



Compensation for Missing Fire Partitions by Water Mist

Dr CONG Bei Hua

Tongji Antai Disaster Engineering Prevention Research &
Development Center

OUTLINE

- Background
- Water Mist Curtain—Alternative to Fire Partitions?
- Case Study
- Summary

Background

Question of Missing fire partition

□ Metro Vehicle Depot

- A very larger enclosure for parking, inspection, conditioning, operation and repair of metro trains.
- Due to overhead line system, it is difficult to install roller shutter as a fire partition.



Background

Question of Missing fire partition

□ Glass Curtain Wall

- High rise buildings are designed openly by using glass and steel structures.
- Fire prevention becomes a challenge due to fire spread through the structurally fragile glass curtain, which need active protection.



Background

Question of Missing fire partition

□ Historical wooden structure village

- Ancient villages and towns are valuable heritages, normally feature wooden structure, and narrow street.
- There is no fire separation or enough safe distance for fire.
- Fire is easy to spread from one side to the other side.



Water curtain as fire partition

GB50084-2001 Code of
Sprinkler System

For water curtain,
Water density : $2\text{L/s}\cdot\text{m}$ ($\leq 8\text{m}$)
Duration time: 3h

if a protected length=10m,
then totally 216m^3 water
demand.



Too large amount of water needed for water curtain
protection

Water mist

Absorption of radiation in water mist

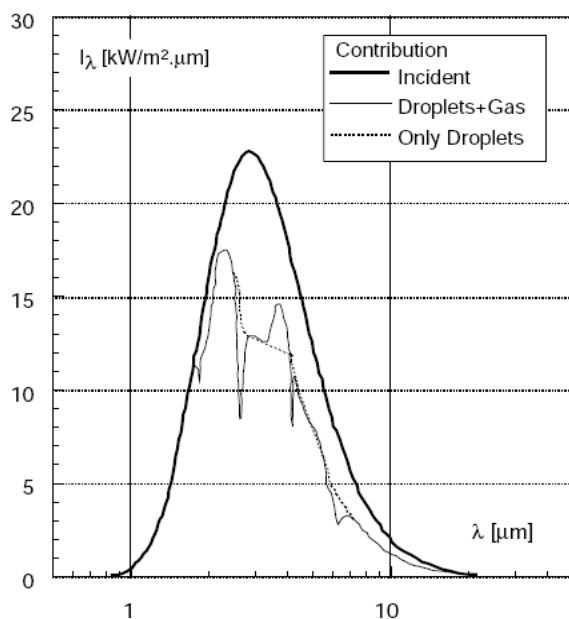


Fig. 4. Spectral attenuation by vertical water curtain.

