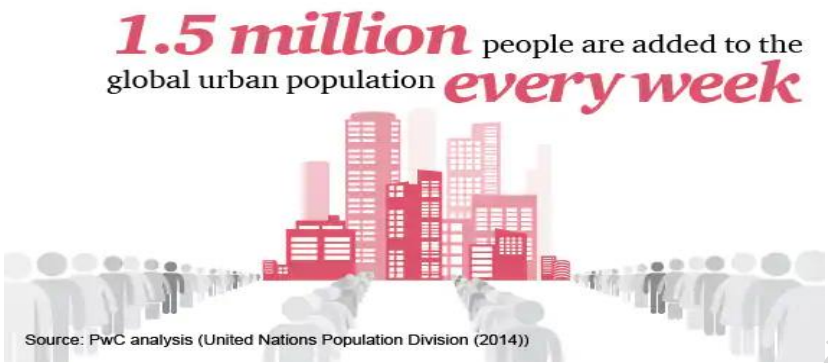
© Zak World of Façades Sydney Conference

Advanced Interactive Dynamic Facades

Technology or Product? Customised Australian Project Solutions

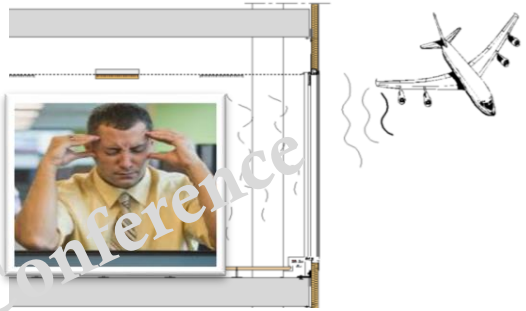
Date: 11 September 2019 – ZAK World Of Facades - ICC Sydney

Future Cities – Shifting Cultural Paradigm



© Zak World of Façades Sydney Conference

Stakeholder Façade Design Considerations



© Zak World of Façades Sydney Conference

Can we say goodbye to glass skyscrapers?

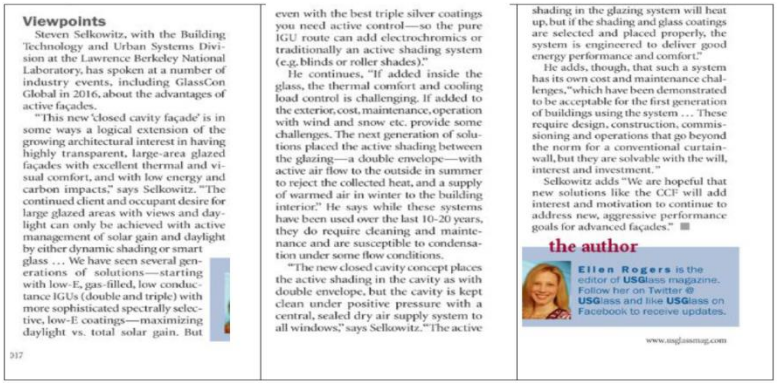
PERMASTEELISA GROUP

www.permasteelisagroup.com

- *Can we say goodbye to glass skyscrapers? (Permasteelisa – CEO)*
- http://www.architectureanddesign.com.au/features/features-articles/can-we-finally-say-goodbye-to-glass-skyscrapers
- "I'm not suggesting we need to lower the amount of glass everywhere – [we should] just be more careful with where and how we use [it]," he says. "The problem is [that] we're using glass in the same way in every climate in Australia. We need to better respond to the unique [characteristics] of our different climates in façade design." - Prof Oldfield UNSW
- US Glass Magazine Vol 52, Issue 2 Feb 2017
- Steven Selkowitz – Director Building Technology and Urban Systems – Lawrence Berkeley National Laboratories LBNL
- *"These require design, construction, commissioning and operations that go beyond the norm for a conventional curtain wall, but they are solvable with the will, interest and investment"*

"This new "Closed cavity façade" is in some ways a logical extension of the growing architectural interest in having highly transparent, large-area glazed facades with excellent thermal and visual comfort with low energy and carbon impacts"

© Zak World of Facades Sydney Conference



Viewpoints

Steven Selkowitz, with the Building Technology and Urban Systems Division at the Lawrence Berkeley National Laboratory, has spoken at a number of industry events, including GlassCon Global in 2016, about the advantages of active façades.

"This new 'closed cavity façade' is in some ways a logical extension of the growing architectural interest in having highly transparent, large-area glazed façades with excellent thermal and visual comfort, and with low energy and carbon impacts," says Selkowitz. "The continued client and occupant desire for large glazed areas with views and daylight can only be achieved with active management of solar gain and daylight by either dynamic shading or smart glass … We have seen several generations of solutions—starting with low-E, gas-filled, low conductance IGUs (double and triple) with more sophisticated spectrally selective, low-E coatings—maximizing daylight vs. total solar gain. But even with the best triple silver coatings you need active control—so the pure IGU route can add electrochromics or traditionally an active shading system (e.g. blinds or roller shades)."

