An overview of the specifying and detailing of masonry construction

June 2019

An Overview of the Specifying and Detailing of Masonry Construction

June 2019

The Institution of Structural Engineers

Constitution of the Working Group

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Foreword

This report is part of the Institution of Structural Engineers response to the formal enquiry into the issues raised by the defective construction of schools in Edinburgh. It highlights the need for effective communication between those parties responsible for design of a project and those charged with the execution of the works. Whilst it is the case that, depending upon the contractual situation, the role of the Structural Engineer will vary there is an overriding requirement to do everything possible to ensure that the design intentions are met during the construction process.

In this report the key aspects of masonry construction have been presented and the main responsibilities highlighted. The importance of ensuring that the type and location of ties is clearly identified on the documentation provided to site is emphasized. Where bed joint reinforcement is required to control movement or enhance lateral load resistance attention is drawn to the need to clearly specify the lap lengths required for the specified product. On occasions where design is carried out by a supplier, for example for shelf angles, it is important that the execution requirements are properly integrated with rest of the construction documentation used on site.

Masonry construction has been successfully used for thousands of years but modern economic masonry construction does require careful attention to detailing and the correct installation of ancillary components. It is not sufficient to leave execution to the bricklayer without clear guidance as to the designer's intentions. To further assist the Structural Engineer in the correct use of masonry the Institution has recently published an updated version of the manual for the design of plain masonry in building structures to Eurocode 6 (BS EN 1996). In addition to the Eurocode itself, BSI publishes very useful NCCI in the form of PD 6697 which gives recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996-2. An updated version of this Published Document is under development as of the release of this guide.

Professor John Roberts

Chair of the Masonry Working Group

1 Introduction and Scope

This document has been prepared as part of the response of the Institution of Structural Engineers to the *Report of the Independent Inquiry into the Construction of Edinburgh Schools – February 2017*.

The Masonry Working Group of the Institution was formed in 2017 to respond formally to the inquiry and to provide guidance to practicing Structural Engineers specifying masonry on construction projects.

This document is intended to provide guidance on the implementation of relevant recommendations from the enquiry and contains the following information:

- A guide to resources and sources of information;
- A designers' checklist for specifiers of materials and construction methods on projects in which masonry is being used (incorporating; masonry units, common pitfalls and a rudimentary responsibility matrix).
- A guide to clear communication of design intent and the use of drawings and specifications issued to site operatives.
- Typical details and resources where such details can be found.

The nature of construction work is highly variable, and this document is not intended as a substitute for good engineering judgement. Rather, this guide to specification and detailing is intended to aid the structural engineer in ensuring the communication of their design intent is clear, and that their responsibilities are fully understood and defined when offering design services.

This document will also serve to highlight any particular services, responsibilities or expertise that may be lacking in a client's design brief – allowing the structural engineer to provide guidance to their client in understanding the requirements when undertaking masonry construction.

The main points from the enquiry related to an effective communication of essential design information in an accessible form to tradesmen working on site. In particular, all relevant structural information, details and specifications impacting on the structural integrity of the building should be included on the structural engineers' drawings. Furthermore, structural engineers should describe in their documentation and drawings the approach adopted in terms of reliance on the inclusion of bed joint reinforcement, wall head and lateral restraints, and wind posts. Information on the construction of external cavity walls should be provided by the structural engineering consultants. (Particularly when they are non-loadbearing.)

This document should help establish the minimum standards required in the production of construction information relating to both loadbearing and non-loadbearing masonry walls. The construction information should be comprehensive, yet concise and should be provided ideally in a single document or set of documents produced by the structural engineer.

Structural engineers should describe in their documentation and drawings the approach adopted in their designs in terms of the importance and reliance on the inclusion of bed joint reinforcement, wall head and lateral restraints or wind posts in the required locations and the inter-dependence of these various components. The proper installation of wall accessories and secondary steelwork should be adequately conveyed in the design documentation such that it is fully understood by those actually building the walls.

2 Sources of Information

There are many sources of information with regards to the design and specification of masonry, mortar, accessories and workmanship. Similarly, good detailing of masonry must be collated from a multitude of documents.

This is a hindrance to comprehensive and detailed design and specification. In light of this, the following table details a summary of valuable resources in the specification and detailing of masonry construction. Where Eurocodes are referenced, it is strongly suggested that the appropriate National Annex be referred to. Note that the following table does not include a comprehensive guide to all literature on masonry construction.

Table 2.1

Document	Includes
BS EN 1990:2002 + A1:2005 *(Incorporating corrigenda December 2008 and April 2010)* **Eurocode – Basis of structural design**	• Basis of 'Limit-state' Design Philosophy
BS EN 1991-1-1:2002 *(Incorporating corrigenda December 2004 and March 2009)* **UK National Annex to Eurocode 1 – Actions on structures** *Part 1-1: General Actions – Densities, self-weight, imposed loads for buildings*	• Weights of materials • Determination of loads due to self-weight etc. • Determination of imposed loading
BS EN 1991-1-3:2003 + A1:2015 *(Incorporating corrigenda December 2004 and March 2009)* **UK National Annex to Eurocode 1 – Actions on structures** *Part 1-3: General actions – Snow loads*	• Determination of Snow Loading on Buildings.

BS EN 1991-1-4:2005 + A1:2010
(Incorporating corrigenda July 2009 and January 2010)
UK National Annex to Eurocode 1 – Actions on structures
Part 1-4: General actions – Wind loads
	• Determination of Wind loading on Buildings
	  • Local wind pressures for panels
	  • Global wind pressures on structure

BS EN 1996-1-1:2005 + A1:2012 *(Incorporating corrigenda February 2006 and July 2009)* **UK National Annex to Eurocode 6 – Design of Masonry Structures** *Part 1-1: General rules for reinforced and unreinforced masonry structures*	• Principles for the design of masonry used in buildings • Rules should be applied to internal masonry acting as buttresses to external walls to ensure adequacy.

Table 2.1 Cont.

Document	Includes
BS EN 1996-2:2006 *(Incorporating corrigendum September 2009)* **UK National Annex to Eurocode 6 – Design of Masonry Structures** *Part 2: Design considerations, selection of materials and execution of masonry*	• Material selection, detailing requirements and particulars of the execution of masonry structures • Durability requirements • Movement in masonry incl. joints, DPCs • Deviations, tolerances and mortar / material quality and workmanship
PD 6697:2010 *Recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996-2*	• Supporting information for designers of masonry
BS EN 771 *Part 1 Specification for masonry units. Clay masonry units* *Part 2 Specification for masonry units. Calcium silicate masonry units* *Part 3 Specification for masonry units. Aggregate concrete masonry units (dense and light-weight aggregates)* *Part 4 Specification for masonry units. Autoclaved aerated concrete masonry units* *Part 5 Specification for masonry units. Manufactured stone masonry units* *Part 6 Specification for masonry units. Natural stone masonry units*	• Specification of performance for masonry units (incl. compressive stresses) (**Note:** that this document only relates to the use of parts 1 to 4 of BS EN 771 – Solid stone (manufactured or natural) masonry covered in BS EN771 parts 5 and 6 is not addressed in this document.)
BS 8000-0:2014 *Workmanship on construction sites. Introduction and general principles*	• General principles regarding tolerance, accuracy preparation of construction materials etc.
BS EN 998 *Part 2: Masonry mortar*	• Specification of mortars for masonry construction (incl. strengths, mixes etc.)
BS 8000-3:2001 *Workmanship on building sites. Code of practice for masonry*	• Recommendations for site operatives • Guidance for 'good practice' on site. • Guidance on the specification of design requirements for required workmanship
The Building Regulations 2010 **Approved Document A**	• Provides minimum wall thicknesses for low rise construction (2C5) • Minimum requirements for wall ties, incl. spacing, provision for joints, openings and return walls(2C8) • Minimum requirements for workmanship (2C19) and manufacture/strength of masonry units (2C20) • Guidance on restraint of walls (2C25, 2C26, 2C27) • Guidance on chases and recesses (2C28, 2C29, 2C30, 2C31)

Table 2.1 Cont.

Document	Includes
BS 8103-2 *Structural Design of Low-Rise Buildings. Code of practice for masonry walls for housing*	• The use of masonry in low rise buildings
Small Buildings Structural Guidance for the Building regulations (Scotland)	• The use of masonry in small buildings
Manual for the design of plain masonry in building structures (Second edition) *(Second Edition – 2018)*	• Design guidance for plain masonry according to BS EN 1996-1-1 for practicing structural engineers. • Updates following significant changes to the Eurocode in 2012 not reflected in the previous edition.
How to design masonry structures to Eurocode 6 *MPA The Concrete Centre*	Part 1 – Introduction Part 2 – Vertical Resistance Part 3 – Lateral Resistance
Failures in masonry construction (CROSS Reports)	The following CROSS reports were some of those considered in the preparation of this document: • No.56 Effective lengths of load-bearing walls • No.82 Wind on internal masonry walls during construction • No.84 Collapse of brickwork cladding • No.92 Collapse of a gable wall • No.99 Collapse of a wall during construction • No.135 Critical wall failure • No.144 A failure survey of free standing walls • No.164 Tying walls to floors in domestic properties • No.177 Gain in strength of mortar slower than concrete • No.242 Stability compromised in school roof • No.295 Masonry fall due to high wind • No.306 Wall collapse from building in city centre - who is responsible? • No.414 Blockwork lateral restraint • No.511 Collapse of infill wall panel • No.602 Padstones out of position leads to collapse

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3 Designers' Checklist

The following checklist has been prepared to aid the designer and specifier in addressing the particulars of masonry construction. References are provided for appropriate standards and regulations, and a basic responsibility breakdown is provided. An indication of appropriate design documentation provided to the contractor is given.

Using this Table

For the appropriate stage in the delivery of a structure (documentation or execution), the designer can consult the table for relevant guidance in the specification of an element of masonry design and use the information contained therein to clearly communicate the information required to ensure structural adequacy.

Element – Denotes the element or aspect of masonry construction considered

Activity Required – Processes (e.g. specification, checking procedures and/or quality assurance requirements) associated with the element

Responsibility – Which party is traditionally involved in undertaking the required activity for a given element.

Design Documentation – Activity undertaken at Design / Documentation Stage

Execution / Construction – Activity undertaken at Construction Stage

Comments – remarks related to the element, associated activities and responsibilities in the context of design and construction. These relate almost entirely to structural implications of design choices and reference appropriate codes / guidance.

Table 3.1

Element	Activity Required	Responsibility A – Architect C – Contractor M – Manufacturer SE – Structural engineer ME – Mechanical / Electrical engineer	Design Documentation	Execution / Construction	Comments
Masonry Units	• Specification	A / SE	•		• Specification to BS EN 771. Clear instruction on the acceptability of alternates (e.g. solid vs. hollow block) Note that Group II masonry units will contain > 25% voids. • Where masonry units (typically facing masonry) is specified by the architect, it is essential that the Structural Engineer review and ensure chosen units meet the minimum engineering requirements, rejecting any specification that does not comply.
	• Delivery Checks • Manufacturer's Declaration	C / M / A / SE M		• •	
Factory Produced Mortar	• Specification	A / SE	•		• Prescribed or designed mortar to be specified. Note that BS EN 9982 does not cover Site-mixed Mortars. • Where masonry mortar is specified based on aesthetic / architectural qualities, the Structural Engineer must ensure it complies with the minimum engineering and durability requirements, rejecting any specification / mortars that do not comply.
	• Third Party Visual Check on production • Manufacturer's test certificates	M M / C		• •	

Table 3.1 (Cont.)

Element	Activity Required	Responsibility	Design Documentation	Execution / Construction	Comments
Site Mixed Mortar					• Not to be used for Execution Class 1 (EXC1) Structures
Bed Joint Reinforcement	• Specification • Delivery Checks • Manufacturer's Declaration • Inspection	SE C / M / SE M / C C / SE	•	• • •	• Check galvanised steel reinforcement is permitted for use in external / internal leaf by the manufacturer. Specify required lap length for reinforcement • Compliance with manufacturer's requirements (particularly lapping of reinforcement, placement within mortar) Check that galvanised reinforcement is not cut on site without treating ends with suitable protection.
Filling of Mortar Joints	• Testing / spot checks	C / SE		•	• Inspection conducted at rate dependent upon size of scheme. Particular attention should be paid to ensure perp-ends (cross joints) are fully filled. – This is particularly important for blockwork.
Location of wall ties	• Specification • Spot Checks	SE C / SE	•	•	• Type 1/2/3 or 4 in accordance with PD6697. Appropriate spacing of ties with particular attention paid to movement joints, openings and corner returns. (min. 2.5 ties/m^2, min. 50mm embedment) • If hollow concrete masonry is being used, the designer should specify the location of wall ties in relation to cross-webs within the block. (Refer to Appendix A for details) • Where cavity widths are large, wall ties should be 'designed' for lower compressive strength than ordinarily rated. (See Table 12 PD6697) • Inspections of wall tie placement, locations and embedment proportional to the size of the proposed scheme.

Table 3.1 (Cont.)

Element	Activity Required	Responsibility	Design Documentation	Execution / Construction	Comments
Windposts	• Specification	SE	•		• The designer should specify appropriate wind posts and suitable fixings to the primary structural members / framing.
	• Installation	C / SE		•	• Structural engineer will need to check that the windposts are in accordance with the design and setting out.
Corbels & Overhangs	• Specification	SE	•		• These are now covered in PD 6697. Designer to specify these in accordance with this. • The designer will need to provide the limiting values for overlapping of the masonry units to ensure that the masonry remains in compression.
	• Installation	SE / C		•	• Structural engineer will need to check that the corbels and overhangs are within the tolerances required and are in compliance with specified dimensions.
Fixing details to Structural Frame	• Specification	SE	•		• Adequate detailing and specification of tying to main structural frame, around movement joints, openings and at corner returns. • Explicit instruction that wall ties are not to be omitted if obstructed by other structural members, but instead reported to the structural engineer if significant, otherwise; ties to be placed at next available space. • Adequate specification of structural thermal breaks with clear understanding of compression, creep, movement characteristics of both frame and break plates. (e.g. compressibility of polymer thermal breaks, shrinkage of concrete frame, expansion of brickwork. • Allowances to be made for tolerances on the main structure. E.g. NSCS indicates that the accuracy of a concrete frame may be +/- 50mm. – Similar allowances will need to be made for the majority of structural systems.

Table 3.1 (Cont.)

Element	Activity Required	Responsibility	Design Documentation	Execution / Construction	Comments
Fixing details to Structural Frame	• Delivery Checks	C		•	
	• Manufacturer's Declaration	M		•	
	• Inspection	C / SE	•	•	
Formation of Movement Joints	• Specification	SE / A	•		• Typical details & specification of suitable gap filling compounds etc. • Locations to be coordinated with other disciplines. Careful attention paid to the different movement characteristics of clay and concrete masonry units. • General guidance indicates 6-7m spacing for concrete masonry units, 9-12m for clay masonry units. • Width of joint to be approximately 1-1.5mm per metre of masonry. • Consider debonded ties across the movement joint which permit shrinkage and thermal movement in the length of the wall whilst resisting wind load etc. orthogonal to the wall • Sleeved ties should be used, and the engineer is to ensure movement is in the direction of the tie Ensure movement joints are not inhibited by fixing back to structural frames either side of the joint.
	• Installation	C / SE		•	• Ensure that Movement joints are properly executed, clear and uninterrupted Check that movement is not inhibited by fixings, frame or hard material bridging across the joint

Table 3.1 (Cont.)

Element	Activity Required	Responsibility	Design Documentation	Execution / Construction	Comments
Intersecting walls	• Specification	SE	•		• Specification of adequate tying and appropriate details in proportion to size of the scheme. • The designer should consider the implications of inadequate tying of cross walls. Stressing the importance of these to the contractor and allowing for suitable inspection if deemed necessary.
Head restraints	• Specification • Installation	SE C / SE	•		• The lack of properly detailed and constructed head restraint will very significantly reduce the capacity of masonry panels. Proprietary head restraints are available for horizontal beams but for inclined members, a bespoke solution may need to be specified
Correct installation of ancillary components shelf angles etc.	• Specification • Delivery Checks • Installation	SE C C / SE	•	 • •	• Head restraints • Frame ties • Cavity wall ties • Allowances for creep, deflection and sagging/hogging behaviour of the surrounding structure • Suitable restraint of non-load-bearing walls. • Checks proportional to the size of the scheme
Lintels	• Specification • Installation	SE C	•	 •	• Lintels should be specified by the designer with appropriate minimum bearing into new masonry (min. 100mm) • Lintels should bear onto whole masonry units (as opposed to cut, or half bricks) • Pistol bricks and weep holes to be specified as required • Packing around lintel and mortar joints to be fully filled
Overall dimensional compliance	• Spot Checks	A		•	• Checks proportional to the size of the scheme. • Compliance to be in accordance with BS EN 1996-2 (Table 3.1)
Placement of Insulation	• Specification	A	•		• Wall ties should be appropriately specified to ensure compatibility with insulation proposed (by others). Note that in many cases, insulation will obscure the wall ties from inspection post installation.
Installation of fire stops	• Specification • Installation	A C		 •	• Generally specified by the Architect.

Table 3.1 (Cont.)

Element	Activity Required	Responsibility	Design Documentation	Execution / Construction	Comments
Finishing of Mortar Joints	• Specification • Visual Inspection	SE / A SE / A	•	•	• Joints to be specified. Design calculations to reflect proposed finishing of joints. • Refer to Figure 3.1 of **Manual for the design of plain masonry in building structures to Eurocode 6 (1st Ed.)** • Note that not all joints are suitable for all types of masonry unit. • Recessed joints are to be avoided due to the resulting decrease in frost resistance. • Ideally specify flushed joints or lightly tooled joints. • Joints are as specified in the design, and in accordance with design calculations.
Cleaning of facing work	• Visual Inspection	A		•	• Inspection conducted at rate depended upon size of scheme.
Aesthetics of completed masonry	• Specification	A	•		• Specification of appropriate benchmarks and agreement with contractor, architect etc. at early stage. • Additional advice on this can be found in PD 6697 • The Architect may specify that test-panels are to be fabricated to establish a suitable aesthetic benchmark.
Cavity Width	• Specification • Spot Checks	SE / A C / SE / A	•	•	• Specification of cavity width coordinated with other consultants, suitable specification of wall ties appropriate for cavity width and specification in accordance with design calculations. • Checks made at rate proportional to the size of the scheme.

Table 3.1 (Cont.)

Element	Activity Required	Responsibility	Design Documentation	Execution / Construction	Comments
Padstones	• Specification • Visual inspection	SE C / SE	•	•	• Size, position and typical details for requirements of bearing new steel onto padstones. Emphasis on tolerances from centre of padstone for new steel based on design calculations / analysis. • The designer should allow for construction loads on adjacent elements. • The designer should allow for loads and moments due to reasonable tolerance and specify the tolerance to which the contractor should work.
Chases	• Specification / coordination	SE / ME	•		• Full coordination of services to ensure no impairment of the structural performance of the element. • Refer to UK National Annex of BS EN 1996-1-1 for help in specifying. • Design assumptions and intent should be present in the Operation & Maintenance (O&M) Manual to facilitate future refurbishment and modification of services. • Specification of the largest acceptable chases and/or general rules for chasing out during future refurbishment in order to facilitate new plant etc.
Cavity trays	• Specification • Specification	A SE	•		• Coordination with other design disciplines. • Weepholes to be specified to prevent moisture buildup.
Damp Proof Course (DPC)	• Specification	A	•		• The structural engineer must take into account the impact of the DPC on structural assumptions and restraint conditions for masonry walls. This can be particularly onerous for parapets.

Table 3.1 (Cont.)

Element	Activity Required	Responsibility	Design Documentation	Execution / Construction	Comments
Sequencing	• Specification • Construction	SE SE / C	•	•	• The Designer should specify the assumed sequence of construction to the contractor as this may influence programme. • Details of the contractor's method statement should be provided to the designer to ensure compliance, with any changes highlighted. • Consider the desire for weather-tightness and the possibility of internal leaves being constructed prior to external leaves (i.e. out of sequence) and the implications this may have on installing masonry, mortar, shrinkage, and wall ties / ancillary elements. • Consider the intermediate stability of single leaf prior to construction of outer leaf. • Contractor's proposed method to be compared with design and detailing assumptions.
Protection of masonry and curing	• Proposal / Method statement	C		•	• The structural engineer should specify that protection and workmanship generally is to BS 8000-0:2014 and BS 8000-1:2001.
Temperature & ambient conditions	• Specification • Reporting	SE C	•	•	• Suitable limits on temperatures / conditions under which masonry is laid. Construction of masonry should be stopped when the ambient temperature falls below 5°C unless special provisions have been put in place. • Monitoring and recording of temperatures during installation and subsequent curing of mortar.
Rate of construction	• Specification • Reporting	SE C	•	•	• Specification on limits on masonry lifts per day. • Recording of height of masonry built in one day.

