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Production of AAC in Russia: history, present stage, perspectives

ABSTRACT: The history of cellular concrete production in the USSR and Russia is recounted. Currently there are 52 AAC plants in Russia, with the capacity of over 30 thousand cubic meters, other 21 plants are being constructed and prepared to start. Autoclaved aerated concrete has a significant portion of the construction market and has great prospects. In 2008 the Autoclaved Aerated Concrete Producers Association has been founded for producers to bring together, to create standard documentation, to share experience and to meet other challenges.

KEY WORDS: autoclaved aerated concrete, blocks, production, standards, association

1. History of cellular concrete production in the USSR

The production of cellular concrete in Soviet Union began to develop intensively in 1930. In view of Soviet economy, the privilege in those times was given to the foam formation method and concrete curing under normal conditions.

AAC production by a method of gas generation on the industrial scale began in 1950. In 1960-70 the technologies of freshly formed cellular concrete massive treatment have been developed and implemented, firstly by means of vibration, then shock-table technique accompanying the process of structure formation in the batch. Along with the changes in the production process, the studies were carried out to find the effect of various factors on the properties of cellular concrete. In particular, the effect of various raw materials and different technological conditions on concrete properties was investigated. On the basis of numerous and integrated tests the optimum conditions were chosen to obtain the standardized values of strength, density and frost resistance.

By the end of 1980 the production capacity of reinforced products and cellular concrete blocks in the USSR was about 6 million m³ per year. In 1989, the mean density of the exterior wall panels was 687 kg/m³, the density of cellular concrete blocks – 643 kg/m³ respectively. At the same time in the design and research organizations in Sverdlovsk (Yekaterinburg) and Leningrad (St Petersburg) the studies were carried out that allowed to start the pilot production of reinforced AAC panels with variable density across the thickness and the density within the panels of 350 kg/m³.

By that time in the USSR more than 200 million m² of residential buildings, over 400 million m² of industrial buildings, more than 5 million m² stockbreeding complexes and more than 20 million m² of cultural and public buildings were constructed with cellular concrete blocks.

Moreover, despite of high level of research and developments inside the country, West Europe achievements were a guide for the Soviet Union industry (for instance, density reduction of AAC panels and blocks down to 300 kg/m³). That was mainly a result of stable quality raw materials and equipment providing highly homogeneous material.

2. The program of AAC production development in the USSR

In 1987, the scientific and technical program “The system of effective construction of residential and public buildings from cellular concrete” for the implementation of tasks in the field of construction of residential buildings was adopted in the Soviet Union. This program consisted of 6 sub-programs:

1. Large - scale production of complete cellular concrete products for residential and public construction based on new technologies;
2. Full equipment for new generation AAC plants with capacity of 150-200 thousand m³ per year;
3. Development of the lime production to meet the needs of the assumed annual output of cellular concrete;
4. The system of effective design solutions for residential and social infrastructure, aimed in design of town complexes on the basis of AAC products;
5. Development of integrated design and technological solutions of buildings and their elements made of cellular concrete;
6. Experimental design and construction of town planning complexes with products from cellular concrete.

The adopted program covered the construction of nearly 250 new plants of autoclaved aerated concrete with assumed increase of production output of the AAC to 40-45 million m³ per year by 1995.

An important task was not only to increase the production rate but also to reduce the density of AAC products. By reducing the density of cellular concrete, the reduction of wall thickness can be achieved and the consumption of materials per 1 m² of total area can be cut down. Thus, at the decrease in density from 600 kg/m³ to 300 kg/m³ the wall thickness can be twice less, while the consumption of materials can be reduced by four times, de-

spite the fact that the development program assumed the 7 times increase of total AAC output.

3. Autoclaved aerated concrete in the new history of Russia

The specifics of the Soviet economy and rising energy prices in the world have led to the situation that the plans to increase the production output of cellular concrete in the Soviet Union had not been fully achieved. On the contrary, instead of the planned growth of autoclaved reinforced products and blocks output from 6 to 40 million m³ the recession of production to the level of 3.5 million m³ occurred.

It should be noted that during the difficult time of the Soviet Union disintegration on the new states, some elements of investment programs were continued. Therefore the equipment from the Ytong company, purchased in the late 80's, was installed in the plant of "Cottage" company in Samara and it started manufacturing of AAC products in 1995. Similar equipment but in a simplified form, was installed in a plant in Naberezhnye Chelny town.