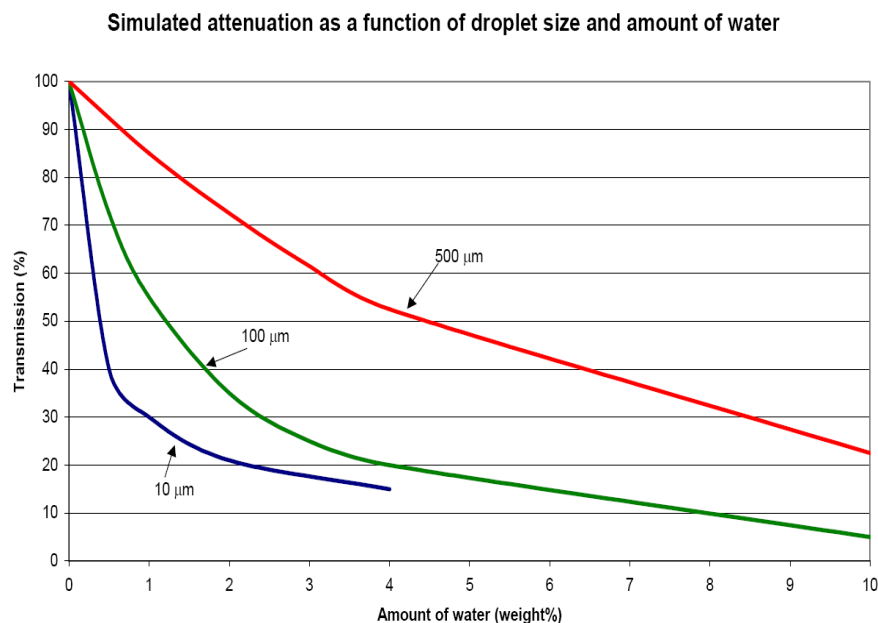


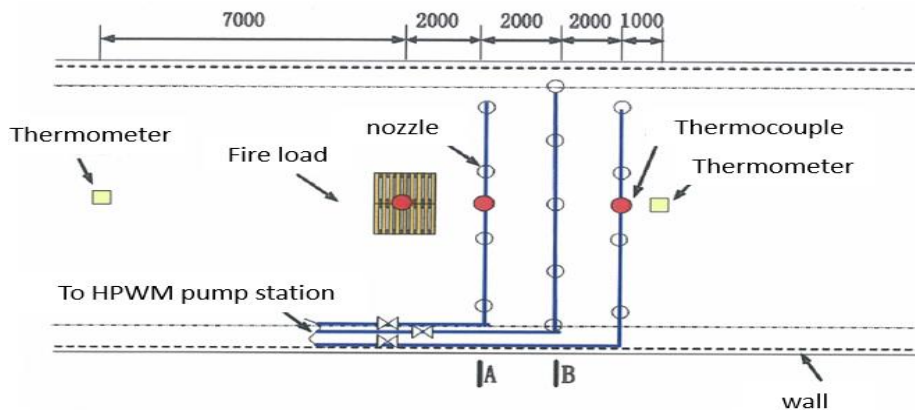
Figure 14 Simulated attenuation 3 meters away from a 1000°C black-body radiation source¹⁰

Bjarne Paulsen Husted, Goran Holmstedt and Tommy Hertzberg. The physics behind water mist systems, Proc.IWMA conference 2004,6-8 October 2004,Rome, Itly.

Water mist curtain

Alternative to water curtain as fire partition?

Fire load HRR 10-12MW



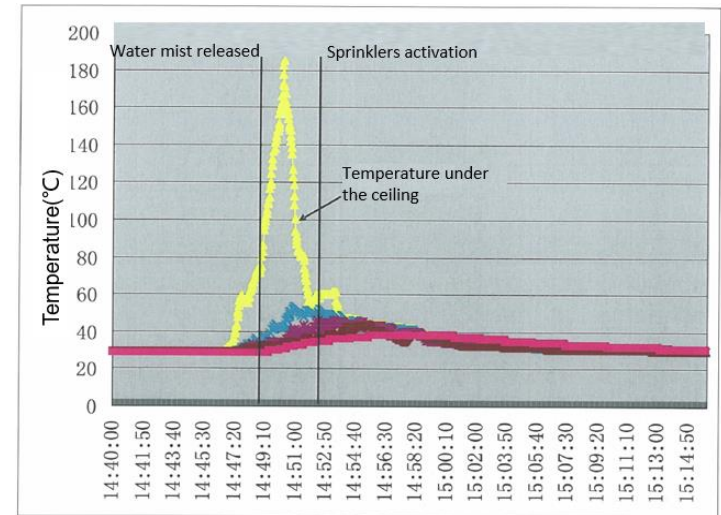
Full scale fire test setup



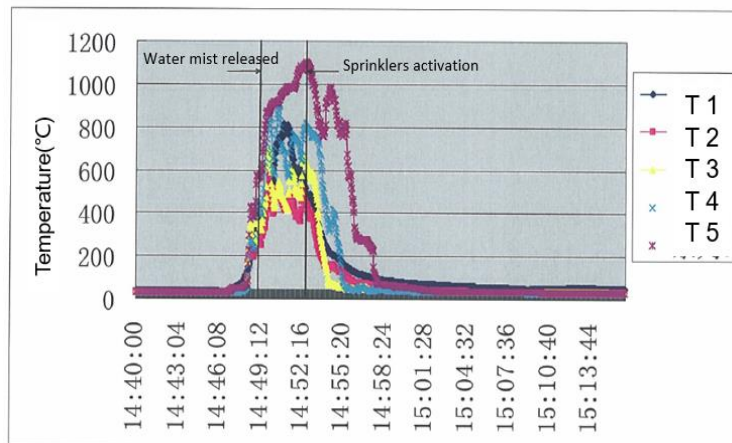
Fire Test – Water Mist as Fire Partition

□ Pass Criteria

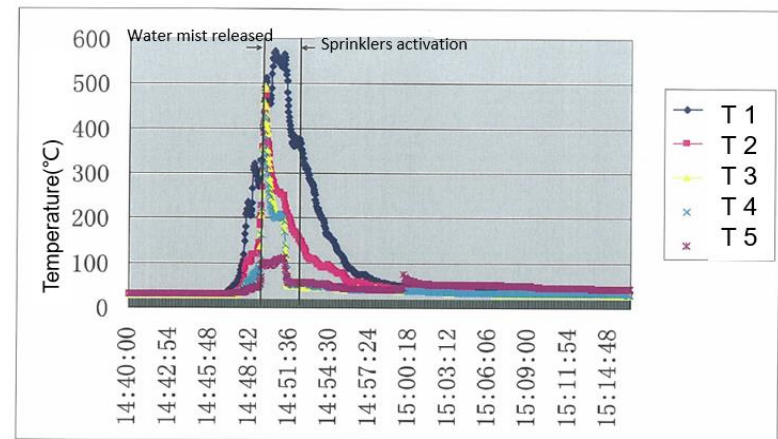
- The temperature on the protected side shall not exceed 180°C
- Heat radiant shall be reduced by 80%
- Obvious smoke separation effect



