Quarry tile and other ceramic floor tiles

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Publisher's version / Version de l'éditeur:
https://doi.org/10.4224/40000681
Canadian Building Digest, 1979-09-01

Canadian Building Digest
Division of Building Research, National Research Council Canada

CBD-206

Quarry Tile and Other Ceramic Floor Tiles

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Originally published September 1979.

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Because of their attractive appearance and hard-wearing properties ceramic materials are extensively used as floor finishing materials, bearing such names as quarry tile, mosaic tile, paving tile, and unglazed or glazed floor tile. Popular with builders in the past, they continue to be a favourite flooring material in modern building.

The various names applied to ceramic floor tiles reflect only in a very general way their characteristics and properties. The term quarry tile (of which the word quarry is derived from the old English word meaning something square) is usually applied to a square, unglazed tile made from a natural clay or shale, as for brick-making but burned at high temperature to produce a dense body low in porosity and high in strength. Quarry tiles are usually red in colour and 150 mm (6 in.) square by 12.5 mm (½ in.) thick.

Paving tile, or pavers, are similar to quarry tile in colour and material but larger in size and of substantial thickness (25 mm; 1 in.), making them suitable for use where a heavy duty floor surface is required, for example, to withstand the abuse of floor traffic in industrial plants. Paving tiles sometimes incorporate an abrasive material that gives the surface slip-resistant characteristics.

In contrast to quarry tile and pavers, other ceramic floor tiles are manufactured from refined clays and other materials selected to produce a dense body of particular colour and texture. The surface of ceramic tile is sometimes embossed for decoration, and it may be glazed, that is, coated with glass to give it a high sheen and gloss. A special purpose tile, conductive tile, is available for use where there is a hazard of explosion from electric spark, such as in hospital operating rooms. The electrically conductive nature of such tiles allows them to drain off static electricity, thus preventing spark discharge.

Ceramic floor tiles are manufactured in a wide range of sizes and shapes from nominally 25 mm (1 in.) squares to 200 mm (8 in.) squares and hexagons, although even larger sizes may also be available. Thickness varies from 5 mm (3/16 in.) for small tiles to 12.5 mm (½ in.) for large ones. The 25 mm (1 in.) square tiles and other small tiles, usually called mosaic tiles, are mounted on sheets 300 mm (1 ft) square for ease of application.

Standards

Requirements for the properties of ceramic floor tiles are given in Standard 75-GP-1M issued by the Canadian Government Specifications Board, Department of Supply and Services, Ottawa. It lists the nominal dimensions and permissible variation of tiles and deals with defects in size and shape such as warping and wedging, and with other defects such as cracks, chips, blemishes, blisters, and colour variation.

An important property of floor tiles is resistance to abrasion, assessed in the standard by the "abrasive wear index"; similarly, if a tile is intended for use where corrosive materials might contact it, it must meet requirements for chemical resistance. Still another requirement of the standard is resistance to thermal shock. The resistance of glazed tile to hairline cracking or crazing from stress between the body and the glaze is assessed by subjecting them to steam at high pressure in an autoclave; if crazing does not develop with this treatment, it is unlikely to develop in service.

Bond Coat and Grout

A tile is held in place by a bond coat, which adheres to the tile and to the material supporting it; spaces between tiles are filled with grout. Bond coat materials include neat portland cement paste, dry-set mortar (a mixture of portland cement, fine sand and additives), organic adhesives, epoxy mortar and furan mortar. Factors affecting the selection of the bond coat material include the nature of the substructure, the service conditions to which the floor will be subjected, and cost. Where a high degree of chemical resistance is required, epoxy or furan mortar may be selected.

Grout must adhere strongly to the tiles and must provide a surface that resists abrasion, impact loads and the other service conditions that affect tiles. In some installations grout is the same material as the bond coat, but in others it may be selected to provide a particular colour, for its stain or chemical resistance, or for some other property. Bond coat and grout materials are frequently obtained as proprietary products that for best results have to be used in accordance with the manufacturer's directions.

