

WIND DRIVEN FIRES

Daniel Brandon *PhD MSc*

October 2018

Research Institutes of Sweden

Fire Research



Background



Forest Products Laboratory



Review of previous studies

- The height of external flaming reduces as the wind increases (while the neutral axis lowers and the flames spread wider either side of the opening).
- A general trend is shown from experimental data of total reducing HRR for increasing wind speeds

References:

Longhua Hu et al. (2015) Proceedings of the Combustion Institute, 2018 Internal Journal of Thermal Sciences. Guoxiang Zhao PhD Thesis, University of Gent, Belgium



Longhua Hu et al. (2017) Façade flame height ejected from an opening of fire compartment under external wind. Fire safety journal.



Review of previous studies

- The height of external flaming reduces as the wind increases (while the neutral axis lowers and the flames spread wider either side of the opening).
- A general trend is shown from experimental data of total reducing HRR for increasing wind speeds

References:

Longhua Hu et al. (2015) Proceedings of the Combustion Institute, 2018 Internal Journal of Thermal Sciences. Guoxiang Zhao PhD Thesis, University of Gent, Belgium



SE



Wind velocity: **o to 4.5 mph** Temperatue: 77°F Wind velocity: **4.5 to 11 mph** Temperature: 59°F

RI. SE



Wind velocity: **o to 4.5 mph** Temperatue: 77°F





Research Institutes

Strong wind:

- Has fluctuating velocity
- Changes the direction of the fire plume constantly
- Strong wind gusts reduce external fire plume







Strong wind:

- Has fluctuating velocity
- Changes the direction of the fire plume constantly
- Strong wind gusts reduce external fire plume







Strong wind:

- Has fluctuating velocity
- Changes the direction of the fire plume constantly
- Strong wind gusts reduce external fire plume





Strong wind:

- Has fluctuating velocity
- Changes the direction of the fire plume constantly
- Strong wind gusts reduce external fire plume





Wind velocity: **4.5 to 11 mph** Temperature: 59°F



Influence of CLT on exterior fire

Predictive modeling :

edictive modeling : Single zone model (which accounted for the contribution of CLT) was used to predict temperatures and heat release rates



Influence of CLT on exterior fire

Predictive modeling :

- Single zone model (which accounted for the contribution of CLT) was used to predict temperatures and heat release rates
- The model does not indicate an increased external heat release rate for increased wind(a maximum heat release rate density corresponding to typical apartment content of 190kW/m2 was used, which limits the heat release rate)



ATF fire tests after 21 minutes



Which compartment has exposed CLT?



30% of CLT ceiling exposed





Fully encapsulated



External exposure

Influence of wind on external exposure:

- 1. Previous research based on CFD and experiments indicate that the height of the fire plume reduces for increasingly strong wind
- 2. Experiments at RISE seem to be in line with this.
- 3. Experiments at RISE indicate that the direction of the fire plume changes constantly in wind as the wind velocity is highly variable. The fire plume only exposes the facades periodically at the same locations.

External exposure

Influence of exposed CLT on external exposure:

- 1. Increasing the airflow in the model of the ATF fire tests does not increase the external combustion.
- 2. Videos of the experiments actually confirm this

Influence on internal exposure



From literature:

- Combustion efficiency remains the same
- HRR increase 30% 70%
- 5-10 x fire growth rate



Influence on internal exposure



-0% HRR increase

- -30% HRR increase of moveable fuel & 10x fire growth rate
- -50% HRR increase of moveable fuel & 10x fire growth rate
- 70% HRR increase of moveable fuel & 10x fire growth rate
- -0% HRR increase
- 30% HRR increase of moveable fuel & 10x fire growth rate
- -50% HRR increase of moveable fuel & 10x fire growth rate
- -70% HRR increase of moveable fuel & 10x fire growth rate

Predictions accounting for

Increase of combustion rates by 30 to 70%

RI. SE

- Increase of fire growth rate (10x)

Influence on internal exposure



Maximum heat release rate of the moveable fuel (%)



Increasing the air flow:

- Increases the heat release rate (indoor)
- Increases the charring rate

But,

- Shortens the fire
- Reduces the total heat release rate of a fire
- Reduces the char depth at the end of a fire
- Reduces the total contribution of wood

Discussion



Increasing the air flow:

- Increases the heat release rate (indoor)
- Increases the charring rate

But,

- Shortens the fire
- Reduces the total heat release rate of a fire
- Reduces the char depth at the end of a fire
- Reduces the total contribution of wood

External exposure

Influence of wind on internal exposure:

- 1. The model suggests an increase of heat release rate, but a reduction of damage
- 2. Experimental results of the FPRF compartment test are in line with this.





THANK YOU

Daniel.brandon@ri.se

+46 706 73 5573

Research Institutes of Sweden
Fire Research