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COST-EFFECTIVE MITIGATION STRATEGY DEVELOPMENT FOR FLOOD PRONE BUILDINGS

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An Australian Government Initiative



Australian Government
Geoscience Australia

OUTLINE

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- Problem Statement
- Research Objectives
- Project Activities
 - Completed
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 - Future
- Proposed Utilisation Projects
- Summary

PROBLEM STATEMENT

- Australia has experienced floods on a regular basis and some communities have been impacted repeatedly over a period of few years due to inappropriate urban development in floodplain areas.
- The flood events have resulted in significant logistics for emergency management and disruption to communities. They have also resulted in considerable costs to all levels of government and property owners to repair damage and enable community recovery.

PROBLEM STATEMENT

Some recent floods in Australia

- 2005 Lismore flood, NSW
- 2010 Victorian flood, VIC
- 2010-11 Queensland flood, QLD
- 2013 Bundaberg flood, QLD
- 2015 Dungog flood, NSW



RESEARCH OBJECTIVES

- To assess cost-effective strategies to mitigate damage to residential buildings from riverine floods.
- To provide an evidence base to governments and property owners for decisions concerning the buildings having the greatest vulnerability in Australian communities by providing strategies for retrofit.

KEY PROJECT ACTIVITIES

- Development of a building classification schema
- Review of mitigation options and development of a floodproofing matrix
- Development of costing modules for all appropriate mitigation options
- Experimental testing of selected building materials and/or components
- Development of strategies for new construction
- Vulnerability assessment of current and retrofitted buildings
- Benefit verses cost analysis and identification of optimal mitigation strategies
- Stakeholder workshops and dissemination of project outcomes

BUILDING STOCK CLASSIFICATION (COMPLETED)

- Classification of residential building stock: review
 - **USA** (HAZUS): 11 types, structural system, storey class
 - **New Zealand** (Riskscape): structural system, wall and roof material, storeys, usage etc.
 - **Germany** (EDAC), 6 types, structural system, based on EMS-98, vulnerability classes
 - **Philippines** (UPD): 15 types, structural system, storey class, wall material
 - **Australia** (Geoscience): 19 types, 1 or 2 storey, elevated/non-elevated, external and internal wall material, garage
 - **UNISDR** (Asia-Pacific): 27 types, structural system, 1, 2 or 3 storey, elevated/non-elevated, water susceptibility, usage

BUILDING STOCK CLASSIFICATION (COMPLETED)

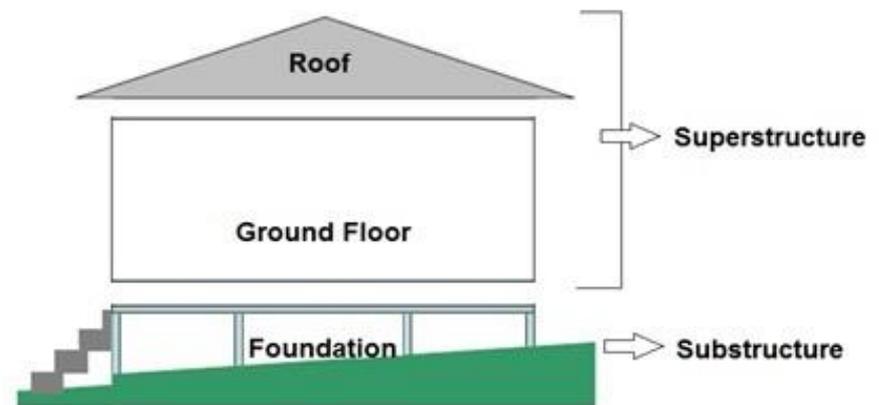
- Classification of residential building stock: proposed

Floor level attributes:

- Construction Period
- Fit-out Quality
- Storey Height
- Bottom Floor System
- Internal Wall Material
- External Wall Material

Roof attributes:

- Pitch
- Material



BUILDING STOCK CLASSIFICATION (COMPLETED)

Selected storey types



Type 1



Type 2



Type 3



Type 4



Type 5

BUILDING STOCK CLASSIFICATION (COMPLETED)

