LOCKWOOD

Designed for good

DESIGNERS CONDENSED STRUCTURAL HANDBOOK MARCH 2015

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Date: 3/03/2015

THE LOCKWOOD SYSTEM
STRUCTURAL HANDBOOK MARCH 2015

INDEX

THE LOCKWOOD SYSTEM STRUCTURAL HANDBOOK

SECTION A GENERAL

1. DESCRIPTION OF THE LOCKWOOD STRUCTURAL SYSTEM

The Lockwood System utilizes solid timber Pinus Radiata wall planks and roofing sarking each tongued and grooved to interlock with the adjacent planks. Wall panels are stiffened by the intersection of either return walls, or laminated timber stiffening members. All returns or stiffening elements are rigidly connected by means of extruded aluminium "profiles" which are tight fitting and form an effective "dovetail" between the adjacent elements.

Roof sarking is stiffened where necessary by laminated timber roof beams spaced to adequately restrict stresses and deflections in the sarking system.

2. FORMAT OF HANDBOOK

A Design Section, Section B, is included in this handbook to assist in the design of Lockwood residential structures in New Zealand.

Calculations are provided to justify the critical structural aspects of the Lockwood method of construction. Design criteria are established, and test information is provided. Each section is indexed in letter and number form - e.g. Page A-1. This provides the facility to be able to introduce updated information as required by code or product changes, the availability of additional test data etc.

Any future additions or alterations to the handbook will be lettered, numbered and dated. With any reissue of amended or additional pages to the handbook, a complete full index of contents will be provided. This will enable check to be made at any stage, that the handbook is complete and up to date.

3. NEW ZEALAND STANDARDS

The following New Zealand Standards have been used in the preparation of this handbook :

AS/NZS1170:2002 “Structural Design Actions”, NZS3603:1993 (including Amendment No. 4), “Timber Structures Standard”, NZS3604:2011, “Timber Framed Buildings”, NZS3606:1987, “Specification for the Manufacture of Glue Laminated Timber”, and AS/NZS1328:1998, “Glue Laminated Structural Timber”

4. COPYRIGHT

5. BSK CONSULTING ENGINEERS LTD

BSK Consulting Engineers are a Rotorua based firm of Consulting Civil and Structural Engineers. The practice maintains a close association with the timber industry and have been principal consultants to Lockwood Buildings Limited since 1968.

SECTION B DESIGN OF LOCKWOOD STRUCTURES

This section has been produced to assist in the design of Lockwood residential structures for New Zealand Wind and Earthquake conditions.

CODE COMPLIANCE

All data in this section of the Handbook has been based on design and testing carried out in strict accordance with the Verification Method B1/VM1 of the New Zealand Building Code Handbook.

Providing this Design section of the Handbook is used correctly, resulting designs will comply with the requirements of Clause B1 Structure of the New Zealand Building Code.

SUB-INDEX

1. EXTERIOR WALL PANEL SIZES - 62mm LOCKWOOD EXTERIOR WALL SYSTEM

Tests have substantiated the following maximum panel sizes, incorporating window joinery.

(i)	N2 Window Panel	4.656m O/A	Page F2
(ii)	N3 Window Panel	4.800m O/A	Page F3
(iii)	PS Window Panel	3.876m O/A	Page F4

These pressure tests were carried out in 1991. In 1995 Lockwoods changed to the Nalco Nulook joinery system. The outer frames of all windows in the Nulook system are slightly stiffer (and stronger) than the joinery used in the tests. The test results are therefore still valid.

The Nalco Nulook ranch slider outer frame is however considerably weaker than the previous Lockwood joinery. Previously advantage was taken of the stiffness of the ranch-slider jamb sections to increase exterior wall panel lengths above the 4.5m maximum where a ranch slider was incorporated in an exterior wall. This no longer applies with the weaker Nulook ranch slider joinery, and panels should be restricted to 4.5m or additional laminated wall stiffeners incorporated into the design.

It is Lockwood Standard practice to limit all 62mm Lockwood wall panel lengths to 4.5m maximum where not covered by the above mentioned tests.
Should room dimensions require exterior wall panel lengths longer than can be provided within the above criteria, additional wall stiffening elements should be introduced to provide additional lateral restraints (return walls or laminated stiffener posts).

Refer B4 for design of laminated columns.

2. EXTERIOR WALL PANEL SIZES - 44mm WALL BATTENED SYSTEM WITH CONVENTIONAL CLADDING OR BRICK VENEER

Tests have substantiated the following maximum panel sizes, incorporating window joinery.

(i) IH2 window panel - 3.244m O/A. 46 x 46 wall battens at 600mm c/c. Minimum width of solid panel adjacent to the window opening of 770mm.

(ii) IH2 window panel - 3.656m O/A. Standard 46 x 46 wall battens at 600mm c/c plus two additional full height 46 x 46 wall battens on each side of the window.

Should room dimensions require exterior wall panel lengths longer than can be provided within the above criteria, additional wall stiffeners should be introduced to provide additional lateral restraints.

Refer B4 for design of laminated columns.

3. EXTERIOR WALL LAMINATED STIFFENER POSTS

(i) EXTERIOR WALL STIFFENER POST DESIGN

As mentioned in Section A, Clause 1, Lockwood wall panels are stiffened by the intersection of either return walls, or laminated timber stiffener columns.

The following design charts (refer pages B5-B8) are given to determine stiffener post sizes required for given Wind Zones, stiffener lengths and lengths of exterior wall stabilised by the column (loaded dimension).

These design charts assume that the laminated column is X-profiled full height to a section of solid wall, and that for columns supporting roof beams (e.g. centrally on gable end walls), at least one 10mmø tie rod is located adjacent to the column.

Structural design of these stiffener columns has been based on structural grade GL8 Glulam columns in terms of AS/NZS 1328.1-1998 and using the "Timber Structures Standard", NZS3603:1993.

(ii) EXTERIOR WALL LAMINATED STIFFENER POSTS – TOP & BOTTOM FIXINGS

All exterior wall laminated stiffener posts are to be effectively fixed top and bottom as below.

(a) At Floor Level One of the Following Fixings Shall be Provided:-

(i) Provide two Pryda Multigrips nail fixed to the sides of each stiffener and to the timber floor or floor plate, in accordance with the Lockwood Standard Details.

or

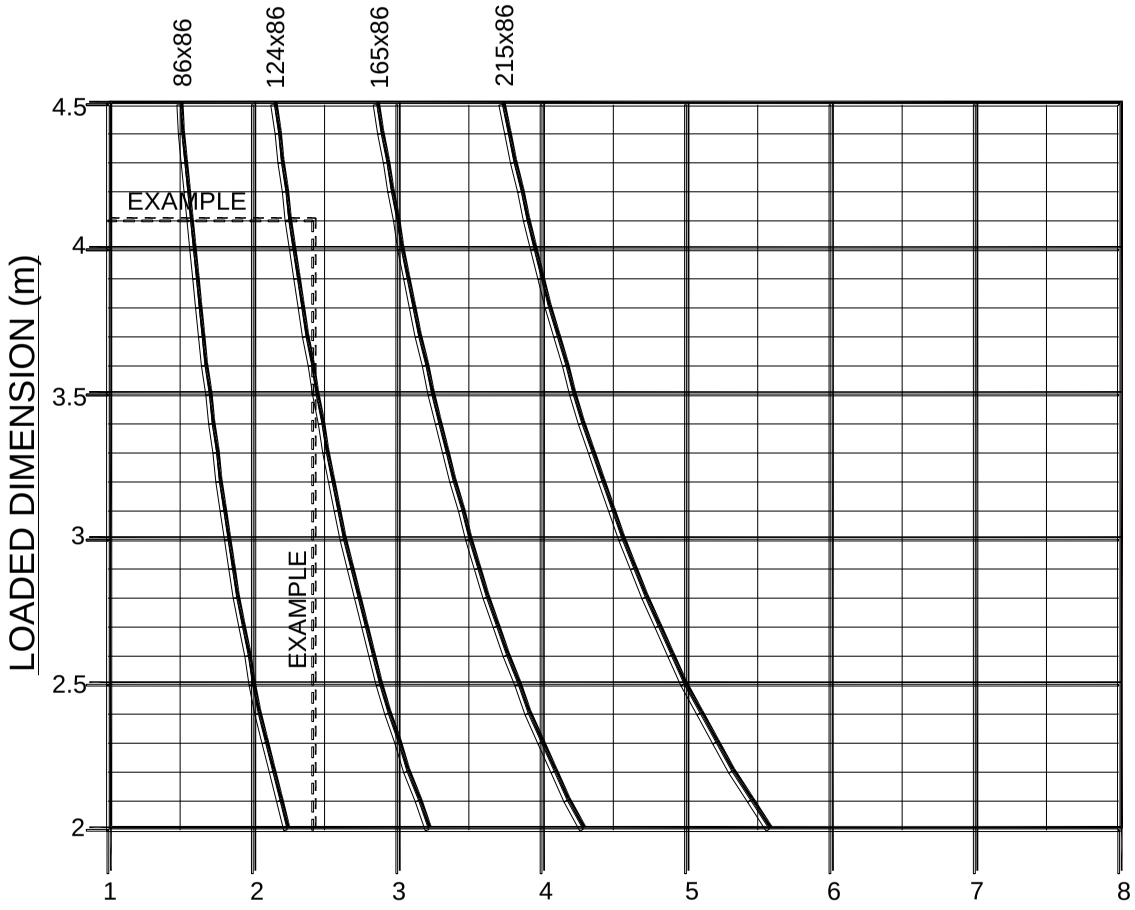
(ii) Carry stiffener through floor and bolt fix to subfloor timbers in accordance with Lockwood Standard Detail B18.

(b) At Roof Level Provide Fixings as Below:-

(i) Stiffeners at side walls – extend stiffener through roof sarking and cut sarking neatly right around stiffener.

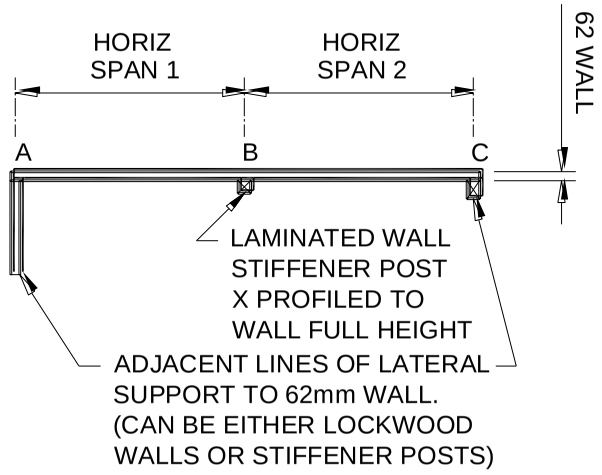
(ii) Stiffeners at end walls supporting beams – tenon and mortice in accordance with Lockwood Standard Details (M12 galvanised pins).

LOCKWOOD STIFFENER SELECTION CHART
VERY HIGH WIND ZONE (TO NZS 3604:1999)



(FLOOR TO UNDERSIDE OF ROOF BEAM
OR FLOOR TO SARKING)

DEFINITION OF LOADED DIMENSION



$$\text{LOADED DIMENSION} = \frac{(\text{HORIZ SPAN 1} + \text{HORIZ SPAN 2})}{2}$$

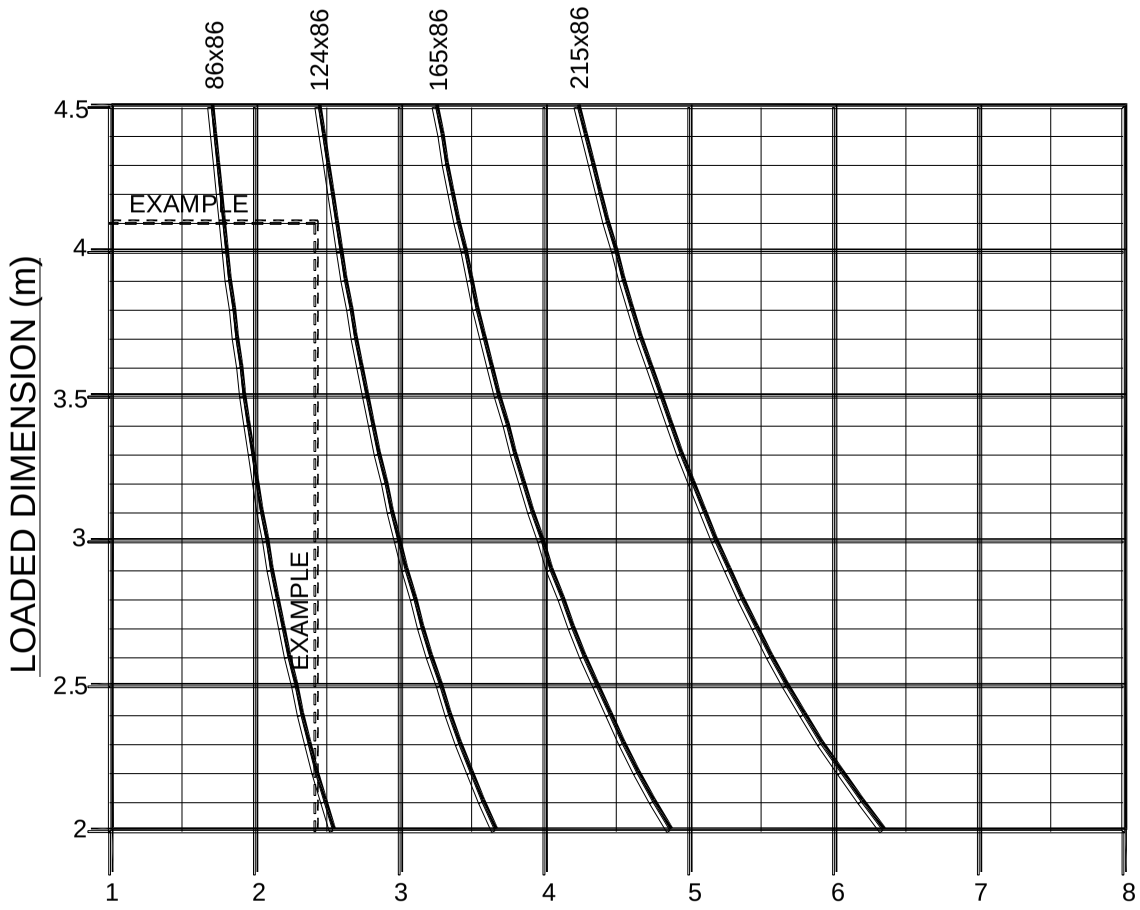
N.B. WALL PANELS BETWEEN LINES
OF LATERAL SUPPORT A, B AND C
MAY CONTAIN SINGLE JOINERY UNITS
(REFER PAGE B-2 OF HANDBOOK FOR
MAXIMUM PANEL SIZES)

EXAMPLE

A POST 2418mm HIGH (14 BOARD STUD)
WITH A LOADED DIMENSION OF 4.1m
REQUIRES A 165x86 LAM STIFFENER POST

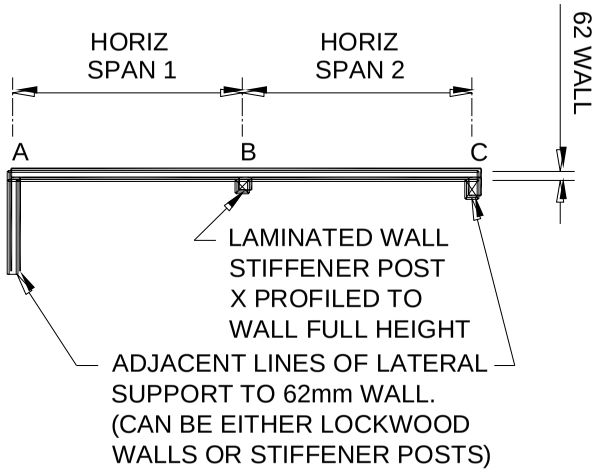
VERY HIGH WIND ZONE

LOCKWOOD STIFFENER SELECTION CHART
HIGH WIND ZONE (TO NZS 3604:1999)



(FLOOR TO UNDERSIDE OF ROOF BEAM
OR FLOOR TO SARKING)

DEFINITION OF LOADED DIMENSION



$$\text{LOADED DIMENSION} = \frac{(\text{HORIZ SPAN 1} + \text{HORIZ SPAN 2})}{2}$$

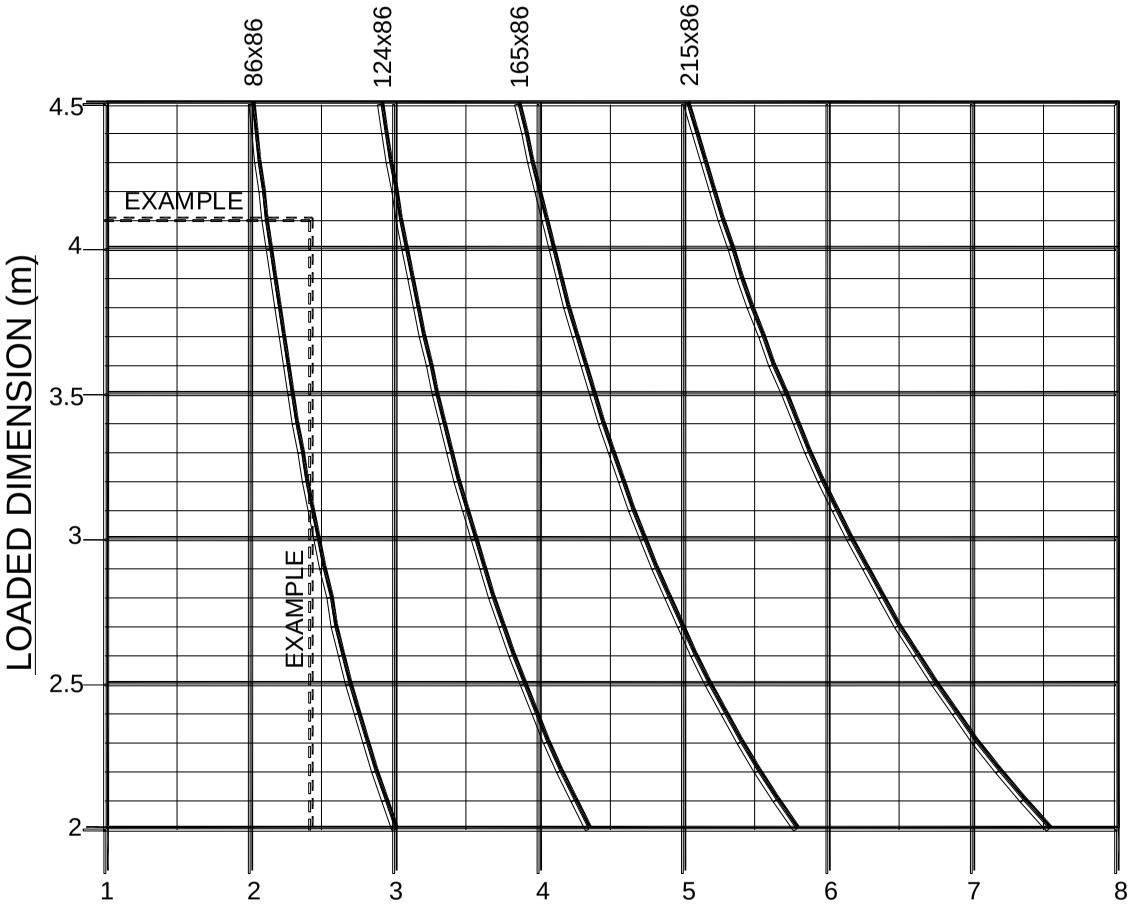
N.B. WALL PANELS BETWEEN LINES
OF LATERAL SUPPORT A, B AND C
MAY CONTAIN SINGLE JOINERY UNITS
(REFER PAGE B-2 OF HANDBOOK FOR
MAXIMUM PANEL SIZES)

