Negative use of finishing materials on Sorel's cement

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Abstract. Magnesium oxide wallboard - sheet construction and designing material based on magnesia binder. Magnesium oxide wallboards are mainly used as a construction substrate in the manufacture of building facades both in new construction and in repair of already constructed objects. One of the most significant disadvantages of this compound is low water resistance of articles, turn to cause corrosion in franked steel constructions.

1 Introduction

Magnesite sheets (MS) used in the manufacture of light facades, both in new construction and renovation of existing facilities, it is also used as a base for plastering. Magnesite fire-resistant sheets, are non-combustible materials of class A, low thermal conductivity and high resistance to high temperatures leads to their use as a structural fire protection to improve the fire resistance of building structures and fireproof bulkheads.

The main components are MS magnesia binder, also known as Sorel cement: magnesium oxide (MgO) 40 - 50% magnesium chloride $MgCl_2$ 30-35%; Further perlite (SiO_2 , volcanic glass 3 - 8%, chips (sawdust) 15%, water, glass fiber, polypropylene fabric. Thus, based on the composition, the following process in the production of factors affect the quality of the MS [1]:

- Quality of glass: the use of high quality glass fiber provides the flexibility and strength of the sheet;
- The number of layers of glass: the more layers, the stronger the sheet allowed to use 3 - 4 layers;
- The addition of mineral wool and its type: reduces the density of the material;
- The percentage of magnesium oxide: the higher the content of magnesium oxide (95%), the stronger the sheet;
- Use of wood chips (the number, type, size, grade) affects the density and strength decrease sheet.

Also important observance of technological modes of production: the violation of their negative effect on the color, strength and durability of the material and the quality of mold: they determine the quality of the surface.

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The leader of the global sales market and production of magnesite is China [2]. The best-known company for the production of MS: Fedmet Resources Corporation, Fengchi Imp. and Exp. Co., Ltd. of Haicheng City (Fengchi Co., Fengchi Mining Co., Ltd. of Haicheng City (Fengchi Mining), Fengchi Refractories Corp. (Fengchi Refractories), Puyang Refractories Co., Ltd.

MS material does possess a sufficient number of advantages, but it has some drawbacks. Firstly, it is more fragile than the plaster-fiber sheet (GVL). Second, the sheets made in China have different quality and often far away from the reference. The main characteristic of this material is that the density of the sheet, and a proportion of magnesite in the composition of: the lower the density of the material, the more loose, more subject to absorption of moisture, is more prone to damage both during transportation on pallets, and when carrying by hand. Despite the low price MS, increased costs related materials, installation, a high percentage of marriage breakdowns. With a very high density material loses its adhesion, its flexibility is noticeably reduced.

The Russian magnesite sheets are sold under various brands, and are mainly divided into four categories ("Premium", "Standard", "Facade", "Economy") in accordance with the categories of glass sheet. Each category has its own properties, characteristics and application (Table 1). The main feature - the density and that it determines the material grade and possible applications. However, the problem lies in the fact that even under the label "Premium" material can be sold in Russia, the characteristics do not correspond to the category assigned to it.

Table 1. Classification MS density in Russian.

Name	The average density of the material	Applications
Super Premium	$\rho = 1200 - 1400 \text{ kg/m}^3$	Interior and exterior cladding of building structures. Creating partitions and wall decorative designs. Facades.
Standard	$\rho = 900 - 1000 \text{ kg/m}^3$;	Interior decoration.
Premium	$\rho = 1000 - 1100 \text{ kg/m}^3$	Installation of wall partitions and forming the base for the floor - "dry screed", as well as the base under a pitched roof.

2 Results

Negative sheets magnesite desiccant properties associated with the fact that they contain free magnesium chloride (MgCl2), which is very hygroscopic. Furthermore, Sorel cement unstable at a relative humidity of 93%. Theoretically, magnesium chloride already begins to absorb moisture at a relative humidity of 33%, but in practice magnesite sheets containing this component begin to absorb moisture from the air in a large amount at a high humidity. In the technical literature clearly indicates that the magnesia binder is not water-resistant at high humidity and that the relative humidity is 93% critical limit [1 - 7].

a series of experiments carried out in Denmark, in which magnesite sheets were placed in an environment with a relative humidity of 93% or less. [8] Sheets absorb moisture from the air in considerable quantities, and absorption process was observed within one month or more. On the surface of the sheet of water drops formed between the 7th to the 14th day with a relative humidity of 93%. The experiments performed at 85% humidity showed similar results. It is stated that:

- The content of magnesium chloride in magnesite sheets (MgCl2) leads to the absorption of moisture;

- After about 7 days is observed on the selection plate surface moisture (relative humidity of 90% or higher);
- Magnesite sheets cause corrosion on adjacent non-metallic parts of stainless steel structures;
- The wooden parts of structures in contact with magnesia sheet begin to absorb moisture more intensively than a normal tree, which causes mold formation (Figure 1.).

Fig. 1. Example of construction

The fluid, which is released magnesite sheets - a concentrated solution with a high content of magnesium chloride, which is corrosive to metal fasteners and trim (Figure 2.) At the points of contact with the sheets [9].

Fig. 2. Corrosion on metal surfaces in contact with the MS

Fire curtains are made of silica material and are well suited to prevent the spread of fire hazards in buildings with an atrium. As a demonstration of the spread of fire hazards presented calculation of materials in the GUI FDS PyroSim, Smokeview (figure 2 – 3).

