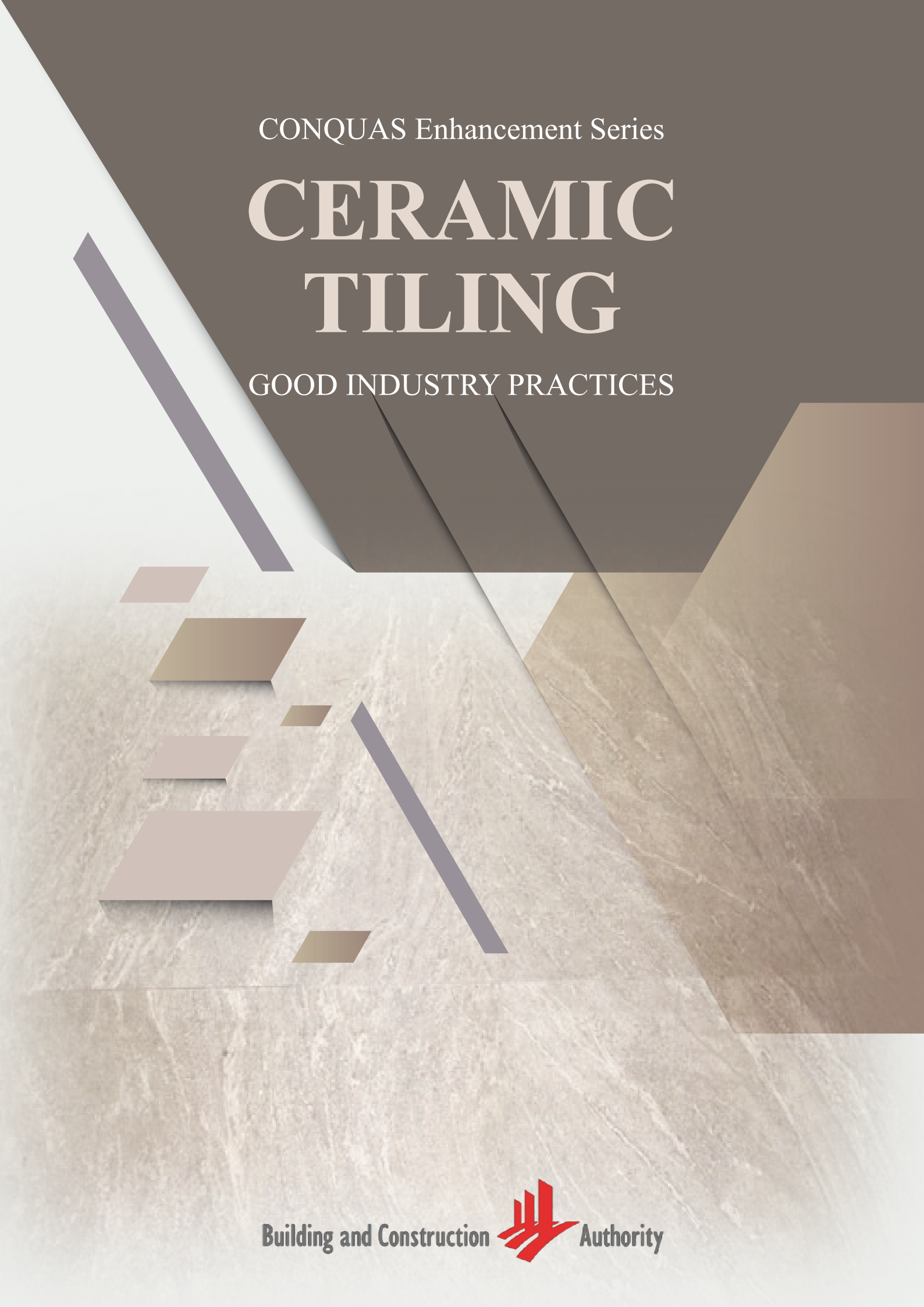
CONQUAS Enhancement Series

CERAMIC TILING

GOOD INDUSTRY PRACTICES



Building and Construction Authority

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FOREWORD

The Building and Construction Authority's (BCA) Construction Quality Assessment System (CONQUAS) has been widely adopted as the de facto national yardstick for measuring the workmanship quality of building projects. To meet rising expectations of homeowners, the Quality Mark (QM) Scheme was launched in 2002 to promote higher consistency in workmanship standards for private residential developments. To help projects achieve the standards in CONQUAS and QM, BCA has developed a series of publications on Good Industry Practices for different trades.

The "Good Industry Practices – Ceramic Tiling" guide is part of the CONQUAS Enhancement Series which shares some of the good practices adopted by practitioners and contractors on how good workmanship quality for ceramic tiling can be achieved on site. It provides simple and practical illustrations on the types of ceramic tiles, quality checks during manufacture and proper installation methods. Common issues associated with ceramic tiling, their causes and possible solutions to address them are also highlighted.

This guide is not meant to be a definitive dictation on how ceramic tiles must be designed and installed. It only serves to illustrate some of the good practices designers and contractors have adopted while designing and installing ceramic tiles. We gratefully acknowledge the contributions of practitioners in the production of this guide and trust that the industry will find this publication useful. We welcome any contributions from readers to further improve any subsequent editions of this guide.

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ACKNOWLEDGEMENT

‘Good Industry Practices – Ceramic Tiling’ was first published in 1999 with a revised edition in 2003. This third edition of ‘Good Industry Practices – Ceramic Tiling’ was developed with inputs from architects, developers, builders, specialist contractors and members of various industry associations and organisations.

A Technical Review Committee was formed to review the contents and good practices identified. We wish to thank the members of the Technical Review Committee for their valuable contributions.

Technical Review Committee for Good Industry Practices – Ceramic Tiling

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Agencies, Organisations and Firms
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CONTENTS

1.0 INTRODUCTION

A ceramic tiling finish is a system comprising no less than substrate, adhesive, stone, grout and movement joints. All components are equally important and intimately related to one another. Adequate compatibility must exist among the components as they could only function collectively. The system could only be as strong as the weakest component, if not worse.

Therefore, design, preparation works, installation, protection and maintenance must take into consideration the performance characteristics of each individual component as well as the in-situ environmental conditions that prevail during the installation process. These considerations are similar for new technologies and materials in Design for Manufacturing and Assembly (DfMA) such as Prefabricated Prefinished Volumetric Construction (PPVC) and Prefabricated Bathroom Unit (PBU). It is recommended to refer to the respective guides for ceramic tiling installation in these technologies.

Due to the volume constraint, this guide will focus on the interior installation of ceramic tiling.

2.0 DESIGN

To achieve good tiling works, it is critical to take into account the material selection besides proper installation and quality control. It is important to understand the characteristics of the selected materials as well as their compatibility with one another to achieve optimal performance.

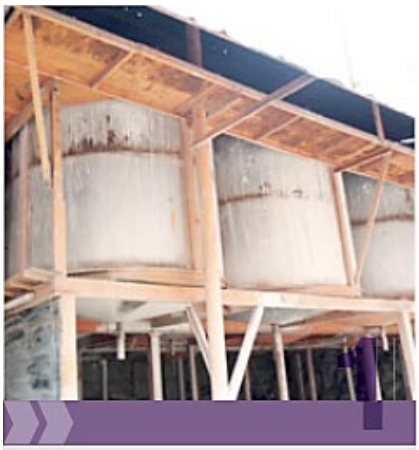
The following design details should be considered:

- Tiles selection
- Adhesives
- Grout joints
- Movement joints
- Waterproofing

2.1. TILE SELECTION

Ceramic tile is a mixture of clay, quartz ferrous sand materials and water. The clays are mined from earth, shaped and then coloured. The clays are then dried and subsequently fired at very high temperature in kilns. Ceramic tile comes in two forms: glazed and unglazed. The primary portion of the tile, known as bisque, can be naturally coloured with highly designed surfaces which can be glazed either in a high gloss or matte finish. Glaze is a liquid glass that is baked onto the bisque. Most ceramic tiles have either a white or red body colouration underneath the glazed finish.

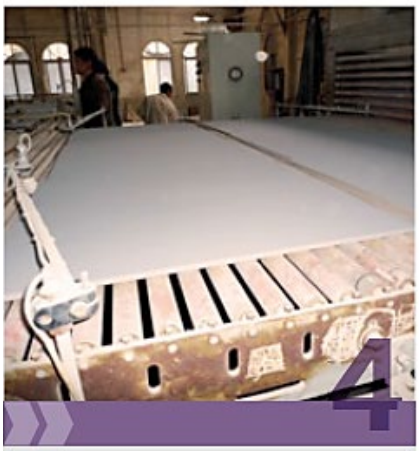
Figure 2.1a illustrates the manufacturing process of ceramic tile extracted from “Design and Material Selection for Quality – Vol 2”.