Ceramic Tile Applied to a Wood Subfloor

The subfloor to which ceramic tile is applied must be sufficiently rigid to prevent it from deflecting excessively under load. In general, for residential construction, a floor system of 12.7 mm (½ in.) plywood on joists spaced 400 mm (16 in.) on centres is adequate to support ceramic tile, provided that either a mortar bed 30 mm (1 ¼ in.) thick is laid on the plywood or an underlay is nailed to it consisting of 6.3 mm (¼ in.) plywood, particleboard, or hardboard.

If a mortar bed is used (Figure 1) a "cleavage" or separation membrane of asphalt sheathing paper, felt, or polyethylene film separates the mortar bed from the plywood. The mortar is prepared from a mixture of portland cement, lime and sand, generally in proportions by volume of one part cement, ¼ part lime, and between 3 and 5 parts sand. If the tiles are to be laid before the mortar bed has hardened, they are soaked in water, drained, then pressed and tapped firmly into the mortar while it is still plastic; cement paste is usually applied as a bond coat to the back of a tile before it is placed. The grout is frequently a mixture of portland cement and fine sand.

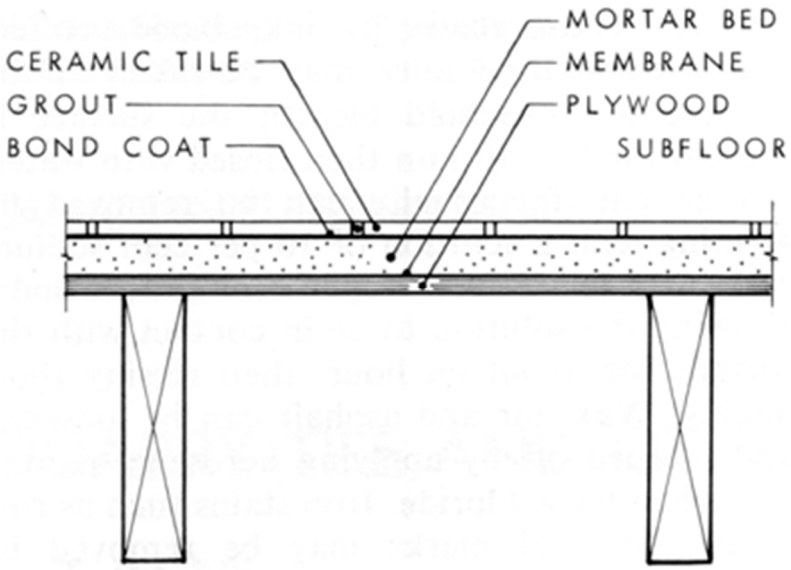

Figure 1. Ceramic tile applied to a wood subfloor with a mortar bed.

If the mortar bed is allowed to harden before tiles are applied to it, it should be cured at least 20 hours at a temperature not less than 21°C (70°F) before the tiles are set, provided the bond coat is dry-set mortar or latex-portland cement mortar. If the bond coat is organic adhesive or epoxy, however, the mortar bed must be cured as before for at least 20 hours, then dried thoroughly before the tiles are set.

If an underlay such as plywood, particleboard or hardboard is used instead of a mortar bed on a wood subfloor (Figure 2), an organic adhesive is applied to both the back of the tile and the underlay and used as the bond coat, although epoxy or other suitable mortar may be similarly applied. The joints between tiles bonded with organic adhesive may be filled with latex-portland cement grout or epoxy grout, but when epoxy mortar is the bond coat the same material is generally used for grout.