Temperature change on the protected side



Temperature change at fire source

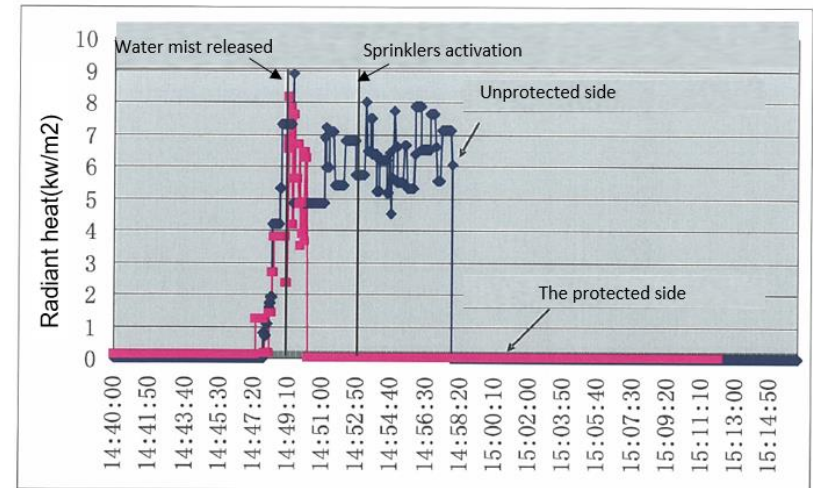


Temperature change on the side of fire location

Fire Test – Water Mist as Fire Partition

□ Pass Criteria

- The temperature on the protected side shall not exceed 180°C
- Heat radiant shall be reduced by 80%
- Obvious smoke separation effect



Application – Beijing Metro

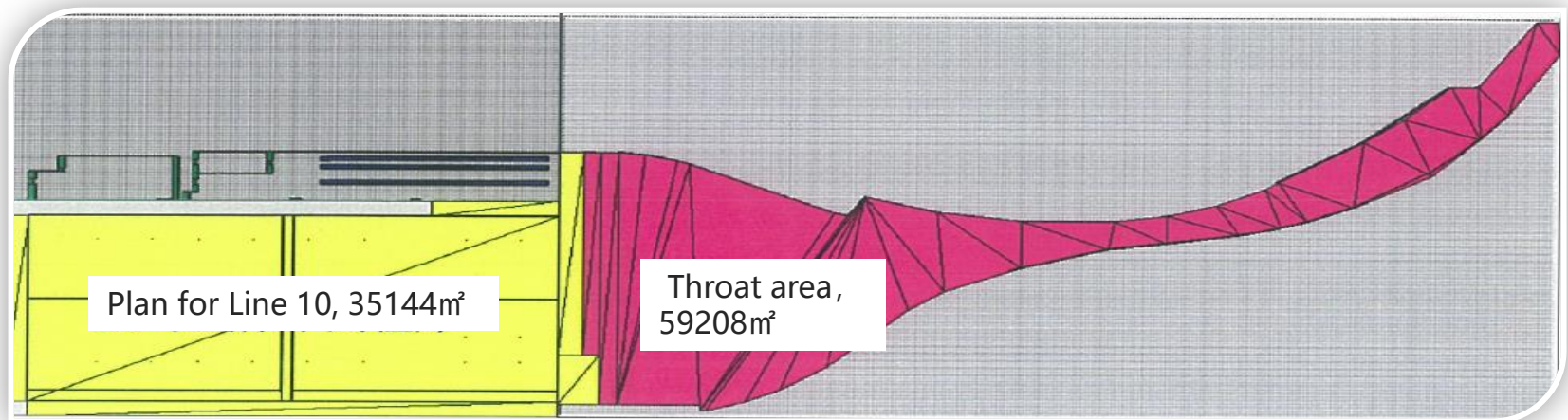
□ Vehicle Depot for Line 6 & 10

- Two- story vehicle depot
- Line 10 on ground floor, Line 6 on underground floor



Application – Beijing Metro

- Car park and Residentials developed above the depot make it underground depot with higher fire risk level as per local fire code
- Due to overhead line system, it is difficult to install roller shutter as fire partition



