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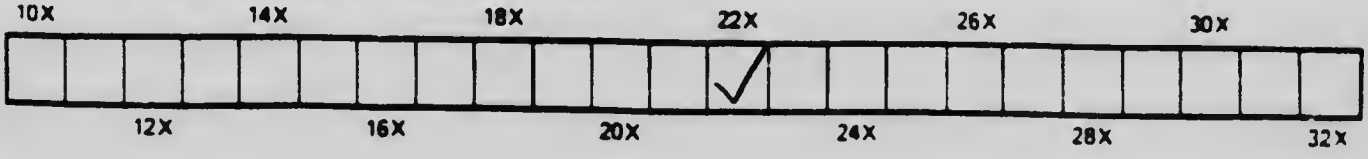

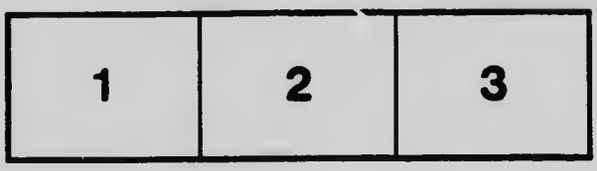

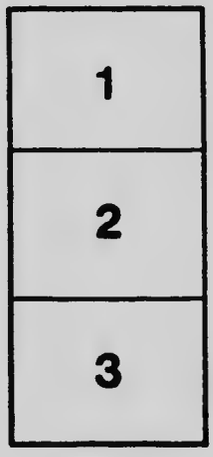

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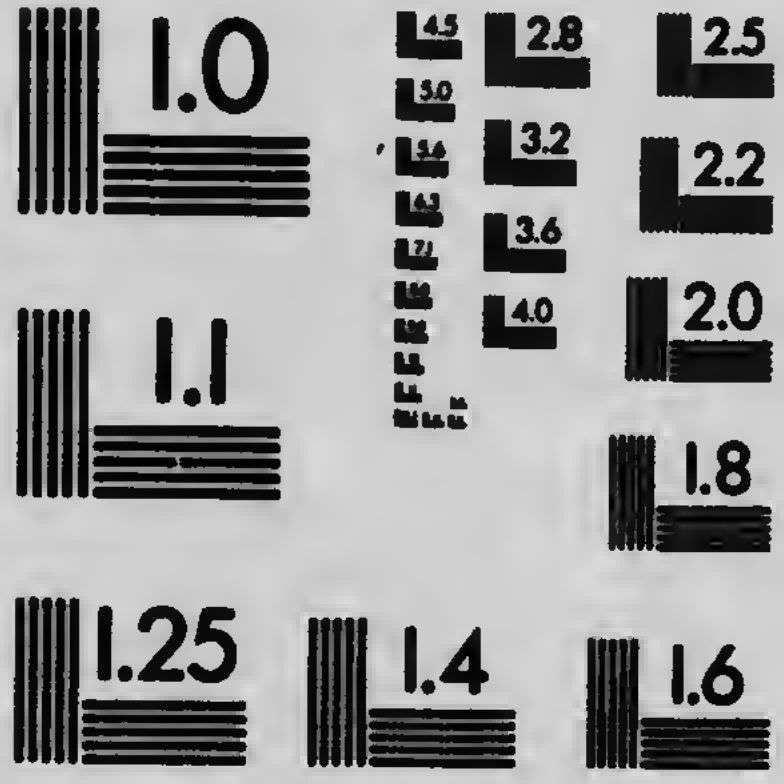

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Standard General Specifications

for

Concrete

and

Reinforced Concrete

Adopted at the Annual Meeting 1915

The

Canadian Society of Civil Engineers

Standard General Specifications for Concrete and Reinforced Concrete

Prepared and Recommended by the Committee and Adopted by the Society at its Annual Meeting, January, 1915

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The Canadian Society of Civil Engineers

STANDARD GENERAL SPECIFICATIONS FOR CONCRETE AND REINFORCED CONCRETE.

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MATERIALS.

1. **CEMENT.**

"Cement" shall be Portland cement complying in every particular with the "Specification for Portland Cement and Standard Methods of Testing" adopted by the Canadian Society of Civil Engineers.

