

# VERMONT CONSTRUCTION SPECIFICATION

## 31 – CONCRETE AND STEEL REINFORCEMENT

### 1. Scope

The work consists of furnishing, forming, placing, finishing, and curing portland cement concrete as required to build the structures and slabs. The work shall also consist of furnishing and placing reinforcing steel.

### 2. Definitions

**Structural Concrete** – Refers to concrete walls, footings, curbs or base slabs that require reinforcing bars.

**Non-Structural Concrete Base Slabs** – Refers to base slabs that do not require reinforcing bars that may or may not require forms.

**Concrete** – Refers to both of the above concrete conditions.

### 3. Material

**Aggregates** shall conform to the requirements of ASTM Specification C33 for specific sizes. The potential reactivity of aggregates with the alkalis in cement shall be evaluated.

**Portland cement** shall conform to the requirements of ASTM Specification C150 for the specific types of cement.

**Fly ash** shall conform to the requirements of ASTM Specification C618, Class C or F except the loss on ignition shall not exceed 3 percent.

**Blast-furnace slag** used as a partial substitution of portland cement in concrete shall conform to the requirements of ASTM Specification C989 for ground granulated blast furnace slag.

**Air-entraining admixtures** shall conform to the requirements of ASTM Specification C260.

**Plasticizing or plasticizing and retarding admixtures** shall conform to the requirements of ASTM Specification C494, Types A, B, D, F, or G and/or ASTM Specification C1017.

**Water-reducing and/or retarding admixtures** shall conform to the requirements of ASTM Specification C494, Types A, B, D, F, or G.

**Accelerating and water-reducing and accelerating admixtures** shall be noncorrosive and conform to the requirements of ASTM Specification C494, Type C and E. The manufacturer shall provide long-term test data results from an independent laboratory verifying that the product is noncorrosive when used in

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concrete exposed to continuously moist conditions.

**Water** used in mixing and curing concrete shall be clean and free from injurious amounts of oil, salt, acid, alkali, organic matter, or other deleterious substances.

**Curing compound** shall conform to the requirements of ASTM Specification C309. Unless otherwise specified on the drawings, curing compound shall be Type 2. All curing compounds shall be delivered to the site of the work in the original container bearing the name of the manufacturer and the brand name. Curing Compound shall be stored in a manner that prevents damage to the container and protects water-emulsion types from freezing.

**Preformed expansion joint filler** shall conform to the requirements of ASTM Specification D1752, Type I, Type II, or Type III, unless bituminous type is specified. Bituminous type preformed expansion joint filler shall conform to the requirements of ASTM Specification D994 or D1751.

**Sealing compound for joints** shall be a cold-application material unless otherwise specified on the drawings and shall be a single component or multiple component type. The sealing compound shall conform to the requirements shown on the drawings.

**Waterstop** shall be an active bentonite/butyl-rubber based material with a standard rate of hydration, unless otherwise specified on the drawings. Installation of waterstop, including clear distances to edge of concrete slabs and structures, shall be in accordance to manufacturer's specifications. An adhesive approved by the manufacturer shall be used to attach and secure the waterstop to the concrete. Provisions shall be made to prevent the waterstop from getting wet and activating the bentonite before concrete placement. Waterstop exposed to water or otherwise damaged shall be removed and replaced.

**Reinforcement steel** shall be free from loose or flakey rust, soil, oil, grease, paint, or other deleterious matter.

**Steel bars** for concrete reinforcement shall be grade 60 deformed bars conforming to one of the following specifications:

- ASTM Specification A615 - Deformed and plain billet-steel bars for concrete reinforcement.
- ASTM Specification A616 with the S1 supplemental requirements – Rail-steel deformed and plain bars for concrete reinforcement.
- ASTM Specification A617 – Axle-steel deformed and plain bars for concrete reinforcement.

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**Dowels** shall be a plain, round steel bar conforming to the same specifications listed above for steel bars.

**Fabricated deformed steel bar mats** for concrete reinforcement shall conform to ASTM Specification A184.

**Plain steel welded wire fabric** for concrete reinforcement shall conform to ASTM Specification A185.

**Deformed steel welded wire fabric** for concrete reinforcement shall conform to ASTM Specification A497.

**Epoxy-coated steel bars** for concrete reinforcement shall conform to ASTM Specification A775.

**Metal plates** shall conform to the requirements shown on the drawings.

### 2. Concrete mix design

The supplier shall be responsible for the design and proportioning of concrete. Unless otherwise specified on the drawings, the compressive strength of the concrete shall be 3000 psi at 28 days. Air entrainment in concrete shall range from 5 to 7 percent and slump shall range from 3 to 5 inches. Mix should anticipate incorporation of water reducers, super plasticizers, set retarders and other admixtures.

