

Division 09 - Finishes

Section 09450 - Stone Facing

Part 1: General

1 01 Summary

The work covered by this Section consists of providing all tools, labour, equipment and materials, and performing all operations in connection with non-load bearing vertical natural stone facing of thickness not exceeding 75 mm including soffits and sloped vertical surfaces.

1 01 01 Section Includes

- 01.0 Interior stone facing.
- 02.0 Exterior stone facing.

1 01 04 Related Sections

- 05810 Expansion Joint Cover Assemblies
- 07150 Damp proofing
- 07200 Insulation
- 07900 Joint Sealers
- 09300 Tiles

1 02 References

1 02 01 Applicable Standards

1 02 01 04 USA Standards

- 1 02 01 04 01 American Society for Testing and Materials (ASTM)
- ASTM A 666: 00 Standard Specifications for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
 - ASTM B 221M: 00 Standard Specification for Aluminium and Aluminium-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes (Metric)
 - ASTM C 97: 96 Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone
 - ASTM C 99: 87 Standard Test Method for Modulus of Rupture of Dimension Stone
 - ASTM C 119: 01 Standard Terminology Relating to Dimension Stone
 - ASTM C 144: 99 Standard Specifications for Aggregate for Masonry Mortar
 - ASTM C 170: 90 Standard Test Method for Compressive Strength of Dimension Stone
 - ASTM C 241: 90 Standard Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic

ASTM C 270: 01	Standard Specification for Mortar for Unit Masonry
ASTM C 503: 99	Standard Specifications for Marble Dimension Stone (Exterior)
ASTM C 568: 99	Standard Specification for Limestone Dimension Stone
ASTM C 615: 99	Standard Specification for Granite Dimension Stone
ASTM C 616: 99	Standard Specifications for Quartz-Based Dimension Stone
ASTM C 880: 98	Standard Test Method for Flexural Strength of Dimension Stone
ASTM C 920: 01	Standard Specification for Elastomeric Joint Sealants
ASTM F 593: 98	Standard Specifications for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F 594: 98	Standard Specifications for Stainless Steel Studs
ASTM F 738M: 01	Standard Specification for Stainless Steel Metric Bolts, Screws, and Studs
ASTM F 836M: 01	Standard Specification for Stainless Steel Metric Nuts

1 02 01 04 03 American National Standard Institute (ANSI)

ANSI A 136.1: 92 Adhesive for Installation of Ceramic Tile

1 02 01 06 British Standards

BS 1199: 76	Sand from Natural Sources
BS 5980: 97	Adhesive for use with ceramic tiles and mosaics
BS 6105: 81	Specification for corrosion-resistant stainless steel fasteners
BS 6213: 00	Selection of constructional sealants – Guide (R)
BS 10095: 99	Heat Resisting Steels and Nickel Alloys

1 02 01 07 German Standards

DIN 18156-2: 78	Materials for ceramic linings by thin mortar bed technique; hydraulic mortar
DIN 18156-3: 80	Materials for ceramic linings by thin mortar bed technique; dispersion adhesive
DIN 18156-4: 84	Materials for ceramic linings by thin mortar bed technique; epoxy resin adhesive
DIN 18515-1: 98	Cladding for External walls – Part 1: Tiles fixed with mortar, principles of design and application.

DIN 18516-3: 99	Cladding for External walls ventilated at rear – Part 3: Natural stone; Requirements, design
DIN-EN 1469: 94	Natural Stone – Finished products, claddings - Specifications
DIN-EN 12057: 96	Natural Stone – Finished products, modular tiles - specifications
DIN-EN 12059: 96	Natural Stone – Finished products, dimension stone work – specifications
DIN-EN 12372: 99	Natural Stone Test methods – Determination of flexural strength under concentrated load
DIN-EN 12407: 00	Natural Stone Test methods – Petrography examination
DIN-EN 12440: 01	Natural Stone – Determination criteria
DIN-EN 12670: 02	Terminology of natural stone

1 02 02

Codes

BS 6093: 93	Code of Practice for the design of joints and jointing in building construction
BS 6270	Code of practice for cleaning and surface repair of buildings
BS 6270-1: 82	Part 1: Natural stone, cast stone and clay and calcium silicate brick masonry
BS 8000-11: 95	Code of Practice for wall and floor tiling; Section 11.2: Natural stone tiles
BS 8298: 94	Code of practice for the design and installation of natural stone cladding and lining

1 03 Definitions

1 03 01

Technical Terms

Abrasive hardness - refers to the wearing qualities of natural stone subjected to abrasion by foot traffic.

Arris - the corner or angle formed by the meeting of two surfaces, especially in mouldings; it can be moulded, unfinished, bevelled, rounded or otherwise shaped.

Axed finish - see bush hammered.

Bush-hammered - a mechanical process which produces textured surfaces. Textures vary from subtle to rough.

Cavity vent - an opening in filled joints of stone cladding to allow the passage of air and moisture from inside the wall cavity to the exterior. These vents may be openings, plastic tubing or wicks.

Cladding - external vertical non-load bearing covering to a structure.

Chamfer - to cut away the edges where two surfaces meet in an external angle, leaving a bevelled joint at the junction.

Dimension stone - natural stone that has been selected, trimmed, or cut to specified or indicated shapes or sizes, with or without one or more mechanically dressed surfaces.

Eggshell finishes - kind of (egg) surface that gives a finish that is neither glossy nor mat.

Fine rubbed - a smooth natural stone finish free from scratches without gloss.

Finish - final surface applied to the face of a natural stone during fabrication.

Fixing - anchor device to support or tie back a stone facing panel/unit.

Flamed - see thermal finish.

Fleuri cut - the effect obtained when a quarried stone block is cut parallel to its natural bedding plane. (see fig. 1/Annex 6)

Gauged - a grinding process to make all panels/units of stone to be used together the same thickness

Granite - a visibly granular, igneous rock generally ranging in colour from pink to light or dark grey and consisting mostly of quartz and feldspars, accompanied by one or more dark minerals. The texture is typically homogeneous but may be gneissic or **porphyritic**. Some dark granular igneous rocks, though not properly granite, are included in the definition.

Gritted - grinding a surface with grit stones.

Grout - a mortar used to fill joints.

Honed - (1) a satin smooth surface of natural stone with little or no gloss. (2) Finish having a dull polish or a matt surface (BS 8298)

Limestone - a rock of sedimentary origin composed principally of calcium carbonate (the mineral calcite), or the double carbonate of calcium and magnesium (the mineral dolomite), or some combination of these two minerals. Re-crystallized limestone, compact microcrystalline limestone, and travertine that are capable of taking a polish are included in the category of marble.

Load bearing fixing - cladding fixing that transfers the self-weight of one or more stone facing panels/units to a structure

Marble - (1) carbonate rock that has acquired a distinctive crystalline texture by recrystallization, most commonly by heat and pressure during metamorphism, and is composed principally of the carbonate minerals calcite and dolomite, singly or in combination. (ASTM C 119)
(2) A metamorphic crystalline rock that can be polished glossy and having different natural colours composed mainly of one or more of the minerals; calcite, dolomite or serpentine.

Panel - a single unit of fabricated stone used for wall covering.

Pointing - the final filling and finishing of mortar joints that have been raked out before.

Polished - the finest and smoothest glossy finish on natural stone. Generally only possible on hard, dense material such as granite and marble.

Polished finish - a highly polished glossy surface which brings out the full colour and character of the marble.

Restrained fixing - cladding fixing that ties back stone facing panels/units to the backing or structure or to another restrained unit

Rough finish - a flat non-reflective surface.

Rubbed - smooth finish obtained by rubbing natural stone with an abrasive (BS 8298)

Sandstone - sedimentary rock composed mostly of mineral and rock fragments within the sand size range (2 to 0,06 mm) and having a minimum of 60% free silica, cemented or bonded to a greater or lesser degree by various materials including silica, iron oxides, carbonates, or clay, and which fractures around (not through) the constituent grains.

Sawn - a natural stone finish with a surface left as the stone comes from the gang saw.

Slab - a lengthwise cut from a quarry block prior to fabrication (MIA)

Smooth finish - a velvety smooth surface with little or no gloss

Stone facing - natural stone wall covering with a final surface finish applied as an exterior or interior vertical surface, thickness of stone not exceeding 75 mm.

Thermal finish - a surface treatment applied by intensive heat flaming.

Tile - a unit of natural stone having a facial area of not more than 0,30 m² and a thickness not exceeding 12 mm.

Travertine - a variety of crystalline or microcrystalline limestone distinguished by layered structure. Pores and cavities commonly are concentrated in some of the layers, giving rise to an open texture. Travertine that is capable to take a polish will be defined as marble.

Vein - (1) a sheet-like body of minerals in marble . (2) A layer seams or narrows irregular body of mineral material different from the surrounding formation.

Vein cut - cutting of a quarried stone block perpendicular to the natural bedding.

Weathering - natural alteration by either chemical or mechanical processes due to the action of constituents of the atmosphere, surface water, or to temperature change.

Weep holes - see cavity vent.

1 03 02

Abbreviations

Q.C. Quality Control

1 04 System Description

1 04 01 01 Design Requirements for Ventilated (Cavity) Stone Facing

A sufficient wide clear cavity shall be provided. The width of the cavity shall be designed to leave a clear gap not less than 10 mm wide after all construction tolerances have been accommodated.

When a cavity wider than 100 mm is necessary a supplementary framework or special fixing shall be provided.

