

Division 09 - Finishes

Section 09400 - Terrazzo and Natural Stone Flooring

Part 1: General

1 01 Summary

The work covered by this section consists of providing all tools, labour and materials and performing all operations in connection with terrazzo and natural stone flooring for units no greater than 40 mm in thickness and 0,30 m2 in area and monolithic terrazzo.

Unless otherwise indicated, all provisions in this section shall apply equally to internal and external work.

1 01 01 Section Includes

- 01.0 Terrazzo tiles and fittings
- 02.0 Monolithic terrazzo,
- 03.0 Natural stone floor tiles and fittings

1 01 04 Related Sections

- 02500 Paving and Surfacing
- 05810 Expansion Joint Cover Assembly
- 07100 Waterproofing
- 07900 Joint Sealers
- 09300 Tile
- 09450 Stone Facing

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 C 33: 93Standard Specification for Concrete Aggregates
- ASTM C 97: 96Standard Test Method 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: 95Standard Definitions of Terms Relating to Dimension Stone
- ASTM C 170: 90Standard Test Method for Compressive Strength of Dimension Stone
- ASTM C 171: 97Standard Specification for Sheet Materials for Curing Concrete

ASTM C 241:	90Standard Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic
ASTM C 503:	96Standard Specification for Marble Dimension Stone (Exterior)
ASTM C 568:	89Standard Specification for Limestone Dimension Stone
ASTM C 615:	96Standard Specification for Granite Dimension Stone
ASTM C 616:	95Standard Specification for Quartz-Based Dimension Stone
ASTM C 880:	96Standard Test Method for Flexural Strength of Dimensional Stone
ASTM C 1028:	96Standard Test Method for Evaluating the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull Meter Method
ASTM D 4068:	01Standard Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water Containment
ASTM D 4397:	00Standard Specification for Polyethylene Sheeting for Construction, Material, and Agricultural Applications

1 02 01 06 British Standards

BS 747:	00Reinforced Bitumen Sheets for Roofing
BS 882:	83 Aggregates from natural sources for concrete
BS 1199:	76Building Sands from Natural Sources
BS 1278:	99Pigments for the Colouring of building materials based on Cement and/or Lime – Specification and Methods of Test
BS 1521:	72Waterproof Building Papers
BS 4131:	73 Terrazzo tiles
BS 5075:	82Concrete Admixtures
BS 5980:	80 Adhesives for Use with Ceramic Tiles and Mosaics
BS 6213:	82Guide to Selection of Constructional Sealants
BS 8204-4:	93 Insitu Flooring / Code of Practice for terrazzo wearing surfaces

1 02 01 07 German Standards

DIN 4226:	83 Aggregates for Concrete
DIN 18500:	91 Cast stone
DIN 18156 - 2:	78 Materials for ceramic linings by thin mortar bed technique; hydraulic mortar
DIN 18156 - 3:	80Materials for ceramic linings by thin mortar bed technique; dispersion adhesive
DIN 18156 - 4:	84 Materials used for the application of ceramic tiling by the thin bed method; epoxy resin adhesive

1 02 02 Codes

BS 5385-5:	94 Code of Practice for the design and installation of terrazzo tile and slab, natural stone and composition block floorings
BS 8000-11:	89 Code of Practice for wall and floor tiling

1 02 03 Other References

Design Manual IV as published by the Marble Institute of America (MIA)
33505 State Street, Farmington, Michigan 48335

Specifications for Architectural Granite as published by
The National Building Granite Quarries Association (NBGQA),
North State Str., Conrad, NH 03301

Terrazzo Design Guide as published by
The National Terrazzo & Mosaic Association (NTMA)
3166 Des Plaines Avenue, Suite 132,
Des Plaines, Illinois 60018

1 03 Definitions

1 03 01 Technical Terms

Abrasive Hardness (H_a) - value for abrasion resistance. Refers to the wearing qualities of stone for floors, stair treads and other areas subjected to abrasion by foot traffic. (see ASTM C 241)

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.

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

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 finish - 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.