4 Additional guidance

Aircrete Products Association Ltd. - www.aircrete.co.uk

Brick Development Association Ltd. www.brick.org.uk

International Masonry Society - www.masonry.org.uk

Concrete Block Association - www.cba-blocks.org.uk

Modern Masonry Alliance - www.modernmasonry.co.uk

Mortar Industry Association - www.mortar.org.uk

The Concrete Centre - www.concretecentre.com

Eurocode 6 Guidance – www.eurocode6.org

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Appendix A - Indicative Details

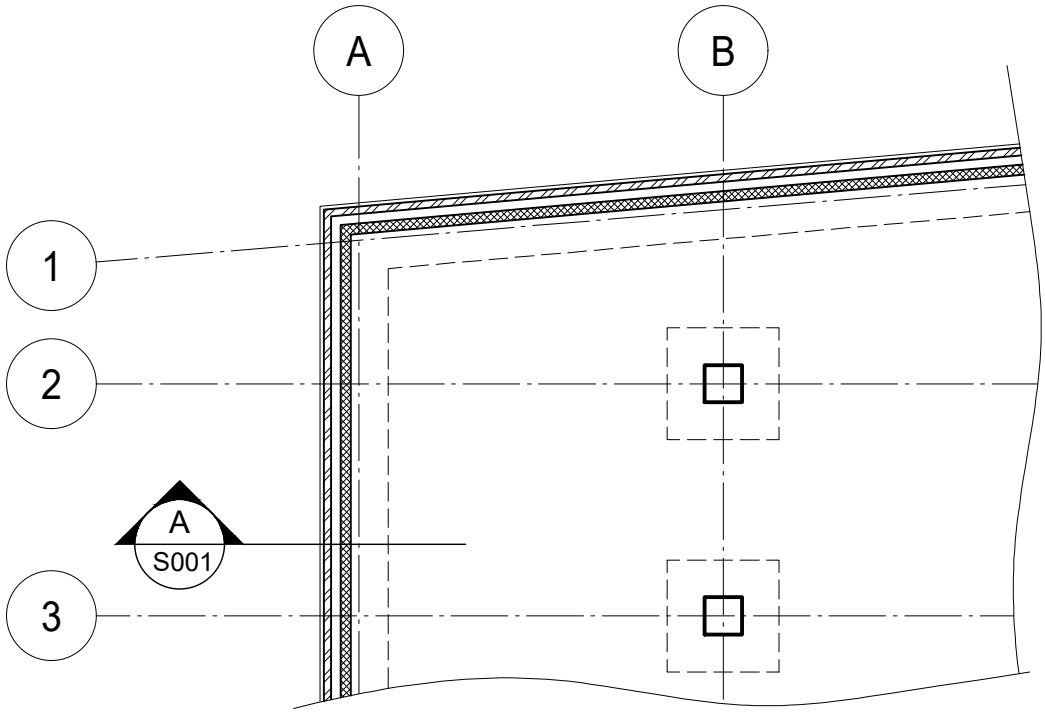
5 Appendix A – Indicative Details

The following details have been prepared to illustrate detailing requirements for masonry, particularly cavity wall construction.

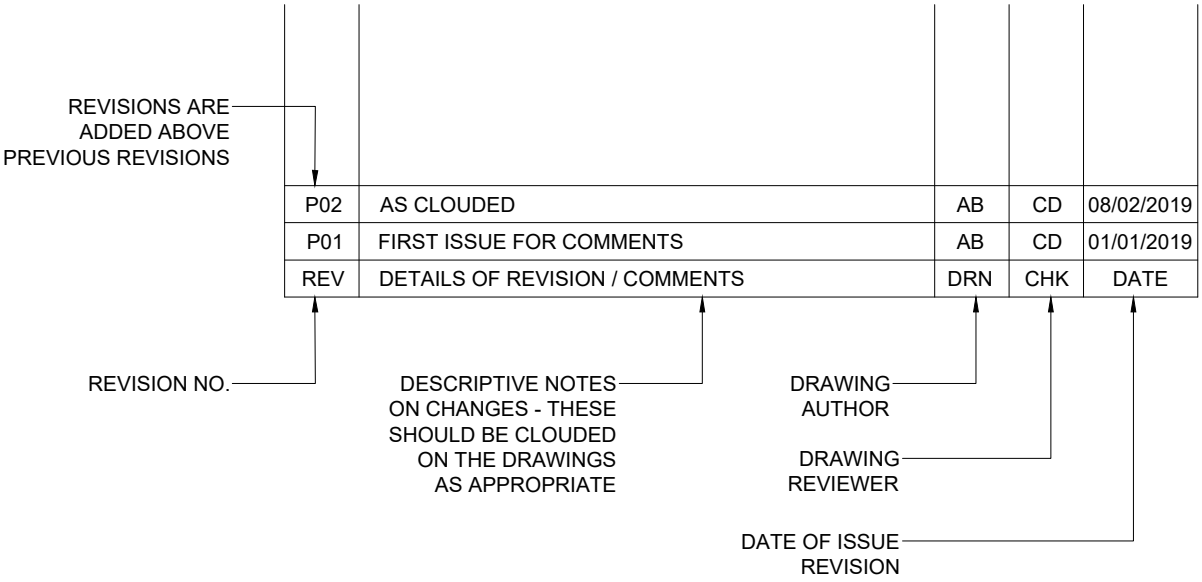
These details are intended only to provide the designer with easily understood diagrams and should not be used as-is for the purposes of construction documentation.

SCHEDULE OF INDICATIVE DETAILS (Cont)

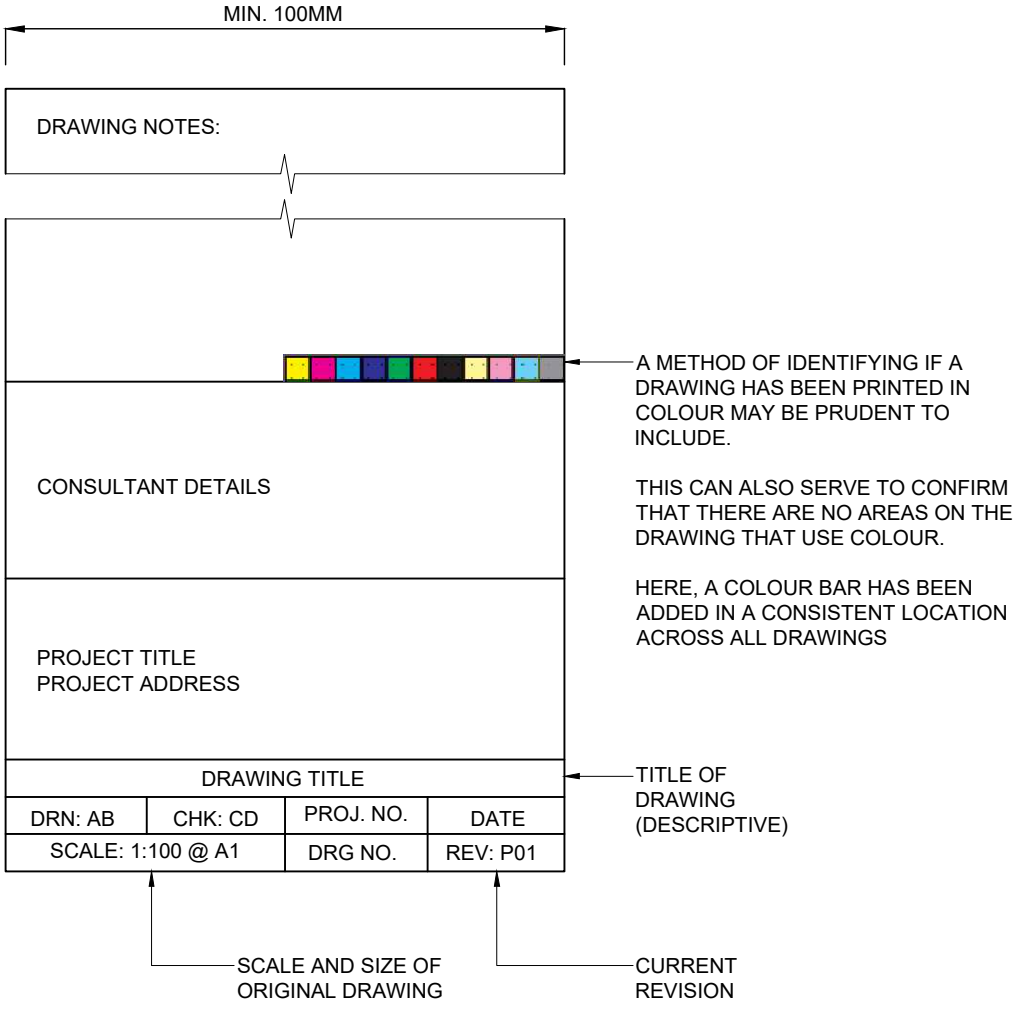
DRAWING STANDARDS AND PRESENTATION



The Institution of Structural Engineers and the members who served on the Masonry Working Group that produced these typical details have endeavoured to ensure the accuracy of its contents. However, the guidance and recommendations given should always be reviewed by those using the report in the light of the facts of their particular case and any specialist advice. No liability for negligence or otherwise in relation to these drawings and its contents is accepted by the Institution, the members of the Masonry Working Group its servants or agents. ***Any person using this document should pay particular attention to the provisions of this condition.***



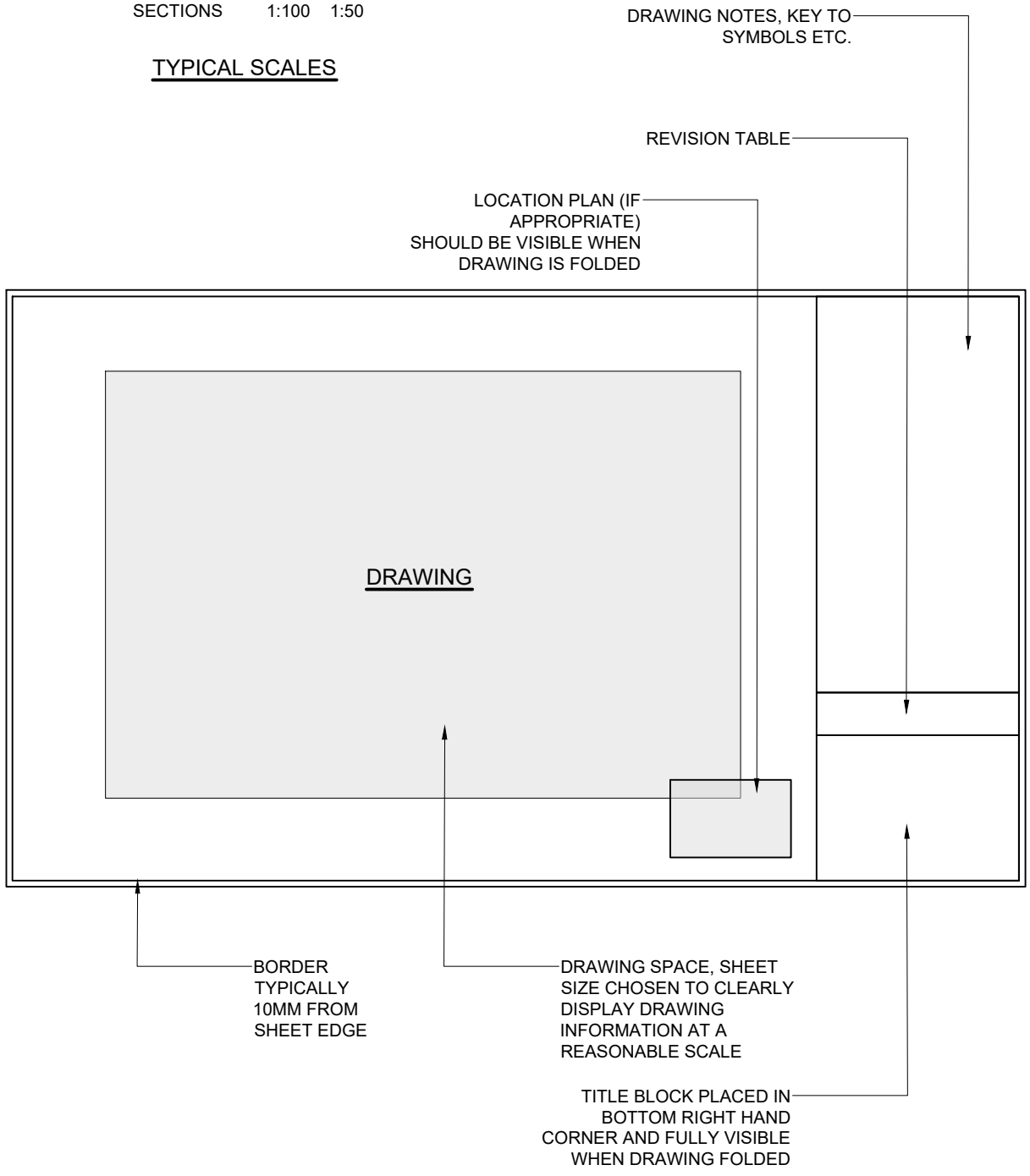
EXAMPLE DRAWING REVISION TABLE



EXAMPLE TITLE BLOCK
TITLE BLOCK MUST CONTAIN ALL RELEVANT DETAILS
TO ENSURE CONTRACTOR AND SITE OPERATIVES
HAVE RELEVANT, UP-TO-DATE INFORMATION

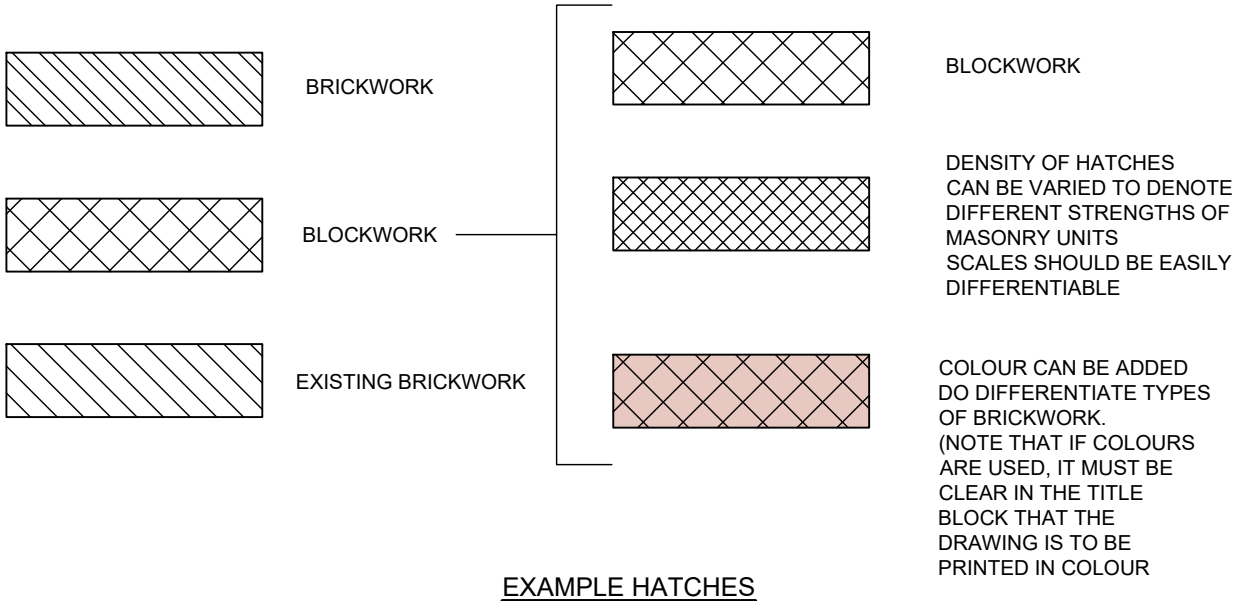
SITE PLAN	1:200	(SOMETIMES 1:500)
GENERAL ARRANGEMENT	1:100	1:50
COMMON DETAILS	1:50	1:20
UNIQUE / SPECIAL DETAILS	1:20	1:10
ELEVATIONS	1:100	1:50
SECTIONS	1:100	1:50

TYPICAL SCALES



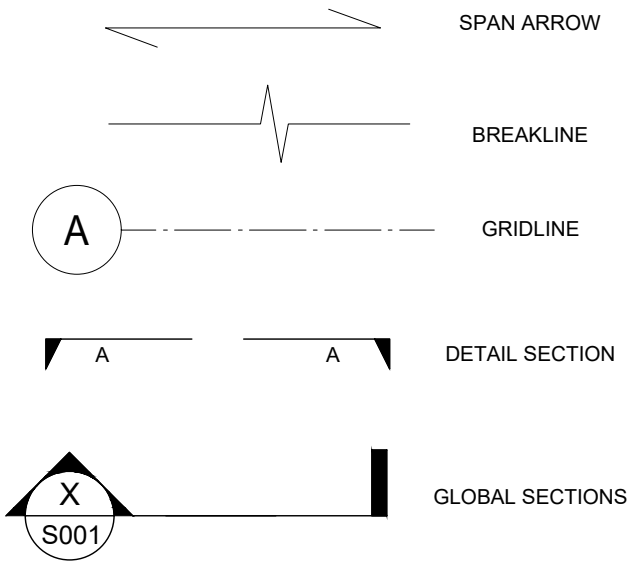
TYPICAL DRAWING LAYOUT

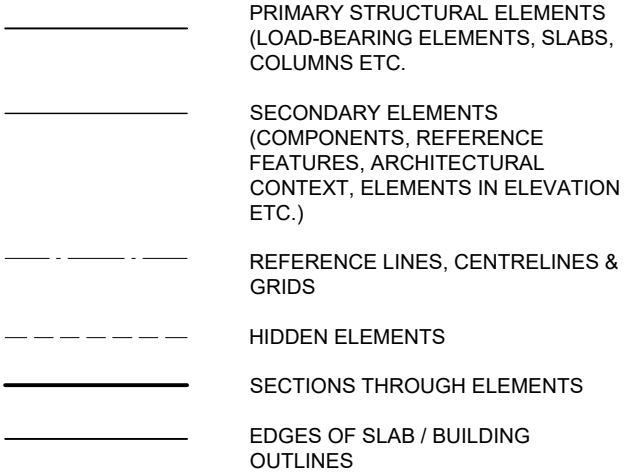
THE FOLLOWING LINES, HATCHES AND SYMBOLS ARE PROVIDED AS EXAMPLES AS TO HOW ELEMENTS MAY BE PRESENTED. FOR FULL SPECIFICATIONS FOR DRAFTING AND CAD STANDARDS, USERS OF THIS MANUAL SHOULD REFER TO BS ISO 128-23:1999



EXAMPLE HATCHES

COMMON 2D HATCH TYPES ARE DETAILED IN BS8541-2:2011 (IN ALL CASES, HATCHES AND COLOURS ARE TO BE DEFINED CLEARLY IN THE DRAWING NOTES)





EXAMPLE LINEWEIGHTS / TYPES

GENERALLY IN ACCORDANCE WITH BS ISO 128

COMMON SYMBOLS

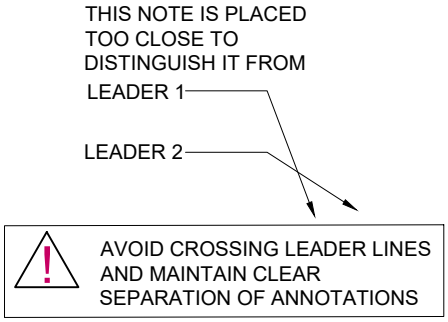
ROMANS ABCDEFGHIJKLMNOPQRSTUBWXYZ 1234567890 !?−=+/()"£%&*#~><{}[]

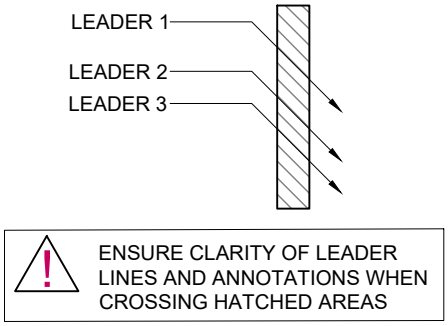
ISOCPEUR ABCDEFGHIJKLMNOPQRSTUBWXYZ 1234567890 !?-=+/()"£%&*#~><{}[]

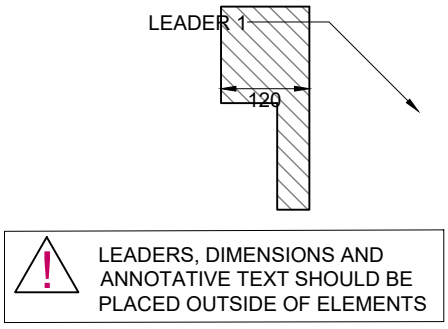
ARIAL ABCDEFGHIJKLMNOPQRSTUBWXYZ 1234567890 !?-=+/()"£%&*#~><{}[]

FONTS SHOULD BE CHOSEN TO MAXIMISE READABILITY AND CLARITY. LETTER HEIGHTS ACCORDING TO BS 8888:2017

COMMONLY USED FONTS





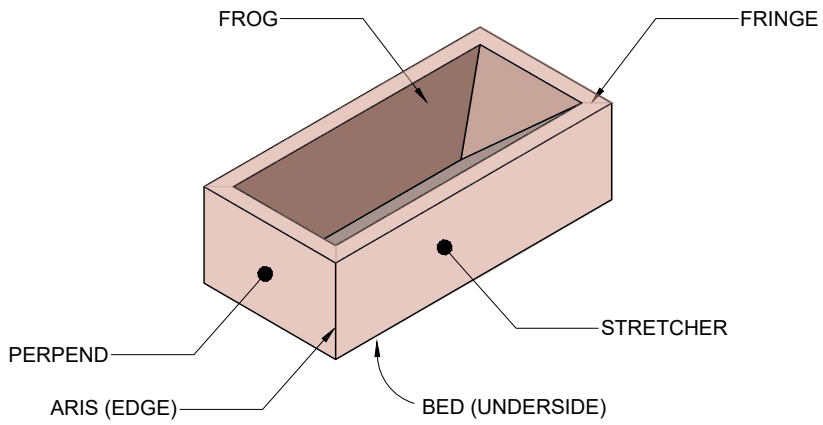


COMMON ERRORS IN ANNOTATION AND DIMENSION NOTATION

COMMON ABBREVIATIONS
(WHERE USED, THEY SHOULD BE DEFINED ON THE DRAWING)

ABOVE ORDNANCE DATUM	AOD
APPROXIMATELY	APPROX.
AT	@
BLOCKWORK	blk
BRICKWORK	brk
CENTRE-LINE	℄
CENTRES	crs or C/C
COLUMN	COL
CONCRETE MASONRY UNIT	CMU
CONFORMITE EUROPEENNE	CE
CONTINUOUS	CONT.
CONTRACTOR'S DESIGN PORTION	CDP
DAMP PROOF COURSE	DPC
DIAMETER	DIA. or Ø
DRAWING	DRG
EQUAL	EQ
EXISTING LEVEL	EL
EXISTING PLAN	EX
EXTERNAL GROUND LEVEL	EGL
FINISHED FLOOR LEVEL	FFL
GENERAL ARRANGEMENT	GA
HEALTH AND SAFETY	H&S
HORIZONTAL	HORIZ
LOAD BEARING	LB
MECHANICAL & ELECTRICAL	M&E
MOVEMENT JOINT	MJ
NOT TO SCALE	NTS
NUMBER OF	NO.
OPERATION AND MAINTENANCE	O&M
PENETRATION	PEN.
POCKET	PKT
PRECAST CONCRETE	PC or PCC
REINFORCED CONCRETE	RC
SAFE WORKING LOAD	SWL
SPECIFICATION	SPEC.
STAINLESS STEEL	S/S
STRUCTURAL SLAB LEVEL	SSL
THICK	THK
TOP OF CONCRETE	TOC
TOP OF FOUNDATION / FOOTING	TOF
TOP OF STEEL	TOS
TOP OF WALL	TOW
UNLESS NOTED OTHERWISE	UNO
VERTICAL	VERT.