Unless joints between individual facing units or panels are designed to remain open, necessary cavity vents (weep holes) shall be provided at points where any entrapped moisture could accumulate.

Unless the building structure already incorporates necessary movement joints, the final design shall provide all necessary vertical and horizontal movement joints necessary to prevent damaging the stone facing due to any movement of the structure and/or the facing.

Anchor design and sizing shall be engineered individually for each application.

All fixings shall allow for three way adjustment to ensure proper fit.

Final design shall be based on specific physical properties of the type of natural stone specified.

When marble is used externally the surface finish should be preferably either honed or eggshell since polished marbles may lose their shine under certain atmospheric conditions.

Unless otherwise proven by structural analysis or performance testing, the minimum thickness of stone shall comply with Table 1/Annex 6.

Where stone facing may be vulnerable to impact damage, special consideration may be necessary. This should include using thicker stones in the affected area, or sealing the backs of the stones before fixing and filling the cavity with a lightweight fine concrete mix after stone fixing.

Design of stone fixing devices shall comply with one or more of the following methods:

- load bearing fixings
- restrained fixings
- combined load bearing and restraint fixings
- face fixings

Typical load bearing, restrained, face and soffit fixings are shown in fig.3-8/Annex 6.

In case the Contract Documents require insulation behind the stone facing in principle, such insulation shall be

-non-combustible or of limited flame spread as required by applicable building code regulations.

- non-absorbent
- rot and vermin proof

Design of ventilated vertical stone facings shall comply with BS 8298 or appropriate MIA requirements unless otherwise indicated.

1 05 Submittals

1 05 01 Product Data

To be submitted for each variety of stone, indicating the petrographic description, commercial name, and country of origin and physical properties.

Manufacturer's catalogues and technical information on all types of fixings, all accessories, and other manufactured products intended to use within the Project.

1 05 02 Shop Drawings

Submit sets of shop drawings, showing general layout, jointing, anchoring, movement joints, and all other information necessary for fabrication and installation, including dimension of each panel/unit of natural stone and its identification (setting) number.

1 05 03 Samples

For each variety of stone showing the full range of variations expected in completed work, in sets of samples of not less than 300 mm².

Anchors and other fixings in sets of samples.

For each colour of grout not less than one square meter samples.

Approval of samples does not constitute approval of final work.

1 05 04 Quality Control Submittals

Documented experience of Contractor's site supervisor

Reports and records of Contractor's internal Q.C.

Reports and records of Contractor's source Q.C.

1 06 Quality Assurance

Sampling, testing and checking procedures shall be recorded on a daily basis (i.e. indicating day, month, year) including corrective actions taken by the Contractor, natural stone manufacturer, or supplier.

Reports and records shall be available for assessment to the Engineer not later than three (3) days after checking and testing.

Reports and records shall be established and maintained in a manner to ensure traceability.

Arrangements shall be made and time allowed in Contractor's work schedule for checking and testing as indicated.

1 06 01 Qualifications

Contractor's site supervisor shall have knowledge of referenced Standards and at least five (5) years of documented experience in natural stone facing work and shall have successfully completed work similar in design, material, and extent to that work indicated for the Project.

Installers shall be familiar with all materials and installation procedures and shall be skilled and trained.

1 06 04 Quality Control

1 06 04 01 Internal Quality Control

Contractor's Internal Quality Control shall include but not limited to:

Checking supplier's test certificates and certificates of compliance to conform to specification and referenced standards prior to first delivery.

Checking supplier's delivery tickets of each delivery for completeness and compliance with supply order and specification.

Checking correct storage of natural stone panels/units every two weeks.

Checking finished stone panels/units at the place of fabrication for compliance with requirements for appearance, soundness, material, and fabrication.

1 06 04 02 External Quality Control

1 06 04 03 Source Quality Control

Obtain each variety of natural stone, regardless of finish, from a single quarry with enough resources to provide material of consistent quality in appearance and physical properties.

Make quarried blocks and slabs available for the Engineer to examine for appearance characteristics.

01.0 The Engineer will select aesthetically acceptable material and will indicate unacceptable material or portions thereof.

1 07 Delivery, Storage and Handling

1 07 01 Packing and Shipping

All natural stones shall be handled individually unless boxed or crated.

When shipped and stored non-staining spacers between stones shall be used.

Identification, location and/or orientation marks shall be clearly marked on each stone unit/panel without damaging the exposed face of the stone.

1 07 02 Storage and Protection

Stone units/panels shall be stored using designed points of support to prevent over-stressing.

When scaffolding is required for the work, no material shall be stored on the scaffolds and runways. Any material supply placed on a scaffold for installation shall not exceed the safe load-bearing capacity of the scaffolding.

Part 2: Products

2 01 Natural Stone

2 01 01 General

All natural stone shall be free of spalls, cracks, open seams and other imperfections that would impair its strength, durability, or appearance and free of minerals that may cause objectionable staining under normal conditions.

Any piece of natural stone showing minor flaws or imperfections shall be referred to the Engineer to decide whether it will be rejected, or allowed for patching or redressing.

Chips at the edges or corners may be patched when approved by the Engineer and provided the structural integrity of the stone is not affected and provided the patch matches the colour and finish of the natural stone.

Obtain each variety of natural stone from a single quarry.

Obtain each type of grout, accessory, sealant and other material from a single manufacturer unless approved otherwise.

2 01 02 Marble

2 01 02 01 General

01.0 Marble shall be capable of taking a polish and shall have the following physical properties in compliance with ASTM C 503:

-Moisture absorption (Test: ASTM C 97)	max.% 0,20 (exterior use) 0,70 (interior use)
-Density, min. kg/m ³ (Test: ASTM C 97)	2595 (Calcite) 2800 (Dolomite) 2690 (Serpentine) 2305 (Travertine)

-Compressive strength, min.MPa (Test: ASTM C 170)	52
-Modulus of rupture, min.MPa (Test: ASTM C 99)	7
-Abrasion resistance, min. Hardness Ha (Test: ASTM C 241)	10
-Flexural strength, min.MPa (Test: ASTM C 880)	7

02.0 Marble shall be capable of taking a polish and shall have the following physical properties:

-Water absorption by weight,	(Test SASO 1026) max.0,20
-Density (bulk specific gravity) kg/m ³	(Test SASO 1026) min.2600
-Abrasion resistance, min. Hardness Ha (Test SASO 1026)	10

2 01 02 02 Marble Wall Panels/Units/Tiles

- 01.0 Marble used as exterior facing shall be of soundness class classification A (see MIA classification system) or equivalent.
- 02.0 Subject to compliance with requirements shown on drawings
- 03.0 Cut:
- 03.1 fleuri cut,

- 03.2 vein cut,
- 04.0 final surface:
- 04.1 rough finish,
- 04.2 smooth finish,
- 04.3 polished finish,
- 05.0 colour:
- 05.1 as indicated.
- 06.0 Subject to compliance with requirements as indicated in ASTM C 503 for marble, marble wall panels/units/tiles shall be of type indicated below, nominal sizes as shown on drawings or otherwise indicated.
- 07.0 imported.
- 08.0 Cut:
- 08.1 fleuri cut,
- 08.2 vein cut,
- 09.0 final surface finish:
- 09.1 polished.
- 09.2 eggshell.
- 09.3 honed.
- 09.4 gritted.

2 01 03 Granite

2 01 03 01 General

01.0 Granite shall have the following physical properties in compliance with ASTM C 615:

-Moisture absorption by weight, max. % (Test: ASTM C 97)	0,40
-Density, min. Kg/m ³ (Test: ASTM C 97)	2560
-Compressive strength, min. MPa (Test: ASTM C 170)	131
-Modulus of rupture, min. MPa (Test: ASTM C 99)	10,34
-Abrasion resistance, min. Hardness Ha (Test: ASTM C 241)	not established
-Flexural strength, min. MPa (Test: ASTM C 880)	not established

2 01 03 02 Granite Wall Panels/Units/Tiles

01.0 Subject to requirements as indicated for granite, granite wall panels/units/tiles shall be of type indicated below, nominal sizes as shown on drawings or otherwise indicated

- 02.0 imported or local
- 03.0 Cut:
- 03.1 fleuri cut,
- 03.2 vein cut,
- 04.0 final surface finish:
- 04.1 polished.

- 04.2 eggshell.
- 04.3 honed.
- 04.4 fine axed.
- 04.5 fine rubbed.
- 04.6 bush hammered.

2 01 04 Limestone

2 01 04 01 General

01.0 Limestone shall have the following physical properties in compliance with ASTM C 568:

-Moisture absorpt. by weight, max.%	12	(low-density)
(Test: ASTM C 97)	7,5	(medium-density)
	3	(high-density)
-Density, min. Kg/m3 (Test: ASTM C 97)	1760	(low-density)
	2160	(medium-density)
	2560	(high-density)
-Compr. strength, min. MPa	12	(low-density)
(Test: ASTM C 170)	28	(medium-density)
	55	(high-density)
-Modulus of rupture, min. MPa (ASTM C 99)	2,9	(low-density)
	3,4	(medium-density)
	6,9	(high-density)
-Abrasion resistance, min. Hardness Ha	10	(low-density)
(Test: ASTM C 241)	10	(medium-density)
	10	(high-density)

2 01 04 02 Limestone Wall Panels/Units/Tiles

- 01.0 Subject to requirements as indicated for limestone, limestone wall panels/units/ tiles shall be of type indicated below, nominal sizes as shown on drawings or otherwise indicated:
- 02.0 imported
- 03.0 local limestone for final selection by the Engineer,
- 04.0 low-density,
- 05.0 medium-density,
- 06.0 high-density,
- 07.0 Cut:
 - 07.1 fleuri cut,
 - 07.2 vein cut,
- 08.0 final surface finish:
 - 08.1 fine rubbed.

