2014-05-03

Measuring Slate Roofing in Accordance With ARM 4: - An Introductory Demonstration.

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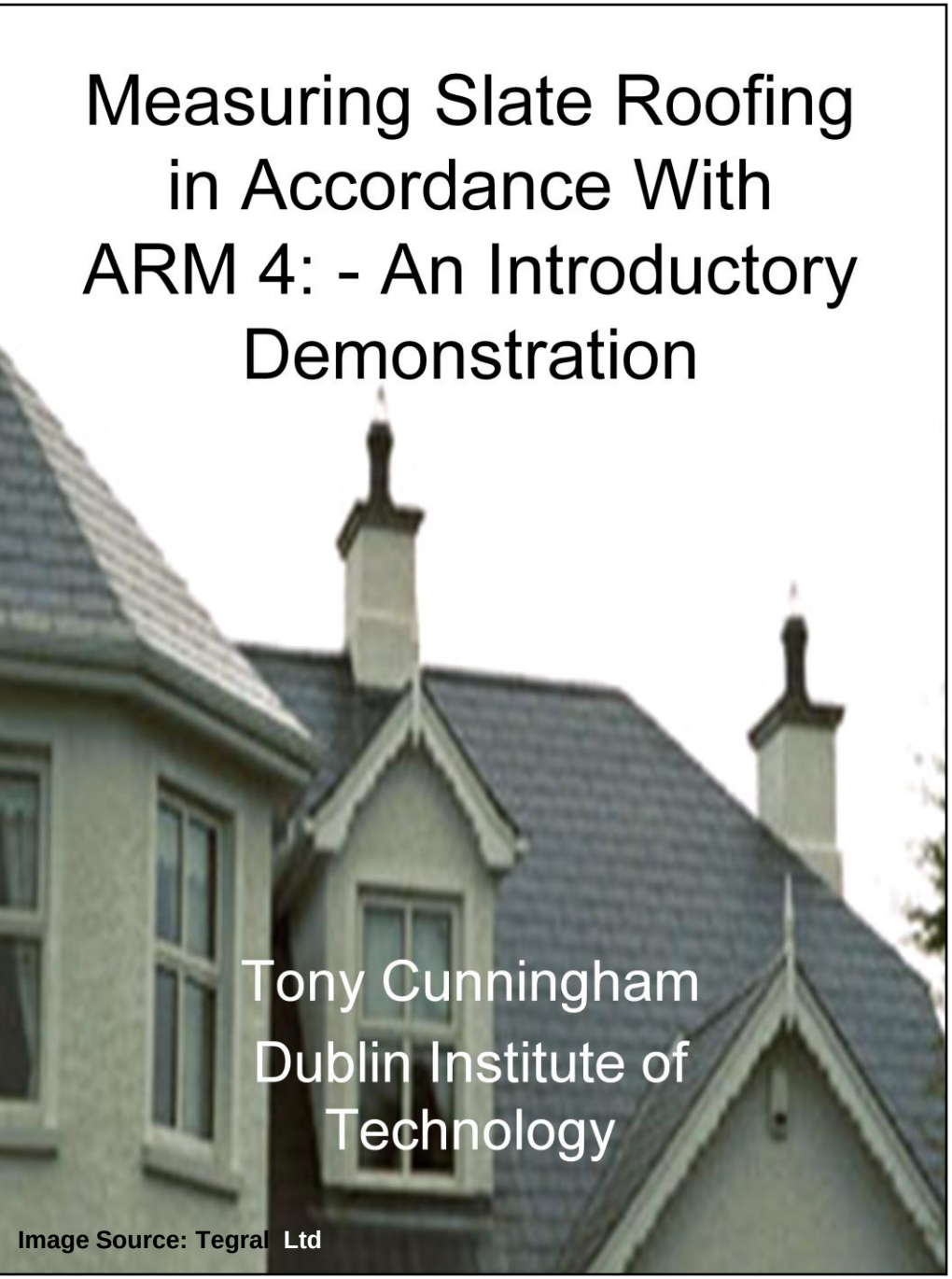


Image Source: Tegral Ltd

Introduction

Pitched roofs are the dominant form of domestic roof construction in the Republic of Ireland. There is a wide range of available coverings with the most common being natural and manufactured slates and interlocking concrete tiling. Terra-cotta and clay tiles are occasionally specified but these are more widely used in the UK. The *Homebond Manual* notes that a number of factors such as cost, location, aesthetics etc. will influence whether tiles or slates are used to cover a roof but whichever option is used, the fixing recommendations of the manufacturer should be adhered to.

Slates

Slate is a natural material excavated from a quarry and cut to thickness and size. Slates can be up to 300 mm × 600 mm in size. A length of twice the width is typical. Each slate has to be holed for nailing to timber roof battens, and two holes per slate will be located either towards the top (head nailed slates) or towards the centre (centre nailed slates).

Interlocking Tiles

These tiles are typically made of concrete and physically interlock together through a series of projections and corresponding grooves.

The National Standard Building Elements (NSBE)

BUILDING (Direct Costs)							SITE (Direct Costs)
Substructure	Structure	Structure Completions	Finishes	Services (Mainly Piped and Ducted)	Services (Mainly Electrical)	Fittings and Furniture	
(1 -) Substructure Generally	(2 -) Structure Generally	(3 -) Structure Completions Generally	(4 -) Finishes Generally	(5 -) Services (mainly Piped and Ducted) Generally	(6 -) Services (Mainly Electrical) Generally	(7 -) Fittings and Furniture Generally	(- 0) Site Generally
(11) Ground, Earth Shapes	(21) External Walls	(31) External Walls : Completions within Openings	(41) Wall Finishes Externally	(51) Heating Centre	(61) Electrical Supply and Main Distribution	(71) Display, Circulation Fittings	(10) Prepared Site
(12) Reserved	(22) Internal Walls, Partitions	(32) Internal Walls, Partitions : Completions within Openings	(42) Wall Finishes Internally	(52) Drainage and Refuse Disposal	(62) Power	(72) Work, Rest, Play Fittings	(20) Site Structures
(13) Floors in Substructure	(23) Floors, Galleries	(33) Floors, Galleries : Completions	(43) Floor Finishes	(53) Water Distribution	(63) Lighting	(73) Culinary Fittings	(30) Site Enclosures
(14) Reserved	(24) Stairs, Ramps	(34) Stairs, Ramps : Completions	(44) Stairs, Ramps : Finishes	(54) Gases Distribution	(64) Communications	(74) Sanitary, Hygiene Fittings	(40) Roads, Paths, Pavings
(15) Reserved	(25) Reserved	(35) Suspended Ceilings	(45) Ceiling Finishes	(55) Space Cooling	(65) Security and Protection	(75) Cleaning, Maintenance Fittings	(50) Site Services (Mainly Piped and Ducted)
(16) Foundations and Rising Walls	(26) Reserved	(36) Reserved	(46) Reserved	(56) Space Heating	(66) Transport	(76) Storage, Screening Fittings	(60) Site Services (Mainly Electrical)
(17) Piled Foundations	(27) Roofs	(37) Roof : Completions	(47) Roof Finishes	(57) Ventilation and Air Conditioning	(67) Reserved	(77) Reserved	(70) Site Fittings
(18) Reserved	(28) Frames	(38) Reserved	(48) Reserved	(58) Other Services (Mainly Piped and Ducted)	(68) Other Services (Mainly Electrical)	(78) Reserved	(80) Landscape, Play Areas
(19) Summary : Building Substructure	(29) Summary : Building Structure	(39) Summary : Building Structure Completions	(49) Summary : Building Finishes	(59) Summary : Building Services (Mainly Piped and Ducted)	(69) Summary : Building Services (Mainly Electrical)	(79) Summary : Building Fittings and Furniture	(90) Summary : Site

The National Standard Building Elements

In Ireland the measurement of new building work is typically organised in accordance with the National Standard Building Elements (NSBE). Elements are defined as '*that part of the building, which always performs the same function irrespective of design or specification*'. The object of the NSBE is to enable design teams to adopt, on a national basis, a common approach to the building process. The Elements stipulate what is included and excluded from each element, which helps design teams coordinate their work and allows the measurement of the work to be divided up among teams while ensuring that all aspects of the building works are fully covered in the Bill of Quantities.