DETAILS RELATING TO DIMENSIONS, TOLERANCES AND SETTING OUT



"THE ANATOMY OF A FROGGED BRICK"

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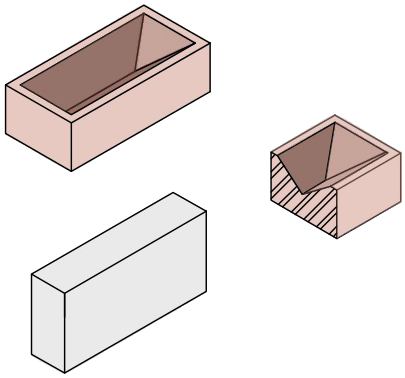
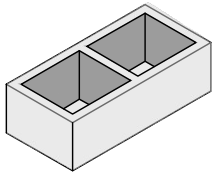


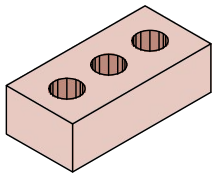
SOLID MASONRY UNITS

(MAY OR MAY NOT HAVE A 'FROG' - A DEPRESSION IN THE BRICK TO REDUCE WEIGHT OF UNIT.)

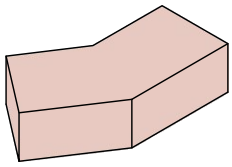
NOTE: IF FROG IS PRESENT, UNIT TO BE PLACED FROG-UP TO ENSURE IT IS FILLED WITH MORTAR. FROG ORIENTATION MAY IMPACT WALL STRENGTH



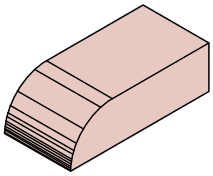
HOLLOW / CELLULAR UNIT



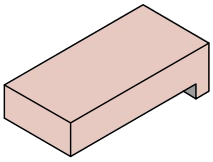
PERFORATED UNIT



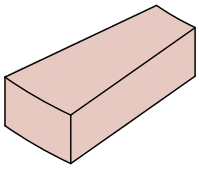
ANGLE / DOG-LEG UNIT



BULL-NOSE / COPING UNITS

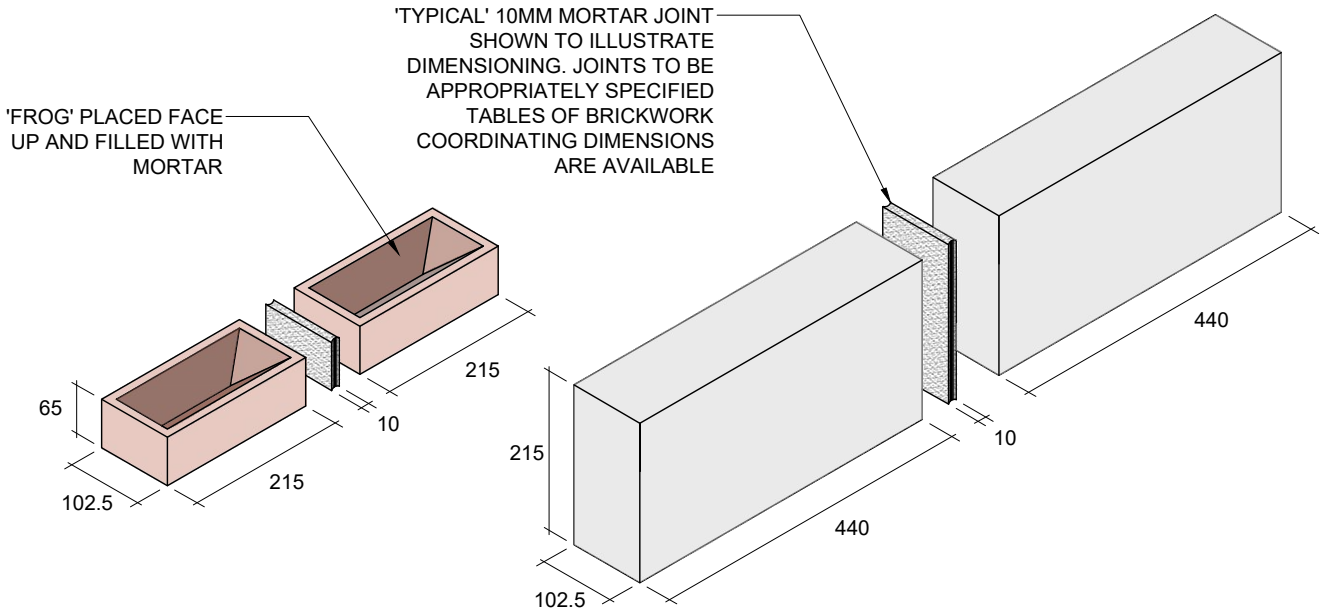


SHELF ANGLE 'PISTOL' BRICK



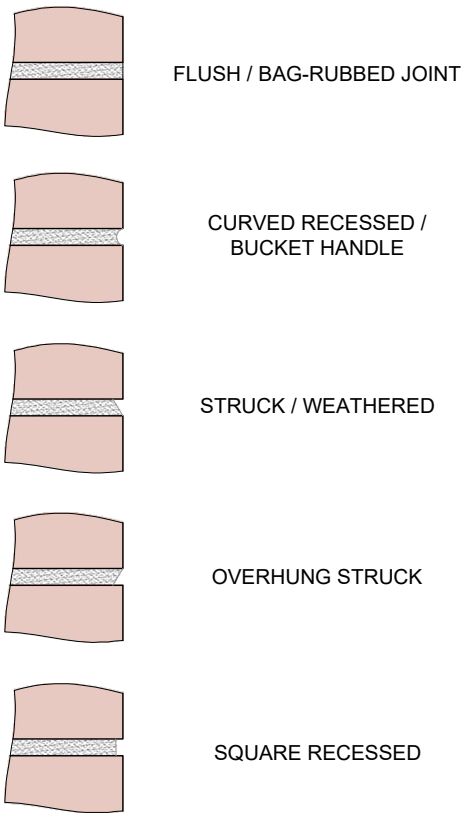
RADIAL / TAPERED UNITS

COMMON MASONRY UNIT TYPES
STANDARD AND SELECTED 'SPECIALS'

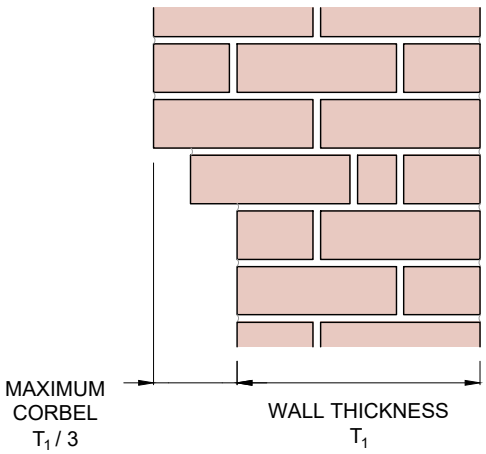


"TYPICAL UK CLAY BRICK DIMENSIONS"

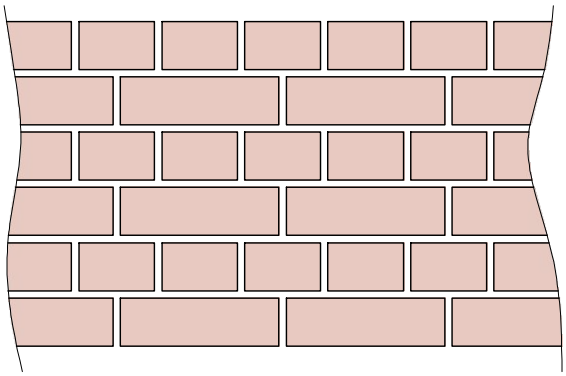
"TYPICAL UK CONCRETE BLOCK DIMENSIONS"



"JOINT FINISHING"

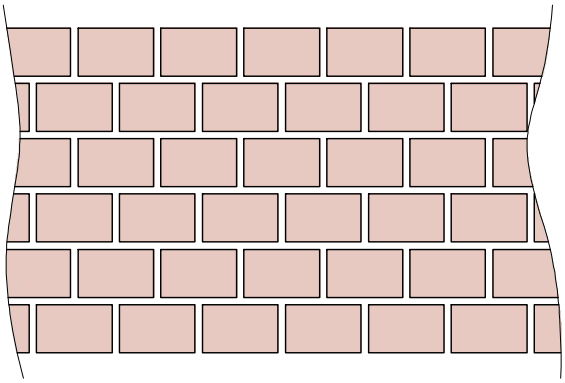


"DIMENSIONING OF CORBELS"



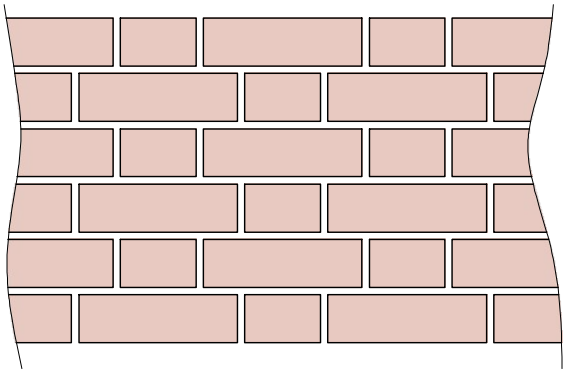
TRADITIONAL ENGLISH BOND

ALTERNATING HEADER STRETCHER COURSES

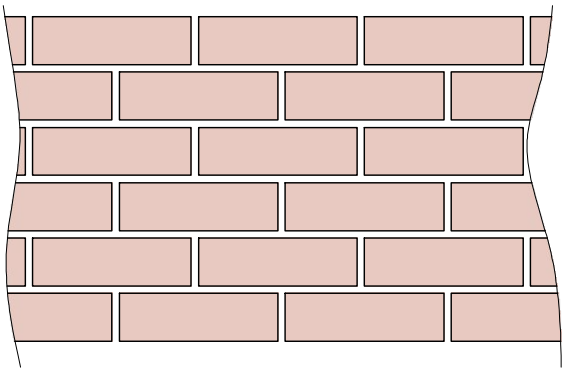


HEADER BOND

ALL HEADERS
(SOMETIMES USED TO FORM CURVED WALLS)

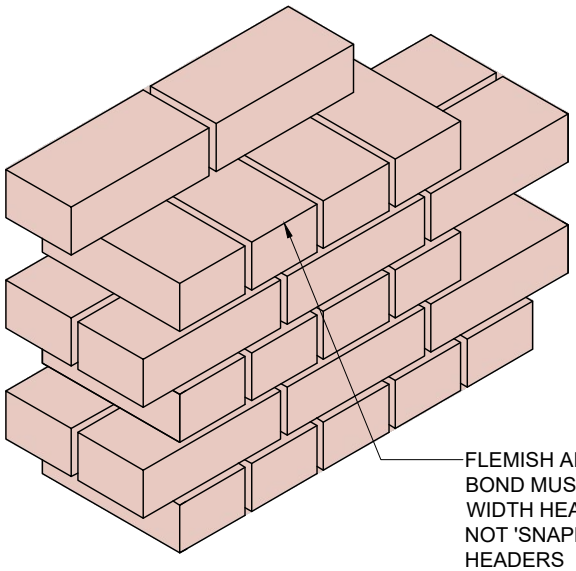


FLEMISH BOND

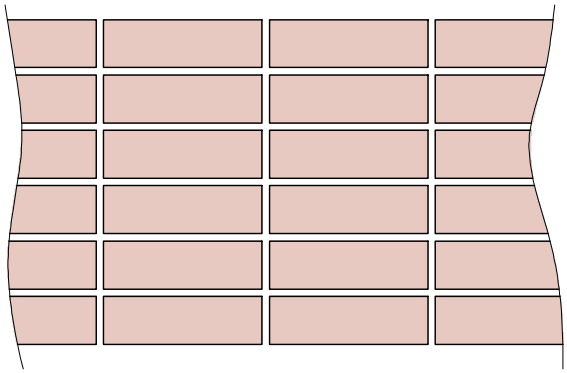


STRETCHER BOND

MOST CAVITY WALL CONSTRUCTION
WILL USE THIS PATTERN FOR AT LEASH ONE LEAF



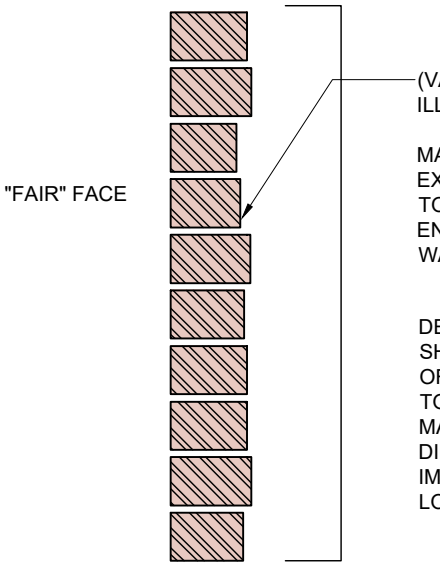
FLEMISH AND ENGLISH BOND MUST USE FULL WIDTH HEADERS AND NOT 'SNAPPED' HEADERS



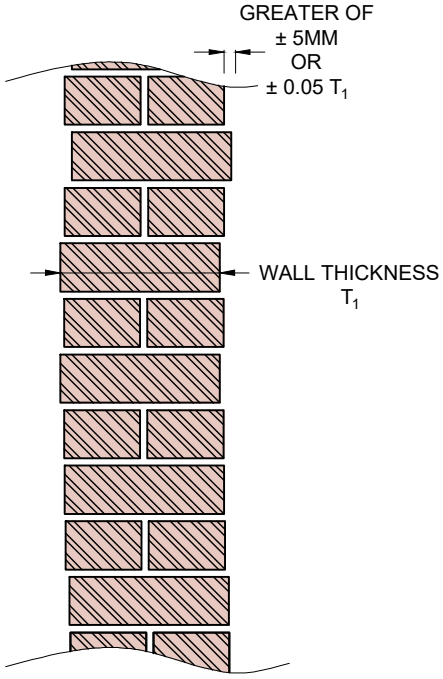
STACK BOND

(NOT GENERALLY RECOMMENDED
FOR STRUCTURAL WALLS AND
NOT COVERED BY BS EN 1996-1-1)

SELECTED COMMON
UK MASONRY WALL BOND PATTERNS
(ELEVATIONS)

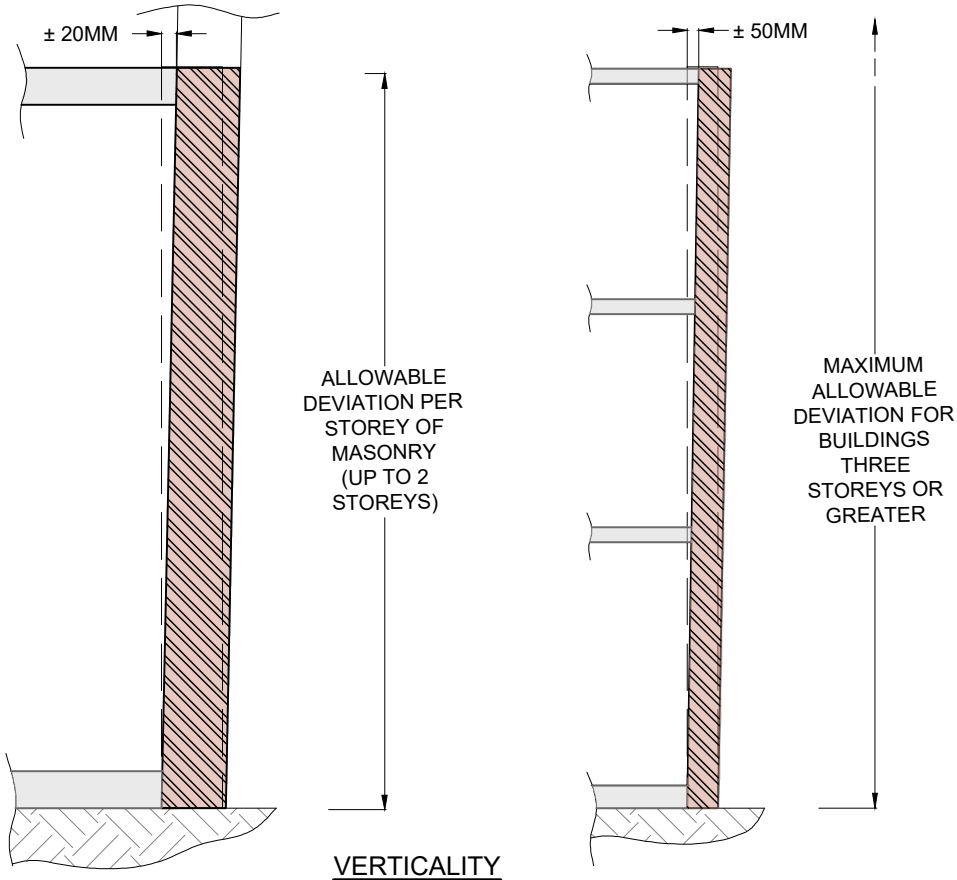


THE THICKNESS OF SINGLE LEAF WALLS WILL BE GOVERNED BY THE DIMENSIONAL TOLERANCE OF MASONRY UNITS



RULES FOR MASONRY WALLS MADE OF MORE THAN A SINGLE LEAF

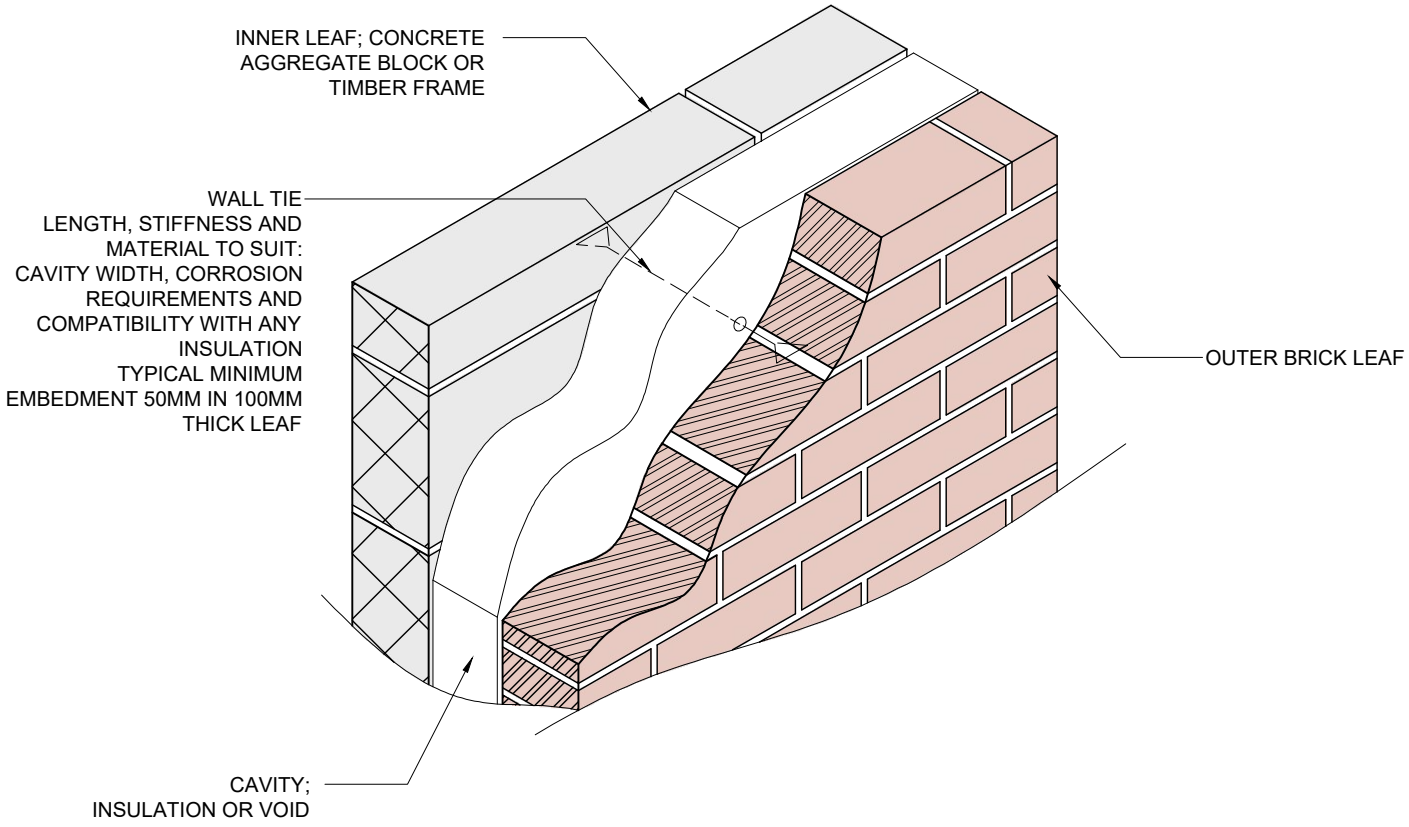
THICKNESS



VERTICALITY

TOLERANCES ON STRUCTURAL MASONRY
(REFER TO BS EN 1996-2 & PD 6697)
(SECTION DIAGRAMS)

