

Storm shutter design study

Front bifold, four sliding window shutters, storm-mode closure and verification



STATE 1 - CLOSED STORM MODE

Timber-faced screen closed across the full glazed front; window panels down; deck clear.



STATE 5 - OPEN AND LOCKED

TWO STATES, ONE SCREEN

The whole building reads as one closed timber face in a storm and as a covered opening in fair weather. This study documents the mechanism that moves between those two states, the loads each state carries, and the work that must be completed before anything is fabricated.

01 DESIGN FREEZE

Architectural intent retained; mechanism redesigned

The whole glazed front closes as a timber-faced screen and the smaller openings close in the same material language. The mechanism is redesigned so one person never lifts a leaf by hand and storm loads do not rely on polymer pins or long deck props.

01 TWIN-LINE BIFOLD LIFT

One common shaft synchronizes both sides; fold initiator, rope points, swivel guides and full path remain H2.

02 POSITIVE WIND RESTRAINT

Steel rollers, jamb channels, cam latches and 25 mm storm pins carry closed-state pressure and suction.

03 NO 4.75 M DECK PROPS

A positive load brake, independent anti-fall device and mechanical full-open locks replace the model props.

04 COUNTERBALANCED WINDOWS

Smaller timber-faced panels slide in captured channels with paired counterweights and positive closed latches.

CONSTRUCTION GATE

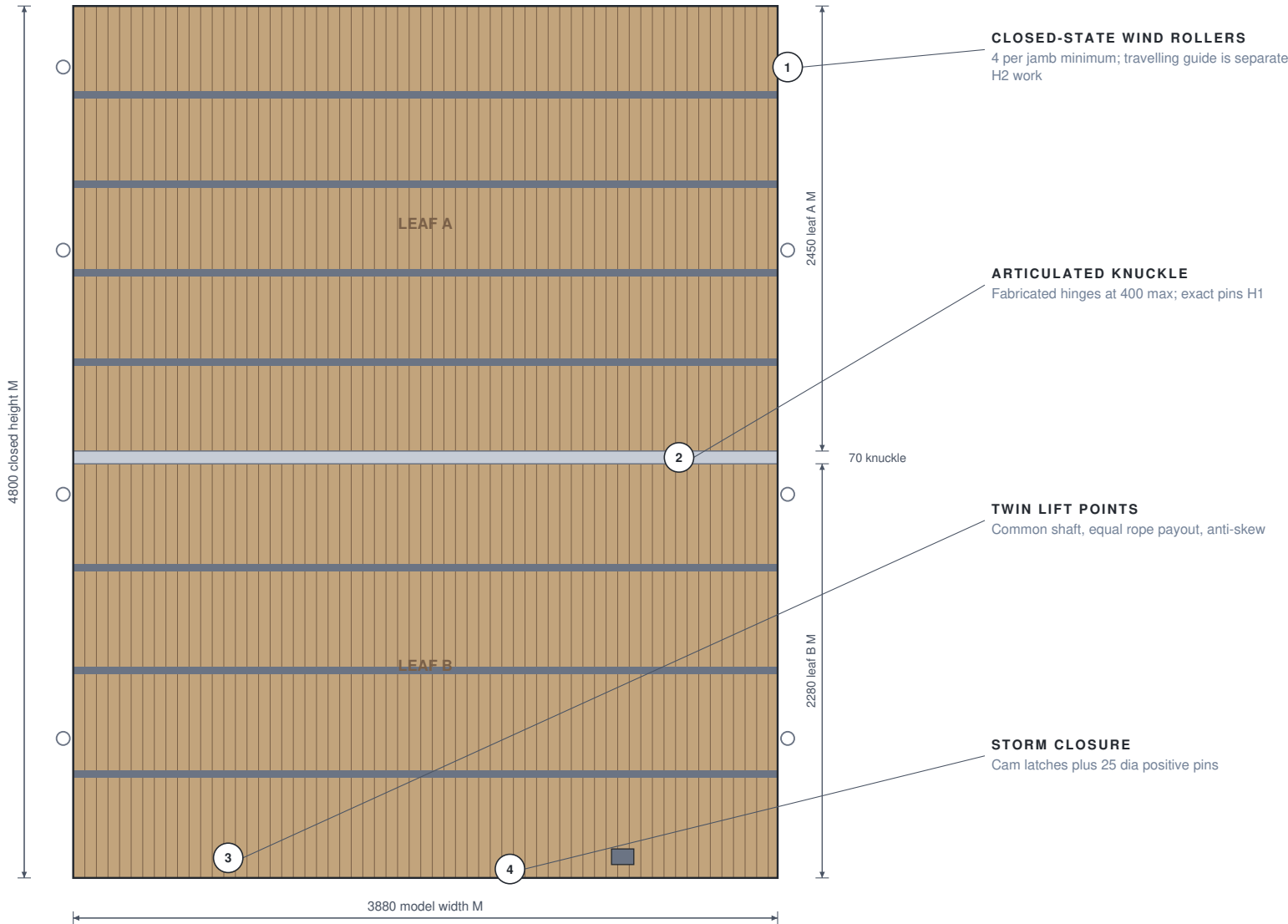
This is a coordinated pre-H2 engineering basis, not a producer statement. Do not order steel, drill the portal, fabricate lifting parts or operate the system until the six hold points on sheet O2-S07 are closed by the named engineer, fabricator and supplier.