EXAMPLE

A POST 2418mm HIGH (14 BOARD STUD)
WITH A LOADED DIMENSION OF 4.1m
REQUIRES A 124x86 LAM STIFFENER POST

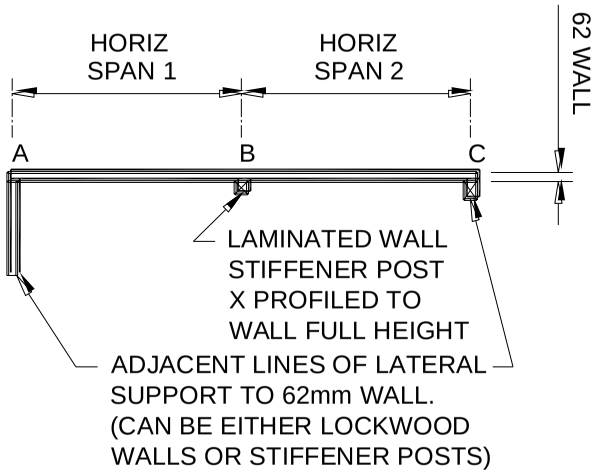
HIGH WIND ZONE

LOCKWOOD STIFFENER SELECTION CHART
MEDIUM WIND ZONE (TO NZS 3604:1999)



(FLOOR TO UNDERSIDE OF ROOF BEAM
OR FLOOR TO SARKING)

DEFINITION OF LOADED DIMENSION



$$\text{LOADED DIMENSION} = \frac{(\text{HORIZ SPAN 1} + \text{HORIZ SPAN 2})}{2}$$

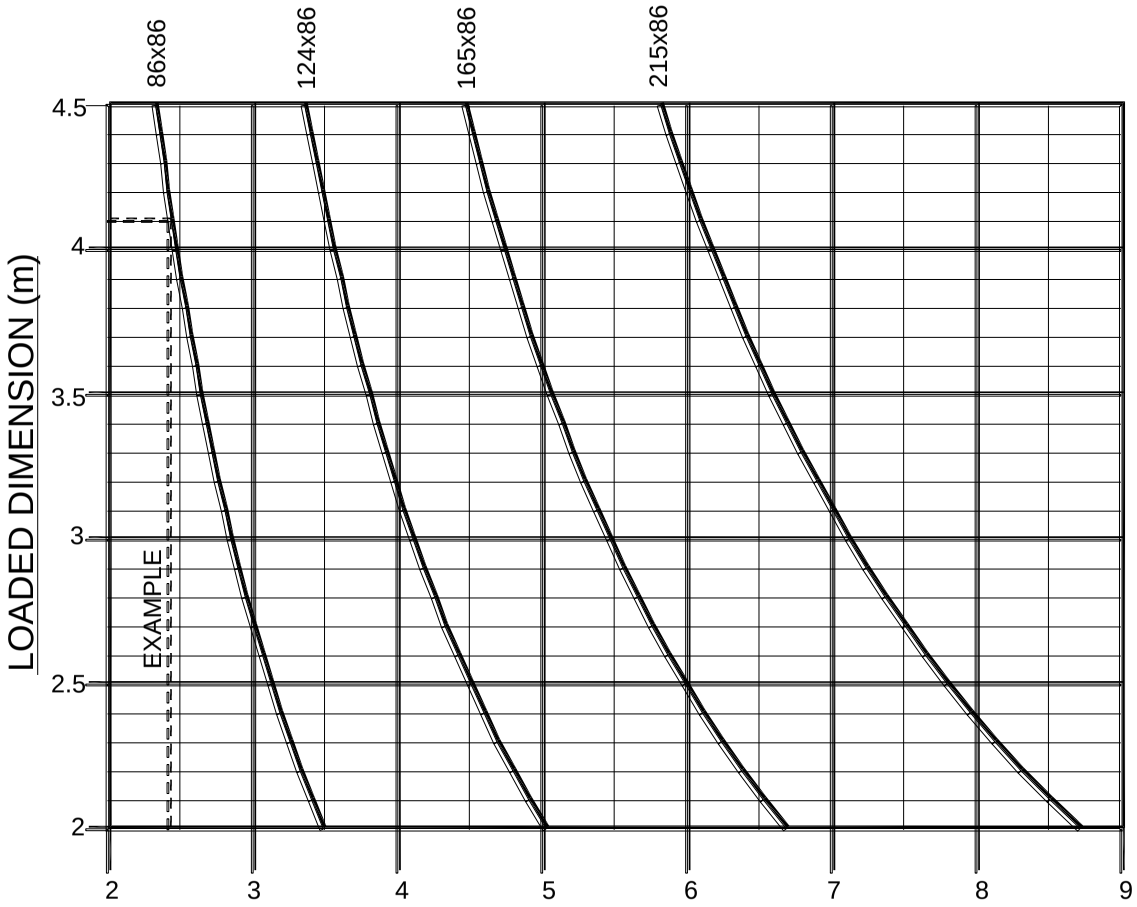
N.B. WALL PANELS BETWEEN LINES
OF LATERAL SUPPORT A, B AND C
MAY CONTAIN SINGLE JOINERY UNITS
(REFER PAGE B-2 OF HANDBOOK FOR
MAXIMUM PANEL SIZES)

EXAMPLE

A POST 2418mm HIGH (14 BOARD STUD)
WITH A LOADED DIMENSION OF 4.1m
REQUIRES A 124x86 LAM STIFFENER POST

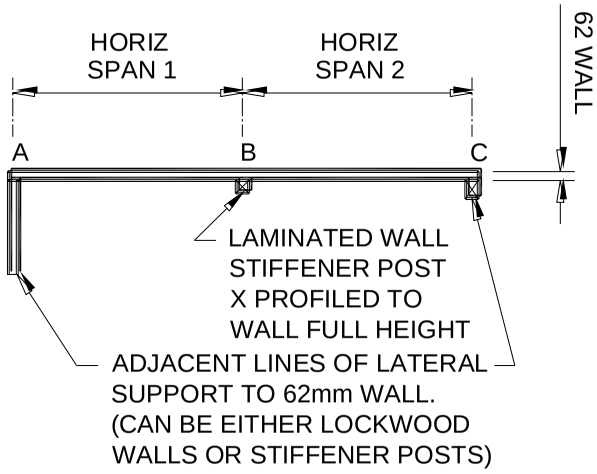
MEDIUM WIND ZONE

LOCKWOOD STIFFENER SELECTION CHART
LOW WIND ZONE (TO NZS 3604:1999)



(FLOOR TO UNDERSIDE OF ROOF BEAM
OR FLOOR TO SARKING)

DEFINITION OF LOADED DIMENSION



$$\text{LOADED DIMENSION} = \frac{(\text{HORIZ SPAN 1} + \text{HORIZ SPAN 2})}{2}$$

N.B. WALL PANELS BETWEEN LINES
OF LATERAL SUPPORT A, B AND C
MAY CONTAIN SINGLE JOINERY UNITS
(REFER PAGE B-2 OF HANDBOOK FOR
MAXIMUM PANEL SIZES)

EXAMPLE

A POST 2418mm HIGH (14 BOARD STUD)
WITH A LOADED DIMENSION OF 4.1m
REQUIRES A 86x86 LAM STIFFENER POST

LOW WIND ZONE

THE LOCKWOOD SYSTEM
STRUCTURAL HANDBOOK 2006
ADDENDUM 1 (OCTOBER 2013)

I. INTRODUCTION

This document amends the Lockwood Structural Handbook, 2006.

The scope of this document is limited to the use of internal 44mm walls and external 107mm walls for the provision of lateral bracing requirements of the New Zealand Building Code, Clause B1 Structure.

The results presented herein have been derived from experimental testing completed by Holmes Solutions in accordance with the BRANZ EM3-V3 testing protocol with the displacement targets modified to reflect the requirements of AS / NZS 1170.1 for non-plaster lined walls. At the completion of the testing, calculations of the Bracing units (BU) capacity of the tested walls were made in accordance to EM3-V3 analyses, with revised F1 and F2 factors to reflect the manufactured form of the walls.

The new Lockwood 107mm insulated external wall system has been verified by BSK Consulting Engineers Ltd to have structural performance at least as good as the 62mm board system referenced in the Lockwood Structural Handbook, 2006.

Lateral bracing calculations completed in accordance with this Addendum, for structures designed in accordance with the Lockwood Structural Handbook, will comply with the requirements of Clause B1 Structure of the New Zealand Building code.

II. EXTERNAL REPORTS

This document makes use of the findings contained in the following external reports:

Lockwood Report 19175 (107mm wall board), BSK Consulting Engineers Limited, February 2013.

Lockwood Wall Bracing Capacity Testing - Report 109800.00.01 (v1.2), Holmes Solutions LP, September 2013

III. COPYRIGHT

IV. CHANGES TO SECTION B- DESIGN OF LOCKWOOD STRUCTURES

B.4. LATERAL STABILITY - BRACING UNIT APPROACH

This clause replaces Section B. Clause 4. LATERAL STABILITY – BRACING UNIT APPROACH. Pages B-9 to B-12, in its entirety.

(a) The lateral stability of the Lockwood form of construction relies on the stiffness that is provided by walls acting as shear panels

(b) When determining Bracing Demand, as set out in NZS 3604:2011 Clauses 5.2 and 5.3, where using roof cladding with a weight no greater than 20kg/m^2 (i.e. most iron roofs) and Lockwood exterior walls, use light roof and wall data throughout in terms of NZS3604:2011, (refer Page X-8 for verification of roof and wall weights).

(c) Bracing Capacity is provided by sections of 44mm Internal and 107mm External walls which satisfy the following conditions:

(1) At least 1.0m in length;

(2) A wall height between 2.2m (13 planks) and 3.6m (21 planks);

*Note: Bracing capacity given in the tables below are valid for 2.2m (13 plank) and 2.4m (14 plank) high walls. Walls higher than 2.4m have reduced bracing capacity calculated by multiplying the given value by **f = 2.4 / height**.*

(3) Is a blank section of wall that contain no windows, doors or other openings;

Note: Wall sections used as bracing elements may be part of a longer wall as long as the conditions above are satisfied.

(4) Contains a minimum of two tie rods, one installed within 150mm of each end of the wall section;

(5) Contains a minimum of one aluminium profile within the length of the section;

Note: Bracing capacity given in the tables below are valid for wall sections containing two aluminium profiles. Wall sections with only 1 profile have reduced bracing capacity calculated by multiplying the given value by 0.8.

Tables B.4.1, B.4.2, B.4.3 and B.4.4 below give Bracing Unit Capacities for wall sections meeting the conditions above, for walls containing two or more aluminium profiles.

Table B.4.1 – Bracing capacity table for 44mm internal wall sections, no openings, 2 tie-rods, 2 aluminium profiles

Length [m]	**1.0**	**1.2**	**1.4**	**1.6**	**1.8**	**2.0**	**2.2**	**2.4**	**2.6**	**2.8**	**3.0**
EQ [BU]	*148	*151	154	158	161	165	168	171	175	178	182

Wind [BU]	98	102	106	110	113	117	121	125	129	133	136
Length [m]	**3.2**	**3.4**	**3.6**	**3.8**	**4.0**	**4.2**	**4.4**	**4.6**	**4.8**	**5.0**	**over 5.0**
EQ [BU]	185	188	192	195	199	202	206	209	212	216	216
Wind [BU]	140	144.5	148	152	155	159	163	167	171	175	175

**Note: If placed on a timber-framed floor these values must be reduced to 120 B/U per metre.*

Table B.4.2 – Bracing capacity table for External 107mm wall sections, no openings, 2 tie-rods, 2 aluminium profiles

Length [m]	**1.0**	**1.2**	**1.4**	**1.6**	**1.8**	**2.0**	**2.2**	**2.4**	**2.6**	**2.8**	**3.0**
EQ [BU]	*150	*171	*174	176	179	181	183	186	188	191	193
Wind [BU]	106	111	116	120	125	129	134	138	143	147	152
Length [m]	**3.2**	**3.4**	**3.6**	**3.8**	**4.0**	**4.2**	**4.4**	**4.6**	**4.8**	**5.0**	**over 5.0**
EQ [BU]	196	198	201	203	206	208	210	213	215	218	218
Wind [BU]	157	161	166	170	175	179	184	188	193	198	198

**Note: If placed on a timber-framed floor these values must be reduced to 120 B/U per metre.*

(d) Further information on the lateral stability of Lockwood structures is given in Section C, including testing information and an example Bracing Unit calculations for a typical house design.

B.9. TIE RODS

Section B. Clause 9. TIE RODS. Page B-25. The following text replaces item 3. of sub-part titled "Tie rods shall be provided in the following positions".

3. For each section of wall used in bracing unit calculations, one tie rod shall be installed at each end of the section length, with each tie rod being not more than 150mm from the end of the wall section.

5. FLOOR BEAMS

Design charts are provided for open floor loadings (pages B14 & B15) for both GL8 and GL10 structural grade glulam floor beams. Point loadings and line loadings should be the subject of specific beam designs.

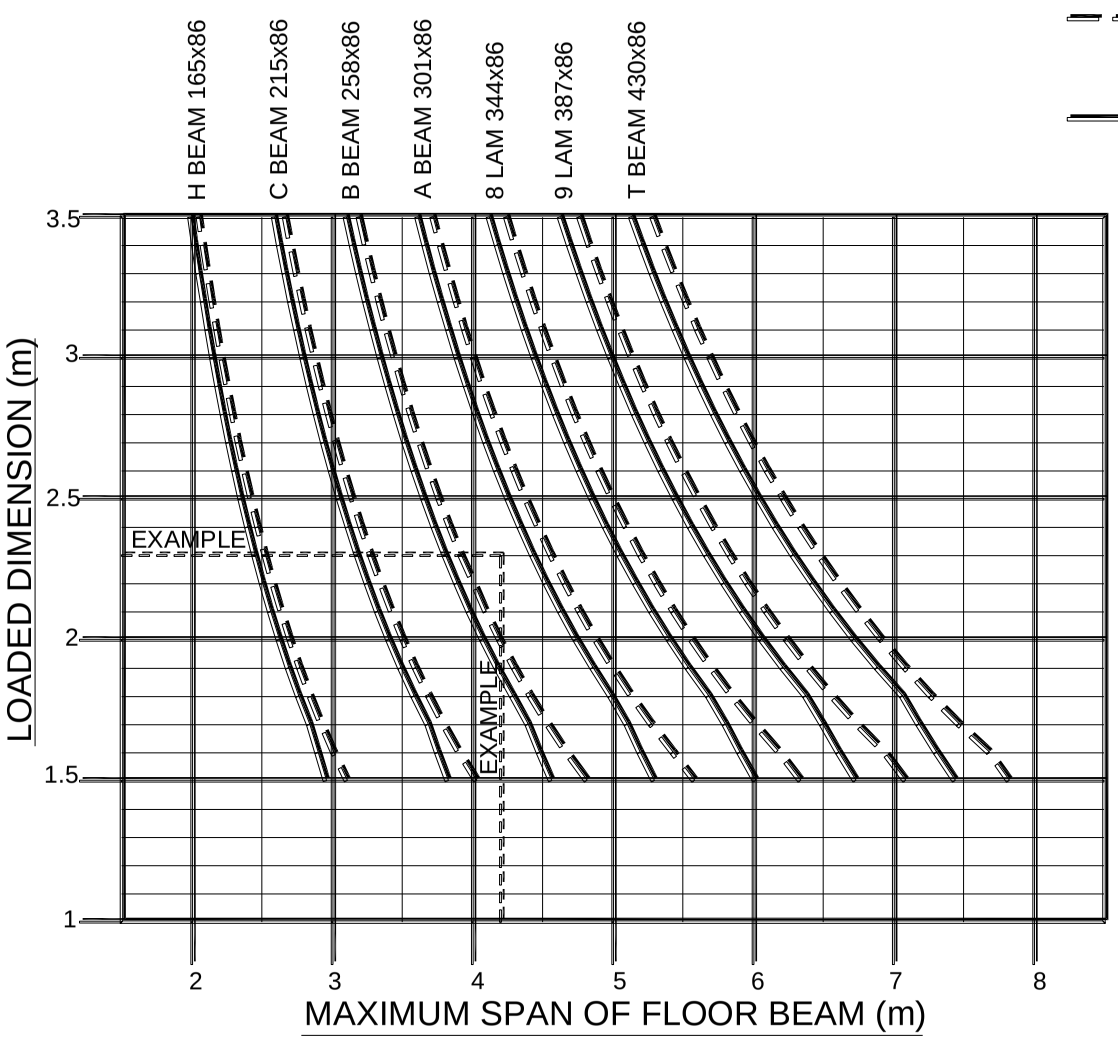
The loadings assumed for design are as follows.