DETAILS RELATING TO CAVITY WALL CONSTRUCTION



"ANATOMY OF A CAVITY WALL" (ISOMETRIC)

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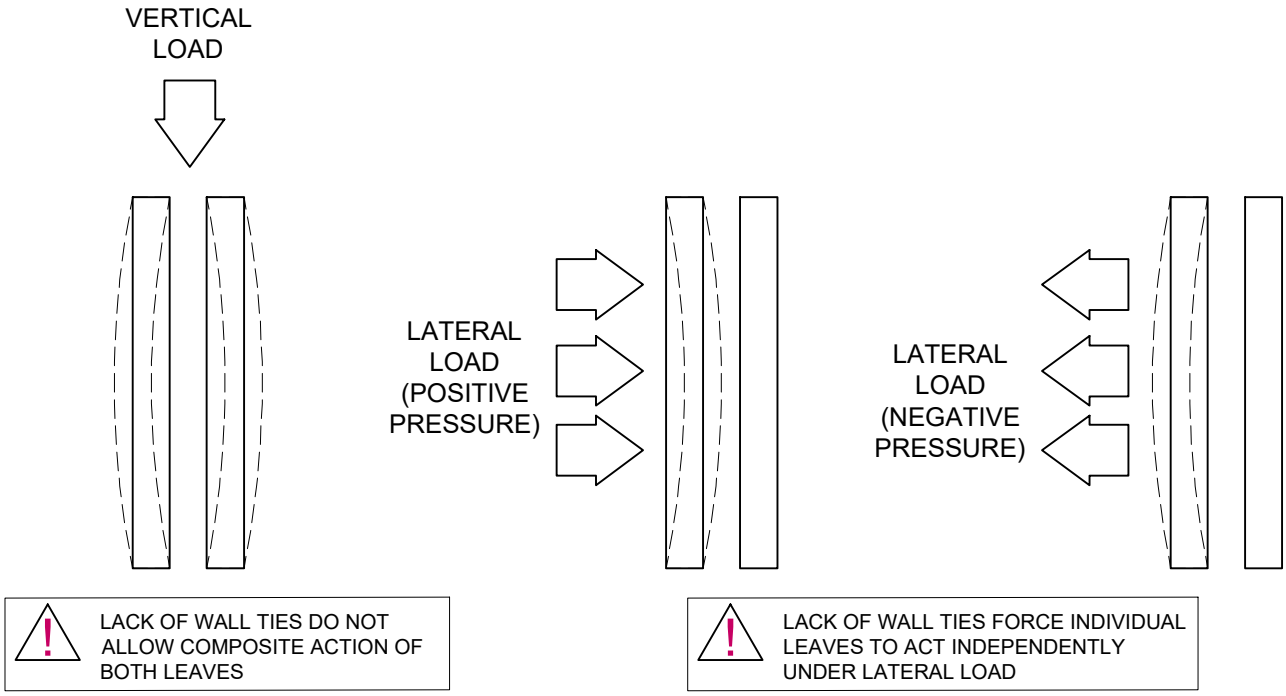
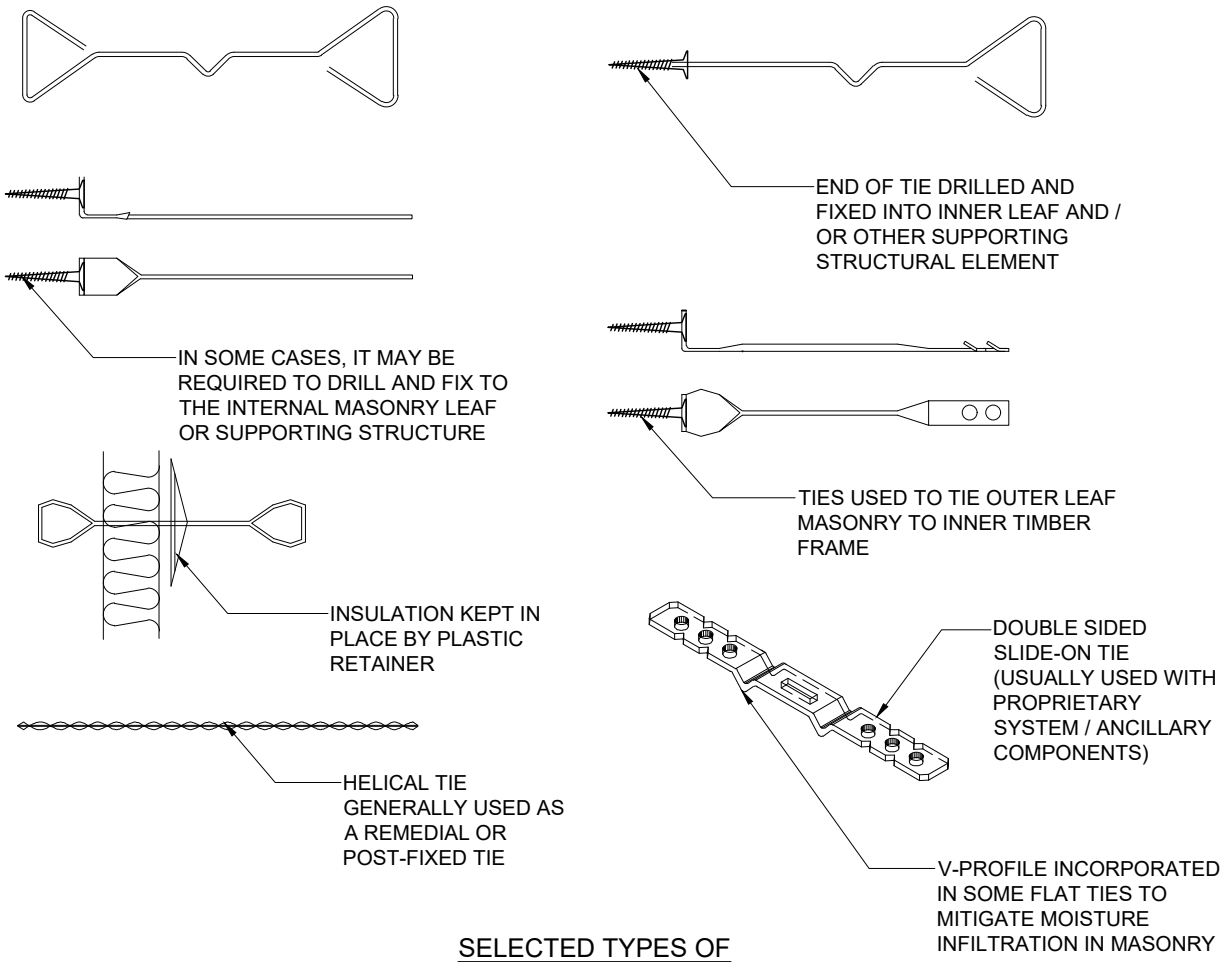
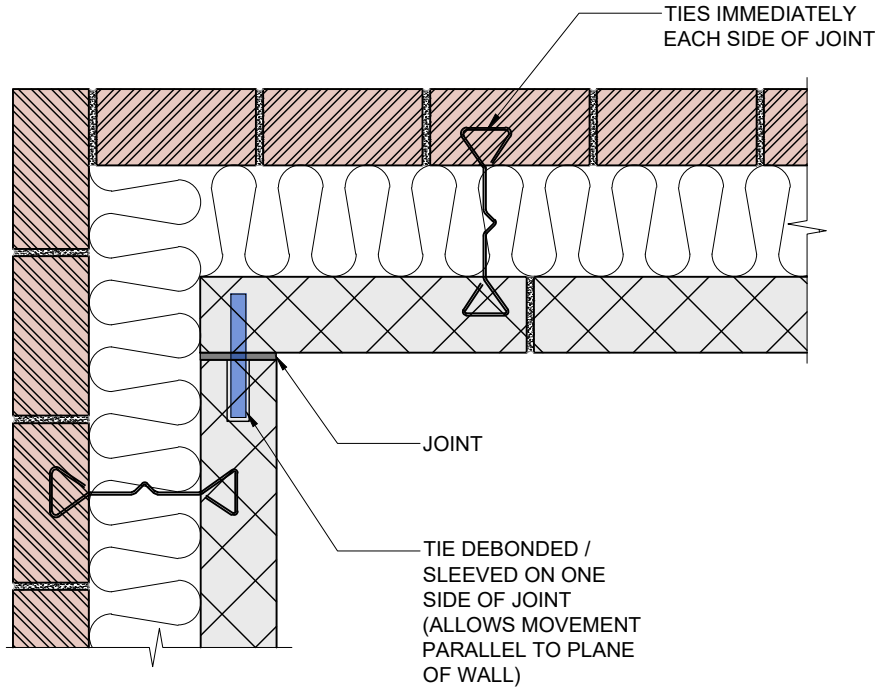


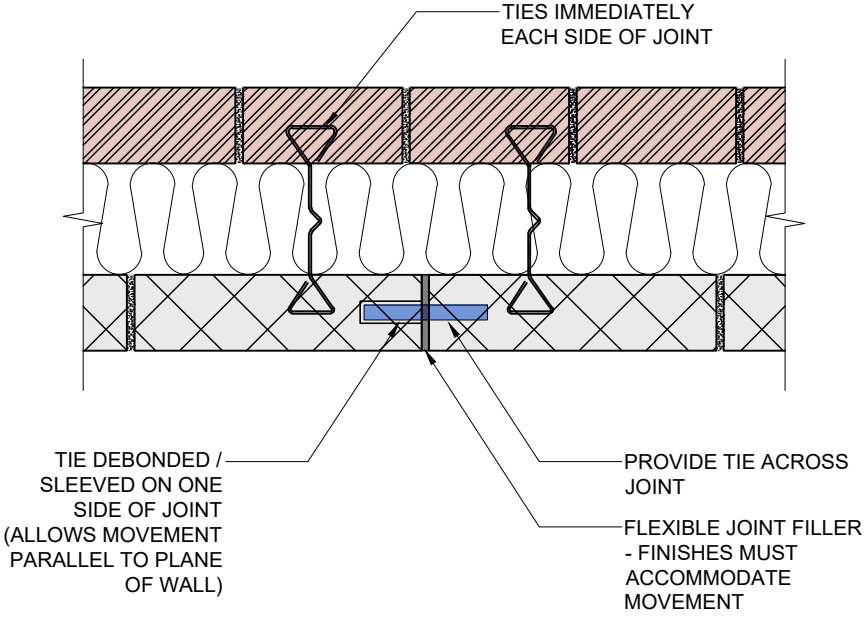
BEHAVIOUR OF CAVITY WALLS WITHOUT TIES



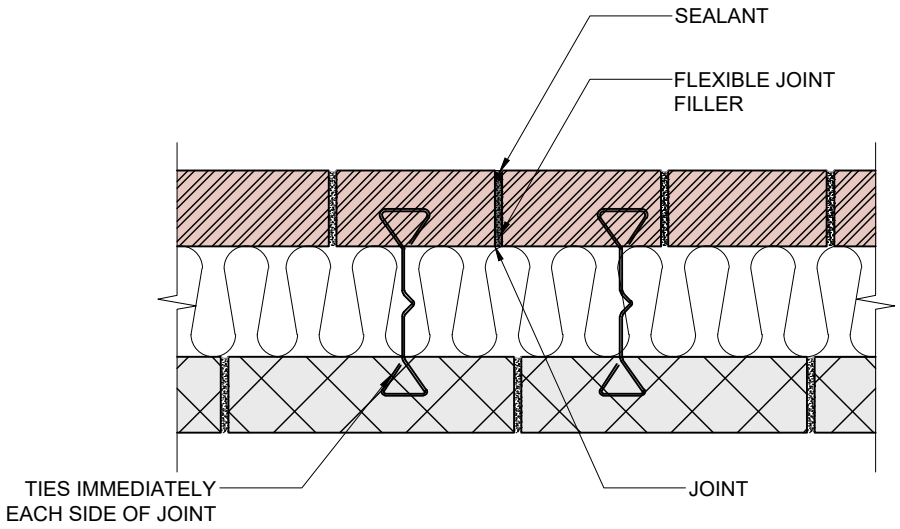
SELECTED TYPES OF CAVITY WALL TIES



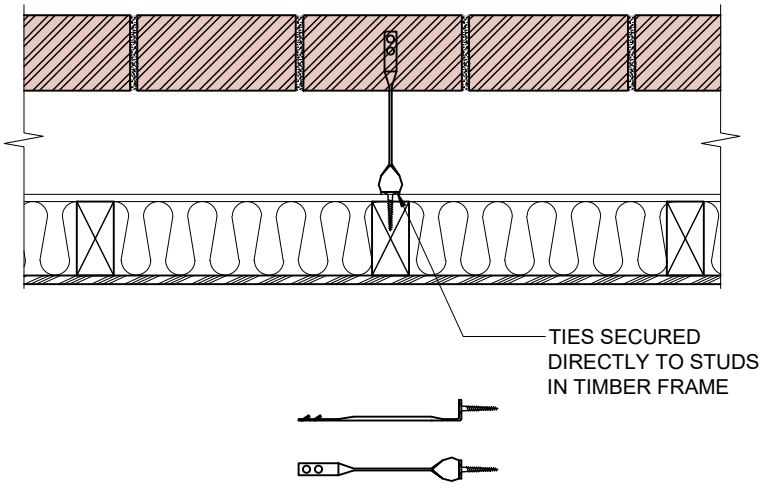
"CONTRACTION JOINT - TYING AT CORNER RETURNS"
(PLAN DETAIL)



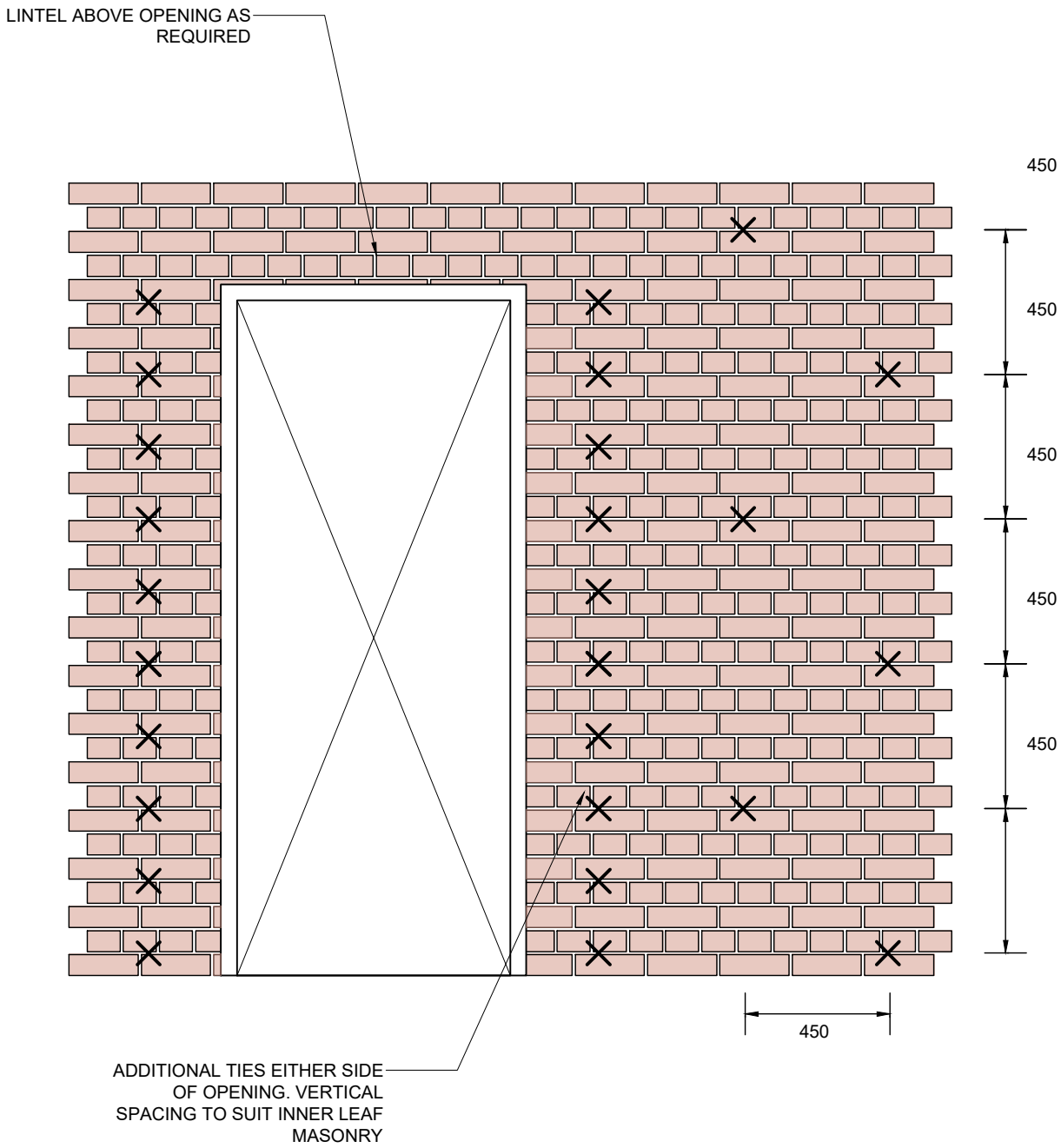
"CONTRACTION JOINT - TYING"
(PLAN DETAIL)



"EXPANSION JOINT - TYING"
(PLAN DETAIL)

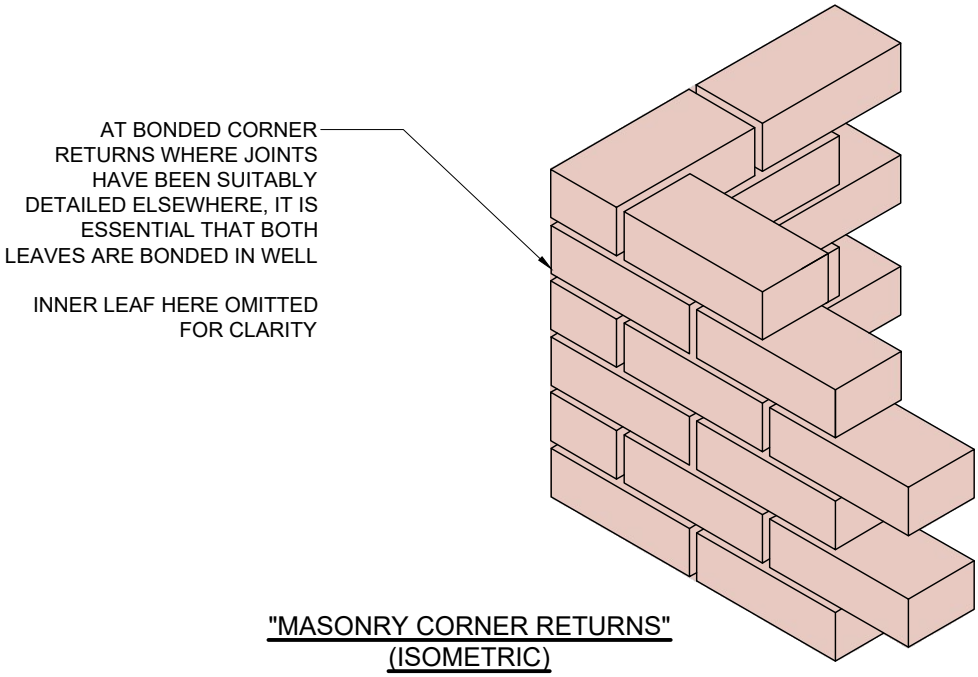


"TYING TO INTERNAL TIMBER FRAME"
(PLAN DETAIL)

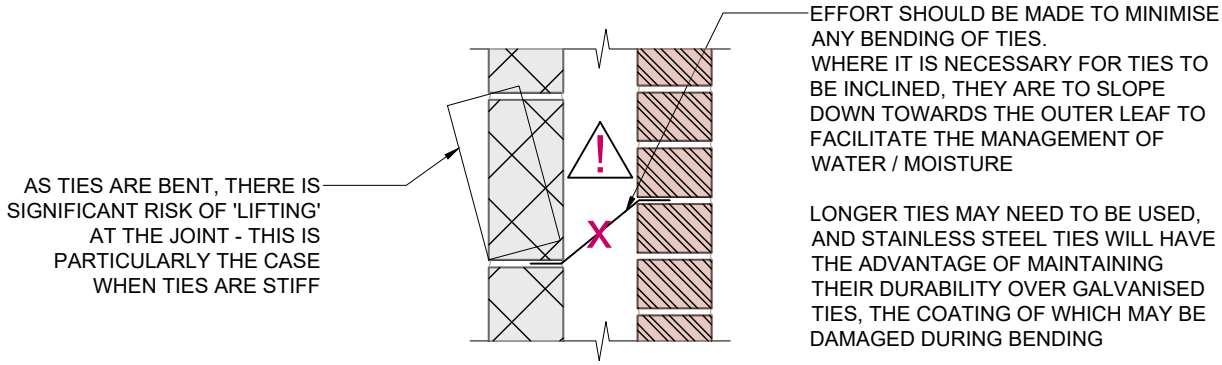


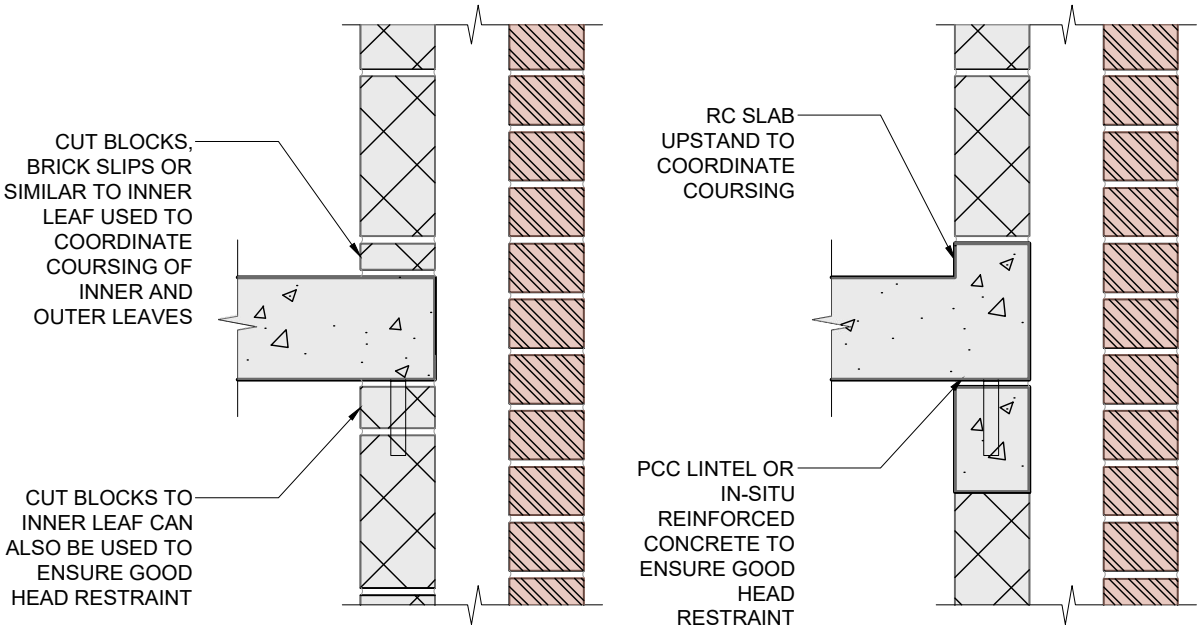
EXAMPLE CAVITY WALL TIE SPACING (ELEVATION)

