ACCEL™

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TECHNICAL BULLETIN
Designing your house to maximise its chances of surviving a tropical cyclone

The information in this supplement and James Hardie's technical literature is only intended for use in relation to the relevant James Hardie products.

CERTIFIED ACCEL™ CONTENT

CYCLONIC AREAS

INTRODUCTION

In the aftermath of tropical cyclone Yasi in February 2011, researchers from the Cyclone Testing Station at James Cook University found that although there were significant failures in the older housing stock, houses built since 1985 fared well and most survived with little or no damage. These findings demonstrate that where engineers and builders have diligently applied the applicable codes and standards, housing has performed satisfactorily.

In this guide James Hardie examines the measures that can be adopted by designers, builders and home-owners to maximise the probability that a house might emerge unscathed from a tropical cyclone.

However, it also shows that smart material selection of external claddings and internal linings, coupled with smart design principles can be the key to minimising considerable and costly damage from internal water penetration and impact.

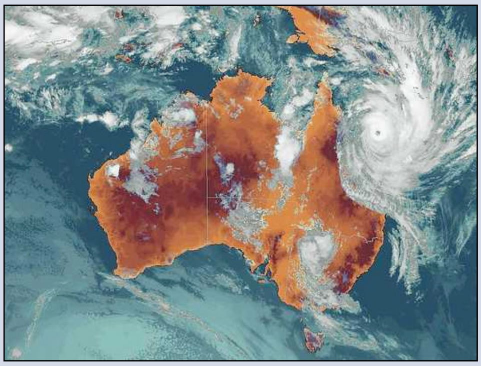

FIGURE 1 CYCLONE YASI STRUCK THE AUSTRALIAN COAST

This supplement outlines the fundamentals of designing and building a house to help maximise its chance of surviving a tropical cyclone.

The designer is responsible for checking with the project certifier that the following information is applicable for your project.

HOUSING DESIGN STRATEGY FOR CYCLONIC WIND AREAS

The creation of all buildings in Australia is governed principally by the Building Code of Australia ("the BCA") and from there the specific relevant codes of practice, standards and other regulatory provisions are called into action.

The 2011 edition of the code has introduced Clause 2.5.7 stating that "where windborne debris impact loading is specified, the debris impact shall be equivalent to (a) a timber member of 4kg mass with a nominal cross section of 100 x 50mm impacting end on at 0.4 V_R for horizontal trajectories and 0.1 V_R for vertical trajectories; and (b) a spherical steel ball 8mm diameter (approximately 2 grams mass) impacting at 0.4 V_R for horizontal trajectories and 0.3 V_R for vertical trajectories". Note that V_R is read from Table B1.2b of the BCA Volume 1, and relates to the return period of the wind speed to be used in the design of a particular structure and depends on the importance level of the building.

Earlier editions of the wind code, AS/NZS 1170.2 touched on the cladding's resistance to flying debris at Clause 5.3.2 and in the absence of quantifiable capacity, it had to be assumed that the external envelope of the house could be penetrated. This would cause a dramatic increase to the internal pressures on the internal linings (walls and ceilings) as shown in Figures 2 and 3.

Therefore to the building developer or designer, provision of a building envelope that is resistant to flying debris is an option only and is not mandatory. If the external cladding is unable to resist these missiles, then the internal lining must be designed for internal pressure resulting from a dominant opening in the windward external wall (ie with design pressure of similar magnitude to the external design pressure). This effect is demonstrated in Figures 2 and 3 below. The Cyclone Testing Station's research has found that many of the houses that do fail in a cyclone do so because of this phenomenon and its knock-on effects (ie once the wall linings and ceilings have given way).

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For the Northern Territory, the BCA's Appendix Northern Territory, Section B, contains at Clause NT3 the requirements for multi-residential buildings of Class 2 (apartment buildings), Class 3 (hostels, hotels etc), Class 9a (health-care buildings) or Class 9c (aged-care buildings) in Wind Region C to incorporate a "**strengthened area**" for use as shelter during cyclonic conditions. An area of the building is thus strengthened as prescribed in that part of the BCA.