General arrangement and model reconciliation

Measured envelope, revised system geometry and the primary closed-state load path

01 CLOSED FRONT ELEVATION

Live-model envelope with proposed restraint points



02 MODEL-TO-DESIGN REGISTER

M model, D design, H hold point

ITEM	RECORDED	ACTION
Overall width	3880 M	Retain
Closed height	4800 M	Retain
Leaf A	2450 M	Retain
Knuckle zone	70 M	Retain
Leaf B	2280 M	Retain
Open projection	2450 M	H2 - revise
Leaf build-up	60 M / 73 D	Update model
Deck props	4750 M	Delete
Stowed props	2240 M	Delete
Acetal guide pin	Old detail	Replace
Lift arrangement	2 cables M	Common shaft D

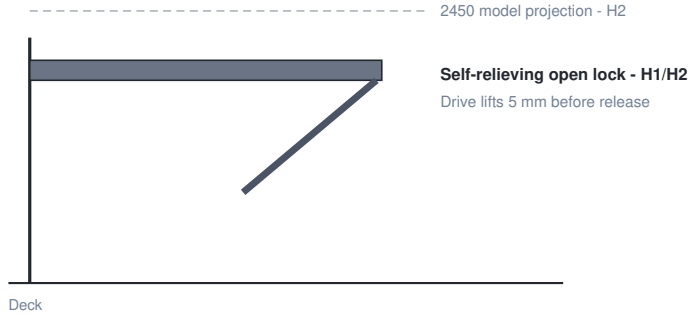
03 LOAD PATH - CLOSED STORM MODE

Screening path only; H1 confirms actions and capacity

- 1 Wind pressure / suction to timber face and sheet backing
- 2 Backing and rails distribute load into each leaf perimeter
- 3 Captured rollers and storm pins transfer load to both jamb channels
- 4 Jamb channels and head hinge transfer load to the structural portal
- 5 Portal transfers actions into floor diaphragm and foundations

04 OPEN SIDE ENVELOPE

Design change from the current 4750 mm deck props



OLD PROP REMOVED

Delete both 80 x 80 x 4750 deck props and the conflicting 2240 stowed props from the model. Open support is resolved at the head and jambs, clear of the deck edge.

Operation logic and kinematic hold point

O2-S02

Each transition states what moves, what constrains it and what must be proved before operation

EXTERIOR / DECK SIDE - K FOLDS OUTWARD

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01 TRANSITION LOGIC

Every stated condition is required before the next state

STATE	WHAT MUST BE TRUE	CONSTRAINT OR STOP RULE
1 Closed + secure	Pins and cams engaged	Drive isolated; crank removed
2A Drive preload	Raise each closure witness mark 2-3 mm	Stop and prove the brake; pins remain engaged
2B Release	Zone clear; withdraw pins and cams only after preload	Confirm fold initiator armed
3 Initiated lift	Positive initiator controls K outward	Swivel B shoes captured; anti-fall active
4 Controlled fold	Same continuous path maintained	Stop on skew over 10 mm, binding, abnormal effort or loss of clear K path
5 Open + lock	Both stops contacted	Both mechanical locks proved before unloading the drive

Closing retraces 5 - 4 - 3 - 2B - 2A - 1. Lift 5 mm before releasing the self-relieving open locks.

02 KINEMATIC DECISION GATE - H2

A sequence of poses is not proof of a mechanism

- H is a fixed head hinge; K follows a defined arc about H.
- At state 2 H-K-B are collinear: rope lift alone cannot choose an outward fold direction.
- H2 must define a positive fold initiator that does not continuously preload storm pins or cams.
- B requires a swivel or trunnion guide shoe; the fixed-axis closed-state wind roller is not the travelling guide.
- Dimension both rope attachment points and route each line clear of the fold through full travel.
- Model leaves differ by 170 mm: 2450 minus 2280. A vertical guide cannot finish as the drawn flat stack; 2450 projection is subject to H2.
- Submit 0/25/50/75/100 percent poses with angles, B levels, clearances, reactions and peak line pull.

HOLD

Do not fabricate or operate. Fold initiator, rope points, swivel B shoes and open locks are prerequisite H2 inputs.

