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SHARIPOV GAYRAT MAMATKULOVICH

CREATION THE ALKALINE FOAMED CONCRETE ON THE BASE OF THE DEVELOPMENT THE SYNTETIC FOAM MAKER

Speciality
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MASTER DISSERTATION
for the competition academic degree of master for the speciality of «Production of the building materials product and constructions»

Dissertation is considered and allowed to the protection.
Man. of chair "PBMPC"
Ph.d. X.V.Yusupov

Scientific leader:
Ph.d.: A.A. Sultanov

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ЎЗБЕКИСТОН РЕСПУБЛИКАСИ
ОЛИЙ ВА ЎРТА МАХСУС ТАЪЛИМ ВАЗИРЛИГИ

МИРЗО УЛУҒБЕК НОМИДАГИ САМАРҚАНД ДАВЛАТ АРХИТЕКТУРА–ҚУРИЛИШ ИНСТИТУТИ

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Магистратура талабаси:
Ғ.М. Шарипов
Илмий раҳбар: Султанов А.А.
Мутахасислиги: “ҚМБваКИЧ”

“Синтетик кўпик хосил қилувчи таркиб яратиш асосида ишқорли кўпикбетон яратиш” мавзусидаги магистрлик диссертациясига

АННОТАЦИЯ

Мазкур магистрлик диссертация синтетик кўпик хосил қилувчи таркибини яратиш ва унинг асосида ишқорли кўпикбетон ишлаб чиқиш муаммосини ечишга бағишланган.

Сўнгги вақтларда мамлакатимизда қурилиш суръати тез ўсаётган пайтда паст кўрсаткичли иссиқ ва товуш ўтказувчан, энергия тежамкор деворбоп материалларга эҳтиёж тез ўсмоқда. Бундай материалларга биринчи навбатда энергия тежовчи иссиқ ва товуш изоляцияли ячейкали бетонлар, хусусан, газобетон ва пенобетонни киритиш мумкин.

Тадқиқотлар йўналиши бўйича ўтказилган адабиётлар таҳлили шуни кўрсатдики, паст эффектив кўпик ҳосил қилувчи ва юқори бўлмаган цемент маркалари ишлатилиши сабабли ячейкали бетонларнинг мустахкамлик кўрсаткичлари паст, чўкиш деформациялари юқори, шу сабабли стандарт талабларига мос келмайди. Бундан ташқари, юқорида кўрсатилган ва хали кўпгина ўз ечимини топмаган муаммолар сабабли айнан паст иссиқлик ва товуш ўтказувчанликка эга ўртача зичлиги 600 ва 800 кг/м^3 бўлган кўпикбетонларни олиш имконияти чекланган.

Изланишлар бўйича қуйидаги назарий фаразлар шаклланилди: Республикамизнинг саноат чиқиндилари ва махаллий хом-ашъе асосидаги синтетик кўпик хосил қилувчининг таркиби ва технологияси танланса ва у

асосидаги кўпикбетонга боғловчи сифатида юқори мустахкам ишқорли цемент ишлатилса, паст иссиқлик ва товуш ўтказувчанликка эга ўртача зичлиги 600 ва 800кг/м^3 бўлган кўпикбетон олиш мумкин.

Хом ашъёлар танланиб, уларни хоссалари ўрганилди. Уларни хоссалари ишқорли ва портландцементли кўпикбетон учун синтетик кўпик хосил қилувчи олиш имконияти борлигини кўрсатиб берди.

Синтетик кўпик хосил қилувчининг иккита таркиби ишлаб чиқилди, уларни ишлаб чиқариш учун бизнинг Республикамизда катта ҳажмда ишлаб чиқариш имкони мавжуд. Ишлаб чиқилган янги такомиллашган синтетик кўпик хосил қилувчи ПОБ-2016 деб номланди ва унинг асосида ишқорли ва портландцемент асосида кўпикбетонлар таркиби олинди.

Тажрибавий ишлаб чиқариш натижалари шуни кўрсатдики, ишлаб чиқариш шароитида ишлаб чиқилган ПОБ-2016 кўпик хосил қилувчи асосида олинган кўпикбетонлар хоссалари, хориждан келтирилган кўпик хосил қилувчи ПБ-2010 асосидаги кўпикбетон хоссаларига мос ва кўпикбетон талабларига мос келади.

Илмий рахбар _____________
(имзо)

Магистратура талабаси _____________
(имзо)

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SAMARKAND STATE ARCHITECTURAL AND CIVIL ENGINEERING INSTITUTE NAMED AFTER MIRZO ULUGBEK

Faculty: Building
Chair of: “PBMGC”
Academic year: 2015-2017

Master: G.M.Sharipov
Scientific leader: A.A.Sultanov
Spesiality: “ PBMGC ”

ANNOTATION

to the master dissertation for the theme:

“Creation the alkaline foamed concrete on the base of the development the syntetic foam maker”

Present master dissertation was dedicated to decision of the problem of the creation alkaline foamed concrete on the base of the development the syntetic foam maker.

It is made the literary review on direction of the explores, which has shown that because of use low effect foam maker and low mark cements, toughness factors of the foamed concrete is low, deforming shrinkage is high and do not correspond to quality of standards, besides impossible get the foamed concretes with average density 600 and 800 kg/m^3, differring exactly low heat- and sound-conduct.

They Are formulated theoretical premiseses of the explores, concluding in that, that selecting composition and technology of the preparation syntetic foam maker on its base and using as astringent hightoughness alkaline cements possible to get alkaline and portland foamed concretes with average density 600 and 800 kg/m3, differring exactly low heat- and sound-conduct, on the base of local material and departure production of our Republic.

It is collected the raw materials and explored their characteristic, which are indicative of possibility of the development on their base syntetic foam maker for alkaline and portland foamed concrete.

It Is designed two compositions of the syntetic spume maker, there are used material which are produced in our republic in greater industrial volume for production. On base of the designed syntetic foam maker POB-2016 are received compositions of the foamed concrete on base of alkaline and portland cements.

The results which got for the experienced-industrial introduction are indicative that, in working conditions on base of designed foam maker POB-2016 possible to get a foamed concrete, which characteristics are similar to the characteristics of the foamed concrete on the base of import foam maker PB-2010 and be up to quality standard for the foamed concrete.

Scientific leader ____________ (signature)

Master ____________ (signature)

CONTENTS

Introduction

Recently, a row of documents have been adopted, in particular, the decree of the President of the Republic of Uzbekistan from February 7, 2017 year №. UP-4947 "Strategy of actions for the five priority directions of the development of the Republic of Uzbekistan in 2017-2021", which mentions the wide introduction of energy-saving technologies into production , decree of the President of the Republic of Uzbekistan № PF-3586 dated March 24, 2006 "On deepening economic reforms and accelerating the development of the building materials industry", resolution of the President of the Republic of Uzbekistan dated 19.06.2009 №. P -1134 "On additional measures to stimulate production increase and improve the quality of wall materials", resolution of the President of the Republic of Uzbekistan dated 17.06.2010 № PP-1354 "On additional measures to expand individual housing construction in rural areas on the basis of standard projects", which have brought to significant changes in the development of the building materials industry and, in general, construction.

Special mention should be made of the sharp increase in demand for energy-efficient wall materials that have low thermal and acoustic conductivity. To such materials, first of all, it is possible to carry energy-saving heat- and sound-proof cellular concrete, in particular, aerated concrete and foamed concrete.

For the production of foam concrete, blowing agents are used. Analysis of foam blowing agents currently used in our country has shown that foaming agents are produced only organic two-component quickly corrupted LLC "XORIJ QURILISH TEXNOLOGIY" from meat tendons, the period of use of which does not exceed 3 months. In addition, such a foaming agent is consumed per 1m^3 foam concrete 1,5 liters and can be used only with separate technology for the production of foam concrete, with modern barotechnology, an organic foaming agent can not be used. The synthetic foaming agents PB-

2000, PB-2010, PB-Lux, Arekom, etc., deprived of such shortcomings, and the consumption of 0,3 ... 0,6 l / m^3 are imported from abroad, mainly from Russia for the currency.

The project executors have a scientific background in the development of a synthetic foaming agent on local raw materials. As a result of the studies carried out, import substituting compositions of a synthetic foaming agent with a long shelf life and a high foaming effect have been developed.

It is known that for the production of non-autoclaved cellular concrete, cement is required that has a number of special properties, in particular high strength (not lower than grade 500), with satisfactory setting times (elongated for aerated concrete, shortened for foam concrete), low water demand, etc. However, such cements are manufactured by our industry in small quantities, which are also expensive under special order, which hinders the growth of production of such efficient energy-saving wall materials. As a result, builders for walls use not heat and sound insulation materials, such as ceramic bricks, stones and concrete wall stones. The analysis of produced cellular concrete in our Republic showed that, due to the use of low-grade cement, their strengths are low and do not meet the requirements of standards, it is impossible to produce cellular concrete with an average density of 300, 400, 500 and 600 kg / m^3, sound conductivity. A special place is occupied by somewhat increased deformations of shrinkage of foam concrete, which, in conditions of a dry hot climate, lead to the appearance of cracks both in the foam blocks themselves and in the wall of these blocks.

At present, a comprehensive analysis of the main areas of resource conservation in the production of building materials is needed, as in all segments of the economy [1, 2, 3, 4].

The scientific supervisor of the master of this work for a row of years has been carrying out research work on alkaline cements, developed in the 60s of the last century by Professor Glukhovsky V.D., characterized by a row of properties, in particular high strength up to 120 MPa, frost resistance, sulfate resistance, for the production of such cements, active mineral substances and industrial waste (granulated blast-furnace, electrothermophosphoric and color slags, soda-salt alloys, etc.) can be used. As a result of the explores, alkaline cements were developed and introduced into production on the basis of local raw materials and industrial wastes with similar properties. Carrying out studies on the development of alkaline cellular concrete on the basis of the proposed foaming agent, alkali and portland cements would make it possible to obtain cellular concrete with properties that meet the requirements of standards and

A preliminary literary survey in the field of research has shown that scientific research in this direction was carried out by scientists of our country, in particular Kasimov I.U., Samigov N.A., Gaziev U.A., Tulaganov A.A., Kamilov X.X. and other scientists, and abroad Volzhensky .V, Bagrov O.N. and other scientists. The analysis of these works showed that for the production of cellular concrete, autoclave technology is needed with the use of high temperature and pressure (0.8 ... 1.0 MPa) of saturated water vapor, or portland cement of the brand not lower than 500, otherwise it is impossible to produce cellular concrete that meets the requirements standards for this type of material.

Earlier in the present laboratory, the authors of the work have obtained alkaline cements of high (up to 1200) grades based on local raw materials, industrial wastes and alkaline non-autoclaved aerocrete with an average density of 400 and 600 kg / m^3, for which the author's certificate of the USSR No. 1597355 " The raw material for the production of cellular concrete "(authors Sultanov A.A., Atabaev K.K.).

Research work was carried out in research and testing laboratory № 5 of SamGASI "New efficient building materials on local raw materials and industrial wastes" accredited for carrying out such work by Uzstandard Agency (Accreditation Certificate No. UZ.AMT.07.MAI.380 dated 17.03..2017., valid until – 17.03.2017).

The main purpose of resource saving is saving and rational use of material and energy resources. The most important direction of resource saving in the building materials industry is the widespread use of secondary mineral resources, which are waste products and local raw materials [12, 17, 20, 21, 22]. Such astringent materials include astringents based on alkali metal compounds, the high chemical activity of which will make it possible to involve in the sphere of construction production widely distributed substances, including local raw materials and by-products of industry, which have not yet found rational use.

Alkaline cements are characterized by low costs of heat and electricity for their production, high physical and mechanical properties, durability. This is due to neoplasms that create structural bonds in the hardened artificial stone based on alkaline binders [6, 10]. Alkaline cements consist of aluminosilicate and alkaline components. As the aluminosilicate component, both blast-furnace and electrothermophosphor slags and active minerals can be used. Such cements are nonfire, unlike portland cement, there is no firing process.

Developing the theory of hardening of alkaline binders, Professor P.V. Krivenko developed principles for regulating the properties of the final product by directing the synthesis of neoplasms in the hardening alkaline stone, which made it possible to create alkaline binders with a predetermined phase composition of structure-forming elements that ensure the predicted properties, regardless of the chemical-mineralogical composition of aluminosilicate constituent [5, 6].

