

Technology and Environment 1

FLAT ROOFS AND ROOF COVERINGS

Learning Outcomes

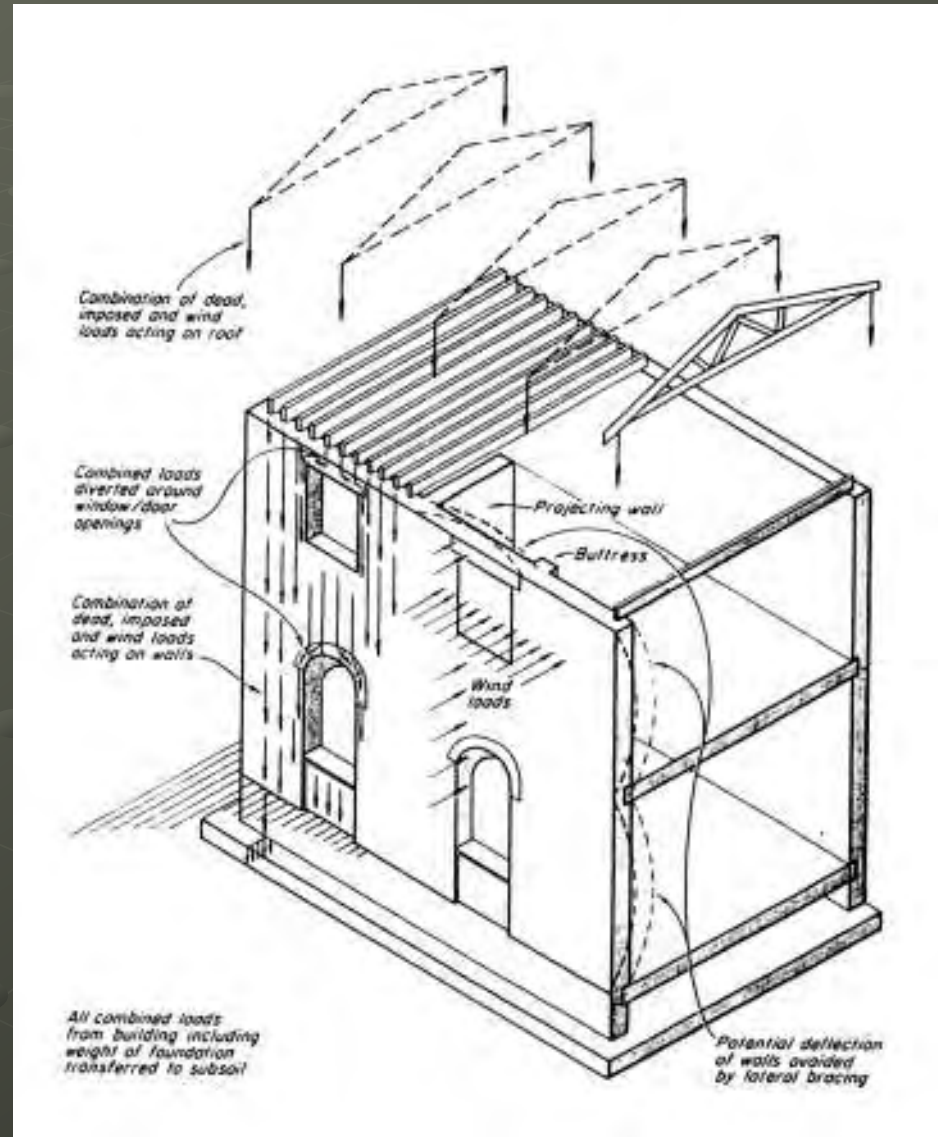
Aim

- To introduce the topic area of flat roof construction for low rise domestic buildings.
- Introduce the range of pitch roof and flat roof coverings available
- **Learning objectives**
- Identify the design requirements for roof constructions and roof finishes - to apply the knowledge to the development of studio and or course work

Roof Functions

● Function

- Weather resistance - protection against rain and snow penetration and wind
- Structural support - support its own weight and the wind and snow loads imposed on it.
- Fire resistance - protection against spread of fire
- Insulation - provide insulation and a sealed envelope to the building, while avoiding condensation.
- Durability - should be designed to last in terms of choice of materials and detail design



Roof Types

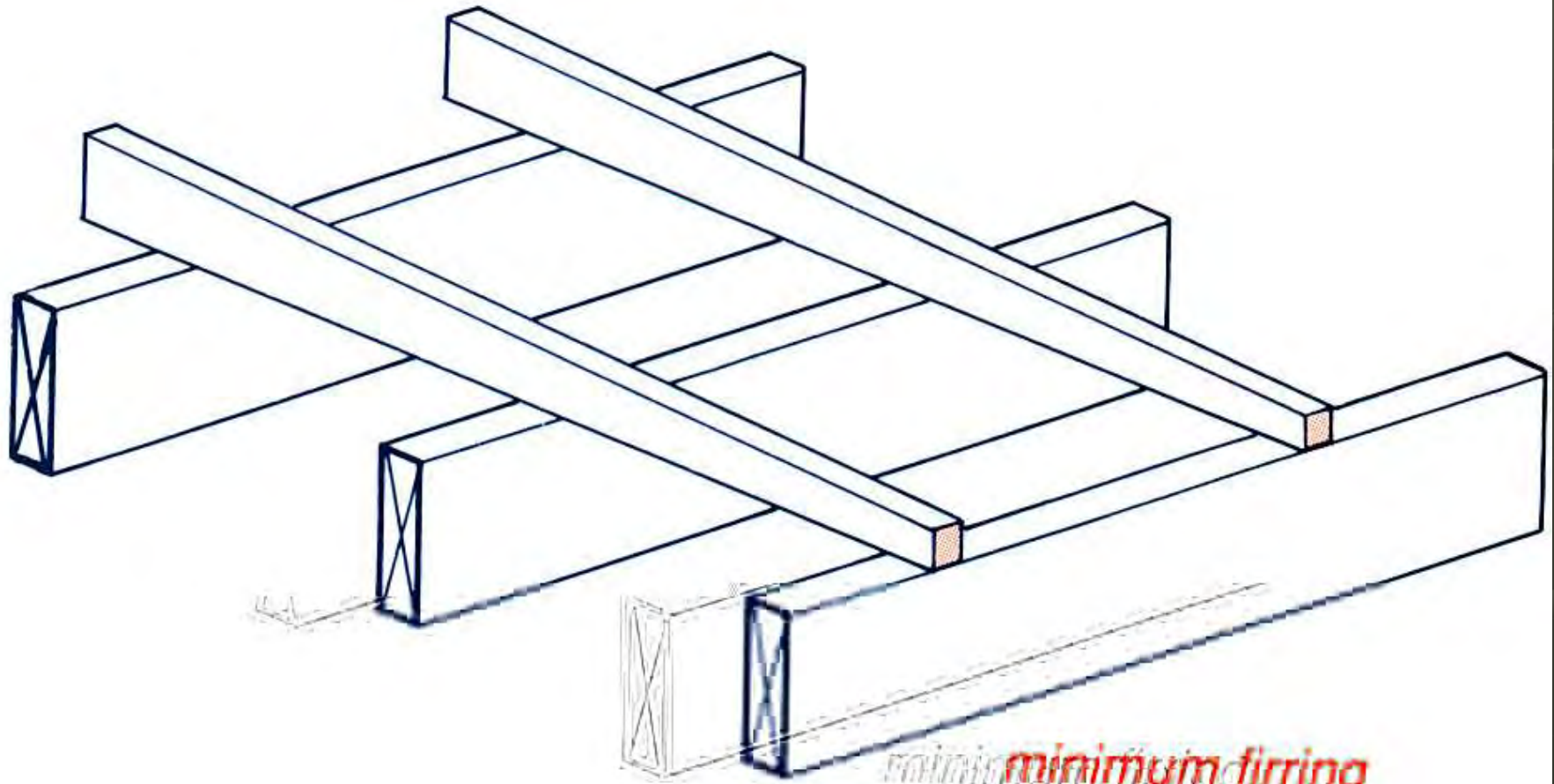
- 1. Pitched roof -are considered to have a pitch of between 10° and over 45° .
- 2. Flat roof – slope under 10°
- 3. Alternatives include - domes, vaulted roofs etc

FLAT ROOFS

● Structure .

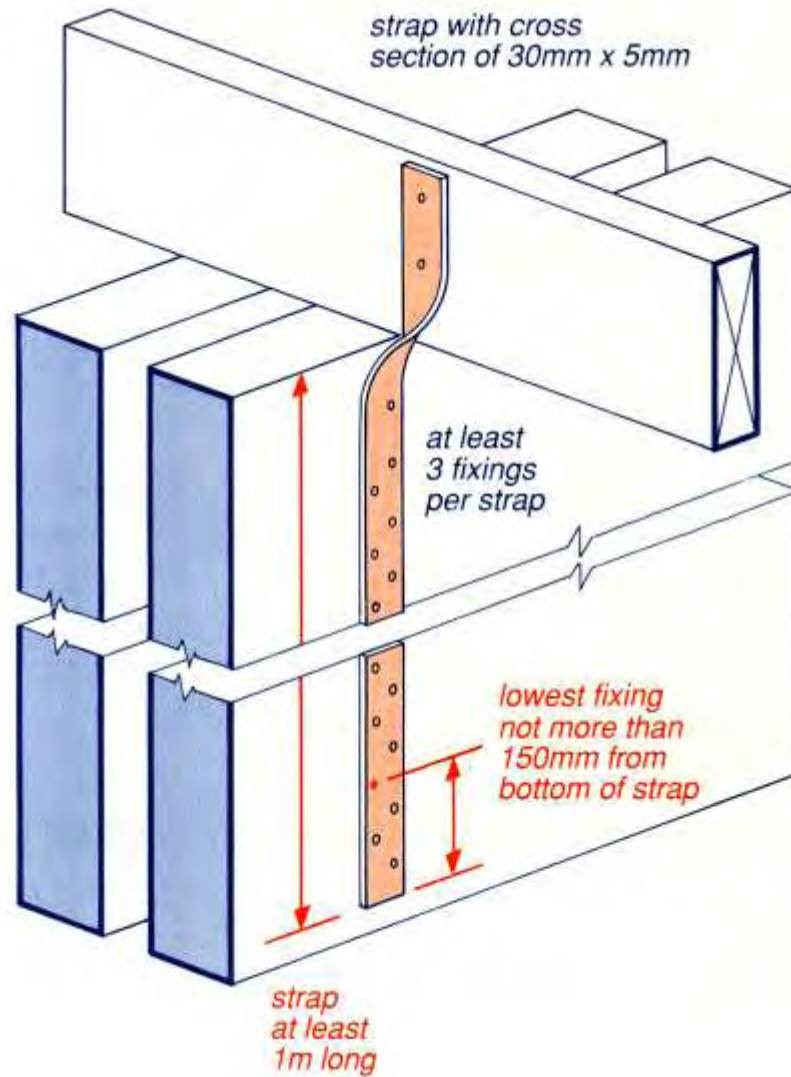
- The structure of a flat roof can be in timber, steel or concrete and is similar to floor design.
- Loading requirements must be established at an early stage, influenced by the detailed design.
- Timber and steel structure can be part of a *cold roof*, *warm roof* and *inverted warm roof* construction.
- Concrete structures can be part of a *warm roof* or an *inverted warm roof* construction.

