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IWMA International Water Mist Association

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High-Pressure Water Mist Applications for Façade Fires

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more info
https://fric.no/en/news

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Outline

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- Experimental Setup
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  - Instrumentation
  - Suppression System
  - Test Matrix
- Results and Discussion
  - Temperature and Damage
  - Heat Flux on the Façade
  - Heat Flux Emitted to the Ambient
  - Water Consumption
- Conclusions and Future Work

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Background

- The Façade system is one of the most important aspects of an architectural design, taking up around 15%–25% of the total construction cost.
- Facade systems are not part of the primary structure of buildings and are not recognized in prescriptive legislation as critical for life safety during a fire event.

Grenfell Tower, London, UK, 2017
The Telegraph

Communication Tower, Changsha, China, 2022
The Guardian

Boulevard Walk Tower, Dubai, UAE, 2022
Daily Mail

Boulevard Walk Tower, Dubai, UAE, 2022
Daily Mail

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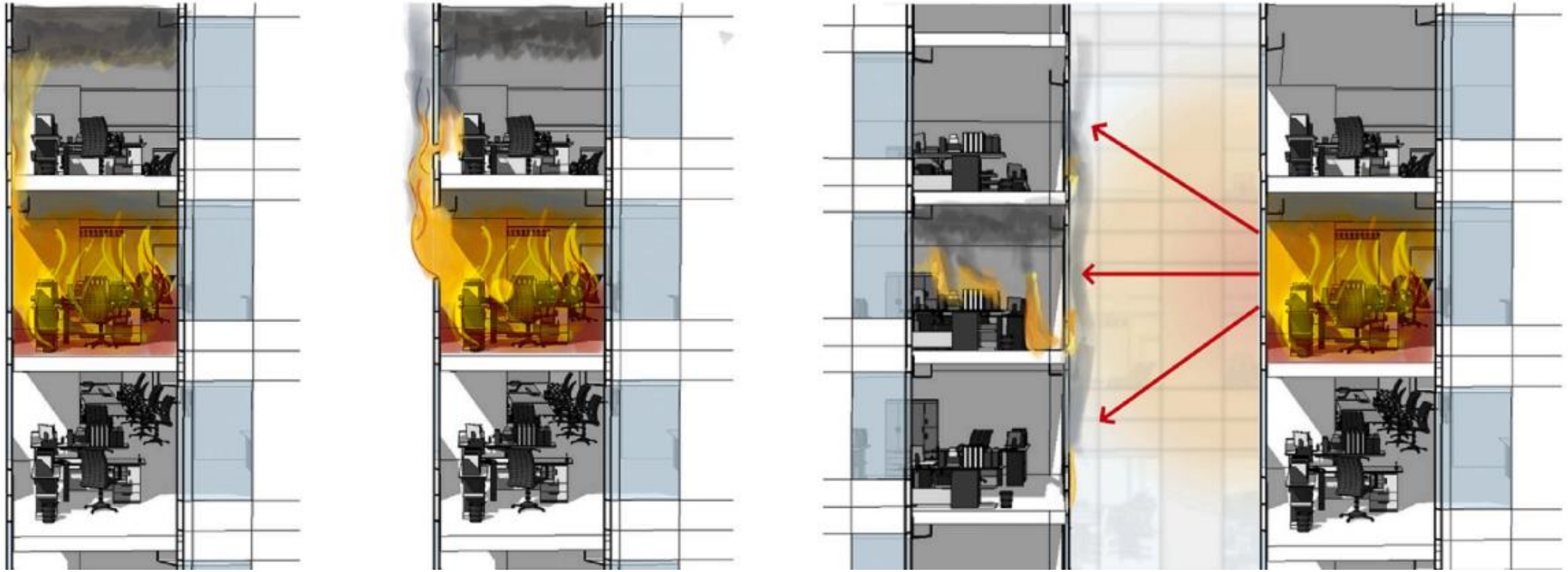
Background

As the fire begins to grow, smoke and heat start building up in the compartment, which results in a potential temperature of 500-1200 C, enough to damage the window glazing or break the window itself.



Wojciech Węgrzyński, Piotr Antosiewicz, Tomasz Burdzy, Piotr Tofiło, Bartłomiej K. Papis, “Experimental investigation into fire behaviour of glazed façades with pendant type sprinklers”, Fire Safety Journal, Volume 115, 2020.

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Recent Studies

W. Węgrzyński et al., 2020

Four full-scale experiments were performed to investigate the protection of non-fire-rated glazed façades by using dedicated conventional pendant-type sprinklers.

- Local damage (cracks) were observed.
- No mechanical failure of the façade.
- No significant post-fire deflection.

Wojciech Węgrzyński, Piotr Antosiewicz, Tomasz Burdzy, Piotr Tofiło, Bartłomiej K. Papis, “Experimental investigation into fire behaviour of glazed façades with pendant type sprinklers”, Fire Safety Journal, Volume 115, 2020.

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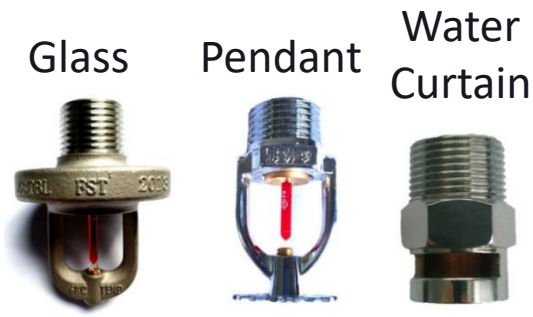
Recent Studies

D. Wang et al., 2023



Eleven full-scale experiments were performed to investigate the protection of non-fire-rated glazed façades by using different types of sprinklers.

Only the pendant sprinkler can protect the integrity of the glass under the same operating pressure (2.5 bar).
The sprinkler type, operating pressure and placement have a great influence on the protection result.

There are no studies on the usage of high-pressure water mist systems for façade fires.

Wang, D., Ju, X., Gui, J. et al. Full-Scale Experimental Study on the Integrity of Tempered Glass Protected by Different Sprinkler Systems in High-Rise Building Fire. Fire Technol 59, 1465–1488, 2023.

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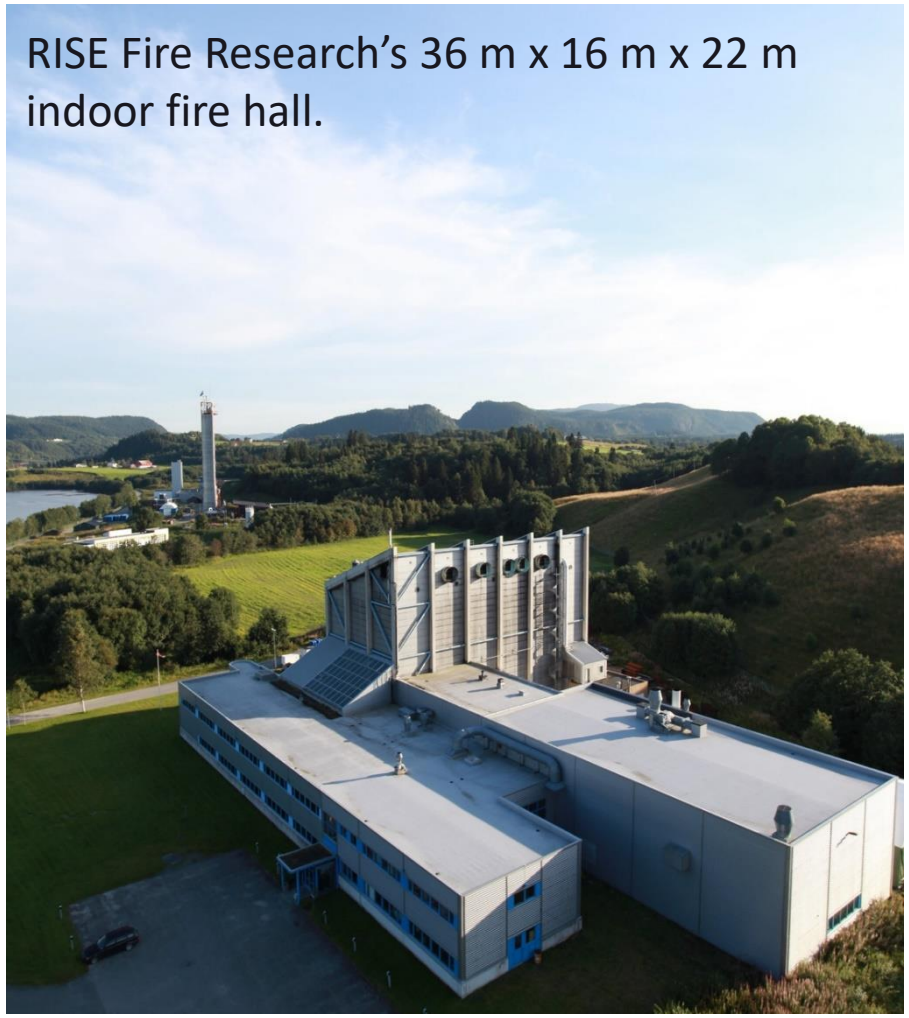
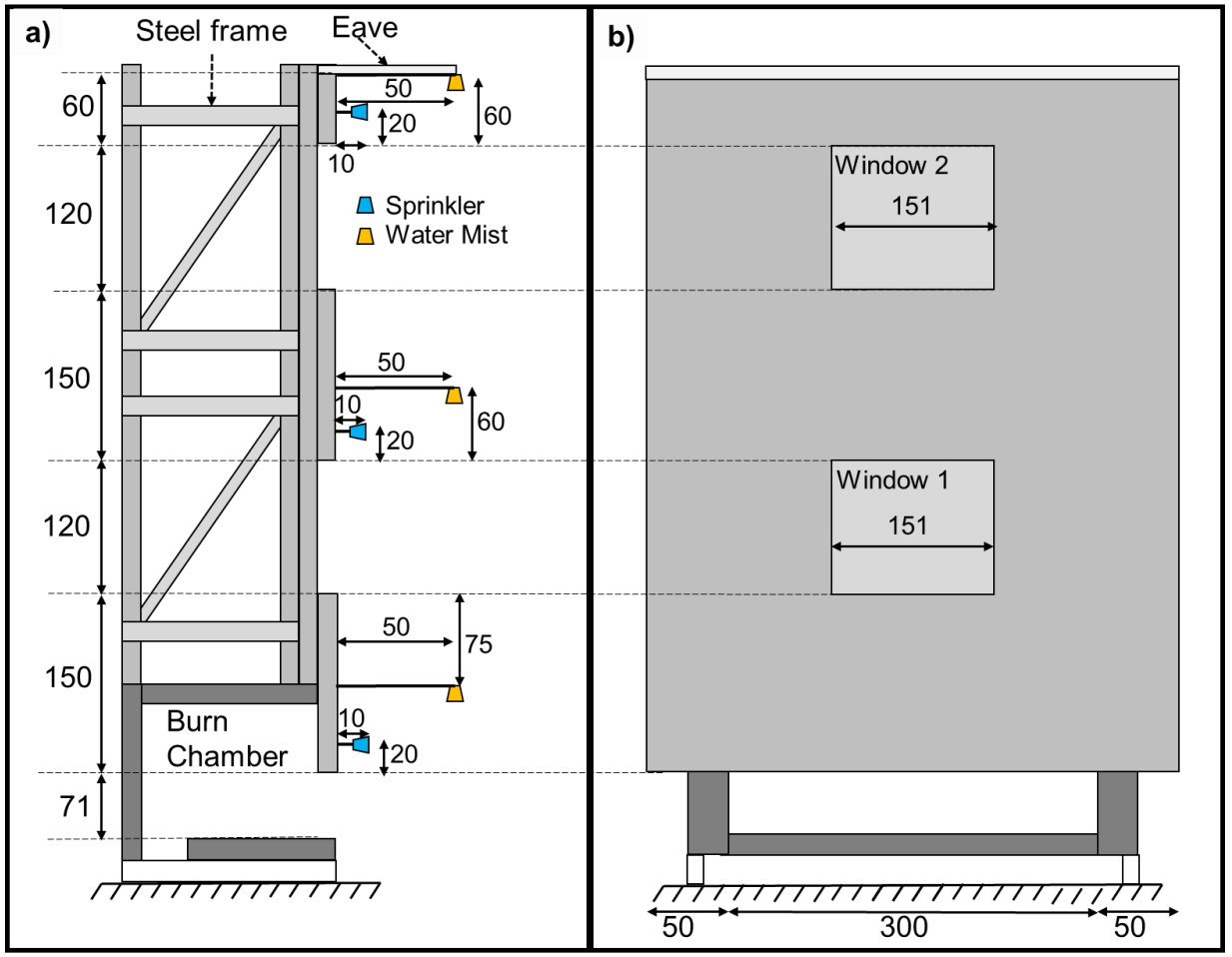
Experimental Setup - Rig

