

The background image shows a building under construction on a hill. The building has a wooden frame and a gabled roof. It is situated on a hillside with a retaining wall. The sky is blue. A large red arrow points from the left towards the building.

Building Resilience

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The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.

Edge 2013. Draft Literature review of New Zealand natural hazards and building resilience information, including New Zealand specific housing resilience

▶ Review

- natural hazards
- existing assessment tools

▶ Site visits to affected properties

▶ Lab assessment of materials

▶ Tool development

▶ Related to materials durability work



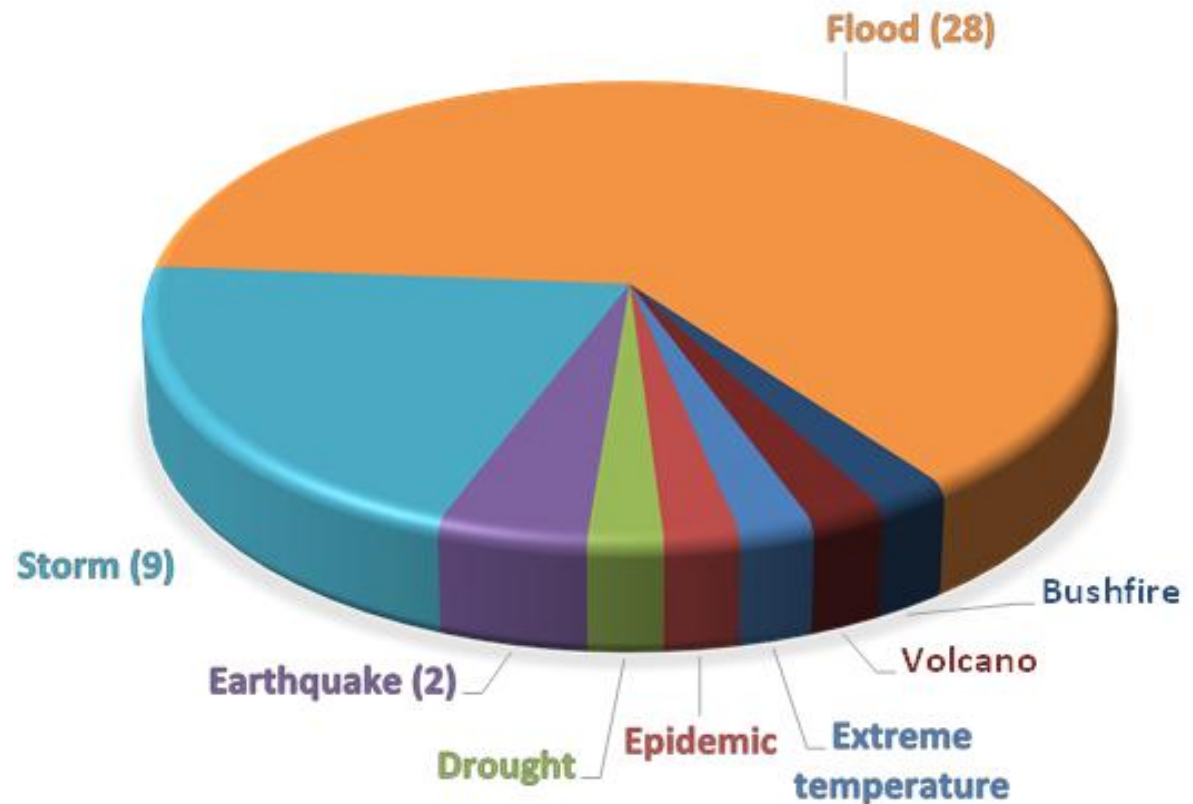
New Zealand Hazards Pre-2010

► Flooding

- 935 severe floods (1920 – 1983)
- Slips and landslides

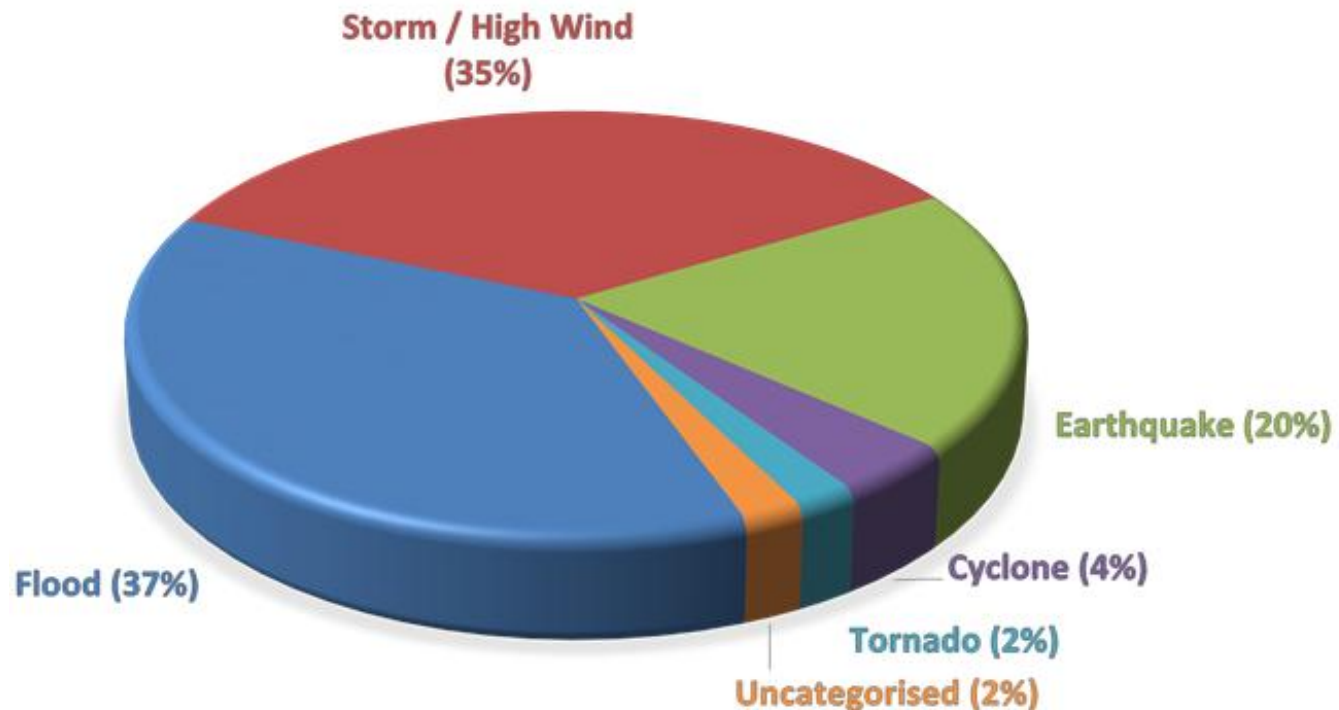
► Storms

- high wind
- tornado



► Natural hazards

- 1968 – 2012
- Excludes Canterbury earthquakes
- All losses (not just housing)



- ▶ **Economic value >\$600b**
- ▶ **Great social value**
- ▶ **Construction**
 - 4 - 5% GDP
 - Employs 8% workforce
- ▶ **Poorly maintained**
 - 25% rated below average
- ▶ **Limited resilience**



Existing Resilience Tools



► Few resilience assessment tools

► Some materials guidance and some ratings

Building Resilience Assessment Tool Output

Assessment Date: 6/28/2011 Facility: Desktop Exercise Site Type: Building

Scales: Risk Color Scale: 0-30, 30-50, 50-70, 70-90, 90-100 Resilience Color Scale: 0-100, 100-200, 200-300, 300-400, 400-500

Summarized Categories	Internal Intrusion	Internal Explosive	Internal CBR	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9
Total Threat (scale of 100)	17.5	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Total Vulnerability (scale of 100)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Total Risk (scale of 100)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Summarized Categories	Earthquake General Shaking	Earthquake Ground Failure	Flood Velocity Surge	Wind Hurricane Tornado	Wind Other	Landslide	Fan From Blast	Fan From Blast	Fan From Blast	Fan From Blast
Total Threat (scale of 100)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Total Vulnerability (scale of 100)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Total Risk (scale of 100)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Resilience Score (1-100)

Performance Measure	Time Measure	Recovery Measure	Recovery Measure
100%	100%	100%	100%