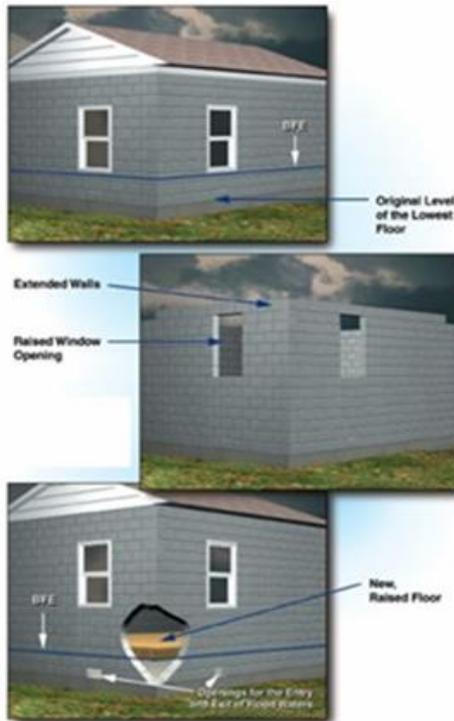
Characteristics of selected storey types

Storey Type	Construction period	Bottom floor system	Fit-out quality	Storey height	Internal wall material	External wall material
1	Pre-1960	Raised Timber	Low	2.7m	Timber	Weather-board
2	Pre-1960	Raised Timber	Low	3.0m	Masonry	Cavity masonry
3	Pre-1960	Raised Timber	Standard	2.4m	Masonry	Cavity masonry
4	Post-1960	Raised Timber	Standard	2.4m	Plasterboard	Brick veneer
5	Post-1960	Slab-on-grade	Standard	2.4m	Plasterboard	Brick veneer

REVIEW OF MITIGATION OPTIONS (COMPLETED)

- Raising floor levels: elevation

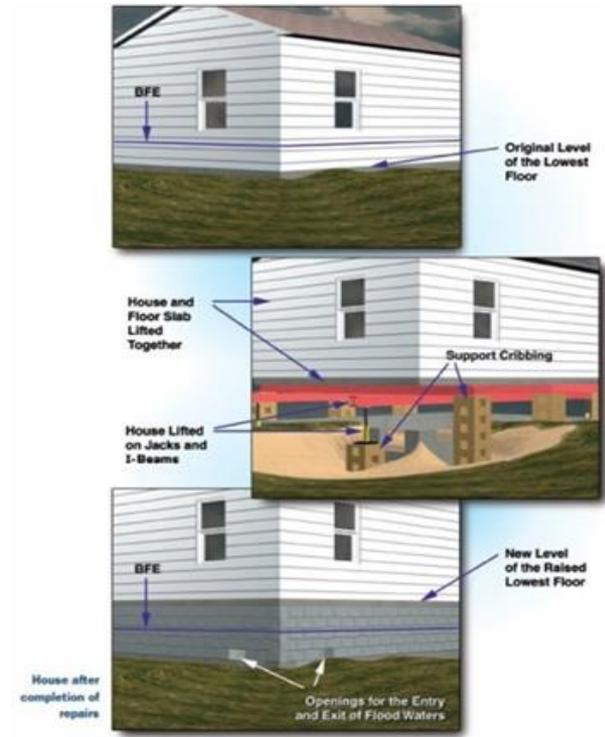
Option 1



Option 2



Option 3



REVIEW OF MITIGATION OPTIONS (COMPLETED)

- Raising floor levels: elevation (Option 3)