As far as practicable the same brand shall be used throughout each piece of work.

2. **SAND.**

"Sand" shall be natural or artificial silicious material having particles graded from fine to coarse. It shall be free from dust, soft particles, vegetable loam or other foreign matter. The particles shall be of such a size that all will pass through a circular hole ⅛" in diameter in a thin plate and that none will pass through a circular hole 1-100" in diameter in a thin plate.

3. CRUSHED STONE.

"Crushed Stone" shall be silicious or calcareous material having fragments graded from fine to coarse. It shall be made by crushing natural rock or boulders having a crushing strength of at least 6,000 pounds per square inch, and be free from flat pieces, dust, soft particles and foreign matter. It shall be clean, hard and durable. The fragments shall be generally uniform in shape and of such a size as to pass through a circular hole 2½" in diameter in a thin plate and that none will pass through a circular hole ⅛" in diameter in a thin plate.

4. GRAVEL.

"Gravel" shall be the naturally produced material corresponding in every particular to the requirements of crushed stone.

5. CINDERS.

"Cinders" shall be hard, clean, vitreous clinker, thoroughly vitrified, crushed to such a size that all will pass through a circular hole 2½" in diameter in a thin plate and none will pass through a circular hole ⅛" in diameter in a thin plate, and be free from sulphides, ashes, coal, coke or any material combustible at a temperature below 1,500° Fahrenheit.

6. WATER.

"Water" shall be fresh water and be free from oil, acid, alkalis, organic or saline matter.

7. STEEL.

"Steel" shall have the properties set forth in Section 31, and be free from mill scale, excessive rust, oil or other foreign matter.

8. MORTAR.

"Mortar" shall be composed of cement, sand and water.

9. CONCRETE.

"Concrete" shall be composed of mortar and crushed stone or gravel, or of mortar and crushed stone and gravel.

10. CINDER CONCRETE.

"Cinder Concrete" shall be composed of mortar and cinders.

11. REINFORCED CONCRETE.

"Reinfofced Concrete" shall be composed of concrete in which steel of small sectional area is systematically embedded at the

time of depositing the concrete for the purpose of forming a structure in which the component parts act together in resisting applied forces.

12. REINFORCED CINDER CONCRETE.

"Reinforced Cinder Concrete" shall be composed of cinder concrete in which steel of small sectional area is systematically embedded at the time of depositing the cinder concrete for the purpose of forming a structure in which the component parts act together in resisting applied forces.

13 RUBBLE CONCRETE.

"Rubble Concrete" shall be the mass obtained by embedding boulders, fragments of rock, or both, in concrete while being deposited in place.

METHODS OF CALCULATION.

14. PROPORTIONING OF PARTS.

Every structure of concrete or of reinforced concrete shall be so designed that any possible combination of loading thereon will not produce stresses of greater intensity than the unit stresses given in this specification.

15. LOADING GENERALLY.

The loads to be resisted shall be considered to consist of the dead load and the live load.

The dead load shall be the weight of the structure itself and any other fixed loads.

The live load shall be all loads other than dead loads.

The loads shall be reduced to their static equivalents by a recognized method of design. All dynamic, vibratory and impact effects shall be considered and provided for.

16. LOADS ON BUILDING COLUMNS.

In the case of columns in buildings which support three or more floors, reduction of live load may be made in accordance with this section, except in the case of buildings such as warehouses in which the floors are liable to be fully loaded simultaneously. For the columns supporting the roof and top floor the full live load shall be taken. For the succeeding columns taken in order, the full live load on such columns may be reduced successively by 5% until a reduction of 50% is reached. For all lower columns the live load shall be taken as at least 50% of that used in calculating the floors.

17. SPAN OF BEAMS AND SLABS.

The effective span of beams or slabs shall be the clear span plus the depth of beam or slab, but need not exceed the distance from centre to centre of supports. Brackets shall not be considered as affecting the clear span in this connection.