Structure / furring pieces



minimum furring
dimensions as
in table above

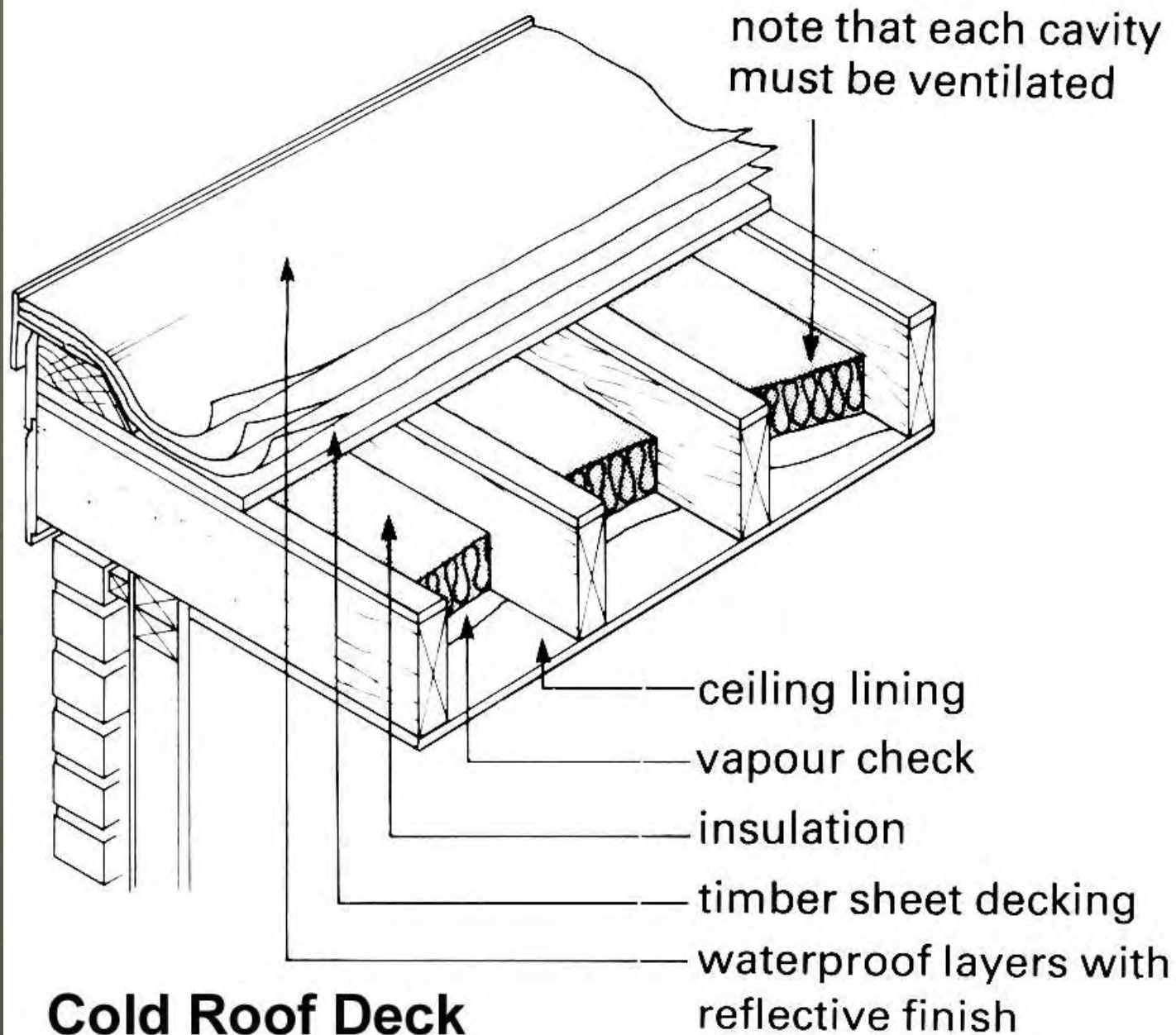
Fixing straps



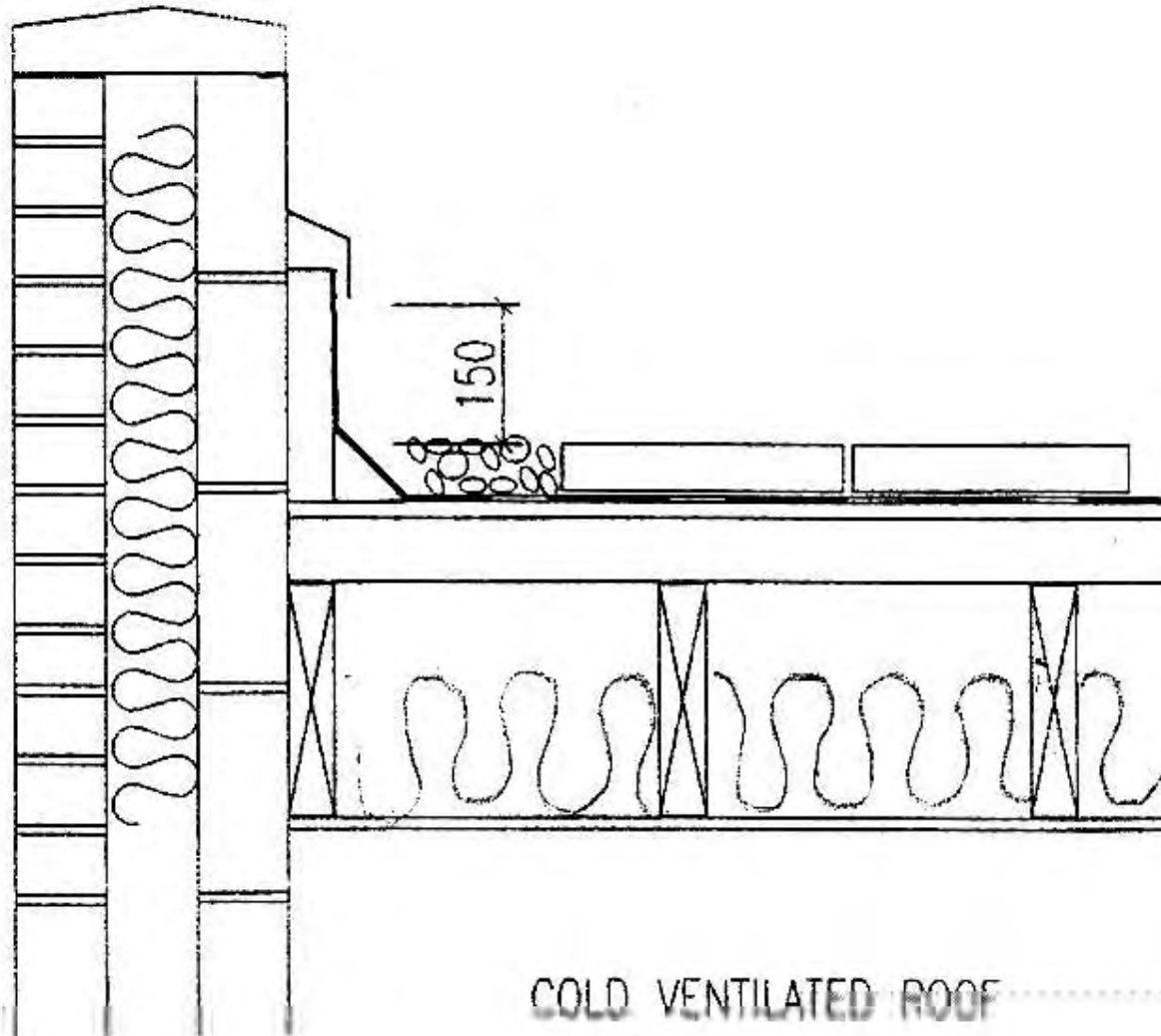
FLAT ROOFS

● Cold roofs

- Similarly to pitched roofs a typical flat cold roof construction will include from the inside out
- Plasterboard or other finishing board
- Vapour control layer (may be combined with finishing board e.g. foil backed gypsum board)
- Structure (steel or timber) and insulation.
- Counter battens providing 50mm
- Ventilation gap
- Decking (often timber)
- Waterproof layer (membrane or built-up felt)



Cold Ventilated Roof



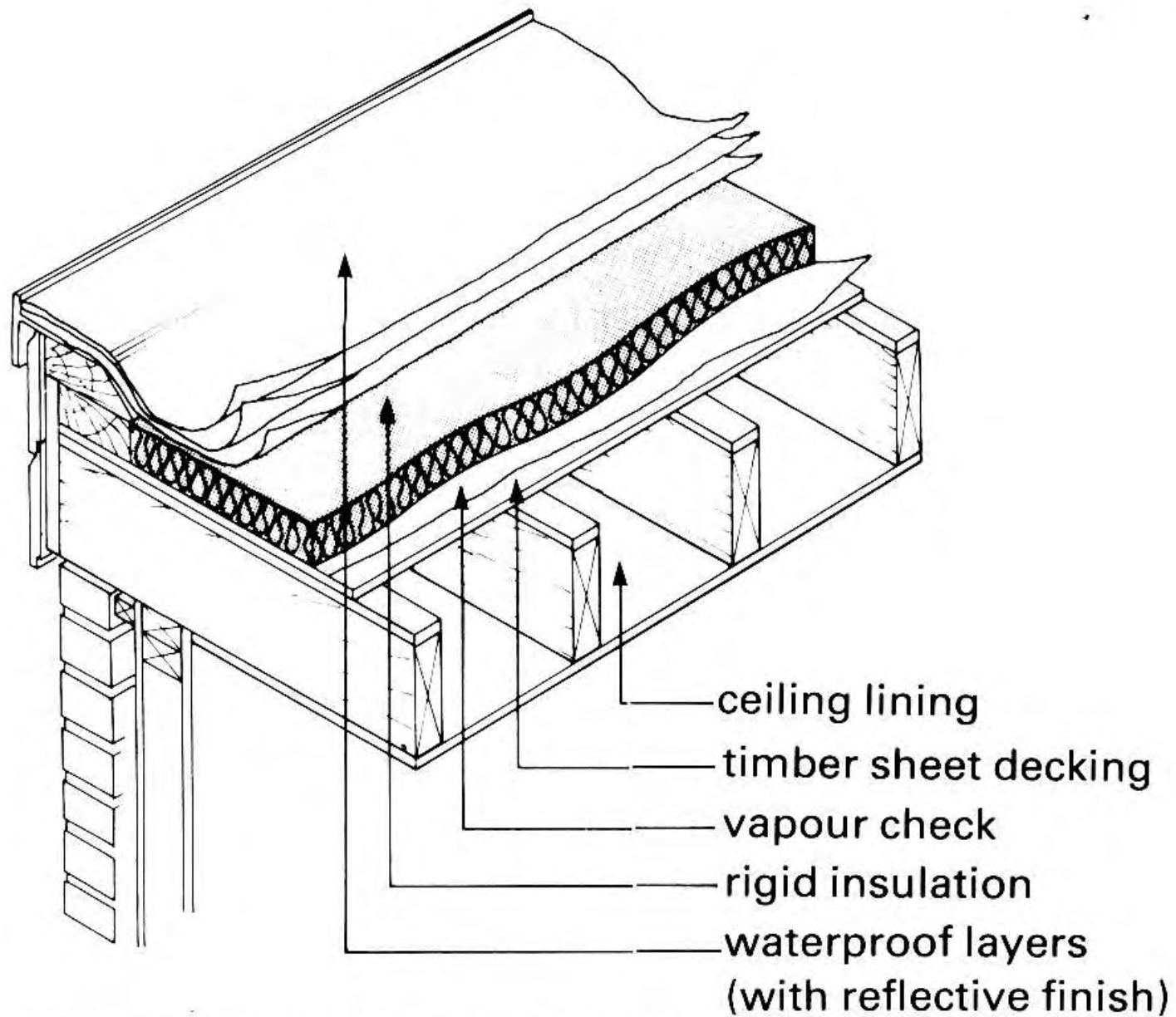
PAVING SLABS
WATERPROOF MEMBRANE
18MM TIMBER BOARD
VENTILATION GAP
STRUCTURE
INSULATION

COLD VENTILATED ROOF

FLAT ROOFS

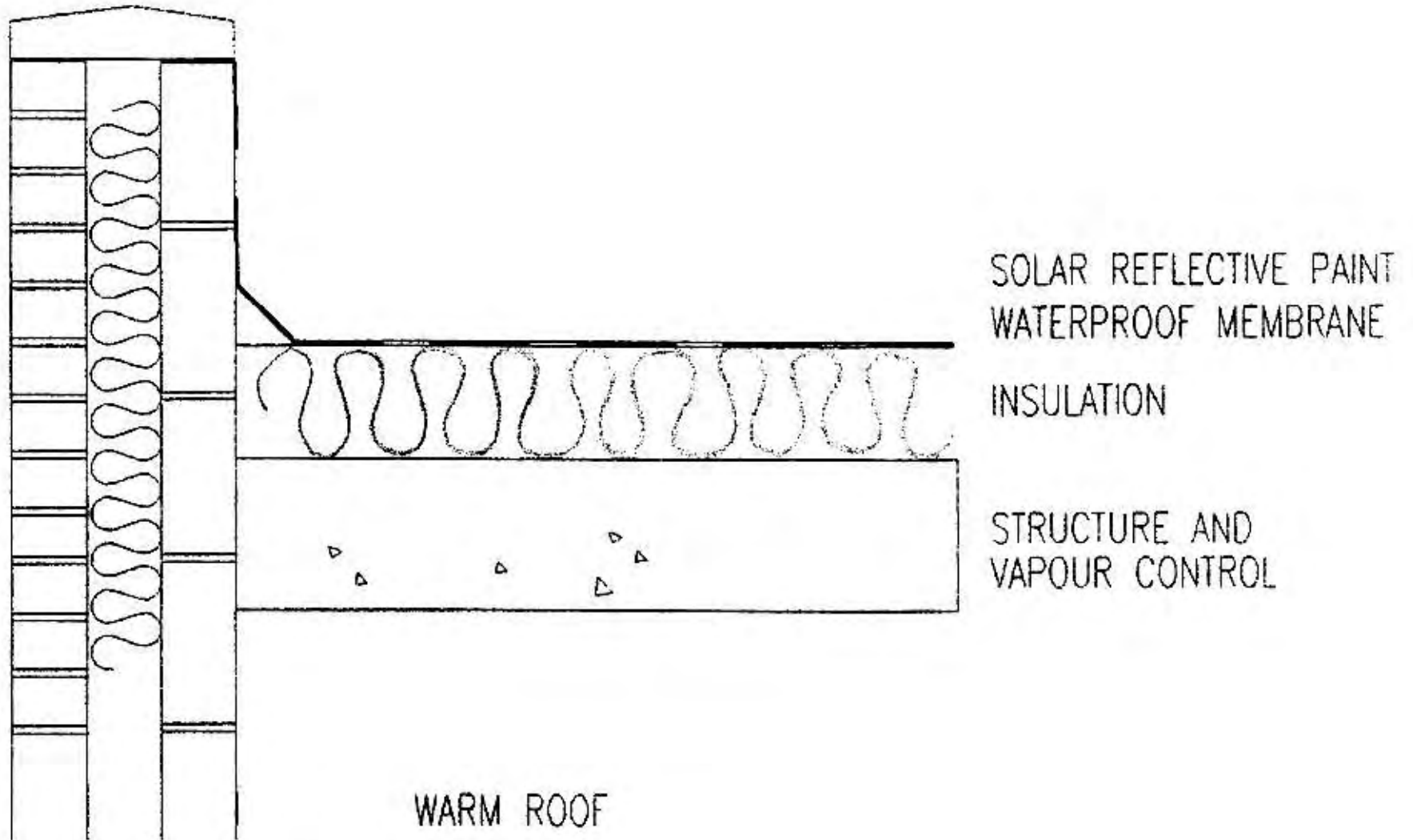
- **Warm roofs**

- Similarly to pitched roofs a typical flat warm roof construction will include from the inside out
 - Plasterboard or other finishing board/treatment
 - Structure (steel, timber or concrete).
 - Vapour control layer.
 - Insulation
 - Waterproof layer (membrane or built-up felt)

