UDC 691.32-033.33

USING OF WASTE OF VARIOUS INDUSTRIAL PROCESSES FOR THE MANUFACTURE OF LIGHT CONCRETE

IGOR MOROZOV, YAROSLAV SEMENYUK
Belorusian-Russian University, Mogilev

Concrete industry is one of the major sources of consuming high volume of natural resources. In this article we try to examine and evaluate the effectiveness of existing ways of solving this problem.

Lightweight concrete based on various aggregates is widely used in industrial and civil construction. The benefit of using this type of concrete is obvious: claydite-concrete structures, for example, due to its low density, can improve the thermal and acoustic properties, as well as to some extent reduce the weight of buildings. Therefore, the number of lightweight concrete produced in the Republic of Belarus and in the world is constantly growing. In 2002, the global total concrete production reached 6.5 billion tons, and in 2009 (according to some data, in 2008), this figure was already 10 billion tons. According to the work we studied, scientists Mechta and and Monteiro (New York, USA), by 2050 the volume of concrete produced annually will increase to 18 billion tons. M. Nomel and A. Riaz in their work from 2015 showed an equation by which one can calculate the amount of carbon dioxide emitted during the manufacture of 1 cubic meter of concrete. So, in the production of 1 cubic meter of concrete from 300 kg of Portland cement, 890 kg of sand, 970 kg of gravel and 150 kg of water, carbon dioxide emissions will be an incredible 287 kg. Of course, it should be borne in mind that during the hardening of concrete, cement consumes about 43% of the total mass of this gas, but the emissions are still enormous. Due to the constant growth of concrete production, this process will increasingly adversely affect the environmental situation in the areas of its production. In this regard, there is a certain motivation to study the possibility of using such components in the production of concrete, which will reduce water consumption and carbon dioxide emissions.

In order to deal with this issue, we have studied several works on this topic. The works of our compatriots (Y. Semenyuk, M. Filchenko), as well as the works of Polish and American authors (P. Tomas, D. Mihalki, M.Godzezh) were accepted.

The source of CO^2 emissions in this case is the cement itself, so if we replace it with another substance, it will be possible to achieve a reduction of CO^2 emissions into the atmosphere. However, the question arises: what can replace the cement? In addition, you can also replace the placeholder with any kind of waste production.

Today, domestic and foreign experts offer ground granulated blast furnace slag, fly ash, sewage sludge (dirt in municipal wastewater treatment plants).

The biggest question in this case is how strong the concrete will be if you replace part of the cement with the above components and what percentage will be optimal.

As part of the work, the test methods of our foreign colleagues were studied. Despite the fact that the methods themselves are non-standard, the process itself and the research methodology are as follows: the aggregates were mixed in a 0.25-cubic-meter motor drum mixer, then were mixed in a mixer with cement, fly ash and lime for 2 minutes. Water was then added and stirring continued for 2 minutes. Further tests were carried out using the cone shrinkage method. After the mixture was prepared, cubes were cast with sides of 100 mm, cylinders with a diameter of 100 mm and a height of 200 mm, prisms with dimensions of 100x100x500 mm and 100x100x300 mm. Samples were compacted using a vibrating table.

To assess the compressive strength of concrete and the quality of the samples as a whole, an ultrasonic pulse method was used. Tests were carried out after 1, 3, 7, 28, 56 and 90 days. The temperature in the laboratory was 29 ± 3 ºC and a relative humidity of 67-82%.

Let's compare the samples made using the above elements with the samples made and tested by the same method, but not including industrial waste products.

The final samples, in which the cement was replaced by waste (fly ash, automobile glass and sewage sludge) to 40% of the mass fraction, with a 10% decrease in the amount of water used, turned out to be 25-40% lighter. The strength was the same from 7 to 56 days, however, they further showed an increase in strength up to 12% (fig. 1).

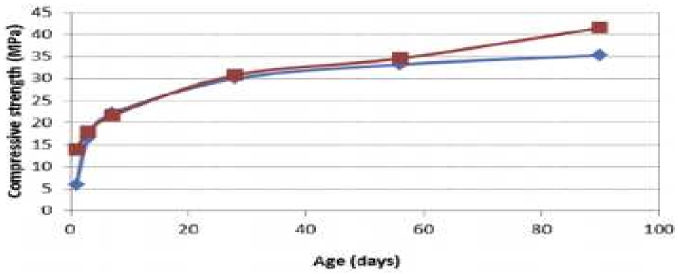

Figure 1. – Compressive strength development of regular (blue line with the rhomb points) and lightweight (red line with the square points) mixes

In conclusion, it should be said that nowadays, when restrictions on production and carbon dioxide are gradually imposed on production of carbon dioxide, and waste is controlled and is worth the money, enterprises should use waste as much as possible for the production of concrete, because we can not only reduce harmful emissions, but also increase the strength characteristics, thermal and acoustic properties of concrete.

REFERENCES

1. Фильченко, М.В. Применение отходов добычи и переработки угля в качестве заполнителей бетонных смесей / М.В. Фильченко, Л.В. Климова // Изв. вузов, Северо-Кавказский регион – 39 с.
2. Mehta, P.K., Advancements in concrete technology / P.K. Mehta. – 1999. – Int. 21, 69.
3. Mehta, P.K. Microstructure, Properties, and Materials / P.K. Mehta, P.J.M. Monteiro. – Third ed. – McGraw-Hill, New York. 2006.
4. Ranjbar, M.M., Madandoust, R., Mousavi, S.Y., Yosefi, S., 201. Effects of natural zeolite on the fresh and hardened properties of self-compacted concrete.Constr. Build. Mater. 47, 806-813.
5. Lee, H.S., Wang, X.Y., 2016. Evaluation of the carbon dioxide uptake of slag-blended concrete structures, considering the effect of carbonation. Sustainability 8 (4), 1-18.
6. Isaia, G.C., Gastaldini, A.L.G., 2009. Concrete sustainability with very high amount of fly ash and slag. IBRACON Struct. Mater. J. 2 (3), 244-253.