RISE Fire Research's 36 m x 16 m x 22 m indoor fire hall.



SP Fire 105



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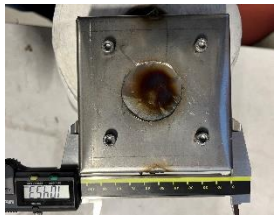
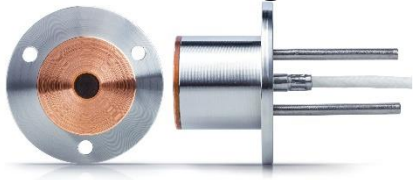
34 TCs

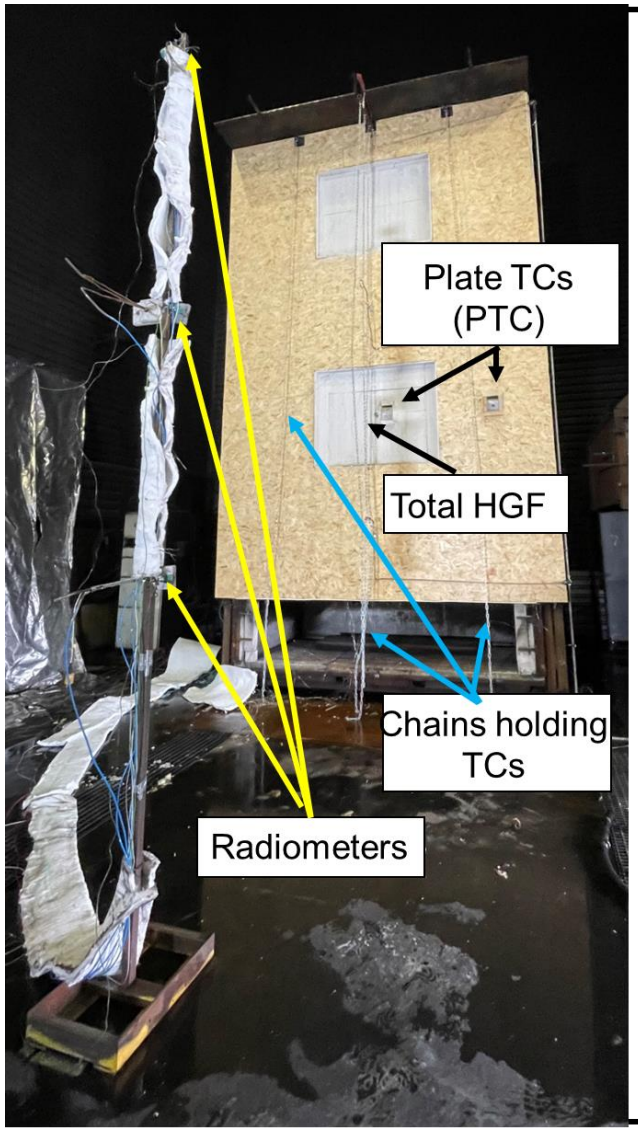
2 Plate TCs

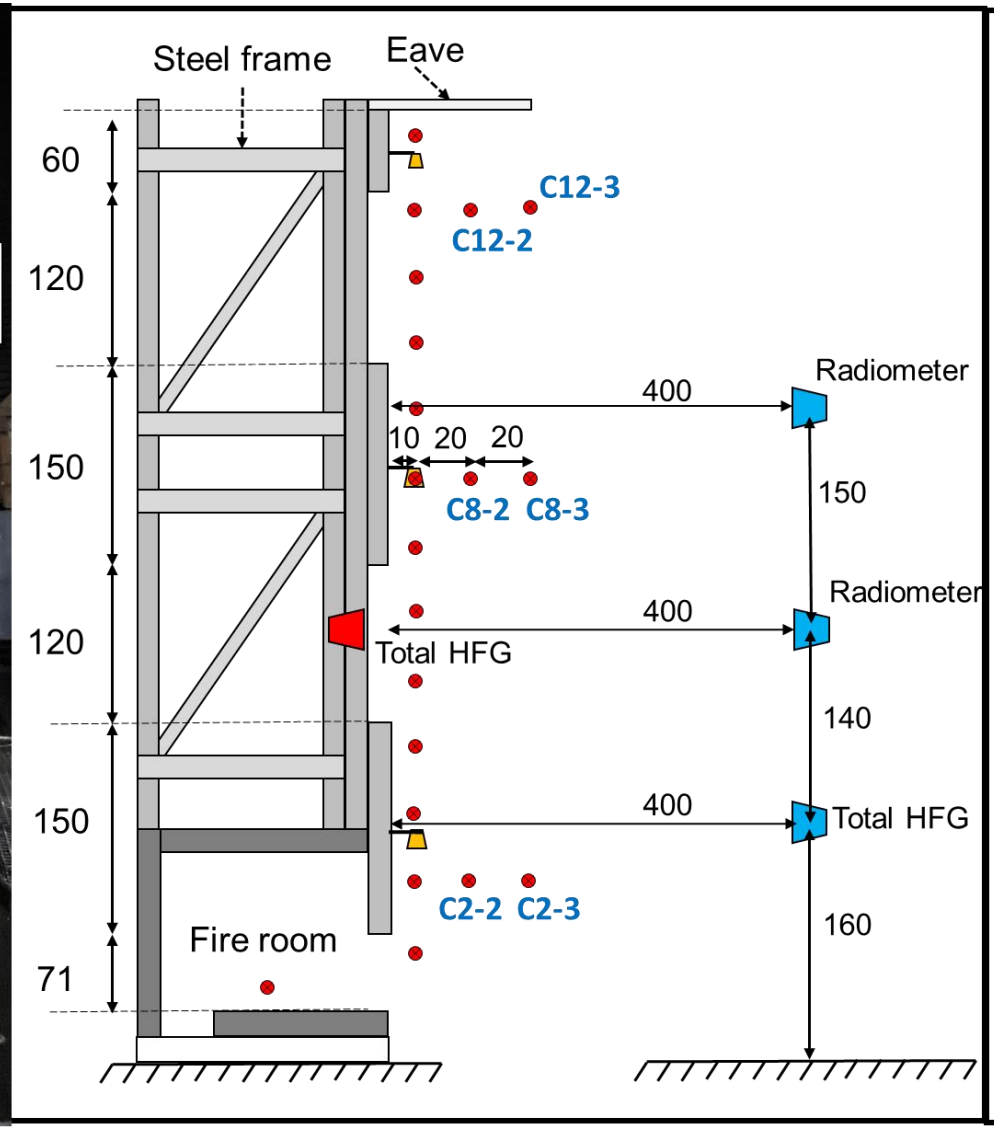


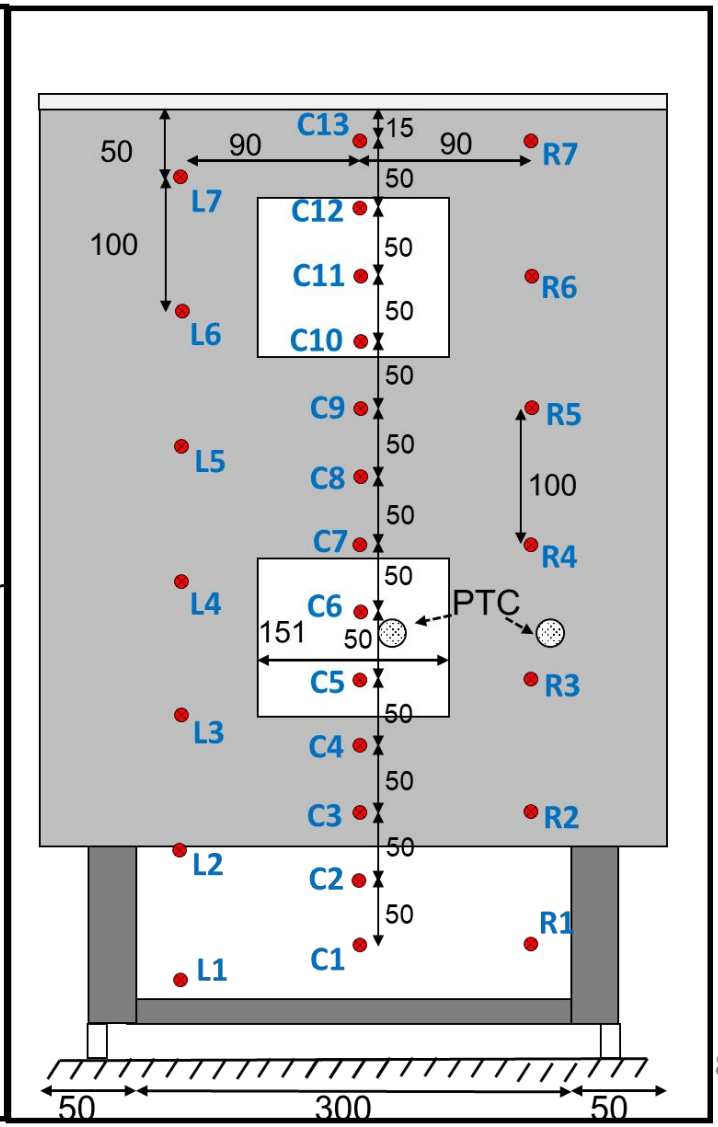
3 radiometers and 2 Heat Flux Gauge



Experimental Setup - Instrumentation







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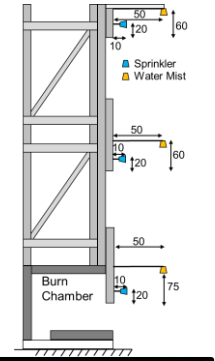
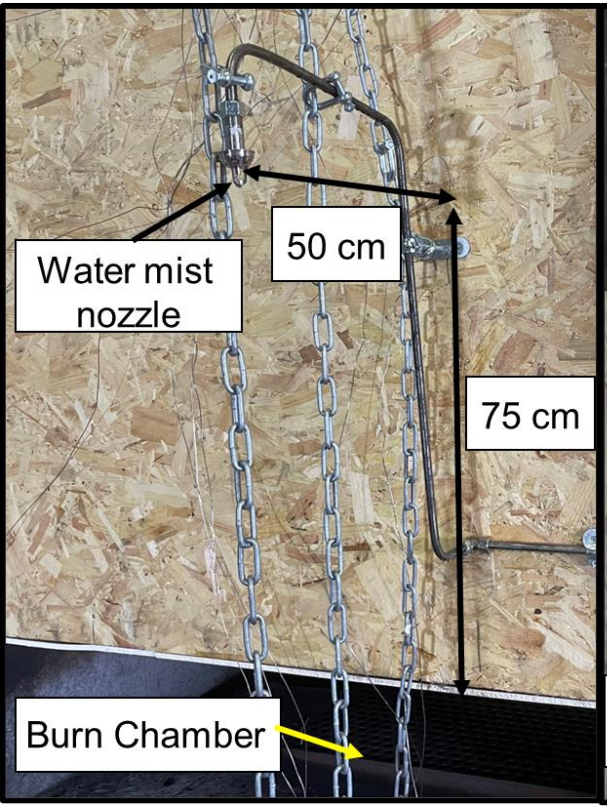
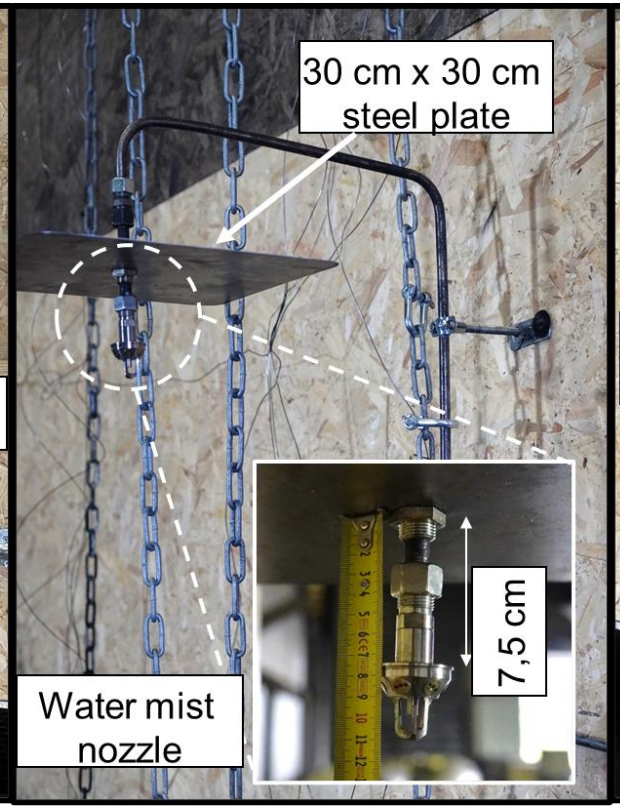
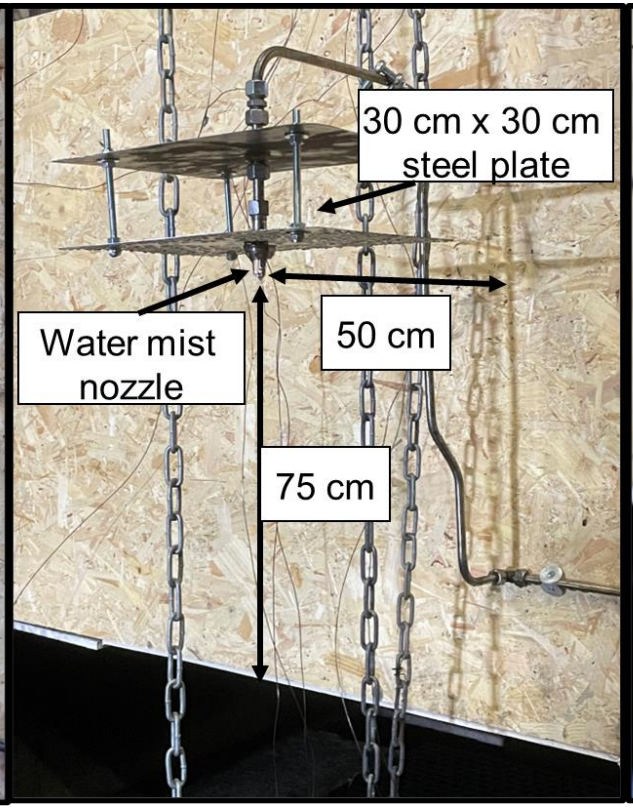
Experimental Setup – Sprinklers and Water Mist

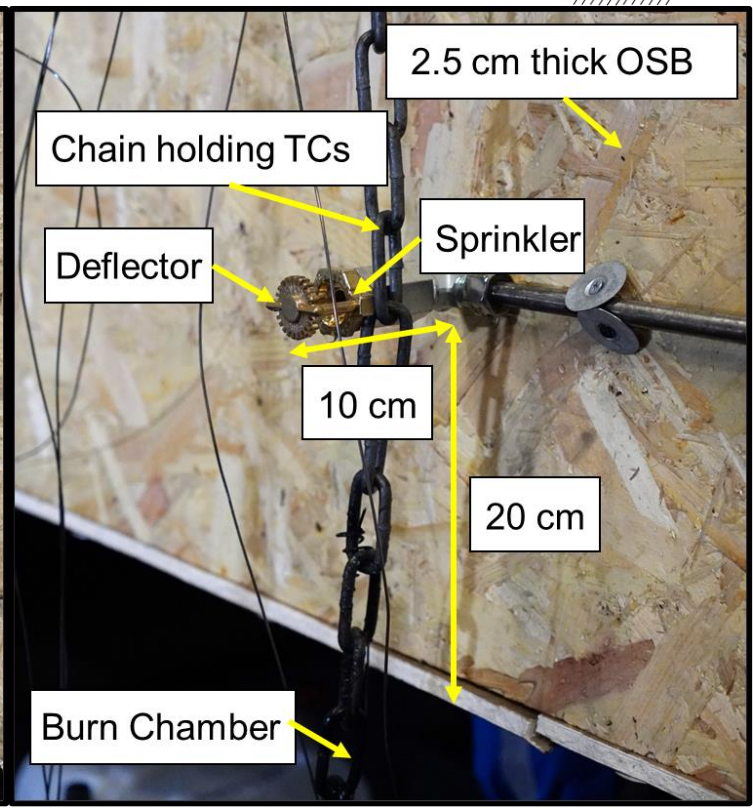


