

STATE STANDARD OF UKRAINE

Building Materials

**CONCRETE.
METHODS for DETERMINATION of
FROST RESISTANCE**

General requirements

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C o n t e n t s

1	Field of use.....	1
2	References documents.....	1
3	Definitions	2
4	General requirements	2
Appendix A		
	Template of frost resistance test log.....	7

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CONCRETES. METHODS for DETERMINATION of FROST RESISTANCE

General requirements

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1 FIELD OF USE

This standard is applicable to heavy, fine-grained, light, and dense silicate concretes (hereinafter referred to as "concretes") and establishes basic and rapid methods for determining its frost resistance.

The methods are used in accordance with guidelines of this standard and DSTU B.B.2.7-48 (GOST 10060.1) ...DSTU B.B.2.7-51 (GOST 10060.4) when selecting the composition and quality control of concrete for concrete and reinforced concrete products, structures and buildings, which are intended for operation under conditions of joint influence of freeze-thaw temperatures and water environment.

When the results of frost resistance determined by basic and rapid test methods differ, the results obtained by basic methods shall be accepted as final.

The structural-and-mechanical method is intended for assessing the frost resistance of concrete when selecting and adjusting its composition by laboratories of industrial enterprises and is not used to control the frost resistance.

2 REFERENCE DOCUMENTS

References to the following standards are used in this document:

GOST 10180-90	Concrete. Methods for strength determination using the testing specimens
GOST 10181.0-81	Concrete mixtures. General requirements for test methods
GOST 22685-89	Moulds for making the testing specimens of concrete. Specifications

3 DEFINITIONS

This standard uses the following terms with appropriate definitions.

3.1 Frost resistance of concrete is the ability to withstand the stresses and keep physical and mechanical properties during repeated alternate freezing and thawing. Frost resistance of concrete is classified using the corresponding frost resistance F index.

3.2 Frost resistance grade of concrete is the number of freezing and thawing cycles of concrete samples established by the regulations, during which the initial physical and mechanical properties are preserved within the specified limits.

3.3 The test cycle is one total period of freezing and thawing of samples.

3.4 Main specimens are samples intended for freezing and thawing (testing).

3.5 Test specimens are samples intended to determine the compressive strength of concrete before starting the test of the main specimens.

4 GENERAL REQUIREMENTS

4.1 This standard establishes the following methods for determining the frost resistance:

Basic methods, namely the first one (for all types of concrete, except for road and airfield pavement) and the second one (for road and airfield pavement);

Rapid methods by repeated freezing and thawing, namely the second one and third one;

Rapid methods during one-time freezing, namely the fourth (dilatometric) and the fifth ones (structural-and-mechanical).

4.2 The test conditions for determining the frost resistance, depending on the method and type of concrete, are accepted in accordance with Table 1.

Table 1

Method ID	Saturation environment	Test conditions		
		Freezing environment, temperature, degrees of C	Thaw environment	Type of concrete
Basic				
First	Water	Air, minus (18+-2)	Water	All types of concrete, except for road and airfield pavement
Second	5% aqueous sodium chloride solution	Air, minus (18+-2)	5% aqueous sodium chloride solution	Concrete for road and airfield pavement
Rapid methods with repeated freezing and thawing				
Second	5% aqueous sodium chloride solution	Air, minus (18+-2)	5% aqueous sodium chloride solution	All types of concrete, except for road and airfield pavement and lightweight concrete with average density of less than D1500
Third	5% aqueous sodium chloride solution	5% aqueous sodium chloride solution, minus (50+-5)	5% aqueous sodium chloride solution	All types of concrete, except for lightweight concrete with average density of less than D1500
Rapid methods with one-time freezing				
Fourth	Water	Kerosene, minus (18+-2)	-	All types of concrete, except for road and airfield pavement
Fifth	Water	Air, minus (18+-2)		All types of concrete, except for road and airfield pavement

4.3 The frost resistance of concrete is determined in the design age, which is established by the regulatory and technical and design documentation, when it achieves the compressive strength proper for its class (grade).

4.4 Measuring instruments, equipment and devices shall meet the requirements of this standard and shall be verified in accordance with the established procedure by state authorities.

4.5 Concrete specimens should be made in moulds that meet the requirements of GOST 22685.

4.6 Specimens are made and tested in batches.

4.7 Concrete mix samples are selected pursuant to GOST 10181.0; samples are made and stored pursuant to GOST 10180.

When making specimens with size of 70 mm, and the maximum aggregate size of concrete mix is up to 40 mm, the aggregate grains larger than 20 mm have to be removed (manually or using the sieve with cell of 20 mm).

4.8 The number and size of manufactured concrete specimens, depending on the method of determining the frost resistance, are accepted pursuant to Table 2.