Taking as a basis for these principles, a group of scientists from the Samarkand State Architectural and Civil Engineering Institute developed alkaline cements and concretes based on local active mineral substances, including alkaline binders for special purposes - high-strength, fast-hardening, sulfate-resistant and low exothermic cements based on active local minerals and industrial wastes. The conducted studies on the development of alkaline cements have shown the possibility of developing cellular alkaline concretes, which is relevant at present [13, 16, 18, 19, 23, 26, 28].

Object and subject of research. The object of explores are foaming agents and cellular concrete based on alkali and portland cement.

Purposes and objectives of explores. The purpose of the work is the development and implementation of synthetic foam makers and effective cellular concrete based on alkaline and portland cements.

To achieve this purpose, the following tasks are set:

- collection and research of raw materials;
- choice of explore methods;
- development of the synthetic blowing agent composition and explore of their properties;
- development of the compositions of cellular concrete based on alkali and portland cement, explore their properties;
- development of ways to improve their strength and deformation properties;
- approbation and introduction into production of the developed foaming agent and cellular concrete on the basis of alkaline and portland cements;
- a feasibility study for the production of foaming agent and cellular concrete.

Scientific novelty. In our country foaming agents are produced only organic, two-component, quickly corrupt LLC "XORIJ QURILISH TEXNOLOGY" of meat tendons, the period of use of which does not exceed 3 months. In addition, such a foaming agent is consumed per 1 m^3 foam concrete 1,5 liters and can be used only with separate technology for the production of foam concrete, with modern barotechnology, an organic foaming agent can not be used. The developed synthetic foaming agent POB-2016 does not deteriorate, the consumption of foaming agent per 1 m^3 relative to the consumption of organic blowing agent is less.

Classification of the techniques used in the experiment.

Tests of binders were made in accordance with the requirements of STAT 310.1 ... 310.3.-76, STAT 310.4-81.

The cellular concrete was manufactured and tested according to the methods given in STAT 25485-89, STAT 27005-86, STAT 12852.0 ... 3-77, STAT 8462-85, STAT 7076-96, STAT 17177-94.

The foaming agent was prepared and tested according to STAT 23409.26-78.

Theoretical and practical degree of importance of the results of experiments. The obtained results of pilot-industrial implementation show that in production conditions can be produced foamed concrete on the basis of the developed foam maker POB-2016, the properties of which are similar to those of foam concrete on the basis of imported foam maker PB-2010 and meet the requirements of the foam standard.

The theoretical and practical degree of importance of the master's dissertation is to study the theory of foam concrete and its introduction into production.

Composition and volume of the master's dissertation. This master's dissertation consists of an introduction, three chapters, main conclusions, conclusion and list of used literature. They are given in the following sequence:

The first chapter provides information on the theoretical prerequisites for the production of effective cellular aerated concrete on alkaline and portland cement, alkaline binders, cellular concrete, and foaming agents for foam concrete. Theoretical prerequisites and research problems are also formulated.

The second chapter provides information on raw materials, the choice of research methods. The corresponding conclusions to the chapter are given.

In **the third chapter**, the final, are presented the results of the conducted experiments, the compositions and properties of the developed foaming agents and foam concrete on their basis. The conclusions are drawn on the basis of the results of pilot-industrial introduction into production and calculation of technical and economic efficiency.

In **the final part** of the master's thesis results of the pilot-industrial introduction of foam concrete on the basis of the developed foam maker POB-2016 are presented, as well as the calculation of the technical and economic efficiency of the developed compositions.

The master's dissertation is printed in a Microsoft Word text editor on the Times New Roman font and consists of 78 pages, including 16 tables, 2 pictures and 49 sources of literature.

The present work is devoted to the development of a synthetic foaming agent on local raw materials and cellular alkali and portland cement concretes.

The work was carried out within the framework of the State Scientific and Technical Program of the Republic of Uzbekistan (IOT-2015-7-26).

CHAPTER 1. Theoretical prerequisites for obtaining efficient cellular concrete made of alkaline and portland cement

1.1 Cellular concrete made of alkali and portland cements

Nowadays, cellular concrete occupies one is the leader in the world practice of construction as a structural and thermal insulating material for the construction of buildings for various purposes. High thermal insulating ability, low density makes cellular concrete an effective material when used in both low-rise and high-rise buildings.

Recently, due to the introduction of new requirements for thermal protection of buildings the market of building materials began to be replenished with products from cellular concrete, which can be used both as carriers and as heat-shielding building materials. The niche in market is occupied also by cement foam concrete of non-autoclaved hardening. As a rule, their use in construction is reduced to the erection of internal partitions or as a filler for enclosing structures, as well as in the form of monolithic construction.

Due to the commissioning of new stringent requirements for thermal protection of buildings and structures, a surge of justified interest in the production of highly effective thermal insulation materials has occurred in recent years. On a number of these materials, cellular concrete is one of the most promising, and the production of non-autoclaved cellular cement concrete has become a priority for various enterprises.

Light, warm and well-processed cellular concrete can contribute to solving the construction problem of the country, since from the cubic meter of mineral raw materials due to the formation of pores in the concrete structure, it is possible to obtain up to 3-4 m3 of highly effective products and structures.

There is a dynamic growth in the production of cellular concrete in modern world construction practice, most of which are enclosing products in the total volume of buildings occupying 45-60%.

Cellular concrete does not burn and does not support combustion, does not contain combustible components, does not emit toxic substances during combustion, has high thermal insulation properties, including in conditions of fire, preserves integrity and bearing capacity for a long time. The material also has a high heat-accumulating capacity, the ecological factor is 2, for comparison, wood I, ceramic bricks 10, the content of natural radionuclides is 10 times lower than normal and corresponds to the strictest sanitary and hygienic requirements. Very efficiently used in high-rise buildings in seismic regions of China, Japan and Mexico, due to the effect of proportional weight reduction of buildings several times and the seismic load on the foundation and soil.

Classification of cellular concrete was changing with their development. Attempts to classify cellular concrete were made earlier, however, their separation was based only on the difference in the method of the porosity and the type of raw materials, what did not give an idea of the diversity of cellular concrete and the prospects for its further development. At the same time, a detailed classification is of practical importance, since it allows you to conduct a conversation between the manufacturer and the consumer in understandable language.

Nowadays, there is a large number of different types of cellular concrete, some of which have found wide application in construction, while others are still promising. Depending on the method of porosity, raw materials, conditions of hardening, density and specific properties, cellular concrete can be classified into separate types (Table 1.1).

Table 1.1 Classification of the foamed concretes [30, 31]

№	Classification feature	Type of cellular concrete according to the classification criterion	Feature of this type of cellular concrete
1	Method for the formation of a porous structure	Aerated concrete	The porous structure is formed as a result of the introduction into the cement-sand mortar of the gassing agent
		Foam concrete	The porous structure is formed as a result of the introduction into the cement-sand mortar of the foaming agent
		Porobeton	The porous structure is formed as a result of the introduction of a large excess of water into the cement-sand mortar, burn-out and other ultra-lightweight additives
2	Main raw materials	Gas silicate Foam Silicate Porosilicate	They differ from aerated concrete, foam concrete, porobeton in that instead of cement, lime or calc-limestone cement is used. The main type of binder is calcium hydrosilicates
		Gasolosilicate Phenosolosilicate Porosolosilicate	They differ from gas silicate, foam silicate and porosilicate, that not sand, but ash of thermal power plants, is used as the silica component. The main type of binder is calcium hydrosilicates
		Gasslagsilicate Phenoslagsilicate Poroslagosilicate	They differ from gas silicate, foam silicate in that the binder contains lime granulated slag in addition to lime. The main type of binder is calcium hydrosilicates
		Газозолошлакосиликат Пенозолошлакосиликат Порозолошлакосиликат	They differ from gas-slag silicate, foam-slag silicate and poroslash silicate in that the composition of the mixture as a siliceous component is ash of thermal power plants. The main type of binder is calcium hydrosilicates
		Газозолобетон Пенозолобетон Порозолобетон	They differ from aerated concrete, foam concrete and porobeton in that the mixture does not consist of sand and ash from TPP. The main type of binder is calcium hydrosilicates
		Газошлакобетон Пеношлакобетон Порошлакобетон	They differ from aerated concrete, foam concrete and porobeton in that the mixture contains ground granulated slag. The main type of binder is calcium hydrosilicates
		Газозолошлакобетон Пенозолошлакобетон Порозолошлакобетон	They differ from aerated concrete, foam concrete and reinforced concrete in that the mix of sand of ash of TPP enters into the mix, and the binder, in addition to cement, contains granular slag. The main type of binder is calcium hydrosilicates
		Газогипсобетон Пеногипсобетон Порогипсобетон	They differ from aerated concrete, foam concrete and porobeton in that the main binder is gypsum or gypsum-like binder. The main type of binder is

			sulphates
		Газокремнебетон Пенокремнебетон Порокремнебетон	They differ from aerated concrete, foam concrete and porobeton in that ground glass is used as the main binder. The main type of binder is quartz
		Газомагнезитосиликат Пеномагнезитосиликат Поромагнезитосиликат	They differ from gas silicate, foam silicate and porosilicate in that magnesite is used as the main binder. The main type of binder is magnesium hydrosilicate
		Gasphosphate-concrete Penophosphate concrete Porophosphate concrete	They differ from aerated concrete, foam concrete and porobeton in that as a binder, phosphoric acid or its salts are used. Basic kind of binder phosphates
		Autoclave	It is obtained by hardening in an autoclave at a saturated vapor pressure corresponding to its temperature
3	Curing conditions	Tempered	Obtained by solidification in a chamber at a vapor pressure not corresponding to its temperature
		Non-autoclave	Obtained by solidification under warming conditions (at normal pressure) or without heating
4	By density	Thermal insulation with a density of up to 600 kg / m^3	In its properties belongs to the categories of heat-insulating cellular concrete
		Structural and thermal insulation with a density of 600-900 kg / m^3	In its properties belongs to the category of structural and thermal insulation cellular concrete
		Structural density of 900-1200 kg / m^3	In its properties belongs to the category of structural cellular concrete
5	Special purpose	Heat-resistant Acid-resistant Alkali-resisting	Has special properties

Cellular concrete of various types is named after the porous form (gas, foam, porous) and then the appearance of the silica component and the type of additional binder for cement, gypsum, siliceous, phosphate, fly ash, slag-alkali (concrete), and for calcareous, magnesian, calc-limestone binders (silicate).

In the case where the binder is a mixture of cement and lime (mixed binder), the name of the material is given the ending "concrete", and where the majority of the binder is accounted for by the lime - "silicate".

The use of sand and various additives is not reflected in the name of cellular concrete. So, the name aerated concrete has received cellular concrete, where the blowing agent is used as the blowing agent, and cement is used as an astringent. Gasolosilicate received this name, because here as blowing agent used blowing agent, as a siliceous component - fly ash, and the binder - lime.

The history of foam concrete originates in the thirties of the last century. The Russian scientist, construction experimenter, Brushkov, added a soap root to the cement slurry, a plant that inhabits Central Asia and forms a foam. As a result, a new building material appeared - the foam concrete. Already later, masters began actively mixing cement with chemical additives - foam or gas-forming substances (aluminum powder, etc.). But, despite its unique thermal characteristics, this building material took root not immediately.

The first studies on foam concrete dates back to the thirties, P.A. Rebinder, A.A. Bryushkov, N.N. Kaufmann and others first developed the technology of non-autoclaved foam concrete and studied its properties [27].

In the former USSR a number of shops for the production of foam concrete products were built, but in the total production of cellular concrete - foam concrete was produced not more than 5%.

Previously, a wide range of significant factors prevented the wide use of foam concrete in construction practice, first of all, the lack of stable foaming agents, as well as low performance indicators. During the manufacturing process, a significant surface sediment of the foam concrete occurred, and due to the sidementation processes, the stratification of the concrete, and the formation of the compacted crust in the lower part, which differed in its physical characteristics sharply from the bulk of the concrete. In the process of operation, under the influence of aggressive factors, alternating stresses appeared on the boundary of the compacted crust and the mass of concrete, and the crust exfoliated, disabling the entire product.

In modern world practice, along with the industrial production of aerated concrete products and structures, the production of foam concrete ones is also increasing. The growth in production and use of foam concrete is due to insignificant investment in production, quick payback and profitability, as well as great demand for a small wall block and thermal insulation coatings.

