



ROOPPUR NPP POWER UNITS 1, 2

WORKING DOCUMENTATION

**Concrete and Reinforced Concrete Structures
Technical Requirements**

RPR.0120.0.0.AS.EC0001

Revision C02

STATE ATOMIC ENERGY CORPORATION "ROSATOM"
JOINT STOCK COMPANY "ATOMSTROYEXPORT"



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STATE ATOMIC ENERGY CORPORATION "ROSATOM"
JOINT STOCK COMPANY
NIZHNY NOVGOROD ENGINEERING COMPANY
"ATOMENERGOPROEKT"
(JSC NIAEP)



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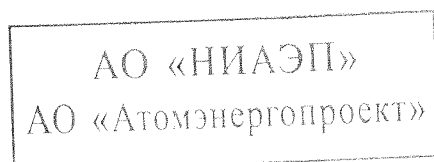
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Revision C02

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ANNOTATION

These technical requirements are developed as part of the General Contract No. 77-258/1414800.

The technical requirements cover heavy-weight, extra heavy, fine-grain, light-weight and self-compacting concrete used in NPP civil engineering structures.

The purpose of the document is to generate uniform technical requirements for reinforced concrete structures for development of detailed drawings, construction and installation process documentation, and for performance of bidding procedures for selection of Contractor for concrete mix production and execution of construction and installation work for Rooppur NPP Project.

Technical requirements for concrete and reinforced concrete structures of buildings and facilities can be updated during design process.

The present documentation covers Rooppur NPP Power Units 1, 2.

LIST OF DOCUMENTS OF THE SET

Designation	Name	Note
RPR.0120.0.0.AS.EC0001-CAA0001	Title block	C02/1.5
RPR.0120.0.0.AS.EC0001-CAB0001	List of documents of the set	C02/2.1
RPR.0120.0.0.AS.EC0001-CEC0001	Purpose and field of application	C02/3.3
RPR.0120.0.0.AS.EC0001-CEC0002	Reinforced concrete structure operating conditions	C02/4.1
RPR.0120.0.0.AS.EC0001-CEC0003	Technical requirements for concrete and concrete mixes	C02/5.3
RPR.0120.0.0.AS.EC0001-CEC0004	Requirements for heavy-weight concrete materials	C02/6.2
RPR.0120.0.0.AS.EC0001-CEC0005	Requirements for self-compacting concrete materials	C02/7.4
RPR.0120.0.0.AS.EC0001-CEC0006	Requirements for extra heavy concrete materials	C02/8.3
RPR.0120.0.0.AS.EC0001-CEC0007	Process requirements for construction and installation work for erection of reinforced concrete structures	C02/9.10
RPR.0120.0.0.AS.EC0001-CEC0008	Requirements for reinforcement and reinforcing structures	C02/10.3
RPR.0120.0.0.AS.EC0001-CEC0009	Requirements for embedded parts	C02/11.4
RPR.0120.0.0.AS.EC0001-CEC0010	Corrosion protection of civil engineering structures	C02/12.2
RPR.0120.0.0.AS.EC0001-CPC0001	List of standards and references	C02/13.5
RPR.0120.0.0.AS.EC0001-CAZ0001	Revision sheet	C02/14.1
	Total: Documents. Sheets	14.47
Note - Note structure: Revision/ Document No in the set. Number of sheets in the document		

PURPOSE AND FIELD OF APPLICATION

1.1 The technical requirements are an integral part of the working construction documentation for Rooppur NPP and cover all cast-in-situ concrete and reinforced concrete structures of buildings and facilities within the design area of JSC "Atomenergoproekt" at NPP Power Units No. 1 and 2 (Table 1.1), excluding the following structures: hydraulic engineering facilities and antivibration foundations for equipment.

1.2 This document defines the general technical requirements for:

- concrete for reinforced concrete structures;
- materials for making concrete mixes;
- concrete mix transportation;
- quality control and acceptance of reinforced concrete structures;
- concreting of structures and concrete curing;
- reinforcement and reinforcing structures;
- reinforcement joints;
- embedded part materials;
- production of embedded parts;
- quality control and acceptance of reinforcing structures and embedded parts during fabrication and installation;
- corrosion protection of reinforced concrete structure surfaces.

Table 1.1

Description	KKS code
Normal Operation Power Supply Building	10UBA, 20UBA
Building for standby emergency power supply diesel power station	11UBN, 12UBN 11UBN, 12UBN
Building for normal operation standby diesel power station	13UBN, 23UBN
Gallery of the common access area	01UBY, 02UBY
Cable trestle	01UBY, 02UBY
Cable tunnel of normal operation system	11UBZ, 21UBZ
Cable tunnel of normal operation system	12UBZ, 22UBZ
Cable tunnel of normal operation system	13UBZ, 23UBZ
Cable tunnel of normal operation system	14UBZ, 24UBZ
Intermediate diesel fuel storage	11UEJ, 12UEJ, 13UEJ, 21UEJ, 22UEJ, 23UEJ
New fuel storage facility	00UFC
Structure for demineralized water tanks and contaminated condensate tank	10UGB, 20UGB
Demineralizing plant building	00UGD
Fire-fighting water tank	01UGF, 02UGF

Table 1.1 (continued)

Description	KKS code
Fre-fighting water and service cooling water pump station	03UGF
Building for tank for collecting spent fire-fighting water from the building 10UJA	10UGF
Building for tank for collecting spent fire-fighting water from the building 20UJA	20UGF
Normal operation cable channel	02UGZ
Reactor building/Inner containment	10UJA, 20UJA
Transport portal of building 10UJA	10UJG
Transport portal of building 20UJA	20UJG
Gallery of the controlled access area	01UJY
Gallery of the controlled access area	02UJY
Gallery of the controlled access area	11UJY, 12UJY
Gallery of the controlled access area	21UJY, 22UJY
Ventilation gallery	13UJY, 23UJY
Process tunnel	11UJZ, 12UJZ, 13UJZ, 21UJZ, 22UJZ, 23UJZ
Reactor auxiliary building	10UKC, 20UKC
Ventilation stack	10UKC, 20UKC
Safety system cable tunnel	10UKH, 20UKH
Control tank facility	11UKZ, 12UKZ, 21UKZ, 22UKZ
Control tank facility	11ULC, 12ULC, 21ULC, 22ULC
Wash water collector tank facility	13ULC, 23ULC
Backwashing water collector tank facility	14ULC, 24ULC
Turbine building	10UMA, 20UMA
Emergency oil drain tank facility	11UMW, 12UMW, 21UMW, 22UMW
Unit water demineralization plant building	10UMX, 20UMX
Localization gate valve station	00UNA
Contaminated heating water drain tank facility	00UNJ
On-site heating systems	10UNZ, 20UNZ

Table 1.1 (continued)

Description	KKS code
Cable tunnel of normal operation system	11UPZ, 12UPZ, 21UPZ, 22UPZ
Cable tunnel of normal operation system	13UPZ, 23UPZ
Cable tunnel of normal operation system	14UPZ, 24UPZ
Cable tunnel of normal operation system	15UPZ, 25UPZ
Cable tunnel of normal operation system	16UPZ, 26UPZ
Chilling machine building	10UQR, 20UQR
Structure of compressed air receivers for cutoff valves	10USC, 20USC
Structure for nitrogen receivers	10USF, 20USF
Storage of highly inflammable liquids and gas fire-fighting cylinders	03USK
Training center	00UYH

This list of buildings and facilities is subject to updating and completion at design and construction phases.

REINFORCED CONCRETE STRUCTURE OPERATING CONDITIONS

1 Assigned service life

1.1 Civil engineering structures for category 1 radiation and nuclear safety critical buildings and facilities – 60 (+ 20) years.

Civil engineering structures for other buildings and facilities - 60 (+10) years.

Service lives of civil engineering structures were assigned taking into consideration the NPP construction period and NPP decommissioning activities specified in brackets.

2 Climatic conditions

2.1 Classification per GOST 15150-69:

- Climatic area of construction - tropical;
- Type of open-air atmosphere – IV, seacoast and industrial atmosphere.

3 Corrosive attack on reinforced concrete structures

3.1 Requirements for concrete in reinforced concrete structures were developed taking into account corrosive environmental attack on concrete and reinforcement in structures exposed to soil, groundwater and atmosphere.

For the development of the technical requirements for concrete, the following were considered:

- chemical analysis of groundwater;
- chemical analysis and corrosiveness of soil;
- corrosive aerosol content in atmosphere;
- concrete corrosion rate in the site atmosphere;
- building and facility specifications and operating conditions;
- radiation effects on reinforced concrete structures (absorbed dose rate up to 1.0 Gy/h – for normal operation and 103 Gy/h – for design-basis accident).

TECHNICAL REQUIREMENTS FOR CONCRETE AND CONCRETE MIXES

1 The following concrete types are used in the design for reinforced concrete structures:

- heavy-weight concrete of average density– from 2200 to 2500 kg/m³;
- fine-grain concrete of average density – from 1800 to 2200 kg/m³;
- extra heavy concrete of average density – 3350 kg/m³;
- self-compacting heavy-weight concrete of average density greater than 2350 kg/m³;
- self-compacting fine-grain concrete of average density – from 1800 to 2200 kg/m³.

According to the purpose of operating conditions, the following quality parameters are established per SP 52-101-2003:

- compression strength class B;
- waterproofness grade W.

Cold resistance type F is not specified for the climatic conditions at Rooppur NPP.

2 To reduce the NPP construction period, self-compacting concrete (SCC) shall be used for the reactor building structures.

Self-compacting concrete enables fast placement, reduces construction period and more easily spreads around densely spaced reinforcement. Flowability and segregation resistance of SCC mix ensure high degree of uniformity, minimum number of voids, constant concrete strength and make it possible to achieve high quality surfaces and durable structures. Generally, SCC has low water-to-cement ratio that facilitates early strength development, early stripping and prompt use of members and structures.

3 Concrete and reinforced concrete structure quality parameters for main buildings and facilities:

- B25 concrete, density min. 2200 kg/m³, W8;
- B60 concrete, density min. 2350 kg/m³, W6;
- B40 concrete, density min. 2350 kg/m³, W6;
- B30 concrete, density min. 2350 kg/m³, W6;
- B30 concrete, density min. 3350 kg/m³, W6;
- B20 concrete, density min. 2200 kg/m³, W6;
- B25 fine-grain concrete, density min. 1800 kg/m³, W6;
- B7.5 light-weight concrete; D1100 according to average specific gravity.

4 Additional physical and mechanical properties of heavy-weight concretes used in main buildings and facilities:

- a) ultimate shrinkage is 30×10^{-5} ;
- b) initial tangent modulus of elasticity of concrete shall be as specified in Table 6.11 SP 63.13330.2012;
- c) initial Poisson ratio is appr. 0.2;
- d) linear thermal elongation coefficient at temperature below 50°C is max. $1 \times 10^{-5} \text{ }^{\circ}\text{C}^{-1}$;
- e) ultimate creep coefficient is 2.0.

Parameters a) and b) shall be controlled for concretes in the prestressed inner containment (IC) of reactor building UJA and in the turbine unit foundation in building UMA, and for concrete in other structures, if these requirements are specified in the detailed drawings.