08.2 sawn.

2 01 05 Sandstone (quartz-based)

2 01 05 01 General

01.0 Sandstone shall have the following physical properties in compliance with ASTM C 616:

-Moisture absorpt. by weight, max.% (Test: ASTM C 97)	20 3 1	(Sandstone) (Quartzite-Sandstone) (Quartzite)
-Density, min. Kg/m3 (Test: ASTM C 97)	2160 2400 2560	(Sandstone) (Quartzite-Sandstone) (Quartzite)
-Mod. of rupture, min. MPa (Test: ASTM C 99)	2,1 6,9 13,9	(Sandstone) (Quartzite-Sandstone) (Quartzite)
-Abrasion resistance, min. Hardness Ha (Test: ASTM C 241)	8 38 8	(Sandstone) (Quartzite-Sandstone) (Quartzite)

2 01 05 02 Sandstone Wall Panels/Units/Tiles

01.0 Subject to requirements as indicated for sandstone, sandstone panels/units/tiles shall be of type indicated below, nominal sizes as shown on drawings or otherwise indicated:

- 01.0 imported sandstone,
- 02.0 local sandstone,
- 03.0 to comply with manufacturer’s representative sample,
- 04.0 for final selection by the Engineer,
- 05.0 Cut:
 - 05.1 fleuri cut,
 - 05.2 vein cut,
- 06.0 final surface finish:
 - 06.1 fine rubbed.
 - 06.2 sawn.

2 02 Fixing Materials

2 02 01 Materials for Spotting and Setting Mortar

2 02 01 01 Cement

Cement used shall be Ordinary Portland cement and shall comply with ISO 680: 90, DIN 1164-1: 94 and DIN 1164-2: 96.

2 02 01 02 Sand

Sand used for mortar shall be a building sand (0-3 mm) from natural sources in accordance with BS 1199, ASTM C 144, or an equivalent standard.

2 02 01 03 Water

Water shall be fresh and clean potable water.

2 02 01 04 Admixtures

Admixtures shall not contain calcium chloride (BS 8298/page 9) and shall be certified by the manufacturer as appropriate for the intended use.

2 02 02 Adhesives

All adhesives shall be certified by the manufacturer as suitable for the application indicated.

2 02 02 01 Cement-based Adhesive

Cement-based adhesive shall comply with one of the following Standards:

BS 5980 type 1 or 3

DIN 18156-Part 2

2 02 02 02 Organic Adhesive

Organic adhesive shall comply with one of the following Standards:

BS 5980 type 2 or 4

ANSI A 136.1

DIN 18156-Part 3

2 02 02 03 Epoxy Adhesive

Epoxy adhesive shall be water cleanable prior to initial setting and shall comply with one of the following Standards:

BS 5980 type 5.

DIN 18156-Part 4.

2 02 03 Fixing Devices

All fixing devices shall be engineered individually for each Project and shall be made of stainless steel, bronze, brass, or extruded aluminium. Steel fixings for interior stone facing may be made corrosion resistant by hot-dip galvanising.

All fixing devices shall be non-staining to prevent possible staining of the face of the cladding due to corrosion. (BS 8298 /page 12)

Stainless steel fixings shall be made of austenitic stainless steel with a carbon content not exceeding 0,06% and shall comply with BS 1149-2, BS 970-1, BS 6105, ASTM A 666 (type 304) or equivalent.

Fixing devices made from extruded aluminium shall comply with ASTM B 221 or equivalent. Alloy and temper shall be as necessary to support all loads imposed without exceeding allowable design stresses, but not less than strength properties of alloy 6063-T6.

Site welding and brazing of stainless steel, aluminium, copper and copper based alloy fixings will only be permitted where the necessary facilities, expert knowledge, skill and inspection and testing facilities are available.

2 02 04 Wire

Wire tiebacks shall be made of stainless steel, copper or copper alloy, minimum thickness 3 mm.

2 03 Grout

Grout shall have low shrinkage and appropriate adhesion and shall be appropriate for the application indicated.

2 03 01 Cement: Sand Grout

Necessary alkali-resistant pigments may be added to achieve white or coloured joints where indicated.

2 03 02 Cement: Lime: Sand Grout

Necessary alkali-resistant pigments may be added to achieve white or coloured joints where indicated.

2 03 03 Proprietary Grout

2 03 03 01 Cement based Grout

Cement based proprietary grout shall consist of factory mixed cement and other ingredients/admixtures to achieve white or coloured joints and shall comply with ANSI A 108.10 or an equivalent standard. Only clean water shall be added at the job-site to obtain the desired consistency.

2 04 Accessories

2 04 01 Joint Accessories

2 04 01 01 General

Any sealant and back-up material used shall be certified by the manufacturer as suitable for the intended use.

Any sealant used for movement joints shall match the colour of grout in stone-faced areas adjoining sealed joints unless otherwise indicated.

Where all joints are required to be sealed, the colour of the sealant shall match the colour of the stone facing unless otherwise indicated.

2 04 01 02 Back-up Material

Back-up strips shall be flexible, compressible type of closed-cell foam, polyethylene, butyl rubber, or open or closed-cell polyurethane, rounded at surface to contact sealant as recommended by the sealant manufacturer.

Bond breaker tapes shall be self-adhesive polyethylene or polytetrafluorethylene (PTFE) tapes.

2 04 01 03 Sealant

Sealant shall be made from:

- 01.0 One-part polysulfide
- 02.0 One-part polyurethane
- 03.0 Two--part polysulfide
- 04.0 Two-part polyurethane
- 05.0 Silicone (low modulus type)

For other requirements see Section 07900 Joint Sealants

2 04 01 04 Shims

Shims shall be made of resilient plastic, non-staining to stone, and sized to suit joint thickness.

2 04 02 Damp proofing Material

See Section 07150 Damp proofing

2 05 Fabrication

2 05 01 General

Fabricate stone facing in sizes and shapes required to comply with requirements indicated, including details shown on drawings and shop drawings.

Cut stone by vein or fleuri cut as indicated to produce pieces of thickness, size, and shape indicated and to comply with fabrication and installation tolerances. If the type of cutting is not indicated, cutting method will be determined and approved by the Engineer.

Clean sawed backs of stones to remove rust stains and iron particles.

Cut joints straight and at right angle to face unless otherwise indicated.

Drill holes and cut mortices, sinkings, notches for cramps, anchors, and lifting devices as indicated or needed to install stones securely in place. Use professional tools that will ensure that cracks do not occur from the process.

Arrange panels/units in the shop or other suitable location in proposed pattern, orientation and sequence for examination and approval by the Engineer. Rearrange panels/units as directed by the Engineer until the layout is approved.

Do not cut and trim non-modular sized units/panels to smaller than modular sized units until layout and pattern are approved by the Engineer

Finish exposed faces and edges of stone to comply with requirements indicated for finish of each type of natural stone required and to match approved samples.

Identify each panel/unit clearly with its identification mark or symbol.

Fabricator's workmen bush-hammering, sandblasting, or dry-grinding without vacuum equipped features shall wear protective head and face helmets equipped with safety-glass lenses and/or respiratory equipment.

2 05 02 Fabrication Tolerances

The length and height dimensions shall not vary from nominal sizes indicated by more than 3 mm.

The thickness of stone shall not vary from nominal thickness by more than 3 mm.

The stone faces shall not vary from the plane by more than 1,5 mm in 1200 mm.

The squareness of natural stone, measured by the length of diagonals, shall not vary by more than 0,5% of the nominal dimension or 5 mm, whichever is less.

The given tolerances shall apply for granite and marble unless otherwise indicated but may be increased for limestone and sandstone depending on the type of stone and the quarry.

2 06 Mortar Mixes

2 06 01 General

Materials shall be batched by weight wherever possible and water addition controlled.

Where weight batching is impracticable, mortar ingredients shall be measured by volume using suitable containers of fixed, measurable size.

When mortar is mixed by hand, it shall be done on a clean non-absorbent surface.

No water shall be added once mixing has been completed.

Any mortar not used within two (2) hours after adding mixing water shall be removed

Admixtures shall only be used when certified by the manufacturer as suitable for the intended use.

2 06 02 Spotting and Setting Mortar Mixes

2 06 02 01 Cement:Sand Semi-dry Mix

Cement: sand semi-dry mix shall be 1:3,5 to 1:4 by volume. (1:3,4 to 1:4,6 by weight)

The water-cement ratio shall be between 0,55 and 0,60.

2 06 02 02 Cement:Lime:Sand Mortar

The cement: lime: sand mortar mix shall be 1:1:5 to 6 by volume.

The mortar shall be mixed to a stiff plastic consistency so that when the mortar bed is fully compacted, free water does not come to the surface.

2 06 02 03 Proprietary Thin-bed Mortar

Shall be factory mixed in proportions appropriate and recommended by the manufacturer for the application indicated.

2 06 03 Grouting Mixes

2 06 03 01 Cement:Sand Grout

The proportions of cement: sand shall be 1: 1 for joints not exceeding 3 mm, 1: 2 for joints between 3-6 mm and 1: 3 for joints wider than 6 mm.