- Basic Live Load Q = 1.5 kPa
- Particle Board floor on joists and 10mm Gib Board ceiling, Dead Load G = 0.4 kPa (represented by solid lines on Design Chart)
- Lockwood 44mm floor planks, Dead Load G = 0.264 kPa (represented by dashed lines on Design Chart)

Structural design of floor beams has been based on structural grade GL8 (page B14) and GL10 (page B15) glulam beams in terms of AS/NZS 1328.1-1998 and using the "Timber Structures Standard", NZS 3603:1993.

Deflection of the floor beams given in the following chart has been limited in line with the criteria recommended for floor beams by AS/NZS 1170.0:2002 "Structural Design Actions, Part O: General Principles". Under this code the long term serviceability limit for mid-span deflection is Span/400.

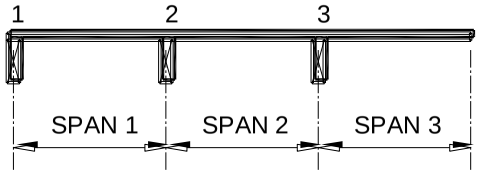
LOCKWOOD FLOOR BEAM SELECTION CHART - GL8 STRUCTURAL GRADE BEAMS



DASHED LINES REPRESENT LOCKWOOD 44mm FLOOR PLANK LOADS (APPROX 0.264 kPa DEAD LOAD)

SOLID LINES REPRESENT PARTICLE BOARD FLOOR ON JOISTS + CEILING LOADS (APPROX 0.4 kPa MAX DEAD LOAD)

DEFINITION OF LOADED DIMENSION



FOR BEAM 1 - LOADED DIM = $\frac{\text{SPAN 1}}{2}$

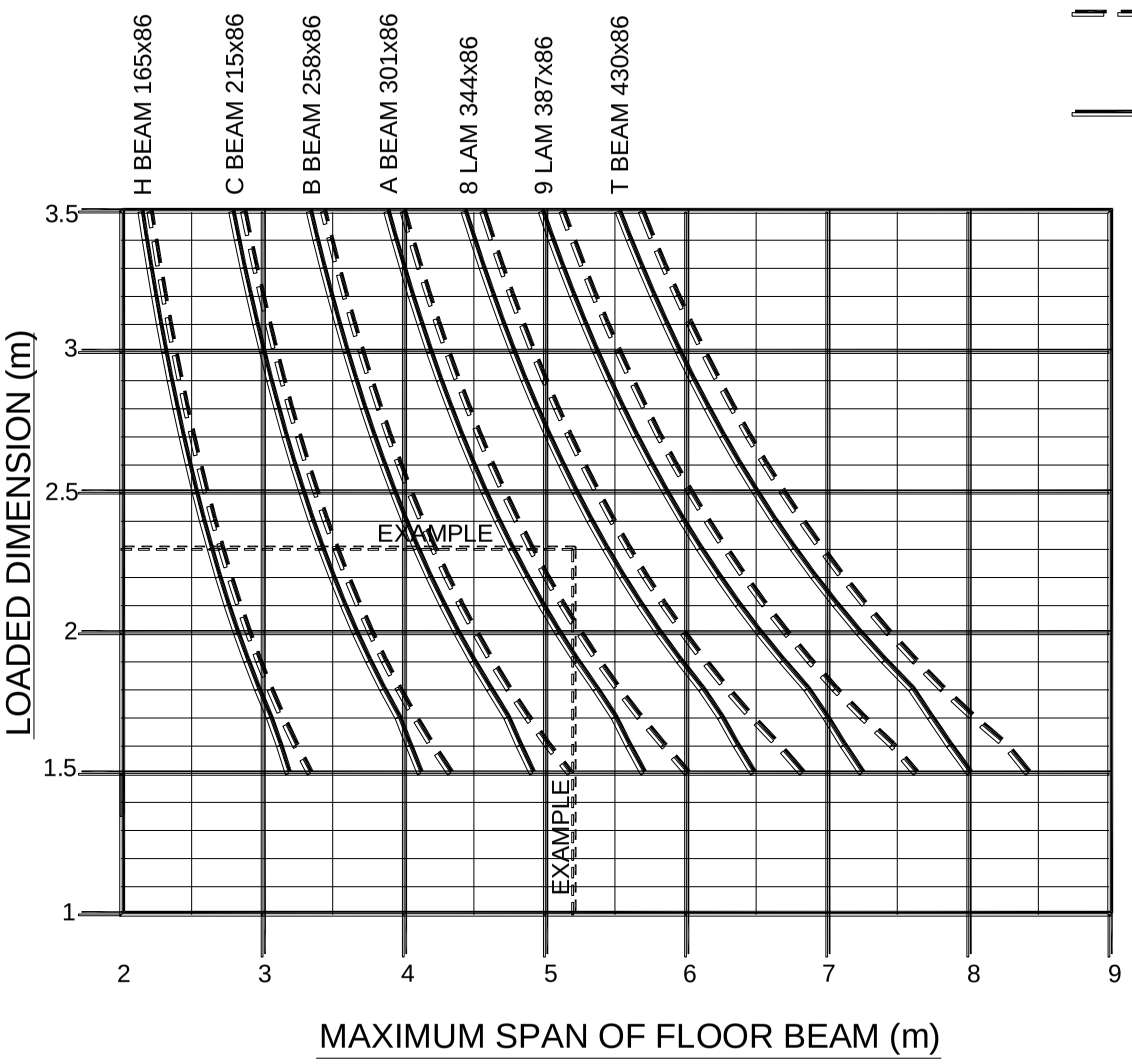
FOR BEAM 2 - LOADED DIM = $\frac{(\text{SPAN 1} + \text{SPAN 2})}{2}$

FOR BEAM 3 - LOADED DIM = $\left(\frac{\text{SPAN 2}}{2}\right)$ + SPAN 3

EXAMPLE

A FLOOR BEAM SPANNING 4.2m SUPPORTING 44mm LOCKWOOD FLOOR BOARDS WITH A LOADED DIMENSION OF 2.3m REQUIRES A 301x86 LAM BEAM (A BEAM)

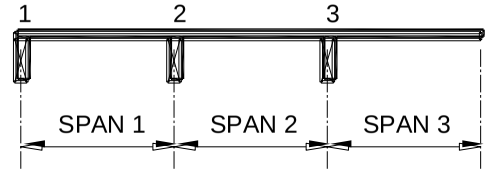
LOCKWOOD FLOOR BEAM SELECTION CHART - GL10 STRUCTURAL GRADE BEAMS



DASHED LINES REPRESENT LOCKWOOD 44mm FLOOR PLANK LOADS (APPROX 0.264 kPa DEAD LOAD)

SOLID LINES REPRESENT PARTICLE BOARD FLOOR ON JOISTS + CEILING LOADS (APPROX 0.4 kPa MAX DEAD LOAD)

DEFINITION OF LOADED DIMENSION



FOR BEAM 1 - LOADED DIM = $\frac{\text{SPAN 1}}{2}$

FOR BEAM 2 - LOADED DIM = $\frac{(\text{SPAN 1} + \text{SPAN 2})}{2}$

FOR BEAM 3 - LOADED DIM = $\left(\frac{\text{SPAN 2}}{2}\right)$ + SPAN 3

EXAMPLE

A FLOOR BEAM SPANNING 5.2m SUPPORTING 44mm LOCKWOOD FLOOR BOARDS WITH A LOADED DIMENSION OF 2.3m REQUIRES A 344x86 LAM BEAM (8 LAM)

6. ROOF BEAMS

A design chart is provided for 35mm sarked roofs, for the standard Lockwood laminated beams, varying spans, spacings and roof pitches (B17).

The loadings assumed for design are 0.25 kPa Live Load and a maximum roof Dead Load of 0.392 kPa. This represents Light Roofing (0.08 kPa maximum), ex 75 x 50 purlins at 900mm c/c, 35mm Lockwood sarking, and either 90 x 45 dummy rafters at 300mm c/c or 140 x 45 dummy rafters at 450mm c/c. Where it is intended to use a Heavy Roof cladding or roof structure heavier than specified above, roof beam design should be the subject of a special design consideration.

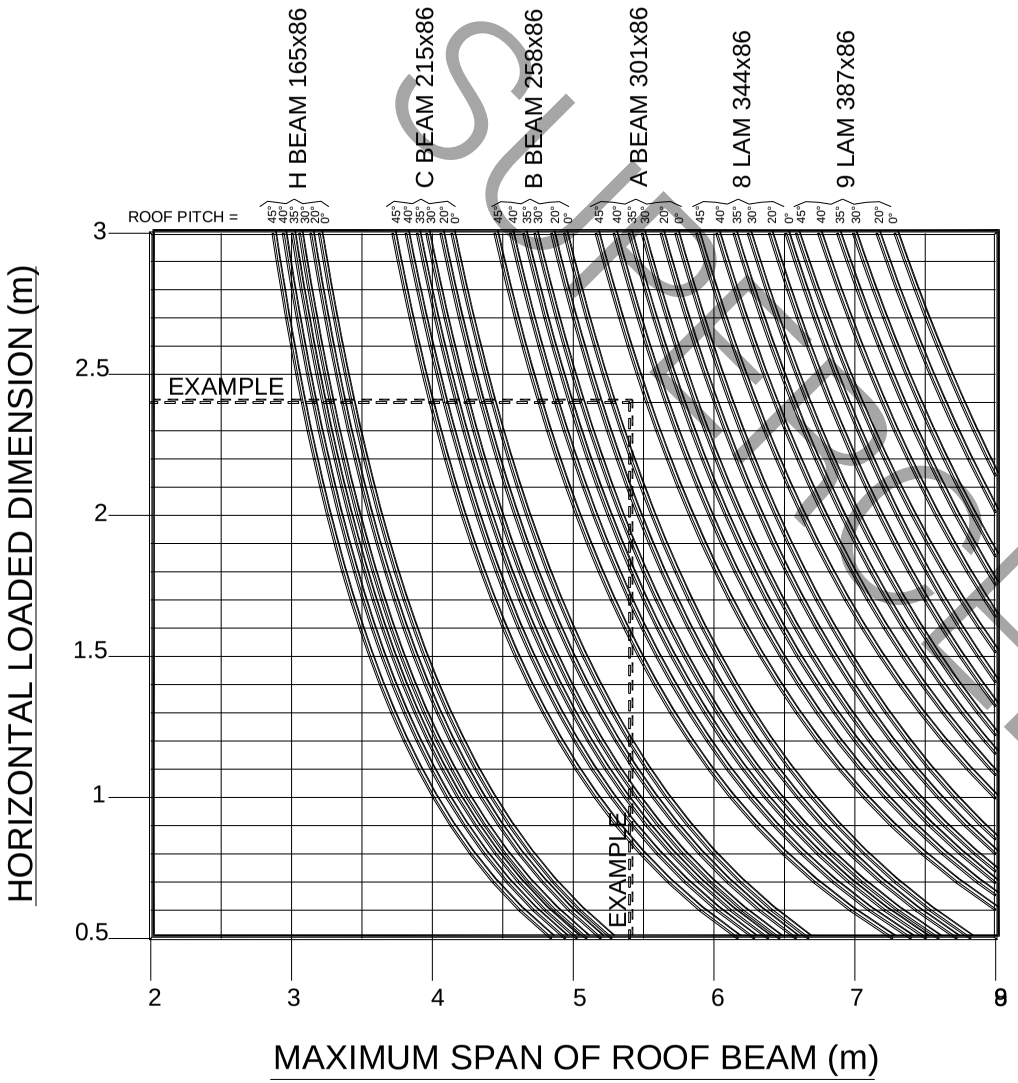
Structural design of roof beams has been based on structural grade GL8 Glulam beams in terms of AS/NZS 1328.1-1998 and using the “Timber Structures Standard”, NZS 3603:1993.

Long term deflection of the roof beams given in the following chart has been limited to the lesser of Span/320 or 25mm maximum. This is within the criteria recommended for roof members by AS/NZS 1170.0:2002, “Structural Design Actions, Part 0 : General Principles”.

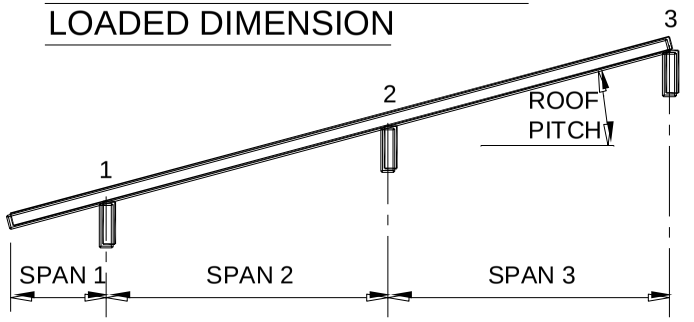
The incorporation of a concrete tile roof increases the dead load of the roof system by approximately 120%. This will result in all beam sizes increasing by at least one laminate. Sarking and lintel spans are also affected. Incorporation of a concrete tile roof should be the subject of a special design consideration.

As deflection limitation controls the design of laminated roof beams, precambering of the beams usually results in smaller member sizes. This procedure is an option for limiting beam sizes in unusually long spans for special designs.

LOCKWOOD ROOF BEAM SELECTION CHART



DEFINITION OF HORIZONTAL LOADED DIMENSION



FOR BEAM 1 - LOADED DIMENSION = $\text{SPAN 1} + \left(\frac{\text{SPAN 2}}{2}\right)$

FOR BEAM 2 - LOADED DIMENSION = $\frac{(\text{SPAN 2} + \text{SPAN 3})}{2}$

FOR BEAM 3 - LOADED DIMENSION = $\frac{\text{SPAN 3}}{2}$

EXAMPLE:

A ROOF BEAM SPANNING 5.4m WITH A LOADED DIMENSION OF 2.4m REQUIRES A 301x86 LAM BEAM (A BEAM)

NOTE: THIS DESIGN CHART HAS BEEN LIMITED TO A MAXIMUM ROOF OF 8m WHICH CORRESPONDS TO A LONG TERM MIDSPAN BEAM DEFLECTION OF 25mm. ROOF BEAMS SPANNING MORE THAN 8m SHOULD BE THE SUBJECT OF A SPECIAL DESIGN

7. DUMMY RAFTERS

(i) DUMMY RAFTER DESIGN

Design charts have been provided for 35mm sarked roofs with 90 x 45 dummy rafters, and for 35mm sarked roofs with 140 x 45 dummy rafters, all dummy rafters to be VSG8 or MSG8 Radiata Pine.

The design charts provided are based on a Light Roof and Very High Wind in terms of NZS 3604:1999 (B20-B21). Where it is intended to use a Heavy Roof cladding or to build within a Specific Engineering Design Wind Area in terms of NZS 3604:1999, dummy rafters should be the subject of a special design consideration.

The maximum dummy rafter spacing is 900mm.

On site the builders must provide continuous temporary rows of support mid-span under sarking for all spans greater than 2.5m, and maintain temporary support until roof fixing is complete.

Sarking deflections should be carefully considered by the designer. Traditionally Lockwood sarked roofs have been designed to limit the long term mid-span deflection to 0.006 x span. Exceeding the 0.006 x span deflection limitation would lead to deflections which may be unacceptable – for example, if it were possible to maintain a line of sight up the roof line.

The 90 x 45 dummy rafter selection chart provided has been designed to limit long term midspan deflections to the 0.006 x span limitation.

For longer spans and where it is desired to further minimise the long term mid-span deflection, a 140 x 45 dummy rafter selection chart has also been provided. This chart has been designed to limit long term deflections to Span/300, (it is felt that for longer spans this tighter deflection limit is appropriate).

(ii) SCREW FIXING OF 90 X 45 DUMMY RAFTERS

The following dummy rafter fixing specification may be used in all wind areas under NZS3604:1999, up to and including Very High Wind, which is the 50 m/s Design Wind Speed.

Special Design wind areas under NZS3604:1999, should be the subject of special design considerations.

(a) SCREWS AND FIXING OF SCREWS

Screws are to be Type 17, 14 gauge x 115mm long, hexagonal washer face, refer Page B22.
6.3mmϕ outside threads.
Class 2 minimum durability rating, or Class 3 or Class 4.

Locate within 200mm of each end of the sarking span and at 1.000m maximum centres along the length of each dummy rafter.

Screw centrally through the 45mm width of the dummy rafter and square to the slope of the roof.

Extreme care must be exercised not to over tighten the screws, as any attempt to over tighten, or to countersink the washer could result in stripping of the timber around the screw threads and a consequential loss of holding power.

The screws shall therefore be tightened until the washer under the head is just snug onto to the top of the dummy rafter.
Care shall be taken, particularly with the first screws, to obtain an optimum torque setting to meet this requirement.

(iii) JOINTS IN 90 X 45 DUMMY RAFTERS

In most situations it is envisaged that all 90 x 45 dummy rafters will be single full length members.

Joints are permissible however near the sarking support lines and the following rules may be applied to help minimise the offcut wastage with respect to positioning of joints in 90 x 45 dummy rafters, refer Page B23):

(a) On any sarking span exceeding 2.300m horizontal span, there shall be no joints in any dummy rafter over the central 70% of the sarking span.
On sarking spans less than 2.300mm, dummy rafters may be joined at any position.

(b) At the end section, (15% of the span at each end), joints shall occur in no more than 50% of the dummy rafters, and joints shall be staggered as much as possible.

On Page B23 we have indicated the central span areas where no joints are permitted in dummy rafters, and the end of sections where joints are permitted, for typical single span and multispan situations.

Each section of each dummy rafter shall be screw fixed as specified in Clause 7(ii) above, i.e. screws within 200mm of each end of each dummy rafter section and at 1.000m maximum centres along the length of each dummy rafter.