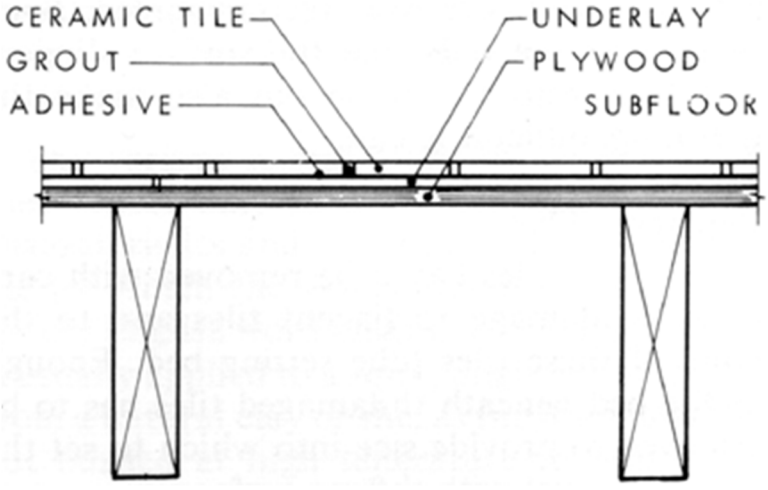

Figure 2. Ceramic tile applied to a wood subfloor with underlay.

Ceramic Tile Applied to a Concrete Subfloor

Ceramic tile is applied to a concrete subfloor in a manner similar to that used for wood subfloors, with a 30 mm (1 ¼ in.) mortar bed for setting the tile. If the subfloor is a slab on grade, or otherwise unlikely to be subjected to deflection, the mortar bed may be applied directly to the concrete (Figure 3). Tiles are set in the plastic mortar using a bond coat of

cement paste or, if the mortar bed has hardened, in a bond coat of dry-set or latex-portland cement mortar.

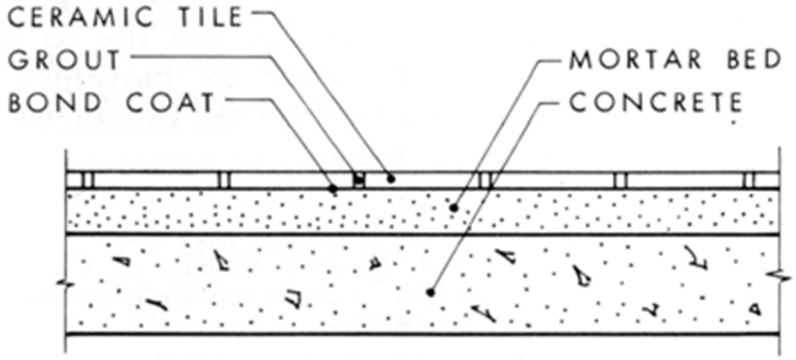

Figure 3. Ceramic tile applied to a concrete subfloor.

If a concrete floor is subjected to bending and other deflection, as tends to be the case with pre cast concrete floor systems, a cleavage membrane of roofing felt, polyethylene film, or other suitable material must be placed over the concrete before the mortar is applied and the mortar bed reinforced with welded wire mesh or other suitable reinforcing material.

Ceramic tiles may be applied without a mortar bed to a concrete subfloor provided it is well cured, dimensionally stable, and has a sufficiently level surface. A bond coat of dry-set mortar, latex-portland cement mortar or organic adhesive may be used, with the first two materials also suitable for use as grout. If a floor is to be subjected to harsh chemicals and severe cleaning methods, the tiles should be fixed and grouted with epoxy mortar or other material of high chemical resistance.

The satisfactory performance of a tiled floor depends on selection of materials suitable for the service conditions, proper preparation of the subfloor, and proper installation of the tile. Detailed information is provided in Ceramic Tile, issued in 1974 by the Specification Writers Association of Canada (now Construction Specifications Canada, Suite 301, 1027 Yonge St., Toronto, Ont., M4W 2K2). Additional information is available in publications of the Tile Council of America (P.O. Box 326, Princeton, N.J., U.S.A. 08540), whose Handbook for Ceramic Tile Installation and American National Standard Specifications for the Installation of Ceramic Tile are particularly useful sources of information.

Problems with Ceramic Tile Floors

The most serious problems with ceramic tile floors are incomplete bonding of the tile to the base material and differential movements between tiles and the concrete subfloor supporting them. If the bond is incomplete, as may result if the bond coat is applied to a dirty base material or tiles are laid too dry, too wet, or not tapped (beaten in) sufficiently, the tiles will not be fixed strongly in place and slight pressure or impact might be sufficient to break them loose.