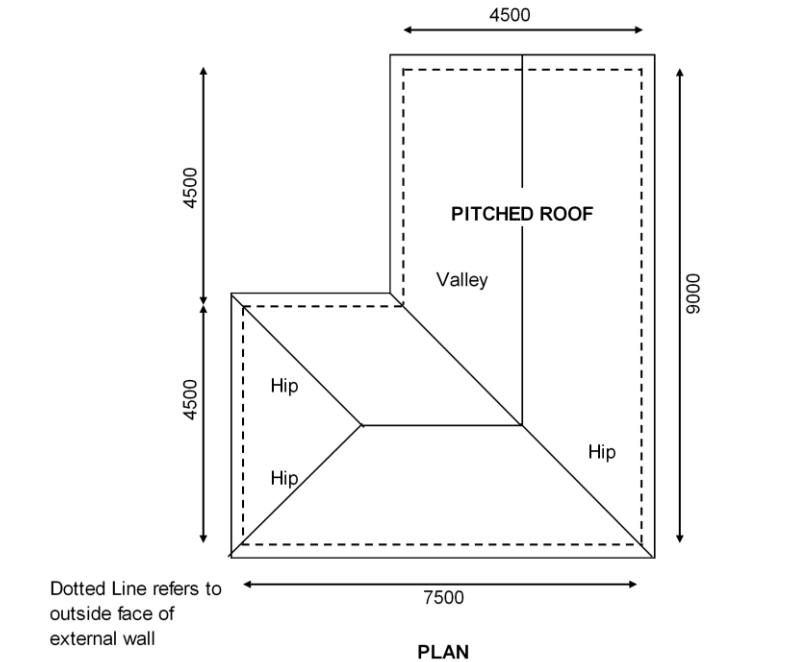
The Table opposite sets out a matrix of elements covering the various building elements. Roof Finishes are measured within the Finishes group of elements where it is located at Element (47).

Element (47) Roof Finishes

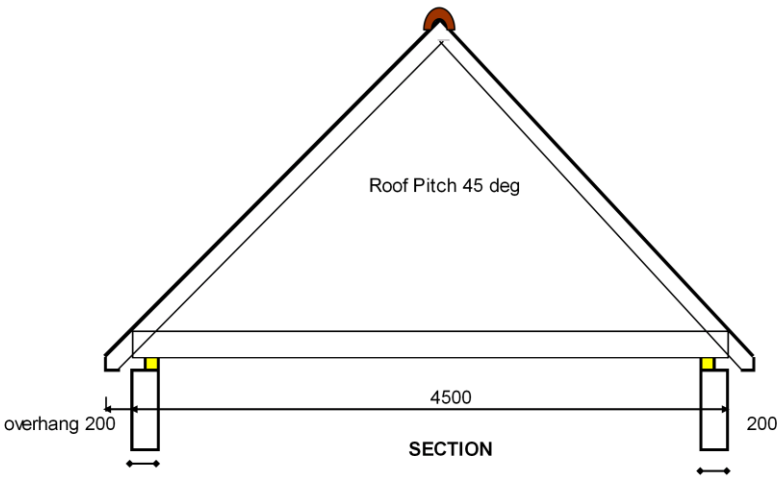
The following work is included within the scope of the Roof Finishes element:

- sheeting, slating, tiling and associated battens and sarking;
- waterproof coatings and screeds;
- insulation;
- roof paving;
- flashings;
- edgings, and
- decorations.

The Worked Example



PLAN



SECTION

The Worked Example

The worked example has been kept deliberately simple for demonstration purposes and has a natural slate roof

It should be noted that the eaves, barge and valley boards and their associated decoration are normally measured in Element (27) Roofs. They are therefore not included in this demonstration.

Specification information:

Slates: Blue Bangor natural slates; 500x250mm blue-black; 100mm head lap; each slate double nailed at centre with copper nails.

Battens: 25x50mm softwood battens pressure impregnated with preservative.

Sarking Felt: One layer sarking felt Type IF to I.S. 36-1: 1996.

Eaves: Double course at eaves; additional 600mm strip of roofing felt.

Verges: Slate undercloak course; slates clipped with approved roof clips and pointed in mortar (1:3).

Ridge and Hip Tiles: Half round clay tile; selected pattern; bedding in mortar (1:3); additional 600mm strip of roofing felt.

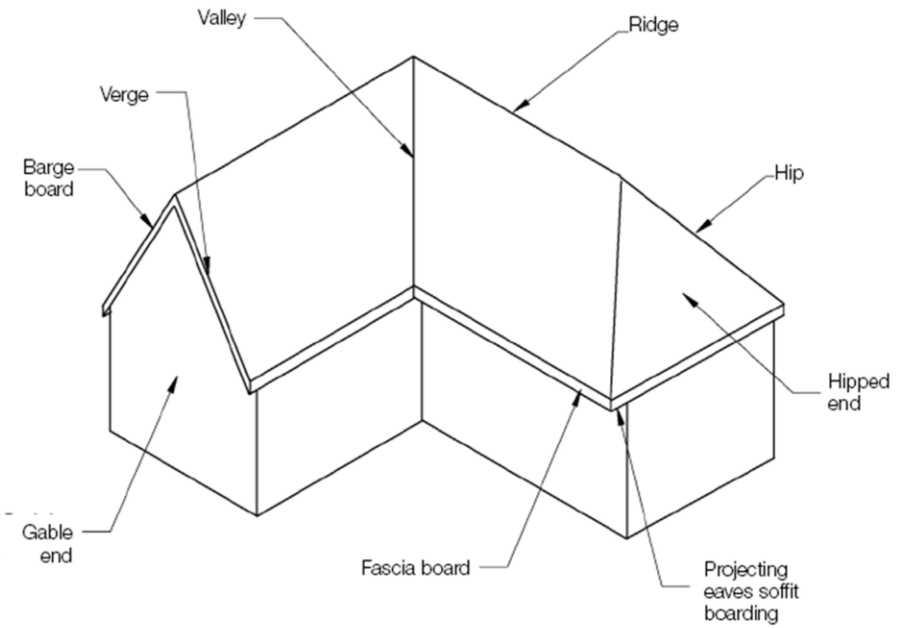
Eaves Ventilators: approved manufacturer eaves ventilator.

Hip Irons: approved manufactre

Valleys: Fair cutting to both sides of valley; Code 5 lead gutter 300-450mm girth.

Glossary of Terms

Source (Riley and Cotgrave, 2008, p.268)



To Take List

It is good practice to prepare a to-take-list by reading through the ARM. This organises the measurement sequence and reduces the chances of forgetting something. The following items have been identified following a study of the drawings and the ARM indicating the appropriate unit of measurement:

- Slate coverings (m2);
- eaves (m);
- verges (m);
- Ridges (m);
- hips (m);
- valleys (m);
- special fittings; ventilators (nr);
- hip irons (nr), and
- lead valley gutter (m).

INFORMATION REQUIRED
- Location Drawings.
- Kind, quality and size of material.
- Minimum extent of side and end laps.
- Method of fixing.
- Size, material and spacing of battens and counter battens.
- Type of underlay.