Flamed - see thermal finish.

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 thin mortar to fill the joints

Honed - a satin smooth surface of natural stone with little or no gloss.

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. Recrystallized limestone, compact microcrystalline limestone, and travertine that are capable of taking a polish are included in the category of marble.

Marble - 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.

Marble chips - marble granules screened to various sizes.

Monolithic terrazzo (thin bed terrazzo) - cementitious terrazzo topping poured on a cementitious base.

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

Precast terrazzo - terrazzo fabricated in moulds and finished in shop or factory (e.g. treads and risers), by compression or vibration.

Rustic terrazzo - a surface variation where in lieu of grinding and polishing, the surface is washed with water or otherwise treated to expose the natural stone chipping.

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.

Terrazzo - derived from the Italian "Terrace" and Terrazzo". Terrazzo consists of marble, granite, or if agreed with the purchaser of other natural stone chipping embedded in cement mortar and cured ground and polished to expose the aggregate and provide a smooth hard finish. Typically used as a finish for floors either as precast tiles or poured in place.

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

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.

Wear - the removal of material or impairment of surface finish through friction or impact.

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

1 03 02 Abbreviations

Q.C.

Quality Control

1 05 Submittals

In compliance with conditions of contract and provisions of Section 01300 the following shall be submitted thirty (30) days before terrazzo and natural stone flooring is scheduled to commence.

1 05 01 Product Data

Complete material list and product data for each type of product proposed to be furnished and installed under this section including manufacturer's colour charts showing full range of colours, textures, pattern, and trim units (fittings) available for each type and composition of tile as indicated for initial selection purposes.

1 05 02 Shopdrawings

The following shall be submitted:

01.0Shopdrawings indicating sizes, dimensions, sections of units, arrangements and provisions for jointing, and other details showing relationship with, and attachment to related work.

1 05 03 Samples

Samples of each item, prepared on samples of adequate size and construction, in sets showing full range of variations expected.

1 05 04 Quality Control Submittals

Documented experience of Contractor's site supervisor(s) as indicated under ref. 1 06 01 Qualifications.

Reports and records of examination as indicated under ref. 3 01 Examination.

Reports and records of Contractor's internal Quality Control as indicated under ref. 1 06 04 01.

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 or supplier if necessary.

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

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 tiling work and shall have successfully completed tile installations similar in material, design, and extent to that 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 Q. C. shall include but not be limited to:

Checking suppliers test certificates and certificates of compliance for tiles and all other material delivered to the site prior to first delivery to conform compliance with specifications.

Checking suppliers delivery tickets of each delivery for completeness and compliance with supply order and specification.

Checking correct storage of materials at least every 2 weeks.

Examination of backgrounds to receive tiling as indicated under ref. 3 01 Examination.

1 07 Delivery, Storage and Handling

1 07 01 Packing and Shipping

Delivery, storage and handling shall be so arranged as to minimise handling.

Adequate precautions shall be taken to guard against the possibility of damage.

When delivered to the site, tiles shall be palletised and packaged shrink-wrapped and edge protected by polystyrene wrapping or wooden casings and stored in a clean and dry lockable storage.

Terrazzo tiles shall not be transported and delivered to the site until a period of at least 7 days after pressing has elapsed and shall not be installed earlier than 28 days after pressing.

Sensitive Material (e.g. adhesive, grout, sealant etc.) shall be labelled with date of manufacture, service life, instructions for proper storage and use, and any necessary precaution related to toxicity and flammability.

1 07 02

Storage and Protection

Tiles shall be stored in a clean and dry lockable storage.

Tiles shall be stored off ground and air shall be allowed to circulate around tiles to avoid staining.

Terrazzo tiles shall be vertically stacked face to face. Thin battens shall be inserted between rows of tiles.

Cement and lime shall be stored under dry conditions and used in order of delivery. Cement or lime, which contains air set lumps, shall not be used and discarded.

Part 2: Products

2 01 Terrazzo

2 01 01 Terrazzo Tiles

Terrazzo tiles shall be made from aggregate and cement with two-part mixes (one for base layer and one for facing layer) and shall be hydraulically pressed before curing. Marble powder may be added if appropriate.