Concrete shall be composed of Portland cement, fine and coarse aggregate and water. An air-entraining admixture shall be used. Concrete shall be furnished by ready-mix methods only, unless otherwise approved by the NRCS representative. The contractor shall furnish the NRCS representative a batch ticket showing the amount of concrete in cubic yards, the time of loading, the time the load was discharged, the revolution counter reading at the time of loading and discharge, and the type and actual quantity of each material including all admixtures used in each batch of concrete.

### 5. Inspecting and testing

During the course of the work, the NRCS representative may perform quality assurance testing as required to assure the concrete meets the design requirements. All tests and inspections are conducted so as not to interfere unnecessarily with the manufacture, delivery, and placement of the concrete.

Any portion of a batch may be tested by the NRCS representative for any of the purposes shown below. Samples taken for testing shall be representative of that part of the batch.

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- a. Determining uniformity of the batch.
- b. Checking compliance with requirements for slump and air content when the batch is discharged over an extended period.
- c. Checking compliance of the concrete with the specifications when the whole amount being placed in a small structure, or a distinct part of a larger structure, is less than full batch.

When a plasticizing admixture is added to the concrete mix at the job site, slump tests may be made both before the addition of the admixture to the concrete mix and after the admixture has been incorporated into the concrete mix.

The tests on concrete are performed by the following methods unless otherwise specified on the drawings:

Type of Test	Test Method (ASTM Designation)
Sampling	C172
Slump Test	C143
Air Content	C231 or C173
Compression Test Specimens	C31 or C42
Compressive Strength Testing	C39
Unit Weight	C138
Temperature	C1064

A strength test for concrete is the average of two standard cured concrete cylinders prepared in accordance with ASTM C31 from the same sample of concrete and tested in accordance with ASTM C39 at 28 days, unless otherwise specified. If one cylinder shows manifest evidence of improper sampling, molding, curing, or testing, it shall be discarded and the strength of the remaining cylinder shall then be considered the compressive strength of the concrete. Should both cylinders show such defects, the entire test shall be discarded.

If both cylinders are discarded or in place concrete that was not sampled is in question, the in place concrete may be sampled by coring in accordance with ASTM C42. For core tests, these requirements shall be followed:

- a. At least three representative cores shall be taken from each area of concrete in question. If one or more of the cores shows signs of being damaged before testing, it shall be replaced by a new one.

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- b. Test cores shall be prepared for testing in accordance with moisture conditioning in ASTM C42 unless the engineer determines that the concrete in the structure will be dry under service conditions. If the concrete is determined to be dry under service conditions, the cores shall be air dried (temperature 60 °F to 80 °F and relative humidity less than 60%) for 7 days before testing and shall be tested dry.

### 5. Steel Reinforcement

**Bending** - Reinforcement shall be cut and bent to the dimensions and configurations shown in the steel schedule. Bars shall not be cut, bent, or straightened using heat or in any other manner that will injure or weaken the material. Bars with kinks, cracks, or improper bends will be rejected.

**Splicing bar reinforcement** - Placement of bars at the lap splice locations, when not in contact, shall not be farther apart than one-fifth the shown lap length and in any case no greater than 6 inches.

**Splicing welded wire fabric - Adjacent** sections shall be spliced end-to-end (longitudinal lap) and side to side (transverse lap) by overlapping a minimum of one full mesh plus 2 inches plus the length of the two end overhangs. The splice length is measured from the end of the wires in one piece of fabric to the end of the wire in the lapped piece of fabric.

**Placing - Reinforcement** shall be accurately placed and secured in position to prevent its displacement during the placement of concrete. Tack welding of bars is not permitted. Metal chairs, metal hangers, metal spacers, and concrete chairs may be used to support the reinforcement. Metal hangers, spacers, and ties shall be placed in such a manner that they are not exposed in the finished concrete surface. The legs of metal chairs or side form spacers that may be exposed on any face of slabs, walls, beams, or other concrete surfaces shall have a protective coating or finish. The coating or finish can be hot dip galvanizing, epoxy coating, plastic coating, or stainless steel. Metal chairs and spacers not fully covered by a protective coating or finish shall have a minimum cover of 0.75 inch of concrete over the unprotected metal part. The exception is that those with plastic coatings may have a minimum cover of 0.5 inch of concrete over the unprotected metal part. Precast concrete chairs shall be manufactured of the same class of concrete as specified for the structure and shall have the tie wires securely anchored in the chair or a V-shaped groove at least 0.75 inch in depth molded into the upper surface to receive the steel bar at the point of support. Precast concrete chairs shall be clean and moist at the time concrete is placed.

