Technology & Environment 1

M4X01974

OPENINGS IN EXTERNAL WALLS – DOORS AND WINDOWS

Learning Outcomes

Aim

- To introduce the topic area of openings in external wall constructions for low rise domestic buildings

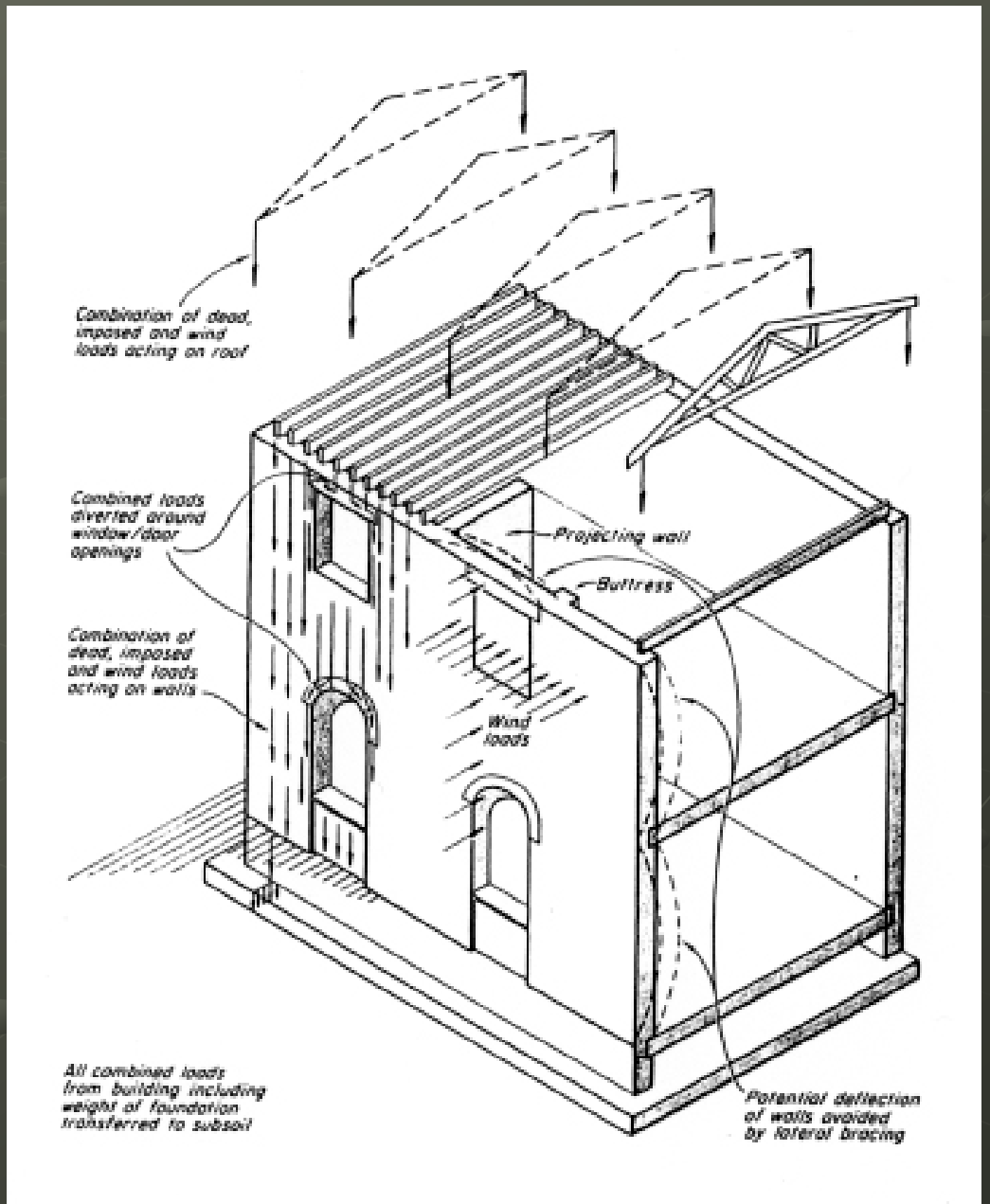
Learning objectives

- To identify the performance requirements of external wall openings regarding formation of doors and windows
- How design technology responds to these requirements and influences the choice of detail / window and door type.


WE INVITE YOU
GOLD
SILVER
WE INVITE YOU

EXTERNAL WALL OPENINGS

- Functions of external wall openings-
- transmission of loads
- thermal insulation
- exclusion of penetrating dampness
- control of air infiltration
- fire resistance
- durability
- access/ egress
- appearance/ aesthetics



WINDOWS / DOORS

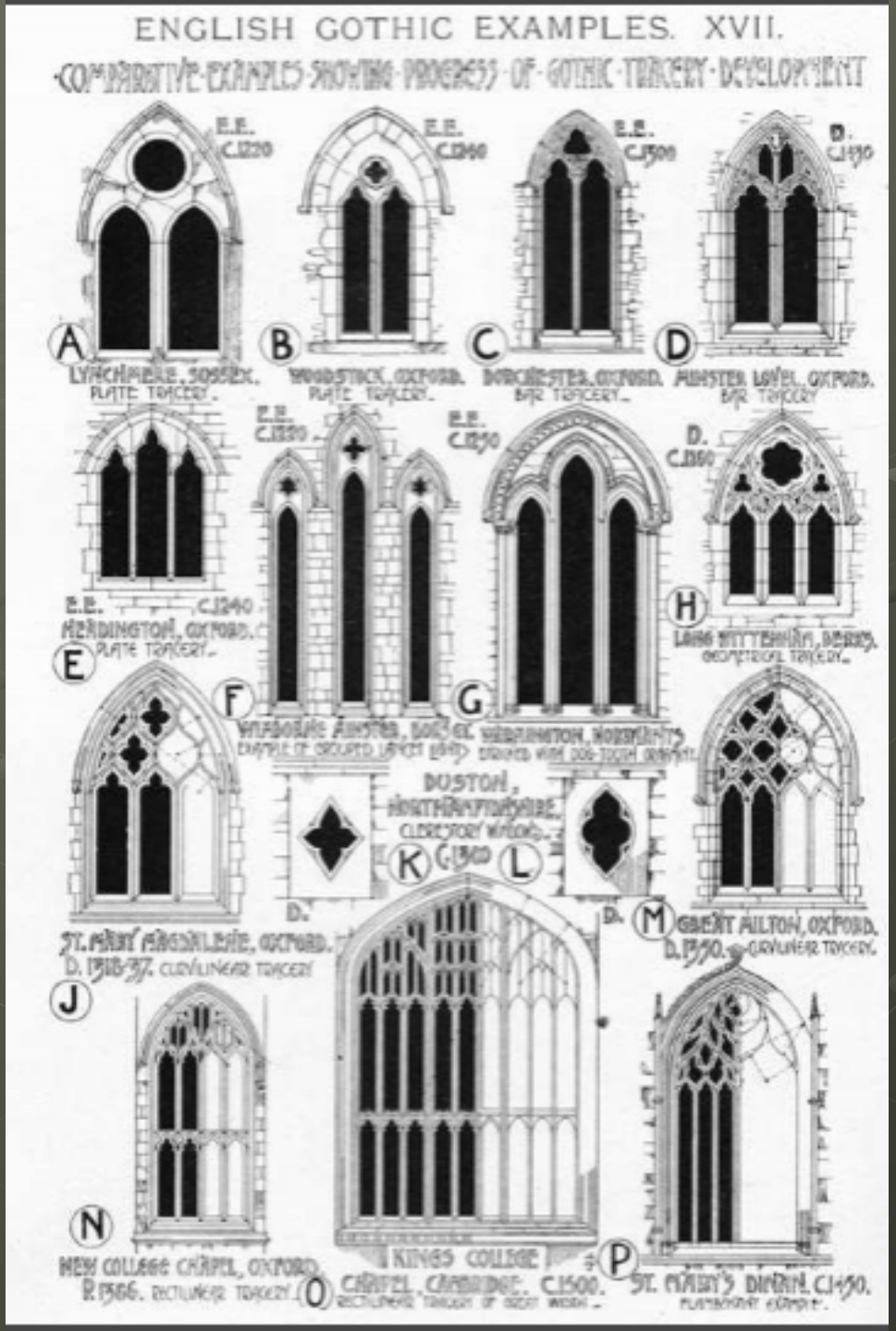
- AESTHETICS
- These are generated by shape, proportion, size, size of components, sub-divisions, materials, colour, glazing and the way the junctions between wall and window are detailed.
- The architectural language should be consistent.





ENGLISH GOTHIC EXAMPLES. XVII.

COMPARATIVE EXAMPLES SHOWING PROGRESS OF GOTHIC TRACERY DEVELOPMENT



WINDOWS

- **Function**
- The design and installation of a window for a particular purpose depends upon several factors, factors which vary in a hierarchy of importance according to situation and use. Some of these factors are:
- provision of daylight to the interior
- ventilation
- pattern of fenestration
- enjoyment of view

WINDOWS /DOORS

- Domestic windows may be manufactured from:
- Softwood (most common, relatively inexpensive, good thermal properties).
- Hardwood (cost effective, long life, good thermal properties).
- uPVC (relatively expensive, low maintenance, difficult to repair).
- Aluminium (expensive, low maintenance, requires thermal break).
- Steel (must have good protective coating, poor thermal qualities).
- Plastic coated softwood (not a big market, relatively expensive, good thermal properties).