Multihazard Interaction Matrix

	Blast	CBR	Earthquake	Flood	Wind	Fan
in change in Blast	100.0%	10.0%	10.0%	10.0%	10.0%	10.0%
in change in CBR	10.0%	100.0%	10.0%	10.0%	10.0%	10.0%
in change in Earthquake	10.0%	10.0%	100.0%	10.0%	10.0%	10.0%
in change in Flood	10.0%	10.0%	10.0%	100.0%	10.0%	10.0%
in change in Wind	10.0%	10.0%	10.0%	10.0%	100.0%	10.0%
in change in Fan	10.0%	10.0%	10.0%	10.0%	10.0%	100.0%

Total Risk AB Score: 100%



▶ Flood and slip affected properties

- After repairs completed

▶ Flood affected properties

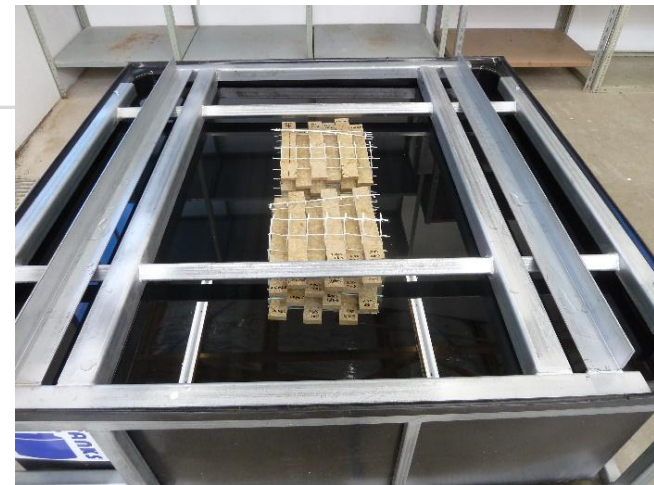
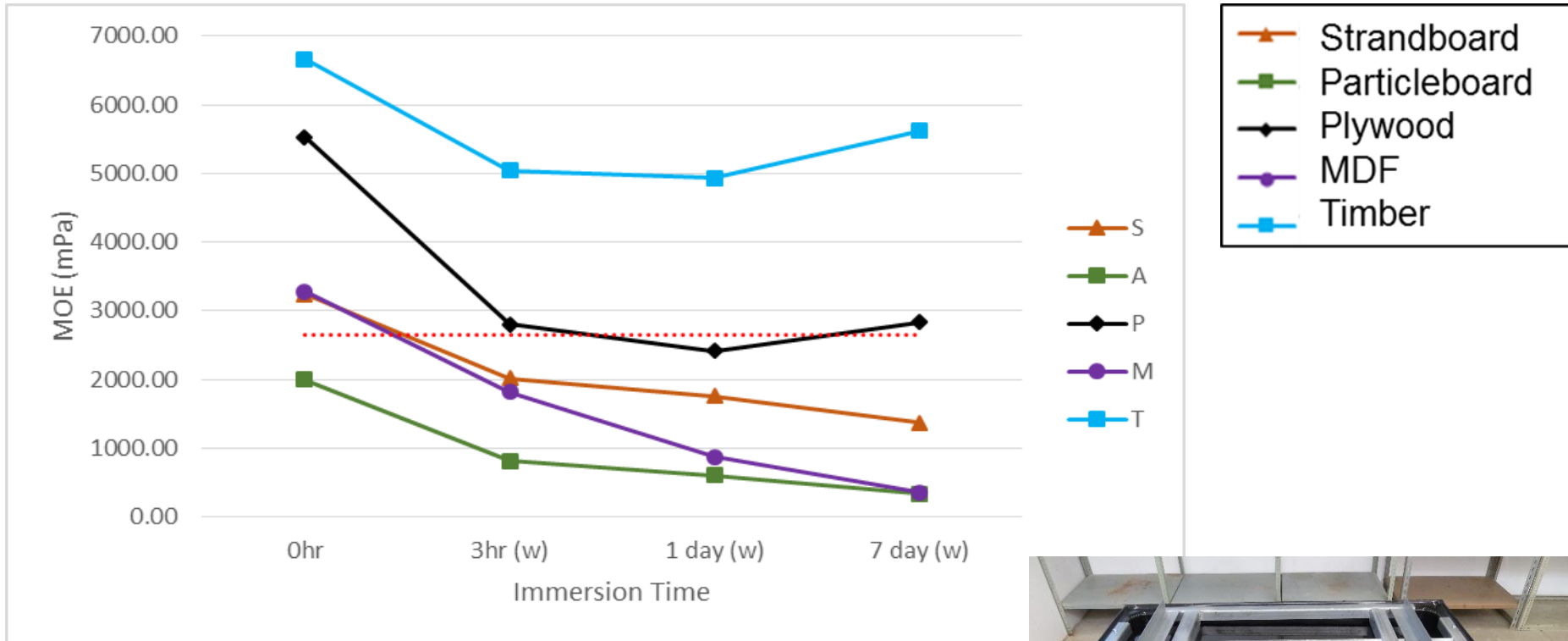
- Christchurch, March 2014
- Immediately post-flooding