2 06 03 02 Cement: Lime:Sand Grout

The proportions of cement:lime:stone dust or suitable sand shall be 1: 2: 6.

2 06 03 03 Proprietary Grout

Proprietary grout shall be mixed according to manufacturers written instructions.

Part 3: Execution

3 01 General Examination

All surfaces to receive stone facing shall be inspected for structural soundness, for existing surface conditions, for installation tolerances and any other conditions affecting the work.

For the record, all conditions found detrimental to requirements and not allowing a proper installation of stone facing, shall be listed in a written report issued by the installer and handed over to the Engineer.

Installation works shall not proceed until satisfactory conditions are provided.

3 02 General Preparation

Provisions shall be made for the completion of all subsidiary works necessary before the application of stone facing begins.

Bases not built accurately or surface conditions that are not suitable shall be corrected and additional time shall be allowed for setting and curing.

For surfaces receiving adhesive or thin-bed mortar fixing, any laitance on the surface and contamination by oil, grease wax, dust or any other substances that inhibits adhesion or may cause staining of stone shall be removed.

Clean natural stone by thoroughly scrubbing with fibre brushes and then drenching with clear water immediately before fixing. Use only cleaning compounds that contain no staining or harsh components or abrasives.

3 03 Installation

3 03 01 General

Erect/install stone facing units/panels level, plumb, and true with uniform joint widths in compliance with drawings and shop drawings.

Use temporary shims to maintain joint width. Unless joints are designed to be left open, remove shims before grouting or pointing.

Fix stone to comply with layout and pattern as indicated. If no special layout or pattern is required, surfaces shall be arranged in blend pattern, stones centred and balanced.

Expansion joints shall be located to coincide and be continuous with structural expansion joints. Other movement joints in the stone facing shall be as indicated.

Unless proved by structural analysis or performance testing otherwise, minimum thickness of stone facing shall comply with table 1/Annex 6 unless otherwise indicated.

Anchor and fixing devices for stone facing shall be designed to withstand dead loads together with wind pressure and suction.

The suitability of fixings of unusual design and position shall be proven by test.

Mechanical fixings shall be provided by one or more of the following methods:

- self support anchors (load bearing fixings)
- restraint fixings
- combined load bearing and restraint fixings
- face fixings

Typical fixings are shown in fig. 3-8/Annex 6

Fixing of natural stone by means of adhesive will be allowed only for thin stone tiles not exceeding 12 mm in thickness and surfaces not exceeding 2,50 m in height.

3 03 02 Exterior Stone Facing

Exterior stone facing by mortar without using any fixing devices is not recommended. In general, stone facing with filled cavity is not recommended.

Arrange panels/units/tiles with veining and other natural markings to comply with the following:

- 01.0 Cut stone from one block or contiguous, matched blocks in which natural markings occur.
- 01.1 Arrange panels/units/tiles with veining horizontal.
- 01.2 Arrange panels/units/tiles with veining vertical.
- 01.3 Arrange panels/units/tiles with veining as indicated on Drawings.
- 01.4 Arrange panels/units/tiles in blend pattern (see fig. 2 /Annex 6).
- 01.5 Arrange adjacent panels/units/tiles book matched (see fig. 2/Annex 6) for single height, diamond match if more than one course in height.
- 01.6 End match panels/units/tiles stacked one above the other if no units are directly adjacent.
- 01.7 Arrange panels/units/tiles sideslip pattern (see fig. 2/Annex 6) if one course height.
- 01.8 Arrange units in end-slip pattern (see fig. 2/Annex 6).

3 03 02 01 Stone Setting with Vented Cavity

3 03 02 01 01 Installation

01.0 Natural stone panels/units shall be set firmly against (cement) mortar spots (spacer dabs) located at or near the restraining fixings and spaced not more than 50 cm apart over the back of the panel/unit. If restraining fixing devices fit into grooves routed into stone facing panels/units, setting mortar spots are not required.

Joint width shall be maintained with non-staining resilient cushions placed at least a joint width back from stone face in case non-load-bearing fixing devices are being used.

If the fixing devices are not self-supporting (load bearing type), support angles shall be provided over all openings, at each storey height, or as indicated. Supporting angles shall have weep holes at least every 60 cm.

Anchors, dowels, cramps, wires and the like shall be securely attached to the structure and to the facing stone according to manufacturer's requirements and as shown on drawings and shop drawings.

A minimum of four anchors shall be provided for panels up to one square meter, with two additional anchors for each additional 0,7 square meter of surface area unless otherwise indicated.

Wire tieback systems shall be only used up to two (2) stories in height.

Cavity vents (weep holes) shall be provided in the joints at approximately 1,5 m horizontal intervals and 6 m maximum vertical intervals unless joints are required to be left unfilled.

Unless otherwise indicated, minimum width of mortar joints shall be 3 mm and of elastomeric sealant joints 5 mm except for structural expansion and other movement joints.

Installation shall be in compliance with requirements established by the Marble Institute of America (MIA) in Design Manual IV and/or in BS 8298 unless otherwise indicated.

3 03 02 01 02 Jointing

- 01.0 Joint width shall be maintained with non-staining resilient cushions placed at least a joint width back from stone face in case non-load-bearing fixing devices are being used.
- 01.1 Joints: grouted to match the colour of the stone facing.
- 01.2 Joints: sealed with elastomeric sealant to match the colour of the stone facing, including joint back up.
- 01.3 Joints: left open, unfilled
- 01.4 Joints: as indicated.
- 02.0 Joint width shall be maintained by a mortar bed screeded level and full, but kept away back 20 mm from the joint face before the stone unit/panel is lowered into place. All joints shall be completely filled. Vertical joints may be filled by pouring grout into joints or rear edges of units/panels being buttered before setting. .

To prevent any squeezing of mortar into the ventilation cavity, performed plastic strips or tapes shall be used.
- 02.1 Joints: grouted to match the colour of the stone facing.
- 02.2 Joints: sealed with elastomeric sealant.

3 03 02 02 Stone Setting with Thin-bed Mortar or Adhesive

Shall be only used for small size natural stone tiles! However, vertical surfaces should not exceed 2,40 m in height.

3 03 02 02 01 Installation

- 01.0 Instructions given by the adhesive or mortar manufacturer shall be observed and followed. If required, background shall be primed.

Where gaps in the background exceed 3 mm, local corrections by dubbing out up to 6 mm thick may be done by using the same adhesive or mortar. However, this method shall be certified as appropriate by the adhesive or mortar manufacturer and approved by the Engineer.

For fixing, the notched trowelling method shall be used: The adhesive or thin-bed mortar shall be applied to the surface as a float coat with a trowel, pressing the adhesive or mortar onto the surface to give a bed thickness not exceeding 3 mm unless otherwise required by the manufacturer, which shall then be combed through with a notched trowel of type recommended by the manufacturer of the adhesive or mortar.

This will give a series of ribs into which the dry natural stone tiles shall be pressed with a twisting or sliding action to obtain maximum bonding. Average contact area shall be at least 95% when not less than three tiles are removed for inspection.

All tiles shall be fixed in position before surface drying of the adhesive or mortar commences.

For external surfaces, only cement-based or epoxy-resin based adhesive or thin-bed mortar shall be used.

3 03 02 02 02 Jointing

- 01.1 Joints: grouted to match the colour of the stone tiles.
- 01.2 Joints: grouted as indicated.

3 03 03 Interior Stone Facing

Stones shall be arranged to pattern as indicated:

Arrange panels/units/tiles with veining and other natural markings to comply with the following:

- 01.0 Cut stone from one block or contiguous, matched blocks in which natural markings occur.
- 01.1 Arrange panels/units/tiles with veining horizontal.
- 01.2 Arrange panels/units/tiles with veining vertical.
- 01.3 Arrange panels/units/tiles with veining as indicated on Drawings.
- 01.4 Arrange panels/units/tiles in blend pattern (see fig.2 /Annex 6).
- 01.5 Arrange adjacent panels/units/tiles book matched (see fig. 2/Annex 6) for single height, diamond match if more than one course in height.
- 01.6 End match panels/units/tiles stacked one above the other if no units are directly adjacent.
- 01.7 Arrange panels/units/tiles sideslip pattern (see fig. 2/Annex 6) if one course height.
- 01.8 Arrange units in end-slip pattern (see fig. 2/Annex 6).

3 03 03 01 Stone Setting with Vented Cavity

3 03 03 01 01 Installation

- 01.0 Natural stone panels/units shall be set firmly against (cement or gypsum) mortar spots (spacer dabs) located at or near the restraining fixings and spaced not more than 50 cm apart over the back of the panel/unit. If restraining fixing devices fit into grooves routed into stone facing panels/units, setting mortar spots are not required.

Joint width shall be maintained with non-staining resilient cushions placed at least a joint width back from stone face in case non-load-bearing fixing devices are being used.

If the fixing devices are not self-supporting (load bearing type), support angles shall be provided over all openings, at each storey height, or as indicated. Supporting angles shall have weep holes at least every 60 cm.

Anchors, dowels, cramps, wires and the like shall be securely attached to the structure and to the facing stone according to manufacturer's requirements and as shown on drawings and shop drawings.

A minimum of four anchors shall be provided for panels up to one square meter, with two additional anchors for each additional 0,7 m² of surface area unless otherwise indicated.

Wire tieback systems (restrained fixings) shall be only used up to two (2) stories in height.

Unless otherwise indicated, minimum width of mortar joints shall be 3 mm and of elastomeric sealant joints 5 mm except for structural expansion and other movement joints.

