EXPOSING GLAZING ASSEMBLIES TO FIREBRAND SHOWERS

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1. ABSTRACT

An experimental campaign was undertaken to determine vulnerabilities of glazing assemblies to firebrand bombardment using the NIST Dragon installed in the Building Research Institute's Fire Research Wind Tunnel Facility (FRWTF). Results of these experiments are presented.

2. INTRODUCTION

Post-fire studies suggest that the firebrands are a major cause of structural ignition of Wildland-Urban Interface (WUI) fires in USA and Australia [1-2]. Firebrand ignition is also important in urban fire spread in Japan. In order to develop scientifically based mitigation strategies, it is necessary to understand the vulnerabilities of structures to firebrand showers. The experimental results generated from the marriage of the NIST Dragon to the Building Research Institute's (BRI) Fire Research Wind Tunnel Facility (FRWTF) have uncovered the vulnerabilities that structures possess to firebrand showers for the first time [3]. These detailed experimental findings are being considered as a basis for performance-based building standards with the intent of making structures more resistant to firebrand attack. An experimental database is also being created to support NIST's Wildland Fire Dynamics Simulator (WFDS) [4].

The present investigation outlines a parametric study that was undertaken to determine glazing vul nerability to firebrand showers. An important quest ion is whether firebrands become trapped, accumul ate inside the corner of the framing of glazing asse mblies, and lead to window breakage. These experi ments are the first to investigate these vulnerabilitie s in a parametric fashion. Prior to conducting these experiments, input was collected from interested p arties in California since large WUI fires have occu rred in this state recently [5].

2. EXPERIMENTAL DESCRIPTION

A detailed description of the NIST Firebrand Generator (NIST Dragon) is not provided here since the device, as well as the mulch type used in this experimental campaign, was identical to those used by Manzello *et al.* [3].

The NIST Dragon was installed inside the test section of the FRWTF at BRI. The facility used a 4.0 m diameter fan to produce the wind field and was capable of producing a flow of 10 m/s. To track the evolution of the size and mass distribution of firebrands produced, a series of rectangular pans (water-filled) were placed downstream of the NIST Dragon.

3. RESULTS AND DISCUSSION

Similar to past studies, the input conditions for the Firebrand Generator were intentionally selected to produce firebrands with mass up to 0.2 g. This was accomplished by sorting the Norway Spruce tree mulch using a series of filters prior to being loaded into the firebrand generator. The same filtering procedure was used as in past studies. Since the procedure for determining the size and mass distribution was identical to prior work, it is not presented here.

After the size and mass distribution of firebrands produced from the Firebrand Generator was determined, a full scale wall fitted with glazing assemblies was installed inside the FRWTF. Two types of glazing assemblies were used for the experiments. The first type was a horizontally sliding window assembly. The second type was a vertically sliding window assembly. Both of these glazing assemblies were double hung since it is also thought that this type of assembly would provide more locations for firebrands to accumulate.

The size of each of the glazing assemblies were the same: 91 cm by 91cm. To mount these assemblies, a 244 cm by 244 cm wall fitted with an open eave was constructed for testing. The wall was constructed using wood framing members spaced 400 mm (16”) on center. Oriented strand board (OSB) was applied over the wood framing members and a moisture barrier was installed over the OSB. Vinyl siding was applied over the moisture barrier. An eave with a total length of 122 cm was constructed and mounted to the wall assembly. For completeness, an image of a typical experiment is shown in Fig. 1.

Figure 1 Picture of wall/eave assembly fitted with a vertically sliding, double hung window exposed to firebrand showers at a wind tunnel speed of 9 m/s.

For, each window assembly considered, two different wind speeds were used. Specifically, the window assemblies were exposed to firebrand showers at wind tunnel speeds of 7 m/s and 9 m/s. It was observed that firebrands accumulated within the framing and this behavior was more pronounced for the vertically sliding glazing assembly; as suspected. Yet, in none of the experiments did the framing sustain sufficient damage for the window assembly to cause glass fallout and/or breakage.

Tests were also conducted to determine if firebrands can produce ignition in fine fuels placed adjacent to the wall assembly and whether the subsequent ignition of fine fuels could lead to ignition of the wall assembly itself. Dead tree needles were placed adjacent to the wall assembly to simulate fine fuels likely to be placed near a structure (such as pine straw mulch).

Firebrands were observed to ignite the needle bed via smoldering ignition, the smoldering ignition become self-sustaining, and a transition to flaming ignition was observed (see Figure 2). The flaming ignition in the needles subsequently melted the vinyl siding and produced self-sustaining smoldering ignition at the base of the wall assembly (within the OSB; this OSB was not even dried).

4. SUMMARY

It must be stated that in real WUI fires, firebrand showers have been observed for several hours and with winds in excess of 20 m/s. It was not possible to conduct experiments using higher wind speeds since the FRWTF was not designed to generate a wind field in excess of 10 m/s. Over the limited wind speeds considered, in none of the experiments did the framing sustain sufficient damage for the window assembly to cause glass fallout and/or breakage. Firebrands were observed to produce ignition in fine fuels placed adjacent to the wall assembly and subsequent ignition of fine fuels lead to ignition of the wall assembly itself. These experiments are important to demonstrate to homeowners the dangers of firebrands and combustibles located too close to structures.

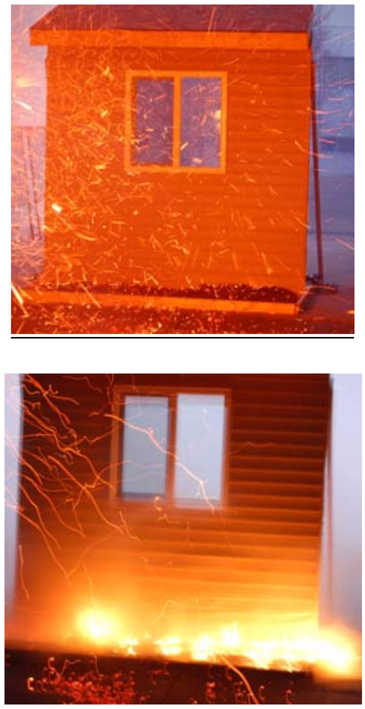

Figure 2 In the top image, firebrands have caused smoldering ignition in the mulch bed. In the bottom image, smoldering ignition has transitioned to flaming ignition and the wall assembly has ignited.

ACKNOWLEGMENTS

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