METHODOLOGY FOR PATHOLOGY DIAGNOSIS OF FITTED CERAMIC TILES

by C. Feliú, A. García Verduch, G. Silva, J.M. Enrique.

Institute of Ceramic Technology. Jaume I University. Castellón.
Ceramic Industries Research Association. (AICE). Castellón (Spain).

SUMMARY

The purpose of this work is to establish a method for the systematic study of the types of pathology which commonly occur in fitted ceramic tiles, in order to determine whether the problems which arise are due to a lack of quality of the ceramic product or a lack of quality with regard to the fitting and maintenance.

With this objective, we have prepared a guidebook/questionnaire to facilitate the systematic and planned collection of data regarding the defect, fitting methods, materials used, environmental conditions, etc... This will help to focus the subsequent detailed analysis, together with laboratory tests, on the possible causes of the problem.

1.- INTRODUCTION.

Ceramic tile quality can be defined as the degree of conformity to the consumer's specifications for a particular use.

This permanent comparison between the technical characteristics of a product and the expectations set on it by the consumer are the factors that regulate the purchase-sale markets. Nevertheless, this

panorama does depend entirely on the ceramic tile sector, as we must understand that this is not a finished product for immediate use by the consumer. The fact that the material has to be fitted introduces a distortion element to this product/consumer relationship, since the user compares his expectations with the final result of the fitted ceramic tiles.

The fact that problems arise in the fitted product causes the consumer to lose confidence in the ceramic tile and therefore in the producer.

The factors which influence the tile/body combination are [1]:

- the materials used (tiles, adhesive, ...)
- the planning and design of the installation in relationto its use,
- the installation (fitting) of the material and
- the maintenance of the whole.

If all these operations are carried out in the most rigorous way,the appearance of problems will be avoided.

2.- PATHOLOGIES IN FITTED CERAMIC TILES

As has already been mentioned, the ultimate objective is to determine the origin of the defects of the tiled surfaces, as it is this with which the consumer is really concerned.

Very often the consumer associates a defect arising in a tiled surface with the ceramic product, and almost never with the other factors which play a part in the fitting.

Knowing the factors which influence fitted tiles, the defects which appear in the tile/fitting combination can be categorized in the following way :

- defects produced during the manufacture of the product.
- defects produced by choosing a ceramic tile inappropriate to the use or place for which it is intended.
- defects arising due to the inadequate fitting of the material.
- defects appearing due to inadequate maintenance and cleaning of the whole.

2.1.- Defects caused during the manufacture of the product.

Ceramic tiles which have manufacturing defects usually reach neither the consumer nor the fitting stage. Nevertheless, either because of a mistake in the visual classification or because of internal defects which are undetectable with the classification means available in the companies, defective articles may appear on the market, and have the capacity to deteriorate the aesthetic and functional characteristics of the covered surface.

The manufacturing defects of tilings and ceramic coatings have already been discussed extensively in various publications. [2]

2.2.- Defects produced by choosing a ceramic tile wich is inappropiated for the use or place for wich it is intended.

The wide range of ceramic products on the market is justified by their multiple uses and by the variety of places in which they can be fitted. At present, the uses of these ceramic products are, among others, the following [3] [4]:

- Interior tiling in houses (kitchen, bathroom, etc.)
- Interior floor tiling in houses.

- Exterior tiling (facades, urban equipment, etc.)
- Exterior floor tiling (terraces, etc.)
- Floor and surface tilings in public buildings (hospitals, schools, etc.)
- Various floor and surface tilings (swimming pools, industrial floors, etc.)

Ceramic floor and surface tilings, which until recent years have been used almost exclusively for covering the walls and floors of bathrooms and kitchens, have, with time and with the progress of the manufacturing technologies, acquired new and wider values as construction materials. The range of applications has been enlarged to include the exteriors of single-family houses, and in particular public buildings, industrial environments, very varied external environments and urban decoration. The choice of a ceramic floor or surface tiling for a particular application must fulfil a series of aesthetic, technical and economical conditions.

Apart from the purely aesthetic considerations, the following conditions must be taken into account:

- The format has to correspond to the surface to be covered, e.g. large formats are not suitable for small surfaces and vice versa.
- Combinations of formats must be chosen carefully.

The characteristics that the ceramic floor tilings and surfaces must have depend directly on the requirements of their use. Therefore in each case the required characteristics and their assigned importance and priority are different.

The builder, architect or person who decides upon the use of a ceramic covering, can choose from a wide range of products which are different not only in their format and dimensions, surface appearance and colour, but as well in their technical characteristics (mechanical, chemical and physical).