TO SUIT 2.5 TIES PER SQUARE METRE
MINIMUM SPACING SHOULD BE
CHECKED ACCORDING TO BS EN 1996-1



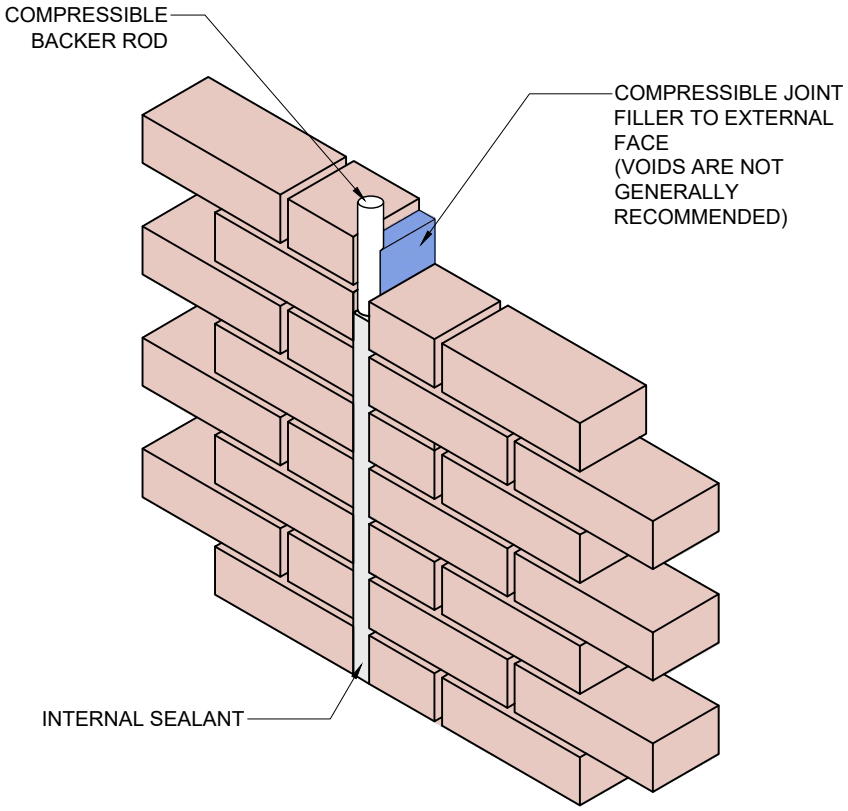
"MASONRY CORNER RETURNS" (ISOMETRIC)





"THE COORDINATION OF BRICK COURSES FOR CAVITY WALL TIES" (SECTION DETAILS)

DETAILS RELATING TO MOVEMENT IN MASONRY



"ANATOMY OF A MOVEMENT JOINT" (ISOMETRIC)

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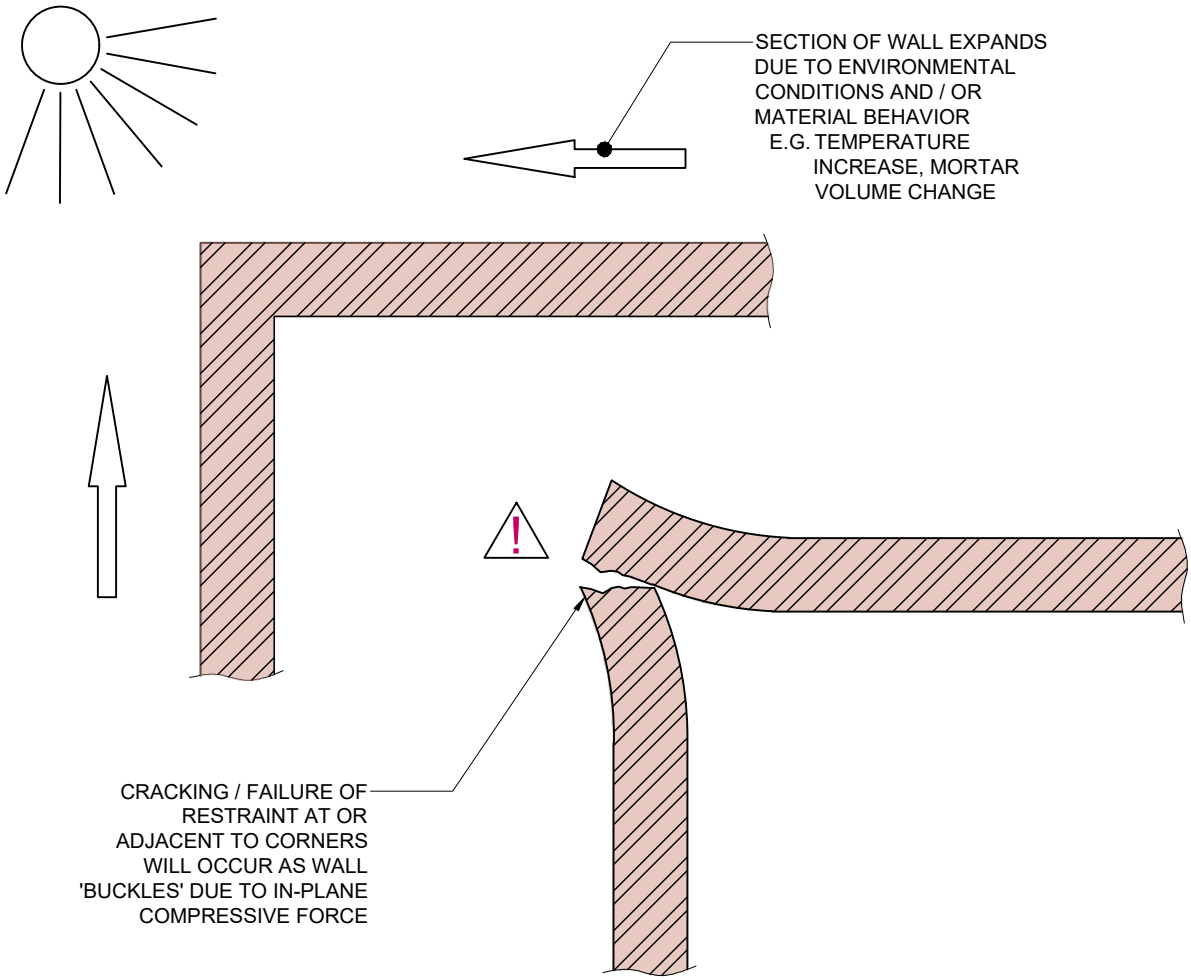
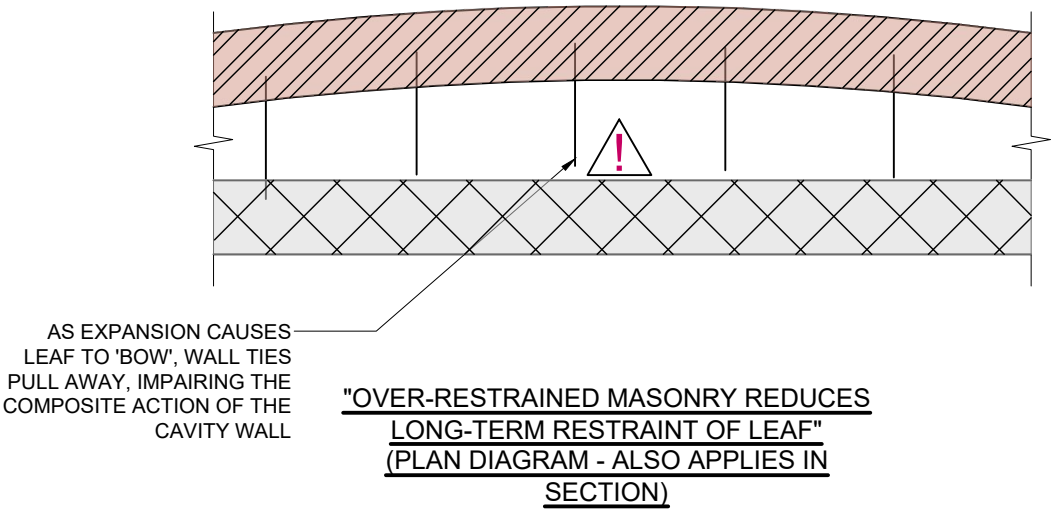


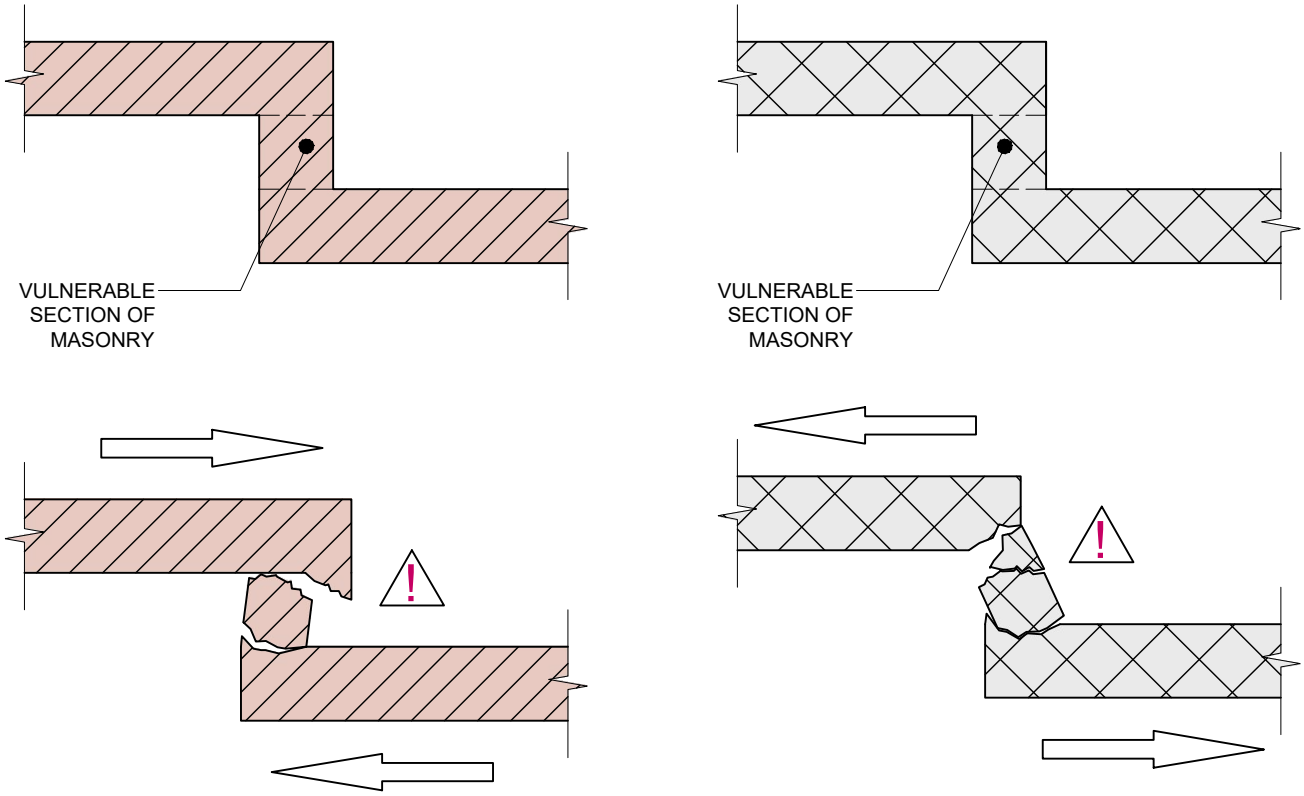
"BEHAVIOUR OF CORNER RETURNS WITHOUT MOVEMENT JOINTS"
(PLAN DIAGRAM)

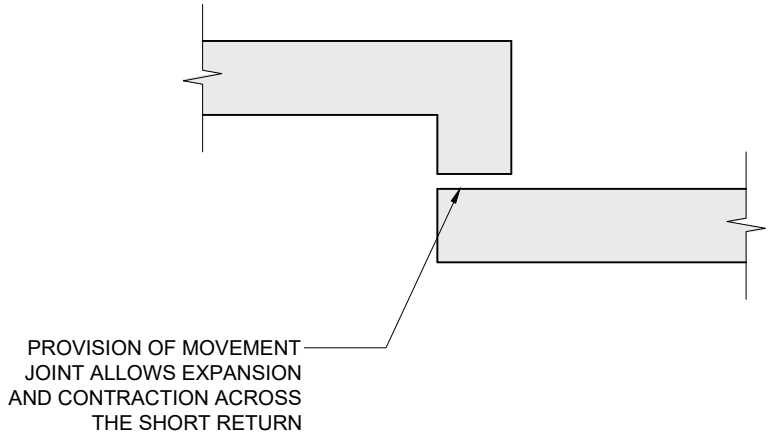


"OVER-RESTRAINED MASONRY REDUCES LONG-TERM RESTRAINT OF LEAF"
(PLAN DIAGRAM - ALSO APPLIES IN SECTION)

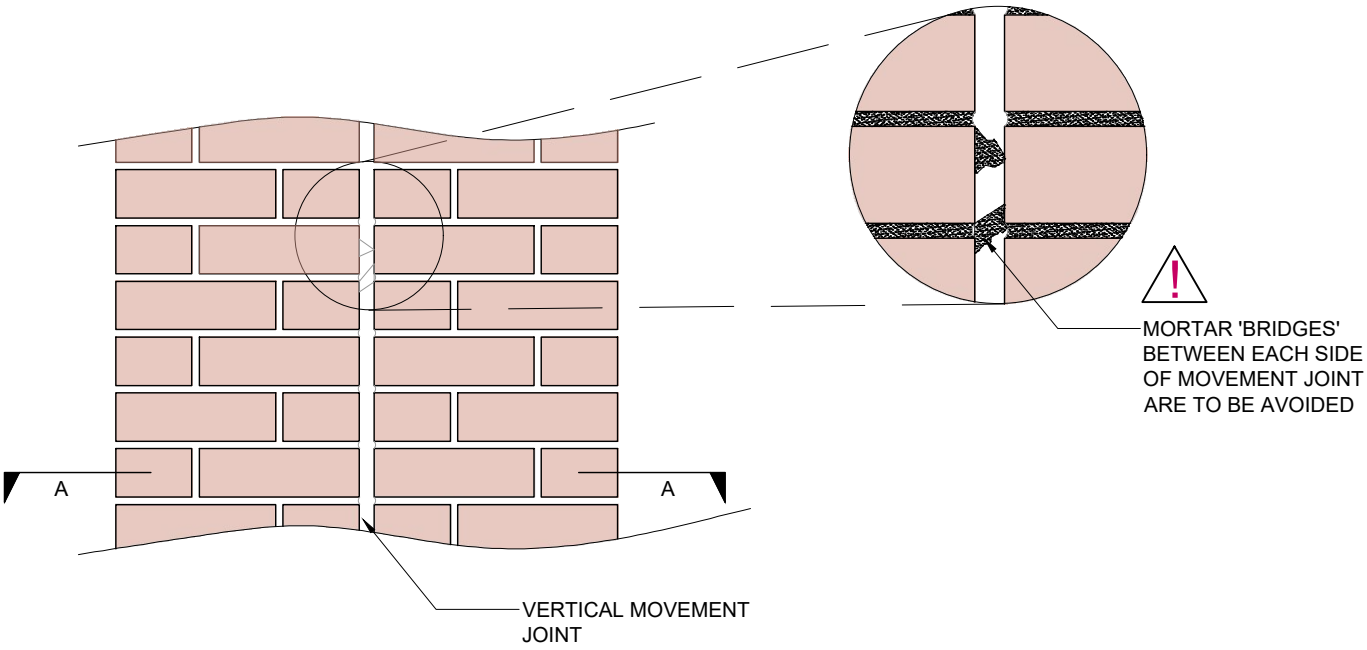
CLAY MASONRY

CONCRETE MASONRY

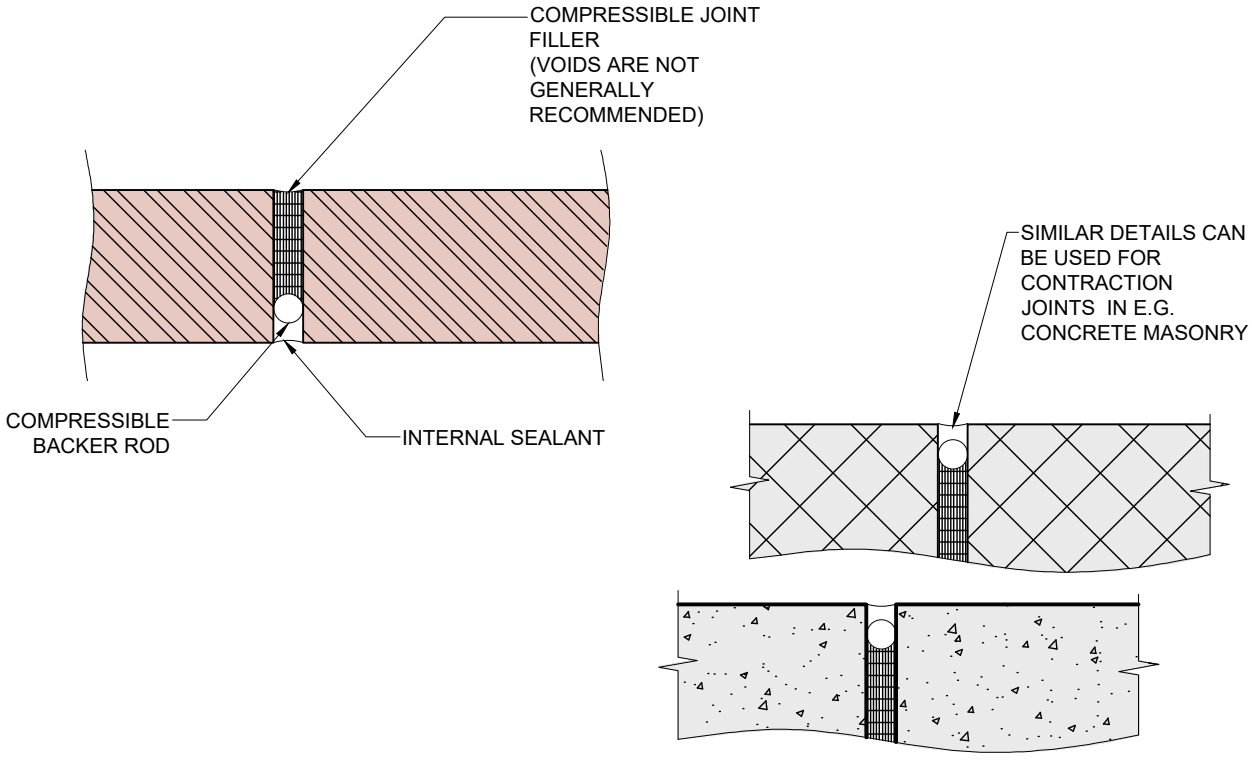




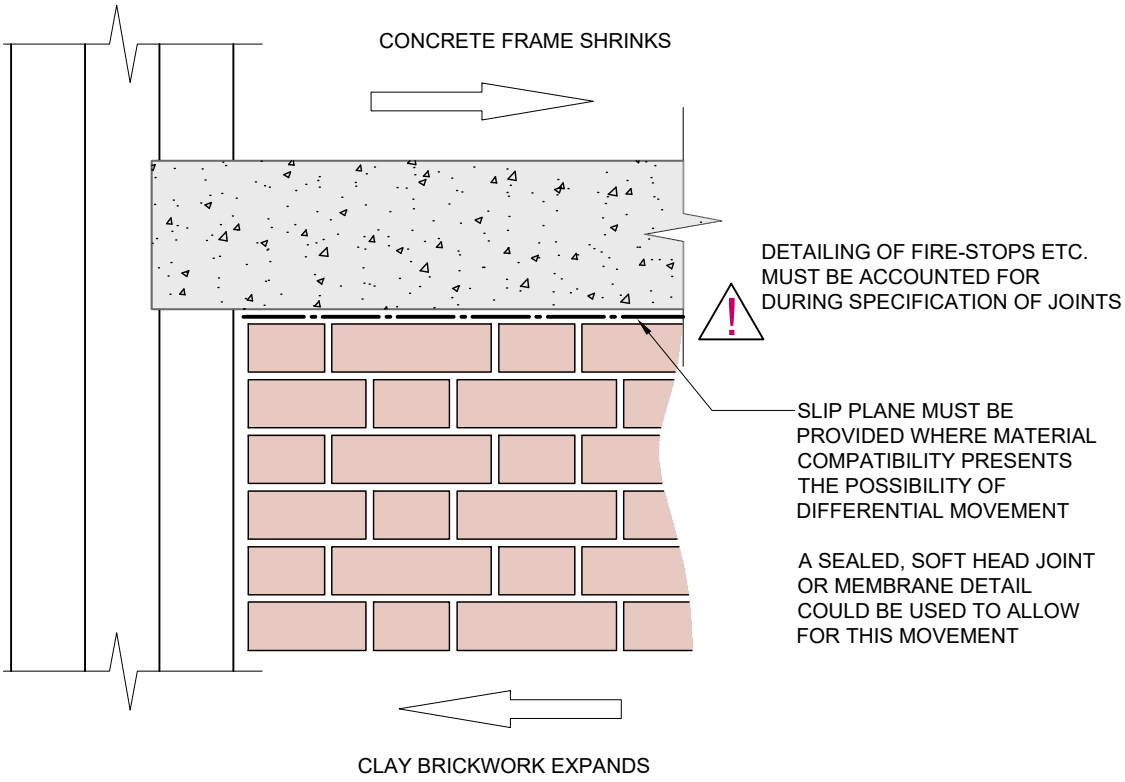
"PROVISIONS FOR ACCOMODATING MOVEMENT OF SHORT RETURNS" (PLAN DIAGRAM)