Parameters c), d) and e) shall be ensured and controlled for concrete in the prestressed inner containment.

5 Concrete mixes shall meet the requirements of GOST 7473-2010.

Rated and design concrete performance shall meet the requirements of SP 63.13330.2012.

6 Requirements for functional performance of heavy-weight fine-grain and extra heavy concrete mixes.

The concrete composition shall ensure:

- compression strength in accordance with SP 52-101-2003 at 28 days and +20 °C;
- minimum shrinkage strain of concrete in structures;
- consistency of concrete mix during placement within the specified limits;
- non-segregation of concrete mix during transportation and placement;
- achievement of the specified concrete and concrete mix performance with minimum cement content;
- minimum water-to-cement-ratio;
- the required type according to concrete waterproofness.

Concrete composition shall be selected in accordance with GOST 27006-86.

Consistency of concrete mix shall be assigned in accordance with concrete workability in a structure.

7 Requirements for functional performance of self-compacting concrete mixes (SCCM test methods).

Concrete mix shall meet the requirements specified in this document and the process documentation developed by a specialized organization for the given reinforced concrete structures.

Quality parameters of the self-compacting concrete mix used for erection of various structures shall be assigned depending on the degree of reinforcement, shape, geometry and other structural features.

SCCM concrete mixes are characterized by the following quality parameters as specified in Table 6.3.10.1 STO SRO-S 60542960 00050 - 2015:

- consistency (slump determining), SF2;
- Viscosity (determining of T_{500} or L-box test), VS1/VF1;
- passing ability (L-box test), PA 2;
- segregation resistance (segregation resistance test), SR2.

Property retention time shall be assigned in accordance with the concreting process and concrete mix transportation time to the concrete placement location.

Basic requirements for SCCM:

- concrete mixes shall have high density and low water-to-cement-ratio;
- concrete mix bleeding shall be max. 0.8 %;
- separation of grout in concrete mix shall be max. 4 %.

8 Preparation of concrete mix.

Concrete mix preparation process shall be clearly time-correlated with further concrete mix transportation, delivery and placement processes depending on the functional performance and setting time of the concrete mix.

Duration of mixing for concrete mix shall be defined in a construction technology laboratory.

9 Self-compacting concrete mixes for civil engineering structures at NPP shall be prepared in accordance with the design and process documentation for specific types of structures and facilities.

Self-compacting concrete mixes shall be produced at concrete plants provided with materials, operations and equipment quality management system in accordance with GOST 7473-2010, GOST 18105-2010, and GOST 26633-2012.

SCCM shall be prepared using fixed or mobile concrete-mixing plants with gravity or forced mixing in accordance with GOST 7473-2010. Concrete-mixing plants shall meet the requirements of GOST 27338-93. Mixer shall enable full uniform mixing of all components, including micro filler with sufficient shearing force for superplasticizer activation.

10 Concrete mix acceptance rules.

Concrete mixes shall be subjected to the manufacturer's technical inspection in accordance with the requirements of GOST 7473-2010 and STO SRO-S 60542960 00050-2015.

Quality control frequency for concrete and concrete mixes shall be defined in accordance with GOST 7473-2010.

Self-compacting concrete mix quality shall be assessed at the factory according to the following characteristics:

- flowability by slump test method;
- viscosity (V-funnel or T_{500});
- preservation ability (time-dependent stable consistency);
- average density;
- segregation resistance;
- entrained air volume;
- temperature.

Concrete quality shall be assessed by strength parameters at design age and other quality ratings specified herein.

REQUIREMENTS FOR HEAVY-WEIGHT CONCRETE MATERIALS

1 General

1.1 Concrete materials shall meet the requirements of GOST 26633-2012 and standards according to which they are produced.

All materials to be used shall have certificates or data sheets for compliance with the standards and regulations, according to which they are produced.

Materials used to make concrete shall be selected taking into account their radiation resistance.

2 Cement

2.1 Portland cement per GOST 10178-85 with clinker composed of C_3S max. 65 %, C_3A max. 7 % and C_3A+C_4AF max. 22 % shall be used. Amount of mineral admixtures shall not exceed 10%. K_2O and Na_2O alkali content in cement shall not exceed 0.6 %. And the mineralogical composition of cement shall be assessed in accordance with GOST 22266-2013.

Cement with low heat of hydration shall be used (cement type IV per ASTM C 150); heat of hydration of cement during 7 days shall not exceed 250 J/g. Heat generation test shall be carried out in accordance with GOST 310.5-88.

3 Coarse aggregate

3.1 High-density igneous crushed stone free of silica admixtures reactive with the cement alkali shall be used as coarse aggregate. Content of alkali soluble silica in the aggregate shall not exceed 50 mmol/l. Graded igneous crushed stone of at least Grade 800 shall be used. The grade corresponds to the ultimate compression strength of water saturated source rock that is determined by the crushability of stone per GOST 8267-93. Metamorphic crushed stone with water saturation not exceeding 2 % and of at least Grade 600 may be used. Crushed stone shall be homogeneous without weak binds, dolomite admixture and silica admixture reactive with the cement alkali. Content of harmful admixtures is specified in GOST 26633-2012.

Coarse aggregate shall be used in the form of size divisions (5...10, 10...20, 20...40 mm). Ratio of coarse aggregate size divisions in concrete shall be defined when selecting the concrete composition. The maximum aggregate grain size shall be assigned depending on the principal reinforcement spacing: 40 mm for foundation slab concrete and 20 mm for other structures. For fine-grain concrete, maximum aggregate grain size shall not exceed 5 mm.

4 Fine aggregate - sand

4.1 Coarse, medium and fine natural sands per GOST 8736-2014 shall be used as fine aggregate for concrete.

Fine aggregates shall be selected according to grain composition, fineness modulus, content of dust and clay particles, petrographic composition, in particular according to content of harmful admixtures. Sand shall contain no harmful admixtures, in particular silica admixtures reactive with the cement alkali. Sand and coarse aggregate shall contain no chlorine salts.

5 Water

5.1 To prepare concrete mix and to water hardening concrete, use water per GOST 23732-2011 containing no harmful admixtures, in particular the following:

- soluble salt content shall be max. 5000 mg/l;
- content of SO_4^{2-} ions shall be max. 2700 mg/l;

- content of Cl^- – ions shall be max. 1200 mg/l;
- total suspended particles shall be max. 200 mg/l;
- water oxidability shall be max. 15 mg/l;
- pH of water shall be within 4...12.5.

Water shall contain no oil products, fats and oils.

6 Additives

6.1 To control and improve concrete and concrete mix properties, reduce cement consumption and achieve the concrete with the required high waterproofness, plasticizing additives per GOST 24211-2008 are recommended.

To reduce exothermic heating, it is recommended to add efficient additives for concrete that contain no reactive harmful admixtures, increase consistency of concrete mix, inhibit concrete mix setting, reduce heat generation rate without reducing mature concrete strength and increasing shrinkage strain and creep.

No polymer additives, calcium or sodium chloride salts or other additives causing corrosion in concrete or reinforcement and embedded parts, and additives generating or causing generation of explosive and poisonous gases at high temperatures up to 210 °C and in case of radiological impact are allowed.

REQUIREMENTS FOR SELF-COMPACTING CONCRETE MATERIALS

1 The requirements for materials used to make concretes were assigned based on the standards and regulations of the Russian Federation. And additional requirements of foreign standards for materials used to make concrete were taken into account.

Materials used to make SCC shall meet the highest requirements. The main requirements for cement, inert materials and additives used to make SCC in accordance with STO SRO-S 60542960 00050-2015 are described below.

Cement

Plain and low-heat-of-hydration portland cements and slag portland cement M400, M500 и M600 (GOST 10178-85) are preferable for use as binder depending on the compression strength requirements for concrete.

To ensure high early and 28-day strength, it is recommended to use cements with high content of C_2S and C_3S minerals and low content of C_3A and C_4AF . Excessive content of C_3A can affect the early strength.

In addition, it is useful to limit content of Na_2O and K_2O expressed as Na_2O to avoid inner corrosion of concrete as a result of chemical reaction between harmful components and admixtures in aggregates and cement alkali.

Cements used to make SCC shall meet the following requirements:

- cement shall be plain, low-heat-of-hydration and have specific surface area max. 4000 cm^2/g ;
- total content of tricalcium and dicalcium silicates ($3CaOSiO_2 + 2CaOSiO_2$) in clinker shall be at least 67 %;
- content of C_3S in cement shall be max. 65 %;
- content of MgO in clinker shall be max. 5 %;
- content of SO_3 in cement – shall be max. 3.5 %;
- content of Na_2O and K_2O expressed as Na_2O in cement shall be max. 0.6 %;
- content of C_3A shall be max. 5 %;
- content of $C_3A + C_4AF$ shall be max. 22 %;
- content of chloride ions in cement shall be max. 0.1 %;
- fineness of cement (passing through 008 mm mesh screen) shall be at least 85 %;
- cement shall meet the requirements of standards for 28 day compression and bending strength;
- initial setting shall take place not earlier than in 2 hours 30 minutes;
- final setting shall take place not later than in 10 hours.

Fine aggregate

High quality natural sands (GOST 8736-2014) shall be used as fine aggregate to make SCC. It is advisable to use gravel and pit sands subjected to additional washing. Crushed sand is prohibited.

Graded sands (size divided) are recommended in order to ensure the best fine fraction ratio in concrete depending on concrete class.

Fine aggregate for SCC shall meet the following requirements:

- sand shall be clean, dense, classified and stable according to grain-size composition;
- sands with rounded grains (close to round form with smooth surface) are recommended;

- medium and coarse sands with fineness modulus within 2.0...3.0 may be used, but sands with fineness modulus within 2.0...2.5 are more suitable;
- 0.63 mm mesh screen residue shall be from 30 to 45 % for sands with $M_f = 2.0...2.5$ and from 45 to 65 % for sands with $M_f = 2.5...3.0$;
- content of particles larger than 10 mm shall be max. 0.5 %; larger than 5 mm – max. 5 % (Class I sands);
- content of particles smaller than 0.15 mm (0.16 mm) shall be max. 5 %;
- true density of sand grains shall be within 2.0...2.8 g/cm³;
- content of dust and clay particles shall be max. 2 %;
- content of clay balls shall be max. 0.25 %;
- content of harmful components and admixtures in sand shall be limited and shall not exceed the allowable limits specified in the standards and regulations.

When self-compacting concrete mixes are used, special attention shall be given to stable grain-size composition of sand.

Coarse aggregate

Coarse aggregate (GOST 8267-93) for SCC shall meet the following requirements:

- crushed stone shall be made from dense rock;
- crushed stone shall be of at least Grade 1200 according to strength (crushability);
- crushed stone grains shall be cube-shaped, content of plate-shaped (flaky) or needle-shaped grains shall not exceed 25 % (flaky and needle-shaped grains in crushed stone necessarily leads to increased cement content);
- when making SCCM, it is advisable to limit maximum grain size of crushed stone to 20 mm;
- crushed stone shall be clean and have constant grain-size composition; it is advisable to use graded crushed stone composed of two size divisions: size 5 to 10 mm and size 10 to 20 mm;
- no clay balls are allowed;
- content of dust and clay particles shall be max. 1 %;
- content of soft rock grains – shall be max. 5 %;
- content of harmful components and admixtures in crushed stone shall be limited and shall not exceed the allowable limits specified in the standards and regulations.