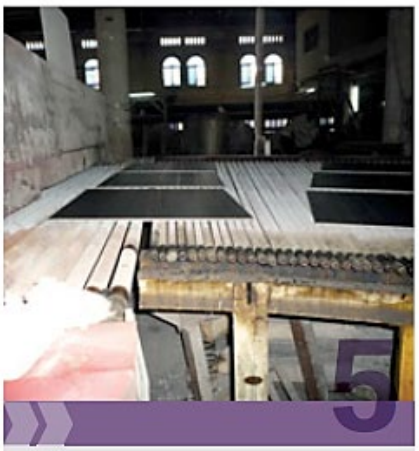
Mix ingredients.

Dry press to make bisques.

1st firing.



Colouring/glazing.



2nd firing.

Mechanical cutting.

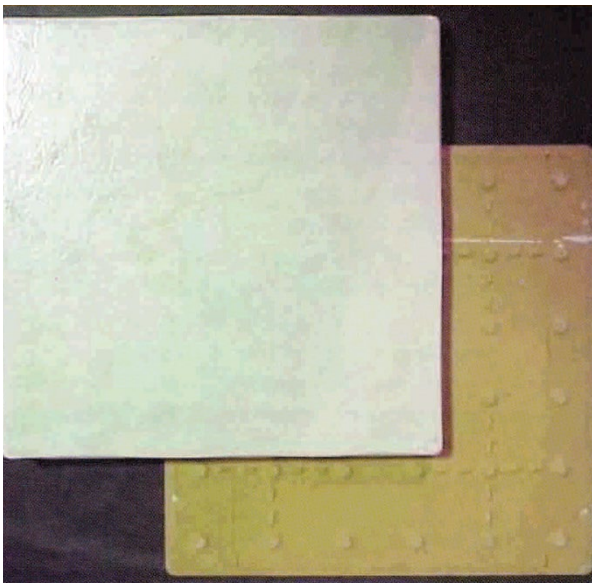
QC Check.

Packing.

Manufacturing process of ceramic tiles
Figure 2.1.a

Fine cracks could appear on the glazed surface when the bisque and glaze expand and contract at different rates. When the cracks show on the surfaces of glazed tiles, it is called crazing. This is a phenomenon caused by tensile stress between the glaze and bisque. In the kiln, if the tiles are fired up to high temperature too quickly or cooled too quickly, it can also result in crazing as a result of thermal shock.

Table 1 (under 2.1.5 - Selection Criteria) of SS 483 shows the classification of ceramic tiles with respect to water absorption and shaping. Dry pressing and extrusion are two common methods in the forming process for tile manufacturing. Dry pressed and extruded tiles can be distinguished from the mechanical keys at the back of the tile as shown in Figure 2.1.b and 2.1.c.



Mechanical key at the back of dry pressed tile
Figure 2.1.b

Mechanical key at the back of extruded tile
Figure 2.1.c

Once the ceramic tile is produced, it will be cut according to the required dimension. Proper equipment are required to cut ceramic tiles.

2.1.1. TYPES OF TILE

The choice of tile depends on the location, functional use of the area and, increasingly in recent year, environmental friendliness. Environmental friendly tiles are certified under the following schemes:

- Singapore Green Labelling Scheme (SGLS), administered by Singapore Environment Council (SEC).
- Singapore Green Building Product (SGBP) labelling scheme, administered by Singapore Green Building Council (SGBC).

The various types of tiles include ceramic tile, porcelain tile, rectified tile, quarry (unglazed) tile, etc.

2.1.2. Porcelain tiles, a type of Homogeneous tiles, are composed of fine porcelain clays and fired at a much higher temperature. This makes the porcelain tiles hardier, less porous and thus more resistant to moisture and stains as compared to ceramic tiles. Porcelain tiles have a consistent colouration and property throughout the entire section of the tile. They are suitable for use in both indoor and outdoor conditions. Porcelain tiles are harder to cut due to their density and hardness.

2.1.3. Rectified tile is defined as a tile that has had all edges mechanically finished to achieve a more precise facial dimension. Unlike a typical factory-edged tile, rectified tile is cut to size after the firing process. This process creates a precise, 90 degree angle smooth edge; as a result, the tiles can be laid with consistent grout joints. Most tiles (both homogeneous and ceramic) may vary in size, after being fired, up to 1.0 % of its size. But the size variations can be substantially minimised through the process of sawing or grinding after the tile is fired.

2.1.4. In recent years, **large format ceramic tiles** were introduced into the market. While ceramic tile is defined as having a surface area not more than 3,600cm^2 with tile edge less than 600mm, large format ceramic tile can be defined as having a surface area of more than 3,600cm^2 and tile edge of less than 1.2m. The thickness of these tiles depend on the type and area of usage. They come in wide varieties of styles and lookalike designs on the surface ranging from concrete, stones to high-polished porcelain. Large format ceramic tiles are available in any style and color that regular tiles come in.

There is another type of large format ceramic tile known as the **large ceramic panel** (Figure 2.1.4). A ceramic panel tile has a surface area of more than 1m^2 with tile edge of more than 1.2m. Thin large format panel can be supplied in 3m length by 1.5m width. They can also be fiberglass reinforced, mechanically cladded and bent.

The constraint of large format ceramic tile is that the wall and floor must be even and level. Therefore, the use of appropriate adhesive and bedding is important. It is recommended to consult an adhesive supplier when choosing adhesive for large format panels. The width of the grout joints must also be compatible with the tile dimension.

Large format panel tile - Size can be as large as 3.6m length 1.5m width and only 6mm thick

Figure 2.1.4

2.1.5. SELECTION CRITERIA

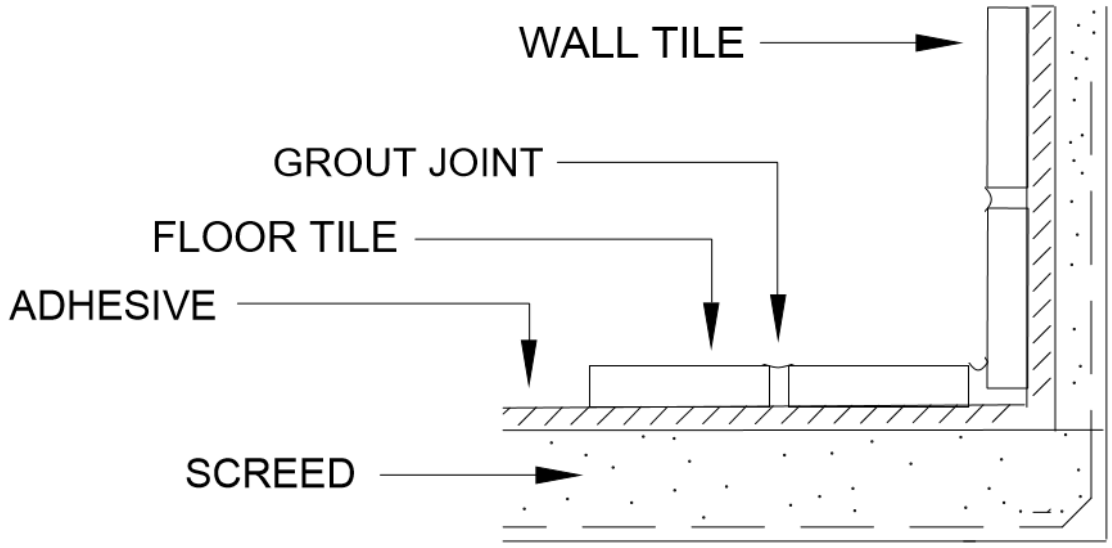
Prior to starting any tiling works, it is important to ensure that the selected tiles are able to meet the project specifications. Table 2.1.5 provides guidance on the selection criteria.

