MINISTRY OF EDUCATION AND SCIENCE OF THE REPUBLIC OF KAZAKHSTAN

Kazakh National Research Technical University named after K.I. Satbayev

Institute of Architecture and construction named after T.K. Bassenov

Department “Construction and construction materials”

Zhanaidarova Maiya

Plant for the production of large-sized reinforced concrete products for bridge structures with a capacity of 70000 m^3 per year

EXPLANATORY NOTE
for diploma project

Specialty 5B073000 – Production of building materials, products and structures

Almaty, 2020 y.

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APPROVED FOR PROTECTION
Head of Department of «CaCM»
D.Tech.Sc., Professor
________ Akmalaiuly K.
«25» 05 2020 y.

EXPLANATORY NOTE
for diploma project

On the subject of: «Plant for the production of large-sized reinforced concrete products for bridge structures with a capacity of 70000 m^3 per year»

Majoring in 5B073000 – Production of building materials, products and structures

Performed Zhanaidarova Maiya

Reviewer
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«___» __________2020 y.

Scientific supervisor
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__________ Kuatbayeva T.K.
«25» 05 2020 y.

Almaty, 2020 y

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5B073000 – Production of building materials, products and structures

APPROVED BY
Head of Department of «CaCM»
D.Tech.Sc., Professor
_________ Akmalaiuly K.
« 27 » 01 ___2020 y.

ASSIGNMENT
for the implementation of the diploma project

For student *Zhanaidarova Maiya*

Theme: Plant for the production of large-sized reinforced concrete products for bridge structures with a capacity of 70000 m^3 per year

Approved *by order of the Rector of the University №762-b from «27» 012020 y.*

Delivery of finished work *«31» May 2020 y.*

Input data for the diploma project: *task for the diploma project, raw materials, construction area*

The list of issues to be developed in the diploma project:

a)technological part
b)calculation part
c)process automation issues
d)construction part
e)issues of product quality control
e)health and safety issues
g)development cost-benefit calculation

List of graphic material: *6 drawings presented*

Recommended main literature: *from 24 titles*

SCHEDULE
Diploma project preparation

Names of sections, list of issues under development	Deadline for submission to the scientific supervisor	Notes
Technological (technological scheme and its description)	27.01.2020 – 25.05.2020	
Heat engineering (calculation of heat engineering equipment)	27.01.2020 – 25.05.2020	
Architectural and construction (design solution of the main production hall)	27.01.2020 – 25.05.2020	
Automation and automation (automation of technological processes)	27.01.2020 – 25.05.2020	
Technical-economic (calculation of main technical-economic indicators)	27.01.2020 – 25.05.2020	
Occupational health and safety (health and safety issues)	27.01.2020 – 25.05.2020	

Signatures
of the consultants and the compliance officer on the completed diploma project, indicating the sections of the project that relate to them

Section names	Consultants Full Name (degree)	Date of signature	Signature
Technological part	Kuatbayeva T.K. D.Tech.Sc., Professor	25.05.2020	
Thermotechnical part	Kuatbayeva T.K. D.Tech.Sc., Professor	25.05.2020	
Architectural and construction part	Bek A.A. (M.Tech.Sc., assistant)	25.05.2020	
Economic part	Kuatbayeva T.K. D.Tech.Sc., Professor	25.05.2020	
Automation	Kuatbayeva T.K. D.Tech.Sc., Professor	25.05.2020	
Occupational safety and health	Kuatbayeva T.K. D.Tech.Sc., Professor	25.05.2020	
Normocontroller	Bek A.A. (M.Tech.Sc., assistant)	25.05.2020	

Scientific supervisor ______________ Kuatbayeva T.K.

The task was accepted by the student ______________ Zhanaidarova M.M.

Date « 25 » 05 2020 y.

АҢДАТПА

Диссертация тақырыбы: «Қуаттылығы жылына 70000 м^3 көпір құрылымдары үшін ірі көлемді темірбетон бұымдарын өндіретін зауыт».

Кәсіпорынның дамыған бас жоспары, технологиялық карталар, техникалық және экономикалық көрсеткіштер, өнімдердің ауқымы, шикізаттың сипаттамалары келтірілген.

Зауыт толығымен автоматтандырылған, 8 сағаттың 2 ауысымында жұмыс істейді. Жұмыс үшін қолайлы жағдайлар сақталады. Зауытты салу және пайдалану көпір құрылымдары үшін ірі көлемді темірбетон бұымдарын маңызды болып табылады.

АННОТАЦИЯ

Дипломная работа выполнена согласно темы: «Завод по производству большеразмерных железобетонных изделий для мостовых сооружений мощностью 70000 м^3 в год».

Разработанный генплан предприятия, технологическая карта, технико-экономические показатели, номенклатура выпускаемых изделий, характеристики исходного сырья представлены в приложениях.

Завод полностью автоматизирован, работает в 2 смены по 8 часов. Благоприятные условия для работы соблюдаются. Строительство и эксплуатация завода по производству большеразмерных железобетонных изделий для мостовых сооружений является актуальным.

ABSTRACT

The thesis is made according to the theme: «Plant for the production of large-sized reinforced concrete products for bridge structures with a capacity of 70000 m^3 per year».

The developed general plan of the enterprise, the technological map, technical and economic indicators, the range of products, the characteristics of the feedstock are presented in the applications.

The plant is fully automated, working in 2 shifts of 8 hours. Favorable conditions for work are respected. Construction and operation of the plant according to production of large-sized reinforced concrete products for bridge structures is relevant.

CONTENTS

INTRODUCTION

At present, modern construction widely uses products and designs for various purposes, different in type of raw materials, production technology in the prefabricated and monolithic construction of buildings and structures.

In work the general principles of designing of the enterprise on manufacture of large-sized ferro-concrete products for bridge constructions by capacity 70000 m^3 a year are shined, features of designing of technological process both the basic, and auxiliary manufactures are stated, design workings out of the enterprises at release of various kinds of production are resulted.

Concrete is one of the oldest building materials. However, use of concrete and R/W for mass building has begun only from second half of 19th century, after reception and the organisation of industrial release portland cement which has become the basic binding substance for concrete and R/W designs and products.

Today one of the most promising structural materials is steel-fiber concrete. It is a fine-grained concrete, which is reinforced with steel fibers (fibers), evenly distributed over its cross section. Of considerable interest is the combined reinforcement with steel fibers, usually prestressed reinforcement.

The essence of steel-fiber concrete is that the steel fibers introduced into the concrete mixture contribute to improving the work of concrete under the influence of various loads. The number of fibers injected into concrete in most cases varies from 0.5 to 2 percent by volume.

Steel fiber concrete has a number of valuable properties. For example, it has a higher tensile strength than conventional concrete. The introduction of fiber in the concrete in the amount of 1-1.5 percent by volume increases its tensile, bending and compression strength. An important quality of steel-fiber concrete is its increased crack resistance. Due to higher crack resistance steel fiber concrete has increased by 1.5-2 times the frost-, heat- and fire resistance, water resistance.

The most effective use of steel-fiber concrete in structures to which the requirements of increased crack resistance, abrasion resistance, resistance to shock and alternating loads. It is advantageous to use it in monolithic, road and airfield surfaces, bridge span structures, trench floors, retaining walls, spraying layers for tunnel shaft lining and fireproof linings, machine foundations, etc. Among prefabricated constructions we can distinguish thin-walled and ribbed coating slabs, elements of shells and fixed formwork, wall and partition panels, floor slabs, road and airfield slabs, underground utility structures, piles, sleepers.

1 Technological part

1.1 Feasibility study of the construction area

The city of Almaty was chosen for the construction of a plant for the production of large-size reinforced concrete products for bridge constructions with the capacity of 70000 m^3 per year due to a number of the following factors: convenient geographical location, climatic conditions, location of raw material sources, social and economic prospects of the region.

Geographical and climatic parameters, as well as a diagram of the wind roses of the region are presented in Annex A.

When calculating the construction area of the plant, the prospect of production expansion or reconstruction is provided.

The projected enterprise represents a highly automated modern complex of buildings and structures for industrial, auxiliary and administrative and household purposes. Change or expansion of the nomenclature, type and volume of let out products with change of capacity of factory is provided.

Rational zoning of industrial, warehouse, auxiliary and administrative and household zones, availability of zones of an accomplishment, safe movement of railway and motor transport etc. is provided.

The nomenclature of products, annual program of production output, as well as characteristics of source materials are presented in Appendix B.

Nomenclature of manufactured products: BK 12.02-A11, CH 9-30, 1PP 50.18 - 100.AV, BR 200.60.20.

Source materials used:

Reinforced steel - for reinforcing plates: hot-rolled periodical profile in accordance with GOST 5781 class S400; hot-rolled steel S240 grade St3sp; for non stressed fittings: reinforcing bars of S400 and S240 classes according to GOST 5781 and reinforcing bars of S500 class periodic profile according to GOST 6727; for mounting hinge: hot-rolled smooth reinforcing bars of S240 class St3sp and St3ps grades or 10GT grade periodic profile S240 according to GOST 5781. Supplier: Steel Service Kazakhstan.

Cement - Portland cement of M500 grade, PTs 500-D0, GOST 10178-85. Supplier: "Leroy Merlin".

Large aggregate - crushed stone from natural stone of eroded rocks, grades of crushing not lower than 1200 according to GOST 8267-93. Supplier: "RGcom".

Fine aggregate - natural quartz sand, GOST 8736-93. Supplier: quarry.

Additives - plasticizing additive of group I C3 - superplasticizer. Supplier: "Leroy Merlin".

Water - GOST 23732-2011.

Stand (formwork) lubrication - SE-2 grease. Supplier: "Leroy Merlin".

1.2 The composition and mode of operation of the enterprise

Table 1 - The mode of operation of the enterprise

Nominal number of working days per year	260
Estimated number of working days per year	253
Same for unloading raw materials from railroad transport	365
Duration of scheduled stops for repairs per day	13
Number of working shifts per day (without heat treatment)	2
Number of working shifts per day (for heat treatment)	3
Number of working shifts per day to receive raw materials and supplies	
by railroad transport	3
by car	2
Working shift duration, h	8

1.3 Products of the enterprise

The nomenclature of the concrete products plant for industrial use is as follows:
1) Bridge beam - 8 percent
2) Pile - 7 percent
3) Pavement slabs - 4 percent
4) Side stone - 2 percent
Productivity of the concrete goods plant is 70000 m^3/year.

We find the productivity of the workshops according to the selected nomenclature of the plant (in percent):

$$8 + 7 + 4 + 2 = 21 \text{ percent}$$

1) Bridge beam

$$70000 \cdot \frac{8}{100} \cdot \frac{100}{21} = 26660\ m^3/year$$

2) Pile

$$70000 \cdot \frac{7}{100} \cdot \frac{100}{21} = 23300\ m^3/year$$

3) Pavement slabs

$$70000 \cdot \frac{4}{100} \cdot \frac{100}{21} = 13300\ m^3/year$$

4) Side stone

$$70000 \cdot \frac{2}{100} \cdot \frac{100}{21} = 6666\ m^3/year$$

Table 2 - Type of products

Product name	Product brand	Sizes, mm	Weight, kg	Type and grade of concrete	Consumption for 1 unit		Release m^3 / year	
					armature, kg	concrete, m^3	by given	by project.
Bridge beam	BK 12.02-A11	11360 x 1400 x 800	10300	heavy, C20 / 25	619.2	4.12	28600	33064
Solid square drive pile	CH 9-30	9000 x 300 x 300	2050	heavy, C20 / 25	36	0.82	25000	28735
Paving slab	1PP 50.18 - 100.AV	5000 x 1750 x 180	3950	heavy. C30 / 35	66.23	1,58	14300	17875
Side stone	BR 200.60.20	2000 x 600 x 200	600	heavy. C25 / 30	7.18	0.24	7100	9466

1.4 Choice of the type of concrete and its technological parameters

For the selected item, the following applies:
steel fiber concrete:
plate of roads of class C30 / 37
heavy concrete:
bridge beam class C20 / 25
pile class C20 / 25
side stone class C25 / 30

The mobility and stiffness of the concrete mixture is assigned taking into account the manufacturing technology of the products and the method of concrete compaction.

For a bridge beam, pile, side stone, concrete mixture with a mobility of 1-4 cm is used, for a plate of roads - 4-6 cm.

Table 3 - Technological parameters of concrete

Product name	Design the class concrete	OK mixtures cm	Density, kg / m ^{3}	Estimated cement consumption per 1 m ^{3}, kg
Bridge beam	C20 / 25	1-4	2400	364
Solid square drive pile	C20 / 25	1-4	2400	370
Paving slab	S30 / 37	4-6	2400	380
Side stone	C25 / 30	1-4	2400	400

1.5 Astringent

Portland cement of the M500 grade is used as a binder for the production of concrete mix for the manufacture of paving slabs, which must comply with the requirements of GOST 10178-85 “Portland cement and slag Portland cement. Technical conditions. ” The brand of Portland cement for compressive strength at 28 days of age is M 500; active mineral additives are not contained in Portland cement. Designation of Portland cement PC 500-D0.

The mass fraction of magnesium oxide (MgO) in the clinker should not be more than 5 percent. The tensile strength of cement in bending at 28 days of age should be at least 5.9 MPa (60 kgF / cm^2), and compressive 49 MPa (500 kgF/cm^2). The beginning of cement setting should occur no earlier than 45 minutes, and the end - no later than 10 hours from the beginning of mixing. The fineness of cement grinding should be such that when sifting a cement sample through a sieve with mesh No. 008 according to GOST 6613-86, at least 85 percent of the mass of the sieved sample passes. The mass fraction of sulfuric anhydride (SO_3) in cement should be in the range from 1.0 to 3.5 percent by weight. The coefficient of variation of the cement tensile strength, calculated according to the test results for the quarter, should not be more than 7 percent.

Table 4 - Binder

Product name	Name of binder	kg, percent	Density, kg / m^3	Activity, MPa	Mark
Bridge beam	Portland cement	0.28	3100	39.2	M500
Solid square drive pile	Portland cement	0.28	3100	39.2	M400
Paving slab	Portland cement	0.28	3100	39.2	M500
Side stone	Portland cement	0.28	3100	49	M500

1.5 Large aggregate

As coarse aggregate, crushed stone from natural stone of igneous rocks should be used, grades of crushing capacity not lower than 1200 according to GOST 8267-93 ”Crushed stone and gravel from dense rocks for construction work. Technical conditions. ”

Crushed stone should contain lamellar and needle-shaped grains up to 15 percent.

Test weight loss for intrusive rocks is 12–16 percent.

The clay content in the lumps should not exceed 0.25 percent.

The content of grains of weak breeds should not exceed 5 percent.

Grade of crushed stone for frost resistance should be at least F200.

The content of dusty and clay particles is not more than 2 percent.

In the production of crushed stone, a radiation hygienic assessment should be made, according to the results of which, they determine the scope. Crushed stone for road construction should be Aeff from 370 to 740 Bq / kg. Crushed stone must be resistant to environmental influences, resistant to the chemical effects of alkali cement.

Table 5 - Coarse aggregate

Product name	Placeholder name	Bulk density, kg / m^3	True density kg / m^3	Voidness percent	Grain composition, percent		
					5-10	10-20	20-40
Bridge beam	granite crushed stone	1650	2670	0.382	100	-	-
Solid square drive pile	granite crushed stone	1650	2670	0.382	thirty	55	fifteen
Paving slab	granite crushed stone	1650	2670	0.382	60	40	-
Side stone	granite crushed stone	1650	2670	0.382	60	40	

1.6 Fine aggregate

Quartz sand of a local quarry is used as a fine aggregate. Sand must meet the following requirements of GOST 8736-93 ”Sand for construction work. Technical conditions”.

Coarse modulus Mk = 2-2.5, medium sand, 2 classes.

The total balance on sieve No. 063 should be from 30 percent to 45 percent. The content of grains with a grain size of 10, 5 and less than 0.16 should not exceed 5 respectively; 15 and 15 percent.

The content of dust and clay particles in the sand, as well as clay in the lumps, should not exceed 3 and 0.5 percent, respectively.

Natural sand during the processing of NaOH (colorimetric test for organic impurities GOST 8555) should not give a color corresponding to or darker than the standard. Sand intended for use as aggregate for concrete should be resistant to the chemical effects of alkali cement. Sand should not contain any foreign contaminants.

Sand should be given a radiation-hygienic assessment. The specific effective activity of natural radionuclides in Aeff sand should be no more than 740 Bk / kg.

Table 6 - Fine aggregate

Product name	Placeholder name	Bulk density, kg / m 3	True density, kg / m 3	Fineness modulus	Grain composition, percent				
					2,5	1.25	0.63	0.315	0.16
Bridge beam	Quartz sand	1700	2620	2.05	-	9	19	40	32
Solid square drive pile	Quartz sand	1700	2620	2.05	-	9	19	40	32
Paving slab	Quartz sand	1700	2620	2.05	-	9	19	40	32
Side stone	Quartz sand	1700	2620	2.05	-	9	19	40	32

1.7 Reinforcing steel

For reinforcing plates in accordance with the drawings, it is necessary to use working reinforcement made of hot-rolled bar steel of periodic profile in accordance with GOST 5781 of class S400, for structural fittings and clamps - hot-rolled smooth reinforcement in accordance with GOST 5781 of steel of class S240 of grade St3sp.