There are were a lot of researches in many countries of the world to improve the technology of foam concrete. Taking into account the positive and negative properties of foam concrete, higher quality foaming agents were created on the basis of synthetic chemical raw materials, corresponding to the production conditions for various types of foam concrete, as well as high-performance equipment for obtaining high-quality technical foam. Effective technologies for production of a wide range of foam concrete products and structures using both traditional raw materials and various industrial wastes and substandard raw materials have been developed.

Various structures of foam concrete, both autoclaved and non-autoclaved (natural hardening and steamed), such as: wall blocks and panels, columns, crossbars, basement frames, staircases and platforms, road plates, trays, heat insulation of pipelines have been developed and normalized.

The method of preparation of molding foam concrete masses depends on the technology adopted and the type of blowing agent used.

Preparation of aerated concrete mixture, regardless of the method of foaming, is based on obtaining a heterogeneous system "gas-liquid-solid" and may be organized in several ways. According to a first process specially prepared foam is mixed with the cement paste or a cement-sand mortar, and then, with vigorous stirring, the mass was prepared aerated mixture in which the subsequent setting and hardening binder fixes the structure of the material (classical scheme).

In the second variant, using the "dry mineralization" technology of the foam preparation, the mixture is prepared by combining the dry components with a foam continuously supplied by the foam generator. At the same time, according to A.P. Merkin, "a single air bubble is reserved by particles of the solid phase and water is sucked from the foam." The result is a highly stable foam concrete mass with a small amount of free water.

On the surface of the foam bubbles, small and hydrophilic particles of the solid phase are sorbed (drawn into the surfactant film). The high saturation of the surfactant at the interface "air pore - dispersion medium" predetermines the formation of a smooth glossy surface of the pore walls. A dense pre-porous layer 12-30 μm in thickness is formed, a layer called the reinforcement zone.

The barotechnology of the production of a cellular concrete mix is promising, providing for saturation of the mass in a sealed mixer with compressed air, and then unloading the mixture into molds, where as a result of the pressure drop there is swelling. By this method, air-entraining surfactant additives are introduced into the mixture and a special hermetic mixer is used.

Other methods of preparation of foam concrete mixes, described in the literature, have not found wide practical application, although the principles contained in them have a perspective.

Therefore, when choosing a method for the production of foam concrete mixes, one should proceed from the specifications for the material, the ability of the enterprise to purchase the necessary equipment, as well as the type of raw materials and a number of other initial conditions for the organization of production.

Variants of technological schemes for the preparation of foam concrete mixtures, which have received wide application are the following:

- Classical (two-stage), in which separately prepare the aqueous foam and water cement paste (or cement-sand mortar), and then they are mixed in a mechanical mixer;

- Dry foam mineralization method;
- Baroque method.

The essence of barotechnology lies in the porosity under the excess pressure of a mixture of all raw components. Foam concentrate and water are dosed by volume, cement and sand by weight (or a dry mix of dry blowing agent, cement and sand is dosed by weight). All components are fed to the foam concrete mixer, where air is compressed by the compressor, creating pressure inside. The foam concrete mixture, obtained in a concrete mixer, is transported under pressure from the mixer to the place of packing into molds or a monolithic structure.

The analysis of these technologies for the production of foam concrete indicates that each of them has its advantages and disadvantages (Table 1.2), which respectively affect the construction and technical properties of the resulting foam concrete and its cost price.

All of the technologies listed below are distinguished by the instability of the resulting cellular structure and, therefore, the properties of the material, since the foam concrete mixture is extremely sensitive to the mineralogical and material composition of the binder and fillers on the one hand, and additives on the other. Another disadvantage is the increased humidity of the foam concrete.

All of the following studies were performed mainly with the use of portland cement binders.

Table 1.2 The main differences in technologies for the preparation of foam concrete **[**32**]**

Method of obtaining	Advantages of technology	Disadvantages and their cause
Tradition	1) The most developed and reliable; 2) The parameters of the foam concrete are regulated by the ratio between the foam and the solution in the composition of the foam.	1) During the mixing process, the structure of the foam is partially destroyed. It depends on the: - duration of mixing - with long stirring, it is possible to destroy all foam and not to get a porous foam; - speed of mixing; - the nature of the circulation of the mixed foam in the mixer and the shape of the mixing blades; - Thixotropic characteristics of the mixture: mobility, viscosity, plastic strength, etc .; - on the stability of the original foam (depends on the type of foam generator).
The method of "dry mineraliza tion»	1) This method is suitable for continuous technology for the production of foam concrete; 2) A stable foam-concrete mixture with a small amount of free water forms; 3) It is possible to control the performance characteristics of the foam concrete by changing the multiplicity of the foam.	1) Accurate and equal-speed dosing of dry components and their uniform distribution in the mixture to be sprayed without destroying it is necessary.
Barotech-nology	1) There is no such complicated technological process as foam generation and, accordingly, foam generator; 2) Possibility of obtaining ultra-light foam concrete (less than 300 kg / m3); 3) Compression of foam and foam mix causes an artificial decrease in their multiplicity; 4) With an increase in the degree of reduction, the technological properties of the mixture are improved - as the pressure increases, the bubbles are compressed in proportion to the excess pressure. In a compressed state, the bubbles harden. The raw material mixture on the outlet from the solution pipeline "expands" due to the pressure drop; 5) Possibility of transportation over long distances, both horizontally and vertically.	1) Multifactorial relationship of process parameters; 2) The need for strict compliance with the sequence of loading components into the mixer, the duration and intensity of mixing.

In view of the foregoing, we consider it necessary to study the influence of existing technological methods for the preparation of cellular concrete compositions based on alkaline or portland cement.

Preparation of foam concrete mixture consists of dosing and mixing of constituent materials: sand, cement, water, foam concentrate and additives.

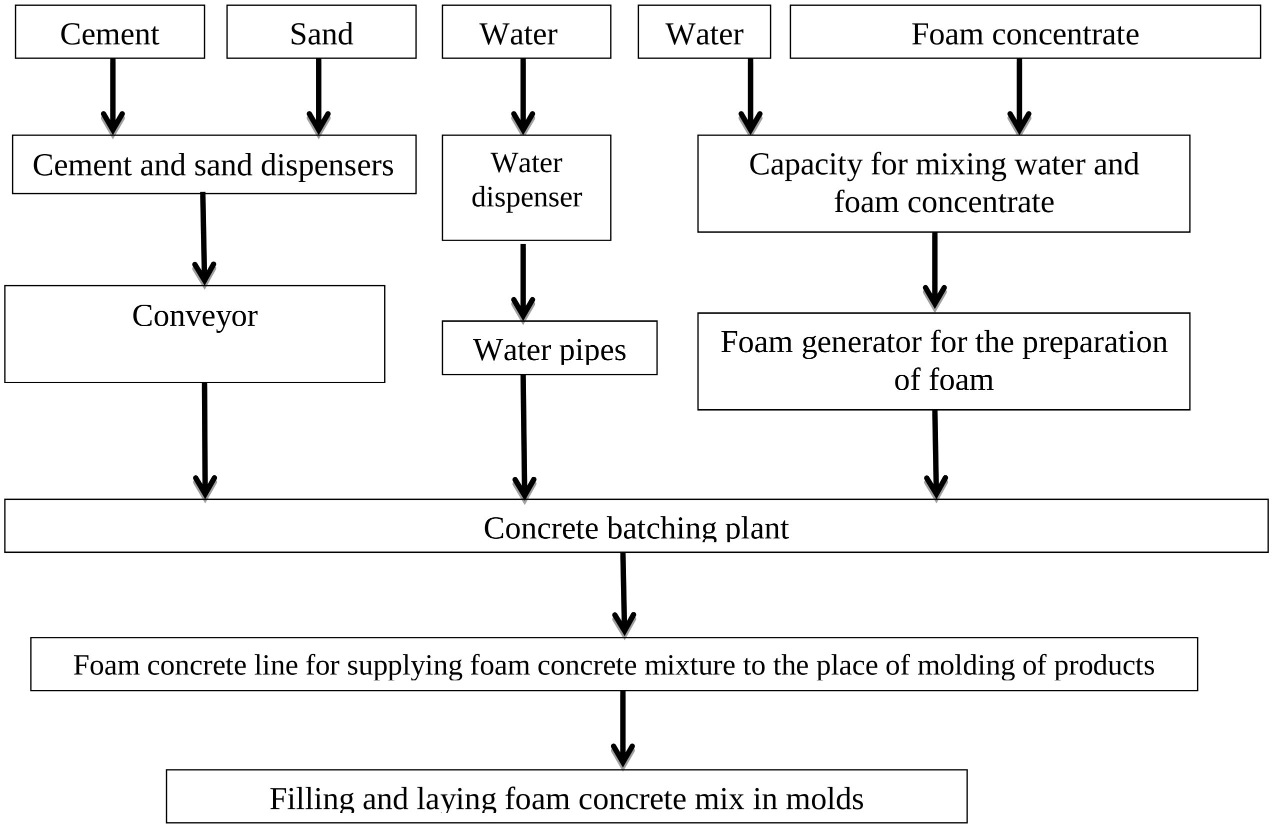


Рис. 1.1 Technological scheme of production of foam concrete.

The process of preparation of a foam concrete mixture includes the following technological steps: loading cement and discharging sand into a storage bin; supply of sand, cement and water; foam preparation; preparation of foam concrete mixture.

Of particular interest from the point of view of thermal conductivity are foam concrete with a density of 200-600 kg / m^3. The complexity of the technology for obtaining low-density heat-insulating foam concrete is related to the features of the porous structure, which contains more than 80% of the air phase, and the volume multiplicity exceeds by 6. Such foam structures have a tightly packed porous structure, practically devoid of intrastructural mobility due to the presence of a rigid, brittle structural framework. These factors determine the susceptibility of foams and foam concrete structures to significant mechanical damage during mineralization and intensive mixing. As a result, materials are obtained with large defects in the cellular structure.

In traditional technology, these shortcomings of high-porosity structures maybe eliminated by adding special additives - stabilizers and thickeners (liquid glass, bone glue, carboxymethyl cellulose, etc.) to the foam concrete. These substances, increasing the viscosity of the solution phase and foam films, significantly improve the structural and mechanical properties of the foam. At the same time, the achieved effect increases with increasing porosity (multiplicity) of the foam concrete mix.

Elimination of the destruction of a highly porous foam structure during the mixing process occurs with an increase in the consumption of these additives, which adversely affects the hardening of the foam concrete and its final properties.

The compromise solution of the problem allows partial destruction of the foam and limits the lower limit of the density of the resulting materials (300-400 kg / m3), reduces the foam utilization coefficient, etc. In addition, due to the high viscosity of the mass, it is difficult to homogenize, require long low- As a consequence, the use of cumbersome, low-productivity foam-mixer of cyclic action. An analysis of the production experience of recent years has shown that the preparation and pumping of such masses through pipelines in a cyclic mode further than 15-20 m also leads to considerable destruction and an increase in the density of foam concrete by 50-150 kg / m^3.

With the purpose of improving the traditional technology and effectively solving the above-mentioned problems in the design of foam concrete bases under the roof, a fundamentally new technology of monolithic foam concrete was developed on the basis of the original “compression-relaxation” process.

According to this method, the entire process of the preparation of foam concrete is performed during the compression of foam and foam concrete mix. Then, the compressed foam concrete mixture is relaxed to the original volume by smoothly removing the compressive force and equalizing the excess pressure inside the mixture to atmospheric pressure.

The most important factor of the developed technology is that the technological principle, which is the basis of the method, makes it possible to apply it also for transporting foam concrete masses, combining the process of preparation of high-quality foam at the stage of reduction with the process of its transfer through the pipeline to the place of packing. In this process, spontaneous relaxation of the foam mass occurs during the pumping and delivery of the mixture. This simplifies and makes more rational the technological scheme of production of monolithic foam concrete and its hardware design.

During compression occurs artificial reduction of the initial volume of the foam structure by compression multiplicity of air pores and increase the proportion of liquid phase, crimped in a reduced volume of the foam structure.

Compression of foam structures with multiplicity above 6 to an artificial multiplicity below 4 leads to qualitative changes in their structural and technological characteristics: a foam structure is formed consisting of mutually remote small spherical pores under excessive pressure of the compressive force and separated by relatively thick liquid partitions. The initial foam structure after compression is deprived of a rigid structural skeleton and acquires an intrastructural mobility. All this contributes to hardening air bubbles, increasing workability and stability of the foam structure in the process of intensive mineralization, homogenization and pumping of the mixture. This method allows to increase the coefficient of foam use, minimize the time of preparation of the foam concrete mixture and use a mixer continuously, and after the restoration of the initial volume of foam - to obtain a highly porous light foam with a minimum defectiveness of the cellular structure and high characteristics.