Water

To prepare concrete mix and to water hardening concrete, use water per GOST 23732-2011 containing no harmful admixtures, in particular the following:

- soluble salt content shall be max. 5000 mg/l;
- content of SO_4^{2-} ions shall be max. 2700 mg/l;
- content of Cl^- ions shall be max. 1200 mg/l;
- total suspended particles shall be max. 200 mg/l;
- water oxidability shall be max. 15 mg/l;
- pH of water shall be within 4...12.5.

Water shall contain no oil products, fats and oils.

Additives

Generally, efficient polycarboxylate-based (superplasticizers) plasticizing chemical additives combined with fine-grained micro fillers (active and inert mineral additives) are used as additives for SCC. In addition, there is a wide range of additives composed both plasticizing chemical agents and micro fillers.

Other additives, including air-entraining agents and agents that accelerate or inhibit concrete curing process, can be used in the same way as in normal concrete taking into

account the recommendations of the additive manufacturer for their use and method of introduction.

Stabilizers - viscosity modifying agents can be used together with superplasticizers to make SCCM in order to stabilize mixes, increase cohesion and segregation resistance of mixes.

In total, the additives used to make SCC shall meet the following requirements:

- ensure low water-to-cement-ratio at the specified spread of concrete mix;
- depending on concreting process, ensure the required time-dependant concrete mix property retention (workability) time;
- ensure the required concrete strength gain in accordance with the design requirements;
- ensure concrete mix stability (no segregation and bleeding);
- improve concrete mix pumpability, self-levelling and self-compacting abilities.

Any additives can be only used for concrete in structures subjected to radioactive exposure after reasonable justification.

Plasticizers

The main purpose of plasticizing additives is to reduce water demand of concrete mixes at the same time ensuring their high consistency and high strength of hardened concrete.

Selection of superplasticizing agents depends on the design requirements for physical and technical specifications of concrete and functional performance of concrete mixes.

New-generation polymer-carboxylate-based superplasticizers make it possible to dramatically reduce water-to-cement-ratio in concrete (to 0.3...0.4) and, in its turn, to make SCCM that ensure high strength of hardened concrete with relatively low cement content.

Fillers

To make SCCM, it is advisable to use powder fillers with fineness lower than 0.125 mm, and more than 70 % of filler shall have fineness lower than 0.063 mm.

SCCM fillers shall meet the following requirements:

- reduce cement content while maintaining the required strength level;
- improve functional performance of SCCM (no segregation and bleeding in mixes with retained consistency);
- reduce water demand of concrete mix.

Both natural materials and waste materials or by-products of fuel, metal, power and other industries can be used as fillers.

Fillers can be divided into two types:

- inert (or semi-inert) mineral fillers, e.g. rock dust (limestone, dolomite and granite) and powder silica sands;
- active mineral additives having pozzolanic properties, e.g. microsilica, HPP fly ashes, granulated blast-furnace slags, etc.

The use of inert micro fillers makes it possible to improve flow characteristics of SCCM, facilitates stabilizing process of mixes, prevents segregation and increases total volume of mortar without increasing cement content. It is useful to use inert micro fillers (including dolomite powder) to make concretes with strength requirements of Classes B30...B60.

Active mineral concrete additive - microsilica (Ms) is a by-product of production of various types of silica alloys. The use of microsilica makes it possible to significantly increase concrete strength, durability, waterproofness and wear resistance. It also increases concrete mix cohesion, bond to reinforcement steel and previously hardened concrete.

Microsilica introduction in concrete mixes significantly reduces cement content. Due to reduced cement content, microsilica concretes feature reduced heat generation.

Microsilica introduction increases concrete density, resistance to carbonization processes and improves protective properties of concrete against reinforcement.

The main component that ensures the additive efficiency is amorphous ultrafine silica, which due to its pozzolanic properties favorably influences structural and mechanical properties of cement stone and concrete. Activity of microsilica with low content of SiO_2 is reduced.

In accordance with the specifications, the following parameters are specified for microsilica:

- mass fraction of microsilica shall be - 90...97 %;
- loss of ignition shall be max. 3...5 %;
- content of SiO_2 shall be max. 65...85 %;
- alkali content ($\text{K}_2\text{O}+\text{Na}_2\text{O}$) shall be max. 2 %;
- content of C_3A shall be max. 3...5 %;
- content of SO_3 shall be max. 0.6 %;
- specific surface area shall be at least 12 m^2/g ;
- bulk density shall be 150...500 kg/m^3 ;

Viscosity modifying agents

The main purpose of stabilizing additives (viscosity modifying agents) is to improve viscosity, segregation and sedimentation resistance, concrete uniformity and concrete mix pumpability. Also, viscosity-control additives are used to minimize influence of change in: inert materials water content, fines content in sand or grain-size composition.

The use of stabilizing additives depends on the design requirements for physical and technical specifications of concretes and functional performance of concrete mixes.

Stabilizing additives may be both organic - and mineral-based.

Complex additives

A variety of widely used multifunctional additives are available for concrete making process. They are introduced in concrete mixes in dry powdered condition and are composed of plasticizing chemical agents and microfillers, including microsilica. The above mentioned additives are rather effective in making concretes with high strength and waterproofness requirements, since they ensure the required concrete quality with relatively low cement content. The additives are particularly efficient in making high-workability concrete mixes with slump of 50 cm and higher.

The final decision depends on the Customer's practice.

REQUIREMENTS FOR EXTRA HEAVY CONCRETE MATERIALS

1 Quality parameters:

- extra heavy structural concrete with average density of 3350 kg/m³;
- compression strength class at least B30;
- grade W6 and W8 according to waterproofness;
- ultimate shrinkage is 30×10^{-5} ;
- linear thermal expansion coefficient with temperature less than 50 °C shall not exceed $1 \times 10^{-5} \text{ }^{\circ}\text{C}^{-1}$;

2 Cement

2.1 Portland cement per GOST 10178-85 with clinker composed of C₃S max. 65 %, C₃A max. 7 % and C₃A+C₄AF max. 22 % shall be used. Amount of mineral admixtures shall not exceed 10 %. K₂O and Na₂O alkali content in cement shall not exceed 0.6 %. And the mineralogical composition of cement shall be assessed in accordance with GOST 22266-2013.

Low heat-of-hydration cement (type IV per ASTM C 150) shall be used; heat of hydration of cement during 7 days shall not exceed 250 J/g. Heat generation test shall be carried out in accordance with GOST 310.5-88.

3 Coarse aggregate

3.1 Provisions shall be made for the use of two types of coarse aggregate.

3.1.1 High-density igneous crushed stone free of silica admixtures reactive with the cement alkali. Content of alkali-soluble silica in the aggregate shall not exceed 50 mmol/l. Graded igneous crushed stone of at least Grade 800 shall be used. The grade corresponds to the ultimate compression strength of water saturated source rock that is determined by the crushability of stone per GOST 8267-93. Metamorphic crushed stone with water saturation not exceeding 2 % and of at least Grade 600 may be used. Crushed stone shall be homogeneous without weak binds, dolomite admixture and silica admixture reactive with the cement alkali. Content of harmful admixtures is specified in GOST 26633-2012.

3.1.2 High-density iron-ore aggregate with iron oxide content at least 60 %, with average density of at least 4.65 kg/cm³, or non-fluxed iron-ore pellets supplied by mining and processing works in accordance with the manufacturers' specifications.

Coarse aggregate shall be used in the form of size divisions (5...10, 10...20 mm). Ratio of coarse aggregate size divisions in concrete shall be defined when selecting the concrete composition.

4 Fine aggregate

4.1 Two types of fine concrete aggregate can be used.

4.1.1 Coarse, medium and fine natural sands per GOST 8736-2014.

Fine aggregates shall be selected according to grain composition, fineness modulus, content of dust and clay particles, petrographic composition, in particular according to content of harmful admixtures. Sand shall contain no harmful admixtures, in particular silica admixtures reactive with the cement alkali. Sand and coarse aggregate shall contain no chlorine salts.

4.1.2 High-density fine aggregate made from metallurgical scale.

Scale is metal industry waste product made during ferrous metal rolling. Machine scarfing, cogging mill and long product rolling mill scale shall be preferred for making concrete.

Requirements for grain-size composition of sand are similar to those of mineral sand in accordance with GOST 8736-2014.

Scale sand shall meet the following additional requirements:

- iron content in scale shall be min. 70 %;
- average density of scale shall be min. 5000 kg/m³;
- scale shall contain no foreign inclusions (metal scrap, debris, scrap brick, etc.) and sintered lumps or plates of greater than 20 mm in size.

Specific requirement for aggregates used in extra heavy concretes are listed in Table 4.1.2.1.

Table 4.1.2.1

Description	Allowable level
Sulfate content expressed as SO ₃ , %	max. 2
Chloride content expressed as CL, %	max. 0.4
Organic impurities, %	0
Aggregate shape, roughness	as normal mineral aggregates
Recommended compression strength, MPa	min. 60

5 Water

5.1 To prepare concrete mix and to water hardening concrete, use water per GOST 23732-2011 containing no harmful admixtures, in particular the following:

- soluble salt content shall be max. 5000 mg/l;
- content of SO₄²⁻ ions shall be max. 2700 mg/l;
- content of Cl⁻ ions shall be max. 1200 mg/l;
- total suspended particles shall be max. 200 mg/l;
- water oxidability shall be max. 15 mg/l;
- pH of water shall be within 4...12.5.

Water shall contain no oil products, fats and oils.

6 Additives

6.1 To control and improve concrete and concrete mix properties, reduce cement consumption and achieve the concrete with the required high waterproofness, plasticizing additives per GOST 24211-2008 are recommended.

To reduce exothermic heating, it is recommended to add efficient additives for concrete that contain no reactive harmful admixtures, increase consistency of concrete mix, inhibit concrete mix setting, reduce heat generation rate without reducing mature concrete strength and increasing shrinkage strain and creep.

No polymer additives, calcium or sodium chloride salts or other additives causing corrosion in concrete or reinforcement and embedded parts, and additives generating or causing generation of explosive and poisonous gases at high temperatures up to 210 °C and in case of radiological impact are allowed.

Only additives specially tested for application in radiation exposed concretes shall be used to make extra heavy concretes.

To achieve cohesion in high-workability extra heavy concrete mixes, it is recommended to introduce microfiller made of the same material as fine aggregate. Fineness of microfiller shall be characterized by specific surface area min. 2000 cm²/g.

Incoming inspection of materials shall be carried out in accordance with STO 1.1.1.03.003.0911-2012 Attachment T.

PROCESS REQUIREMENTS FOR CONSTRUCTION AND INSTALLATION WORK FOR ERECTION OF REINFORCED CONCRETE STRUCTURES

1 General

1.1 Code of practice, including concrete mixing, transportation and placement, curing of newly placed concrete, formwork design and stripping timing shall be developed as part of process documentation for work execution programs for reinforced concrete structure erection, taking into account the requirements of SP 70.13330.2012 and Process Procedures.