Water Mist with no plates | Water Mist with plates | Water Mist with plates V2 | Sprinkler









- The high-pressure water mist nozzles are manufactured by Danfoss Fire Safety A/S. Their K-factor is 2.75 and pressure is 100 bar.
- VdS-approved conventional pendent sprinklers with a working pressure of 12.5 bar max and 0.35 bar min were used. Their K-factor is 80.
- Bulbs of the nozzles were removed before the test.

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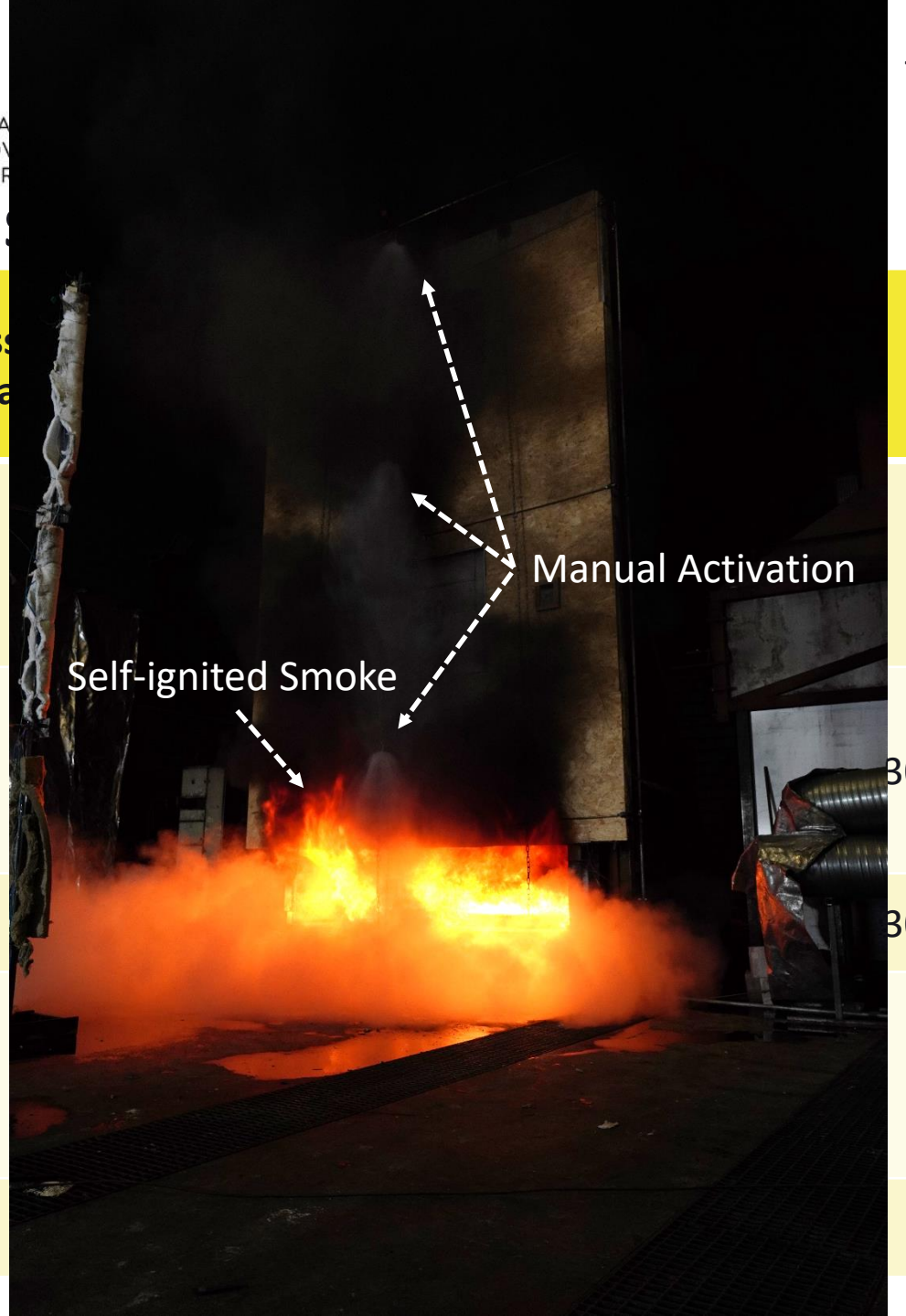
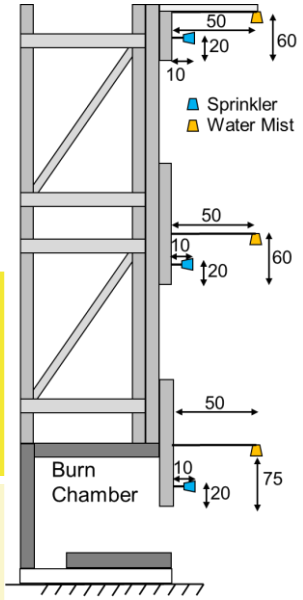
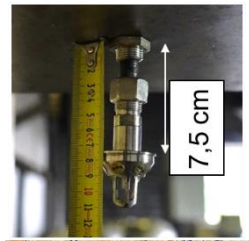
Experimental S

The suppression system was activated manually after observing the self-ignition of smoke leaving the burn chamber.