The use of a strengthened area is not required for a **Class 1 dwelling**, such as the common suburban family home, in any of the states and territories. However, a wall's resistance to impact loads caused by flying debris may need to be catered for. Here the design intent is not to provide a building that is completely impenetrable to flying debris, but instead to provide one that will not collapse due to loss of structural stability, which is principally due to racking shear or 'bracing' capability. Thus there has been to date no requirement for the wall cladding or façade to have any quantitative resistance to penetration by flying debris.

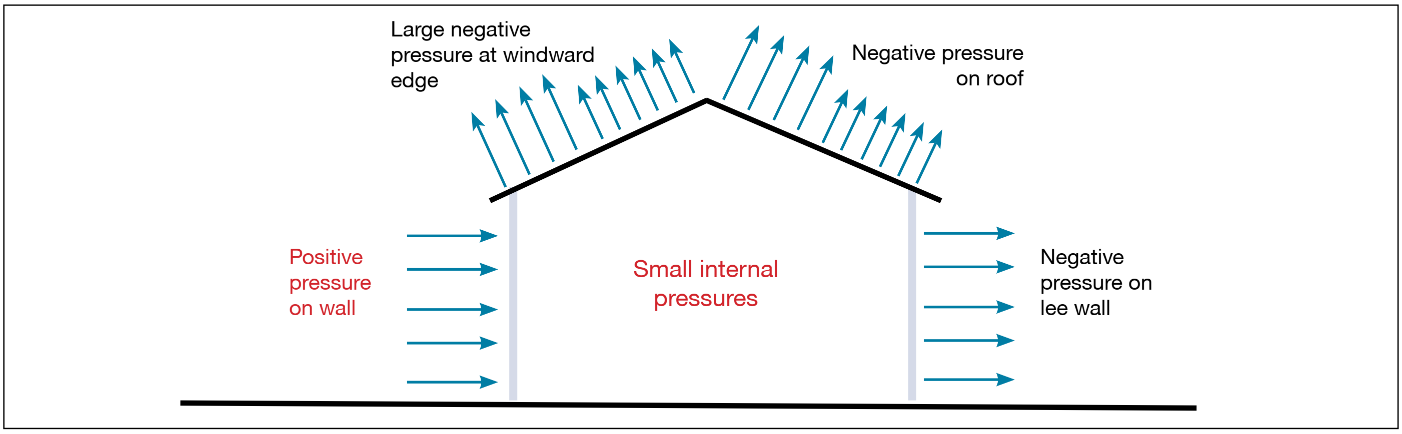

FIGURE 2 WIND PRESSURE DISTRIBUTION WHEN NO OPENINGS IN EXTERNAL ENVELOPE OF HOUSE

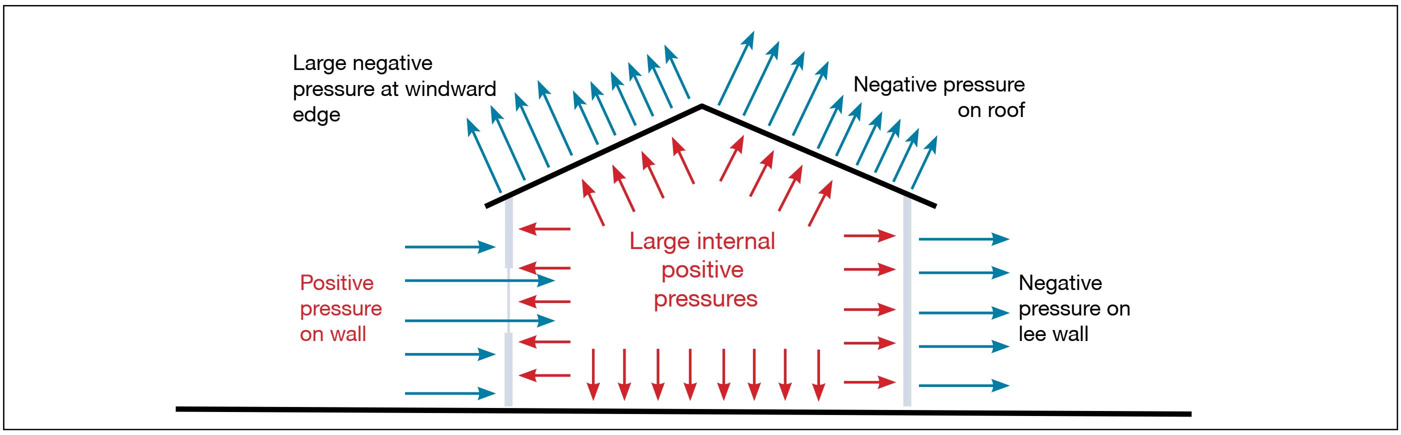

FIGURE 3 WIND PRESSURE DISTRIBUTION WHEN OPENING MADE IN EXTERNAL ENVELOPE OF HOUSE IN THIS CASE BY WIND-BORNE DEBRIS

NOTE
Figures 2 and 3 used by permission of the Cyclone Testing Station and taken from its presentation to builders and certifiers titled "Keeping It Together in a Cyclone".

WIND LOAD DESIGN BACKGROUND INFORMATION

The BCA defines the appropriate Australian Standard for the determination of the design load, which in the case of wall claddings for housing is AS/NZS 1170: 2002 Part 2, “Wind Actions” or AS 4055: 2006 “Wind Loads for Housing”. The building designer calculates the design wind speed from these codes and determines the design pressure after considering the relevant surface pressure coefficients and then ensures that the wall cladding system is able to resist the applied forces with the appropriate low level of risk.

AS/NZS 1170.2:

Designing for the internal wall pressures, from Clause 5.3.1 the designer knows that *“internal pressure is a function of the relative permeability of the external surface of the building”*, and this code clause has the implication in cyclonic Regions C and D that, unless it can be test-proven that the specified missile will be resisted, the assumption must be made that the cladding will be holed such that the internal linings can potentially experience the same relative magnitude of design pressure as the external cladding.

AS 4055:

The pressure coefficients for wind classes C1 to C4 in Table 3.2 of AS 4055 have been selected so as to include already the effect of dominant openings in the external cladding due to puncturing by wind-borne debris