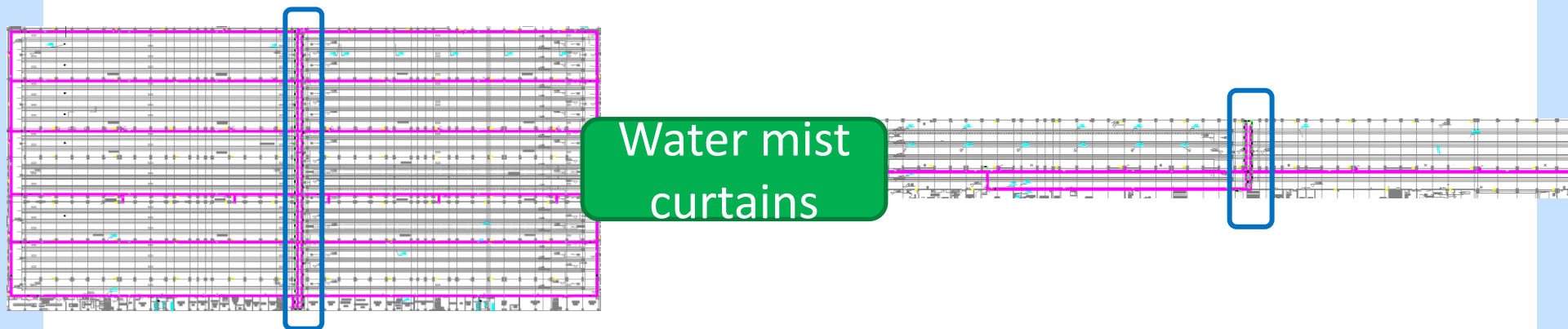
Application – Beijing Metro

- ❑ Water mist curtains are designed with open nozzles based on full-scale fire test results(66 nozzles)
- ❑ 2-3 rows of nozzles to produce a water mist partition.
- ❑ Automatic activation by detection.



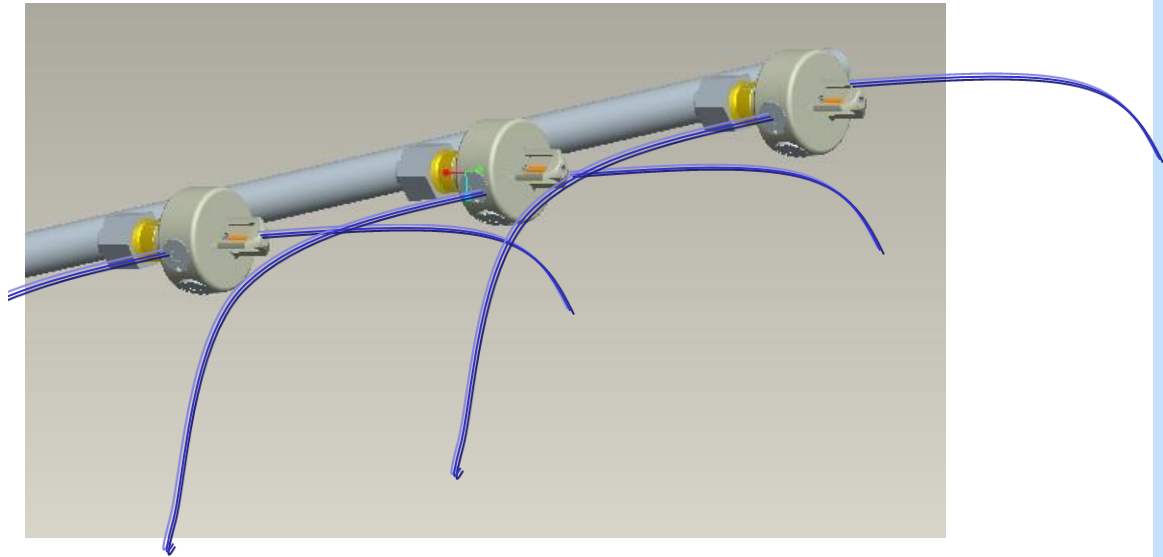
Application – Beijing Metro

- ❑ Compact high pressure pump unit : 400l/min
- ❑ Small bore stainless steel pipework installed
- ❑ Water tank for 120 min duration
- ❑ Jockey pump to prefill water in pipes prior to section v
- ❑ 51 water mist guns for manual intervention



Water mist curtain

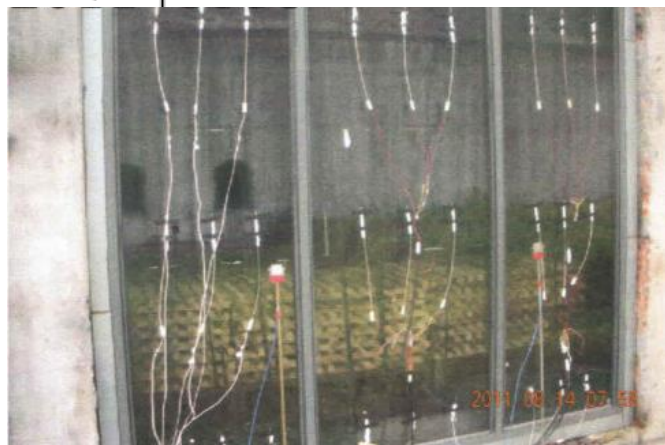
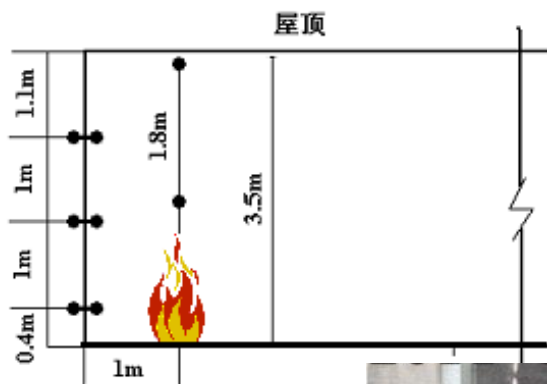
Alternative to water curtain as cooling protection?



