V - THE INTERNATIONAL STANDARDS FOR CERAMIC FLOOR / WALL TILES. PRESENT SITUATION AND WORK IN PROGRESS

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In the ceramic paving and tiling sector, standardization has transgressed the confines of national and european borders and expanded throughout the world. The European Standardization Committee (CEN) has already completed the preparation of common standards, for which a revision procedure is being initiated: in fact, according to CEN ruling, a standard should be revised and reapproved (or not) five years after it comes into effect, in order to critically evaluate its efficacy and eventually implement any modifications considered necessary, because of new technological developments, for example, or different requirements arising from the end users. It is obvious that, for technical standards, obsolescence problems can also arise, these are solved by periodical revisions and up-dates.

At a European level, this work has parallel activities in some areas: the application of a world standard, to be carried out by the ISO (International Standards Organisation), which provides a harmonization between european standards and standards outside Europe, in particular in those countries that are directly interested in the production and, more generally, in the market of ceramic tiling and paving. Not only european standards, but also other countries standards must be taken into account in this work (e.g. ANSI/ASTM, australian, canadian and japanese standards, etc.), taking each one of these requirements and changing them into a body of standards that has a validity on a world scale. The evaluation to be performed is difficult if only because existing standards are based on different requirements and often very different (if not antithetical) customs. However, this conformity is necessary if only to protect, in an unequivocal, clear way, the producers, distributors and consumers of ceramic tiles.

On the basis of these considerations, the ISO appointed a technical committee, the ISO/TC 189, in 1985, with the object of preparing a technical standard for the sector. This act assumes a particular importance if, the structure and composition of the above mentioned Committee are firstly considered:

- P-members (those members directly involved in the industry) represent 75% of worldwide production of ceramic tiling and paving pieces;

- taking into account the O-members (those members not directly involved in the industry, but who have declared their interest), 85% of world production is represented on the committee; this means that the great majority of the manufacturing community is involved or has an interest in the studies, which guarantees a suitable representativeness in all that the committee implements and decides.

If the working programme, as defined in the course of the first meeting, especially the selection of Working Documents,is considered, it can be immediately seen that the european standard is always utilized (if it exists, obviously), whether for the classification of tiles (on the basis of water absorption and formation method), or for the characteristics and testing methods, confirming the validity of the years of work carried out in europe. Obviously other standards have been taken into consideration, particularly for characteristics that are not considered in the original version of the european norms: this is true whether it is bearing in mind other requirements or carrying out a critical evaluation of the european norms in the various years since they came into effect. The work of ISO/TC 189 is similar and complementary to the revisory activities that are happening in Europe, for which reason CEN/TC 67 (european equivalent of ISO/TC 189) decided to stay the revision of standards that have expired, and wait for the results of studies carried out by the ISO.

For a better comprehension of the role and type of activity of the latter, we briefly resume the procedures followed by the ISO.

- within the Technical Committee there are two working groups operating, one concerned with perfecting testing methods (WG1, headed by C. Palmonari of the Italian delegation), and one that must define requirements (WG2 headed by an English man, L. Burton); these committees draw up "Work Items" for specific areas, once these are approved, they are registered as "Draft Proposals" by the ISO Central Secretariat.

- the Technical Committee Assembly, headed by the american, R. J. Kleinhans whose office is constantly working with the United States through W. Bauer, discusses and votes on these. Once these are approved, the ISO Central Secretariat registers them as "Draft International Standards" and sends them to member countries of the ISO for comments and a vote;

- when the "Draft International Standards" receive the approval of 75% of the voting members and the majority of the P-member Technical Committee, they are sent to the ISO council which, after approval, authorize publication as an "International Standard" (ISO Standard).

The work carried out until now by the ISO/TC 189 can be considered as an initial re-

examination and improvement of EN standards, brought about by the incorporation of standards taken from other non-european countries, and the development of new standards, from aspects and areas not covered by EN standards.

One of the first actions of the committee was to approve the incorporation of each one of the EN product standards into one document for each class of tile. This procedure, which is used in various countries, eliminates repetitions in sections common to all classes, and makes the product specifications for all tiles available to the consumer in one document. However, as some countries require the publication of only some of the product specifications, it is considered opportune to deal with the characteristics of each and every one of the tile classes in a separate chapter from the standard group.

