CERAMIC TILE ADHESIVES AND GROUTS A CASE FOR QUALITY

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SYNOPSIS

The nature and types of modern ceramic tile adhesives and grouts are described. Their quality in terms of their application properties and performance in use are reviewed in the context of current National Standards. Performance criteria such as open- time, adhesion strength, water resistance, resistance to strain and microbiological aspects are explored and defined.

The importance of the certification of product quality and of third-party accredited quality assurance is stressed.

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Ceramic tile adhesives form an important category within the general adhesives classification, a category, which together with ancillary products, such as grouts, primers and sealants, has to be linked closely to the nature of ceramic tiles and natural stone tiles as well as the constructional substrates to which they are adhered.

Ceramic tile adhesive manufacture is an industry within its own right, and the adhesives are viewed as specialist products within the context of National Standards.

The ceramic tile adhesive provides a superior alternative to the traditional methods of fixing tiles with sand and cement mortars. Over the last 40 years adhesives have replaced the traditional methods to varying extents throughout the world. In the U.K., for example, virtually all wall tiles are fixed with adhesive and a significant proportion of floor tiles. Even then the sand and cement fixing that is carried out often uses polymer-modified mortars and polymer slurry bonds and not the straightforward unmodified cement/sand mortars.

The earliest formulated ready-mixed adhesives used to fix ceramic tiles were developed and introduced in the United Kingdom between 1951 and 1958. These products were based upon solutions of rubbers or synthetic resins dissolved in organic solvents. They had the advantage of being ready-mixed, and hence were ready-to-use, and were effective adhesives. They did, however, suffer the disadvantages associated with flammable, and sometimes toxic, organic solvents. In 1959 the first safe, water-based dispersion adhesives were developed and introduced to the tile fixing market. Also, in that year the first cementitious powder adhesive was introduced. Nowadays the solvent-based ceramic tile adhesive has largely disappeared and the market is served by a number of water-based dispersion products and proprietary cementitious adhesives. In fact, modern ceramic tile adhesives fall into four major categories:

1. Organic dispersion adhesive

The organic dispersion adhesive is in the form of a ready-to-use paste, and is a mixture of polymer dispersion binding agents, organic additives, mineral fillers and water.

2 .Cementitious adhesives

These are powders based on hydraulically hardening cements, fillers and organic additives. The powders are mixed with water on site immediately prior to use.

3. Cementitious adhesives modified with polymer dispersion

These are hydraulically hardening adhesives consisting of a cement-based powder to which a modified dispersion of a cement-compatible polymer is added in place of the gauging water.

4 .Organic reactive polymer adhesives

An organic reactive polymer adhesive contains a reactive polymer such as an epoxide or polyurethane resin as the binder with mineral fillers and organic additives. The adhesive is normally supplied in two or three components.

The majority of tiles in the European market generally are fixed with the cementitious adhesive, often modified with the polymer dispersions. The organic dispersion adhesive is less common in mainland Europe, representing typically between ten and twenty percent of the total adhesive markets. In the U.K. and the U.S.A., however, the situation is quite different with dispersion adhesives being much more important and representing probably greater than 50% of these markets.

High quality dispersion adhesives offer advantages over and above their convenience of use and resulting improvements in work rates. Dispersion adhesives in the U.K. are used by professional tile fixers for wall tiling with total confidence. These adhesives can match the strength and water resistance of a cementitious product. However, the adhesive does have to dry out completely and its binder coalesce and film-form before its water resistance is achieved. This is the only reason why these products are not recommended for exterior use or in conditions of total water immersion where wetting before drying out is a possibility. The product, though, is capable of combining water resistance and true flexibility. Therefore it is eminently suitable for tiling dry lining or partition walls. The product is also ideal for Gypsum plaster, avoiding any possibility of a reaction between the calcium sulphate and cement.

The organic reactive adhesives are specialist products used for their chemical resistance and impervious waterproofing properties.

National Standards for ceramic tile adhesives have been published in Britain (under BSI), Germany (under DIN), USA (under ANSI), France (in accordance with UEAtc - European Union of Agreement), Australia (under the Standards Association of Australia), and Canada (under the Canadian Government Specifications Board). These National Standards are currently being considered by a CEN Working Group establishing a new European Standard for ceramic tile adhesives, which should eventually form the basis of an International ISO Standard.