In the production of highly porous heat-insulating foam concrete of increased viscosity with the addition of a stabilizer-thickener, changes in the structural and technological characteristics of foam masses that occur during their preparation in the crimped state practically neutralize the effect of additives that increase the viscosity of the mixture. Thus, their presence does not change the conditions and the regime for obtaining a homogeneous qualitative foam at the stage of reduction, and at the stage of production the action of the additives is completely restored as a result of complete relaxation of the volume and the formation of a highly porous foam, which sharply increases its structural viscosity and the ability to keep on the inclined surface.

The use of modern effective stabilizers-thickeners in combination with a similar method of their use allows to minimize and regulate their content in the material, to provide high characteristics of the resulting materials and the required viscosity of the deposited masses, depending on the angle of inclination.

The table shows the physical and mechanical characteristics of a monolithic heat-insulating foam concrete without special reinforcing additives and fibers based on the cement binding grade PTS500D-0 and modern foaming agents without special hardening additives, the use of which in the developed technology increases the strength of foam concrete by 20-30%.

Table 1.3 Properties of foam concrete

Density, kg/m^3	Strength when compressed, MPa	Coefficient of thermal conductivity In dry condition, W / (m ° C)	Steam-nachaemost, mg / (Ida)	Sorption humidity, mass.%
200	0,3	0,055	0,3	13
300	0,7	0,07	0,26	13
400	1,25	0,09	0,23	12
500	1,8	0,1	0,2	12
600	3,2	0,12	0,17	11

There are well-known works of Sherman in the field of production of alkali cellular concrete. These works shown\ the possibility of obtaining alkali cellular concrete 400..1200 density kg / m3. According to these works, the properties of alkaline cellular concrete depends on the type of slag used and properties of the resulting foam concrete, which can be regulated be choosing the type of slag. However, these concretes are not insulating.

Structural autoclave aerated concrete was obtained by O. Sikorsky. Based on slag-alkaline cement and loess. As a result of the research, he developed gas concrete with a density of 800 ... 1500 kg / m^3 with a strength of 2.5 ... 12.5 MPa, density of 400 ... 800 kg / m^3 with a strength of 1.5 ... 8.0 MPa.

A number of works by Bagrova B.O. are devoted to the development of alkaline cellular concrete. The author investigated non-autoclaved cellular concrete on the basis of granulated blast furnace slags. The strength of such concrete was 2.8 ... 7.8 MPa at a density of 700 ... 1000kg / m^3. The author suggested introducing polystyrene bisers into the alkaline foam concrete in order to reduce the water absorption of the foam concrete. However Bagrov B.O. payed the main attention to the use of non-ferrous metallurgy slags in order to obtain heat-insulating materials and established the principle possibilities of obtaining both aerated concrete and foam concrete using one technology. In his opinion, the regularities of hardening of alkaline compositions are analogous to the regularities of hardening compositions based on Portland cement clinker. Based on the results of the research Bagrova B.O. It can be concluded that he obtained non-autoclaved cellular concrete based on portland cement, not differing from alkaline cellular concrete. According to Bagrova B.O. Increasing the strength of cellular alkaline concrete will be observed only in autoclaving.

Bagrov B.O. And Baranov A.T. conducted studies of autoclave alkaline cellular concrete with a density of 500 ... 1200 kg / m^3 and a compressive strength of 3.2 ... 5.9 MPa.

Krivenko P.V. And Melnyk G.B. carried out research also on autoclaved cellular concrete on the basis of various types of slags. Krivenko P.V. And S. Ushtkin carried out studies of autoclaved cellular concrete on liquid glass.

Analysis of these studies showed that these autoclave technology is used that does not meet modern requirements of energy saving.

In the studies Rumin, Gots, Chislitsky and Omelchuk the formation of micro- and macrostructure of alkaline cellular concrete was studied and the patterns of formation of the porous structure were determined. As a result of research, Omelchuk V.P. suggests to introduce into the composition of alkaline cellular concrete slag from steel smelting, which will allow to regulate the processes of structure formation. This allowed the researchers to obtain non-autoclave foam concrete with a compressive strength of 2.5 ... 12.8 MPa and 12.0 ... 19.6 MPa at a density of 600 ... 900 kg / m^3 and 1000 ... 1200kg / m^3, respectively.

The introduction of steelmaking slag into the composition of alkaline cellular concrete complicates the technology of production of foam concrete and leads to the rise of the product’s price. Only the use of local raw materials will simplify the technology and reduce the cost of producing a unit of production, i.e. foam concrete.

Dissertational work of Atabaev K.K. is dedicated to the development of slag-alkali gassing concretes. As a result of the research, the author obtained alkaline gas concrete with the density of 600 ... 900 kg / m^3 on the basis of electrothermophosphor slag. However, such materials are intended for soundproofing, i.e. in aerated concrete the pores are in communication.

Recently, a number of works on the development of non-autoclaved alkaline foam concrete have been carried out at the Research Laboratory No. 5 of SamSACEI, in particular, the work of Sultanov AA, Yakubov SF, Kakhharov S.H.

As a result of the studies conducted by Yakubov, alkaline foam concrete is obtained, properties are given in table 1.4.

Table 1.4 Physical and mechanical properties of alkaline foam concrete

№	The name of indicators	Unit. amend.	Value
1	Density in dry condition Mark according to density	kg/m^3	595 D 600
2	Compressive strength Concrete class for compressive strength	MPa	2,3 B 1,5
3	Shrinkage upon drying	mm/m	2,1
4	Sorption humidity at relative humidity: 75% 90%	%	10 14
5	Thermal conductivity	$W/(mx^0C)$	0,14
6	Frost resistance Mark for frost resistance	cycles	25 F25

Research by Kakhharov, Sh.Kh. are devoted to the improvement of physicomechanical parameters of alkaline non-autoclaved foam concrete. As a result of the research it was established that the strength and deformability of alkaline cellular concrete can be regulated by introducing additives having a fibrous structure. It is proposed to introduce wollastonite and basalt fiber into the foam concrete mix, which will allow increasing the compressive strength of alkaline foam concrete up to 2.0 ... 2.2 MPa at a density of 600 kg / m^3. The same effect was obtained when portland cement was used as an astringent. This will allow the production of such materials.

In the field of development of alkaline cements and foam concrete on their basis, a number of scientists under the leadership of A.Tulaganov are conducting the researches in the Tashkent Architecture and Construction Institute. As a result of the research, the authors developed and studied the compositions of modified non-burning alkaline binders based on basalt. It was found that the activity of such astringents developed up to 70 MPa with the introduction of basalt in an amount of 15%. It is shown that the most effective amount of basalt introduced as a modified aluminosilicate component is 30% of the mass of the binder, while the compressive strength of the binder varies between 40-50 MPa. The compositions of modified foam concrete with an average density of 350 to 800 kg / m^3 and compressive strength up to 1.5 MPa have been optimized. It is shown that the most significant factor affecting the strength of non-burning alkaline binders is the silicate module of the alkaline component.

Analysis of studies of cellular concrete on the basis of alkali and portland cement and study of the features of their production showed that it is necessary to switch to the production introduction of such materials in Uzbekistan. However, the growth of production of such materials is hampered by the lack of production of a foaming agent in our region and the development and introduction of foaming agents on local raw materials and materials will dramatically increase the production of foam concrete in Uzbekistan.

1.2 Foam makers for the foamed concretes

Foam is a dispersed system consisting of cells - gas bubbles (vapor) separated by liquid (or solid) films. Typically, gas (vapor) is considered as a dispersed phase, and liquid (or solid) as a continuous dispersion medium. Foams, in which the dispersion medium is a solid, are formed when curing solutions or melts saturated with a gas. Liquid or solid films that separate gas bubbles form a film framework that is the basis of foam.

Foams with a liquid dispersion medium are of the greatest interest for describing the processes occurring in them, and they are more widely used in practice.

The structure of the foams is determined mainly by the ratio of the volumes of the gas and liquid phases, and depending on this ratio the foam cells can have a spherical or polyhedral shape. Cells of foam take a form close to spherical if the volume of the gas phase exceeds the volume of the liquid by no more than 10-20 times. In such foams, the bubble films have a relatively large thickness. Cells foams for which the ratio of volumes of gas and liquid phases is several tens and even hundreds are separated by very thin liquid films; Their cells are polyhedra. During the aging of the foam, the spherical shape of the bubbles turns into a multi-faceted form.

Foams, like other disperse systems, can be obtained in two ways: dispersive and condensing.

In the dispersed process, the foam is formed as a result of intensive joint dispersion of the foaming solution and air. Technologically, dispersion occurs when gas jets pass through a layer of liquid (in bubbling or aeration plants, in devices with a "foam layer" used for cleaning off gases, in foam generators of some types, having a grid irrigated with a foaming solution); Under the action of moving devices on a liquid in an atmosphere of a gas or by the action of a moving liquid on an obstacle (in technological apparatuses with stirring by agitators, shaking, whipping, transfusion of solutions); When the air is blown by the moving jet of the solution (in some foam generators intended for extinguishing fires).

The condensation method of obtaining foams is based on changing the parameters of the physical state of the system, leading to supersaturation of the solution (working medium) with gas. The same method includes the formation of foams as a result of chemical reactions and microbiological processes accompanied by the release of gaseous products.

Supersaturation of the solution with gas and as a result of this foaming occurs when a reduced pressure is created in the apparatus with a solution, with an increase in the temperature of the solution (during solution evaporation, distillation, etc.), when substances that reduce the solubility of gases are introduced into the solution.

The production of foams can be caused by the action of several sources of foaming simultaneously. Thus, some technological processes are carried out with aeration and mixing.

Frothers are substances, aqueous solutions of which can form foam. There are many known foaming agents, but in the production of cellular concrete, foaming agents can be used that will have: a) the strength of the films so that the foam does not break down when mechanically mixed with the mineral part of the solution and ensures the stability of the freshly prepared cellular mixture, until the binder is set and the formation Sufficiently strong skeleton of cellular concrete; B) a large yield in relation to the solution taken (the multiplicity of the foam) and the fine-meshed structure; C) sufficient viscosity of the foam films, which prevents the stratification of the cellular mixture and ensures a uniform distribution of the mineral particles of the solution throughout the volume. In addition, the foaming solution should not have a harmful effect on the physical and technical properties of cellular concrete during its hardening under various conditions.

Previously, the quality of foam can be judged on the basis of its properties in the air, such as resistance, multiplicity, syneresis.

Resistance to foam is its ability to stay in the air for a long time without destroying it. Persistence is characterized by the destruction of the foam column in height per unit time.

Foam (foam output) is a quantity that indicates how many times the volume of foam is greater than the volume of an aqueous solution of a foaming agent.

The syneresis of foam is the separation of the liquid phase from it. Syneresis is characterized by the amount of liquid released from the foam per unit time.

The stability of foam in the first period (4-5 hours) after pouring the honeycomb mixture into the molds can be judged by the precipitation of the cellular mixture. When using high-quality materials and the correct selection of the composition of cellular concrete, the mixture, filled in molds, should not precipitate.

High parameters of foam properties (multiplicity, durability), ensuring the production of high-quality cellular concrete, depend not only on the type of foaming agent, but also on the concentration of the aqueous solution and on the presence of stabilizers in the solutions of the foaming agent.

Usually, they use such foaming agents as glutinous, resinosaponin and some synthetic foaming agents, such as sulfonol, SVM “Astra”, “Planeta”, “Vita”, “Aelita”, “Scrubernaya paste”, “NIET”, “NEOPOR”, “PC-UNIPOR”, “PB-2000”, “PB-2010”, “PB-Lux” and others, the foam of which by multiplicity, durability and the coefficient of use meets the requirements of building standards.

The raw materials for the glutinous, resinosaponin foaming agent must meet the requirements: bone glue, glue, honeycomb, pine rosin, sodium hydroxide.

The most important characteristic of the quality of the blowing agent is its *utilization factor*, i.e. the ratio of the volume (foam) in the mesh mixture to the volume of foam introduced into the solution mixture.

A quality porogen is considered to be one with an utilization factor of at least 85%. In addition, in order to assess the quality of the foaming agent, an important indicator is the production of a non-shrinkable honeycomb mixture.

A list of some synthetic blowing agents and their compositions are given in Table. 1.5.

