Firebrand Generation Data Obtained from a Full Scale Structure Burn

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1. ABSTRACT

A full-scale, proof-of-concept experiment was conducted to investigate firebrand production from a burning structure. In this experiment, NIST researchers were invited to set up instrumentation during a structure burn down. As the structure burned, firebrands were collected using an array of water pans. In addition, structure components, namely wall and re-entrant corner assemblies made simply from oriented standard board (OSB) attached to wood studs, were burned to collect firebrand data from components to compare both results under wind. Results of all of these firebrand measurements are presented here.

2. INTRODUCTION

Fires in the Wildland-Urban Interface (WUI) have become a problem in the USA as well as many other countries throughout the world. WUI fires often result in catastrophic damage to property and displace tens of thousands of people. Anecdotal evidence as well as post-fire damage assessment studies suggests that wind driven firebrand showers are responsible for a majority of structure ignitions in WUI fires [1]. Without physical knowledge regarding how firebrands ignite structures in WUI fires, it is impossible to develop risk assessment and mitigation tools intended to reduce structure losses in these fires. Little, if any, data exists regarding firebrand production from actual structures.

To this end, in collaboration with the Northern California Fire Prevention Officers, (NORCAL FPO, a section of CALCHIEFS), a full-scale, proof-of-concept experiment was conducted to investigate firebrand production from a burning structure. Details are provided elsewhere [2].

In addition, a wall and re-entrant corner assemblies were burned down to collect firebrand data from components (oriented standard board (OSB) attached to wood studs) under wind in the Building Research Institute's (BRI) Fire Research Wind Tunnel Facility (FRWTF). Both firebrand data from a full-scale structure burn and controlled structure component burn are compared.

3. EXPERIMENTAL DESCRIPTION

The full-scale structure used for the experiments was a two story house located in Dixon, California. Debris piles were used to ignite the structure, and it took approximately two hours after ignition for complete burn down. The picture of the house burn is shown in Fig. 1. A large amount of water was poured onto the structure several times to control the fire. Firebrands were collected by using a series of water pans placed near (4 m) from the structure and on the road about 18 m downwind to the structure. After deposition into the water pans, the firebrands were filtered from the water using a series of fine mesh filters [2].

For comparison, three experiments were performed in BRI's wind tunnel, shown in Fig. 2, using the experimental conditions in table 1. A wall assembly and re-entrant corner assemblies shown in Fig. 3 were used for experiments since they are typical residential construction in USA. Wood studs of both a wall assembly and re-entrant corner assemblies were spaced 40 cm on center, and OSB was used as the exterior sheathing material. The assemblies were ignited using a T-shaped burner for 10 min under no wind. The T-shaped burner was placed on the outside of assemblies since the purpose was to simulate ignition from outside fire. After turning the burner off and wind tunnel on, it took 6 min and 30 min to finish experiments when the wall assembly and the re-entrant corner assemblies could not support flaming, respectively. Firebrands were collected by using a

Fig. 1 Picture of a House Burn

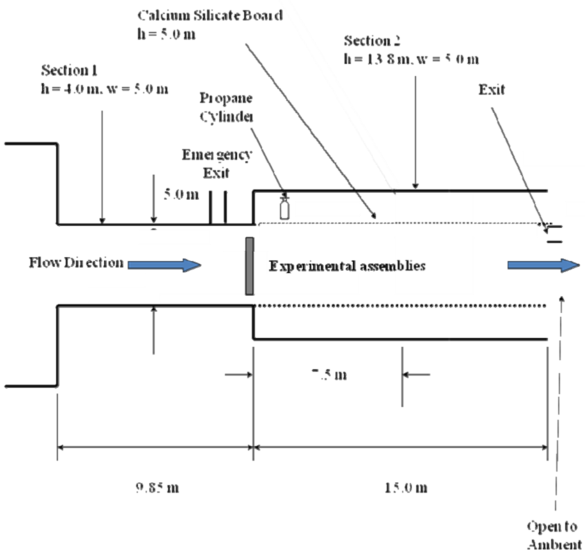

Fig. 2 Schematic of FRWTF in BRI
(See Fig. 3 for Detail of Experimental Assemblies)

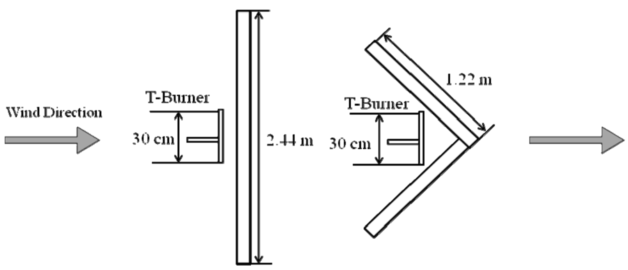

Fig. 3 Schematic of Experimental Assemblies
(Left: Wall Assembly, Right: Re-entrant Corner Assembly)

series of water pans placed behind the assemblies. After deposition into the water pans, the firebrands were filtered from the water using a series of fine mesh filters.

Firebrands were dried in an oven and the mass and size of each firebrand was measured by a precision balance and using digital image analysis, respectively.