Glass protected by water mist curtain

Fire Test – Water Mist as cooling protection

Alternative to water curtain as cooling protection?



Fire load HRR 6 MW

Full scale fire test setup



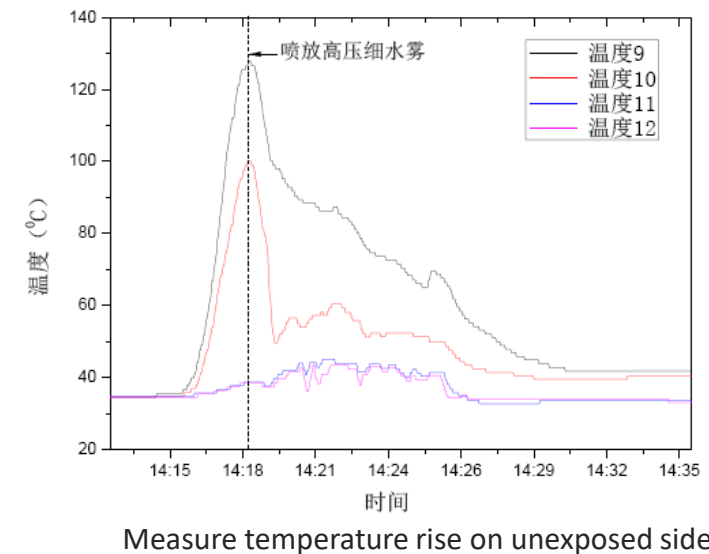
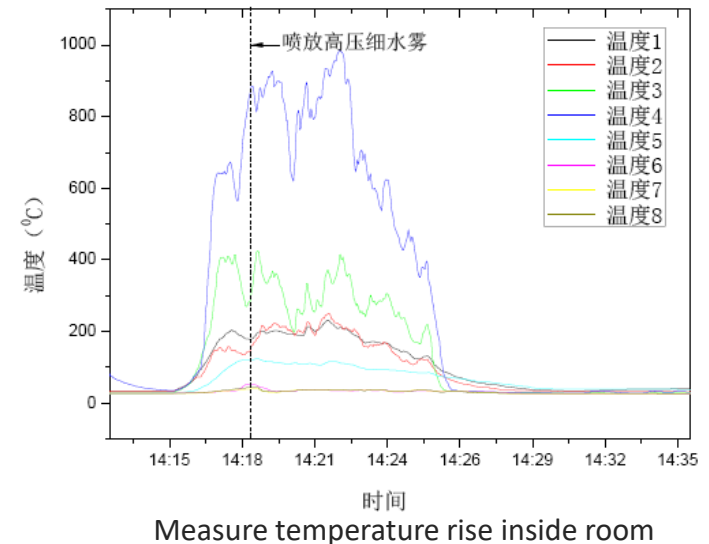
Fire Test – Water Mist as cooling protection

Pass Criteria

- The temperature on the protected side shall not exceed 140°C
- No by eye visible holes through the glass