The edges of the tile shall be perpendicular to the surface. The planes of the upper and lower surfaces shall be parallel and adjacent vertical edges of square tiles shall be at right angle to each other. All arises shall be sharp and true.

The minimum transverse (flexural) strength shall be 3 N/mm² and the total water absorption shall not exceed 8%. The water absorption of the tile-face shall not exceed 0,4 g/cm² when sampled and tested in compliance with BS 4131.

The maximum dimensional deviation shall be 3 mm in length and width and 6 mm in thickness. However, for each shipment of tiles the tolerances shall not exceed 1 mm for length and width and 3 mm for thickness.

Aggregate for base layer shall consist of naturally occurring materials such as crushed or uncrushed gravel, crushed stone, natural sand or crushed gravel sand and shall comply with one of the following standards:

BS 882, ASTM C 33, DIN 4226.

The nominal tile sizes shall be as indicated.

2 01 01 01 Facing Layer

The facing layer shall be formed as an integral part of the tile and shall be not less than 6 mm after grinding and shall be free from projections, depressions, flakes and crazes.

Cement for the facing layer shall be gray, white or tinted Portland cement shall comply with ISO 680: 90, DIN 1164-1: 94 and DIN 1164-2: 96.

If pigments are used they shall comply with requirements of BS 1014 or shall be certified otherwise as suitable for the intended use.

01.0 Aggregate for facing layer shall be graded marble chipping of adequate hardness, angular in shape as distinct from elongated and flaky,

01.1 max. nominal size: 5 mm,

01.2 max. nominal size: 12 mm,

01.3 max. nominal size: 25 mm,

01.4 final finish: ground and grouted to a fine grit finish.

01.5 final finish: ground, grouted and subsequently re-ground to a fine grit finish.

02.0 Aggregate for facing layer shall be graded natural stone chipping similar to characteristics of marble in compliance with manufacturer's representative sample tile(s):

02.1 max. nominal size 25 mm,

02.2 final finish: ground and grouted to a fine grit finish.

02.3 final finish: ground, grouted and subsequently re-ground to a fine grit finish.

2 01 02 Precast Terrazzo

Shall comply with requirements of ref. 2 01 01 Terrazzo Tiles.

Shapes and dimensions shall be as indicated.

All stair treads shall be provided with at least two (2) shop-fabricated abrasive insert strips of aluminium oxide, silicone carbide (Carborundum) or solid rubber unless otherwise indicated.

2 02 Natural Stone

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 so that the patch does not detract from the appearance.

2 02 01 Marble

2 02 01 01 General

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

Absorption by weight, max.% (ASTM C 97)	0,20 (exterior use)	
	0,70(interioruse)	
Density, min. kg/m3 (ASTM C 97)		2595 (Calcite) 2800 (Dolomite) 2690 (Serpentine) 2305 (Travertine)
Compressive strength, min.MPa (ASTM C 170)		52
Modulus of rupture, min. MPa (ASTM C 99)		7
Abrasion resistance, min. Hardness Ha (ASTM C 241)		10
Flexural strength, min. MPa (ASTM C 880)		7

2 02 01 02 Marble Floor Tiles

Subject to compliance with requirements as indicated for marble, marble floor tiles shall be made from:

- 01.0 imported marble,
- 02.0 local marble for final selection by the Engineer,
- 03.0 final surface finish:
 - 03.1 polished,
 - 03.2 eggshell,
 - 03.3 honed,
 - 03.4 gritted,
- 04.0 minimum thickness unless otherwise indicated: 10 mm.

The nominal tile sizes shall be as indicated.