Table 2.1.5: Ceramic tile selection criteria

Ceramic tile selection criteria	Requirements
1. Water absorption	- Water absorption in tiles provide a measure of porosity. A high water absorption value indicates a porous tile body while a low value indicates a compact tile body. - In wet area, tiles with low water absorption should be used.
2. Modulus of rupture and breaking strength	- Modulus of rupture and breaking strength of ceramic tiles give an indication on where the tiles can be used. (Refer to SS 483). - Light loading areas are those where normal low-density pedestrian traffic e.g. domestic and office locations, are likely to occur. - Heavy loading areas are those where high density pedestrian traffic, and/or heavy load, are likely to occur, e.g. in industrial and engineering premises. - Tiles that withstand the required loading need to be selected accordingly.
3. Abrasion resistance	- Resistance to deep abrasion of unglazed tiles for floor should refer to ISO 10545-6. - Resistance to surface abrasion of glazed tiles for floor should refer to ISO 10545-7.
4. Slip resistance	- For safety reason, the slip resistance classification needs to be established based on usage of the location. Reference can be made to SS 485:2011.
5. Crazing resistance	- If soaking of tiles are required, glazed tiles should be tested to confirm that soaking would not lead to crazing should refer to ISO 10545-11.
6. Dimensions and surface quality	- Tiles used should have adequate dimensional characteristics (length, width, thickness, straightness or sides, rectangularity, surface flatness) and surface quality to match the design expectation, e.g. joint width, uniformity and alignment.
7. Thickness	- Generally, thin tiles are more vulnerable to impact damage. - Such floor tiles should have a minimum thickness of 8mm for better functional usage. - Ratio of tile thickness to size should be controlled. Thickness of tile should increase following the increase in tile size to avoid cracks. - Nowadays, bigger tiles with thin thickness are being fabricated with greater breaking strength or impact resistance. - Tiles can be tested for impact resistance in accordance to ISO 10545-5.
8. Special requirements	- Stain resistance should be considered for kitchen and supermarket and should refer to ISO 10545-14. - Chemical resistance should be considered for laboratories, industrial kitchen and chemical processing plant and should refer to ISO 10545-13.

2.2. ADHESIVE BEDDING

Bedding refers to the mortar, or in general terms ‘thin-bed” adhesive, thick bed mortar or levelling bed which is the screed or render (Figure 2.2). The lower and upper limits of the thickness of the adhesive should be specified by the manufacturer. Site personnel should follow the manufacturer’s instructions and apply adhesive only to the specified thickness.



Adhesive bedding
Figure 2.2

2.2.1. TYPES OF ADHESIVE

In accordance to EN 12004/12002 and ISO 13007-1, tile adhesives fall into 3 major categories:

- Cementitious (Type C): Mixture of hydraulic binding agents, aggregates and additives; to be mixed with water or other liquid before use.
- Dispersion (Type D): Mixture of binding agent in the form of polymer dispersion, additives and other mineral fillers which is ready for use.
- Reaction-resin (Type R): Mixture of synthetic resins, mineral fillers and additives in which hardening occurs by chemical reaction.

2.2.2. ADHESIVES SELECTION

Some ceramic tiles are highly absorbent. It is important to select the correct adhesive to ensure its performance, i.e. to limit water absorption from adhesive to the tiles.

There is no single formula of adhesive that is compatible with all types of tiles and substrates. It is important to note that, depending on the formulator’s technical competence and marketing strategy, products belonging to the same type of adhesive could perform significantly differently. Table 2.2.2.a and 2.2.2.b provides suggestions on the selection of adhesives.

Table 2.2.2.a: Adhesive selection criteria

Adhesive selection criteria	Requirements
1. Types of tile	- The adhesive materials should be compatible with the tiles used.
2. Types of substrate	- Different substrate types and their characteristics affect significantly the adhesive selection of the tile finish system. - Table 2.2.4 provides a general guide on different types of substrate.
3. Application properties of adhesive	- The requirement of open time (maximum interval after application at which tiles can be embedded in the applied adhesive) should cater for the site application needs, considering the differences between the site conditions and that of a standard laboratory.
4. Final properties of adhesive	- The requirement of tensile adhesion strengths should suit the worst combination of site conditions and workmanship, considering the tensile strengths after water immersion and after heat ageing as robustness and durability checks.

Table 2.2.2.b: Types of substrate

Types of substrate	Requirements
1. Floor	
1.1 Reinforced concrete floor	- Screeding required. The screed may be bonded or unbonded depending on the flexibility and condition of the substrate. - Pipes and ducts should not be laid within the thickness of a screed.
1.2 Screed thickness	- Nominal thickness of site-batched bonded screed should be 40mm & not < 25mm at any isolated point. - Nominal thickness of site-batched unbonded screed should be 75mm & not < 50mm at any isolated point. Otherwise, the screed should be reinforced with non-oxidising mesh of 100mm centre and 2mm diameter. - For proprietory screed, follow thickness recommended by manufacturer.
2. Wall	
2.1 Masonry walls	- Rendering required.
2.2 Reinforced concrete walls	- If plump satisfies the conditions specified, they may be able to receive tile installation directly. Otherwise, rendering would be required. - A splash coat (typically comprises cement, dry sand and latex in the ratio of 1:1:1 by weight) may be applied before rendering to enhance bonding.
2.3 Aerated precision concrete wall	- If plump satisfies the conditions specified, only suitable primer may be needed. Otherwise, rendering would be required. - If in doubt, it is a good practice to seek the recommendations of the manufacturers to ensure the compatibility of the render/plaster mix with the APC blocks.
2.4 Proprietary partition walls	- Manufacturers should certify the suitability of uses for these proprietary partition walls. - Installation to be in accordance with the manufacturers' instructions.
2.5 Render thickness	- For site-batched render, its total thickness should not be > 20mm, otherwise, strips of non-oxidising ribbed metal lathing should be anchored onto the substrate prior to plastering. - For proprietary render, follow thickness recommended by manufacturer.

2.3. SPECIFICATION OF GROUTS

The joint width of tiles is not just a matter of design preference. The manufacturing tolerance of the tiles should also be considered. For example, when using more dimensionally accurate tiles (e.g. dry pressed tiles), the joint width could be smaller than using dimensionally less accurate tiles (e.g. extruded tiles).

In accordance to BS 5385-3:2014, the width of the grout joint should not exceed the tile thickness. There is a provision for wider joints if wider joints are required to accommodate dimensional irregularities in the tiles, maintain modular control or provide a decorative effect. The depth of the grout joints should be at least 2/3 of the tile thickness.

While the minimum joint widths may be different between the wall and floor tiles, it is a good practice to adopt a uniform joint width for both tiles. This will enable the joints to be consistent and straight throughout the wall and floor tiles.

Grout is the material that is used to fill up the gap between tiles and support the tiles. It is classified into cementitious and reaction-resin types. They should have suitable fineness and consistency that are compatible with the designed joint width, such that grout can fill the joints successfully. Selecting the right type of grout is as important as selecting the right tile and adhesive. Before proceeding, it is advisable to test its compatibility with the tile. Table 2.3 provides guidance on the selection criteria in accordance to BS EN 13888 and ISO 13007-3.

Table 2.3: Grout selection criteria

Grout selection criteria	Requirements
1. Application properties	- Cleaning time (time interval between filling the joints and start cleaning the tiles). - Service time (time interval after which the tiling can be put into service). - Pot life.
2. Shrinkage resistance	- Should be able to prevent cracking. - Any cracking, either in the grout line itself or between the grout and tile, should be considered as failure.
3. Abrasion resistance	- Abrasion resistance is important for floor applications.
4. Compressive strength	- Compressive strength is important for applications.
5. Water absorption	- Water absorption is pertinent to stain cleaning considerations.
6. Chemical resistance	- Chemical resistance can be a key property to certain applications such as industrial kitchen and chemical processing plant.

2.3.1. CLASSIFICATIONS OF GROUT

There are 2 types and classifications of grout in accordance to EN 13888 and ISO 13007-3:-

- Cement-based grout (CG) : available in Sanded Grouts or Non-sanded Grout
  - ❖ Normal Performance (CG1)
  - ❖ Improved Performance (CG2)

- Epoxy-based grout (RG)

Grout is visible and can be water-resistant. However, in most Portland cement based grouts, water or other liquids can still be absorbed into the joints due to its capillary pores. Table 2.3.1 describes different types of grout and applications.

Table 2.3.1: Different types of grout and applications

Types of grout	Description	Application
Cement grout (CG) – Sanded	Consists of fine graded aggregates, Portland cement, synthetic resins and coloured pigments added with water retentive additive. The water retentive additive allows the grout to stay moist until the cement cured.	- Used for larger grout joint - 3mm or larger. - Excellent alternative for natural stone and heavier tiles
Cement grout (CG) – Non-sanded	Consists of very fine filler, synthetic resins, coloured pigment and water retentive additive. The water retentive additive allows the grout to stay moist until the cement cured.	- Used for smaller grout joint - 3mm or smaller. - Easier to apply on dry or vertical surfaces.
Epoxy grout (RG)	Consists epoxy resin, silica fillers, pigments and a hardener. Epoxy grout is waterless mix formed by mixing a base material (part A) and a hardener (part B).	- Ideal for porous and moisture sensitive stones. - Have very low water absorption, higher compressive strength, are resistant to staining and easy to maintain.