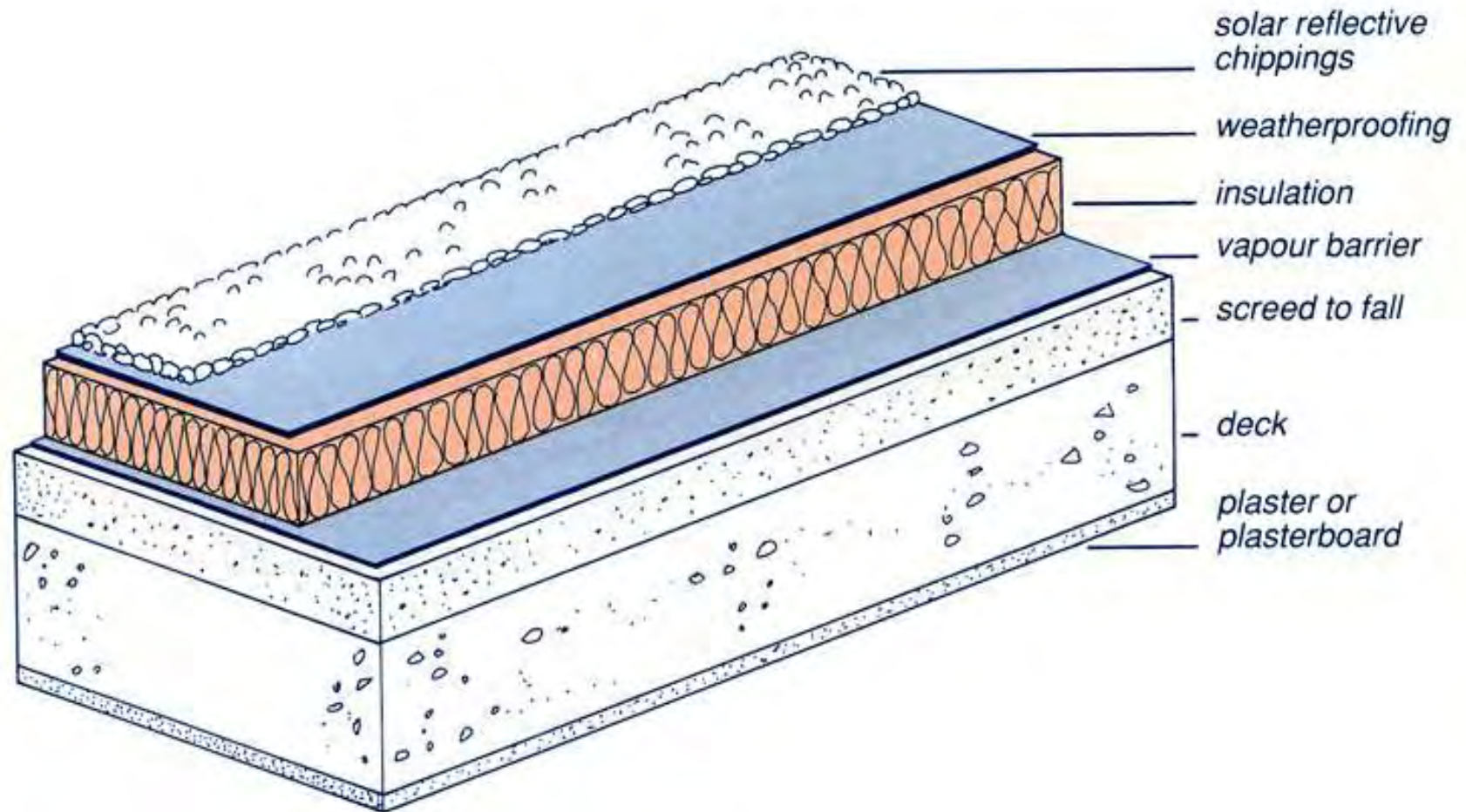


Warm Deck Sandwich Construction

Warm Roof



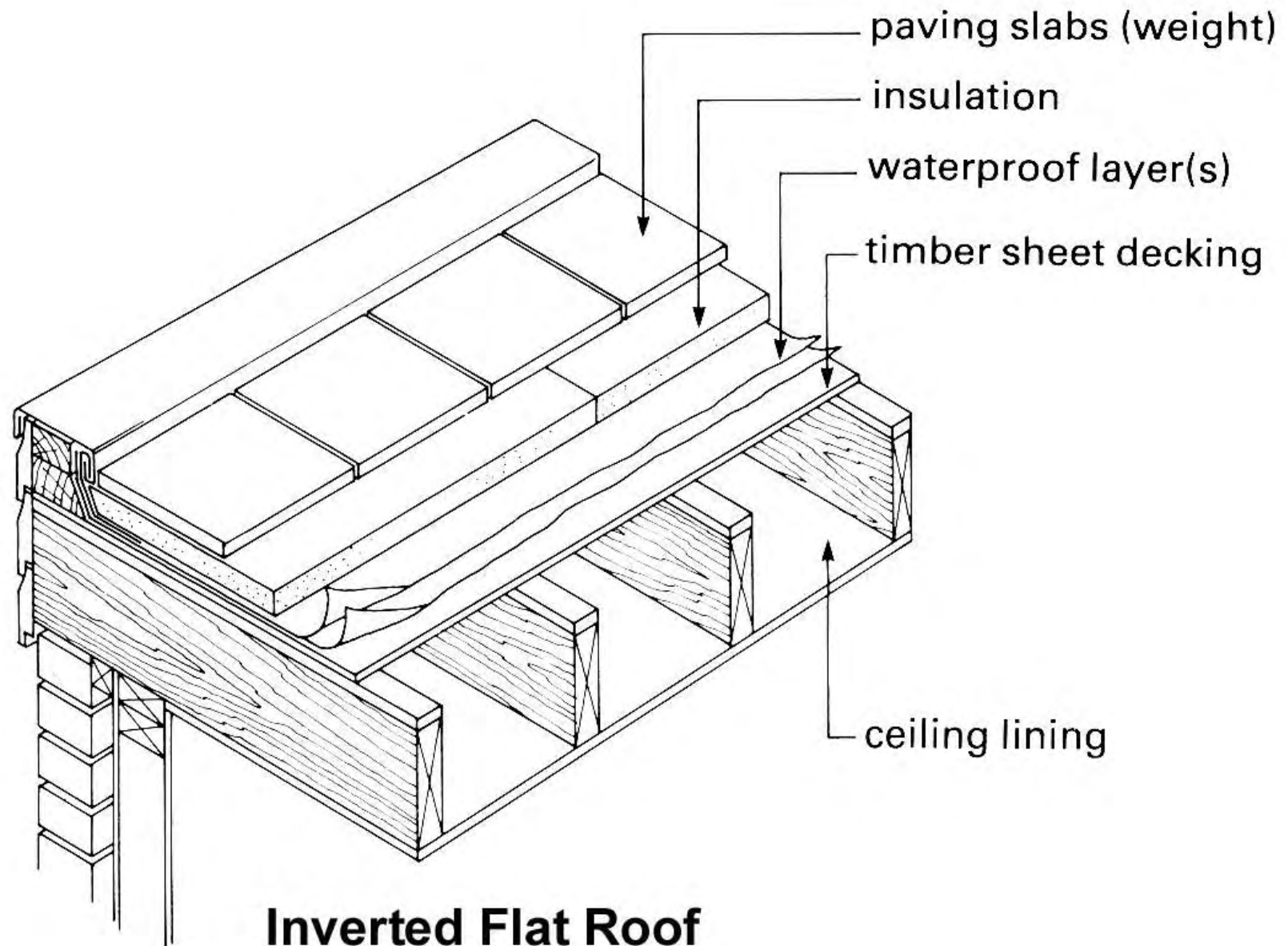
WARM DECK (concrete)



FLAT ROOFS

- **Warm inverted roofs**

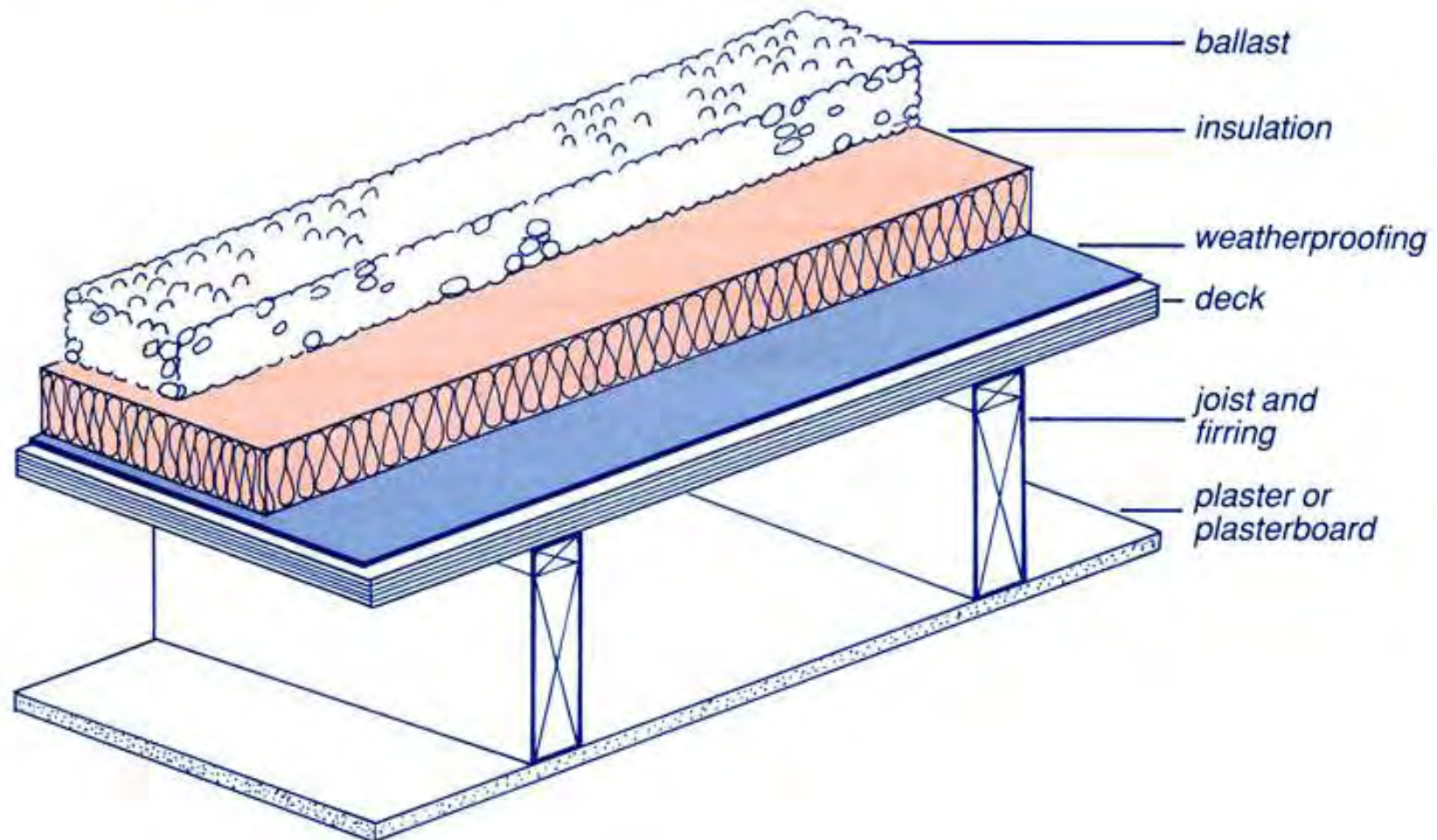
- Similar to warm roofs, but have inverted the order of the insulation and the waterproofing layer. Typical build-up from the inside out is :
- Plasterboard or other finishing board/treatment
- Structure (steel, timber or concrete)
- Vapour control layer (may be under structure)
- Waterproof layer (membrane or built-up felt)
- Insulation
- Ballast (paving slabs, or other materials to keep the insulation in place)



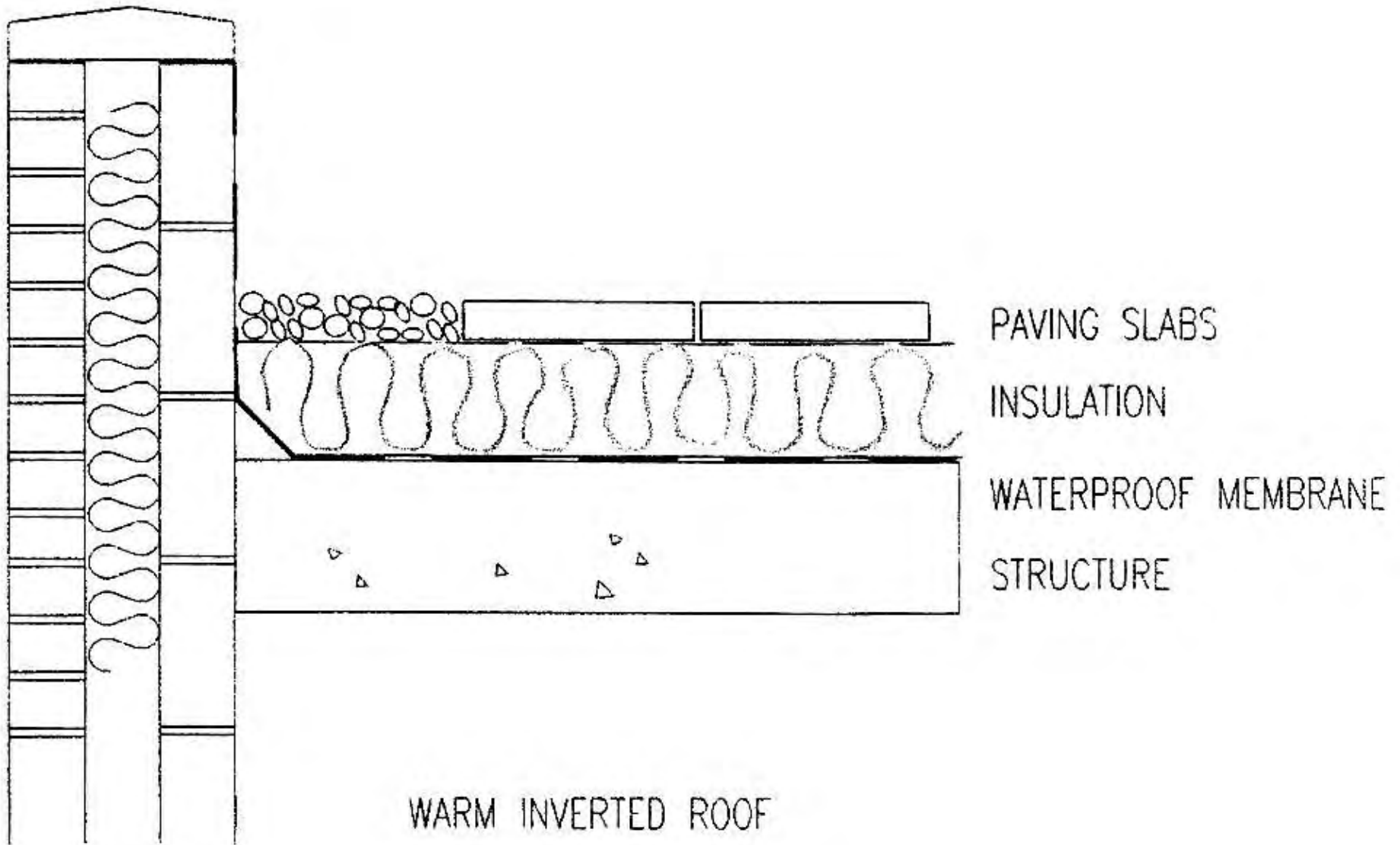
Inverted Flat Roof

INVERTED ROOF (timber)

(NOT suitable for slopes greater than 10°)



Warm Inverted Roof



FLAT ROOFS

- Waterproofing layer options:
- *Bitumen Felts* consist of fibre mats impregnated with bitumen.
- Mineral granules are used to prevent degradation from ultraviolet light.
- Three layers are generally used and bonded together with hot bitumen.
- It is a relatively energy intensive solution and the roof covering is essentially impossible to recycle.