Ceramic coverings have a number of characteristics that make them stand out from other alternative materials. These characteristics can be categorized in the following way :

- Intrinsic characteristics : resistance to water, humidity, chemical agents, biological agents, light, etc.
- Characteristics related to comfort: soundproofing, thermal isolation, superficial appearance, etc.
- Safety characteristics: incombustibility, electrical safety, asepsis, etc.
- Aesthetic properties: geometric regularity, superficial uniformity, etc.
- Cleaning and maintenance properties.

Therefore, when choosing a ceramic floor or surface tiling, the environment in which it is going to be used must be taken into account, since this environment defines some of the requirements that the material must have.

The result and duration of a ceramic floor tiling or surface depends on the correct choice of the material and in particular on its suitability for the intended use.

To ensure the correct use of materials, the following recommendations should be considered:

- Climate : in the case of exterior applications in regions where the temperature can drop below 100ºC, the behaviour of the materials in freezing conditions must be known.

- Structure and nature of the support material : when the support material is elastic, it is advisable to fit small format pieces.

- Function of the site : Public and industrial sites require ceramic floor tilings and surfaces with

higher chemical and mechanical resistance capacities than those for houses and other residential uses. In the case of ceramic floor and surface tilings to be used in hygienic environments (hospitals, clinics, etc.) or schools, the absence of superficial porosity must be guaranteed in order to ensure that everything is clean and free of infection.

- Situation of the site : Ceramic floor tilings to be used in sites that are exposed to sand or other abrasive materials (for instance through spaces open to the exterior) must have a higher resistance to the abrasion.

- Special conditions of use : Ceramic floor tilings to be used in places where there could be water-spillage or accumulation of liquids (edges of swimming pools, industrial kitchens, car-washes, etc.) must be made to resist slipping.

Once we know the intended use of the ceramic floor and surface tilings, and the environment and conditions of use of the places where they are going to be fitted, the material most suitable to each application can be chosen, and its requirements defined accordingly without unnecessary overestimation.

2.3.- Defects caused by inadequated fitting of the material

Problems caused by inadequate fitting of the material are rarely detectable at the time of installation, but instead tend to occur at some later time either due to the deterioration of the material itself or because the fitted material has not withstood the conditions for which it was designed.

Installation defects are not due only to poor fitting, but also to other factors such as atmospheric agents etc. In addition, it should be noted that the changes experienced by the bonding material from the very moment of fitting mean that in most cases it is impossible to determine whether the implementation or composition is the most suitable one.

Among the most common defects caused by inadequate fitting are poor adherence, fractures due to lack of expansion joints, blackening between tiles, etc.

The building industry still needs to look into improving the professional training of the tiler, including training in new fitting methods, use of the correct tools, use of special tile adhesives, etc. Inadequate training endangers considerably both the image and the development of ceramic floor and surface tilings.

2.4.-Defects arising due to inadequate maintenance and cleaning of the material

This section covers the problems caused by incorrect cleaning and maintenance. These problems are a result of being unaware of the technical characteristics of the material, which should be fully specified by the producer.

Some typical examples of problems due to inadequate cleaning and maintenance include those which result from the use of corrosive chemicals for cleaning away residual bonding material from the tiles after fitting, and cleaning gloss finish tiles with naturally abrasive products, etc.

3.-METHODOLOGY FOR PATHOLOGY DIAGNOSIS IN CERAMIC TILES

Unfortunately the study of pathologies in fitted ceramic tiles is limited to determining the causes of the problems, since normally it is not possible to offer solutions which do not involve the removal of the ceramic floor or surface tiling.

The major difficulty in carrying out these studies is the lack of information from those involved about the materials and their installation, i.e. from the customer, the tile vendor, the manufacturer, the builder, the architect, the technical architect, etc. Apart from this incomplete and biased

information, whether deliberate or accidental, there is also the fact that most of the materials fitted have already experienced physical and chemical changes which make it difficult to assess their suitability at the time of fitting. Another problem which often arises during data collection is the clear tendency of those concerned to assign the defect to a particular cause. From this moment on, all the information supplied or requested seems to confirm the original theory. Without sufficient experience, this methodology of assuming a cause and then trying to prove it often serves to obscure other associated causes which should be taken into account, and may include the principal one.

It would therefore be very useful to introduce a questionnaire describing the defect, based on the "effects" produced, i.e. what is observed, and not on the possible "causes", which are what produce them. For example, the user would never consider chemical attack or abrasion, which are causes, but rather their effect or effects, such as the appearance of marks, a change in colour, or the surface losing its gloss, etc...

