TECHNICAL BULLETIN – TB099

DIFFERENTIAL MOVEMENT & TILE FINISHES

August 18, 2014

INTRODUCTION & SCOPE

WHAT IS DIFFERENTIAL MOVEMENT?

Differential movement is that expansion/contraction and or deformation movement that occurs at different rates, and often in different directions, between materials in a structurally sound building. Typical differential movement may be due to:

- Shrinkage of substrates, e.g. concrete or wood shrinkage due to drying.
- Thermal and moisture related expansion/contraction of tiles and substrates, e.g. timber swelling in very humid and/or damp and/or wet conditions, or natural stone tiles experiencing dimensional change when in contact with fresh adhesive.
- Reversible movements of substrates, e.g. vibrations and deflections.

Evidence of differential movement between substrates and tile finishes may include the following;

- Peaking of tiles.
- Loose and/or drummy tiles.
- Cracking and spalling of grout in joints between tiles.
- Compression of sealant in movement joints.
- Opening or Closing of movement joints.

Differential movement between the tile finish and the substrate may result in failure. When failure occurs, the typical modes of de-bonding can be;

- Between the tile and the adhesive. (Described as Adhesion failure).
- Within the adhesive layer. (Described as Cohesion failure).
- Between the adhesive and the substrate. (Described as Adhesion failure).
- Within the substrate. (Described as Cohesion failure).

Failure can occur in whichever is the weakest link in the tiling system. The adhesive is generally weaker than the tiles or concrete substrates hence failures are commonly observed in the adhesive layer. However, where the substrate is weaker than the tiles or the adhesive, failure may occur in the substrate and some of the substrate remains adhered to the adhesive when these loose tiles are removed.

The value of the adhesion strength of the tiling system is therefore critical. The tile adhesive performance standard ISO13007 (which has now replaced Australian Standard 4992.1-2004) requires minimum tensile bond strength of 0.5 MPa to be achieved under wet and dry test conditions. However when the tile finish is exposed to service and climatic conditions and subjected to differential movements, deformability (often referred to as flexibility) of the adhesive is required to “accommodate” the stresses generated due to differential movements. Note: the substrate is assumed to be structurally sound.

Cement based adhesives are relatively rigid even though they may have high tensile bond strength (resistance to pull apart forces acting at right angles to the plane of the adhesive layer), and high shear bond strength (resistance to forces acting parallel to the plane of the adhesive layer).

The performance of cement based adhesives may be improved by the addition of polymer additives. These additives provide increased adhesion and limited flexibility as determined by the degree of deformation observed before failure occurs. Failure of the tile system occurs when differential movement is greater than the capacity of the tiling system to absorb this movement.

Note: Movement within the ground supporting any structure is not discussed in this bulletin although the effects on a tile finish within the structure may appear similar.

The classification of adhesives according to ISO 13007 (replacing AS4992) is based on the principal binder used in each adhesive. Thus adhesives may be classified as Cement based (powder) adhesives, Dispersion (premixed emulsion paste) adhesives and Reaction (generally 2 part systems that must be, mixed together such as epoxies) adhesives.

(Ardex Technical Bulletin TB169 provides a brief summary of this classification).

Cement based adhesives are by far the most used (economical and versatile) category and includes formulations containing rubber crumb fillers. Additional deformation characteristics may be provided by mixing the cement based adhesive powders with liquid polymer emulsions. (note: rubber crumb added to the adhesive is considered as a filler only with negligible contribution to the deformation performance) However the benefits of increased deformation in the adhesive layer to accommodate any differential movement between the tile finish and the substrate may be overcome by the lack of suitable stress relieving mechanisms, called movement joints, in the tile finish. The more deformable the adhesive, the greater the requirement for correctly placed and installed movement joints in the tile finish.

HOW TO LESSEN THE EFFECTS OF DIFFERENTIAL MOVEMENT

The effects of differential movement may be reduced by following the recommendations set out in Australian Standard 3958.1. These recommendations may be summarised as follows;

- Reduce large areas of a tile finish into several smaller sections bounded by movement joints. These joints may also be located to provide symmetry to the joint layout and/or tile pattern as an additional feature in the tile finish.
- Ensure movement joints are placed at all perimeters where the tile finish abuts restraints such as walls, columns, penetrations (such as pipes, brackets and waste fittings) and the like through the tile finish.
- Ensure movement joints around perimeters are continued across doorways to complete a continuous joint around each tile section. Each panel or section of tiles must be bounded by a movement joint or otherwise unrestrained.
- Ensure the adhesive used has sufficient thickness under the tiles so that it may deform to its' designed movement capability.
- Ensure the movement joints are to full depth of the tile finish and adhesive layer. Each movement joint is to be raked free of adhesive and/or grout residues down to the substrate.
- Deep movement joints shall include a suitable compressible backing rod so that the flexible sealant is able to achieve the manufacturers recommended sealant thickness to joint width ratio.
- Ensure movement joints are provided at all changes in direction of the substrate.
- Ensure movement joints are placed at all changes in the plane of the substrate.
- Ensure movement joints are located over existing joints in the substrate even if this means cutting the tiles to provide these joints.

The above summary of the recommendations of AS3958 indicates the requirement to reduce to very small amounts, any differential movement that may occur in each section of the tile finish bounded by the movement joints. Any small movement that does occur may then be within the adhesive deformation capability and the stresses generated can be relieved by compressing the flexible sealant in the movement joints.

IMPORTANT
This Technical Bulletin provides guideline information only and is not intended to be interpreted as a general specification for the application/installation of the products described. Since each project potentially differs in exposure/condition specific recommendations may vary from the information contained herein. For recommendations for specific applications/installations contact your nearest Ardex Australia Office.

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Reason for bulletin
Regular review, Reference to ISO13007.

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