(iv) DOUBLE 90 X 45 DUMMY RAFTERS

Where the design chart requires dummy rafters at centers less than 450mm it is permissible to use double dummy rafters at twice the spacing, e.g. instead of 90 x 45 dummy rafters at 300mm centers, can use double 90 x 45 dummy rafters (on edge) at 600mm centers. Double dummy rafters should be nailed together (side by side) with 90 x 3.55mmø FH galvanized nails at 300mm centers.

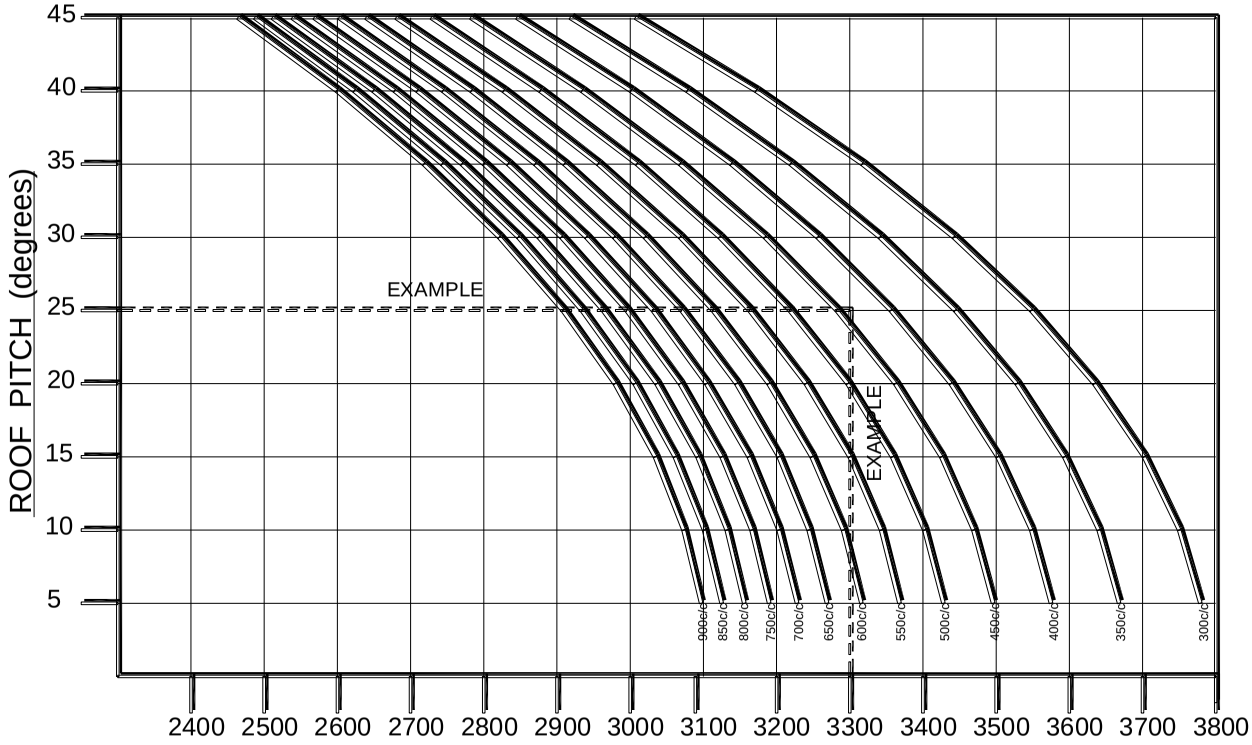
Screw fix double dummy rafters to 35mm sarking centrally through alternate 90 x 45 members along length as Clause 9.1(a), i.e. screws within 200mm of each end of each dummy rafter section and at 1.000m maximum centers along length.

(v) FIXING OF 140 X 45 DUMMY RAFTERS

Ex 150 x 50 dummy rafters to be fixed to sarking with Lumberlok **CPC40** (concealed purlin cleats). Locate cleats within 200mm of each end of sarking spans and at 900mm maximum centres both sides of each dummy rafter.
Each CPC40 cleat to be fixed to rafters with 4 nails (30 x 3.15mmϕ FH galvanised), and to sarking with 2/10 gauge x 30mm wood screws, class 2 minimum durability rating, or class 3 or class 4.

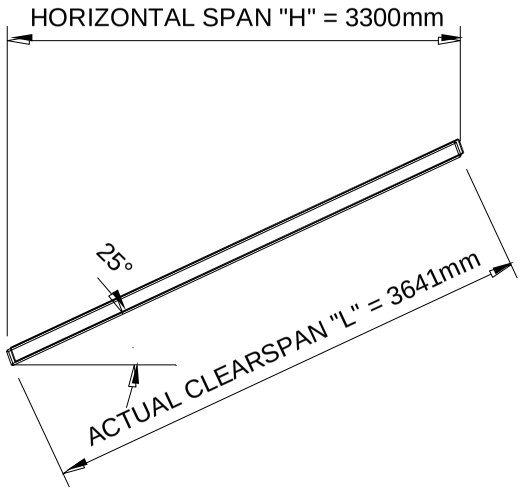
CPC40 cleats may also be used to fix 90 x 45 and double 90 x 45 dummy rafters, as specified above.

90x45 DUMMY RAFTER SELECTION CHART (35mm sarking)



EXAMPLE:

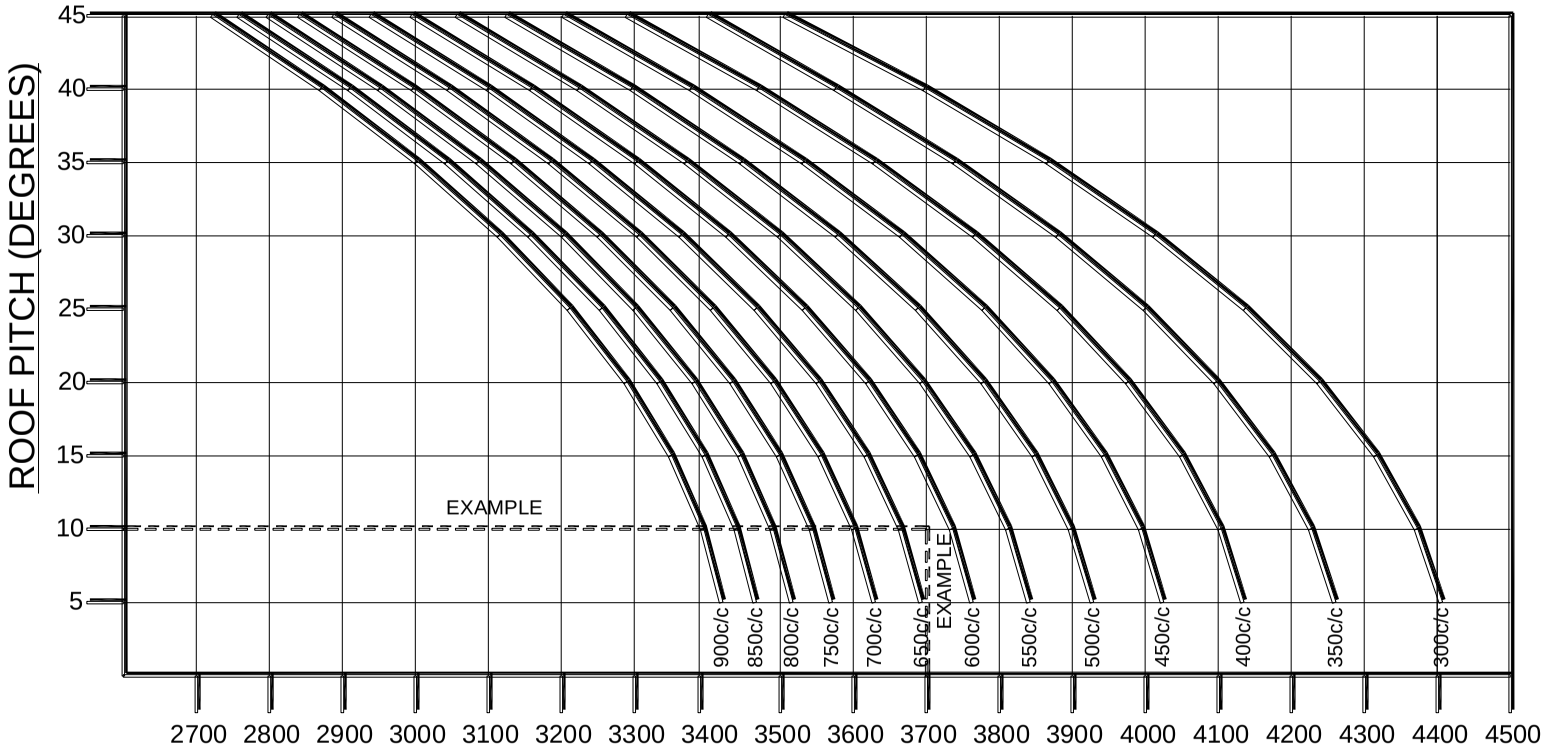
A HORIZONTAL CLEAR SPAN OF 3300mm AT 25° REQUIRES 90x45 DUMMY RAFTERS AT 400mm CRS. MAXIMUM LONG TERM DEFLECTION OF 0.006 L = 21.8mm



NOTE:

DUMMY RAFTER CENTRES ARE TABULATED FOR 90x45, MSG8 OR VSG8, RADIATA PINE DUMMY RAFTERS, AND A LONG TERM DEFLECTION LIMITATION OF 0.006 L $\left(\frac{\text{SPAN}}{167}\right)$

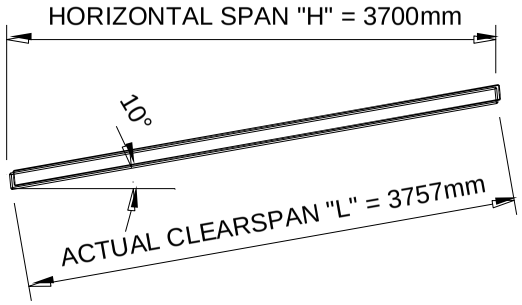
140x45 DUMMY RAFTER SELECTION CHART (35mm SARKING)



HORIZONTAL CLEAR SPAN ``H'' (mm)

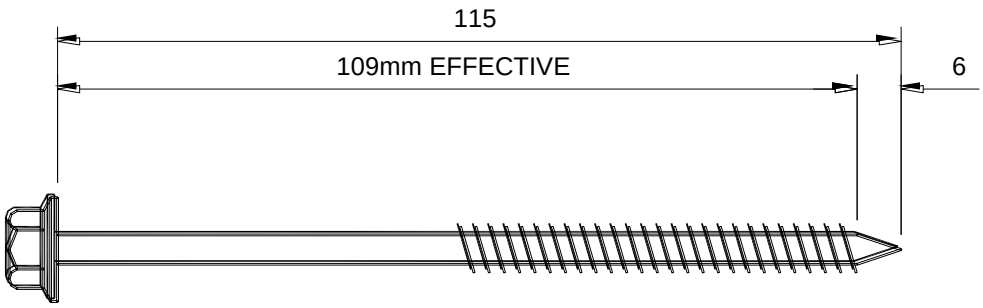
NOTE:

DUMMY RAFTER CENTRES ARE TABULATED FOR 140x45, MSG8 OR VSG8, RADIATA PINE DUMMY RAFTERS, AND A LONG TERM DEFLECTION LIMITATION OF 0.0033L $\left(\frac{\text{SPAN}}{300}\right)$



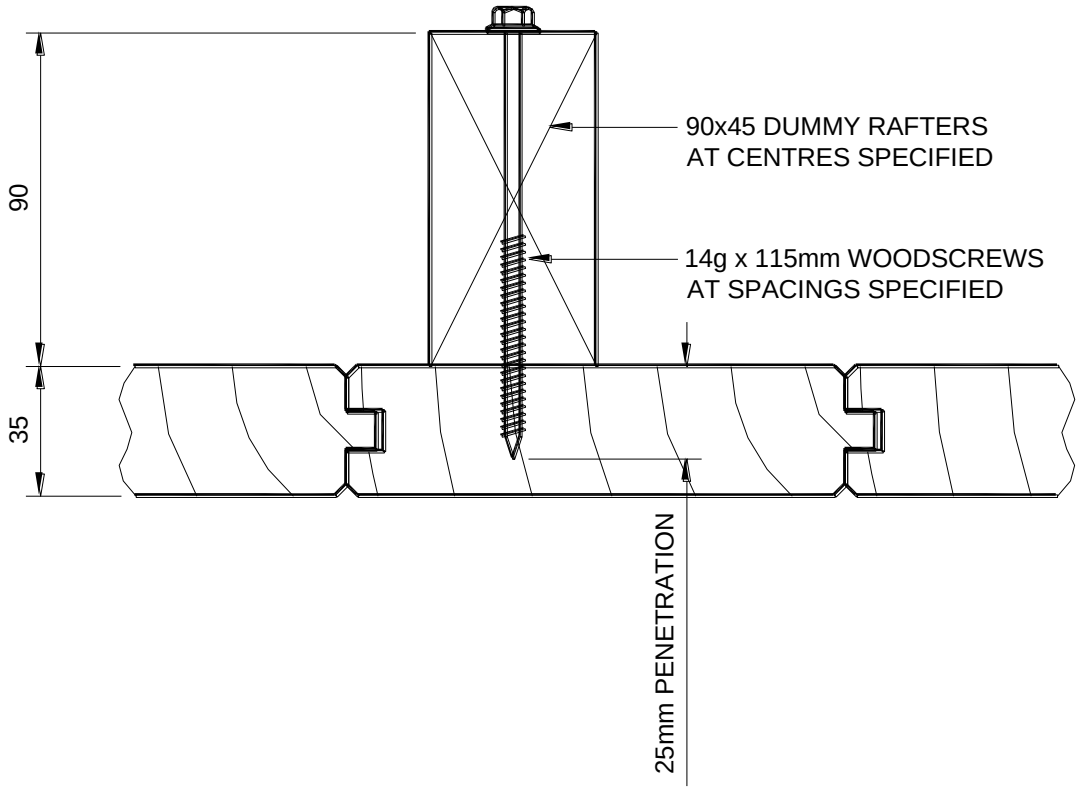
EXAMPLE:

A HORIZONTAL CLEAR SPAN OF 3700mm AT 10° REQUIRES 140x45 DUMMY RAFTERS AT 600mm CRS. MAXIMUM LONG TERM DEFLECTION OF $\frac{\text{SPAN}}{300}$ = 12.5mm

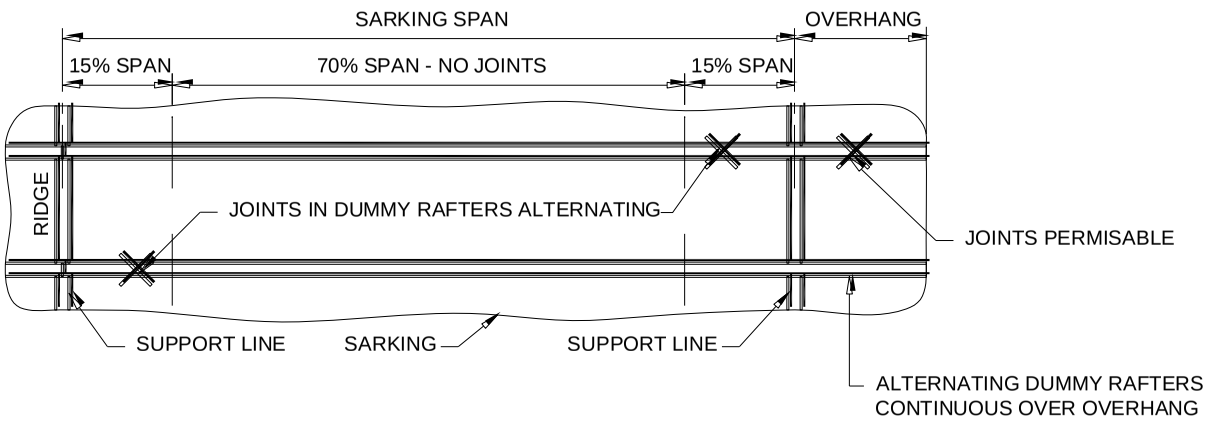


FORTRESS 14g x 115mm 1:1

TYPE 17 HEXAGONAL WASHER FACE

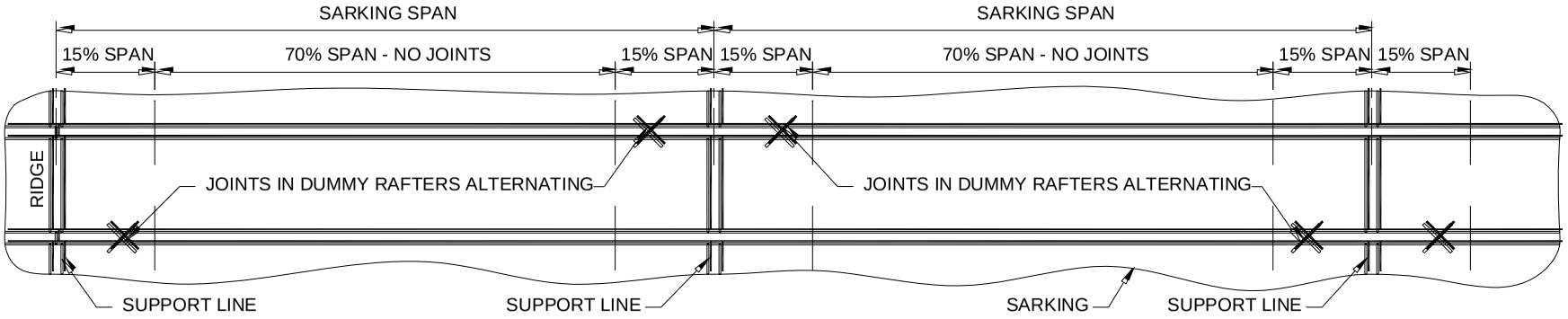


TYPICAL 90x45 DUMMY RAFTER FIXING 1:2



SINGLE SARKING SPAN

JOINTS SHALL OCCUR IN NO MORE THAN
50 % OF THE DUMMY RAFTERS



MULTIPLE SARKING SPANS

JOINTS SHALL OCCUR IN NO MORE THAN
50 % OF THE DUMMY RAFTERS

8. FASCIA BEAM SPANS AND SUPPORT POST FOUNDATION SIZES

The following Table gives maximum fascia beam spans (maximum post spacings) for various sarking spans (supported by the fascia beam) and for different wind zones (in terms of NZS3604:1999).

