Development of Building Safety Evaluation Technology for Post-Earthquake Fire

(Period of Study: From FY 2015 to FY 2017)

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1. Foreword

In the event of a large earthquake, it is quite likely that a building may sustain damage not only from an earthquake but also from a post-earthquake fire. As there may be cases where it is difficult to engage in normal firefighting activities following an earthquake, the extent of damage from a post-earthquake fire can become quite serious. [1]

In the wake of an earthquake disaster, an emergency risk assessment is conducted from the standpoint of preventing a secondary disaster, among other things. But if a fire breaks out in a building, causing the temperature of a structure to rise, it could lead to a deterioration in the rigidity, strength, etc., of the main structural elements of a building. With regard to a building that has sustained earthquake damage, as well as fire damage, there is currently no established method for adequately confirming its safety.

In this study, with the aim of establishing a method for evaluating the safety of a building that has sustained damage from a post-earthquake fire, we assessed, through tests, etc., the effects of heat penetration in the event of traces of cracks, etc., occurring in the components or claddings of a building.

2. Temperature Characteristics of Steel Components during Post-Earthquake Fire

It is likely that the refractory materials of refractory-coated steel components may be cracked, lost, or otherwise damaged due to an earthquake, etc. In this study, to simulate a fire situation, we conducted heating tests by providing clearances as surrogates for cracks on steel columns and steel beams that were refractory-coated by a molded plate attaching construction method (calcium silicate plate) and a wraparound construction method (heat-resistant rock wool felt) (Photo 1). It was found through the tests that the larger a crack width was, the faster the temperature of steel components, an indicator of fire resistance performance of components, rose. To assess the heat impact on cracked sections, we quantified relationships between the crack width and the rise in temperature by establishing a temperature estimation model (Figure 2) taking into consideration the heat balance on the cracked sections.

3. Temperature Characteristics of Concrete Floors during Post-Earthquake Fire

In the case of reinforced concrete components, it is quite likely that heat penetration through cracks could lead to a deterioration in fire resistance performance and post-fire strength. In this study, with the aim of evaluating the safety of damaged floor slabs (Figure 3), we assessed the thermal effects around cracks and surrounding areas through tests (Figure 4). Our next step is to study the development of a strength evaluation model for the main structural elements of a building that has sustained damage from both an earthquake and a post-earthquake fire.

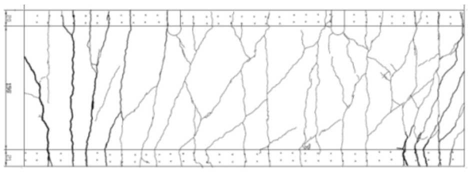

Figure 3. Assessment of the actual condition of cracks on concrete floor

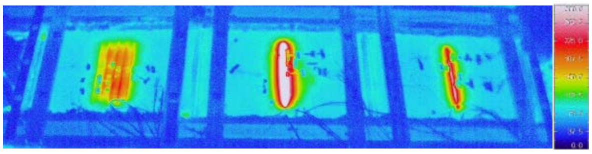

Figure 4. Thermal image of temperatures of cracked sections

Reference:
1) "How to design the new demarcation of cities that meets the future needs of architecture, cities and the environment", Material for Architectural Institute of Japan's research committee meetings (2015)

Photo 1. Specimen of steel components

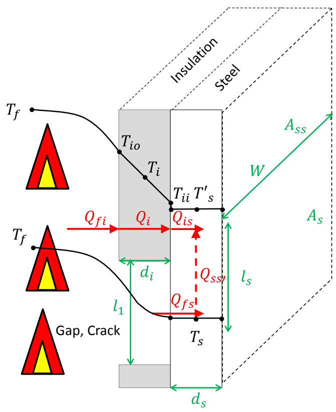

Figure 1. Heat transfer model on cracked sections

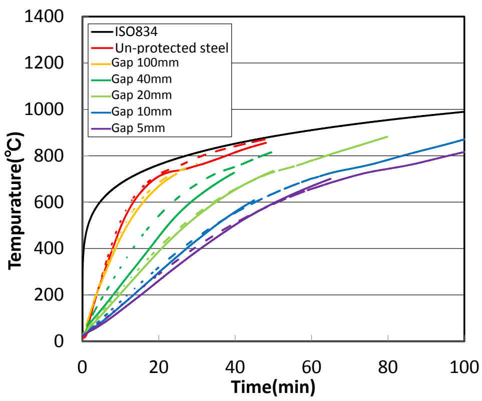

Figure 2. Trends in temperature of steel plate on cracked sections