High density or structural plastic rebar accessories designed to ensure maximum concrete bond may be substituted for metal or concrete accessories in spacer applications as approved by the NRCS representative. Exposure of plastic rebar accessories at the finished concrete surface shall be kept to a minimum. Plastic rebar accessories, when used, shall be staggered along adjacent parallel bars and shall be placed at intervals no closer than 12 inches. Plastic rebar accessories shall

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not be used in concrete sections 6 inches or less in thickness.

Reinforcement shall not be placed until the prepared site has been inspected and approved. After placement of the reinforcement, concrete shall not be placed until the reinforcement has been inspected and approved by the NRCS representative.

**Storage** - Steel reinforcement stored at the work site shall be placed on platforms, skids, or other supports. This is done so that contact with the ground is avoided and the material is protected from mechanical damage and/or corrosion.

### 6. Forms

Forms shall be of good quality wood, plywood, steel, or other approved material and shall be mortar tight. The forms and associated falsework shall be substantial and unyielding and shall be constructed so that the finished concrete conforms to the specified dimensions and contours. Form surfaces shall be smooth and free from holes, dents, sags, or other irregularities and shall be maintained in this condition throughout the work. Forms shall be coated with a nonstaining form release agent before being set into place.

When a superplasticized concrete mix is used, forms shall be coated according to the manufacturer's recommendations with a form release agent that is specifically formulated for plasticized concrete. Forms shall be designed to withstand the increased pressures of the superplasticized concrete and the increased impact forces resulting from larger drop heights used in placing the superplasticized concrete.

Metal ties or anchorages that will be embedded in the concrete shall be designed to break off below the surface of the concrete.

### 7. Preparation of forms and subgrade

Before placement of concrete, the forms, embedments, and subgrade shall be free of chips, sawdust, debris, water, ice, snow, extraneous oil, mortar, or other harmful substances or coatings. Any form release agent on the reinforcing steel or other surfaces required to be bonded to the concrete shall be removed.

Rock surfaces shall be cleaned by high pressure air-water cutting, sandblasting, or wire brush scrubbing, as necessary, and shall be wetted immediately before placement of concrete. The earth surface shall be firm and damp. Placement of concrete on mud, dried earth, noncompacted fill, or frozen subgrade is not permitted. All ice, snow, and frost shall be removed, and the temperature of all surfaces, including the reinforcing steel and other steel inclusions, to be in contact with the new concrete shall be no colder than 40 degrees Fahrenheit.

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Items to be embedded in the concrete such as reinforcement (including dowel bars), waterstop, etc. shall be positioned accurately and anchored firmly. Placement of reinforcing steel or other appurtenances into and around wet or "green" concrete will not be allowed.

Weepholes in walls or slabs shall be formed with nonferrous material.

### 8. Conveying

Concrete shall be delivered to the site and discharged completely into the forms within 1.5 hours or before the drum of truck has revolved a total of 300 revolutions, whichever comes first, after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85 degrees Fahrenheit or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes. In hot weather conditions set retarder is highly recommended.

Superplasticized concrete can be conveyed and placed when the temperature of the concrete is below 95 degrees Fahrenheit and the slump of the concrete remains within the allowable slump range.

The NRCS representative can allow an appropriate extension of time when the setting time of the concrete is increased a corresponding amount by the addition of an approved admixture. In any case concrete shall be conveyed from the mixer to the forms as rapidly as practicable by methods that prevent segregation of the aggregates or loss of mortar.

### 9. Placing

Concrete shall not be placed until the subgrade, forms, steel reinforcement, and other embedments are inspected and approved by the NRCS representative. For walls and columns, subsequent higher placements of concrete shall not be placed until the concrete below the new placement has gained sufficient strength to support the concrete dead load and any superimposed loads without distress.

The contractor shall have all equipment and material required for curing available at the site ready for use before placement of concrete begins.

The contractor shall give reasonable notice to the NRCS representative before each placement. Such notice shall be far enough in advance to give the representative adequate time to assure that the subgrade, forms, steel reinforcement, and other preparations comply with specifications. Other preparations include, but are not limited to, mixing and delivery equipment and system, placing and finishing equipment and system, schedule of work, workforce, and heating or cooling facilities, as applicable. All deficiencies are to be corrected before concrete is delivered for placing.