Table 1.5 Formulations of foaming solutions for the preparation of 10 liters of foam [31]

Foamer	Quantitative content, g	Стабилизатор пены, г					
		TNF	KMS-4	Dissolving glass	Mezdro-glue adhesives	Bone glue	Water, l
Sulfanol	40	40	-	80	„	_	0,5
Sulfanol	40	40	80	-	-	-	0,5
Sulfanol	30	-	-	-	50	-	0,5
SVM «Астра»	30	20	80	-	-	-	0.5
SVM «Планета»	30	-	-	-	80	-	0,5
Scrubbing paste	100	-	-	70	-	-	1.0
SVM «Вита»	-	100	-	-	-	-	0,5
SVM «Аэлита»	50	-	100	-	-	-	0,5
SVM «Альфин»	80	-	100	-	-	-	0,5
SVM «Прогресс»	70	-	90	-	-	-	0,5
OP-2	65	-	-	-	-	175	0,5

The most important characteristic of the quality of the blowing agent is its ***utilization factor***, that is, the ratio of the volume of gas (foam) in the mesh mixture to the volume of gas (foam) that forms the gasifier under the given conditions, or the volume of foam introduced into the solution mixture.

A quality porogen is considered to be one with an utilization factor of at least 85%. In addition, in order to assess the quality of the foaming agent, an important indicator is the production of a non-shrinkable honeycomb mixture.

The raw materials for the glutinous, resinosaponin foaming agent must meet the requirements.

Glutinous foamer.

The name of this foaming agent comes from the names of those basic substances from which it is made - rosin and bone or glue. In addition to rosin, which is a resin, and glue can be used caustic alkali to saponify rosin, i.e. transfer it to a detergent. All starting materials must satisfy the requirements of the corresponding requirements.

The preparation of the foaming agent consists of the following operations. First, a glutinous solution, an aqueous solution of caustic alkali and rosin soap are prepared.

To prepare the glue solution, the glue is broken into pieces of 2-3 cm in size, laid in an iron tank and poured with water, the temperature of which is 15-20 ° C. The ratio of glue and water is 1: 1 by weight. Water-stained glue is kept for 24 hours. Then the contents in the tank are heated with hot water or steam at a temperature of 40-50 ° C for 1.5-2 hours until the glue is completely diluted.

For the preparation of rosin soap, sodium hydroxide is dissolved in water at boiling (at a rate of 166 g NaOH per liter of water) and with continuous stirring, rosin is added, preliminarily ground and screened through a sieve with holes of 5 mm. The ratio of rosin and sodium hydroxide solution is 1: 1, with rosin being taken by mass and alkali solution by volume, for example 1 kg of rosin and 1 liter of alkali.

Boiling rosin and alkali lasts 1.5-2 hours until the complete dissolution of rosin, characterized by a homogeneous color and the absence of lumps and grains. Evaporated by boiling water is replenished with hot water (70-80 °C). As a result, a rosin soap is obtained.

Glutinous foamer is obtained as a result of mixing glutinous solution with rosin soap in a proportion of 1: 0.7 by weight. Mixing is carried out at the temperature of glutinous solution 30 °C and rosin soap 60 °C, thoroughly mixing the adhesive solution in small portions poured into rosin soap. Glutinous foamer can be stored in a tightly closed wooden, glass or ceramic container in a cool place, but at a positive temperature. Before use, the foaming agent is diluted with hot water (50 °C) in a proportion of 1: 5 by volume.

Smolosaponin(resinosaponin) foamer.

This foaming agent is prepared from the soap root, which grows in Central Asia and Kazakhstan. It contains saponin and resinous substances.

Preparation of foaming agent consists of the following operations: crushing the root; Soaking in water; Boiling and soaking the root in the resin extract. After grinding the root in a stone crusher or mill, it is sieved through a sieve with holes of 1-2 cm. The remaining root on the sieve is ground again. You can grind in large meat grinders, previously soaking the root in water for 24 hours.

Then the root is placed in a metal tank with water for 48 hours. The mass ratio of the soap root to the mass of water is 1:10. The infusion is poured into a separate container, and the root is left in the tank and again filled with water to the same level. The water in the tank is boiled until a density of at least 1.01 g / cm3 is obtained. During boiling, water is added to the tank, maintaining the original level. The aqueous solution of resin extract obtained after boiling is poured into the second tank, and the root goes to waste.

In the second tank, a new portion of the crushed soap root is laid in the same proportion as in the beginning, i.e. 1:10.

Extraction of saponin from the root with a solution of resin extract is continued until a liquid of density 1.02 g / cm^3 is obtained. The resulting tarosaponin foaming agent is poured into a storage tank. In the same tank, you can pour the saponin solution from the first tank, and the remaining root after the extraction from the second tank is transferred to the first tank and poured in the same proportion of water and boiled to obtain a solution of resin extract of the same density. Then the aqueous solution of the resin extract is poured into the second tank and a new portion of the soap root is laid there and after extraction of the saponin a new portion of the foaming agent is obtained.

It is poured into the third tank, and the remaining root is again extracted from it with a resin extract, i.e. the process is repeated again.

Frother from hydrolyzed blood.

For this foaming agent is required technical blood, blood sodium, sulfuric iron, ammonium chloride. The blood must be fresh, unfrozen. Chemicals must meet the requirements.

The preparation of a foaming agent consists of the following operations:

а) obtaining a 20% solution of sodium hydroxide;

б) hydrolysis of blood;

в) neutralization of hydrolyzed blood solution;

г) preparation of a 15% solution of ferrous sulfide;

д) mixing hydrolysed blood with iron.

Dissolving caustic sodium in water to a density of 1.23 g / cm^3, a 20% alkali solution is obtained. Hydrolysis of blood occurs when adding to it a 20% solution of alkali in an amount of 2% of the mass of blood per dry substance Na_2O and heating for 2 hours at a temperature of 80-90 °C.

Neutralization of hydrolyzed blood is made with ammonium chloride at the rate of 1.35 kg per 1 kg of Na_2O consumed for hydrolysis of water, in small portions with constant stirring. After the solution is cooled to room temperature. The finished foaming agent is produced in a foam concrete mixer when preparing foam, adding a 15% solution of iron sulfate or copper sulfate to the neutralized hydrolyzed blood at a ratio of 1:0.3 by volume. Such a frothing agent in a foam concrete mixer is diluted with water in the required amounts.

The disadvantage of the above mentioned foaming agents is that they require organic materials (bone glue, medicated glue, fresh blood and soap roots, which is not present in Uzbekistan), which tend to deteriorate and give off an unpleasant smell, resulting in deterioration of the quality of the foam.

Some foaming agents are available in ready-made form and do not need to be prepared at the factory, but only diluted with water in an amount ensuring a high-quality foam. These include various synthetic blowing agents produced by chemical plants, as well as their waste. The advantages of using synthetic blowing agents are obvious. They do not have to be made in the plants of cellular concrete, they do not rot, do not emit smells, they have stable properties. The use of synthetic blowing agents makes it possible to greatly simplify the technology for the production of foam concrete.

Alumosulfonaphthene foaming agent.

To prepare the aluminosulfonaphthenic foaming agent, kerosene contact, alumina sulfate, sodium hydroxide and water are used.

Kerosene contact contains petroleum sulfonic acids, minor amounts of sulfuric acid, kerosene, ash and water. It is produced in refineries when the kerosene distillate is treated with sulfuric anhydride.

Kerosene contact (class II) must satisfy the following requirements:

A) the content of sulfonic acids is not less than 50%;

B) the ratio of the content of sulfonic acids to the oil content is not less than 10;

C) the ratio of the content of sulfonic acids to ash content is not less than 200;

D) the ratio of the content of sulfonic acids to the content of sulfuric acid is not less than 45;

E) color - from dark yellow to brown.

Caustic sodium, used to neutralize kerosene contact and produce an aqueous solution of the sodium salt of petroleum sulfonic acids (surfactant), must satisfy the requirements of STAT 2263-79.

Sulfuric acid alumina, which is a stabilizer of foam and honeycomb mixture, must satisfy the requirements of 5155-74 and contain:

A) aluminum oxide ($A1_2O_3$) - not less than 9%;

B) free sulfuric acid (H_2SO_4) - not more than 2%;

C) iron, in terms of Fe_20_3 - not more than 0.5%;

D) arsenic oxide (AsO_3) - not more than 0.003%;

E) insoluble residue - not more than 23%.

The preparation of the aluminosulfonaphthenic foaming agent consists of the following operations: 1) preparation of a 20% aqueous solution of sodium hydroxide; 2) preparation of an aqueous solution of sulphate alumina; 3) neutralization of kerosene contact (production of sodium salt of petroleum sulfonic acids); 4) alkalizing the sodium salt of petroleum sulfonic acids; 5) mixing the sodium salt of petroleum sulfonic acids with an aqueous solution of sulfurous acid.

To obtain a 20% aqueous solution of sodium hydroxide, it is dissolved with continuous stirring in such an amount of water (1: 4), until the density of the solution is 1.23.

To prepare an aqueous solution of sulphate alumina, large chunks of it are crushed to a size of 3-5 cm, placed in a wooden tank and poured hot water at a weight of 1: 2. After that, the water-saturated sulfate alumina is exposed to the hot steam for 2-2.5 hours, or it is kept in hot water for 20 to 24 hours. The density of the aqueous solution should be 1.16. After thorough mixing and then obligatory cooling to a temperature of 15 °, the solution is considered ready.

Kerosene contact is first diluted with water in a ratio of 1: 2 (by volume), and then add a 20% aqueous solution of caustic sodium in small portions (with the obligatory mixing). In this case, free sulfuric acid passes into sodium sulfate, and petroleum sulfonic acids into the sodium salt of petroleum sulfonic acids. The neutralization end is set by means of litmus paper.

Kerosene contact after neutralization must be heated to a temperature of 80-90 °, so that the separation of the solution is better and faster. Kerosene, oily substances and by-products of neutralization in the form of a gray flocculent mass when heated are collected in the upper layer of the liquid to be removed. The lower layer (the bulk of the liquid), which is an aqueous solution of the sodium salt of petroleum sulfonic acids (density 1.06-1.07), after cooling to a temperature of 15 °C and additions to it of 50-60% (by volume) of an aqueous solution of sodium hydroxide , with a density of 1.12 (alkalinization), is used to prepare the working composition of the foaming agent. Caustic sodium is added to a solution of the sodium salt of petroleum sulfonic acids in order to obtain a neutral medium when mixed with a solution of sulfurous acid. The resulting alumina hydrate improves the quality of the foam. In the production of the aluminosulfonaphthenic foaming agent, it is necessary to cool the solution of aluminum sulfate and a solution of the sodium salt of petroleum sulfonic acids to a temperature of 15 °C, since the foam from non-cooled solutions can not be obtained. When processing kerosene contact with caustic sodium, it is necessary to obtain a neutral medium. This will allow a good cleaning of the solution of the sodium salt of petroleum sulfonic acids from kerosene and oil, which impair the quality of the foam.

Aqueous solutions of aluminum sulfate and a sodium salt of petroleum sulfonic acids, alkalized caustic soda, contained in different containers (the first - in the wood, the second - in the metal). Mixing of these solutions is carried out in a foam concrete mixer in the manufacture of foam, since the premixing of the solutions worsens the foaming properties over time.

The disadvantages of the aluminosulphonaphthene foaming agent include the fact that it, like the glue foam frothner, is prepared on the basis of three types of raw materials: kerosene contact, caustic sodium, sulphate alumina.

Table 1.6 Properties of foaming agents NEOPOR and NIET

Characteristic	Type of blowing agent	
	НЕОПОР	НИЕТ
Concentration, %	2	2
Density, g/sm^3	1,1	1,07
Multiplicity of foam from an aqueous solution on a foam generator, %	560	400
pH of the medium	7,3	7,5
Coefficient of foam resistance in a cement mixture	0,9	0,9

Table 1.7 Technical characteristics of the foaming agent 1G-Unipore

№	The name of indicators	Indicator values by TU
1.	Appearance	The liquid is dark brown color, without foreign inclusions
2.	Smell	Specific
3.	Presence of sediment, %	no more than 0,20
4.	Multiplicity of foam	no less than 6
5.	Foam stability, min. (50% water separation)	no less than 50
6.	The hydrogen index pH, ±0,5	7
7.	Density at 20°C, g/sm^3 ±0,002	1,120
8.	The dilution factor, %	2,5

Analysis of species, raw materials, manufacturing techniques and properties of known blowing agents showed that similar raw materials are available in our region and, consequently, it is possible to organize the production of foaming agents in Uzbekistan. To do this, it is necessary to conduct research on the development of synthetic foam formulations based on local raw materials and to produce an experimental-industrial lot.