WINDOWS and DOORS

- **Standard window and door ranges**
- may be designed and made individually but this can be expensive
- ‘standard' ranges cheaper due to mass production
- Minimum use of timber
- Reasonable weatherproofing

WINDOWS

- **Common visual faults of standard windows**
- Reasons why these windows are often aesthetically poor. The patterns of many are asymmetrical about the vertical and horizontal axes, they lack a clearly resolved vertical or horizontal emphasis and do not balance visually. The effect of this is a visual restlessness in the overall proportions of the windows and their divisions.
- Another problem seen from the outside is that the part of the window that opens reads as the dominant element, not the frame itself. This is in contrast to the situation where the junction created by the frame, reveal or surround is the more important part of the composition.

FASHION

- **The effect off fashion**
- In the period from the 1950’s to the 1970s, windows with large areas of undivided glass-‘picture windows’ – became popular for living rooms in houses. When these large fixed lights were coupled to standard windows to provide necessary ventilation, the visual effect was even more unsatisfactory.
- In the 1970’s another fashion started interest changed from misunderstood precepts of 'modern movement' to equally misunderstood 'Georgian'. Window manufacturers responded by producing variations on their existing ranges with the glazing areas subdivided by crude glazing bars.
- 1980’s and 1990’s uPVC – crude, heavy section

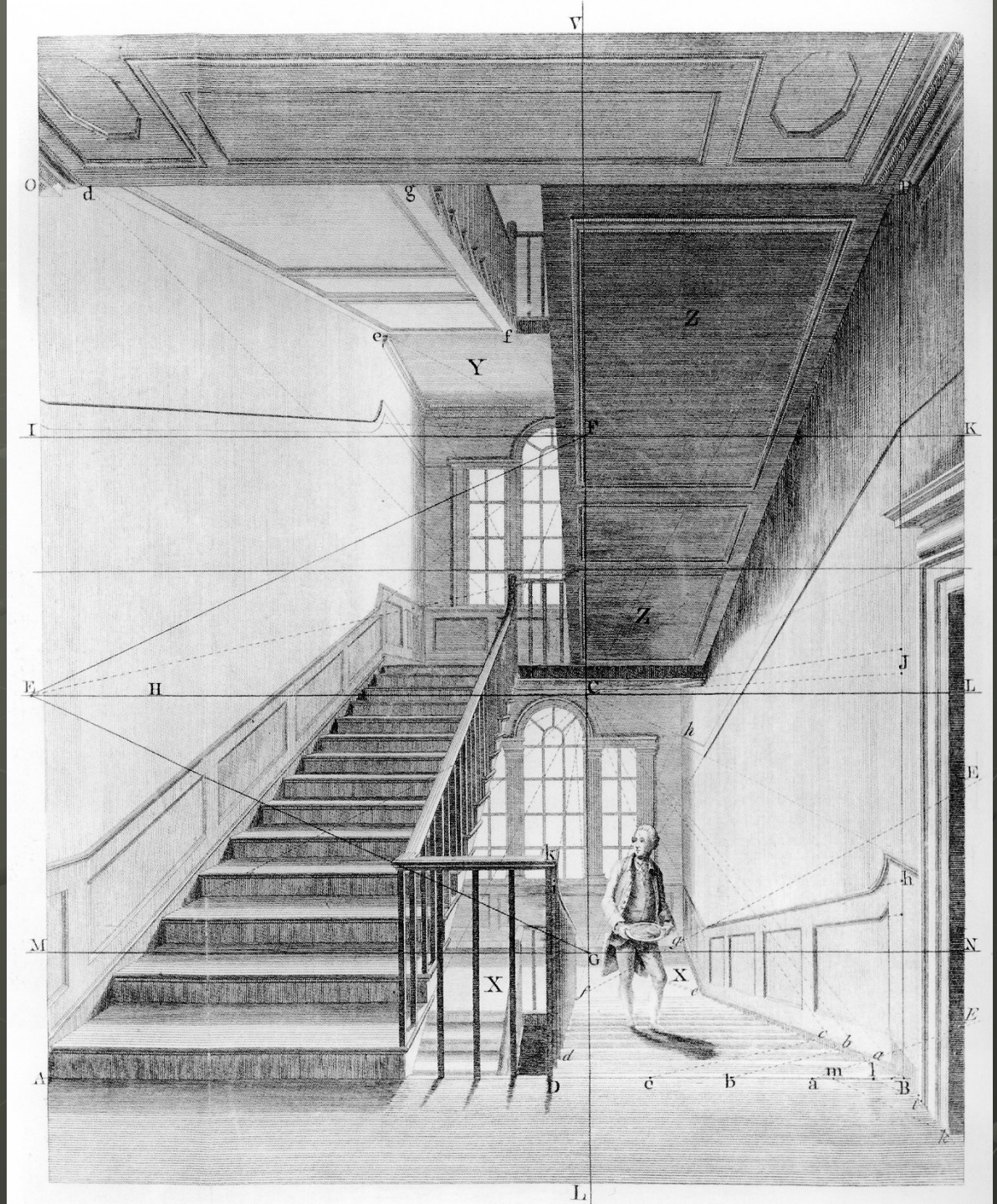
Advantages of division

- there are advantages and disadvantages in subdividing areas in to smaller panes.
- Practical advantages. It is more difficult to see into rooms - this gives a greater degree of privacy; glazing units may be thinner and therefore less costly; it may give more security.
- Visual advantages. It avoids the window appearing as a blank hole in the facade; the pattern created can be part of the overall composition.
- Practical disadvantages. Sub-dividing a window involves increased manufacturing costs of the window itself; this is also true for very small double glazing units.

Georgian Windows

- Double hung sash windows
- no casements or lights to protrude when opened to break up the facade.
- The proportions of the window and their divisions are often closely related to the golden section which assists the overall visual harmony.
- The design of the internal shutters, the mouldings and specifically the glazing bars are based on the principle of reducing the effect of glare when looking out.
- The effect of sunlight striking the window at an angle highlights the mouldings giving additional interest.
- The wood used for glazing bars was better quality softwood than the wood generally used today. This meant that the bars could be extremely slender and therefore less intrusive when viewing out.
- By comparison the glazing bars of modern windows are thicker and the mouldings are less delicate. The imitation is feeble and instead of adding delight they become obstructions.

Georgian Proportions



Chiswick House



WINDOWS AND DOORS

- **Installation**
- Three main factors have to be taken into consideration when inserted into the masonry structure of a building. These are:
- Maintenance of the structural stability of the wall,
- Prevention of the ingress of water to the inner surfaces,
- Prevention of rapid heat transfer from inside to outside,

A further factor which may be taken into consideration is

- the drainage of water from the glazed surface

OPENINGS

- Openings such as doors and windows in walls, interrupt the transfer of load to the foundations. In these instances, support must be provided over an opening- a lintel, beam or an arch. These effectively transfer load around the opening and into the existing walls.

LINTELS

- Traditionally timber was use for lintels.
- Today mild steel or pre-cast concrete is used

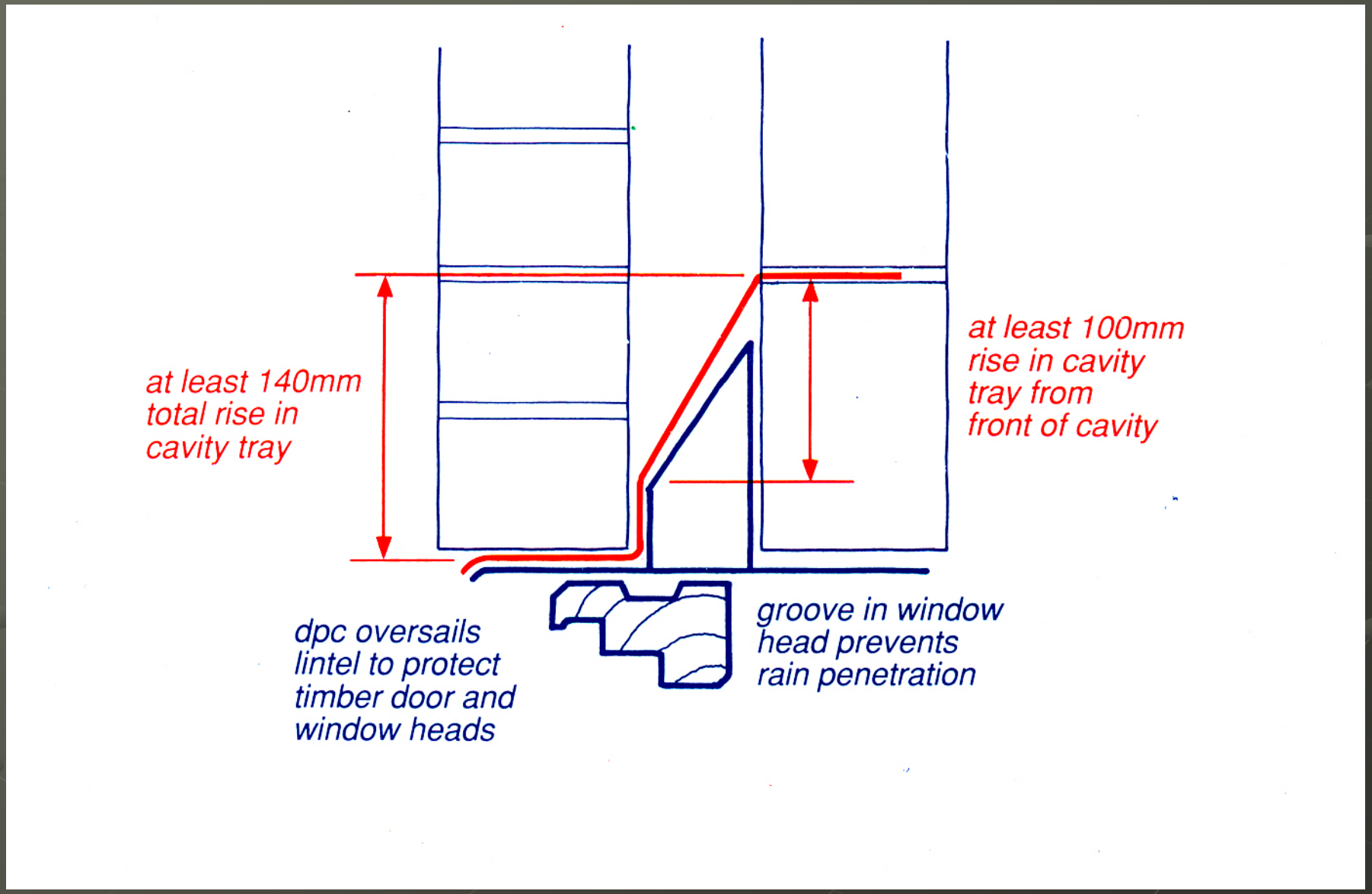
LINTELS

- For cavity wall construction:
- Steel or stainless steel lintels which carry both the inner and outer leaf in one combined lintel