2.3.2. GROUT PERFORMANCE CRITERIA

Table 2.3.2.a: Guide on grout performance for CG based on EN 13888 and ISO 13007-3

Fundamental characteristics	Requirement
1. Abrasion resistance	≤ 2000 mm^3
2. Flexural strength	≥ 2.5 N/mm^2
3. Compressive strength	≥ 15 N/mm^2
4. Shrinkage	≤ 3 mm/m
5. Water absorption after 30 minutes	≤ 5 g
6. Water absorption after 240 minutes	≤ 10 g
Additional characteristics	**Requirement**
7. High abrasion resistance	≤ 1000 mm^3
8. Water absorption after 30 minutes	≤ 2 g
9. Water absorption after 240 minutes	≤ 5 g

Table 2.3.2.b: Guide on grout performance for RG based on EN 13888 and ISO 13007-3

Grout performance	Requirements
1. Abrasion resistance	≤ 250 mm^3
2. Flexural strength	≥ 30 N/mm^2
3. Compressive strength	≥ 45 N/mm^2
4. Shrinkage	≤ 1.5 mm/m
5. Water absorption after 240 minutes	≤ 0.1 g

2.3.3. JOINTS AT DOOR AREA

The joints of door frame to floor and wall should be neat, gap-free and consistent (Figure 2.3.1.a). When closed, the gap between the door and floor should be neat and consistent. The joint at floor divider area (Figure 2.3.1.b) should also be neat and uniform throughout.

Neatly cut tile at door frame
Figure 2.3.1.a

Neat joints at floor divider of completed unit
Figure 2.3.1.b

2.4. MOVEMENT JOINTS

Movement joints are provided to accommodate movement in large continuous finished areas, or between adjacent building components (e.g. brick wall and concrete column) and dissimilar substrates. These can be:

- In-situ joints which are formed during construction or sawn cut afterwards, filled with filler board and backer rod, and sealed with a suitable sealant or;
- Pre-fabricated movement joints which are installed prior to the laying of tiles.

The backer-rod material in the movement joint should be compatible with the sealant used. It should be flexible, compressible without forcing sealant out.

The sealant should be capable of accommodating the anticipated amount of movement without loss of adhesion to the sides of the joints and be able to withstand the normal service conditions affecting the installation, e.g. resistance to water and, where applicable, ultraviolet light.

The designer, in consultation with the supplier/manufacturer, are encouraged to specify movement joints and show locations and details on drawings and specifications. Table 2.4 provides guidance on the locations of movement joints and their appropriate joint widths.

Table 2.4: Location of movement joints and their appropriate joint widths

Location of joints	Minimum joint width
1. Structural movement joints should be carried through screed/render, bedding and tile layer. If the joints in the base structure are not straight and parallel, or if their layout does not coincide with that of the floor tiles, guidance should be sought from the designer.	Not less than the existing structural joint widths
2. Where tilework abuts restraining surfaces, such as columns, beams, perimeter walls, curbs, pipes and ceiling.	Interior walls - 3 ~ 5mm Interior floors – min. 5mm
3. At junctions where the substrate changes alignments, such as concave wall corners, or where the substrate changes materials, such as between conventional clay bricks and aerated precision blocks.	
4. At perimeters and to divide floor and wall tiling into bays at the following intervals: • Interior walls at interval of 5 to 6m • Interior floors at the interval of 5 to 7m • Interior floors and walls exposed to direct sunlight at the interval of 3.6 to 7m	

2.5. PLANNING OF TILE LAYOUTS

The designer should prepare tile layouts which take into consideration the minimum joint width and the tolerance of selected tiles.

Tile layout planning should consider the size of tiles used and shape of the area to be tiled. Care should be taken to minimise the number of tiles that need to be cut for satisfactory visual effect. Cut tiles should be placed at less visible corners. They should be of width greater than half of the tile size.

V-Box is used to check tile squareness and size variation before laying, in order to minimise inconsistent joints during installation. While handling the tiles, there should also be visual check for tile defects, damages, stain marks and inconsistent tonality. V-Box can be customized according to the size of the tiles. Figure 2.5 shows the use of V-Box to check tiles squareness and size variations.

V-Box to check tiles squareness and size variations
Figure 2.5

Before commencing any pre-tiling work, it is important to check that all the services are well incorporated and coordinated in the approved shop drawings.

To ensure that the owner's requirements particularly on a project's acceptable tolerances are fully understood, the contractor should construct a mock-up unit for owner's approval before carrying out the actual tiling works. This arrangement enables the main contractor and sub-contractors involved to know the exact level of quality which they are expected to deliver. A mock-up unit will also enable all parties to confirm the layout, detailing and the compatibility of the different materials.

2.6. WET AREAS

Wet areas are areas within a building that are exposed to water splashing or direct wetting. The areas are commonly installed with discharge outlets and provided with water inlet supply. It is important to seek the recommendations of the suppliers when selecting tiles in wet areas.

Gradient in wet areas should be laid to fall in accordance to specification and towards the discharge outlet. Gradient may vary depending on whether the area is enclosed or exposed to weather condition, and space usage. The direction and gradient of the fall must also be planned and indicated in drawings. Insufficient gradient, uneven laying of tiles and lippage in wet area may lead to ponding of water on the tiles.

2.7. WATERPROOFING

Waterproofing refers to the normal protection of the tiles from damages due to both rising damp and direct contact with water, such as in a shower compartment.

Continuous rising damp due to capillary action should be prevented by a proper vapor barrier below floor slab and/or of any damp-proof-course in wall.

A tile finish, even when its joints are filled with impervious grout, cannot stop water from passing through. In wet areas, a waterproofing membrane should always be installed to prevent water penetrating to the neighboring areas and below. The water trapped between the waterproof membrane and the tile layer can only evaporate by passing through the tile layer.

The type of waterproofing material used for wet area has evolved over the years with cementitious waterproofing being used most commonly in recent years. It is easy to mix and apply, and readily available from suppliers. Please follow the manufacturers' instructions to ensure an accurate mix of materials.

For more details on waterproofing in wet areas, refer to Good Industry Practices Guide – Waterproofing for Internal Wet Area, CONQUAS® Enhancement Series.

Waterproofing membrane at wet areas
Figure 2.7

3.0 DELIVERY, HANDLING AND STORAGE

3.1. CERAMIC TILES

The quality of tiles delivered should be similar to the approved samples selected by the owner or the designer. It is important to confirm the country of origin of the tile and to check on the surface appearance of tiles upon delivery to site. No cracks or chip should be found. Dimensions of tiles should be as per project's specifications. To prevent staining during storage, the tiles should be wrapped and stored in their original packages in a dry, firm and level ground. They should be stacked on pallets to prevent damages arising from dampness.

Good site management practice to demarcate material storage areas can improve material management as well as prevent obstruction of access. It is crucial to comply with safety requirement when it comes to stacking of pallets.

The photos below (Figure 3.1.a to 3.1.d) demonstrate good practices for the transportation and storage of materials.

Transporting materials to site
Figure 3.1.a

Offloading materials from lorry crane
Figure 3.1.b

Sending materials for storage
Figure 3.1.c

Storage of ceramic tiles
Figure 3.1.d

It is a good practice to place large format tiles / panels on A-frame to prevent warping (Figure 3.1.e).

Handling and transport using A frame
Figure 3.1.e

The use of frame (Figure 3.1.e and 3.1.f) may be required for the handling and installation of large format tiles.

Handling of large format tile using frame
Figure 3.1.f

3.2. BEDDING, ADHESIVE AND GROUTING MATERIALS

Extra care should be taken to ensure that the bedding materials used are compatible with the tile and substrate. In addition, grout used should be compatible with the tile and tile-bed material. Where necessary, checks should be conducted with the supplier on the suitability of these materials.

Bedding, adhesive and grouting materials should be delivered and stored in the original packaging to ensure that seals and labels are kept intact until time of use. The materials should be protected from damage or contamination by water, moisture, excessive heat, foreign matter or other causes. The package or pallets must not be allowed to rest directly on the concrete or earth surface and should be well elevated from the resting surface to avoid contamination or staining from any foreign objects that may be around the packaging/pallets (Figure 3.2).