All James Hardie fibre-cement external cladding is designed to cater for the external pressure only – as is generally stated in the literature – and hence the designer needs to make provision separately for the internal lining, which in the case of cyclonic areas would sustain a wind load of similar magnitude to the external pressure. Refer to sub-section (iii).

MISSILE PENETRATION TESTING

In 2010 and 2012 the Cyclone Testing Station conducted missile penetration tests on James Hardie lightweight composite wall solutions developed by James Hardie consisting of 6mm thick HardieFlex™ sheet fixed over flat or corrugated metal sheeting used as the resistant backing layer. The tests concluded that although the metal sheet layer was deformed (and in some cases cracked) there was no opening, thus satisfying AS/NZS 1170 wind-driven debris impact test requirements described earlier. The James Hardie cladding solutions based on the testing are presented in Table 1 and are likely to be suitable for most buildings in Regions C and D.

JAMES HARDIE’S GUIDELINES FOR YOUR HOUSE

If you own a house in a cyclonic area, or you are considering the purchase of a property in these areas – or if your house needs to be repaired after a cyclone – then you might consider the following recommendations to maximise the chances that your property will survive a cyclone event with minimal or no damage.

(i) Framing:

The wall frame is to be of light-gauge metal with a thickness between 0.55mm to 1.6mm base metal thickness (BMT) constructed in accordance to the NASH Standard for Residential and Low-rise Steel Framing Part 1: Design Criteria. The studs are spaced between 300 and 600mm spacing depending on the dictates of the wind load design. HardieBreak thermal strips are to be fixed behind the backing layer and in front of the steel framing.

(ii) Option 1: James Hardie Debris Resisant Systems:

For this option a debris-resistant system is used, and these include various James Hardie fibre-cement cladding products in combination with a backing layer of metal sheeting as in Table 1. You should refer to your local building inspector or structural engineer for the wind speed and missile projection speed that the cladding is required to resist.