The classification of fitted ceramic tile pathologies according to the observed effects, together with the causes which give rise to them, could take the following form:

EFFECTS OBSERVED IN FITTED TILE ARRANGEMENTS	CAUSES OF THE EFFECTS
DEFECTS ARISING IN FITTED TILE ARRANGEMENT PRIOR TO USE	
Appearance related defects:	
- Shape related defects	- Misalignment - Lack of orthogonality - Unstraight sides - Curvature - Non-planar fitting - Incorrect joint size for the type of tile used
- Size related defects	- Calibres
- Finish related defects on the (colour, gloss)	- Production defects side which is visible - Shades - Defective design of the visible surface apparent in the arrangement
Texture related defects	- Non-melted portions - Anti-slip design

EFFECTS OBSERVED IN FITTED TILE ARRANGEMENTS	CAUSES OF THE EFFECTS
PROBLEMS ARISING IN FITTED TILE ARRANGEMENTS DURING USE	
Chipping	- Impacts and piercing - Freezing - Expandable particles within the tile - Lack of adherence in the glaze/support - Others: thermal shock, crypto-fluorescence, ...
Cracking	- Glaze/support joint tension - Thermal shock - Expansion due to humidity - Shrinkage of the mortar
Stains	- Open pores - Dirt-retaining texture - Deterioration of the surface due to opening or creation of pores and increase in roughness: + chemical attack + abrasion/scratching - Fluorescence (permeability) - Retention of dirt/fungus due to porous joints between tiles
Colour change	- Abrasion/Scratching - Chemical attack - Permeability (substrate humidity)
Loss of gloss	- Abrasion/scratching - Chemical attack - Efflorescence or patina
Breakage	- Extension/compression forces: + holes in mortar + floor tiling not floating and wit hout joints + band of supporting structure - Impact - Thermal shock - Freezing - Expansion due to humidity - Dilation/contraction due to temperature change
Loss of adherence between tile and support	- Expansion due to humidity - Dilation/Contraction due change in temperature - Design of the bonding surface (porosity and shape) - Shrinkage of the mortar - Tensions within substrate + Hardening + Structural movements + Heating by radiation - Efflorescence - Incorrect bonding surface preparation
Slipping	- Patina due to cleaning agents - Elimination of surface particles which make it anti-slipping + Chemical attack + Abrasion - Presence of water

Starting with this classification it is possible to design a guide/questionnaire (Appendix 1) which uses the questions asked to systemize the research into the causes of the pathologies which occur most frequently in fitted ceramic floor and surface tilings.

Furthermore, as an addition to the questionnaire, there is a list of the equipment required for studying the various pathologies in situ.

4.- ACKNOWLEDGEMENTS.

The authors wish to express their thanks to all those customers, manufacturers and associates who, over many years, have helped to improve our knowledge of the problems occurring in fitted ceramic floor and surface tilings.

5.- REFERENCES.

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[2] J.R. Amorós Albaro et al. (1991): Defectos de Fabricación de Pavimentos y Revestimientos Cerámicos. Ed. AICE-ITC, Castellón.

[3] Escardino, A.; Gonzáles, M. (1991): Azulejos y pavimentos cerámicos españoles. Ed. Ministerio de Industria, Comercio y Turismo, Madrid.

[4] Porcar, J.L. (1987): Manual-Guia Técnica de los Revestimientos y Pavimentos Cerámicos. Ed. ITC-Diputación de Castellón, Castellón.

APPENDIX 1 -Ceramic floor and surface tilings - behaviour when in service.

QUESTIONNAIRE

1.GENERAL INFORMATION

1.1. PETITIONER
Name and full address:
Telephone, Telex, Telefax:

1.2. FITTER
Name and full address:
Telephone, Telex, Telefax:

1.3. VENDOR AND/OR DISTRIBUTOR
Name and full address:
Telephone, Telex, Telefax:

2.AFFECTED BUILDING

2.1. LOCATION
Address, means of access, and sketch if necessary.

2.2. NATURE OF THE BUILDING
Single-family house, Public building (theatre, church, auditorium, school, hospital, etc.), Flat or apartment block, Commercial building or establishment, Industrial building, Office building, Sports building, etc...

2.3. NATURE OF THE DAMAGE
Brief description.

2.4. LOCATION OF THE DAMAGED AREA
Brief description:

2.5. Time between the fitting of the ceramic material and the appearance of the damage:

3.MATERIAL AFFECTED BY THE DAMAGE

3.1. TYPE
Floor or Surface tiling

3.2 .DESCRIPTION OF THE MATERIAL
Format:
Shape (Square, Rectangular, Curved, ...)
Manufacture:
Shaping (Dry pressing, Extrusion, ...)
Firing (Single firing, Double firing, ...)
Surface finish (Glazed, Non-glazed, ...)