2 02 02 Granite

2 02 02 01 General

Granite shall have the following physical properties:

Absorption by weight, max. % (ASTM C 97)	0,40	
Density, min. Kg/m3 (ASTM C 97)	2560	
Compressive strength, min. MPa (ASTM C 170)		131
Modulus of rupture, min. MPa (ASTM C 99)	10,34	
Abrasion resistance, min. Hardness Ha (ASTM C 241)		not established
Flexural strength, min. MPa (ASTM C 880)		not established

2 02 02 02 Granite Floor Tiles

Subject to requirements as indicated for granite, granite floor tiles shall be made of:

- 01.01 imported granite,
- 02.0 local granite for final selection by the Engineer,
- 03.0 final surface finish:
 - 03.1 polished,
 - 03.2 eggshell,
 - 03.3 honed,
 - 03.4 fine axed,
 - 03.5 fine rubbed,
 - 03.6 bush hammered,
- 04.0 minimum thickness unless otherwise indicated: 10 mm.

The nominal tile sizes shall be as indicated.

2 02 03 01 General

Limestone shall have the following physical properties:

Absorption by weight, max.% (ASTM C 97)	12	(low-density)
	7,	(medium-density)
	3	(high-density)
Density, min. Kg/m3 (ASTM C 97)	1760	(low-density)
	2160	(medium-density)
	2560	(high-density)
Compressive strength, min.Mpa (ASTM C 170)	12	(low-density)
	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)
	10	(medium-density)

10

(high-density)

2 02 03 02 Limestone Floor Tiles

Subject to requirements as indicated for limestone, shall be made of:

- 01.0 imported limestone,
- 02.0 local limestone for final selection by the Engineer,
- 03.0 low-density,
- 04.0 medium-density,
- 05.0 high-density,
- 06.0 final surface finish:
 - 06.1 fine rubbed,
 - 06.2 sawn,
- 07.0 minimum tile thickness unless otherwise indicated: 10 mm.

The nominal tile sizes shall be as indicated.

2 02 04 Sandstone (quartz-based)

2 02 04 01 General

Sandstone shall have the following physical properties:

Abrasion by weight, max.% (ASTM C 97)	20	(Sandstone)
	3	(Quartzite-Sandstone)
	1	(Quartzite)
Density, min. Kg/m ³ (ASTM C 97)	2160	(Sandstone)
	2400	(Quartzitic-Sandstone)
	2560	(Quartzite)
Modulus of rupture, min. MPa (ASTM C 99)	2,1	(Sandstone)
	6,9	(Quartzitic-Sandstone)
	13,9	(Quartzite)
Abrasion resistance, min. Hardness Ha	8	(Sandstone)
		(ASTM C 241)
	8	(Quartzitic-Sandstone)
	8	(Quartzite)

2 02 04 02 Sandstone Floor Tiles

Subject to requirements as indicated above, sandstone tiles shall be made of:

- 01.0 imported sandstone,
- 02.0 local Saudi sandstone for final selection by the Engineer,
- 03.0 final surface finish:
 - 03.1 fine rubbed,
 - 03.2 sawn,
- 04.0 minimum tile thickness unless otherwise indicated: 20 mm.

Nominal tile sizes shall be as indicated.

2 03 Tile Bedding Material

2 03 01 Cement

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

2 03 02 Sand

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

2 03 03 Water

Water shall be fresh and clean drinking water. Seawater will not be allowed for mixing water.

2 03 04 Adhesive

All adhesive shall be certified as suitable for the intended use.

2 03 04 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 03 04 02 Organic Adhesive

Organic adhesive shall comply with one of the following standards:

BS 5980 type 2 or 4

DIN 18156-Part 3

2 03 04 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 03 05 Admixtures

2 03 05 01 Admixtures to Bedding Mortars

Admixtures to bedding mortars may be air entraining-, water reducing, plasticizing-, or retarding agents and shall comply with BS 5075 or an equivalent standard.

2 03 05 02 Admixtures to Adhesives

Admixtures to adhesives shall be used in accordance with manufacturer's instructions. They shall not be added to any adhesive unless approved by the manufacturer of the adhesive.

2 03 06 Bonding Agents

Bonding agents shall be used in accordance with manufacturer's instructions and shall be certified as suitable for the intended use. They shall not re-emulsify.