WALL OPENINGS

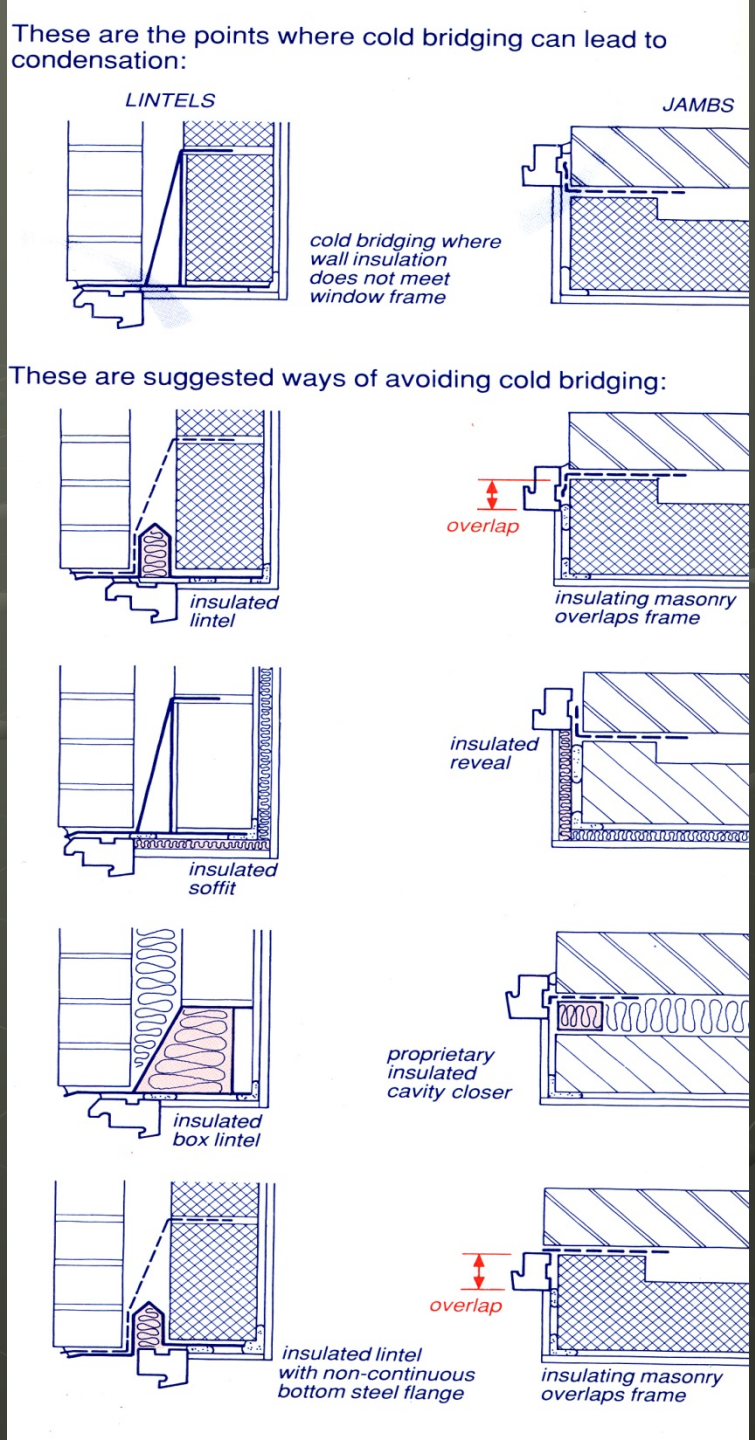
- TERMINOLOGY
- An opening formed in an external wall consists of:
- a head
- jambs (reveals)
- a cill (if a window)
- or threshold (if a door).

Cavity Tray at head - detail section



Cold bridging

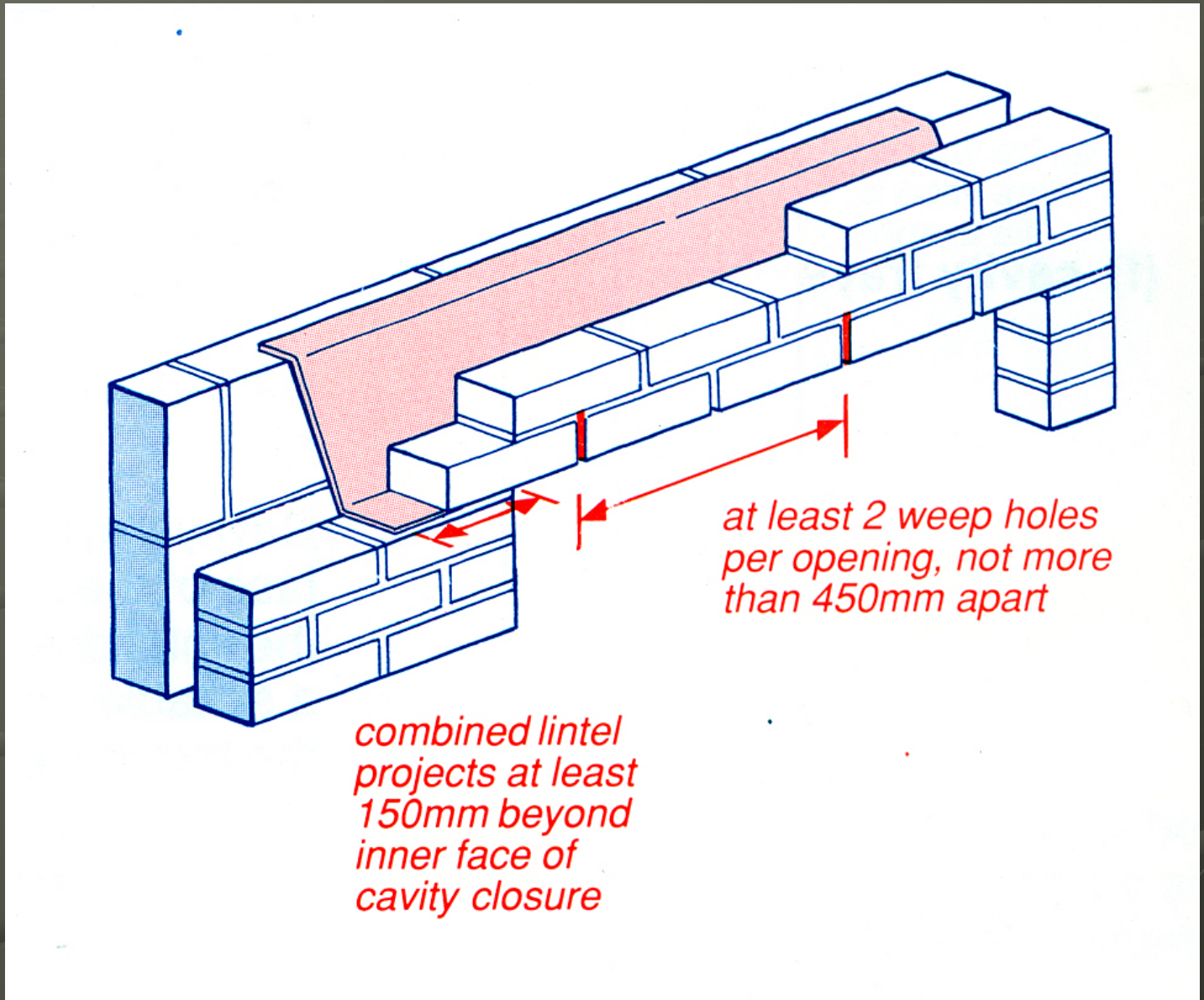
- The risk of condensation at reveals and soffits becomes more likely as the wall insulation increases