Test #	Nozzle Type	Press (ba	Plate	Activation time after ignition (min:sec)
1	WM	100		11:30
2	WM	100	30 steel plate. V1	8:25
3	WM	100	30 steel plate. V2	8:06
4	Sprinkler	1.8		13:14
5	-	-		-







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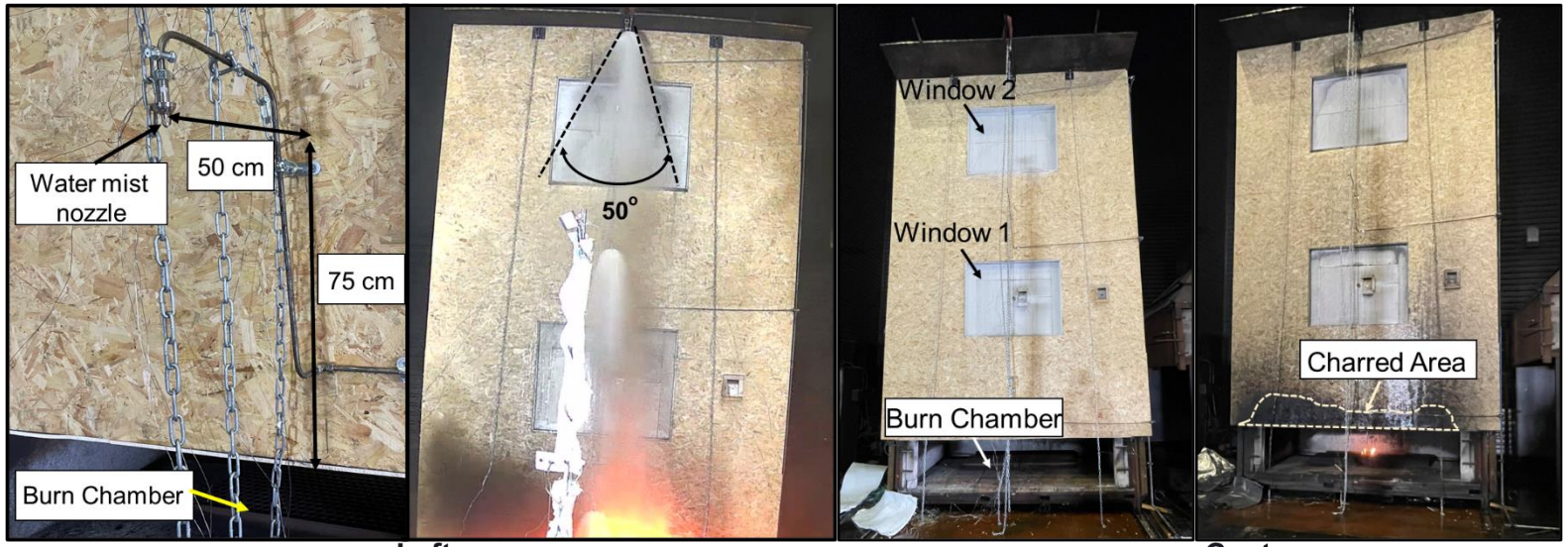
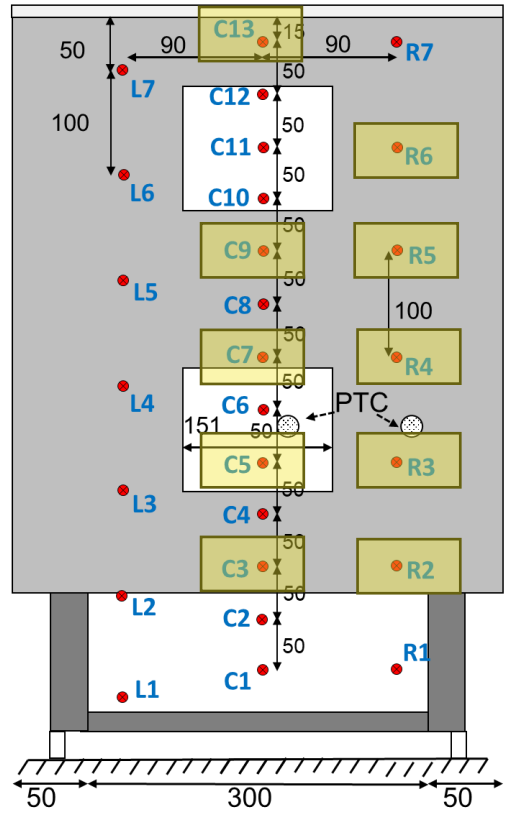
Results and Discussion – Temperature and Damage

Test 1 - Water Mist with no Plates



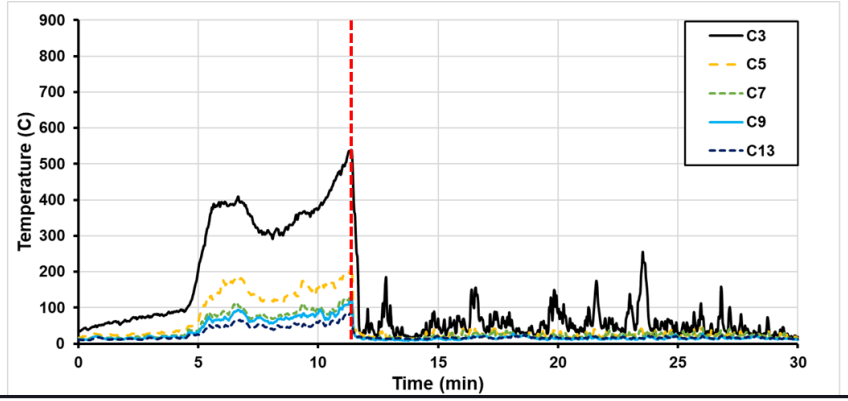
Left Center

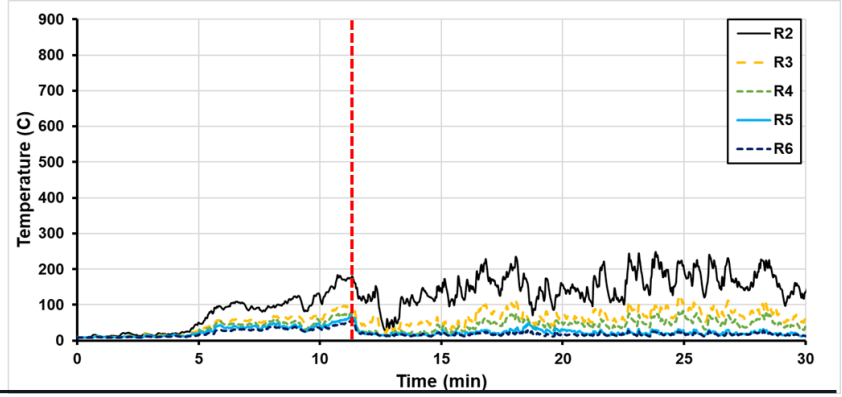
Minor damage: 6% of the façade charred.