Leaf fabrication and mass control

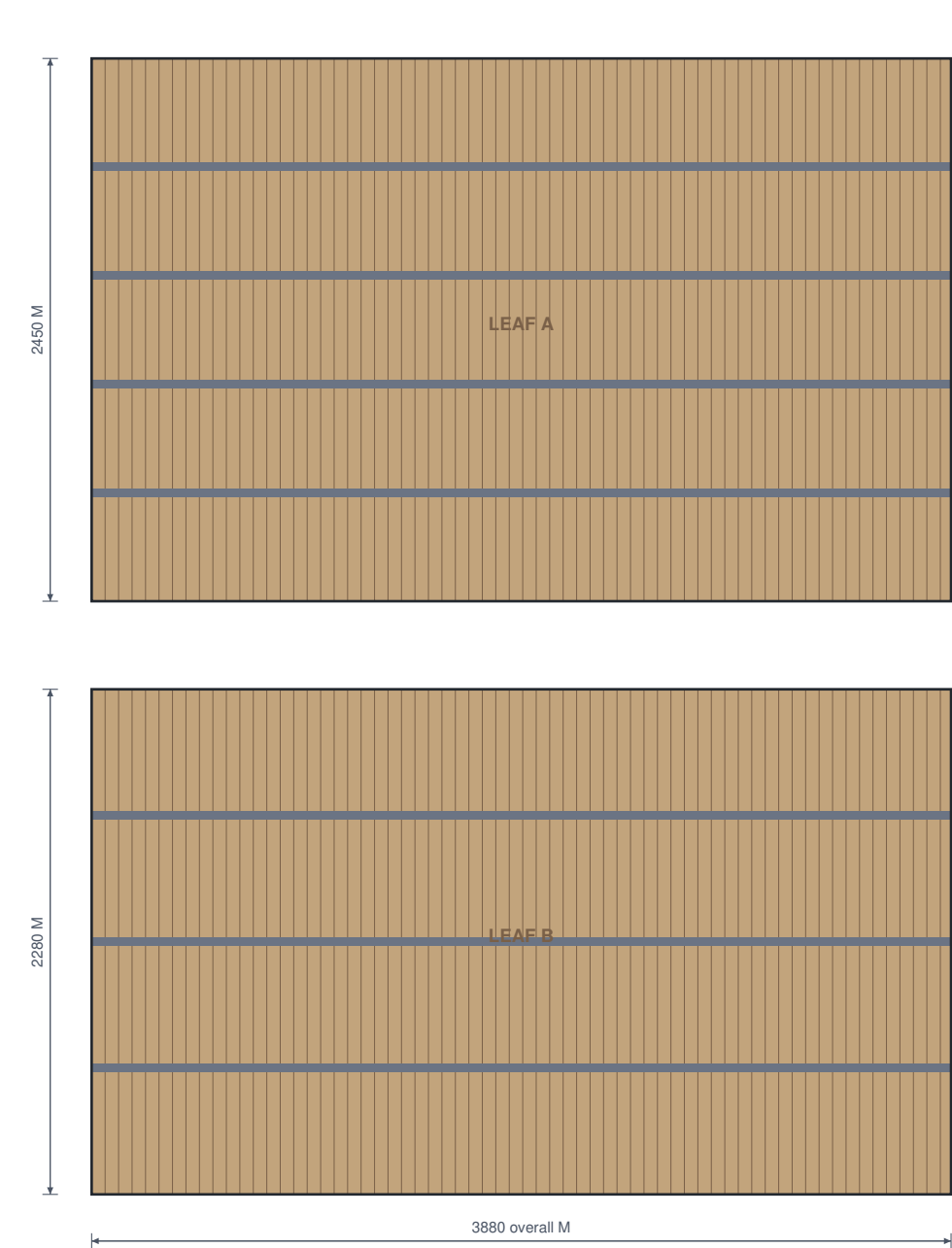
O2-S03

Welded frames, backing sheet, timber face and assembly tolerances

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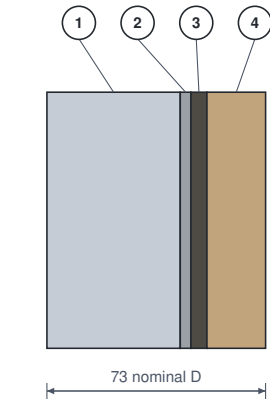
01 FABRICATION ELEVATION

Both leaves viewed from outside; weld distortion controlled before facing



02 LEAF BUILD-UP

Nominal overall 73 mm



- 1 **75 X 50 X 3 RHS**
50 face depth; final size H1
- 2 **1.2 SHEET BACKING**
Continuous; sealed and drained
- 3 **2 MM ISOLATION STRIP**
EPDM between steel and timber
- 4 **68 X 19 MACROCARPA**
10 gap; seal all faces

03 FABRICATION NOTES

- Weld to qualified procedure; grind only where detailed.
- Check frame diagonals within 3 mm before sheet fixing.
- Hot-dip galvanize after fabrication; vent and drain every hollow section.
- Use compatible isolation washers with 316 timber fixings.
- Seal sheet edges and penetrations; provide bottom drain slots.
- Trial assemble both leaves, hinges, rollers and lift eyes in the shop.

04 PRELIMINARY MEMBER SCHEDULE

Capacity and weld sizes remain H1

ITEM	PROVISIONAL SPECIFICATION	ST
Perimeter	75 x 50 x 3 RHS, 50 face depth	P
Intermediate rails	50 x 50 x 3 SHS at 600 max	P
Backing	1.2 G550 ZM-coated sheet	P
Outer face	68 x 19 macrocarpa at 78 pitch	D
Knuckle plates	10 plate at 400 max	P
Knuckle pins	20 dia 316 with bushes	P
Lift eyes	12 plate, full-penetration weld	P
Fasteners	316, isolated from coated steel	D

05 MASS CONTROL

First-principles takeoff, excludes final coatings

LEAF A	329.1 kg est
9.51 m2 - steel 139.6 kg - timber 81.9 kg - backing 89.5 kg - hardware 18.0 kg	
LEAF B	298.1 kg est
8.85 m2 - steel 120.6 kg - timber 76.2 kg - backing 83.3 kg - hardware 18.0 kg	

DESIGN LIFTING MASS

627.2 kg current takeoff - use 700 kg provisional H2 dead load before factors. H2 shall increase 700 kg if the completed hardware takeoff or shop mass is greater.