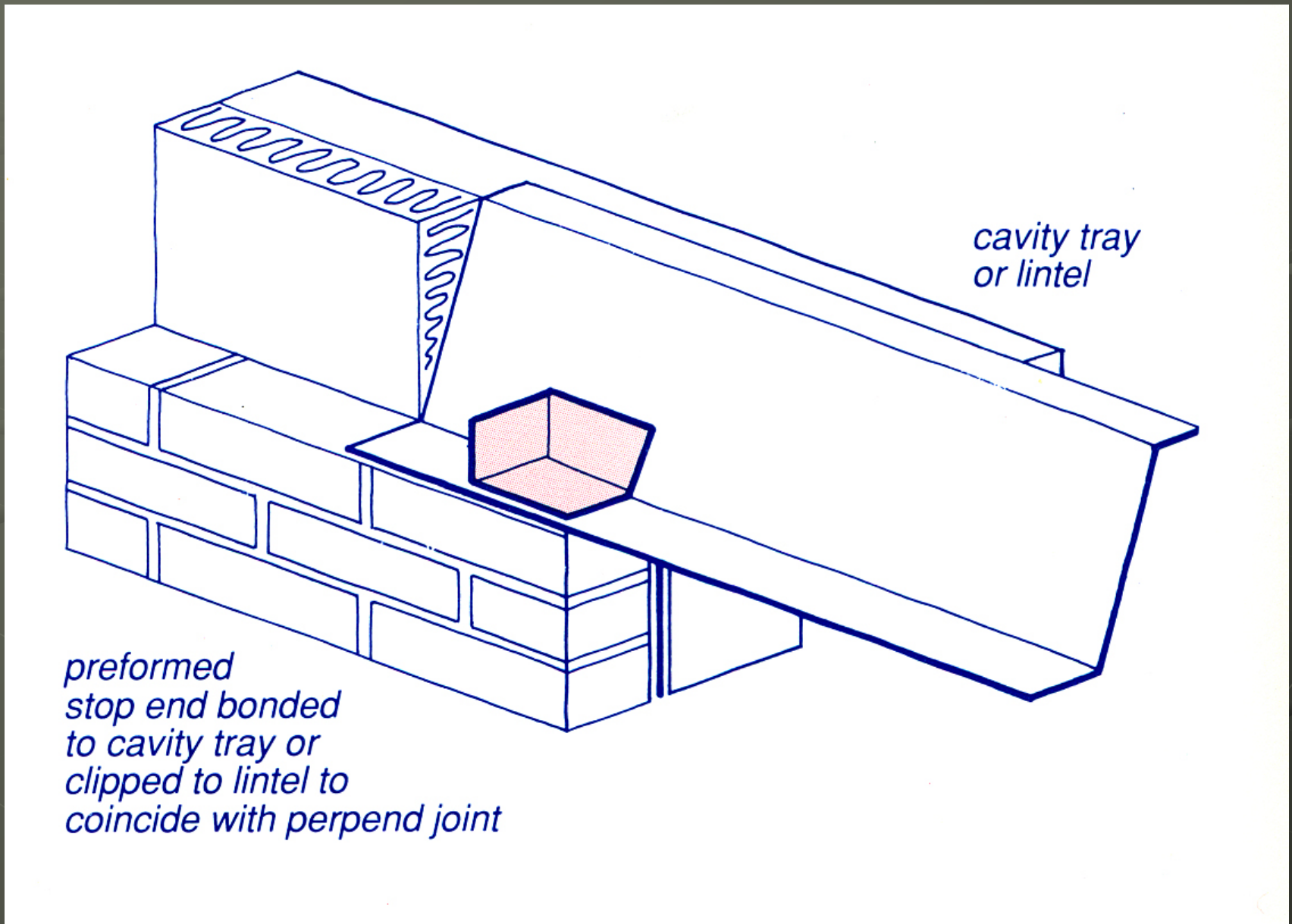
CAVITY WALL OPENINGS

- HEAD
- The function of the head is to carry the triangular load of masonry / brickwork over the opening and transmit the load to the jambs at the sides. This is achieved by the use of a lintel.

Cavity Trays with weep holes



Cavity Tray stop ends

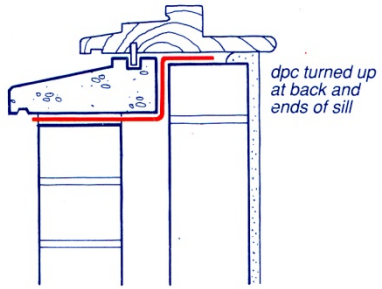


Dpcs around openings

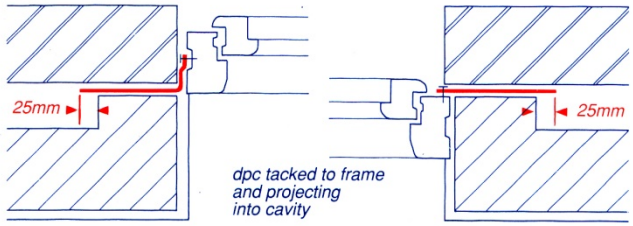
(e) dpcs around openings

A dpc should be provided at jambs of openings and at heads and sills as required by the design.

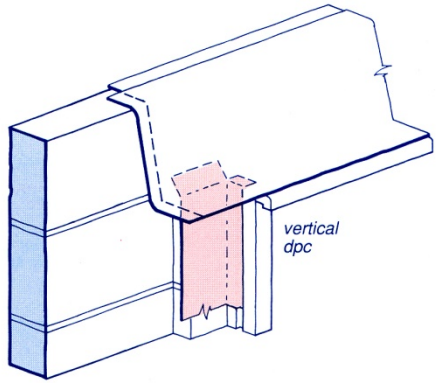
Where a jointed or permeable sill is used (all sills in Northern Ireland and the Isle of Man), a dpc should be placed between the sill and the outer leaf, turned up at the back and ends of the sill.



150mm wide vertical dpcs should be nailed to the full height of the frame. The dpc should protrude into the cavity by about 25mm and extend up to the underside of the lintel where it should be turned back towards the inner leaf.



NORMAL EXPOSURE SEVERE EXPOSURE

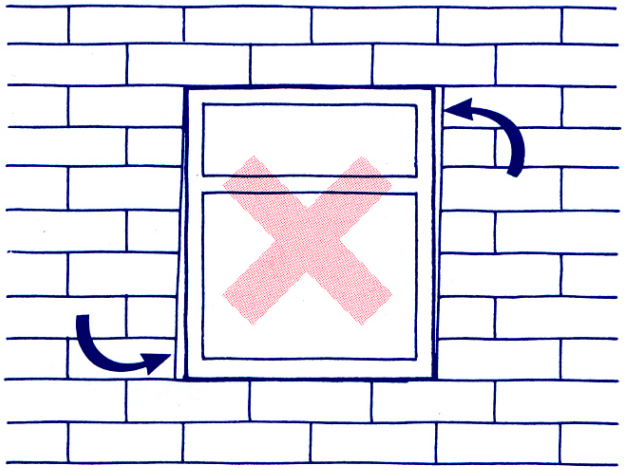


openings

Masonry may be built around either:

- the frame in-situ, or
- a profile or template to enable the frame to be fitted later.

Openings should be the correct size and square. The brickwork should butt closely against the frame. The frame should not be distorted by forcing bricks against the jamb.



frames should not be distorted

Window and door frames, when built-in, should be fixed with:

- frame cramps, or
- proprietary cavity closers, or
- plugs and fixings.

Timber plugs should not be used in vulnerable positions, such as the outer leaves of walls.

CAVITY WALL OPENINGS

- CILL
- The function of the cill is to shed rain that runs down the face of window or door away from the opening and face of the wall.

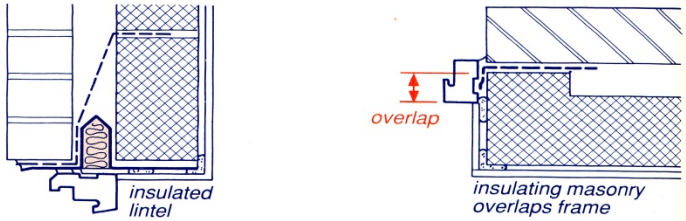
CAVITY WALL OPENINGS

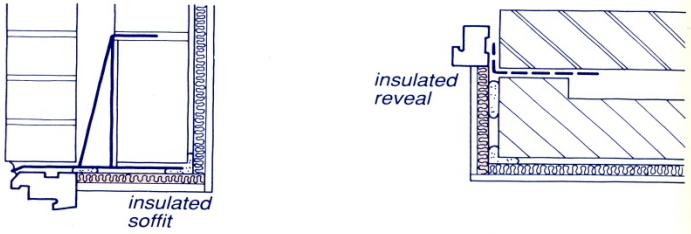
- JAMB
- The function of the jamb is to close of the construction of the cavity by turning the inner leaf towards the outer leaf to form a butt joint in which is placed a vertical dpc

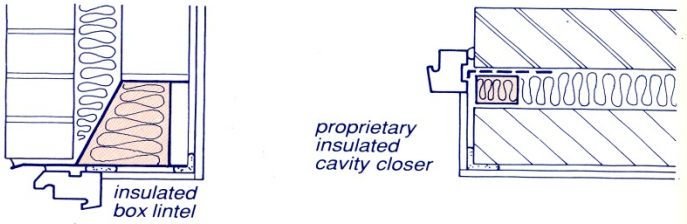
These are the points where cold bridging can lead to condensation:

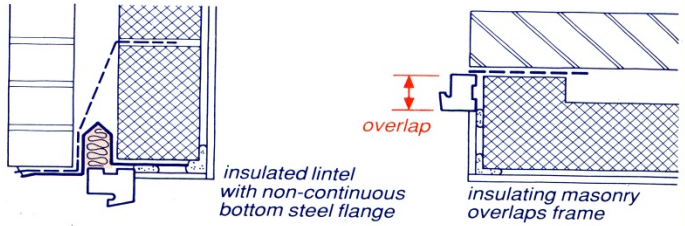


These are suggested ways of avoiding cold bridging:





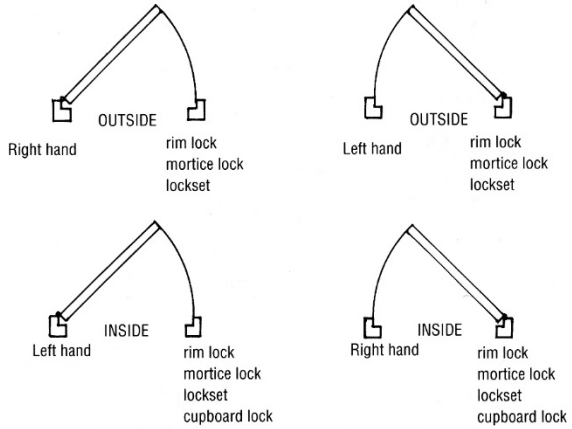




DOORS

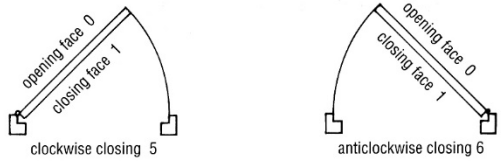
Door handing

The traditional way of describing the configuration of a door is by the 'hand' – see **1**. There is also the ISO coding method **2** which describes a door's action as clockwise or anticlockwise. Despite its name it is not international and not widely used. Different components for a door sometimes conflict as, for instance, a door which requires a right hand rebated mortice lock may need a left hand overhead door closer. When in doubt, the specifier should draw a diagram.



