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NEW PORISATED MATERIALS AND DETAILS BASED ON HIGH STRENGTH GYPSUM

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SUMMARY

One of the most effective ways to decrease material volume cost of engineering and exploit parameters of structures is to use porisated materials and details made of it. High parameters of exploitation of porisated high strength gypsum and facilities of their variation without strength decrease allowed to suggest system of materials and details on its base. Porisated high strength gypsum was used in decorative elements of ceilings and walls, wall panels for interior constructions for civil engineering and industrial building. It was also used for constructions of warm floors and for external walls in one- and two-storey houses. On injecting acids in media of gypsum stone a chemical reaction takes place and gas generates. This process has been investigated for different acids and salts.

INTRODUCTION

One of the most effective ways to decrease material capacity and simultaneously to increase exploit parameters of structures is to use durable porizated materials and details. Widely known materials of porised variety are gas concrete and gas silicate, which lose 20-25% of their strength due to reaction between free CaO and CO_2 of external air media. The production of named material is connected with high expenses of energy for autodave treatment after moulding, so monolithic construction on its base is impossible.

Taking this into account, it seems more advisable to use porizated gypsum compounds based on high quality gypsum, preferably of α -modification with high air resistance. More perspective promises to be porisation of gypsum by additives, allowing to get homogeneous material with stable characteristics and developed cellular porosity - gas gypsum.

PRODUCTION OF DURABLE MATERIALS

The essence of gas gypsum production follows. The gypsum stone in the majority of deposits contains 10 to 30 percent carbonate admixtures which is the reason for low strength characteristics of gypsum. After acid injection a chemical reaction takes place and CO_2 releases. A detailed study of gas generation in reactions with different acids and salts, acids of middle force with dissotiation constants $K_D = 10^{-2} \div 10^{-5}$, whose calcium salts are of poor water-solubility, have proved to be more preferable. Such acids as oxalic, tartaric, maleic and succinic satisfy these requirements. The process of gypsum mass porisation by one of these acids is finished in 3 to 10 minutes.

The most effective appears to be oxalic acid allowing to obtain three times the amount of gypsum mass with comparably small amount of acid. As the result calcium oxalate CaC_2O_4 is obtained, soluble ability of which is 1/4000 in comparison with two-hydrate gypsum. This is the main factor affecting the production of durable porisated materials, suitable both for inner and outer constructions.

Good solubility of oxalic acid in cold water is one of its technological advantages. It does not evaporate and keeps its gas-generating ability for considerable period of time.

The next point in the production of durable materials is the creation of such rheotechnological conditions, that are most favourable for optimal distribution of pores. This is achieved by plasticizers activating the process of gas generation. It takes place if the ultimate stress of displacement is $\tau_0 \leqslant 40$ Pa and plastic viscosity is about $\eta_1 = 2 \cdot 10^2$ Pa sec. In such conditions the pores are mainly of spherical shape so the poric structure of gas gypsum with average density 450 ÷ 800 kg/m^3 may be characterised by the equation of pyramidal distribution of gas cells

$$\psi = \frac{4\pi}{1.7685(2+\frac{\sigma}{r_1})}$$

where σ is the thickness of walls between pores and
r_1 is the radius of the main model pore.

The pyramidal distribution of pores allows the material to have maximal volume of pores of spherical shape. Vibration technology delivers for porisated concrete of some level of porisity distribution closel corresponding to pyramidal. The optimal character of porosity produces such conditions under which the increase of concentration of oxalic acid increases relative quantity of closed pores and by that decreases maximal water content for 13-25% versus porisated concrete (of the same density) and decreases maximal sorbtion vapour content (under ψ = 100% and temperature of area media 19 ± 2 °C).

Fig. 1 shows that porised gypsum material with average density about 700 kg/m^3, has maximal sorbial vapour content about 3.75 times lower than porisated concrete.

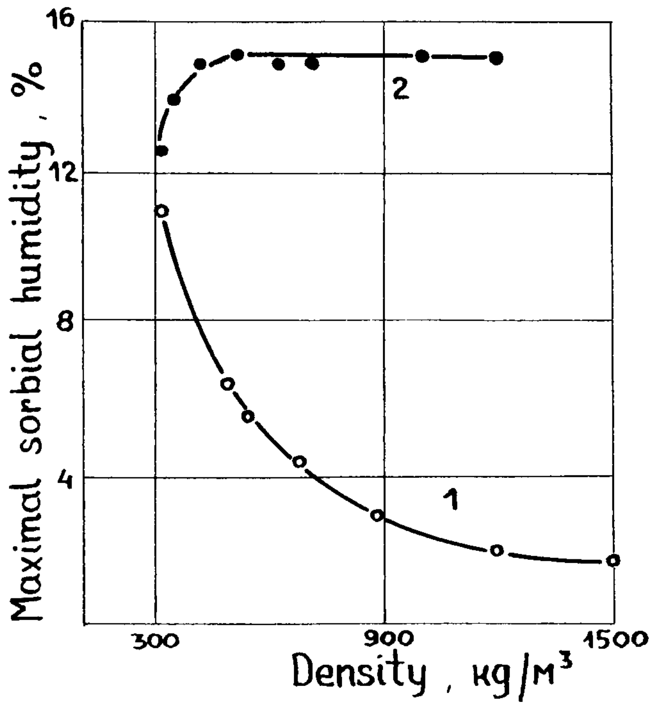


Fig. 1. Dependence of maximal sorbial wapour content of gas gypsum (1) and porisated concrete (2) on density