"JOINT IN MASONRY"
(ELEVATION)



"THE CONSTRUCTION OF JOINTS"
(SECTION DETAILS)



"SLIP PLANES IN FRAMED CONSTRUCTION"
(ELEVATION)

DETAILS RELATING TO THE REINFORCEMENT OF MASONRY

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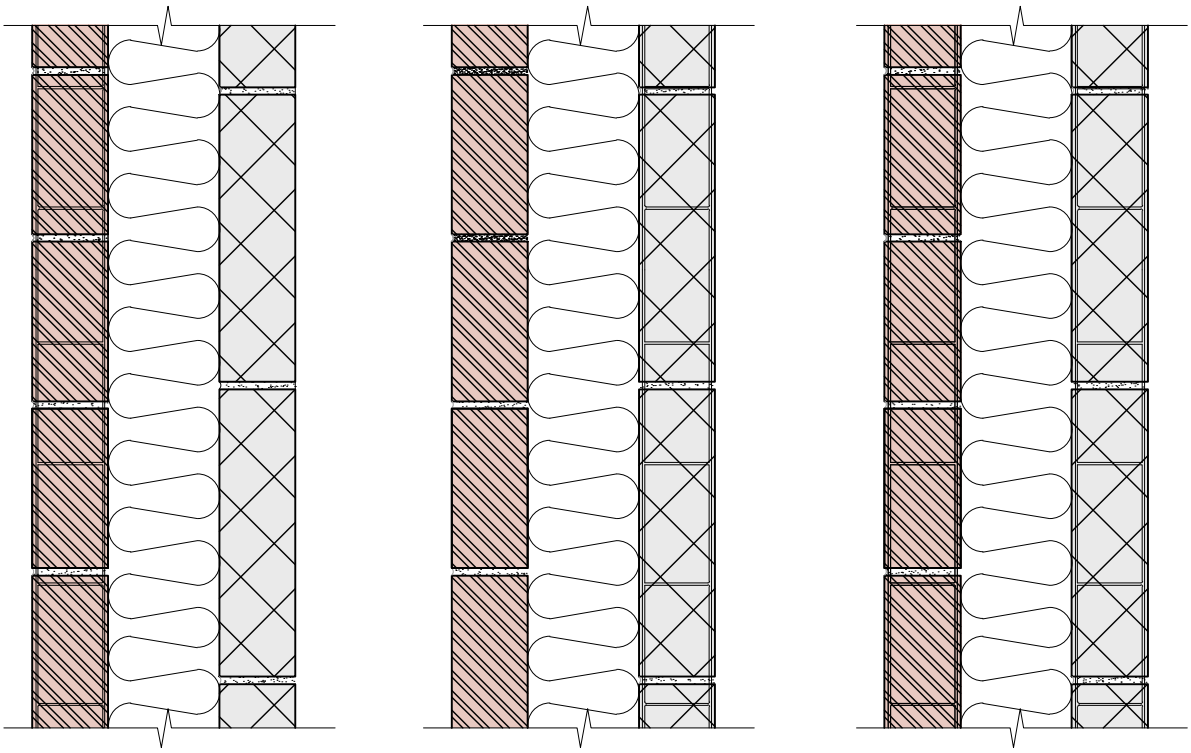
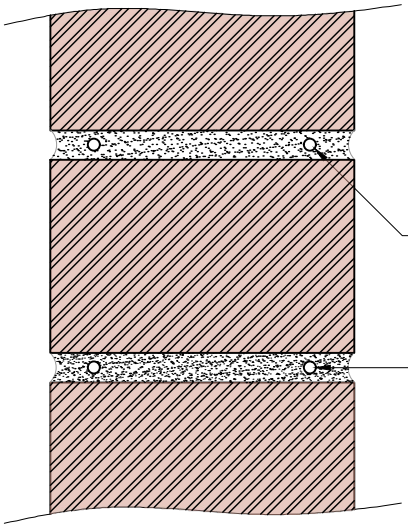
EXTERNAL LEAF

INTERNAL LEAF

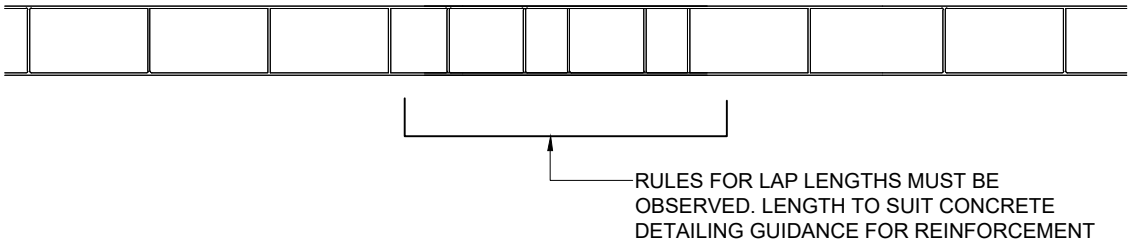
BOTH LEAVES



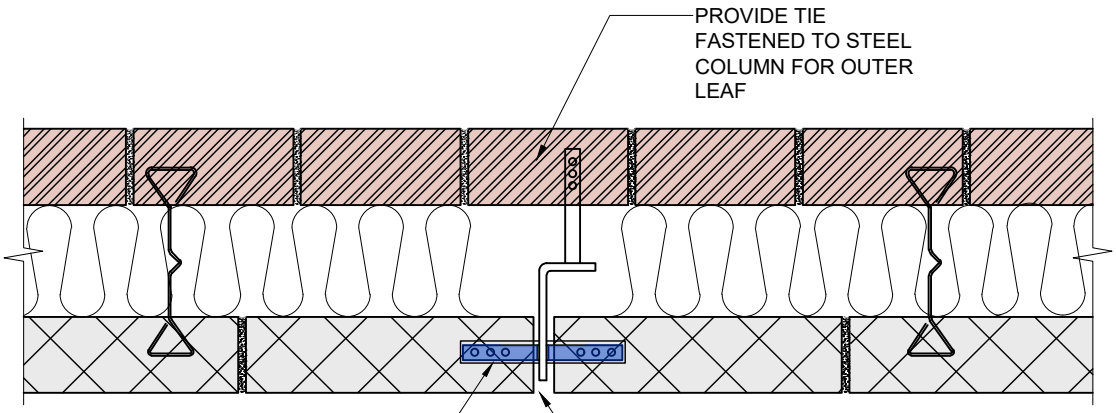
"DETAIL ON BED JOINT REINFORCEMENT"
(PLAN DETAILS)



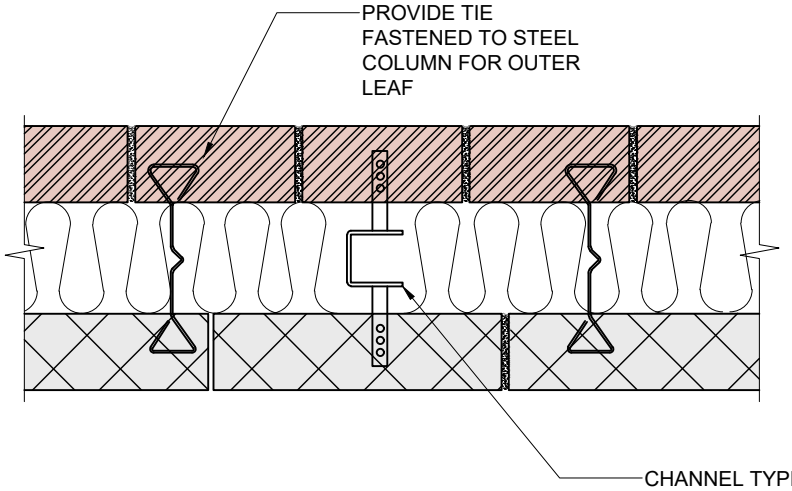
"PLACEMENT OF BED JOINT REINFORCEMENT"
(SECTION DETAIL)



"LAPPING OF REINFORCEMENT"
(PLAN DIAGRAM)



"WINDPOSTS IN MASONRY"
ANGLE SECTION
(PLAN DETAIL)



"WINDPOSTS IN MASONRY"
CHANNEL SECTION
(PLAN DETAIL)

NOTE: WINDPOSTS MUST BE FIXED TOP AND BOTTOM TO A STRUCTURAL MEMBER

DETAILS RELATING TO SUPPORT AND / OR RESTRAINT OF MASONRY (INCORPORATING INTERFACES WITH OTHER STRUCTURAL ELEMENTS)

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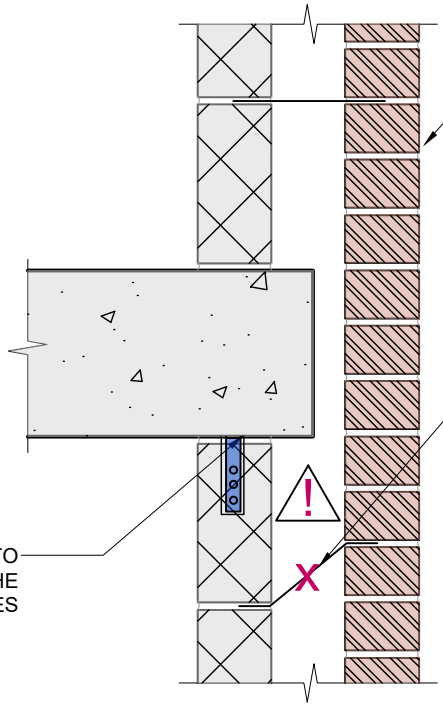
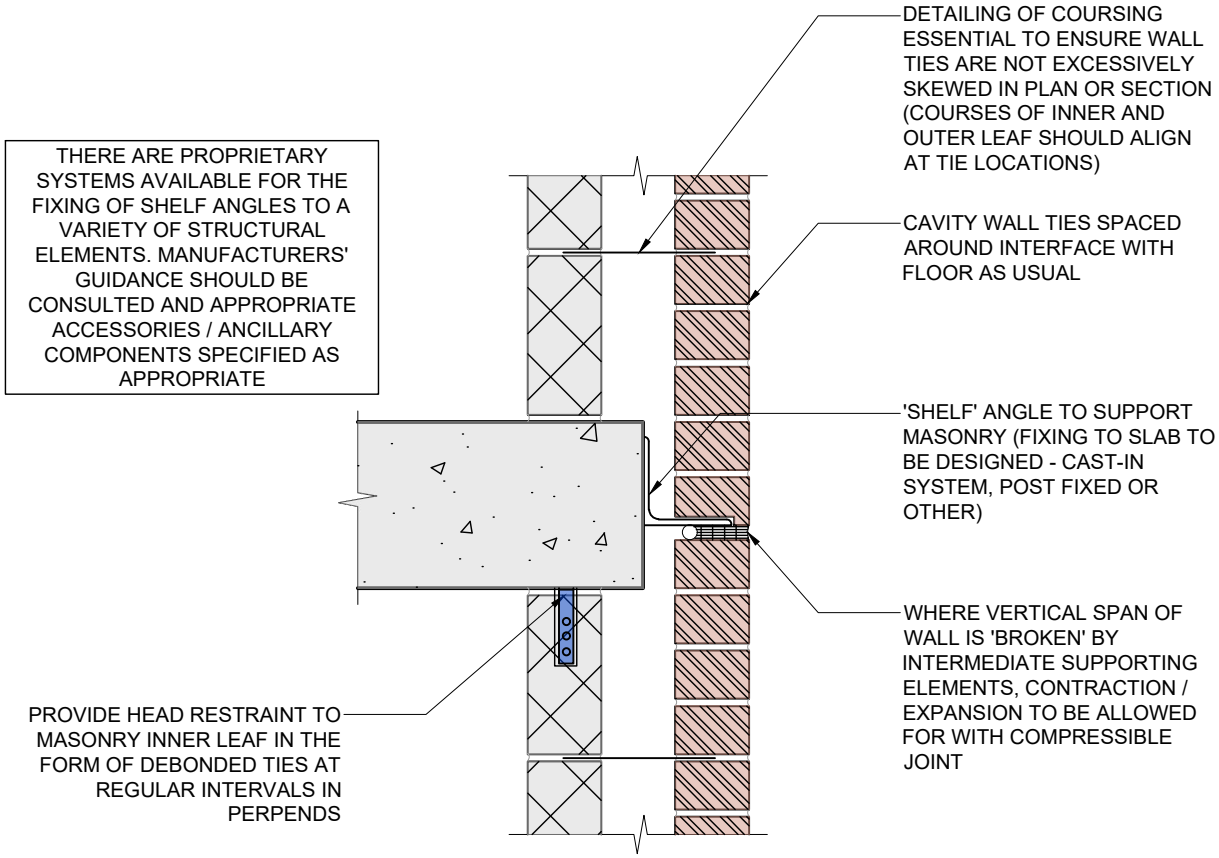
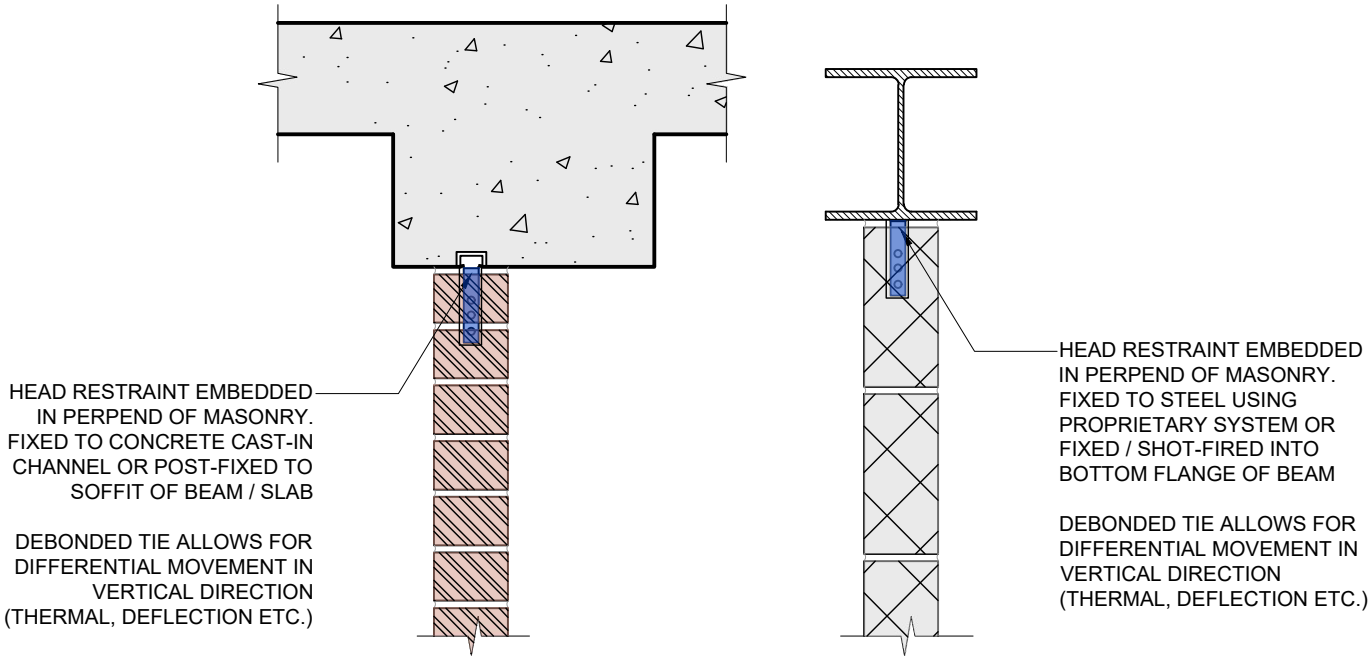


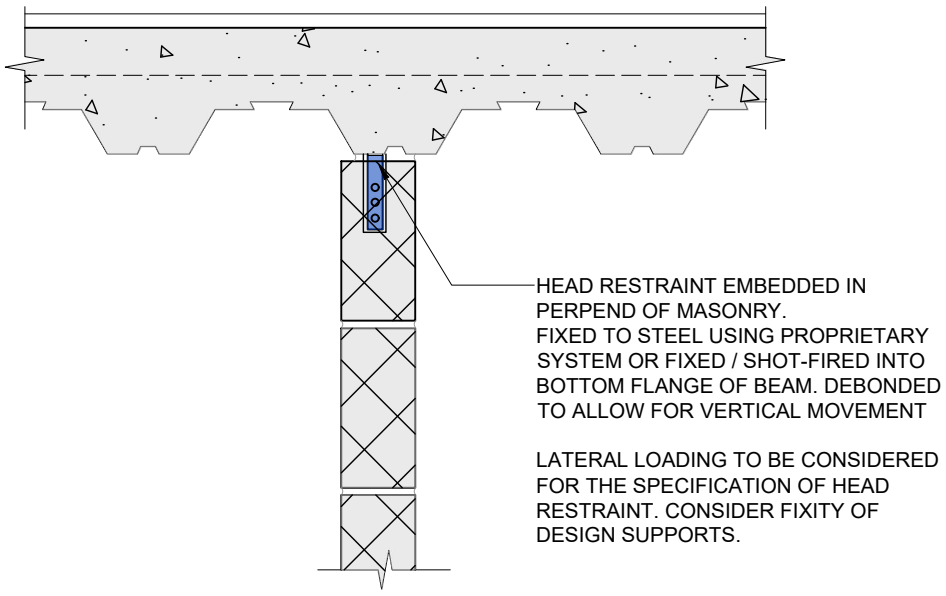
"FRAMED CONSTRUCTION WITH CONTINUOUS EXTERNAL LEAF" (SECTION DETAIL)



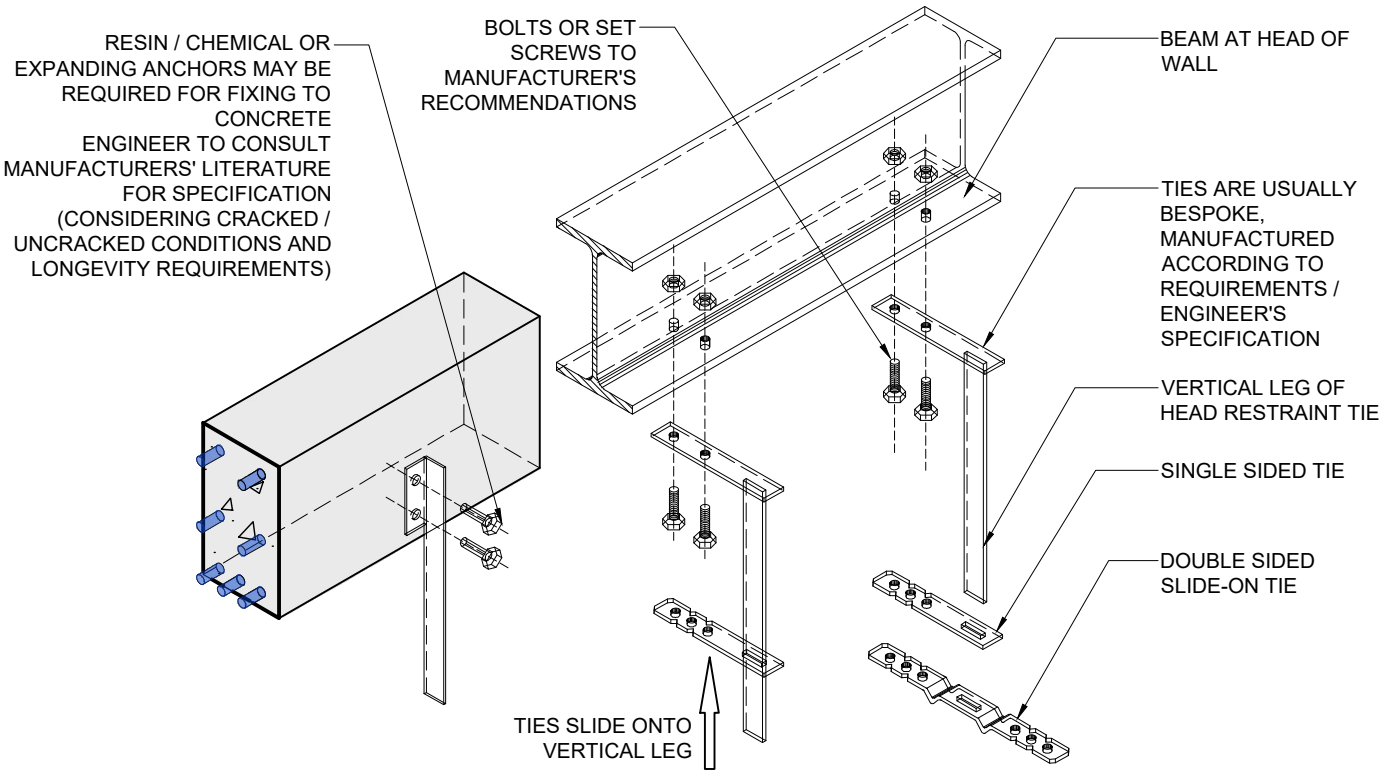
"FRAMED CONSTRUCTION WITH SHELF ANGLE / INTERRUPTED EXTERNAL LEAF" (SECTION DETAIL)