1 Handing method

The definition of an OUTSIDE FACE of a door is:
the external side of a door in an external wall;
the corridor side of a room door;
the side of a communicating door on which the hinge knuckles are not seen when the door is closed;
the space between them in the case of twin doors;
the room side of a cupboard, wardrobe or closet.

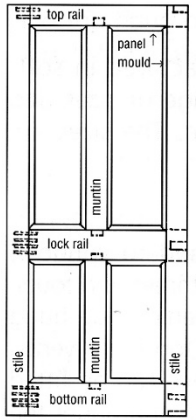


2 ISO coding method

	CODE			
clockwise closing	= 5	e.g.	5.0 =	clockwise closing / opening face
anticlockwise closing	= 6		5.1 =	clockwise closing / closing face
opening face	= 0		6.0 =	anticlockwise closing / opening face
closing face	= 1		6.1 =	anticlockwise closing / closing face

Direction of CLOSING and DOOR FACE are given to identify the door configuration as examples above.

Traditional wooden doors definitions and typical sections



The rails are fixed to the full height styles with haunched tenons & wedged.

Muntins are tenoned to rails

Dowels, as shown on LHS, can also be used for a stronger joint which withstands well uneven shrinkage.

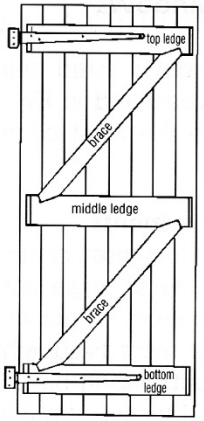
All frame sections are grooved at least 9 mm to house the panels.

Stiles are normally ex 100 × 50 or 125 × 50

Bottom & lock rails are deeper, typically ex 200 × 50

Panels should be min 6 mm ply for internal doors and min 9 mm ply for external doors

Four panelled door

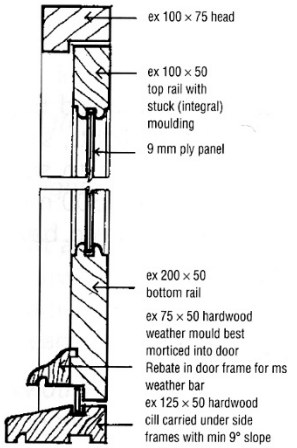


Door made up of ex 150 × 32 ledges and ex 100 × 32 braces with ex 25 mm t+g 'V' jointed boarding not more than ex 125 mm wide.

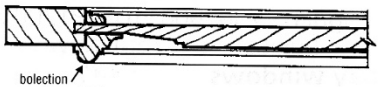
Ledges are screwed to the boards and the boards are nailed to the ledges.

Door hung with steel Tee hinges or with stronger wrought iron strap hinges and fastened with a suffolk latch.

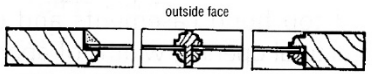
Ledged & braced boarded door



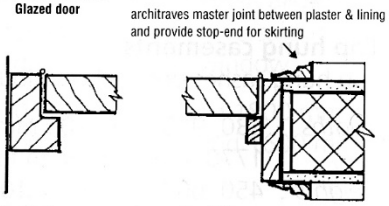
External door frame
for inward opening door



Raised and fielded panel



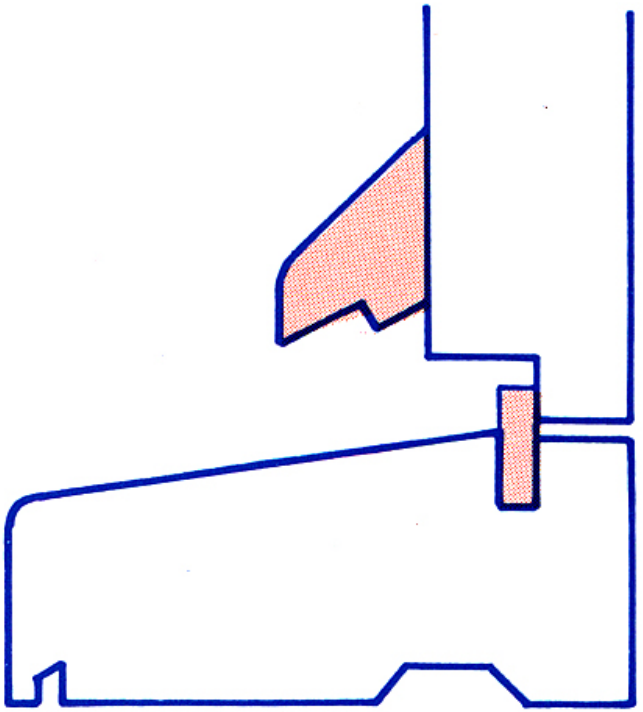
Glazed door



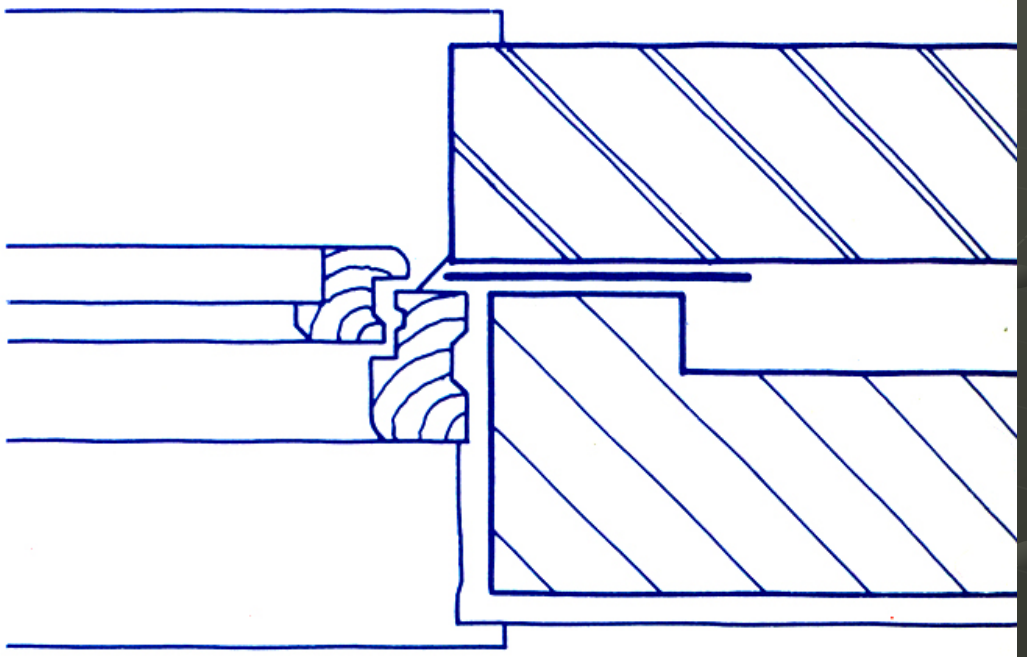
Door frame
ex 100 × 75 with rebate for door stop. Can be erected before walls or built into opening

Door lining
ex 32 mm with width to suit wall
Linings are thinner than door frames and for internal doors only. They have planted stops and are fitted to finished opening

DOORS



water bar and weatherboard provided for external doors



'check' reveal provided in areas of Severe or Very severe exposure

DOORS

Doors

Standard doors are still manufactured primarily in imperial sizes. The manufacturers claim that this is because of demands by the building trade. There is also a need for replacement doors in older properties and the apparently odd size 2′8″ × 6′8″ is still produced for this reason. There is more demand for metric sizes for large scale building projects but the choice is still limited. Unless a large quantity of doors is ordered, standard sized doors are still significantly cheaper than specials.

Because of the need to accommodate wheelchair users, wider doors are now more in demand. An 800 mm clear opening is considered the absolute minimum for a wheelchair user. Sixty mm should be deducted from the actual door width to arrive at the clear opening size. This dimension takes into account the thickness of the door and hinges standing open at one side and the rebate or stop on the other side.

