PAPER ON CALCIUM SULPHATE ($CASO_4$) FLOW SCREED

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1. ORIGIN AND MARKET OF ANHYDRITE FLOW SCREED

The use of anhydrite (anhydrous calcium sulphate) in the production and laying of screed has a long tradition in Germany. Its use in the building trade dates back to about 1917 or 1918.

When Germany was separated after the war, the application of the material developed in different ways. Whereas naturally occurring anhydrous calcium sulphate was the most important material for producing anhydrite screed in East Germany, synthetic anhydrite, occurring as a by-product in the production of hydrogen fluoride (desulphurization plants) was increasingly used in West Germany.

In the former East Germany up to 1989 it is estimated that some 75 million square metres of conventional anhydrite screed and the same area of flow screed was laid. However, in West Germany in 1989 the market share of conventional anhydrite screed was just 6% and the share of flow screed a mere 3%. In the current DIN standards for screed (valid since May 1992) flow screeds are treated as special materials.

The targeted application of chemicals in the form of high performance liquefiers has now resulted in a new way of working. Since the reunification of Germany there has been a distinct shift in the market development as a result of:

a) the raw material situation

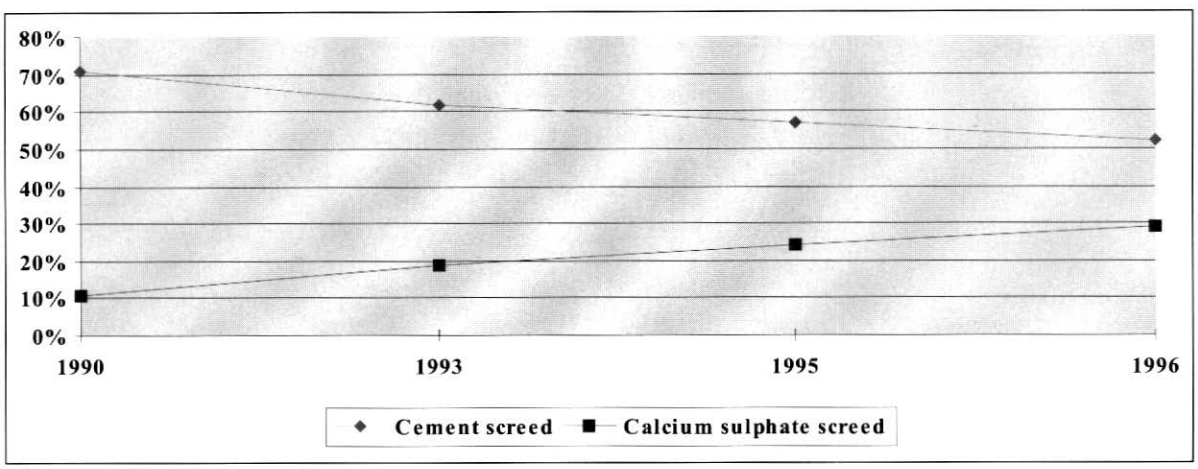
We differentiate between the following raw materials for anhydrite flow screed:

- naturally occurring anhydrite

- synthetic or chemical anhydrite
- thermal or REA anhydrite
- alpha hemihydrate as high-strength calcined gypsum

b) the technical progress

The preparation and handling of materials has drastically changed. Nowadays it is no problem to consistently produce and pump homogeneous mortar. Volumes of 3 up to about 14 cubic metres can be handled per hour and pumped through hoses up to 200 metres long over heights of 50 to 60 metres. Consequently a three-man crew can lay 500 to 700 square metres of screed in one day.



(Source: Knauf-Marketing)