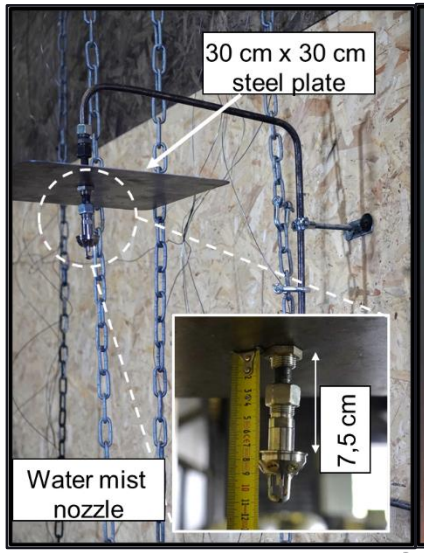
Right

3 WM – No Plate

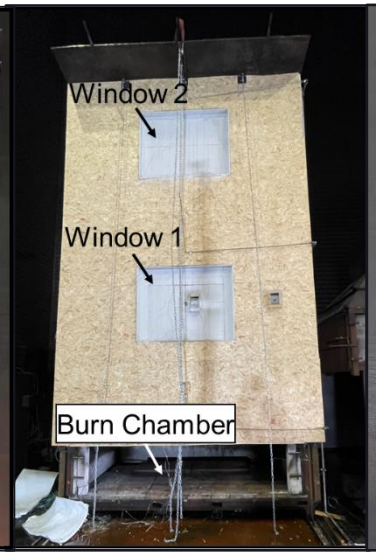


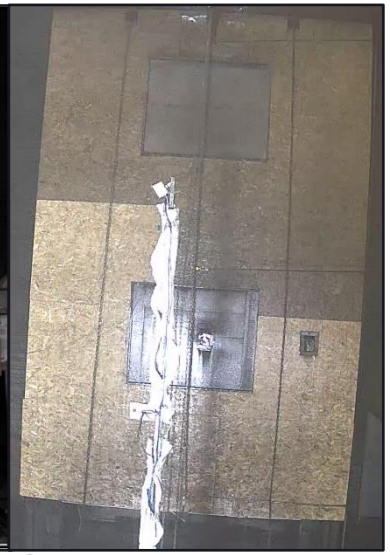


Test 2 - Water Mist with Plates V1



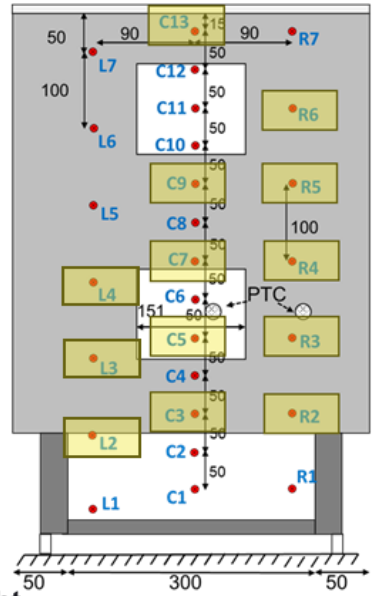
Left





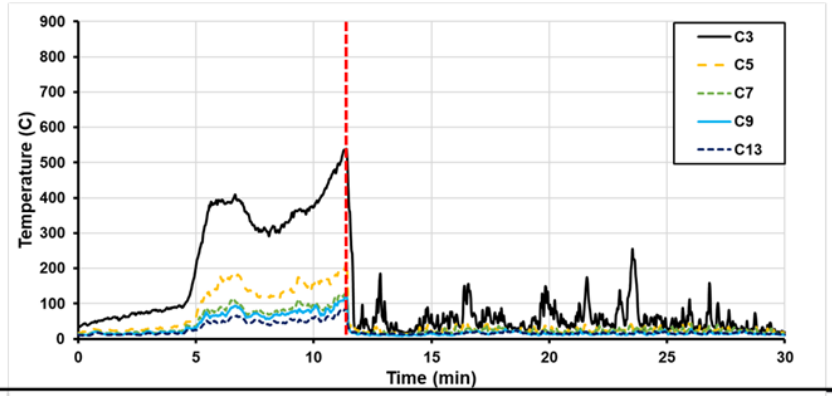
Center

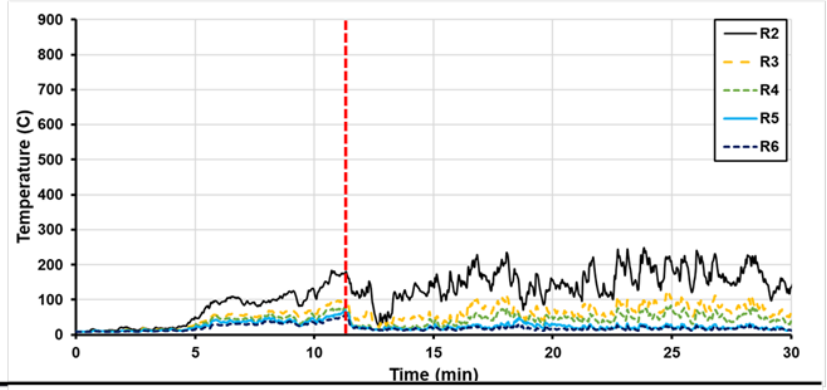
Minor damage:
5% of the façade
charred.



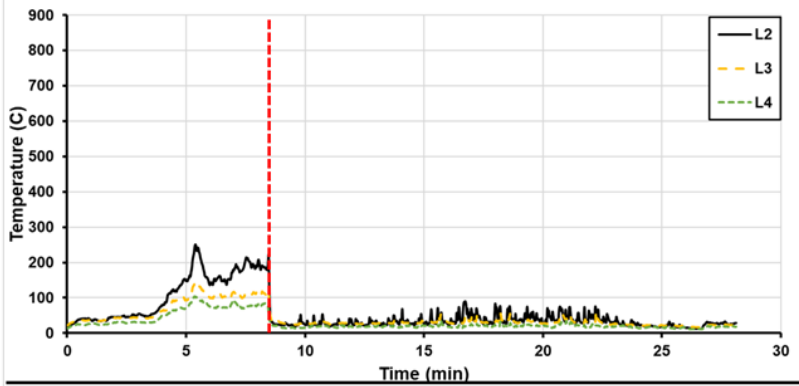
Right

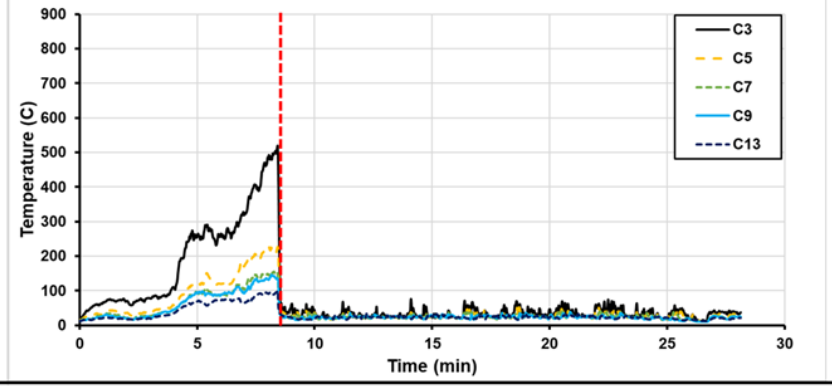
3 WM – No Plate

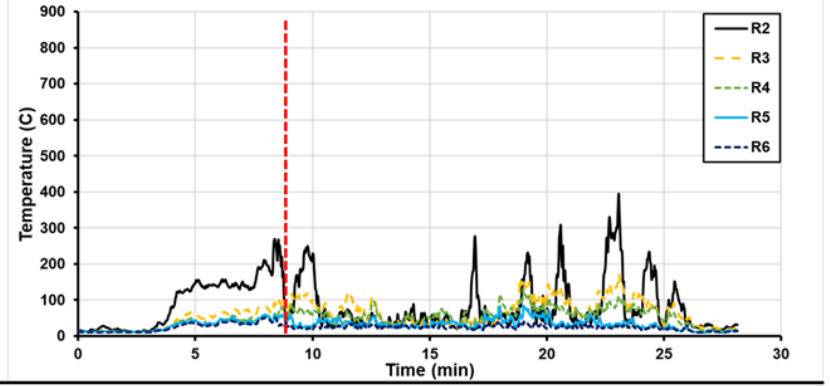




3 WM with Plate







Test 3 - Water Mist with Plates V2

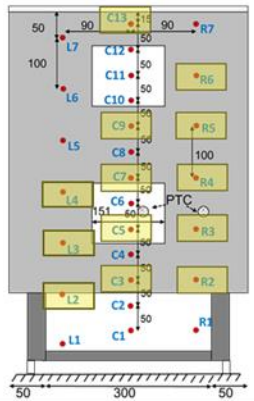
Moderate damage:

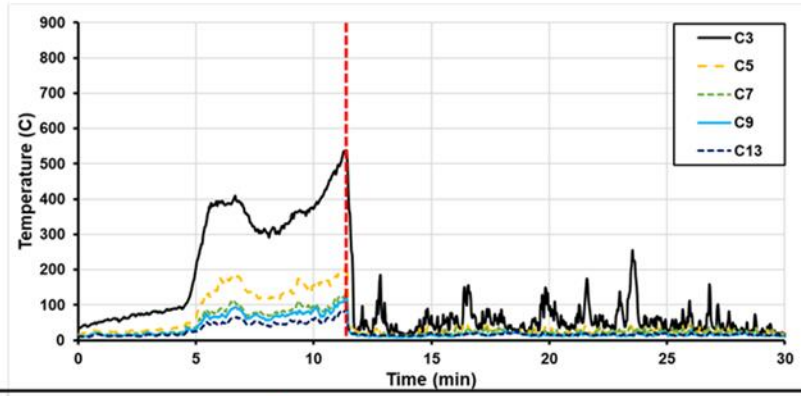
Left

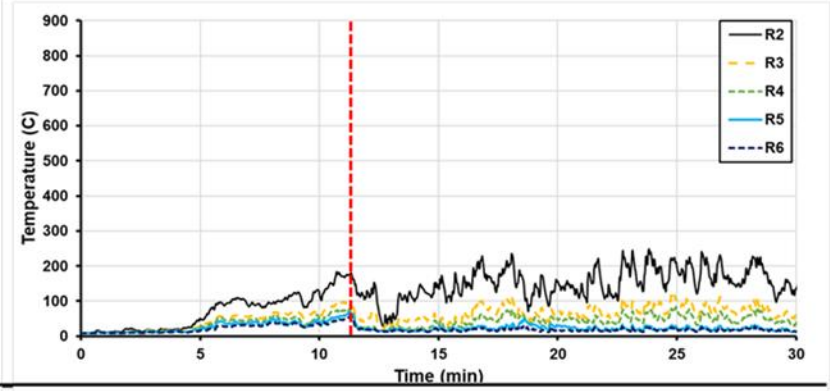
Center

Right

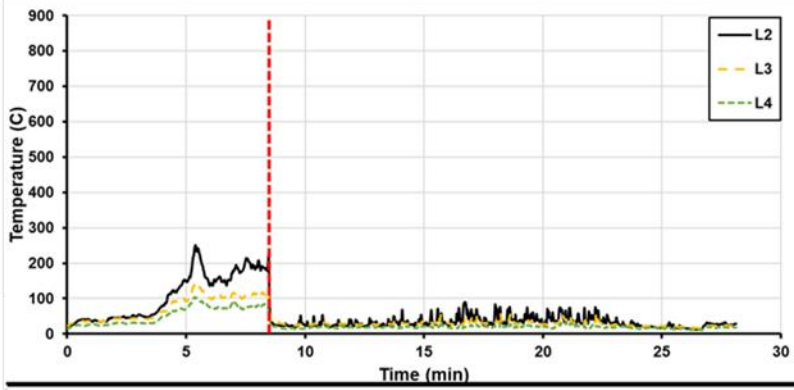
3 WM – No Plate

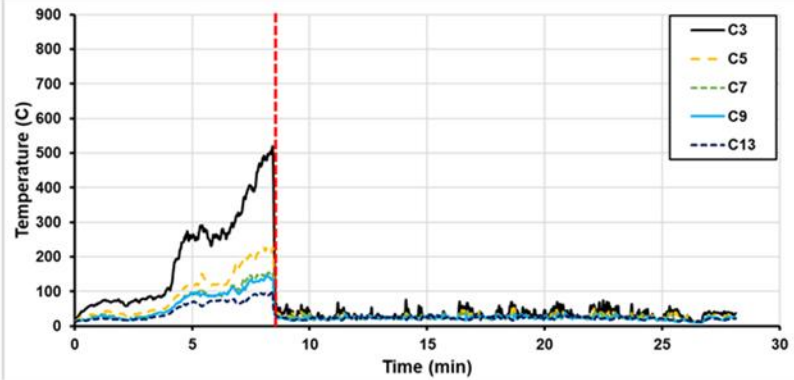


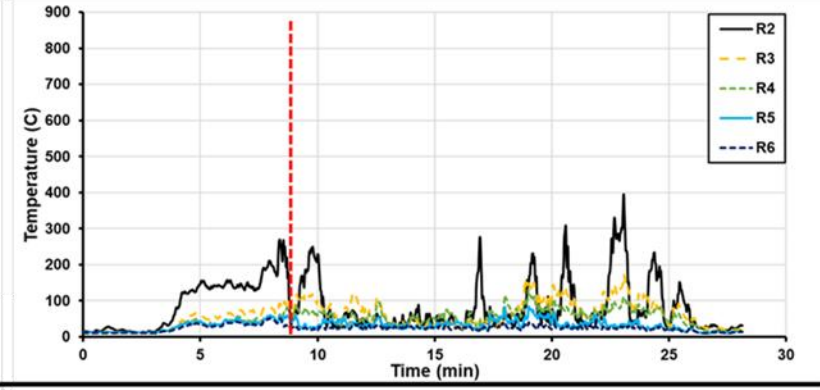




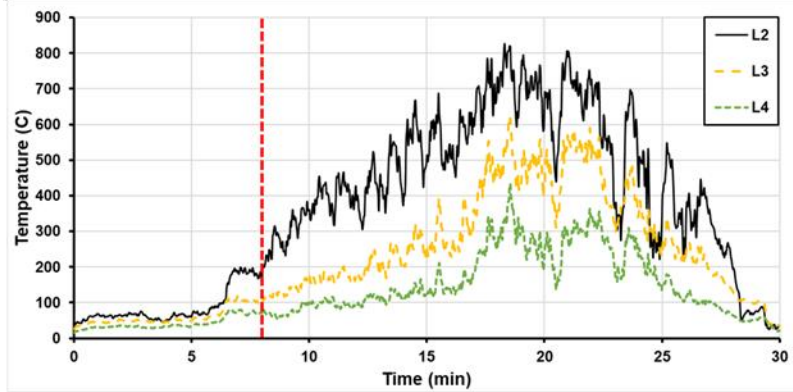
3 WM with Plate

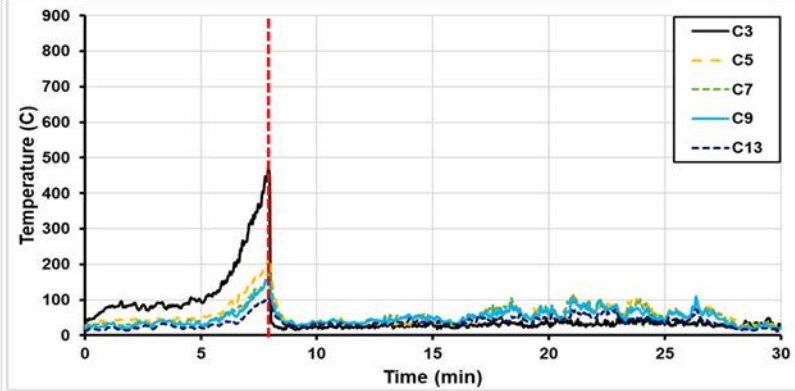


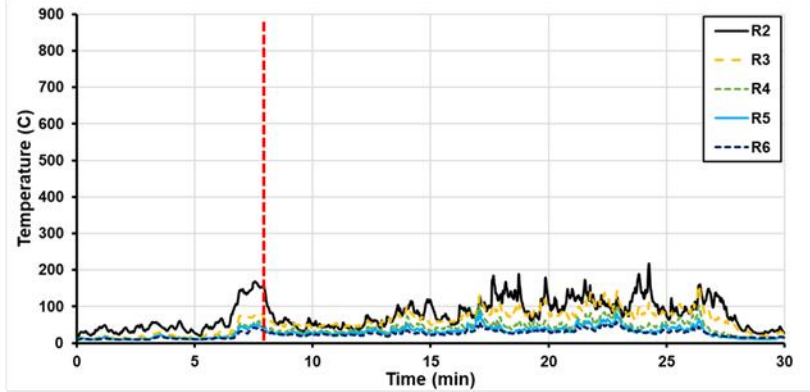




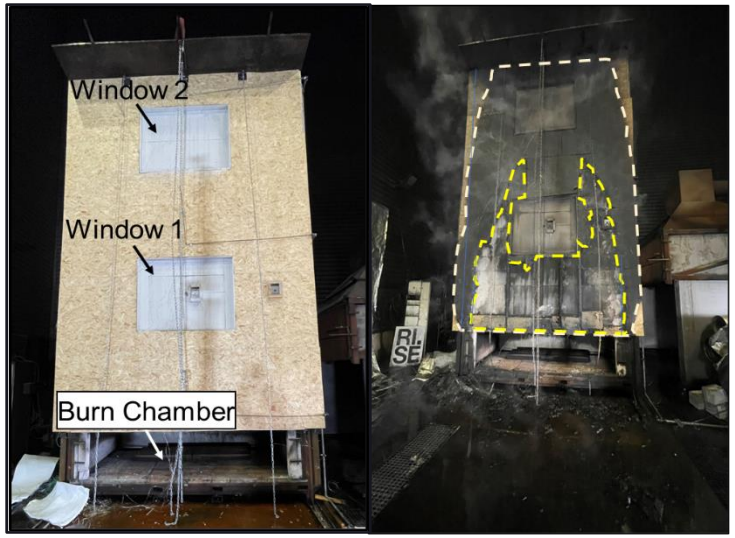
1 WM with Plate



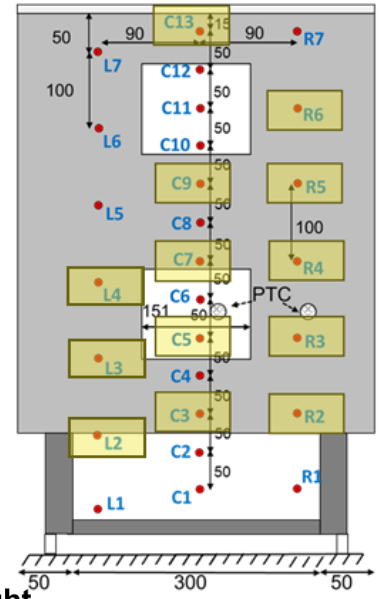




Test 5 - Baseline

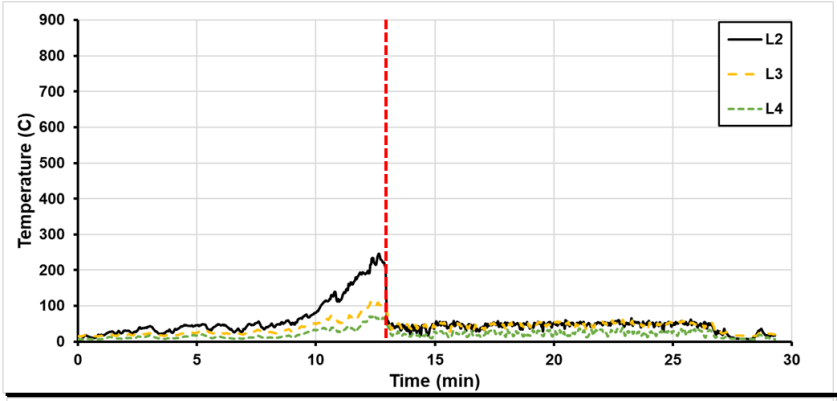


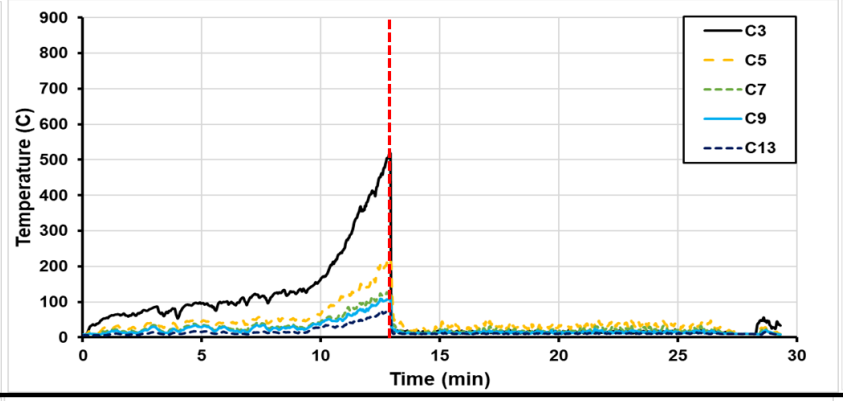
Major damage:
30% of the façade surface burned out, and 96% was heavily charred.