Conclusions to chapter I, theoretical background and research problems

Analysis of literature data on the field of research allowed us to draw the following conclusions.

1 Analysis of studies of cellular concrete on the basis of alkali and portland cement and study of the features of their production showed that it is necessary to switch to the production introduction of such materials in Uzbekistan. However, the growth of production of such materials is hampered by the lack of production of a foaming agent in our region and the development and

introduction of foaming agents on local raw materials and materials will dramatically increase the production of foam concrete in Uzbekistan.

2 Analysis of species, raw materials, manufacturing techniques and properties of known foaming agents has shown that similar raw materials are available in our region and, therefore, it is possible to organize the production of foaming agents in Uzbekistan. To do this, it is necessary to conduct research on the development of a synthetic foaming agent based on local raw materials and to produce an experimental-industrial lot.

These conclusions led to the theoretical assumption of the possibility of obtaining a synthetic foaming agent based on local raw materials and the development of foam concrete with a density of 600 kg / m3 and lower based on alkali and portland cement.

In this regard, the purpose of the work is the development and implementation of synthetic foam formulations and effective cellular concrete on the basis of alkali and portland cement.

To achieve this purpose, the following tasks are set:

- collection and research of raw materials;
- choice of research methods;
- development of the synthetic blowing agent composition and study of their properties;
- development of the compositions of cellular concrete based on alkali and portland cement, study of their properties;
- development of ways to improve their strength and deformation properties;
- approbation and introduction into production of the developed foaming agent and cellular concrete on the basis of alkaline and portland cement;
- a feasibility study for the production of foaming agent and cellular concrete.

CHAPTER 2. Characteristics of source materials and the methods of the explores

2.1 Source raw materials

In the present explores as alumosilicate component was used electrothermophosphoric slag of Dzhambul phosphoric combine, containing mass.%: SiO_2 -41,24, Al_2O_3 -2.72, Fe_2O_3 -0.45, CaO- 44.87, MgO-5.00, SO_3-0.83 with the module of main 1,13 and activities 0,07.

As alkaline component was used high module industrial sodium-vapor fluid glass (STAST 13078-81) with silicate module 1, 2, 3 and density 1250, 1300 kg/m^3, technical calsilazed soda (STAST 5100-85) with density of the water solution 1200 kg/m^3.

For the regulations of toughness factors (toughness under bend and compression) in composition of foamed concrete was entered basalt filament, received from Djizak area basalt. With this purpose were incorporated wallastonite of Kuytash quarry of Djizak area, consisting of mineral $CaSiO_3$ basically and having stringy (needle) construction. The length of single filament fibres forms 20-50 mkm, length of the filaments 20-50 mms, moisture 4,5 %.

The electrothermophosphoric slag was used in milled powder form with specific surface 300-310 m^2/kg, which was checked by instrument PSX-2 and strainer with № 008.

At development of foamed concrete on base of the portland cement was used portland cement of the mark PS 400 A 0 OAS "Kyzylkumcement", which chemical composition is provided in tabl. 2.1.

As small filler was used enriched river sand of Zerafshan career with Mk=2,1 2,3, agreeable the requirements of STAST 8269-93.

During the test of astringent was used sand, agreeable to the STAST 310.4-81

For development the foam maker were used superficially-active syntetic auxiliary material OP-10 (STAST 8433-81), fluid glass sodium-vapor (STAST 13078-81), mezdr glue (STAST 3252-80) and aluminum sulphurtart technical

(STAST 5155-74). The physic-mechanical factors of auxiliary material OP-10, which base on the mixture of mono- and dialkil-fenols by oxide of the ethylene, are provided in tabl. 2.2.

Table 2.1 Chemical composition of the raw materials

№	Name of the raw material	Contents of oxides, mass, %									M_o	M_a	$K_к$
		SiO_2	Fe_2O_3	Al_2O_3	R_2O	CaO	MgO	SO_3	l.u.t.	Amount, %			
1	Electro thermic phosphoric slag of the Djambul area	41,24	0,45	2,72	0,2	44,87	5,0	0,83	3,14	99,55	1,13	0,07	1,26
2	OAS «Qizilqumsement»s portland sement PS 400 A 0	21,84	3,75	4,78	1,47	64,79	2,59	0,33	0,30	99,82	2,97	0,22	

Table 2.2 The physic-mechanical factors of auxiliary material OP-10

№	Name of factor	Значения показателя
1	Exterior	Liquid like butter light-yellow colour
2	Exterior of water solution to concentrations 10 g/l	Transparent liquid
3	Mass share of main material, %	82
4	Mass share of water, %	0,3
5	Hydrogen factor pN of water solution to concentrations 10 g/l	7
6	Warm-up limits of the brightening of the water solution to concentrations 10 g/l, ^{0}C	80-90

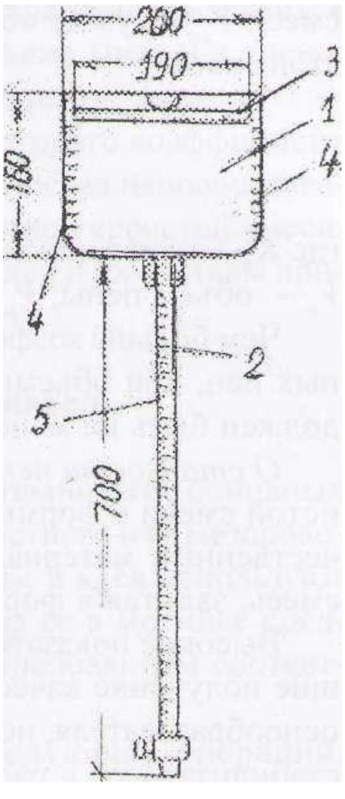
2.2 Choice the methods of explore

The test of astringents were produced in accordance with requirements of STAT 310.1…310.3.-76, STAT 310.4-81 with such difference that alkaline astringent were mixed with not water, but water solution of the alkaline component.

Harden of samples was realized termo-moisture processing, which was conducted on mode 3+6+2 hour at temperature izoterm endurances 90-95 ^{o}C and in nature conditions: water - in capacities with water by temperature 20+2 ^{0}C, normal - in camera with hydraulic shutter and air-dry - under room temperature with moisture of the air 60 75 % [49].

Foamed concretes were made and felt on methods, provided in STAT 25485-89, STAT 27005-86, STAT 12852.0…3-77, STAT 8462-85, STAT 7076-96, STAT 17177-94.

Foam maker were made and felt on methods, provided in STAT 23409.26-78.



Pic. 2.1 Instrument for determination a quality of foam

Determinations of increase, stability and sineresys of spumes are produced on instrument. Instrument (pic. 2.1) consist of three main parts: container 1, glass tube and bob 3.

Container 1, glass or celluloid,

with internal diameter 200 mms and height 160 mms (volume of the container is aproximately 5 l) has in bottom a hole, with which united tube 2 with diameter 14 mms and height 700 mms (volume of the tube 100 sm^3) with tap in adown. Bob 3 presents itself aluminum plate by diameter 190 mms and weight 25g. There is scale 4 On wall of the container 1 for measurement of the height of the pole spume (in sm). On tube 2 are located scale 5 for measurement of the liquids (in sm^3), stood out from spume [32].

For determination a quality of spume instrument fill with spume and define through 1 hour following features spume: the setting spume (by scale 4) departure to liquids (by scale 5), increase of spume i.e. attitude of the initial volume spume in container 1 (5024 sm^3) to volume of the liquids, stood out after full destruction spume.

The foam is considered satisfactory if in hour its sediment will not more than 10 mms and departure to liquids - not more than 80 sm^3. Increase of foam must be not less 20.

Increase of foam in working conditions possible to define on formula:

$$K_n = \frac{\gamma_p}{\gamma_n}, \qquad /1/$$

where: K_n – increase of foam;

y_p - density of the solution of foam maker;

$y_п$ – density of the foam.

For the most full feature quality of foam necessary to know not only characteristic of foam on air, but also its characteristic at period of the fabrication foamed mixtures and after it.

About stability of foam at period of the fabrication will right to judge on factor of the output cellular mixture $K_в$, attitude of the volume cellular mixture F to amount of the volumes spume F and solution V, taken for forming this mixture

:

$$K_в = \frac{V_{яс}}{V_n + V_p}, \qquad /2/$$

where: $K_в$ - factor of the output cellular mixture;

$V_{яс}$ - volume of the foamed mixture;

$V_п$ – volume of the foam;

Vp - volume of the mortar.

Than more factor of the output, that above quality of foam qualitative foams,, under three-dementional weight damp cellular mixture (пенобетон) 800 kg/m3, must be not less 1.

.

Conclutions to the chapter 2

1 For undertaking the explores were used local materials, explored their physic-chemical characteristics, as raw material for reception foamed concretes.

2 For fabrication samples and undertaking the test are accepted standard and general taken methods of the explores.

CHAPTER 3. Development the composition of syntetic foam maker and foamed concrete on their base.

3.1 Syntetic foam maker for the alkaline and portland foamed concretes.

Any foam maker for production foamed concrete must satisfy following requirements:

- constancy characteristic, regardless of parties

Foam makers must have an alike features, regardless of parties and time of the issue. Otherwise be necessary constant re-adjustment of technological process production or if not to do it is, product will be lowered quality.

- sufficient shelf time

Foam maker must have a shelf time not less 1year. If shelf time less, that come to buy small party of foam maker and constantly buy new. This can be problematic, in connection with big time of delivery on railway and remoteness some production.

Also, at completion of the building season and significant reduction of the volume of production, unclaimed foam maker can will in general spoil before the following season.

- small consuption

Consuption of foam maker must not exceed 1,5 litres on 1 kub.m. produced foamed concrete. This necessary for two reasons. First: for greater amount of the product got from one loading foamgenerator. Second: for smaller influence upon process of the repeating over and over again fomed concrete. As is well known, at lot amount of foam maker used for preparation foamed concrete, can increase time of harden of foamed cocncrete, be lowered its toughness, increase the shrinkage.

- simplicity of the preparation

Foam makers must not be an much-component. Increase amount of components is complicates process of the preparation worker solution of foam maker and reduces accuracy of dosage of component. One-component foam makers has an advantage, particularly, when use in building condition. In order to avoid litterring pipe line and accumulations setting in worker capacities, necessary that foam maker was well dissolve in water.

- high increase and stability

Increase of foam maker and stability of foam - a main physical characteristic of technical foam, which characterize a quality of foam maker.

They hang from type of foam maker, device of the preparation of foam, which in significant measure influence on physic-mechanical characteristics of foamed concrete.

Increase of foam maker must be not less 10. This required for reduction of the negative action of foam maker on hydratation of astringent.

Increase of foam maker is defined to formula: it is necessary to divide volume of gotten foam into volume of source foam maker. Often foam makers are delivered in concentrated type and require diluting by water.

Then increase is defined: volume of got foam divided on volume of the source water solution.

On toughness of foamed concrete renders the influence an amount carried in foamed mixture of water with foam, which brings to the additional forming of capillary foams.

The reduction W/H (water-hard correlation refer to dictionary) in foaming solution changes factor C that brings to increase the density of got foam maker. So, in technologies of foamed concrete some producers use comparatively high factor W/H. For such technological acceptance, enlarging factor C, introduces possible to get the foamed concrete with smaller density, reducing the negative influence of foam makerto the hydratation of astringent.

Use the spumes with high increase (named conditionally "dry spumes") brings about redistribution of water from hardenning solution in between film layer bladder of spume.

Such effect exists when use determined type of foam makers and spumes raised to viscosity.

- correspondence to sanitary-hygenic rate

Foam makers should be non-toxic, non-explosive and, according to the classification according to STAT 12.1.007-76, belongs to the 3rd, 4th class of low-hazardous substances, and meet sanitary and radiation-hygienic requirements. Biodegradability of the developed software must meet the requirements for surfactants in the production of building materials when using surfactants.