TABLE 1 WIND-DRIVEN DEBRIS IMPACT RESISTANT JAMES HARDIE CLADDING SYSTEMS

Thermal Break	Missile Resistant Backing Layer as Layer 2 (Inner Layer)	James Hardie External Cladding Products as Layer 3 (Outer Layer)	
James Hardie Hardie-Break thermal strip	Missile Impact Velocity (m/s)	Metal Sheet Details	
	15	One layer of 0.42mm BMT G550 Lysaght Panelrib® corrugate sheet	Scyon™ Linea™ weatherboard Scyon™ Axon™ cladding Scyon™ Stria™ cladding Scyon™ Matrix™ cladding HardieTex™ system EasyLap™ Panel cladding PanelClad® sheet ExoTec® façade system ComTex® façade system HardieFlex™ sheet (min 6mm thick) PrimeLine® weatherboards HardiePlank™ weatherboards
	34 (Will satisfy most buildings in Region C)	Two layers of 0.42mm BMT G550 Lysaght Panelrib® corrugate sheet OR Two layers of 0.55mm BMT G300 Lysaght Colorbond® flat sheet	
	40 (Will satisfy most buildings in Region D)	Two layers of 0.55mm BMT G300 Lysaght Colorbond® flat sheet	

Layer 1 (Thermal break): See Table 1
As per the building code regulations, a thermal break strip must be installed between the metal frame and the metal sheeting. James Hardie recommends the James Hardie HardieBreak thermal strip.

Layer 2 (inner layer of metal): Select from Table 1
Fasten metal sheet(s) to all framing members at 300mm maximum centres including studs and top and bottom wall plates. Use a wafer-head Class 3 10-16x16mm screws. Overlap corrugations by 150mm. (HardieBreak thermal strips are to be fixed behind the backing layer and in front of the metal framing). Fasteners fixing metal sheets must be flush to prevent moisture ingress.

Layer 3 (outer layer of fibre cement): Select from Table 1
James Hardie external flat sheet products must be fixed at 200mm maximum centres to the wall frame. Refer to current installation manuals for each product to determine if closer fastener spacing is required (this depends on the wind load pressures applicable at each site). James Hardie weatherboards and plank products must be fixed as per the current installation manual for the specific site.

Under current legislation, as explained earlier, you do not need to use external claddings that are impenetrable to the airborne debris created by the cyclonic winds. If you choose this approach, which we have called **Option 2**, then you must ensure that your internal linings are designed and installed to cater for the full external design pressures (refer to **Table 2**).

(iii) Option 2: Penetrable Systems:
Even if your external lining has been designed to resist being holed by the impact from flying debris and your doors and windows have the necessary protection against windborne debris, it is better to select and fix the internal wall and ceiling linings so as to have the capacity to resist the same wind pressures as the exterior walls.

James Hardie has a number of products suitable for this application. These products are also resistant to moisture damage which will further help to reduce the amount of water damage to a building if a cyclone should hit. Table 2 outlines requirements for fastener and stud spacing for fixing 6mm thick James Hardie fibre cement sheet as the internal linings in relation to the external wind classification for your house.