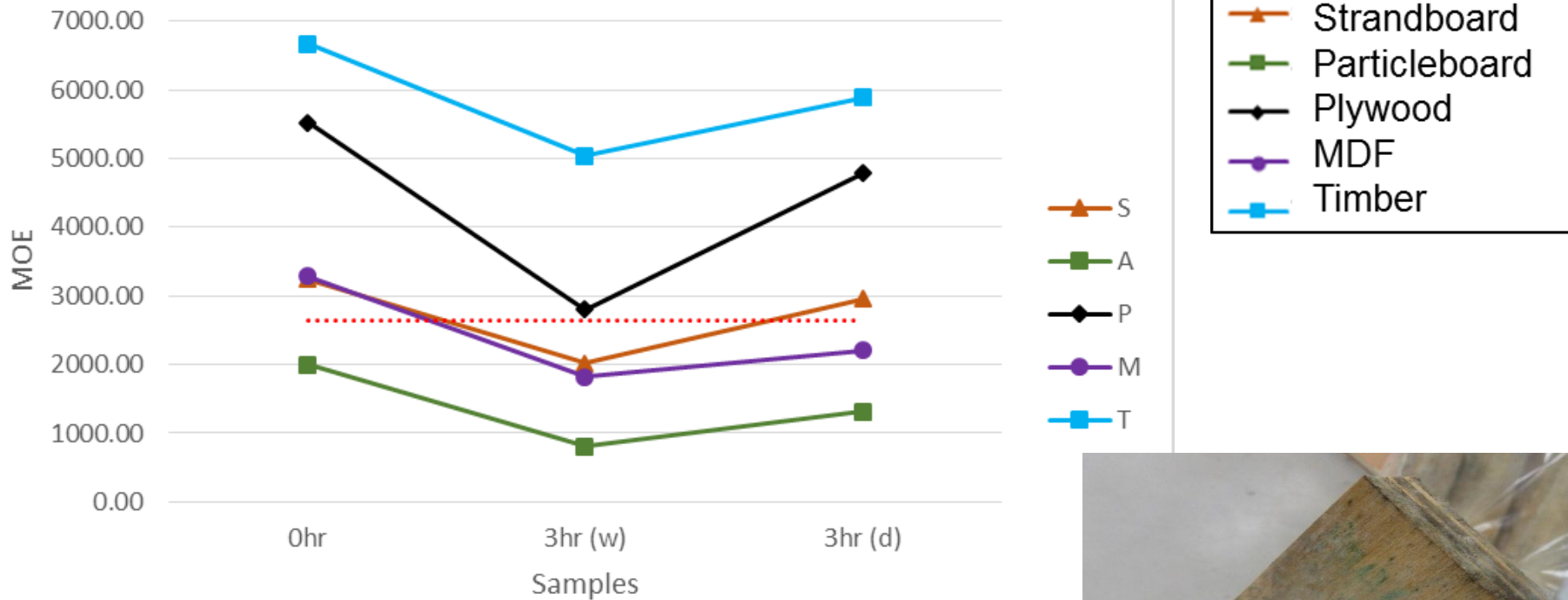
▶ Add to component resilience knowledge

▶ Observations supported resilience risk assessment approach

Flooring



Flooring



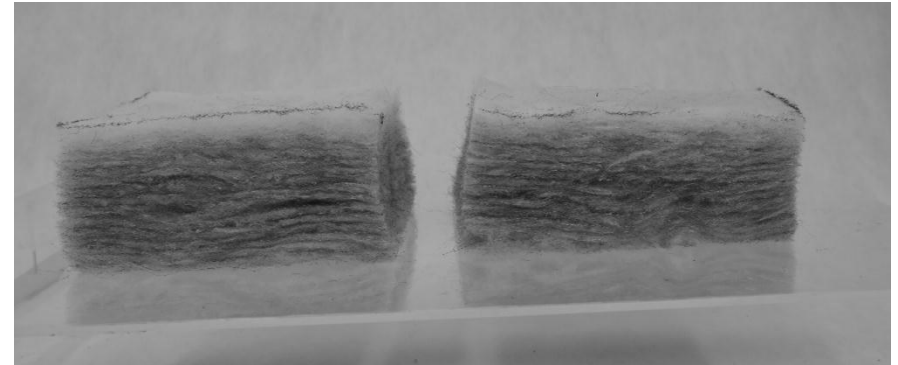
Material	Indicative BRANZ Rating
