TILE LAYING ON PROBLEMATIC SUPPORTS. NEW SUPPORTS NEED NEW TECHNOLOGIES

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PRELIMINARY REMARKS

Many people outside the industry and people who do not have much involvement with the building trade find it hard to believe, but even the construction industry (in fact, especially the construction industry) is in the throws of an upheaval caused by a flurry of new technical developments. New building materials demand new methods of dealing with them. These new basic principles are just as often to be found in the new building sector as in modernization and rebuilding work - sectors which, in most parts of the world, are, from the point of view of volumes, more interesting in this present connection than new building.

For the floor-tiling business, the following are of special interest: wood and particle boards and sandwich type plaster boards (from the most basic to anhydrite screeds), but also old cement or asphalt screeds with or without a coating and with greater or lesser amounts of fissuring, old tile coverings, and even metal substrates - all these need to be covered with some form of tiling. Many of these substrates are regarded as «difficult», at least in the light of traditional tile-laying techniques, since:

a) they show a persistent tendency towards deformations, are more flexible than stable (sandwich type plaster board, wood, chip board), and, in the case of composition floors, exhibit a tendency to shrink and buckle,

b) even in their pristine state they are already prone to fissuring, which has to be bridged over (old floors, old tile coverings),

c) over the course of time they display fissuring, mostly through shrinkage during drying and precipitation processes (all types of screed), a phenomenon which tends to get worse if the necessary settlement joints are not incorporated,

d) they often remain moisture-sensitive and must therefore be sealed.

Within this context, there is a need for tile-laying systems which

* sufficiently uncouple a tile covering from the substrate so that transverse forces and buckling do not communicate themselves to the floor covering, while continuing to provide the necessary mechanical support,

* can also bridge over the fissures (up to about 2 mm) which arise during the «lifespan» of the building,

* provide an effective degree of sealing in the cases cited above,

* are user-friendly and thus reduce risks to the floor-tiler to acceptable levels.

As a rule, sealing can only be effected in such cases in combination with other materials. The official recommendations and instructions offer the floor-tiler only limited help in this regard. So the German Code of Practice, for example, tells us, in its

«Remarks on the execution of sealing in combination with the covering and laying of tiles and panels for interior areas» (Position: February 1988) that «As a rule, this sealing remains effective in the event of fissures in the substrate up to 0.2 mm in breadth.»

Later it says:

«The substrate should only become distorted to a limited extent after the sealing has been carried out. In substrates which shrink and creep, the sealing and cladding materials should be applied at the last possible moment.»

There is also a clear-cut statement to the effect that:

«As the standard value one may assume that, on substrates of concrete and stonework, sealing and cladding materials should be applied approximately 6 months after construction.»

Just as unequivocal is the following statement:

«Lime- and gypsum-plastering and white coat, wood and derived timber products, are not suitable as substrates for sealing of this type.»

To sum up:

* The old floors referred to above generally show fissuring in excess of 0.2 cm.

* Regarding the renovation of balconies, building work involving sealing, surface drainage, composition floors and floor-tiling should be regarded as the exception, and not just in the case of older buildings. No height reserve is allowed for by legislation. In renovation work, therefore, it is not possible to proceed in accordance with this method. In most cases, however, damage to balconies is water damage, so renovation therefore always means first and foremost sealing. In circumstances such as these, this is something which can only be carried out in combination with other materials.

In the bare-brick and interior works of 1994 you can scarcely find a corner which has not been worked over with

* lime-coating and white coat

* wood and derived timber products
* sandwich type plaster board
* (increasingly) anhydrite products

Does this mean that ceramic products are being left out in the cold? That is something which should certainly not be allowed to happen.

The building materials industry is therefore confronted with the task of developing solutions which offer peace of mind to builders and architects, while reducing, for the craftsman, the risks associated with guarantees. Such a solution, which simultaneously seals and uncouples while providing the tiles with an appropriate substrate, is presented in the following pages.

A MAT WHICH SEALS AND UNCOUPLES

The kernel of this process is a special mat which achieves an uncoupling of floor and tile covering. It is made of polyethylene and provided with an approximately 4 mm high undercut ribbed bridge. A supporting web is attached to one side (see fig. 1).