2 04 Grout

Grout shall have low shrinkage and appropriate adhesion and shall be suitable for the conditions to be met.

2 04 01 Cement:Sand Grout

See ref. 2 10 03 (Mixes)

Necessary alkali-resistant pigments shall be added to achieve

01.0 white joints

02.0 coloured joints as approved by the Engineer.

2 04 02 Cement:Lime:Sand Grout

See ref. 2 10 03 (Mixes)

Necessary alkali-resistant pigments shall be added to achieve

01.0 white joints

02.0 coloured joints as approved by the Engineer.

2 04 03 Proprietary Grout

2 04 03 01 Cement based Grout

Cement based grout shall consist of factory mixed cement and other ingredients/admixtures to achieve

01.0 white joints

02.0 coloured joints as approved by the Engineer and shall comply with an applicable standard. Clean water shall be added at the job-site to obtain the desired consistency.

2 05 Sealants and Back-up Material for Movement Joints

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

Any sealant used shall match the colour of grout in tiled areas adjoining sealed joints unless otherwise indicated.

2 05 01 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 05 02 Sealant

Sealant shall be:

01.0 Epoxide Polysulphide sealant. (See Section 07900)

02.0 Polyurethane sealant. (See Section 07900)

03.0 Polysulphide sealant. (See Section 07900)

04.0 Silicon sealant (See Section 07900)

2 06 Expansion Joint Cover

See Section 05810 Expansion Joint Cover Assembly

2 07 Separating Layer/Cleavage Membrane

Separating layer/cleavage membrane shall be of:

- 01.0 polyethylene film, thickness > 0,10 mm and shall comply with ASTM D 4397 or ASTM D 4068
- 02.0 building paper to comply with BS 1521 or ASTM C 171
- 03.0 bituminous felt to comply with BS 747

2 08 Material for Tanking

See Section 07100 Waterproofing

2 09 Accessories

2 09 01 Trim Units (Fittings)

All trim units (fittings) shall match the tiles and shall be from the same source unless otherwise indicated.

Type, size, colour and pattern shall be as indicated.

2 09 02 Division Strips

Division strips to separate floor tiles from other floor finishes shall be made of:

- 01.0 brass
- 02.0 extruded aluminium
- 03.0 stainless steel

with integral provision for anchorage to mortar bed or substrate unless otherwise indicated.

Dimension of division strips shall be suitable for the intended use.

2 09 03 Expansion Joint Cover

See Section 05810 Expansion Joint Cover Assemblies

2 10 Mixes

2 10 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 measurement.

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.

Mixes shall comply with BS 5385.

2 10 02 Bedding Mortar Mixes

2 10 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 10 02 02 Cement: Sand Mix bonded to Base

Cement: sand mortar shall be 1: 3 to 1: 4 by volume (1:3,4 to 1:4,6 by weight)

2 10 02 03 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 10 03 Grouting Mixes

2 10 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 10 03 02 Cement:Lime:Sand Grout

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

2 10 03 03 Proprietary Grout

Proprietary grout shall be mixed according to manufacturer's written instructions.

Part 3: Execution

3 01 General Examination

All backgrounds to receive tiling shall be inspected for structural soundness, for existing surface conditions, contamination, and any potentially deleterious material prior to commencing floor-tiling work.

All surfaces to receive floor tiling shall be level and true. Where falls have been incorporated in the base, they shall be examined for correctness.

Where floor tiles are to be bonded to concrete floors by a cement: sand mortar bed on a separating layer, the concrete surface shall be steel trowel finished.

Installation works shall not proceed until satisfactory conditions are provided.

The tiling Contractor shall notify the Engineer in writing of any defects or conditions that will prevent a satisfactory tile installation.

3 02 General Preparation

Before installation commences at least 6 weeks shall be allowed for any cementitious base to dry out.

Provisions shall be made for the completion of all subsidiary works necessary before the application of floor tiles begins i.e. installation of anchors, electrical, mechanical and sanitary installations, and similar items located in or below tiled areas.

