

### **Building External Finishes – Wet-fixed Tiles**

Building external finishes protect external building elements from weathering and, at the same time, enliven the aesthetic outlook of buildings. There are a variety of systems and forms of such external finishes. Ceramic or mosaic tiles wet-fixed on cement-sand mortar rendering are one of such system/form, which are commonly used in Hong Kong.

2. Incidents of tile detachments in the past had highlighted the importance of proper installation of external finishes to the concrete substrate. This practice note promulgates guidelines and good practices for the design and construction of wet-fixed tiles for building external finishes. Authorized Persons (AP), Registered Structural Engineers (RSE) and Registered General Building Contractors (RGBC) are strongly advised to follow these guidelines and practices if wet-fixed tiles are used for external finishes to their buildings, so as to achieve a minimum safety standard with a view to minimizing detachment.

#### **Design and Construction**

3. While the quality of contemporary tiling products/systems is improving, their proper installation depends very much on the availability of proper design and good workmanship. AP and RSE should therefore make provisions for proper design and specifications for tiling works to suit each building, and RGBC are advised to ensure that their trade-tested workers are properly trained by the manufacturer to specific requirements of the proprietary products before carrying out tiling works such that the required standards can be achieved.

4. General guidelines and good practices for the design and construction of external finishes, as well as quality assurance and supervision for external finishes works are provided in Appendix A to this practice note. Reference should also be made to the standards listed in Appendix B, which are relevant to external rendering and tiling works.

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## **Maintenance**

5. Tiling should be regularly inspected for any possible defect on the tile surface or joints, which could occur as a result of building movements or climatic changes. Such defects could lead to water penetration and should be rectified before they become worse. It is also strongly recommended that AP and RSE should inform owners of new buildings to arrange for debonding monitoring survey at periodic intervals. An effective means to conduct such survey is by hammer tapping supplemented, as appropriate, with an infra-red thermographic scanning and/or other void detection techniques conducted by specialist on the external finishes.

## **Alternative**

6. Apart from the guidelines promulgated in this practice note, alternative solutions may exist and new products are continually being developed and become available in the market. AP/RSE/RGBC are reminded to exercise their own professional judgment when following these guidelines or other alternatives available in the market.

7. A similar practice note has been issued to all Registered Contractors.

( H W CHEUNG )  
Building Authority

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## **General Guidelines for the Design and Construction of Wet-fixed Tiles for Building External Finishes**

Wet-fixed tiles are normally adhered to the rendering via a bed of proprietary adhesives or cement sand slurry, whilst the rendering is bonded to the external walls of buildings via spatter dash and/or bonding agent.

### **Design Consideration**

2. Thermal effects, water penetration and pollution are the major factors to be considered when choosing suitable materials for both the tiles and the tile bedding, and in designing the movement joints in terms of maximum spacing and width. Wide enough joints, usually 8 mm to 10 mm but in any case not less than 3 mm, should be provided between the tiles to enable the insertion of grout to curb water collection and dirt penetration at possible voids or cavities.

### **Substrate Preparation and Application of Spatter Dash/Rendering**

3. The substrate must be rigid and sound. For concrete surfaces, the weakness of substrate is often due to the presence of honeycombs or loose particles not properly remedied/removed prior to the application of rendering. Substrate with dirt, oil, grease, loose particles, dust, paint and efflorescence etc, that is not properly cleaned up also impairs its bonding with the rendering. It is important that the substrate should be dampened, but should not be too wet at the time of rendering.

4. To achieve good bonding, all undesirable materials should be removed before applying spatter dash or rendering, and spatter dash should be applied onto the substrate preferably within 24 hours after striking off of formwork. RGBC should, in consultation with the AP and RSE, prepare suitable remedial measures (including the application of bonding agent) when spatter dash is not applied within this period of time.

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5. Sufficient time for the drying out and initial shrinkage of concrete substrate is important in enabling good bonding of rendering. A period of six weeks is recommended for this purpose. If an intermediate substrate, e.g. an additional layer of rendering, is required, each layer should be given ample time, normally several days or according to the manufacturer's recommendation in case proprietary product is used, to permit drying and shrinkage to take place before the subsequent coat is applied, while the final coat should be cured and left to dry for at least two weeks.