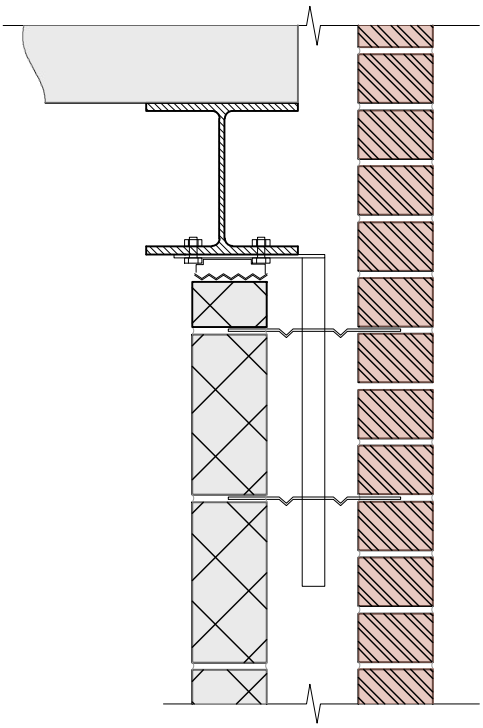
"HEAD RESTRAINT TO MASONRY WALLS TO PRIMARY STRUCTURAL FRAMES" (SECTION DETAIL)



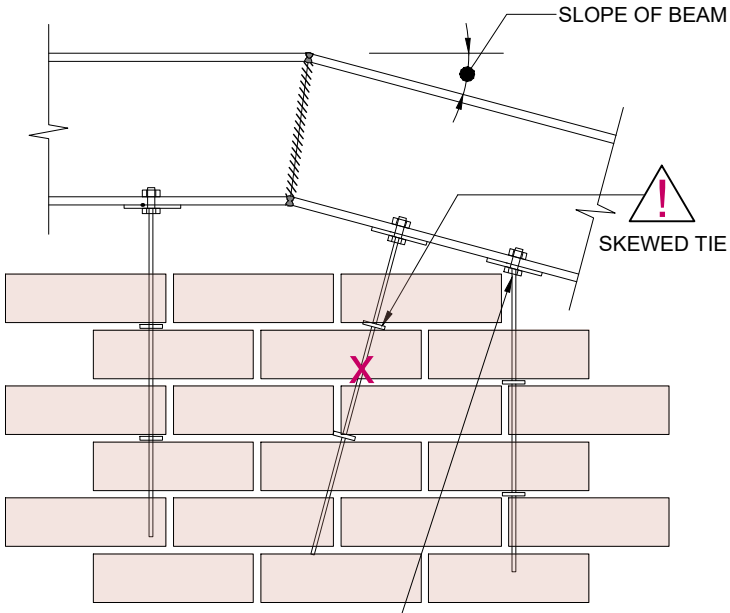
"HEAD RESTRAINT TO MASONRY WALLS TO COMPOSITE DECKING" (SECTION DETAIL)



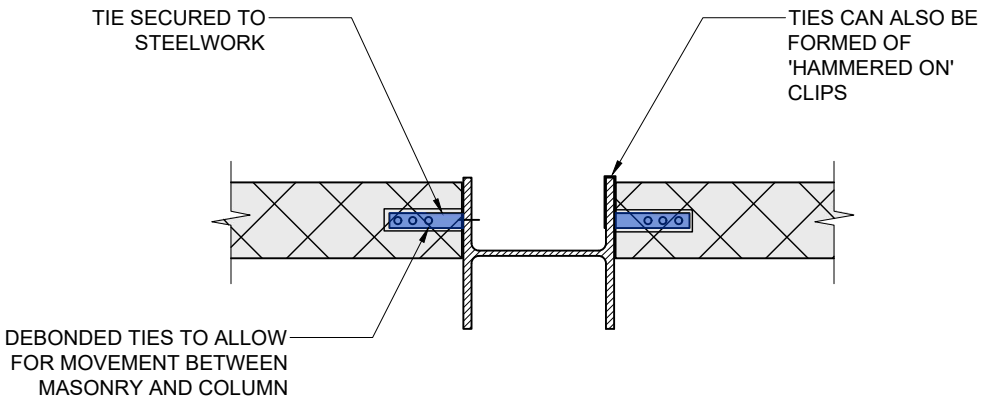
"THE USE OF BESPOKE CAVITY HEAD RESTRAINTS"
(ISOMETRIC)



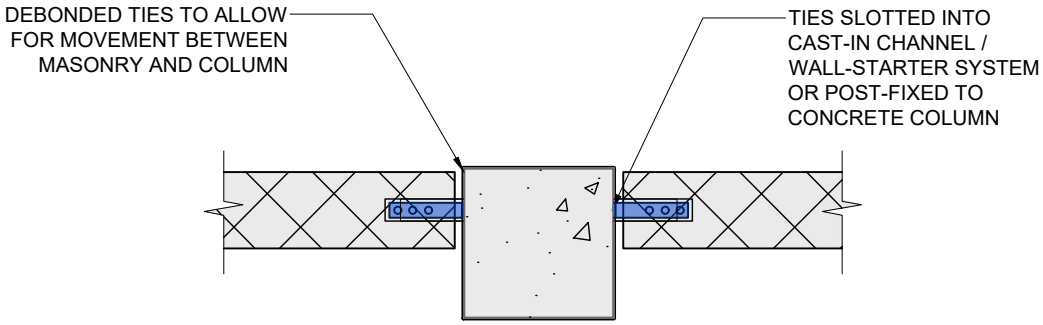
"THE USE OF BESPOKE CAVITY HEAD RESTRAINTS"
(SECTION DETAIL)



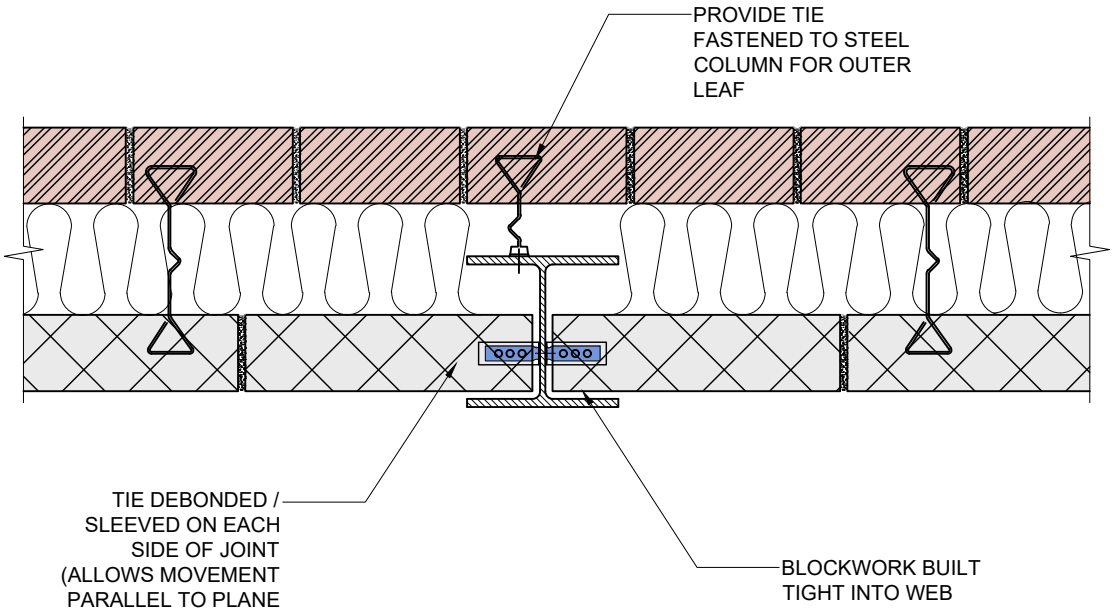
"THE USE OF BESPOKE CAVITY HEAD RESTRAINTS WITH INCLINED BEAMS"
(ELEVATION)



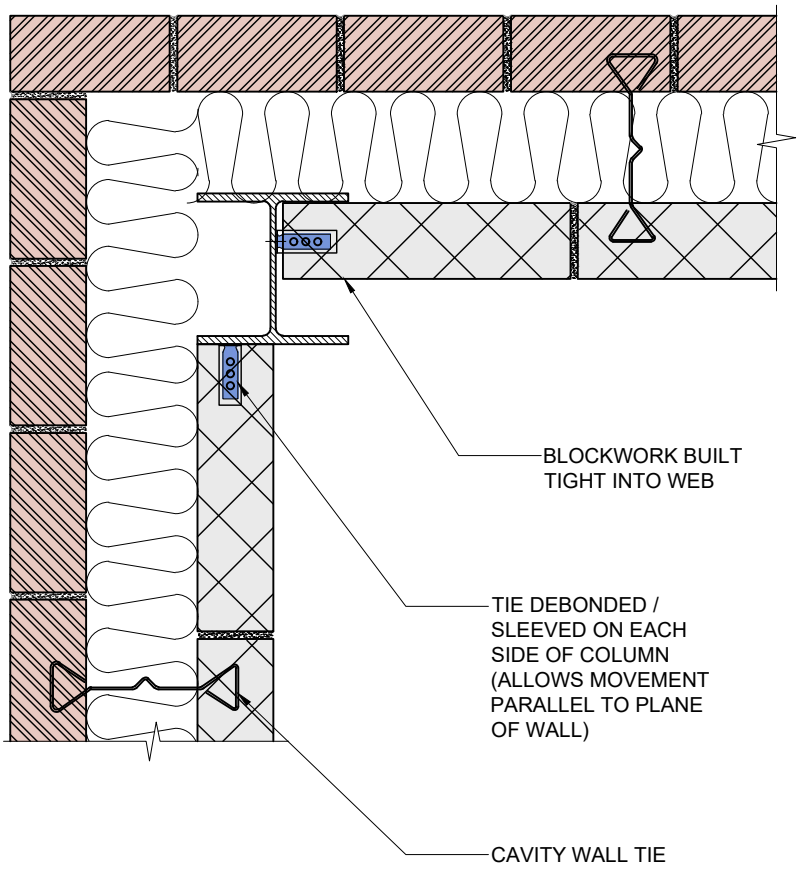
"TIES TO FLANGES OF STEEL COLUMN"
(PLAN DETAIL)



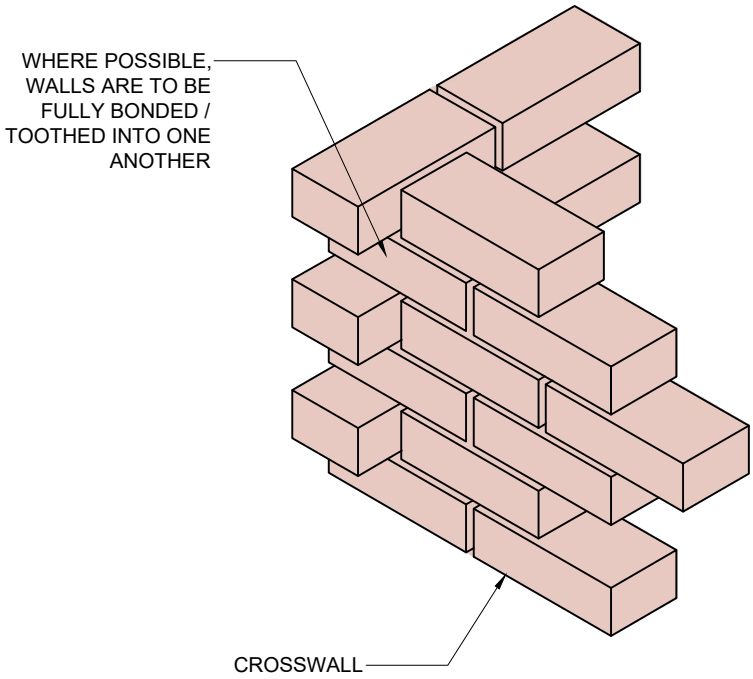
"TIES TO CONCRETE COLUMN"
(PLAN DETAIL)



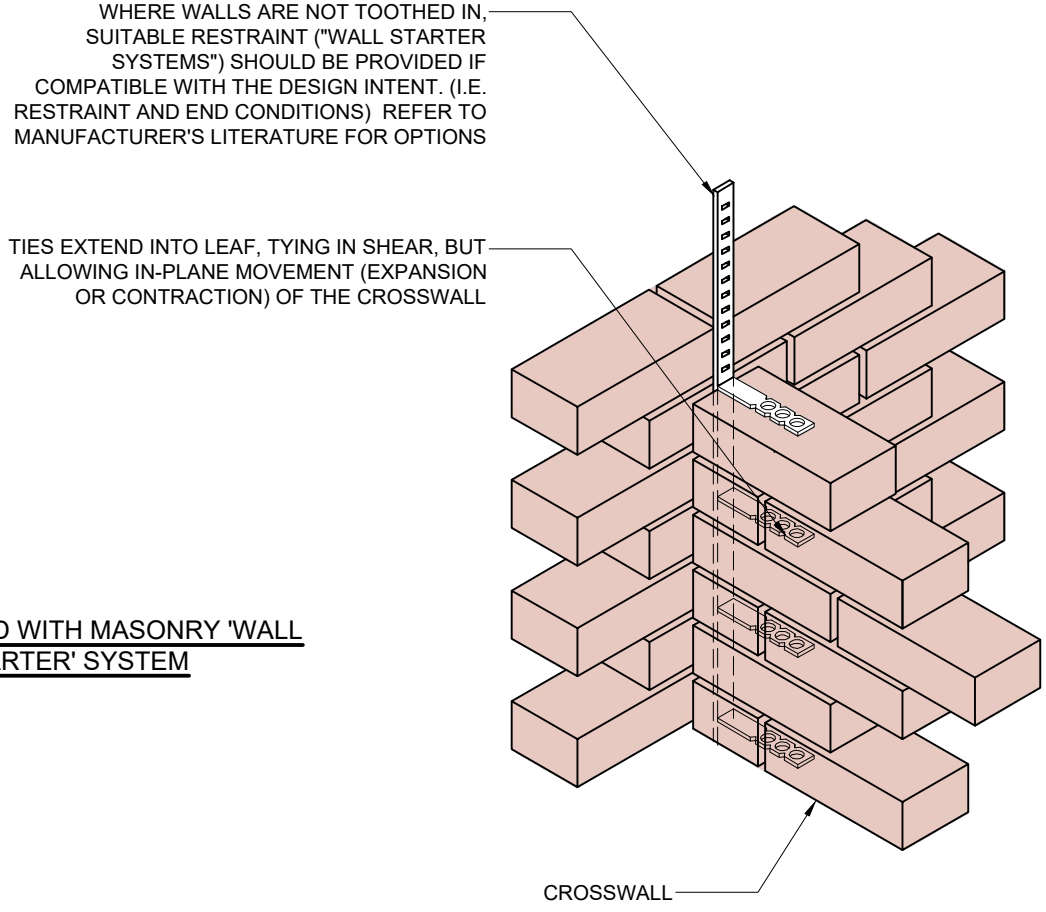
"CAVITY WALL CONSTRUCTION - RESTRAINT TO PRIMARY STRUCTURAL ELEMENTS" - STRAIGHT (PLAN DETAIL)



"CAVITY WALL CONSTRUCTION - RESTRAINT TO PRIMARY STRUCTURAL ELEMENTS" - CORNER (PLAN DETAIL)

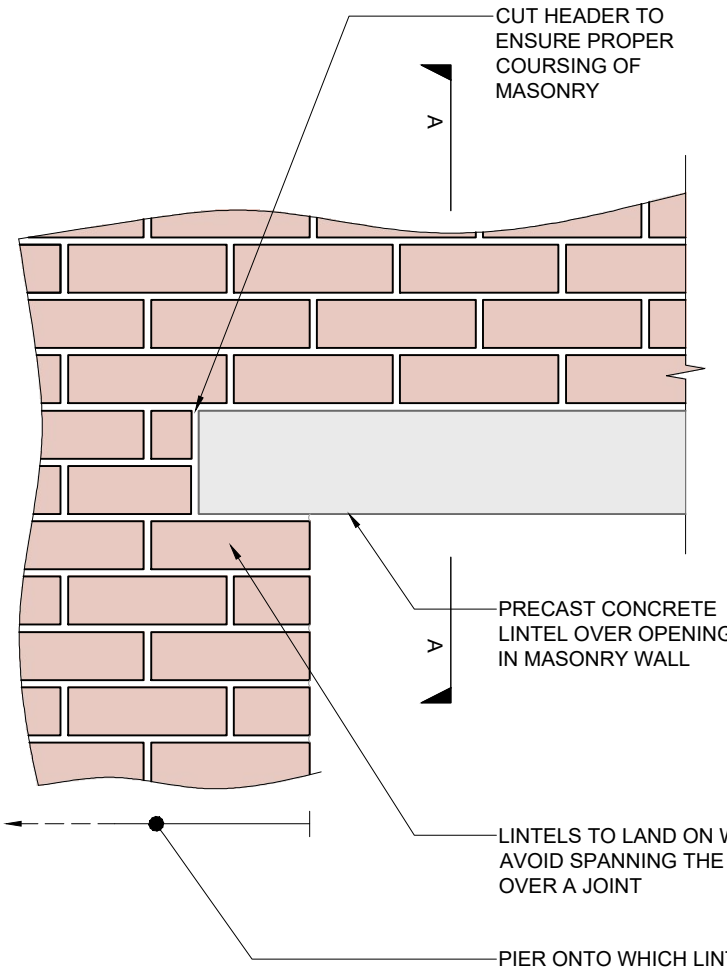


FULLY BONDED

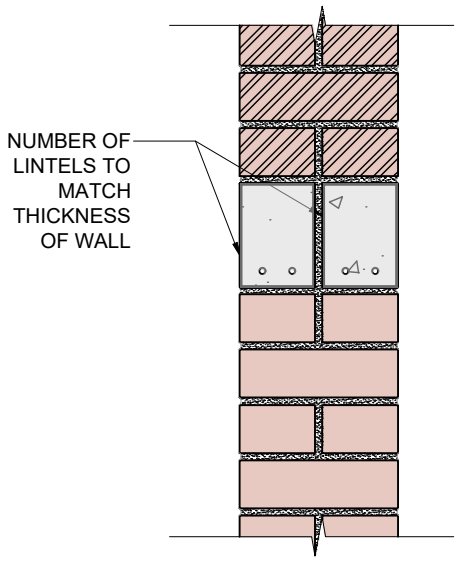


TIED WITH MASONRY 'WALL STARTER' SYSTEM

"RESTRAINT OF CROSSWALLS" (ISOMETRIC)



"LINTELS IN NEW MASONRY"
(ELEVATION)