Typical sizes of single leaf standard doors (metric)

	926 × 2040	826 × 2040	807 × 2000	726 × 2040	626 × 2040	526 × 2040	Thickness (mm)
Exterior							
Solid panelled			*				44
Glazed panelled			*				44
Flush		*	*				44
Steel faced			*				44
Framed and ledged			*				44
Ledged and braced			*				36
Interior							
Solid panelled				*			35
Glazed panelled		*	*	*			40
Flush	*	*		*	*	*	40
Moulded panelled	*	*		*	*	*	35 and 40
Fire							
½ hour	*	*	*	*	*	*	44
1 hour		*		*			54

Damp-proof courses (DPCs)

DPCs provide an impermeable barrier to the passage of moisture from below, from above or horizontally. They can be flexible, semi-rigid or rigid. Rigid DPCs are only suitable for rising damp. Soft metal DPCs are expensive but safest for intricate situations. Cavity trays are needed above elements that bridge cavities to direct water to outside. DPCs should be bedded *both* sides in mortar. Seal DPCs to floor membranes. Upper and vertical DPCs should always lap over lower or horizontal ones. DPCs must not project into cavities where they may collect mortar and bridge the cavity.

Type	Material	Minimum thickness mm	Joint	Application	Remarks
Flexible polymer based	polyethylene	0.46	100 mm min lap and sealed	H at base of walls, under cills, vertical jambs	appropriates lateral movement; tough, easy to seal, expensive, can be punctured
	bitumen polymer	1.5	100 mm min lap and sealed	H at base of walls, stepped; CT; V at jambs	
Flexible bitumen based	bitumen/hessian base	3.8	100 mm min lap and sealed	H at base of walls, under copings, cills; CT, V at jambs	hessian may decay, but OK if bitumen not disturbed. If cold, warm DPC before use, may extrude under high loads or temperatures
	bitumen/hessian base/lead	4.4	100 mm min lap and sealed	H at base of walls, under copings, cills; CT, V at jambs	lead lamination gives extra tensile strength
Semi-rigid	mastic asphalt	12.0	none	H under copings	grit should be added for key, liable to expand
	lead	1.8	100 mm min, welted against damp from above	H under copings, chimney stacks	corrodes in contact with mortar, protect by coating both sides with bitumen
	copper	0.25	100 mm min, welted against damp from above	H under copings, chimney stacks	good against corrosion, difficult to work, may stain masonry green
Rigid	slate	two courses 4.0	laid to break joint	H at base of free-standing and retaining walls	very durable, bed in 1 : 3 sand cement
	brick to BS 3921	two courses 150	laid to break joint	H at base of free-standing and retaining walls	good for freestanding walls

H = horizontal; V = vertical; CT = cavity tray.

Damp-proof membranes (DPMs)

DPMs are sheet or liquid membranes designed to resist damp caused by capillary action. They do not have to perform as well as tanking membranes, which must resist water pressure.

DPMs may be positioned under site slabs providing the hardcore is smoothed with 25 mm minimum rolled sand or preferably 25 mm smooth blinding concrete. This position is more vulnerable to damage than placing them over smooth finished site slabs. In this position the membrane can prevent satisfactory bonding between slab and screed, so a thick screed is needed, ideally at least 63 mm.

DPMs must be carried up to lap or join DPCs in walls. Brush-applied membranes are better than sheets in this respect.

Care must be taken not to penetrate membranes when laying. Any pipe ducts must be in position before screeds are poured, as any subsequent chasing could well damage the DPM.

Type	Description
Low density polyethylene film (LDPE)	Min 0.3 mm thick. Cheapest DPM, protects against methane and radon gas. No good against any water pressure. Joints must be rigorously taped. Easy to penetrate on site
Cold-applied bitumen solutions; coal tar; pitch/rubber or bitumen rubber emulsions	Ideally three coats. Must be carefully applied to avoid thin patches and pinholes
Hot applied pitch or bitumen	Ideally three coats. Must be carefully applied to avoid thin patches and pinholes
LDPE plus bitumen sheet	Not as easily displaced as LPDE film and easier to overlap. Small perforations less likely, as will 'self heal'
High density polyethyene (HDPE) with bitumen to both faces	High performance PE core is coated both sides with bitumen, with upper surface bonded to this PE film. Underside has film which is released before laying
Epoxy resin	Two-coat system for newly laid concrete slabs which have not fully dried out. Second coat scattered with fine sand. Suitable for moisture-sensitive flooring, e.g. PVC, cork, lino, wood
Mastic asphalt	12–16 mm thick, not often used under screeds but more often as a combined DPM/floor finish 20–25 mm thick and layed on a glass fibre isolating membrane
Ethylene propylene di-monomer (EPDM)	1.2 and 1.4 mm synthetic rubber sheet (Pirelli), strong and not affected by chemicals, exposure to ozone, UV light, continuous wet, freeze–thaw cycles, microbe attack. Used for foundations, dams, reservoirs etc.

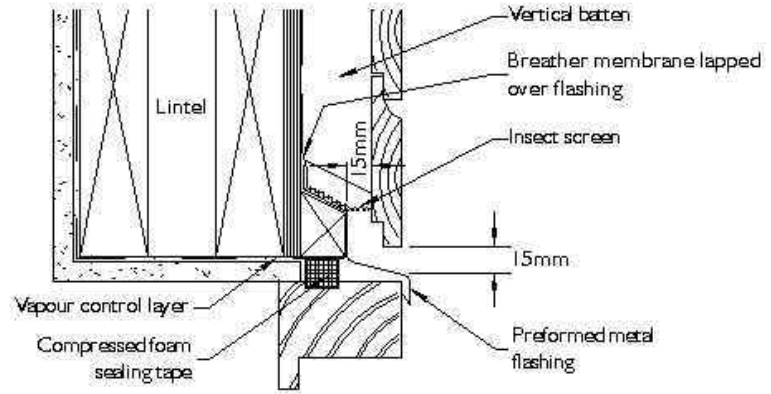
Sources: *Specification 94*
Ruberoid Building Products Ltd

High performance window in horizontal timber cladding

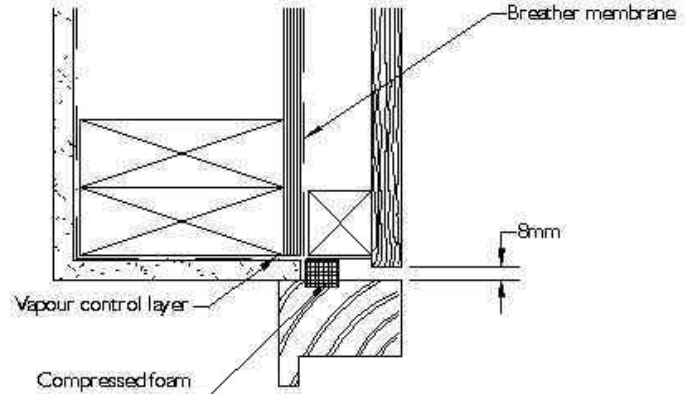


Typical Scandinavian treated softwood high performance window.