ARM 4 Section I Roofing – Slate and Tile Coverings

I

CATEGORIES 1	2	3	4	Unit
1 General Rules				
2 Coverings	1 sloping ≤45° 2 sloping > 45° stating slope 3 vertical	1 ≤300mm >300mm	1 curved	m²
3 Eaves 4 Verges 5 Ridges 6 Hips 7 Valleys 8 Vertical angles	4 detailed description		2 raking 3 curved	m
9 Special fittings	5 purpose made tiles 6 ventilators 7 finials 8 hip irons 9 soakers 10 saddles	2 detailed description		nr
10 Holes	11 ≤0.50m girth >0.50 ≤1.00m girth >1.00 ≤2.00m girth >2.00m girth			

Slate and Tile Coverings

ARM 4 Roofing

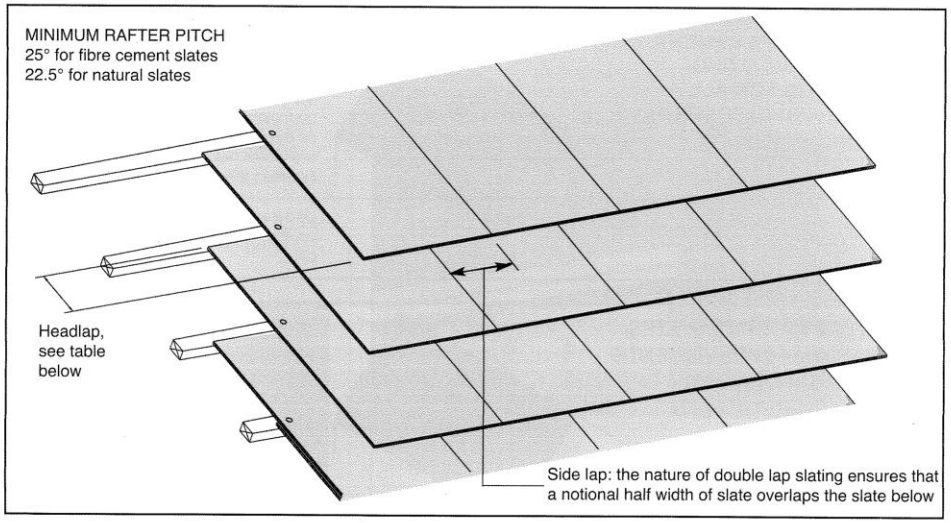
Roofing is measured in accordance with Section I of ARM 4 – Roofing Cladding and Waterproofing.

Section I sets out the rules for measuring various roof finishes which are arranged in the following categories:

- mastic asphalt, waterproof and gas proof non flexible sheet coverings (pages 68 & 69);
- slate and tile coverings (pages 70 & 71);
- rigid sheet coverings and decking (pages 72 & 73), and
- flexible sheet metal coverings (pages 74 - 77).

Typical Slating Details

FIBRE CEMENT AND NATURAL SLATES



Source: Homebond House Building Manual

Measuring slate roofing

The rules for measuring slate and tile coverings are set out on pages 70 and 71 of ARM 4. The following information is given in slating and tiling descriptions:

- Kind, quality and size of materials
- Minimum extent of side and end laps
- Method of fixing
- Size, materials and spacing of battens and counter battens
- Type of underlay

For example a specification heading in a Bill of Quantities might read:

Tegral Thrutone blue-black fibre cement slates; 600x300mm; 75mm headlap; fixing in accordance with the manufacturer's instructions to and including 25x50mm softwood batten pressure impregnated with preservative and 'Blizzard' heavy duty underlay felt.

Measurement Rules

Work is measured on the exposed face - including the projections over the eaves and the gutters.

No deductions are made for voids not exceeding 0.50m2 -unless occurring at the boundary of the work

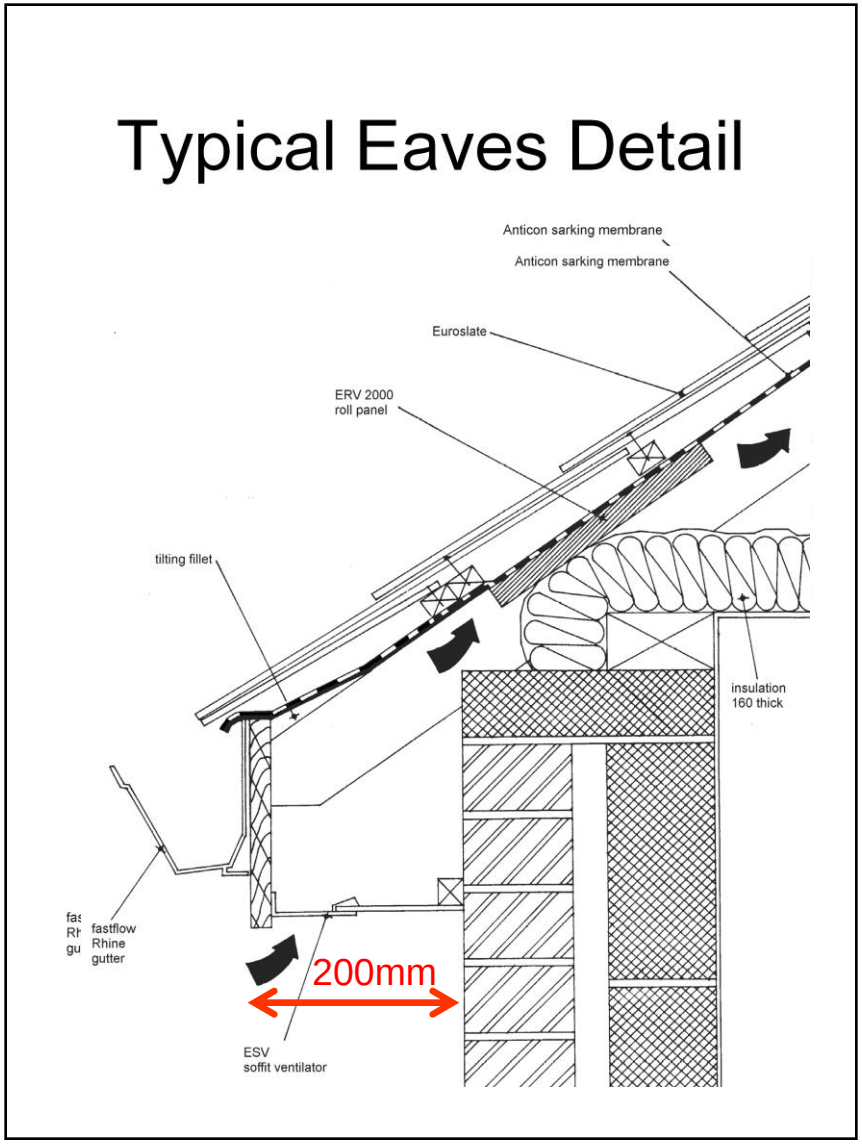
Deemed To Be Included

The following are deemed to be included:

1)Work in forming voids not exceeding 0.50m2;

2)Cutting to work subsequently covered and

3)Notches



Source: Hore, O'Kelly and Scully, (2009) *Seeley and Winfield's Building Quantities Explained Irish Edition*

Eaves Details

The detail shown on the left is taken from *Seeley and Winfield's Building Quantities Explained Irish Edition* (Hore, O'Kelly and Scully, 2009) and shows a typical eaves detail associated with a slate roof.

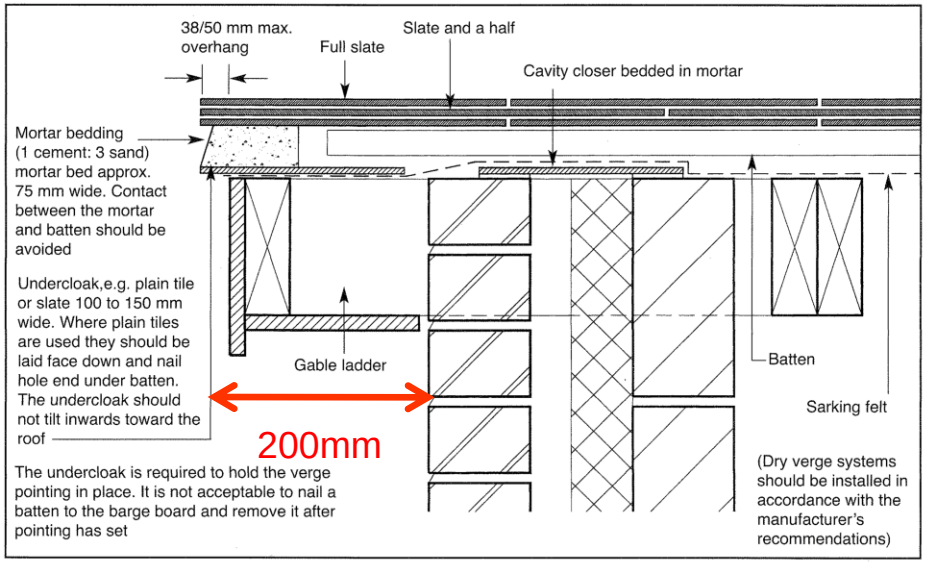
Eaves and other boundary conditions are at the interface of the roofing and carpentry trades and it is easy to leave out items which must be measured. For example, in the detail opposite the tilting fillet, the soffit and fascia boarding at the eaves and their associated decoration would normally be measured in Element (27) Roof (structure). It would be logical that the soffit ventilator shown the detail would also be fixed by the carpenters at this stage. However on occasion these are measured in the Roof Finishes element of the Bill.