Particleboard	1
Strandboard	2
Plywood	3
MDF	1
Timber	4



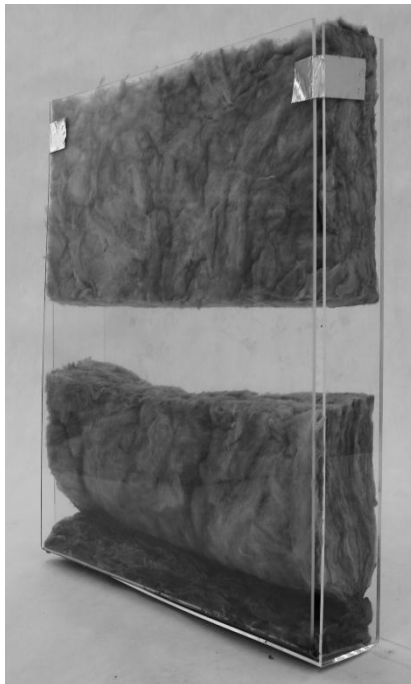
Wall Insulation



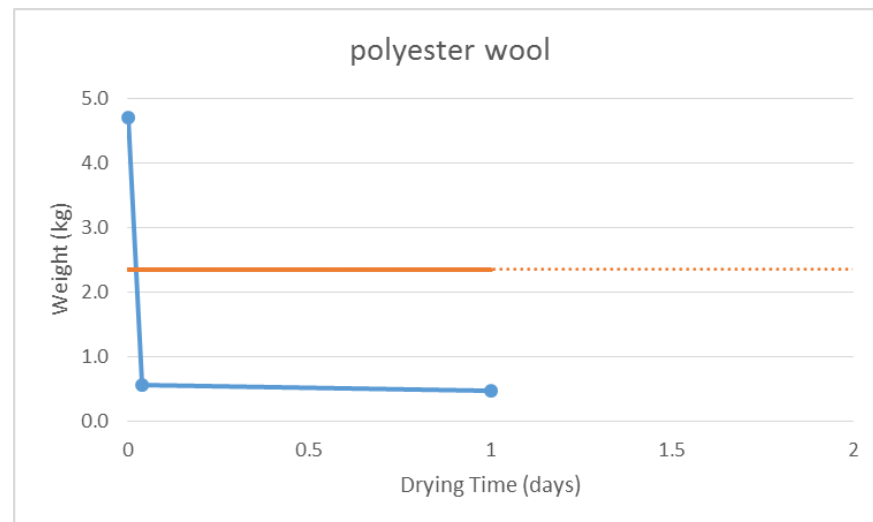
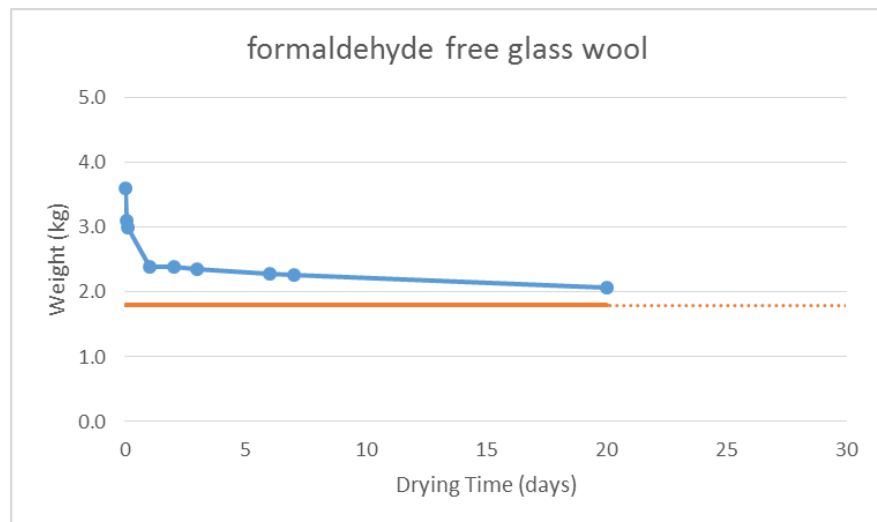
Formaldehyde free glass wool