The maximum post spacings are given based on a standard 235 x 32 Lockwood GL8 Grade laminated fascia beam.

Sarking Span (metres)	Maximum Post Spacing (metres	Design Wind Speed			
		50m/s Very High	44m/s High	37m/s Medium	32m/s Low
1.2	4.200	0.231m^3 (700x700x500)	0.168m^3 (600x600x500)	0.105m^3 (500x500x500)	0.066m^3 (500x500x300)
1.5	4.000	0.278m^3 (700x700x600)	0.203m^3 (600x600x500)	0.127m^3 (500x500x500)	0.081m^3 (500x500x400)
1.8	3.800	0.319m^3 (700x700x700)	0.233m^3 (700x700x500)	0.142m^3 (600x600x400)	0.095m^3 (500x500x400)
2.1	3.600	0.354m^3 (700x700x700)	0.259m^3 (700x700x600)	0.172m^3 (600x600x500)	0.106m^3 (500x500x500)
2.4	3.400	0.386m^3 (800x800x600)	0.283m^3 (700x700x600)	0.184m^3 (600x600x500)	0.119m^3 (500x500x500)
2.7	3.300	0.420m^3 (800x800x700)	0.308m^3 (700x700x700)	0.196m^3 (700x700x400)	0.128m^3 (500x500x500)
3.0	3.200	0.453m^3 (800x800x700)	0.332m^3 (700x700x700)	0.212m^3 (700x700x500)	0.138m^3 (600x600x400)

Note that the concrete volumes shown above assume 20 MPa minimum grade concrete. Normal density 24 kN/m^3. The sizes shown are for the maximum post spacing indicated.

For lesser posts spacings the concrete volumes may be reduced proportionately. For example for the 50m/s design condition, 1.2m sarking span and posts spaced at 2.8m c/c, the volume of concrete at each internal post is given by

$$V = 0.231 \times \frac{2.8}{4.2} m^3 = 0.154 m^3$$

At posts at ends of spans the concrete volumes may be halved.

In the shaded area the fixing at the top of the post on to the 235 x 32 fascia requires two Pryda Multigrips between the post and the back fence of the fascia (above the sarking), in addition to the 2 M10 galvanised bolts. Refer Lockwood Detail D-25.

Alternatively provide 6 nails (100mm x 4ø galv.) through the fascia into the post, in addition to the 2/M10 galvanised bolts.

9. TIE RODS

SCOPE

This section sets out the minimum requirements for tie rods to provide structural tie down and for bracing stability in Lockwood walls, based on the following limitations:
(Designs exceeding these limits should be the subject of specific engineering design.)

- 35mm sarking plus 90 x 45 dummy rafters at 900mm c/c (spans requiring larger dummy rafters or dummy rafters at closer centres to be the subject of specific engineering design).
- A "Light" roof and "Very High Wind", both in terms of NZS 3604:1999.
- Maximum 7.2m roof truss span (no allowance has been made for girder truss point loadings).
- Maximum 0.6m eaves width.
- Maximum 1.5m verandah roof width.
- Maximum 45º roof pitch.

Tie rods shall be provided in the following positions:

1. One tie rod adjacent to each external corner – or one tie rod in the corner profile.

2. One tie rod each side of each b or b repair profile positions.

3. One tie rod at each end of each bracing panel used in bracing unit calculations.
   - double tie rods in special panels, e.g. Panel No. 16 (1.786m ply faced panel).

4. One tie rod adjacent to each exterior wall opening. Spacing not to exceed limits given in Clauses 5 to 10 below (refer also Lintel Design section).

5. On 62mm exterior walls – (sarked roof systems), at 2.7m maximum c/c, or 3.3m maximum c/c where top board stiffened by 140 x 45 E beam (refer Lintel design section for E beam nailing specifications).

6. On 62mm exterior walls – (trussed roof systems), at 2.1m maximum c/c or 2.7m maximum c/c where top two boards bolted together at mid span (maximum 12mmø holes drilled for bolts).

7. On 44mm exterior walls (sarked roof systems), at 2.2m maximum c/c, or 3.2m maximum c/c where the top two boards are nail plated together (refer Lintel design section for nail plate fixing specifications).

8. On 44mm exterior walls (trussed roof systems), at 1.8m maximum c/c, or 2.5m maximum c/c where the top two boards are nail plated together (refer Lintel design section for nail plate fixing specifications), or 2.9m maximum c/c where the top two boards are nail plated together and stiffened by a 145 x 45 lintel stiffening member (refer Lintel design section for E beam nailing specifications).

9. Adjacent to each internal or external post or stiffener which is supporting a roof beam and which is not effectively tied down at roof level by bolting through the mortice and

tenon and at floor level by effective bolting (Lockwood Standard Detail B-19).

10. Internal 44mm walls supporting roof loads, at 2.6m maximum centres.
A 140 x 45 E beam to be provided for fixing of sarking planks. E beam nailed to wall with 75 x 3.15mmø jolt head galvanised nails at 180mm c/c (Maximum), staggered up and down along length. Nail each sarking plank through into top of E beam with 2/100 x 4.0mmø flat head galvanised nails.

11. In any case where the top board of an external side wall (supporting roof loads) is not a complete board or does not fit within the above criteria, the tie rod spacing should be the subject of specific engineering design.

10. LINTEL DESIGN

SCOPE

All lintel design has been based on the following limitations:
(Designs exceeding these limits should be the subject of specific engineering design.)

- 35mm sarking plus 90 x 45 dummy rafters at 900mm c/c (spans requiring larger dummy rafters or dummy rafters at closer centres to be the subject of specific engineering design).
- A "Light" roof and "Very High Wind", both in terms of NZS 3604:1999.
- Maximum 7.2m roof truss span (no allowance has been made for girder truss point loadings).
- Maximum 0.6m eaves width.
- Maximum 1.5m verandah roof width.
- Maximum 45º roof pitch.

A SIDE WALLS – ALL JOINERY EXCLUDING BI-FOLDS

1. 62mm Wall System, Sarked Roof

(a) One board lintel is adequate for clear spans up to 1.866m (2 light windows). Tie rods at a maximum spacing of 2.7m c/c.

(b) One board lintel plus 180 x 45 special E beam is adequate for clear spans up to 2.752m (3 light window).
Tie rods at a maximum spacing of 3.3m.
Top of E beam angle cut to sarking pitch. Nailing 75mm x 3.15mmø jolt head galvanised nails at 200mm c/c staggered.

2. 62mm Wall System, Trussed Roof

(a) A one board lintel is adequate for clear spans up to 1.866m (2 light window). Tie roads at a maximum spacing of 2.1m.

(b) A two board lintel (bolted) plus 140 x 45 E beam is adequate for clear spans up to 2.752m (3 light window).
Tie rods at a maximum spacing of 3.1m c/c.
Bolting – one M10 galvanised bolt centrally on lintel span. Holes drilled 12mm maximum diameter.
140 x 45 E beam nailed to wall boards with 90 x 3.55ø jolt head galvanised nails at 200mm c/c staggered.

3. 44mm Wall System, Sarked Roof

(a) One board lintel is adequate for clear spans up to 1.866m (2 light window). Tie rods at a maximum spacing of 2.2m c/c.

(b) A two board lintel, nail plated together is adequate for clear spans up to 2.752m (3 light window).

Tie rods at a maximum spacing of 3.2m.
Under each truss on exterior face of 44mm wall boards provide a 6N10 (190mm x 76mm) Pryda knuckle nail plate centrally over the joint between the top two boards (190mm dimension oriented vertically).

4. 44mm Wall System, Trussed Roof

(a) A two board lintel nail plated together is adequate for clear spans up to 1.866m (2 light window).
Tie rods at a maximum spacing of 2.5m.
Nail plating as 3(b) above.

(b) A two board lintel nail plated together (as 3(b) above), plus a 190 x 45 lintel stiffening is adequate for clear spans up to 2.752m (3 light window).
Tie rods at a maximum spacing of 3.1m c/c.

Ex 200 x 50 (190 x 45 finished dimension), VSG8 or MSG8 Structural Grade (minimum) Radiata Pine, within batten space. Ex 200 x 50 nailed to 14th board hard up under top plate with 75 x 3.15mmø FH galvanised nails at 120mm c/c staggered up and down along length.
Nail through top plate into top of ex 200 x 50 with 100 x 4.0mmø FH galvanised nails at 300mm c/c.

B END WALLS AND GABLE END WALLS – ALL JOINERY EXCLUDING BI-FOLDS

62mm and 44mm wall systems, sarked and trussed roofs.

(a) Point loads from beams the subject of special consideration.

(b) A one board (minimum) lintel is adequate for clear spans up to 2.752m. Tie rods at a maximum spacing of 3.0m c/c.

(c) A two board (minimum) lintel is adequate for clear spans up to 3.070m. Tie rods at a maximum spacing of 3.200m c/c
44mm wall boards to be nail plated together at 1.2m maximum centres (similar to A 3(b) above).
62mm wall boards to be bolted (as in A 2(b) above)

(d) A five board minimum lintel is adequate for clear spans up to 4.00m.
All 44mm wall boards to be nail plated together at 1.2m maximum centres (similar to A 3(b) above).
62mm wall boards to be bolted (as in A 2(b) above)

C SIDE WALLS – BIFOLD JOINERY

Note: All lintel flitch plate options as given below to be the subject of specific engineering design and detailing

1. 62mm Wall System, Sarked Roof

(a) One board lintel is adequate for clear spans up to 1.570m (FB doors).
Tie rods at a maximum spacing of 2.7m.

(b) One board lintel plus 140 x 45 E beam is adequate for clear spans up to 1.866m (2 light windows).
Tie rods at a maximum spacing of 2.7m c/c.
Top of E beam angle cut to sarking patch. Nailing 75mm x 3.15mmø JH galvanised nails at 200mm c/c staggered.

(c) One board lintel plus ex 250 x 50 special E beam plus 130mm x 6mm steel plate screw fixed to the inside face of 62mm top board, is adequate for clear spans up to 2.752m.
Tie rods at a maximum spacing of 3.1m c/c.

(d) One board lintel plus ex 250 x 50 special E beam plus 150mm x 10mm steel plate screw fixed to the inside face of the 62mm top board is adequate for clear spans up to 3.07m.
Tie rods at a maximum spacing of 3.4m c/c.

2. 62mm Wall System, Trussed Roof

(a) A two board lintel Bolted together at mid-span (as A2(b)) is adequate for clear spans up to 1.866m.
Tie rods at a maximum spacing of 2.6m c/c.

(b) A two board lintel plus 240 x 45 E Beam is adequate for clear spans up to 2.370m (FB3 doors).
Tie rods at a maximum spacing of 2.6m c/c.
Top of E beam angle cut to sarking patch. Nailing 75mm x 3.15mmø JH galvanised nails at 200mm c/c staggered.

(c) A two board lintel bolted together at mid-span (as A2(b)) and stiffened by an ex 300 x 50 (290 x 45 finished dimension) special E beam nailed to the top boards, is adequate for clear spans up to 2.752m (3 light window).
Tie rods at a maximum spacing of 3.1m.
290 x 45 E beam nailed to wall boards with 90 x 3.55mmø JH galvanised nails at 300mm c/c top and bottom.

3. 44mm Wall System, Sarked Roof

(a) A two board lintel nail plated together (as in A 3(b) above), plus a 140 x 45 lintel stiffening is adequate for clear spans up to 1.866 (2 light window).
Tie rods at a maximum spacing of 3.2 c/c.

Ex 150 x 50 (140 x 45 finished dimension), VSG8 or MSG8 Structural Grade (minimum) Radiata Pine lintel stiffening, within batten space. 140 x 45 nailed to 14th board hard up under top plate with 75 x 3.15mmø FH galvanised nails at 120mm c/c staggered up and down along length.
Nail through top plate into top of ex 150 x 50 with 100 x 4.0mmø FH galvanised nails at 300mm c/c.

(b) A two board lintel nail plated together (as in A 3(b) above), plus a 240 x 45 lintel stiffening is adequate for clear spans up to 2.752m (3 light window).
Tie rods at a maximum spacing of 3.9m c/c.
Ex 250 x 50 (240 x 45 finished dimension), VSG8 or MSG8 Structural Grade (minimum) Radiata Pine lintel stiffening within batten space (nailed to boards as in C 3(a) above).

(c) A two board lintel nail plated together (as in A 3(b) above), plus a 290 x 45 lintel stiffening is adequate for clear spans up to 3.07m (FB4 doors).
Tie rods at a maximum spacing of 3.9m c/c.
Ex 300 x 50 (290 x 45 finished dimension), VSG8 or MSG8 Structural Grade (minimum) Radiata Pine lintel stiffening within batten space (nailed to boards as in C 3(a) above).

4. <u>44mm Wall System, Trussed Roof</u>

(a) A two board lintel nail plated together (as in A3 (b)) is adequate for clear spans up to 1.866m (2 light window).
Tie rods at a maximum spacing of 2.5m c/c.

(b) A two board lintel nail plated together (as A3 (b) above), plus a 240 x 45 lintel stiffening is adequate for clear spans up to 2.320m (FB3 doors).
Tie rods at a maximum spacing of 2.6m c/c.

Ex 250 x 50 (240 x 45 finished dimension), VSG8 or MSG8 Structural Grade (minimum) Radiata Pine, within batten space. Ex 250 x 50 nailed to 14th board hard up under top plate with 75 x 3.15mmø FH galvanised nails at 120mm c/c staggered up and down along length.
Nail through top plate into top of ex 250 x 50 with 100 x 4.0mmø FH galvanised nails at 300mm c/c.

(c) A two board lintel nail plated together (as in A3 (b) above), plus a 290 x 45 lintel stiffening is adequate for clear spans up to 2.752m (3 light window).
Tie rods at a maximum spacing of 3.2m c/c.
Ex 300 x 50 (290 x 45 finished dimension), VSG8 or MSG8 Structural Grade (minimum) Radiata Pine within batten space.
Ex 300 x 50 nailed to boards hard up against top plate, with 75 x 3.15mmø FH galvanised nails at 240mm c/c along length, top and bottom.
Nail through top plate into top of ex 300 x 50 with 100 x 4.0mmø FH galvanised nails at 300mm c/c.

5. END WALLS AND GABLE END WALLS – BIFOLD JOINERY

62mm and 44mm wall systems, sarked and trussed roofs.

(a) Point loads from beams the subject of special consideration.

(b) A one board (minimum) lintel is adequate for clear spans up to 1.866m. Tie rods at a maximum spacing of 2.6m c/c.

(c) A two board (minimum) lintel is adequate for clear spans up to 2.752m. Tie rods at a maximum spacing of 3.200m c/c.
44mm wall boards to be nail plated together at 1.2m maximum centres (similar to A 3(b) above).
62mm wall boards to be bolted (as in A 2(b) above)

(d) A five board minimum lintel is adequate for clear spans up to 4.00m.
All 44mm wall boards to be nail plated together at 1.2m maximum centres (similar to A 3(b) above).
62mm wall boards to be bolted (as in A 2(b) above)

10.1 SOLID 97mm & 107mm BOARD LINTELS

DESCRIPTION

There are three types of solid top boards, a pine board, an aluminium clad board and a cedar clad board.
All board types are vertically laminated Radiata Pine. All laminates are machine stress graded to ensure that a minimum modulus of elasticity of 8.0GPa is achieved.

SCOPE

All lintel design has been based on the following limitations:
(Designs exceeding these limits should be the subject of specific engineering design).

(a) SARKED HIP OR GABLE ROOF (REFER TABLE 1)

- 35mm sarked roof with either 90 x45 or 140 x 45 dummy rafters
- Maximum 25 degree roof pitch
- A maximum horizontal sarking span supported by lintel of 3.2m and a maximum 0.6m eaves width (2.2m loaded horizontal dimension)
- A “light” roof and “Very High Wind” in terms of NZS 3604:1999.

(b) TRUSSED ROOF (REFER TABLE 2)

- A “light” roof and “Very High Wind” in terms of NZS 3604:1999
- Maximum 25 degree roof pitch
- Maximum 7.2m roof truss span (no girder truss point loads)
- Maximum 0.6m eaves width

TABLE 1: SARKED HIP OR GABLE ROOF

The following table gives lintel types required for Lockwood sarked roofs when using solid 97mm or solid 107mm top boards, for selected opening sizes and subject to limitations given in scope 10.1 (a) above.

JOINERY OPENING (mm)	**SOLID 97mm or 107mm TOP BOARD LINTEL**
ALL JOINERY EXCLUDING BI-FOLDS	
1866	1 Board
2752	1 Board
3710	1 Board + Ex 190 x 45 E-beam
BI-FOLD JOINERY	
2320	1 Board
2752	1 Board + Ex 190 x 45 E-Beam
3070	1 Board + 130 x 10mm FL*

* FL stands for mild steel flat plate (flitched top board lintel).