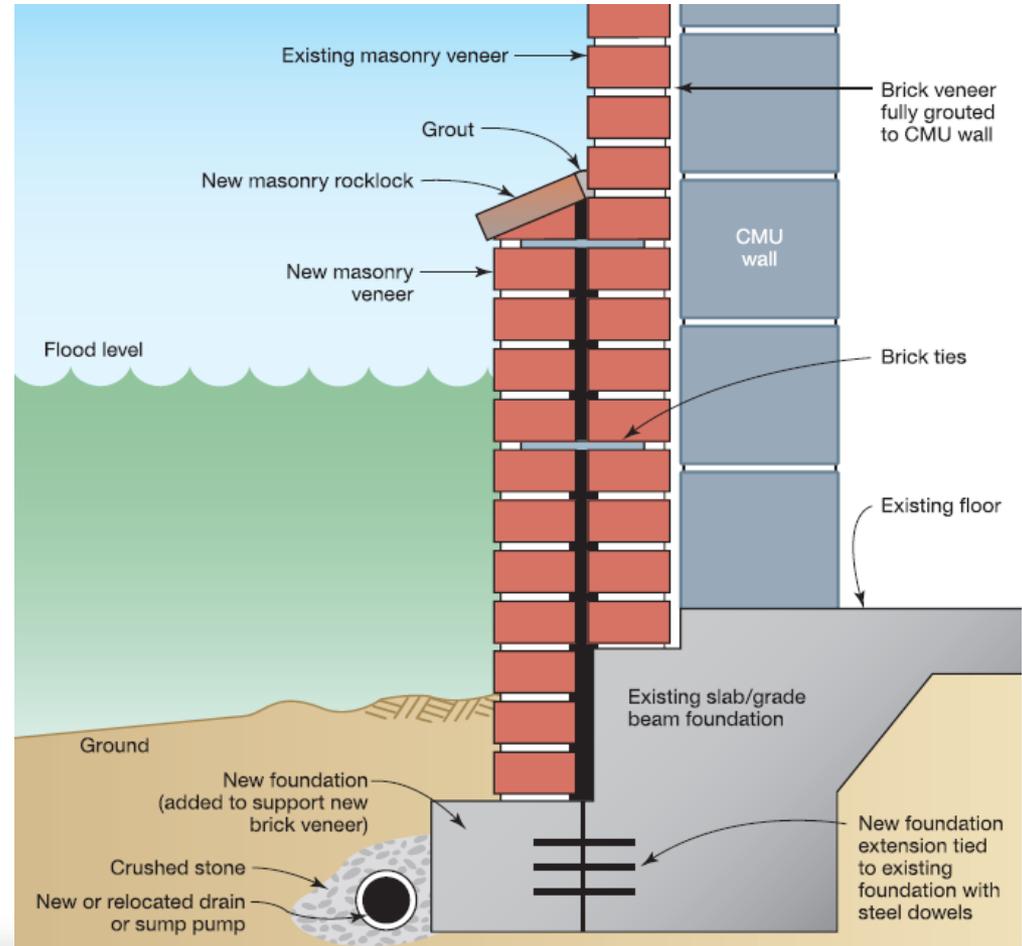
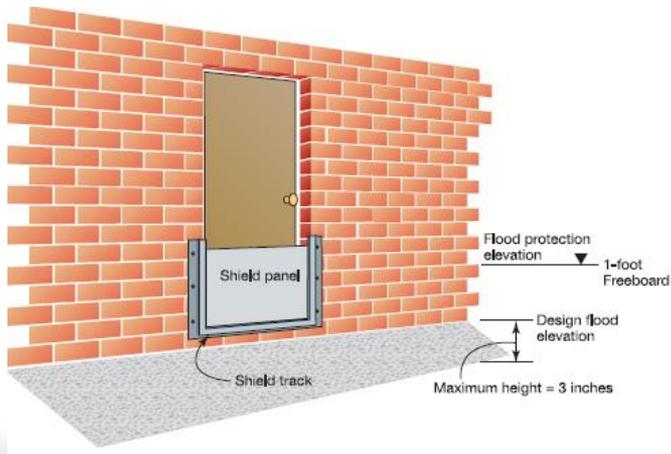
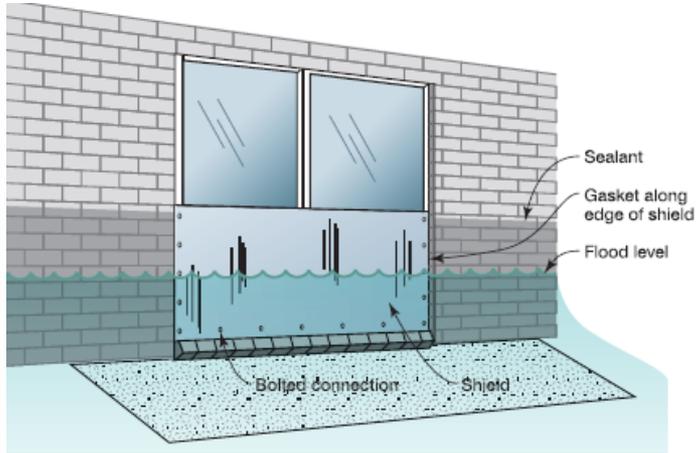
REVIEW OF MITIGATION OPTIONS (COMPLETED)