The actual laying is effected by applying tile adhesive to the floor and pressing in the mat with the supporting web so that it becomes mechanically anchored to the substrate. The choice of adhesive is determined by the type of substrate (see fig. 2, 3).

On the upper side of the mat, now stuck down, an hydraulic tile adhesive is now applied with a square notched trowel, and into this layer of adhesive the tiles are directly laid. The adhesive anchors itself mechanically in the undercut, dovetailed bridges (fig. 4).

The mat was designed for laying tiles on all kinds of «difficult» substrates. These include cracked screeds, old tile coverings, wood and chip board, metal surfaces, anhydrite screeds, etc. In installation, the ribbed bridges on the reverse side remain free (fig. 5), so that voids of equal size are created. In this way, tensions arising from the substrate are reduced, and this will go some way towards preventing these tensions from communicating themselves to the layer of tiles. At the same time, the voids facilitate vapour pressure equalization in any moisture which may still be in the substrate.

As a further advantage, the mat creates a seal against non-pressurized water. The individual channels can be sealed on the overlaps with special adhesive tape (fig.6).

The functional principle of the mat is thus the prevention of a gravity-actuated bind of the tiles to the substrate. What is produced is, so to speak, a «floating layer of tiles». It also achieves, however, a good mechanical bind with compensation and bridging of tensions and fissures. In addition, a seal is achieved between layer and substrate.

The principle of «uncoupling» - it should be mentioned in passing - is not a discovery of the manufacturers. If you can recall the numerous, umpteen square metres big, ceramic surfaces which decades - and even centuries ago - were produced without joints, and without any fissures being visible today, the basic principle will, in its essentials, already be familiar to you. In those far-off days, tiles were laid in mortar over a sand stratum - or a «stabilized» sand stratum (fig 7). This took care of the «uncoupling», thus ensuring many years without damage.

When all is said and done, the possibilities for application of this mat system in the ceramics field have still not been exhausted.

Test report by the wall and floor coverings research and consultancy institute of the SÑurefliesner Vereinigung o. V. certificated the mat, commenting on its high level of ability to sustain movement and a sealing quality comparable to DIN 18 195.

Test report by the Swedish Government Testing Institute in Stockholm: successful testing of the mat as a sealant in combination with ceramic coverings.

Test report by the TCA (Tile Council of America) dated 28.3.89: test of the ability to withstand heavy loads of industrial flooring constructed using the mat.

Test report by the TCA dated 21.9.91: testing of the application of ceramics on wood substrates with the assistance of the mat.

Test report of Ceram Research, British Ceramic Research Limited, dated January 1992: testing of the application of ceramics on wood substrates with the assistance of the mat.

Test report of the TCA dated July 1992: testing of the application of ceramics on fixing plates with the assistance of the uncoupling mat system.

Test report of the Ceramic Institute of dated June 1992: determination of the adhesive strength of tiles on the mat.

Test report of the TCA dated December 1989: loading test of tiles laid on the mat over fixing plates.

Test report of the Societe Francaise de Ceramique dated 5.2.93: test of the ability to withstand heavy loads of industrial flooring constructed using the mat.

Some practical examples

a) On balconies and terraces in renovation and new building work (fig. 8)

Load-bearing building components such as balcony cantilever plates made of concrete have, as is well-known, to be protected on a lasting basis from penetration by moisture. In the application of the mat system, it is sufficient to fit the concrete cantilever plate with a descending gradient screed and then seal this with the mat.

Tile and plate coverings can be laid onto this directly by the «thin bed» process. The advantage: low construction height and economy (not true of screeds), time savings (not counting exsiccation time for screeds) and faster completion at greatly reduced cost.

Construction using this sealing, load-bearing and uncoupling system offers considerable advantages, especially in renovation. Thus the existing layer, as long as it is capable of bearing a load, does not need to be ripped up. Any loose parts have to be removed, and any unevenness which may exist has to be trowelled off. The surface has to be prepared in such a way that a bonding agent appropriate to the case will adhere to it. A missing or insufficient gradient must be compensated for with a suitable filling or compensating mortar. On the surface thus prepared, hydraulic tile adhesive must now be laid using a 6 x 6 square notched trowel, and the mat then stuck into it.