Wool polyester



Wall Insulation

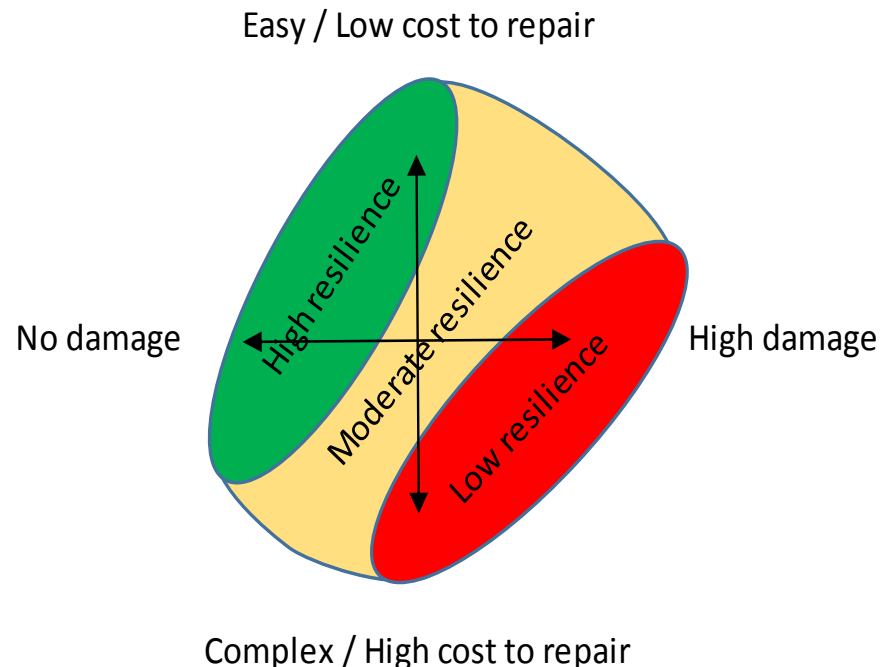


Material	Water Uptake (kg)	Drying Time – to lose half water taken up (days)	Indicative BRANZ Rating
Polyester	0.63	10	3
Formaldehyde free glass wool	3.60	35*	1
Phenolic resin bonded glass wool	6.24	240*	1
Polyester/Wool	4.71	<1	3