The quality of ceramic tile adhesives is manifest in a number of ways but basically can be categorised into application characteristics and product performance in use. Indeed, one can list at least 55 separate characteristics of an adhesive which are needed to fully define its performance and its acceptability to the applicator! Of these the following characteristics are, however, probably the most important in defining the overall quality of the product.

* Adhesive strength
* Water retention - open-time and adjustability-time
* Water resistance
* Resistance to temperature
* Freeze/thaw resistance
* Resistance to excessive strain development
* Resistance to mould growth
* Flexibility (deformability)

Appendix I outlines the test methods and requirements for measuring these characteristics defined in the UEAtc, DIN, BSI and ANSI Standards.

ADHESION

The most important requirements are that the adhesive has good cohesive strength and provides sufficient adhesion to the substrate and to the tile, such that the tile finish remains bonded under the conditions and the stresses to which it is subjected during the normal lifetime of the installation. Adhesion of a ceramic tile adhesive can be measured in tensile and in shear. Both are relevant to the integrity of a tiling finish.

DIAGRAM

If, for example, a substrate shrinks behind the ceramic tile finish then the adhesive is subjected to shear stress. However, as the tiles themselves cannot move and release the strain they tend to bulge outwards and a tensile strain is imposed on the adhesive layer. If the degree of shrinkage involved is sufficiently high then the result may be that the adhesive will fracture cohesively in tension, allowing the tiles to bulge outwards.

Adhesion strength in shear is usually measured by stressing in a tensometer a tile to tile assembly along the plane of the bond until the bond breaks. Adhesion in tensile is measured either by a pull-off test, carried out from a tile bonded to a standard substrate such as a concrete slab, or by a tile assembly such as that shown above. Both methods give valid results, each having their own advantages and disadvantages.

These adhesion test pieces are also used to measure such characteristics as the open-time of the adhesive, by assembling the test pieces at different time intervals after the adhesive application, or the resistance of the adhesive to certain conditions, such as water immersion, by conditioning the test pieces in the appropriate way after they have been assembled.

OPEN-TIME

Water retention and surface skinning are very important properties of ceramic tile adhesives which have a significant effect on the open-time and adjustability-time of the adhesive in use. Ceramic tile adhesives are used in thin layers in comparison with cement/sand mortars. Consequently any tendency for the adhesive to lose its water to the background too quickly or to form a skin on its surface too soon after application will seriously reduce the level of adhesion obtained to the tiles. The sensitivity of these characteristics are aggravated by high ambient temperatures and relative humidity.

Open-time is defined as the amount of time the tile fixer has to place his tiles onto an adhesive bed after application of the adhesive before the level of adhesion obtained becomes seriously reduced. If the adhesive has a short open-time then it will skin over rapidly and it this skin is not broken when placing the tile then the back of that tile will not be wetted by the adhesive and the resulting adhesion will be very much reduced.

Adjustability-time is the time that the fixer has available to adjust tiles once they are placed into position on the adhesive bed. It is also dependent on water retention. If the adhesive loses its water by evaporation, or by absorption into the substrate too quickly, then the mobility of the adhesive is destroyed and attempts to adjust the position of the tile will either not be possible or, if forced, will reduce the cohesive strength attained.

Normally in a high quality adhesive one is looking for an open-time and adjustability-time of 15-20 minutes, regardless of the ambient temperatures involved. One of the consequences of using a low cost adhesive with little or no expensive organic additives present is that the open-time and adjustability-time are the first qualities to suffer.

WATER RESISTANCE

Adhesives used to fix tiles externally and in wet duty installations such as swimming pools and showers obviously have to have a high level of water resistance. In this context water resistance defines the ability of the adhesive to withstand contact with water without deterioration and should not be confused with the term "waterproof" which requires that the product should be impervious to water in addition to it being water-resistant.

Water resistance is measured by immersing adhesion test samples in water after allowing the adhesive layer to dry and cure and to measure the wet strength after immersion for a set period of time. In various National Standards mentioned this can vary from 7-21 days immersion.

RESISTANCE TO TEMPERATURE

Temperature resistance of adhesives is measured by subjecting the cured test adhesive samples to temperatures between 60°C and 100°C for a period of time. At present there are differing views as to whether the test pieces (usually shear) should be allowed to recover to normal laboratory temperatures for 24 hours before being tested, or whether they should be broken hot immediately after being removed from the oven. The latter is more demanding, being influenced by the thermoplastic qualities of the adhesive, particularly if it is a polymer dispersion product.