He continues, "If added inside the glass, the thermal comfort and cooling load control is challenging. If added to the exterior, cost, maintenance, operation with wind and snow etc. provide some challenges. The next generation of solutions placed the active shading between the glazing—a double envelope—with active air flow to the outside in summer to reject the collected heat, and a supply of warmed air in winter to the building interior." He says while these systems have been used over the last 10-20 years, they do require cleaning and maintenance and are susceptible to condensation under some flow conditions.

"The new closed cavity concept places the active shading in the cavity as with double envelope, but the cavity is kept clean under positive pressure with a central, sealed dry air supply system to all windows," says Selkowitz. "The active shading in the glazing system will heat up, but if the shading and glass coatings are selected and placed properly, the system is engineered to deliver good energy performance and comfort."

He adds, though, that such a system has its own cost and maintenance challenges, "which have been demonstrated to be acceptable for the first generation of buildings using the system … These require design, construction, commissioning and operations that go beyond the norm for a conventional curtain-wall, but they are solvable with the will, interest and investment."

Selkowitz adds "We are hopeful that new solutions like the CCF will add interest and motivation to continue to address new, aggressive performance goals for advanced façades."

the author

Ellen Rogers is the editor of USGlass magazine. Follow her on Twitter @USGlass and like USGlass on Facebook to receive updates.

www.usglassmag.com

Interactive Dynamic Façade Innovations: Are we ready?

PERMASTEELISA GROUP

www.permasteelisagroup.com

© Zak World of Façades Sydney Conference

"Don't bother me with new ideas, I've got a battle to fight!"

or……. “Don’t bother me with new ideas, I’ve got a building to build!”

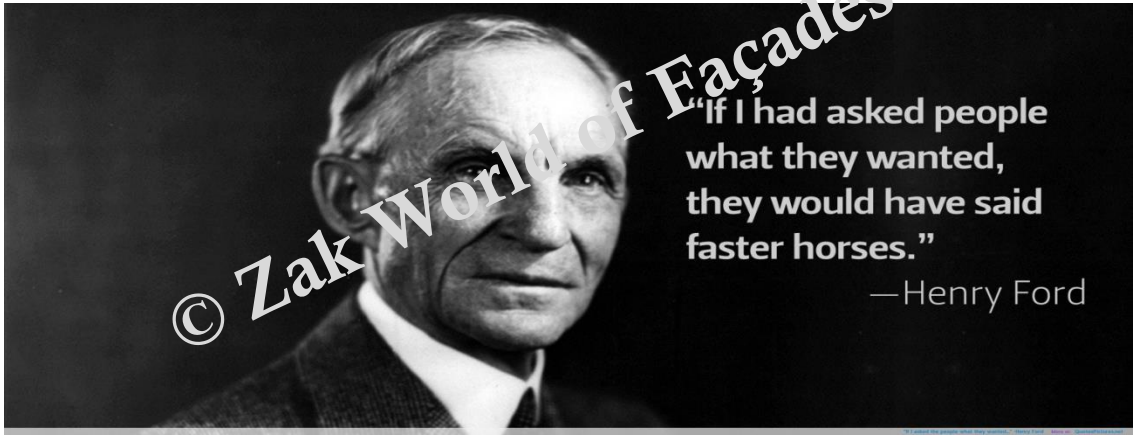
Are we ready? New ideas & Innovation: Gaps vs Trends

PERMASTEELISA GROUP

www.permasteelisagroup.com

- Gaps – opportunity for *disruptive* technology = Create a market through innovation (200 George St)

- Trends – identify market indicators; pre-empt movements = *anticipate* the market through innovation



© Zak World of Façades Sydney Conference

Are we ready?