Installation shall be in compliance with requirements established by the Marble Institute of America (MIA) in Design Manual IV and/or in BS 8298 unless otherwise indicated.

3 03 03 01 02 Jointing

- 01.0 Joint width shall be maintained with non-staining resilient cushions placed at least a joint width back from stone face in case non load bearing fixing devices are being used.

- 01.1 Joints: grouted to match the colour of the stone facing.
- 01.2 Joints: sealed with elastomeric sealant to match the colour of the stone facing, including joint back-up.
- 01.3 Joints: left open, unfilled
- 01.4 Joints: as indicated.
- 02.0 Joint width shall be maintained by a mortar bed screeded level and full, but kept away back 20 mm from the joint face before the stone unit/panel is lowered into place. All joints shall be completely filled. Vertical joints may be filled by pouring grout into joints or rear edges of units/panels being buttered before setting. .To prevent any squeezing of mortar into the ventilation cavity, performed plastic strips or tapes shall be used.
- 02.1 Joints: grouted to match the colour of the stone facing.
- 02.2 Joints: sealed with elastomeric sealant.

3 03 03 02 Stone Setting with Thin-bed Mortar or Adhesive

Shall be only used for small seized natural stone tiles! However, vertical surfaces should not exceed 2, 40 m in height.

3 03 03 02 01 Installation

- 01.0 Instructions given by the adhesive or mortar manufacturer shall be observed and followed. If required, background shall be primed.

Where gaps in the background exceed 3 mm, local corrections by dubbing out up to 6 mm thick may be done by using the same adhesive or mortar. However, this method shall be certified as appropriate by the adhesive or mortar manufacturer and approved by the Engineer.

For fixing, the notched trowelling method shall be used: The adhesive or thin-bed mortar shall be applied to the surface as a float coat with a trowel, pressing the adhesive or mortar onto the surface to give a bed thickness not exceeding 3 mm unless otherwise required by the manufacturer, which shall then be combed through with a notched trowel of type recommended by the manufacturer of the adhesive or mortar.

This will give a series of ribs into which the dry natural stone tiles shall be pressed with a twisting or sliding action to obtain maximum bonding. Average contact area shall be at least 95% when not less than three tiles are removed for inspection.

All tiles shall be fixed in position before surface drying of the adhesive or mortar commences.

3 03 03 02 02 Jointing

- 01.1 Joints: grouted to match the colour of the stone tiles.
- 01.2 Joints: grouted as indicated.

3 03 04 Installation Tolerances

- 01.0 Variation from plumb: Do not exceed 3 mm in 2400 mm, or 6 mm maximum.
- 02.0 Variation of linear building line: For positions shown in drawings, do not exceed
 - 02.1 3 mm in 2400 mm.
 - 02.2 6 mm in 6000 mm.

- 02.3 10 mm maximum.
- 03.0 Variation in cross-sectional dimensions: From dimensions indicated, do not exceed plus or minus 3 mm.
- 04.0 Variation in joint width: Do not vary joint thickness more than 1,5 mm or $\frac{1}{4}$ of joint width, whichever is less.
- 05.0 Variation in plane between adjacent stone units/panels: Do not exceed 1 mm difference between planes of adjacent units/panels.

3 03 05 Movement Joints

In order to prevent a build up of compressive forces, movement joints shall be as indicated in drawings and where necessary due to the method of stone fixing.

Where stone panels/units are set in mortar bed, horizontal and vertical movement joints shall be provided at 5,00 m maximum intervals and between 1,50 m - 3,00 m away from any corner unless otherwise indicated.

Movement joints shall be sealed with an elastomeric sealant.

Joint width shall depend on the expected amount of movement and the maximum strain that can be accommodated by the sealant. Joint width shall not be less than 10 mm per 5,00 m stone facing.

3 04 Field Quality Control

3 05 Adjusting and Cleaning

Replace damaged stones and finished surfaces in a way that results of stone matches approved samples and mock-ups, complying with all other requirements and showing no evidence of being replaced.

Replace joints not matching approved samples and mock-ups in design, size, colour and other requirements.

Cleaning of natural stone shall be carried out after setting, pointing, grouting and curing has been finished.

Cleaning shall be in compliance with recommended procedures of the natural stone manufacturer. Cleaning agents shall only be used when recommended by the manufacturer as suitable for the intended use.

3 07 Protection

Surfaces to receive natural stone facing shall be scheduled as late as possible in the building program in order to reduce danger from damage and contamination.

Vulnerable stone facings exposed to other construction works shall be protected by temporary casings.

Part 4: Method of Measurement

4 01 General

The quantities to be paid will be measured in place or will be determined from drawings and shop drawings.

Work will be measured on the exposed surface.

Where work is measured by area, no deductions shall be made for voids not exceeding 0,1 m².

Exterior and interior stone facing will be measured separately.

Stone facing with vented cavity will be measured separately.

Soffits, columns, pillars and the like will be measured separately.

4 02 Units of Measurement

Surfaces will be measured by m² for each specified type, grade and surface characteristic of natural stone.

Soffits, columns, pillars and the like will be measured by m² for each specified type, grade, and surface characteristic of natural stone.

Structural expansion joints may be measured by linear meter (m).

5 Part 5: Basis of Payment

5 01 General

Payment will be made for complete work including furnishing all material, equipment, tools, scaffolding, storage facilities, water, power, for all labour, mixing, samples, checking, examination, testing, quality assurance, cleaning the site and including but not limited to the following ancillary works.

Material which is unnecessarily wasted or otherwise misused shall be replaced at Contractor's expense.

No payment will be made for unauthorised operations.

Material or work which does not conform to specification requirements shall be removed and replaced on Contractor's expense.

5 02 Ancillary Works to be Included in the Unit Price Rates

The following ancillary works shall be included in the unit price rates:

Facing around openings, connections to adjacent components, laid to pattern, sloped vertical surfaces, cuttings to holes for pipes, sockets, switches, outlets and the like, fixing templates, preparation of backgrounds including priming, protecting and cleaning.

All anchorage items.

Grouting where indicated.

All movement joints except structural expansion joints including cleaning, priming, joint back-ups and sealing.

Any width, height, girth, size or shape of slab or feature

Bedding and fixing including bedding mortars, adhesives and fixing materials

All cutting and internal and external angles, intersections and joints

Layout and treatment of joints including grouting

Movement joints

Cleaning, sealing and polishing

Working over and around obstructions

Overhand working.

Annex: Tables and Figures

6 01 Tables

Table 1: Minimum Thickness of Stone

Stone location	Stone type			
	Stone thickness			
	G Mw SL Q mm	T Ls K mm	Mb mm	Ls Ss mm
Cladding (external)				
Less than 3.7 m above ground or floor level and continuously supported (incl. fascias)	20	20	20	50
Fascias less than 3.7 m above ground or floor level and continuously supported (incl. fascias)	30	30	NA	50
More than 3.7 m above ground or floor level and continuously supported (incl. fascias)	40	40	NA	75
Soffits (including inclined soffits) ⁴⁾	40	40	NA	75
Sills, copings and supported reveals	30	30	NA	50
Stone faced concrete units	30	30	NA	50
Lining (internal)				
Less than 7 m above ground or floor level and continuously supported (incl. fascias) ⁵⁾	20	20	20	50
Less than 7 m but more than 3.7 m above ground or floor level on corbels in slots (incl. fascias)	30	30	NA	50
More than 7 m above ground or floor level (incl. fascias)	30	40	NA	75
Soffits (including inclined soffits) ⁴⁾	40	40	NA	75

Abbreviations

G	Granites	NA	not applicable
Ls	limestone (e.g. Portland, Bath, Clipsham)	T	Travertines
LsH	Hard limestones (e.g. Roman stone)		
Mb	Brecciated marbles		
Mw	Homogeneous marbles		
Q	Quartzites		
SL	States(those unlikely to delaminate)		
Ss	Sandstones(e.g. York,Northumberland, Scottish)		

4)The figures in the table apply to soffit stones not exceeding 900 mm x 600 mm. If stones of a greater size are required consideration should be given to using some face fixings and/or additional fixings in the length and/or increased thickness.

Internal soffit stone not less than 1.2 m and not more than 3.7 m above floor level, continuously supported at reveals may be 20 mm thick for G, Q, SL, T,

Lsh, Mw, and 50 for Ls and Ss.

5) Internal cladding between 3.7 m and 7 m in height in a continuous face should have an intermediate corbel course.