As non-tensioning reinforcement, bar reinforcing steel of classes S400 and S240 in accordance with GOST 5781 and reinforcing wire of a periodic profile of class S500 in accordance with GOST 6727 should be used.

Mounting loops should be made of hot-rolled rod smooth reinforcing steel of class S240 of grades St3sp and St3ps or of periodic profile S240 of grade 10GT according to GOST 5781.

Requirements for reinforcing products:

The shape and dimensions of reinforcing products and their position in the slabs must correspond to those indicated in the working drawings.

Welded reinforcing products must meet the requirements of the working drawings and GOST 10922, GOST 23279.

1.8 Steel fiber

Steel fiber obtained from wire, sheet, slab, melt should be used as reinforcing components of steel-fiber-concrete mix.

For the manufacture of road slabs, fiber made of corrosion-resistant steel of the Hareks trademark type SF 01-32, TU 0991-125-46854090-2001, manufactured by AOZT Kurganstalmost using the technology of the German company Vulkan Harex by milling steel slabs from steel grades, should be used St3sp or St3ps according to GOST 380.

Nominal sizes of fiber "Hareks": length - 76 mm; section across the length - width 1.8 mm; average thickness 0.3 mm; twisting relative to the longitudinal axis 70 ± 30 °.

The temporary resistance of the Hareks fiber to a gap should be not less than 600 MPa.

There should be no dirt, rust or grease on the surface of the fiber, except for traces of process grease, dirt and rust. Surface defects (risks, scratches, burrs) are not defective.

Table 7 - Fittings

Product name	Type of reinforcement	Reinforcement class	Ø mm	Regulatory resistance	Design resistance
Bridge beam	Wireframes	S500	28	500	450
			14	500	450
		S240	8	240	218
	Tensile fittings	S1200	8	1200	1000
	Mounting loops	S240	12	240	240
	Mortgages	Carbon steel			
Solid square drive pile	Wireframes	S500	22	500	450
			sixteen	500	450
		S240	10	240	218
	Tensile fittings	S1200	12	1200	1000
	Mounting loops	S240	12	240	218
	Mortgages	Steel C235	10	235	230
Paving slab	Wireframes	S400	8	500	450
		S240	8	240	218
	Mounting loops	S240	12	240	218
	Butt products	S240	12	240	218
Side stone	Wireframes	S240	6	240	218
	Mounting loops	S240	8	240	218

The composition of the steel-fiber concrete mixture of steel fiber "Hareks" should be 0.8 percent-1 percent by volume, i.e. approximately 60-80 kg per 1 m^3.

Packaging for fibers should provide protection from moisture during transportation and storage. The mass of fibers in one package should be 15-50 kg.

1.9 Water

Water intended for the preparation of concrete mixtures must meet the requirements of GOST 23732-2011.

The water content of organic surfactants, sugars or phenols should not exceed 10 mg / l, soluble salts - 3000 mg / l, ions SO_4^{-2}- 2000 mg / l, ions Cl^-- 600 mg / l and suspended particles not more than 200 mg / l .

The total content of sodium (Na) and potassium (K) ions in water in the composition of soluble salts should be no more than 1000 mg / l. Water is allowed for use if there are traces of oil products, oils, fats on the surface.

The hydrogen indicator of water (pH) should be at least 4 and not more than 12.5. Oxidation of water should be no more than 15 mg / l. Water is allowed for use with an odor intensity of not more than 2 points. Water containing foaming agents is suitable for use with a foam resistance of not more than 2 minutes. In places of water intake, the content of coarse impurities in the water should be no more than 4 percent by volume. In addition to these restrictions, there should be no impurities in the water that affect the physico-mechanical characteristics and quality of concrete.

1.10 Additive

In this project, a plasticizing additive of group I C3-superplasticizer is used. This additive increases the mobility of the concrete mixture without compromising strength.

The mobility of the mixture within 45 minutes should not be reduced by more than half.

The plasticizing additive C3 is made on the basis of sodium salts, a condensation product of naphthalenesulfonic acid and formaldehyde. This is a dark brown liquid with a density of 1.15-1.2 g / cm ^{3} or a non-caking dark brown powder, readily soluble in water. In case of precipitation, it is recommended to dissolve it before heating or diluting it with hot water and then mix the solution thoroughly.

C3 Aqueous solutions do not change their properties when heated to 85 ^{o}C, and freezing to -40 ^{o}C.

Warranty period of storage - 6 months. Fire and explosion proof additive.

1.11 Lubrication

The grease should have good adhesion to the metal, not cause corrosion of the metal and the destruction of concrete, be constant in composition and stable during storage; hold well on a vertical surface. Lubrication should ensure that products are removed from the mold without damage. Also, the lubricant should provide mechanization and automation of its preparation and its application to the surface; be fire safe; Do not create unsanitary conditions in the workshop.

In order to better retain grease on the surface, it is heated to a temperature of 55-60 ^{o}C . At higher temperatures, the lubricant breaks down. When the temperature is lowered to 35-40 ^{o}C there is a sharp increase in viscosity, which precludes its application and transport.

Emulsol consists of spindle oil and high polymer synthetic fatty acids. So that during storage the emulsol does not exfoliate, it is necessary to mix it periodically.

1) The lubricant must remain liquid, form an opaque film or turn into a powdery layer after hardening.

2) The lubricant must not have harmful effects.

3) The grease must not dissolve in water.

4) Grease should not cause stains on concrete.

5) Lubrication must not cause corrosion of fittings and molds.

6) The grease should not evaporate when the temperature rises.

7)Lubrication should provide the maximum possible process of mechanization of application.

8) The lubricant must be provided with sufficient adhesion to the surface of the molds, be uniform and constant in its properties.

Emulsion lubricants are divided into two groups: OE-1, PE-1, OE-2 and PE-2. OE-1 and PE-1 is used for lubrication of horizontal surfaces, and OE-2 and PE-2 are used for vertical and horizontal surfaces.

In this case, OE-2 grease is used. For the preparation of grease, paddle mixers SMZH-18 are used.

1.12 Selection and justification of the production method

The main operations in the manufacture of precast concrete are the preparation of concrete mix, molding and hardening of products.

Paving slabs made of steel fiber concrete are manufactured by aggregate-flow technology.

With this production method, the mold and the product are moved using a crane with a technological post.

Aggregate-flow technology is widespread. Its main advantage is versatility and the ability to quickly change lines from the production of one product to the production of another, which does not require large expenses. It is highly cost-effective in mass production.

The number of products with this technology depends on the degree of perfection of the design and vibration equipment, the tightness and condition of the forms, excluding the air tray during vibration and possible leakage of cement milk, as well as the availability of effective lubricants.

The main posts of the aggregate-production line are: molding, consisting of a paver and a vibratory platform; heat and moisture treatment having pit chambers; product forming, cleaning, lubrication, mold assembly and installation of working fittings; surface finishes. In addition to the main posts in the workshop, intermediate warehouses for storing reinforcing bars, nets, frames, backup forms, etc. are provided.

To ensure production flow, a corresponding expansion of the entire technological process into separate operations and especially the molding process is required to reduce its cycle time.

1.13 Calculation of the warehouses of raw materials

Sand storage calculation:

Warehouse capacity by volume:

$$V = \frac{Py \cdot S \cdot S_f \cdot K_f \cdot 1{,}04}{0{,}9 \cdot T_w}, \qquad (1)$$

where P_y – is the annual productivity of the workshop, m^3/g;
S_f – stock of aggregate in stock, days;
S – aggregate consumption per 1 m^3 products, kg;
1,04 – coefficient of possible losses;
T_w – the number of working days per year;
K_f – coefficient taking into account fractions aggregate composition;
0,9 – warehouse filling ratio.

a) For a bridge beam:

$$V_1 = \frac{33064 \cdot 0{,}657 \cdot 7 \cdot 1{,}15 \cdot 1{,}04}{0{,}9 \cdot 253} = 920{,}27\ m^3$$

b) For a pile:

$$V_2 = \frac{28735 \cdot 0{,}695 \cdot 7 \cdot 1{,}15 \cdot 1{,}04}{0{,}9 \cdot 253} = 734{,}28\ m^3$$

c) For a paving slab:

$$V_3 = \frac{17875 \cdot 0{,}750 \cdot 7 \cdot 1{,}15 \cdot 1{,}04}{0{,}9 \cdot 253} = 492{,}9\ m^3$$

d) For the side stone:

$$V_4 = \frac{9466 \cdot 0{,}750 \cdot 7 \cdot 1{,}15 \cdot 1{,}04}{0{,}9 \cdot 253} = 261{,}03\ m^3$$

Sand storage capacity:

$V_{sum.store} = V_1 + V_2 + V_3 + V_4$ = 920,27+734,28+492,9+261,03=2408,48m^3

Stack Length:

$$L = \frac{V \cdot tg40}{h^2} = \frac{2408{,}48 \cdot 0{,}8390996}{9^2} = 24{,}95\ m$$

where 40 ^{o} - the angle of repose of the filler;
h is the height of the stack, m

Warehouse Area:

$$F = \frac{2 \cdot L \cdot H}{tg\alpha} = \frac{2 \cdot 25{,}95 \cdot 9}{tg40} = 535{,}2\ m^2$$

Stack width

$$B = \frac{F}{L} = \frac{535{,}2}{24{,}95} = 21{,}45\ m$$

We accept a stacking-trench warehouse with dimensions of 22x26m.

Calculation of the rubble warehouse:

a) For a bridge beam:

$$V_1 = \frac{Py \cdot S \cdot S_f \cdot K_f \cdot 1{,}04}{0{,}9 \cdot T_w} = \frac{33064 \cdot 1{,}285 \cdot 7 \cdot 1{,}05 \cdot 1{,}04}{0{,}9 \cdot 253} = 1426{,}32 \ m^3$$

b) For a pile:

$$V_1 = \frac{28735 \cdot 1{,}285 \cdot 7 \cdot 1{,}05 \cdot 1{,}04}{0{,}9 \cdot 253} = 1239{,}57 \ m^3$$

c) For a paving slab:

$$V_3 = \frac{17875 \cdot 1{,}164 \cdot 7 \cdot 1{,}05 \cdot 1{,}04}{0{,}9 \cdot 253} = 698{,}48 \ m^3$$

d) For the side stone:

$$V_4 = \frac{9466 \cdot 1{,}260 \cdot 7 \cdot 1{,}05 \cdot 1{,}04}{0{,}9 \cdot 253} = 698{,}48 \, m^3$$

Crushed stone warehouse volume:

$$V_{sum.store} = V_1 + V_2 + V_3 + V_4 = 1426{,}32+1239{,}57+698{,}48+400{,}4= =3764{,}77 m^3$$

Stack length at a height of 10 meters:

$$L = \frac{V \cdot tg40}{h^2} = \frac{3764{,}77 \cdot 0{,}8390996}{10^2} = 31{,}6 \, m$$

Warehouse Area:

$$F = \frac{2 \cdot L \cdot H}{tg\alpha} = \frac{2 \cdot 31{,}6 \cdot 10}{tg40} = 753{,}19 \, m^2$$

Stack Width:

$$B = \frac{F}{L} = \frac{753{,}19}{31{,}6} = 23{,}8 \, m$$

We accept a stacking-trench warehouse with dimensions of 22x34m.
Distance from the sub-tunnel to the railways:

$$l = \frac{h}{tg18} = \frac{10}{0{,}325} = 30{,}76 \, m$$

1.14 Calculation of the warehouses of cement

$$V_c = \frac{\left(\frac{\Sigma P_y \cdot C \cdot S_c \cdot 1{,}04}{0{,}9 \cdot n}\right)}{\rho_c} = \left(\frac{33064 \cdot 0{,}37 \cdot 7 \cdot 1{,}04}{0{,}9 \cdot 253} + \frac{28735 \cdot 0{,}37 \cdot 7 \cdot 1{,}04}{0{,}9 \cdot 253} + \frac{17875 \cdot 0{,}36 \cdot 7 \cdot 1{,}04}{0{,}9 \cdot 253} + \frac{9466 \cdot 0{,}37 \cdot 7 \cdot 1{,}04}{0{,}9 \cdot 253}\right) =$$

$$= (391{,}1 + 339{,}9 + 205{,}7 + 111{,}97) = 1048{,}67 \, m^3$$

where P_y – annual productivity
C – average cement consumption per 1 m^3 production
S_c – stock of cement in the warehouse
1,04 – coefficient of possible losses
0,9 – stock filling ratio

n – the number of working days in a year.
We accept 6 silos with a capacity of 250 m^3 .

1.15 Calculation of the warehouses of the reinforcing shop

The area for metal storage is calculated by the formula:

$$A = Q_{24h} \cdot T_k \cdot \frac{k}{m}, \quad (2)$$

where Q_{24h}- daily requirement, t;
T_k- shelf life, days;
k - coefficient taking into account walkways, passages during storage of steel in racks and in closed warehouses (2.5);
m is the mass of steel placed in 1m^2warehouse, t/m^2;

$$Q = \Sigma m_A \cdot n = \Sigma m_{sf} \cdot n, \quad (3)$$

where m_{sf} – is the mass of reinforcement in one product;
n is the number of products manufactured per day.

1) S500 Ø28, m=1,2 t/m^2
Q = 534,7·16+270,48·137=45610,96 kg/day = 45,61 t/day

A = 45,61·20·2,5÷1,2 = 1900,4 m^2

2) S500 Ø22, m=1,2 t/m^2
Q = 9,9·144 = 1,43 t/day
A =1,43·20·2,5÷1,2 = 59,6 m^2

3) S500 Ø16, m=1,2 t/m^2
Q = 10,7·144 = 1,54 t/day
A =1,54·20·2,5÷1,2 = 64,2 m^2

4) S1200 Ø8, m=1,2 t/m^2
Q = 47,28·16+22,12·137 = 3,79 t/day
A = 3,79·20·2,5÷1,2 = 157,9 m^2

5) S1200 Ø12, m=1,2 t/m^2
Q = 3,3·144 =0,5 t/day
A = 0,5·20·2,5÷3,2 = 20,8 m^2

6) S240 Ø6, m=3,2 t/m^2
Q = 5,98·320=1,9 t/day
A = 1,9·20·2,5÷3,2 = 29,7 t^2

7) S240 Ø8, m=3,2 t/m^2
Q = 1,2·320+3,55·16+2,1·137 = 0,7 t/day
A = 0,7·20·2,5÷ 3,2 = 10,9 m^2

8) S240 Ø12, m=3,2 t/m^2

Q = 2,1·16+2,1·137+2,1·144 = 0,6 t/day

A = 0,6·20·2,5÷3,2 = 9,4 m^2

9) S240 Ø10, m=3,2 t/m^2

Q = 5·144 = 0,7 t/day

A = 0,7·20·2,5÷3,2 = 10,9 m^2

10) C235, m=1,2 t/m^2

Q = 5·144+2·137 = 0,99 t/day

A = 0,99·20·2,5÷3,2 = 41,25 m^2

The total area of warehouses will be:

$$A_{sum} = \Sigma A =$$

=1900,4+59,6+64,2+157,9+20,8+29,7+10,9+9,4+10,9+41,25=2305,05m^2

1.16 Calculation of the warehouses of finished products

We determine the area of the warehouse for storage of finished products:

a) For a bridge beam:

$$A_1 = \frac{Q_{24h} \cdot T_k \cdot k_1 \cdot k_2}{Q_n} = \frac{130{,}68 \cdot 10 \cdot 1{,}5 \cdot 1{,}3}{1} = 2548{,}26\ m^2$$

where Q_{24h}daily performance, m^3;

T_k- storage time at the finished goods warehouse, days;

k_1- coefficient taking into account driveways, k_1=1,5 ;

k_2 - coefficient taking into account the type of crane. For overhead crane $k_2 = 1{,}3$;

Q_n - norm storing articles for 1 m^2,m^3.

b) For a pile

$$A_2 = \frac{113{,}57 \cdot 10 \cdot 1{,}5 \cdot 1{,}3}{1} = 2214{,}7\ m^2$$

c) For a pavement slab

$$A_3 = \frac{70{,}65 \cdot 10 \cdot 1{,}5 \cdot 1{,}3}{1} = 1377{,}28\ m^2$$

d) For the side stone

$$A_4 = \frac{37{,}41 \cdot 10 \cdot 1{,}5 \cdot 1{,}3}{1} = 729\ m^2$$

Total area:

$A_s = A_1 + A_2 + A_3 + A_4$ =2548,26+2214,7+1377,28+729=6869,24m^2

1.17 Calculation of the number of production lines and equipment

1. Required number of production lines in the workshop:

$$N_{t.l.} = \frac{P_{year}}{P_{year.a.} \cdot K_{e.u.}} = \frac{14300}{19187{,}52 \cdot 0{,}97} = 0{,}8 \approx 1\ line$$

$$P_{year.a.} = P_{year} \cdot P_{sm} \cdot T_{sm} \cdot N_f \cdot V_i = 253 \cdot 2 \cdot 8 \cdot 3 \cdot 1{,}58 = 19187{,}52 \text{ m}^3\text{/year}$$

where P_{year} – the productivity of the plant;

$P_{year.a}$ – annual output of the aggregate-production line;

$K_{e.u}$– utilization rate of equipment of the aggregate-production line.

$$P = 14300 \cdot \frac{1}{0{,}8} = 17875 \text{m}^3\text{/year}$$

2. Required number of molding machines:

$$N_{f.m.} = \frac{P \cdot T_C}{B_{sft} \cdot n \cdot V_i \cdot K_{i.o}} = \frac{17874 \cdot 0{,}33}{4048 \cdot 1 \cdot 1{,}58 \cdot 0{,}97} = 0{,}95$$

Accept 1 car.

where T_c– the duration of the molding cycle, T_c=20 min;

B_{sft} – estimated working time fund, h;

n - the number of simultaneously molded products.