- Relocation



REVIEW OF MITIGATION OPTIONS (COMPLETED)

- Dry floodproofing



REVIEW OF MITIGATION OPTIONS (COMPLETED)

- Dry floodproofing



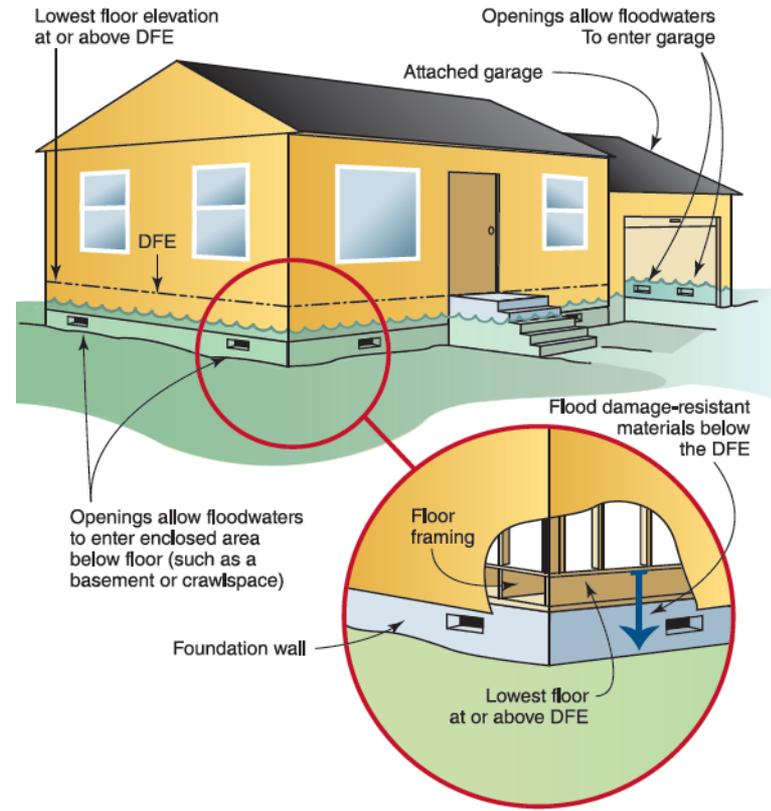
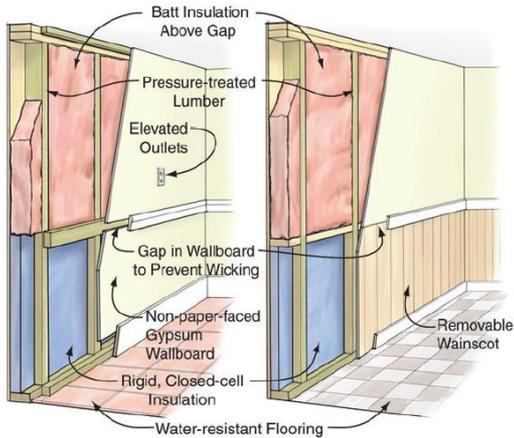
REVIEW OF MITIGATION OPTIONS (COMPLETED)

- Dry floodproofing



REVIEW OF MITIGATION OPTIONS (COMPLETED)

- Wet floodproofing



REVIEW OF MITIGATION OPTIONS (COMPLETED)