3.3. PATTERNING TREATMENTS.
Engobe, Base glaze, Aerography, Serigraphy, Guttering, Natural stone effect (granite, marble, ...), Third fire patterning, ...

3.4 .SURFACE FINISH:

Gloss, matt, Ceria, Smooth, Undulating, Rustic, Relief, ...

3.5 .COLOUR:

3.6. COMMERCIAL CATEGORY:

3.7. DATES OR PERIOD OF MANUFACTURE:
3.8. DESCRIPTION OF PACKAGING, IN PARTICULAR THE IDENTIFICATION MARKINGS (SHADE, CALIBRE, MODEL NUMBER, ...)

3.9. MANUFACTURER
Name and full address:

3.10 .PIECES AVAILABLE FOR STUDY

3.10.1. New pieces manufactured at the same time. Who has them?

3.10.2. Single pieces which have been fitted. Who has them?

3.10.3. Can samples be removed from the affected area?

4.DATA RELATING TO THE FITTING OF THE MATERIAL

4.1. PLACE

4.1.1. Wall
Interior, Exterior covered, Exterior uncovered

4.1.2. Floor
Interior, Exterior covered, Exterior uncovered

4.2. ORIENTATION OF THE MOST AFFECTED AREA
North, East, South, West.

4.3. STRUCTURE OF THE BUILDING
Reinforced concrete, Iron, Breeze block, Brick

4.3.1. Dates or period during which the structure was completed:

4.3.2. Total number of storeys:4.3.3.Which are the most damaged storeys:

4.4. BASE ONTO WHICH THE FLOOR OR SURFACE TILE IS FITTED
Brief description:

4.4.1. Dates or period during which the base was completed:

4.5. BONDING OR SEALING MATERIALS
Indicate the make, the type, the mix proportions, and the preparation details of the materials used.
Mortar (Cement, Sand, Water, other additives), Cement, Bonding-cement, Adhesive, Fillets, ...

4.6. FITTING METHOD

4.6.1. Draw the type of material fitting

4.6.1. Fixing the ceramic material:
Onto a continuous layer of glue, Individual fixing piece by piece, ...

4.6.2. Joints between the pieces:
Wide, Narrow, Metal, ...

4.6.3. Of what material are the joints between the pieces made?

4.6.4. Porosity of the joint material:

4.6.5. Is the joint material cracked in the areas where the damage has occurred?

4.6.6. Dilation joints in the ceramic surface.
Description of the nature, condition, depth and seal of the dilation joints:4.6.7.How and when have these joints opened?

4.6.8. Are there any joints or separations where the floor meets the wall?

4.6.9. Dilation joints in the underlying base.
Information on the existence and condition of other dilation joints in the materials that form part of the structure and the base on which the ceramic floor or surface tiling is fixed.

4.6.10. Do the dilation joints of the ceramic surface coincide with other dilation joints of the underlying base or the structure ?

4.6.11. Does the depth of the dilation joints include the whole base so as to reach the structure?

4.6.12. Time between the completion of the structure and the fixing of the ceramic material:

4.6.13. Time between the completion of the base and the fixing of the ceramic material onto it:

4.6.14. Wetting of porous ceramic pieces before fitting.
None, Slight, Average, Severe

4.6.15. Were there any adverse climatic conditions during or immediately after the fitting of the material?
Hot dry air, Freezing, ...

4.6.16. Efflorescence, patina, veiling and colour changes.
In the ceramic tiles, In the mortar or in the joints, In the bricks, ...

4.6.17 Working practice of the fitters. Did they charge by the piece ?

4.7. NEW OR REFORMATION WORK. Specify.

4.7.1. In the reformation work, was the existing ceramic material removed in order to install the new one ? Was the new material fitted on top of the previous one ?.

4.7.2. What was the condition of the old ceramic surface
which has been recovered with new material ?.
In good condition, Worn away, With separate broken pieces, With cracks through several pieces, With loss of flatness, ...

5. DATA RELATING TO THE DAMAGED AREA

5.1. Areas:
Total area fitted: . . . . . m^2
Total area affected : . . . . . m^2. If this data is unavailable, describe in some way the magnitude of the damage.

5.2. Dates:
Approximate date on which the fitting of the floor and surface tiling was completed:

5.3. Approximate date on which the damage was detected:

5.4. DESCRIPTION OF THE DAMAGED AREA
Provide a sketch of the area.
Sketch of the area where the damage has occurred, indicating the positions of the pillars, beams, windows, etc. Indicate the most affected areas on the sketch.