FLAT ROOFS

- Waterproofing layer options:
- ***Mastic Asphalt** consists of bitumen recovered from crude oil or naturally occurring asphalt.*
- *Applied generally to concrete structures on a separating layer.*
- *A brittle thermoplastic should only be used on heavyweight decks and protected from UV light with reflective chippings or paint.*
- *Very energy intensive process and material.*

FLAT ROOFS

- Waterproofing layer options:
- *Polymeric single-ply membranes* include PVC, EPDM and others.
- *The membranes may be reinforced with a fabric core and joints are made either on or off site by gluing or hot air welding techniques.*
- *Most polymeric membranes are applied in similar ways and can be mechanically fixed, glued or loose laid weighed down with ballast.*

FLAT ROOFS

- Waterproofing layer options:
- **PVC - Polyvinyl Chloride** membranes are manufactured from vinyl chloride monomer and ethylene dichloride both which are known carcinogens and powerful irritants.
- High levels of dioxins have been found around PVC manufacturing plants and numerous toxins are released during manufacture to water, air and land.
- Additives such as phthalates used as plasticisers are thought to be hormone disrupting/mimicking substances are thought to be linked with falling sperm counts in humans and animals.
- PVC is inert when in use, but in a fire can release hydrochloric acid and dioxins as well as carbon monoxide and fumes.

FLAT ROOFS

- Waterproofing layer options:
- **EPDM** - is a synthetic rubber membrane with similar embodied energy to PVC, but is associated with minimal environmental damage.
- It is extremely durable and can be reused as a roof membrane if installed with mechanical fixings

GREEN ROOFS

- **Planted roofs**
- Using a single-ply membrane as a base a roof can be planted.
- Planted roofs can be expensive.
- Extensive or intensive.

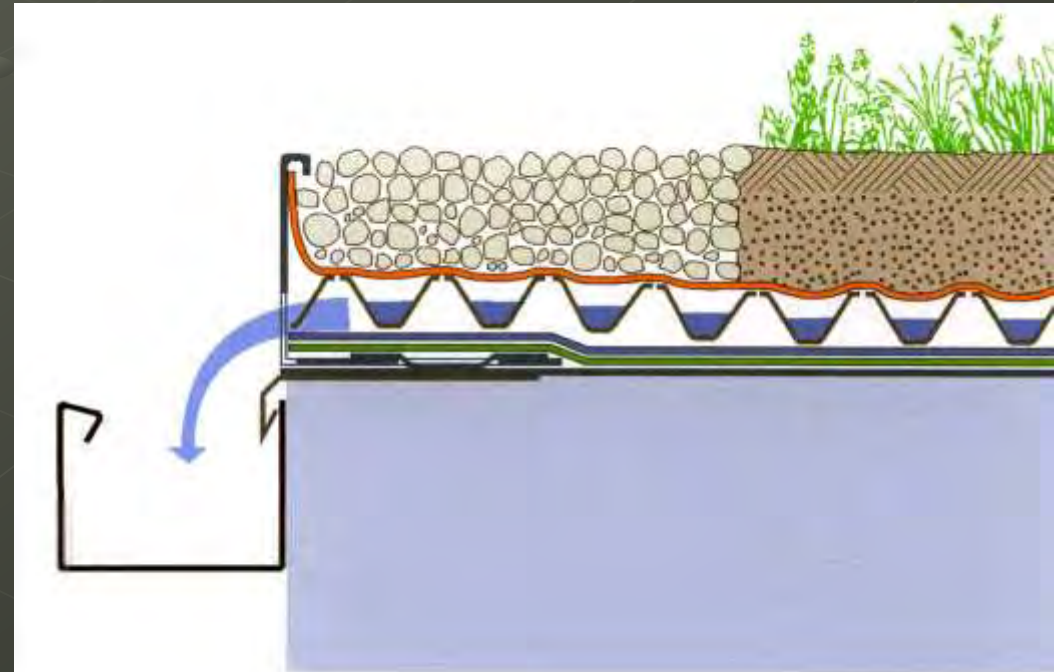
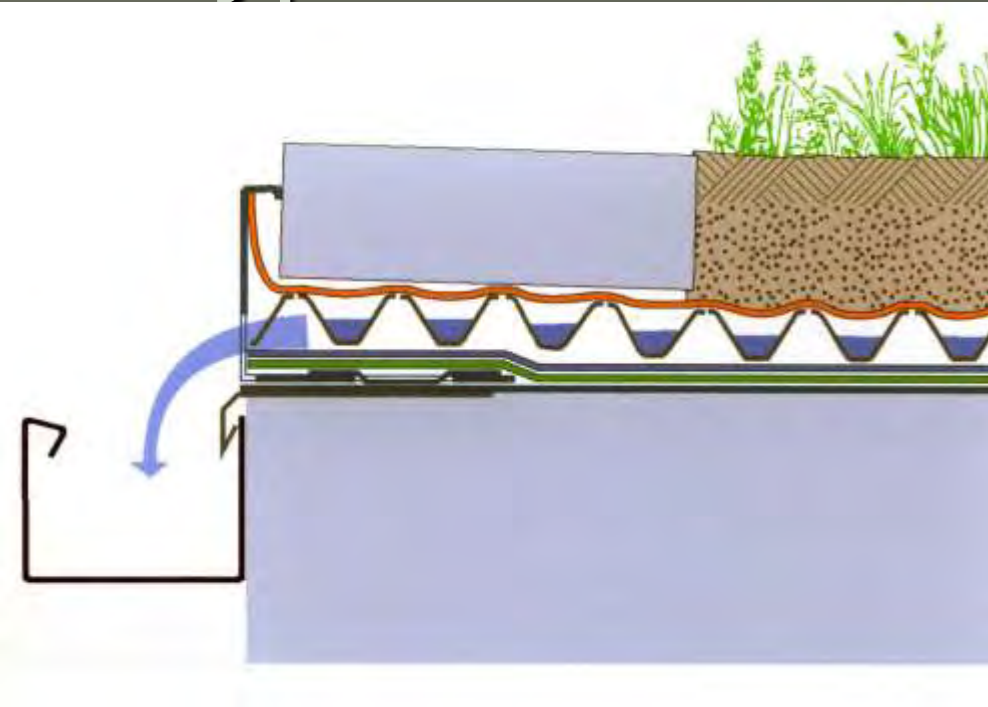
Ty-cwrdd Bach



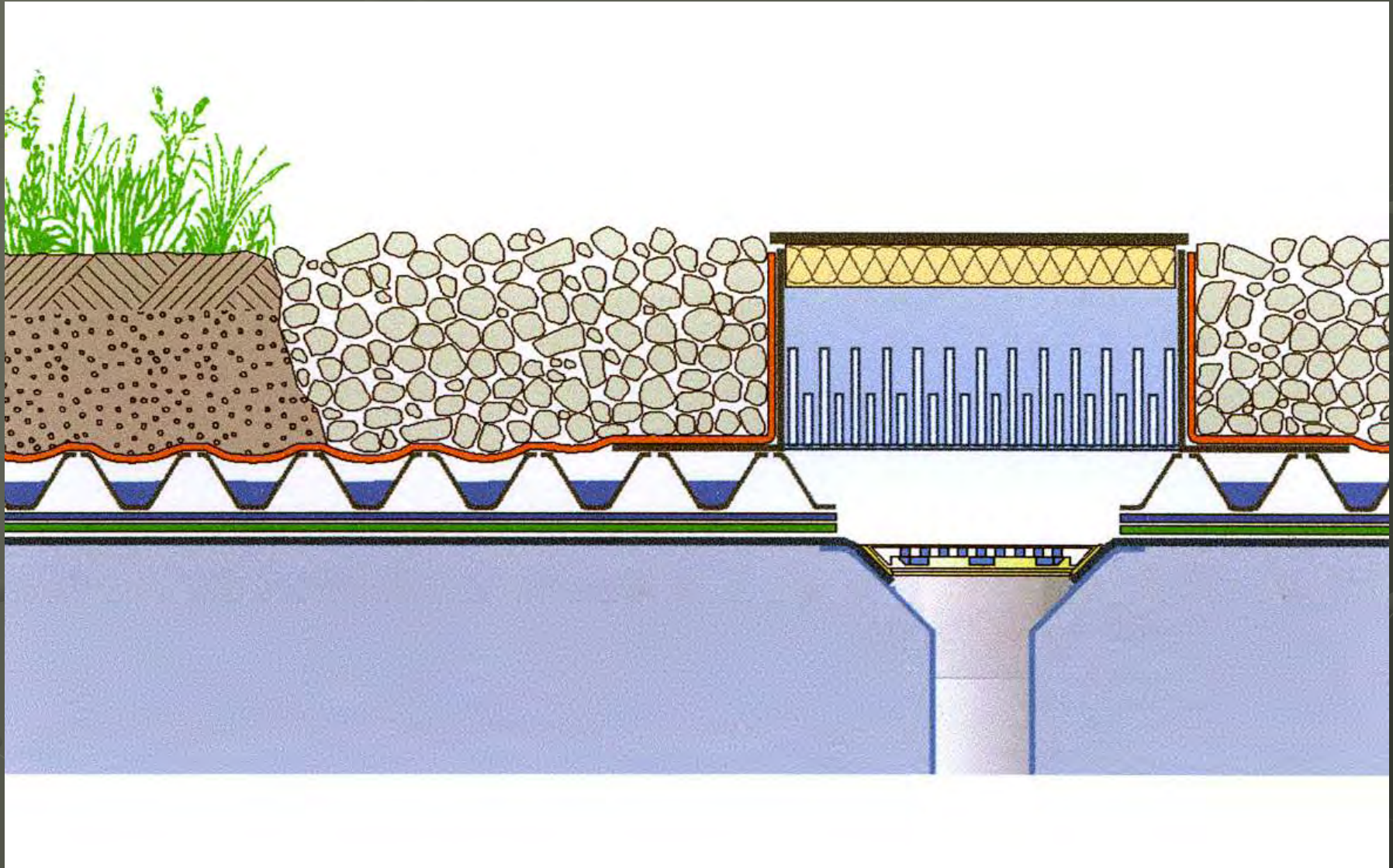
GREEN ROOFS

- **Extensive roofs** involve the installation of a minimal layer of soil (e.g. 100mm) to grow grasses and sedum. The relatively light makeup of the roof generally does not impose substantially greater loads on the roof structure than alternative roofing materials. Extensive roofs are not designed for regular access.
- Elements of extensive green roofs
- Vegetation: Grasses-Shrubs
- Extensive Soil. - max. 300mm (Saturated weight: ca.350 *kg/m²*)
- Filter Fleece
- Drainage and Reservoir Board (optional)
- Protective and Reservoir Fleece (optional) . Root barrier and separating layer (can be combined)
- Insulation (alternative position as with cold roof)
- Waterproofing layer

Typical Eaves Details /Green Roof



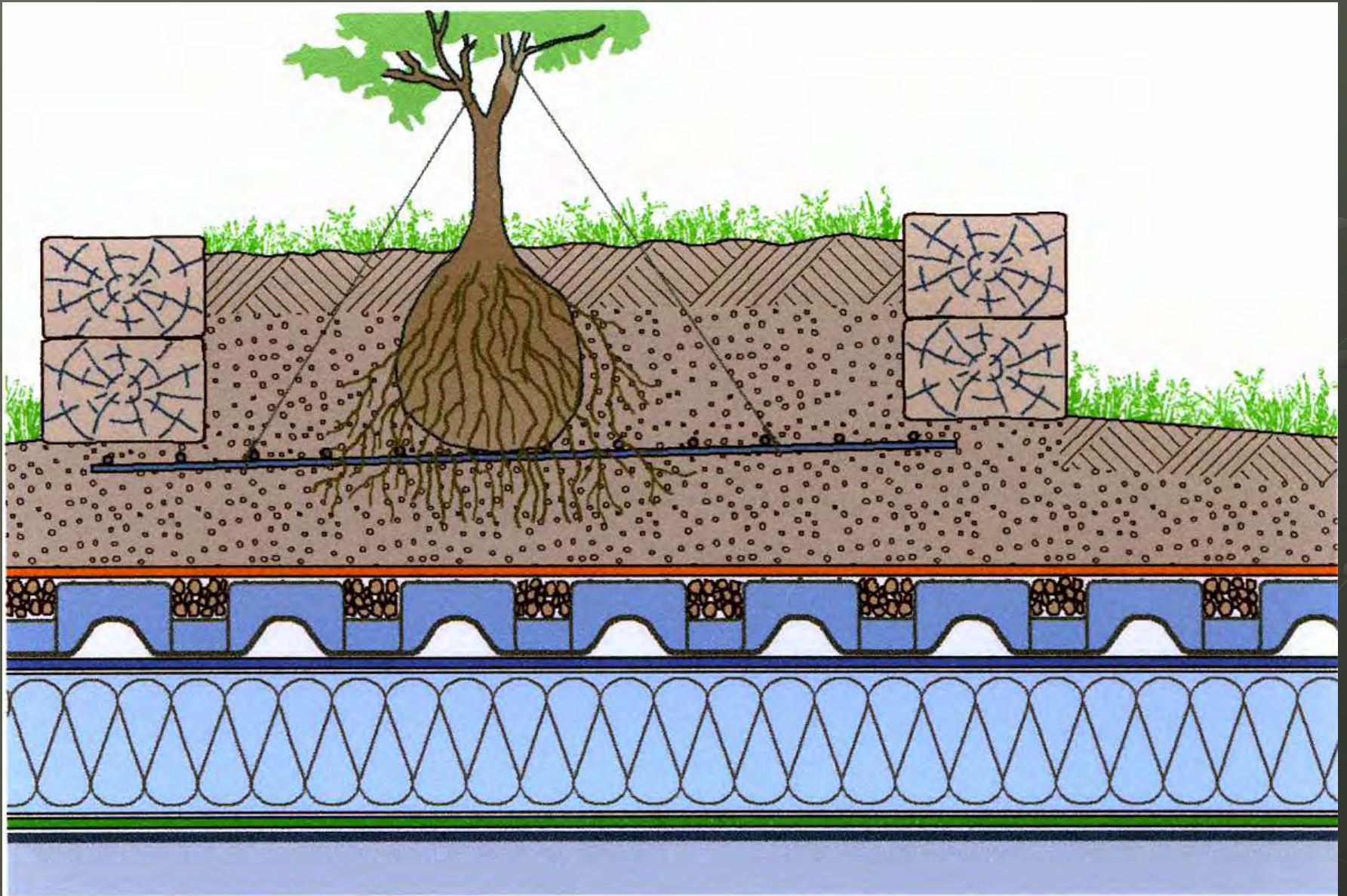
Green Roof /rainwater outlet



GREEN ROOFS

- **Intensive roofs** are designed to be inhabited and involve the installation of between 300 and more than a metre of soil grow grasses, but also shrubs and trees. Intensive roofs impose substantially greater loads on the roof structure than alternative roofing materials and the structure has to be sized accordingly.
- Elements of intensive green roofs
- Vegetation: Shrubs-Small trees-Lawns- Trees . Intensive Soil 840mm or more (Saturated weight: ca.750 kg/m²) .
- *Filter Fleece*
- Drainage and Reservoir Board
- Protective and Reservoir Fleece
- Root barrier and separating layer (can be combined)
- Insulation (alternative position as with cold roof)
- Waterproofing layer