18. BENDING MOMENTS OF BEAMS AND SLABS.

Taking w to represent the equivalent static load per unit length of span of beam or slab, and l to represent the effective span length, the following bending moments shall be used:—

(a) For beams or slabs supported at both ends without constraint, $+\frac{wl^2}{8}$

(b) For beams or slabs continuous over three or more equal spans, $+\frac{wl^2}{12}$ at centres of interior spans and $-\frac{wl^2}{12}$ over their intermediate supports; and $+\frac{wl^2}{10}$ at the section of maximum bending moment in end spans and $-\frac{wl^2}{10}$ over their inner supports.

(c) For beams or slabs continuous over two equal spans only, $-\frac{wl^2}{8}$ over the centre support, and $+\frac{wl^2}{10}$ at the section of maximum bending moment in the spans.

When the spans are of unequal lengths, or when special cases of loading arise, the bending moments over the supports shall be computed on static principles, and the moments in the spans shall be determined on the assumption that the moments at the supports are only effective to fifty per cent. of their static value.

19. ASSUMPTIONS FOR STRESSES IN BEAMS AND SLABS.

The stresses in beams and slabs due to the bending moment shall be determined from the principles of the bending of homogeneous beams, using the following assumptions,—

(a) that the modulus of elasticity of concrete in compression is constant,

(b) that the tensile resistance of concrete is negligible, and the steel reinforcement carries all the tension,

(c) that plane transverse sections of a beam before bending remain plane after bending,

(d) that the steel and concrete are properly bonded together, and that in beams reinforced on the compression side the two materials are stressed in compression in the ratio of their moduli of elasticity,

(e) that initial stress in the beam due to shrinkage of the concrete is negligible,

(f) that the effective depth of a beam or slab is measured from the extreme compression layer to the centre line of the tension reinforcement.

20. PROPORTIONING OF TEE BEAMS.

In beam and slab construction the design shall provide efficient bond between the slab and beam. The slab on one or both sides of the stem of the beam shall be regarded as forming part of the compression area of the beam. The effective width of slab so acting shall not exceed one-fourth of the span of the beam, and the overhang on each side of the stem shall not exceed four times the slab thickness, nor twice the width of the stem.

Where a tee-beam is continuous, as at a column, and the bending moment undergoes reversal, the stresses due to the end moment shall be computed as for a rectangular beam reinforced on both tension and compression sides.

21. PROPORTIONING OF SLABS.

When the reinforcement of the slab runs in one direction only, computations shall be made by the formulæ for simple beams.

When employing flat slab systems where the reinforcement runs in two or more directions the designer shall use his judgment in the interpretation of theories regarding stresses therein, and of experimental results obtained from slabs so reinforced.

22. PROPORTIONING OF PIERS AND COLUMNS.

When the unsupported length of a compression member subjected to axial load does not exceed six times the least dimension of its effective area, it shall be deemed a pier, and if its unsupported length exceed the above limit it shall be deemed a column. All columns shall be reinforced.

The effective area of a column shall be the area included within the line circumscribing and touching the outermost reinforcing.

The diameter of a column shall be the least dimension of its effective area.

The length of column shall be measured between its lateral supports, neglecting bracketing, and shall not exceed fifteen times its diameter.

UNIT STRESSES.

23. Ultimate Compressive Strength of Concrete.

In the absence of tests on concrete made from the materials to be used, the following values shall be taken as the ultimate compressive strength of concrete, twenty-eight days after mixing, having the proportions of ingredients as set forth.

	Ultimate compressive strength in pounds per square inch				
Proportion of ingredients (cement, sand, crushed stone or gravel)	1:1:2	1:1½:3	1:2:4	1:2½:5	1:3:6
Kind of crushed stone or gravel					
Granite, trap rock	3300	2800	2200	1800	1400
Gravel, hard limestone or hard sandstone	3000	2500	2000	1600	1300
Soft limestone or soft sandstone	2200	1800	1500	1200	1000
Cinders	800	700	600	500	400

24. Compressive Stress in Piers and Abutments.

The compressive stress in concrete piers and abutments shall not exceed 25% of the ultimate compressive strength of the concrete.

25. Bearing Stress on Piers and Abutments.

The bearing stress on piers and abutments shall not exceed one-third of the ultimate compressive strength of the concrete, if the compression be applied to a surface of concrete less than one-half the surface of the pier or abutment, otherwise the bearing

stress shall not exceed 25% of the ultimate compressive strength of the concrete.