Durability of gas gypsum depends on basic gypsum strength quality; strength of details made of it is proportional to quality parameters, density being the same (Table 1). In common case relation strength/density may be approximated by polynomical function $R = k\,\gamma^n$, where k is a constant, numerically corresponding to strength in flexure or compression in dry or moistured condition of gas gypsum when $\gamma = 1000$ kg/m^3 ; n is a constant of non-linearity, generally depending on the amount of admixtures in gypsum. For binders with carbonate contents cver 15 %, n equals to 2.

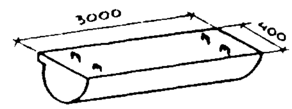
The study of deformative characteristics of gas gypsum with density 700 kg/m^3 showed that in dry condition it acts like a linearly-elastic body up to stress level $\sigma = 0.8\,R_{pr}$, the curves of creep deformation being exponential, and may be described by equations of linear viscoelasticity.

Table 1 Main physico-mechanical characteristics of gas gypsum, gas silicat and porisated concrete in dependence of their average density

Characteristics	Average density, kg/m^3						
	300	400	500	600	700	800	900
Strength limit of gas gypsum under compression (dry)*, MPa	0.5-0.7	1.0-1.5	1.7-2.5	2.9-4.0	3.6-5.2	5.1-7.0	6.4-9.0
Coefficient of heat conduction, Wt/m·K :							
- gas gypsum (dry)	0.15	0.16	0.19	0.22	0.24	0.29	0.35
- porisated concrete (dry)	0.09	0.10	0.12	0.14	0.16	0.20	0.23
- porisated concrete (moisture content 8%)	0.15	0.17	0.19	0.22	0.24	0.28	0.31
- gas silicat (moisture content 8%)	-	0.15	0.16	0.19	0.23	0.35	-
The volume of pores,%							
- gas gypsum	83	79	74	73	71	67	64
- porisated concrete on silicat sand with specific area 2650 cm^2/g	89	85	81	77	74	70	60
- gas silicat on silicat sand with specific area 2350 cm^2/g	87	83	79	74	70	66	62
Moisture limit content,%							
- gas gypsum	59	52	48	41	37	31	26
- porisated concrete	70	60	52	47	43	41	39

* The variations of strength characteristics are because of corresponding variations of gypsum G-10...G-13 after standard

Table 2 Main spheres of using gas gypsum in building

<table>
<tr><th>Characteristics</th><th>Figures</th></tr>
<tr><td>Decorative-acoustic hang elements for concert halls
$\gamma = 450-500\ kg/m^3$;
$R_{cz} = 1.5-3$ MPa</td><td>
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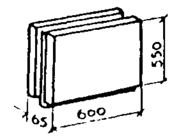
<tr><td>Profiled and ribbed stabs of inner walls
$\gamma = 600\ kg/m^3$;
$R_{cz} = 3.5$ MPa</td><td>
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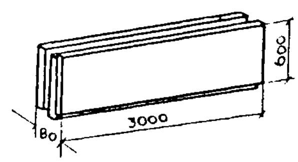
<tr><td>The same panels reinforced by cut glass fibres
$\gamma = 600\ kg/\ m^3$;
$R_{cz} = 3.5$ MPa</td><td>
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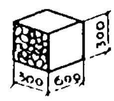
<tr><td>Units of external walls of low-storey houses
$\gamma = 700-750\ kg/m^3$;
$R_{cz} = 5.0$ MPa</td><td>
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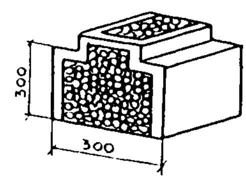
<tr><td>Heat isolating gas gypsum for monolite cores in finishing moulds of monolite buildings
$\gamma = 450-500\ kg/m^3$;
$R_{cz} = 1.5-2$ MPa</td><td>
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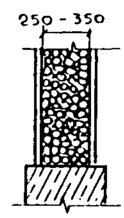
<tr><td>Constructive-isolating gas gypsum for monolite building in take-off moulds
$\gamma = 700-750\ kg/m^3$;
$R_{cz} = 5.0$ MPa</td><td>
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<tr><td>Casting heat isolating layer under gypsum floor foundations
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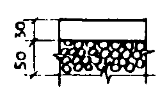
$R_{cz} = 1.5-2$ MPa</td><td>
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Moistured gas gypsum has another law of deformation. Under stresses about 0.3 - 0.4 R_{pr} , it shows non-linearity which is connected with the development of plastic deformations. For this reason the usage of gas gypsum in constructions under the conditions of air humidity more than 60 %, should be limited by stress level of 0.2 R_{pr} (determined in dry condition). Simple technology of producing materials or details using gas gypsum, low expenses of energy (no autodave treatment is necessary), high air resistence and frost resistence of gas gypsum allowed the authors to propose a broad scale of materials and details for monolite and prefabricated constructions (Table 2). It is accepted as a basis for the usage of gas gypsum in building in the USSR till 1990.