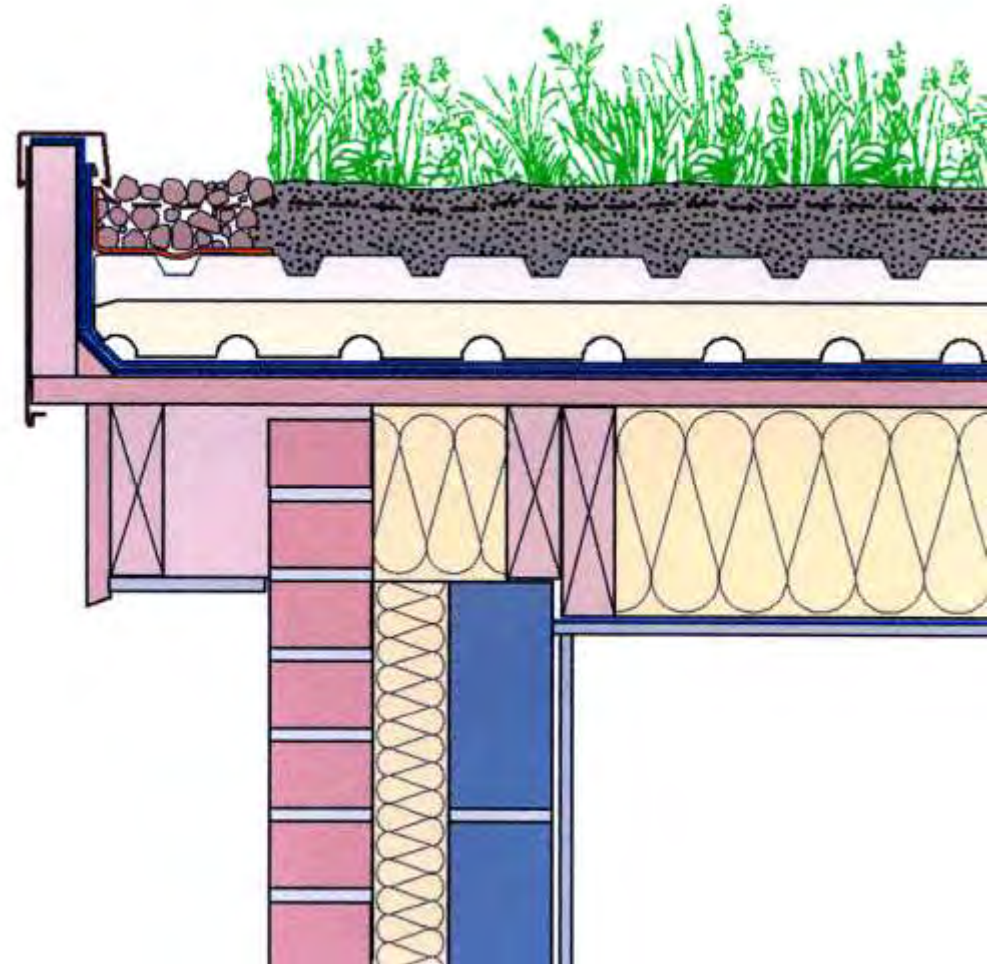
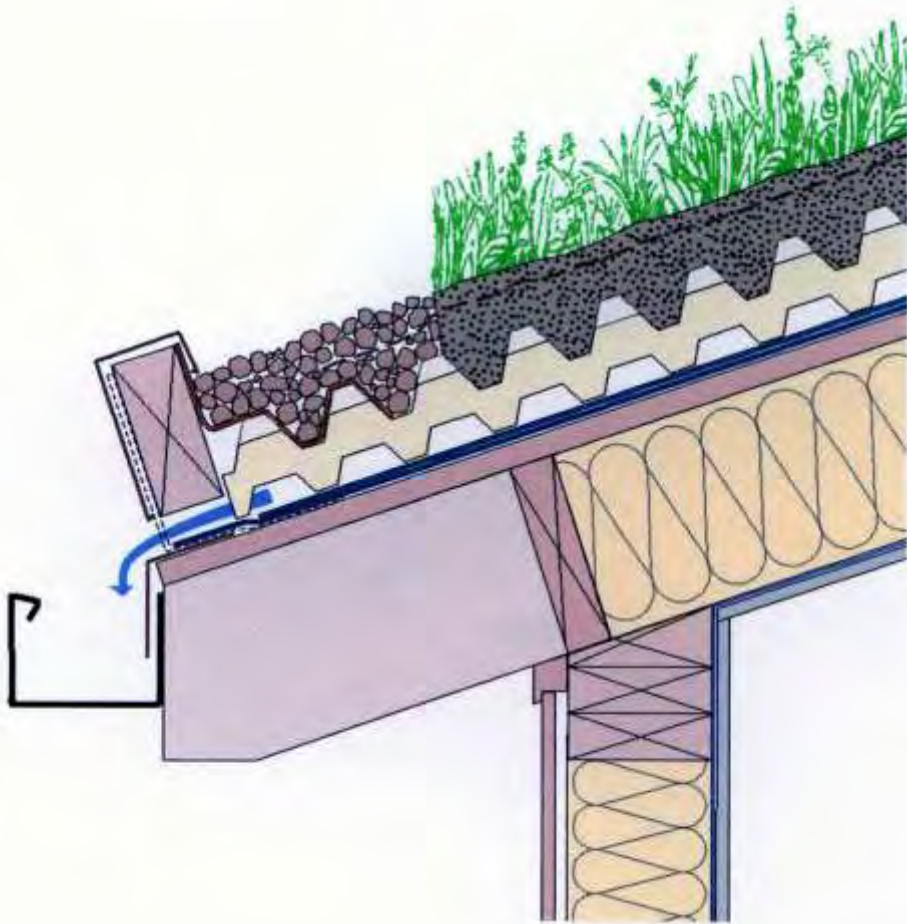
Green Roof Landscaping



GREEN ROOFS

- **Green Roofs** can provide ecological and economical advantages.
- improved micro climate
- relief of the sewerage systems by the retaining of rain water
- providing a favourable habitat for plants, animals and human beings .
- improved noise absorption
- reduced costs of energy due to improved heat insulation

Pitched Green Roof



GREEN ROOFS

- Green Roofs can help counteract the negative effects of the typical climate of our cities facing
- low humidity
- high concentrations of dust
- pollution
- overheating

ROOF COVERINGS

● METAL ROOFS

- *Lead, zinc, copper, steel and aluminum* can be used to cover roofs in domestic and commercial buildings.
- Metal roofs can be installed in a number of ways by using the following systems:
 - Flat metal sheeting (copper, lead, zinc)
 - Standing seam metal roofs
 - Profiled metal roofs (steel, aluminium, zinc)

Standing Seam Zinc Roof



Standing Seam Zinc Roof



ROOF COVERINGS

● METAL ROOFS

- Flat metal roofing involves bending metal sheets over a ply support board with timber rolls to create waterproof joints between the sheets (usually 600 mm wide).
- Traditional batten roll detail

ROOF COVERINGS

● METAL ROOFS

- Standing seam roofing involves folding sheets of metal over metal clips supported on ply or metal bases. The folding of the sheets can be done partially or completely on site. The metal clips (T shaped) can be of different heights and materials (usually metal, but now also available in insulating plastic compounds). The shape of the metal profiles can be selected as required.
- Traditional standing seam
- *modern standing seam*

ROOF COVERINGS

● METAL ROOFS

- Profiled metal roof involves fixing preformed sheets of metal on a supporting structure. Size and shape of profiled sections vary.
- Profiled metal roofing

ROOF COVERINGS

● METAL ROOFS

- A protective coating may be required to prevent the metal roof from degrading. Lead, copper, aluminium and zinc can be used without protective coating; steel (unless it is stainless steel) needs a coating.

ROOF COVERINGS

● METAL ROOFS - *LEAD*

- Lead -should be covered with a patination oil to prevent staining.
- Lead can corrode as a result of moisture condensation on the inside face of the metal and should be ventilated as a cold roof.

ROOF COVERINGS

● METAL ROOFS - COPPER

- Copper - forms a thin insoluble protective film when exposed to air which progressively changes the shiny golden reddish metal to brown and then green.
- Copper sheets can be pre-patinated before installation.

ROOF COVERINGS

● METAL ROOFS - ALUMINIUM

- Aluminium - can be used in its natural finish called 'mill finish' and will weather to a matt grey.
- It can also be anodised or powdercoated which can provide further protection and can colour the aluminium.

ROOF COVERINGS

● METAL ROOFS - ALUMINIUM

- *Zinc - does not need a protective coating, however to increase its life zinc can be alloyed with titanium or copper.*
- *Stainless steel - can be used without coating*
- *Steel - can be protected with a polyester powder coating,terne coating or galvanised finish*



PITCHED ROOF COVERINGS

Roof Coverings and Roof Pitch

- Pitched roof coverings have to be installed at different minimum slopes.
- To avoid rain penetrating in to the structure.
- Roof accessories are designed for specific slopes i.e. Velux windows min 15 deg

Minimum slopes for pitched roof coverings

- Plain tiles 40 deg min
- Clay interlocking tile 22.5 deg min
- Concrete interlocking tiles 17.5 deg min
- Slate 20 deg (mainly 30 deg)
- Fibre reinforced cement slates 17.5 deg
- Thatch 45 deg