26. COMPRESSIVE STRESS IN COLUMNS.

The safe axial load on columns shall be determined by the following formulæ,—

(1) Columns with longitudinal reinforcing only,

$$P = Af_c [1 + (n-1)p]$$

(2) Hooped columns,

$$P = Af_c [1 + (n-1)(2.4h + p)]$$

in which P = safe axial load, in pounds.

A = effective area of column, in square inches.

A_s = sectional area of longitudinal steel embedded in the concrete, in square inches.

$p = \frac{A_s}{A}$

f_c = 25% of the ultimate compressive strength of the concrete, in pounds per square inch.

n = modular ratio of steel to concrete = 15.

$h = \frac{\text{volume of circumferential reinforcing}}{\text{volume of column enclosed}}$.

$\frac{P}{A}$ shall not exceed 50% of the ultimate compressive strength of the concrete.

For columns with longitudinal reinforcing only, p shall not be less than 0.01 nor more than 0.04.

Columns shall be deemed hooped columns when h is not less than 0.0075 nor more than 0.015, and when p is not less than 0.01. The value of (h+p) for hooped columns shall not exceed 0.05, and h shall not exceed p.

When the above stresses are used the length of a hooped column shall not exceed ten times its diameter as defined in Section 22.

27. COMPRESSIVE STRESS IN BEAMS.

The compressive stress at the extreme layer of beams shall not exceed 32½% of the ultimate compressive strength of the concrete. The estimated compressive stress due to the end moment on a continuous beam may be allowed to exceed this value by 15%.

28. SHEARING STRESS IN BEAMS.

The shearing stress, v, in the concrete of beams shall be computed by the following formula,—

$$v = \frac{V}{bjd}$$

in which V = total shear at any section, in pounds.
b = breadth of a rectangular beam, or of stem of tee-beam, in inches.
d = depth of beam, in inches.
jd = distance from tensile reinforcing to centre of compression, in inches.

For beams having tension reinforcing only, v shall not exceed 2% of the ultimate compressive strength of the concrete.

For beams in which part of the tension reinforcing is bent, as opportunity offers, so as to provide inclined shear reinforcing, the value of v shall not exceed 3% of the ultimate compressive strength of the concrete.

For beams in which v exceeds 3% of the ultimate compressive strength of the concrete additional shear reinforcing shall be provided in the form of stirrups inclined or normal to the tension reinforcing, and looped around or connected to it. Using the above notation and letting s = spacing of stirrups, in inches, each stirrup shall be designed to withstand a pull of $\frac{2Vs}{3jd}$ if set normally to the tension reinforcement, and a pull of seven-tenths of this amount if inclined at 45° to the tension reinforcing. The spacing of the shear stirrups shall not exceed 60% of the depth of the beam. Stirrups shall be of such a length that they approach within two inches of opposite faces of the beam, and they shall be so anchored or bonded that they can develop the pull for which they are designed. The value of v for beams so reinforced shall not exceed 6% of the ultimate compressive strength of the concrete.

29. BOND STRESS.

The bond stress between concrete and steel shall not exceed 4% of the ultimate compressive strength of the concrete for plain or deformed bars, nor 2% of the ultimate compressive strength of the concrete for drawn wire.

30. MODULAR RATIO.

The ratio of the modulus of elasticity of steel to that of concrete shall be taken as 15.

31. STEEL.

Steel for reinforcing, whether in the form of bars or structural shapes, shall have the following physical properties,—

	Medium Steel		High Carbon Steel		Cold-Twisted Bars from Medium Steel as specified
	Plain	Deformed	Plain	Deformed	
Ultimate Tensile Strength, in pounds per sq. inch = T	55,000 to 70,000	55,000 to 70,000	Minimum of 80,000	Minimum of 80,000	
Yield Point Minimum, in pounds per sq. inch	33,000	33,000	50,000	50,000	55,000
Elongation, Minimum, per cent. in 8 ins.	1,400,000 / T	1,250,000 / T	1,200,000 / T	1,000,000 / T	5%
Cold Bend without Fracture (t = thickness or diameter, d = inside diameter of bend).					
For bars, or specimens cut from structural shapes, where t is less than ¾"	180° d = t	180° flat	180° d = 3t	180° d = 4t	180° d = 2t
For bars, or specimens cut from structural shapes, where t equals or is greater than ¾"	180° d = t	180° d = t	90° d = 3t	90° d = 4t	180° d = 3t