In the worked example a 200mm projection indicated by the red arrow has been taken from the face of the external wall to the outside face of the fascia board. Note however that the slating overhangs this point and some allowance should be included in the measurements for this.

The *Homebond Housebuilding Manual* recommends that an additional 500mm (minimum) wide layer of sarking felt which should be fitted at the eaves. An extra row of slates is also required for this detail. The measurement of the ERV ventilator panel is measured as part of this worked example for demonstration purposes.

Typical Verge Detail

FIBRE CEMENT AND NATURAL SLATES



Typical bedded verge (double lap fibre cement slates).

Source: *The Homebond Housebuilding Manual* (2012) p 233

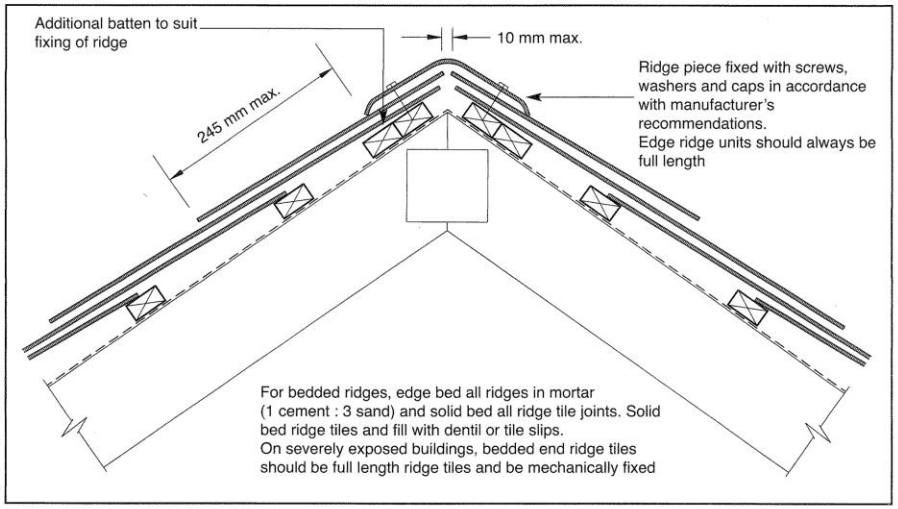
Verges

Verges are located at gable ends of buildings. It is very common, particularly in older buildings to finish the roof almost flush with the outside face of the gable wall – the slating often projects 50mm and is then pointed with cement mortar in order to weatherproof the building.

The worked example is based on the detail shown to the left and shows a projecting verge of 200mm. The soffit and barge boards and their associated decoration will have been included already in Element (27) Roofs.

Rates for verges are deemed to include under cloak courses, bedding, pointing and cutting on boundary. Nevertheless this information is often included in detailed verge descriptions. Slates may also be clipped at this location with slate clips.

Typical Ridge and Hip Details



Typical fibre cement ridge detail.

Source: *The Homebond Housebuilding Manual* (2012) p 233

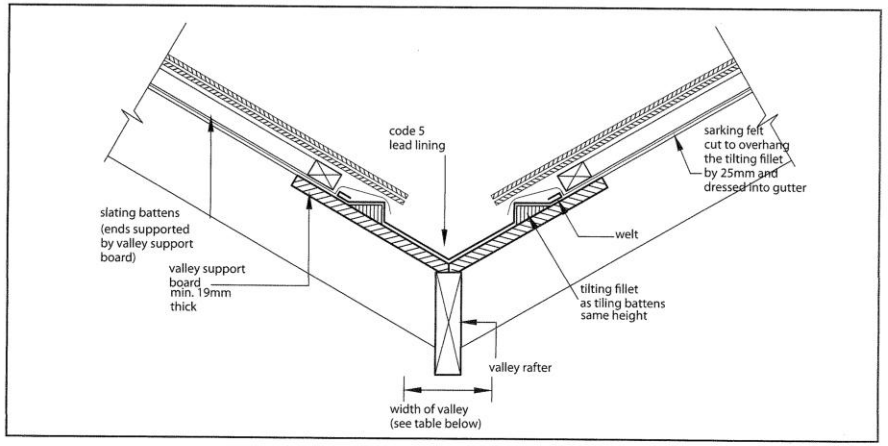
Ridges and Hips

A variety of cappings and tiles are available to finish a roof. The detail on the left shows an angular ridge capping, however the worked example has half round clay tiles which are fixed by bedding in cement mortar.

The *Homebond Housebuilding Manual* recommends that the sarking felt should be carried over the ridge by a minimum of 225mm. Homebond also recommend that hips should have an extra layer of sarking felt of at least 600mm wide.

Typical Valley Details

FIBRE CEMENT AND NATURAL, SLATES TYPICAL VALLEY DETAIL



Source: *The Homebond Housebuilding Manual* (2012) p 224

Valley Details

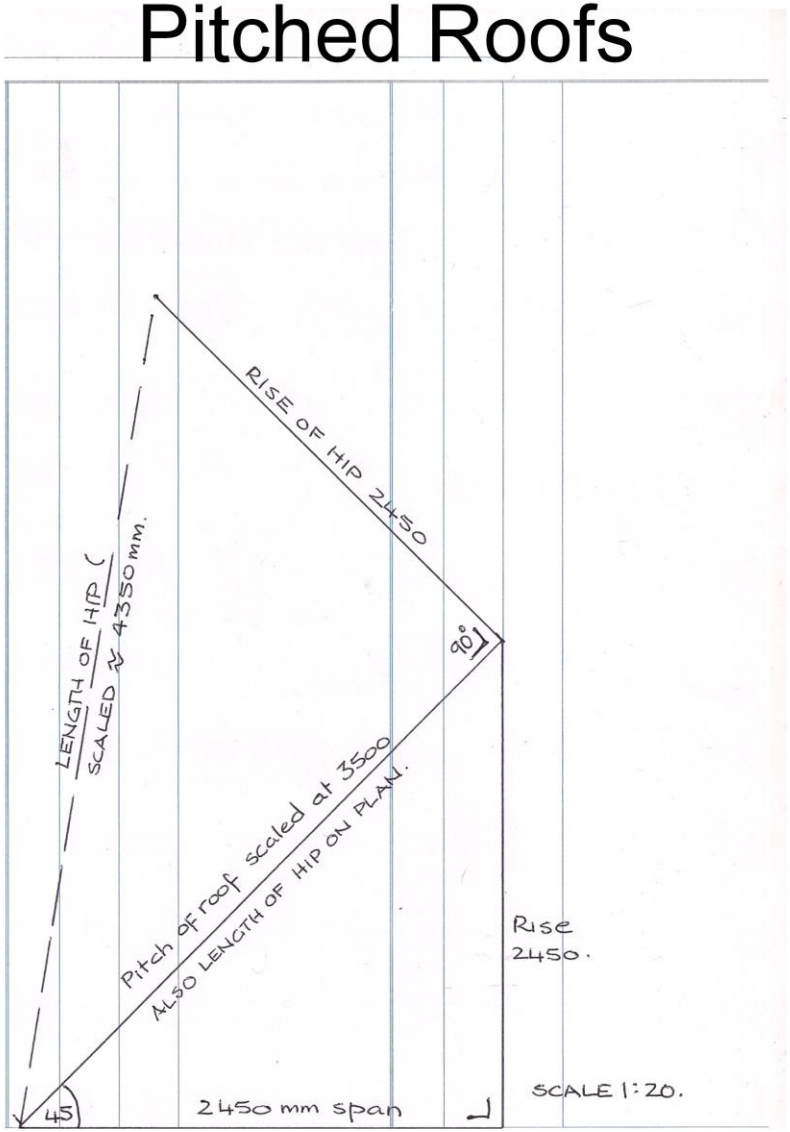
A range of metals can be used to line valley gutters, including lead, copper, aluminium and zinc of which lead valleys are the most common.