6 02 Figures

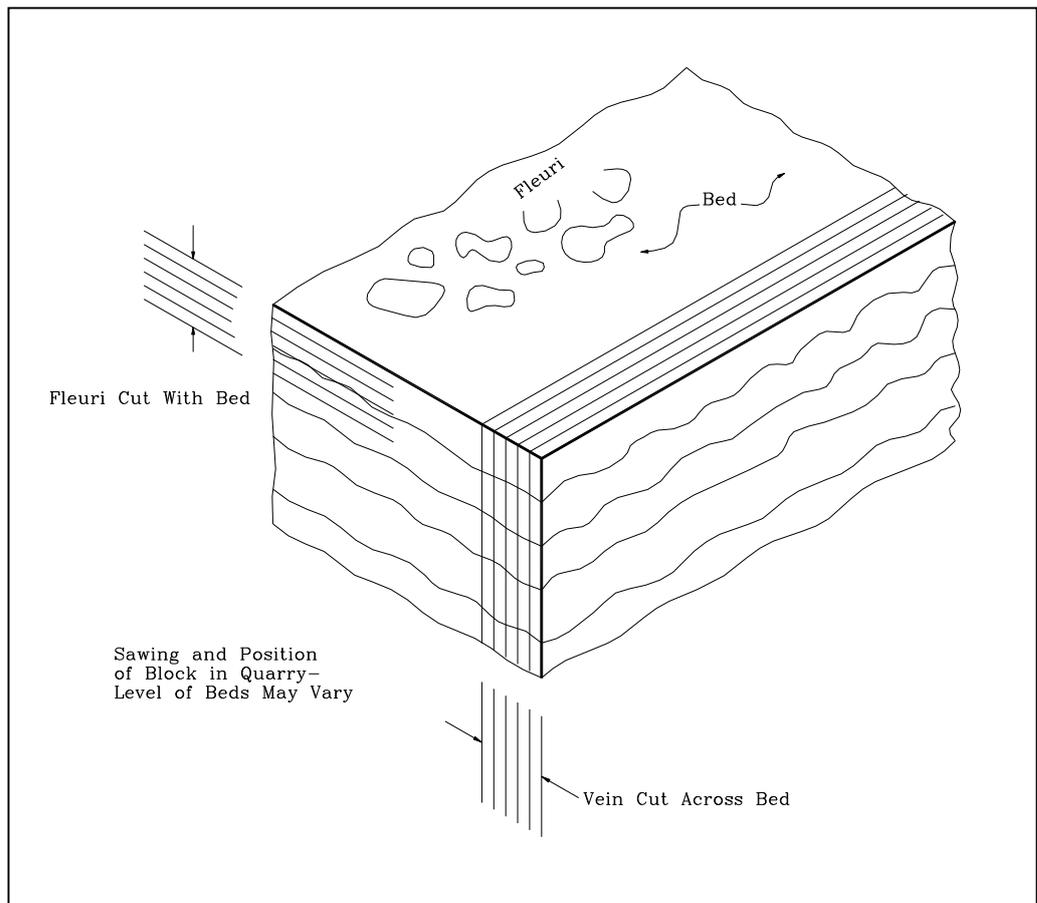


Fig. 1: Fleuri and Vein Cut

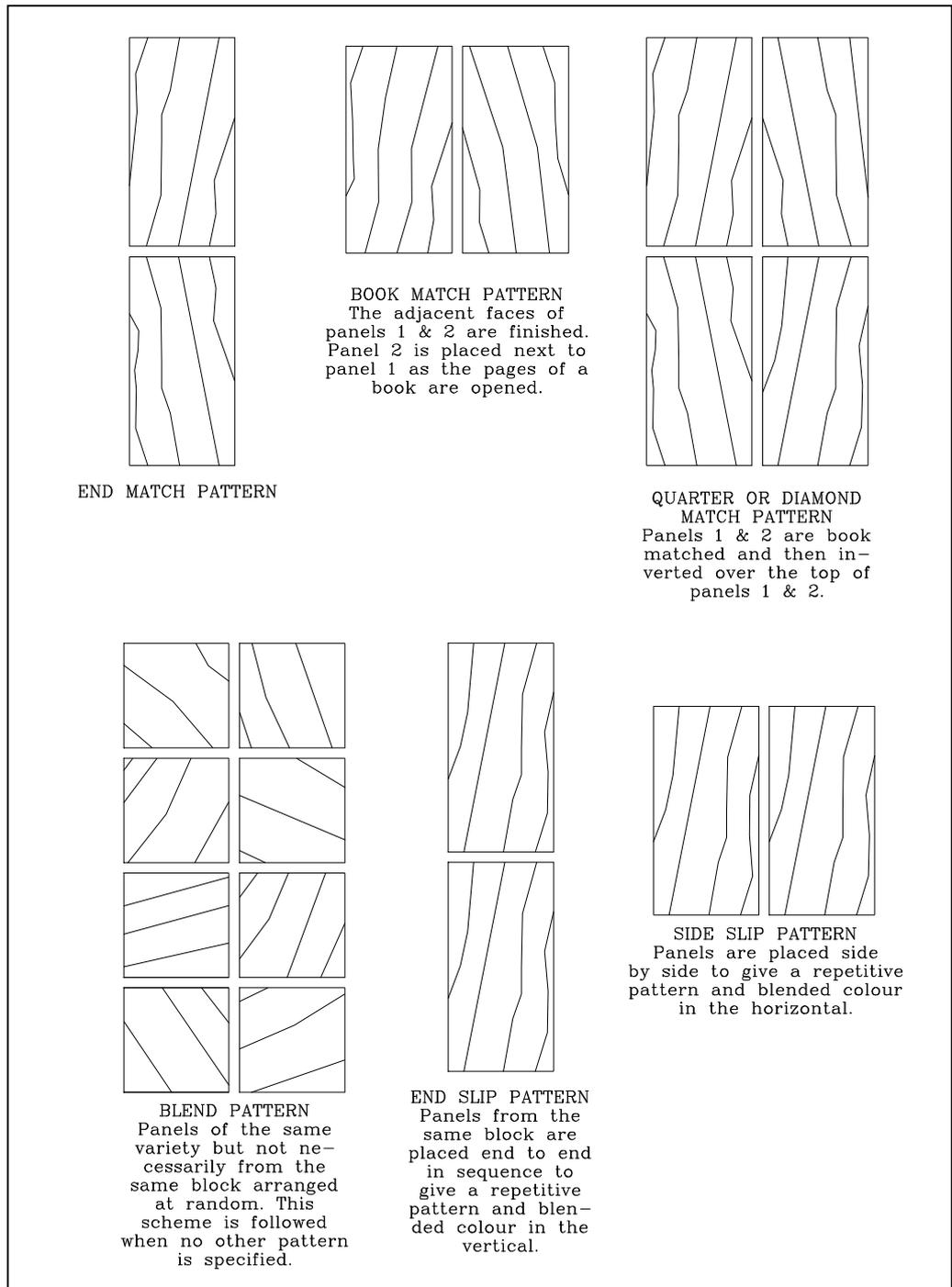


Fig. 2: Stone facing patterns

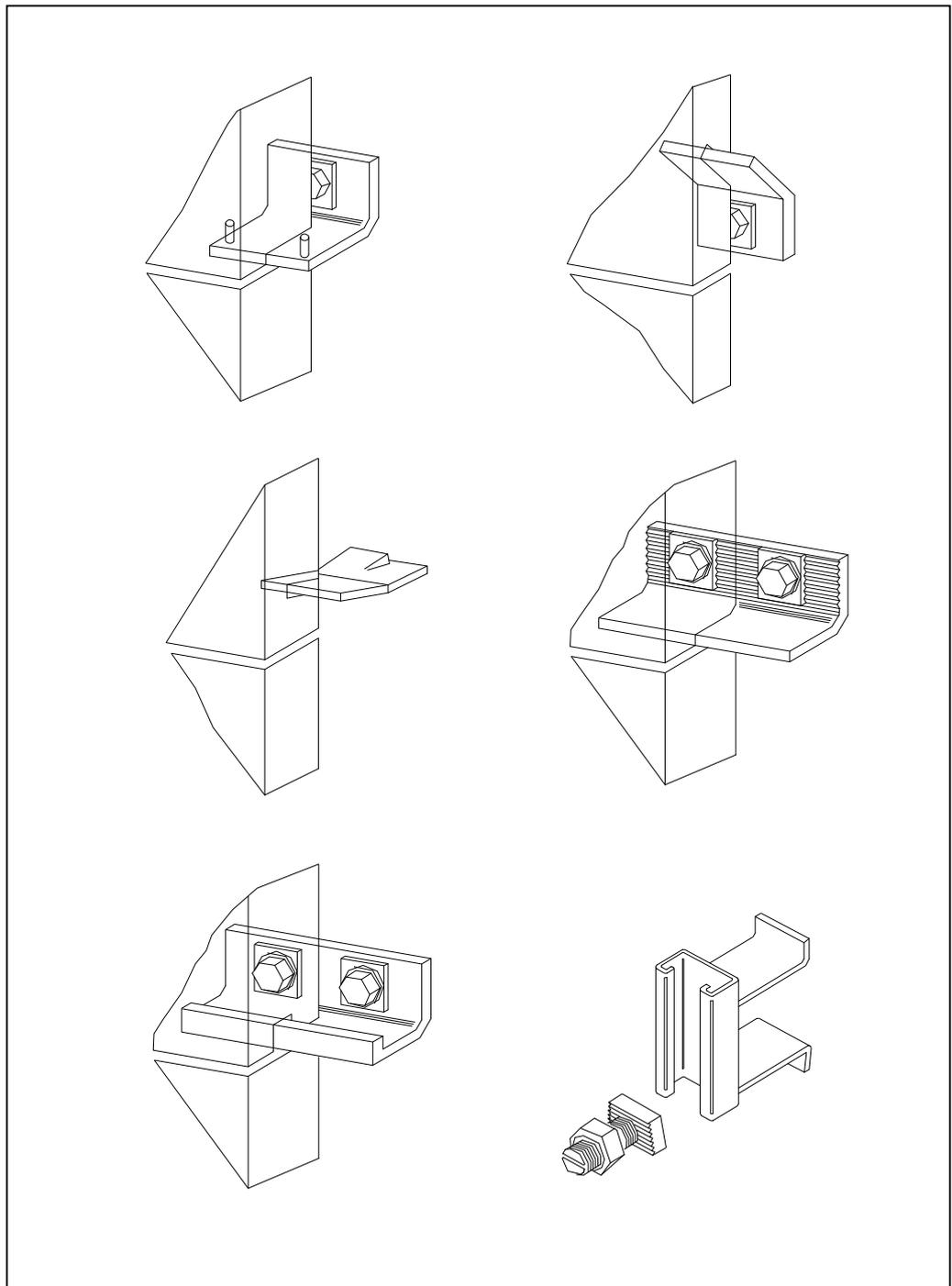


Fig 3: Illustration of typical load bearing fixings

