THE PAST AND FUTURE OF STRUCTURAL FIRE ENGINEERING IN THE USA

John L. Gross

National Institute of Standards and Technology, Gaithersburg, Maryland USA

Abstract

In 1791, just four years after the U.S. Constitution was signed, President George Washington issued the first regulations limiting building heights in the nation's new capital of Washington D.C., "concerned as much about structural and fire safety as about urban design" (Lewis, 1994). Thus, regulations in the U.S. to limit the consequences of fire date back over 200 years to the founding of the United States of America.

The U.S. grew rapidly with population centres in Philadelphia, New York, Boston, Chicago and San Francisco. Along with this growth came devastating fires that affected all of these burgeoning cities. The Great Chicago Fire of 1871, in which over 17,000 buildings were destroyed, marked a significant turning point in building practice whereby the fire resistance of a building became a key design objective. "Although the early knowledge of the requirements for fire protection resulted from a study of the behaviour of structures in fires and from examination of fire-damaged buildings, the development of skeleton-type construction made the necessity for fire endurance testing apparent" (Shoub, 1961). New York City was the first American city to introduce a standard fire test method in the 1899 New York Building Code (Babrauskas and Williamson, 1978). But it was the Great Baltimore Fire of 1904 that prompted the American Society for Testing and Materials (ASTM) to organize a national effort to standardize fire resistance testing.

By 1914, when Simon Ingberg joined the National Bureau of Standards (now the National Institute of Standards and Technology), "fires in the U.S. were claiming several thousand lives annually and property losses exceeded $250 million, 10 times the rate of any country in Europe" (Gross, 1991). Recognizing the national fire problem of frequent structural collapses and multi-building conflagrations, Ingberg focussed on "fundamental engineering data to serve as a basis for the revision and reconstruction of state and municipal building codes" (Gross, 1991). "Ingberg's work on fire severity and fire resistance was adopted by national standards and model building codes…and his classification of building types (fireproof, incombustible, exterior-protected and wood) remains the basis for requirements for fire resistance of building components…" (Evans *et al.*, 2001).

The development of the performance-based approach to structural design has re-vitalized interest in the U.S. in structural fire engineering. The application of engineering principles in the areas of fire dynamics, heat transfer, and structural mechanics has made possible the prediction of performance of a structural system exposed to threatening fires. Such advances highlight the need for validation of analytical predictions with results of large-scale experiments on structural components, assemblies and systems under realistic fire conditions. NIST has constructed a new experimental facility, the National Fire Research Laboratory (NFRL), for conducting such research.

This Keynote Lecture recounts the historical development of building code requirements for fire in the U.S. and makes the case for the need for experimental data on real-scale structural systems under realistic fire conditions in support of structural fire engineering. Further the lecture will describe the capabilities of the NFRL and provide an update on the commissioning of the new lab and plans for future tests.

Keywords: fire design, full-scale testing, performance-based design, validation

REFERENCES

Babrauskas, V. and Williamson, R. B. 1978. *The Historical Basis of Fire Resistance Testing – Part II, Fire Technology,* Vol. 14, No. 4, Nov.

Evans, D., Gross, D. and Wright, R. 2001. Test of the Severity of Building Fires, A Century of Excellence in Measurements, Standards, and Technology, Lide, D.R. (ed.), NIST Special Publication 958, National Institute of Standards and Technology, Gaithersburg, MD.

Gross, D. 1991. Fire Research at NBS: The First 75 Years, Fire Safety Science – *Proceedings of the Third International Symposium,* July 8-12, Edinburgh, Scotland.

Ingberg, S.H. 1929. Fire Resistance Requirements in Building Codes, Quarterly of the National Fire Protection Association, Vol. 23, No. 2, NFPA, Boston, MA.

Lewis, R. 1994. Testing the Upper Limits of D.C. Building Height Act, The Washington Post, Saturday, April 23, Washington, D.C.

Shoub, H. 1961 Early History of Fire Endurance Testing in the United States, Special Technical Publication No. 301, ASTM, Conshohocken, PA