Simultaneously with the installation of equipment from Ytong company, several other AAC producing plants were built using Hebel machines, for example the plant in the city of Lipetsk, «211 KZHBI» in Sertolovo town near St. Petersburg, «Zabudova» in Belarus. At the same time an AAC producing plant «Sibit» began to work in the city of Novosibirsk with the equipment of Ytong.

Due to the production of the plants with imported equipment, starting in the years 1994 – 1997, more than 0.5 million m³ AAC blocks with high precision geometrical dimensions appeared on the Russian construction market. The products of plants mentioned above, which became truly «AAC of a new-generation», significantly influenced the design of residential and public buildings with monolithic frame. This time coincided with the growth of commercial construction in the late nineties.

Until 1998, there was no inflow of relatively large private investments in the production of construction materials in Russia. In connection with the situation on the construction market the small enterprises appeared, which produced non-autoclaved aerated concrete. In many regions of Russia the definition of "foam block" was frequently used and, consequently, has become synonymous with "cellular concrete", that was quite motivated due to almost complete absence of autoclaved aerated concrete masonry units.

Table 1

INSTALLED CAPACITY OF AAC PLANTS IN RUSSIA.

Year	1990	1995	2000	2005	2010	2013*
Installed capacity, thousand m³ per year	1291	1928	2348	4508	7850	13575
Growth over the period, thousand m³	0	637	420	2160	3342	5725

*data for 2013 was quoted as declared by the plans and signed contracts to supply equipment

Changes in the volume of wall building materials production in Russia began after the year 1998, when the demand for housing increased. Obviously, the overall growth of construction volumes has led to a gradual increase of investments in the construction materials industry, which contributed to an appreciable increase in the AAC manufacture (Table and Figure 1).

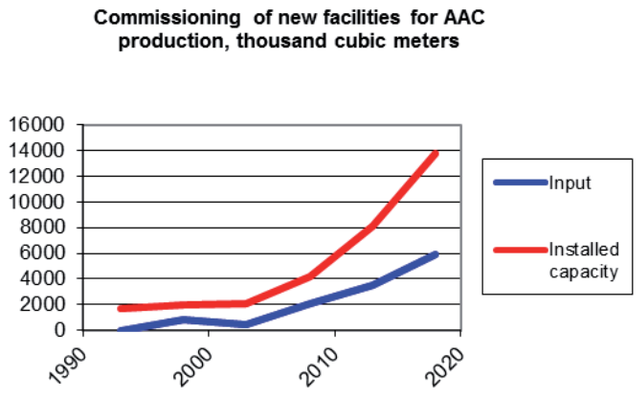

Fig. 1. Input of AAC production facilities in Russia.

4. Standard requirements for AAC and its performance

In the late ninties the construction with AAC blocks on the thin-layer mortar began at construction sites in Moscow, St. Petersburg, Novosibirsk and other cities, although still in the eighties the AAC brickwork on a glue only was expected to be used in practice and considered to be prospective.

In connection with the manufacture of exact sized AAC blocks and laying them on the thin-layer mortar, the question of standard characteristics of cellular concrete constructions becomes topical. Then the publications reporting the actual values of the equilibrium moisture equal to 4-6% for AAC blocks in building envelope structures appeared. The question of the actual value of the equilibrium moisture content was discussed in the government agencies, where a decision was made concerning the possibility to issue permissions for using calculated values of humidity and coefficient of thermal conductivity, provided by a request of a plant. In 2001, the domestically obtained data relating to the properties of AAC blocks were published in the report "Determination of heat engineering characteristics of cellular concrete" by Research Institute of Building Physics by request of the «Polikwart » company.

On the basis of separate tests in the Research Institute of Concrete and Reinforced concrete, AAC blocks with density grades of D350 and D400 are referred to a group of structural and heat-insulating materials, though permission for the use of such units are issued with indication for particular manufacturers. In the early two thousands the studies were carried out to define more exactly the heat-engineering characteristics of autoclaved aerated concrete, with financing from particular plants or their sale representatives. Due to that financing the benefits were received by single plants

and there was no question of changes in the Russian standards. The opportunity to get financial support for repetition of tests and research was a motivation of inaction for organizations responsible for updating the standards for cellular concrete.