3. Required conditional load capacity of the vibration platform:

$$Q_B = Q_F + Q_C = 3{,}16 + 3{,}4 = 6{,}5\, m$$

$$Q_B = V_I \cdot M = 1{,}58 \cdot 2 = 3{,}16\, m$$

where Q_F- is the mass of the form;

Q_C- mass of concrete mix.

$$Q_B = V_I \cdot \rho_C \cdot K_c = 0{,}96 \cdot 1{,}58 \cdot 2{,}49 \cdot 0{,}9 = 3{,}4\, m$$

where K_c- is the joining coefficient.

We accept the vibroplate SMZH-200.

4. Required paver hopper volume:

$$V_B = K_1 \cdot K_2 \cdot V_I = 1{,}1 \cdot 1{,}2 \cdot 1{,}58 = 2{,}08\, m^3$$

where K_1 is the safety factor (1.1 - 1.2);

K_2 - coefficient taking into account the incomplete filling of the hopper (1.2 - 1.4).

We accept a concrete paver CMZ-166.

5. The geometric dimensions of the TVO cameras:

a) Chamber length

$$L_k = n_1 \cdot l_f + 2l_z + (n_1 - 1) \cdot l_1 = 1 \cdot 5{,}6 + 0{,}25 \cdot 2 = 6{,}1\, m$$

where l_z— is the gap between the chamber wall and the mold, l_z=0,25 m;

n_1 — the number of stacks along the length of the chamber, n_1=1.

$$l_f = l_u + 2 \cdot \Delta l_f = 5 + 2 \cdot 0{,}3 = 5{,}6\, m$$

where l_f— is the length of the form, m.

b) Camera width

$$B = n_2 \cdot b_f + 2 \cdot b_3 + (n_2 - 1) \cdot b_2 = 2 \cdot 2{,}25 + 2 \cdot 0{,}3 + 0{,}25 = 5{,}35\, m$$

where n_2- is the number of piles across the width of the chamber, n_2=2.

$$b_f = b_u + 2 \cdot \Delta b_f = 1{,}75 + 2 \cdot 0{,}25 = 2{,}25\, m$$

where Δb_f= 0,25 m;

b_f— the width of the form, m.

c) Chamber height

$$H_k = h_f \cdot n + (n-1) \cdot h_2 + h_1 + h_1 == 0{,}38 \cdot 5 + (5-1) \cdot 0{,}075 + 0{,}15 + 0{,}16 = 2{,}51\, m$$

$$h_f = h_u + \Delta h_f = 0,18 + 0,2 = 0,38\ m$$

where h_f - is the height of the form, m;

Δh_f= 0,2 m;

h_f=0,075 m - distance between the shapes in height, m;

n - is the number of cameras along the height of the camera, n = 5;

h_1= 0,5 m - distance from the top of the form to the bottom of the lid;

h_3=0,16 m - gap between the bottom of the chamber and the shape.

6. Camera load factor

$$K_l = \frac{V_m}{V_k} = \frac{10 \cdot 1,58}{2,51 \cdot 5,35 \cdot 6,1} = 0,19$$

where V_k- is the geometric volume of the inner section.

7. The duration of the full cycle of heat treatment

$$T_{lt}=t_r+t_f+t_{pre}+t_{ht}+t_{iso}+t_{ct}+t_p+t_d+t_z+t_{unload.t} = 0,33+6+3+3+2+0,33+3,3+3,3 = =21,62\ h$$

where t_r – rebar time;

t_{lt}– load time;

t_{pre} – the time of preliminary exposure (6 hours);

t_{ht} – heating time (3 hours);

t_{iso}– isothermal exposure time (3 hours);

t_{ct} – cooling time (2 hours);

$t_{unload.t}$ – unloading time;

T_{lt} – lapping time.

8. Number of installations

$$N = 1 + \frac{P}{B_r \cdot \Sigma Vk.g. \cdot K_{a.k.} \cdot K} = 1 + \frac{17875}{253 \cdot 1,58 \cdot 10 \cdot 1,09 \cdot 0,97} = 5,22$$

where P - is the annual line productivity, m^3;

τ_{year}- annual time fund, days.

$$K_{a.k.} = \frac{24}{T_{sum}} = \frac{24}{21,92} = 1,09$$

Accept 6 steaming cameras.

9. Required number of forms:

$$N_f = m + g_t - 2 + \frac{t_{ht} - z \cdot t_{on}}{\tau} = 4 + 10 - 2 + \frac{14 - 1 \cdot 2}{0,33} = 49$$

where m - is the number of posts on the production line, m^3;

τ_{ht}- heat treatment time.

Accept 49 forms.

2 Thermotechnical part

Thermal treatment of the product (steel-fibre concrete pavement slabs) is carried out in a pitted chamber.

The pit-type chambers are used in aggregate-flow and semi-conveyor technology. Floor, semi-shallow and buried can be manufactured depending on the ground water level. The main constructive disadvantage is the system of product loading. Frequent removal of the lid breaks the tightness of the upper part of the chamber (hydraulic shutter), which leads to "knock-out" steam from the installation. They are made of reinforced concrete or combined.

Maintenance technology consists of the following: forms with products are loaded into the pit chamber. After full loading, the lid closes, the water gates are filled and steam starts to flow. In the process of heating and isothermal ageing, the steam condenses, gives off heat and is removed as condensate through a condensation system. At the end of the shutter speed, the steam is stopped and the steam-air mixture is removed through a channel. The water in the water gates boils and is also removed from the chamber as a steam-air mixture. Air enters the chamber through the freeing gates, which cools the product, heats itself and is also evacuated through a duct. After the products have cooled down, the chamber opens and the products are unloaded. Since the chamber is not a hermetic installation, the air pressure in the chamber is practically maintained. When steam is fed into the chamber, there is air in the chamber [19].

One of the conditions for rational use of steam is the organization of its supply. A circular perforated tube with holes is used as a steam line. Steam from the main steam line is fed into the chamber through the supply line. Adjustment of supply is performed by a valve. From the main steam line, steam is supplied through the supply line to the lower and upper steam line located on opposite sides and equipped with nozzles [19].

To remove air during the lifting period t, the capillaries are equipped with a return pipe with a hydrostatic precipitator and a valve which, as the steam is filled, removes air and prevents the return flow to the chambers.

2.1 Calculation of thermal installations and units

1. The geometric dimensions of the TVO cameras

1.1. Camera length

$$L = n_1 \cdot l_f + 2l_g + (n_1 - 1) \cdot l_1$$

where l_f— is the length of the form, m.

$$l_f = l_u + 2 \cdot \Delta l_f \quad (4)$$

$$\Delta l_f = 0{,}3 \text{ m}$$

$$l_f = 5 + 2 \cdot 0{,}3 = 5{,}6\ m$$

where l_g-is the gap between the chamber wall and the mold, l_g= 0,25 m;

n_1- number of stacks along the length of the chamber, n_1=1.

$$L = 1·5,6 + 0,25·2= 6,1 \text{ m}$$

1.2. Camera Width

$$B = n_2 \cdot b_f + 2 \cdot b_3 + (n_2 - 1) \cdot b_2 = 2·2,25+2·0,3+0,25=5,35 \text{ m}$$

where b_f- is the width of the form, m.

$$b_f = b_u + 2 \cdot \Delta b_f = 1,75+2·0,25=2,25$$

where Δb_f=0,25 m;

n_2- number of piles across the width of the chamber,n_2=2.

1.3.Camera Height

$$H_k = h_f \cdot n + h_2 \cdot (n-1) + h_2 + h_3 == 0,38 \cdot 5 + 0,075 \cdot (5-1) + 0,15 + 0,16 = 2,51\text{m}$$

where h_f- is the height of the form, m.

$$h_f = h_m + \Delta h_f = 0,18 + 0,2 = 0,38 \text{ m}$$

where Δh_f= 0,2 m;

l_2= 0,075 m - distance between forms in height;

n - number of shapes along the height of the chamber, n = 5;

h_1= 0,15 m - distance from the top of the mold to the bottom of the lid;

h_3= 0,16 m - gap between the bottom of the chamber and the shape.

2. Number of products in the chamber

$$K = n_1 \cdot n_2 \cdot n = 1 \cdot 2 \cdot 5 = 10\text{unit}$$

3. Volume of material in the chamber

$$V_m = K \cdot V_{fm} = 10 \cdot 1,58 = 15,8\ m$$

4. Camera load factor

$$K_z = \frac{Vm}{V_k} = \frac{10 \cdot 1,58}{2,51 \cdot 5,35 \cdot 6,1} = 0,19$$

where V_k- is the geometric volume of the inner section.

5. The duration of a complete heat treatment cycle

$$T_{sum} = t_z + t_{unload} + t_{tbo} = 3,3 + 3,3 + 14 = 20,6 \text{ h}$$

where t_{tbo}- TBO time = 14 h;

t_{unload} - unloading time = 3,3 h.

$$t_z = \left(\frac{K}{n_f}\right) \cdot \tau_f = \frac{10}{1} \cdot 0,33 = 3,3\ h$$

6. Number of installations

$$N = 1,1 \cdot \frac{Vyear}{Vk.g} = 1,1 \cdot \frac{17875}{3104,7} = 5,75$$

$$V_{k.g} = V_m \cdot \frac{\tau_{year}}{T_{sum}} = 15,8 \cdot \frac{4048}{20,6} = 3104,7\ m^3/year$$

where τ_{year}- is the annual time fund, days;

V_{year}- annual line productivity, m^3.

Accept 6 steaming chambers.

2.2 Calculation of the need for electricity, steam, compressed air and lubrication

Calculation of the need for compressed air

In the production of precast concrete, compressed air is spent on pneumatic transport, the operation of the equipment of the reinforcing shop, the pneumatic control of concrete mixing equipment and the operation of the equipment of cement warehouses. The need for compressed air for the molding workshop for the production of crane beams is determined for each type of equipment, based on the specific consumption of compressed air specified in the technical specification, unit of time and its pressure.

The calculation of compressed air is determined by the formula:

$$B_{compression} = \Sigma B_i K_{c.unc.c} K_{dc}, \quad (5)$$

where K_{dc}- is demand coefficient;

$K_{unacc.c}$- coefficient of unaccounted consumers, 1.2.

Table 8 - Required amount of water

Name of equipment	Quantity of consumers	Consumption air m³/h	Demand coefficient K_{dc}	Air Consumption, m³		
				hourly	daily	yearly
Paver	1	1	0,1	0,24	1,38	349,14
Air scraper	2	12	0,2	5,76	138,24	34977,72
Spray rod	2	30	0,1	7,2	172,8	43718,4
Total				13,2	312,42	79045,26

$$B_{compression} = (1\cdot 0,1+12\cdot 0,2+30\cdot 0,1)\cdot 1,2\cdot 2=13,2\ (m^3/h)$$

2.3 Energy consumption for technological needs

Reduced installation power:

$$P_n = \sqrt{P \cdot V \cdot P_n}\text{ , kW,} \quad (6)$$

where P_n-rated installed power, kW;

$\sqrt{P \cdot V}$- relative duration of inclusion (percent of working time).

$$P_a = K_{dc} \cdot P_n, \text{ kW}, \qquad (7)$$

where P_a - active load, kW;

K - demand coefficient.

$$Q_m = P_a \cdot tg\varphi \quad , \text{kW}, \qquad (8)$$

where Q_m - reactive load, kW;

$tg\varphi$ - power factor.

Electricity consumption for technological needs:

$$W_n = \sqrt{W_a^2 + W_p^2} \ , \text{kW}, \qquad (9)$$

where $W_a = P_m \cdot t$;

$W_p = Q_m \cdot t$;

t - is the operating time of the equipment, h.

The calculation results bring in the table:

Table 9 - Electricity consumption

Name of equipment	Quantity of PC	PV	P_n, kW	P_n, kW	tgφ	Kc	Maximum load		Electricity consumption, kW·h		
							P_m kW	Q_m kW	W_a	W_p	W_n
Pavement crane	1	0.14	42	15.7	1.52	0.2	8.4	12.76	15881.6	24124.94	40006.54
Concrete hand	1	0.15	20.4	7.9	1.17	0.3	6.12	7.16	3186.78	3728.33	4604.69
Vibrating platform	1	0.035	149	27.9	1.33	0.3	8.37	11.12	4235.2	5626.7	9861.9
Self-propelled trolley	2	0.35	7.5	4.44	1.02	0.3	1.33	1.36	673	688.2	1361.2
								Amount	23976.58	34168.17	55834.2

Specific energy consumption:

$$W_y = \frac{55834{,}2}{17875} = 3{,}12 \text{ kW} \cdot h$$

2.4 Calculation of the needs of steam and lubrication

Calculation of steam for a thermal installation is adopted in accordance with aggregated indicators per unit of processed products. Calculation of steam according to aggregated indicators is carried out according to the scheme:

1. Reveal the volume of products to be processed in a thermal installation.

2. Set the specific steam consumption for the selected settings and accepted processing parameters.

With an average steam consumption of 170 kg per 1 m^3 of concrete, the annual demand for production in a pair will be:

$$B_n = H_{cp} \cdot Q_{year} = 170 \cdot 17875 = 3038750\ year = 500{,}45\ kg/h$$

Grease requirement:

The lubrication rate of 200 g per 1 m^2 the developed surface of the form per day:

B_c= $H_{avg} \cdot S_f \cdot n_f$ = 0,2·11,18·44 = 98,384 kg/day = 24891,152 kg/year

where S_f – the area of the expanded form, m ^{2};

n_f – number of products molded per day.

2.5 Water consumption for technological needs

Water consumption for technological needs.

Water in the workshop for the production of road slabs is used to flush forming equipment. The specific consumption of water for these needs is 0.5 liters per $m^2$of cultivated area.

Water consumption:

$$B_{tn} = 1{,}2 \cdot \Sigma B_i K, \quad (10)$$

where B_{tn}- total hourly water consumption, l / h ;

K- coefficient of unaccounted consumers, K= 1.25;

1,2 - coefficient for unaccounted losses.

Table 10 - Specific water consumption

Name of equipment	Quantity, units	Specific water consumption, l	
		per day	in year
Pavement	1	75	18975
Hydraulic shutter	8	720	182160
		795	201135

Table 11 - Consumption of resources

Name resource	Units measurements	Consumption	
		in hour	in year
Compressed air	m^3	13,2	79045,26
Electric power	kW	13.8	55834.2
Steam	kg	500,45	3038750
Water	l	33,125	201135
Grease	kg	6,15	24891,152

3 Architectural and construction part

The general plan of the enterprise considers zoning of the territory, blocking of individual premises, individual shops and structures into a smaller number of production units, when fulfilling sanitary and fire design standards.

The adopted technological scheme for the production of products determines the structure of the plant, the composition of the equipment and its placement in production buildings. Single-storey multi-span buildings are used for the production shops of precast concrete plants. One-story shops is determined by a large mass of products, the movement of which is carried out by beam cranes or bridge cranes.

Industrial buildings have a structural scheme with a full frame.

The main elements of the frame are prefabricated reinforced concrete structures: columns, crane beams, trusses, floor slabs. The walls are made of precast concrete panels.

Window frames are made of steel or aluminum frames. Lights of light aeration purpose have a U-shaped profile with a width of 6-12 m.

The reinforcement workshop is located in standard unified spans equipped with a 5-ton overhead crane or two beam cranes.

The concrete mixing plant is located in a multi-story frame building made of prefabricated reinforced concrete elements. An inclined transport gallery adjoins the concrete mixing workshop, which is made of prefabricated reinforced concrete or metal structures with fences made of lightweight panel elements.

The master plan of the plant is a project of the location of buildings and structures, utilities, roads and railways located in accordance with the technological scheme and ensuring the normal functioning of the enterprise (CNaR I-89-80, part II. Design standards. Chapter 89. General plans of industrial enterprises).

The plant is located taking into account the prevailing wind rose. The building site area of the plant is 45-50 percent.

When using railway transport, an in-plant railway network was designed to ensure the supply of raw materials and the shipment of finished products associated with the railway access road.

A ring highway with auxiliary roads and entrances was designed on the territory of the plant. When the layout of the general plan, sanitary and hygienic and fire safety requirements, as well as the conditions of labor protection and environmental protection, are met.

3.1 Plant Design

We design the plant for the production of expanded perlite in accordance with the requirements of CNaR II-99 “General Plans of Industrial Enterprises”. The mutual arrangement of buildings and structures is carried out taking into account the emitted harmful substances and wind rose.

