WINDOWS DOORS & FACADES EVENT 2018

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MIDDLE EAST FACADES 2018

Window & Door Performance In High Rise Buildings

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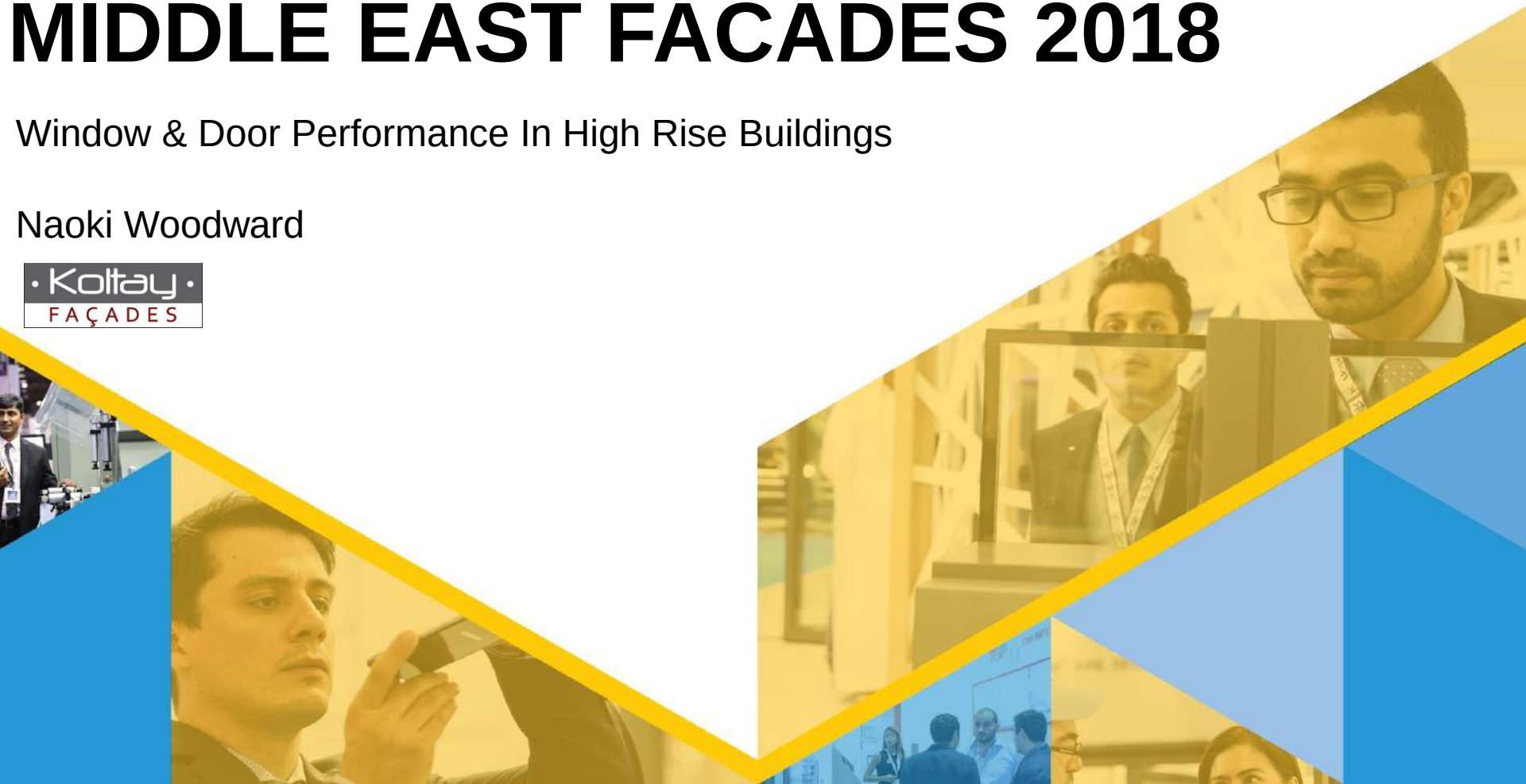