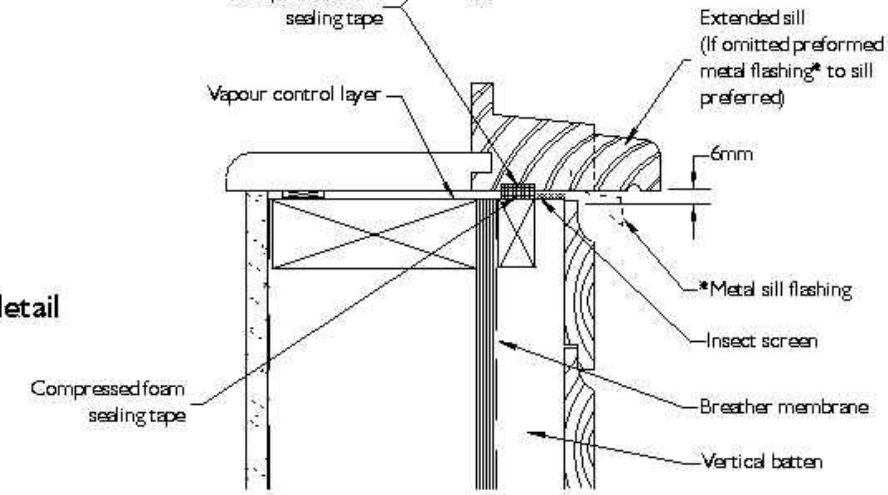
Head detail



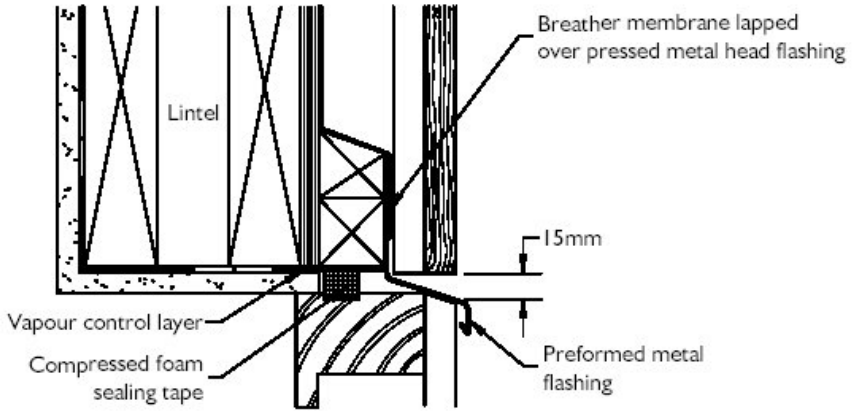
Jamb detail



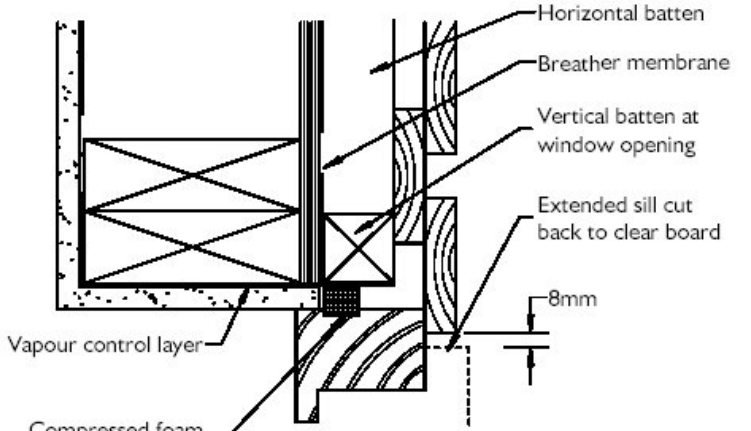
Sill detail



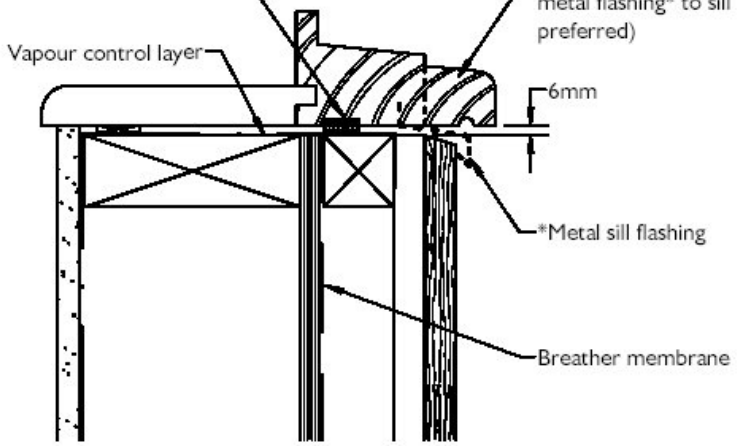
Head detail



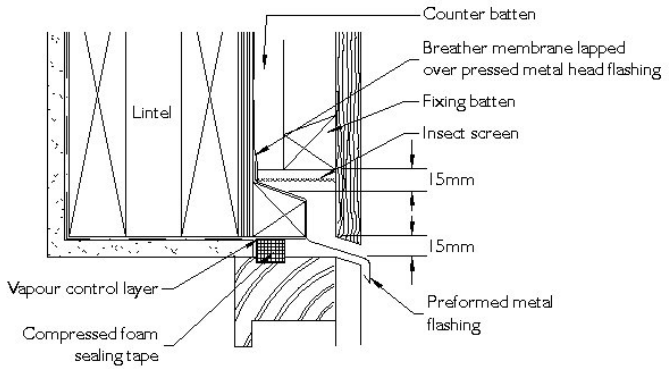
Jamb detail



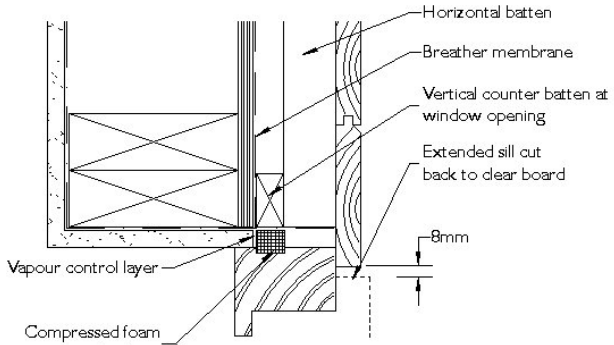
Sill detail



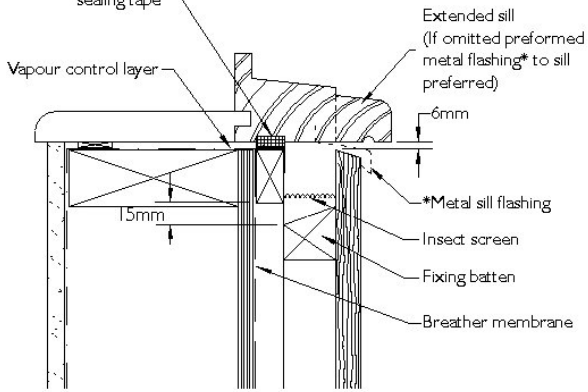
Head detail



Jamb detail



Sill detail



DESIGN CONSIDERATIONS



Window in a slate clad wall -timber frame construction




rationel
BEDFORD
ASTRA
GYM
G551 HEP
rationel

Ty-cwrdd Bach



Modern Speculative Housing





1930’s semi detached house with cavity wall construction

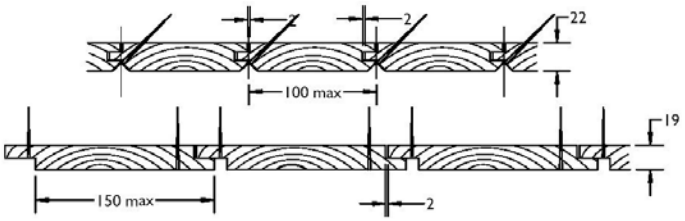


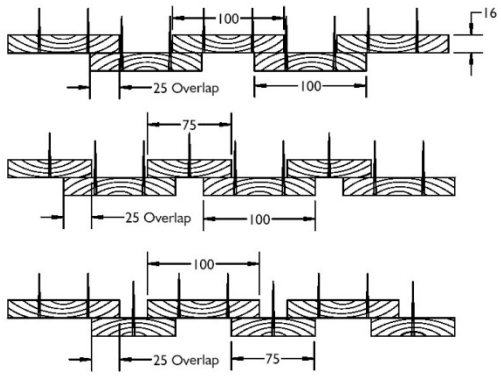
Example of a 17th century solid wall constructed cottage with 21st century partial filled cavity wall constructed extension

TIMBER FRAME CLADDING

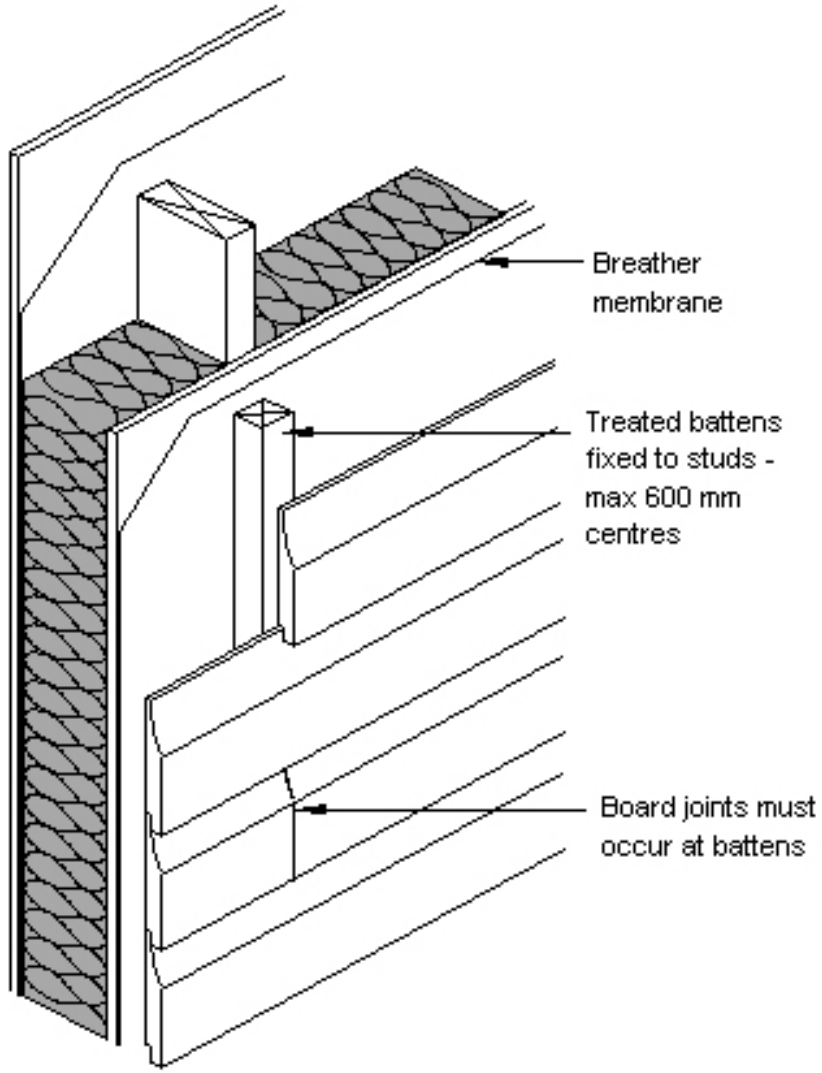
- Thin/ lightweight materials such as timber boarding, tile hanging, cement render on mesh etc. which can be fixed directly back to the timber panel.
- Heavier materials such as brickwork or blockwork which are built independently off their own foundation and tied back to the timber panel for stability

