress and unleashing hellish fires on them. Speaking to CSCE Dr. Kodur said "The efforts of BPAT is to establish how better buildings can be designed", adding that the debate in engineering circles will endure for years beyond that. "We want to look at how we can improve without sacrificing too much of what we really need" in the traditional building world, he explained.

Building materials are designed to resist fire, he explained, but not the kind of high-temperature inferno that resulted from the burning of the aviation fuel.

When asked if engineers could build a skyscraper that could withstand an airplane blast, he said it was possible but added: "It would be very hard, a bunker maybe, and who knows if you could use that building for anything?" Dr. Kodur has said that for the first time large steel buildings had completely collapsed due to a fire, relying on an earlier review of literature (as part of NATO award) on steel structures from around the world.

Dr. Kodur's current research interests include how high-strength concrete columns can be made more fire-resistant. Figure 1 shows a high-strength concrete column failing after a fire resistance test. The 300 mm square column, 3.8 metres high, is part of the series of columns Dr. Kodur tested recently to develop fire resistance design guidelines for HSC columns for incorporating in Codes and Standards.

Concrete contains tiny pockets of trapped moisture, he explained. When it is overheated, the pressure from the moisture becomes tremendous, causing chunks to literally explode off the column. He is now experimenting with mixing small amounts of fibrous poly-propylene into the concrete as a fire retardant. In theory, the small fibres are intended to release the pressure build-up and allow the column to stand longer.

The column furnace itself at NRC, the only one of its kind in North America, can apply a metric tonne of pressure. Mr. Kodur said his high-temperature furnace has been able to help the designers of the Hibernia oil rigs deal with issues of the fire resistance of concrete columns. Eventually, the use of the fibres might make its way into Canada's building codes. One of the most important tasks performed at NRC is developing better, safer building techniques and codes for Canadians.

CHTS visits Montreal, Quebec in December 2001

On December 5 and 6, 2001, CSCE was the host to the China Highway and Transportation Society (CHTS). During CHTS' visit to Toronto and Montreal, both learned Societies had the opportunity to exchange information on their respective activities and to discuss how we can further promote the exchange and cooperation between CHTS and CSCE.

Many thanks to Dr. Todd Chan, our Liaison Officer for China, Mr. Randy Pickle, our Ontario Regional Chair, and Mr. Mahmoud Lardjane, our Programs Coordinator, for having organized all details for these visits. The individuals who attended these visits were:

China Highway and Transportation Society

- Mr. Li Juchang, Chairman, China Highway and Transportation Society;
- Mr. Zhang Zhiqiang, Vice-Chairman, China Highway and Transportation Society;
- Mr. Wang Weizhou, Board member, China Highway and Transportation Society, General Manager of Luqiao Company in Yiyang Cooperation;
- Mr. Liu Wenjie, Deputy Secretary General, China Highway and Transportation Society; and
- Mr. Shu Mingxin, Researcher of Research Institute of Highway, Ministry of Communications.

The Canadian Society for Civil Engineering

- Anne-Marie Leclerc, Assistant Deputy, Ministry of Transportation;
- Pierre Asselin, Quebec Regional Chair;
- Randy Pickle, Ontario Regional Chair;
- Todd Chan, Liaison Officer for China;
- Mahmoud Lardjane, Programs Coordinator; and
- Michel Langelier, Executive Director