Introduction

- Relevant weather performance standards
- High level comparison
- Determination of suitable performance
- Wind tunnel analysis – High Rise
- Peak pressure applicability
- Realistic performance levels
- Performance following modifications
- Conclusion

Relevant Weather Performance Test Standards - Windows/Doors

ASTM

- **Air Infiltration/Exfil': ASTM E283**
- **Water Penetration: ASTM E331**
- **Wind Resistance: ASTM E330**

EN

- **Air Permeability: EN 1026 (Classification EN 12207)**
- **Watertightness: EN 1027 (Classification EN 12208)**
- **Resistance to Windload: EN 12211 (Classification EN 12210)**

CWCT

- **References respective EN standards for windows/doors**

EN/ASTM Air/Water/Wind – Key Similarities/Differences

Similarities

- Air/Water Duration 15mins
- Wind - Serviceability/Safety

Differences (too many to list!)

- Water flow rate, application, stepping of pressures
- Test Conditions (Environmental)
- Dynamic Testing
- Water tightness re-testing (after wind resistance)
- Required performance at low pressure
- Classifications

No preference – but presentation based on EN standards!!

How do we determine suitable performance?

BS 6375

- **Provide exposure categories, but really written for low-rise buildings (in the UK)**
- **Typical Air/Water values only up to 300Pa @ >2kPa**
- ***Equates to circa 15% design pressure***

AAMA 101

- **Provides indication of 'optional' required performance for a given design pressure: <15% peak pressure**

CWCT

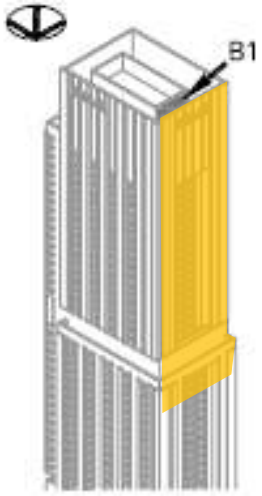
- **0.25 design wind pressure (ENV-1992-2-4 gust calculation)**

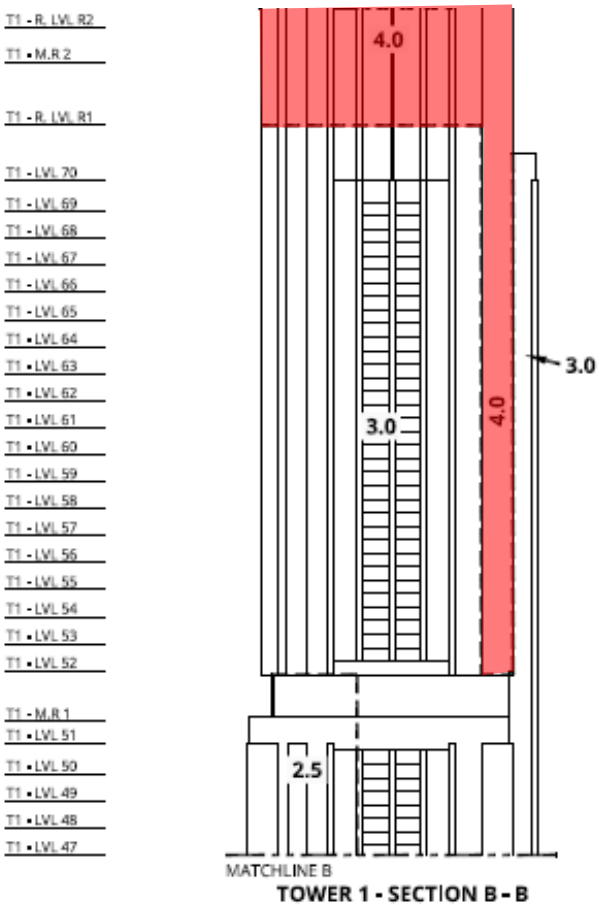
Wind!