Work Execution Programs (WEP) shall include the following:

- structure erection and concreting sequence;
- measures and equipment to ensure the required installation accuracy and spatial stability of structures during fabrication, pre-assembly, transportation and installation in their final position;
- reliable bracing of reinforcement structures during erection and ensuring stability of structures during concreting;
- occupational safety.

2 Concrete mixes

2.1 Normal concrete mixes

2.1.1 Making and transportation of concrete mixes

Concrete mix composition with required quality shall be selected per GOST 27006-86 taking into account the requirements for classes of operation of concrete per GOST 31384-2008.

Sampling frequency for compliance assessment shall be in accordance with STO 1.1.1.03.003.0911-2012 Table 16.2.

The properties of the selected concrete mix shall comply with the concreting process, including gauging time and conditions, concrete mix making and transportation methods and conditions, and other process features (GOST 7473-2010 and GOST 10181-2014).

Concrete mixes shall meet the quality requirements for workability, segregation, porosity, temperature, time-dependant property retention, entrained air volume and compaction factor.

Concrete mix can be transported from the mixing location to the construction site in truck mixers and ready-mix trucks.

In this case, measures shall be taken to avoid concrete mix segregation and loss of consistency below the allowable limit.

Transportation method and means shall be selected in accordance with other processes, including concrete mix handling and features of the given concrete mix.

Transportation time shall be minimized and shall not exceed the allowable time for concrete mixes that ensures maintenance of the functional performance within the specified limits.

2.1.2 Concrete mix placement

2.1.2.1 Concrete mix placement temperature shall be selected based on the requirement for minimizing thermal shrinkage cracking.

Reinforced concrete structure concreting shall be carried out in casting sequence. Concrete mix shall be placed in horizontal layers with consecutive one-way direction of placement for all layers. Any next concrete mix layer may be placed before concrete setting

in the previous layer. Interval between placement of adjacent concrete mix layers without construction joints shall be defined by the construction technology laboratory.

The distance between horizontal construction joints (concreting section height) and time to the start of concreting of the next section shall be defined during the WEP development in accordance with the requirement for limiting concrete cracking due to exothermic heating and based on the maximum pressure on the stay-in-place formwork specified in the design.

Construction joint surfaces, if not otherwise specified in the design, shall be normal to the axis of concreted columns and beams, slab and wall surfaces. Concreting may be continued upon achievement of the concrete strength of min. 1.5 MPa.

It is advisable to concrete foundation slabs in layer-by-layer sequence with division into concreting sections in plan. Layer heights, concreting sections sizes, concreting sequence and intervals, and horizontal surface reinforcement requirement and design shall be adopted in accordance with the process documentation as part of the work execution program. Concreting process documentation shall be developed by a specialized organization taking into account the requirements herein and shall be based on the analysis of heat-stressed concrete during hardening in order to limit thermal shrinkage cracking both on the surface and inside. For foundation slab, concreting joints shall have step-by-step height isolation. Step width shall be at least 1.5 of step height.

In case of concreting throughout the foundation slab height, concreting joints shall be located directly under the main walls of the building along the longitudinal axis of the building wall; if this requirement cannot be met, avoid concreting joint location in the foundation slab areas, where shear forces Q are maximum, i.e. locate the joints at a distance greater than $\frac{1}{4}$ of slab span and parallel to the smaller side of slab.

For concreting of other building elements, construction joints may be made:

- for columns - at the top of foundation, bottom of beams and crane cantilevers, bottom and top of floor slabs;
- for beams cast-in-situ with slabs - by 20...30 mm below the slab bottom;
- for flat floor slabs with aspect ratio more than 2 - in any location parallel to the smaller side of slab;
- for flat floor slabs with aspect ratio less than 2 - within the support structure (walls or beam) along the central axis of the structure.

In case when a vertical construction joint is made in the area of T-shaped wall joint, the joint shall be made in the form of a key equal in height to the adjacent wall width and 50 mm deep, see figure 2.1.2.1.1.

In case when a vertical construction joint is made in a wall thicker than 400 mm, keys of at least 50 mm in depth shall be provided (figure 2.1.2.1.2).

The concreting WEP shall include measures (e.g. temporary support posts) to ensure bearing capacity of floors and to withstand the newly placed concrete load during concreting of overlying walls and floors. These measures shall be in force until the concrete in the walls supported by the floor slab reaches 50 % of the design strength.

Removable formwork and floor supporting structures shall be dismantled considering the loads created during erection of overlying structures, and these loads shall not exceed the allowable limits.

If there are no walls under the overlying walls, formwork and floor supporting structures shall be dismantled after development of 70 % of the design strength in the concrete in the overlying walls and floors (figure 2.1.2.1.3).

Construction joint arrangement shall be specified in the work execution program in accordance with the detailed drawing requirements in the process documentation and this document.

Free dropping height of concrete mix shall be such that to avoid concrete segregation and formwork damage. Height of concrete layers placed by continuous method shall be defined in the work execution program depending on the adopted method of compaction and concrete-mixing production capacity.

Never add water at the the concrete mix placement location in order to increase its consistency.

The placed mix shall be thoroughly compacted. Non-compacted areas, segregations and voids are not allowed. In case when any defects are detected after stripping, they shall be repaired in accordance with the repair documentation. Quality of concrete in structures shall be controlled in accordance with SP 70.13330.2012. During concrete mix compacting, never support vibrators on the reinforcement, embedded parts and framework members.

Compliance criteria according to workability are listed in STO 1.1.1.03.003.0911-2012 Table 16.1.

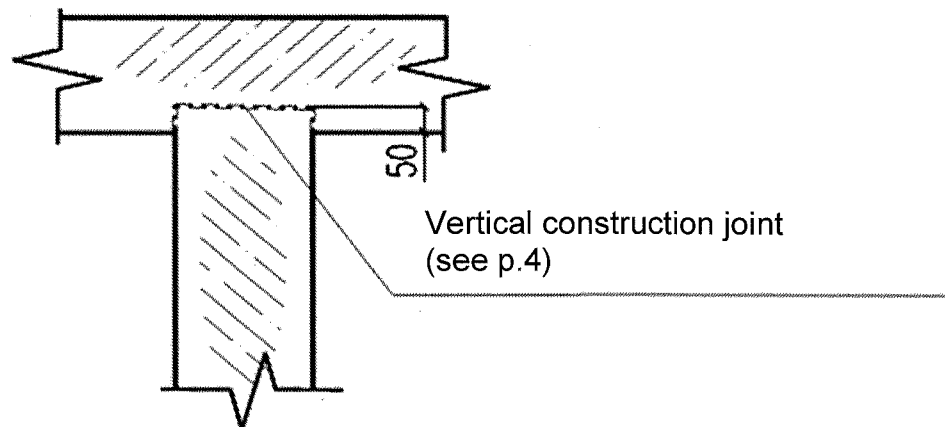


Figure 2.1.2.1.1

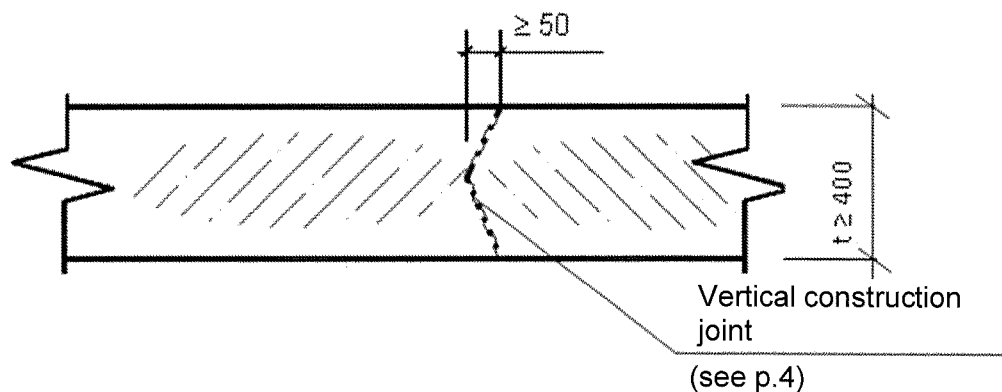


Figure 2.1.2.1.2

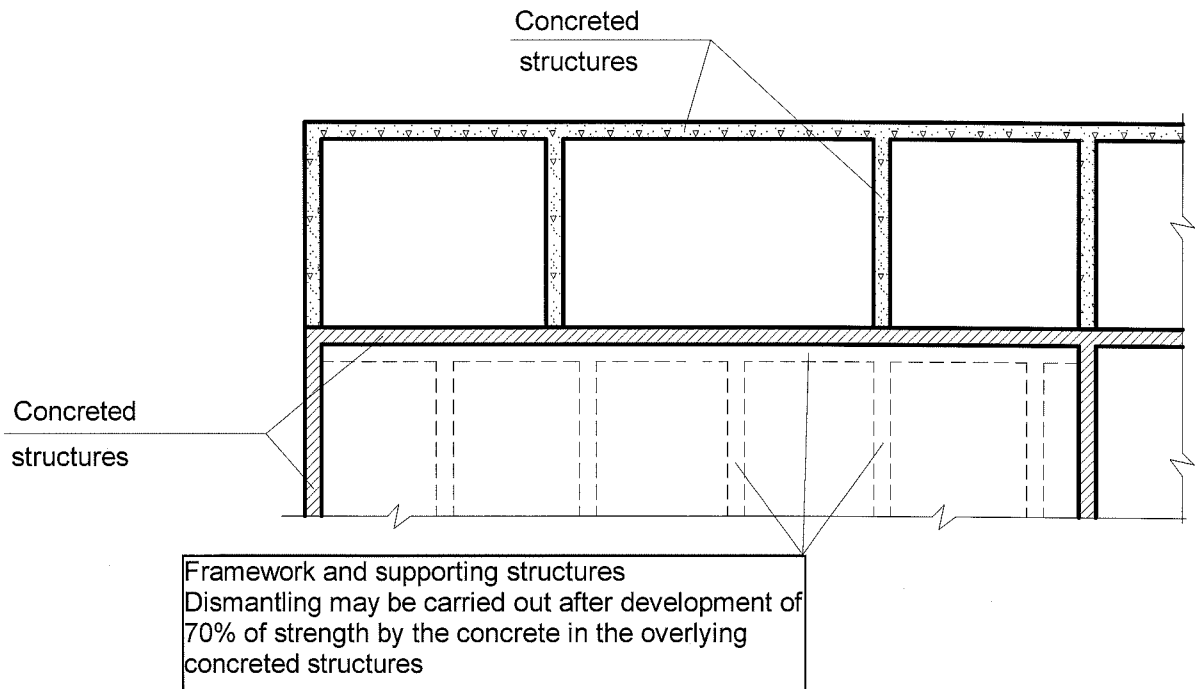


Figure 2.1.2.1.3

2.2 Self-compacting concrete mixes (SCCM)

2.2.1 Making and transportation of concrete mixes (SCCM)

2.2.1.1 SCCM composition design and preparation shall be strictly in accordance with the approved process procedure and the requirements of STO SRO-S 60542960 00050-2015.

SCCM shall be made at plants with equipment, operations and materials properly controlled in accordance with the quality control system. SCCM manufacturer shall have ISO 9001:2008 quality management system certificate.