Fig 1. Development in Germany

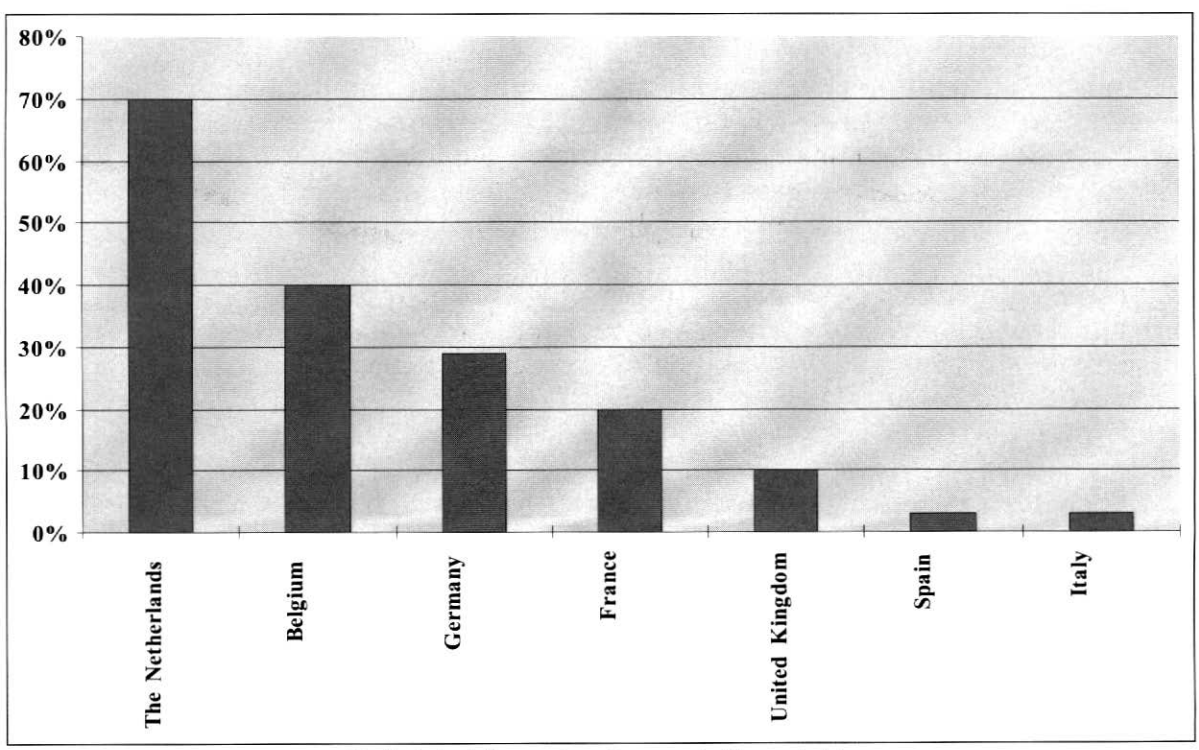


Fig 2. Anhydrite as a base for ceramic tiles and slabs

2. ANHYDRITE FLOW SCREED AS A BASE FOR FLOOR FINISHES

Calcium sulphate screed is an ideal base for tiles in dry rooms.

Underfloor heating systems are being increasingly used to optimize energy use and to improve the personal comfort in houses while at the same time providing optimum and uniform heat distribution. Such systems are made of screed that is subsequently covered either with ceramic tiles or slabs, or with concrete or natural stone work. Anhydrite flow screed is particularly advantageous in such cases as these as it

- has high thermal conductivity
- encases the pipes well and so produces a good heat transfer when laid wet
- can be laid with a thin screed thickness
- has short heating up times.

The various systems on the market today can be divided up into four basic types with regards to the type of heating system (warmwater underfloor heating and electrical underfloor heating) and the position of the heating pipes or electrical elements in the floor section (installed either in the insulation layer or in the screed). Temperatures in the vicinity of the heating elements vary depending on the type of system installed and the position of the elements, although for all systems the heat produced by the underfloor heating system is limited by the maximum temperature required at the floor surface.

The differences in temperature between the upper and lower parts of the floor construction cause arching to occur. If the temperature moduli of elasticity as well as the deformation parameters of the screed and floor covering are different then this arching leads to stresses that can cause the layers to separate or cause cracking in the screed.

However, anhydrite flow screed is completely unsuitable for wet areas, such as bathrooms, showers, industrial kitchens, and for outside use.

Flow screed must be carefully prepared and checked if it is to fulfil its purpose properly. The most important criterion is the internal moisture content of the flow screed. The upper limit of moisture for laying floor coverings that are impervious to water vapour, which includes tiles, is 0.5% by weight.

The internal moisture content is the moisture content remaining in a porous building material after it has been stored under specific conditions of temperature and relative humidity until it has a constant weight. There is a relationship here between the screed water content and the relative humidity at a specific temperature.