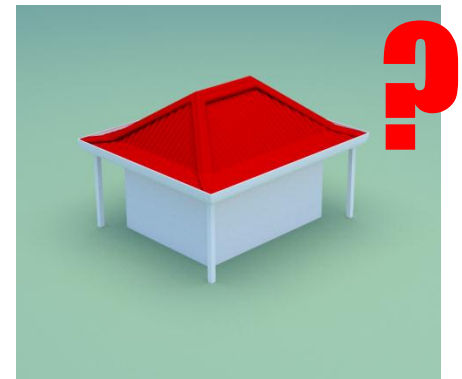
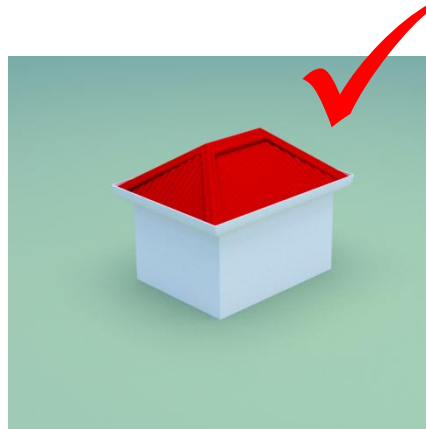
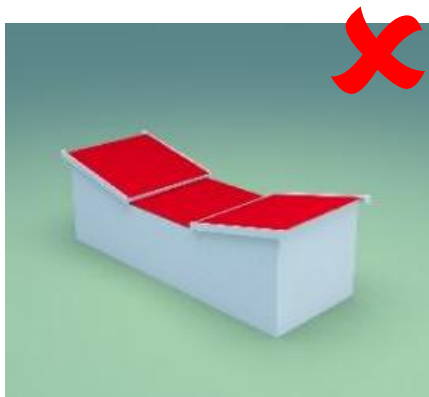
Component Resilience Tool

- ▶ Approach mirrors FEMA and ART BRKD
- ▶ Building component rating for all hazards
- ▶ Component resilience rating scaled
 - ▶ 5 = High
 - ▶ 1 = Low

Bedroom Furniture	Rating
Metal framed	4
Hardwood framed	4
Softwood framed	4
Laminated particle board	1
Laminated MDF	1



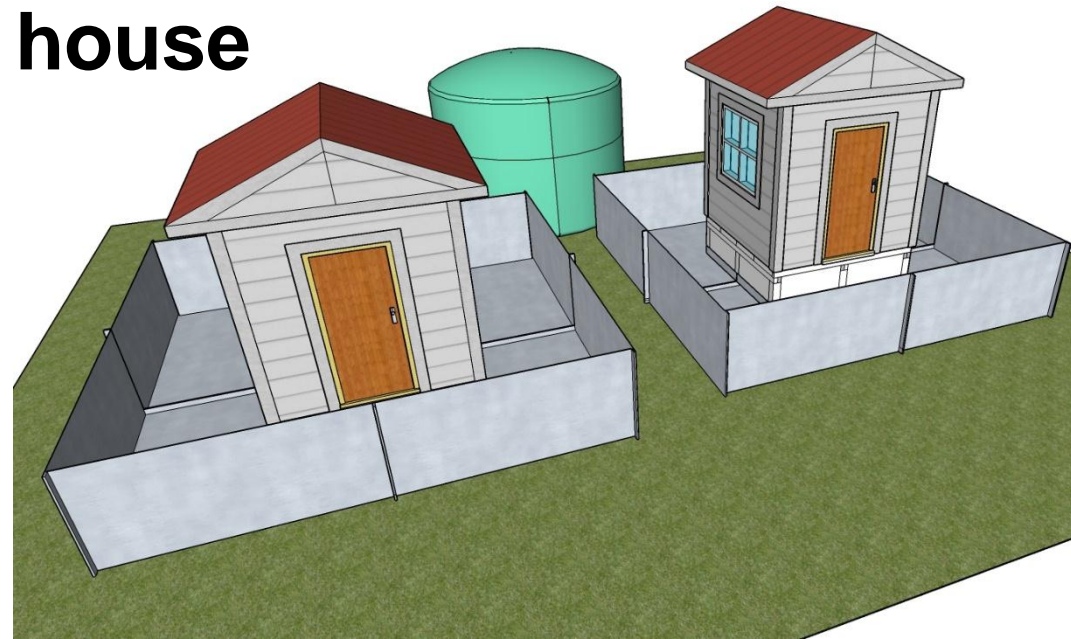
- ▶ Adapted findings from overseas
- ▶ Indicate design as a contributing factor
- ▶ Identified potential risk features
 - Complex roofs
 - Additions e.g. verandas
 - Extensive glazing, skylights



► Lab testing

- Internal wall linings
- Systems: interactions between components
eg linings + insulation

► Small scale test house



Acknowledgements



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