4.9 Test specimens have to be without external defects, their average density shall not differ from the minimum by more than 50 kg/m³.

4.10 The mass of the samples is determined with an error of no more than 0.1%.

4.11 Test specimens of concrete before strength test, and the main specimens before freezing, are saturated with water (salt solution), its temperature is (18±2) degrees of Celsius. For saturation, the specimens are immersed in liquid for 1/3 of their height for 24 hours, then the liquid level is raised to 2/3 of the specimen height and kept in this condition for another 24 hours, after that the specimens are completely immersed in liquid for 48 h so that the liquid level is higher than the upper edge of the specimens by at least 20 mm.

Table 2

Freeze - thaw method	Specimen size, mm	Number of specimens, pcs	
		testing	main
First	100x100x100 or 150x150x150	6	12
Second	100x100x100 or 150x150x150	6	12
Third	100x100x100 or 70x70x70	6	6
Fourth	100x100x100 cylinders: Diameter: 70 Height: 70	-	3
Fifth	100x100x100 or 150x150x150	3	3

Note: For the concrete of hydrotechnical structures tested using the first method, it is allowed to use specimens with size of 200x200x200 mm.

4.12 The number of testing cycles of the main concrete specimens during one day should be at least one.

4.13 The ratio between the number of test cycles and the frost resistance grade of concrete for methods based on freezing-and-thawing is taken from Table 3.

Table 3

Test method	Concrete type	Number of freeze-thaw cycles for frost resistance grade of concrete												
		F25	F35	F50	F75	F100	F150	F200	F300	F400	F500	F600	F800	F1000
First (basic)	All types of concrete, except for road and airfield pavement	15*	25	35	50	75	100	150	200	300	400	500	600	800
		25	35	50	75	100	150	200	300	400	500	600	800	1000
Second (rapid)	All types of concrete, except for road and airfield pavement and lightweight concrete with average density of less than D1500						20	30	45	75	100	150	200	300
				8	13	20	30	45	75	100	150	200	300	450
Third (rapid)	All types of concrete, except for road and airfield pavement and lightweight concrete with average density of less than D1500	-	-	-	2	3	4	5	8	12	15	19	27	35
Second (basic)	Concrete for road and airfield pavement			35	50	75	100	150	200	300	400	500	600	800
				50	75	100	150	200	300	400	500	600	800	1000
Third (rapid)	Concrete for road and airfield pavement	-	-	-	-	5	10	20	37	55	80	105	155	205

* Above the line there is the number of cycles, after which an interim test is performed; below the line there is the number of cycles corresponding to the grade of concrete in terms of frost resistance.

4.14 During the interim period of testing, the condition of the specimens is monitored: appearing the cracks, chips, scaling of the surface. When the specified

defects appear, the tests are stopped, and it is recorded in the test log that the concrete does not meet the required level of frost resistance.

4.15 When the specimens of different sizes are frozen simultaneously in the freeze cabinet, the time for holding the specimens inside is taken to be suitable for the largest specimens.

In case of forced interruption in the test, the specimens are kept in the air for not more than 5 days before continuing the test; the specimens are saturated again with water (salt solution) according stated in par.4.11.

If the test is interrupted for more than 5 days, the test is resumed with a new set of specimens.

4.17 The initial data and test results of testing and main concrete specimens under the first-third methods are entered in the test log, its template id provided in Appendix A.

Appendix A
(recommended)

**TEMPLATE OF TEST LOG
for FREEZE THAW TESTING OF CONCRETE**

Table A.1

Initial data of testing and main specimens							Results of specimen testing									
							Testing specimens			Main specimens						
										Interim testing						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Date of specimen receipt	ID of batch (set) and their labelling	Size of specimen, mm	Date of specimen manufacture	Mass of specimen, g	Compressive strength class (Grade) of concrete	Design frost resistance level of concrete, cycle	Signature of the person who received a specimens for testing	Date of testing	Compressive strength in saturated condition, MPa	Average strength, MPa	Starting date of testing	Mass of saturated specimen before testing, g *1	Average mass, g *	Starting date of interim testing	Number of interim cycles	Mass of specimen, g *

Results of specimen testing															
Main specimens															
Interim testing						Final testing									
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Average mass, g *	Reduction of average mass, %*	Compressive strength, MPa	Average strength, MPa	Variation of average strength, %	Signature of the person who performed the interim testing	Date of final testing	Number of cycles from the testing start	Mass of specimen, g *	Average mass, g*	Reduction of average mass, %*	Compressive strength, MPa	Average strength, MPa	Variation of average strength, %	Conclusion on the testing results	Signature of the responsible person

Laboratory Head Full name

¹ * The columns are used only when the concrete for road and airfield pavement is tested