Anhydrite flow screed is normally laid on an insulating or separating layer. The drying behaviour on the insulating or separating layer is generally independent of the subsurface. The downward drying process that occurs in composite screed is to a large extent prevented by the impervious insulating or separating layer it is laid on. The

moisture gradient of screed, without floor covering, on insulating or separating layers is always from the bottom to the top. The moisture content of thin screed diminishes considerably quicker than that of thick screed. Usually when conditions and screed composition are similar the screed thickness on an area basis should be considered when determining the drying time. In dry room conditions and temperatures an approximately 4 cm thick screed layer is usually mature for all types of floor coverings after about 3 to 4 weeks. Anhydrite flow screed shrinks only slightly when drying compared with cement screed, and therefore is scarely distorted during drying. This has, however, not been proved for the more recent binders with a calcium sulphate base. Initial observations reveal that shrinkage is larger in screed produced with these binders than it is in screed produced almost exclusively from synthetic anhydrite binders.

Owing to the widely varying conditions and parameters it is not possible to determine the moisture content of screed in advance. Consequently the maturity of the floor must be determined by measurement. How and when screed for underfloor heating is to be measured must be included in the job specifications and subsequently coordinated. For instance the marking of three measuring points per 200 m^2 by the heating engineer, embedding the marked points in screed by the builder, and the measuring at the marked points by the tiler. A CM tester is used for measuring on the building site.

Besides determining the moisture content it is necessary to rub off any loose surface layers from the flow screed and to apply a primer. This primer protects the screed against moisture given off from the thin-bed mortar, and also increases the adhesion between the mortar and the screed.

Today's flow screeds to be grouped under the heading of screeds with calcium sulphate binders must always be abraded. A conventional surface grinding machine should be used with abrasive paper (grade 16). Dust should be removed using an industrial vacuum cleaner. Hard surfaces and slivers of material that are not firmly attached to the load bearing screed surface as well as surface irregularities that cannot be removed by abrading are all defects that must be ground off.

Any cracks caused by shrinkage have to be thoroughly sealed with plaster resin. Moreover layers of filler must as far as possible retain the mixing water so as to prevent moisture penetrating the subsurface. As an additional precaution movement joints must be included in the tiled surface even if the flow screed was laid as one continuous area.

Owing to the different expansion coefficients it is necessary to install a movement joint in the tiled surface in the doorways. It is also recommended to include a movement joint every 5 metres in the tiled surface.

3. ANHYDRITE FLOW SCREED AS A HEATED STRUCTURE

Heated structures consisting of anhydrite flow screeds form an ideal substrate for floor tiling in residential environments. As a result of the high density of the anhydrite flow screed, optimum heat transmision is achieved. When the screed is installed, its fluid consistency ensures that the heating pipes are fully embedded.

The anhydrite screed should be installed and spread immediately after ending the mixing process or after delivery at the building site, then levelled and compacted. The surface is to be rubbed off and smoothed. The surface should not be dusted or wetted.

The temperature of the anhydrite screed should not be less than 5°C when the screed is installed. It should be then kept at a temperature of at least 5°C for another two days. The screed should also be protected for two days against heat, driving rain and air currents. This is usually assured without any special measures at smaller building sites when the building is closed.

The anhydrite screed should be allowed to dry unhindered and should not be exposed to the continuous action of moisture. Regions in the screed that are potentially exposed to moisture shall be protected by a vapour seal. Such measures should be defined beforehand by the designer in drawing up the building plans.

The anhydrite screed should not be walked on for two days, and should not be subjected to further loading after five days have passed.

As the newly installed anhydrite flow screed can already be heated after 5 days, the domestic moisture level of 0.5% CM (carbide method) is reached within 20 days. Tile installation can possibly take place faster than with a conventional cement screed.

The thickness and mechanical strength or hardness of screeds fitted with underfloor heating are to comply with the values detailed in Table 2, according to the type of construction involved.

Surface testing and treatment is to be carried out as with non-heated structures. A greater expansion should however be taken into account in the design, involving additional movement joints.