FREEZE/THAW RESISTANCE

Freeze/thaw tests are a factor of the DIN and UEAtc Standards. The freeze/thaw resistance of ceramic tile adhesives is measured by cycling the adhesive test piece assemblies through freeze/thaw cycles (-15°C - +12°C) after first being soaked in water. The ability to withstand these cycles without serious deterioration in adhesive strength are considered to be important requirements, particularly for Norther European countries. It is not constant freezing which is the condition that is most searching but the action of freezing itself. Current thinking is that the freeze/thaw test for adhesives should reflect the test cycle carried out for ceramic tiles under EN 202. The importance of the test is, at the time of writing, a contentious issue, with some experts believing that it is the most important single requirement for testing adhesives to be used externally in countries which are subjected to freeze/thaw conditions, whilst others believe that adhesives are capable of withstanding freeze/thaw cycles providing they have a good degree of water resistance.

RESISTANCE TO EXCESSIVE STRAIN DEVELOPMENT

This test, which is a requirement of BS 5980, measures the tensile strain on a ceramic tile surface glaze resulting from shrinkage in the adhesive bed. Excessive shrinkage during the drying and hydration of a cementitious adhesive will result from either an unbalanced formulation or from the adhesive being used to a greater bed depth than it can tolerate. The strain development is measured by fixing a strain gauge to the surface of the tile, and in BS 5980 the strain development on a tile surface should not be more than 250 microstrain after 6 months.

FLEXIBILITY

Flexibility is a quality often claimed in modified cementitious adhesives, particularly the polymer-modified cementitious adhesives. However, it is not clear as to precisely what is meant by "flexibility" in this case. Probably the most practical test for categorising so-called 'flexible adhesives' is the measurement of the deformation of an air-dried strip of the adhesive under load (Appendix 2). However, it does not relate to the performance of the adhesive layer behind a tile finish where a greater degree of hydration of the cement is thought to influence the result significantly.

There is, however, little doubt that the 'flexibility', or perhaps more precisely the 'ability of the adhesive to deform', is more pronounced in a polymer dispersion-modified adhesive than it is in a single-part adhesive containing polymer redispersible powder.

GROUTS

As yet there are few, if any, Standards defined for grouts, although one is currently being drawn up as part of the European standardisation work on ceramic tile adhesives and grouts. Grouts which are normally cementitious, polymer-modified cementitious or organic reactive polymer based should:-

(a) Have good gap filling properties for the designed joint width, not shrinking or cracking at that joint width. This is often a problem when pure cement is used as the grouting medium.

(b) The cementitious grout should retain its water sufficiently well in the joint such that the cement is allowed to hydrate to a level which ensures that the desired durability is achieved and which avoids soft joints.

(c) Reactive grouts, such as those based on an epoxide resin, are used because of their chemical resistance when cured and their impermeability.

(d) Hygiene is an important issue in grouts particularly when used between tiles in food processing areas, kitchen, dairies, etc. Current EEC Directives and UK regulations require that surfaces likely to be in contact with food should be easy to maintain in a sterile condition and should not contaminate or taint food. In cementitious grouts the high pH of the cement bond is generally sufficient to prevent fungal growth or microbial contamination from occurring, providing the surface of the grout is maintained by regular cleaning. However, reactive resin grouts are generally preferred in these installations due to the fact that they are impervious and are resistant to attack from acids, such as citric or lactic.

The test for anti-fungal properties is included in BS 5980, which is used for adhesives as well as grouts. The test (see Appendix 3) measures the ability of the cured adhesive or grout to prevent the growth of Aspergillus Niger on its surface. Due to the hygiene requirements of the Construction Products Directive it is probable that an effective test, such as that defined in BS 5980, will be included in the EN Standard for adhesives and grouts.

The quality of adhesives and grouts as defined in the terms discussed, and their overall performance and reliability, are related to the formulation, the quality of raw materials, the manufacture, and to the application of the products.

Low cost cementitious adhesives, for example, will tend to keep to a minimum the cement content, which will obviously affect the potential cohesive strength available even if all the cement is hydrated. However, of greater potential seriousness perhaps is the minimising of the expensive water soluble polymers and redispersible polymer powders, which if not present in the correct quantity, type and balance will reduce the open-time and the level of adhesion to the surfaces being bonded. The consequences of weaknesses in this area may not be immediately apparent but can be manifest after the tiling finish has been in use for some time. The inevitable lateral movements in the substrates, particularly in exterior installations involving drying shrinkage and thermal movement, may

eventually be sufficient to break the adhesive bond.