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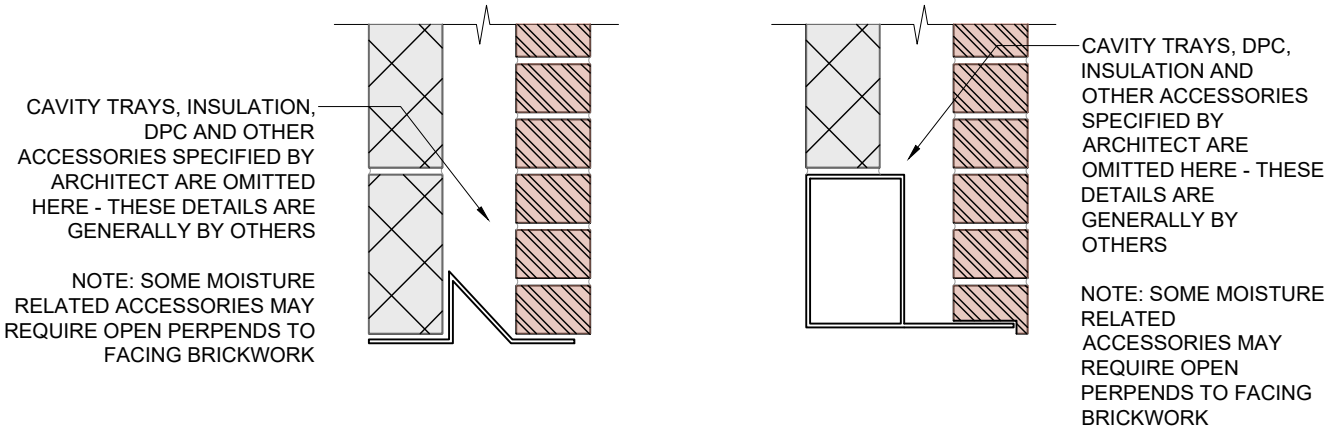
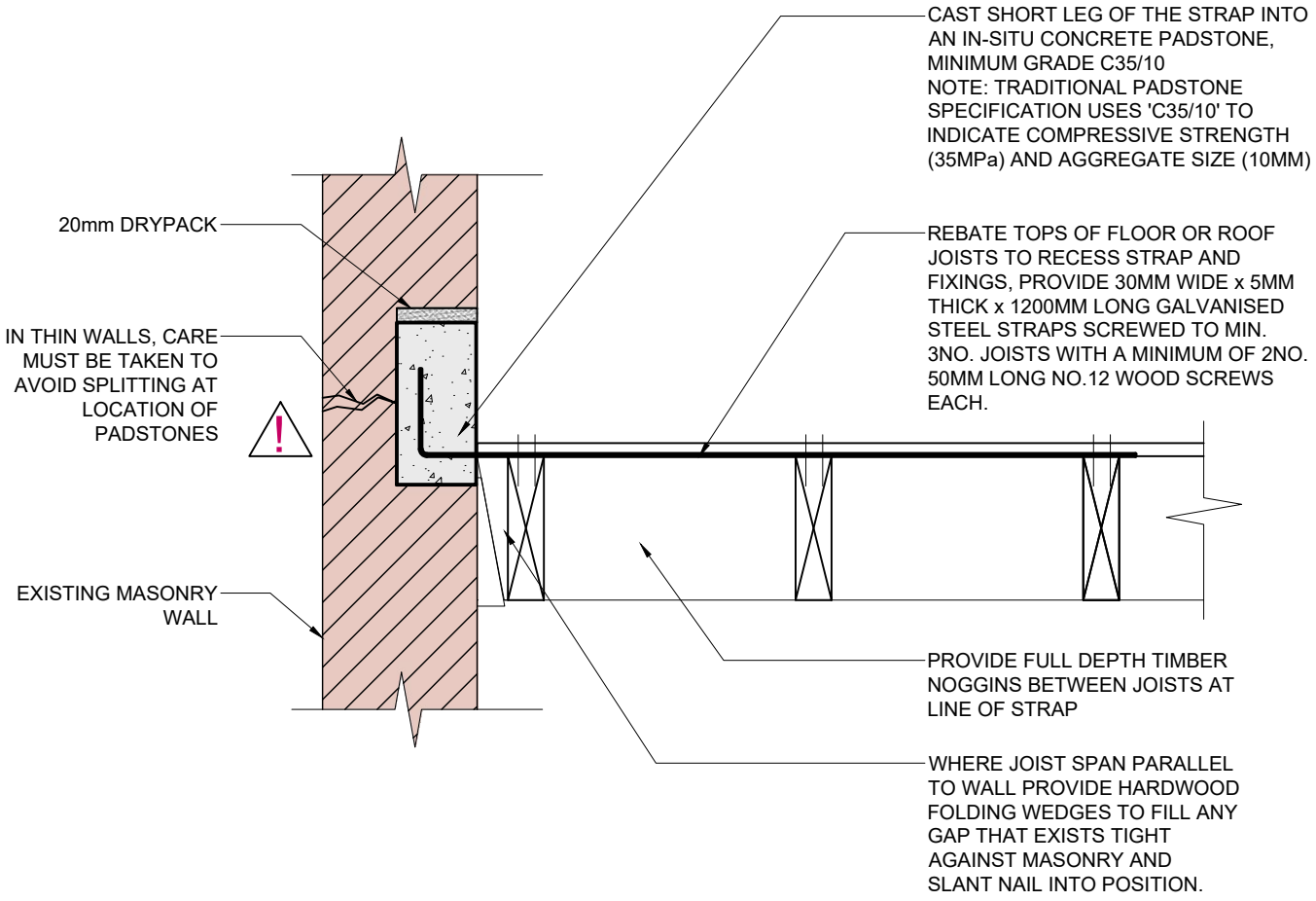
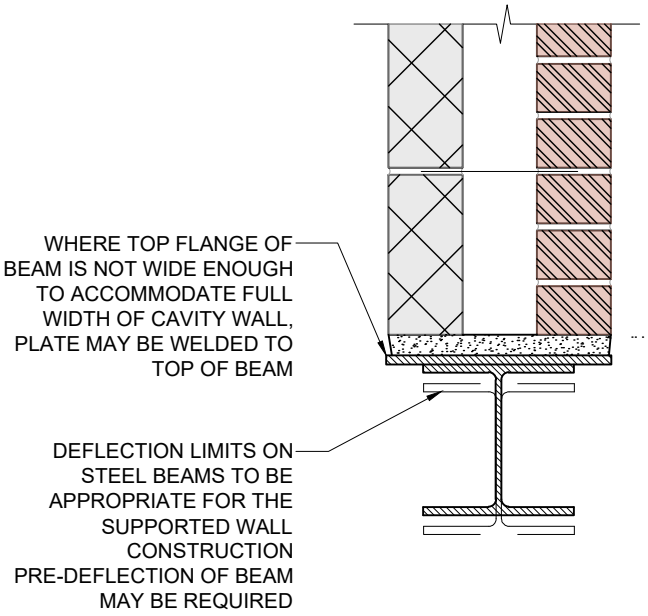
"LINTELS IN NEW MASONRY"
(SECTION DETAIL)



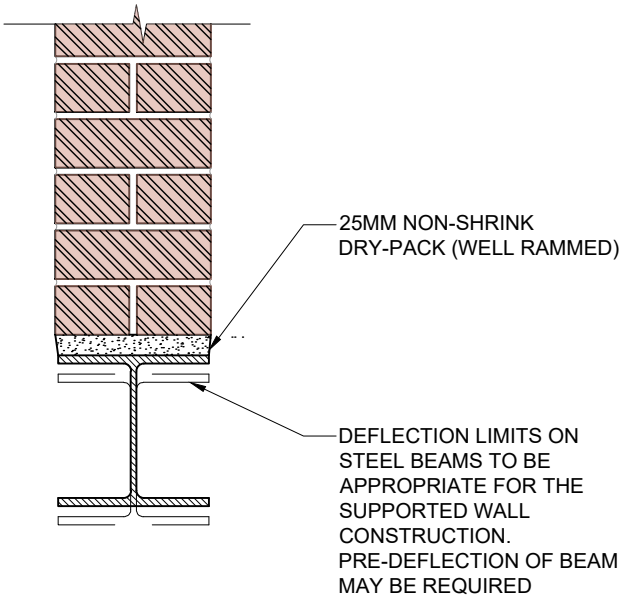
"PRESSED STEEL CAVITY WALL LINTELS"
(SECTION DETAIL)



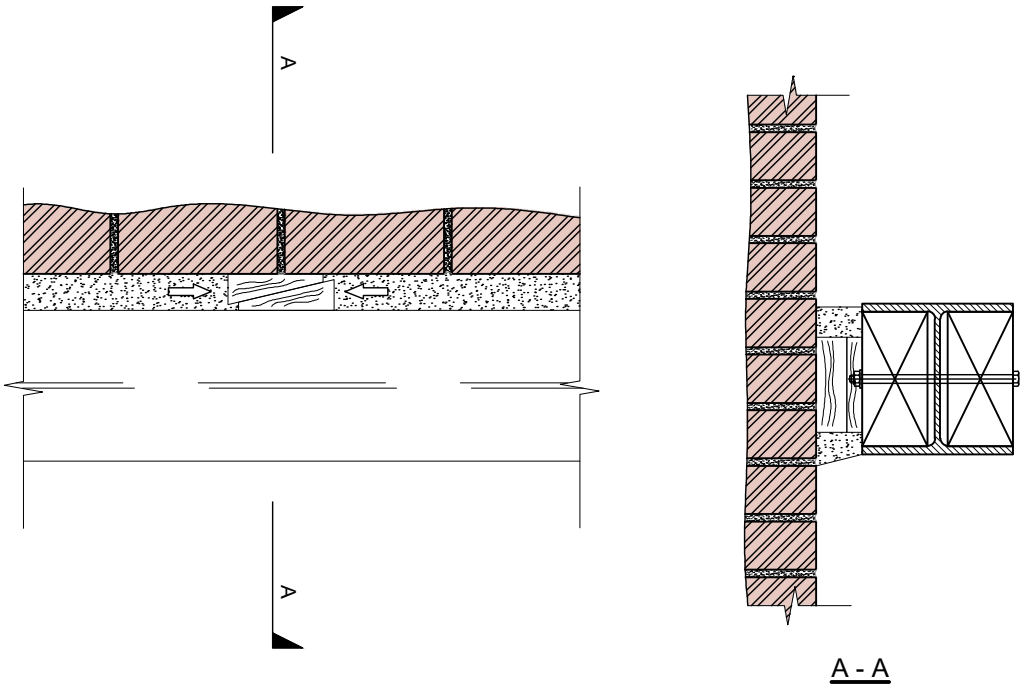
"RESTRAINT STRAPPING FOR NEW FLOORS IN EXISTING TRADITIONAL MASONRY CONSTRUCTION" (TO COMPLY WITH APPROVED DOCUMENT A OF THE BUILDING REGULATIONS)
(SECTION DETAIL)



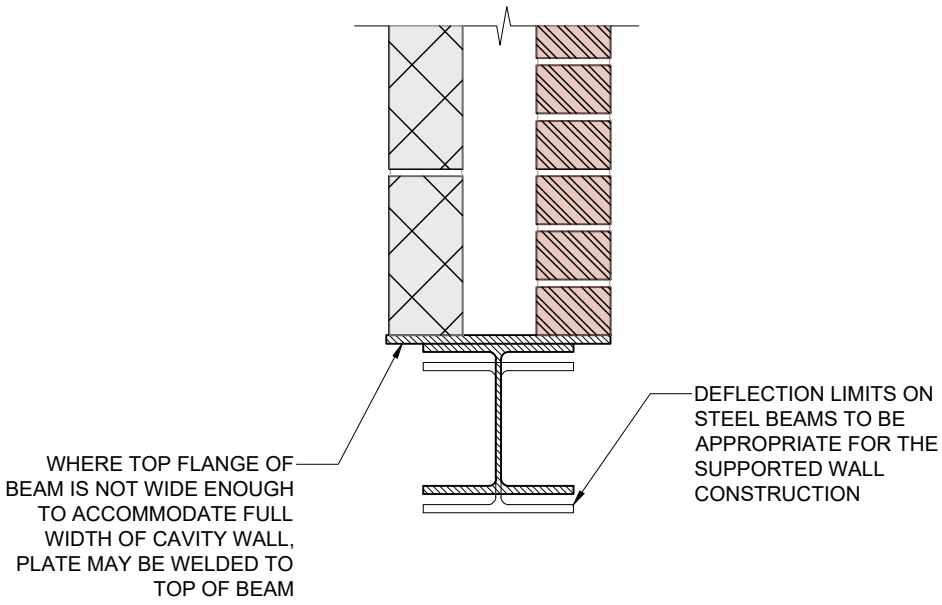
"SUPPORT OF EXISTING MASONRY CAVITY WALLS ON STEEL BEAM" (SECTION DETAIL)



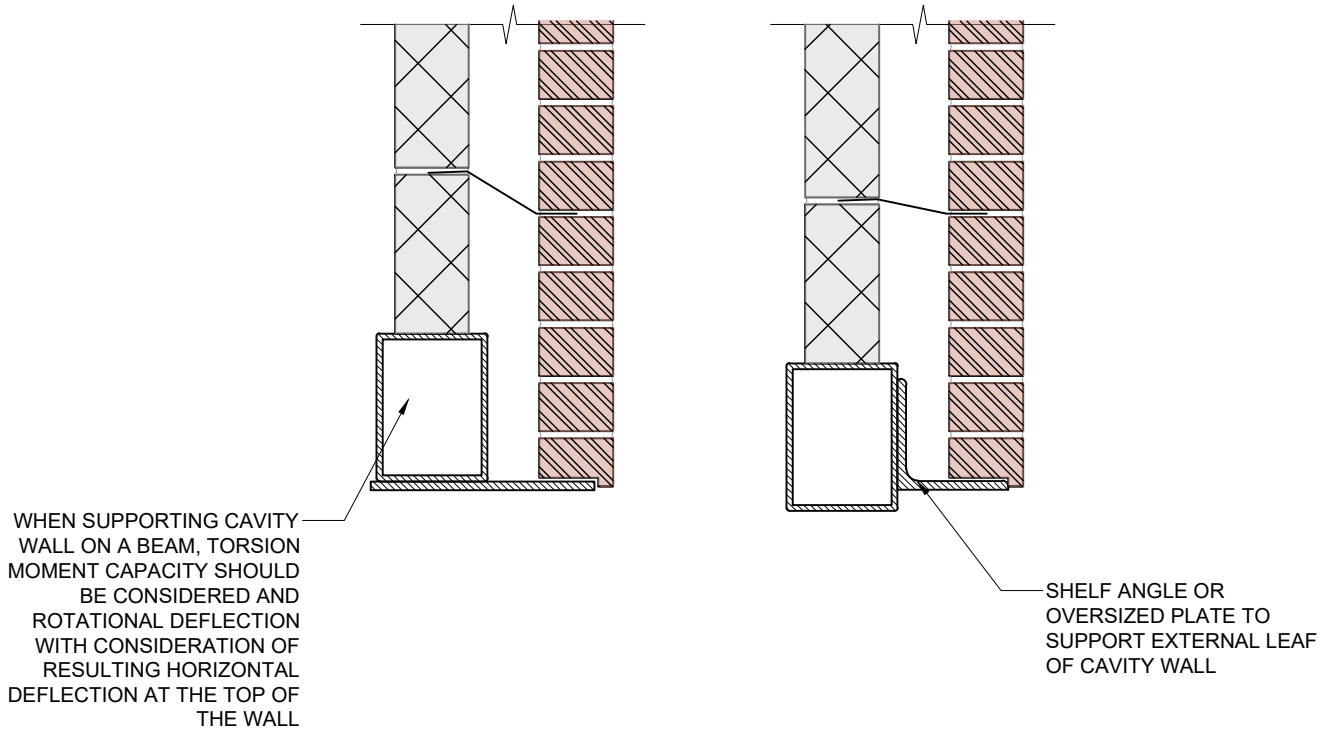
"SUPPORT OF EXISTING SOLID MASONRY WALLS ON STEEL BEAM" (SECTION DETAIL)



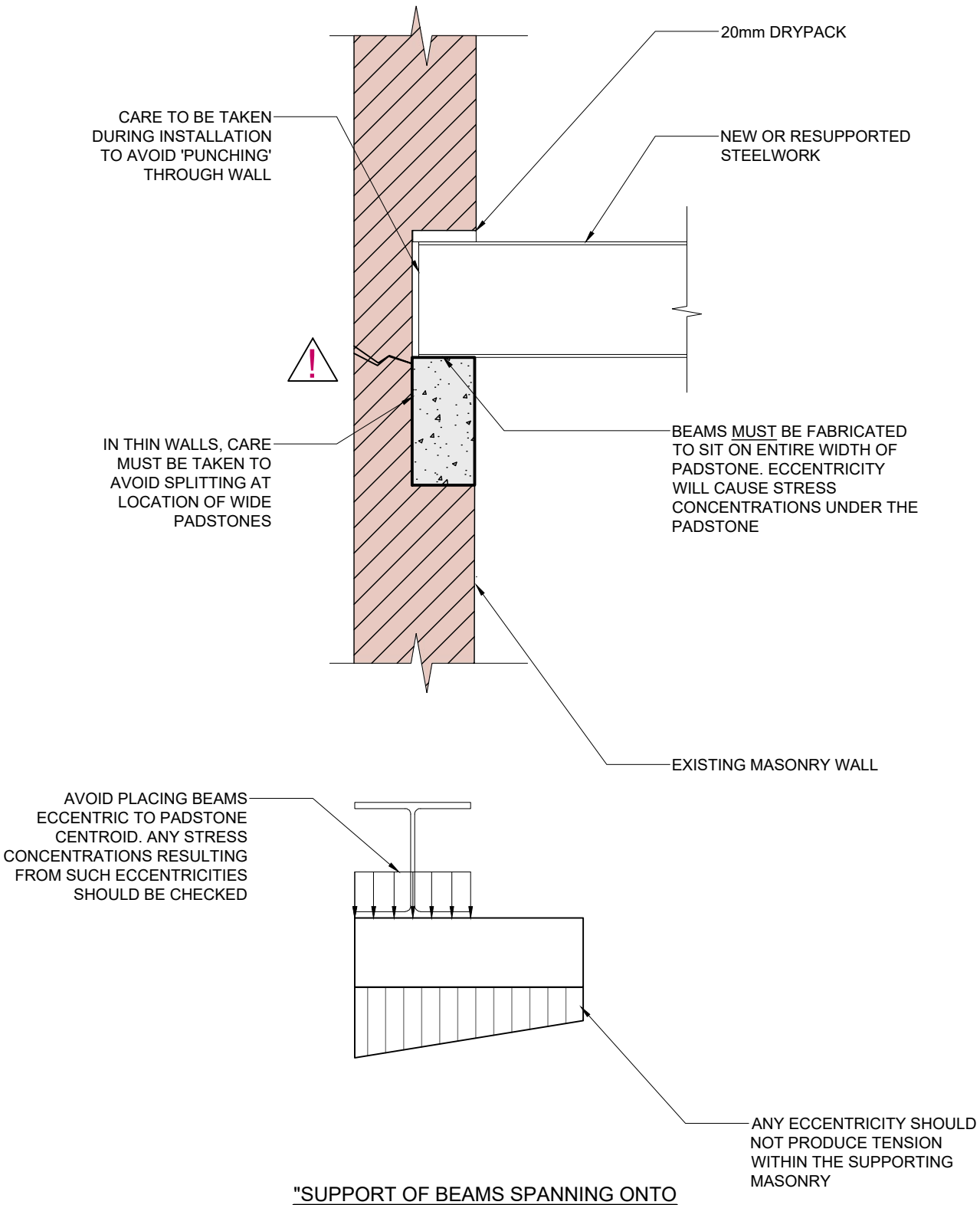
"PROVISION OF RESTRAINT WITH BEAMS SPANNING PARALLEL TO MASONRY WALL" (SECTION DETAILS)



"SUPPORT OF NEW MASONRY CAVITY WALLS ON STEEL BEAM"
(SECTION DETAIL)



"SUPPORTING CAVITY WALL ECCENTRICALLY ON STEELWORK"
(SECTION DETAIL)



"SUPPORT OF BEAMS SPANNING ONTO TO MASONRY WALL"
(SECTION DETAIL)

OPENINGS, SERVICE PENETRATIONS AND CHASES

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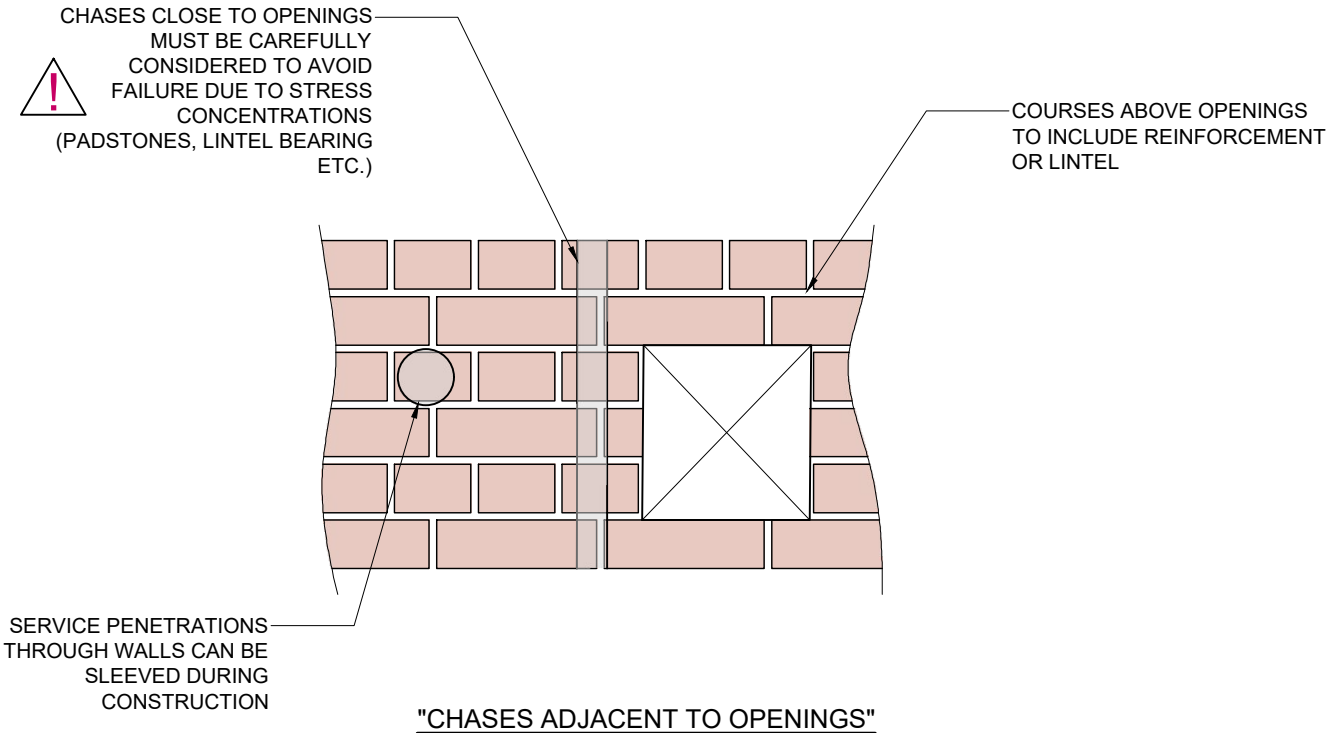
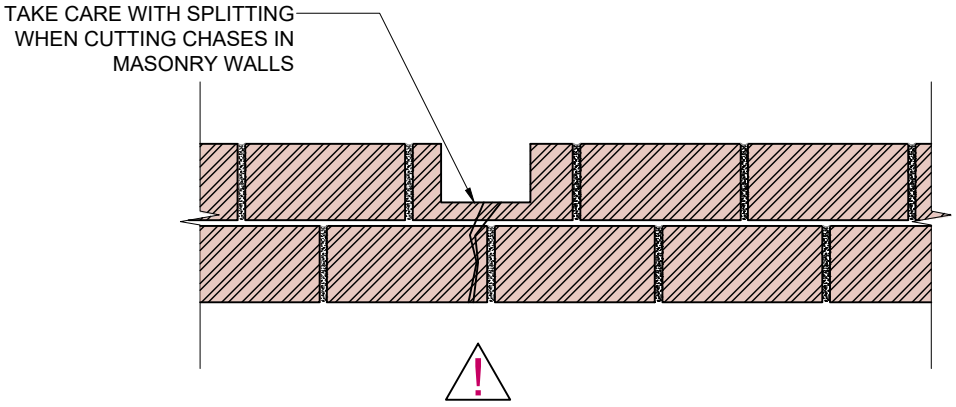


"CHASES ADJACENT TO OPENINGS"
(ELEVATION)



"CHASES IN SOLID MASONRY"
(SECTION DETAIL)

IN-DEPTH DETAILING RECOMMENDATIONS CAN BE FOUND IN BS EN 1996 AND THE ACCOMPANYING NATIONAL ANNEX

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