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Assembly of Ceramic Coverings on Gypsum Surfaces

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Abstract. Ceramic claddings in the buildings are often tiled on gypsum surfaces, which mainly consist of plasters made of ready dry mixes and walls made of gypsum blocks. One should know about their specific properties, such as absorbency, smoothness and lack of chemical bonding with cement based adhesive mortars. This paper discusses the subject of assembly of ceramic claddings on such substrates and shows examples of damages caused by executive errors. The first part of the paper describes methods of preparing the surface before assembly of ceramic claddings, with particular emphasis on the proper surface priming. The principles of choosing the right mortar for tiling works are also presented. In the second part of the paper, examples of assembly errors are presented, as a result of which the ceramic claddings become detached from the gypsum surfaces. The results of measurements and observations have been described and the reasons for failure of wall claddings have been given.

1. Introduction

Indoor ceramic coverings are often laid on gypsum surfaces which include mainly plasters prepared from ready-made dry mixtures and walls made of gypsum blocks. This publication discusses the issue of assembling ceramic coverings on this type of surface and provides examples of defects caused by defects in workmanship.

Gypsum plasters and blocks usually provide an even, stable and appropriate strong surface under ceramic coverings. However, it is necessary to remember their specific features:

- high absorbability, causing fast removal of water from adhesive mortar. This is not applicable to water-resistant gypsum blocks, impregnated in the factory using hydrophobic silicone agents to reduce soaking,
- high smoothness which results in a small contact surface between the surface and adhesive mortar. In the case of gypsum mortars, it is recommended to trowel the surface roughly, however, quite often it is necessary to assemble ceramic coverings on smoothed plasters,
- lack of a chemical bond between gypsum and cement which is most frequently the basic component bonding assembly mortars,
- the possibility that chemical compounds will precipitate on the surface of gypsum material which have a destructive effect on adherence of adhesive mortar which may take place in the case of improper preparation of the surface and with unfavourable thermal and moisture conditions.



2. Surface preparation

Before any ceramic coverings are made, it is necessary to check the condition of the surface. The moisture of gypsum elements should not exceed 1 %. One necessary action is to remove dust, remaining mortars and other contamination from the surface of the walls. Any bigger cavities are filled with gypsum mortar or using a special repair putty. Attention should also be paid to whether the surface has not been covered with a gypsum finish. This problem occurs especially in those rooms where assembly of tiles is not anticipated on the entire wall e.g. in home kitchens. Frequently, first the finish is applied and then ceramic tiles are placed on some surfaces. What happens then is that wall coverings fall off together with a layer of finishing material [1, 2].

Priming of the surface is the necessary preparation process aimed at:

- reducing soaking and reinforcing the surface,
- binding dust and loose particles,
- creating a buffer layer in order to prevent penetration of sulphate ions from gypsum to adhesive mortar.

The priming agent should penetrate the surface and cannot form a peculiar glasslike layer on its surface. In the case of walls exposed to direct contact with water, it is necessary to make a water-resistant coating. The criteria for choosing primer agent used to prepare the surface are presented in the table below.

Table 1. Criteria for choosing primer agent used to prepare the partition surface for tiling

Moisture conditions	Examples	Type of gypsum surface	Purpose of using the preparation	Preparation type
Surfaces not having direct contact with water and not exposed to frequent condensation of water vapour	a) walls in dry rooms,	Surface with high absorbability: gypsum plasters, regular gypsum blocks	Reduce soaking, reinforce surface, create a buffer layer, bind dust and loose particles	Preparations with penetrating effect developed for surfaces with high absorbability
	b) walls in rooms with periodically increased moisture (home toilets, kitchens, bathrooms) apart from zones around showers, bath tubs, wash basins	Surface with low absorbability: impregnated gypsum blocks	Create a buffer layer, bind dust and loose particles	Preparations developed for surfaces with low absorbability
Surfaces exposed to direct contact with water or condensation of water vapour	a) zones around showers, bath tubs, wash basins in rooms with periodically increased moisture - home toilets, kitchens, bathrooms (in order to make walls, it is recommended to use impregnated blocks, class H2)	Surface with high absorbability: gypsum plasters, regular gypsum blocks	Create a tight layer protecting against the influence of water	Preparations forming a water-resistant layer (e.g. liquid foils). If the manufacturer recommends, apply preliminary priming using agent reducing soaking
	b) showers in companies, sports facilities (in order to make walls, it is recommended to use impregnated blocks, class H1)	Surface with low absorbability: impregnated gypsum blocks	Create a tight layer protecting against the influence of water	Preparations creating a water-resistant layer (e.g. liquid foils)