Industrial enterprises emitting gas, smoke, dust, noise as a result of their work in relation to the nearest residential area should be located on the leeward side for prevailing winds, determined by the rose of the winds. They must also be separated from the borders of residential areas by sanitary protection zones.

3.2 General plan of the enterprise

The designed factory of concrete products for transport purposes consists of the main and auxiliary workshops.

The main workshops include:

1. Two molding workshops for the production of bridge beams with bench technology. Each workshop has two production lines with a capacity of 8339 m^3 / year.

2. One molding workshop for the production of paving slabs with a capacity of 17875 m^3 / year with one aggregate-flow line.

3. The molding workshop for the production of driven piles of solid square cross section with a productivity of 28735 m^3 / year with one aggregate-flow line.

4. Molding shop for the production of side stones with a capacity of 9466 m^3 / year with one aggregate-flow line.

5. Reinforcing shop for the production of reinforcing products: nets, frames, embedded parts, mounting loops and individual rods. The fittings in the molding workshops come from the reinforcement workshop on self-propelled trolleys. The workshop is located perpendicular to the molding workshops.

6. The concrete mixing plant produces heavy concrete of class C20 / 25, C25 / 30, C30 / 37 for products of a given nomenclature. Concrete mixture is prepared in the concrete mixing workshop and fed through the concrete loading rack to the molding shops.

7. The warehouse of finished products is intended for storage of finished products until they are exported before their export to the consumer. Warehousing is carried out in open areas.

8. Storage of the binder is carried out in silos, from which it enters the BSC using pneumatic conveying.

9. Storage of aggregates is carried out in a stack-trench warehouse, which are equipped with stacked conveyors and unloading machines.

10. On the territory of the plant there is an administrative and housing building, in which there are household premises, laboratories of the Quality Department, administration rooms, etc.

Ancillary production includes:

1. Repair and mechanical workshop, designed for the repair and maintenance of production equipment and vehicles of the enterprise.

2. Compressor, designed to supply compressed air to industrial needs.

3. A boiler room, which serves for heating rooms in the winter, as well as for the production of steam.

4. The transport workshop, representing cars, rail and in-shop transport.

5. The warehouse of fuels and lubricants.

6.Transformer.

7. Fire reservoir.

The specified area of the workshop is S = 1836 m^2(18 x 102 m).

The workshop for the production of paving slabs from steel fiber concrete has dimensions 24 x 84 meters. Production facilities are selected depending on the size of the processing lines placed in the workshop, the size of the equipment and the conditions for its placement in compliance with the required driveways and passages.

The main type of industrial building is frame, this is due to the presence in many industrial buildings of large concentrated loads, shocks and shocks from technological and crane equipment.

Reinforced concrete structures are characterized by high durability, incombustibility and low deformability.

Overall dimensions of the building of the main workshop:

1) the step of the columns along the span is 6 meters;

2) the span is set depending on the dimensions of the processing equipment, taking into account passages and driveways of 24 meters;

3) the height of the shop is calculated by the formula:

$$H \quad = H_1 + H_1 = h_1 + h_2 + h_3 + b_1 + b_2 + 500 + 100$$

where 500 and 100 - safety standards for the operation of machines and mechanisms;

h_1- height of equipment;

h_2- height of the element transported by the crane;

h_3- length of the sling;

b_1 and b_2 - dimensions of crane equipment.

$$H \quad = 3100+180+1450+2400+1900+500+100=9630 \text{ mm}$$

The crane part of the column:

$$H_1 = h_1 + 500 + h_2 + h_3 + b_1 - 150 - h_b =$$

$$= 3100 + 500 + 180 + 1450 + 2400 - 150 - 1000 = 6480 \text{ m}$$

Supercrane part of the column:

$$H_2 = h_b + 150 + b_2 + 100 = 1000 + 150 + 1900 + 100 = 3150 \text{ mm}$$

We select the column, taking into account that 1000 mm of the column length is installed in the foundation and that the H_2 columns are not less than the calculated value.

We accept a column from the series KE 01-52 of the brand KD III -36 with a height of H = 10.8 m.

The building houses a bridge crane with a lifting capacity of 20 tons. Crane beams rest on the console of columns. Their length is selected based on the pitch of the columns. A series of crane beams KE-01-50. Considering the crane loading capacity, we select a crane crane beam BKNA 6 - 3t, length 6 meters, weight 4.1 t. Crane beams are not only load-bearing structures, but also serve to give rigidity to the building.

4 Automation of technological processes

The automation scheme is presented in the graphical part of the work.

Description of the main automation scheme -

1. Pressure retention by means of a pressure switch;
2. Cement level fixing in silos;
3. Moisture level fixing in inert material bunkers and fixing the moisture level in the mixer itself;
4. Inert material weight fixation;
5. Fixing the water weight;
6. Additive weight fixation; Additive weight fixation
7. Cement weight fixing
8. Automatic block shutter closure when parameters are exceeded

Used automated control systems (ACS) - Siemens equipment, in particular: controllers SIMATIC S7-300, CPU central processor modules, signal modules SM, communication processors CP, functional modules FM; controllers OVEN PLC150 [4], ACS "LCD Thermal Control" [5].

4.1 Functional diagram development

The system of automatic control of the process of heat treatment of reinforced concrete in the pit chamber is based on temperature measurement by two sensors TE - platinum resistance thermometers. Sensor signals pass through HK amplifiers. One signal passes through the x(-1) inverter and goes to the adder ∑. The second signal goes directly to the adder, where both signals are added and compared with the set temperature TA. If the sum of the signals meets the set temperature in the TA, then the signals from the HK amplifiers are directly fed to the other adder. From this adder the signal is fed to the x1/2 amplifier. From this amplifier, the signal is fed to the TI display device.

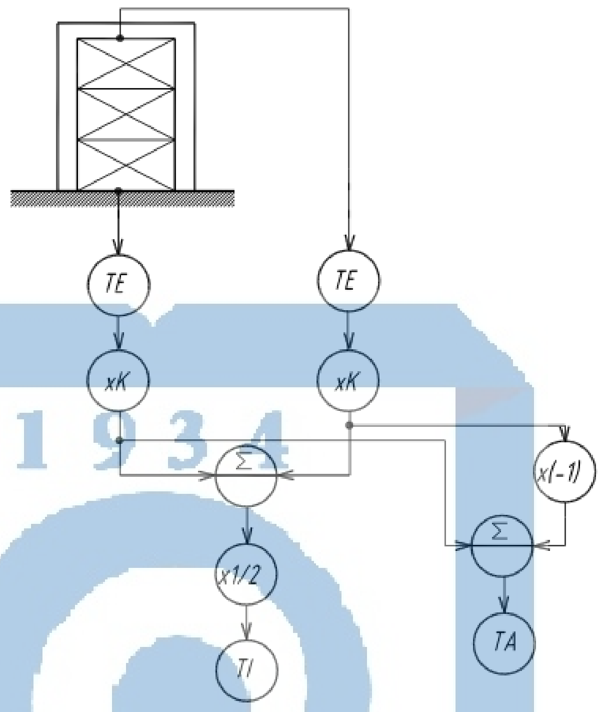

Figure 1 - Functional diagram

5 Economic part

5.1 Calculation of the selling price of precast concrete structures

The selling price includes cost of production, profit, taxes and duties paid from revenues. The main element of the selling price is cost of production. At formation of the prime cost of production on items of expenses the following grouping of expenses is established:

- basic materials;
- auxiliary materials for technological purposes;
- fuel (heat energy) for technological purposes;
- electric power for technological purposes;
- the basic salary of industrial workers;
- social contributions;
- expenditures on preparation and development of production (for newly developed products);
- general production expenses;
- general economic expenses;
- taxes and contributions attributable to production costs;
- cost of production (for newly developed products); general production expenses; taxes and contributions attributable to production costs;
- non production expenses (costs related to sales of products);
- total cost of production.

6 Technical-economic part

TEP of the projected plant:

- Calculation of investment costs - 101,66 mill.tenge.

Project cost estimates, construction cost estimates, equipment cost estimates, construction cost estimates, investment cost estimates are provided in the annex.

- Estimation of production costs - 14953,2 tenge/m^3.

The cost of raw materials per annual output, the cost of water, electricity, steam, monthly wage fund, depreciation charges, cost of production are presented in Annex E.

- Project profitability calculation - 10 percent.

Sales revenue, net payback margin and major TPP are shown in Annex E.

7 Occupational Health and Safety

Ensuring safe, comfortable and convenient operation are developed during the development of the master plan and technology projects, through automation of technical processes, increasing reliability and safety of the units, as well as creating comfortable environmental conditions.

The following harmful production factors on the territory of the plant include the following, with MPC values: dust 7 mg/m^3, noise - 70 dB, local vibration - 80 dB, air speed - 0.5 m/s, humidity - 41 percent, lighting - 700 lux, electromagnetic field with an industrial frequency - 50 Hz.

For maintenance of pure air use: installations - dust collectors, removal of toxic substances, automation and mechanization of all processes.

To limit the impact of vibration measures are taken: vibration isolation of units with dynamic loads, a design solution that takes into account the parameters of dynamic effects, the transfer of units to remote control. To determine the force of vibration oscilloscope H-700, vibrometer VEP-4 is used.

To limit the impact of noise the following measures are taken: isolation of noise devices in separate compartments, creation of an isolated cabin with noise-absorbing shields for personnel, installation of noise silencers, installation of vibration units on elastic shock absorbers.

To optimize lighting, artificial and emergency lighting systems are used.

To ensure fire [12], [14], [15] safety it is necessary to have a specific amount of water reserve, primary fire extinguishing means (fire extinguishers) are used.

Calculation of the required water volume for fire [12], [14], [15] extinguishing is 216 m^3/h.

Water consumption rates for external fire [12], [14], [15] extinguishing are given in Annex 10.

In order to reduce defective products and solid waste, the following measures and equipment are provided:

- Primary crushing of waste by hydraulic excavators with "scissors" or hydraulic hammer;
- Screening and air separation in a two-level screen;
- secondary crushing of large lumps in a rotary crusher;
- Separation into fractions and dispatch to finished product warehouses.

CONCLUSION

In the diploma work the plant for the production of large-size reinforced concrete products for bridge structures with the capacity of 70000 m^3 per year is designed. According to the production technology, the most common and optimal aggregate-flow method of production was adopted, with a number of advantages described in the previous parts. On technical and economic indicators it is obvious high profitability of the plant, low cost of production. The payback period was ..., which is a good indicator. An important role is played by the close location of the raw material base, which significantly affects the cost of products.

Designing of the plant for production of large-size reinforced concrete products for bridge constructions with capacity of 70000 m^3 per year, with perspective expansion or reconstruction, shows correctness and profitability both for the concrete region and for the republic as a whole. The effectiveness of steel and concrete structures can also be achieved by reducing the labor costs for reinforcement work, reducing steel and concrete consumption by reducing the thickness of structures, combining technological operations of concrete mixture preparation and reinforcement, increasing the durability of structures and reducing the cost of running repairs.

Steel and concrete are now actively used in precast construction. But its mass introduction is constrained by the lack of industrial production of commercial fiber.

The undoubted advantage of fiber reinforced concrete has led to a wide interest in its use in the domestic and foreign market for construction and repair. More than 15 countries use fiber as a reinforcing agent, among them the USA, Japan, Canada, Germany, Great Britain, Norway, Austria, New Zealand and others.

In a word, steel-fiber concrete is extremely necessary for a construction complex. Experience of its application shows economic efficiency, benefit and rationality in the manufacture of multi-purpose building structures.

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Description of Climate

The place of construction of the plant of industrial reinforced concrete goods is the city of Almaty.

According to SNIP RK 2.04-01-2001 "Building climatology" the territory of Almaty is located in I In climatic subarea, which is characterized by: long hot summer, short winter, lack of strong winds. The wind rose is built according to the data from SNIP "Building climatology". These wind roses are described in the Table A.1.

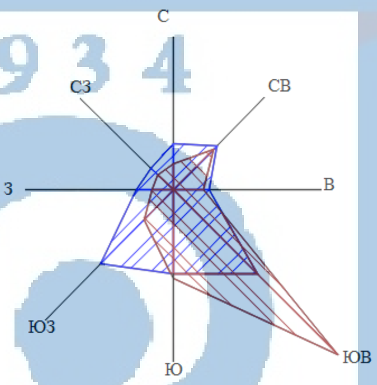

Figure A.1 - Wind Rose of Almaty [1]

Table A.1 - Wind direction indicators for July and January [1]

Month	N	NE	E	SE	S	SW	W	NW
January	9	12	7	23	16	20	7	6
July	5	11	6	45	17	8	4	4

Climate data for Almaty [hide]

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °C (°F)	18.2 (64.8)	21.9 (71.4)	29.8 (85.6)	33.2 (91.8)	35.8 (96.4)	39.3 (102.7)	41.7 (107.1)	40.5 (104.9)	38.1 (100.6)	31.1 (88.0)	25.4 (77.7)	19.2 (66.6)	41.7 (107.1)
Average high °C (°F)	0.7 (33.3)	2.2 (36.0)	8.7 (47.7)	17.3 (63.1)	22.4 (72.3)	27.5 (81.5)	30.0 (86.0)	29.4 (84.9)	24.2 (75.6)	16.3 (61.3)	8.2 (46.8)	2.3 (36.1)	15.8 (60.4)
Daily mean °C (°F)	−4.7 (23.5)	−3 (27)	3.4 (38.1)	11.4 (52.5)	16.6 (61.9)	21.6 (70.9)	23.8 (74.8)	22.9 (73.2)	17.6 (63.7)	9.9 (49.8)	2.7 (36.9)	−2.8 (27.0)	10.0 (50.0)
Average low °C (°F)	−8.4 (16.9)	−6.9 (19.6)	−1.1 (30.0)	5.9 (42.6)	11.0 (51.8)	15.8 (60.4)	18.0 (64.4)	16.8 (62.2)	11.5 (52.7)	4.6 (40.3)	−1.3 (29.7)	−6.4 (20.5)	5.0 (41.0)
Record low °C (°F)	−30.1 (−22.2)	−37.7 (−35.9)	−24.8 (−12.6)	−10.9 (12.4)	−7 (19)	2.0 (35.6)	7.3 (45.1)	4.7 (40.5)	−3 (27)	−11.9 (10.6)	−34.1 (−29.4)	−31.8 (−25.2)	−37.7 (−35.9)
Average precipitation mm (inches)	34 (1.3)	42 (1.7)	75 (3.0)	100 (3.9)	106 (4.2)	57 (2.2)	47 (1.9)	30 (1.2)	27 (1.1)	60 (2.4)	56 (2.2)	41 (1.6)	675 (26.7)

Figure A.2 - Almaty climate [12]

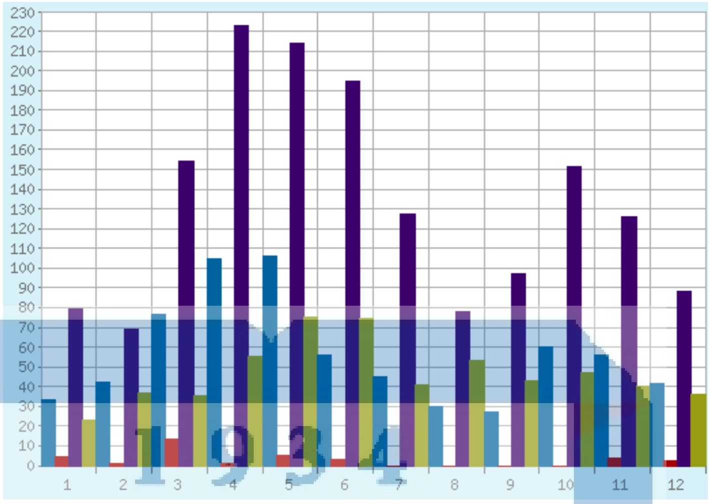

Figure A.3 - Average monthly precipitation of Almaty [1]

Calculation of human resources (Number of staff employed)

The average employment rate is 0.89, which satisfies the current economic conditions.

The total number of workers engaged in mechanized operations (operation of machines and mechanisms in the production process) regardless of the mode of production, must meet the condition:

$$N_m = \frac{1}{B_{sfm}} \Sigma B_{sfw} \cdot M_i \cdot N_i \quad \text{, human;} \qquad (B.1)$$

where B_{sfm},B_{sfw} – estimated fund of working time of the machine and the worker, h;

M_i – number of machines of the i-th type used in the production process, M_1 = 1 item (slipform paver), M_2 = 1 item (vibrating platform), M3 = 1 item (bridge crane);

N_i – number of workers servicing one machine, N_1 = 1 human, N_2 = 1 human, N_3 = 1 human.

The annual fund of machine and worker working time is determined by formulas:

$$B_{sfw} = n_{year}^{w} \cdot t_{sfw}^{24h}, h, \qquad (B.2)$$

$$B_{sfm} = n_{year}^{w} \cdot t_{sfm}^{24h}, h, \qquad (B.3)$$

where: n_{year}^{w}- number of working days per year, 253;

t_{sfw}^{24h}, t_{sfm}^{24h} - working time of the worker and the machine per day and hour respectively.