- sufficient stability of foam in solution

This is one of the most important indicators of the quality of technical foam. This technological parameter is characterized by the coefficient of foam stability in the cement test in laboratory tests, and in the production conditions, the foam utilization factor. The value of these coefficients reflects not only the compatibility of technical foam with the medium of the hardening solution, but also shows the volume fraction of the use of foam in the preparation of the porous solution. In laboratory studies, the foam resistance coefficient is determined manually by mixing for 1 minute in equal volumes (1 L) of cement paste (W / C = 0,4) and foam, followed by measuring the volume of the porous dough obtained. The coefficient of foam stability in the cement test is calculated as the result of the arithmetic mean of three measurements. Simply put, it takes 1 liter of foam and 1 liter of cement. Within 1 minute they are mixed, and then the volume of the obtained foam is measured. The volume of the foam is divided by 2 and we get a certain number, let's call it C. The resulting technical foam can be considered satisfactory if the value of C is from 0,8 to 0,85, and the qualitative value is C = 0,95. For example, based on the Arekom foaming agent, foam with C = 0,96 can be prepared. This indicator of foam resistance is associated with the density and strength of the resulting foam concrete. Then higher the foam stability coefficient, then smaller the foam volume is required to produce the foam concrete of the required density and, accordingly, a lower consumption of the foaming agent is necessary. Foaming agent, like any additive, in excessive quantity at the initial stage slows down and can completely stop hardening of the binder. The amount of foaming agent that has passed into the liquid system of the hardening binder depends on C. The amount of foaming agent in the liquid phase of the binder can be determined through C. It is therefore necessary to use foams of higher multiplicity, reducing the volume of the foaming agent introduced into the concrete mixture, but keeping the high value of C. These technological parameters of the foam are in interrelation and contradiction. Therefore, for each composition of foam generator and technical foam, it is necessary to determine their priority impact on the technological and physical-mechanical properties of the foam concrete.

The persistence of a porous mixture in time is characterized by the precipitation of a foam concrete mix. It can be assumed that the influence on the deposition process is affected by the change in the pH of the medium of solidifying concrete and the redistribution of the surfactant (surface active agent - blowing agent) in the dispersed system. When the structural strength of the interporal partitions is insufficient (the result of the action of the surfactant), their breakthrough and fusion occurs. Such changes in the porous mixture over time are measured by the height of the suspension of the porous mixture to its initial height. The smaller the precipitation of the foam concrete mixture, the better the foamer and the prepared technical foam.

- technical-econmic

The consumption of foaming agent in money terms should not exceed 2 $ per 1 cubic meter of produced foam concrete. If this indicator is exceeded, its use becomes economically inexpedient because of the large influence on the cost of production. Moreover, it is obvious that more expensive foaming agents will not increase the quality of the products in accordance with the increased cost. This criterion immediately cuts off all imported foaming agents and leaves the Russian ones.

The main criteriaы for evaluating the properties of foaming agents: the concentration of a foaming agent in the preparation of a stable foam; еhe foam multiplicity and the coefficient of foam stability in the binder solution. These indicators should be used for the initial assessment of the quality of the foam maker.

Studies on the development of a foaming agent were carried out in two formulations using the main product of auxiliary substance OP-10 of domestic production. Below are the technologies and compositions of the developed foaming agents.

The analysis of foaming agents for foam concrete showed that the most suitable for the conditions of our region and for the high alkaline environment that exists in alkaline binders is the aluminosulfonaphthene foaming agent. To produce it, kerosene contact is used, sulfuric acid alumina, caustic sodium and water, which are produced in our republic in large industrial volumes.

The aluminosulfonaphthene foaming agent was prepared according to the following technology:

1) Preparation of a 20% aqueous solution of sodium hydroxide: to obtain a 20% aqueous solution of caustic sodium, it was dissolved with continuous stirring in such an amount of water (1: 4), so that at 20^0C the density of the solution was 1.23.

2) Preparation of an aqueous solution of sulphate alumina: to prepare an aqueous solution of sulphate alumina, large chunks of it were crushed to a size of 3-5 cm, stacked in a wooden tank and poured hot water at a weight of 1: 2. After that, the water-saturated sulphate of alumina was kept in hot water for 20 to 24 hours. The density of the aqueous solution should be 1.16. After thorough mixing and then obligatory cooling to a temperature of 15 °C, the solution is considered ready.

3) Neutralization of kerosene contact (production of the sodium salt of petroleum sulfonic acids): the kerosene contact was first diluted with water in a ratio of 1: 2 (by volume), and then 20% aqueous sodium hydroxide solution was added in small portions (with mandatory re-mixing). In this case, free sulfuric acid passes into sodium sulfate, and petroleum sulfonic acids into the sodium salt of petroleum sulfonic acids. The neutralization end was set by means of litmus paper.

4) Alkalinization of the sodium salt of petroleum sulfonic acids: the kerosene contact after neutralization was heated to a temperature of 80-90 °, in order to better and faster pass through the separation of the solution. Kerosene, oily substances and by-products of neutralization in the form of a gray flocculent mass upon heating are collected in the upper layer of the liquid that was removed. The lower layer (the bulk of the liquid), which is an aqueous solution of the sodium salt of petroleum sulfonic acids (density 1.06-1.07), after cooling to a temperature of 15 ° C and additions to it of 50-60% (by volume) of an aqueous solution of sodium hydroxide , With a density of

1.12 (alkalinization), is used to prepare the working composition of the foaming agent. Caustic sodium was added to a solution of the sodium salt of petroleum sulfonic acids in order to obtain a neutral medium when mixed with a solution of sulfurous acid. The resulting alumina hydrate improves the quality of the foam. In the production of the aluminosulfonaphthenic foaming agent, it is necessary to cool the solution of aluminum sulfate and a solution of the sodium salt of petroleum sulfonic acids to a temperature of 15 ° C, since the foam from non-cooled solutions can not be obtained. When processing kerosene contact with caustic sodium, it is necessary to obtain a neutral medium. This will allow a good cleaning of the solution of the sodium salt of petroleum sulfonic acids from kerosene and oil, which impair the quality of the foam.

5) Mixing of the sodium salt of petroleum sulfonic acids with an aqueous solution of alumina sulfate: aqueous solutions of alumina sulfate and sodium salts of petroleum sulfonic acids, alkaline with sodium hydroxide, are contained in different containers (the first - in the wood, the second - in the metal). Mixing of these solutions was carried out in a foam concrete mixer in the manufacture of foam, since the premixing of the solutions worsens the foaming properties over time.

The results of explores of the prepared two compositions of aluminosulfonaphthene foaming agents are given in table. 3.1.

Table 3.1 Properties of the developed foam makers

Characteeristics	Formulations of foaming agent	
	I	II
Appearance	Fluid of light-brown color, without foreign inclusions	
Smell	Specific	
Concentration, %	2	2
Density, g/sm^3	1,1	1,07
Multiplicity of foam from an aqueous solution on a foam generator, %	560	540
pH of the medium	7,3	7,5
Coefficient of foam resistance in a cement mix	0,9	0,9

The analysis of the results obtained from the studies of the aluminosulfonaphthene foaming agent indicates that, in terms of quality, the foaming agents obtained are analogous to blowing agents produced abroad.

The most acceptable for the conditions of our region and for the high alkaline environment that exists in alkaline binders is the ***foamer based on the OP-10 auxiliary substance, which was named by us POB-2016.*** For its production, auxiliary substances OP-10, sulfuric acid alumina, liquid glass and water are used, which are produced in our republic in large industrial volumes.

Foam generator POB-2016 was prepared from OP-10 according to GOST 8433-81, liquid glass according to GOST 13078-81 and additives, giving stability to foam and accelerating hardening of foam concrete.

The foaming agent was prepared according to the following technology:

1. preparation of an aqueous solution of liquid glass with a density of 1300 kg / m^3;

2. mixing of OP-10 solution with a density of 1040 kg / m^3 with a solution of liquid glass with a density of 1300 kg / m^3 in a ratio of 1:1.5;

3. dilute sulfuric acid alumina with water to a density of 1220 kg / m^3;

4. joint mixing of OP-10 solutions and liquid glass with a solution of alumina in a ratio of 1:20.

In order to improve the composition of the foaming agent POB-2016, namely, to increase the foam stability, the liquid glass was replaced with an organic substance-with an adhesive glue in accordance with GOST 3252-80. The technology of preparation of this foamer from the technology POB-2016 differs in that an aqueous solution of glue is prepared in advance by dissolving the glue in heated water to a density of 1020 kg / m3. The ratio of the solution OP-10 to the solution of the adhesive glue is 1: 5.

The results of studies of the two formulations of foaming agents based on OP-10 are shown in Table. 3.2.

Table 3.2 Properties of developed foaming agents based on OP-10

Characteristic	Formulations of foaming agent	
	I	II
Appearence	Liquid of light yellow color, without extraneous inclusions	
Smell	Spesific	
Density, g / cm^3	1,1	1,12
Multiplicity of foam from an aqueous solution on a foam generator, %	520	530
pH of the medium	7,0	7,0
Coefficient of foam resistance in a cement mixture	0,95	0,95
Foam stability, 60/90 min	0,94/0,91	0,91/0,88

The shelf life of the developed foaming agents is more than one year (since the foaming agents were developed in 2016), taking into account the storage requirements. Store the foaming agents in a dry place at temperatures from + 50 ° C to + 500 ° C, relative humidity of 50 to 90% and prevent from direct sunlight.

Thus, the compositions of foaming agents were prepared: aluminosulfonaphthene foaming agent, foaming agent POB-2016 and analogue POB-2016 with replacement of liquid glass with organic glue. In quality, the foaming agents obtained are analogous to blowing agents produced abroad. Consequently, it is possible to proceed to approbation of the developed foaming agents for the production of foam concrete on the basis of alkaline and Portland cement.

3.2 Foam concrete based on alkali and portland cement

An analysis of the studies devoted to the study of the hardening of alkaline cements and the study of their physico-mechanical properties showed that along with high physical and mechanical properties, alkaline cements have durability [6]. Along with this, the properties of alkaline cements depend on the type of aluminosilicate and alkaline components, the conditions of hardening and other conditions. Therefore, prior to the development of the foam concrete composition, some compositions of alkaline cements and the composition of Portland cement were investigated. These compositions and their strength parameters after steaming by the regime of 3 + 6 + 2 hours at the temperature of isothermal aging of 90-92 ^{0}C, and also on the 28th day of hardening under normal conditions are given in table. 3.3.

Table 3.3 Compositions and strength parameters of alkaline cements

№	Composition of stringent, %		Type and quantity of alkali component			Ultimate strength after steaming, MPa, upon		Strength limit for 28-day hardening, MPa, upon	
	cement	ETPh	soda	liquid glass	water	bending	pressing	bending	pressing
1	100	0	0	0	0,4	3,2	26,0	4,2	34,0
2	0	100	0,4	0	0	4,0	32,0	4,3	34,0
3	10	90	0,4	0	0	4,6	42,0	4,4	40,1
4	0	100	0	0,4	0	6,3	59,3	6,2	59,0
5	10	90	0	0,5	0	6,8	66,2	6,8	65,1

The test results indicate that the strength parameters of alkaline cements, regardless of the hardening conditions, are higher than those of portland cement. At what this difference comes to 3 marks. Thus, while the strength of portland cement during bending and compression after 28 days of normal hardening was 26 and 34 MPa, for the corresponding hardening conditions, alkaline cements showed 32 and 34 MPa when using soda, 59.3 and 59 MPa, using liquid glass. These figures are approximately 70 ... 80% higher than Portland cement. Introduction of up to 10% of cement in the composition of alkaline cement, this difference increases to 90% (Table 3.3).

Thus, the obtained research results indicate that using alkaline cements of grades 300 and 400 as alkaline component of soda, and using alkaline cement of 500 and 600 grades as an alkaline component of liquid glass, such high strength parameters of alkali Cements can be explained by the composition of neoplasms in the hardening products of alkaline cement stone [6].

The investigated compositions of foam concrete on the basis of alkaline cements and Portland cement, their strength indexes and density are given in table. 3.4. As a frothing agent in these formulations, the developed foaming agent POB-2016 was used. The obtained results of the research indicate that foam foams with a density of 600 kg / m3 can be produced using the alkaline cement (Table 3.4, Compositions 1-8) and portland cement (Table 3.4, composition 9). In this case, the strength of the foam concrete depends on the type of alkaline component used and the amount of cement additive to be introduced, when using as an alkaline component of liquid glass, the compressive strength of foam concrete is higher than when using soda. The introduction of cement is more effective when used as an alkaline component of soda than with the use of liquid glass. So, the introduction of 10% and 20% cement in foam concrete on the 28th day of hardening increases from 1,03 to 1,57 MPa in comparison with the composition without the addition of cement. The increase in the amount of the additive to 30% strength is sharply reduced, which may be due to rapid coagulation of cement minerals in a highly alkaline medium. The introduction of a cement additive in the foam concrete on the basis of liquid glass does not increase the strength of the foam concrete, while the setting time is sharply reduced (Table 3.4).