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Concrete shall be placed and consolidated to prevent segregation of the mix components. The concrete shall be deposited as closely as possible to its final position in the forms. It shall be worked into the corners and angles of the forms and around all reinforcement and embedded items to prevent segregation of aggregates or excessive laitance. The depositing of concrete shall be regulated so that the concrete can be consolidated with a minimum of lateral movement. Concrete placed against a sloping surface shall start at the lowest elevation and work upwards to the highest elevation.

Concrete shall not be dropped more than 5 feet vertically unless suitable equipment is used to prevent segregation. When a superplasticized concrete mix is used, concrete shall not be dropped more than 12 feet vertically unless suitable equipment is used to prevent segregation.

### 10. Layers

Slab concrete shall be placed to design thickness in one continuous layer unless otherwise specified.

Successive layers of fresh concrete between construction joints shall be placed at a rate fast enough that the preceding layer is still plastic and can be easily mixed with the fresh concrete such that seams (cold joints) or plane of weakness do not occur. If the surface of a previously placed layer of concrete has taken a set to the degree that it will not flow and mix with the succeeding layer when vibrated, the contractor shall discontinue placing concrete and shall make a construction joint. If placing is discontinued when a layer is incomplete, the ends of the incomplete layer shall be formed by a vertical bulkhead.

### 11. Consolidating

All concrete shall be consolidated with internal type mechanical vibrators capable of transmitting vibration to the concrete at frequencies not less than 8,000 impulses per minute, unless otherwise specified on the drawings or approved before placement. Vibration shall be supplemented by spading, rodding, and hand tamping as necessary to ensure smooth and dense concrete along the form surface, in corners, and around embedded items. The contractor shall provide a sufficient number of vibrators to properly consolidate the concrete immediately after it is placed. A sufficient number of standby vibrators shall be kept onsite during the placement of concrete.

Vibration shall compact the concrete and bring it into intimate contact with the forms, reinforcing steel, and other embedded items while removing voids and pockets of entrapped air. The location, insertion, duration, and removal of the vibrators shall be such that maximum consolidation of the concrete is achieved without causing segregation of the mortar and coarse aggregate or causing water or cement paste to flush to the surface. Vibration shall be applied to the freshly deposited concrete by rapidly inserting the vibrator and slowly, in an up and down motion, removing the



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vibrator at points uniformly spaced at not more than 1.5 times the radius of the area visibly effected by vibration. Generally, this is at 5 to 10 seconds per foot on 14-inch spacings or less. The area visibly affected by the vibrator shall overlap the adjacent, just vibrated area. The vibrator shall extend vertically into the previously placed layer of fresh concrete by at least 6 inches at all points. This ensures effective bond between layers. In thin slabs the vibrator(s) should be sloped toward the horizontal to allow operations in a fully embedded position.

Vibration shall not be applied directly to the reinforcement steel, the forms, or other embedded items unless otherwise specified on the drawings. Vibration shall not be applied to concrete that has hardened to the degree that it does not become plastic when vibrated. If surface vibrators are used, they may contact forms when consolidating thin slabs.

The use of vibrators to transport concrete in the forms or conveying equipment is not permitted.

Surface vibrators may be used to consolidate slabs 8 inches and less in thickness. Slabs more than 8 inches thick shall be consolidated with internal vibration and may be augmented through use of surface vibrator, such as vibrating screeds, plate or grid vibratory tampers, or vibratory roller screeds.

### **12. Construction joints**

Construction joints shall be installed as shown on the drawings. Construction joints shall be made at the locations shown on the drawings unless otherwise specified on the drawings or approved by the NRCS representative

### **13. Expansion and contraction joints**

Expansion and contraction joints shall be installed as shown on the drawings. Expansion and contraction joints shall be made only at locations shown on the drawings.

### **14. Waterstop**

Waterstop shall be an active bentonite/butyl-rubber based material with a standard rate of hydration, unless otherwise specified on the drawings. Installation of waterstop, including clear distances to edge of concrete slabs and structures, shall be in accordance to manufacturer's specifications. An adhesive approved by the manufacturer shall be used to attach and secure the waterstop. Provisions shall be made to prevent the waterstop from getting wet and activating the bentonite before concrete placement. Waterstop exposed to water or otherwise damaged shall be removed and replaced.