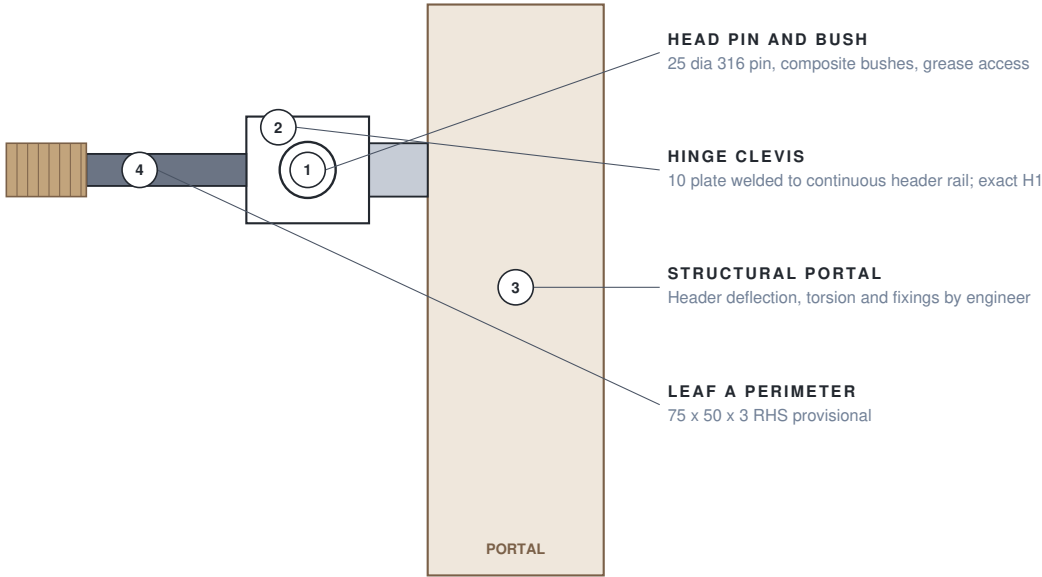
Head hinge, lift drive and fall protection

Common shaft, twin ropes, guarded drums and independent open-state restraint

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01 DETAIL H1 - HEAD HINGE SECTION

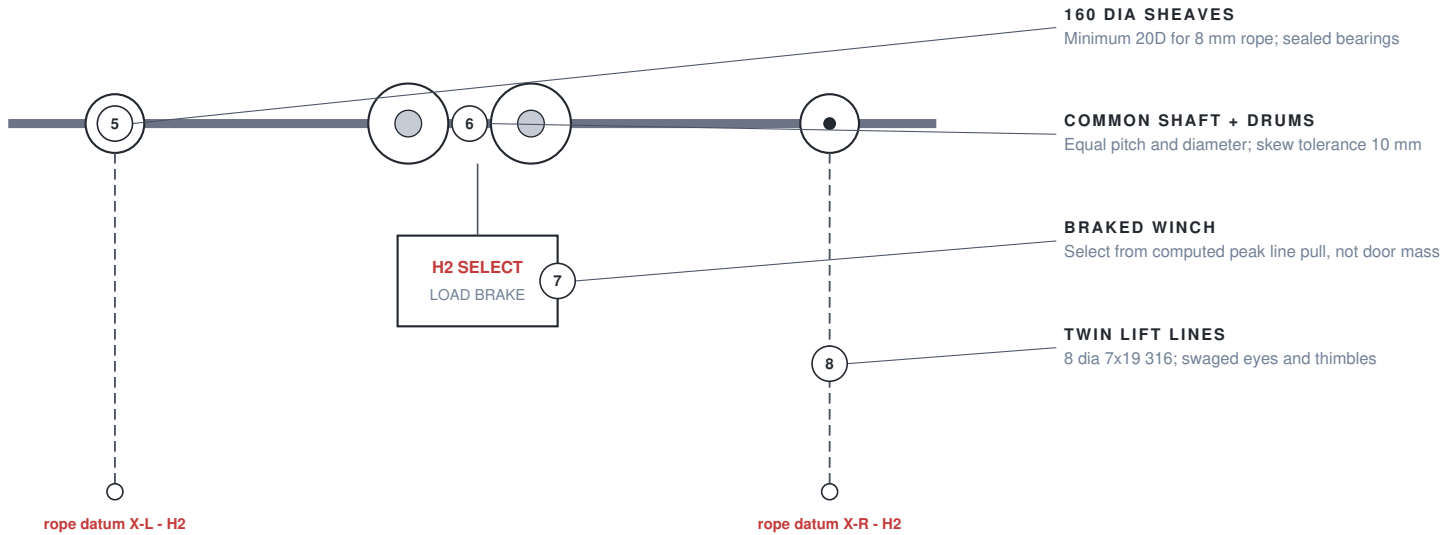
Section through one hinge clevis and portal header



Provide a removable weather cover over the full hinge line; flash independently of the structural clevises.