For each ⅛" increase in diameter or thickness above ¾" nominal diameter or thickness, and for each 1-16" decrease in diameter or thickness for bars below 7-16" nominal diameter or thickness a deduction of 1% shall be made from the above specified percentage of elongation; but these modifications for elongation shall not apply to cold twisted bars.

Material shall be free from injurious seams, flaws or cracks, and shall have a workmanlike finish.

Bars shall preferably be rolled from billets.

Cold twisted bars shall have at least one complete twist in a length equal to twelve times the thickness of the bar.

Re-rolled bars more than 1" in diameter shall not be accepted.

32. UNIT STRESSES FOR STEEL.

The following unit stresses for steel shall not be exceeded,—

In Tension,

Medium steel, high carbon steel and cold-twisted bars, 16,000 pounds per square inch.

Re-rolled bars, 12,000 pounds per square inch.

In Compression,

All steel, 15 times the specified unit stress for the concrete in which it is embedded.

GENERAL REQUIREMENTS IN DESIGN.

33. LIMITING PROPORTIONS OF INGREDIENTS OF MORTAR GENERALLY.

Not more than three parts of sand shall be added to one part of cement.

To make mortar, the exact proportions shall be determined before the commencement of the work, having in mind the strength and density required and the characteristics of the materials to be used.

34. LIMITING PROPORTIONS OF INGREDIENTS OF CONCRETE GENERALLY.

The number of parts of crushed stone or gravel, or of crushed stone and gravel in concrete, shall not exceed twice the number of parts of sand in the mortar of the concrete.

The exact proportions of the ingredients shall be determined before the commencement of the work, having in mind the strength and density required and the characteristics of the materials to be used.

35. PROPORTIONING OF INGREDIENTS FOR WATERPROOF CONCRETE.

Where waterproofness is necessary the proportions of ingredients of the concrete shall be determined by experiment to obtain the requisite strength and the maximum density.

36. LIMITING PROPORTIONS OF INGREDIENTS IN CONCRETE FOR BEAMS, ETC.

In building construction one mixture shall be used throughout for girders, beams and slabs. In no case shall there be used a mortar containing more than two and one half parts of sand to one part of cement.

37. LIMITING PROPORTIONS OF INGREDIENTS IN CONCRETE FOR COLUMNS.

In building construction one mixture shall be used for the columns throughout the same story. In no case shall there be used a mortar containing more than two parts of sand to one part of cement.

38. CRUSHED STONE OR GRAVEL FOR FIREPROOF CONCRETE.

Where fireproofness is necessary, crushed stone or gravel containing more than 5% of carbonates shall not be used.

39. EMBEDMENT OF STEEL.

The distance from the surface of the concrete to the nearest surface of the reinforcing steel shall not be less than the side or diameter of the bar, and in no case shall it be less than ¼". For this purpose bars of other than square or circular section shall be considered as having the diameter of an equal circular section.

40. SPACING OF STEEL.

The distance from centre to centre of adjacent bars shall not be less than the perimeter of the larger of the bars.

In slabs the distance from centre to centre of adjacent bars shall not exceed twice the depth of the slab.

41. SPLICING OF STEEL.

As far as practicable all reinforcing bars shall be in one length. When splices or laps are necessary they shall be made so as to develop the full strength of the bar.

42. MINIMUM LENGTHS OF SLAB REINFORCING.

The ends of slab reinforcing shall completely cross the beam or girder on which the slab rests.

43. REINFORCING IN COLUMNS.

Vertical reinforcing bars shall be carried into the footings a sufficient distance to transmit the stress in the steel to the concrete of the footing by means of bearing and bond stresses. The bars

of the lower sections of columns shall extend above the upper surface of the slab a sufficient distance to enable the bars of the next succeeding section of column to be effectively bonded with them.