Positive Pressures

Largest peak positive cladding pressure + 4.0 kPa

Majority of positive wind pressures + 2 kPa to + 3 kPa maximum



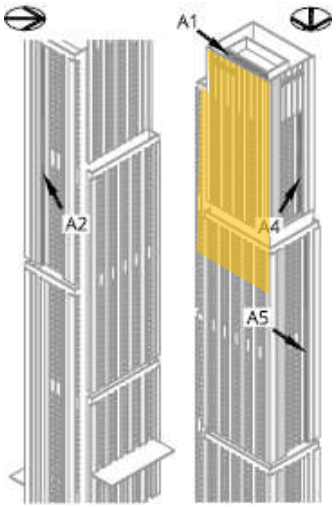


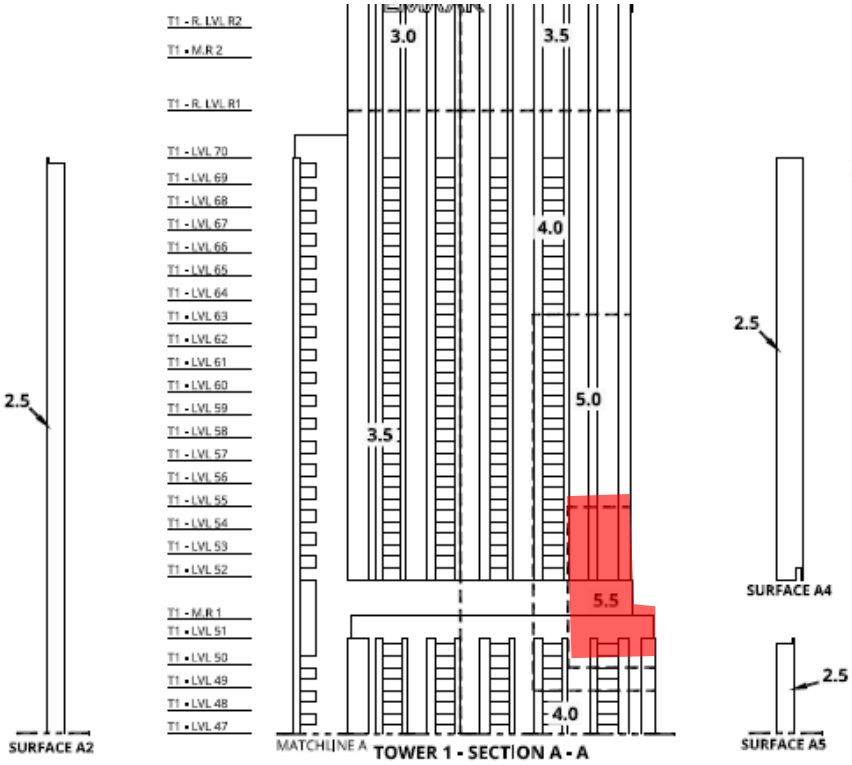
Negative Pressures

Largest peak negative cladding pressure – 5.5 kPa

Majority of negative wind pressures in the range of -2.5 kPa to - 3.5 kPa

(but up to – 4.0 to - 5.0 kPa at upper portions of tower)





Weather Performance Requirements

Wide range of pressures - positive/negative, but what is critical?!

Negative Pressures (- 5.5 kPa)
- **Not necessarily critical to user comfort**
- **Water penetration not a concern**
- **High pressures - structural relevance only**
- **Air Exfiltration/whole building air leakage (low pressure testing)**