Dry and ventilated storage facilities should be provided on site to maintain the temperature range within appropriate levels recommended by the manufacturers.

Proper storage of adhesives
Figure 3.2

4.0 PREPARATORY WORKS

4.1. SURFACE PREPARATION

The surface of substrate to be laid should be free from dirt, dust, oil, grease or other contaminants. All concrete substrates must also be sound and hard with adequate strength to ensure good bond.

Any loose materials must be removed using high pressure cleaner or water jet. The photos (Figure 4.1.a to 4.1.f) demonstrate some surface preparatory works prior to laying of screed or plaster.

Removing concrete protrusion
Figure 4.1.a

Cleaning surface with water
Figure 4.1.b

Cleaning surface with broom
Figure 4.1.c

Checking level of surface
Figure 4.1.d

Checking substrate hollowness
Figure 4.1.e

Checking moisture content
Figure 4.1.f

4.2. LAYING OF FLOOR SCREED/RENDER

4.2.1. FLOOR SCREED

For floor, where screeding is required, pre-packed screed can be considered. It has consistent quality of the mortar mix.

Screed should be allowed to air cure based on the period recommended by the manufacturers before tiling begin. After curing, moisture content should be checked. Permissible moisture content depends on project requirement. Any hollowness or cracks need to be rectified to ensure soundness of the screed. Floor evenness also needs to be checked. It should not exceed a tolerance of more than 3mm gap over 2m prior to tiling work. This tolerance is not accumulative over the entire span of the floor. Self-levelling screed may be required to correct the floor evenness. For a screed thicker than 50mm, a layer of non-oxidising metal-mesh should be considered to be placed in the middle as reinforcement and to reduce occurrence of screed surface cracks. The screeding base shall be air cured for at least 7 days before laying of floor tiles.

The photos below (Figure 4.2.1.a to 4.2.1.e) show the process of the laying of the floor screed.

Provide level pegs to ensure uniform and level surface
Figure 4.2.1.a

Provide level pegs before screeding
Figure 4.2.1.b

Apply a layer of slurry bond coat using brush or roller and lay screed mortar immediately
Figure 4.2.1.c

Levelling the screed to a flat surface with timber/aluminum trowel
Figure 4.2.1.d

Finishing up the screeding works
Figure 4.2.1.e

4.2.2. MOISTURE CONTENT (MC) OF SUBSTRATE

Prior to the installation of ceramic tiles, it is important to ensure that the substrate is thoroughly cured. Substrate could be the floor screed or concrete slab (screedless flooring system). Thorough curing is crucial towards achieving equilibrium relative humidity of the substrate. This minimises movement of moisture between the substrate on the ceramic tiles and joints. If the ceramic tiling is installed onto a substrate that is not completely cured, the moisture movement may cause debonding of cementitious adhesive or staining of joints. There are various methods, be it non-destructive or destructive, to test the moisture in the substrate.

One of the methods is to check the Relative Humidity (RH) of concrete. This is done by drilling a small hole in the substrate based on tester's specification 24hrs before the testing and sealing it up. A reading within the hole 24hrs later will indicate the RH of the concrete. The optimum is to have the RH within the range of 40% to 70%.

Checking of RH by drilling
Figure 4.2.2.a

Checking surface moisture content
Figure 4.2.2.b

The common method used in Singapore is measuring the moisture content of the substrate. This is done by placing the measuring device on the substrate surface. The surface moisture content should be less than 6% or as specified by the tile manufacturer.

4.2.3. WALL RENDER

Cement-sand based render is commonly used. Similar to floor screed, render should be allowed to air cure based on the period recommended by the manufacturers before tiling begins. Checks as mentioned for the floor, similarly, need to be carried out for the wall as well.

Wall rendering, strips of non-oxidising ribbed metal latching should be added if render thickness exceed 20mm.

Allow the rendering to air cure for at least 7 days before placing tiles.

The M&E contractor should identify the concealed services in the wall by marking their locations on the surface of the render. This serves as a pre-cautionary measure to prevent any damages to the concealed services arising from subsequent installation works.

4.3. SETTING OUT TILING

It is important to set out tiles lines (Figure 4.3.a and Figure 4.3.b) according to the approved tiling setting out drawings. Care should be taken to minimise the number of tiles that need to be cut for satisfactory visual effects. Where tile cutting is necessary, the position of cut tiles should be planned and marked before laying tiles. Cut tiles should be placed at less visible corners.

Contractors need to work out in advance the methods to deal with interruptions to surfaces (such as openings).

It is a good practice to allocate switches and power points at the edge of tiles to minimise cutting of tiles.

Wall tile setting out
Figure 4.3.a

Floor tile setting out
Figure 4.3.b

5.0 INSTALLATION

5.1. ADHESIVE BEDDING - MATERIAL PREPARATION

To prevent poor performance and failure, adhesive bedding should be mixed with consistent proportions. When proprietary products are used, the manufacturer's instructions should be followed, especially for the mixing proportions, procedure and slaking time, where applicable.

The photos below (Figure 5.1.a to 5.1.d) demonstrate the preparation process.

Amount of water or liquid latex added according to manufacturer's specs
Figure 5.1.a

Adding powder into the container according to manufacturer's specs
Figure 5.1.b

Mix with electric mixer
Figure 5.1.c

Adhesive mix ready for use
Figure 5.1.d

Table 5.1: Surface preparation for different types of substrates

Type of substrate	Surface preparation	Remarks
1. Masonry surfaces e.g. brick walls	- Check level and render to level.	In wet areas, apply waterproofing membrane before rendering.
2. Reinforced concrete surfaces	- Concrete to cure for 28 days. - Apply screed to level if necessary.	
3. High-precision concrete block surfaces	- If level satisfies, suitable primer may be applied. Otherwise, apply render to level.	If in doubt, seek the recommendations of the manufacturers before rendering.
4. Proprietary partition walls e.g. dry walls	- Manufacturers of these boards should certify their suitability of uses. The boards should be installed in strict accordance with the manufacturer's instructions, especially with spacing and grade requirements of the supporting metal studs to ensure the rigidity of the substrate. Boards and steel frames should be strong enough to take the load of the tiles. - The boards may be coated with a suitable primer to adjust moisture absorption before tile installation. The board manufacturer's instructions should be strictly followed. - The surface boards should be free from contaminations such as dust, laitance, grease, wax, loose or flaking areas etc. - For more details, refer to Good Industry Practices Guide – Drywall Internal Partition, CONQUAS® Enhancement Series.	

5.2. LAYING OF TILES

Adequate lighting must be provided when laying tiles. Tiles that are slightly out of alignment may show up badly when lighting falls on them.

For large format panel or tiles, adhesive should be applied on both the slab and back surface of tile to ensure sufficient and proper coverage for the tiles.

When handling the installation of large format ceramic panel on the wall, an aluminum frame with suction pads is recommended. The use of suction pads on metal frame helps to minimise damage to large format panel/tile.

The photos below (Figure 5.2.a to 5.2.h) demonstrate the process of tile laying for floor.

Cleaning ceramic tile to remove dirt and dust before laying
Figure 5.2.a

Trowelling adhesive with notched trowel
Figure 5.2.b

Adhesive fully trowelled
Figure 5.2.c

Applying adhesive on back surface of tile
Figure 5.2.d

Using mallet to tap on tile for good coverage of tile adhesive between tile's back and floor substrate
Figure 5.2.e

Checking adhesive coverage during tiling
Figure 5.2.f

Checking the evenness and lippage after laying each tile
Figure 5.2.g

Plastic spacer for consistent joint
Figure 5.2.h

The photos below (Figure 5.2.i to 5.2.l) shows the tile laying process for wall tiles.