Type of screed	Type of construction	Screed nominal thickness in mm [1) 2)]	Covering height in mm	Certification test Bending tensile strength β_{BZ} in N/mm²	
				Min. individual Value	Mean value
Anhydrite AE 20 Cement ZE 20	A1	45 + *d*	45	2.0	2.5
	A2	50 + *d*	-		
	A3	45 + *d*	25 [3)]		
	B,C	45	-		

1) *d* is the outer diameter of the heating element.
2) The compressibility of the insulating membrane shall be not exceed 5 mm.
3) The sum of the distances of the heating elements from the top and bottom surfaces of the screed slab shall be at least 45 mm.

Table 2. *Nominal thickness and mechanical strength or hardness of heated screeds installed on insulating membranes at traffic loads of 1.5 kN/m².*

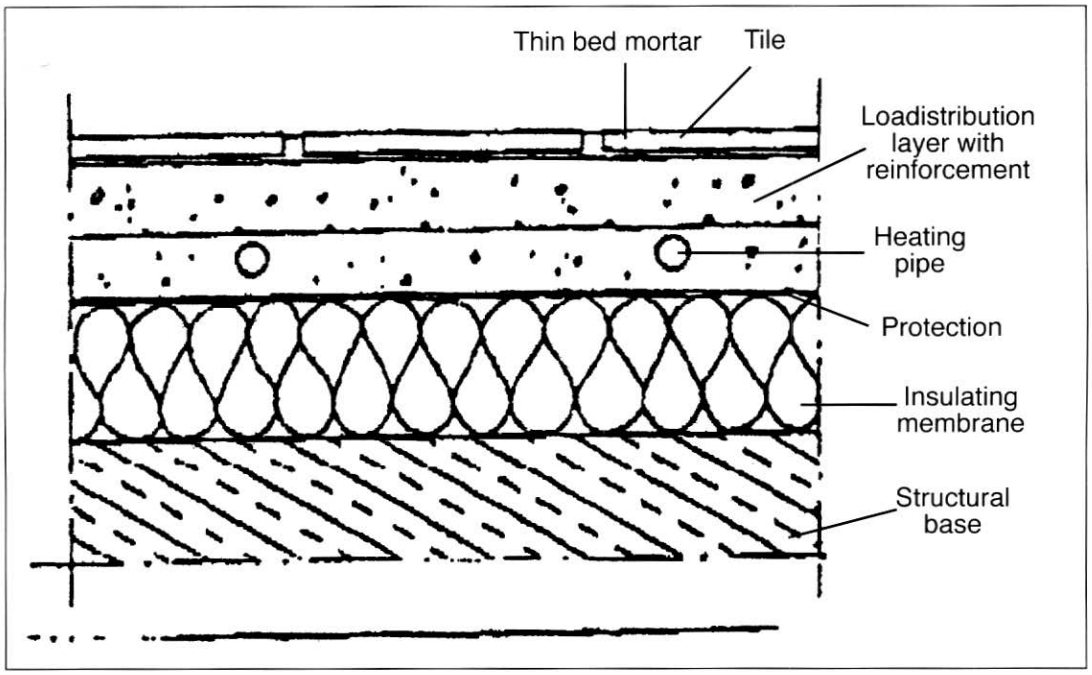


Fig. 3. Thin bed tile installation on a hardened load distribution layer.

4. DAMAGE AND THE CAUSE OF DAMAGE

The most common type of damage is caused by moisture encroaching subsequently from above or below, for example as a result of burst pipes or water coming from above, or rising damp due to ground contact. The consequence is that the flow screed expands, loses its strength (formation of ettringite) and the tiles become loose. In such cases the fracture zone is in the upper part of the screed.

Tiles may also become loose as a result of the residual moisture in the screed being too high at the time the tiles were laid. In this case as the screed dries the moisture rises and cannot escape through the tiles so that ettringite is formed. The result is that the tiles become loose. This can be avoided by making sure the residual moisture content of the screed has decreased sufficiently before tiling, for example by measuring it.

Cracks in tiled surfaces laid on flow screed are another form of damage. A number of things can cause this, for example the thickness of screed being too thin, the presence of folds in the underlying seal, underfloor heating pipes not lying deep enough and the different movement characteristics of the tiling and the screed.

Calcium sulphate flow screed, when it is properly laid and properly tiled, is a building material with a bright future, not only ecologically but also for the workforce on the building site.

Let's seize the opportunity and use this material!