02 DETAIL H2 - SYNCHRONIZED LIFT DRIVE

Front elevation behind the guarded head cover



NO INDEPENDENT WINCHES

Two separate hand winches can rack and jam the door. Use one common shaft or a certified synchronised operator with position monitoring.

03 LIFT AND RESTRAINT REQUIREMENTS

The brake is operational control; independent devices prevent uncontrolled descent

- 1 ROPE**
Each line, end and anti-fall to carry the H2 single-line failure case with stated impact factor; AS 2759 basis.

- 2 ENDS**
Pre-stretched rope, swaged eyes and adjustable dead ends. Dimension attachment datums; re-tension after H6 cycles.

- 3 DRUM**
Prove about 4.7 m travel, fleet angle, three dead wraps and the complete twin-drum head envelope at H2.

- 4 ANTI-FALL**
Independent rated device each side; arrest a rope, shaft or brake failure without relying on the surviving line.

- 5 OPEN LOCK**
Two self-relieving mechanical locks: drive lifts 5 mm before release; no dependence on rope tension.

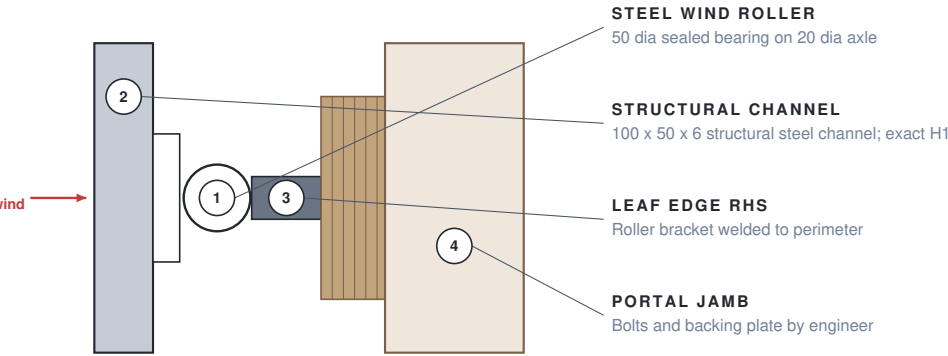
- 6 GUARDING**
Fixed removable covers over the drums, sheaves, shaft, rope entry and leaf-to-leaf knuckle pinch zone.

Jamb restraint, storm pins and weather seals

Closed-state wind path and serviceable water-management interfaces

01 DETAIL J1 - CAPTURED WIND ROLLER

Plan at roller; mirrored at opposite jamb

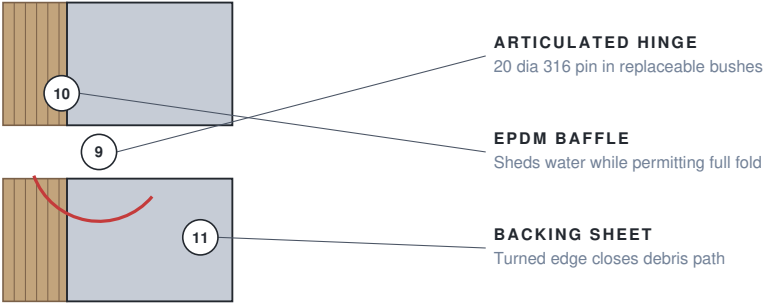


CLOSED-STATE RESTRAINT ONLY

The travelling swivel guide is H2 work; see O2-S08. UHMWPE is noise lining only and is not in the primary wind-load path.

03 DETAIL K1 - KNUCKLE AND SEAL

Section closed; opening arc kept clear

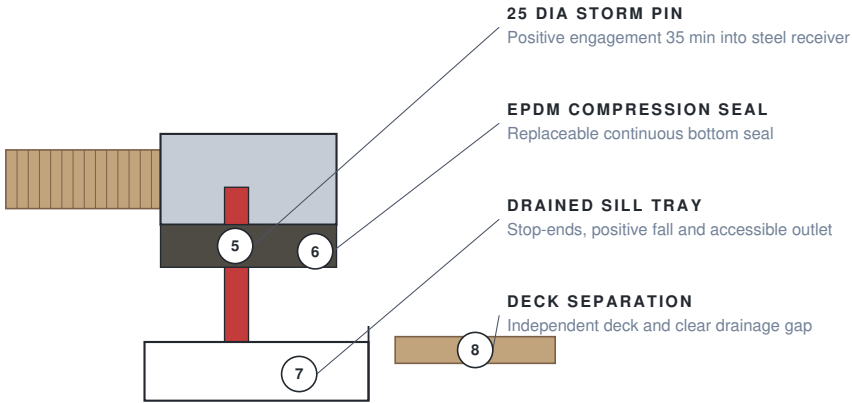


PINCH ZONE

Provide a full-width guard clear of the swept hinge path.

02 DETAIL S1 - BOTTOM CLOSURE

Section through storm pin, compression seal and drained sill



Two over-centre cam latches draw the leaf onto seals; pins carry restraint and must be visibly engaged.