5.5.1. Describe in detail the damage of the ceramic material together with an accompanying sketch of the damaged piece or pieces if necessary.

5.5.2. Explain how any special pieces or accessories are involved in the damage, for example : edgings, plugs, fillets, skirting boards and others.

5.6. EXISTING INSTALLATIONS
Describe the installations which are in the affected area:
- external installations (thermos, heating equipment, pipes, pumps, engines, machinery).
- built-in installations, such as anchorages and conduits of any kind.

5.7. ENVIRONMENTAL CONDITIONS

Describe any adverse environmental conditions which exist in the affected area:

- Atmosphere contamination
- Persistent humidity of whatever origin
- Salty air due to nearness of sea.
- Accessability of soluble compounds from the ground.
- Sporadic or persistent contamination by noxious substances in storage.
- Excessive insulation.
- Other conditions. Describe.

6. DEFECT DESCRIPTION

TYPE 1.-PROBLEMS OCCURRING IN THE FITTED TILE ARRANGEMENT PRIOR TO USE

1.1.- APPEARANCE RELATED DEFECTS
1.1.1.- SHAPE RELATED DEFECTS
1.1.2.- SIZE RELATED DEFECTS
1.1.3.- FINISH RELATED DEFECTS (COLOUR AND GLOSS).

1.2.- TEXTURE RELATED DEFECTS

TYPE 2.-PROBLEMS OCCURRING IN THE FITTED TILE ARRANGEMENT DURING USE

2.1.- CHIPPING
2.2.- CRACKING OF GLAZE
2.3.- APPEARANCE OF STAINS
2.4.- COLOUR CHANGE OF THE OBSERVED SURFACE
2.5.- CHANGE IN GLOSS OF THE OBSERVED SURFACE
2.6.- BREAKAGE
2.7.- LOSS OF ADHESION TO WALLS OR FLOORS
2.8.- SLIPPING

6.1. SHAPE RELATED DEFECTS

Specific questionnaire for this type of defect.

6.1.1. Is the separation (the fitting joints) greater at some vertices than at others, for aparticular tile?

6.1.2. Is there any apparent deformation of the tile, such as:
- lack of orthogonality (misalignment)
- lack of straightness of sides

6.1.3. Is there any apparent lack of flatness in the floor or surface tiling ?

6.1.4. The lack of flatness always occurs in the same part of the tile:
- on an edge,
- at a vertex or
- in the centre ?

6.1.5. Is there any apparent loss of adhesion of the tiles?

6.1.6. When the tiles are struck, can a hollow sound be heard coming from behind them ?

6.1.7. Is the curvature present in single pieces or spread over several pieces ?

6.2. SIZE RELATED DEFECTS
Specific questionnaire for this type of defect

6.2.1. Is the defect to do with the fact that there are tiles of different sizes or calibres ?

6.2.2. Are the tiles of different sizes the same model ?6.2.3.Do the ceramic tiles of different sizes come from the same box ?

6.2.4. Has the packaging of the ceramic tiles been kept ? Does it indicate the "calibre" ?. If so please specify.

6.2.5. Indicate the type of ceramic tile:
Dry pressed, extruded.

6.2.6. Indicate the width of the joints of the ceramic tiles: approximately _____mm

6.2.7. Are ceramic tiles of different sizes randomly distributed, or is there a specific area where the sizes are all the same, but different to that in other areas?

6.3. FINISH RELATED DEFECTS (COLOUR AND GLOSS)
Specific questionnaire for this type of defect

6.3.1. Does the apparent defect in the ceramic tile surface correspond to one of the following types:
a) Cracks: Any break in the ceramic tile body
b) Cracking: Fracturing of the glaze, appearing as a crack with an irregular trace.
c) Lack of glaze: small areas in the ceramic tile glazed face which have no glaze.
d) Undulation (small depression): unintentional depression in the ceramic tile surface.
e) craters
f) Holes (perforations): very small holes in the surface of the glazed ceramic tile
g) Unintentional non-uniformity of the ceramic tile surface
h) Spots and stains: Any spot which makes an unintentional contrast with the observed surface of the ceramic tile
j) Defects under the glaze
k) Pattern defects
l) De-toning
m) Splintering of the sides
n) Blunting (of the edges)
o) Border: Abnormally large accumulation of glaze in the form of a linear swelling along an edge
p) Surface protuberances (lumps, bulges, ...)
q) Lines and scratches
r) Bubbles: Small superficial bubbles, either open or closed, resulting from the expulsion of gases during the firing process
s) Others (Describe in detail)

6.3.2. Is the problem systematic or does it only affect certain tiles?

6.3.3. Is the effect apparent in single tiles or only when several are observed together?

6.3.4. In the case of patterned tiles, are they fitted in the same orientation?

6.3.5. If the problem involves variations in colour between one piece and another (shades), are they areas of one colour next to areas of another? Are they groups of tiles or single tiles which stand out from the rest?