Concrete interlocking tiles

Slate Roof



Concrete or clay pan tiles



Clay plain tiles

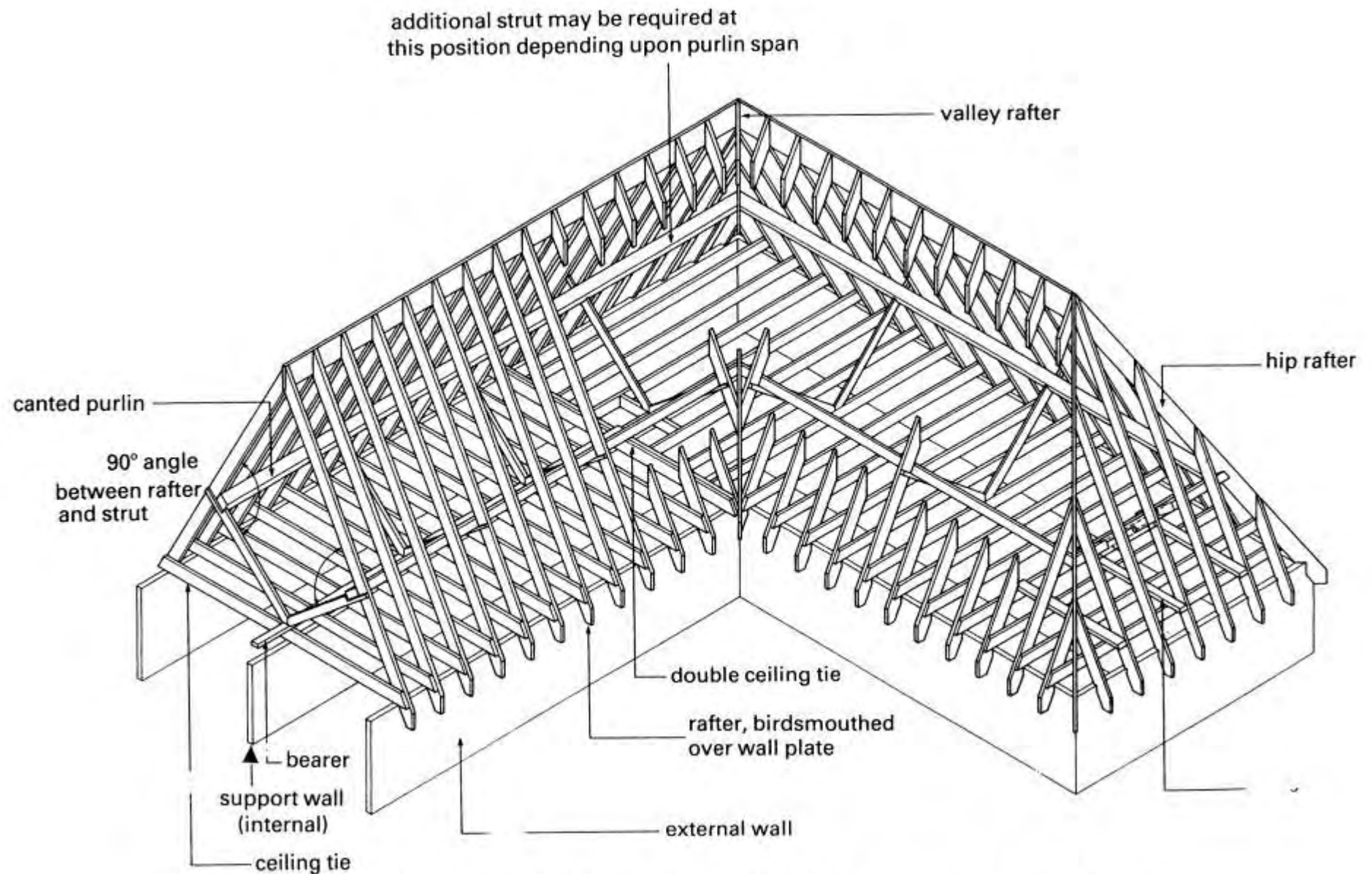


Modern Speculative Housing



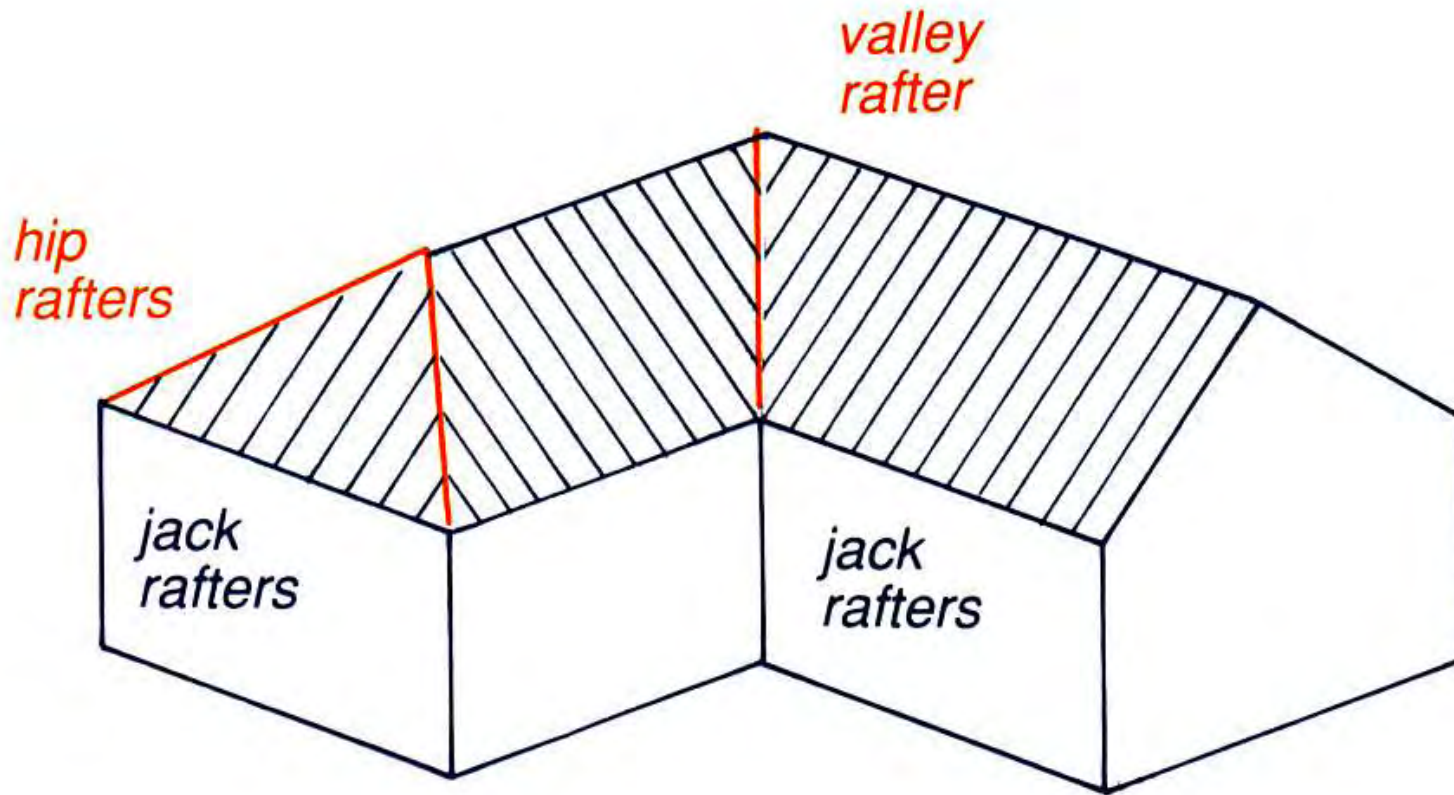
Roof Constructions

- The standard build-up of a roof includes (from the inside out)
 - 1. Supporting structure
 - 2. Sarking felt / membrane - secondary protection layer
 - 3. Battens
 - 4. Roof covering - primary protection layer

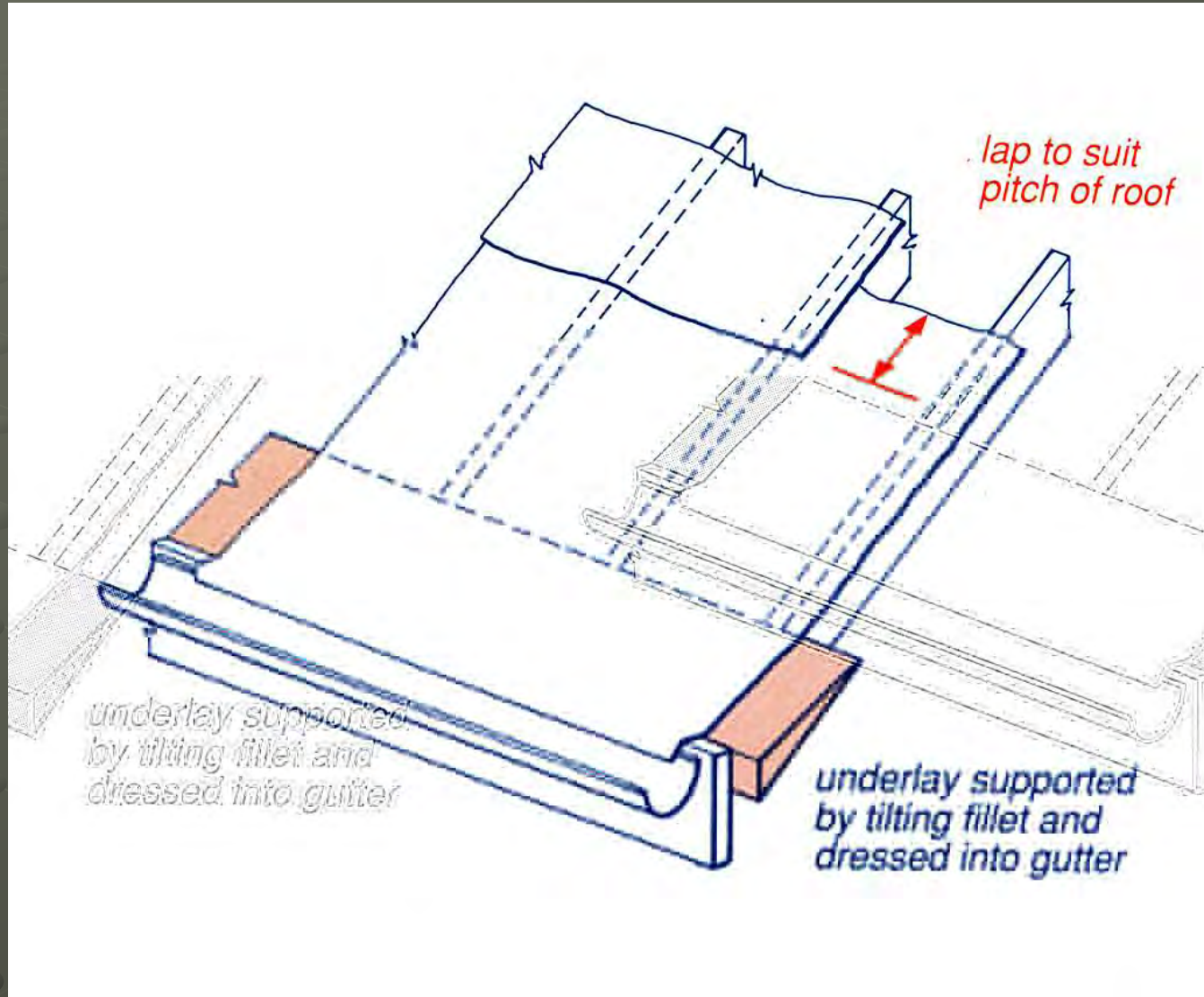


Typical construction of purlin roof with strut, showing hip and valley details

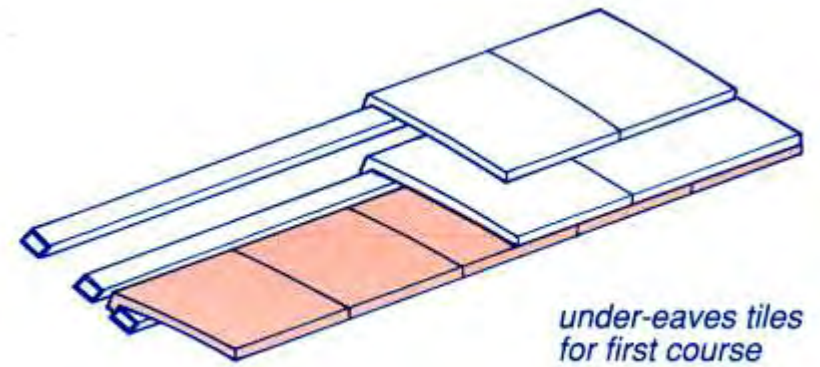
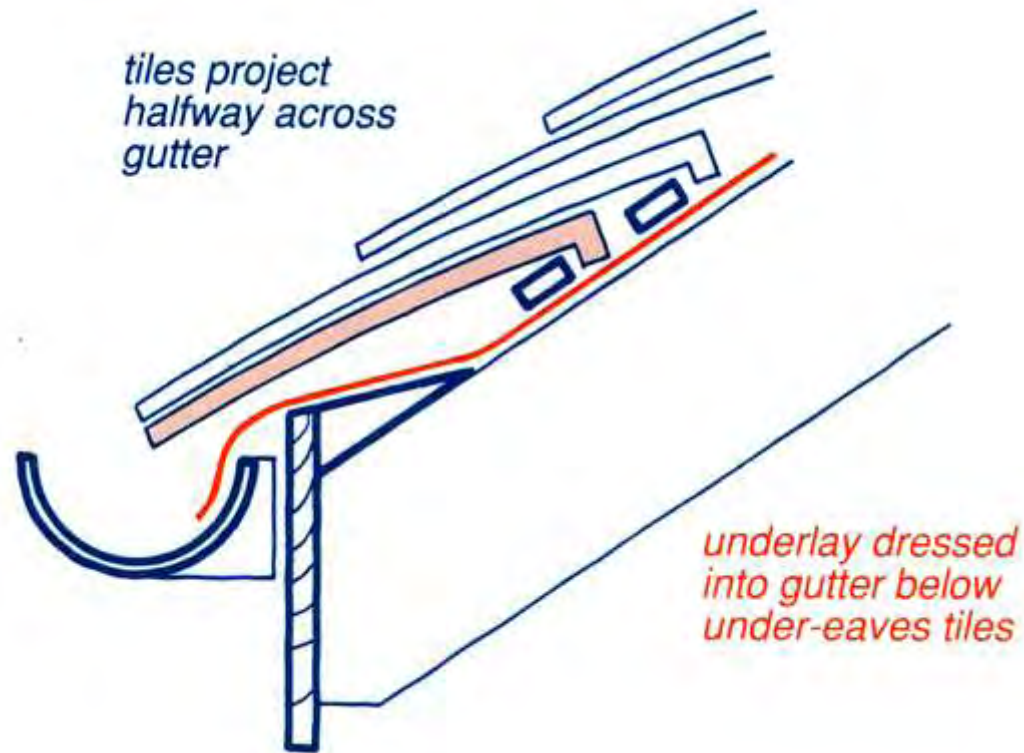
Hip, valley and gable



Pitched Roof Underlay



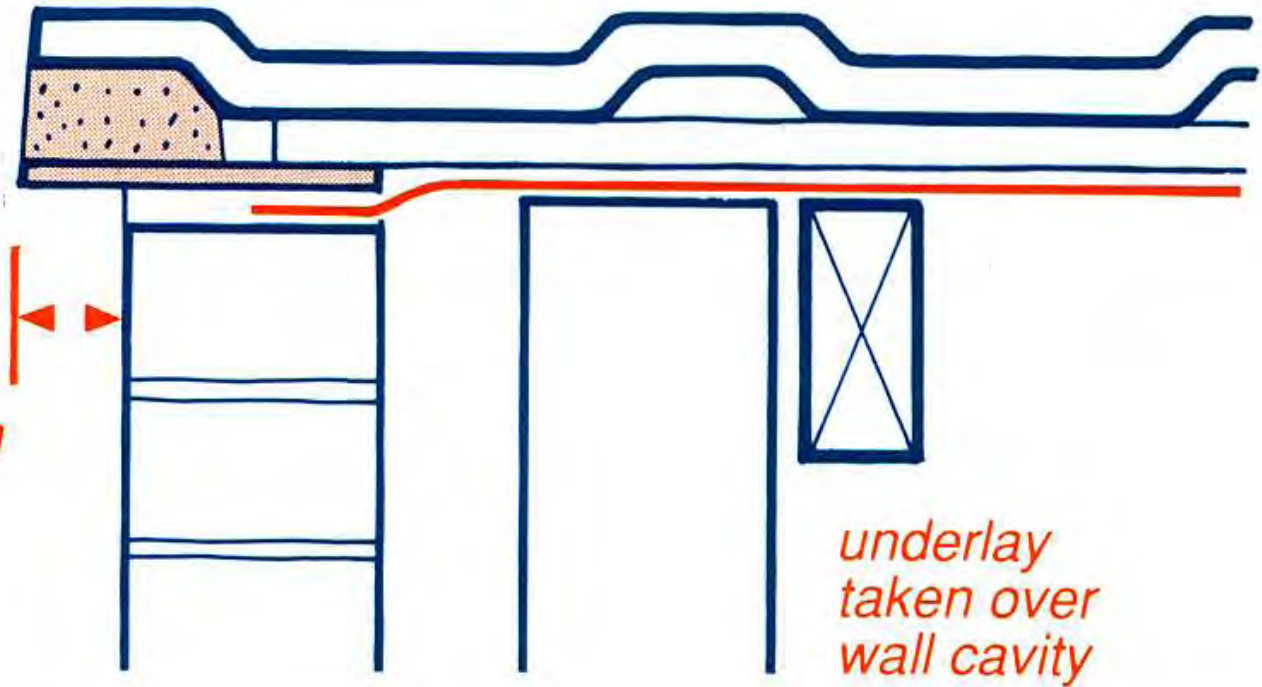
Eaves Detail



Typical Verge Detail

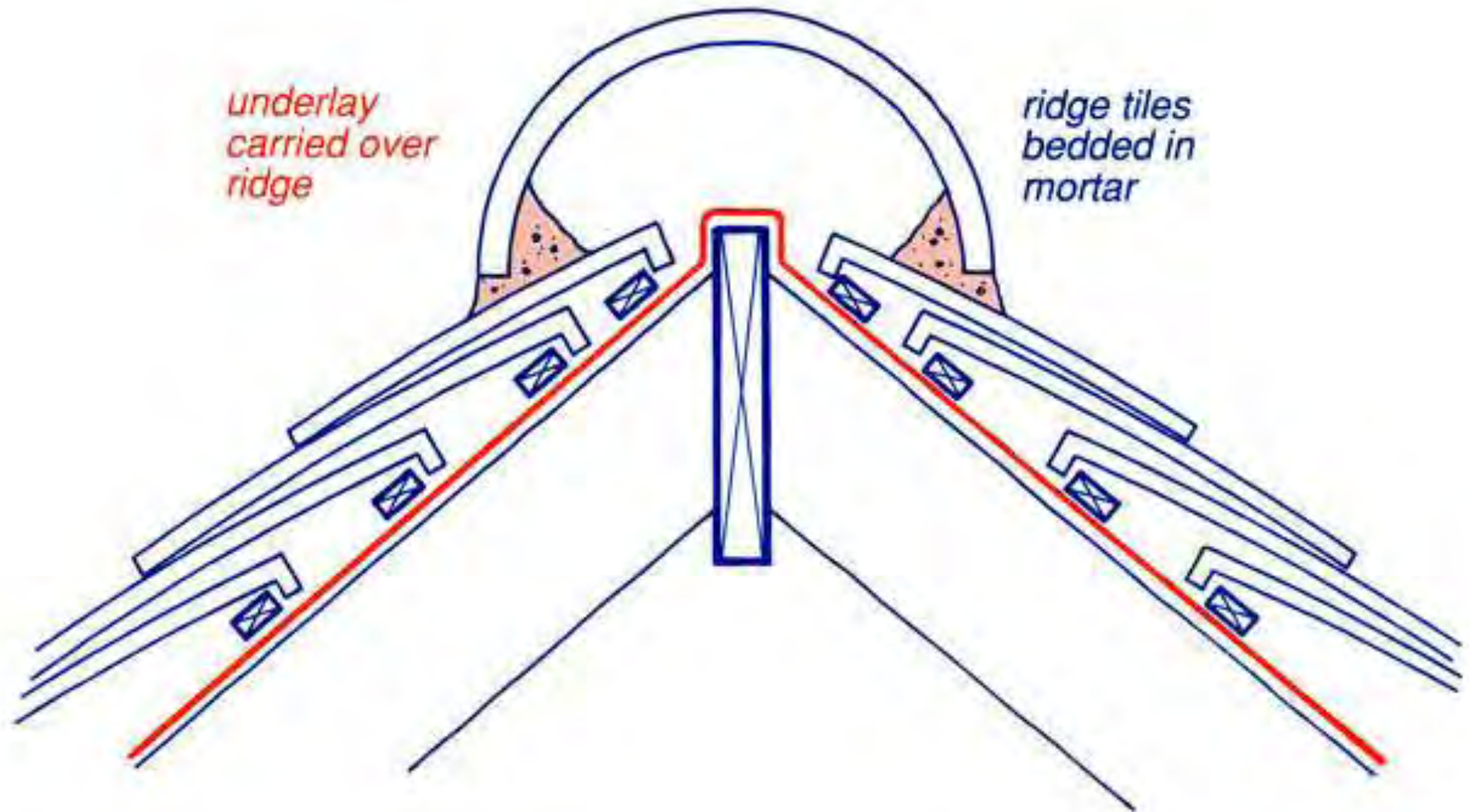
*verge tiles bedded
in mortar on
tile undercloak*