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

Any laitance on the surface of the background and contamination by oil, grease wax, dust or any other substances that inhibits adhesion of the tiles or may cause staining shall be removed.

All loose material on the surface of backgrounds shall be removed by suitable professional tools.

The finished floor level shall be established and properly marked in each room or area to receive tiling.

3 03 Installation

3 03 01 General

Tiles shall be laid to pattern as indicated. If no special pattern is required, surfaces to receive floor tiling shall be centred and balanced.

Tile work shall be extended into recesses and under equipment and fixtures to form a complete covering without interruptions.

Tiles shall be closely fit to piping, fixtures and other penetrations so that plates, collars or covers overlap tiles.

Cuts shall only be made where no alternative is possible. Generally, cuts shall be positioned on the outer edges of surfaces.

All joints shall be straight and of even width.

All finished areas and surfaces shall be flat, level and true. The surface shall be true, when checked with a 2 m straightedge, any gap found shall not exceed 3 mm and the straightedge shall not be obstructed.

No greater area of mortar or adhesive shall be applied than can be worked before setting.

Before any fixing, colour and shade variations shall be checked. Variegated tiles shall be thoroughly mixed.

Temperatures in tiled areas shall be maintained at 10 deg. C or more during installation and for at least 7 days after completion, unless higher temperatures are required by referenced standards or manufacturer's instructions.

Expansion joints shall be located in tiled surfaces to coincide and be continuous with structural movement joints.

Additional movement joints shall be positioned where floor tiles abut restraining surfaces such as walls, columns, door frames, pipes, where tiling is continuous across of junctions of different backgrounds. In addition, surfaces exceeding 25 m² shall be bay jointed unless otherwise indicated.

3 03 02 Terrazzo Flooring

3 03 02 02 Terrazzo Floor Tiles

3 03 02 02 01 Cement: Sand Semi-Dry Mix Bedding

The dryness of the mix shall result in less adhesion between the bed and the concrete base that cleavage can occur.

Before the semi-dry mix is laid, the base shall be swept clean and slightly dampened.

The semi-dry mix shall then be spread to a thickness of about 10 - 15% thicker than the final bed thickness and shall be partially compacted, leaving the surface true and flat to the required level; the final bed thickness shall be at least 25 mm.

A slurry of thick, creamy consistency (cement: fine sand 1: 1) shall be applied either to the back of each tile before placing or alternatively on the partially compacted mortar bed.

The tiles shall then be placed and tapped into position by using professional tools (e.g. rubber mallet) with regular and straight joints between 2 mm and 3 mm wide. Full contact between slurried tile backs and mortar bed shall be ensured.

Any surplus bedding material, which may have risen to the surface, shall be removed and the surface washed and tiles completely cleaned.

3 03 02 02 02 Cement: Sand Mortar bonded to Base

The clean and properly prepared concrete slab shall be kept wet for several hours prior to placing the mortar bed.

Within a period of 30 min. before placing the mortar bed, a thin layer of neat cement shall be spread on the concrete surface and brushed to a thin uniform coating.

The stiff, plastic mortar bed shall be applied immediately over the thin cement coating between wooden fillets while the slurry is still wet and shall be levelled, tamped and fully compacted. A slurry of neat cement and water shall be applied to the back of the tiles. Alternatively, the levelled mortar bed shall be dusted with a thin dry cement layer sprinkled with a fine sieve and lightly trowelled assuring that the cement becomes dampen.

The tiles shall then be placed and tapped into position with regular and straight joints between 2 mm and 3 mm wide.

The final bed thickness shall be 15 - 25 mm except for units greater than 500 x 500 mm when the bed thickness shall be 30 - 50 mm thick.

Any surplus bedding material, which may rise to the surface, shall be removed and tiles completely cleaned.