4. RESULTS and DISCUSSIONS

The firebrands collected both from the full-scale structure burn and structure components (wall/reentrant corner assemblies) were compared with firebrand data from burning vegetation from Manzello et al. [3] and are shown in Fig. 4. In Fig. 4, firebrands greater than 25 cm^2 projected area or with more than 5 g mass are eliminated for a detailed comparison. Figure 4 shows that the size and mass distribution of firebrands at two locations (one is 4 m from a structure, the other is 18 m downwind from structure) were similar. It was also found out that the size and mass distribution of firebrands from experiment No.2 and No.3 were quite similar while the one from experiment No.1 had more variety of projected area at a certain mass, especially within 10 cm^2 projected area. The size distribution of firebrands collected in this study was observed to have some similarity as well as some difference. The firebrands in this study were observed to have a large projected area for similar mass classes. In addition, a bigger firebrand with more than 50 cm^2 area was found in this study while all the firebrands in Manzello *et al.* [3] had less than 40 cm^2 projected area.

Figure 5 shows that the size distribution of firebrands collected from a full-scale structure burn and wall and reentrant corner assemblies compared with firebrand data from Vodvarka's study [4], in which firebrand size from a full-scale wooden house was measured by using polyethylene sheets. It was found that most of firebrands from a full-scale structure, both 18 m downwind from structure and 4 m from structure have less than 10 cm^2 projected area. Most of firebrands from wall and re-entrant corner assemblies had less than 10 cm^2 projected area with firebrands from the wall assembly generally larger than those from re-entrant corner assemblies. In addition, the size distribution of the firebrands in this study was larger and broader than those of Vovardka [4], in which most of firebrands was small, around 80 % of them with less than 1 cm^2 projected area. It is important to note that water was applied during the house burn because this experiment was a part of firefighter training.

5. SUMMARY

Firebrands were collected from a full-scale structure burn in this study. In real WUI fire, most of firebrands are produced without water being applied. Even though the situation is different, this study serves as a first step to observe firebrand generation from a real structure since there are few studies which observed firebrand generation from real structures to date. The wall and re-entrant corner assemblies made simply from OSB and studs were burned under wind in BRI's FRWTF, and firebrands were collected for comparison. In this study, the size and mass distribution of firebrands collected at the burn site and from wall and reentrant corner assemblies was observed to have some similarity to those collected from vegetation burns as well as some difference. The size distribution of the firebrands in this study was larger and broader than in Vodvarka's study.

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Table 1 Experimental Conditions

	Exeprimental Assemblies	Wind Speed	Time to Finish
No. 1	wall assmebly	6 (m/s)	30 (min)
No. 2	reentrant corner assembliy	6 (m/s)	30 (min)
No. 3	reentrant corner assembliy	8 (m/s)	6 (min)

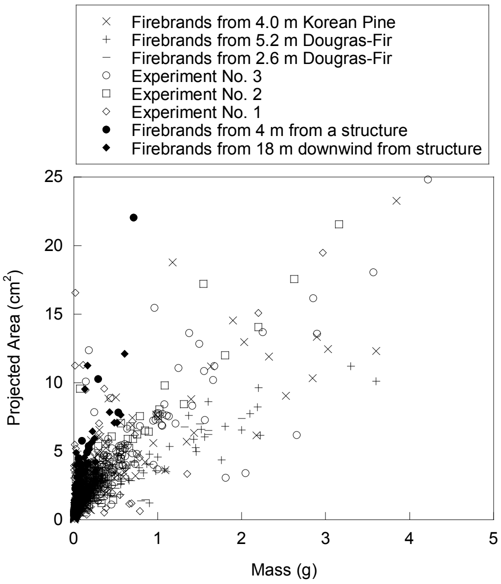

Fig. 4 Size and Mass Distributions of Firebrands

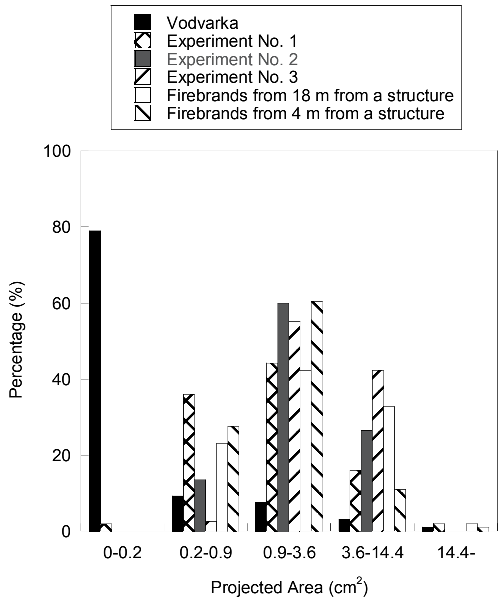

Fig. 5 Size Distributions of Firebrands

REFERENCE

[1] Maranghides, A., Mell, W.E., Fire Technology 47 (2011) 379-420

[2] Suzuki, S., Manzello, S.L., Proceeding of JAFSE Annual Symposium 2011 (2011) 418-419

[3] Manzello, S.L., et. al, Fire and Materials Journal 22 (2009) 21-31

[4] Vodvarka, F.J. IIT Research Institute, Chicago, IL. (1969) 33 p.