With regard to the activity of each of the working groups, WG2 obviously cannot complete the product specifications until all testing methods have been defined; however, an agreement has been reached on everything concerning dimension tolerances, and various product identification problems (what are split tiles, what are quarry tiles, etc..) have been resolved. Of particular interest is the tentative introduction of two new classes of floor tiles: the first is derived from the subdivision of group I into two subgroups: the group Ia, that includes tiles with a water absorption $E < 0.5\%$, and group Ib, to which floor tiles with a water absorption of $0.5\% < E < 3\%$ belong; the second is the splitting of group III into group IIIa, with $10\% < E < 20\%$ and group IIb with $E > 20\%$. It has also been decided to adopt the phrase "friction co-efficient" instead of "slipping" or "precipitation", when weighing up the anti-skid characteristics of the tiles, to avoid any implication that could have repercussions of a legal/ insurance nature: the product standards will only indicate the friction co-efficient values as declared by the manufacturer, leaving the problem of defining optimum fields of use for the tiles to another standards body.

As far as the testing methods apply, it has been acknowledged in some cases that the present european standards were valid and, as a result, have been readopted with some small alterations, where necessary.

This is the case in standards relating to the determination of:

- characteristics of dimensions and appearance

- lineal thermic dilation co-efficient

- dilation through humidity

- resistance to scratching

- resistance to thermic shock

- resistance to deep abrasion (unglazed floor tiles)

For characteristics not considered in the EN standards, the testing methods proposed by american standards have been approved, with small modifications. This is the case for the determination of small differences of colour in glazed floor tiles of the same dye-lot and for the determination of the extractable lead and cadmium content in tiles (this last test applies to floor tiles used in areas where food is handled). Staying in the area of characteristics not dealt with by the EN standards, it was preferred not to fix a specific standard for electric conductivity; such a requirement, important in certain areas of application (in operating theatres, for example), is, however, only concerned with a very small amount of uses, and, as such, it was decided not to include it in a general set of standards.

In the case of other characteristics, even where set methods for european standards were followed, it was considered necessary to include certain modifications to perfect methods which, after close examination over the years, since they came into effect, have exhibited some limiting factors. The methods (already tested) for determining water absorption, flexion resistance and resistance to surface abrasion of glazed floor tiles deserve special mention.

In the case of **water absorption**, a fundamental parameter for the classification of floor tiles, we came up against two methods which differed from each other even in concept:

- the european method, which involves impregnation with boiling water, thus giving an indication of open porosity (a specially important parameter where characteristics during use are concerned);

- a method proposed by the USA and based on vacuum impregnation.

Various laboratories presented a considerable quantity of data, from which the conclusion was drawn that the vacuum method was the most accomplished and precise method and requires the shortest time (only 45 minutes, compared with 7 hours for the EN method, and 29 hours for the ASTM method). However, in spite of the majority of the committee favouring the vacuum method, the problem of possible repercussions from the adoption of this more precise method, for some european manufacturers whose tiles ran the risk of changing class presented itself. Because of this, the committee approved an outline of the proposal, according to which the measurement of water absorption, from which the product class is defined, continues being carried out according to the present EN norm (immersing the samples in boiling water for two hours). However, other measurements determined by this test (apparent porosity, apparent specific weight, apparent density) are established by the use of vacuum impregnation.

Even for the determination of **flexion resistance**, it was necessary to critically re-examine the method proposed by EN 100. With the present tendency for producing ever thinner tiles, it also seemed essential to fix a minimum value for fracture resistance. Such a requisite, however, is presently foreseen by the French classification, UPEC, for ceramic tiling and by the American specifications, ANST. It must be remembered that the fracture modulus, whose calculation eliminates the effect of thickness, represents more than the measurement of a characteristic but also a measurement of the performance of the tile. After a careful comparative evaluation of the existing testing methods, on the basis of numerous laboratory data, it was agreed and approved to maintain the methods proposed by EN 100, adding a modification, concerning the evaluation of the resistance to fracture, to the calculation. It was observed that this parameter can undergo variations, as can any other condition (type of glaze and support, water absorption, etc.), when translated from square tiles to tiles of other shapes. This discrepancy can be solved by multiplying the resistance value (as read from the test instrument), by the ratio of the distance from the support rollers to the length of the fracture section; in this way a "calculated" value of resistance, which is independent of the shape of the tile and which can therefore be used to define minimum performance requirements, is obtained.

As happened in Europe, the problem of **resistance to abrasion of the surface of glazed floor tiles** was also the subject of lengthy discussions in the ISO, on the other hand, the relevance of this characteristic for evaluating the ambit of use for paving tiles is well known, as are the responses that it frequently gives rise to. The approved method, that envisages the adoption of just one damp testing procedure (PEI), has the following innovations:

- it introduces a "minimum threshold of wear" (100 turns), all tiles must withstand this limit without visible alterations or they cannot be classified as paving tiles.

- for the method for observing the degree of abrasion, a specific standard will be elaborated to be used not only for glaze abrasion but also for visually evaluating other types of resistance (chemical resistance and resistance to stains); the standard envisages the use of a "viewing box" already included in the american standard).