6. The thickness of each coat of rendering should not be less than 8 mm nor greater than 16 mm, and the total thickness should not be more than 20 mm. In case proprietary product is used, the thickness of each layer and the total thickness of rendering should follow the manufacturer's recommendation.

7. Particular attention should be paid where the surface of substrate is undulating, and rendering so applied may be uneven or excessive in thickness. This may give rise to variable stresses and may cause debonding. Under such circumstances, the incorporation of suitable reinforcement or expanded metal lathing anchored to the concrete substrate should be considered. The utilization of a proprietary adhesion system with additives in the rendering may also help.

8. As a good practice, and wherever practicable, tiling installations should work downwards, i.e. from higher points towards lower points of construction. This would not only give sufficient time for drying and shrinkage, but also ensure that deformation due to loadings from additional storeys have taken place before the wall tiles are applied. Since the rendering receiving the wall tiles plays a crucial role in the bonding/debonding of the building external finishes, the cement-sand mortar rendering should be examined and tapped to detect signs of debonding, if any, and the defective rendering should be rectified before the installation of the wall tiles.

### **Mechanical Keys**

9. Mechanical keys should be provided to prevent the rendering material from sagging or sliding during application. Spatter dash is an effective form of mechanical keys. Other forms of mechanical keys such as mechanical scratching and bush hammering to concrete substrate surface may also be considered.

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10. The use of projected horizontal fins to subdivide the external tiles in panels of reasonable size to provide extra support to the self-weight of external rendering and tiles is a good practice, and its application is encouraged whenever practicable.

### **Movement Joints**

11. At the time of rendering, adequate movement joints to the full depth of the rendering should be formed in tiling works. They should be sealed up with suitable sealants.

12. Movement joints should be provided between panels at regular intervals to allow for thermal movements.

13. Movement joints should also be provided where tiling works abuts restraining surfaces, over construction joints, control joints or movement joints in the substrate structure. Expanded metal lathing should be fixed over the cold joints before rendering.

### **Selection of Materials**

#### *Tiles*

14. Tile materials should be compatible with the substrate and rendering, carefully handled and not be contaminated. The choice of tiles should be considered in conjunction with the adhesive system to be used. Tiles with poor water absorption are not recommended for use as external wall finishes. Should it be used, special polymer modified adhesive should be applied in accordance with the recommendations of the manufacturers, so as to ensure good and durable adhesion between the tiles and the rendering. If in doubt, tests should be carried out to confirm the compatibility of the tiles and the rendering system before the actual commencement of works.

15. Tiles should also be carefully selected in terms of size and thickness. The weight of tile should be controlled and considered in the design. Tiles with size larger than 0.1 m<sup>2</sup> should be secured by mechanical means.

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16. When proprietary tile adhesive is used, both the tiles and the rendering should not be too wet, else the bonding strength cannot be developed. Where ceramic tiles and cement slurry are used, the tiles should be soaked in water for a minimum of 30 minutes, stacked to drain off the surface water immediately before tiling. The rendering receiving wall tiles should also be dampened. Ceramic tiles for external use up to first floor height should have water absorption not more than 0.5% while those above first floor height should have water absorption of not more than 3%. Where pre-grouted paper-faced mosaic tiles are used, the adhesives should cover the entire area of each tessera.

#### *Bonding agent/cement sand mortar rendering*

17. Where bonding agent is used, it should usually be mixed with cement and sand before it is applied onto the substrate. Bonding agent should also be used as an admixture to the cement sand mortar, for better result, before the mortar is applied onto the substrate. This would improve its compressive and tensile strength, and also allow the mortar to be applied in thinner sections, thus reducing the weight of the construction. Recommendations provided by the manufacturers should be followed when using these bonding agents.

18. Pre-mixed and pre-packaged products such as dry mix rendering should preferably be used when high performance standards and bonding strength are required. Special chemical additives in suitable proportions are sometimes used in good quality dry mix rendering to enhance the performance. Recommendations provided by the manufacturers should be followed when using these products.

#### *Sealants*

19. 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 its intended function, i.e. providing resistance to water and ultraviolet light.

#### *Grouts*

20. Tile grout is an integral component of an effective tiling adhesive system. Grouts should have good working characteristics, low shrinkage and good adhesion to the sides of the tiles, while being able to be cleaned off the face of the tiles. The grout should preferably be of type CG2 in accordance with BS EN 13888:2002.

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21. Grouting should commence as soon as possible after tiling is completed and the adhesive bedding has hardened sufficiently.