A well designed product, manufactured from a controlled process, however, will give the reliability and durability required of the tiling finish. The adhesive should be certified to conform to the National Standards mentioned, and eventually to the EN and ISO standards. They should be manufactured by a controlled process which is third-party accredited through the Quality Assurance Standard - ISO 9002.

It is important to mention that the requirements defined in the Standards mentioned are minimum requirements for a quality adhesive and any creditable manufacturer will ensure that not only does his product exceed those requirements with a good safety margin but that many other important characteristics of adhesives and grouts are not defined in the Standards are tested and monitored.

The ceramic tile market in Europe at the present time is dynamic, being influenced by such factors as the increasing use of fully vitrified monocottura tiles with very low water absorptions, the use of large format tiles, the increasing requirement for faster fixing systems and expanding legislation in areas such as safety and hygiene. One response to the use of the low water absorption tiles is the increasing specification of polymer dispersion-modified cementitious adhesives. These products, which are either available as a two-part system, or as a polymer dispersion admixture for use with a unmodified cementitious adhesive, gives a higher level of adhesion to the low water absorption tiles as shown in Appendix 4, increases the ability of the adhesive to be deformed and reduces its water absorption or permeability.

The fixing of large format tiles normally requires that the adhesive be buttered onto the back of the tile as well as being applied to the substrate itself. New adhesives are now available which have a greater ability to "wet out" the back of the tile and to give good contact areas without the need for back buttering.

Fast track building techniques create new demands on the adhesives and in the UK in particular the use of the rapid-setting cementitious adhesives providing a floor tile finish which can be walked on and grouted only two hours after fixing is becoming more and more popular.

The health and safety aspects of products and their ability to safely contact foodstuffs, has already been mentioned but there is a requirement now that the manufacturer tests his grouts to ensure that they are safe for contact with foodstuffs and to mark the packaging accordingly.

Therefore, in conclusion, it is important to reiterate that proprietary ceramic tile adhesives and grouts provide a cost effective and reliable method of fixing tiles onto all substrates and in all interior and exterior conditions providing that the substrates themselves are stable, that the adhesive is applied by the correct methods, which have been defined in separate papers, and that the adhesive and the grout used are of a high quality, exceeding the requirements of the various National Standards and that their performance is assured through third party accreditation.