Negative situation with the standards maintained from 1998 till 2005. However, the continued increase in the number of new plants led to a qualitative change of the situation. The plants «Teplit», «ECO», «Aeroc» and a number of previously launched plants, initiated the inclusion in the work plan TK465 «Building» a program for the revision of national standards GOST 25485-89 and GOST 21520-89 in a part related to AAC. The work on development of new standards for AAC was coordinated by State scientific and research institute of reinforced concrete.

Eighteen months of work on the standards has resulted in creation and publication of the GOST 31359-2007 «Cellular autoclaved curing concretes. Specifications» and GOST 31360-2007 «Wall unreinforced products of cellular autoclaved curing concrete. Specifications». Standards were adopted by the Interstate Commission for Scientific and Technical Standards, Technical Regulation and Standardization in Construction and were put into action in Russia as national standards.

In the accepted standards the restrictions were removed, the differentiation of concretes by sorts were put in order, tabular requirements were replaced by parametric series, the unification of requirements to materials was carried out and a full list of quality characteristics of autoclaved aerated concrete and its products was defined. Since the publication of these standards, the production and use of AAC in Russia has started to meet modern requirements.

5. Autoclaved aerated concrete producers association (NAAAC)

The non-profit partnership «Autoclaved Aerated Concrete Producers Association» gets together the efforts of specialists from several enterprises to promote collaboration, development and creation. At present, National Association consolidates ten industrial structures with total capacity of more than 3 million m³ per year, representing about 40% of the total installed capacity for the AAC production in Russia (Fig. 2).

In general the work of NAAAC is aimed at specifications and standards work out for more efficient and rational AAC products application in construction. In 2009 the decision was taken to work out a standard to facilitate the design of building structures using AAC items. Scientific and Technical Council of the Association is a coordinator for development of this standard. The versions of separate sections of the standard are being performed by various higher educational institutions The work over the standard relating to AAC products application in construction is expected to be completed by mid to end of 2011.

In addition to the standard documentation, the Association develops activities that promote the exchange of experience among the

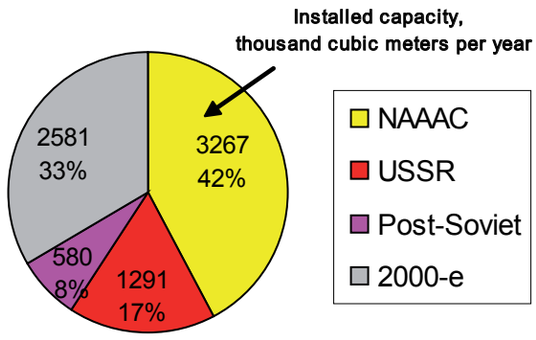

Fig. 2. Structure of production capacity, October 2010.

enterprises in regards to the production, the strategy of interaction with suppliers and the practice of the finished products application. It should be noted that the Association actively cooperates with federal and regional authorities which are responsible for the technical policy of the state in the field of regulation, construction and energy.

6. AAC industry nowadays and prospects of development

There are 52 AAC plants in Russia nowadays; they reveal a production capacity more than 30 thousand m³. Twenty one other new plants are being built and prepared for start-up, the works on the construction of 5 other plants are suspended.

Currently, the total installed capacity of all plants is about 8 million m³ per year. It is expected that as soon as the new plants are launched, the production capacity in 2013 may reach about 14 million m³ of AAC products per year.

At the moment about 85% of AAC items are produced in Russia on the modern equipment that ensures high accuracy of dimensions and obtaining high strengths at low density values.

The prospects of AAC production in Russia are closely bound up with general trends of economic development of the country and with the line of the structure development of housing and communal services and tariff policy in the power engineering sector. The proportion of AAC products application in construction has been growing rapidly in the last decade, because in comparison with other materials, AAC products have high strength and heat insulating characteristics, and they are cheap and durable when applied as a wall material.

Volumes of AAC products application in Russia varies greatly from region to region. For example, in St. Petersburg about 0,2 m³ AAC is consumed per 1 m² of housing being put into operation, and in some areas of the central regions it is less than 0,05 m³. Such situation arises from building traditions, unequal distribution of production capacities and incomplete work over modern standards background that regulate AAC products application.

The potential for growth in consumption and AAC industry development in Russia is great.