In the next working stage, the front ribbed bridges of the mat are trowelled off and the tiles laid directly into the thin bed.

The construction height required is low, only amounting to about 15 mm depending on the thickness of the tile. The mat forms a functionally secure seal in combination with the tile-covering.

Fig. 9: differences between traditional balcony construction and construction using the sealing, load-bearing and uncoupling system.

b) Tile laying on lightweight substrates

Especially in modernization and renovation, but increasingly also in new building, lightweight materials such as wood chip or sandwich type plaster board are being used in walls and floors. In many cases they have been fitted after relatively old wood coverings have been rendered capable of sustaining the weight of them through the stripping out of decaying surfaces. But such materials are also resorted to in the subsequent erection of intermediary walls - e.g. in the building of garret storeys.

Flexible substrates - rigid covering material (fig. 10)

These substrates form the substructure for contoured or functional coverings. Since this form of construction still tends to be reserved for «wet» rooms, any floor-laying work must prevent the penetration of moisture into the substrate.

In bathrooms or kitchens, one is in such cases almost always concerned with ceramic tiles. Thus materials are joined to one another which demonstrate completely different physical behaviours: tiles are a notably rigid covering material, while lightweight substrates, in contrast, suffer continuous alterations in shape, even during installation itself. The tiles must therefore, on the one hand, hold firm, which suggests a gravity-actuated bind, while at the same time allowing flexibility, something which suggests precisely the opposite.

In such cases, the mat system works in a threefold way: it protects the existing substrate from dampness and forms an air space over it for the vapour pressure equalization of any remaining moisture beneath. The tiles are bound by a gravity-actuated bind to the mat, but not to the substrate: the mat uncouples the two levels. Through its structure, it is able to prevent tensions in the substrate from acting against the covering layer. In this context, the mat opens up new vistas for the application of ceramic material as load-bearers of floor-coverings manufactured from one of the many recently introduced building materials made on a wood and gypsum basis.

c) Protection of screed surfaces (fig. 11)

Concrete buckles over a long period of time - at least 6 to 12 months. This ultimately leads, in a gravity-actuated bind of the tile covering, to shearing strains, and increases the risk of the ceramics becoming detached.

In addition, contraction fissures in the composition floor continue into the tile layer.

By using the mat to paste over the composition floor, such eventualities are effectively provided for. In addition, such an action allows the creation of joints in the tile covering which are independent of the course of the joints in the composition floor from both a technical and an optical point of view.

d) Industrial floors made with ceramics (fig. 12)

The foregoing remarks on the shrinkage of concrete are also relevant here.

The prevention of damage using existing procedures is only possible by creating a separation layer, and through the additional construction of a self-supporting mortar and ceramic layer, in which the mortar layer has to be at least 70 mm thick and sheathed.

This self-supporting layer is questionable on building technology grounds, since it is once again prone to shrinkage and distortion into concave or convex shapes, which itself can lead to damage to the ceramic layer.

The cost of workmanship

Conventional construction of this kind requires

* 8 to 10 cm construction height
* a relatively long construction period
* considerable expenditure on materials (for 1 square metre about 70 litres of mortar separation-layer (sheathing) contact mud.
* substantial labour costs
* considerable risks in the carrying out of the work, which may be performance-dependent or weather-dependent.

E.g. on warm days, the mortar of a composition floor can, even if decelerators are applied, hardly be kept in a workable state for an entire day, especially if additional air currents are entering open building sites.

Risks in workmanship:

For the client, the supervisory engineer and the employer, it is largely a matter of chance whether the craftsman brings to the task the necessary degree of care, the essential expertise in building technology and the appropriate practical building knowledge.

This is especially true when firms are only sporadically entrusted with such «special commissions», and are thus by definition lacking in the necessary experience.

Advantages in floor-laying with the mat system

Preparation of the surfaces to be laid:

With careful planning, the concrete surfaces can be so prepared that the load-bearing and uncoupling layer can be stuck directly to them.