APPENDIX 1

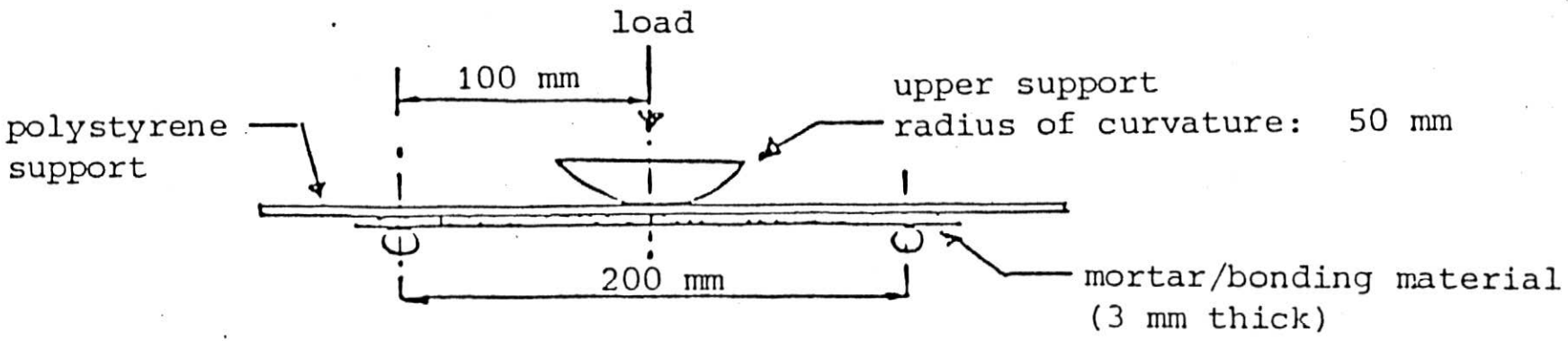
ADHESIVE PROPERTIERS DEFINED IN THE MAJOR NATIONAL STANDARDS

	BS 5980	UEATc	DIN	ANSI
Application Properties				
* Pot Life		+		+
* Water Retention		+		
* Sensitivity to Water Ratio		+		
* Open Time	+	+	+	+
* Adjustability Time	+	+	+	+
* Setting Time				+
* Tile Slip	(+)	+		
* Area of Contact		+	+	
Performance in Use				
* Flexibility (deformability)		+		
* Fungal Resistance	+			+
* Shrinkage (strain development)	+			+
* Impact Resistance		+		
* Ability to Take Load		+		+
* Tendency to Stain Tiles	+			+
Tensile Strength				
* After 3 Days (external adhesives)		+		
* After 7 Days (reaction adhesives)				+
* After 14 Days	+			
* After 28 Days	+	+	+	
* After Water Immersion	+	+	+	
* After Heat Ageing	+	+	+	
* After Freeze-Thawing		+	+	
Shear Strength				
* After 3 Days		+		
* After 14 Days	+			+
* After Water Immersion	+			+
* After Heat Ageing	+			+

(+) = optional

APPENDIX 2

DEFORMATION UNDER LOAD
ACCORDING TO UEATc MOAT



APPENDIX 3

DETERMINATION OF RESISTANCE TO MOULD GROWTH ACCORDING TO BS 5980: 1980

B.1 Materials

B. 1. 1 Potato Dextrose agar*, mixed and sterilized, approximately 400 ml. per test