Thus, on the basis of the developed synthetic foaming agent POB-2016, foamed concrete compositions based on alkaline and Portland cements have been obtained, which makes it possible to proceed to pilot-industrial testing of them in production conditions and to technical and economic calculations.

Table 3.4

Composition and options of alkaline foamed concretes

№	Filler (sand), g/l	Composition of astringent, %		W/S,%			ПОБ-2016	Limit to toughness at compression R_{cmp}, MPa, under harden during, day				Density, kg/m^3
		ETF	Sement	Soda	fluid glass	water	l/m^3	3	7	14	28	
1	200	100	-	0,6	-	-	1.6	-	0.21	0.784	1.03	610
2	200	90	10	0,6	-	-	1.6	0.32	0.455	0.74	1.23	620
3	200	80	20	0,6	-	-	1.6	0.363	0.54	0.83	1.57	610
4	200	70	30	0,6	-	-	1.6	0.23	0.3	0.48	0.57	600
5	200	100	-	-	0,6	-	1.6	0.64	0.77	0,962	1,67	610
6	200	90	10	-	0,6	-	1.6	0.51	0.64	0.8	1.33	610
7	200	80	20	-	0,6	-	1.6	0,52	0,82	0,96	1,64	620
8	200	70	30	-	0,6	-	1.6	Periods of grasp is short				
9	200	-	100	-	-	0,6	1.6	0,361	0,51	0,65	0,94	600

3.3 Experimental-industrial introduction of developed foam concrete

The carried out researches on development and study of synthetic foaming agent and foam concrete on the basis of alkali and Portland cements and the results of laboratory studies obtained thus made it possible to proceed to pilot-industrial testing of their manufacture and application.

In the period from 01 to 07 October 2016, an experimental production lot of a synthetic foam generator POB-2016 with a volume of 150 liters and foam blocks on alkaline and portland was produced in the technological line of the Uzbek-Belarusian-Russian joint venture as a limited liability company "ALINA INVEST" Cements using this foamer with a volume of 100 m^3.

Foam maker POB-2016 was prepared from OP-10 according to GOST 8433-81, liquid glass according to GOST 13078-81 and additives, giving stability to foam and accelerating hardening of foam concrete.

The foaming agent was prepared according to the following technology:

- mixing OP-10 solution with a density of 1040 kg / m^3 with a pre-prepared solution of liquid glass with a density of 1300 kg / m^3;

- dilute sulfuric acid alumina with water to a density of 1220 kg / m^3;

- joint mixing these two solutions.

For comparison, the foaming agent PB-2010 of Russian production (AO «Ивхимпром»).

As an astringent for the production of foam concrete was used portland cement JSC "Kyzylkumcement" brand PTS400 D0.

The filler was the river sand of the Zerafshan deposit with a modulus of 2.1.

For the production of alkaline foam concrete, was used the ground electrothermophosphor slag of the Zhambyl phosphate plant, containing mass%:

SiO_2 -41.24, Al_2O_3 -2.72, Fe_2O_3 -0.45, CaO-44.87, MgO-5.00, SO_3-0.83 with 1.13 basicity modules and activity 0.07. The fineness of the grinding was 270 m^2 / kg by the PSX-2 instrument. As an alkaline component was used, an aqueous solution of sodium soda, calcined according to GOST 5100-85, density 1180 kg / m^3.

Foam concrete mixture was prepared on the equipment of LLC "XORIJ QURILISH TEXNOLOGIY" using separate technology on the technological line of JV LLC "ALINA INVEST". From the foam concrete mixture, blocks of 600x300x200, 400x300x200, 600x300x100, 500x300x120, 600x300x150 and 400x200x200 mm were filled. Compositions of foam concrete and its properties are given in table. 3.5, 3.6 and 3.7.

Table 3.5 Compositions of foam concrete

№ of composition	Design density, kg/m^3	Consumption of materials, kg/m^3				
		cement	sand	POB-2016	PB-2010	water
1	600	360	200	1,5	-	216
2	600	360	200	-	0,5	216
3	800	360	400	1,2	-	220
4	800	360	400	-	0,4	220

Table 3.6 Physical and mechanical properties of foam concrete based on portland cement

№	The name of indicators	Unit of measure.	The values of the indices for the compositions according to table 1			
			№1	№2	№3	№4
1	Density in dry condition Mark according to density	kg/m^3	610 D 600	595 D 600	820 D 800	795 D 800
2	Compressive strength Concrete class for compressive strength	MPa	1,3 B 1,0	1,6 B 1,5	1,9 B 1,5	2,2 B 1,5
3	Shrinkage upon drying	mm/m	2,1	2,1	2,0	2,0
4	Sorption humidity at relative humidity	75% 90%	10 14	10 14	10 14	10 14
5	Thermal conductivity	Wt/(mx^{0}C)	0,14	0,14	0,16	0,16

Table 3.7 Physical and mechanical properties of foam concrete based on alkaline cement

№	The name of indicators	Unit of measure.	The values of the indices for the compositions according to table 1			
			№1	№2	№3	№4
1	Density in dry condition Mark according to density	kg/m^3	620 D 600	605 D 600	810 D 800	820 D 800
2	Compressive strength Concrete class for compressive strength	MPa	1,4 B 1,0	1,5 B 1,5	1,9 B 1,5	2,1 B 1,5
3	Shrinkage upon drying	mm/m	2,0	2,1	2,0	2,1
4	Sorption humidity at relative humidity	75% 90%	10 14	10 14	10 14	10 14
5	Thermal conductivity	$Wt/(mx^0C)$	0,14	0,14	0,16	0,16

The obtained results indicate that in production conditions foam foam can be produced on the basis of the developed foaming agent POB-2016, the properties of which are similar to the properties of foam concrete on the basis of imported foam former PB-2010 and meet the requirements of the foam standard. To organize the production of such blowing agents and foam concrete, it is necessary to develop a technological instruction and organization standards.

3.4 Calculation of technical and economic efficiency

Calculation of economic efficiency of the developed synthetic blowing agent POB-2016 and foam concrete on its basis with the use of electrothermophosphor slag and portland cement was carried out in relation to the conditions of JV LLC ALINA INVEST. The cost of 1 ton of ground slag was accepted according to the commodity-invoices of the supplier-NPTChF "Imorat ADA", 1 kg of auxiliary substance OP-10 and liquid glass at the vendor's invoice - MAX LUXE SERVICE Ltd., technical soda, Portland cement, Prices as of 01.10.2016.

The economic efficiency of the production of foaming agent POB-2016 and foam concrete on the basis of alkali and Portland cement was determined in accordance with SN 509-78 "Instruction for determining the economic efficiency in the construction of new equipment, inventions and rational proposals [48□. The base variant was the foam concrete on portland cement with the use of the foaming agent PB-2010 manufactured in Russia. The cost of 1 liter PB-2010 was adopted on the basis of data provided by JV LLC ALINA INVEST.

In view of the fact that the operating costs per unit of the structural element, both in kind and in cash, do not change from the application of a new type of product, the economic efficiency was determined by the following formula:

$$Э=(З_1-З_2)\times А_2 \text{ , sum/t}$$

where $З_1$ and $З_2$ – the resulted expenses for manufacture of a unit of production according to the basic and offered variants, sum;

$$З_1=С_2+Ен\times К_1; \qquad З_2=С_2+Ен\times К_2;$$

where: $С_1$ and $С_2$- current costs for compared options, sum;

$К_1$ and $К_2$- associated capital investments when using the basic and proposed options per unit of output, sum;

$$К= Ф/А_2$$

where: Ф- cost of fixed assets and production assets, sum;

$А_2$- annual volume of implementation of the proposed option, m^3;

Ен – standard efficiency coefficient (O,15).

Based on the results of the calculations, the cost of the basic option, i.e. Foam concrete on the basis of Portland cement with the use of the foaming agent PB-2010 is 167 200 sum / m3. This includes the cost of Portland cement (360 × 420 UZS = 151,200 UZS) and foam maker PB-2010 (0,5 × $ 5 × 6400 UZS = 16,000 UZS).

The cost price of one liter of foaming agent POB-2016 is (1 × 10,000 sum + 1.5 × 1,500 sum + 0.1 × 6,000 sum) / 2600 = 4,940 sum. Then the prime cost of foam concrete on Portland cement and the developed foam generator POB-2016 is 151 200 sum + 1.5 × 4,940 sum = 158 610 sum. The actual economic effect from the production of 1 cubic meter of foam concrete on the basis of the foaming agent POB-2016 will be 167 200-158 610 = 8 590 UZS. When manufacturing an industrial lot in the volume of 100 m3 - (100 × 8,590)= 859,000 sum. At the same time, the foaming agent imported for currency is replaced.В случае использования щелочного цемента себестоимость 1 $м^3$ пенобетона составит (360×120 сум+1,5×4 940 сум + 36x480 сум)= 67 890 сум. При выпуске промышленной партии в объёме 100 $м^3$ – (167 200-67 890) ×100=9 931 000 сум.

Thus, the economic effect from the production of 1 m3 of foam concrete on the foaming agent POB-2016 when using Portland cement as an astringent in the production conditions of the JV LLC ALINA INVEST will be 8,590 UZS and using as alkaline cement a cement- 99 310 UZS. The economic effect from the production of 100 m3 of foam concrete was, respectively, 859,000 and 9,931,000 sum.

Conclutions to the chapter 3

1 Based on the explores carried out, two compositions of synthetic and mixed foaming agents have been developed: POB-2016 on the basis of OP-10 auxiliary substance and mixed synthetic and organic raw materials. For the production of these foaming agents, materials are used that are produced in our republic in large industrial volumes.

2 Based on the synthetic foam blower POB-2016, foamed concrete compositions based on alkaline and Portland cements have been obtained, which makes it possible to proceed to pilot industrial testing of them in production conditions and to technical and economic calculations.

3 The obtained results of pilot-industrial implementation show that in production conditions foam foam can be produced on the basis of the developed foam generator POB-2016, the properties of which are similar to those of foam concrete on the basis of imported foam former PB-2010 and meet the requirements of the foam standard.

4 Calculation of technical and economic efficiency from the production of 1 m3 of foam concrete on the foaming agent POB-2016 when using portland cement as an astringent in the conditions of the production base of JV "ALINA INVEST" LLC amounted to 8 590 sum and when using as alkaline cement cementer - 99 310 UZS. The economic effect from the production of 100 m3 of foam concrete was, respectively, 859 000 and 9 931 000 sum.

General conclusions

1An analysis of studies of cellular concrete on the basis of alkali and Portland cement and study of the features of their production showed that it is necessary to switch to the production introduction of such materials in Uzbekistan. However, the growth of production of such materials is hampered by the lack of production of a foaming agent in our region and the development and introduction of foaming agents on local raw materials and materials will dramatically increase the production of foam concrete in Uzbekistan.

2 Analysis of species, raw materials, manufacturing techniques and properties of known blowing agents showed that similar raw materials are available in our region and, consequently, it is possible to organize the production of foaming agents in Uzbekistan. To do this, it is necessary to conduct research on the development of a synthetic foaming agent based on local raw materials and to produce an experimental-industrial lot.

3 To carry out the research, local materials were used, their physicochemical properties were studied, as raw materials for the production of alkaline cements and cellular concrete on their basis. Standard and generally accepted research methods have been adopted for the manufacture of samples and testing.

4 Based on the studies carried out, two compositions of synthetic and mixed foaming agents have been developed: POB-2016 on the basis of OP-10 auxiliary substance and mixed synthetic and organic raw materials. For the

production of these foaming agents, materials are used that are produced in our republic in large industrial volumes.

5 Based on the synthetic foam blower POB-2016, foamed concrete compositions based on alkaline and Portland cements have been obtained, which makes it possible to proceed to pilot industrial testing of them in production conditions and to technical and economic calculations.

6 The obtained results of pilot-industrial implementation show that in production conditions foam foam can be produced on the basis of the developed foam generator POB-2016, the properties of which are similar to those of foam concrete on the basis of imported foam former PB-2010 and meet the requirements of the foam standard.

7 Calculation of technical and economic efficiency from the production of 1 m^3 of foam concrete on the foaming agent POB-2016 when using portland cement as an astringent in production conditions JV "ALINA INVEST" LLC amounted to 8 590 UZS and when using as alkaline cement cementer-99 310 UZS. The economic effect from the production of 100 m^3 of foam concrete was, respectively, 859 000 and 9 931 000 UZS.

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