**V.S. Semenov, D.V. Oreshkin, T.A Rozovskaya**

## PROPERTIES OF LIGHTWEIGHT MASONRY MORTARS WITH HOLLOW GLASS MICROSPHERES FOR WINTER CONDITIONS

The authors provide their research findings concerning lightweight masonry mortars with hollow glass microspheres and antifreeze admixtures. These mortars are used in the construction of filler structures at negative temperatures. The application of multilayer filler structures causes reduction of their thermal homogeneity factor. Therefore, single-layer filler structures have the strongest potential. There is a need to employ lightweight masonry mortars to ensure the thermal homogeneity of structures made of lightweight concrete blocks. The masonry mortar that has traditional weight reduction fillers (such as inflated pearlite, vermiculite etc.) demonstrate low strength properties, as such fillers have a high water content. Hollow glass (or ceramic) microspheres are known as efficient fillers for lightweight mortars. Multiple research undertakings contain information on the masonry mortar that has the following properties: average density of dry mortar — 450 kg/m$^3$, thermal conductivity factor — 0.17 W/(m·°C), compressive strength at the age of 28 days — 3.2 MPa, water retention rate — over 90 %.

The climatic conditions of Russia determine the need to perform masonry works at negative temperatures. Adding antifreeze admixtures is an easy and cheap method that guarantees hydration of the Portland-cement at negative temperatures. The subject of this research covers masonry mortars that have a 15 % hollow glass microsphere content and antifreeze admixtures. Contemporary antifreeze admixtures are multifunctional. Therefore, traditional antifreeze admixtures such as sodium chloride, calcium chloride, sodium nitrite, sodium nitrate, sodium formate, potash were used in the research. The per-cent content of antifreeze admixtures was calculated. The following properties of masonry mortars with a 15 % content of hollow glass microspheres and antifreeze admixtures were identified: average mortar and mortar mixture density, setting time, water retention, compressive and bending strength, and water absorption. Standard research methods were employed.

Every mortar has an 8 cm mobility. The benchmark mixture has an average density of 1.085 kg/m3, average cement stone density of 980 kg/m3, compressive strength at the age of 28 days — 19.8 MPa, water retention rate — 97 %, setting time — 4.5 hours.

The attention was driven to the strength analysis of mortars with hollow glass microspheres and antifreeze admixtures at positive and negative temperatures. The authors proved that antifreeze admixtures demonstrated a negative influence on the strength and setting time of the mortar if hardened at 20 °C. The strength of mortars with antifreeze admixtures was below that of the benchmark mortar. Mortars that had sodium nitrite and sodium chloride demonstrated better results, while the mortar with calcium chloride showed the lowest strength.

Sodium nitrite, sodium formate and potash were mostly efficient at negative temperatures. The mortar with sodium nitrite demonstrated the highest strength, as it had hardened at the positive temperature. Optimal mixtures for the temperature of –10 °C were developed by the math planning method.

The results of the microstructure analysis for optimized mixtures are provided in the article. The finding of the authors are that at the temperature of –10 °C the following mixtures have the best properties: lightweight masonry mortars with hollow glass microspheres and sodium nitrite (7 %), or sodium formate (5 %), or potash (7 %) with a setting retarder added.

**Key words:** masonry mortars, lightweight cement mortars, hollow glass microspheres, antifreeze admixtures, mortars for winter seasons.

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About the authors: **Semenov Vyacheslav Sergeevich** — Candidate of Technical Sciences, Associate Professor, Department of Building Materials, **Moscow State University of Civil Engineering (MGSU)**, Office 515 ULK, 26 Yaroslavskoe shosse, Moscow, 129337, Russian Federation; +7 (495) 287-49-14, ext. 3092; science-isa@yandex.ru;

**Oreshkin Dmitriy Vladimirovich** — Doctor of Technical Sciences, Professor, Chair, Department of Building Materials, **Moscow State University of Civil Engineering (MGSU)**, Office 135 KMK, 26 Yaroslavskoe shosse, Moscow, 129337, Russian Federation; +7 (499) 183-32-29; dmitrii_oreshkin@mail.ru;

**Rozovskaya Tamara Alekseevna** — postgraduate student, Department of Building Materials, **Moscow State University of Civil Engineering (MGSU)**, Office 515 ULK, 26 Yaroslavskoe shosse, Moscow, 129337, Russian Federation; +7 (495) 287-49-14, ext. 3092; tom-ka@list.ru.

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