Reinforcing bars over 1″ diameter, if not lapped, shall have their ends trimmed square and be butted with a sleeve not less than 12″ long.

The steel ties holding the vertical reinforcing in its assigned position shall not be more than 12″ apart.

44. FIREPROOFING.

Where fireproofing is required the steel reinforcing shall be protected by at least ¾″ of concrete in slabs, 1½″ of concrete in beams, and 2″ of concrete in columns, but in no case shall the protecting layer be of less thickness than that required by Section 39.

In concrete piers and abutments which may be subjected to the action of fire the outside concrete for a depth of 1½″ shall be considered as a protecting layer and shall not be computed in determining the effective area of the pier or abutment.

45. CONTRACTION JOINTS.

Contraction joints shall be provided unless sufficient steel is embedded to safely withstand temperature changes.

In mass concrete subjected to temperature changes construction joints shall be provided at abrupt changes of section, and preferably at sections not more than thirty feet apart.

WORKMANSHIP.

MORTAR AND CONCRETE.

46. FOUNDATIONS.

The foundations shall be trimmed as accurately as practicable and shall be at least to the dimensions on the approved drawings. Form work shall be erected wherever foreign material can become mixed with the concrete or mortar while the same is being deposited.

The bearing stratum shall be cleaned of all foreign material. It shall also be free from water if practicable. Under no circumstances shall mortar or concrete be deposited in running water.

47. FORM WORK.

Form work shall be substantially and accurately constructed. It shall be plumb and true to line, well fixed, braced and supported

to carry the imposed loads, and be rigid enough to retain proper alignment and correct contours until the concrete will have become well set. Form work shall be sufficiently tight to prevent leakage. Immediately before depositing concrete the form shall be carefully cleaned out, after having been finally trued up. A thin, even coating of soft soap or oil may be applied to new forms before erection. Such a coating shall be applied in every instance where form work is to be used more than once. Form work that has been previously used shall be thoroughly cleaned before re-erection and given a protecting coat of the same material as that already used on it. Form work shall be so fastened together that it may be removed without injury to any part of the permanent structure.

48. STORAGE OF CEMENT.

Cement shall be stored in a weather-tight ventilated building. The floor of the building shall be raised above the ground to ensure dryness.

The cement shall be neatly piled in carload lots in the original sacks, and be marked in a distinctive manner for identification purposes.

49 STORAGE OF SAND, CRUSHED STONE AND GRAVEL.

All sand, crushed stone and gravel shall be piled on a site which has been cleaned free from vegetable and other foreign materials.

50. MEASURING OF INGREDIENTS.

All sand, cement, crushed stone and gravel shall be measured by loose volume.

The necessary amount of water to produce the required consistency of mortar or concrete shall be determined from time to time, taking into account the atmospheric conditions and the variations of moisture in the sand, crushed stone or gravel before mixing.

All of the materials shall be systematically measured throughout the whole of the work, and the required proportions shall be accurately maintained.

51. MIXING OF INGREDIENTS.

All mortar and concrete shall be made in batch mixers unless it is impracticable to do so, in which case it shall be mixed by hand.

Mixing by hand shall be done on a smooth water-tight platform. The sand and cement shall first be mixed dry until the whole mass

is homogeneous and of perfectly even color throughout. Sufficient water shall then be added to make flowing mortar. In the process of making the mortar the materials shall be turned over at least five times. If concrete is to be made, wetted crushed stone or gravel shall then be added and the whole mass turned over at least four times and until it has become homogeneous and of even color and consistency.

Mixing by machine shall produce a homogeneous mass of concrete perfectly uniform in color and even in consistency. The whole mass shall be in continuous motion within the machine for a period of not less than one minute, and the entire batch shall be discharged before any further materials are placed in the machine.

The re-mixing or re-tempering of mortar or concrete which has partly set shall not be permitted.

The general consistency of the mortar or concrete shall be such that the mass will flow readily in the forms, and that it can be conveyed from the mixer to the forms without separation of the ingredients.

The temperature of the mixture on completion of the mixing shall not be less than 40° Fahrenheit. The water, sand and crushed stone or gravel shall be heated, if necessary, to obtain this result. In no case shall crystals of ice either in the sand or in the crushed stone be permitted to reach the mixing platform or the mixing machine.