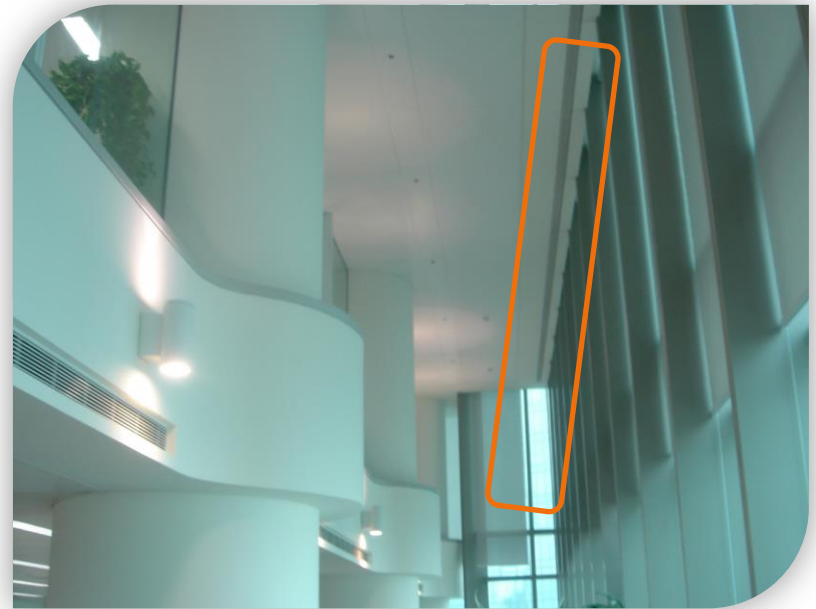


Glass break without protection by water mist



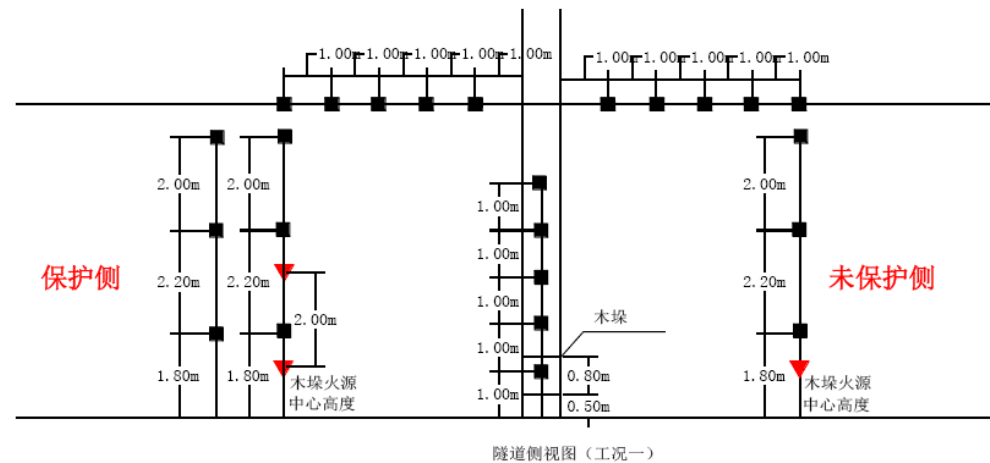
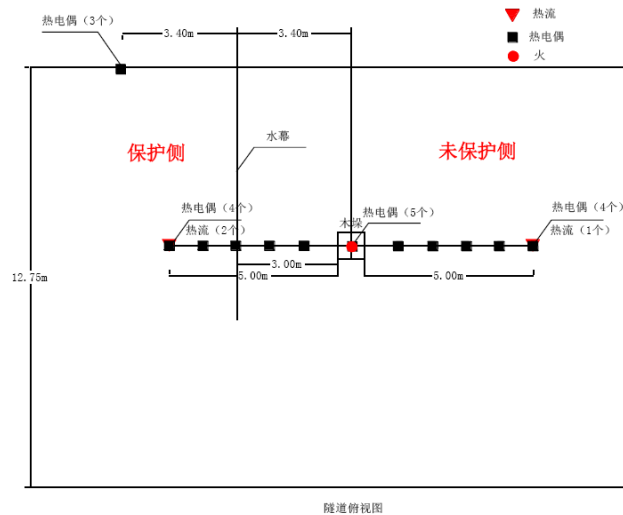
Application – Glass Cooling protection

- ❑ Mingshen Bank buildings are designed openly by using glass and steel structures, thus fire prevention becomes a challenge.
- ❑ Adjacent floors are separated by glass + water mist cooling to have reduced glass cost and requirement on structure



Water mist curtain

Alternative to water curtain as fire proof wall?