The bond may also be broken as a result of differential movements between the tiles and the concrete subfloor. Concrete shrinks as it dries and ages, whereas ceramic tiles expand. The unrestrained movement of a concrete subfloor, for example, could amount to 0.03 per cent linear shrinkage, but that of the tile covering it could amount to as much as 0.1 per cent expansion. Such movements applied to a floor 30.5 m (100 ft) long amount to a shrinkage in the concrete of about 9 mm (3/8 in.) and expansion in the tiles of about 30.5 mm (1 ¼ in.). The resulting high stress set up between the tiles and the concrete may lead to the shearing off of the tiles, either where they contact the bond coat or in the bond coat itself. The tiles then lift free of the subfloor in an "arching" pattern or buckle in a ridge.

The stress developed between the tiles and the concrete subfloor as a result of differential movement increases with increasing expanse of floor. In a small floor it is unlikely that enough stress will develop to shear the tiles from the concrete; a large floor can therefore be designed

to negate the effects of differential movement by treating it as a number of relatively small floor areas, separated by joints designed to accommodate movement.

In general, if the larger dimension of a floor is less than 3.6 m (12 ft), movement or control joints will not be required. In floors of large expanse, depending on the nature of the materials used and the service conditions, spacing of joints may be as close as 3.6 m (12 ft) or as far apart as 7.2 m (24 ft). Joints should be provided in both directions, and there should be a perimeter joint where the floor abuts the walls. In addition, joints should be provided between the floor and any other restraining surfaces such as curbs, columns and pipes. Where there is a movement joint in the concrete subfloor there should be a corresponding joint in the bedding mortar and tile at least as wide as that in the concrete. Joints should not be less than 6 mm (¼ in.) wide, and in some cases may be as wide as 19 mm (3/4 in.). They must be filled with a suitable back-up strip and sealant, carefully installed to ensure that the sealant bonds firmly to the sides of the tiles.

Detailed information on the need for control joints and their design is given in the Handbook for Ceramic Tile Installation mentioned previously. The recommendations of the supplier of particular floor tile materials concerning the provision of control joints and other aspects of installation should be sought and followed.

Maintenance

Quarry tile and other ceramic tile floors are easy to care for and normally require little maintenance. A tile floor may be washed with warm water to remove minor soiling or with warm water containing detergent when soiling is heavy. Mildly abrasive scouring powder can be used on unglazed tiles but not on glazed ones. A cleaning solution should not be left on the floor any longer than is necessary; and after cleaning the floor should be rinsed thoroughly and the water mopped up to leave the floor as dry as possible.

Heavy stains are usually not difficult to remove. Those made by ink, blood, coffee, mustard and food juice may be taken off by the use of household bleach; the surface is washed for 5 to 10 min then rinsed with water. Grease and fat usually can be removed by washing with a solution of 10 per cent sodium carbonate in water or 5 per cent caustic soda, allowing the solution to be in contact with the surface for about an hour, then rinsing thoroughly. Wax, tar and asphalt can be loosened and scraped off by applying kerosene, naptha or carbon tetrachloride. Iron stains such as rust stains and tool marks may be removed by washing with a 5 per cent solution of hydrochloric acid in water; the same remedy is used for the removal of hardwater deposits and efflorescence of calcium or magnesium carbonate. This solution or other acid should not be used on glazed tile, and when used on other tiles must be rinsed thoroughly.

The application of linseed oil or a polish to ceramic tile floors is not recommended. Such treatments not only make the surface slippery and dangerous to walk on but also make the tiles more difficult to clean.

Replacing Tiles

Damaged tiles have to be removed with care to avoid damage to adjacent tiles and to the bond of these tiles to the setting bed. Enough of the bed beneath the damaged tiles has to be removed to provide space into which to set the new tiles level with the floor surface.

Concluding Remarks

Quarry tile and other ceramic tiles provide attractive floors that are durable and easy to maintain. Several factors have to be considered to obtain a satisfactory tile floor, particularly the service conditions of the floor, the nature of the base to which the tiles are applied, and the properties of the tiles, their bonding agents and grouts. Strong adhesion of the tile to its base and the accommodation of movements between them are important for the satisfactory performance of a tiled floor.