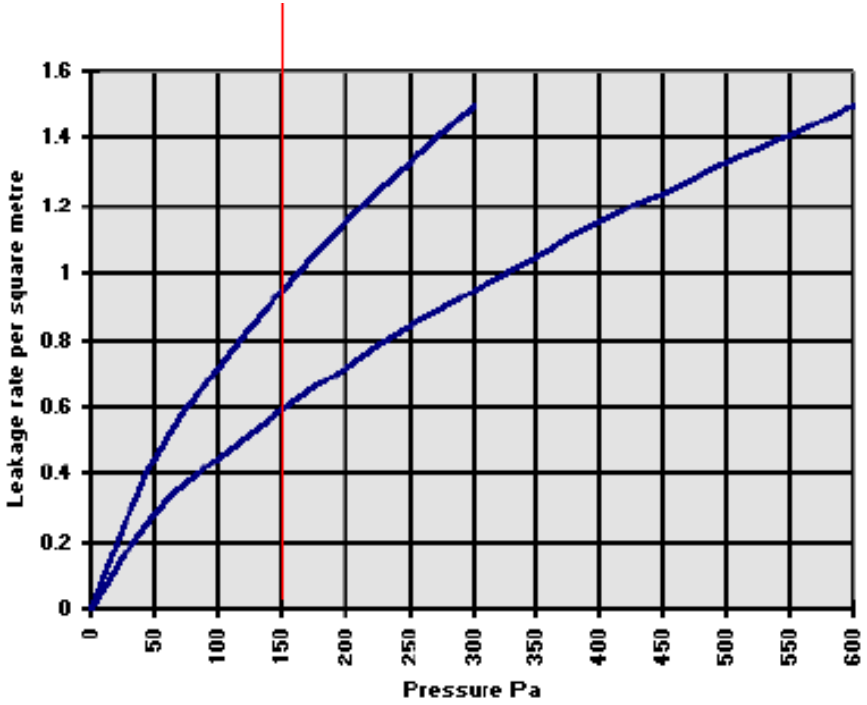
Positive Pressures (+ 4.0 kPa)
- **Critical to user comfort (drafts)**
- **Water penetration**
- **Air Infiltration**

4000Pa x 0.25 = 1000Pa test pressure for water..

and air?

Air Permeability
-Testing/High Pressures

- Testing to higher pressures show tighter performance at all pressures
- Why?
- Max' 600Pa OK!



Table/Data from CWCT

Air Permeability -Testing/Low Pressures

- EN Classification based on reference air permeability at 100Pa
- Lower peak test pressures worse performance @ 100Pa
- Building air leakage tested as exfiltration normally at 50Pa
- Reference performance at 50Pa can be calculated using adjacent equation

$$Q = Q_{100}\left(\frac{P}{100}\right)^{2/3}$$

where:

Q_{100} is the reference air permeability at a test pressure of 100 Pa
Q is air permeability at a test pressure P.

4.4 Classification based on the overall area

Table 1 : Reference air permeabilities at 100 Pa and maximum test pressures, related to overall area, for classes 1 to 4

Class	Reference air permeability at 100 Pa $m^3/h \cdot m^2$	Maximum test pressure Pa
0	Not tested	
1	50	150
2	27	300
3	9	600
4	3	600

Weather Performance -Testing Pressure Summary

Air Infiltration
- **High pressures (300Pa, 600Pa, 0.25p)**
- **Low Pressure (50Pa, 100Pa)**

Air Exfiltration
- **Low pressure; Whole building air leakage (50Pa, 100Pa)**

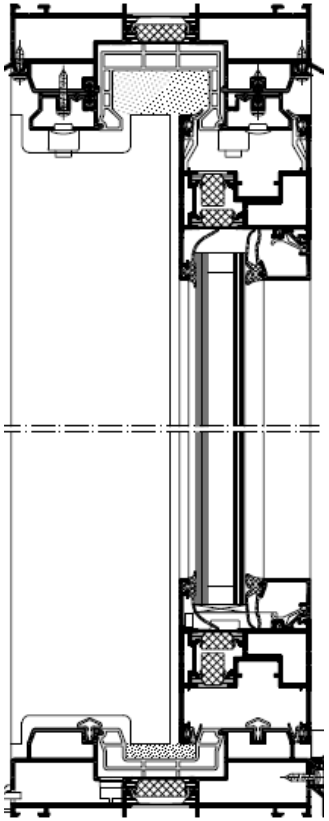
Water Penetration
- **Max' peak *positive* wind pressure (4 kPa, 1000Pa – 0.25p)**

Wind Resistance
- **Max' peak wind pressure relevant to window/door location**

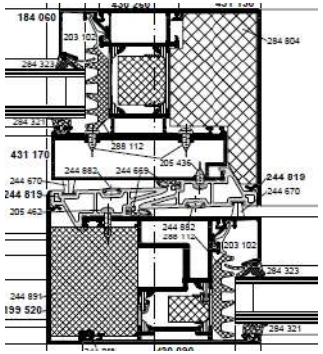
Proprietary Systems - Weather Performance