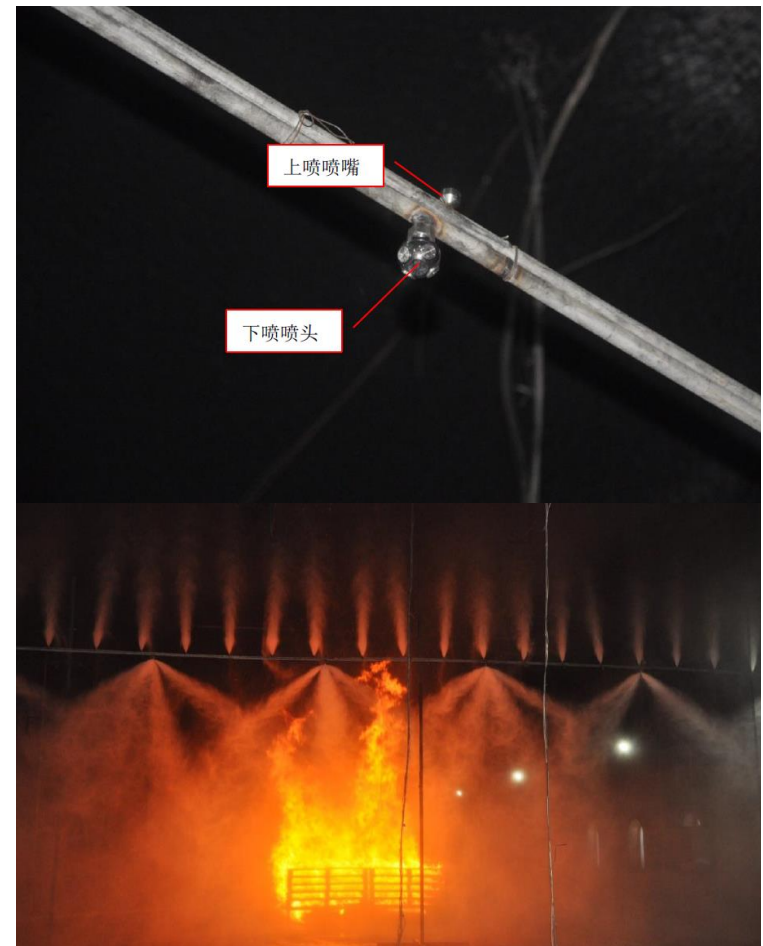
Full scale fire test setup

Fire Test – Water Mist as Fire Proof Wall

Alternative to water curtain as fire proof wall?



Fire load HRR 3 MW



Fire Test – Water Mist as Fire Proof Wall

Pass Criteria

- The temperature on the protected side shall not exceed 180°C
- Heat flux shall be less than 0.5 kW/m²

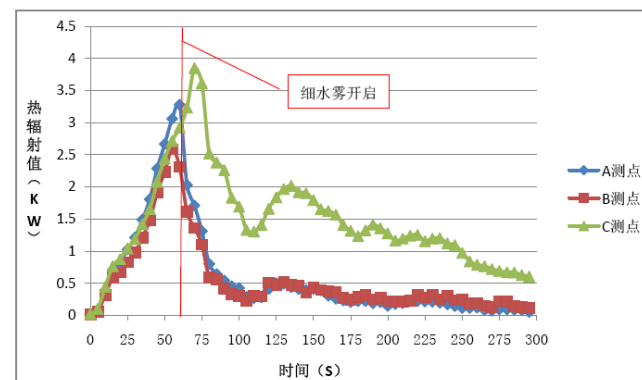


图 4-11 保护侧及未保护侧热辐射随时间的变化
heat flux on both sides

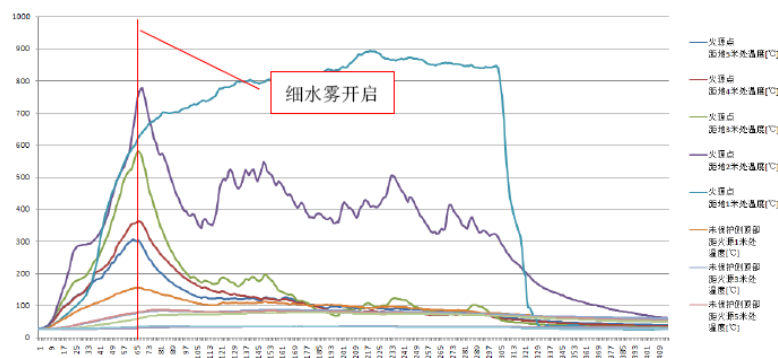


图 4-9 火源与未保护一侧的火场温度随时间的变化

Measure temperature at the side of fire

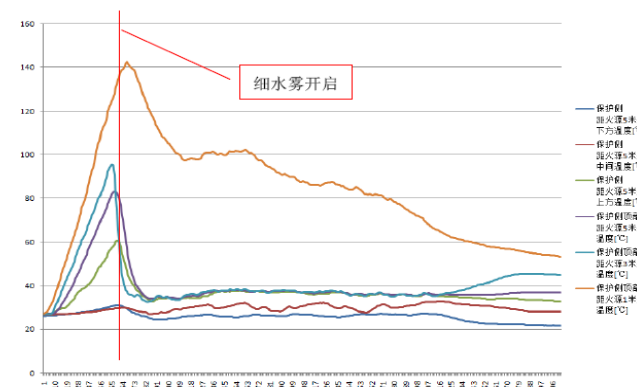
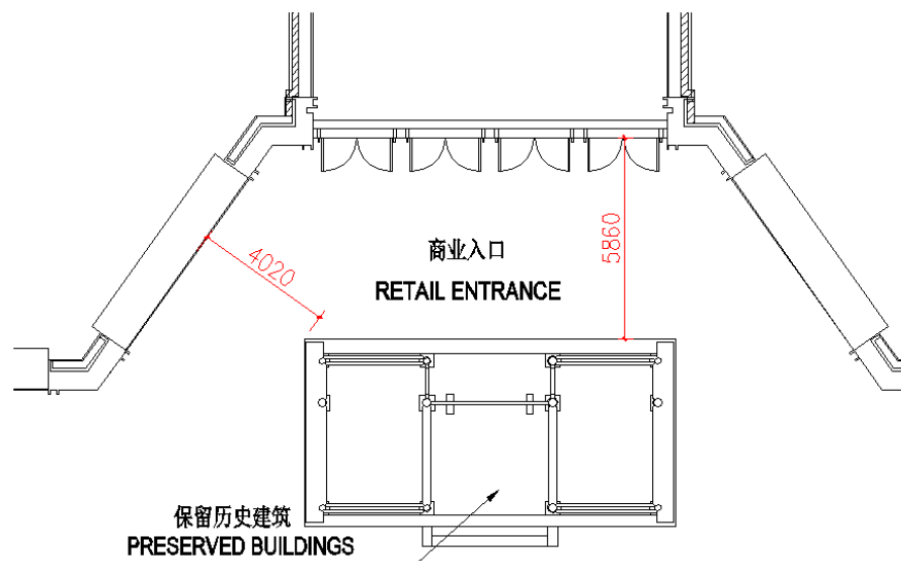