PERMASTEELISA GROUP

www.permasteelisagroup.com

Current trends & opportunities

- **Smart Buildings** –
  - Automated BCS control building operations HVAC, comfort, (day)lighting, security
  - Optimization of space, energy reduction and reduced environmental impacts **(Celergon)**
- **3D/BIM Modelling**
  - Early stage partnering (PCSA)
  - Digital Design, Procurement, Manufacturing, Logistics, QESH & Site Integration (**PMF**)
- **Energy-efficient buildings**:
  - Saves energy, cut costs, reducing environmental impacts.
  - “Developing these buildings requires a whole-building design approach”.
  - Buildings are up to 70 percent more efficient than the average commercial buildings. **(EPBD, Capsol Excellent, MFreeS, D3, TEC, Timber Facades)**
- **Prefabrication/Modular Design:**
  - Rapid Prototyping
  - Additive Manufacture

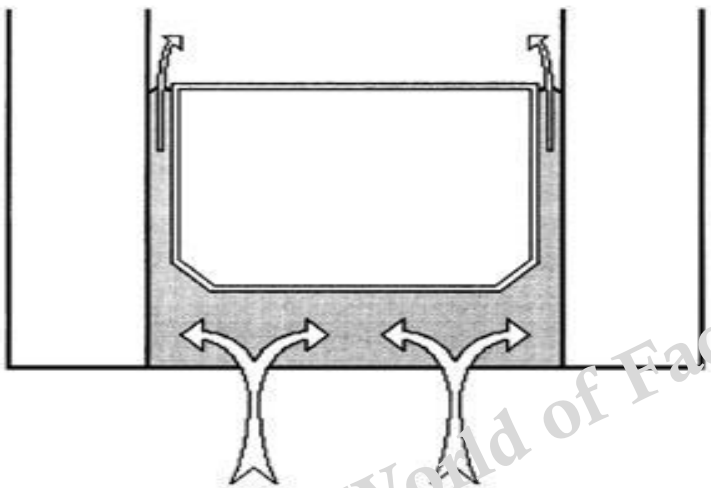
© Zak World of Facades Sydney Conference

Construction Innovation? – Sustainability & IGU's

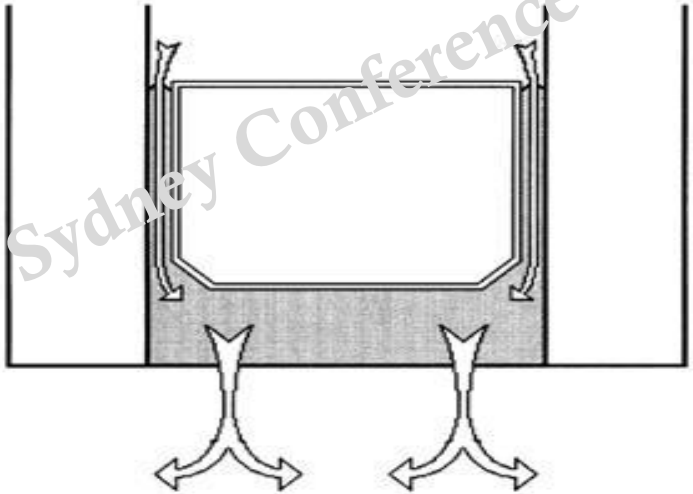
PERMASTEELISA GROUP

www.permasteelisagroup.com

- Moisture penetration and gas loss



Moisture penetration

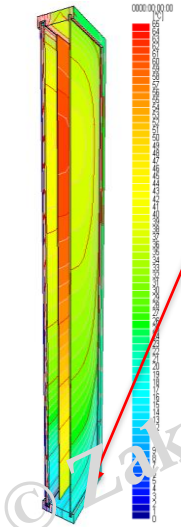


Gas loss

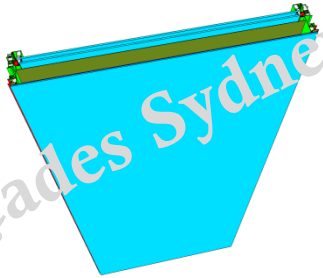
© Zak World of Façades Sydney Conference

State-of-the-Art Advanced Facades: Condensation Risks?

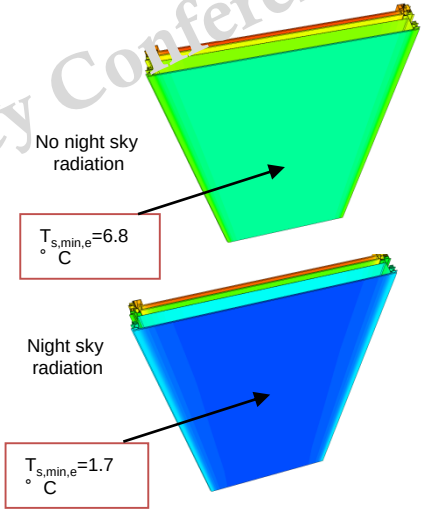
- In open systems condensation will occur in Double Skin Facades
  - Active wall: on interior of DGU (incorrectly distributed air flow)
  - Interactive wall: on interior of outer pane (night sky radiation effect)
  - Shadow boxes



Active façade: local cold zones due to incorrect air flow distribution



Outside view of an interactive wall



Surface temperature can be lower than dewpoint temperature.