40mm to 50mm



*underlay
taken over
wall cavity*

Hip / Ridge Detail



Cold Roof /Slate finish

Radvent Eaves Ventilation Packs (8188) for rafters centres up to 450mm, (8190) for rafter centres up to 600mm.

Radvent Eaves Extension Pack (8488) for rafter centres up to 450mm, (8489) for rafter centres up to 600mm.

UPVC Extension Tray

Trays overlap

UPVC Eaves Ventilator Tray

Underlay

50 x 125mm S.W. battens

Cembris Blids (4701)
Must be mechanically fixed

PVC apron

UPVC Fascia Gutter Unit nailed
into fascia board

Eaves ventilator tray skirt
dressed into gutter

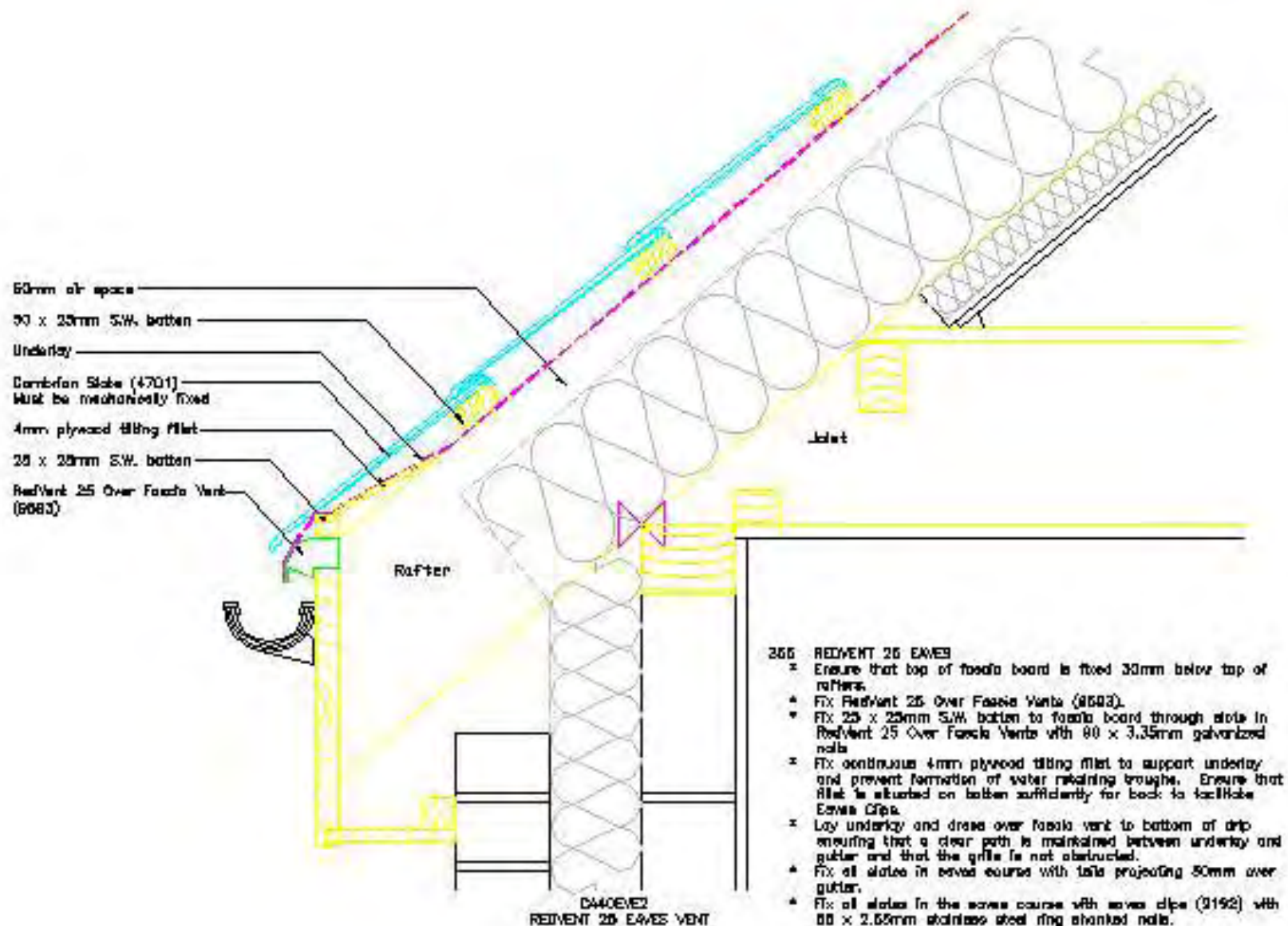
Trussed Rafter

CHANGES TO RADVENT
EAVES VENT

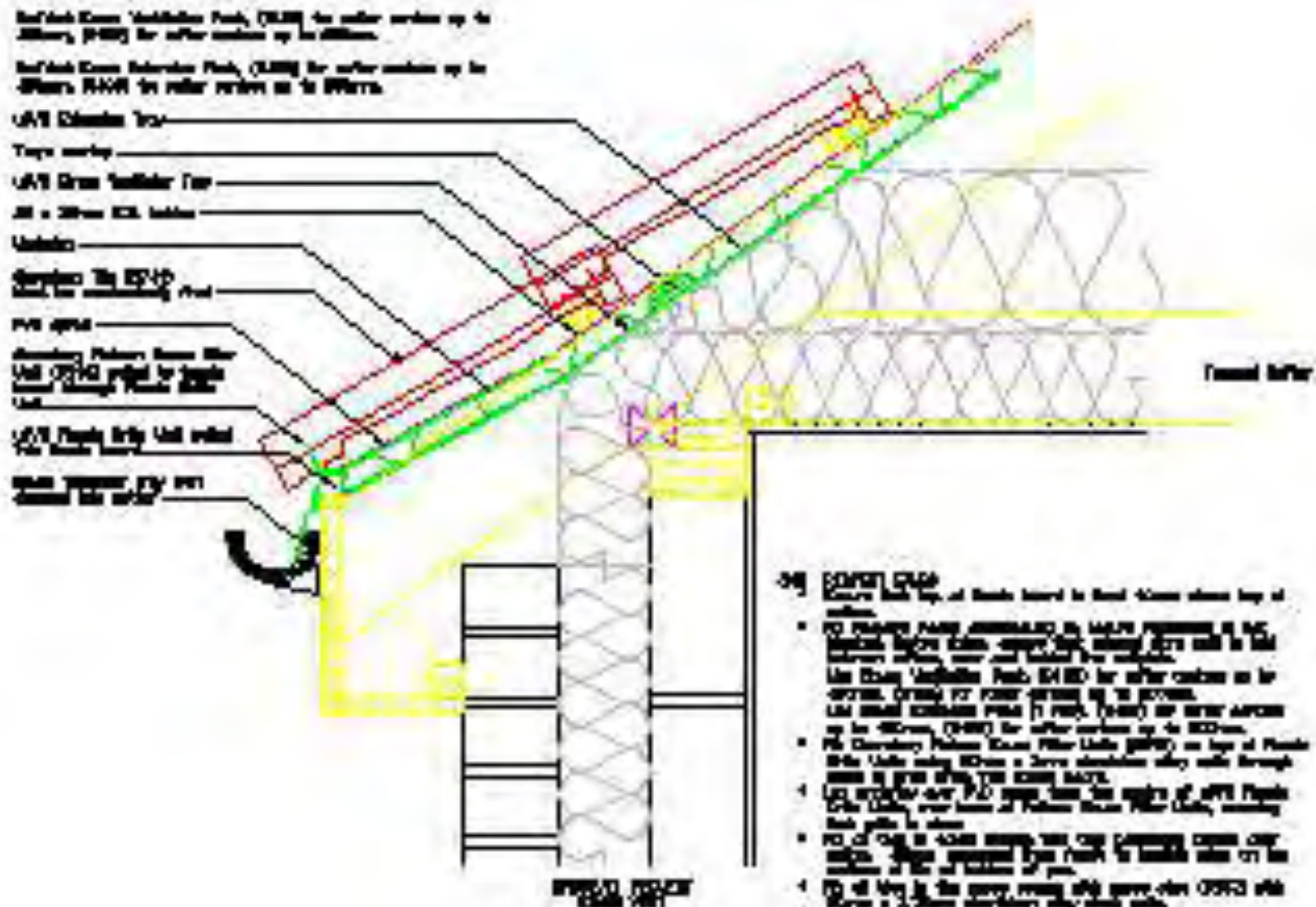
345 RADVENT EAVES

- ▼ Ensure that top of fascia board is fixed 10mm above top of rafters.
- ▲ Fix Radvent Packs continuously to ensure ventilation is not blocked. Before fixing, ensure that mineral fibre quilt is laid between rafters, over and behind the wallplate.
Use Eaves Ventilation Pack (8188) for rafter centres up to 450mm, (8190) for rafter centres up to 600mm.
Use Eaves Extension Pack (1 row), (8488) for rafter centres up to 450mm, (8489) for rafter centres up to 600mm.
- ▼ Lay underlay over PVC apron from top centre of UPVC Fascia Gutter Unit, ensuring that grille is clear.
- ▲ Fix all slates in eaves course with tails projecting 50mm over gutter.
- ▼ Fix all slates in the eaves course with eaves clips (8192) with 25 x 2.4mm stainless steel ring shanked nails.

Warm roof / slate finish



Cold Roof /Concrete Tile



Concrete tile / low pitch 17.5 deg

Minimum 10mm waterproofing, (11mm) for minor drains up to 400mm (11mm) for major drains up to 600mm

Reinforced Green Edgeless Pave, (11mm) for minor drains up to 400mm (11mm) for major drains up to 600mm

SPV Edgeless Tray

Tray overlap

SPV Edgeless Tray

DL 1 50mm S.V. bottom

Underlay

Mini Structural Slab (40mm)