The annual fund of concrete slipform paver time:

$$B_{sfm1} = 253 \cdot 13 = 3289\ h$$

The annual fund of vibratory platform time:

$$B_{sfm2} = 253 \cdot 4{,}24 = 1072{,}72\ h$$

The annual fund of time bridge crane:

$$B_{sfm3} = 253 \cdot 18{,}8 = 4756{,}4\ h$$

Annual fund of performer's time (including 18 days of vacation):

$$B_{sfw} = 235 \cdot 8 \cdot 2 = 3760\ h$$

The total number of workers employed in mechanized operations:

$$N_m = \frac{1}{3760} \cdot (3289 \cdot 1 \cdot 1 + 1072{,}72 \cdot 1 \cdot 1 + 4756{,}4 \cdot 1 \cdot 1) = 2{,}42\ people$$

Accept N_m = 3 people.

The number of workers engaged in manual operations:

$$N_p = \frac{F_{year} \cdot H_p}{B_{sfw}}, \text{ human,} \qquad (B.4)$$

where F_y - annual number of moulds.

$$M_{year} = \frac{B_{sf} \cdot 60}{R} = \frac{4048 \cdot 60}{20} = 12144\ h$$

where H_p - total labor intensity of all manual operations at all posts of the production line; according to the operational schedule H_p= 72,5 human-min = 1,2 human-hour.

$$N_p = \frac{12144 \cdot 1{,}2}{3760} = 3{,}87\ people$$

Accept N_p = 4 people.

The total number of people working on the board production line will be: 3 +4 = 7 people.

Calculating the need for basic manpower for the working shift, we compare the result with the data on the number of workers on the basis of operational schedule of production of the product.

The number of auxiliary workers is taken at a rate of 25-30 percent of the total number of production workers. Then establish the need for engineering and technical workers, based on the technical and technological complexity of production, the number of teams, the number of work shifts.

The final data on the number of workers in the shop we reduce to a statement.

Table B.1 - Record of the number of workers

Work category	Number of shifts, man		Total in the shop
	I-shift	II- shift	
Basic workers: Shape-shifter III Reinformer III Reinformer IV Former III Crane operator IV	 2 1 1 1 1	 2 1 1 1 1	 4 2 2 2 2
Total	6	6	12
Auxiliary workers: Electrician Mechanic	 1 1	 1 1	 2 2
Total	2	2	4

Table continuation

ITR and employees: Shop Manager Master Technologist Lab technician	 1 1 1	 1 1	 1 2 2 2
Total	3	2	5
Number of employees			21

The specific labour intensity of the products is calculated using the following formula:

$$H = \frac{n_{sh} \cdot t_{sh} \cdot N_{sh}}{Q_{sh}} = \frac{2 \cdot 8 \cdot 6}{70{,}65} = 1{,}58 \;\; human - hour\, s/m^3$$

where n_{sh}- number of shifts per day;

t_{sh}- shift duration;

N_{sh}- average number of a team of workers;

Q_{24h}- production volume per day

.

Table C.1 - Monitoring and evaluation of the quality of performed operations

Object of control	Controlled parameter			Place of Control Sampling	Frequency of control	Who controls or conducts the tests	Control method (PD symbol)	Test Measuring Instruments		Control results reporting
	Name	Nominal value	Longitudinal deviation					Type, brand, ND designation	Measuring range, error, accuracy class	
1	2	3	4	5	6	7	8	9	10	11
Form quality	Operational Control									
	Limit deviations of design parameters are not more than In length In height	8 mm 6 mm	not more than	plant	At least once a year	Master OTK, workshop technologist, workshop foreman	GOST 25781	Roulette measurement ZPK2-20BNT/1 GOST 17502	Measurement Limit 0-20000 mm, 2kl	certificate of acceptance

	Protection of welds on working surfaces	need to be flush protected	roughness of 40 mkm is allowed.				Measurement in accordance with GOST 25781-83	Micrometer, angle piece GOST 3749-77	up to 250mm 1kl.	same
Form quality	Cracks and fingerprints deeper than a sink are not permitted on work surfaces.	2 mm 3 cm^2 1 mm		Receiving platform, workshop	At least once a year, one cassette set	Quality Assurance Master with workshop technologist	GOST 25781	Depth gauge GOST 7661-67 Ruler GOST 427-75 Depth gauge GOST 7661-67	Measurement Limit 0-100 mm error 0,01 mm Measurement Limit 0-300mm Measurement Limit 0-100 mm 0.01mm	Changeover log

Table continuation

Forms cleaning quality	Thorough cleaning of concrete residue on all sides			Post demolding and mold preparation	Total permanent	Shop foreman	Visually GOST 10922-75			Operational Control Log
Emulsion lubrication quality	Viscosity Temperature Coat thickness of applied lubricant	11 – 13 s 55 - 60°C 0,2 - 0,3 mm	within, not more than	Laboratory	Selectively once for cooking	Lab technician	Technology Card	Measuring with a viscometer GOST 9070-75, stopwatch GOST 5072-79	20-150 s 0…60 s	Lubricant control log
	Quality of grease application	even layer		demolding station	continuous	Shop foreman	Visually			
Form assembly	Closing density of the sides			Shop	continuous Choice one, three times a shift	Shop foreman	Visually Technology card, working drawings			Operational Control Log

Table continuation

Product reinforcement quality	Installing the reinforcement frame in the working position	according to the drawings	compliance with	reinforcing post	sampled three times per shift	workshop foreman	visually	Roulette ZPK 2-10BNT/1 GOST 7502	0-10000mm 2 cl	
	Installation according to design of mortgage parts and mounting loops	same	same	reinforcing post	sampled three times per shift	workshop foreman	visually	Roulette ZPK 2-10BNT/1 GOST 7502	0-10000mm 2 cl	
Preparation of concrete mixture	Checking the bunker closures			Dosing bunker	Once a shift	CMU operator	Inspection and surveillance			

Table continuation

	Checking the dosing accuracy		+-1% for cement, water; +-2% for aggregates and fibres	Weighing equipment for pipettes	At all times, if necessary	CMU operator, lab	Clock type indicator, control weights	Weighing weighers with clock type indicator UCC 1-400/300 10-1.0038 USK - 400-3/36	0-400 kg 1 kg 0-800 kg 2 kg	
	Follow the loading sequence of the source materials	1.coarse aggregate; 2.Fine aggregate; 3.Cement; 4.Water 5.Steel fibre		Mixer	At all times, if necessary	Operator, lab, counter, lab technician	Visually CNaR 3.09.01-85			
	Mixing duration of concrete mixture	60-70 s		Mixer	At all times, if necessary	CMU operator, lab	Time measurement, CNaR 3.09.01-85	Clock, stopwatch		

Table continuation

Quality of concrete mixture	Mobility of concrete mixture	ОК 4 – 6 cm	within	molding post	Once a shift	Lab technician	Measurement GOST 10181.0 GOST 10181.1	Standard cone GOST 10181.1 Ruler GOST 427 Stopwatch GOST 5072	0-300 mm 1 mm 0-60 s 1 s	Concrete production control log
	Paving uniformity			molding post	sampled three times per shift	Shop foreman	Visually			Concrete production control log
Quality of paving concrete in the mold	Vibration compaction duration	30 – 40 s	compliance with	molding post	continuous	Shop foreman Quality Assurance Master	time measurement	Clock, stopwatch	0 – 60 s	Concrete production control log

Table continuation

Heat Treatment Mode	TVO duration: pre-existing lift isothermal heating cooling	6 3 3 2		Pithole camera	sampled, once per hour	Lab technician	Watching the clock; CNaR 3.09.01-85	Clocks	0-24 h	TVO mode control log
	TVO Temperature	60°C		Pithole camera	every hour	Lab technician	Temperature measurement	thermometer GOST 2823	0…100°C error 1%	same
Finishing quality	debugging	Troweling quality		molding post	sampled	Shop foreman	Visually			
	Repair with a solution of small cracks, sinks of air pores, cleaning of all mortgaged parts			Finalisation post	All the time	Shop foreman	Visually			Operational Control Log

Table continuation

Storage of finished products	proper storage control			finished goods warehouse	continuous	workshop foreman	visually, GOST 13015.4-84, GOST 9818-85			
Acceptance inspection (periodic testing)									
Finished goods	Strength, rigidity, crack resistance			finished goods warehouse	sampled	Lab, accred center.	Test GOST 8829	Test bench		Conclusion from the tests

	Frost resistance of concrete	F300	not lower than	finished goods warehouse	Once a week	accred center.	Sample Series Testing GOST 10060-95	MS-500 GOST 8905 Freezer GOST 10060 Scales T-5000 GOST 24104 Sodium chloride (5%) GOST 4233 Water GOST 23732 Saturation bath (5% solution) Defrosting bath Frost Resistance Tank for Specimens	0-500 kN -18 ±2oC 50-5000 g 1 g 18 ±2oC 120 ×120 ×140 mm	Same

Table continuation

	Waterproofing	W12		finished goods warehouse	at least once a year	accred center.	Definition by the wet spot method GOST 12730.0, GOST 12730.5	Water proofing installation GOST 12730.5 Cylindrical forms Scales PH-10 GOST 24104 Water GOST 23732	Pmax=1,3 MPa $Ø_{inner}$=150 h=150mm 100-10000 g 5g 20±5oC	same

	Sterilability	0,5 g/cm^2	no more than	finished goods warehouse	at least once a year		Sample testing, abrasion mass loss measurement GOST 13087	Circles of abrasion type LKI-2, Scales Techn. GOST 24104. Trammel caliper GOST 166 - 89. Steel rulers according to GOST 427 - 75. sand according to GOST 6139 - 78.	0-250 mm 0,1 mm 0…50 cm ±1mm	same
	Determination of the specific effective activity of natural radionuclides.	370 Bk/kg	no more than	finished goods warehouse	When delivered to production or when the supplier changes.	SES	Concrete Mixture Sample Testing GOST 30108-94	radiometer GOST30108	100…1000 Bk/kg error <30% 10…50% Cs-137,K-40, Ra-226,Th-232	Protokol

Table continuation

Acceptance inspection (acceptance test)										
Concrete quality control, products	Class of concrete for compressive strength,	C30/37	at least	molding post	every batch	lab	Testing of GOST 10180, GOST18105 cube samples	Forms 2FK,3FK Press PSU-125	15x15x15 cm 0…1250 kN, error 1%	Test Log of Concrete and Concrete Mixtures
	Concrete's compressive strength	70%	at least	same	selectively, once every five months	lab technician	GOST10180, GOST18150 cube testing GOST13015-86	Forms 2FK, 3FK Press PSU-125	15x15x15 cm 0…1250 kN, error 1%	Test Log of Concrete and Concrete Mixtures

Table continuation

Precision manufacturing	Deviation of sizes from design	length:±5 mm width: ±5mm thickness: ±3 mm	no more than	Finishing post	Each batch (5 pcs. for a batch size up to 25 pcs., if more, 8 pcs.)	master	Measurement GOST 26433.0, GOST 26433.1	roulette GOST 7502	0…10 m ±1 mm	acceptance log
	Deviation from the straightness of the front surface profile	2mm	no more than	Finishing post	Each batch (5 pcs. for a batch size up to 25 pcs., if more, 8 pcs.)	master	Measurement GOST 26433.0, GOST26433.1	Ruler SHD GOST 8026 Metal ruler GOST 427	0-1000 mm 1cl 0-300mm, 1mm	acceptance log
	welded joint strength			Armature Shop	Each batch	Controller	Testing of Welded Joints GOST 10922	Breaking machine UMM-100	0…100 kN	same

	Deviation of the thickness of the protective layer of concrete to thereinforcement	Thickness of protective layer 25mm	+10mm -3mm	Forming post	Each batch	master	GOST 17625 GOST 22904	IZS-10N TU-25-06.1885-79	5-30 mm 10-60 mm ±10%	same
	Deviation of position of steel mortgages from the designed one, not more.		±5	same	same	same	GOST 13015.0 measurement	Measuring with roulette 3PK2-20BNT/1 GOST17502	Measurement limit 20 m 2cl	same
Surface quality and product appearance	Compliance with the requirements for the specified categories of surfaces	A6, A7	not more than the values specified in Table 3 GOST 13015.0	Finishing post	same	master	Sink, tie rod and influx measurement GOST 9818, GOST 13015.0, 26433.0, 26433.1	Range metal GOST 427-75, depth gauge GOST 166-90	0-1000mm ±1mm 0-150mm ±0,1mm	same

Table continuation

	Cracks in the concrete	are not allowed	except for shrinkage and other technological widths not exceeding 0.1mm	Finishing post	same	same	Determination of the presence, width and length of cracks GOST 26433.0, GOST 26433.1	Probe set no. 2, GOST166-90	0,02-0,5mm 2cl. exact	same
	Stains on the surface	grease and rust spots are not allowed		same	every item	same	visual evaluation			
	Labeling quality	Consistency of the brand to the working drawings, correct application		Finished product warehouse	continuous	test master, lab technician	visually GOST 28042, GOST 13015.2			

Table C.2 - Name of measuring and testing instruments

Name of measuring and testing instruments	Type and brand designation	The name of the dock. On means	Measurement Limit	Accuracy class (division price)	Controlled parameters
Vibro platform laboratory	SMZH-539	TU22-5735-82			Moulding, stiffness
Compression Machine	MS-500	GOST 8905-82	500 kN	1%	Determination of the strength of crushed stone
Test Machine	MII-100	GOST 8905-82	1000 kg/cm^2		Bending strength
Breaking Machine	UMM-100	GOST7853-84	0…100 kN		Strength and mechanical characteristics of reinforcement
Concrete Protection Layer Meter	IZS-10N	TU-25-06.1885-79	5-30 mm 10-60 mm	±10%	Thickness of protective layer profile obliqueity, not flatness
Ruler	SHD	GOST 8026-75	0-2000	2 cl.	profile obliqueity, not flatness
Viscometer	VZ-246	GOST 1975-75	20-150 s		Lubricant viscosity
Thermometer	TT	GOST 2823-75	0-100°C	1%	Temperature Measurements
pH meter	LPK-01		0-14 pH	0,1 pH	Hydrogen water index
Table continuation					
Vessel for soaking	KP-306 KP-305		d=120±1 h=300±1		Content of clay and dust particles
Standard cone		GOST 10181.1-81			Determination of the mobility of beta mixtures
Trammel	ISH-1	GOST 166-90	0 – 125	0,1 mm	Fittings diameter, grain size of gravel
Table continuation					
Freezer		GOST 10060	-18 ±10C		Frost resistance
Cylinder with punch			d=75 h=75		Grade by crushed stone
Stopwatch		GOST 5072-79	0 – 60 s	1 s	Time meter
Laboratory scales		GOST 24104	50 – 1000 g	0,01 g	Mass of samples
Scales		GOST 13882-68	100 – 10000 g	1 g	Weight of materials

Table C.3 - Basic lab equipment list

Drying cabinet	SNOL-3,5	GOST 13447	0…105° C		Sample Drying
Vick's needle device	OGC-1	TU25-06-602-68	0-40 mm	0,5mm	Test setting time for the cement
Vick's Pestle Device	OGC-1	TU25-06-602-68	0-40 mm	0,5mm	Normal density of the cement
Standard funnel with measuring cylinder	LOV	TU25-06-70			Bulk density of raw materials mats
Molotok Kashkarova			0-60 MPa	0,01	Strength Determination
Radiometer	RKP-305 MS	GOST 30108	100-1000 Bk/kg	30%	Aeff
Le Chatelier appliance		GOST 310.2-76			True density of cement, sand
Roulette	ZPK2-20BNT/1	GOST 17502-89	0-20000 mm	2 cl	Length, width, height
Depth gauge		GOST 7661-67	before 100mm	0,01mm	Depth of air pore shells
Lupa	LI-4-10	GOST 25706-83	less than 15mm	0,1 mm	Sink depths, cracks
Corner	UP-2-250	GOST 3749-74	less than 250	1cl	rib cages
Stylus set		GOST 166-90	0,02…0,5mm	2cl	crack opening width

Water consumption rates for external firefighting

Calculation of water consumption for fire extinguishing [2].

Useful capacity for external fire extinguishing is determined by the formula for 3 hours of fire extinguishing.

$$Q = \frac{q \cdot T \cdot n \cdot 3600}{1000} = \frac{20 \cdot 3 \cdot 3600}{1000} = 216 \text{ , м}^3/\text{ч}$$

where Q - pond volume, m^3/h;

n - estimated number of fires (for the area up to 150 ha = 1, over 150 ha - 2 fires);

T - estimated fire extinguishing time, h; T = 3 hours

q - water flow, l/s; q = 20 l/s.

