SCATTERING & TRANSPORT OF FIREBRAND: EFFECT OF FIREBRAND SHAPES

bushfire&natural HAZARDSCRC

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INTRODUCTION:

Firebrands are burning pieces of litter, for example, bark, leaf, and twigs. They can be transported by wind from meters to kilometers from the fire front. Firebrands are responsible for causing spot fires during the spread of bushfire. Firebrands are the primary factor in house loss during bushfire [1]

To study the aerodynamic of firebrands, a firebrand generator is constructed [1], to produce a uniform flow field for firebrands.

Firebrands are classified into three generic shapes: cubical, cylindrical and square disc (Table 1) to represent the litter material [2].

RESEARCH QUESTION: WHAT IS THE EFFECT OF FIREBRANDS SHAPE IN THEIR TRANSPORT AND DISPERSION?

METHOD:

To study the scattering of non-burning firebrands, 250 firebrands at a rate of 0.33 firebrands/sec injected into firebrand generator [1] to avoid the disturbance of flow field caused by firebrands in the generator. The videography at 720p & 120fps is carried out to record the trajectory of firebrands ejecting from the firebrand generator [1].

Fig. 1 shows the first impact location for different firebrand shape, the effect of bouncing & collision are ignored as it varies with surface. The experiments are carried out 10 times to achieve acceptable convergence in particle distribution (Fig. 2), it is measured as maximum deviation between successive average particle distribution.

Results:

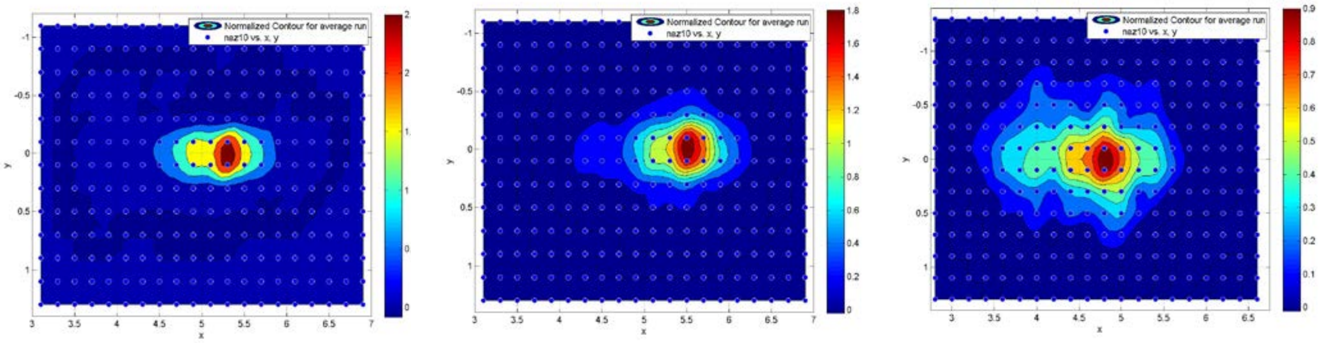

Fig. 1: Normalized distribution of non-burning firebrands after 10 experimental runs for (a) cubical, (b) cylindrical, and (c) square disc

Table 1: Physical properties of non-burning firebrands used in this study

Shape	Average Dimension (mm)	Average Mass (g)	Average Density (kg/m³)
Cubical	LBH=12.45×12.45× 12.45	0.829	575.16
Cylindrical	L=11.61, Ø =6.19	0.172	492.95
Square Disc	LBH=10.18×10.18×2.23	0.119	512.50

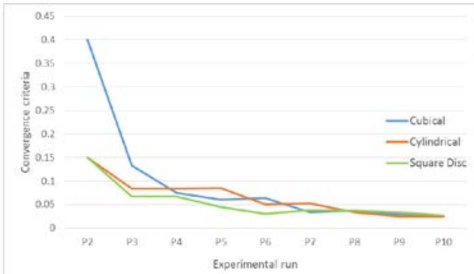

Fig. 2: Variation of convergence criteria with experimental run

Conclusion:

- The shape has effect in scattering of firebrands in perpendicular to flow field and range of firebrands along the flow field
- **Dispersion** of non-burning firebrand in perpendicular to flow field varies as: **square disc > cylindrical > cubical**
- **Range** of non-burning firebrand varies as: **cubical > cylindrical > square disc**

End User Comment:

Fire brands contribute significantly to house loss and suppression difficulty in bush fires. The spotting process is also a major source of uncertainty in fire spread prediction. This project is generating insights into the mechanics of ember transport that will aid the development of improved spotting models in the future. - Dr Simon Heemstra, NSW Rural Fire Service

FUTURE WORK:

Quantitative validation of firebrand transport(on going).

Effect of wind speed in the scattering of firebrands and their likelihood to cause spotfire in litter fuel bed[3].

References:

[1] Wadhwani, R., Sutherland, D., Moinuddin, K., Thorpe, G., & Macindoe, L. (2015) Refinement and validation of firebrand transport sub model for a physics based bushfire prediction model: Design of a firebrand generator. AFAC 2015, Adelaide

[2] Tohidi, A., Kaye, N., & Bridges, W. (2015). Statistical description of firebrand size and shape distribution from coniferous trees for use in Metropolis Monte Carlo simulations of firebrand flight distance. Fire Safety Journal, 77, 21-35.

[3] Manzello, S. L., Cleary, T. G., Shields, J. R., Maranghides, A., Mell, W., & Yang, J. C. (2008). Experimental investigation of firebrands: generation and ignition of fuel beds. Fire Safety Journal, 43(3), 226-233.

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