04 DURABILITY AND MAINTENANCE

Coastal exposure makes replaceability part of the design

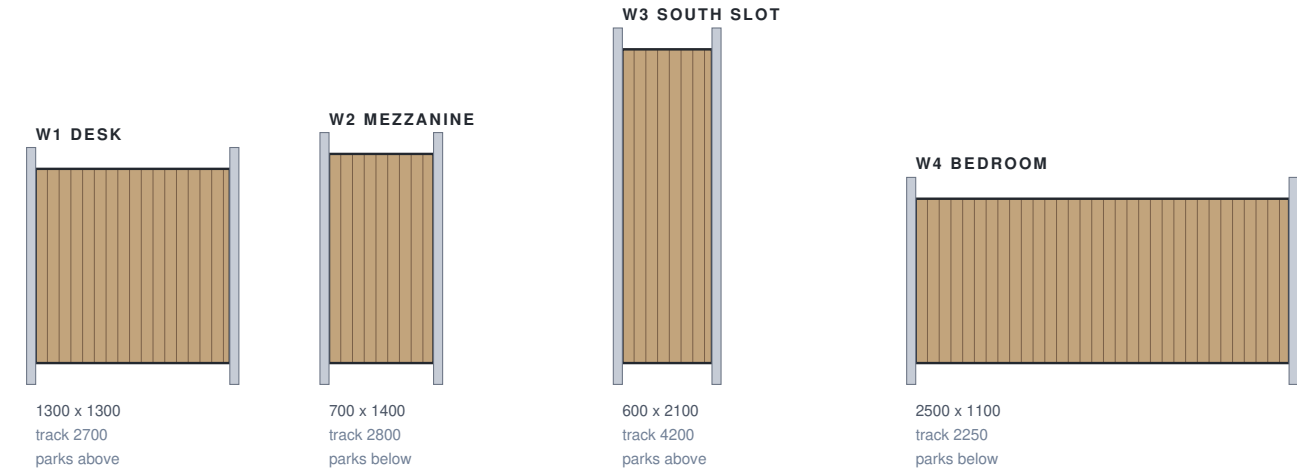
Steel	Hot-dip galvanize fabricated carbon steel, then apply a compatible marine duplex coating system after vent-hole touch-up.
Stainless	Use 316 or higher for exposed pins, ropes and fasteners; isolate stainless from coated carbon steel and aluminium.
Timber	Seal macrocarpa all faces before assembly. Predrill, allow movement and provide replaceable face battens.
Drainage	No sealed hollow pockets. Vent and drain RHS, channels, covers and sill receivers at their lowest points.
Access	Head cover, jamb covers, drums, sheaves, pins, rollers and seals removable with standard tools from a stable platform.
Service	Inspect before each storm closure; annual competent-person service; rope replacement to supplier criteria.

Sliding window shutters

Four modelled openings with counterbalance, captured guides and positive storm latches

01 OPENING SCHEDULE

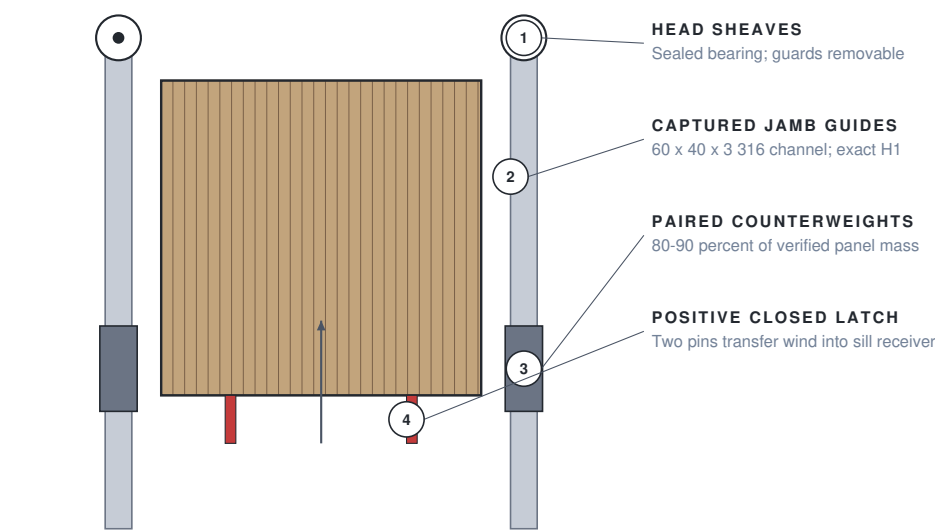
Current live-model panel and track envelopes



Track envelopes: W1 2700 - W2 2800 - W3 4200 - W4 2250 M

02 DETAIL W1 - COUNTERBALANCED ARRANGEMENT

Elevation and jamb section; repeat both sides



OPERATING FORCE TARGET

Counterweight each panel to leave a 10-20 percent closing bias. Verify by test: sustained hand force at the handle not more than 80 N through full travel.

03 WINDOW SHUTTER FABRICATION BASIS

The panel locks structurally when closed; ropes and catches do not resist storm pressure

ITEM	PROVISIONAL SPECIFICATION	QUANTITY	ST	CHECK
Panel frame	40 x 40 x 3 SHS; rails at 600 max	1 / opening	P	H1
Outer face	1.2 sheet + 68 x 19 macrocarpa	1 set	D	Shop
Jamb guides	60 x 40 x 3 316 channel, drained	2 / opening	P	H1
Guide rollers	Steel sealed-bearing rollers; polymer wear strips	4 min	P	Shop
Counterbalance	2 ropes, 2 weights, guarded head sheaves	1 system	P	Test
Storm closure	2 bottom pins + 2 cam latches + EPDM seal	1 set	P	H1
Access	Removable jamb/head covers; safe operating position	1 set	D	H5

04 MODEL UPDATES AND SPECIAL CHECK

MODEL UPDATES

Current window panels are 45 mm thick. The fabrication basis is approximately 62 mm. Update every open and closed component, recheck track offsets, and verify parked panels do not obstruct flashings or roof drainage.