Before the start of work, all personnel involved in SCCM production and supply processes shall undergo training carried out by specialists experienced in work with self-compacting concretes.

To achieve stable properties of SCCM, additional measures are required for initial selection of components and during incoming inspection of concrete batches for uniformity. To meet these requirements, component quality control frequency shall be increased and tolerance shall be specified such that SCCM production per shift is within the compliance criteria and no additional tests and/or batch composition correction are required.

2.2.1.2 SCCM shall be transported in truck mixers. When concrete mix is being transported to the construction site, it is constantly mixed in the mixer at 8...10 rpm.

Before SCCM is loaded in the mixer at the concrete plant, ensure that the mixing drum is empty and contains no water that could have remained in it after the truck mixer cleaning.

Before ordering concrete mix to the construction site, ensure that all preparatory activities prior to concreting have been completed and the section is ready for concreting.

2.2.2 SCCM delivery and placement

Concrete mix shall be delivered in the concreting sections using concrete pumps and booms.

Concreting of structures with SCCM shall be carried out in consecutive horizontal layers. Height of layers shall be assigned in accordance with concreting rate, concrete mix

preservation and setting time, and maximum allowable concrete mix pressure on the formwork, including the IC sealed liner.

Concrete mix shall be delivered in the section at properly arranged dedicated locations. Thus, for concreting the IC and OC structures and NPP facilities walls, concrete mix shall be supplied via the formwork windows arranged in form panels (with wall height more than 4 m) and over the top of formwork.

Maximum interval between the concrete mix delivery points for delivery in concreting section (in plan) shall be 6...7 m.

Concrete volume multiple of one mixer or 1/2 of mixer shall be delivered to each concrete mix delivery point.

Based on the experience of concreting using SCCM, height of concrete dropping into the concreting section shall not exceed 0.5 m.

Taking into consideration consistency of concrete mix, its placement and distribution shall be carried out without using vibrators. SCCM is compacted by gravity.

For IC and OC concreting, construction laboratory representatives shall check the level of concrete placed in the structure such that difference in concrete layers along the perimeter of the containments does not exceed 0.5 m.

For wall concreting, concrete mix can be delivered into the formwork space according to the following options:

Option 1

Concrete mix shall be delivered to the section via removable elephant trunks attached to the top of section (trunk diameter shall be selected in accordance with the reinforcement cage cells).

During installation of reinforcement and framework cages, points for passing elephant trunks of the required sizes shall be provided, if required.

The trunks may have specific length, as applicable, and may be composed of several sections with length of 1.0 m each. Example of removable elephant trunks is shown in figure 2.2.2.1.

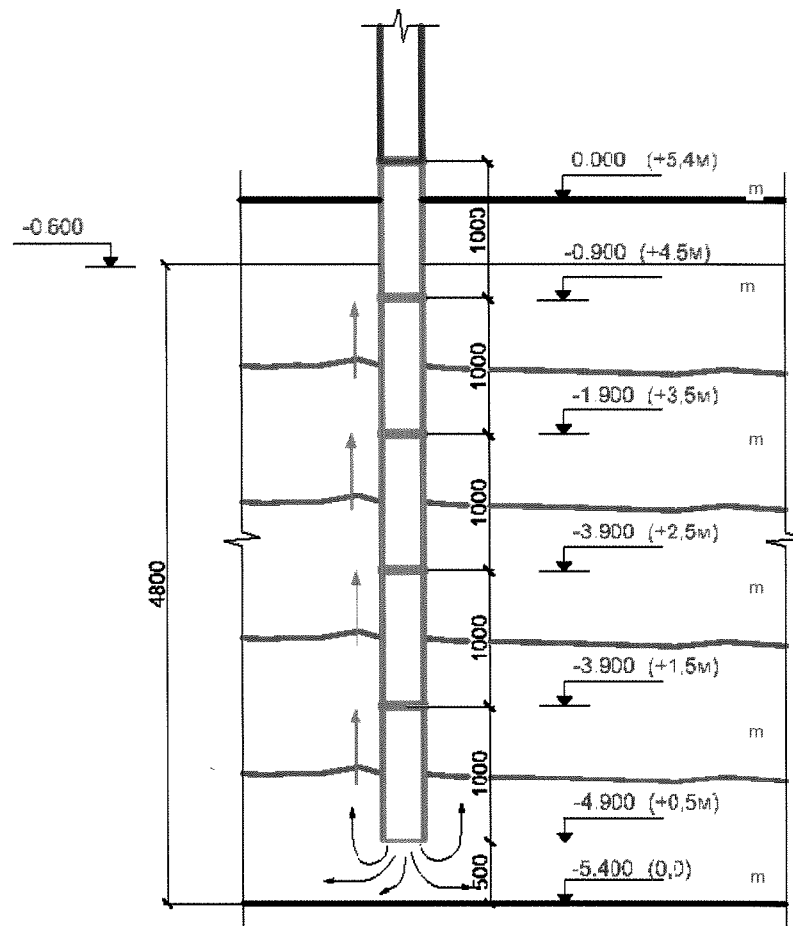


Figure 2.2.2.1 - Removable elephant trunks for concrete mix delivery into concreting section

Option 2

Concrete mix is delivered via metal pipes going throughout the section height. The metal pipe shall be made as a structural member with openings located along the pipe length with intervals of 0.5...1.0 m.

3 Concrete curing

3.1 Concrete curing shall be carried out in accordance with the requirements of SP 70.13330.2012.

Immediately after concreting completion, open surfaces of the newly placed concrete shall be thoroughly protected against water evaporation and precipitation during the period of compression strength development of at least 70 %. Then, temperature and humidity conditions shall be maintained to ensure strength gain of the concrete.

4 Construction joint surface preparation

4.1 Prior to concreting horizontal surfaces of construction joints shall be cleaned from contamination, debris, dust and cement skin.

Immediately before placement of concrete mix, the cleaned surfaces shall be treated with water and purged with compressed air. During concreting the construction joint surface shall be wet.

Vertical surface of construction joints shall ensure bonding with the newly placed concrete of at least 0.7 Rbt (Rbt is design tensile strength of concrete per SP 63.13330.2012).

When there is no natural roughness, construction joint surfaces shall be machined to achieve the specified roughness (convexity and concavity of at least 5 mm).

Rough surface shall be made uniformly throughout the construction joint area and shall have an approximately equal amount of convex and concave points (40...60 %). The maximum dimension (width or length) of convex and concave points shall not exceed 50 mm.

5 Quality control during concrete mix making and placement

5.1 Quality control during normal concrete mix making and placement

5.1.1 Quality control rules for concrete materials and concreting work, including concrete mixing, transportation and placement, and curing of newly placed concrete, shall be developed as part of process documentation for reinforced concrete structure erection, including the requirements of SP 70.13330.2012, Chapter 16 and Appendix T to STO 1.1.1.03.003.0911-2012.

To meet the requirements for concrete and reinforced concrete structures, quality control measures, including incoming, operational and acceptance inspection, shall be carried out.

During incoming inspection, concrete mix shall be checked for compliance with the contract terms and conditions in accordance with the concrete mix quality documents, and tests shall be carried out for determining the specified quality parameters of concrete mixes in accordance with the requirements of WEP and Process Procedure.

During operational inspection, actual concreting conditions and methods, and concrete hardening conditions shall be checked for compliance with WEP and Process Procedure.

During acceptance inspection, actual concrete quality parameters shall be checked for compliance with all specified design quality parameters.

Strength of concrete in cast-in-situ structures at intermediate and design age shall be tested by static methods per GOST 18105-2010 using non-destructive strength test methods per GOST 17624-2012 and GOST 22690-2015 or destructive method per GOST 28570-90 with 100 % strength test (each structure). Use of non-static inspection methods and strength test methods using test samples made at concreting point is only allowed in exceptional cases specified in GOST 18105-2010.

Concrete shall be tested for waterproofness according to concrete waterproofness test results to be presented by the concrete mix supplier. If required, concrete waterproofness can be tested and determined per GOST 12730.5-84 using rapid test method according to air permeability of concrete.

Other specified quality parameters of concrete shall be tested in accordance with the applicable standards for performance test methods.

Average density of concrete shall be determined and assessed per GOST 12730.1-78 or GOST 17623-87.

Concrete moisture content shall be determined and assessed per GOST 12730.2-78 or GOST 21718-84 or GOST 23422-87.

Shrinkage strain and creep of concrete shall be determined and assessed per GOST 24544-81.

Concrete wear shall be determined and assessed per GOST 13087-81.

Samples shall be collected from structures for concrete strength assessment in accordance with GOST 28570-90.

Concrete placement and compaction shall be carried out according to WEP such that the specified concrete density and uniformity are ensured in accordance with the concrete quality requirements specified for the given structure in this document, GOST 18105-2010 and GOST 26633-2012.

Concreting sequence shall be defined so that concreting joints are arranged in accordance with the building and facility erection procedure, structural features and design

requirements. And the required surface contact strength in the concreting joint and strength of structure with concreting joints shall be ensured.

For concreting of solid structures with self-compacting concrete mixes, concrete mix can be placed simultaneously over the entire structure area with overlapping mix spread zones.

Any next concrete mix layer may be placed before concrete setting in the previous layer. Interval between placement of adjacent concrete mix layers without construction joints shall be defined by the construction technology laboratory. Upper layer of the placed concrete mix shall be by 50...70 mm lower than the top of form panels.

During concrete mix compacting, never support vibrators on the reinforcement, embedded parts, tie rods and other framework fastening components. Internal vibration immersion depth in concrete mix shall ensure its penetration in the previously placed layer by 5...10 cm. Movement interval for internal vibrators shall not exceed 1.5 working radius of the vibrators; for external vibrators it shall ensure 100 mm overlapping of the previously compacted area boundary by the vibrator pad.

Concrete mix shall be compacted in each placed layer or each vibration nozzle position until settlement is stopped, cement paste gloss appears on the surface and in formwork contact areas and no air bubbles appear.

5.2 Quality control during SCCM making and placement

5.2.1 Quality of delivered concrete mix shall be assessed at the construction site for compliance with the requirements specified in the concreting process procedure.

Each SCCM batch delivered to the customer shall be accompanied with the actual data on concrete mix composition.

Each truck mixer filled with concrete mix shall be accompanied with quality control document in accordance with GOST 7473-2010.

Qualitative assessment of SCCM performance shall be carried out by a specialized organization (construction technology laboratory) that has qualified personnel and proven procedures for SCCM testing.

The following concrete mix performance parameters shall be assessed during incoming inspection:

- workability - using Abrams cone with a locking ring (slump 56...62 cm);
- concrete mix porosity - by entrained air volume (within 1...3 %);
- preservation ability (time-dependent stable consistency);
- concrete mix temperature (min. + 15 °C);
- average density;
- mortar separation (max. 4 %);
- bleeding (max. 0.8 %).

Cohesion/segregation resistance shall be visually assessed according to bleeding.

Concrete mix shall be accepted for placement in a structure, if actual properties of the mix are in accordance with the requirements specified in the Work Process Procedure.

In case when the concrete mix does not meet the procedure requirements or the concrete sample contains apparent signs of segregation, the mix shall not be accepted for placement in a structure.