The lead valley must be supported by boarding which is measured in Element (27) Roofs. The tilting fillets indicated in the detail are also measured in Element (27).

Code 5 lead should be used to form valley linings not less 500mm wide.

Measurement Rule 4 for Slate and Tile Roof states that raking cutting shall only be measured to boundary work, this includes valley conditions.

Scaling Lengths on Pitched Roofs

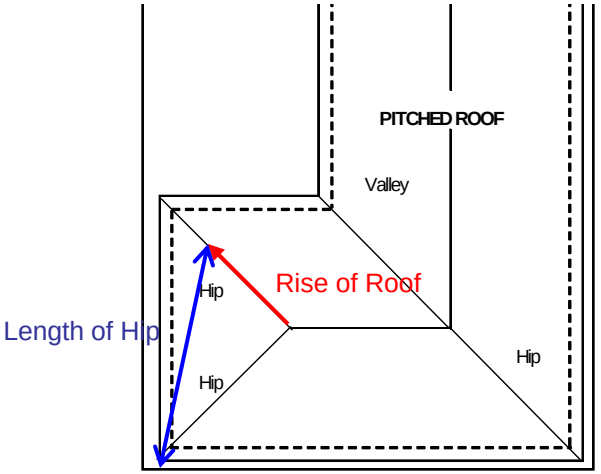


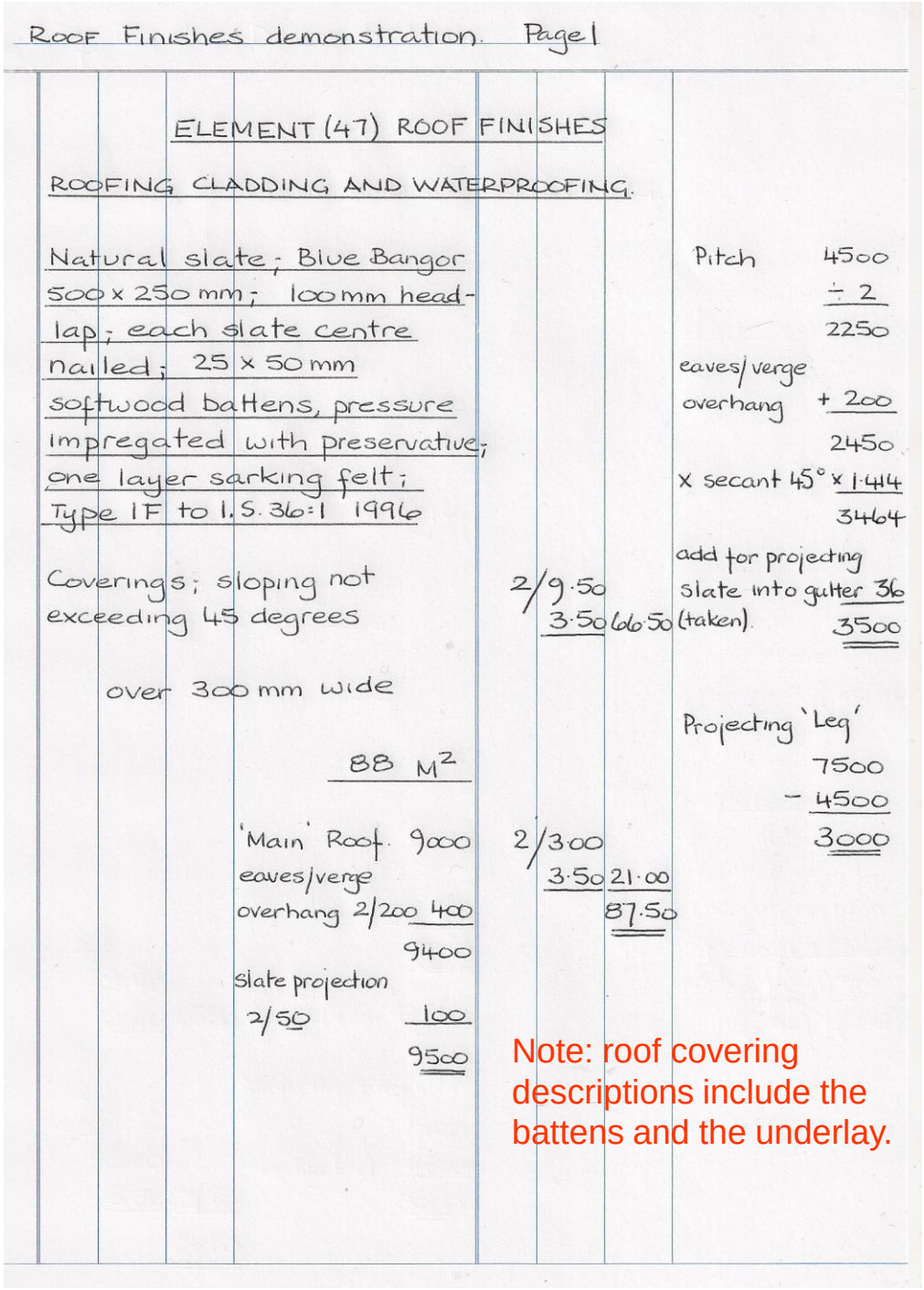
Scaling versus figured dimensions

Although it is best practice to use figured dimensions when measuring building work, in practice the measurement items such as the length of the pitch of a roof is often scaled directly from the main cross sections through the building. This is acceptable providing that the scale is checked and is accurate.

Where drawings are not to scale, dimensions can be found using trigonometry or by applying the pythagoras theorem. Another approach is to construct a scaled diagram as shown opposite. The larger the scale the more accurate the measurement will be. The diagram following is at 1:20 and can be constructed using a protractor or set square. The figure opposite shows how the length on the pitch of the roof and the length of the hip may be established from a scaled diagram.

In practice the length of the hip is often found by plotting the rise of the roof along the adjoining hip/valley and scaling the resulting offset length. This would usually be drawn on the roof plan as shown below.




Roof Finishes demonstration. Page 1

ELEMENT (47) ROOF FINISHES

ROOFING CLADDING AND WATERPROOFING.

Natural slate; Blue Bangor 500 x 250 mm; 100mm head-lap; each slate centre nailed; 25 x 50 mm softwood battens, pressure impregated with preservative; one layer sarking felt; Type 1F to I.S. 36:1 1996

Coverings; sloping not exceeding 45 degrees

over 300 mm wide

88 M²

'Main' Roof 9000
eaves/verge overhang 2/200 400
9400
slate projection 2/50 100
9500

2/9.50
3.50 66.50

2/3.00
3.50 21.00
87.50

Pitch 4500
÷ 2
2250
eaves/verge overhang + 200
2450
x secant 45° x 1.414
3464
add for projecting slate into gutter 36
3500 (taken)

Projecting 'Leg'
7500
- 4500
3000

Note: roof covering descriptions include the battens and the underlay.

Roof Coverings

Roof coverings are measured in m^2 stating whether the pitch is a) not exceeding 45 degrees b) exceeding 45 degrees or c) vertical. In addition areas not exceeding 300mm wide are measured separately. Curved work is also measured separately.