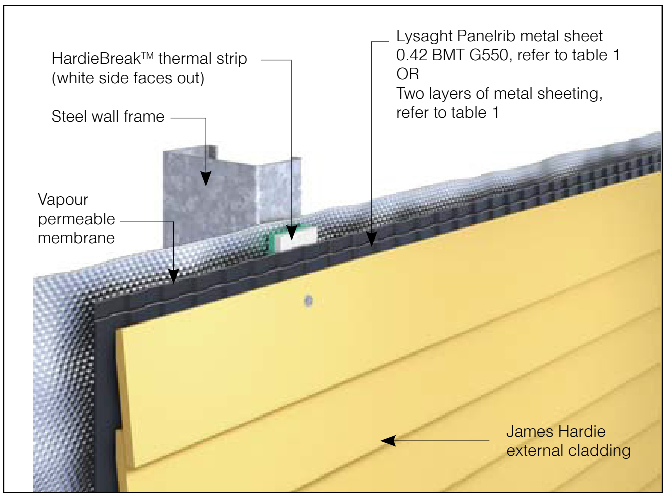

FIGURE 4 MISSILE PENETRATION SOLUTIONS

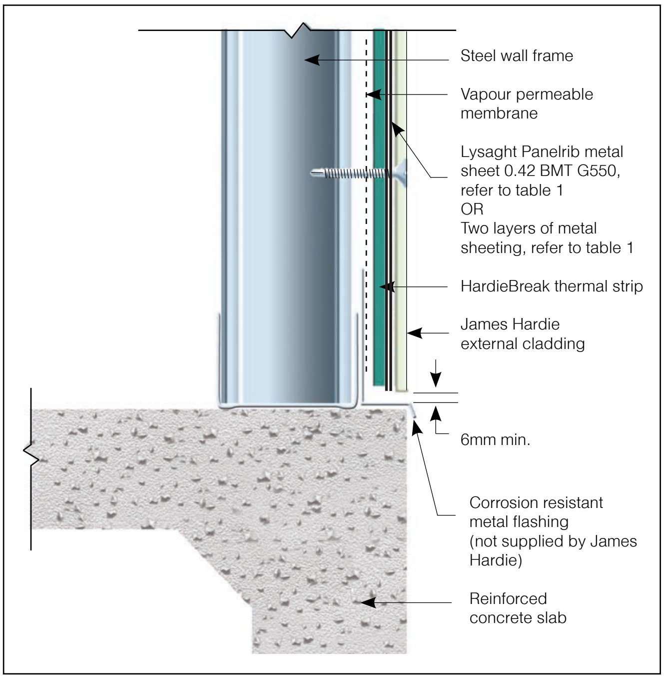

FIGURE 5 SLAB EDGE DETAIL SHOWING REQUIRED FLASHING

TABLE 2 FIXING REQUIREMENTS FOR 6MM VILLABOARD, HARDIEFLEX, VERSILUX & HARDIEGROOVE SHEETS USED AS INTERNAL LINING IN HOUSES IN CYCLONIC AREAS

AS 4055 Cyclonic Wind Classification	Maximum Stud Spacing (mm)	Maximum Fastener Spacing (mm)
C1 & C2	450	200
C3 & C4	450	150

(iv) Fixity and tie-down of roof:
Engage a suitably qualified building professional to check that your house's roof is properly designed and installed, ensuring that it has adequate tie-down all the way down to the foundations, adding lock-nuts to cyclone rods where necessary, checking that all connections are properly made and are of the correct size and number, and that cyclone washers are used when connecting sheet-metal roofing. If the roof is tiled, ensure that appropriate sarking is used. For new roofs you might consider metal sheeting instead of tiles because tiles pose a risk to surrounding properties as windborne flying debris. Otherwise ensure that strong enough clips are used to hold the tiles in place.

(v) Garage and shed doors and roller-shutter doors:
These items have been seen to perform poorly in recent cyclone events and you must ensure that they have:
(a) Adequate design wind pressure capacity,
(b) Are adequately framed and fixed into place and
(c) Where necessary based on the design solution adopted for the external cladding, have the appropriate debris screens or resistance to impact.

(vi) Fixity of windows and doors generally:
Ensure that these items have:
(a) Adequate design wind pressure capacity,
(b) Are adequately framed and fixed into place and
(c) Where necessary based on the design solution adopted for the external cladding, have the appropriate debris screens.

(vii) Fixity of add-on structures:
Ensure that these items such as awnings, lean-to canopies etc have:
(a) Adequate design wind pressure capacity and
(b) Are adequately framed and fixed into place.

For further information contact James Hardie Technical Support on 13 11 03.

The information in this supplement is to be used as a guide only. The designer is responsible to identify and address all areas of building design ensuring it complies with all relevant codes and is fit for purpose.