©ZAK World of Façades Sydney Conference

mfree-S: No condensation inside the cavity

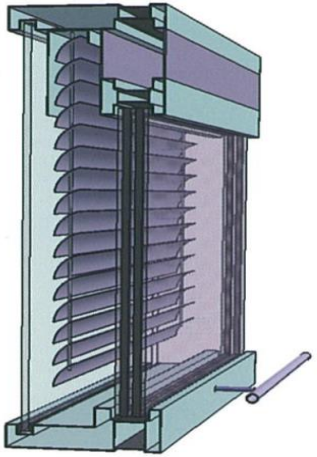
But how is this achieved and guaranteed?

www.permasteelisagroup.com

Advanced Interactive Dynamic Facades, mfree-S: An Australian Perspective

© Zak World of Façades Sydney Conference

Advanced Interactive Dynamic Facades: MFreeS: What & Why?



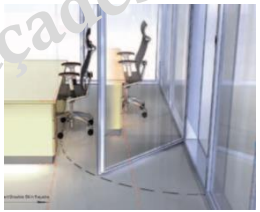
mfree-S Closed Cavity Facade

- A compact 'Double Skin Facade'
- Clear Glass Pane
- Shading Device
- High Performace DGU
- Dry Air

© ZAK World of Façades Sydney Conference

mfree-S Closed Cavity Facade

- Continually flushed with dry air – low cavity RH% resulting in low dew point.
- External monolithic glass
- Minimal access to cavity
- Minimal risk of damages to shading device
- Two surfaces to maintain (cleaning)
- Blinds can be considered in the analysis since it is outside of the main insulation – Low SHGC, High thermal performance



IGU – with jockey sash

- Naturally ventilated towards the internal of the building.
- External monolithic is not possible due to high condensation risk.
- Jockey sash = door hardware for every panel.
- Four surfaces to maintain – potential damage to shading device.
- Additional clearance space required for sash opening swing
- ESD engineer need to clarify if blinds can be considered if it is inside of the main insulation – Low thermal performance

Mfree-S: Product vs. Technology

PERMASTEELISA GROUP

www.permasteelisagroup.com

- Product: An assembly of components resulting in a standard performance
- Technology: Base system that can engineered for various performance requirements
- MFreeS is a *technology* encompassing design, quality control and engineering through R&D development, testing and software development in order to provide a degree of confidence and minimize risk
- MFreeS is NOT a pressurized façade system! In fact it must have a certain degree of leakage! Why?
- The system MUST be carefully *engineered* for each building type and location so as to:
  - Eliminate the risk of failure (i.e. condensation, blinds motors, heat build up)
  - Provide a cost effective solution (efficient sizing and operation of plant)

© ZAK World of Façades Sydney Conference

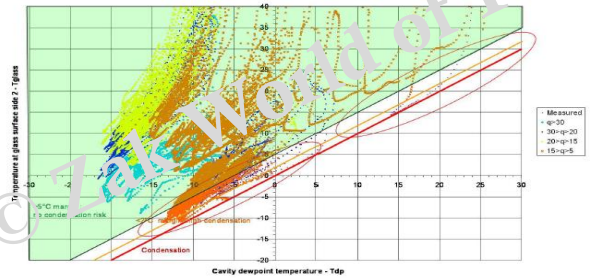
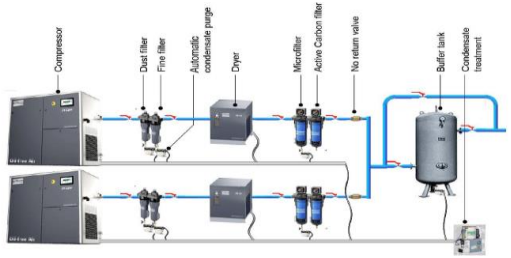


Figure 2. 9: Condensation risk graph : All measurement results over the period 21/3/2005-11/7/2005 and 30/9/2005-26/3/2006 including very low air flows < 15 l/h



Design Requirements: Summary

PERMASTEELISA GROUP

www.permasteelisagroup.com

- Essential design and engineering steps for a MFreeS façade
- Technology is fundamentally simple, but simple over sights and inexperience can lead to problems!