The worked example presents a L shaped roof. There are two likely approaches to measuring this type of roof:

1. break the roof down into the 'main' roof and the projecting 'leg' and measure them individually, or
2. add the length of the projecting 'leg' to the length of the 'main' roof' this approach is possible where the width of the roof and its pitch are constant over the whole building.

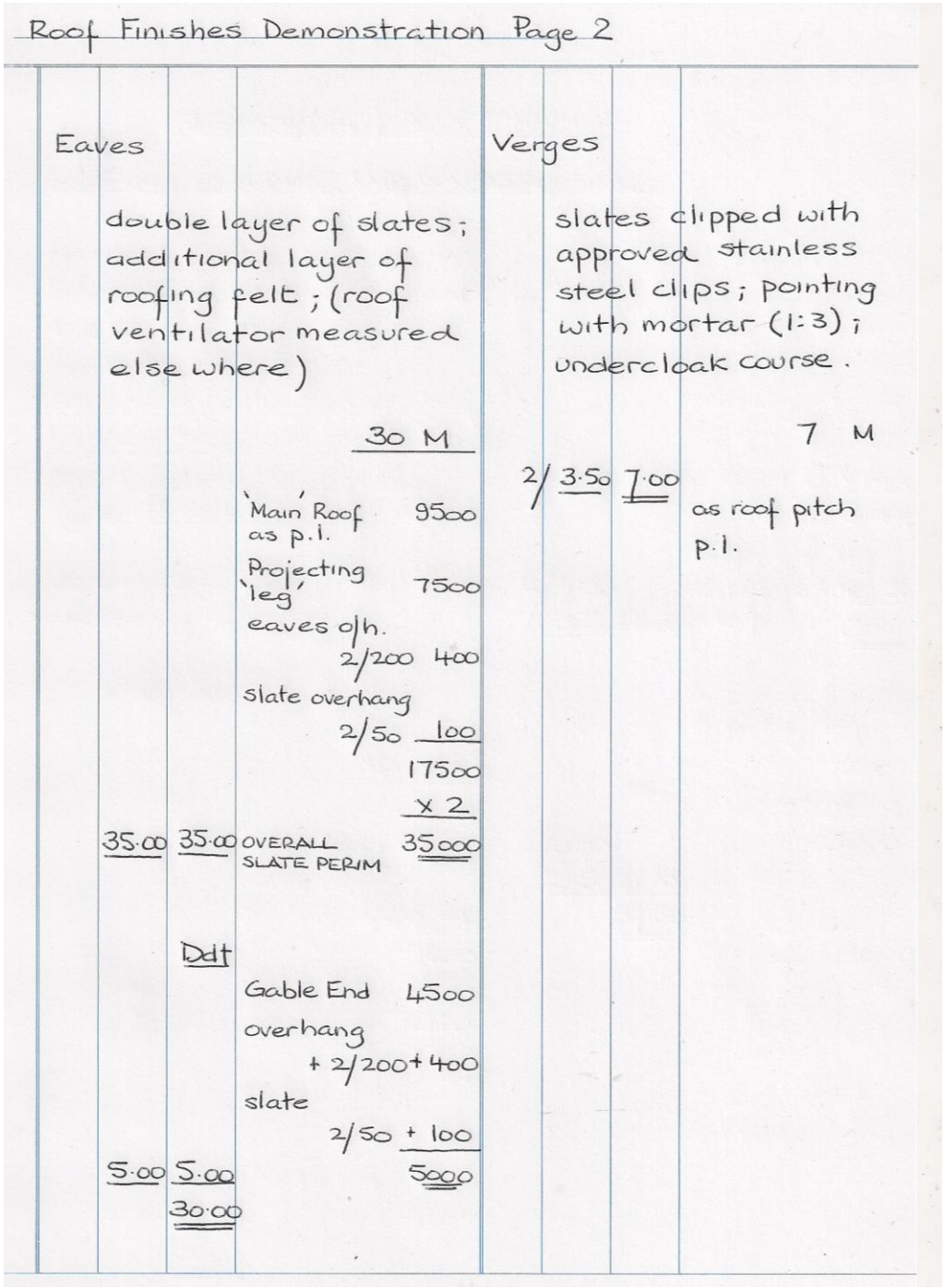
The roof lengths are adjusted for eaves and verge projections in both cases (200mm in each case).

The first approach described above, is used in this worked example. The first task is to establish the overall length of the roof, this is based on the length on the outside of the building indicated by the broken line (9000) on the building plan and adjusting this for the eaves and verge overhangs (2/200) an arbitrary allowance of 50mm on both ends has been added to the result to cover the projection of the slating beyond the facia and barge boards. This produces an overall length of 9500mm.

The length of the pitch on the roof is calculated using the length of the base, 2450, (half span + the eaves overhang) multiplied by the secant for a 45 degree pitch which is a factor of 1.414. 36mm has then been added to the result to allow for the small projection of the slates over the gutter and round off the dimension.

This pitch could also have been found by dividing by the length of the base by the cosine of 45˚ **or** could have been figured using pythagoras $\sqrt{(2.45)^2+(2.45)^2}$.

The length of the projecting leg of the roof has been found by deducting the width of the gable end fron the overall width of the building.



Boundary details

Boundary conditions on slating and tiling such as eaves, verges, ridges, hips, valleys, and vertical angles must be measured. **Boundary details are measured in linear metres giving a detailed description.** Curved and raking work are measured separately.

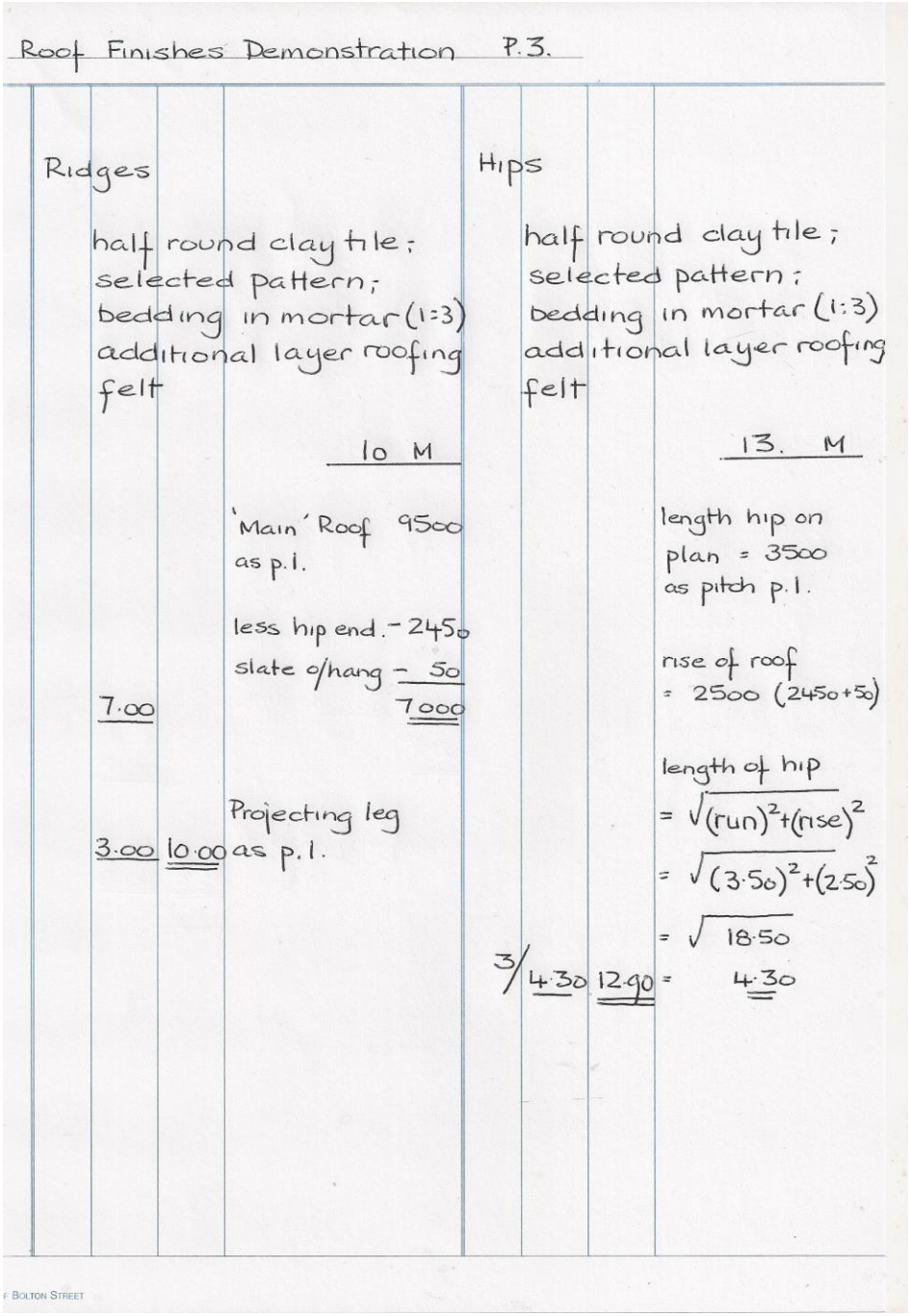
In this worked example it has been assumed that the tilting fillets, fascia, barge and soffit boarding and their associated decoration shown on the details have previously been measured as part of Element (27) - Roof Structure.