### *Reinforcement*

22. Metal reinforcement should be of austenitic stainless steel wire. The wire should preferably be 2.5 mm in diameter welded into mesh size of approximately 50 mm x 50 mm. Fixings should be of austenitic stainless steel. Galvanized reinforcement is only suitable for limited areas in sheltered locations and is not recommended to be used externally or at locations constantly exposed to moisture.

### **Alternative Pre-cast Method for Tile Installation**

23. Off-site pre-cast method for tile installation has recently gained popularity for better quality control available in a factory environment rather than with on-site installation.

### **Quality Assurance and Supervision of External Tiling Works**

24. RGBC are advised to ensure that their workers are properly trained and trade-tested for tiling works. In this connection, relevant training courses and trade tests are provided by the Construction Industry Council Training Academy (CICTA) of the Construction Industry Training Board (CITB) and other approved organizations.

25. RGBC should, based on the provided specification and in consultation with the AP and RSE, develop detailed method statements, quality assurance and testing procedures, including the level and degree of supervision to be provided for the tile installation works at an early stage of a project to demonstrate how the performance requirements and standards of workmanship can be achieved. RGBC are advised to ensure that their trade-tested workers are properly trained by the manufacturer to specific requirements of the proprietary products before carrying out tiling works such that the required standards can be achieved.

26. RGBC are responsible for providing qualified / experienced personnel on site to supervise the carrying out of the external rendering and tiling works as specified, including the preparation of the concrete substrate, the application of rendering, the provision of effective mechanical keys and movement joints, and the application of external finishes. AP/RSE should carry out audit checks on the level and degree of supervision provided by the RGBC.

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## **On Site Pull-off Tests**

27. External wall tiles should undergo on-site pull-off test to confirm that they will perform satisfactorily. RGBC should, based on the provided specification and in consultation with the AP and RSE, develop the pull-off test proposal, the acceptance criteria and non-compliance action plan prior to the commencement of the tiling works. The sampling rate of the pull-off test should be at least three samples of each type of wall tiles for every ten typical floors or part thereof for a building block when tiles are fixed on rendering over concrete substrate or direct on concrete substrate or fixed with slurry on rendering over concrete substrate, and the location of each sample should be selected by the AP/RSE. These samples should not be taken from tiles installed over waterproofing layers.

28. On-site pull-off tests should be carried out by a laboratory which is accredited under the Hong Kong Laboratory Accreditation Scheme (HOKLAS) for the particular test concerned. Test results should be reported on a HOKLAS Endorsed Certificate. A Directory of Accredited Laboratories in Hong Kong is obtainable from the Hong Kong Accreditation Service (HKAS) Executive, Innovation and Technology Commission. Up-to-date information on accredited laboratories and their scopes of accreditation are available on the HKAS website at <http://www.itc.gov.hk/hkas> .

29. Infra-red thermographic scanning by specialist is an effective tool for generally locating cavity areas behind the external finishes and can be adopted, as appropriate, as a supplementary measure for quality assurance.

(7/2008)

**Relevant Standards on External Rendering and Tiling Works**

Standard	Description
BS EN 197-1: 2000	Cement – Part 1: Composition, specifications and conformity criteria for common cements
BS EN 1348:2007	Adhesives for tiles – Determination of tensile adhesion strength for cementitious adhesives
BS 4483: 1998	Steel fabric for the reinforcement of concrete – Specification
BS 4550-6:1978	Methods of testing cement. Standard sand for mortar cubes
BS 5385-2 : 2006	Wall and floor tiling Code of Practice for the design and installation of external ceramic wall tiling and mosaics (including terra cotta and faience tiles)
BS 6213: 2000	Selection of construction sealants – Guide
BS 8000-16:1997	Workmanship on building sites – Part 16: Code of Practice for sealing joints in buildings using sealants
BS EN 12004:2007	Adhesives for tiles – Requirements, evaluation of conformity, classification and designation
BS EN 13139:2002	Aggregates for mortar
BS EN 13888:2002	Grouts for tiles – Definitions and specifications
BS EN 13914-1:2005	Design, preparation and application of external rendering and internal plastering. External rendering
BS EN 14411:2006	Ceramic tiles – Definitions, classification, characteristics and marking
BS EN 14647:2005	Calcium aluminate cement. Compression, specifications and conformity criteria