In this case, the laboratory representatives shall immediately inform the contractor's QA, designer's supervision representatives and engineering supervision representatives.

In case of regular defects in quality of concrete mix delivered to the construction site, this fact shall be recorded in the concrete work log.

The contractor's QA representatives shall promptly inform the concrete plant about noncompliance of the concrete mix with the required specifications in order to ensure prompt composition correction.

Mixer with concrete mix that does not comply with the process procedure requirements shall be returned to the concrete plant to make corrections in the concrete mix.

Dilution of concrete mix (to increase its consistency) delivered to the point of placement with water or plasticizers (and their mixes) is prohibited.

5.2.2 Concrete mix quality shall be assessed with the following frequency:

- a sample shall be collected from the first mixer to assess all properties (mentioned above);
- when the above mentioned parameters are stabilized, further assessment shall be carried out according to consistency; cohesion and temperature in each mixer shall be visually assessed.

5.2.3 When concrete mix is placed in a concreting section, the following performance parameters shall be assessed:

- concrete mix placement rate (throughout the concreting period);
- height of concrete mix dropping (during pumping);
- uniform spread of concrete mix in framework (during placement);
- concrete mix layer thickness (during placement).

Concreting rate shall be calculated based on concrete hardening conditions, coverage time, layers thickness and maximum allowable load of concrete mix on the structure formwork.

Reduced concreting rate can result in occurrence of apparent boundaries between layers. Increased concreting rate can result in increased pressure on framework above the design value.

In case of change in concreting rate by more than 5 m³/h, the construction technology representatives shall immediately inform the contractor's QA, designer's supervision representatives and engineering supervision representative, and make an appropriate record in the concrete work log.

During concreting, the level of concrete placed in the structure shall be checked every two hours. If the difference in layers is more than 0.5 m, the concrete mix shall be immediately re-distributed between the concrete delivery points in order to level the concrete layer surface in the section.

Concrete mix shall be delivered into the framework of the concreted structure using concrete boom via elephant trunks through the center of the structure and into dedicated openings provided in the reinforcement cage. Elephant trunks are installed in each of the concrete mix delivery points and shall be used to prevent concrete mix dropping (concrete mix dropping height shall not exceed 0.5 m).

Taking into consideration consistency of concrete mix, its placement and distribution shall be carried out without using vibrators; concrete mix shall be compacted by gravity.

6 Acceptance of completed concrete and reinforced concrete structures

6.1 For acceptance of completed concrete and reinforced concrete structures or facility portions (concreting sections), the following shall be checked:

- compliance of structures with the detailed drawings and the above listed requirements;
- concrete strength, waterproofness and density;
- quality control documents for the materials and components used in the structure.

Acceptance of completed concrete and reinforced concrete structures or portions of buildings and facilities shall be documented in the structure examination reports. And acceptance of critical reinforced concrete structures, i.e. structures, in which deviations from the design detected during the building inspection cannot be repaired without dismantling or damage of other structures, shall be documented in the critical structure examination reports.

The critical building and facility structures, for which the critical structure examination reports shall be prepared, include the following reinforced concrete structures:

- building and facility foundations (including foundation slabs);
- bearing walls and columns;
- floors, crossbeams and girders;
- primary and secondary containment structures;
- underground tunnels and channels;
- equipment foundations.

For creation of the critical structure examination reports, the construction supervisor shall submit the following as-built documents:

- concealed work inspection reports for acceptance of reinforcement structures, embedded parts, etc;
- actual geodetic location sketches for reinforced concrete structures and embedded parts;
- appraisal, examination, laboratory and other test results for work executed during the building inspection;
- documents supporting the fact of construction materials quality inspection;
- materials replacement approval documents (engineering solutions);
- other documents that reflect actual fulfilment of design solutions.

The critical structure examination reports shall meet the requirements of SP 70.13330.2012.

6.2 Dimension tolerances for reinforced concrete structures shall be specified in the detailed drawings in accordance with the requirements of GOST 21779-82.

When the dimension tolerances are not available in the detailed drawings, they shall be adopted in accordance with SP 70.13330.2012 Table 5.12.

For dimension tolerances for reinforcement production and installation, see "Requirements for Reinforcement and Reinforcing Structures" (RPR.0120.0.0.AS.EC0001-CEC0008).

6.3 High quality surfaces that require no further plastering and filling shall be achieved by elaborated formwork that meets the requirements for the applicable concrete surfaces. Concrete surface quality requirements depending on the purpose of the structure and further surface finishing shall be specified in the detailed drawings.

REQUIREMENTS FOR REINFORCEMENT AND REINFORCING STRUCTURES

1 Reinforcement for reinforced concrete structures

1.1 To reinforce concrete and reinforced concrete structures, hot rolled plain round bars and die-rolled sections of Classes A240 and A400 per GOST 5781-82 and Class A500C per GOST R 52544-2006 shall be used.

To reinforce increased protective layer of reinforced concrete structures in certain areas specified in the design, reinforcing fabric per GOST 23279-2012 and GOST 2715-75 shall be used. The fabric shall be made from Class B500 reinforcement – Class Bp-1 GOST 6727-80 cold rolled wire or Class B500C GOST R 52544-2006 cold formed reinforcement.

2 Technical requirements for production and installation of reinforcing structures

2.1 Reinforcing steel shall be protected against damage and corrosion during transportation and storage.

For making bent bars in accordance with the detailed design, minimum bending inside diameter shall be in accordance with SP 52-101-2003 paragraph 8.3.30.

Dimensions of bent bars shall be specified in drawings for outside faces, and of clamps - for inside faces (figures 8 и 9 per GOST 21.501-2011).

Reinforcement shall be installed in accordance with the work execution program containing instructions on installation sequence for certain components, delivery and joining methods, etc.

When bars are installed in their final positions, they shall be secured at the intersections by binding wire in accordance with the design. Each overlapping joint shall be tied in a double knot in three points: in the center and ends of the joint.

To provide protective layer for lower reinforcement of foundation and floor slabs, use cement-sand mortar spacers or concrete blocks. Never use steel spacers.

The following types of reinforcement bar joints shall be provided:

- overlap joint (requirements for this joint are specified in the detailed drawings);
- welded joint per GOST 14098-2014 (requirements for this joint are specified in the detailed drawings);
- Bartec type butt joint using threaded sleeves (TU 4842-192-46854090-2005, "Mechanical Joints of Dextra Bartec Reinforcement. Specifications") taking into consideration the requirements of RD EO 0657-2006 "Provision for the Use of Mechanical Joints in Reinforcement for Reinforced Concrete Structures in Nuclear Power Plant Buildings and Facilities";
- loop joints per STO SRO-P 60542948 00035-2015.

Threaded sleeve joints shall ensure the strength equivalent to the connected bars, in particular, for repeated and dynamic loads.

For butt joints of reinforcement, types of joints and welding procedures may be replaced by the other types of welded joints with similar performance in accordance with GOST 14098-2014 Appendix 2.

The following types of welded joints per GOST 14098-2014 are allowed: K1-Kт; C1-Ko; C14-Mн; C15-Pc; C17-Mн; C19-PM; C21-Ph. Welded joint C23-Pэ is allowed, if it is specified in the detailed drawings.

Welded joints shall be made in accordance with the technical requirements of GOST R 52544-2006 Appendix B and GOST 14098-2014.

Binding of cruciform joints and overlap joints of reinforcement shall meet the requirements of GOST 10922-2012 Appendix G. And two-row, cruciform or builder's knots shall be used for cruciform joints.

Technical requirements for anchorage of reinforcement bars in the existing concrete structures shall be specified in a separate document and detailed drawings.

3 Quality control and acceptance

3.1 Reinforcement shall be supplied in batches and accompanied with a quality control document containing the requirements similar to those specified in GOST 7566-94 para.3.7.

Tensile and bend test samples shall be collected from each batch. Chemical composition of steel shall be also controlled (if no appropriated data are specified in the quality control documents).

3.2 Butt joints of reinforcement shall be accepted in accordance with SP 63.13330.2012.

3.3 Requirements for design position tolerances of reinforcement bars shall be specified in the detailed drawings. If the tolerance are not specified in the detailed drawings, they shall be adopted in accordance with SP 70.13330.2012.

3.4 Acceptance inspection of reinforcing structures shall include:

- check of reinforcing structure dimensions for compliance with the design requirements per GOST 10922-2012 and SP 70.13330.2012;
- threaded sleeve joint quality inspection in the form of tensile test.

When any equipment is used to join bars by crimping, joint quality inspection shall be carried out in accordance with the equipment operating instructions with mandatory tensile test to fracture using test specimens of joints in the following quantities:

- at least six reinforcement joints of similar diameter for joining tool testing;
- at least three reinforcement joints of similar diameter per each 200 joints made using one set of joining tools.

Acceptance of all reinforcing structures shall be recorded in the concealed work inspection reports. The concealed work inspection reports shall be prepared in accordance with SP 70.13330.2012.

4 Reinforcement block requirements

Reinforcement blocks shall be made in the form of space wall frames and reinforcing formwork systems of floors (with stay-in-place steel formwork). Reinforcing formwork systems shall be used in the sealed volume of reactor building UJA.

Fabrication, storage, transportation and pre-assembling of reinforcement blocks shall be carried out in accordance with the dedicated process documents, requirements and recommendations specified in the detailed drawings for reinforcement blocks.

Special equipment shall be provided in the process documents for reinforcement blocks to ensure:

- fabrication and pre-assembling with dimension tolerances for entire structure and separate structural members that do not exceed the tolerances provided in the detailed drawings and this document;
- stiffness, stability and permanent geometrical shape of structures during tilting, storage, transportation, installation and concreting.

Reinforcement blocks shall be installed in accordance with the process procedures for erection of civil engineering structures and work execution programs based on these procedures.

For reinforcement block fabrication, use the tolerances that do not exceed those specified in the detailed drawings for these structures.

When the dimension tolerances are not specified in the detailed drawings, they shall be adopted in accordance with the requirements herein.

Tolerances for fabrication of reinforcement block girders:

- linear dimensions of girders per GOST 21779-82, accuracy class 5;
- linear dimensions of angles per GOST 21779-82, accuracy class 5;
- straightness of face surfaces of angles shall be within 2 mm per 1 m;
- installation of girder braces and struts in relation to nominal dimensions shall be within ± 10 mm.

Tolerances for fabrication of reinforcement flat bars and cages per GOST 10922-2012, accuracy class 7:

- cage width shall be within ± 2.5 mm;
- installation of lateral reinforcement in flat cages in relation to nominal dimensions shall be within ± 5 mm.

Tolerance for reinforcement block girder installation:

- lengthwise ± 5 mm;
- vertical lengthwise tolerance max. 10 mm;
- difference in height of supporting surfaces of girders max. 3 mm.

Tolerances for flat reinforcement cage installation:

- lengthwise ± 10 mm;
- heightwise ± 10 mm;
- vertical lengthwise tolerance max. 10 mm.

Tolerance for horizontal reinforcement installation:

- in vertical direction ± 5 mm;
- in horizontal direction ± 10 mm;

Diagonal difference between angular girders of reinforcement blocks shall be max. 20 mm.