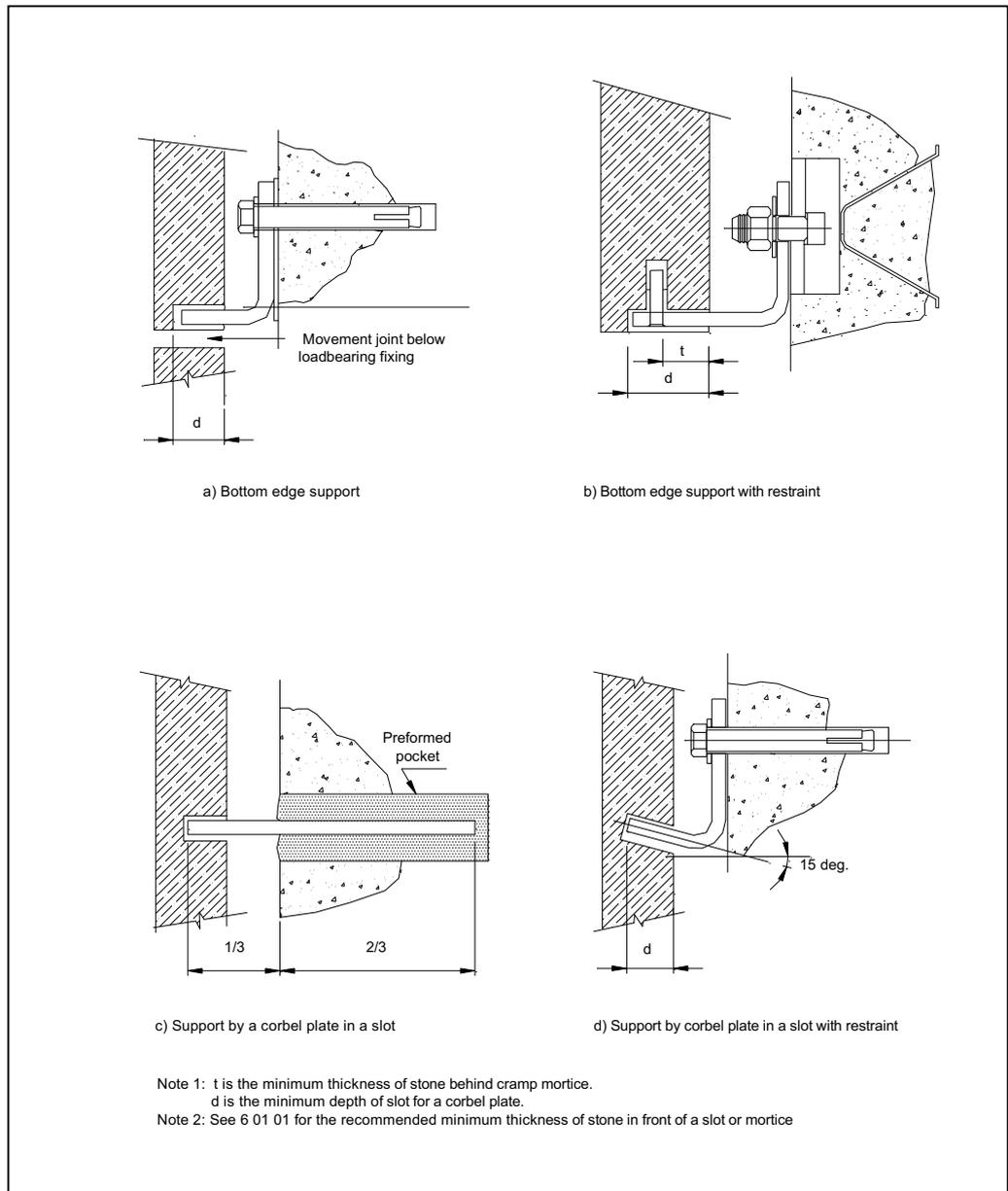


Fig. 4: Details of typical load bearing fixings

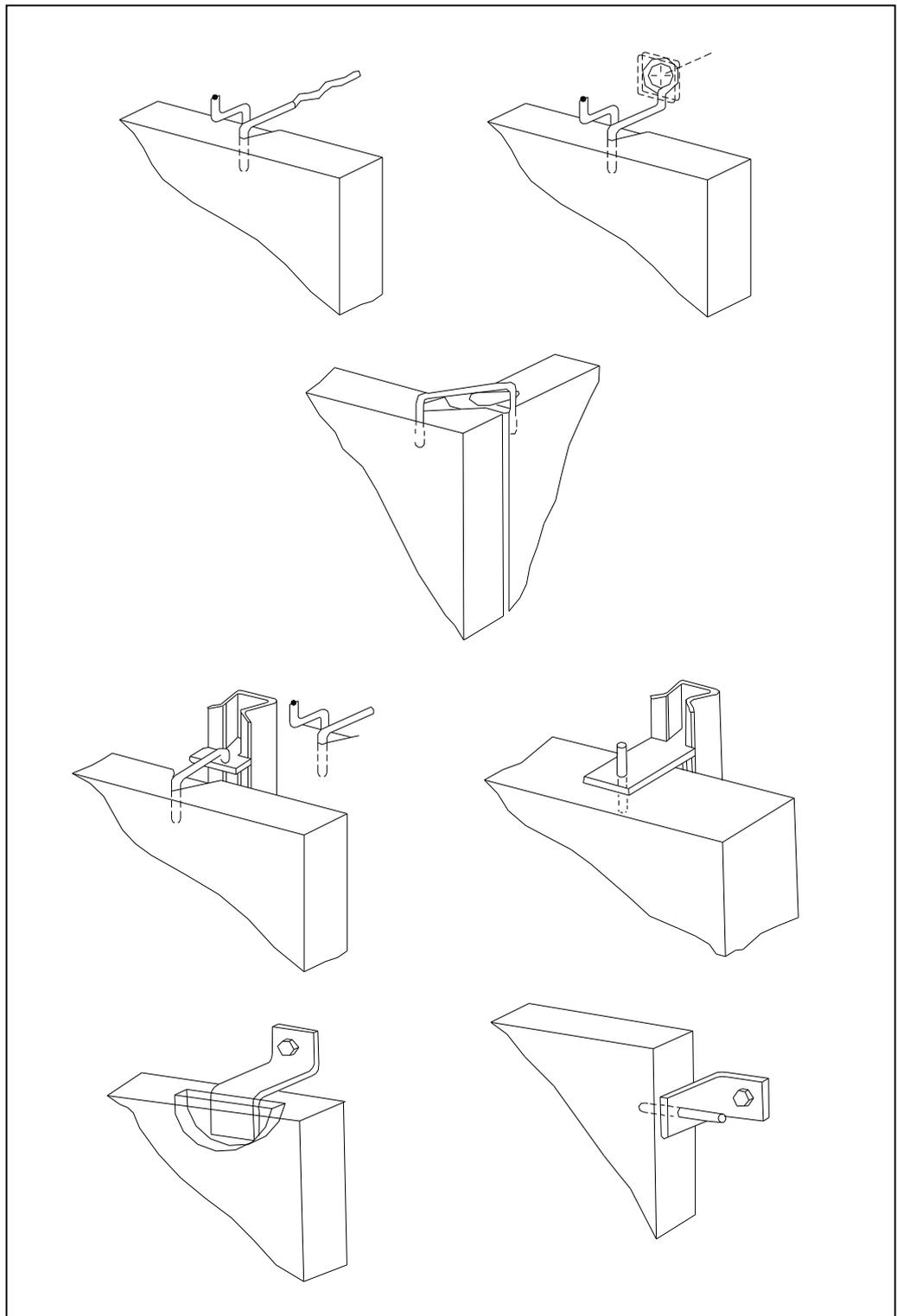


Fig. 5: Illustration of typical restraint fixings

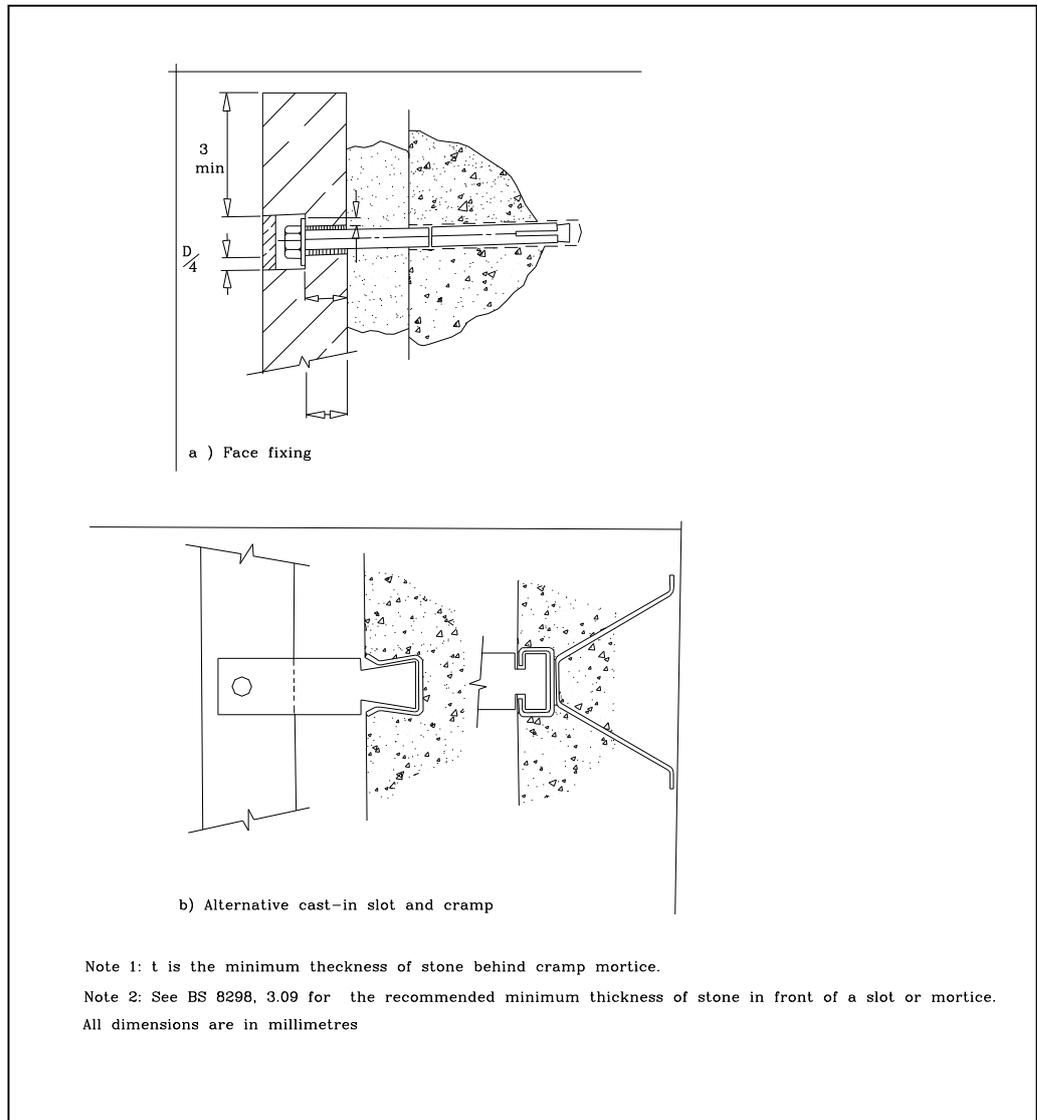