- Wet floodproofing



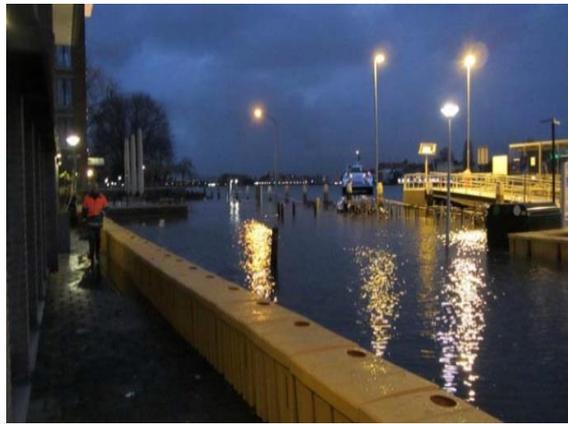
REVIEW OF MITIGATION OPTIONS (COMPLETED)

- Wet floodproofing



REVIEW OF MITIGATION OPTIONS (COMPLETED)

- Flood barriers



REVIEW OF MITIGATION OPTIONS (COMPLETED)

Floodproofing Matrix

Storey Type	Elevation (Extending walls)	Elevation (Building a second storey)	Elevation (Raising the whole house)	Relocation	Flood Barriers (Temporary)	Flood Barriers (Permanent)	Dry Floodproofing	Wet Floodproofing (existing)	Wet Floodproofing (renovation)
1	N/A	N/A			N/A	N/A	N/A		
2	N/A		N/A	N/A			N/A		
3			N/A	N/A	N/A	N/A	N/A		
4	N/A		N/A	N/A	N/A	N/A	N/A		
5	N/A		N/A	N/A					

DEVELOPMENT OF COSTING MODULES (COMPLETED)

Cost of elevating for selected storey types

Storey Type	Elevation (Extending walls)	Elevation (Building a second storey)	Elevation (Raising the whole house)
1	N/A	N/A	\$78,200
2	N/A	\$213,500	N/A
3	\$397,700	\$429,700	N/A
4	N/A	\$405,200	N/A
5	N/A	\$431,000	N/A

DEVELOPMENT OF COSTING MODULES (COMPLETED)

Cost of using flood barriers for selected storey types

Storey Type	Flood Barriers (Permanent)		Flood Barriers (Temporary)		
	1.0m high	1.8m high	0.6m high	1.2m high	1.8m high
1	N/A	N/A	N/A	N/A	N/A
2	\$133,500	\$177,600	\$62,500	\$111,800	\$136,300
3	N/A	N/A	N/A	N/A	N/A
4	N/A	N/A	N/A	N/A	N/A
5	\$154,300	\$208,300	\$164,600	\$144,100	\$176,200

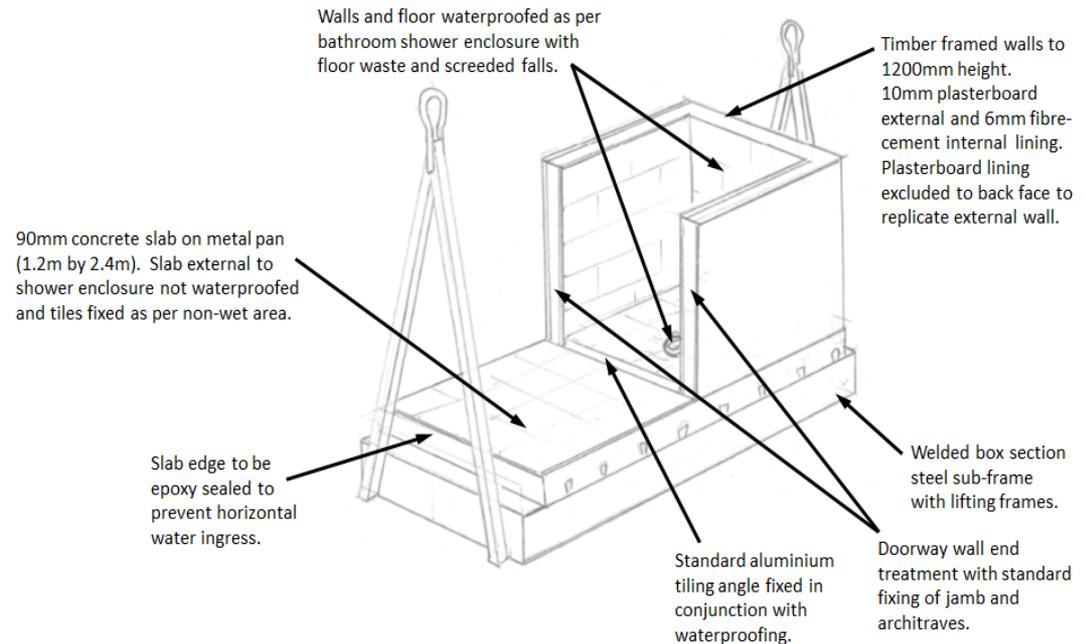
DEVELOPMENT OF COSTING MODULES (COMPLETED)