Intersections of flat reinforcement cage vertical bars and horizontal reinforcement shall be tied with wire in points specified in the detailed drawings. Thermal treated wire per GOST 3282-74 shall be used in reinforcement joints.

Flatness of steel plates in stay-in-place formwork per GOST 19903-2015 shall be of high degree.

Stay-in-place steel forming structures shall be of Class 1 per GOST R 52085-2003.

Tolerance for reinforcement block installation:

- in longitudinal direction ± 10 mm;
- in lateral direction ± 10 mm;
- installation of additional flat reinforcement cages and separate reinforcement bars ± 5 mm.

REQUIREMENTS FOR EMBEDDED PARTS

1 General

1.1 Embedded parts are installed in concrete and reinforced concrete structures and are designed for framing, fastening of steel structures, piping and air ducts, for penetration of piping, air duct and cables through walls and floors.

2 Embedded part materials

2.1 The following steel grades and types of rolled stock shall be used for embedded steel structures:

- rolled stock for steel structures, GOST 27772-88;
- commercial-quality carbon steel, GOST 380-2005;
- commercial-quality carbon steel rolled bars and sections GOST 535-2005;
- commercial-quality carbon steel rolled plates GOST 14637-89.

For steel structures included in the sealed volume of the containment, use steels in accordance with NP -010-16 Appendix 1.

For anchorage of embedded parts, use reinforcement steel in accordance with para. 1 "Requirements for Reinforcement, Reinforcing Formwork Structures" herein.

3 Requirements for embedded parts with welded joints made per GOST 14098-2014

3.1 Embedded parts shall be made in accordance with the requirements of this document from reinforcement steel and rolled products that meet the requirements of standards or specifications for reinforcement steel and rolled products.

Anchor bars shall be welded to flat elements of embedded parts in accordance with GOST 14098-2014.

Inspection and acceptance of embedded parts shall be carried out in accordance with the requirements herein.

Reinforcement of Classes A240 and A400 per GOST 5781-82 and Class A500C per GOST R 52544-2006 shall be used as anchor bars for embedded parts.

It is advisable to use electrodes per SP 70.13330.2012 as welding materials for welding anchors to flat elements of embedded parts.

Actual linear dimension deviations in welded embedded parts shall not exceed the tolerances specified in the detailed drawings. If no tolerances are specified in the detailed drawings, actual linear dimension deviations shall not exceed the limits listed in GOST 10922-2012 Table 1 depending on the accuracy class of reinforced concrete structures per GOST 21779-82.

Flatness tolerance of external faces of flat embedded part elements shall not exceed 3 mm.

Angle between the flat element surface and anchor bar of embedded part shall be within the limits specified in GOST 14098-2014.

Edges of flat elements of embedded parts shall be cleaned from flame cutting burrs and slug.

Embedded part elements and welded joints shall be free from loose rust and scale, signs of oil and other contaminations. Weld metal in welded joints and base metal in heat affected zones shall have no visually detected cracks. Transition from weld metal to base metal shall be made without base metal undercutting. All carters shall be filled.

No weld metal interruptions and slug inclusions, burns of flat elements of embedded parts, holes, surface burns of base metal and lack of penetration are allowed.

Dimensions and amount of external defects in arc welded joints shall not exceed those specified in GOST 10922-2012 Table 3 Items 1 and 2.

Deviations of dimensions specified in GOST 14098-2014 for structural elements of welded joints shall not exceed the values listed in GOST 10922-2012 Table 2 Items 8 and 9.

Average ultimate strengths of T-joints and lap welded joints in reinforcement with flat elements of embedded parts shall be not less than those specified in GOST 10922-2012 Table 4 depending on the difference between the maximum and minimum values.

4 Requirements for embedded parts with welded joints made per GOST 5264-80

4.1 Welded joints in rolled products with flat elements of embedded parts and with tubular embedded parts shall be made per GOST 5264-80.

Embedded parts shall be made per GOST 10922-2012. Embedded parts shall be installed in accordance with SP 70.13330.2012.

Welded joint height shall be equal to the lowest thickness of welded elements, except for the joints specified in the design.

Dimensions of welded joint roots and seams, and tolerances for welded seam cross sections shall be as specified in GOST 5264-80.

No weld metal interruptions and slug inclusions, burns of rolled elements of embedded parts, holes, surface burns of base metal and lack of penetration are allowed.

Dimensions and amount of external defects in welded joints, and deviations from dimensions specified in GOST 5264-80 for structural elements of welded joints shall not exceed those listed in GOST 10922-2012.

5 Embedded part marking

5.1 Embedded parts or embedded part batch shall have a label containing the following details:

- type or identification of embedded parts;
- number of embedded parts in the batch;
- batch number and date of manufacture;
- QA stamp indicating acceptance of the product or batch.

6 Embedded part installation requirements

6.1 Tolerances for embedded part installation in cast-in-situ reinforced concrete structures shall not exceed those specified in the detailed drawings.

When the installation tolerances are not specified in the detailed drawings, they shall be adopted in accordance with SP 70.13330.2012.

For extra critical embedded parts that require high accuracy, dedicated devices and instruments shall be used during installation in cast-in-situ reinforced concrete structures. For installation of these embedded parts, special process documents shall be developed as part of the work execution programs.

6.2 Embedded parts installed in reinforced concrete structures can have the following dimension tolerances (except for cases specified in the design):

- flatness tolerance for face surfaces of embedded parts in relation to horizontal and vertical concrete surface is max. 5 mm;
- tolerance for position of flat elements of embedded parts is within ± 10 mm. In certain cases, tolerances for position of flat elements of embedded parts may be up to 100 mm to enable installation of embedded parts in accordance with the design requirements;
- tolerance for tubular embedded part axes is within ± 10 mm;
- flatness tolerance for faces of flat embedded part elements shall not exceed - 5 mm.

Burning of main reinforcement during welding of bracing elements is not allowed.

Embedded part bracing shall withstand loads that occur during concreting and vibration of newly placed concrete mix.

Possible deviations and displacements during concreting of embedded parts shall not exceed the tolerances mentioned above.

Deviation from the design position of door frames shall not exceed the manufacturer's tolerances specified in the installation drawings.

No deviations of the main reinforcement from the design position exceeding the tolerance specified in the design are allowed during embedded part installation and concreting.

In points of attachment of embedded parts to reinforcement, all intersections between the vertical and horizontal reinforcement shall be tied with binding wire and additional bracing shall be made with the embedded part pressed to the framework in accordance with the work execution program.

7 Requirements for embedded parts and steel structures made from structural steel per GOST 27772-88

7.1 For the purpose of production of embedded parts and steel structures, GOST 27772-88 steel may be replaced in accordance with STO 02494680-0045-2005 Table 1 and additional requirements for impact strength of rolled plates and rolled sections taking into account Appendix C and Table C1 of SP 16.13330.2011.

Higher grade steels may be used (of higher strength class) within the same steel group in accordance with SP 16.13330.2011 Appendix 1.

8 Quality control and acceptance

8.1 Inspection and acceptance during production of embedded parts with reinforcement anchors with welded joints made per GOST 14098-2014.

8.1.1 Embedded parts shall be accepted by QA after visual inspection, measurements and mechanical tests.

Embedded parts shall be accepted in batches. A batch of finished embedded parts shall contain products of the same size (type) made in accordance with the unified procedure by the same welder.

In addition, one embedded part batch may contain parts per GOST 10922-2012 (section 3.4 paragraph 5, 6; section 3.5 sub-paragraph 2; section 3.6).

The batch size shall not exceed the number of parts made during one shift.

Number of parts collected from the batch for visual inspection and measurements shall not be less than three and less than 10% of the total number of parts in the batch.

Each selected embedded part shall be inspected in accordance with GOST 10922-2012 (section 3.15).

Dimensions of structural elements shall be checked during inspection of welded joints.

In case when, during visual inspection and measurements of embedded part, at least one part does not meet the requirements specified in this document, repeated inspection shall be carried out for twice as much number of parts.

When, during the repeated inspection, at least one part does not meet the requirements of this document, all parts from this batch shall be accepted separately and repaired.

Visual inspection results and measurements shall be recorded in the acceptance report. Welded joints of embedded parts shall be checked for compliance with the average strength requirements by mechanical test of test specimens collected from the batches accepted after visual inspection and measurements. Three mechanical test specimens of welded joints and base metal of bars shall be collected from the batch.

Mechanical test of test specimens shall be carried out in accordance with the requirements of GOST 10922-2012 (sections 3.26...3.30).

8.2 Inspection and acceptance during production of embedded parts made from rolled steel with welded joints made per GOST 5264-80.

8.2.1 The scope and methods of inspection of welded joints in rolled products with flat elements of embedded parts and with tubular embedded parts shall be defined in accordance with the design requirements. Embedded part quality control shall be performed in accordance with SP 53-101-98. Welded seams shall be checked for tightness in accordance with GOST 3242-79 and PNAE G-7-019-89 using the methods and in the scope specified in the design.

8.3 Inspection and acceptance during embedded part installation

8.3.1 Embedded parts installed in reinforced concrete structures shall be accepted by QA.

Embedded parts shall be accepted in accordance with SP 70.13330.2012.

Embedded parts shall be undergo 100% acceptance.

The following aspects shall be checked during acceptance of embedded parts:

- embedded part acceptance reports prepared after visual inspection, measurements and mechanical tests as specified in para. 8.1;
- flatness tolerance for face surfaces of embedded parts in relation to concrete surface;
- linear dimension tolerance for flat elements of embedded parts;
- tolerance for tubular embedded part axes;
- flatness tolerance for face surfaces of embedded parts.

Methods for inspection and acceptance during production of embedded parts with welded joints made per GOST 14098-2014 shall be as specified in GOST 10922-2012.

For production of embedded parts with welded joints made per GOST 5264-80, methods and scope of inspection shall be specified in the design (see para. 8.2).

8.4 Test methods for installed embedded parts.

8.4.1 Embedded parts installed in reinforced concrete structures shall be tested using the following measurement tools: properly verified tape measures, rulers and callipers. Measurement error shall be up to 1.0 mm.

Other measurement tools that ensure the required accuracy of measurement may be used.

9 Transportation and storage

9.1 Measures shall be taken to avoid any mechanical damage of embedded parts during transportation.

Embedded parts shall be stored indoors.

COROSION PROTECTION OF CIVIL ENGINEERING STRUCTURES

1 Pre-installation corrosion protection of carbon steel embedded parts

1.1 Controlled access area within the sealed volume of the reactor building.

Pre-installation corrosion protection of flat embedded parts shall be made according to the following scheme:

- aluminizing with coating thickness of 200 μm per GOST 7871-75 (on both sides, including ends);
- two coatings of EP-5285 epoxy enamel per TU 95 2184-90 (face and end surface);
- total coating thickness is 250 μm .

Corrosion protection of inner surfaces of pipe penetrations and outer surfaces (including flanges) to a depth of 30 mm from the pipe end shall be made according to the full scheme:

- TsINEP zinc-rich epoxy primer, one 50 μm coating per TU 2312-022-12288779-2000;
- EP-5285 epoxy enamel, four coatings per TU 95 2184-90;
- total coating thickness is 210 μm .