Fig. 6: Details of typical restraint fixings

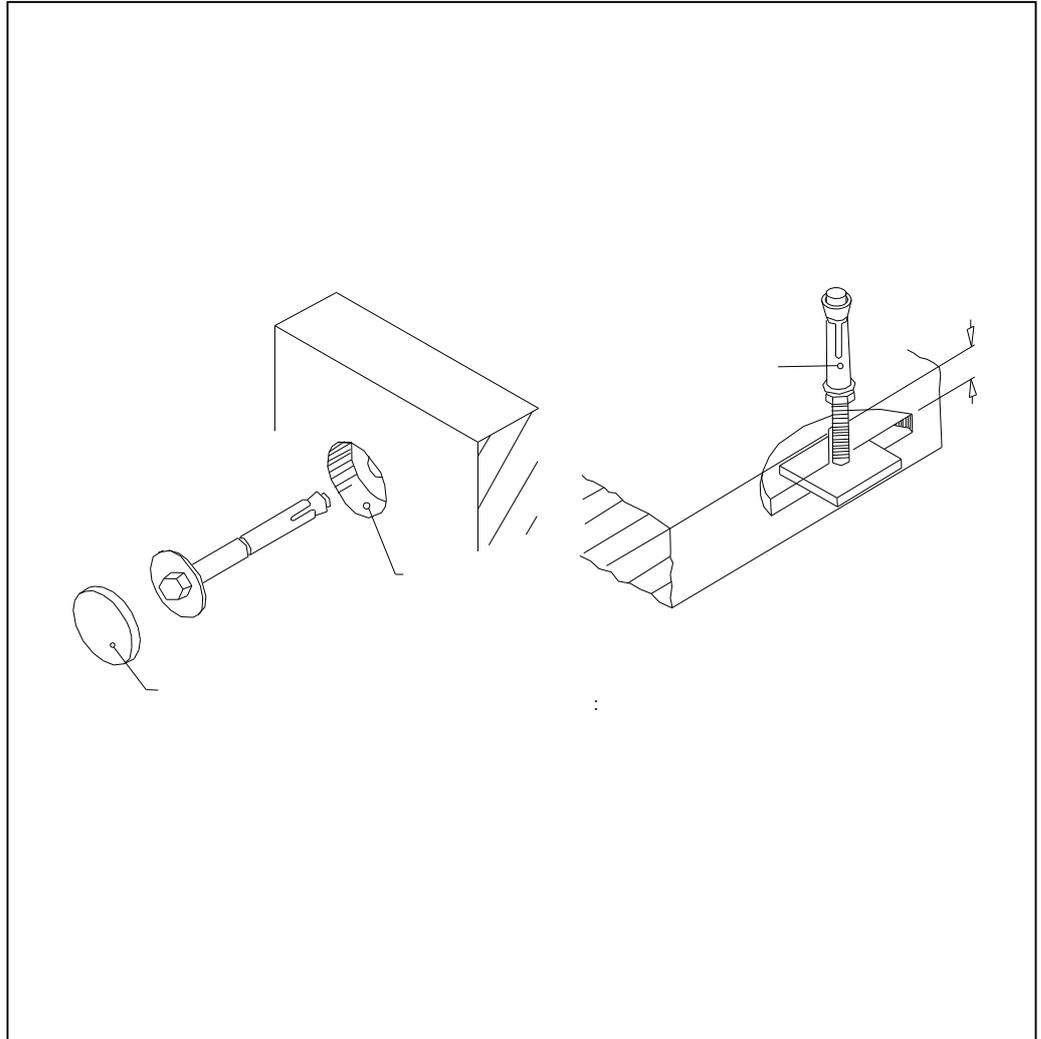


Fig. 7: Illustration of typical face and soffit fixings

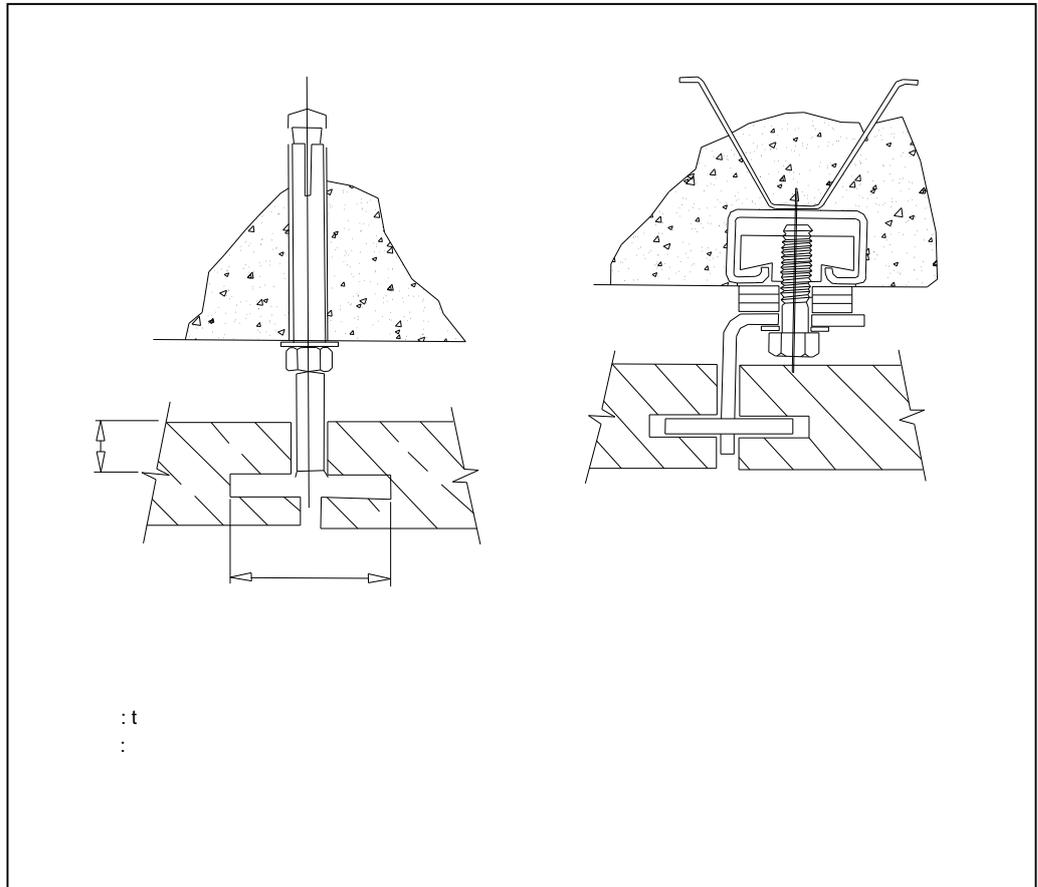


Fig. 8: Detail soffit fixing