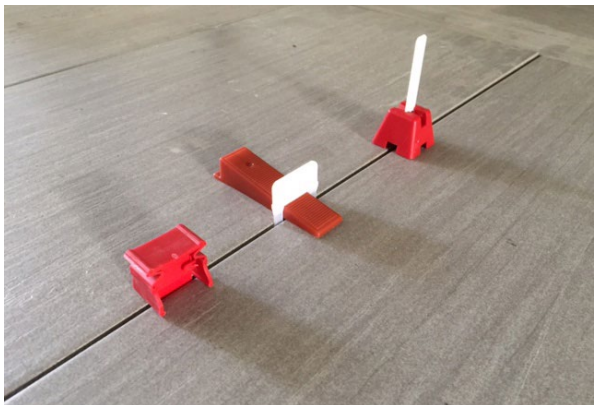
Applying adhesive with notched trowel on wall
Figure 5.2.i

Applying adhesive on back surface of tile
Figure 5.2.j

Installing tile on wall
Figure 5.2.k

Using rubber mallet to tap on tile after laying for uniformity
Figure 5.2.l

To minimise lippages when installing tiles, a suitable tile levelling system should be considered (Figure 5.2.m). Tile levelling system with a 2-in-1 function acting as a tile spacer as well are available in the market. This will help reduce/eliminate the need to level the edges and ensure consistency of the joint width. Such levelling systems can be used to address lippages that may be encountered when laying large format tiles / panel in stretcher bond pattern.



Different types of tile levelling system
Figure 5.2.m

5.3. GROUTING

Grouting can be carried out once the tile adhesive has set. The mixing method and procedure for preparing pre-packed cementitious grout paste should be in accordance to the manufacturer's recommendation. Dry or semi-dry mix should not be used to fill the joints.

Open joints collect dust and deleterious substances and thus reduce the quality of the grouting. Hence, it is advisable to fill up grout joint as soon as possible. To achieve consistency of pointing colour, it is recommended to grout one location e.g. bedroom, kitchen, etc. in one operation using the same mix ratio. The tile joints should be filled completely with the grout paste.

The grout should be given enough time to set. Surplus grout needs to be cleaned off with adequate tools. For most grouting products, a damp hard cellulose sponge and clean water should suffice. Once cleaning process is completed, the grout should be protected long enough for proper setting and hardening before foot traffic is allowed.

The photos below (Figure 5.3.a to 5.3.d) demonstrate the grouting process.

Surface preparation to receive grout mix
Figure 5.3.a

Grout joints to be filled up with grout mix
Figure 5.3.b

Filling of grout joints
Figure 5.3.c

Removal of surplus grout
Figure 5.3.d

5.4. MOVEMENT JOINT INSTALLATION

The depth of the movement joints should be controlled, as specified by the sealant manufacturer, by proper filling material (e.g. polystyrene foam board) and compressible backer-rod with closed pores.

The joints should be sealed by sealant of adequate durability and movement accommodation factor (MAF). It is a good practice to abide strictly to the sealant manufacturer's recommendation.

5.5. INSPECTION OF COMPLETED WORKS

The finished works should be inspected to ensure they meet the client's requirements and standards. Table 5.5 shows the inspection checklist for final inspection of ceramic tiling works.

Table 5.5: Checklist for final inspection of ceramic tiling works

Inspection checklist
1. CONQUAS Assessment – Jointing

1.1 Tile size should be consistent and according to specifications.

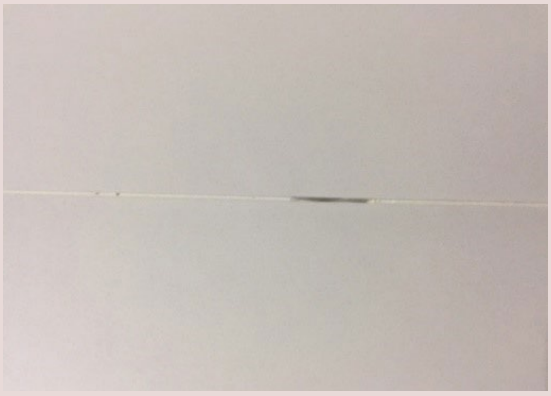
Use of measuring tape to measure tile
Figure 5.5.a

1.2 Joints are aligned and consistent with skirting and wall tiles.

Joints aligned with wall tiles
Figure 5.5.b

1.3 Consistent and neat pointing.

Good pointing works
Figure 5.5.c



Pointing defects – joints not properly filled
Figure 5.5.d

2. CONQUAS Assessment – Finishing

2.1 Mortar stains or paint drips should not be seen.

Good surface finishes
Figure 5.5.e

Paint stains
Figure 5.5.f

2.2 Consistent color tone.

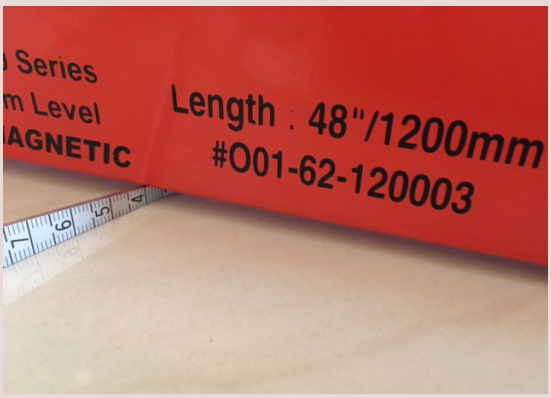
Consistent tonality –
pattern and shades are well blended
Figure 5.5.g

Inconsistent tonality
Figure 5.5.h

3. CONQUAS Assessment – Evenness

3.1 Surface are even (not more than 3mm over 1.2m). For floor, level to proper falls in wet areas like kitchen and toilet. No ponding should occur at any part of the floor.

Evenness not more than 3mm over 1.2m
Figure 5.5.i



Evenness not more than 3mm over 1.2m
Figure 5.5.j

3.2 Lippage between 2 tiles should not be more than 0.5mm.

No lippage
Figure 5.5.k

Lippage between tiles not more than 0.5mm
Figure 5.5.l

4. CONQUAS Assessment – Cracks & Damages

4.1 From distance of 1.5m, no chips, cracks and other visible damages.

Chipping
Figure 5.5.m

Cracks
Figure 5.5.n

5. CONQUAS Assessment - Hollowness

5.1 No hollow sound when tapped with a tapping rod.

Figure 5.5.o

6.0 PROTECTION

The site control of environmental conditions should be maintained after completion of the tiling work, until the longest curing time of the materials has lapsed.

No traffic is permitted on the tile flooring for 4 days after completion. After 4 days, only light foot traffic is permitted for a further 10 days. Protection to floor tiles should be provided immediately after completion and after defects has been rectified and surface cleaned. Works involving heavy impact vibration on areas around the completed area should also be prohibited during the curing process for the materials.

The completed area should be covered with adequate protection to prevent any damage. Stronger protection materials should be used for areas with heavy traffic.

It is also important that contractors communicate and co-ordinate between trades to prevent damages and unnecessary reworks. Establishing a plan for trade working timeframe is useful in achieving an ideal curing process and preventing work conflict between trades.

The protection material is only removed before handing over to property owner.

The photos below (Figure 6.a to 6.d) show some of the good practices for tile protection.

Laying of protection over completed floor tiles
Figure 6.a

Laying of protection over completed floor tiles
Figure 6.b

Laying of protection over completed floor tiles
Figure 6.c

No entry to prevent damages to completed tiles
Figure 6.d

The upturn protection (Figure 6.e) at the perimeter of the wall improves robustness and reduces tearing, staining and damage at the corners. Sufficient overlap of protection sheet is important towards achieving a sound floor protection system.

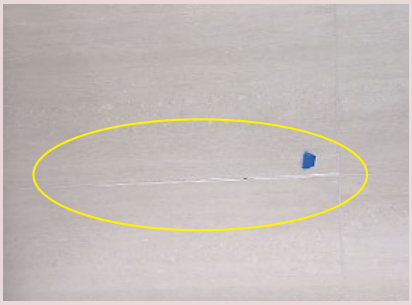
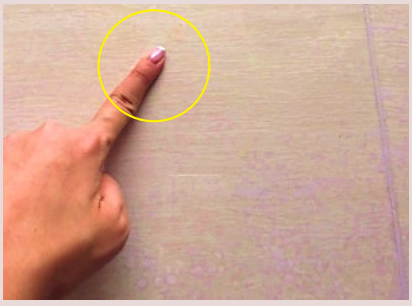
Upturn protection at wall perimeter
Figure 6.e

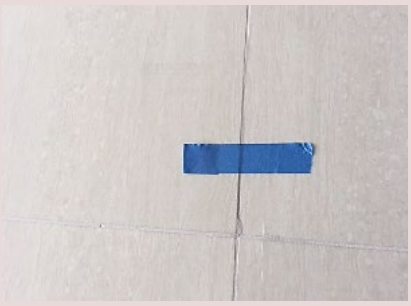
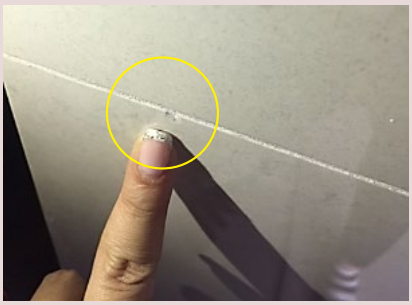
7.0 COMMON FEEDBACK & MAINTENANCE

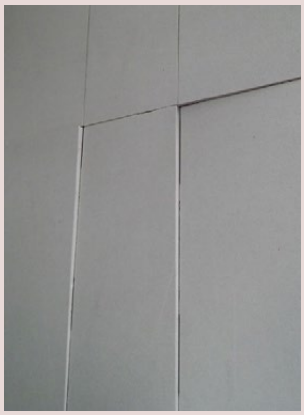
7.1. COMMON FEEDBACK

To achieve good ceramic tiling, all stakeholders should understand the common feedback related to tile installation and how to prevent them. Workers should be skilled and take pride in their craftsmanship. For common issues like lippages and chipped edges, the tiles may have to be replaced or repaired if they are deemed unacceptable by the contractual requirement.