Nr	Item	Measurement	Procurement	Design & Eng.	Testing	Quality control	Commissioning
1.	Preliminary economic assessment	PBP< target Flow< economic limit		☐			
2.	Cavity Air-tightness CCF	K < K$_{target}$		☐	☐	☐	☐
3.	Cleanliness inside the cavity	No dust nor stains	☐	☐		☐	
4.	Accessibility of the cavity	Maintenance of blinds & dust removal		☐			
5.	Condensation risk assessment CCF for target cavity air-tightness	No condensation risk Design air flow		☐			
6.	Compressed air system sizing to *Design air flow*	Materials list Cost	☐	☐			
7.	Blind motors & controls blind system selection	Durability test 10 year Warranty	☐	☐	☐		
8.	Thermal assessment	Selection of Glass properties, blind color and frame color		☐			
9.	thermo-mechanical properties	Material durability 10 year Warranty	☐	☐			
10.	Compressed air system sizing	Plans finished Materials list complete		☐			

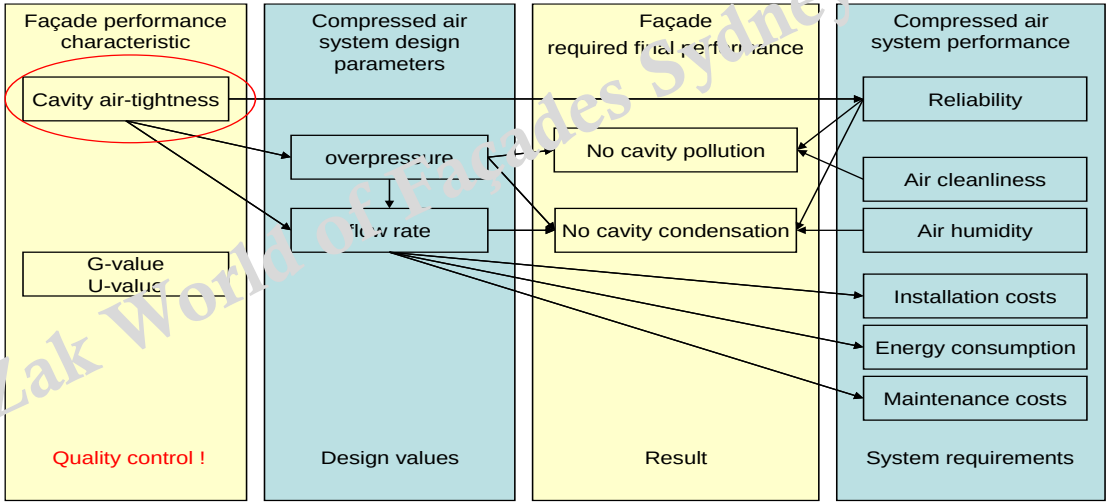
© ZAK World of Façades Sydney Conference

Design Requirements: Cavity Air Tightness

PERMASTEELISA GROUP

www.permasteelisagroup.com

- Cavity pollution and condensation risk influenced by cavity air tightness
- Air flow rate increases as cavity is less air tight
- Higher installation and operation costs of plant
- BUT… cavity must not be completely airtight otherwise dry air exchange will not occur. Cavity must have a certain degree of leakage!



Relationship between cavity air-tightness and system performance

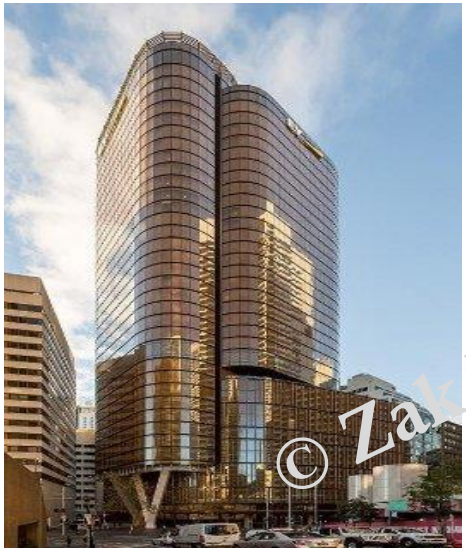
© Zak World of Façades Sydney Conference

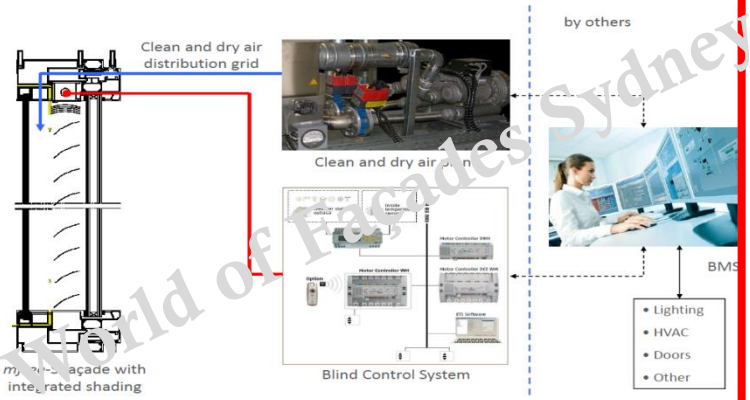
Glazed Curtain Wall Facades: Advanced Dynamic Systems