Cost of electricity

Calculation of selling price for precast concrete structures

Materials cost calculation

The selling price of 1 m^3 of a road plate made of steel-fiber concrete 1PP 50.18 - 100.AV is calculated with the following initial data:

- concrete volume in one product Vb= 1.58 m^3 ;
- material consumption per 1 m3 of the structure:

cement - 0,36 t;
sand - 0,576 m^3 ;
crushed stone - 0,705 m^3 ;

- valve consumption per one structure:

S400 ø6 - 52,8 kg;
S240 ø20 - 7,92 kg;
S240 ø16 - 4,04 kg;
S240 ø10 - 1,24 kg;
S500 ø5 - 0,28 kg;

- resource consumption per 1 m^3 of the structure:

water -0,14 m^3 ;
heat energy - 0.72 Gcal;
electricity - 3.12 kW/h;

-construction volume of buildings V_{heat}= 9 thous. m^3;

-shop floor volume V_{pr}= 21369,6 m^3; shop floor - single-storey production building with precast concrete frame;

- total heating capacity V_{heat}^{est} = 4,5 m^3;
- crane heights – 7,6 m;
- annual output – P_{year}= 17875 m^3;
- type of heat treatment chamber: produced in pitted chambers;

Determination of the cost of thermal energy

The cost of thermal energy per unit of production is determined by a formula:

$$C_{h.e.} = n_{h.e.} \cdot V_{h.e.} = 0{,}009 \cdot 2087{,}41 = 18{,}78\ tenge/m^3$$

where $n_{h.e.}$ – specific energy consumption for heat treatment Gcal/m^3;

$V_{h.e.}$ – heat cost, tg/Gcal.

Determination of the cost of power energy

The cost of power energy per unit of production is determined by a formula:

$$C_{e.e.} = n_{e.e} \cdot V_{e.e.} = 3{,}12 \cdot 16{,}53 = 51{,}57\ tenge/m^3$$

where $n_{e.e}$ – specific power consumption, kW/m^3;

$V_{e.e.}$ – electricity price equal 16,53 tenge/ kW·h.

The cost of thermal energy

The cost of thermal energy is determined by a formula:

$$C_{heat}^{prod} = n_{wat}^{prod} \cdot \frac{V_{heat}}{C_{year}} = 16{,}43 \cdot \frac{17{,}12}{17875} = 0{,}0157\ tenge/m^3$$

where n_{wat}^{prod} -energy consumption for hot water supply of industrial premises, Gcal;

V_{heat} - cost of energy for heating and hot water supply 17,12 tenge/Gcal, at supply from CHPs C_{heat}.

$$n_{wat}^{prod} = \psi \cdot N_m = 0{,}747 \cdot 22 = 16{,}43\ Gcal/year$$

where ψ- thermal energy rate per person per year, Gcal/(person per year);

N_m- number of production workers, shop equipment maintenance workers, as well as managers, specialists and employees of the shop, people.

ψ= 0,747 Gcal/(human-year);

$$N_m = N_{work} + N_{service} + N_m = 12 + 4 + 6 = 22\ people$$

Calculation of general operating expenses

Depreciation of workshop equipment costs

To determine the depreciation charge, the carrying value of the equipment is calculated in advance and represents the sum of the selling prices of the equipment and its delivery and installation costs. The cost of assembling the equipment is 8 percent and the cost of delivery is 6 percent of the selling prices.

Table E.1 - Depreciation charge

Equipment name	Cost, tenge		Quantity, units	Total weight, t	Total cost, tenge	Delivery costs, tenge	Cost of installation, tg	Carrying value, tg
	t	unit						
Concrete Screeder		200	1	-	3 200	1 92	25 6	3 648
Bridge crane		6700	1	-	1 6700	1 002	13 36	1 9038
Self-propelled trolley		345	2	-	6 690	4 01,4	53 5,2	7 626,6
Forms		300	1 0		1 3000	7 80	10 40	1 4820

The amount of depreciation charges for each item of equipment is determined by a formula:

$$A_{sumi} = N_{ai} \cdot \frac{C_{bi}}{100}, \tag{E.1}$$

where N_{ai}- depreciation rate on i-type equipment, percentage;
C_{bi}- book value of i-th equipment, tenge.

Table E.2 - Calculation of depreciation charges for equipment

Concrete Screeder	3648	13,9	507,07
Bridge crane	19038	5,5	1047,09
Self-propelled trolley	7626,6	12,5	953,3
Forms	14820	24,5	3630,9

Total A_{obi}: 6138,36.

$$C_{ob} = \frac{A_{ob}}{P_{year}} = \frac{6138,36}{17875} = 0,34 \text{ tenge/m}^3$$

Depreciation charge on the value of buildings and structures

Depreciation charge on the cost of buildings and constructions within general production expenses includes depreciation charge on the shop floor:

$$S_m = \frac{A_b}{P_{year}}, \quad (E.2)$$

where A_b - amount of depreciation deductions for the workshop building, tg/yr;

$$A_b = C_{vm} \cdot V_{vm} \cdot \frac{N_a}{100} = 4760 \cdot 21369{,}6 \cdot \frac{2{,}5}{100} = 2542982{,}4$$

where C_{vm}- cost of 1 m^3 of workshop construction volume (4760 tg/m^3);

V_{vm}- construction volume (21369,6 m^3);

N_a- depreciation rate for the workshop building is 2.5 percent.

A_b= 28·21369,6·2,5/100= 2542982,4 tenge/year;

The amount of depreciation charges for special constructions A_{ss} for pit, crevice and trapezoidal underground chambers is determined by a formula:

$$A_{ss} = \frac{(C_{cham} \cdot V_к \cdot H_{cons} + C_{steeam\ s.} \cdot V_k \cdot 0{,}85 \cdot H_{chamber} + C_{instr} \cdot K_k \cdot H_{chamber} + C_{steam} \cdot V_k \cdot H_{steam} + C_{cham} \cdot H_{chamber})}{100}, \quad (E.3)$$

where: $C_{cham} \cdot V_k$– cost of building part of heat treatment chambers, tg;

$C_{steam\ s.} \cdot V_k$ – cost of the steam supply system, tg;

$C_{vent} \cdot V_k$ – ventilation system cost, tg;

C_{transm}– cost of the pits for transmitting devices, tg;

$C_{instr} \cdot K_k$– cost of instrumentation and automation system device, tg. All data are taken from the calculations by the formula;

H_{cons}, $H_{steam.s}$, $H_{chamber}$– depreciation rate of 8.4 percent for the construction part, steam supply system and chamber pits, respectively;

H_{aut} – the same for KIP and automation systems, equal to 20 percent;

H_{vent} – the same for the ventilation system, equal to 12.1 percent..

Chamber volume:

$$V_k = l_k \cdot b_k \cdot h_k \cdot k_k = 2{,}51 \cdot 5{,}35 \cdot 6{,}1 \cdot 6 = 491{,}48\ m^3$$

$$C_{cham} \cdot V_к = 130 \cdot 491{,}48 = 63892{,}8 \text{ tenge}$$

$$C_{transm} \cdot V_к = 8{,}4 \cdot 491{,}48 = 4128{,}43 \text{ tenge}$$

$$C_{steam} = 1900$$

$$C_{vent} \cdot V_к = 0$$

$$C_{steam} \cdot k_к = 1900 \cdot 6 = 11400 \text{ tenge}$$

$$A_{ss} = \frac{(63892{,}8 \cdot 8{,}4 + 4128{,}43 \cdot 0{,}85 \cdot 8{,}4 + 11400 \cdot 20)}{100} = 7941{,}76 \text{ tenge/year}$$

$$S_m = \frac{(14958{,}72 + 7941{,}76)}{17875} = 1{,}28 \text{ tenge/m}^3$$

Calculation of general economic expenses

The cost of thermal energy

The cost of thermal energy is determined by a formula:

$$S_{heat}^{est} = (n_{heat}^{est} + n_{wat}^{est}\ ) \cdot \frac{C_{heat}}{P_{year}} = (161{,}42 + 13{,}45 \cdot \frac{10}{17875} = \ 0{,}098\ tenge/m^3$$

where n_{heat}^{est}- energy consumption for heating general factory premises, Gcal;

n_{wat}^{est}- energy consumption for hot water supply of general plant premises, Gcal;

C_{heat}- cost of energy for heating and hot water supply, with the supply from CHPs C_{heat} =10 tg/Gcal.

$$n_{heat}^{est} = \eta \cdot V_{heat}^{est} \cdot t \cdot T = \ 0{,}0106 \cdot \ 4{,}5 \cdot 18 \cdot 188 = 161{,}42\ Gcal/year$$

where η- thermal energy rate for heating 1000 m^3 of heated volume of the building on 1^{0}C in a day, 0,0106 Gcal/ (1000 m^3·^{0}C·day);

V_{heat}^{est}- heated volume of factory premises (factory management buildings, warehouses), thous.m^3;

t – indoor air temperature, ^{0}C;

T – heating season, day/year;

$$n_{heat}^{est} = \psi \cdot N_{est} = 0{,}74 \cdot 18 = 13{,}45\ Gcal/year$$

where ψ - thermal energy rate per person per year, Gcal/(person);

ψ=0,747 Gcal/(man-Year) ;

N_{est}- number of general household staff, people;

N_{est}=18 people.

Depreciation charges for general plant buildings and structures

Depreciation charges in general business expenses are determined by a formula:

$$C_{est} = \frac{A_{est}}{P_{year}} = \frac{10395}{17875} = 0{,}58\ tg/m^3$$

where A_{est}- amount of depreciation charges for general purpose buildings, tg/year.

The amount of depreciation charge for Aest general plant buildings is determined by a formula:

$$A_{est} = S_{est} \cdot V_{est} \cdot N_{am} \div 100 = 46{,}2 \cdot 9 \cdot 2{,}5/100 = \ 10395\ tg/year$$

where S_{est}- cost of 1 m^3 of construction volume of administrative and utility buildings tg/m^3, S_{est}=46,2 tg/m^3;

V_{est}- construction volume of administrative and household buildings, m^3;

N_{am}- depreciation rate for general factory buildings equal to 2.5 percent.

Determination of technical and economic indicators of production

The definition of technical and economic indicators is based on the previous sections.

Table E.3 - Technical and economic indicators of production

Name of indicators	Units of measure	Indicator value
The annual program of the workshop: (a) In natural units b) measurement values	m^3 mill.tenge	17875 305,2894
Volume of production site	m^3/m^2	8,86
Cost of production	tenge/m^3	14953,2
Profit from product sales	mill.tenge	26,713
Moulding capacity	human·h/m^3	226,1
Shop construction capital investments	mill.tenge	101,66
Profitability of production	percent	10
Endowment	tenge/1 tenge	465,8
One year's output per worker: a) In kind b) by value	m^3/human tenge/human	446,875 7617385,5
Consumption of material resources per unit of production:		
(a) Electricity	kW·h/m^3	3,12
b) thermal energy	Gcal/ m^3	0,009
c) cement	kg/m^3	0,360
d) sand	kg/m^3	0,750
e) crushed stone	kg/m^3	1,164
f) water	kg/m^3	0,140
g) steel fibre	kg/m^3	0,067

Протокол анализа Отчета подобия Научным руководителем

Заявляю, что я ознакомился(-ась) с Полным отчетом подобия, который был сгенерирован Системой выявления и предотвращения плагиата в отношении работы:

Автор: Жанайдарова Майя Мұратқызы

Название: Plant for the production of large-sized reinforced concrete products for bridge structures with a capacity of 70000 m3 per year

Координатор:Тогжан Куатбаева

Коэффициент подобия 1:2,3

Коэффициент подобия 2:0

Замена букв:0

Интервалы:0

Микропробелы:0

Белые знаки: 0

После анализа Отчета подобия констатирую следующее:

☑ обнаруженные в работе заимствования являются добросовестными и не обладают признаками плагиата. В связи с чем, признаю работу самостоятельной и допускаю ее к защите;

☐ обнаруженные в работе заимствования не обладают признаками плагиата, но их чрезмерное количество вызывает сомнения в отношении ценности работы по существу и отсутствием самостоятельности ее автора. В связи с чем, работа должна быть вновь отредактирована с целью ограничения заимствований;

☐ обнаруженные в работе заимствования являются недобросовестными и обладают признаками плагиата, или в ней содержатся преднамеренные искажения текста, указывающие на попытки сокрытия недобросовестных заимствований. В связи с чем, не допускаю работу к защите.

Обоснование:

Работа признается самостоятельной, и студент допускается к защите.
………………………………………………………………………………………………………

29.05.2020
………………………… ………………………………………

Дата *Подпись Научного руководителя*

Протокол анализа Отчета подобия

заведующего кафедрой / начальника структурного подразделения

Заведующий кафедрой / начальник структурного подразделения заявляет, что ознакомился(-ась) с Полным отчетом подобия, который был сгенерирован Системой выявления и предотвращения плагиата в отношении работы:

Автор: Жанайдарова Майя Мұратқызы

Название: Plant for the production of large-sized reinforced concrete products for bridge structures with a capacity of 70000 m3 per year

Координатор: Тогжан Куатбаева

Коэффициент подобия 1:2,3

Коэффициент подобия 2:0

Замена букв:0

Интервалы:0

Микропробелы:0

Белые знаки:0

После анализа отчета подобия заведующий кафедрой / начальник структурного подразделения констатирует следующее:

☑ обнаруженные в работе заимствования являются добросовестными и не обладают признаками плагиата. В связи с чем, работа признается самостоятельной и допускается к защите;
☐ обнаруженные в работе заимствования не обладают признаками плагиата, но их чрезмерное количество вызывает сомнения в отношении ценности работы по существу и отсутствием самостоятельности ее автора. В связи с чем, работа должна быть вновь отредактирована с целью ограничения заимствований;
☐ обнаруженные в работе заимствования являются недобросовестными и обладают признаками плагиата, или в ней содержатся преднамеренные искажения текста, указывающие на попытки сокрытия недобросовестных заимствований. В связи с чем, работа не допускается к защите.

Окончательное решение в отношении допуска к защите, включая обоснование:

……Обнаруженные в работе заимствования не обладают признаками плагиата.……………
……………………………………………………………………………………………
……Работа признается самостоятельной, и студент допускается к защите.……………………
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……………………………………………………………………………………………

…29.05.2020……… ……………………………………………

Дата *Подпись заведующего кафедрой / начальника структурного подразделения*

МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ РЕСПУБЛИКИ КАЗАХСТАН
СӘТБАЕВ УНИВЕРСИТЕТІ

ОТЗЫВ

НАУЧНОГО РУКОВОДИТЕЛЯ

на дипломную работу
(наименование вида работы)

Жанайдаровой М.
(Ф.И.О. обучающегося)

5В073000 – Производство строительных материалов, изделий и конструкций
(шифр и наименование специальности)

Тема: «Plant for the production of large-sized reinforced concrete products for bridge structures with a capacity of 70000 m^3 per year»

Строительство мостовых сооружений предполагает применение новых конструктивных решений, технологий, материалов. Оптимизировать экономические затраты хорошо помогают эффективные строительные материалы, такие как железобетон.

В работе Жанайдарова М. указала физические, технические и экономические преимущества применения железобетона и большепролетных изделий на его основе для мостовых сооружений.

Были приведены оптимальные составы железобетона; проанализированы физико-механические свойства строительных материалов, в зависимости от технологических факторов.

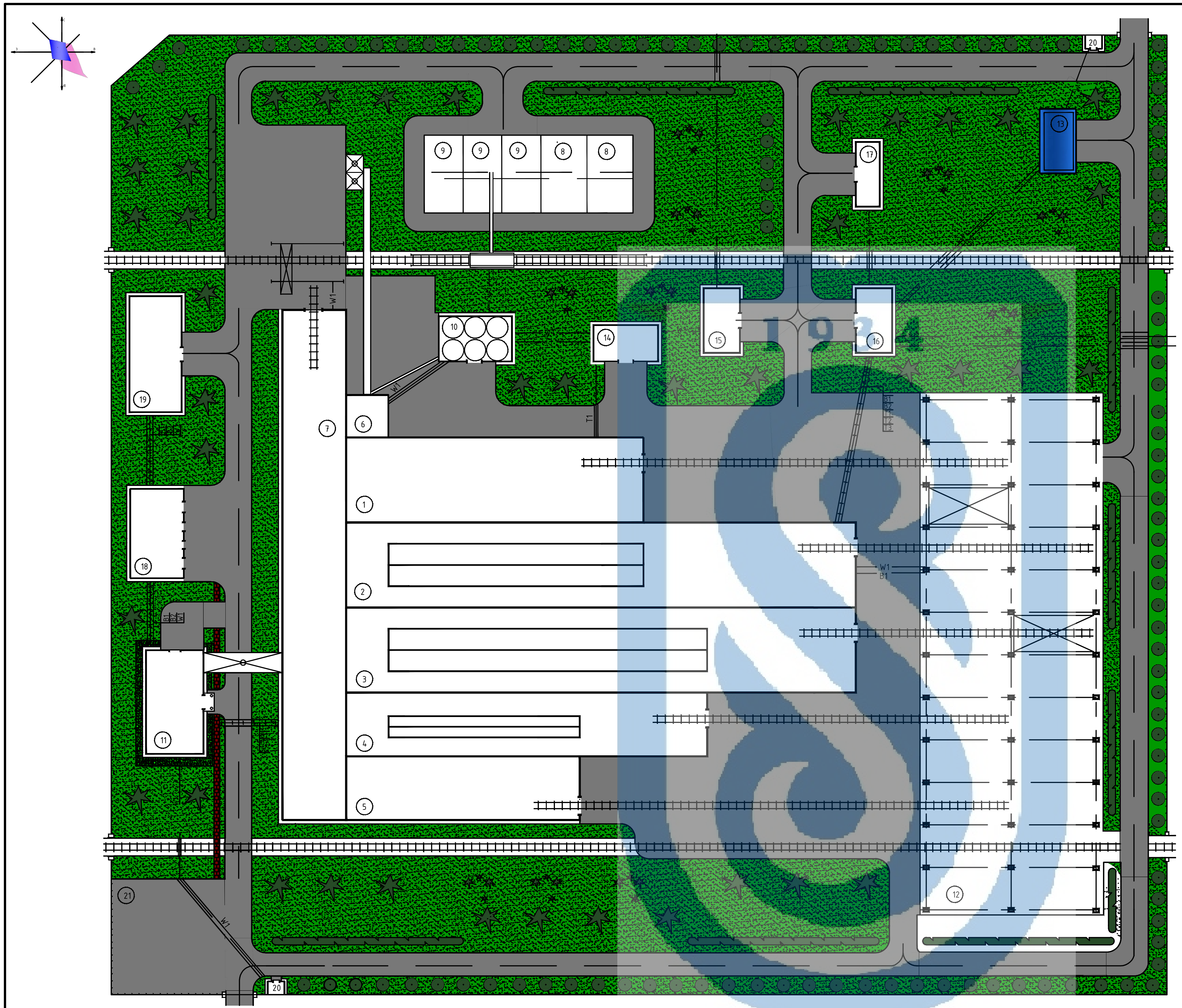
Вышеуказанные сведения свидетельствуют о соответствии выполненной работы современному уровню.