The following are some of the common feedback from owners.

Common feedback	Possible causes	Recommendations
1. Jointing  Dirty joints or bad pointing **Figure 7.1**	• Poor quality of grouts used • Joints not properly filled • Tiles not cleaned after tiling	√ Select suitable grouting materials √ Joints should be properly filled √ Tiled surfaces to be properly cleaned after setting time
2. Finishing  Staining **Figure 7.2.a**	• Possibly stained by other trades if unprotected • Spillage of chemicals • Efflorescence – salts within the tiles or tile-bed or cement-based substrate	√ Ensure proper protection √ Avoid spillage √ Avoid excessive wetting or moisture
 Tonality **Figure 7.2.b**	• Did not sort or dry lay prior to installation	√ Dry lay prior to installation √ Proper labelling √ Installer to double check labels prior to installation √ Establish acceptable tonality range

Common feedback	Possible causes	Recommendations
3. Evenness  Uneven surface or lippage **Figure 7.3.a**	• Tiles with dimensional defects • Varied tile thickness • Uneven substrate or screed • Incorrect bedding thickness • Lack of consideration for curing of bedding material • Insufficient levelling of each tile	√ Select suitable tiles √ Correct tile thickness √ Proper surface preparation √ Use proper tools √ Ensure proper curing √ Ensure tiles are level and even using spirit level
 Uneven surface or lippage **Figure 7.3.b**	• Insufficient tapping of tiles into position • Premature loading onto freshly competed tiling	√ Ensure tiles are uniformly tapped into position √ Ensure proper protection
4. Cracks & Damages  Chipping **Figure 7.4.a**	• Direct impact • Damaged by other trades after laying if unprotected • Poor cutting and handling	√ Ensure proper protection √ Ensure proper protection √ Use proper tools
 Scratches **Figure 7.4.b**	• Damaged by other trades after laying if unprotected • Poor handling	√ Ensure proper protection √ Use proper tools

Common feedback	Possible causes	Recommendations
 Cracked tiles **Figure 7.4.c**	• Inadequate expansion or control joints • Tiles laid over crack • Direct impact • Excessive external vibration	√ Allow movement joints √ Need special treatment √ Proper protection √ Avoid butt joint √ Allow movable joints
 Adhesion failure **Figure 7.4.d**	• Inadequate provision of expansion or control joints • Incompatible tile and bedding material • Concrete or cement / sand screed not properly cured and drying shrinkage cracks occur after tiling • Substrate not properly cleaned and prepared • Contamination of the back of tile by dust and dirt deposit • Incorrect installation of tiles e.g. insufficient tapping of tiles into position or tiles were applied onto the adhesive layer after the “open time” had lapsed • Inadequate provision of mechanical keys in tiles	√ Allow movement joints √ Use suitable materials √ Allow sufficient curing √ Proper surface preparation √ Clean back of tiles before installation √ Follow correct tile installation method √ Allow adequate mechanical key or use appropriate adhesive

Common feedback	Possible causes	Recommendations
5. Hollowness  Hollow tiles **Figure 7.5.a**	• Air entrapped or void in either the setting bed or slab, causing one part of the floor to sound differently than another • Separation of waterproofing membranes installed between a slab and the bedding material • Elevation of subsurface is irregular, causing one part of the floor to sound differently than another	√ Tiles to be properly laid √ Acoustical effect rather than bonding problems √ Tiles to be properly laid

7.2. MAINTENANCE

Prior to handing over the property to the owner, it is important to ensure that the tiles are clean and that there is no grouting haze. Warm water and neutral pH cleaner are recommended for cleaning and regular maintenance.

APPENDIX A

Inspection and Test Plan
Project :
Scope of work :

S/No	Activity	Responsibility	Inspection method	Requirement reference	Acceptance criteria	Initial stage	Records
1.	**SUBMISSION**						
1.a	Shop drawings	MC / D / O	Review	-	Approved	Initially	Approved submissions
1.b	Ceramic tile samples	MC / D / O	Review	Section 2.1	Approved	Initially	Approved submissions
1.c	Adhesive samples	MC / D / O	Review	Section 2.2	Approved	Initially	Approved submissions
1.d	Test reports	MC / D / O	Review	-	Approved	Initially	Approved submissions
1.e	Technical data	MC / D / O	Review	-	Approved	Initially	Approved submissions
2.	**INCOMING MATERIALS INSPECTION**						
2.a	Ceramic tiles	MC / D / O	Visual / measure	Section 3.1	As per approved samples & shop drawings	Each delivery	Delivery dockets
2.b	Adhesives	MC / D / O	Review	Section 3.2	Confirm to specifications	Each delivery	Delivery dockets
2.c	Grouts	MC / D / O	Review	Section 3.2	Confirm to specifications	Each delivery	Delivery dockets

Prepared by : _____	Verified by : _____	Approved by: _____
Date : _____	Date : _____	Date : _____

Legend: **MC – Main Contractor** **D – Designer** **O – Owner**

APPENDIX A

Inspection and Test Plan *(continued)*
Project :
Scope of work :

S/No	Activity	Responsibility	Inspection method	Requirement reference	Acceptance criteria	Initial stage	Records
3.	**IN PROCESS INSPECTION**						
3.a	Check substrate	MC / D / O	Visual / measure	Section 4.1	Surface flat, solid, clean and free of foreign materials	Before laying screed	Checklist @ Appendix B
3.b	Laying screed	MC / D / O	Visual / measure	Section 4.2	Screed level and no formation of cavities	Before laying stone tiles	Checklist @ Appendix B
3.c	Preparing adhesive	MC / D / O	Visual / measure	Section 5.1	Manufacturer's instruction	100% work done	Checklist @ Appendix B
3.d	Laying tiles	MC / D / O	Visual	Section 5.2	Fit tiles neatly and true level	100% work done	Checklist @ Appendix B
3.e	Check tiles surfaces	MC / D / O	Visual / measure	Section 5.5	Within 3mm tolerance per 1.2m or with proper gradient	100% work done	Checklist @ Appendix B
3.f	Check tiles joints	MC / D / O	Visual / measure	Section 5.5	Maintain uniform joint widths	100% work done	Checklist @ Appendix B
3.g	Hold point prior to grouting	MC / D / O	-	-	-	-	-

Prepared by : _____	Verified by : _____	Approved by: _____
Date : _____	Date : _____	Date : _____

Legend: **MC – Main Contractor** **D – Designer** **O – Owner**

APPENDIX A

Inspection and Test Plan *(continued)*
Project :
Scope of work :

S/No	Activity	Responsibility	Inspection method	Requirement reference	Acceptance criteria	Initial stage	Records
4.	**GROUTING**						
4.a	Grout mix	MC / D / O	Visual	Section 5.3	Manufacturer's instruction	100% work done	Checklist @ Appendix B
4.b	Completely fill joints	MC / D / O	Visual	Section 5.3	Smooth and flush on surfaces	100% work done	Checklist @ Appendix B
4.c	Removing surplus grout	MC / D / O	Visual	Section 5.3	Surface is clean	100% work done	Checklist @ Appendix B
5.	**FINAL INSPECTION**						
5.a	Cleaning	MC / D / O	Visual / measure		Surface is clean	At completion	
5.b	Protection	MC / D / O	Visual / measure	Section 6	Finish work is protected	At completion	
5.c	Work acceptance	MC / D / O	Visual / measure		As per specifications	At completion	Inspection records
6.	**WORK HAND-OVER**						
6.a	Rectification works	MC / D / O	Visual	-	-	At hand over	-
6.b	Inspection by owner	MC / D / O	-	-	-	At hand over	-