TABLE 2: TRUSSED ROOF

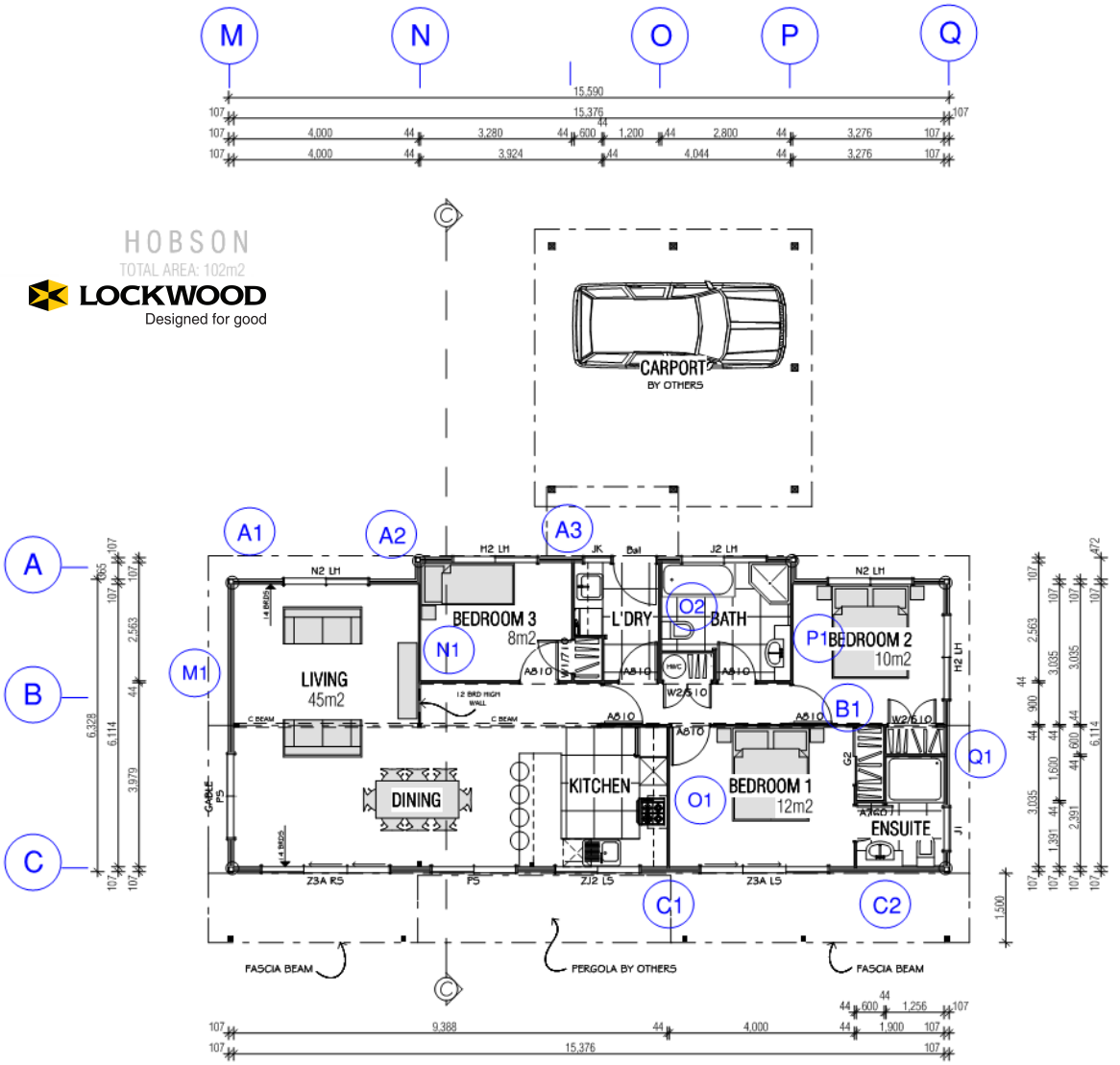
The following table gives lintel types required for trussed roofs when using solid 97mm or solid 107mm top boards, for selected opening sizes and subject to limitations given in scope 10.1 (b) above.

JOINERY OPENING (mm)	SOLID 97mm or 107mm TOP BOARD
ALL JOINERY EXLUDING BI-FOLDS	
1866	1 Board
2752	1 Board
3710	1 Board + Ex 130 x 10mm FL*
BI-FOLD JOINERY	
2320	1 Board + Ex 190 x 45 E-beam
2752	1 Board + Ex 130 x 10 FL*
3070	1 Board + Ex 150 x 10mm FL*

* FL stands for mild steel flat plate (flitched top board lintel).

11. EXAMPLE BRACING CALCULATION

Name:	Hobson (example)
Location of Story:	Single
Building height to apex:	4.0m
Stud height:	2.4m
Roof height above eaves:	1.4m
Gross Area:	102 m^2
Average roof pitch:	20 deg
Building length:	15.6m
Building width:	6.5m
Floor type:	Concrete Slab
Wind zone:	High
EQ zone:	3
Soil Type:	D/E



BRACING EXAMPLES

LOCKWOOD WALL BRACING CALCULATION SHEET ALONG

Bracing line			Bracing elements provided					Bracing Achieved			
Line Label	Min B/U's Required (Wind)	Min B/U's Required (EQ)	Bracing Element No	Wall Type	Floor Type	No. of Aluminium Profiles	Wall Section Length (m)	B/U Wind Achieved	B/U E/Q Achieved	Line B/Us Achieved (Wind)	Line B/Us Achieved (EQ)
A	234	234	A1	External 107mm	Concrete	One	1.0	84.8	120	276	390
			A2	External 107mm	Concrete	One	1.0	84.8	120		
			A3	External 107mm	Concrete	Two or more	1.0	106	150		
B	100	102	B1	Internal 44mm	Concrete	Two or more	3.6	148	192	148	192
C	234	234	C1	External 107mm	Concrete	Two or more	1.2	111	171	249	357
			C2	External 107mm	Concrete	Two or more	2.4	138	186		
D										0	0
E										0	0
Total B/U Achieved										673	939
From Sheet A Total B/U Required										380	612

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Further bracing information

LOCKWOOD WALL BRACING CALCULATION SHEET ACROSS

Bracing line			Bracing elements provided						Bracing Achieved			
Line Label	Min B/U's Required (Wind)	Min B/U's Required (EQ)	Bracing Element No	Wall Type	Floor Type	No. of Aluminium Profiles	Wall height (planks)	Wall Section Length (m)	B/U Wind Achieved	B/U E/Q Achieved	Line B/Us Achieved (Wind)	Line B/Us Achieved (EQ)
M	100	100	M1	External 107mm	Concrete	Two or more	13	3.6	166.0	201	166	201
N	100	100	N1	Internal 44mm	Concrete	Two or more	13	3.0	136.0	182	136	182
O	100	100	O1	Internal 44mm	Concrete	Two or more	13	3.0	136.0	182	261	353
			O2	Internal 44mm	Concrete	Two or more	13	2.4	125.0	171		
P	100	100	P1	Internal 44mm	Concrete	Two or more	13	2.0	117.0	165	117	165
Q	100	100	Q1	External 107mm	Concrete	Two or more	13	2.2	134.0	183	134	183
Total B/U Achieved											814	1084
From Sheet A Total B/U Required											811	612

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Internal 44mm	Concrete	One	Single	Light	Light	Yes
External 107mm	Timber	Two or more	Upper of two	Heavy	Medium	No
			Lower of two		Heavy	

Wall Type	Floor Type			Length (m)																		
				1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.8	3	3.2	3.4	3.6	3.8	4	4.2	4.4	4.6	4.8	5
Internal 44mm	Concrete	EQ	Internal 44mmConcreteEQ	148	151	154	158	161	165	168	171	175	178	182	185	188	192	195	199	202	206	209	212	216
Internal 44mm	Concrete	Wind	Internal 44mmConcreteWind	98	102	106	110	113	117	121	125	129	133	136	140	144.5	148	152	155	159	163	167	171	175
External 107mm	Concrete	EQ	External 107mmConcreteEQ	**150**	171	174	176	179	181	183	186	188	191	193	196	198	201	203	206	208	210	213	215	218
External 107mm	Concrete	Wind	External 107mmConcreteWind	106	111	116	120	125	129	134	138	143	147	152	157	161	166	170	175	179	184	188	193	198
Internal 44mm	Timber	EQ	Internal 44mmTimberEQ	**120**	**144**	154	158	161	165	168	171	175	178	182	185	188	192	195	199	202	206	209	212	216
Internal 44mm	Timber	Wind	Internal 44mmTimberWind	98	102	106	110	113	117	121	125	129	133	136	140	144.5	148	152	155	159	163	167	171	175
External 107mm	Timber	EQ	External 107mmTimberEQ	**120**	**144**	**168**	176	179	181	183	186	188	191	193	196	198	201	203	206	208	210	213	215	218
External 107mm	Timber	Wind	External 107mmTimberWind	106	111	116	120	125	129	134	138	143	147	152	157	161	166	170	175	179	184	188	193	198

Profile count	Factor
One	0.8
Two or more	1.0

Wall height	Factor
13	1.00
14	1.00
15	0.93
16	0.87
17	0.82
18	0.78
19	0.73
20	0.70
21	0.66

12. 107 insulated wall board structural performance

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18 February 2013

Lockwood Group
Private Bag RO3034
ROTORUA

Attention: Mr David Mac Farlane

Dear Sir

RE: LOCKWOOD 107mm INSULATED WALL BOARD

OUR REF: 19175

As requested, we provide below a brief summary of the Lockwood Insulated Wall Board in relation to its structural performance.

1. DESCRIPTION OF THE LOCKWOOD INSULATED BOARD

The Lockwood Insulated Wall Board originally consisted of two 33mm to 39mm boards spaced apart 25mm by the incorporation of two 7mm ply spacers. Resulting in a 97mm wide profile.

The increase in width over the Lockwood 62mm exterior board, and the spacing, provide insulation advantages in comparison to the solid 62mm Lockwood board.

Recently the plywood spacers have been increased in width to provide a 35mm space for insulation, resulting in a 107mm wide profile.

The 7mm ply spacers are exterior grade construction ply and are pressed into matching cuts machined into the solid boards, and glued with Resorcinol Glue.

2. STRUCTURAL PERFORMANCE OF LOCKWOOD INSULATED BOARD

At the inception of the Lockwood 97mm Insulated Wall Board, a series of tests were carried out to determine the structural characteristics of the system.

These test included:

(a) Bend tests on Lockwood 97mm Insulated Wall Boards.
(b) Corner profile tests.
(c) Bracing panel tests.
(d) Compressive load tests.
(e) Beam connection tests.
(f) Tensile, vertical shear and horizontal shear tests.

Throughout this testing it was found that the structural performance of the Lockwood 97mm Insulated Wall Board system exceeded that of the Lockwood

62mm board system in all respects. On this basis it is therefore a reasonable approach to use the 62mm Lockwood Board Structural Handbook (April 2006) for design purposes.

No further testing has been carried out on the new 107mm boards. However, as there has been no change in the overall dimensions of the solid timber components it is believed that the 10mm increase in width will not have a detrimental effect on the structural performance of this system.

3. CODE COMPLIANCE

Both the Lockwood 97mm Insulated Wall Board system and the 62mm board system have been tested in strict accordance with the verification method B1/VM1 of The New Zealand Building Code Handbook.

4. SUMMARY

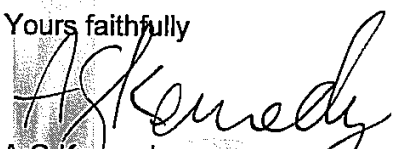
Testing of the Lockwood 97mm Insulated Wall Board has verified that the structural performance of this system (and therefore the 107mm system also) is at least as good as the Lockwood 62mm board system.

We therefore advise that the design of structures using the 97mm or 107mm Lockwood insulated board should comply with the requirements contained in the Lockwood Structural Handbook (April 2006), for the 62mm board system. All reference to "62mm board system" can be directly replaced with "Lockwood 97mm or 107mm Insulated Wall Board system".

Providing the Structural Handbook is used correctly, resulting designs will comply with the requirements of Clause B1 Structure of The New Zealand Building Code.

Please advise if we can assist further in this matter.

Yours faithfully



A G Kennedy
BE, MIPENZ(Structural), CPEng
BSK CONSULTING ENGINEERS LTD

LOCKWOOD
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Appendix A

Addendum 1

Top plate fixings for trussed roofs
Date: 05/05/20166
as supplied by BSK Consulting Engineers Ltd

Full engineer documentation available on request

TOP PLATE FIXING TO LOCKWOOD TOP BOARD FOR TRUSSED ROOFS

As requested we have completed the structural design work, and provide below our report.

1. BRIEF

We have been requested to provide minimum top plate fixing requirements onto exterior Lockwood walls for 20 degree and 25 degree trussed roofs with truss spans up to 8.0m (both hip and gable type roofs).

2. DESIGN BASIS (ASSUMPTIONS)

All structural design has been based on the following:

- Extra High Wind in terms of NZS 3604:2011
- Top Plates to be fixed onto a full (172mm) solid Lockwood top board
- Assumed 90 x 45 or 140 x 45 top plates (minimum 40mm finished thickness)
- Proprietary roof trusses at 900mm crs
- Roof truss to top plate fixings to be as specified by truss designer
- This guideline is based on the analysis of a simple rectangular plan, no allowance has been made for girder truss load.

3. TOP PLATE FIXINGS

90 x 45 or 140 x 45 top plates to be fixed to top of Lockwood walls with 90 x 3.15mmϕ galvanised nails at 300mm centres centrally into top board.

Also provide M10 x 160(minimum) galvanised coach screws with 50 x 50 x 3mm galvanised washers adjacent to each roof truss centrally into top board (100mm max from truss).

- **Where uplift load at individual truss supports exceeds 7.6kN (refer truss manufacturer report for uplift loads) specific design is required for top plate fixing. In this instance special care should be taken to ensure adequate tie down is provided via tie rods through to foundations.**

- **Where uplift load at individual supports is less than or equal to 3.0kN (refer truss manufacturer report for uplift loads) 14 gauge x 110mm type 17 hex washer head screws may be used in place of the above specified 160mm (minimum) coach screws**.

Joints in top plates as Standard Lockwood Detail 4-270-C (2 / Pryda MP4R5 knuckle nail plates).

Note: All work shall comply with the New Zealand Building Code, NZS3604:2011, Standard Lockwood Details and Structural Handbook where not specifically covered in this report.

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Appendix B

Addendum 2

Laminated double 107mm solid board lintel span chart
Date: 22/08/2017
as supplied by BSK Consulting Engineers Ltd

Full engineer documentation available on request

RE: LAMINATED DOUBLE 107mm SOLID BOARD LINTEL SPAN CHARTS

As requested we have calculated recommended maximum spans for the proposed laminated double board lintel and provide the following span charts.

CHART # 1 – Sarked Roof + Standard Joinery
CHART # 2 – Sarked Roof + Bi-Fold Joinery
CHART # 3 – Trussed Roof Max High Wind + Standard Joinery
CHART # 4 – Trussed Roof Max Very High Wind + Standard Joinery
CHART # 5 – Trussed Roof Max Extra High Wind + Standard Joinery
CHART # 6 – Trussed Roof Max Extra High Wind + Bi-Fold Joinery

1. LINTEL DEFLECTION LIMITS

These charts have been based on the following calculated long term deflection limits (Mid Span)

STANDARD JOINERY - A maximum long term deflection of 6mm
BI-FOLD JOINERY - A maximum long term deflection of 3mm

A maximum deflection limit of 12mm has been used for wind uplift loads (all joinery types).

2. DESIGN LOADS

Design loads have been calculated based on standard Lockwood details and the assumption of "light" roof cladding.

All structural design has been based on the following standards:

AS/NZS1170 "Structural Design Actions", NZS3603:1993 (including Amendment No.4), "Timber Structures Standard", NZS3604:1999 "Timber Framed Buildings", NZS3606: 1987 "Specification for the Manufacture of Glue Laminated Timber", and AS/NZS1328/1998, "Glue Laminated Structural Timber".

Note: No allowance has been made for snow loads. Where potential snow loads are present these should be checked by an Engineer.

3. LAMINATED DOUBLE 107mm SOLID BOARD LINTELS.

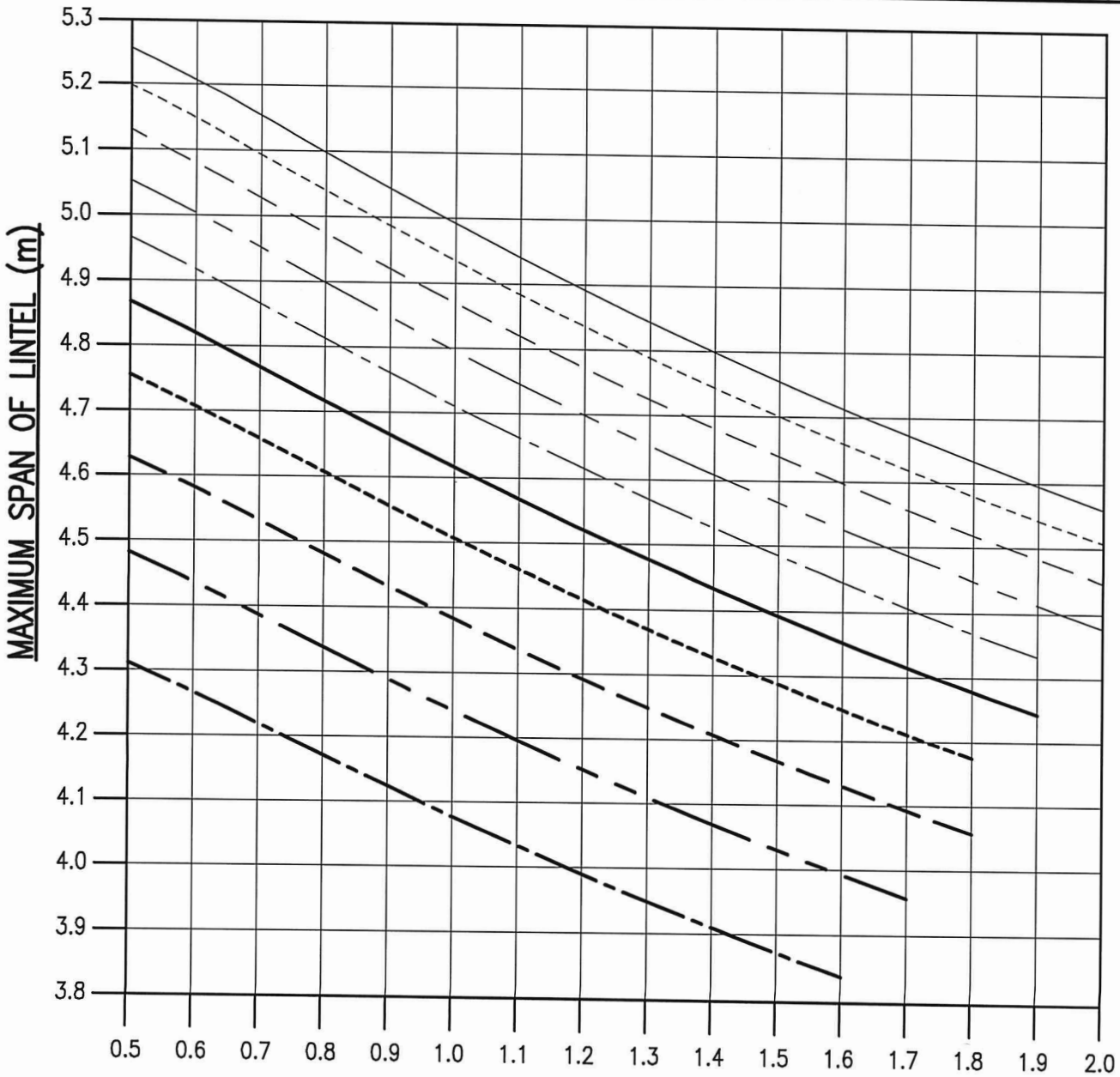
Laminated double board lintels are to be 107mm wide x 344mm (cover) and minimum GL8 structural grade in terms of AS/NZS1328.1-1998.