B. 1. 2 Pieces of test piece tile, 25 mm. x 25 mm.,cut from tiles 101 mm. x 101 mm. x 9 mm. (3.4.1). Three such pieces are required for each adhesive under test.

B. 1. 3 Actively growing culture of Aspergillus niger CM. 17454.

B. 2 Apparatus. The following apparatus is required in addition to normal mycological apparatus.

B. 2. 1 Incubator, capable of being controlled at 29 ± 1º C and 90 ± 5% r.h.

B. 2. 2 Glass Petri dishes, complying with the requirements of BS 611.

B. 3 Procedure

B. 3. 1 Heat sterilize the pieces of test piece tile in separate closed glass Petri dishes at 110º C for 2 h. Allow to cool.

B. 3. 2 Apply the adhesive under test, as aseptically as possible, in a layer approximately 3 mm. thick on the biscuit side of the pieces of tile. Replace the test pieces, adhesive side uppermost, in the Petri dishes.

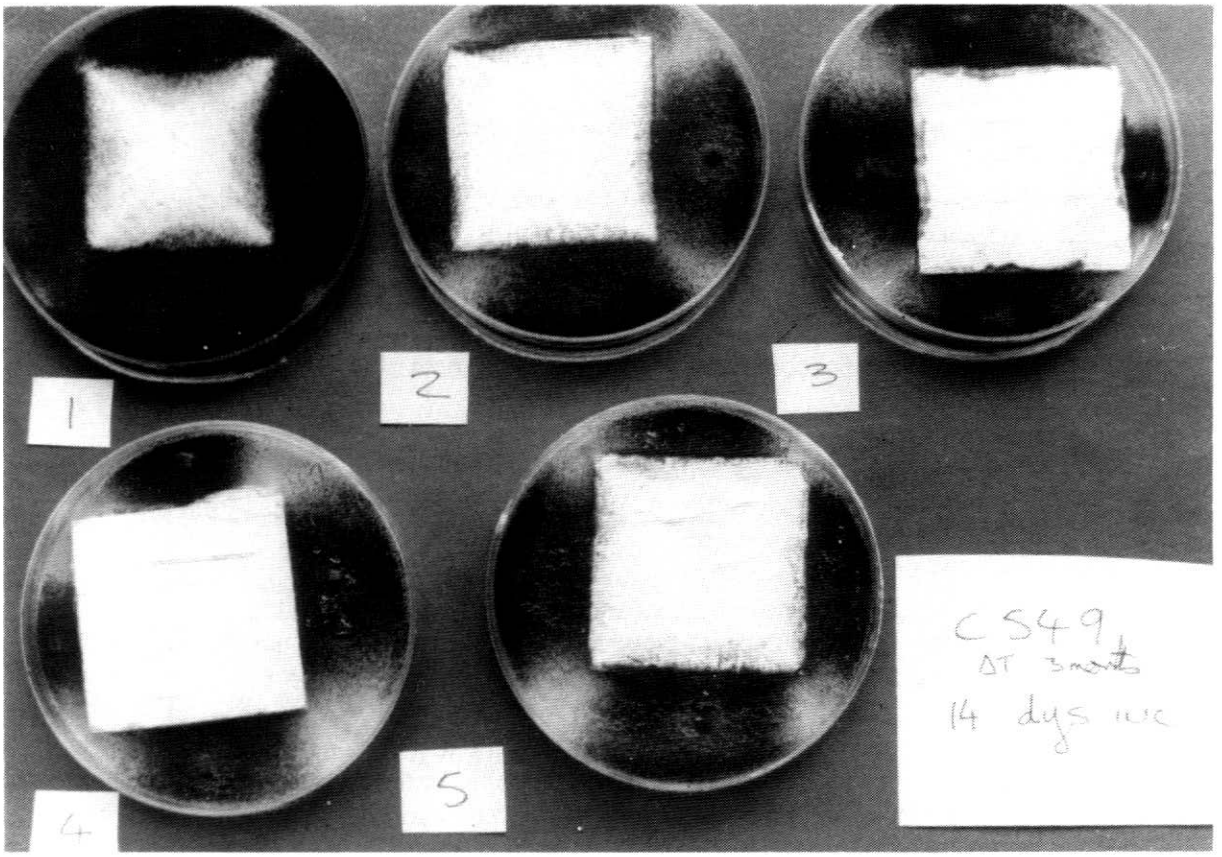
B. 3. 3 Pour the molten potato dextrose agar aroun the test pieces, taking care to prevent the medium from touching the adhesive, until the medium is level whit the tile/adhesive interface. When the medium has solidified, place the Petri dishes in the incubator at 29 ± 1º C for 24 h.