图 4-10 受到高压细水雾带保护一侧的火场温度随时间的变化

Measure temperature rise on protected side

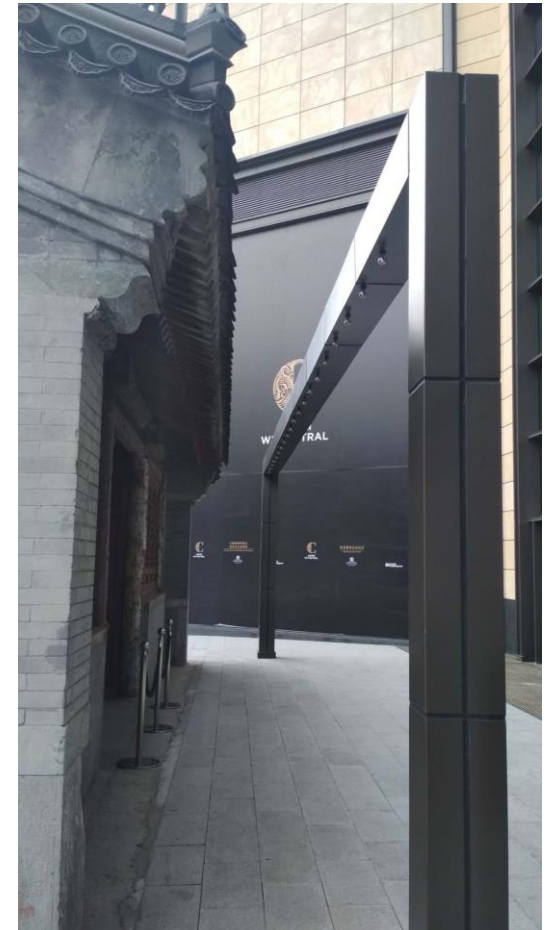
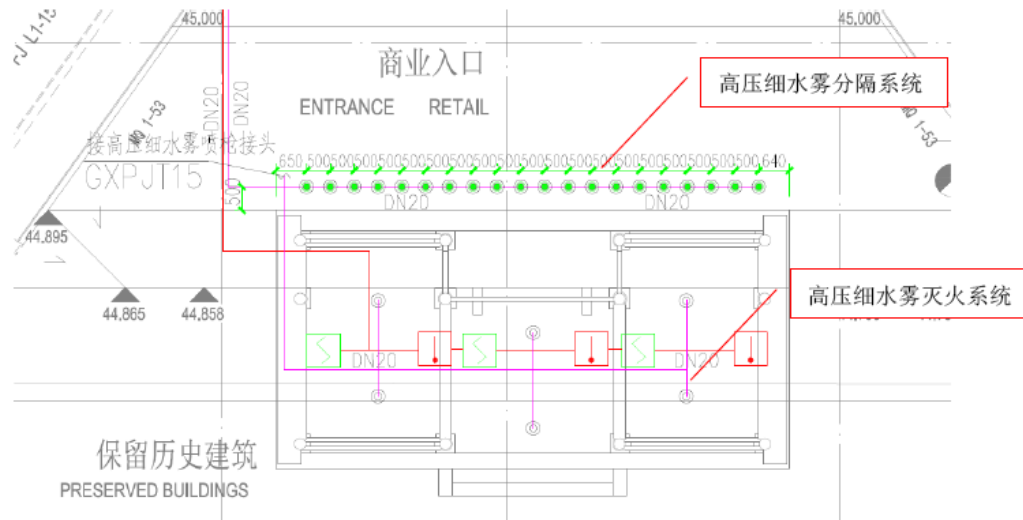
Application – Beijing Pulun Palace Heritage

- ❑ As per China code, the distance to historic heritage shall be at least 14m.



Application – Beijing Pulun Palace Heritage

- ❑ Full-scale fire tests were done to determine design configuration.
- ❑ Water mist nozzles installed along the gate



Summary

- ❑ Water mist is proved to be a valuable alternative to fire partition due to high efficient cooling, heat blocking, and little water demand.
- ❑ Full scale fire tests were needed to verify the protection performance of water mist curtain case by case.
- ❑ More research were aslo needed to investigate the factors affecting the reliability of water mist system as alternative to fire partition.



ANY QUESTIONS?

Email: bhcong@tongji.edu.cn
congbeihua@tongtai-sh.com