SPECIAL CHECK - W4 BEDROOM

The 2500 x 1100 panel is the widest and most prone to racking. Provide linked counterweights or anti-racking cable and shop-test full travel.

Storm-mode closure, hold points and verification

The package is ready for disciplined review; fabrication starts only after the gates close

01 STORM-MODE CLOSURE CHECKLIST

Laminate and mount inside the entry cupboard

- ☐ 01
- Check forecast and close before winds make operation unsafe.
- ☐ 02
- Clear deck, sill drains, jamb channels and every shutter travel path.
- ☐ 03
- Lower W1-W4; engage both bottom pins and both cam latches at every opening.
- ☐ 04
- Lower main bifold under the load brake; confirm both sides remain level within 10 mm.
- ☐ 05
- Compress head, jamb, knuckle and sill seals with the cam latches.
- ☐ 06
- Engage all main storm pins. Verify each witness mark shows full engagement.
- ☐ 07
- Remove and lock away the winch crank. Isolate powered controls if fitted.
- ☐ 08
- Photograph the closed facade and record date, operator and any defect.

03 VERIFICATION RECORD

Any HOLD blocks lifting-part fabrication and operation

CHECK	STATE	EVIDENCE
Live model re-read	PASS	3880 x 4800, leaves 2450 + 70 + 2280, four window panels
Geometry arithmetic	HOLD	Leaf stack equals 4800; 2450 open projection is subject to H2
Mass recomputation	HOLD	627.2 kg takeoff; H2 uses 700 kg minimum and increases it if final hardware is heavier
Primary wind path	PASS	Polymer removed from structural restraint; steel rollers and pins shown
Prop conflict	PASS	4750 and 2240 props removed from construction design; model update listed
Lift synchronization	PASS	Common shaft required; independent winches prohibited
Kinematic path	HOLD	Straight-line dead point plus 170 mm unequal-link offset require H2 inputs and study
Operating safety	HOLD	Open lock reactions, operating wind limit and recovery procedure require H1/H2/H4
Structural capacity	HOLD	Requires site actions and CPEng member/connection design H1

02 FABRICATION HOLD POINTS

Close with signed evidence, not a verbal assumption

- H1

STRUCTURE

CPEng confirms site wind actions, leaf members, hinges, rollers, pins, jamb channels, portal and foundation load path.
- H2

LIFT + KINEMATICS

Specialist first fixes fold initiator, rope datums and swivel B shoes; then proves motion, peak line pull, drive, anti-fall and locks.
- H3

DURABILITY

Architect/engineer confirms coating system, metal compatibility, drainage, replaceability and B2 design life.
- H4

OPERATION

Designer sets opening/closure wind limits and issues warning labels, exclusion zone, jam, arrest and emergency recovery rules.
- H5

ACCESS + SAFETY

Builder confirms safe access for operation and maintenance; guarding and any powered controls reviewed to AS/NZS 4024 basis.
- H6

SHOP TEST

Record each leaf mass, proof test, 20 cycles, rope re-tension, brake hold, anti-fall, skew and water-shedding tests.

04 REFERENCE AND ISSUE BASIS

Use the current cited editions and selected supplier literature

- 01
- NZ Building Code B1/VM1, 2nd edition effective 28 Jul 2025 - actions and structural design.
- 02
- AS/NZS 1170.0 and AS/NZS 1170.2:2011 as modified by B1/VM1 - wind actions and load combinations.
- 03
- NZ Building Code B2/AS1 and project durability assessment - exposed coastal components.
- 04
- AS/NZS 1554.1 and NZS 3404 / SNZ TS 3404 as applicable - structural steel and welding.
- 05
- WorkSafe Safe Use of Machinery - guarding, anti-freefall, controls and lockout principles.
- 06
- AS/NZS 1418 series and AS 2759 - winch duty and steel-wire-rope use; applicability confirmed by H2 supplier.
- 07
- Bifold door industry precedent - synchronized lift, wind rollers, positive latches and structural header reactions.