Uneven concrete surfaces can be flattened out with a self-blending levelling mixture onto which the mat can then be directly laid (fig. 13).

The building technology advantages of using Ditra-mats are:

The laying can be carried out on very young concrete substrates (in theory, as soon as the necessary traffic load for the laying has been achieved).

The mat uncouples the covering so that no gravity-actuated bind arises; it does however mechanically anchor the covering to the substrate extremely firmly.

The mat forms a layer which is water-resistant and resistant to noxious matter, and which thus protects the concrete substrate from penetration by such media.

In other respects, the process forms a good aftertreatment for fresh concrete layers, since the removal of water is strongly retarded. The hollows in the bridges on the back of the mat facilitate vapour pressure equalization in the underside vapour layer.

Advantages in workmanship:

No specialist knowledge is required for the work.

The considerable expenditure on labour in the laying of the mats relates to the application of the hydraulic tile adhesive with a 6 x 6 mm-square notched trowel (the adhesive can be somewhat «slimmer» than usual).

The mat is then laid down with the anchorage web on the layer of adhesive and «ironed in» with a float.

On its upper surface, middle bed mortar can, if necessary, be applied either immediately or subsequently with a coarse notched trowel, and into this mortar the ceramic can be bedded.

The ceramic or clinker plate is to be dimensioned in accordance with the traffic load.

In industrial flooring involving high-lift truck or HGV traffic, a clinker plate of 20 mm strength is recommended, which can also be worked with «grating joints» using traditional «vibration» laying techniques.

In addition to the known and proven jointless surface which is produced by vibration laying, an especially high laying performance is also achieved (fig. 14).

Also recommended in this case is mechanical vibration with a jarring machine (fig. 15).

In normal hand-laying, however, whether with or without joints, a high standard of performance and quality can also be achieved.

The covering itself should then, if appropriate, be divided up into smaller sections with settlement joints. In this process, a brass profile is recommended to protect the edges, so that the space for the joint has sufficient elasticity to be easily filled in (fig. 16).

Also suitable, in surfaces with a lower mechanical load, are, for example, expansion profiles made of composite hard/non-rigid synthetic material.

Renovation with the mat system on old floor-coverings and substrates

General problems in renovation work:

* Only a limited construction height is available
* The surfaces display fissures and other forms of damage
* The surfaces are covered in oil paint or other foreign matter or coatings
* In extension work or rebuilding, the surfaces are already incrusted with previous coverings

* In conventional renovation, it is often necessary to completely chisel out the old layers or apply an expensive surface pretreatment, in which, in most cases, there is no certainty of being able to bridge over the fissures on a lasting basis.

Advantages:

* With the mat system, a low construction height of about 8 mm and a high degree of tile strength are achieved

* Fissures and scars from old sections of flooring as well as other damaged areas are permanently bridged by the mat

* In the preparation of old surfaces, it is possible, if a tile adhesive, possibly with plastic reinforcement, will adhere to them, to anchor the mat in it with the load-bearing web

Specifications can be relatively undemanding since no shearing stresses can arise later on.

* The layers can be executed very simply, even in stages, and can even be laid while renovation or (re)building work is in progress

* In the application of fast-drying adhesives, a very rapid resumption of work is possible. Even partially newly laid screed part-surfaces can immediately be glued over with them, depending on accessibility.

Laying in accordance with the foregoing process is possible even with small laying gangs - or even with just one man. There are never any problems with ensuring that the laying is carried out with sufficiently fresh laying material. Work can be interrupted at any place and any time and then resumed without difficulty.

e) Tiles on anhydrite flooring (fig. 17)

This in itself outstanding building material causes a certain amount of head-scratching among tile-layers when it is used as a substrate. The reasons:

* An anhydrite floor must be completely dry before the tiles can be laid: residual moisture must not exceed 0.5%.

* Like all gypsum-based building materials, anhydrite floors are very moisture sensitive, even later on, and must therefore be protected against every burden of moisture.

* The sinter layer on the surface must be removed, since it does not permit sufficient adhesion of the tile-covering.