Eaves

The eaves is measured by calculating the overall perimeter of the roof in the first instance including the eaves overhang and slate projections over the gutters (35.00m) and then adjusting for the verge (deduct 5.00m).

Verges

The length of the verge is the same as the length of the pitch on the roof. Note that although the undercloak courses are deemed to be included in the rates it has been included in the description in the interests of providing clarity.



Ridges and Hips
Ridges and hips to slate roofs are measured in linear metres giving a detailed description.

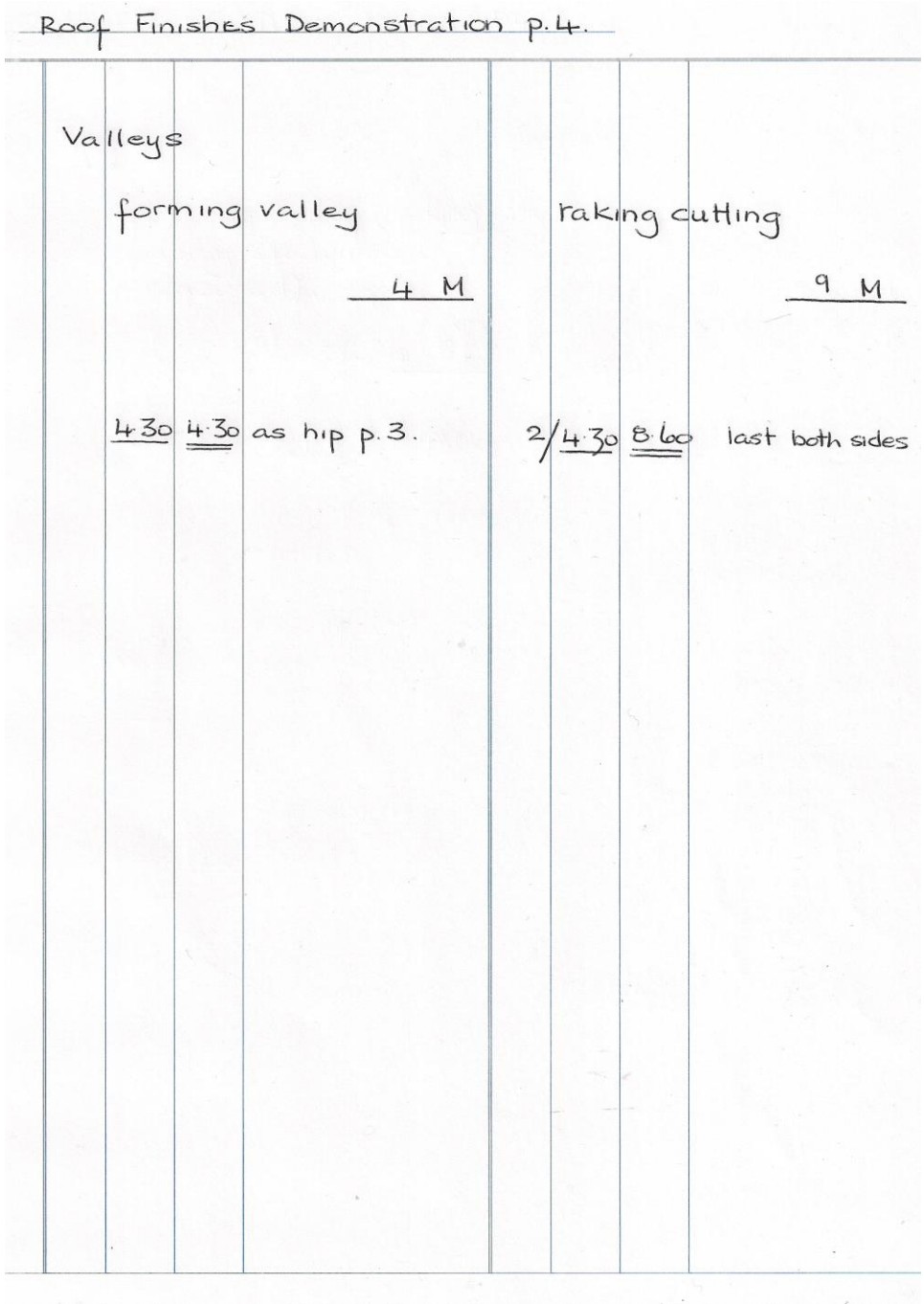
Hips tiles are usually the same specification as the ridge, but are kept separate as hips typically cost more and involve carrying out raking cutting on the slates.

Ridges
The length of the ridges has split into the two runs. The length of the main run is based on the overall length of the roof – found on page 1 of the take off. The length of the ridge projecting leg has also been calculated on page 1 of the take off.

Hips
The length of the hip has be calculated using Pythagoras' theorem by finding the square root of the total of the length of the hip on plan squared plus the length of the rise of the roof squared.

Seeley and Winfield's Building Quantities Explained: Irish Edition gives the following formula at page 162 for working out the length of a hip
Length of hip = $\sqrt{(\text{common rafter})^2 + (\frac{1}{2} \times \text{roof span})^2}$.

In practice the length of the hip is found by plotting the rise of the roof along perpendicular to the hip on plan and scaling the resulting length. This would usually be drawn on the roof plan as shown on slide 11.



