

STABILITY LIMIT STATES ASSESSMENT OF STEEL FRAMED STRUCTURES UNDER FIRE LOADING

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This research seeks to provide a framework for a rigorous approach to fire engineering that specifically focuses on developing a methodology and supported technologies to simulate and assess the performance of steel buildings subjected to fire. The research will incorporate ideas from probabilistic seismic design as the basis for an overall model for fire engineering. This model uses Intensity Measure to evaluate Damage Measures based on Engineering Indices to come up with a series of Decision Variables.

The motivation for this research is two fold. First, it is based on the relative lack of study of this subject done in the United States. While other countries, primarily Great Britain and the rest of Europe to a lesser extent, are doing a lot of work in this area, relatively little is being done here. The U.S. building codes on the subject are based largely on empirical formulas, the performance of single elements, and use of “standard fires”, that often bear little resemblance to realistic fires. By developing a usable, more realistic model for evaluating the whole frame or structural performance the potential for economic and practical benefit is great. Savings from a more rational approach to fireproofing requirements could come from first costs (the reduction in fireproofing), in service maintenance inspections (the ability to see unprotected members and evaluate them directly, for instance after an earthquake), innovative structures, and more consistent risk and reliability.

This project will first review current practice and previous work to understand and better define the problem. It will then seek to bring together the various aspects of fire engineering in a Probabilistic Foundation for Fire Performance Assessment model. In presenting this model it will seek to investigate the Intensity Measure, the temperature of the fire and the fire severity. Through use of various models it will attempt to better quantify the fire severity, or the destructive potential of a fire. From there it will next examine the Engineering Indices, the deflection in members, the distortion of members and the fire resistance (a time) of a structure. This research project will largely focus on this aspect of the model. It will seek to better understand and present ways of looking at the entire structure or a frame’s performance due to the change in temperature in the members. This will include models for determining the temperatures reached by members during a fire based on the Intensity Measure. It will also model the deflections and distortions of members due to changes in material properties and their geometry due to the increase temperatures. It will seek to model the interaction of connections as well as other portions of the building that may or may not necessarily be engulfed by the fire. Finally it will seek to develop a rational method to determine fire resistance time for a building. These Engineering Indices will then be related to Damage Measures in a structure, looking at structural, non-structural, and contents damage. These Damage Measures will be looked at in terms of the full spectrum of level of loss and functionality of the structure after a fire. The research will then show the relation to Decision Variables dealing with life safety, building loss and facility downtime.

It is hoped that the results of this research project will be a step towards making fire engineering in the United States a more rational process and provide a unifying basis for further work in the area. It is hoped that this rigorous model for fire engineering, that is also related to similar

methods for looking at seismic engineering, will lead to its acceptance as a easily understood starting point for further research in the subject.