- an extra class of resistance to abrasion is introduced, besides the 1500 turns of EN 154 (that defines upper limits for class III), another 4 figures are set for turning, (2200, 3000, 6000 and 12000), which define class IV. If the tiles show no sign of visible abrasion at 12000 turns, they are classified as class V. The need to create a differentiation on a higher level arose from the fact that there are tiles on the market, at the moment, that have a high resistance to abrasion and which were undervalued by the EN 154 figure of 1500 revolutions, which did not take

into account technological evolution, as in the performance requirements for the paving material.

The work of defining testing methods for other characteristics is still in progress, thus we are limited to giving a description of the present state of play for these studies.

Chemical Resistance. It was initially planned to group the methods corresponding to glazed and unglazed floor or wall tiles into one standard, but we realised that such a hypothesis could give rise to problems in classification of the results, hence it was decided to keep the two standards separate, (as do the european standards). The modifications to be applied are directed towards reducing as far as possible, (and without reducing the validity of the method) the testing time, and simplifying classification, introducing 3 classes of resistance. The test solutions are those which are presently envisaged by the EN standards for the two types of floor tiles. For evaluation of the degree of adhesion, see the standard for visual examination, mentioned above.

Resistance to stains. First of all it must be remembered that the EN standards only foresee such a test for glazed tiles and include it in the standard for chemical resistance. According to the thinking of WG 1, there should, on the contrary, be an express standard for both types of product. Moreover, the possibility of changing the "staining agents" used has been considered and examined; according to EN 122, methylene blue and KMnO4, chosen on the basis of the type of reaction that they explain, must be used. (One is a typical staining agent with penetrating action, while the second indicates, as it develops, an oxidation reaction.) However, the range of staining agents with which floor tiles can come into contact is much greater, so it was considered necessary to add other agents (such as olive oil, black shoe polish, cigarette ash, etc.), which were representative, although they were different types of stains, of a much greater spectrum of substances, analogous to everyday life. Preliminary tests show that, on comparing these new staining agents, resistance can be moderate, especially in the case of unglazed floor tiles. However, if we take into consideration the type of detergents and cleaning to be used, this obviously influences the final result of the test. The hypothesis was made that, if there was a certain margin of discretion, for example, including in the standard the possibility of experimenting with dissolvents appropriate to the types of stain, whilst leaving the staining agents and adhesion methodology fixed, the standard would remain "open", in that way leaving the field open to experimentation with new solutions without any impediment from comparisons to research that is in continuous progress. In any case, this deals with a methodological direction that requires further study.

Likewise, in the case of evaluation of **resistance to ice,** it is not easy to draw up a completely satisfactory methodology, if only because the meteoclimatic conditions of various countries are distinct, and because the damage mechanism of ice is encouraged by freeze/defreeze phenomena characterized by cyclic behaviour. For an adequate method of evaluation, lengthy test methods would be necessary which would result in infrequent application in the case of quality certification. The possibility of drawing up two methods was considered; a fast method for supplying indications on the "consideration of freezing risk", and a longer, more complex method (unidirectional would be best) that anticipates all type of indications, including behaviour in conditions of real use. The preparation of an "open" standard was also suggested, where the test laboratory chooses the minimum and maximum temperatures of thermic cycles, according to meteoclimatic conditions which the tiles may encounter. Both hypotheses possess advantages and defects and, as a result, the study is still in progress.

Finally, the **friction co-efficient**. There are three accredited methods for evaluating this:

- the american system: this provides a static friction co-efficient;

- the english system: this allows the calculation of the dynamic friction co-efficient;

- the german system: this simulates real conditions, (the operator walks on the tiles, which are placed on an "in crescendo" inclined plane), and gives a value corresponding to the co-efficients.

Here also, the three methods have their own advantages and defects, although we feel that we should orientate ourselves more towards the english method. At the moment comparative tests are being carried out to see if there is a correlation between the different methods. It should be mentioned that the slipping or precipitation method is quite complex, being the result of a static and dynamic component; on the other hand, the simulation of real conditions, (as, for example, in the german standard), has the disadvantage of being too dependent on subjective conditions, (such as those depending on the operator); moreover, it is not possible to carry out tests with this method where the phenomenon of slipping or precipitation can originate from a series of factors unreproducible in the laboratory, as for example the cleanliness/maintenance condition of the surface, which often has a notable influence on anti-slipping behaviour or, at least, on the tile surface.

This overview, although only a summary, gives a picture of the methodological paths presently being followed; it is being attempted to improve the existing standards so we can move towards new demands, from the manufacturers as well as the consumers, considering different experiences and domains. There are many problems, some of which have already been resolved, others are still on the drawing board. It is, however, considered that the spirit of co- operation between the members of the ISO/TC 189 Technical Committee represents a sure guarantee that the standards to be approved will constitute an advantageous progress for the ceramic tile industry worldwide.