Lintel boards to extend a minimum of 150mm past joinery opening each end. Provide tie rods both sides of joinery openings as lintel uplift restraints for all cases.

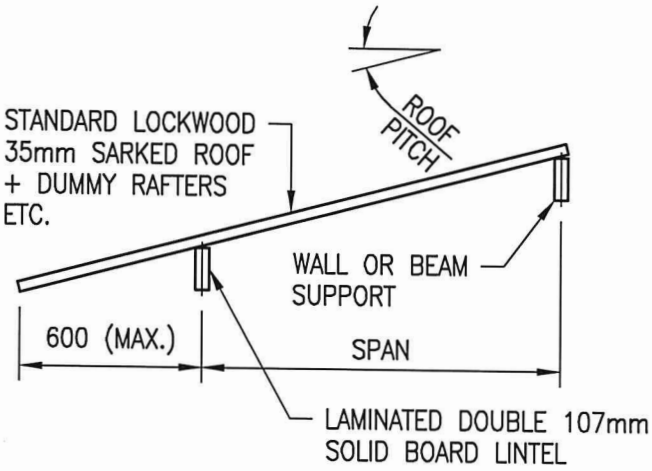
Note: All work shall comply with the New Zealand Building Code, NZS3604:2011, Standard Lockwood Details and Structural Handbook where not specifically covered in this report.

CHART#1 – SARKED ROOF WITH STANDARD JOINERY

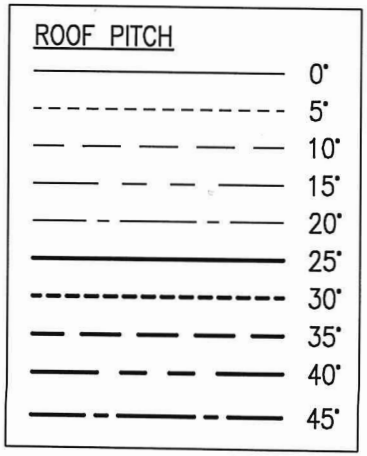
LAMINATED DOUBLE 107mm SOLID BOARD LINTEL SPAN CHART



DEFINITION OF HORIZONTAL LOADED DIMENSION



HORIZONTAL LOADED DIMENSION = ($\frac{SPAN}{2}$)



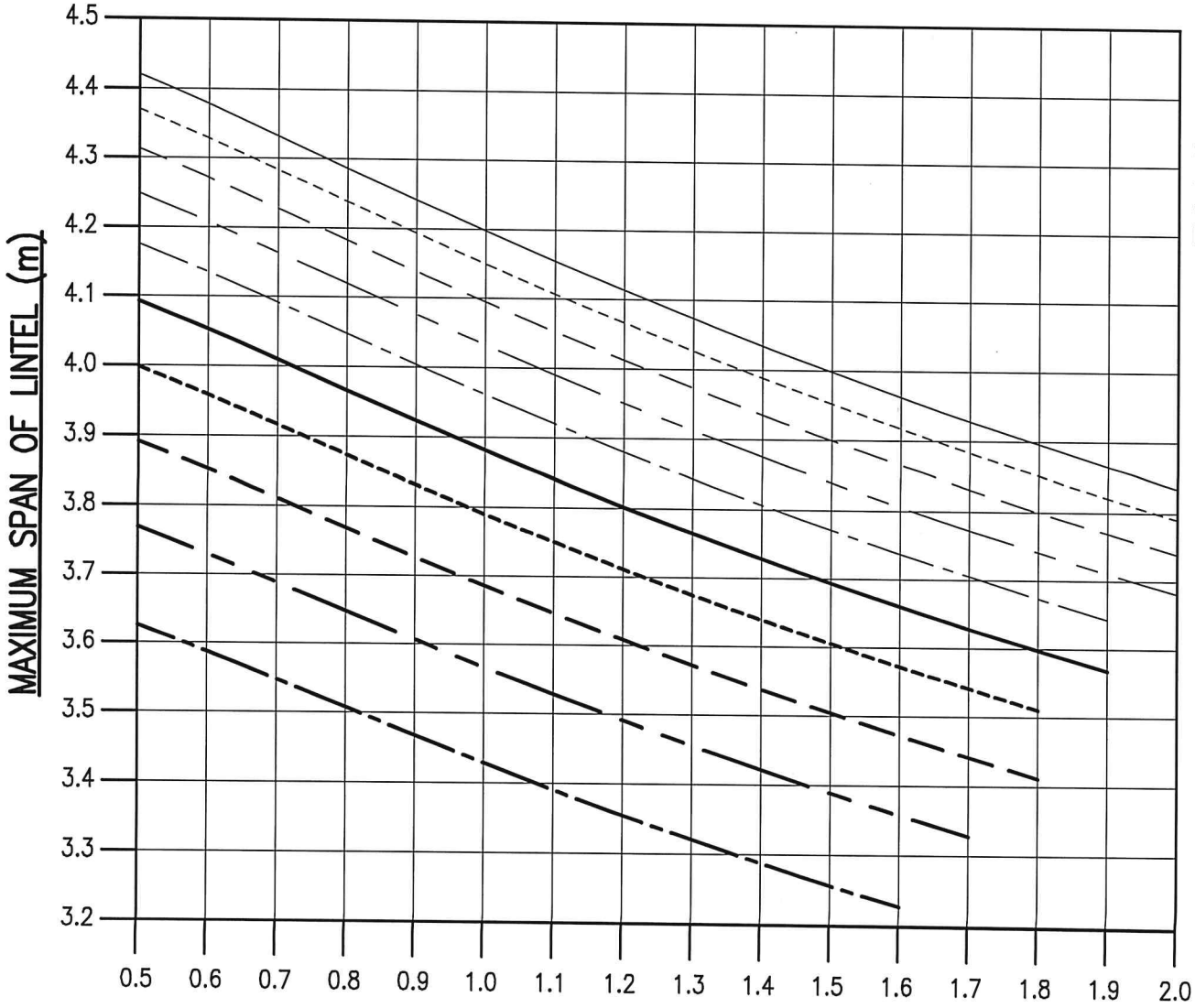
NOTE:

SOLID 107mm WALL BOARD LINTELS TO BE STRUCTURAL GRADE GL8 IN ACCORDANCE WITH AS/NZS 1328.1:1998

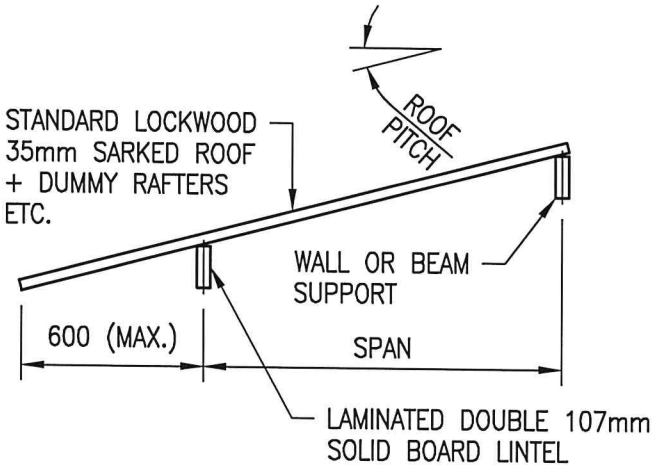
NOTE: PROVIDE LOCKWOOD TIE RODS BOTH SIDES OF JOINERY OPENINGS AS LINTEL UPLIFT RESTRAINTS FOR ALL CASES

CHART#2 – SARKED ROOF WITH BIFOLD JOINERY

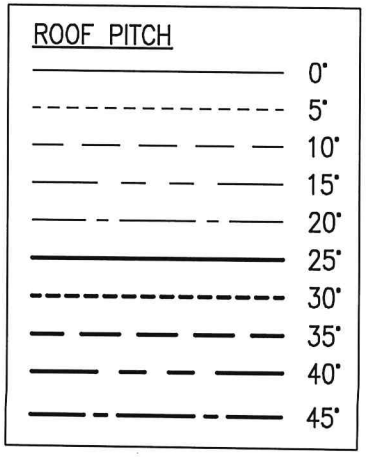
LAMINATED DOUBLE 107mm SOLID BOARD **BIFOLD** LINTEL SPAN CHART



DEFINITION OF HORIZONTAL LOADED DIMENSION



HORIZONTAL LOADED DIMENSION = ($\frac{SPAN}{2}$)



NOTE:

SOLID 107mm WALL BOARD LINTELS TO BE STRUCTURAL GRADE GL8 IN ACCORDANCE WITH AS/NZS 1328.1:1998

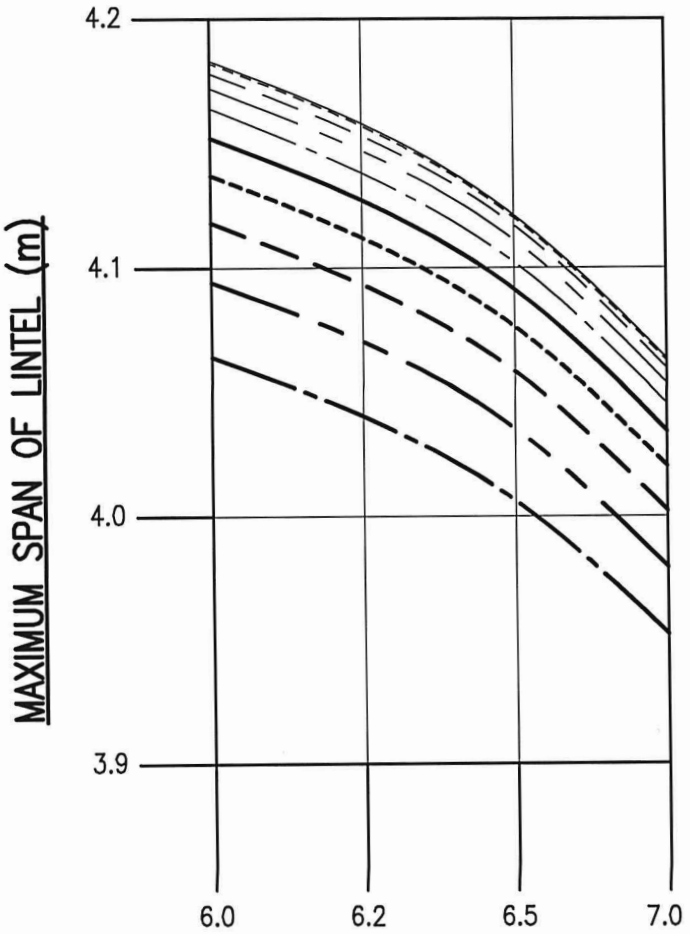
NOTE: PROVIDE LOCKWOOD TIE RODS BOTH SIDES OF JOINERY OPENINGS AS LINTEL UPLIFT RESTRAINTS FOR ALL CASES

CHART#3 – TRUSS ROOF – LOW TO HIGH WIND – STANDARD JOINERY

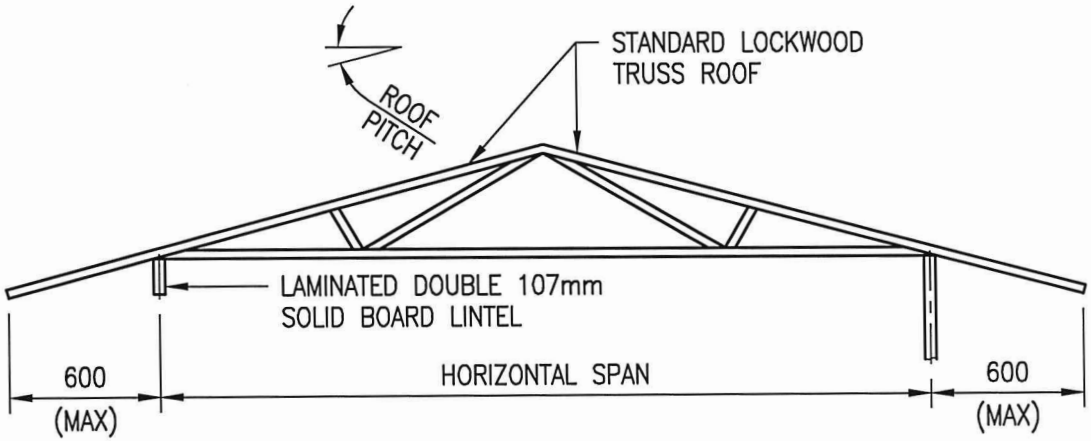
LAMINATED DOUBLE 107mm BOARD LINTELS SPAN CHART

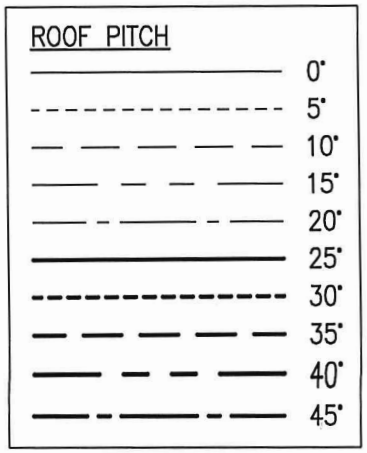
(MAXIMUM HIGH WIND IN TERMS OF NZS3604)

LOW TO HIGH WIND



DEFINITION OF HORIZONTAL SPAN





NOTE:

SOLID 107mm WALL BOARD LINTELS TO BE STRUCTURAL GRADE GL8 IN ACCORDANCE WITH AS/NZS 1328.1:1998

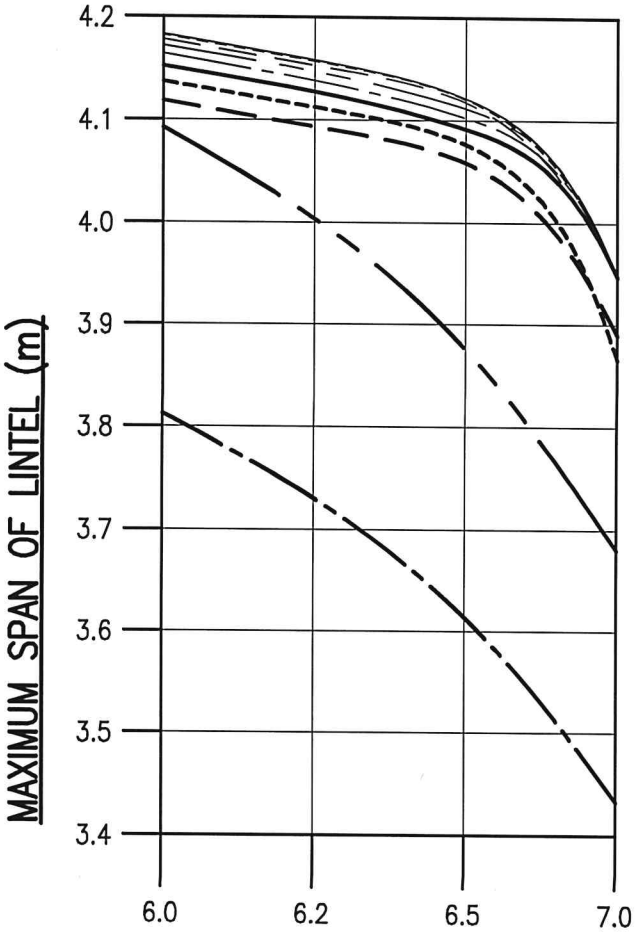
NOTE: PROVIDE LOCKWOOD TIE RODS BOTH SIDES OF JOINERY OPENINGS AS LINTEL UPLIFT RESTRAINTS FOR ALL CASES

CHART#4 – TRUSS ROOF – VERY HIGH WIND – STANDARD JOINERY

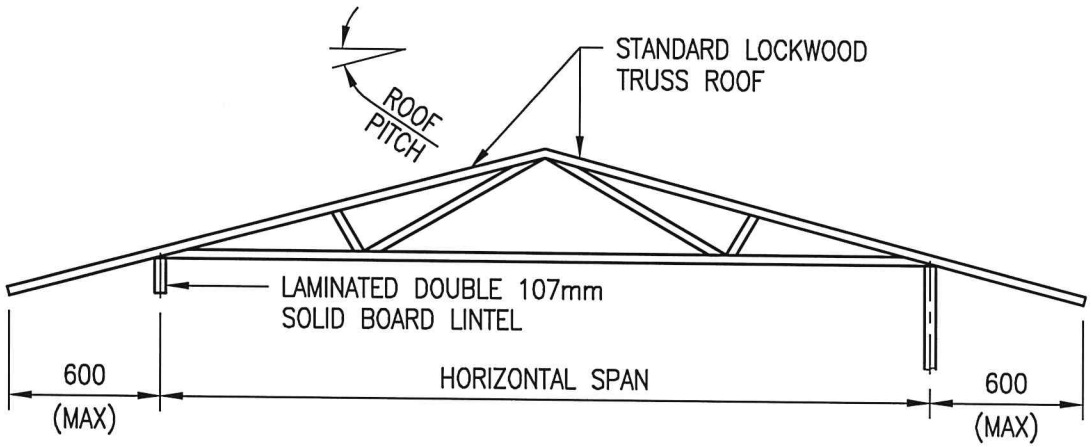
LAMINATED DOUBLE 107mm BOARD LINTELS SPAN CHART