Window/Door Types

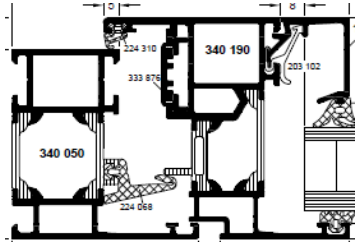
Sliding Door – Cill/head

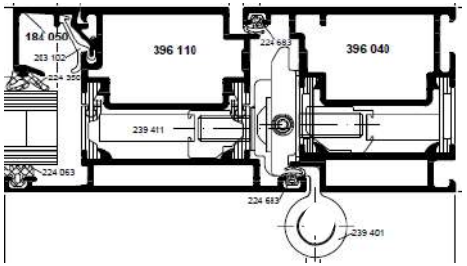


Sliding Door - Interlock

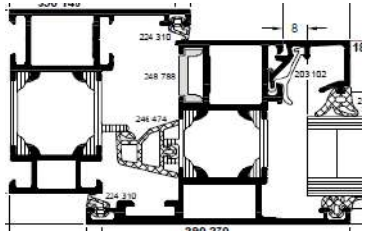


IO Window





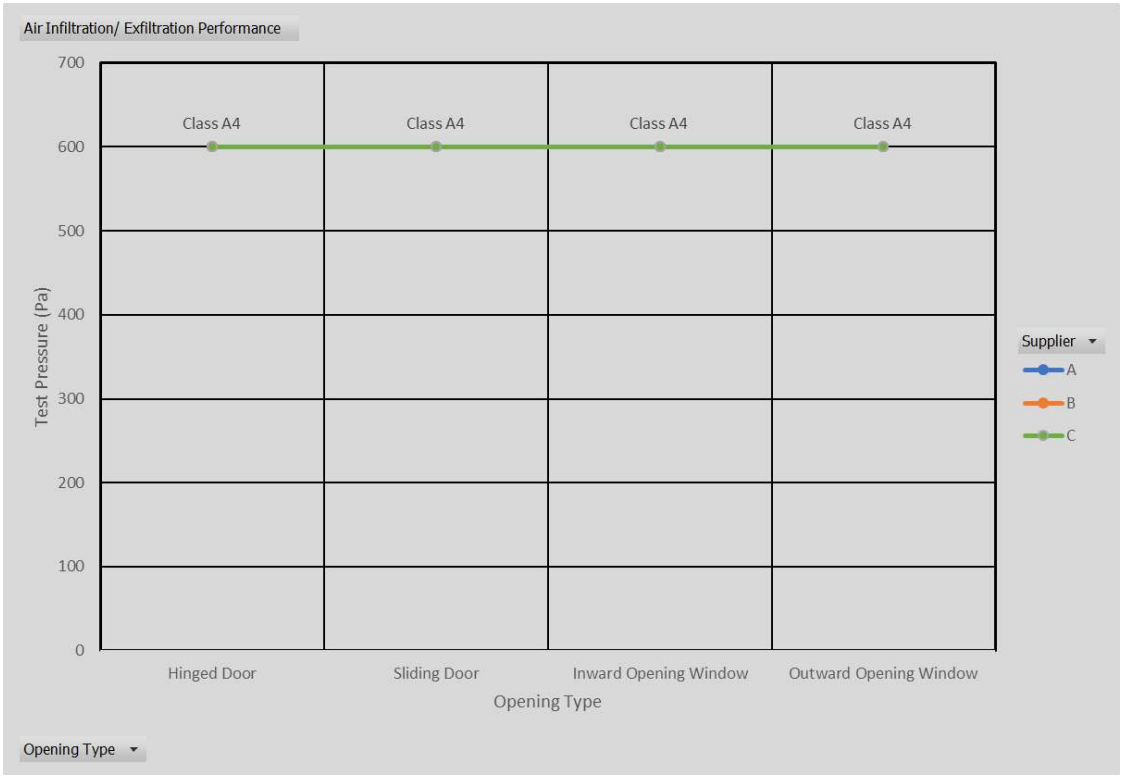