6.3.6. If the packaging has been kept, please indicate the shade.

6.4. TEXTURE RELATED DEFECTS
Specific questionnaire for this type of defect

6.4.1. Is there any colour or gloss change associated with the change in texture?

6.4.2. In the case of unintentionally rough textures, is the rough texture caused by discrete particles spread over the tile?

6.4.3. In the case of floor tiling, was resistance to slipping requested?

6.5. CHIPPING
Specific questionnaire for this type of defect

6.5.1. Does the chipping occur in individual tiles or in groups of tiles?

6.5.2. Are there any cracks or fissures associated with the chipping?

6.5.3. In the case of glazed tiles, has the chipping exposed the ceramic support ?

6.5.4. In the previous case, does the chipping affect the support, or only involve the unsticking of the glaze from the support?

6.5.4.I s the chipping circular in nature or does it have directionality?

6.5.5. Is the type of chipping:
- conical, with the vertex inside the tile,
- conical, with the vertex in the upper part of the tile,
- circular, with onion-shaped fissures?6.5.6.Can any particles be seen inside the chipped region?

6.5.7. During what stage of the construction was the material fitted (before partitioning, after painting, ...)?

6.5.8. After fitting was the material subsequently protected with sawdust, wood, boxes, ... until the completion of the work?

6.5.9. Are any piercing or heavy objects handled in the area where the chipping has been observed?

6.5.10. Has the chipping occurred at the tile edges? Do these edges protrude from the plane of the tiles?

6.5.11. Is there any circulation of mobile devices with wheels (vehicles, trolleys, ...). What kind of wheels do they have (steel, rubber, ...)?

6.5.12. In the case of chipping in walls, is there furniture (tables, chairs, beds, ...) at the same height as the chipping?

6.5.13. Are the chipped ceramic tiles outside, where there is the possibility of freezing?

6.5.14. Has the chipping occurred in tiles which are subject to puddle formation under certain conditions?

6.6. CRACKING OF THE GLAZE
Specific questionnaire for this type of defect

6.6.1. Does the cracking of the glaze layer of the ceramic tiles occur in isolated pieces or in groups of tiles?6.

6.2. If the cracking occurs in groups of tiles, is it possible to observe any regularity or orientation ?

6.6.3. Is there also any cracking of complementary pieces such as ornamental pieces, skirting boards, etc ...?
If so, give a short description.

6.6.4. Are there any associated cracks in the support ?

6.6.5. Does the cracking occur only in ornamental pieces and not in the rest ?

6.6.6. Are there humidity sources or humid environments where the cracking occurs ?

6.7. APPEARANCE OF STAINS
Specific questionnaire for this type of defect

6.7.1. Did the defect occur before or after using the installation ?

6.7.2. During what stage of the construction was the material fitted (before partitioning, after painting, ...)?

6.7.3. After fitting, was the material subsequently protected with sawdust, wood, boxes, ... until the completion of the work?

6.7.4. Who carried out the first cleaning operating of the fitted material and how ? The fitters themselves ? Other personnel of the building company ? A cleaning company ? (Give the name and address of the company)

6.7.5. Give the following dates if possible:
Date of fitting:
Date of first cleaning:
First date of use:
Date on which the defect occurred:
Other possible dates of interest:

6.7.6. Give the following information if possible, pointing out if it is a FIRST CLEANING or if it is the maintenance cleaning performed by the USER:
+ Cleaning agents used (chloric acid, soap, bleach, ammonia, ...). Specify the concentrations employed, the make and the manufacturer. Indicate if it is possible to obtain samples.
+Mechanical means employed (cloths, automatic cleaners, polishers, ...). Specify the type of brush or disk used.
+Method of cleaning. Indicate how long the reagents are in contact with the material, the number of times that cleaning has been carried out, special procedures in areas which were not fully cleaned the first time, ...).

6.7.7. Is there any surface deterioration associated with the stains ?
- Loss of gloss
- Increased roughness
- Increased dirt retention

6.7.8. Indicate the type of stain.
- spots
- uniform stains
- stains associated with some decorative effect of the tile (serigraphy, graining, relief, ...)