1.2 Controlled access area outside the sealed volume of the reactor building.

Pre-installation corrosion protection of flat embedded parts shall be made according to the following scheme:

- TsINEP zinc-rich epoxy primer, one 50 μm coating per TU 2312-022-12288779-2000 (on both sides, including ends);
- EP-5285 epoxy enamel, two coatings per TU 95 2184-90;
- total coating thickness is 130 μm .

Corrosion protection of inner surfaces of pipe penetrations and outer surfaces (including flanges) to a depth of 30 mm from the pipe end shall be made according to the full scheme:

- TsINEP zinc-rich epoxy primer, one 50 μm coating per TU 2312-022-12288779-2000;
- EP-5285 epoxy enamel, four coatings per TU 95 2184-90;
- total coating thickness is 210 μm .

1.3 Common access area.

Pre-installation corrosion protection of flat embedded items in the common access area premises and buildings and outdoors shall be carried out as follows:

- Zinol zinc-rich paint, two coatings per TU 2313-012-12288779-99 (on both sides, including ends);
- total coating thickness is 80 μm .

Corrosion protection of inner surfaces of pipe penetrations and outer surfaces (including flanges) to a depth of 30 mm from the pipe end shall be made according to the full scheme:

- Zinol zinc-rich paint, three coatings per TU 2313-012-12288779-99;
- total coating thickness is 120 μm .

1.4 Final corrosion protection of external surfaces of embedded parts shall be made together with corrosion protection of civil engineering structures of in the sealed volume according to detailed drawings.

2 Corrosion protection of civil engineering structures

2.1 Corrosion protection of reinforced concrete and steel structures in the common access area shall be implemented according to the detailed drawings.

2.2 Corrosion protection of outdoor carbon steel structures shall be performed as follows:

- TsINEP zinc-rich epoxy primer, one 60 μm coating per TU 2312-022-12288779-2000;
- IZOLEP-mio epoxy enamel, two 120 μm coatings per TU 2312-050-12288779-2005;
- Politon-UR (UF) acrylic urethane enamel, one 60 μm coating per TU 2312-033-12288779-2002;
- total coating thickness is 240 μm .

2.3 Corrosion protection of carbon steel structures in the common access area shall be performed as follows:

- TsINEP zinc-rich epoxy primer, one 50 μm coating per TU 2312-022-12288779-2000;
- EP-140 epoxy enamel, four coatings per TU 24709-81;
- total coating thickness is 200 μm .

3 Surface preparation of carbon steel embedded parts in the common access area shall be performed as follows:

- degreasing of surface up to grade 1 per GOST 9.402-2004;
- grit blasting from scale and oxides up to grade 2 per GOST 9.402-2004;
- dust removal.

In the common access area, local mechanical cleaning of metal surfaces is allowed up to grade 3 per GOST 9.402-2004 followed by dust removal.

4 Floor, wall and ceiling finishing in the common access area is specified in the detailed drawings.

Requirements for concrete surface preparation for application of protection coatings (floors, walls and ceilings) are listed in the detailed drawings (drawings with marking 011 and 012) in accordance with SNiP 3.04.03-85 Table 2.

LIST OF STANDARDS AND REFERENCES

Document identification number	Name of document
384-FZ	Technical Regulations on the Safety of Buildings and Facilities. Federal Law
NP-010-16	Rules for Arrangement and Operation of Localizing Safety Systems at Nuclear Power Plants.
PNAE G-7-019-89.	Unified Procedures for Control of Base Materials (Semi-Finished Products), Welded Joints and Weld Deposits on NPU equipment and piping. Tightness Control. Gas and Liquid Methods.
PiN AE-5.6	Structural Design Code for NPP with Different Types of Reactors
GOST 10178-85	Portland Cement and Blast-Furnace Slag Portland Cement Specifications
GOST 10181-2014	Concrete Mixes. Test Methods.
GOST 10922-2012	Reinforcement and Embedded Parts, Their Welded, Tied and Mechanical Joints for Reinforced Concrete Structures. General Specifications
GOST 12730.1-78	Concrete. Density Test Methods
GOST 12730.2-78	Concrete. Moisture Test Methods
GOST 12730.5-84	Concrete. Waterproofness Test Methods
GOST 13087-81	Concrete. Wear Test Methods
GOST 14098-2014	Welded Joints of Reinforcement and Embedded Parts in Reinforced Concrete Structures Types, Structures and Sizes
GOST 14637-89	Commercial-Quality Carbon Steel Rolled Plates. Specifications
GOST 15150-69	Machines, instruments and other industrial products. Modifications for different climatic regions. Categories, operating, storage and transportation conditions as to environment climatic aspects influence
GOST 17623-87	Concrete. Nuclear-Radiation Method for Average Density Determination
GOST 17624-2012	Concrete. Nuclear-Radiation Method for Average Density Determination
GOST 18105-2010	Concrete. Ultrasonic Method for Strength Determination

Document identification number	Name of document
GOST 19903-2015	Hot Rolled Steel Plates. Dimensions
GOST 21.501-2011	Design Document System for Construction. Rules for Execution of Detailed Documentation for Architectural and Construction Solutions
GOST 21718-84	Construction Materials. Dielectric Moisture Metering Method
GOST 21779-82	System for Ensuring Accurate Geometrical Parameters in Construction. Manufacturing Tolerances
GOST 22266-2013	Sulfate-Resistant Cement. Specifications
GOST 22690-2015	Concrete. Non-Destructive Mechanical Strength Test Methods
GOST 23422-87	Construction Materials. Neutron Moisture Metering Method
GOST 23279-2012	Welded Reinforcement Fabric for Reinforced Concrete Structures and Products General Specifications
GOST 23732-2011	Water for Concrete and Mortar. Specifications
GOST 24211-2008	Additives for Concrete and Mortar. General Specifications
GOST 24544-81	Concrete. Shrinkage Strain and Creep Test Methods
GOST 24709-81	EP-140 Enamels. Specifications
GOST 26633-2012	Heavy-Weight and Fine-Grain Concrete. Specifications
GOST 27006-86	Concrete. Composition Selection Rules
GOST 2715-75	Metal Wire Mesh. Types. Parameters and Basic Maximum Dimensions
GOST 27338-93	Power-Operated Concrete-Mixing Plants. General Specifications
GOST 27339-93	Truck Mixers. General Specifications
GOST 27772-88	Rolled Stock for Steel Structures. General Specifications
GOST 28570-90	Concrete. Strength Test Methods Using Specimens Collected from Structures
GOST 310.5-88	Cement Heat Generation Test Methods
GOST 31384-2008	Corrosion Protection for Concrete and Reinforced Concrete Structures General Technical Requirements

Document identification number	Name of document
GOST 3242-79	Welded Joints. Quality Control Methods.
GOST 3282-74	General-Purpose Low Carbon Steel Wire. Specifications
GOST 380-2005	Commercial-Quality Carbon Steel Grades
GOST R 52085-2003	Formwork. General Specifications
GOST R 52544-2006	Weldable Reinforcement Die-Rolled Sections of Classes A500C and B500C for Reinforced Concrete Structures. Specifications
GOST 5264-80	Manual Arc Welding, Welded Joints. Basic Types, Structural Elements and Dimensions
GOST 535-2005	Commercial-Quality Carbon Steel Rolled Bars and Sections General Specifications
GOST 5781-82	Hot Rolled Steel for Reinforcement of Reinforced Concrete Structures. Specifications
GOST 6727-80	Low Carbon Steel Cold-Drawn Wire for Reinforcement of Reinforced Concrete Structures. Specifications
GOST 7473-2010	Concrete Mixes. Specifications
GOST 7566-94	Steel Products. Acceptance, Marking, Packing, Transportation and Storage
GOST 7871-75	Aluminium and Aluminium Alloy Welding Wire Specifications
GOST 8267-93	Dense Rock Crushed Stone and Gravel for Construction Work. Specifications
GOST 8736-2014	Sand for Construction Work. Specifications
GOST 9.402-2004	Unified Corrosion and Ageing Protection System. Paint Coatings. Preparation of Metal Surfaces for Painting
RD EO 0657-2006	Provision for the Use of Mechanical Joints in Reinforcement for Reinforced Concrete Structures in Nuclear Power Plant Buildings and Facilities
SNiP 3.04.03-85	Corrosion protection for civil engineering structures
SP 16.13330.2011	Steel Structures. Code of Practice. Updated version of SNiP II-23-81
SP 28.13330.2012	Corrosion protection of civil engineering structures Code of Practice. Updated version of SNiP 2.03.11-85
SP 48.13330.2011	Construction Management. Updated version of SNiP 12-01-2004

Document identification number	Name of document
SP 52-101-2003	Concrete and Reinforced Concrete without Reinforcement Pre-Tensioning
SP 52-102-2004	Pre-Tensioned Reinforced Concrete Structures
SP 53-101-98	Fabrication and Quality Control of Civil Engineering Structures
SP 63.13330.2012	Concrete and Reinforced Concrete Structures. General Provisions. Code of Practice. Updated version of SNiP 52-01-2003
SP 70.13330.2012	Bearing and Enclosing Structures. Code of Practice. Updated version of SNiP 3.03.01-87
STO 02494680-0045-2005.	Rolled Stock for Steel Structures. Grades of Steel. Organization Standard
STO 1.1.1.03.003.0911-2012	Concrete for Civil Engineering Structures and Radiation Protection of Nuclear Power Plants
STO SRO-P 60542948 00035-2015	Organization Standard Nuclear Power Facilities. Design of NPP Reinforced Concrete Structures with Loop Joints of Reinforcement Bars
STO SRO-S 60542960 00050-2015.	Organization Standard Nuclear Power Facilities. Main Requirements for Execution of Work with Self-Compacting Concrete Mixes (SCCM)
TU 14-9-102-76	A600C Thermomechanical Hardened Rolled Stock for Reinforcement of Reinforced Concrete Structures
TU 2313-012-12288779-99	TsINOL Zinc-Rich Corrosion Protection Compound (AK-0440 Primer)
TU 2312-022-12288779-2000	TsiNEP Zinc-Rich Corrosion Protection Primer (EP-0439)
TU 2312-029-12288779-2002	POLITON-UR Enamel
TU 2312-033-12288779-2002	POLITON-UR (UF) Enamel
TU 2312-050-12288779-2005	IZOLEP Enamel
TU 4842-196-46854090-2005	Mechanical Joints of Dextra Bartec Reinforcement
TU 95 2184-90	EP-5285 Finishing Enamel. Specifications

Document identification number	Name of document
VSN 025-69	Temporary Instructions for Calculation and Design of Angular Loop Joints of Reinforced Concrete Structures
ISO 9001:2008	Quality management systems. Requirements
EN 1992-1 Eurocode 2	Design of Reinforced Concrete Structures Part 1. General Design Rules and Building Design Rules
EN 206-1	Concrete. General Technical Requirements. Production and Quality Control.

REVISION SHEET

Rev.	Sheet (page) numbers				Total number of sheets in the docu- ment	Docu- ment No.	Signa- ture	Date
	changed	replaced	new	deleted				
1 (C02)	-	All	-	-	47	3632-16	<i>Hyl</i>	31.10.16