CLADDING OPTIONS

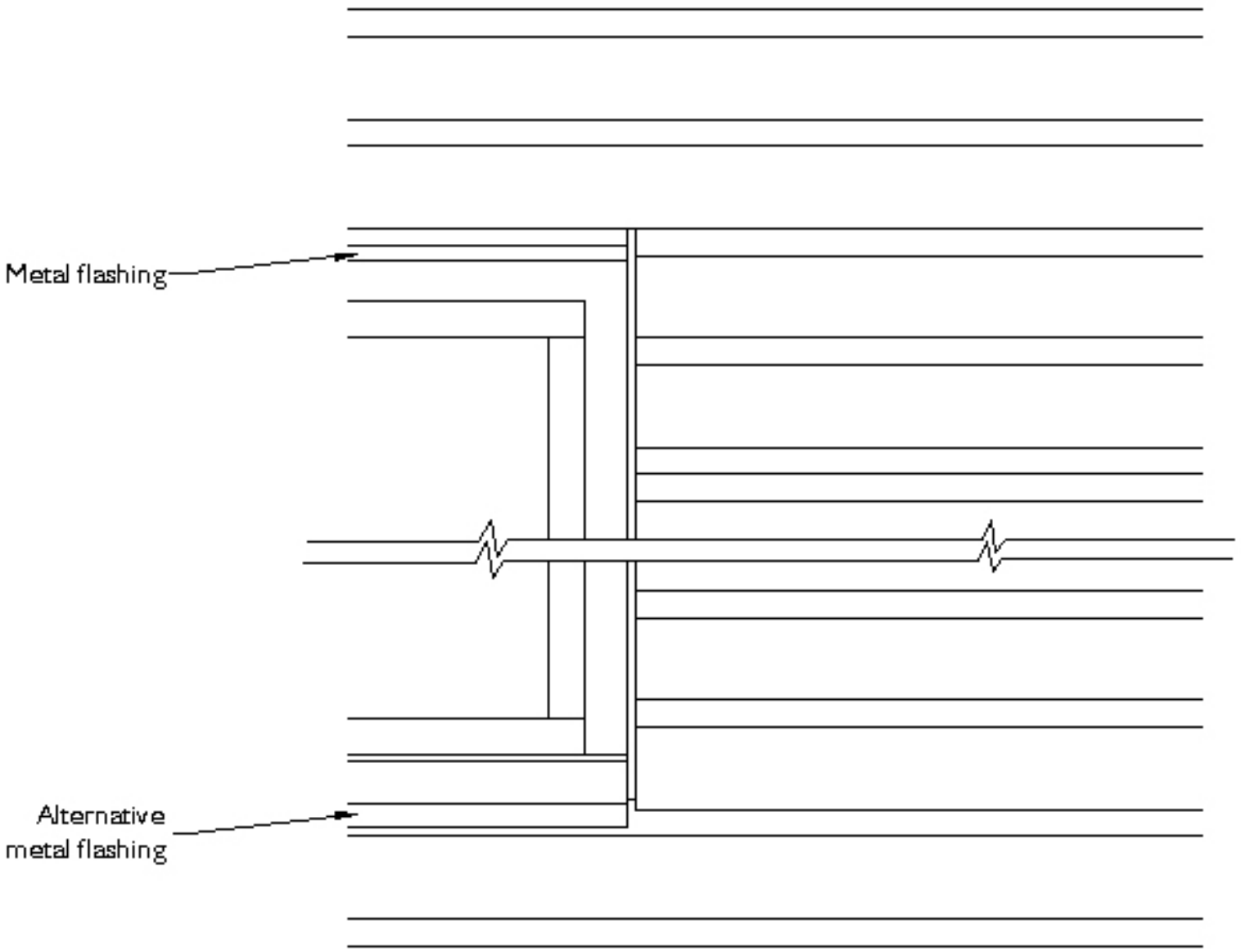




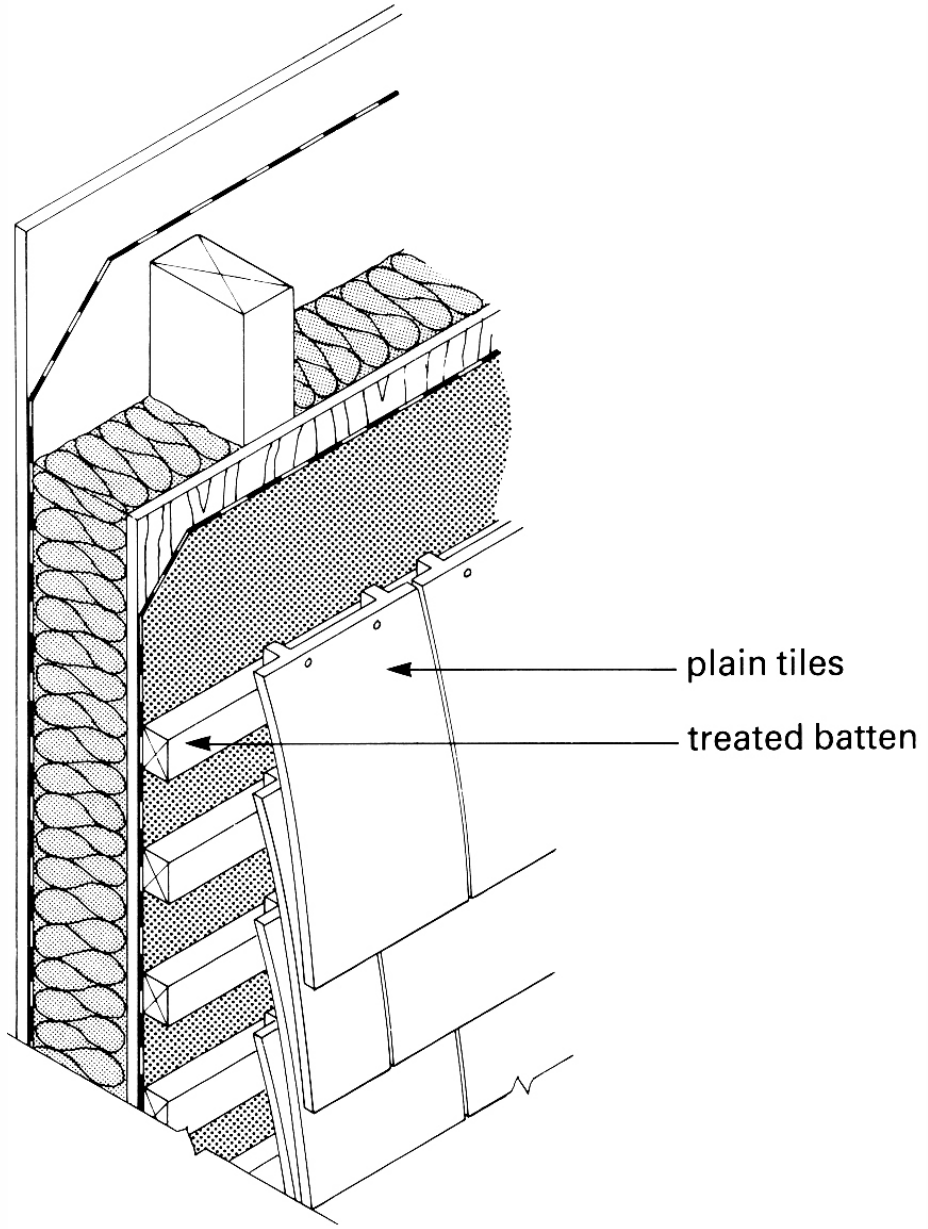
CLADDING OPTIONS

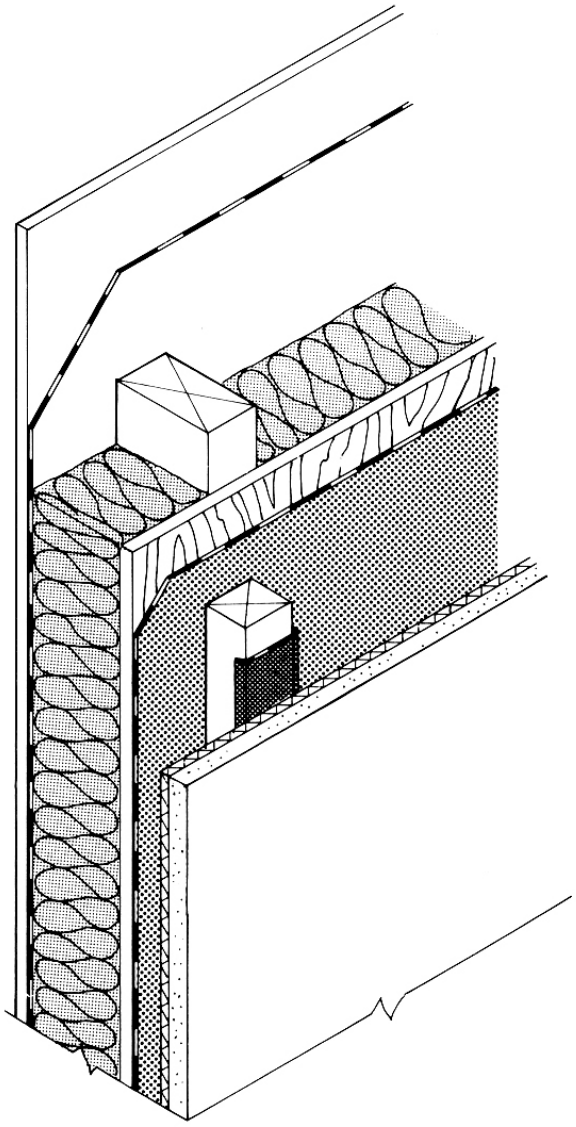


Horizontal Cladding



Tile hanging or external render





QUESTIONS

- **Typical questions**
- Q Draw sections through the head, jambs and sill of a casement timber window to how it is constructed and assembled within a masonry wall which has a brick outer leaf, 100mm cavity and a 100mm block inner leaf.
- Q What is meant by the following terms? Illustrate your answers where applicable with sketches. Mullion; transom; casement; opening light; metal lintel, cavity closer; sill; sub-sill.

Reading List & further info

- **Building Research Establishment**. *BRE thermal insulation avoiding risks*. BRE Garston, 1989.
- **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
- **Michael McEnvoy**. *External components*, in Mitchell's Building series. Longman, Harlow 1994
- **Alan Everett**. *Materials*, in Mitchell's Building series, 5th edition. Longman, Harlow 1994
- **Bruce Martin**. *Joints in Buildings*. Godwin 1977.
- **W.B. McKay**. *Building Construction Volumes 1-4*. Longman.