Hinged Door



OO Window

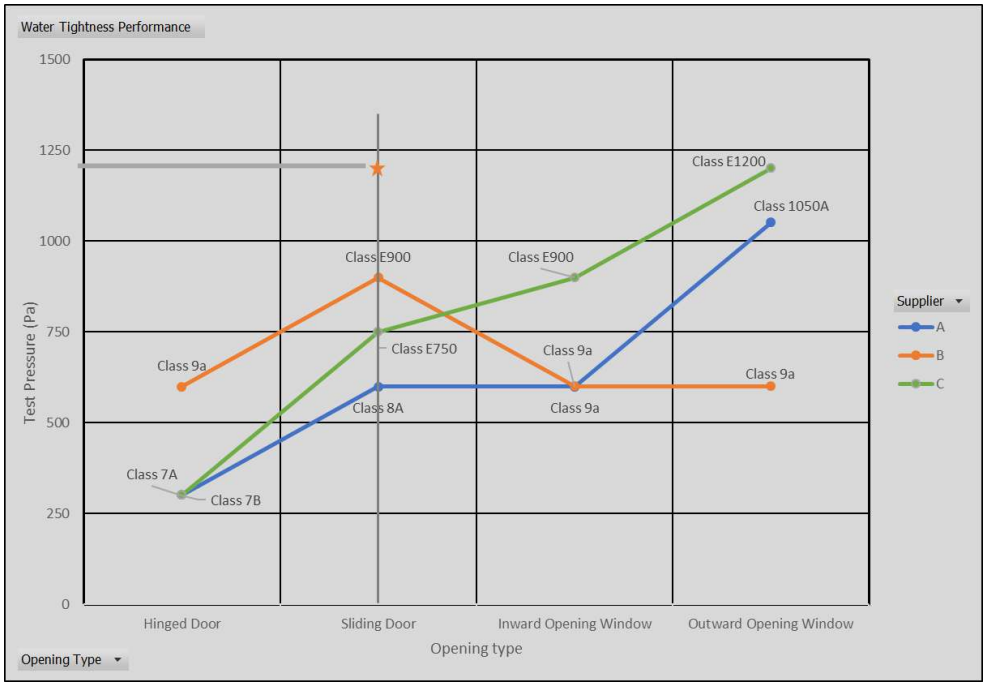
Air Permeability
EN 12207

- Equal performance across all key door/window types
- Jumps from 300Pa to 600Pa classification
- Classification to max' 600Pa only
- Testing >600Pa not of value