6.7.9. Did the stains assume a peculiar form, e.g. spilt liquids, drops, circular shapes, ...?

6.7.10. Did the stains appear in certain areas of the tile, in particular, at the edges ?. If so, do the stains affect the adjacent tiles symmetrically ?

6.7.11. Has there been any increase in the number and extent of the stains ? Is this associated with the cleaning methods, or even with the use of stronger cleaning methods ?

6.7.12. Can the stains be eliminated with normal cleaning ? Indicate the time they take to reappear.

6.7.13. Do the stains appear locally in areas of transit or work (around tables, doors, workbenches, corridors, ...?

6.7.14. Is there any veiling or patina associated with the stains, either on the tile surface or at the fitting joints ?

6.7.15. Are there any possible humidity sources in the areas where the stains have appeared (pipes, floor, wet mortar,...) ?

6.7.16. Is the stain blackish in colour with a metallic gloss ? If so, indicate whether there are any sources of sulphurous gases (septic tanks, industrial site chimneys, ...)

6.8. CHANGE OF COLOUR OF THE VISIBLE SURFACE
Specific questionnaire for this type of defect

6.8.1. Did the defect occur before or after using the installation ?

6.8.2. During what stage of the construction was the material fitted (before partitioning, after painting, ...)?

6.8.3. After fitting, was the material subsequently protected with sawdust, wood, boxes, ... until the completion of the work?

6.8.4. Who carried out the first cleaning operating of the fitted material and how ? The fitters themselves ? Other personnel of the building company ? A cleaning company ? (Give the name and address of the company)

6.8.5. Give the following dates if possible:
Date of fitting:
Date of first cleaning:
First date of use:
Date on which the defect occurred:
Other possible dates of interest:

6.8.6. Give the following information if possible, pointing out if it is a FIRST CLEANING or if it is the maintenance cleaning performed by the USER:
+ Cleaning agents used (chloric acid, soap, bleach, ammonia, ...). Specify the concentrations employed, the make and the manufacturer. Indicate if it is possible to obtain samples.

+Mechanical means employed (cloths, automatic cleaners, polishers, ...). Specify the type of brush or disk used.
+Method of cleaning. Indicate how long the reagents are in contact with the material, the number of times that cleaning has been carried out, special procedures in areas which were not fully cleaned the first time, ...).

6.8.7. Is there any surface deterioration associated with the change of colour ?
- Loss of gloss
- Increased roughness
- Increased dirt retention

6.8.8. Is the change of colour associated with some decorative effect of the tile (serigraphy, graining, relief, lustre...) ?

6.8.9. In the case of any lustre or other decorative effect on the glaze, were the tiles protected whilst the joints between the tiles were filled ?

6.8.10 .Has there been any increase in the change of colour? Is this associated with the cleaning methods, or even with the use of stronger cleaning methods ?

6.8.11. Do the colour changes appear locally in areas of transit or work (around tables, doors, workbenches, corridors, ...?

6.8.12. Are there any possible humidity sources in the areas where the colour change has occurred (pipes, floor, wet mortar,...) ?

6.9 CHANGE IN GLOSS OF THE VISIBLE SURFACE
Specific questionnaire for this type of defect

6.9.1. Did the defect occur before or after using the installation ?

6.9.2. During what stage of the construction was the material fitted (before partitioning, after painting, ...)?

6.9.3 .After fitting, was the material subsequently protected with sawdust, wood, boxes, ... until the completion of the work?

6.9.4. Who carried out the first cleaning operating of the fitted material and how ? The fitters themselves ? Other personnel of the building company ? A cleaning company ? (Give the name and address of the company)

6.9.5. Give the following dates if possible:
Date of fitting:
Date of first cleaning:
First date of use:
Date on which the defect occurred:
Other possible dates of interest:

6.9.6. Give the following information if possible, pointing out if it is a FIRST CLEANING or if it is the maintenance cleaning performed by the USER:
+ Cleaning agents used (chloric acid, soap, bleach, ammonia, ...). Specify the concentrations employed, the make and the manufacturer. Indicate if it is possible to obtain samples.
+Mechanical means employed (cloths, automatic cleaners, polishers, ...). Specify the type of brush or disk used.
+Method of cleaning. Indicate how long the reagents are in contact with the material, the number of times that cleaning has been carried out, special procedures in areas which were not fully cleaned the first time, ...).

6.9.7. s the loss of gloss associated with some decorative effect of the tile (serigraphy, graining, relief, lustre...) ?6.9.8In the case of any lustre or other decorative effect on the gloss, were the tiles protected whilst the joints between the tiles were filled ?