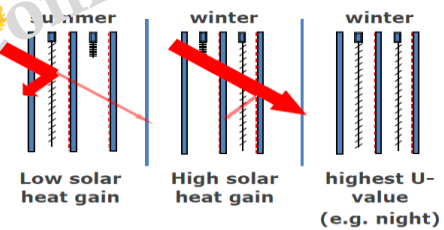
PERMASTEELISA GROUP

www.permasteelisagroup.com

- Since the 90's; architectural trend – transparency & enhanced natural daylight
- Necessity to develop multi-layer facades; use of clear glazing and integrated shading systems
- Permasteelisa Dynamic systems: Closed interstitial blind cavity reducing maintenance costs (Mfree S™©, D3©™), Intelligent management systems (BMS) allow regulated balance between natural daylight, solar transmission control and glare improving occupant comfort and productivity (EPBD)







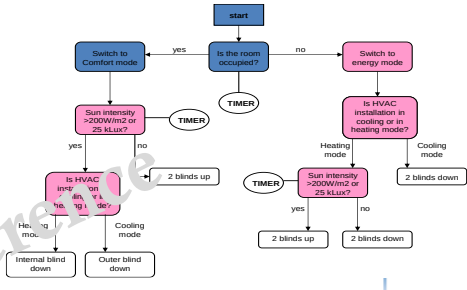
200 George St (MFreeS ™©,) (Left)
& D3 ™©, Intelligent Façade Scheme (Right)

D³ Façade mock-up introduced at Glasstec

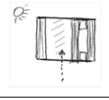
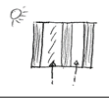
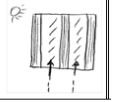
© Zak World of Façades Sydney Conference

Interactive Dynamic Façade Innovations – Controlling Comfort Environments

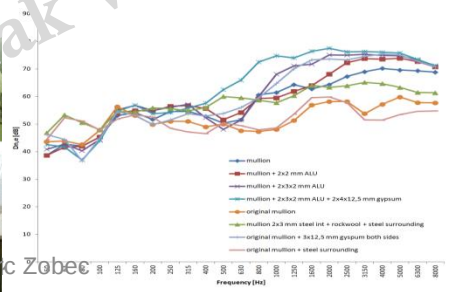
- BCS extension 1: Enhanced D3 control
  - System topology and component selection specifically for D3 control system
  - Assessment for maximisation of energy and comfort gains
  - More detailed control strategy/algorithms



- Green buildings rating systems
  - Assign & receive valuable credits for our innovation technology (façade systems and prediction tools) for green building rating systems

	(A) Present PISA applications			(B) Immediate PISA future	
	A1	A2	A3	B1	B2
Glazing configuration	Single skin CW with selective glazing and Integrated blinds contols	IW with integrated blind controls	mfree-S with integrated blind controls	mfree-S+ with integrated blind controls	mfreeS+ Integrated Dual System with integrated blind with integrated blind controls
					

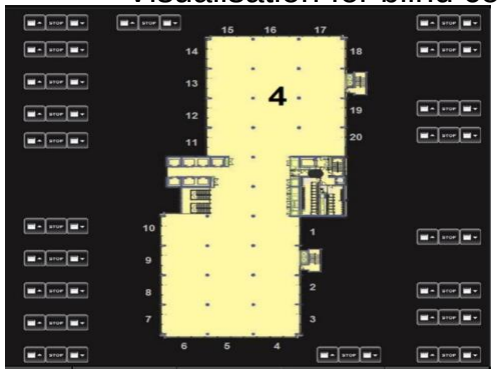
- Acoustic flanking
  - Assessment methodology for detailed assessment for acoustic flanking performance and testing benchmarks (added to our ALABIK software)



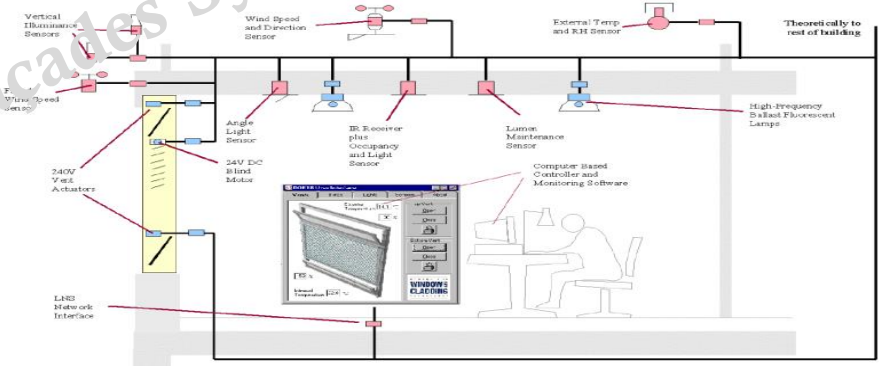
© Zak World of Façades Sydney Conference