52. PLACING ABOVE WATER.

The surface on which concrete is to be deposited shall be specially cleaned for the purpose. If the surface be rock it shall be given a coat of grout composed of equal parts of cement and sand well brushed into the surface and all the crevices. If the surface, vertical or otherwise, be of concrete which has set hard it shall be spalled or roughened and afterwards thoroughly brushed over with grout composed of equal parts of cement and sand. If the surface be of concrete which has not set hard the spalling or roughening may be omitted, but grout composed of equal parts of cement and sand shall be applied as specified above.

Mortar and concrete shall be placed immediately after being mixed.

Mortar or concrete which has partly set shall not be used.

Concrete shall be conveyed in watertight carriers and deposited in such a manner that the ingredients will not be separated, and the mass shall be consolidated by being worked after placing. The coarser ingredients shall be removed from contact with the formwork by the manipulation of a special tool.

The depositing of concrete at expansion joints shall be done with the same care and attention as that required to ensure a smooth finish to exposed surfaces.

In all cases laitance which may have formed on the surface of deposited concrete shall be carefully and entirely removed.

Concrete shall be deposited in approximately horizontal masses, and the work shall be stopped only at regular or temporary vertical bulkheads.

Arch rings shall be built in sections of such length as will permit of all concrete in any one section being placed without stopping. If circumstances render this impracticable, bulkheads shall be placed normal to the line of pressure.

In building bench walls or abutments of arches the tops of such walls shall be finished normal to the line of pressure, and no horizontal joints shall be made.

During freezing weather concrete shall be taken from the mixer and deposited in the forms so that no part of it shall be frozen and the temperature of the mass when deposited shall not be less than 35° Fahrenheit. The concrete shall be prevented from freezing until setting has taken place and until the process of hardening has begun.

Trowelled or floated horizontal surfaces shall be not less than one inch in thickness. They shall be composed of concrete proportioned according to the requirements for wear. The mortar shall contain at least one part of cement to two parts of sand. The nominal size of the crushed stone or gravel shall not exceed half the thickness of the wearing course, and in no case shall it exceed ¾".

If possible the surfacing shall be applied immediately after the placing of the mass concrete, but when this is impracticable the mass concrete shall be thoroughly washed and treated with a coat of grout composed of equal parts of cement and sand thoroughly brushed in before the surfacing is applied. In trowelling or floating the surface pure cement unmixed with sand shall not be used.

53. CURING.

Concrete shall be protected from the direct rays of the sun for at least three days after being deposited when the maximum temperature is above 60° Fahrenheit in the sun.

For a period of seven days after being deposited concrete shall be kept moistened when the maximum temperature in the shade is above 60° Fahrenheit.

54. **Form Removal.**

The forms shall not be removed from concrete work until the concrete is safely self-supporting, and, where additional concrete is to be added, until it has sufficient strength to safely sustain the superimposed load.

55. **Placing Under Water.**

When concrete is to be deposited under water the site shall be cleared from all foreign matter and all currents of water shall be eliminated. The concrete shall be deposited immediately after mixing in such a way as to displace the water and at the same time to obviate the separation of the ingredients. The work shall be carried on continuously if practicable and in such a manner as to prevent the formation of laitance between successive masses of concrete.

REINFORCED CONCRETE.

56. **General.**

All the requirements of the preceding sections shall apply to reinforced concrete as far as consistent.

57. **Crushed Stone and Gravel.**

The largest fragments of crushed stone or pieces of gravel for reinforced concrete shall be of such a size as to pass through a circular hole ¾" in diameter in a thin plate.

58. **Storage of Steel.**

Steel shall be stored on skids clear of the ground and protected from rain and snow.

59. **Fabrication and Placing of Steel Reinforcing.**

All steel reinforcing shall be fabricated and placed in strict conformity with the dimensions on the approved drawings, and it shall be truly lined up and so held in position that displacement shall not occur during the depositing or manipulation of the concrete.

No material shall be permitted to adhere to the surface of the steel reinforcing until the concrete in which it is to be embedded is being deposited.