- 3 03 02 02 03 **Grouting**
- Grouting shall not start until the mortar bed has set.
- Joints shall be grouted with white or grey cement as indicated. Pigments shall not exceed 5% by mass.
- Joints shall be completely filled by squeegee until settlement ceases.
- Excess grout shall be removed leaving filled joints flush with the tile surface.
- After grouting, terrazzo tiles shall be thoroughly washed with clean water.
- 3 03 02 02 04 **Grinding**
- Grinding and polishing shall commence after the grouted joints are thoroughly hardened but no sooner than 3 days after grouting.
- The tiled surface shall be mechanically ground to remove surplus grout and to correct any unevenness between adjacent tiles.
- All grinding residues and dust shall be washed off and voids shall be filled with similar grout.
- After 24 hours, the surface shall be re-ground.
- Finally, the surface shall be wet polished to receive
- 01.0 its final finishes as indicated.
- 02.0 a non-slip safe walking surface of 0,5 anti-slip coefficient of friction when tested in compliance with ASTM C 1028.
- 3 03 03 Natural Stone Flooring**
- 3 03 03 01 Marble Tile Flooring**
- 3 03 03 01 01 **Thin Bed Adhesive Bedding**
- Thin bed adhesive bedding shall only be applied, if thickness of tiles is less than 10-15 mm.
- 3 03 03 01 02 **Cement: Sand Mortar Bedding bonded to Base**
- The clean and properly cleaned concrete slab shall be kept wet for several hours prior to placing the mortar bed.
- Within a period of 30 min. before placing the mortar bed, a thin layer of neat cement slurry shall be spread on the concrete surface and brushed to a thin uniform coating.
- The stiff, plastic mortar bed shall be applied immediately over the thin cement coating between wooden fillets while the slurry is still wet and shall be levelled, tamped and fully compacted. A slurry of neat cement and water or a cement-based adhesive shall be applied to the back of the tiles. Alternatively, the levelled mortar bed shall be dusted with a thin dry cement layer sprinkled with a fine sieve and lightly trowelled assuring that the cement becomes dampen.
- 3 03 03 02 Granite Tile Flooring**
- 3 03 03 02 01 **Thin Bed Adhesive Bedding**
- Thin bed adhesive bedding shall only be applied, if thickness of tiles is less than 10-15 mm.
- 3 03 03 02 02 **Cement:Sand Mortar Bedding bonded to Base**
- The clean and properly cleaned concrete slab shall be kept wet for several hours prior to placing the mortar bed.

Within a period of 30 min. before placing the mortar bed, a thin layer of neat cement slurry shall be spread on the concrete surface and brushed to a thin uniform coating.

The stiff, plastic mortar bed shall be applied immediately over the thin cement coating between wooden fillets while the slurry is still wet and shall be levelled, tamped and fully compacted. A slurry of neat cement and water or a cement-based adhesive shall be applied to the back of the tiles. Alternatively, the levelled mortar bed shall be dusted with a thin dry cement layer sprinkled with a fine sieve and lightly trowelled assuring that the cement becomes dampen.

3 03 03 03 Limestone / Sandstone Tile Flooring

3 03 03 03 01 Cement: Sand Semi-Dry Mix Bedding

Before the semi-dry mix is laid, the base shall be swept clean and slightly dampened.

The mix shall then be spread to a thickness of about 10 - 15% greater than that required for the actual bed and thoroughly tamped, compacted and down off to the required level.

Then a slurry consisting of 1 part cement and 1 part fine sand shall immediately spread and trowelled over the bed in an even layer about 2 mm thick. Alternatively, the slurry may be applied to the back of the tiles to combine with the semi-dry mix.

The tiles shall then be placed and tapped firmly in position by using professional tools like a rubber mallet.

The average thickness of the mortar bed shall be about 70 mm. Where falls and cross-falls have to be formed in the mortar bed, the thickness shall not exceed 100 mm. In any case, the minimum thickness shall not be less than 40 mm.

Any bed material brought to the surface at the joints shall be wiped from the face of the tile with a damp sponge or cloth as soon as possible after the tile has been placed in position.

3 03 03 03 02 Cement: Lime:Sand Mortar Bedding

The clean and properly prepared concrete slab shall be dampened immediately before spreading the mortar to prevent excessive absorption of water from the mortar.

In addition, the back of each tile shall be slightly dampened immediately before laying.