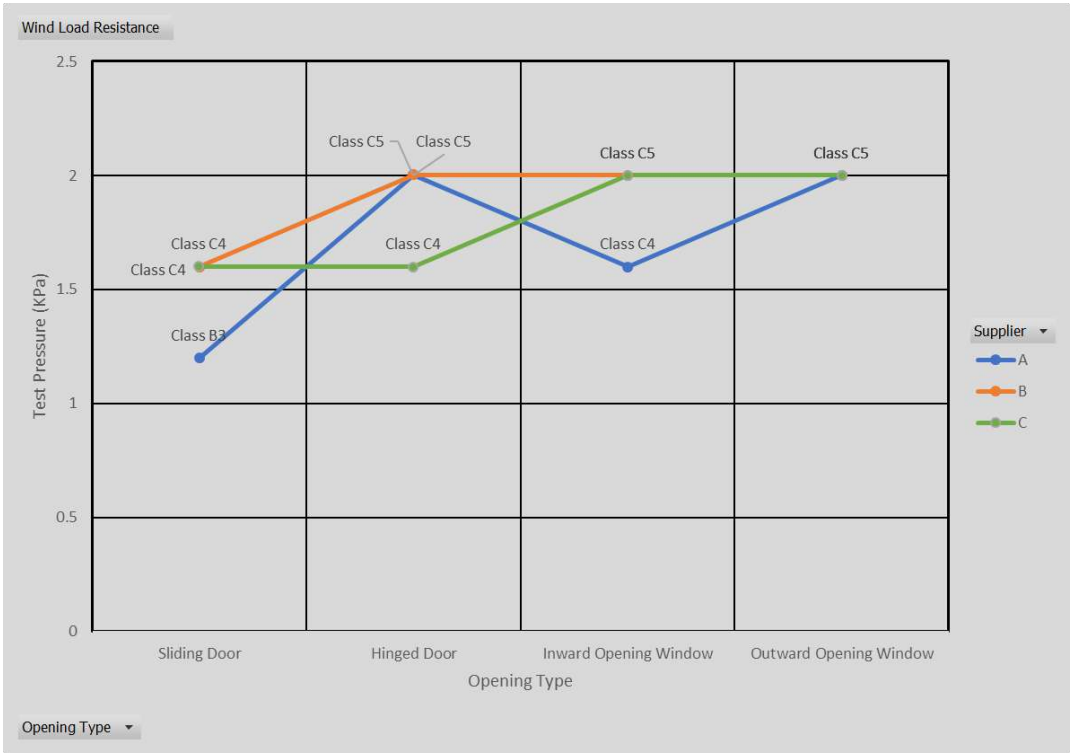
Water Resistance
EN 12208

- Hinged (swing) Door Consistently worst performing type
- Sliding Door -up to E1200
- IO Windows – generally 600Pa, ≤E900
- OO Windows – up to E1200, though ≤E1000 more typical/realistic



Wind Resistance
EN 12210

- Worst case peak loads applicable (normally negative)
- Most systems Class C5 (2kPa windload) as standard
- Sliding door worst structural performance, Class B3 - C4 (1.2kPa – 1.6 kPa)



Performance Matrix

Windload (Required air/water test pressure 0.25p)	Swing Door			Sliding Door			IO Window			OO Window		
	AIR	WATER	WIND	AIR	WATER	WIND	AIR	WATER	WIND	AIR	WATER	WIND
≤ 4800 Pa (1.2kPa)	N/A			N/A			N/A			N/A		
≤ 4000 Pa (1kPa)	N/A			N/A			N/A			N/A		
≤2400 Pa (600Pa)												
≤2000 Pa												
≤ 1200 Pa (300Pa												

- **Wind Resistance Classification vs peak windload for air/water performance**
- **Values only met by a single product/supplier or performance borderline**

After System Modifications

Windload (Required air/water test pressure 0.25p)	Swing Door			Sliding Door			IO Window			OO Window		
Text goes here	AIR	WATER	WIND	AIR	WATER	WIND	AIR	WATER	WIND	AIR	WATER	WIND
≤ 4800 Pa (1.2kPa)	N/A			N/A			N/A			N/A		
≤ 4000 Pa (1kPa)	N/A			N/A			N/A			N/A		
≤2400 Pa (600Pa)												
≤2000 Pa												
≤ 1200 Pa (300Pa)												

- Swing/Sliding Door Structural Performance – dependent on spans
- Window Structural Performance: More restricted than doors
- Door Weather (Air/Water): More restricted than windows!
- Window Weather (Air/Water): Additional locking points, further drainage provision, gasket changes

Recommendations

- Opening elements are not practical to be located in regions with > + 4.8 kPa windload
- Sliding doors are opening type most suited to high windload locations (structurally) but generally up to 4 kPa only *single slider behind fixed light
- Windows suitable at locations with peak wind pressures up to circa 3.5 kPa dependent on size, design and hardware set
- Swing doors suitable < 2.4 kPa
- Above only takes into account weather performance not other aspects such as operation and usage.
- Window/door systems in high rise ‘within’ other façade system type i.e unitised

Conclusion

- **Early design stage coordination - location and opening type**
- **Wind Tunnel required to facilitate this**
- **Should consider opening vent/door selection along with other aspects such as usability, mechanical strength, hardware connection to framing.**
- **Improve stakeholder satisfaction and reduce issues during construction stage (testing)**

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THANK YOU

SPEAKER INFO

Naoki has over 11 years experience in facade design, testing, specification and project management. He is currently involved with a number of high profile projects in Dubai from design through to delivery stages, and builds on significant experience gained within the European facade market working for both supplier, consultant and main contractor.