In the case of making water-resistant coatings, one cannot forget to glue in sealing tapes and caps in places exposed to leakage e.g. in corners between floor and wall, in corners between walls, in the places where utility pipes pass through coverings. The sealings are placed after the first layer of the preparation is made, and then additionally one or two layers are applied.

3. Selection of assembly mortar

When the assembly adhesive is selected, one should remember the following principles [3]:

- in the case of walls not exposed to direct contact with water or condensation of water vapour, cement or dispersion adhesives, that is ready-mixed compounds consisting of aqueous dispersions of binding agents, minerals fillers and additions, can be used,
- walls exposed to a direct contact with water or condensation of water vapour – use cement adhesives.

Please note also that on smooth surfaces, adhesion is not the result of mechanical anchoring of adhesive particles as occurs in the case of rough surfaces. Obtaining satisfactory adhesion requires the application of adhesives with appropriately high polymer contents. These compounds (most often added to adhesives in the form of powdery acrylic resins) form a network of bonds which in connection with the structure of cement slurry ensure that a sufficiently strong adhesion bridge is obtained. A factor which should also be taken into account is the flow of adhesive from vertical surfaces – products characterized by a low level of flow should be chosen [4].

Specialized adhesives developed for gypsum surfaces are available in the Polish market. They are characterized by a high resistance to sulphate ions which is checked by performing the test of sulphate expansion in subsequent endurance tests according to SAS (Shock Absorbing System) technology. These adhesives do not require priming of gypsum surfaces.

4. Examples of mistakes in workmanship

The first example concerns the assembly of ceramic tiles in the kitchen on walls finished with gypsum plaster on which a thin layer of low-strength gypsum finish was applied. On the surface prepared in this way, ceramic tiles were laid in the zone between kitchen furniture and in the plinth layer. After a certain time, the tiles came off from the surface. After the inspection it turned out that stratification of the gypsum finish took place where a part of it remained on the wall and a part on the surface of the cement adhesive (figure 1).

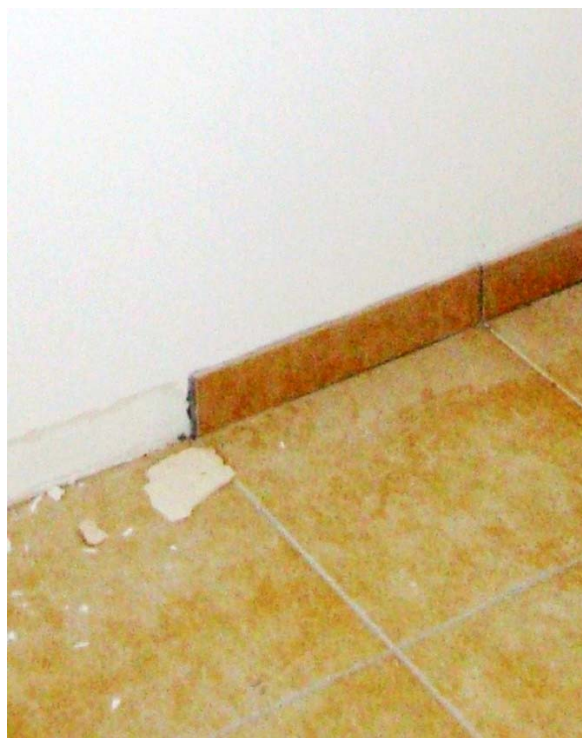


Figure 1. Falling of ceramic tile plinth as a result of stratification of gypsum finish

Perhaps the defect might not have happened if before laying of tiles, the base had been primed with a high quality deeply penetrating preparation which would have reinforced its layer near the surface.