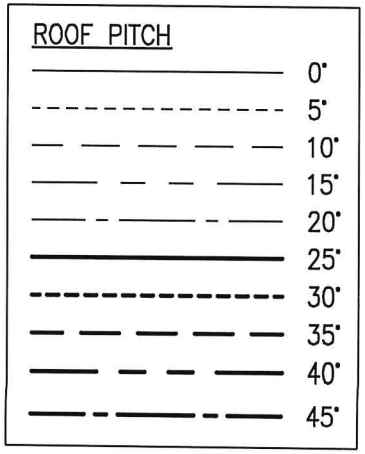
(MAXIMUM VERY HIGH WIND IN TERMS OF NZS3604)

VERY HIGH WIND



DEFINITION OF HORIZONTAL SPAN





NOTE:

SOLID 107mm WALL BOARD LINTELS TO BE STRUCTURAL GRADE GL8 IN ACCORDANCE WITH AS/NZS 1328.1:1998

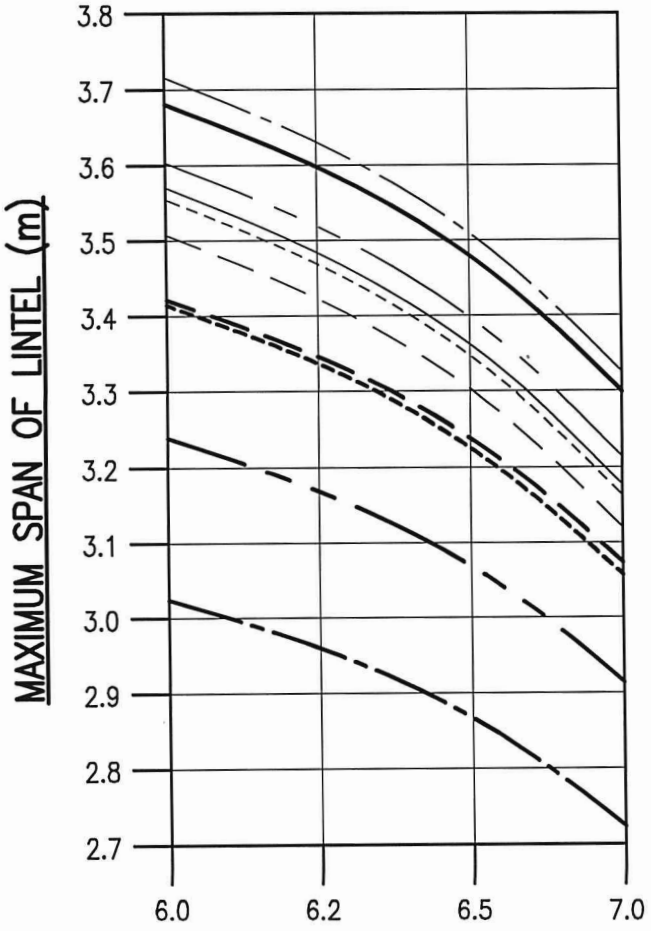
NOTE: PROVIDE LOCKWOOD TIE RODS BOTH SIDES OF JOINERY OPENINGS AS LINTEL UPLIFT RESTRAINTS FOR ALL CASES

CHART#5 – TRUSS ROOF – EXTRA HIGH WIND – STANDARD JOINERY

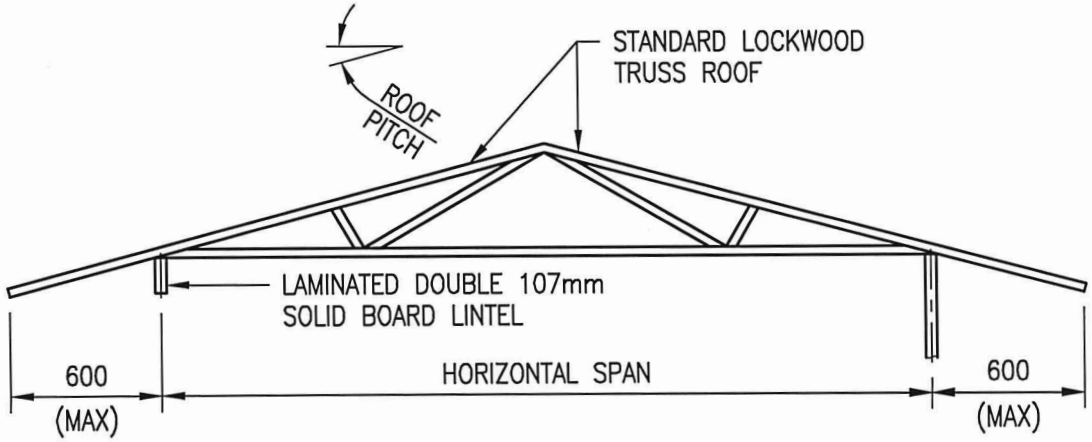
LAMINATED DOUBLE 107mm BOARD LINTELS SPAN CHART

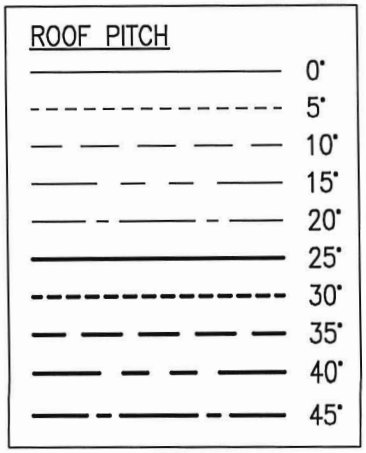
(MAXIMUM EXTRA HIGH WIND IN TERMS OF NZS3604)

EXTRA HIGH WIND



DEFINITION OF HORIZONTAL SPAN





NOTE:

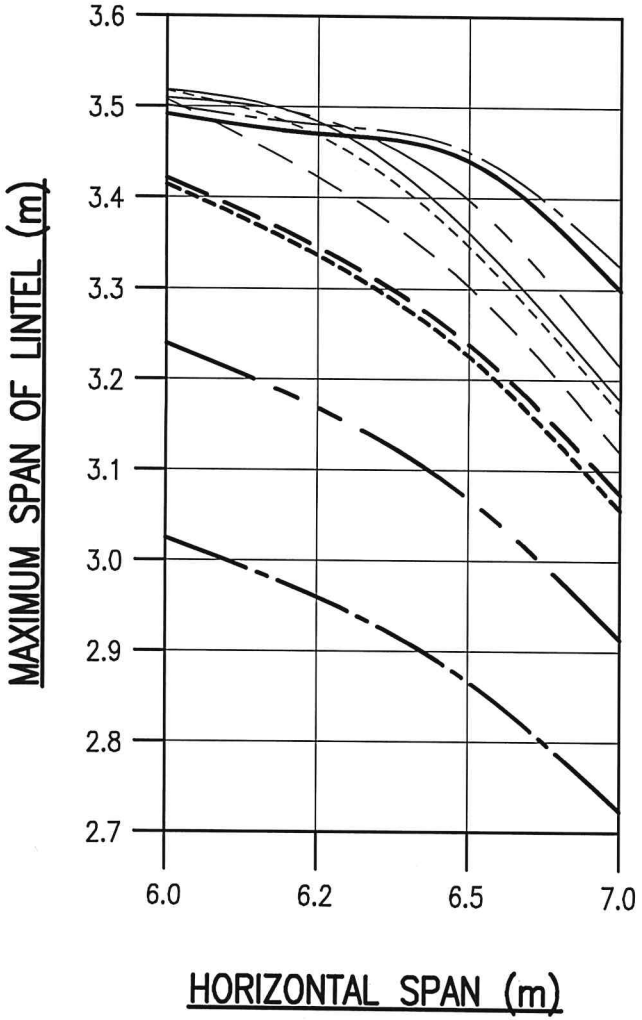
SOLID 107mm WALL BOARD LINTELS TO BE STRUCTURAL GRADE GL8 IN ACCORDANCE WITH AS/NZS 1328.1:1998

NOTE: PROVIDE LOCKWOOD TIE RODS BOTH SIDES OF JOINERY OPENINGS AS LINTEL UPLIFT RESTRAINTS FOR ALL CASES

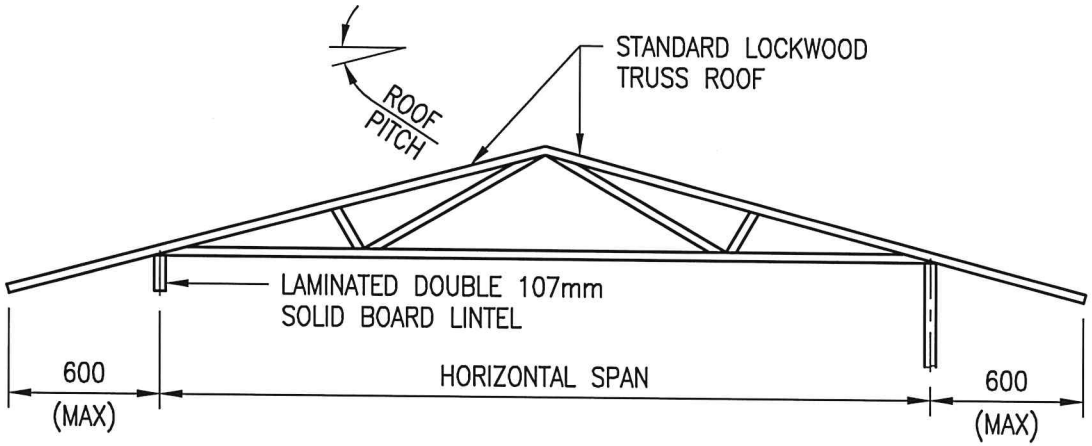
CHART#6 – TRUSS ROOF – UP TO EXTRA HIGH WIND – BIFOLD JOINERY

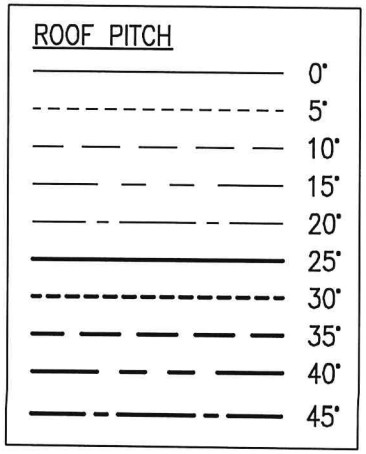
LAMINATED DOUBLE 107mm SOLID BOARD **BIFOLD** LINTEL SPAN CHART

(MAXIMUM EXTRA HIGH WIND IN TERMS OF NZS3604)



DEFINITION OF HORIZONTAL SPAN





NOTE:

SOLID 107mm WALL BOARD LINTELS TO BE STRUCTURAL GRADE GL8 IN ACCORDANCE WITH AS/NZS 1328.1:1998

NOTE: PROVIDE LOCKWOOD TIE RODS BOTH SIDES OF JOINERY OPENINGS AS LINTEL UPLIFT RESTRAINTS FOR ALL CASES

LOCKWOOD
Designed for good

Appendix C

Addendum 3

Revised roof beam span chart
Date: 10/06/2021
as supplied by BSK Consulting Engineers Ltd

Full engineer documentation available on request

REVISED LOCKWOOD ROOF BEAM CHART

As requested, we have completed the structural design work to extend the current Lockwood roof beam chart to include horizontal loaded dimensions up to and including 3.6m and attach the revised chart.

1. DESIGN BASIS

The loadings assumed for this design are as follows:

Design live loads of 0.25kPa and 1.1kN in accordance with AS/NZS1170.1.

The design dead load has been calculated in each instance as that resulting from a light roofing material (such as iron roofing) supported by conventional timber purlins on 140 x 45 dummy rafters and 35mm sarking in accordance with the standard Lockwood dummy rafter span chart. This is equivalent to a “light roof” in terms of NZS3604:2011.

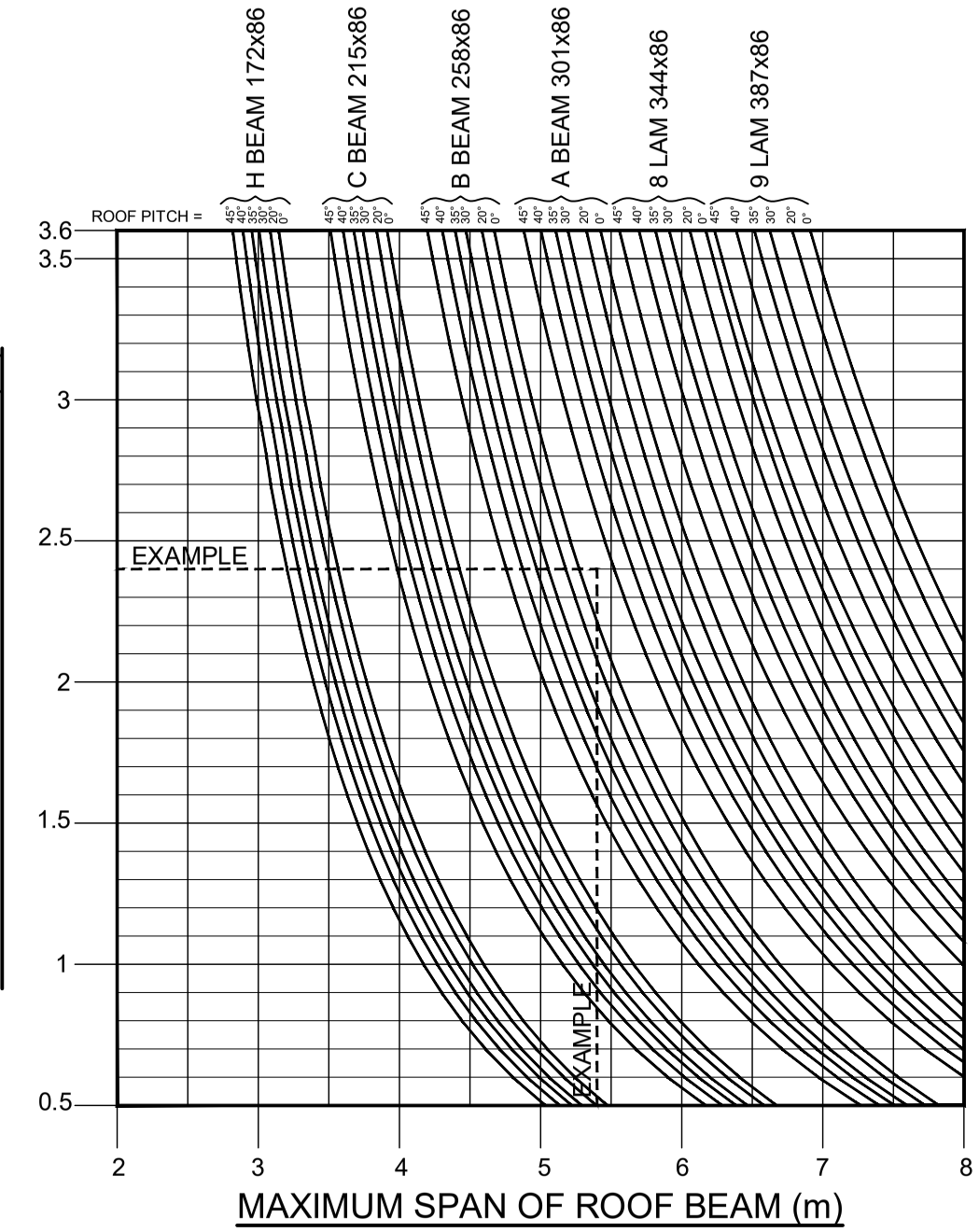
Where it is intended to use a heavy roof cladding or roof structure heavier than that specified above, roof beam design should be the subject of specific engineering design.

Structural design of roof beams has been based on structural grade GL8 Glulam beams in terms of AS/NZS 1328.1-1998 and using the “Timber Structures Standard”, NZS 3603:1993.

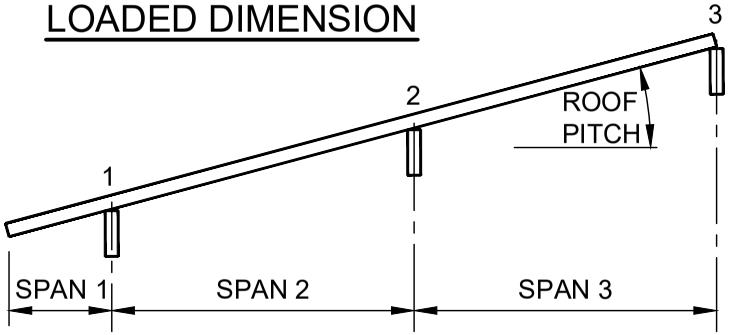
Long term deflection of the roof beams given in the following chart has been limited to the lesser of Span/320 or 25mm maximum. This is within the criteria recommended for roof members by AS/NZS 1170.0:2002, “Structural Design Actions, Part 0: General Principles”.

No snow load has been allowed for in the development of this chart. Where it is intended to build in an area that requires design for snow loads the roof beam design should be the subject of specific engineering design.

LOCKWOOD ROOF BEAM SELECTION CHART



DEFINITION OF HORIZONTAL LOADED DIMENSION



FOR BEAM 1 - LOADED DIMENSION = SPAN 1 + $\left(\frac{\text{SPAN}}{2}\right)$

FOR BEAM 2 - LOADED DIMENSION = $\frac{(\text{SPAN 2} + \text{SPAN 3})}{2}$

FOR BEAM 3 - LOADED DIMENSION = $\frac{\text{SPAN 3}}{2}$

EXAMPLE:

A ROOF BEAM SPANNING 5.4m WITH A LOADED DIMENSION OF 2.4m REQUIRES A 301x86 LAM BEAM (A BEAM)

NOTE: THIS DESIGN CHART HAS BEEN LIMITED TO A MAXIMUM ROOF OF 8m WHICH CORRESPONDS TO A LONG TERM MIDSPAN BEAM DEFLECTION OF 25mm. ROOF BEAMS SPANNING MORE THAN 8m SHOULD BE THE SUBJECT OF A SPECIAL DESIGN