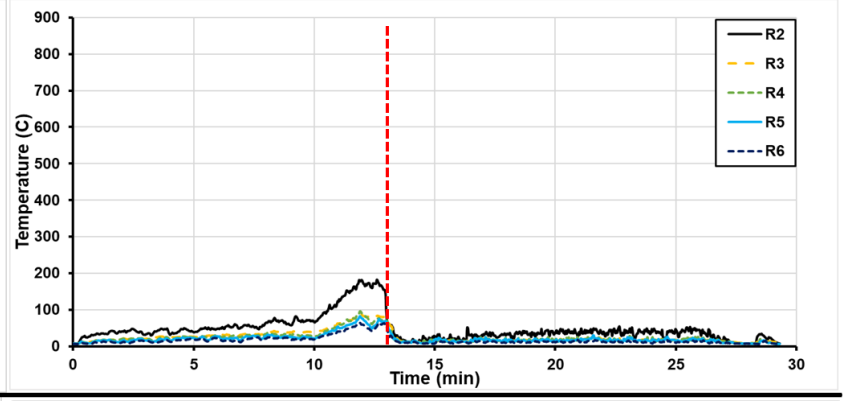


Left | **Center** | **Right**

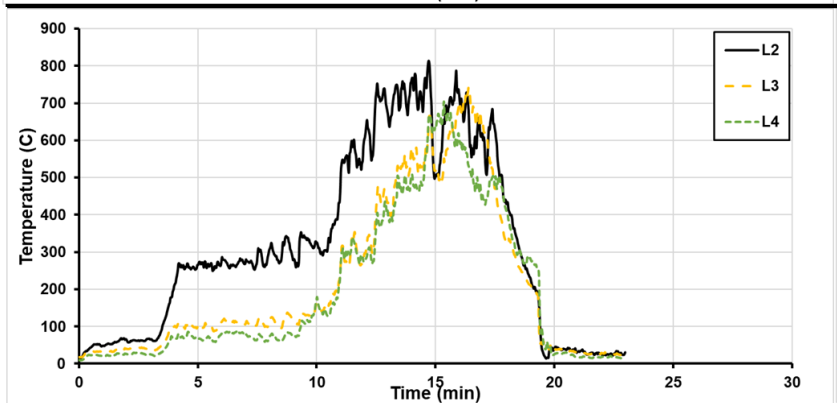
Sprinkler

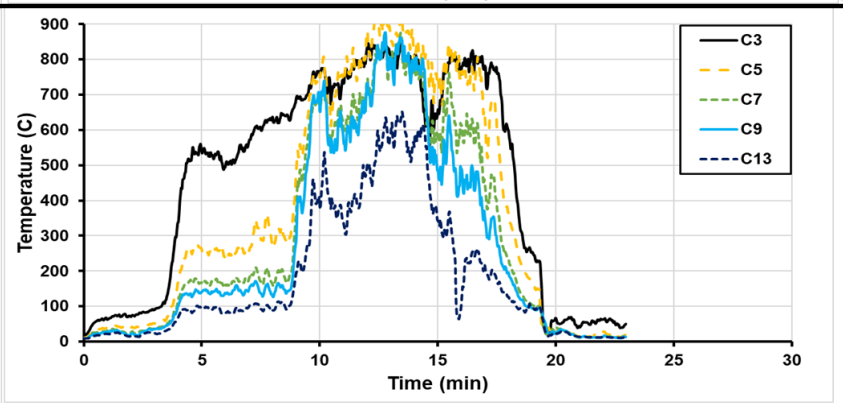


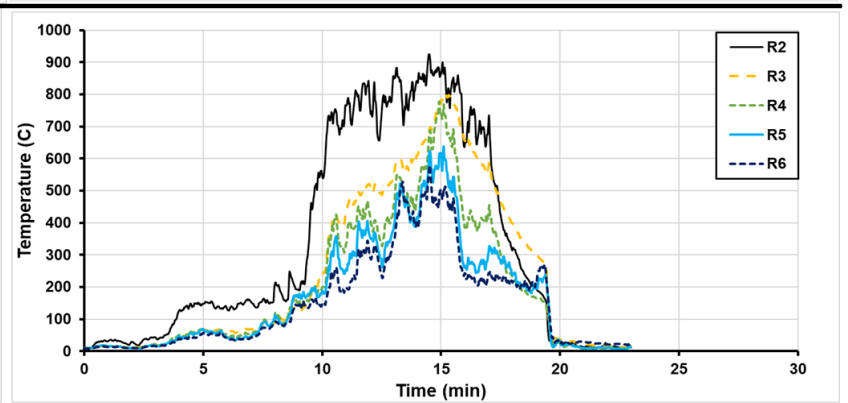




Free Burn







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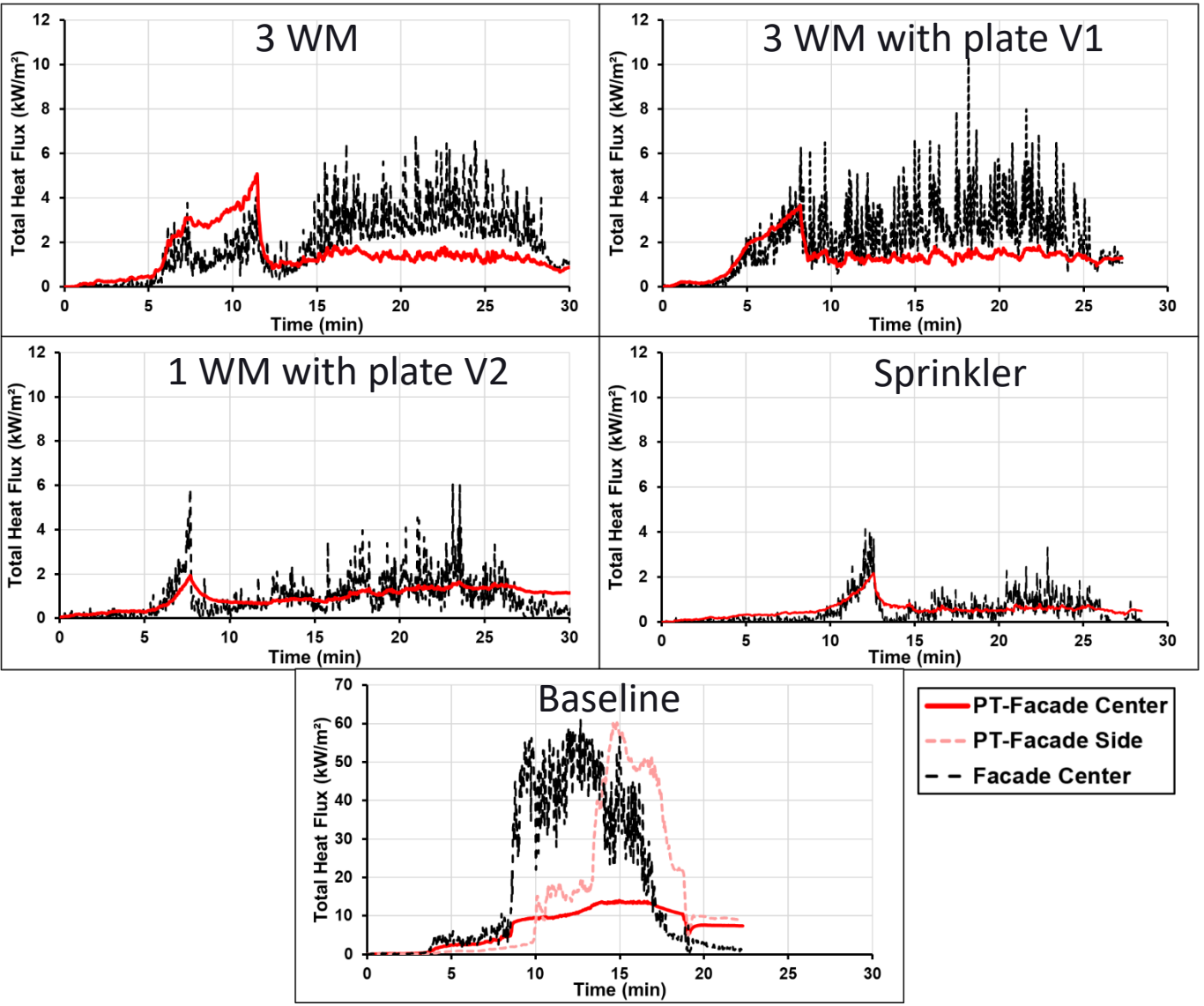
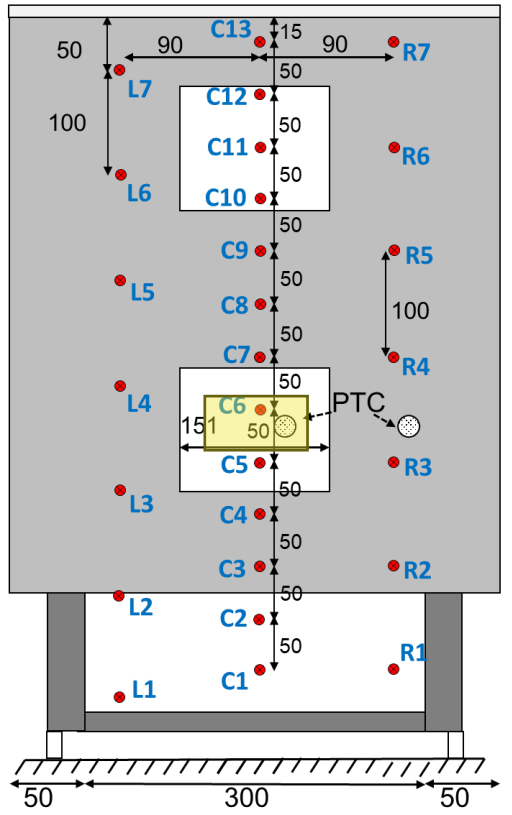
Results and Discussion – Heat Flux on the Façade



- All tested suppression system resulted a very low heat fluxes on the façade, well below 12 kW/m².
- Baseline test reached up to 60 kW/m² before manually extinguishing of parts of the façade had to be initiated to prevent structural damage.



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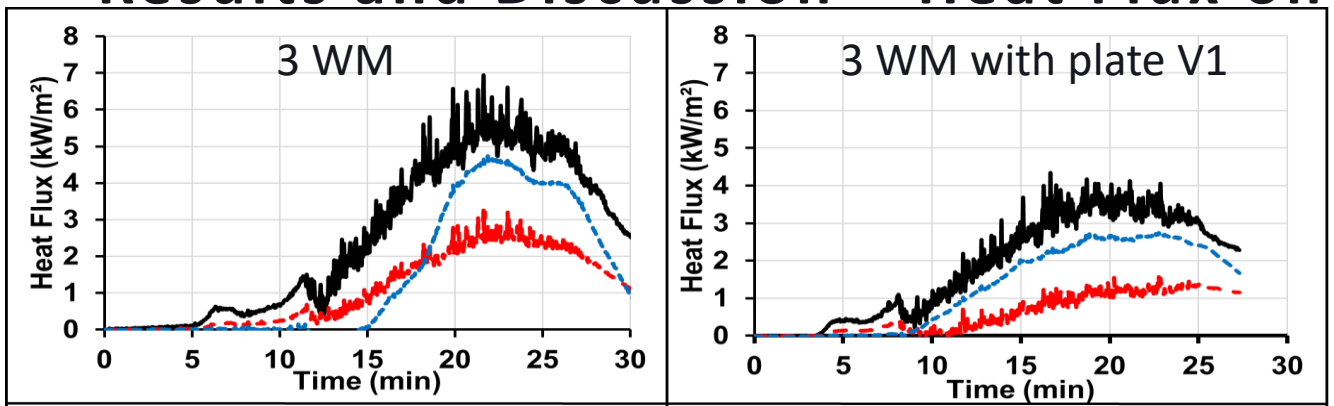
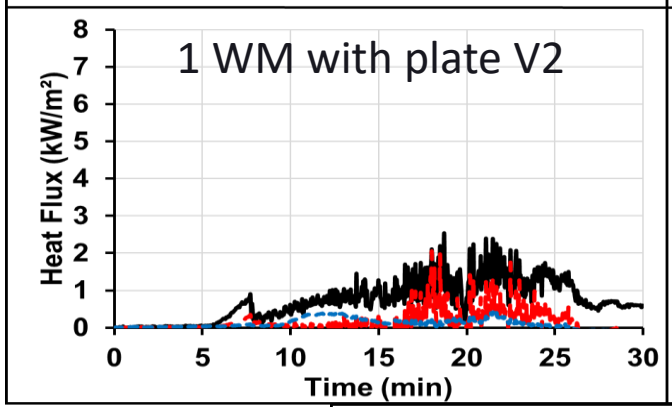
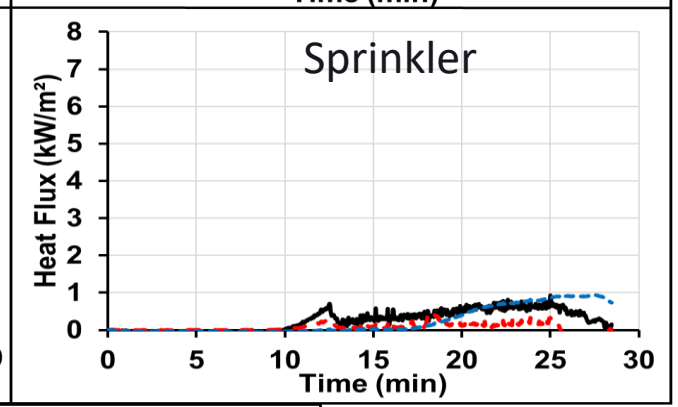
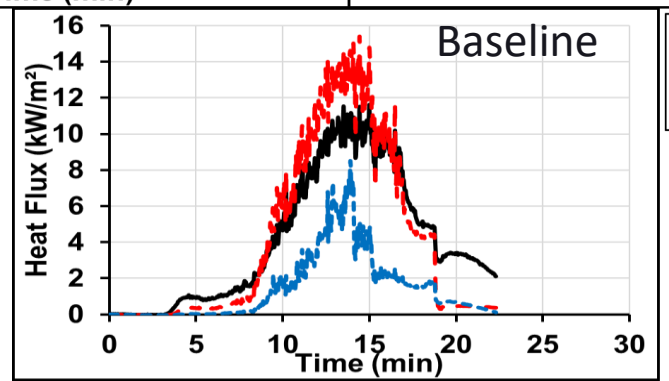
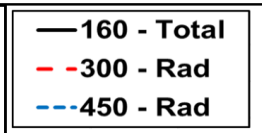
Results and Discussion – Heat Flux on the Façade