NEXT ISSUE

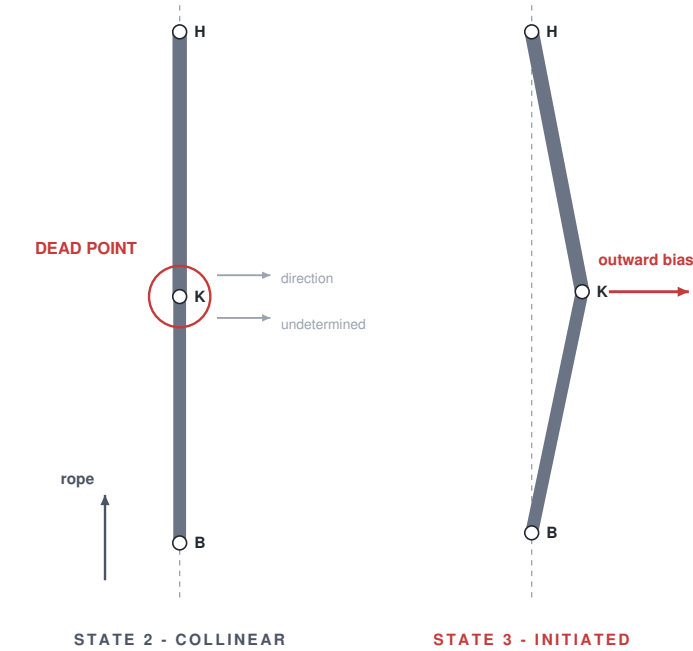
After H1-H5: incorporate certified sizes and product data, update the SketchUp components, issue fabricator shop drawings, then complete H6 before installation.

Pre-H2 mechanism inputs and open-state safety

Mandatory definition before a motion study can prove the lift; all geometry on this sheet is hold-point work

01 INPUT A - POSITIVE FOLD INITIATION

Rope lift alone cannot choose an outward fold direction at H-K-B collinearity



H2 shall select and draw a cam, kick link, controlled over-centre set or certified bifold operator that positively drives K outward before significant B lift.

The closed hard stop or selected mechanism carries any bias. Storm pins and cam latches shall not be continuously preloaded by the initiator.

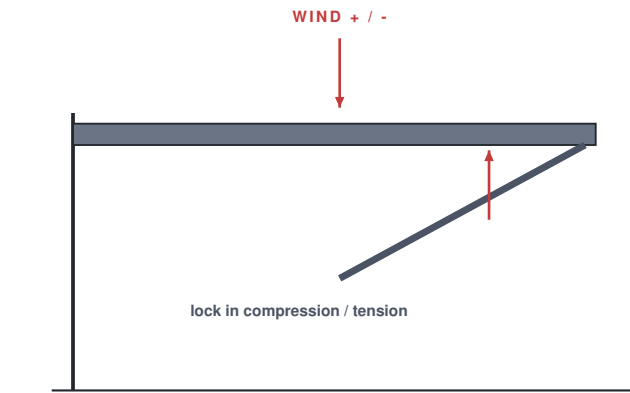
H2 PREREQUISITE

No operation or motion-study sign-off until the initiator and its reactions are defined.

Screening geometry only: a plain vertical guide through the head binds near 69 deg with B still about 0.9 m below the head, so it cannot reach the drawn flat stack.

03 OPEN-STATE LOAD PATH AND LOCK CONCEPT

Open mode is not storm mode; H1 and H4 set reactions and the mandatory closure threshold



Screening action: 9.51 m2 x 1.95 kPa is about 18.5 kN before coefficients. H1 shall design the leaf, hinges, two locks, portal and foundations for the selected open case.

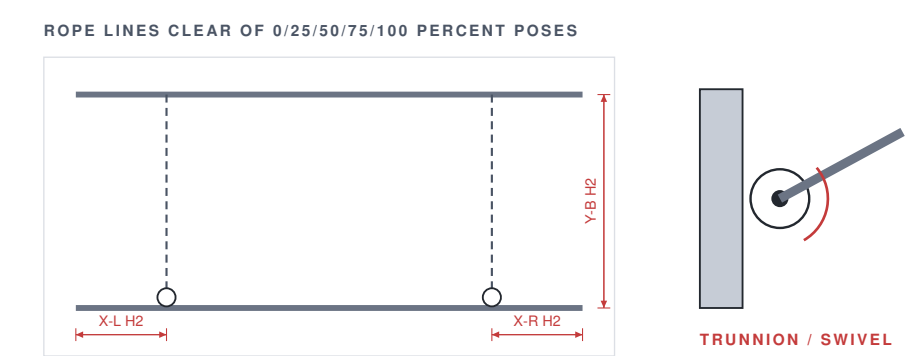
Each lock is positive and self-relieving: the drive raises the leaf about 5 mm before its captive pin can release. Exact geometry and reaction are H1/H2.

CLOSE BEFORE THE H4 WIND LIMIT

Do not leave the shutter open unattended.

02 INPUT B - ROPE DATUMS AND SWIVEL B GUIDE

These are inputs to H2, not dimensions that may be chosen after the study



SEPARATE COMPONENTS

The fixed-axis J1 wind roller is closed-state restraint. A separate swivel or trunnion shoe must accommodate leaf rotation without binding. Dimension both rope attachment points and route each line clear of the fold through full travel.

04 CONTROL MATRIX AND OPERATOR RULES

Prefer geometric interlocks; warnings are the minimum residual control

HAZARD	PREVENTION	RECOVERY
Drive vs pins	Crank block or permanent warning; 2A before 2B	Stop; unload; inspect pins / eyes
Unlock under load	Self-relieving lock needs 5 mm lift	Re-engage both locks; reset drive
Jam / skew over 10	Painted jamb graduations; adjustable rope ends	Stop; do not force; lower if clear
Anti-fall arrest	Independent device each side	Isolate; support; competent inspection
Mid-travel park	Prohibited	Return to locked open or secure closed

OPENING	H4 wind OK - zone clear - anti-fall serviceable - 2A preload - 2B release - initiator proved - lift - both locks proved
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