Prepared by : _____	Verified by : _____	Approved by: _____
Date : _____	Date : _____	Date : _____

Legend: **MC – Main Contractor** **D – Designer** **O – Owner**

APPENDIX B

CHECKLIST FOR IN-PROCESS INSPECTION OF CERAMIC TILING WORKS
Project:
Location:

Checklist	Acceptance criteria/ Requirement reference	Date of inspection	Remarks
Surface preparation			
1. Check age of concrete substrate	- Concrete cure for 28 days		
2. Check substrate surface	- Surface flat, solid, clean and free of foreign materials		
Preparation and laying of screed			
3. Wet concrete surface prior to laying screed	- Surface is in a saturated-surface-dry condition		
4. Lay screed	- Section 4.2		
5. Check screed surface	- Screed is level and no formation of cavities		
6. Moist cured screed	- Screed cured for a duration recommended by manufacturers		
Preparation of adhesives			
7. Check adhesive mix	- Follow manufacturer's instruction		
Laying tiles			
8. Laying adhesive	- Section 5.1		
9. Laying tiles	- Section 5.2		
10. Check tiles surface and joints	- Use spirit level to ensure tiles are within 3mm per 1.2m and joint widths are uniform		
11. After tiles are firm, clean off excessive adhesive	- Surface is clean		
12. Protect freshly laid tiles against stepping	- Section 6		
Grouting			
13. Check grout mix	- Follow manufacturer's instruction		
14. Completely fill joints	- Joints are smooth and flush on surfaces		
15. Removing surplus grout	- Section 5.3		
Protection			
16. Protect completed tiling works	- No traffic is permitted for a duration recommended by the tiles and adhesive suppliers		

REFERENCES

ASTM F2170 - 11 Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs using in situ Probes

DIN 51094:1996 Testing of the light fastness and colour fastness of ceramic tiles for walls and floors

BS 5385-1:2009 Wall and floor tiling. Design and installation of ceramic, natural stone and mosaic wall tiling in normal internal conditions. Code of practice

BS 5385-2:2015 Wall and floor tiling. Design and installation of external ceramic, natural stone and mosaic wall tiling in normal conditions. Code of practice

BS 5385-3:2014 Wall and floor tiling. Design and installation of internal and external ceramic and mosaic floor tiling in normal conditions. Code of practice

BS 5385-4:2009 Wall and floor tiling. Design and installation of ceramic and mosaic tiling in special conditions. Code of practice

BS 5385-5:2011 Wall and floor tiling. Design and installation of terrazzo, natural stone and agglomerated stone tile and slab flooring. Code of practice

BS 8203:2001+A1:2009 Code of practice for installation of resilient floor coverings

BS 8204-1:2003+A1:2009 Part 1: Concrete bases and cementitious levelling screeds to receive floorings. Code of practice

EN 12004:2007 Adhesives for tiles – Definitions and specifications

EN 13501-1:2007+A1:2009 Fire classification of construction products and building elements. Classification using test data from reaction to fire tests

EN 13888:2009 Grouts for tiles – Definitions and specifications

ISO 13007-1:2014 Ceramic tiles - Grouts and adhesives - Part 1: Terms, definitions and specifications for adhesives

ISO 13007-3:2014 Ceramic tiles - Grouts and adhesives - Part 3: Terms, definitions and specifications for grouts

ISO 10545-3:1995

Ceramic tiles – Determination of water absorption, apparent porosity, apparent relative density and bulk density

ISO 10545-5:1996
Ceramic tiles – Determination of impact resistance by measurement of coefficient of restitution

ISO 10545-6:1995
Ceramic tiles – Determination of resistance to deep abrasion for unglazed tiles

ISO 10545-7:1996
Ceramic tiles – Determination of resistance to surface abrasion for glazed tiles

ISO 10545-10:1995
Ceramic tiles – Determination of moisture expansion

ISO 10545-11:1994
Ceramic tiles – Determination of crazing resistance for glazed tiles

ISO 10545-13:1995
Ceramic tiles – Determination of chemical resistance

ISO 10545-14:1995
Ceramic tiles – Determination of resistance to stains

ISO 10545-17
Ceramic tiles – Determination of coefficient of friction

SS 483:2000 Specification for ceramic tiles – definitions, classification, characteristics and marking (Please note that as of October 2017, SS 483:2000 has been withdrawn. Compliance to the standard would be determined by the enforcer, regulator or the specifier.)

SS 485:2011 Specification for slip resistance classification of pedestrian surface materials (Please note that as of October 2017, SS 485:2011 is under review. Compliance to the standard would be determined by the enforcer, regulator or the specifier.)

SS CP 68:1997
Code of Practice for ceramic wall and floor tiling

Note

CONSTRUCTION QUALITY ASSESSMENT SYSTEM (CONQUAS®)

The Construction Quality Assessment System (CONQUAS®) is an assessment service offered by BCA to assess the quality of workmanship of new building projects.

CONQUAS® is an assessment standard for all new Public Sector projects under the Bonus Scheme for Construction Quality (BSCQ). This scheme gives direct incentive to construction companies for achieving good quality work. For Private Sector projects, CONQUAS® is also used by the developers as the quality yardstick for their projects.

The CONQUAS® assessment scope covers structural, architectural and M&E works. Structural works are assessed throughout the construction period during the superstructure stage while architectural and M&E works are assessed during and after the completion of the project.

Applications must, therefore, be submitted before the commencement of superstructure works. Projects that are eligible for CONQUAS® are:

1. All new public building projects. It is also applicable for public projects with combination of new building works and demolition, upgrading, addition & alteration, renovation and conservation works if the contract value for the new building works is at least S$5 million.
2. Private projects with CONQUAS® requirement under URA/SLA/HDB/JTC land sales agreement and;
3. All other new private building projects.

Fees are charged base on the Gross Floor Area (GFA) of the projects and payable upon acceptance of application.

CONQUAS® is a registered trademark in Singapore, United Kingdom, Australia, South Africa, PRC, Hong Kong SAR, Malaysia, India and Thailand.

BCA QUALITY MARK

BCA QUALITY MARK FOR GOOD WORKMANSHIP SCHEME

The BCA Quality Mark for Good Workmanship scheme was launched on 1 July 2002 to help developers meet the rising expectation of Singaporeans for better quality homes. Aimed to encourage developers to consistently deliver quality homes, over 89,000 residential units from various major developers have been committed to the scheme since its launch.

Under the Scheme, BCA will assess the workmanship quality of the internal architectural finishes of every unit of newly completed residential projects. The assessment will cover all locations within the units (bedrooms, bathrooms, kitchen, living & dining rooms, balconies, utility yard, where applicable). In addition, the assessment will include water ponding test for all internal wet areas like bathrooms/toilets and RC flat roofs, in-process inspection on key trades and optional BCA Watertightness Test on windows.

The Quality Mark for Good Workmanship will be issued to individual apartment unit that achieves the stipulated quality workmanship standard (a minimum CONQUAS® score for internal finishes) set by BCA. The Quality Mark certifies the condition of the apartment unit at the time of inspection. Any unit that fails to achieve the standard will not be issued the Quality Mark.

ELIGIBILITY FOR THE QUALITY MARK SCHEME

The voluntary scheme is open to developers and builders that meet the following criteria:

a. Participated in CONQUAS® for earlier projects. Those projects will have to meet a minimum CONQUAS® score stipulated by BCA;
b. Completed full unit assessment for at least one project (not required if the builder has prior Quality Mark experience); and
c. Projects that undergo such unit assessment will also need to be subjected to CONQUAS® scoring.

For further enquiries and application details, please contact the following officers from Quality and Certification Department:

CONQUAS®
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BSCQ
Ken Ho — Tel: 6730 4496 — Email: ken_ho@bca.gov.sg

QUALITY MARK
Linn Naing Win — Tel : 6730 4488 — Email: linn_naing_win@bca.gov.sg

CONQUAS® / BSCQ / QUALITY MARK
Enquiry — Tel : 6730 4400

For more information you can visit our website at http://www.bca.gov.sg.
Click on IQUAS>CONQUAS or Bonus Scheme for Construction Quality or Quality Mark

For more information on the CONQUAS and Quality Mark performances of developers and contractors, please visit our **Quality Housing Portal** at https://www.bca.gov.sg/Professionals/iquasscorechart/

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