Interactive Dynamic Façade Innovations – Controlling Comfort Environments

- BCS extension 2: Web-based interfaces (new)
  - Visualisation for blind control without local hardware



- BCS extension 3: Enhanced shadow management (new)
  - Accurate prediction of shadow
  - Reflection from other buildings / water surfaces



- BCS extension 4: Daylight management (new)
  - research on (day)light management

- Combined room climate controller (new)
  - State-of-the-art algorithms
  - Optimisation, with BMS sensors to user
  - Self-learning

© Zak World of Facades Sydney Conference

Interactive Dynamic Façade Innovations: FiMTMD & Movable Fire Barrier

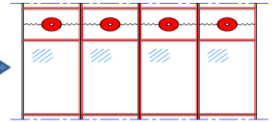
PERMASTEELISA GROUP

www.permasteelisagroup.com

Description / Main reason for research / Request

There are different ways the facade can help the building to reduce the building vibrations:

More promising solution in short period is the Facade Integrated Multi Tuned Mass Damper



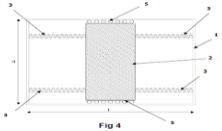


Fig 4

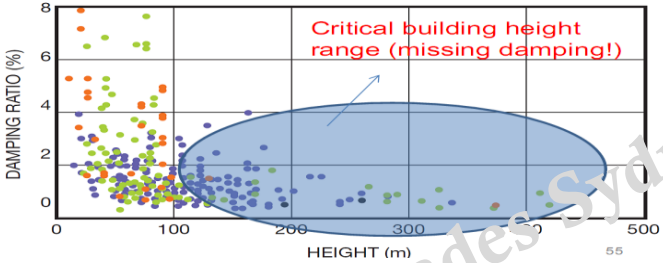
Spring-mass-damper unit can be produced and integrated in the spandrel area of the facade

DAMPING

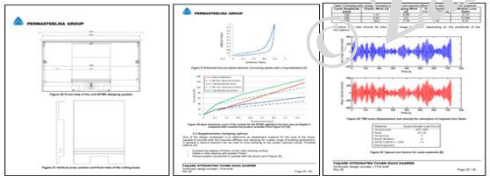
Current trend of building design goes in the direction of slender buildings, affected then by comfort issues due to the large values of accelerations

In order to repair the design shortcomings additional sources of damping must be considered:

- Building strengthening/Outriggers
- Viscous-elastic beam/column connections
- Tuned mass damper



55



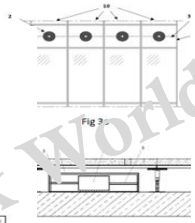


Fig 3b

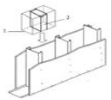


Fig 3c

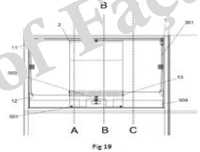


Fig 19

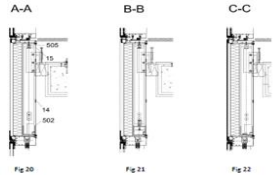
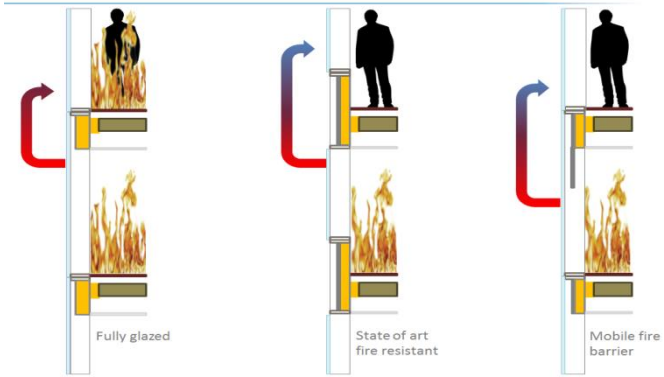


Fig 20 Fig 21 Fig 22



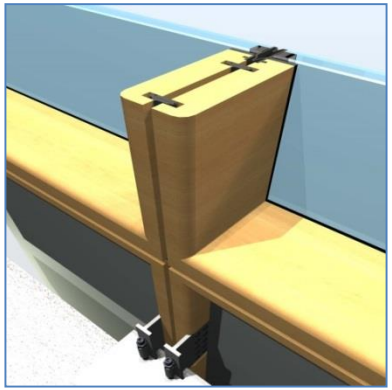
Movable Fire Barrier: against vertical spread of fire.