Cost of dry and wet floodproofing for selected storey types

Storey Type	Dry Flood-proofing	Wet Flood-proofing	
		Existing structure	Substantial Renovation
1	N/A	\$11,700	\$68,000
2	N/A	\$15,400	\$56,600
3	N/A	\$17,400	\$104,300
4	N/A	\$15,500	\$140,000
5	\$154,320	\$17,400	\$149,800

EXPERIMENTAL TESTING OF BUILDING COMPONENTS (ONGOING)

Component 1: Tiled surfaces within a brick veneered slab-on-ground house



Notes:-

- 1) 6 specimens: 3 non-shower, 3 shower
- 2) Specimens soaked for 4 days to 0.6m depth above tiles and then dried. Drying entails removal of external plasterboard wall lining and washing out wall cavity.
- 3) Post-flood waterproofing check requires temporary gate across "U" sealed to wall ends and floor and flooded to 0.3m depth.
- 4) Tile delamination to be testing with selected in-situ tile pull-off testing.
- 5) Moisture consent samples to be taken prior to wetting, after wetting and after drying.

EXPERIMENTAL TESTING OF BUILDING COMPONENTS (ONGOING)

Component 2: Manufactured timber sheet wall bracing

Reversed cyclic testing regime to rack wall.



Timber framed wall to 2400mm height. Oriented Strandboard and/or HDF lining one face as per standard residential bracing panel.

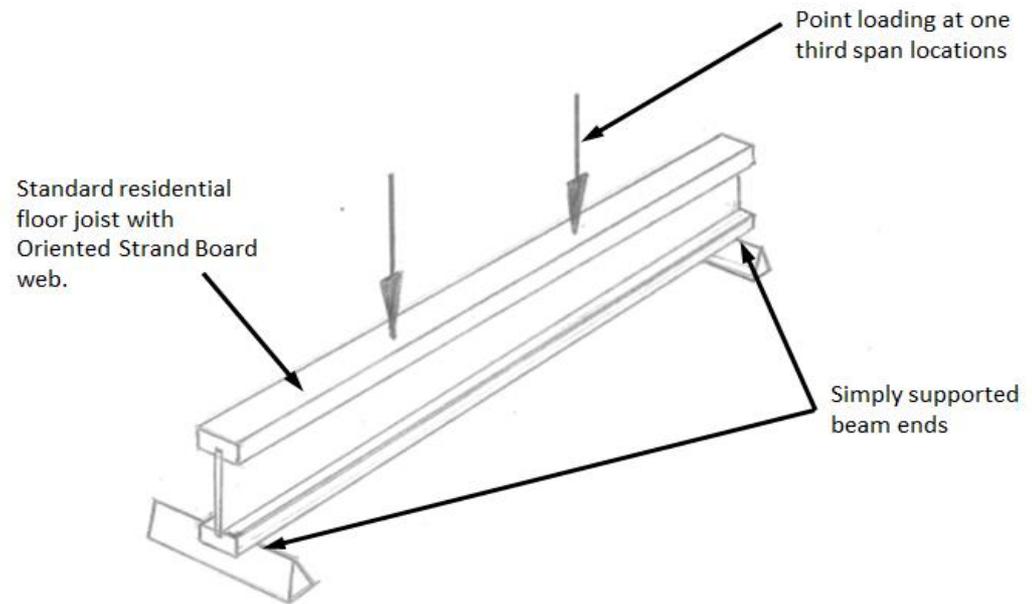
Fixed base.