B. 3. 4 Innoculate two of the Petri dishes whit the Aspergillus niger, using four small pieces of innoculun evenly spaced on the medium around the test piece. The third Petri dish is a control to check for contamination. Incubate all three Petri dishes at 29 ± 1º C for 14 days.

B. 3. 5 Examine all three Petri dishes for evidence of mould growth. Record the extent of moul growth on the adhesive. Repeat the tes if:

(a) the control shows contamination;
(b) the innoculum did not grow.

APPENDIX 3

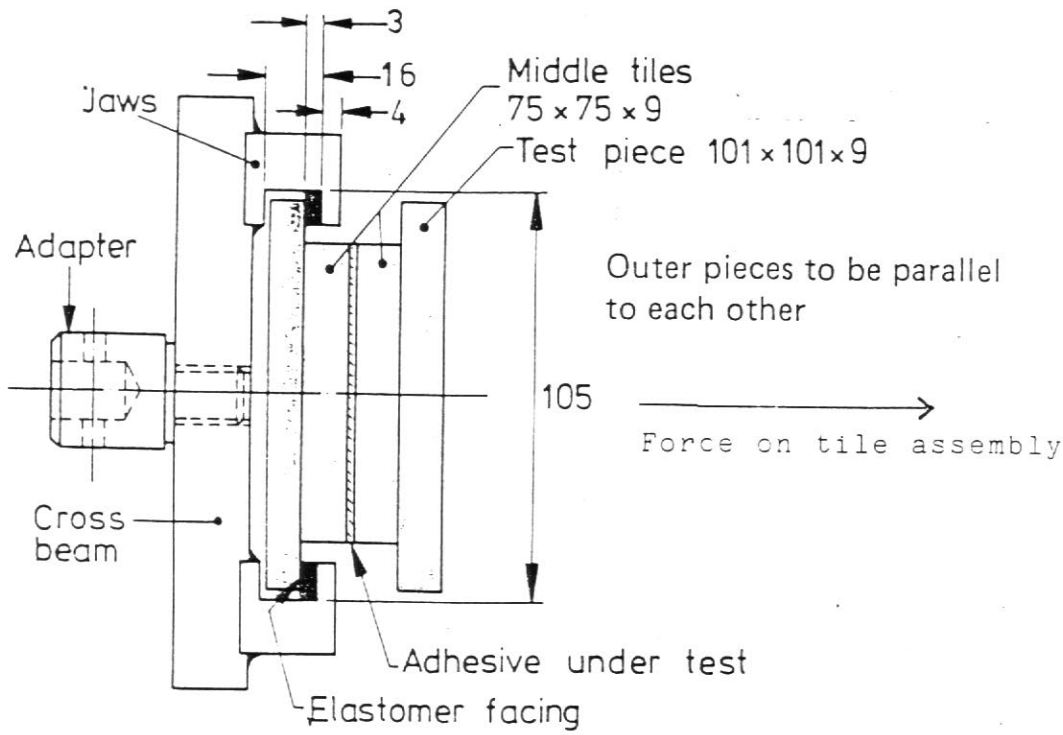


DETERMINATION OF RESISTANCE TO MOULD GROWTH ACCORDING TO BS 5980: 1980

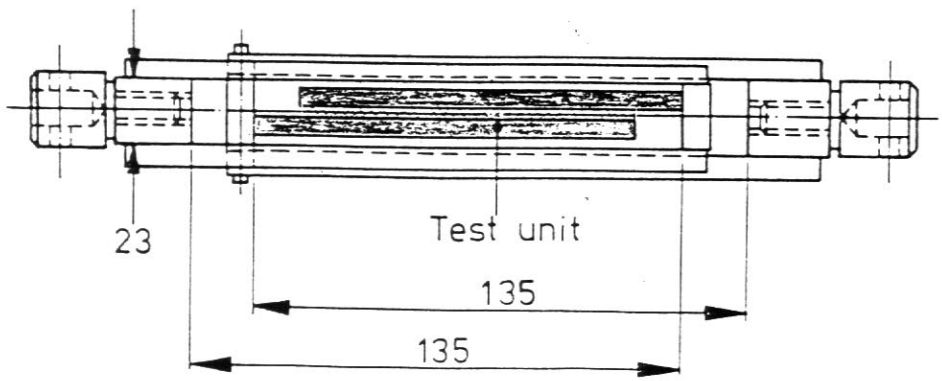
APPENDIX 5

ADHESION STRENGTH TESTS TO BS 5980 : 1980

DETERMINATION OF TENSILE ADHESION STRENGTH



DETERMINATION OF SHEAR ADHESION STRENGH



All dimensions are in millimetres.

Force on
Tile Assembly

FLOOR TILING

RECOMMENDED BAL ADHESIVE

BASE	INTERIOR DRY CONDITIONS	INTERIOR WET CONDITIONS	EXTERIOR FLOORS
CONCRETE	TYPE 1 CLASS AA CEMENT-BASED ADHESIVE	TYPE 1 CLASS AA CEMENT-BASED ADHESIVE	TYPE 1 CLASS AA TWO-PART DISPERSION MODIFIED CEMENT-BASED ADHESIVE
SCREEDS	TYPE 1 CLASS AA CEMENT-BASED ADHESIVE	TYPE 1 CLASS AA CEMENT-BASED ADHESIVE	TYPE 1 CLASS AA TWO-PART DISPERSION MODIFIED CEMENT-BASED ADHESIVE
TIMBER	TYPE 1 CLASS AA TWO-PART DISPERSION MODIFIED CEMENT-BASED ADHESIVE	TYPE 1 CLASS AA TWO-PART DISPERSION MODIFIED CEMENT-BASED ADHESIVE	NOT RECOMMENDED
EXISTING GLAZED & UNGLAZED CERAMIC TILES	TYPE 1 CLASS AA TWO-PART DISPERSION MODIFIED CEMENT-BASED ADHESIVE	TYPE 1 CLASS AA TWO-PART DISPERSION MODIFIED CEMENT-BASED ADHESIVE	TYPE 1 CLASS AA TWO-PART DISPERSION MODIFIED CEMENT-BASED ADHESIVE
VINYL TILES	TYPE 1 CLASS AA TWO-PART DISPERSION MODIFIED CEMENT-BASED ADHESIVE	TYPE 1 CLASS AA TWO-PART DISPERSION MODIFIED CEMENT-BASED ADHESIVE	NOT APPLICABLE
ASPHALT	TYPE 1 CLASS AA TWO-PART DISPERSION MODIFIED CEMENT-BASED ADHESIVE	TYPE 1 CLASS AA TWO-PART DISPERSION MODIFIED CEMENT-BASED ADHESIVE	CONTAC TECHNICAL DEPT.