Производство железобетона и большепролетных изделий из него, определяет экономическую эффективность производства.

Результаты работы могут быть использованы для получения железобетонных большепролетных изделий, в строительстве мостов и мостовых сооружений. Дипломная работа представлена на английском языке.

В целом, представленная работа заслуживает положительной оценки – 95 баллов.

Научный руководитель
Доктор технических наук, профессор
(должность, уч. степень, звание)
_______________ Куатбаева Т.К.
(подпись)
«_24_» ____05_____ 2020 г.



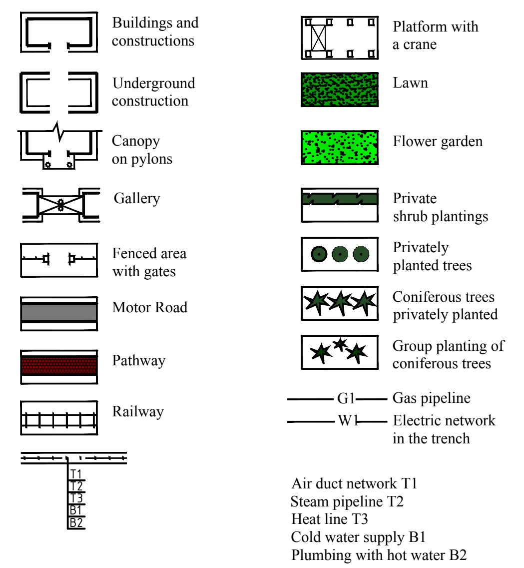
Exploitation of buildings and structures

Pos.	Name	Notes
1	Forming shop	
2	Forming shop	
3	Forming shop	
4	Forming shop	
5	Forming shop	
6	Concrete-mixing unit	
7	Reinforcement shop	
8	Crushed stone warehouse	
9	Sand storage	
10	Cement storage	
11	Administrative and domestic complex	
12	Finished product warehouse	
13	Fire reservoir	
14	Compressor room	
15	Transformer	
16	Boiler house	
17	Fuel and lubricants warehouse	
18	Garages	
19	Repair and mechanical workshop	
20	Checkpoint	
21	Parking	

Technical and economic indicators of the general plan

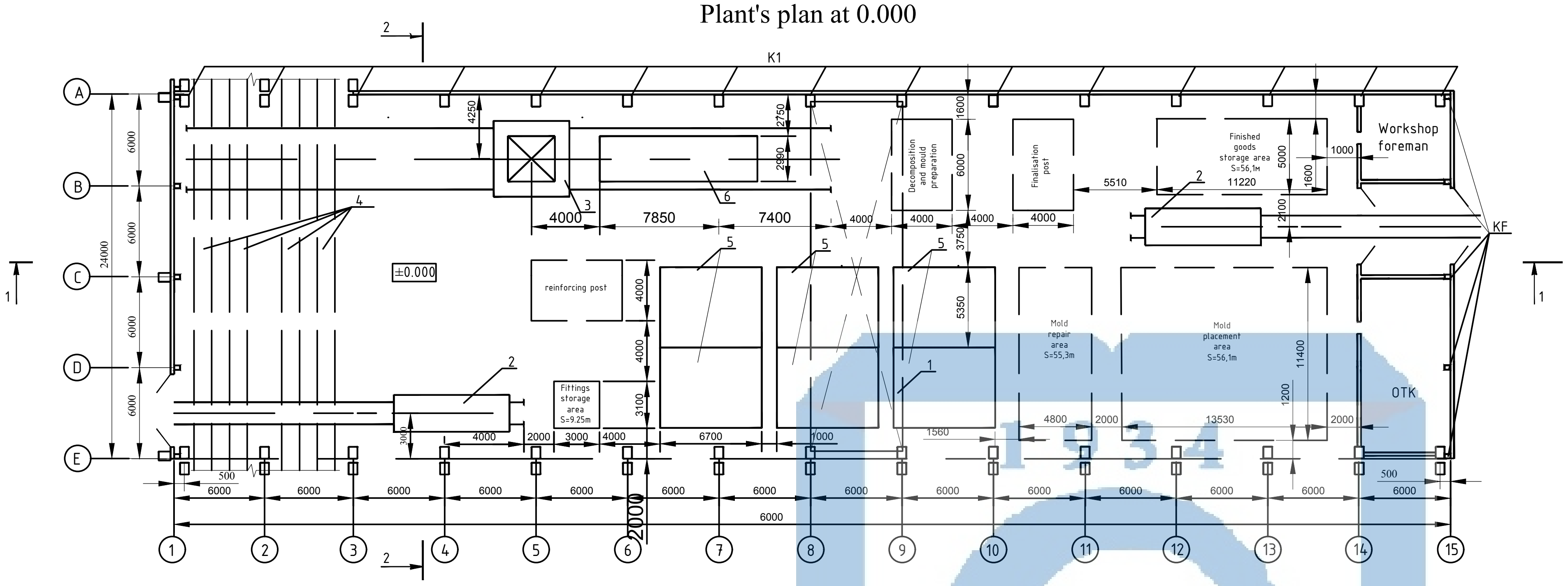
Pos.	Name	Unit	Meaning
1	Area of territory	M^2	52503,4
2	Buildings area	M^2	11620
3	Territory development coefficient	%	78,3
4	Used area	M^2	24210,3
5	Length of railroad tracks	M	195
6	Area under the railroad track	M^2	1310
7	Length of roads	M	1320
8	Area of roads and sites	M^2	9560,4
9	Territory Usage Coefficient	%	51,8
10	Warehouse area	M^2	1628
11	Fence length	M	890
12	Greening area	M^2	5303,4

Connotations

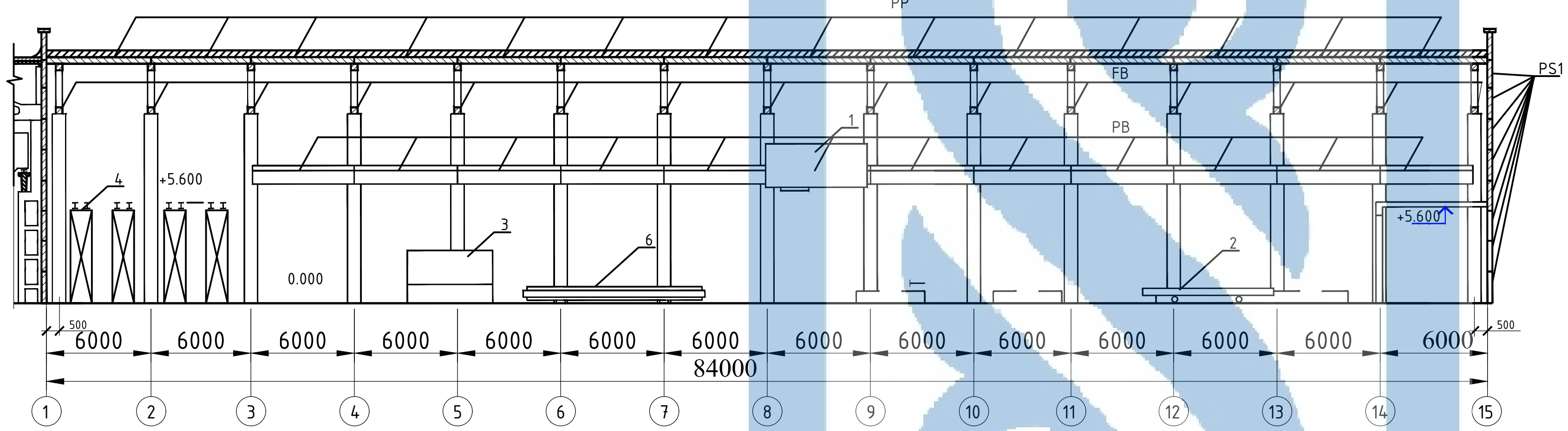


Size Sheet	Document №	Signature	Data	KazNRTU - 5B073000.29-03.2020 DP		
				Plant for the production of large-size reinforced concrete products for bridge constructions with the capacity of 70000 m3 per year		
Dev.by	Zhanaidarova M.M.			Architectural and construction part	Stage: S	Sheet: / Sheets: 6
S.supervisor	Kuatbayeva T.K.					
N. Contr.	Bek A.A.			General plan	Department of Construction and Building Materials	
Head of Dept.	Akmalaiuly K.					

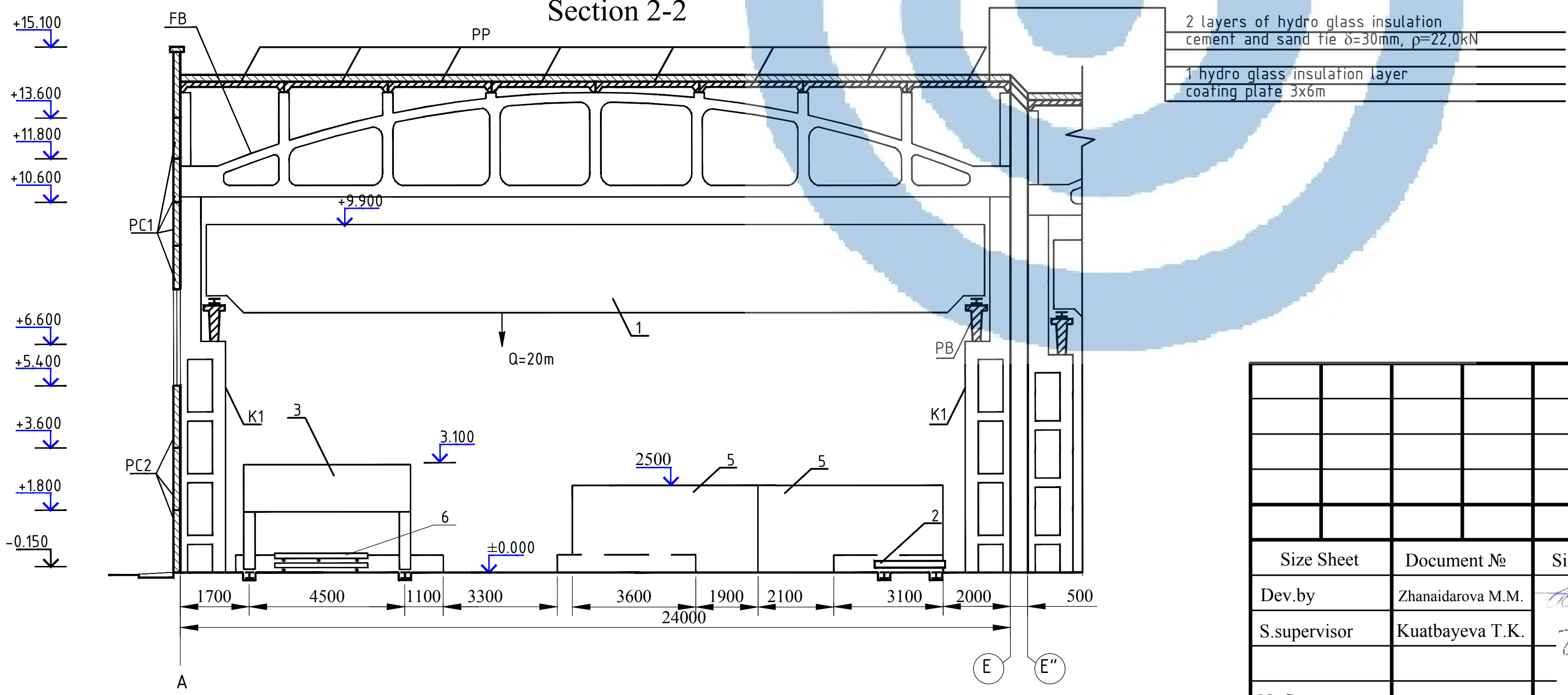
Plant's plan at 0.000



Section 1-1



Section 2-2



Specification of technological equipment

Pos.	Connotation	Name	Qua	Mass, kg	Notes
1	GOST 3332-54	Bridge Crane	1	28500	Q=20m
2	TU 22-5953-85	Self-propelled trolley SMZH-151	2	3000	
3	TU 22-6004-85	Concrete Screeder SMZH-166	1	9500	
4	TU 22-161-85	Concrete trestle	4		
5		Pithole camera	6		
6	TU 22-5953-85	Vibroplatform SMZH-200	1	6600	

Specification of reinforced concrete structures

Pos.	Connotation	Name	Qua	Mass, kg	Notes
FB	Batch 1.463-3	Rowderless Farm 4FB-243A-IIIv	15	6500	
K1	Batch K3 01-52	Column KD III-36	30	10000	
PB	Batch K3-01-50		24	4100	
KF	Batch K3-01-55	Column half-timbered KF	8	5700	
PP	Batch 13-93-III	Coating plate PG4AIIIvt	112	2650	
PS1	Batch 1.432-5	Wall Panel PSZH-2a / 1,2x6	48	2100	
PS2	Batch 1.432-5	Wall Panel PSZH-2 / 1,8x6	48	1400	

Size Sheet	Document №	Signature	Data	
Dev.by	Zhanaidarova M.M.			
S.supervisor	Kuatbayeva T.K.			
N. Contr.	Bek A.A.			
Head of Dept.	Akmalaiuly K.			