Valleys

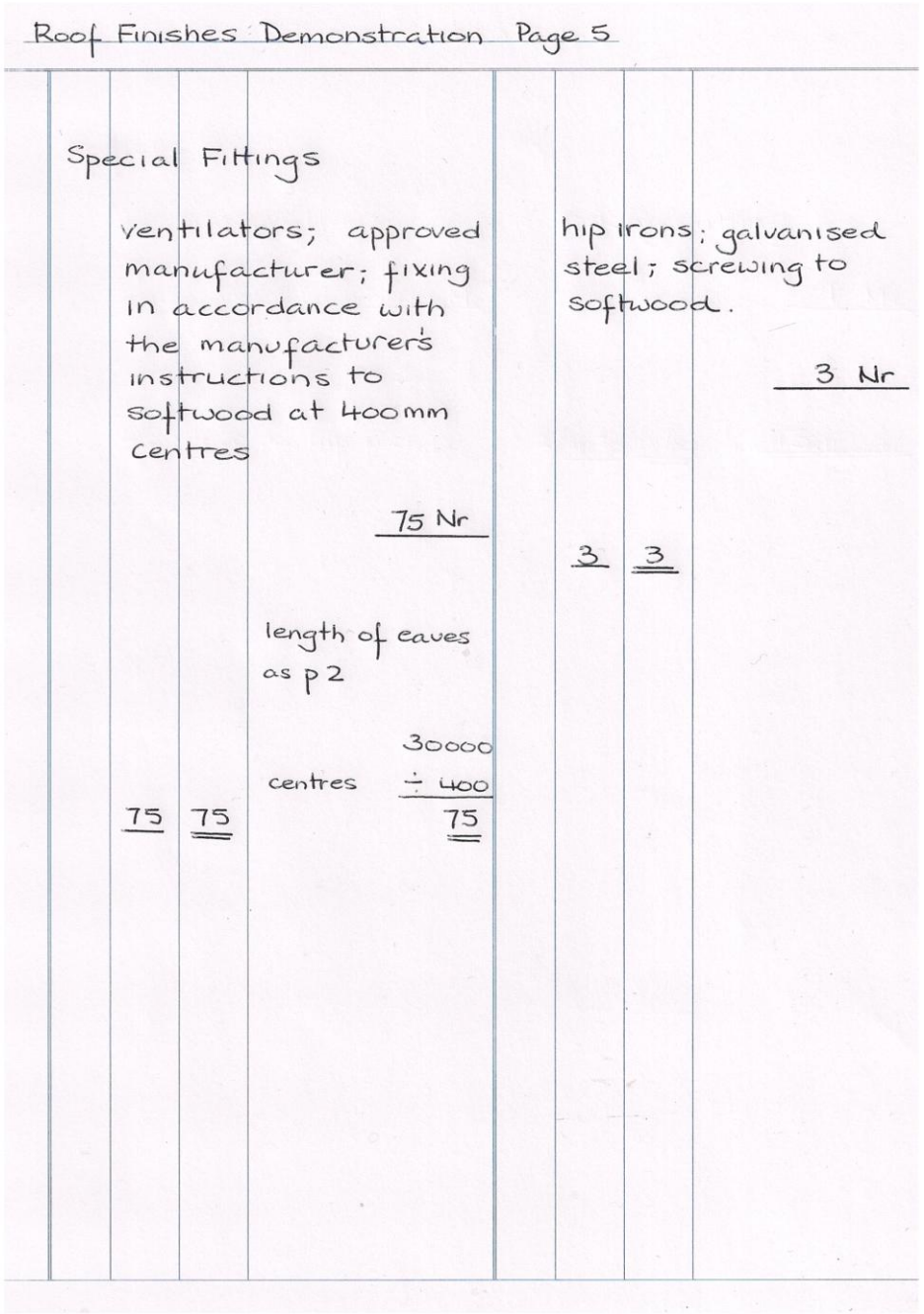
Valleys to slate and tile roofs are measured in linear metres giving a detailed description. As this item is considered to be a boundary raking cutting to the line of the valley has been also been measured.

The length of the valley is the same as the hip.

Raking cutting has also been separately measured to both sides of the valley.

In practice it is more probable that these two items will be combined in a single linear item which may read:

Forming valley; raking cutting both sides - (m).

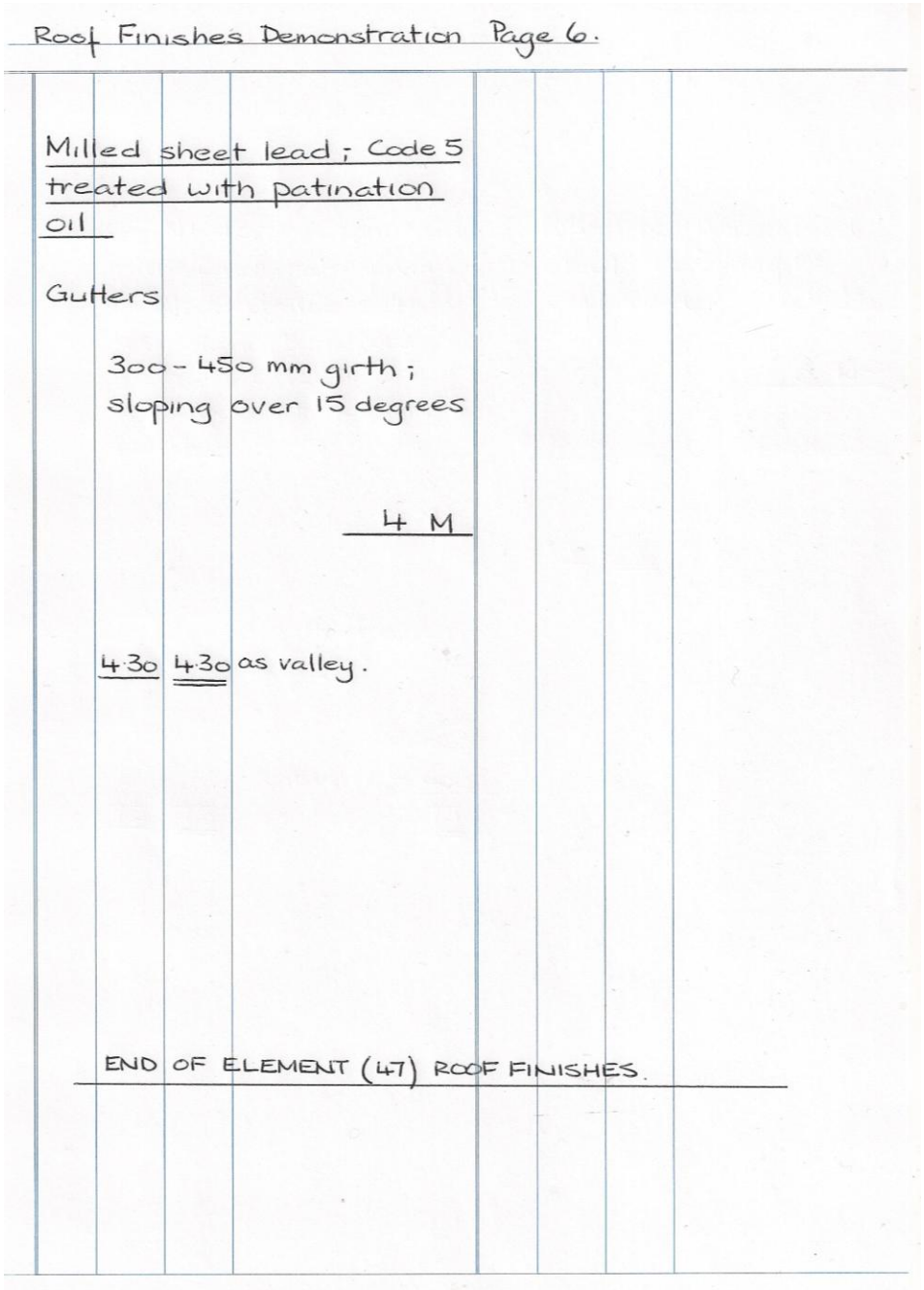


Special Fittings

Special fittings such as purpose made tiles, ventilators, finials, hip irons, soakers and saddles are enumerated giving a detailed description.

In this instance the roof ventilation panel shown on the eaves detail has been measured. The number of panels required depends on the spacing of the rafters and this has been worked out by dividing the length of the eaves (30,000mm) by the centres of the rafters (400mm) to give a total of 75 panels.

A hip iron is specified to the bottom of each of the three hips to reinforce this vulnerable position.


Roof Finishes Demonstration Page 6.

Milled sheet lead; Code 5 treated with patination oil

Gutters

300 - 450 mm girth; sloping over 15 degrees

4 M

4.30 4.30 as valley.

END OF ELEMENT (47) ROOF FINISHES.

Valley Gutter

The rules for flexible sheet metal work are set out on pages 74-77 of ARM 4. These require details of the kind and quality of the metal, gauge and/or thickness and the nature of the base to which it is attached to be described.

Gutters are measured in linear metres giving a detailed description stating the girth in 150mm stages. Curved, sloping >15°, secret, stepped, or fabricated gutters must be so described.

The measurement of the gutter is very straightforward as it is the same as the valley length.