6.9.9. Has there been any increase in the loss of gloss ? Is this associated with the cleaning methods, or even with the use of stronger cleaning methods ?

6.9.10. Does the loss of gloss appear locally in areas of transit or work (around tables, doors, workbenches, corridors, ...?

6.10. BREAKAGES
Specific questionnaire for this type of defect

6.10.1 .Do the breakages in isolated tiles or in groups of tiles ?

6.10.2. Can the breakages be described as fissures or cracks?

6.10.3. If the breakage affects groups of tiles, is there any regularity or orientation ?

6.10.4. Do the breakages also affect complementary pieces such as skirting boards, edges, plugs, etc...?

6.10.5. Do the fissures have a thread-like form such that they can only be identified with backlighting ?

6.10.6. Is the breakage continuous across various pieces ?

6.10.7. Is there any chipping in the area of the breakage ?

6.10.8. Is it possible to determine wether the breakage is sunken or raised ?6.10.9.Are the breakages near to load-bearing structures (pillars, beams, etc...) ?

6.10.10. Are there any raised or sunken areas in the region of the breakage ?.
If so, give a brief description.

6.10.11. Are there any symptoms of settling of the building such as cracks in stairways, the facade, door and window frames, etc.?.
If so, give a brief description.

6.10.12. If any floor or surface tiling from another manufacturer was installed in the same building, have breakages occurred in them as well ?

6.10.13. By tapping the tile, is it possible to detect a lack of adhesive material in some parts of the tile (in particular, the vertices) ?

6.10.14 Can the tiles with breakages be easily extracted or unstuck ?

6.11. LOSS OF ADHESION TO THE WALLS AND FLOOR
Specific questionnaire for this type of defect

6.11.1. Does the unsticking of the ceramic tiles occur in isolated pieces or in groups ?

6.11.2 .If the unsticking occurs in groups of tiles, is there any regularity or orientation ?

6.11.3. Is there also any unsticking of complementary pieces such as skirting boards, edges, plugs, etc...?
If so, give a brief description.

6.11.4. Where does the unsticking occur?
- Between the ceramic tile and the mortar.
- Between the mortar and the base.

6.11.5. Are there any raised areas or places which sound hollow when struck ?
If so, give a brief description.

6.11.6. Is there any humidity in the areas where unsticking has occurred ?

6.11.7. Are there any symptoms of settling of the building such as cracks in stairways, the facade, door and window frames, etc.?.
If so, give a brief description.

6.11.8. If any floor or surface tiling from another manufacturer was installed in the same building, has any unsticking occurred in them as well ?

6.12. SLIPPING PROBLEMS
Specific questionnaire for this type of defect.

6.12.1. Was ANTI-SLIPPING requested in the purchase order ?

6.12.2. Are there any manufacturer's details regarding this ? (brochures, packaging, ...) ?

6.12.3. Has the slipping problem existed since the beginning or has it been increasing progressively ?

6.12.4. Did this problem coincide with a change in the cleaning products ?6.12.5.Does the slipping problem occur :
- on a clean, dry floor
- on a clean, wet floor
- on a wet, dirty floor (muddy)

6.12.6. Does the slipping problem occur:
- with any type of footwear
- only with bare feet
- with special footwear

6.12.7. Is the slipping problem
- general on the whole floor tiling
- locally in ramps, stairways, ... (Specify).

6.12.8. Are there any associated defects (stains, colour change, loss of gloss,...) ?

6.12.9. If the material described by the manufacturer as "anti-slipping" has grains or relief, has there been any change with time (loss, wear,...) ?

6.12.10. Indicate the type and frequency of cleaning of the affected areas.

APPENDIX 2 - Ceramic floor and surface tilings - Behaviour when in service

EQUIPMENT

Apart from stationary or recording instruments, the usual equipment for studying the variouspathologies of ceramic floor and surface tilings in situ normally consists of:

1.- 35 mm camera with 210 mm objective lens.

2.- Automatic flash or torch.

3.- Tripod for exposures without flash.

4.- Soft pencil to detect changes in textures.

5.- Rubber eraser to determine the ease with which stains can be removed.

6.- Lantern to detect changes in gloss.

7.- Pocket magnifying glass with a built-in light.

8.- Water level .

9.- Telescopic rule for curvatures and raised areas.

10.- Graduated scales for photographic reference.

11.- 2m metric tape measure.

12.- Various cleaning agents and utensils.

13.- Indelible ball-point pen for labelling samples.

14.- Resistant plastic bags of various sizes.