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## 15. Removal of forms, supports, and protective coverings

Forms, supports, and protective coverings shall be removed as soon as practical after the concrete has gained sufficient strength to support its own weight and superimposed loads. Removal shall be done so that the concrete surface is not damaged and sudden or excessive stresses are not induced. The minimum period from completion of the concrete placement to the removal of the forms shall be based on cumulative times below.

**Cumulative time** - The total accumulated time, not necessarily continuous, that the air adjacent to the concrete is above 50 degrees Fahrenheit and the specified concrete curing has occurred concurrently will be determined. Forms may be removed after the total accumulated time shown:

### Accumulated form removal times

Forms		Time <u>1/</u>
Sides of Slabs or Beams		12 Hours
Undersides of Slabs or Beams	Clear Span	<u>2/</u>
	< 10 Feet	4 Days
	10 to 20 Feet	7 Days
	> 20 Feet	14 Days
Sides of Walls or Columns	Height Above Form	<u>3/</u> <u>4/</u>
	< 10 Feet	12 Hours
	< 20 Feet	24 Hours
	> 20 Feet	72 Hours

- 1/ Table values apply to normal concrete. Values for concrete that contains cements or admixtures that significantly retard or accelerate strength gain will be determined by the NRCS representative and based on actual design mix data.
- 2/ Values apply to members designed to support significant superimposed loads. Values for members designed for only self weight when placed in service shall be 50 percent greater.
- 3/ Values apply to members not subject to significant horizontal loads. Additional time or rebracing is needed for members subject to significant wind or other horizontal loads.
- 4/ Subsequent higher lifts may be placed after 12 hours.

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## 17. Finishing formed surfaces

All formed concrete surfaces shall be true and even, and shall be free from overtolerance depressions, holes, projections, bulges, or other defects in the specified surface finish or alignment.

All surfaces shall have the following surface treatment unless otherwise specified on the drawings:

- Repair defective concrete (See Section 20).
- Fill all form tie holes (See Section 20).
- Correct surface depressions deeper than 1 inch.
- Remove or smooth fins and abrupt projections that exceed 0.75 inch.

## 18. Finishing unformed surfaces

All exposed surfaces of the concrete shall be accurately screeded to grade and then float finished unless otherwise specified on the drawings. The float finish shall result in a surface that has no irregularities of more than 0.25 inch when checked with a template or straight edge that is 10 feet long.

All exposed surfaces of concrete shall be accurately struck off to grade after placement and consolidation are completed. Following strikeoff, the surface shall be immediately smoothed by darbying or bull floating before any free water has bled to the surface. Surfaces subject to hoof, foot or tire traffic shall be roughen with a broom or other means to provide good traction. The concrete shall then be allowed to rest until the bleed water and water sheen have left the surface and the concrete has stiffened to where it will sustain foot pressure with only about 0.25-inch indentation. At this time all joints and edges that are exposed to view and are not chamfered shall be finished with edging tools. After edging and hand jointing is complete, all exposed surfaces shall be floated with wood or magnesium floats. The floating should work the concrete no more than necessary to remove screed, edger, and jointer marks and to produce a compact surface uniform in texture.

Water shall not be sprinkled or added to the surface of the concrete during the darbying, bull floating, floating, or other finishing operations to facilitate finishing.

## 19. Curing

Freshly placed concrete shall be cured a minimum of 7 days in accordance with the recommended practices set forth in this section. A curing process shall be started as soon as the concrete has hardened sufficiently to prevent surface damage. Curing concrete, including exposed surfaces of formed concrete and concrete in forms, shall be maintained at a satisfactory moisture content for at least 7 days following placement. If forms are removed before the end of the 7-day curing period, the interrupted curing process shall be reestablished and maintained until a full 7-day curing period is achieved. A satisfactory moisture condition is:

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- a. Continuous or frequent application of water or use of a saturated cover material, such as canvas, cloth, burlap, earth, or sand.
- b. Prevention of excessive water loss from the concrete by use of an impermeable coating (curing compound) or covering (plastic, paper).

The application of water or covering shall not erode, mar, or otherwise damage the concrete. Plastic film or paper shall meet the requirements of ASTM C171. Black covering shall not be used when concreting in hot weather.

Curing compound may be used for exposed surfaces or formed surfaces after patching and repair are completed. Unless otherwise specified on the drawings, the curing compound shall be white pigmented and conform to ASTM C309, Type 2, Class A or B. Clear curing compound (Type I) or clear with fugitive dye (Type 1-D) may be used. Curing compounds shall not be used on a surface that is to receive additional concrete, paint, tile, or other coatings unless the contractor demonstrates that the membrane can be satisfactorily removed or can serve as a base for the later application.