Must be mechanically fixed

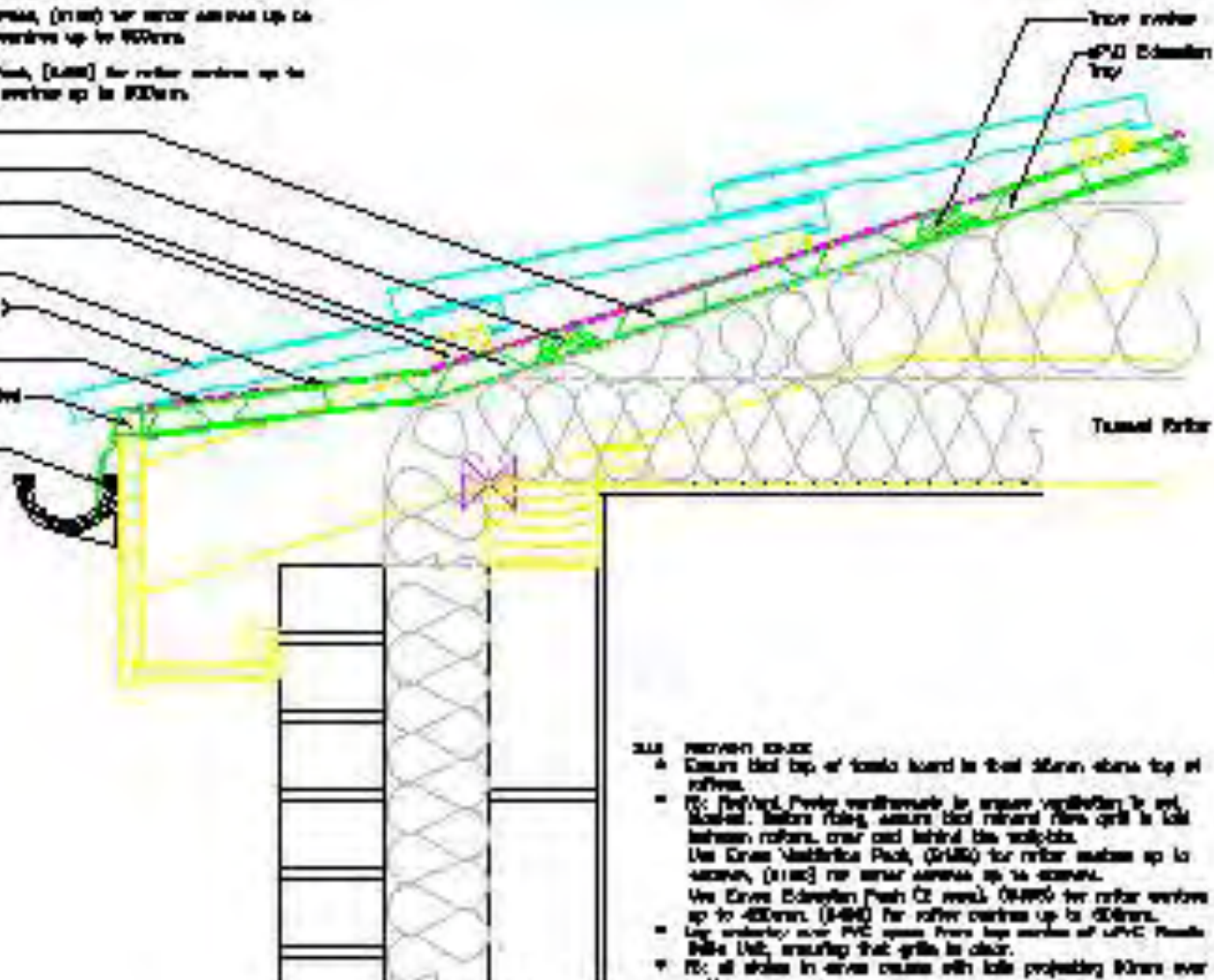
PVC space

SPV Frameless Tray Unit raised

with female board

Green ventilator tray with

male board

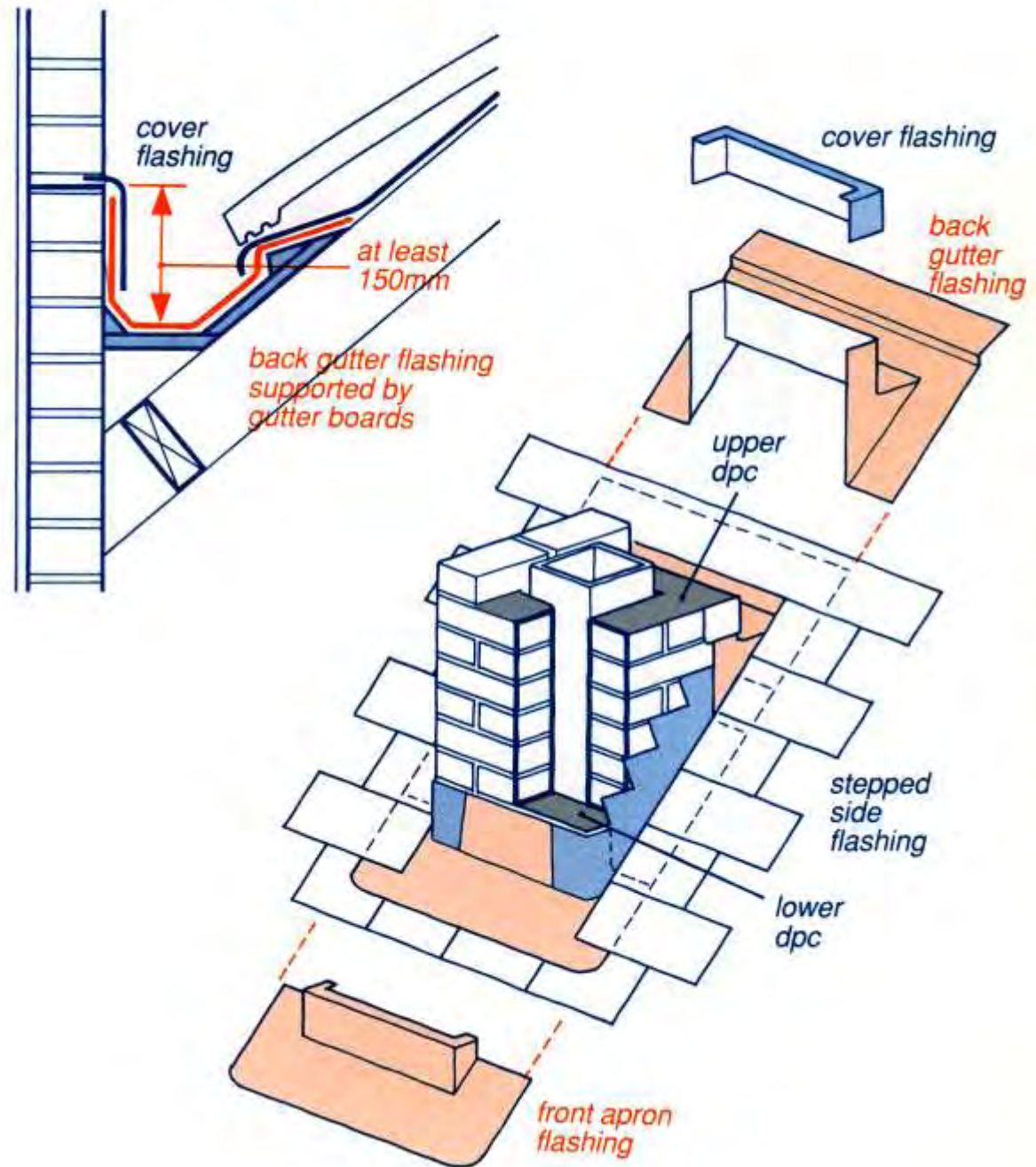


ALL PRESENT WORK

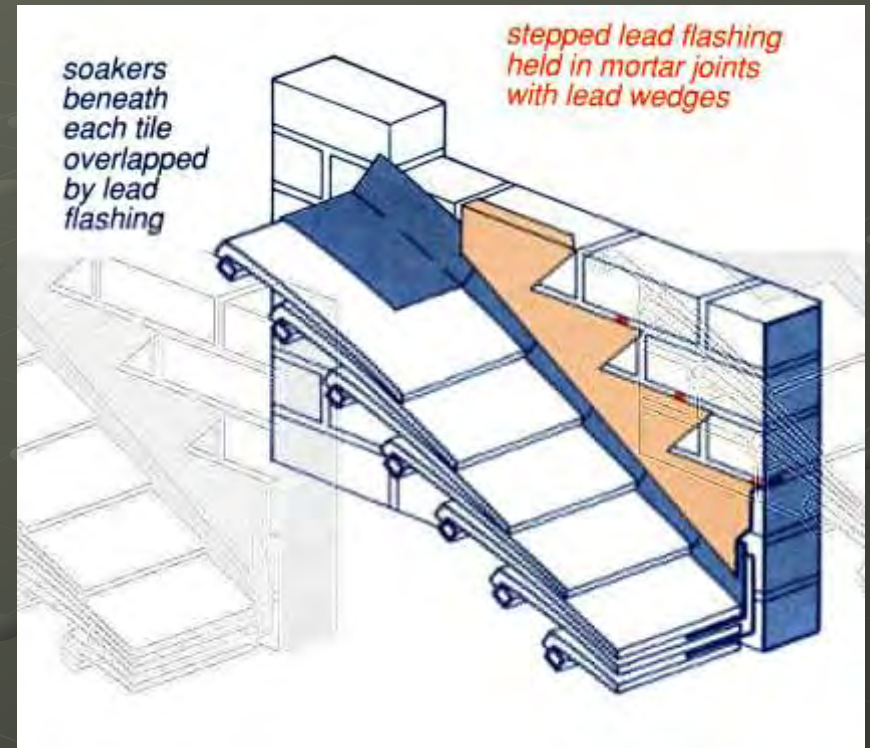
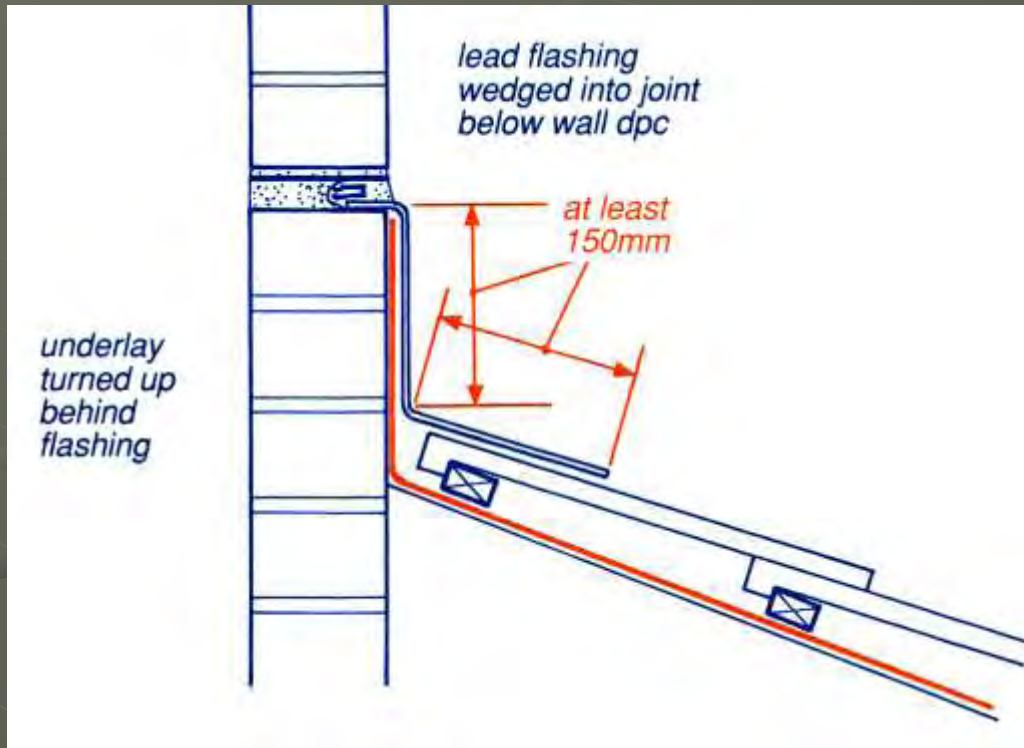
- Ensure that top of female board is fixed down above top of roof.
- For reinforced Pave waterproofing to square ventilator to be fixed. Before fixing, ensure that raised frame grill is laid between rafters, over and behind the waterproofing. Use Green Ventilator Pack, (11mm) for minor drains up to 400mm, (11mm) for major drains up to 600mm. Use Green Edgeless Pave (11mm) for minor drains up to 400mm, (11mm) for major drains up to 600mm.
- Lay underlay over PVC space from top surface of SPV Frameless Tray Unit, ensuring that grill is clear.
- For all drains in green course with hole projecting down over surface.
- For all drains in the green course with pipe slips (100mm) with DL 1 50mm S.V. bottom along with male.

Chimney Details

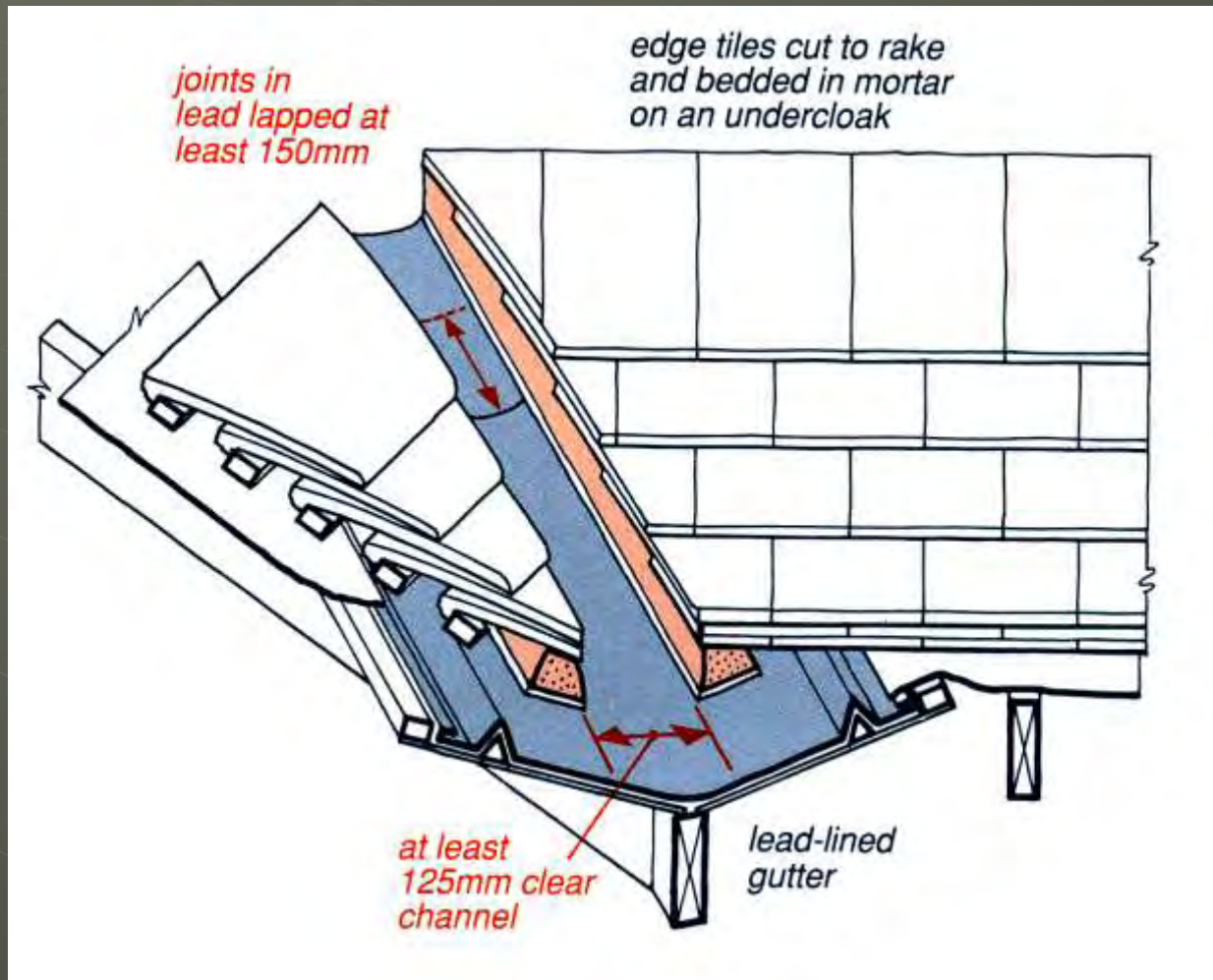
DETAIL OF BACK GUTTER



Lead Abutment Details



Lead lined valley



Reading List & further info

- **D Osbourn.** *Introduction to building*, in Mitchell's Building Series. Longman, Harlow 1993.
- **Jack Stroud Foster.** *Structure & fabric Part 1*, in Mitchell's Building series, 6th edition. Longman, Harlow 2000
- **W.B. McKay.** *Building Construction Volumes 1-4*. Longman.
- **The Building Regulations Part A**
- TRADA Timber Research and Development - Roof tiles and roofing systems
- www.alumasc-exteriors.co.uk Green roof Zinco
- LDA Lead Development Association www.ldaint.org
- Copper Development Association www.cda.org.uk