WALL TILING
RECOMMENDED BAL ADHESIVE

BACKGROUND	INTERIOR DRY CONDITIONS	INTERIOR WET CONDITIONS	EXTERIOR WALLS
BRICKWORD, CONCRETE, DENSE BLOCKWORD	TYPE 1 CLASS AA CEMENT-BASED ADHESIVE	TYPE 1 CLASS AA CEMENT-BASED ADHESIVE	TYPE 3 CLASS AA TWO-PART DISPERSION MODIFIED CEMENT-BASED ADHESIVE
LIGHTWEIGHTBLOCKWORD	TYPE 3 CLASS AA TWO-PART RUBBER LAXTED-BASED ADHESIVE	DIRECT FIXING NOT RECOMMENDED	NOT RECOMMENDED
CEMENT PLASTER	TYPE 1 CLASS AA CEMENT-BASED ADHESIVE TYPE 2 CLASS B DISPERSION ADHESIVE	TYPE 1 CLASS AA CEMENT-BASED ADHESIVE	TYPE 3 CLASS AA TWO-PART DISPERSION MODIFIED CEMENT- BASED ADHESIVE
GYPSUM PLASTER	TYPE 1 CLASS AA CEMENT-BASED ADHESIVE ONTO PRIMED PLASTER TYPE 2 CLAS B DISPERSION ADHESIVE	TYPE 1 CLASS AA CEMENT-BASED ADHESIVE ONTO PRIMED PLASTER	NOT RECOMMENDED
GYPSUM PLASTERBOARDS	TYPE 3 CLASS AA TWO-PART DISPERSION MODIFIED CEMENT- BASED ADHESIVE ONTO PRIMED PLASTER TYPE 2 CLASS B DISPERSION ADHESIVE	TYPE 3 CLASS AA TWO-PART DISPERSION MODIFIED CEMENT- BASED ADHESIVE ONTO PRIMED PLASTER	NOT RECOMMENDED
TIMBER PARTITIONS	TYPE 3 CLASS AA TWO-PART DISPERSION MODIFIED CEMENT- BASED ADHESIVE TYPE 2 CLASS B DISPERSION ADHESIVE	TYPE 3 CLASS AA TWO-PART RUBBER LAXTED-BASED ADHESIVE	TYPE 3 CLASS AA TWO-PART RUBBER LAXTED-BASED ADHESIVE
CEMENT FIREBOARD	TYPE 3 CLASS AA TWO-PART RUBBER LAXTED-BASED ADHESIVE	TYPE 3 CLASS AA TWO-PART RUBBER LAXTED-BASED ADHESIVE	TYPE 3 CLASS AA TWO-PART RUBBER LAXTED-BASED ADHESIVE
EXISTING GLAZED CERAMIC TILES OR GLAZED BRICKS	TYPE 3 CLASS AA TWO-PART RUBBER LAXTED-BASED ADHESIVE	TYPE 3 CLASS AA TWO-PART RUBBER LAXTED-BASED ADHESIVE	TYPE 3 CLASS AA TWO-PART RUBBER LAXTED-BASED ADHESIVE
PAINTED SURFACES	TYPE 3 CLASS AA TWO-PART DISPERSION MODIFIED CEMENT- BASED ADHESIVE TYPE 2 CLASS B DISPERSION ADHESIVE	TYPE 3 CLASS AA TWO-PART RUBBER LAXTED-BASED ADHESIVE	TYPE 3 CLASS AA TWO-PART RUBBER LAXTED-BASED ADHESIVE

SPECIALIST FIXING

RECOMMENDED BAL ADHESIVE

WHEN FIXING	INTERIOR DRY CONDITIONS	INTERIOR WET CONDITIONS	EXTERIOR SITUATION
MARBLE	TYPE CLASS AA CEMENT-BASED ADHESIVE OR TYPE 3 CLASS AA TWO-PART DISPERSION MODIFIED CEMENT-BASED ADHESIVE	TYPE CLASS AA CEMENT-BASED ADHESIVE OR TYPE 3 CLASS AA TWO-PART DISPERSION MODIFIED CEMENT-BASED ADHESIVE	TYPE CLASS AA CEMENT-BASED ADHESIVE OR TYPE 3 CLASS AA TWO-PART DISPERSION MODIFIED CEMENT-BASED ADHESIVE
GLASS OR PORCELAIN MOSAIC	TYPE CLASS AA CEMENT-BASED ADHESIVE PLUS WATER RESISTANT FLEXIBLE POLYMER DISPERSION ADMIXTURE	TYPE CLASS AA CEMENT-BASED ADHESIVE PLUS WATER RESISTANT FLEXIBLE POLYMER DISPERSION ADMIXTURE	TYPE CLASS AA CEMENT-BASED ADHESIVE PLUS WATER RESISTANT FLEXIBLE POLYMER DISPERSION ADMIXTURE