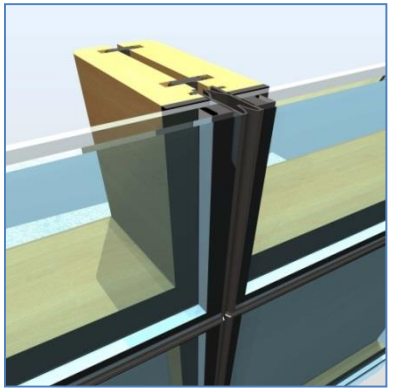
Activation- stand-alone or through BCS integration

© Zak World of Façades Sydney Conference

Glazed Curtain Wall Facades: Advanced Low Embodied Carbon & Energy

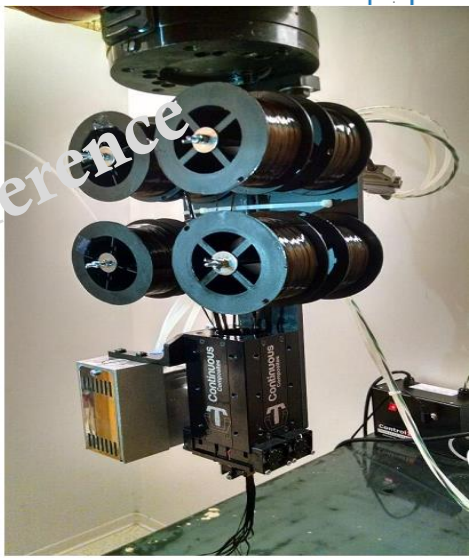
- Greater Eco-sustainability can be achieved through the use of thermally efficient façade materials with low embodied carbon and energy:
  - Glass Fibre Reinforced Polymers (left)
  - Timber (right)

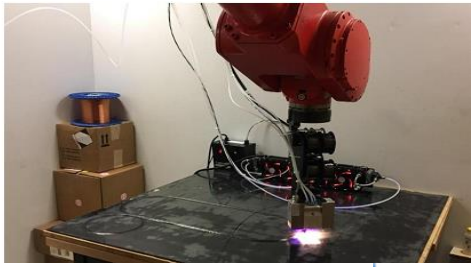




© Zak World of Façades Sydney Conference

Interactive Dynamic Façade Innovations: Additive Manufacturing & Digital Fabrication





© Zak World of Façades Sydney Conference

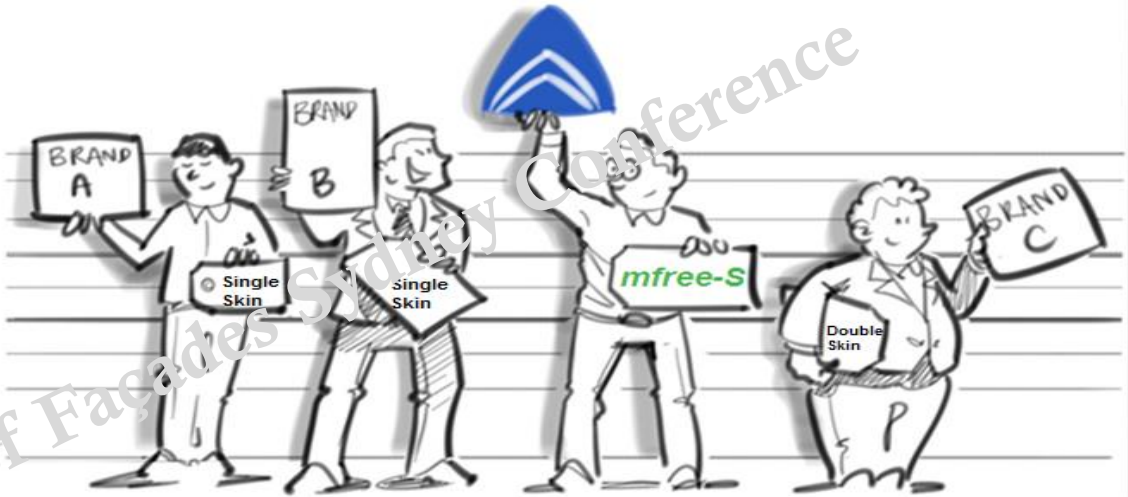
Interactive Dynamic Façade Innovations: Additive Manufacturing & Digital Fabrication

Interactive Dynamic Façade Innovations: Additive Manufacturing & Digital Fabrication

3D Printing, Additive Manufacturing, Digital Fabrication

PERMASTEELISA GROUP

www.permasteelisagroup.com



www.permasteelisagroup.com

rethinking the built environment

© Zak World of Façades Sydney Conference

© Zak World of Façades Sydney Conference

GARTNER PERMASTEELISA SCHELDEBOUW