Theoretical tips and recommendations

The German Tile Industry Association, to take just one example, has published a series of tips and hints on the laying of tiles on anhydrite floors.

According to these, before the actual laying begins it must be established that a maximum residual moisture of 0.5 % has been achieved.

The tile-layer must ascertain the degree of moisture with the help of a so-called CM device. Depending on the time of year and weather conditions, this may require the rooms to be heated.

If floor heating is built in, the composition floor must be slowly heated once and then cooled again. The tile-layer must allow himself to monitor this process through a heat protocol. In the recommendations it is also mentioned that anhydrite floors must be kept dry. In damp rooms, and rooms with floor drains, corresponding measures (sealing) must therefore be implemented. Logically, these can only be achieved in combination with the tile-covering.

The surface of the anhydrite floor has to be ground off (using emery paper of graining 16) to remove the sinter layer, and dust from the grinding must then be sucked away with an industrial vacuum cleaner. The Association cite various testing methods for judging the quality of the thus treated surfaces.

Finally, a suitable filler must be applied, which must harmonize with the substrate and the tile adhesive.

Joints in the screed must be taken over congruently into the tile-covering - a requirement which applies even to cement floors. In door areas, settlement joints are to be provided in the tile-covering.

The tile-layer must make sure that he is paid separately for this preparatory work.

And in practice?

This long account has pointed out the dilemma for the craftsman. How much time should one allow in practice for drying, heating and cooling ? Who really knows his way around moisture measurement, grinding off and filling ? Where does sealing have to be done ? In a word: in respect of these and other questions, one must simple leave the craftsman to make up his own mind.

What craftsman really wants to, or is able to, argue the toss in a professionally qualified sort of way with master builders and architects ? What remains for the craftsman are the risks associated with the guarantee, even if all the rules have been followed.

The advantages of the use of sealing and load-bearing systems are, in the main:

* The problem of residual moisture can be ignored; even when the figure is over 0.5%, work can be still be carried out

* The anhydrite floor need not be sanded off. It provides a foundation onto which the mat can be stuck with hydraulic adhesive (tooth trowel 6 x 6).

* The mat also provides a sealing. The anhydrite floor is thus protected against moisture on a lasting basis.

* The jointing in the floor need not be identical to that in the tile-covering, since the two edges are independent of one another. Movement joints in the covering can be adjusted in the light of both technical and optical considerations.

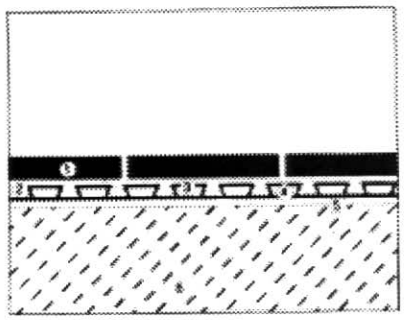

Figure 1

Recommended types of adhesive:

a) For mineral plasters, concrete and screed, as well as gypsum, gypsum plaster board, gypsum plasters, etc.
- hydraulic tile adhesives;
- hydraulic tile adhesives with synthetic additives, according to manufacturer's directions;
- epoxy resin or cold-curing resin adhesives;
- dispersion adhesives (for indoor use only);

b) For particle board, hard tibeboards, etc.:
- epoxy resin or cold-curing resin adhesives;
- dispersion adhesives (for indoor use only);

c) For coatings, affixed ceramic cove rings, oil paint, varnish coatings, etc.:
- hydraulic adhesives with synthetic additives;
- epoxy resin or cold-curing resin adhesives;
- dispersion adhesives (for indoor use only).

These adhesive recommendations are intended for general guldance only and do not claim to cover all situations. For specific applications, selection of the adhesive must be made by the specialist involved.