60. **Cleaning of Form Work.**

Immediately before depositing the concrete the form work shall be entirely cleaned of all foreign material, preferably by the use of a pressure hose and nozzle discharging water, steam or air.

In column forms an opening shall be provided at the bottom of the form work of every column in order that every particle of foreign material may be readily removed.

61. DEPOSITING OF CONCRETE.

The concrete shall be deposited in small quantities preferably as a uniform stream. It shall be manipulated in such a manner as to ensure perfect adhesion to the entire surface of the steel reinforcing and to remove all impounded water or air.

In depositing concrete in columns the work shall be discontinued at the elevation of the bottom of beams for a period of not less than three hours before depositing the beam concrete. In the absence of beams the elevation of the bottom of the slab shall be taken as the stopping plane. Before commencing the depositing of the beam concrete (or slab concrete in beamless systems), every column shall be examined for laitance, which if present shall be immediately removed.

The concrete for slabs shall be deposited continuously with the beams. Special care shall be exercised to procure perfect homogeneity of tee-beam construction.

62. DISCONTINUANCE OF WORK.

Every structural element shall be completed without discontinuance if practicable. Unless completed in one operation, beams and slabs shall be discontinued only by the use of vertical bulkheads placed at the section of maximum bending moment.

63. FREEZING WEATHER.

In protecting reinforced concrete from frost a system which will drive the moisture out of the concrete shall not be used.

64. FORM REMOVAL.

The forms shall not be removed until the times named in the following table have elapsed after depositing concrete, not counting periods in which the temperature has been below 35° Fahrenheit.

Part	Minimum number of 24-hour days elapsed after depositing
Posts under beams and girders....	20
Floor slab panels	10
Wall forms	2
Column forms.....	4
Sides of beams and girders	4
All other parts	10

CINDER CONCRETE.

65. **General.**

All the requirements of the preceding sections shall apply to cinder concrete as far as consistent.

66. **Storage of Cinders.**

Cinders shall be stored on a site which has been cleaned free from vegetable and other foreign materials.

REINFORCED CINDER CONCRETE.

67. **General.**

All the requirements of the preceding sections shall apply to reinforced cinder concrete as far as consistent.

68. **Size of Cinders.**

The largest particles of cinders for reinforced cinder concrete shall pass through a circular hole ¼″ in diameter in a thin plate, and none shall pass through a circular hole ⅜″ in diameter in a thin plate.

RUBBLE CONCRETE.

69. **Soundness of Boulders and Rock.**

All boulders and pieces of rock shall be perfectly sound, impervious and durable.

70. **Embedding Rubble.**

All boulders and pieces of rock shall be thoroughly cleaned of foreign material, and after being wetted they shall be either floated into the concrete matrix or placed upon a floating bed with full bearing, in which case the concrete, as it is being raised around them, shall be manipulated in a manner similar to that required for exposed faces of walls. The mortar in the concrete shall be made to adhere perfectly to every part of the surface of the boulders and rock. When work is discontinued a sufficient number of boulders shall project above the concrete surface to ensure bond with succeeding concrete work.

TESTS AND INSPECTION.

71. **Tests of Materials.**

All the materials shall be systematically tested in accordance with the recognized rules of the art for each material. The results of the tests shall comply with the requirements of these specifications.

72. FIELD TESTS OF CONCRETE.

Tests shall be made on concrete and mortar as the work progresses to check the density of the mixtures and the rate of setting. The test pieces shall be cubes, rectangular prisms or cylinders, having a volume not less than one-fourth of a cubic foot. They shall be poured from the regular run of the mortar or concrete as deposited, and be left to set under the same conditions as the material in the structure. There shall be two such test pieces made from each day's work. The test pieces shall be carefully examined before the form work is removed.

73. TEST LOADS ON FLOORS.

Test loads may be applied to a floor at any time after sixty days from the hardening of the concrete, but they shall not exceed one and one-half times the live load for which the floor has been designed. On removal of the test load, after its application for twenty-four hours, the amount of permanent deflection shall be negligible, having regard to the purpose for which the structure is required.

74. INSPECTION.

There shall be constant competent inspection throughout the whole of the work.