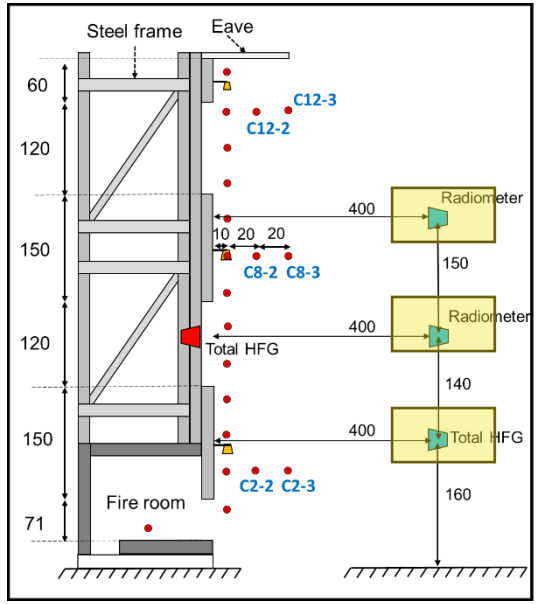








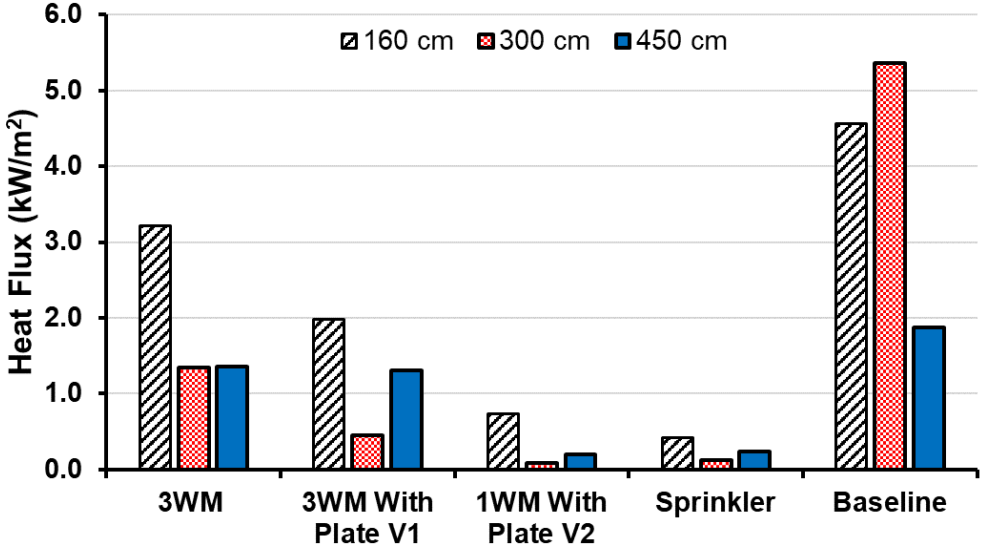


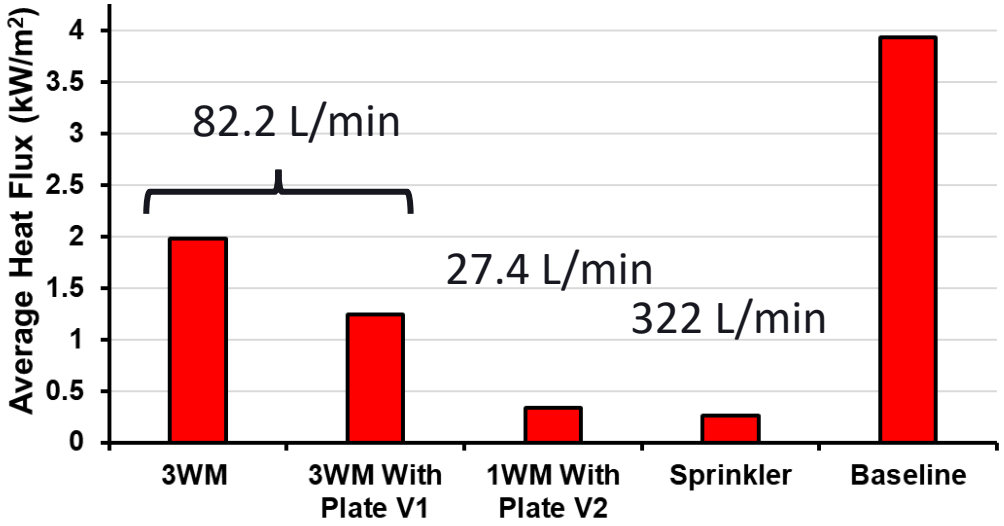


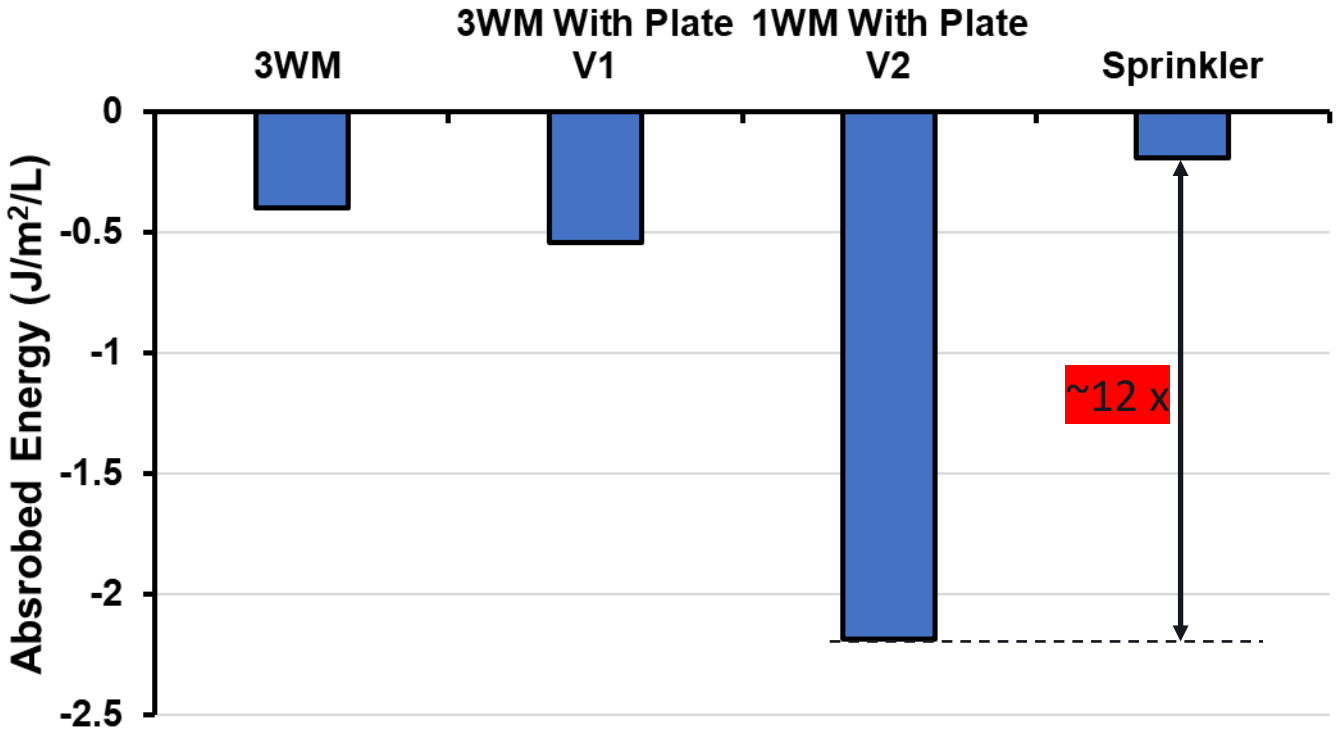
- The radiative heat flux measured 400 cm away from the burning façade varied 6-14 kW/m² in the baseline test.
- The heat flux measurements show that the emitted heat flux decreased with the addition of steel plates on the water mist nozzles.
- Without a suppression system, continuous exposure to radiation may cause the remote ignition of adjacent façades made from wood or synthetic materials.

Results and Discussion – Water Consumption

Heat Flux measured at 400 cm away from the façade







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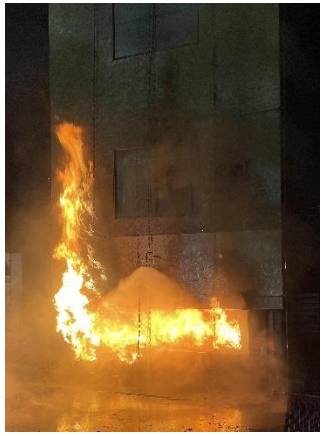
Conclusions and Future Work

- The results demonstrated the importance of a sufficient wide spray angle to ensure cooling of the façades far sides.
  - The wider spray angle decreased the damage on the façade.
  - The wider angle also reduced the measured heat flux 400 cm from the facade on average by 44% and 59%, respectively

- The single high-pressure nozzle system effectively suppressed the temperature at the center however, not robust, as the flame was able to spread on the side of the façade.



- The sprinkler system was the most effective in controlling the façade temperature, the vertical and horizontal flame spread, and the heat flux.
  - The large droplets formed streams of water running down a façade.
  - However, the sprinkler was the least efficient system as the water consumption was **four times** larger than the WM.

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Conclusions and Future Work

- The sprinkler system attenuated, on average, **98%** of the incident flux onto the façade compared to the baseline. No damage was observed after the fire.

- During the baseline, the façade temperature and the emitted heat flux 400 cm from the façade reached up to 900 °C and 15 kW/m², respectively. This may cause the self-ignition of wood and synthetic materials on the nearby buildings.

- The efficiency of the high-pressure WM systems can be optimised by changing the nozzle alignment.

- The effect of wind on the droplet dispersion should be further investigated

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TUSEN TAKK!

Suggestions or technical input for FRIC webinars?
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