Notes:-

- 1) 5 specimens tested dry and 5 specimens tested after wetting and drying for each of OSB and hardboard lining.
- 2) Specimens fully soaked for 4 days and then dried.
- 3) Testing regime to follow standard wall racking test protocol for plasterboard lined residential framed walls.
- 4) Moisture content samples (3) to be taken prior to wetting, after wetting and after drying.

EXPERIMENTAL TESTING OF BUILDING COMPONENTS (ONGOING)

Component 3: Engineered timber joists



Notes:-

- 1) 8 specimens tested dry, 8 specimens tested wet and 8 specimens tested after wetting and drying for H2 treated and untreated OSB.
- 2) Specimens fully soaked for 4 days and then dried.
- 3) Testing regime to follow standard monotonic loading to failure process. End restraint conditions to be resolved.
- 4) Moisture content samples (3) to be taken prior to wetting, after wetting and after drying of both flange and web elements.

NEXT STEPS

- Vulnerability of selected storey types to a wide range of inundation depths will be assessed for existing and retrofitted buildings.
- All retrofit options will be assessed in cost benefit analysis through a consideration of a range of severity and likelihood of flood hazard covering a selection of catchment types.
- The work will provide information on the optimal retrofit types in the context of Australian construction costs and catchment behaviours.

UTILISATION PROJECT: FLOODPLAIN MANAGEMENT

- **Background:** The vulnerability of buildings to flood inundation is becoming better understood through a range of research initiatives. These initiatives include co-funded research by the BNHCRC, the (then) DCCEE and collaborations between GA, the City of Sydney, Insurance Australia Group (IAG) and Attorney General's Department through a National Emergency Management Project (NEMP).
- **Proposal:** A study of how the vulnerability and mitigation outcomes of the afore-mentioned projects can be generalised to be compatible with the data resolution level typically available to many floodplain managers.
- **Outcome:** To form the basis for the development of national best practice guidelines developed under the direction of the National Flood Risk Advisory Group (NFRAG) to inform flood risk and mitigation assessments.

UTILISATION PROJECT: ICA's RESILIENCE RATING TOOL

- **Background:** The Insurance Council of Australia (ICA) has developed through their consultant Edge Environment an App called the Building Resilience Rating Tool (BRRT). It provides a resilience score for residential homes based on the nature of the building and the best understanding of the local hazard.
- **Proposal:** As the tool is not presently quantitative and does not address the increased building resilience achieved through mitigation retrofit, the outcomes of the CRC flood mitigation project would be logical inputs into the tool development as it moves to a more quantitative mitigation focussed tool and captures likely changes to premium costs.
- **Outcome:** The tool will be able to provide quantitative mitigation benefits.

UTILISATION PROJECT: LAUNCESTON RISK MITIGATION ASSESSMENT

- **Background:** The investment in flood mitigation works for flood prone communities is expensive and the benefits may take many years to be realised. The project provides a significant opportunity to review the actual cost versus benefit from the significant mitigation works recently completed.
- **Proposal:** To undertake an economic review of the new levee structures constructed to protect Launceston. This involved engagement of the local government and flood authority and will utilise research from the BNHCRC flood project to assess supplementary mitigation actions.
- **Outcome:** The project will assess the benefit versus cost of the flood mitigation investment to date in Launceston to reduce community flood risk. Furthermore, it will also assess the effectiveness of further investment in mitigation works to reduce the residual flood risk.

SUMMARY

- The economic losses due to floods have been increasing in recent decades due to vulnerable construction types and because of rapid urban development in floodplains.
- Flood risk management not only includes the measures taken by government but also includes mitigation measures adopted by private property owners to reduce the potential losses.
- This BNHCRC project aims to conduct a comprehensive analysis of mitigation options and evaluate each of them through cost benefit analysis for use in Australian conditions.
- The result will be an evidence base to inform decision making by governments and property owners to reduce building vulnerability and future flood losses.

THANK YOU

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