The mortar shall be spread evenly between wooden fillets and compacted thoroughly leaving the surface true and flat. A slurry of neat cement and water shall be applied on the back of the tiles. Alternatively, the levelled mortar bed shall be dusted with a thin dry cement layer sprinkled with a fine sieve and lightly trowelled assuring that the cement becomes dampen.

Tiles shall then be laid on the mortar bed to proper positions and pressed in while the mortar bed is still workable with regular and straight joints of about 3 mm unless otherwise specified.

The thickness of the mortar bed shall be 15 - 25 mm except for tiles greater than 500 x 500 mm and thickness greater than 40 mm, the mortar bed shall be 30 - 50 mm.

3 03 03 04 Natural Stone Grouting

Grouting shall not start until the mortar bed has set. Any dust or debris that may have collected in the joint shall be removed.

Joints shall be completely filled by squeegee until settlement ceases.

01.0 Joints in marble and granite flooring shall be filled with:

01.1 cement based grout ref. 2 04 03 01.

01.2 cement: sand grout ref. 2 04 01.

01.3 proprietary grout ref. 2 04 03

02.0 Joints in limestone and sandstone flooring shall be filled with:

02.1 cement: lime: sand grout ref. 2 04 02.

02.2 proprietary grout ref. 2 04 03.

Surplus grout shall be cleaned off from the tile face as work proceeds. Sawdust shall not be used to clean off grout.

3 03 05 Separation Layer/Cleavage Membrane

The concrete base shall be smooth to allow for free movement of the separation layer/cleavage membrane.

The separating sheets shall be loosely laid with a lap of 100 mm minimum to all joints.

3 03 07 Accessories

3 03 07 02 Division Strips

Division strips shall be installed to manufacturer's instructions level and flush with adjacent surfaces unless otherwise indicated.

3 05 Adjusting and Cleaning

3 05 01 Terrazzo

Cleaning of terrazzo shall be carried out after setting, pointing, grouting, curing, grinding and polishing has been finished.

Terrazzo shall be cleaned with water and a neutral sulphate-free detergent certified by the manufacturer as suitable for the intended use.

Greasy deposits may be removed by detergent incorporating an organic solvent or alkaline detergent (pH > 9).

After cleaning, terrazzo surfaces shall be sealed with a sealant certified by the manufacturer as suitable for the intended use to prevent staining. Wax polishes and linseed oil shall never be used.

3 05 02 Natural Stone

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.

After final cleaning a (impregnating and hardening) sealant shall be applied in compliance with sealant manufacturer's instructions.

3 07

Protection

Areas to receive terrazzo or a natural stone finish shall be scheduled as late as possible in the building program in order to reduce danger from damage and contamination.

During the laying operation, tiled areas shall not be accessible except for the tiling operatives.

Completed tiling shall not be subject to traffic for at least seven (7) days unless otherwise recommended by the adhesive manufacturer.

For general protection, the completed areas shall be covered by a heavy Polyethylene sheeting of type that will not stain or discolour the finished surface.

When equipment or other heavy loads has to be removed over finished surfaces, special precaution shall be taken e.g. use of timber planking. However, moving tackle and the protection itself shall not damage the finished surface.

Stair finishing, nosing and other vulnerable constructions 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.

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

4 02 Units of Measurement

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

Coves, decorative strips etc. will be enumerated.

Floor channels will be measured by linear m including outlets, corners, stop ends and the like.

Stair treads and risers will be measured by linear m for each specified type, grade and surface characteristic.

Separation layers will be measured by m². No allowance will be made for measurement of overlapping joints. No deductions will be made for void not exceeding 0,50 m².

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 unit price rate for tiling will include tiling around openings, connections to adjacent components, laid to pattern, falls and cross falls, bay jointing, sloped surfaces, cuttings to holes for pipes, sockets, switches, outlets and the like, fixing templates, preparation of backgrounds including priming, grouting, protecting and cleaning.

The unit price rate for tiling will include all movement joints including structural expansion joints, cleaning, priming, joint filling 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