Figure 2

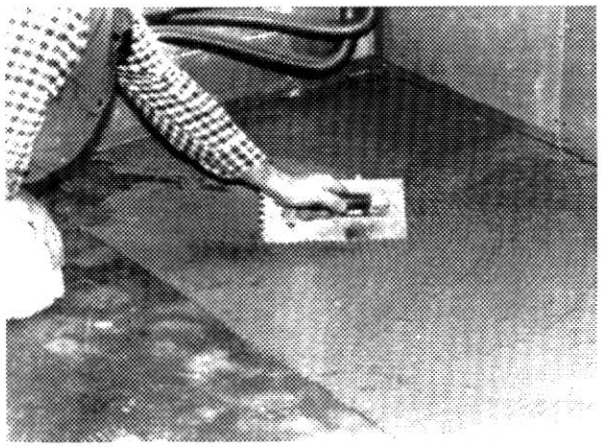

Figure 3

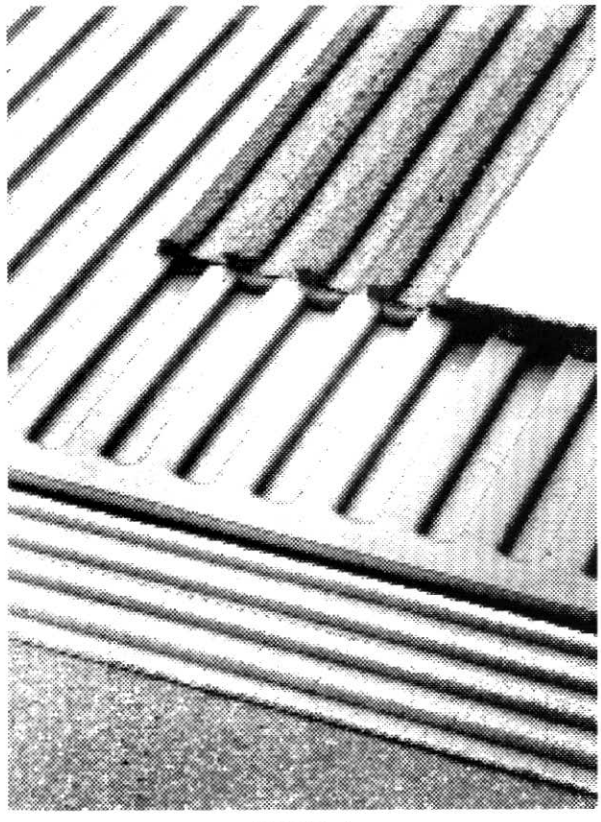

Figure 4

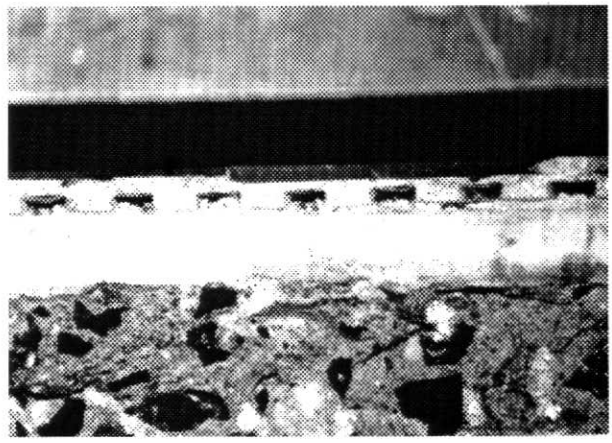

Figure 5

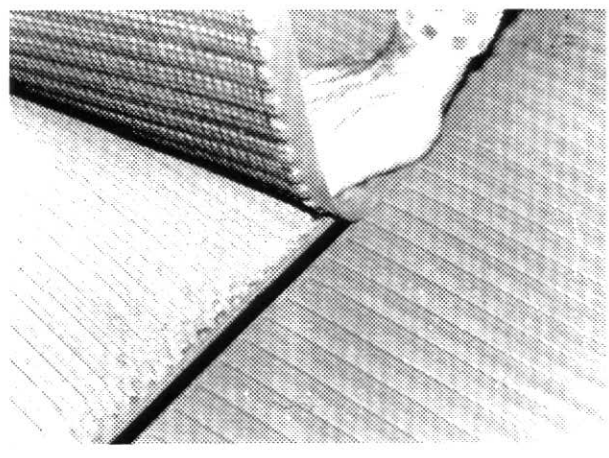

Figure 6

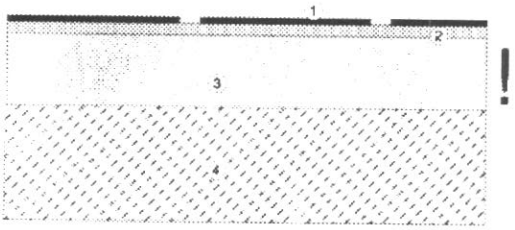