There are a number of studies aimed at reducing the negative properties of magnesite sheets when used in wet conditions [1 - 7, 10 - 13], but the practical application of these results have not yet found that due to an increase in the cost of MS in the case of modifications to the composition of panels. In [10], the authors propose to increase the

water resistance of articles made of magnesia binders, adding to them in the form of powders of minerals such as wollastonite, diopside, zeolite. At the same time it increases the strength and decreases the magnitude of shrinkage during solidification. The addition of wollastonite in an amount of 60 - 80 parts by weight leads to increased strength in high humidity (over 95%). Also diopside can be used to improve water resistance. In [11] investigated the possibility of increasing the water resistance of articles made of magnesia binders due to the introduction in their structure of dunite and serpentinite.

A study [12] describes the possibility of reducing the cases of the appearance of efflorescence on the surface of products with the addition of the binder diabase. The author of [13] proposes to use semi-aquatic, hydrated calcium sulfate (gypsum building brand G-5AP), reducing water consumption and prolongs the binder setting. Abroad MS hardly used for capital construction projects. For example, the authoritative organization of ICC-ES, which for many years been a leader in the technical assessment of building materials, in their research concluded that magnesite boards can not be used in environments with high humidity levels. According to American standards, magnesite panels are prohibited from using public buildings in showers and bathrooms [14].

James Hardie Company (USA), specializing in the production of coating materials, strongly criticized magnesite panel in 2007. At the initiative of the company's advisory council was created, which, after a number of studies, insisted on the prohibition of the use of panels, which are based on magnesia binder, as a cladding material [15]. Denmark has received considerable attention in 2015. MS research institute Bunch NGO [8], with the conclusion of the inappropriate use of MS. Investigations initiated collapse and corrosion of glass sheets used for cladding library complex Dokk1 or Dokken is a building, public library and culture center in Aarhus, Denmark. It is situated on Hack Kampmanns Plads in the city center by the waterfront next to the Custom House.

Fig. 3. Dokk1 Library. Casper Dalhoff / polfoto.

Fig. 4. Corrosion on Dokk1 designs. Foto: Teknologisk Institut

Opened in June 2015, Dokk1 became the largest library in Scandinavia, the building area of 35.6 thousand. M2 (Fig. 3) is located at the mouth of the river Aarhus (project Schmidt Hammer Lassen Architects). In June 2016 it reported on the fact that the exterior facade of the building structure damaged by corrosion, fell into disrepair about 3.000-4.000 m surface of the facades and the replacement cost is estimated at 19 - 26 million kroons (see Figure 4)... Experts explain the incident sea and humid climate of Denmark, and it is necessary to use appropriate materials for this type of climate. Is being audited by the other major Danish facilities. [16]

3 Discussion

Thus, using magnesia sheets unsuitable environmental conditions and operating conditions of corrosion develops mold formed as Sorel cement is not stable at high relative humidity (above 80%). The presence of wood chips as a part of MS also promotes the growth of mold. Galvanized fasteners, trim, etc. on designs of the facade, made of MS, it is recommended to replace as high risk of collapse of the panels due to damage by corrosion of the facade elements.

Overall, the negative impact on the constructions at operation MS casts doubt on the feasibility of its application to the high requirement for quality of work sites. Discovered in Denmark problems with magnesia sheet, due to the climatic conditions in which they are used. However, it is clear that the complexity of the use of such material will exist in other areas with similar climatic conditions - in the Nordic countries, and in all other countries and territories with a wet and maritime climate, as well as relevant humidity conditions in the room.

References

1. Azhikina N.V. Steklomagnezit - new lining material, Magazine of Civil Engineering **1**, 32 – 37 (2010)
2. Matthew C. B. Reactions of compounds occurring in Sorel's cement. Cement and Concrete Research **7**, 575 – 583 (2003)
3. El-Gammal M.A., Ayman M.H. El-Alfy and Mohamed N.M. ASR **8**, 2024 – 2032 (2012)
4. Manalo. Construction and Building Materials **41**, 642–653 (2013)
5. X. Lin, B. Liu, X. Wang, L. Zhu, X. Jin, X. Liu, G. Zhang, D. Xu. Ceramics International **43**, 1455-1459 (2017)
6. J. Jurišová, L. Fellner, L. Pach. Acta Chimica Slovaca **8(2)**, 87 – 90 (2017)

7. El-Gammal M.A., Ayman M.H. El-Alfy and Mohamed N.M. ASR **8**, 2024 - 2032 (2012)
8. URL:http://www.bunchbyg.dk/wp-content/uploads/2016/08/MSSCE2016_Word_208.pdf
9. URL: www.byg-erfa.dk/fugtsugende-vindspærreplader
10. V.N. Zyrjanova, E.V. Lytkina, T. I. Berdov. Proceedings of the universities. Building **3**, 21 - 26 (2010)
11. Zyrjanova V.N., Berdov T.I., Vereshhagin V.I. Proceedings of the universities. Building **8**, 21 – 25 (2009)
12. Lytkina E.V. Proceedings of the universities. Building **9**, 26 – 29 (2010)
13. Mirjuk O.A. Proceedings of the universities. Building **2**, 31 – 36 (2011)
14. URL: http://www.icc-es.org/Reports/pdf_files/ESR-2880.pdf
15. URL: http://www.icc-es.org/Criteria_Development/0710-pre/responses/AC386.pdf
16. URL:<http://jyllands-posten.dk/aarhus/erhverv/ECE8745371/naar-vi-naar-hen-til-november-driver-vandet-ned-ad-pladerne/>