KazNRTU - 5B073000.29-03.2020 DP

Plant for the production of large-size reinforced concrete products for bridge constructions with the capacity of 70000 m3 per year

Architectural and construction part	Stage	Sheet	Sheets
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Plant's plan at 0.000. Sectional drawings 1-1, 2-2

Department of Construction and Building Materials

Products

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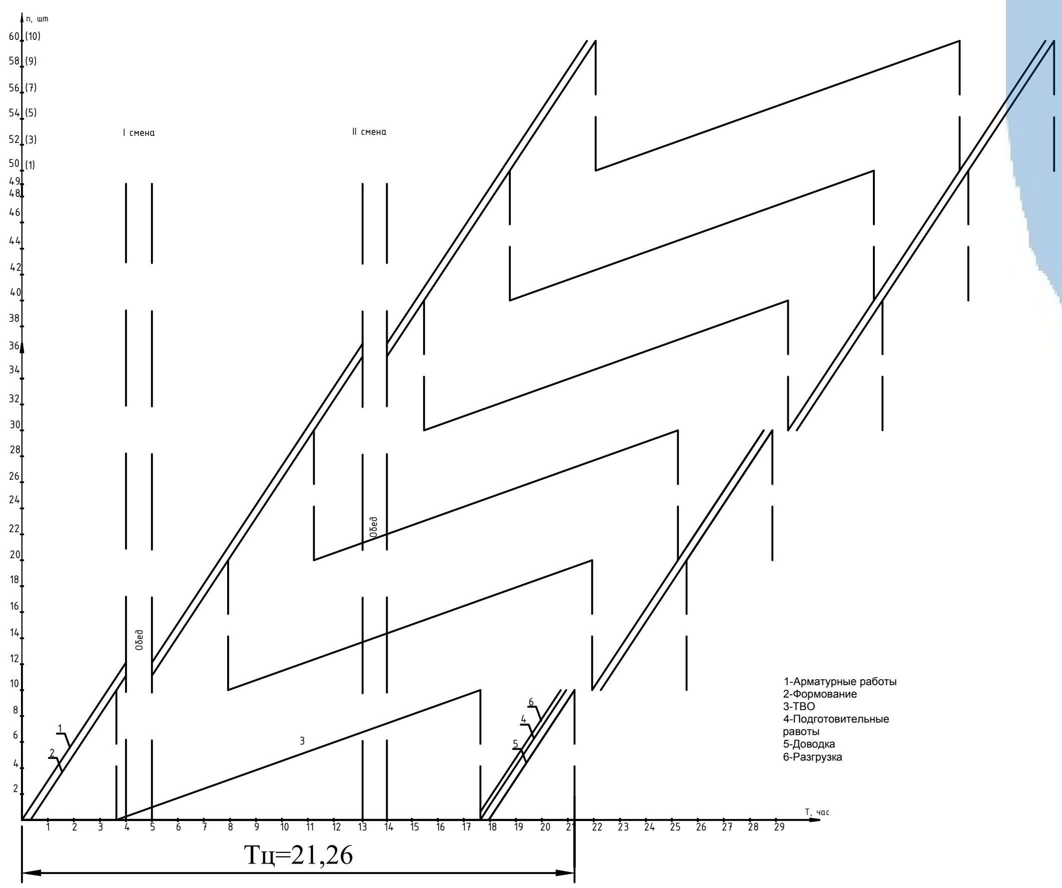
Beam bridge
BK 12.02-A11
11360 x 1400 x 800
Heavy, C20/25

Paving slab
1PP 50.18 - 100.AV
5000 x 1750 x 180
Heavy, C30/35

Employment cycle of workers

Profession, category	Markings	cont.	Time, min (1–20)	Coef. of empl.
Shape-shifter III	P1	18,05		0,9
Shape-shifter III	P2	16,64		0,83
Armature dealer IV	A1	19,9		0,99
Armature dealer III	A2	16,91		0,84
Former III	Ф	17,94		0,9

Process cyclogram



Operation schedule

№post	Name post	Name of an operation	Labor intensity	Work. num.	Duration	1–20
1	PREPARATORY	1.Opening the pit cells.	0,2	1	0,2	P1
		2.Unloading of moulds.	1,7	1	1,7	P1
		3.Installation of forms on the post decouples	1,45	1	1,45	P1
		4.Decomposition of products after steaming.	4,8	2	2,4	P1, P2
		5.Cleaning the mold of concrete.	7,0	1	7,0	P1
		6.Lubricating the mold.	2,8	1	2,8	P1
		7.Form assembly.	5,0	2	2,5	P1, P2
2	ARMATURE	1.Installing the form to the post armature stacking	1,2	1	1,2	A1
		2.Installation of fittings in the mould.	9,2	2	4,6	A1,A2
		3.Installation of mounting loops.	4,3	1	4,3	A1
		4.Installation of mortgage parts.	5,2	1	5,2	A1
		5.Installation of gaskets for to form a protective layer.	4,6	1	4,6	A1
3	FORMONE	1.Установка формы на вибростол	1,03	1	1,03	F
		2.Заполнение бетоноукладчика и подача бетонной смеси к виброплощадке.	3,4	1	3,4	F
		3.Укладка бетонной смеси в форму.	3,7	1	3,7	F
		4.Sealing the concrete mixture and levelling.	8,4	1	8,4	F
		5.Removing the mold from the vibrating table	1,03	1	1,03	F
		6.Loading of moulds with the products in pitted cell	0,2	1	0,2	F
		7.Closing the pit cells.	0,18	1	0,18	F
4	POST OF CONTRACTION	1 Product surface grout after steaming	22,1	2 1	9,8 2,51	A2 P2
		2.Labelling	1,95	1	1,95	P2

Specification of technological equipment

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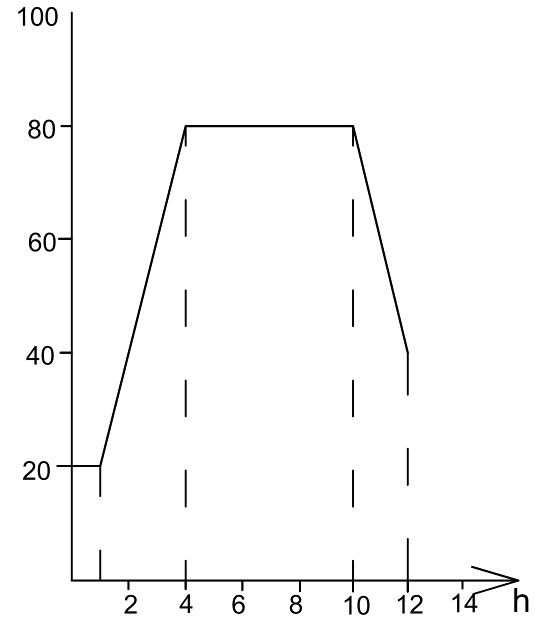
6	TU 22-5953-85	Vibroplatform SMZH-200	1	6600	

Heat Treatment Mode Schedule



Safety Technology

Concrete works may be performed by persons at least 18 years of age, who have been trained in their profession and have been medically certified, after receiving an introductory briefing, workplace safety instruction, and an 8-hour program of training in safe working methods.

When concrete mixes are fed, poured, compacted and heat-treated, vibration, noise, high ambient humidity and other factors have a harmful effect on the body.

Steam dispensers of cassette plants should be fenced off or installed in places that prevent the operator from getting burnt. Steam pipes should be covered with thermal insulation, before starting steam into compartments, check the condition of steam pipes, regulating devices.

A considerable amount of moisture is released during heat treatment. In order to remove this moisture and maintain the air exchange, the moulding shop should have a supply and exhaust ventilation.

Moving mechanisms (slipform paver, bridge crane, etc.) must have a correct acoustic alarm. All electric actuators must have a reliable grounding.

When compacting the concrete mixture, the worker must not come into direct contact with oscillating elements and vibrators.

Size Sheet	Document №	Signature	Data
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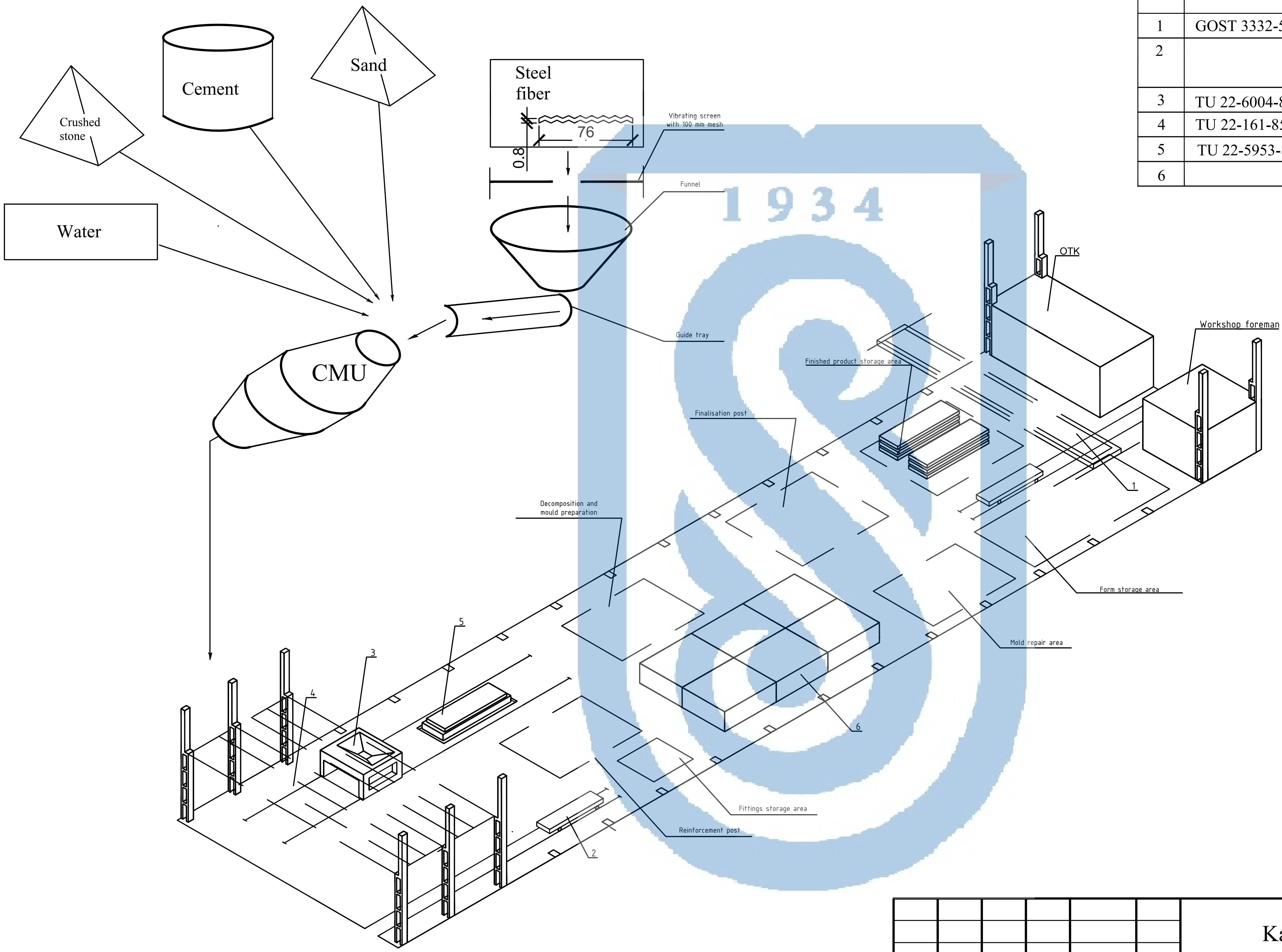
Plant for the production of large-size reinforced concrete products for bridge constructions with the capacity of 70000 m3 per year

Technological part	Stage	Sheet	Sheets
	S		6

Technical map

Department of Construction and Building Materials

Technological scheme



Specification of technological equipment

Pos.	Connotation	Name	Qua.	Mass, kg	Notes
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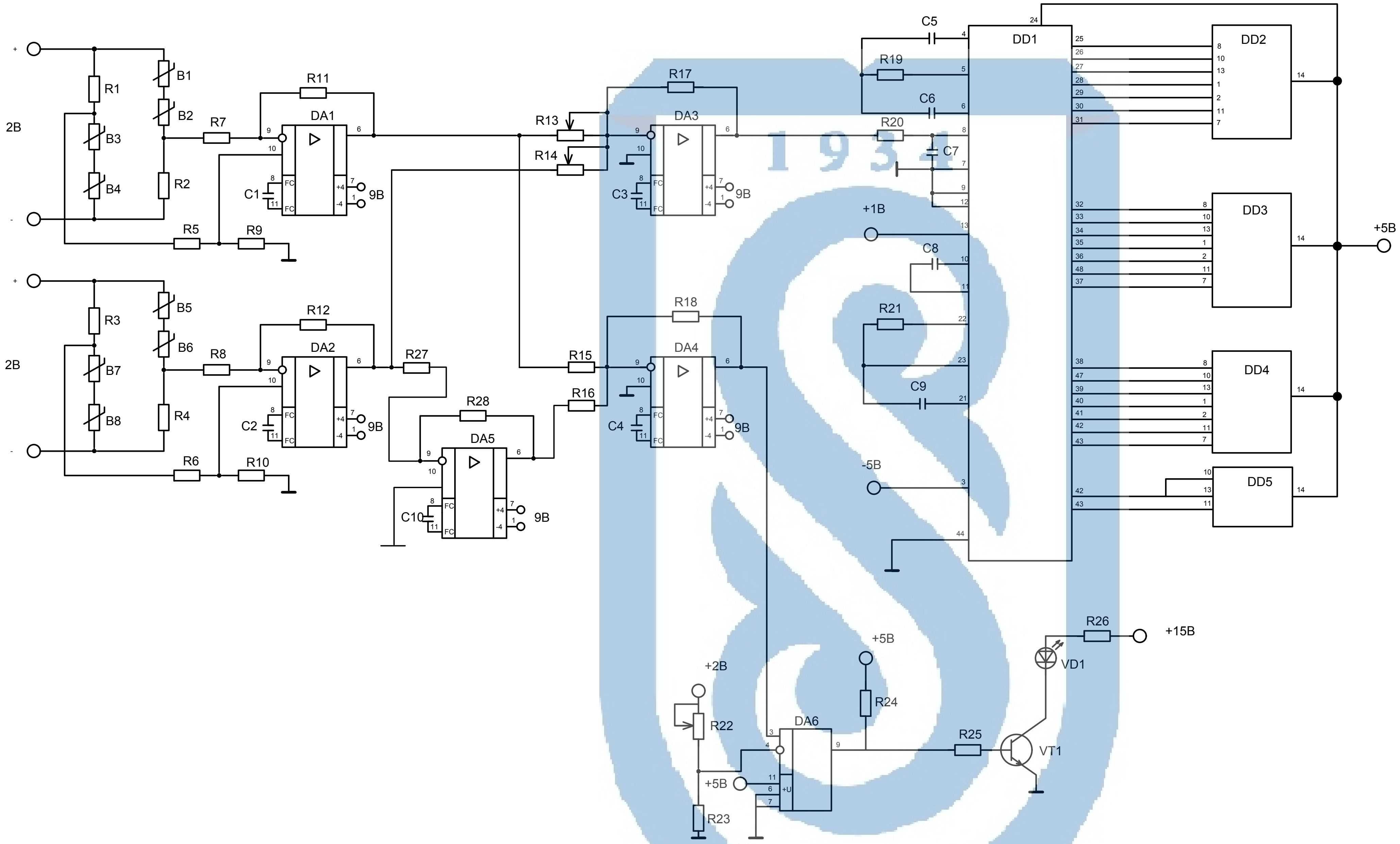
Technological part

Stage	Sheet	Sheets
S		6

Technical scheme

Department of Construction and Building Materials

Circuit diagram



Marking	Name	Qua.	Notes
B1...B8	Copper resistance thermometer	8	
VT1	Transistor KT 503A	1	
Vd1	LED AL 304B	1	
	Resistors		
R1...R4	MLT 0.25 100 (кОм) +10%	4	
R5...R12	MLT 0.25 3 (кОм) +10%	8	
R13,R14	MLT 0.25 20 (кОм) +10%	2	
R15,R16	MLT 0.25 300 (кОм) +10%	2	
R17,R18	MLT 0.25 3 (кОм) +10%	2	
R19	MLT 0.5 100 (кОм) +10%	1	
R20	MLT 0.5 1 (кОм) +10%	1	
R21	MLT 0.5 100 (кОм) +10%	1	
R22	MLT 0.25 5.6 (кОм) +10%	1	
R23	MLT 0.25 1 (кОм) +10%	1	
R24	MLT 0.25 1 (кОм) +10%	1	
R25,R26	MLT 0.25 2 (кОм) +10%	2	
R27,R28	MLT 0.25 3 (кОм) +10%	2	
	Capacitors		
C1..C4,C10	KM 5 0,015 (nF) +10%	5	
C5	KM 5 0,1 (nF) +10%	1	
C6	KM 5 0,47 (nF) +10%	1	
C7	KM 5 0,01 (nF) +10%	1	
C8	KM 5 1 (nF) +10%	1	
C9	KM 5 100 (nF) +10%	1	
	Circuits		
DA1...DA5	K140УД9	5	
DA6	K554CA3	1	
DD1	K572PV2	1	
DD2...DD5	ALS324B	4	

Marking	Name	Qua.	Notes
TE	Platinum resistance thermometer	2	
xK	Amplifier	2	
·(-1)	Inverter	1	
S	Summator	2	
TA	Targeting device	1	
TI	Display Device	1	
x(1/2)	Amplifier	1	

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Automation

Stage	Sheet	Sheets
S		6

Circuit diagram

Department of Construction and Building Materials

Name of indicators	Units of measure	Indicator value
The annual program of the workshop: a) In natural units b) by value	 m^3 mill. tenge	 17875 305,2894
Removal of products from the production area	m^3/m^2	8,86
Cost of production	tenge/m^3	14953,2
Profit from product sales	mill. tenge	26,713
Moulding capacity	hum-hour/m^3	226,1
Shop construction capital investments Profitability of production	mill. tenge	101,66
Phono Report	percent	10
One year's output per worker:	tenge/1tenge	465,8
a) In kind b) by value Consumption of material resources per unit of production: a) electricity b) steam technology c) cement d) sand e) crushed stone f) water g) steel fibre	m^3/hum tenge/hum kW/h Gkal/m^3 t/m^3 t/m^3 t/m^3 t/m^3 t/m^3	446,875 7617385,5 3,12 0,009 0,360 0,750 1,164 0,140 0,067

Name of indicators	Units of measure	Indicator value
Main equipment utilization factor: -overhead travelling crane -concrete paver -self-propelled trolley -vibrating platform		 0,6 0,38 0,06 0,42
Employment rate of workers: Former F Shapemaker P1 Shapemaker P2 Reinformer A1 Armature fitter A2		 0,9 0,9 0,83 0,84 0,99
Labor intensity of product manufacturing	hum-hour/unit	1,58
Production output on 1st worker per shift	unit/hum-hour	3,07
Turbidity of the mold per day		1,09
Process Cycle Duration	hour	0,33
The level of mechanization of the production process: a) Level of mechanized labour coverage of workers b) degree of mechanization of labour	 percent percent	 28,5 25,7

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Plant for the production of large-size reinforced concrete products for bridge constructions with the capacity of 70000 m3 per year

Economic part	Stage	Sheet	Sheets
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Technical and economic indicator of production

Department of Construction and Building Materials