Figure 7

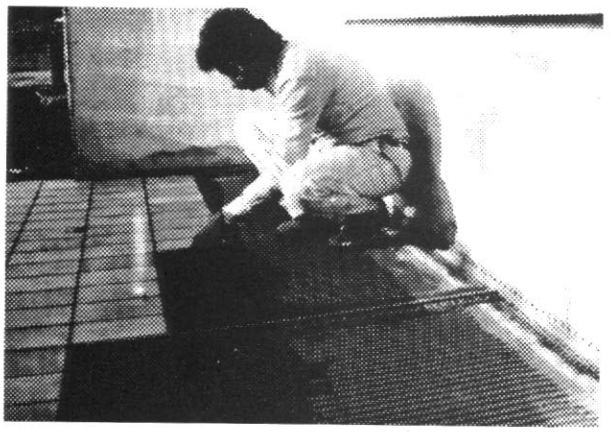

Figure 9

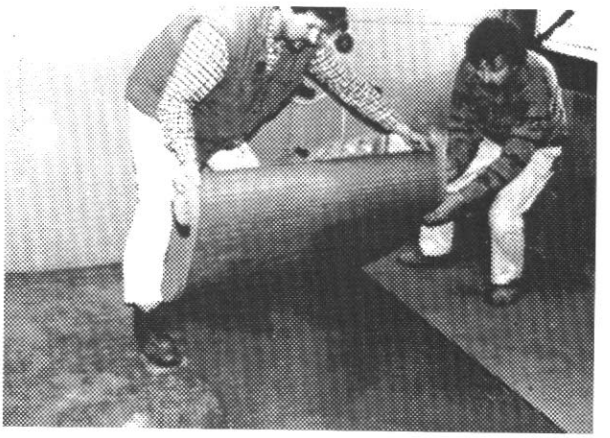

Figure 10

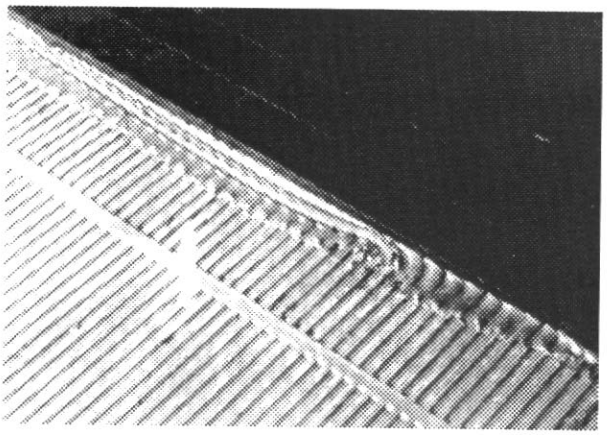

Figure 12

Figure 13

Figure 14

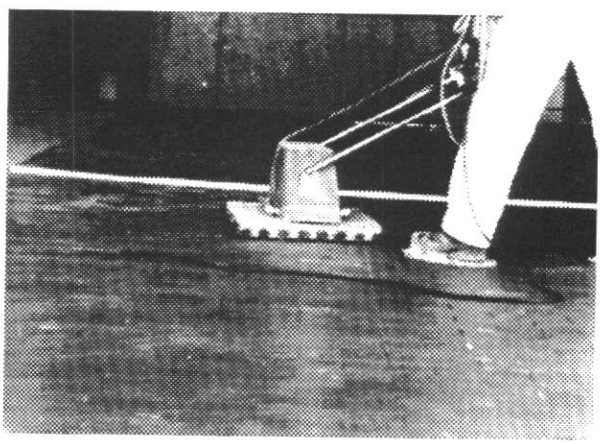

Figure 15