The second of the described examples concerns damage to ceramic coverings in a hotel structure. Tiles in the bathrooms were laid in the winter season and in spring the coverings loosened from the wall surface. The loss of adhesion occurred mainly in the surface layer of gypsum blocks from which the walls were made. Traces of gypsum remained on the surface of the loosened cement adhesive (figures 2, 3). High-quality flexible mortar, characterized by a low flow, was used to assemble the tiles. The walls were primed using a preparation for absorptive bases, diluted with water in the ratio of 1:1.



Figure 2. Wall surface after the tiles came off



Figure 3. Tiles which came off with visible traces of gypsum on the layer of cement adhesive

As a part of the technical expert's opinion, an analysis of all elements forming the bond was carried out, as a result of which it was determined that the materials used were not of poor quality. Average surface hardness of the gypsum blocks measured using Shore's method was 65 versus 55 C units required for medium density blocks based on the PN-EN 12859 standard [5]. In order to determine the

appropriate superficial strength of the gypsum blocks, the test for tearing the surface layer of the wall performed at the construction site using a portable 'pull-off' instrument was essential. Average fracture test of 1.14 MPa was obtained. This is a value higher than the required initial tensile strength of cement adhesive amounting to 1.00 MPa according to the PN-EN 12004 standard [6] (flexible adhesive, C2 TE type).

A response regarding the causes of the defect was provided by the analysis of phase composition of the materials which indicated the presence of considerable amounts of thaumasite ($\text{CaSiO}_3 \cdot \text{CaCO}_3 \cdot \text{CaSO}_4 \cdot 15\text{H}_2\text{O}$) in the contact zone between the cement adhesive and the gypsum base. This compound is generated as a result of the reaction of calcium, silicate, carbonate and sulphate ions in aqueous solution. The conditions favourable for its generation are low temperature (approx. 5°C) and high air moisture. The rapidly forming thaumasite causes a decomposition of the cement slurry structure, the consequence of which is damage to the adhesive bridge generated at the interface of cement adhesive and gypsum.

The analysis of all circumstances accompanying the occurrence of the damage showed the following failures in workmanship:

- assembly of ceramic tiles on a base which has not dried,
- conducting covering work in winter in unheated and moist spaces, the evidence of which was the mould appearing in many places on gypsum plasters in the bathrooms,
- using an improper primer intended for bases of high absorbability, additionally dissolved in water in the ratio of 1:1. The bathroom walls in this building were made using impregnated gypsum blocks, class H2, characterizing by low soaking (up to 5% after 2-hour immersion in water according to [5]). The primer used migrated down the wall surface and failed to form a contact layer which would prevent migration of sulphate ions into the cement slurry.

5. Conclusions

Detachment of ceramic tiling is a common building defect which provides a serious economic risk and in some cases can also represent the threat to people's safety. Laying of ceramic coverings on gypsum bases requires a thoughtful selection of primers and thin-layer assembly slurries. It is not acceptable to use preparations, which are intended for gypsum bases according to their technical description with no further analysis. Actual absorbability of the material and priming purpose should be taken into account.

During evaluation of the base condition, it is also necessary to pay attention to the possibility of its weakening as a result of prior application of gypsum finish on the wall surfaces. If this problem occurs, a layer of the finish should be removed (ground), if it is sufficiently soft, or a deep penetrating primer should be used, and then the strength of the base should be examined.

It is recommended to use specialized assembly slurries resistant to sulphate ions; especially in the case of performing covering work on gypsum surfaces in prestige structures or in unfavourable thermal and moisture conditions.

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