Curing compound shall be thoroughly mixed before applying and be agitated during application. A continuously agitating pressure sprayer is used for application at a uniform rate of not less than 1 gallon per 175 square feet of surface. Manual hand pump sprayers may be used. The compound shall form a uniform, continuous, adherent film that shall not check, crack, or peel and shall be free from pinholes or other imperfections.

All surfaces covered with curing compound shall be continuously protected from damage to the protective film during the required curing period.

A surface subjected to heavy rainfall or running water within 3 hours after the compound has been applied or that is damaged by subsequent construction operations during the curing period shall be resprayed in the same manner as for the original application.

Water for curing shall be clean and free from any substances that cause discoloration of the concrete.

### 20. Concrete patching, repair or replacement

**Patching** - All form bolts, metal ties, and similar forming restraints shall be removed below the surface of the concrete and their cavities repaired. Small cavities, large air holes, minor honeycombed areas, and other superficial imperfections that require patching to meet the specified finish requirements shall be thoroughly cleaned and filled. Holes left by bolts or straps that pass through the concrete section shall be filled solid with a dense, well-bonded, nonshrink patching material. Proprietary patching material shall be appropriate for the type of repair, used within the manufacturer's recommended limits, and applied according to the manufacturer's recommendations.

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**Repair or replacement** - The contractor shall repair or replace concrete that does not meet the requirements of this specification. When proprietary patching material is proposed in the plan, the manufacturer's data sheets and written recommendations shall be included in the plan.

Repair material or replacement concrete shall have properties, color, and texture similar to and compatible with the concrete being repaired or replaced. Repair or replacement concrete work shall be performed only when the NRCS representative is present.

Curing of repaired or replaced concrete shall be started immediately after finish work is completed and as specified in section 18 or as specified by the manufacturer of proprietary compounds.

### 21. Concreting in cold weather

Concrete construction shall not be done between November 15<sup>th</sup> and April 1<sup>st</sup>. Methods for concreting in cold weather shall be performed when, for more than 3 consecutive days, the following conditions exist:

- The average daily air temperature at the job site is less than 40 degrees Fahrenheit. (The average daily air temperature is the average of the highest and lowest temperatures occurring during the period from midnight to midnight.)
- The air temperature at the job site is not more than 50 degrees Fahrenheit for more than half of any 24-hour period.

Concrete shall be protected against freezing during the first 24 hours after placement whether or not the average weather conditions specified above for cold weather concreting exist. The following provisions also shall apply unless otherwise specified:

- a. When the cement is added to the mix, the temperature of the mixing water shall not exceed 140 degrees Fahrenheit nor shall the temperature of the aggregate exceed 150 F.
- b. The temperature of the concrete at the time of placing shall be within the placement temperature range shown below, unless otherwise specified.

<b>Least Dimension of Section</b>	<b>Placement Temperature</b>
Less than 12 Inches	55 to 75 °F
12 to 36 Inches	50 to 70 °F
36 to 72 Inches	45 to 65 °F
Greater than 72 Inches	40 to 60 °F

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- c. The minimum temperature of the concrete for the first 72 hours after placement shall not be less than the minimum temperature shown above. Concrete structures shall be immediately protected after concrete placement by covering, housing, insulating, or heating concrete structures sufficiently to maintain the minimum temperature adjacent to the concrete surface. If the minimum temperature requirements are not met and the concrete did not freeze, the protection time will be extended a period equal to twice the number of hours the temperature was below the minimum temperature.
- d. Exhaust flue gases from combustion heaters shall be vented to the outside of the enclosure. The heat from heaters and ducts shall be directed in such a manner as to not overheat or dry the concrete in localized areas or to dry the exposed concrete surface.
- e. At the end of the protection period, the concrete shall be allowed to cool gradually. The maximum decrease at the concrete surface in a 24-hour period shall not exceed 40 degrees Fahrenheit.

### 22. Concreting in hot weather

Methods for concreting in hot weather shall be in accordance with the requirements set forth below.

For the purpose of this specification, hot weather is defined as any combination of the following conditions that impair the quality of freshly mixed or hardened concrete by accelerating the rate of moisture loss and rate of cement hydration, or otherwise resulting in detrimental results:

- High ambient temperature
- High concrete temperature
- Low relative humidity
- Wind velocity
- Solar radiation

Whenever the above conditions exist or when climatic conditions are such that the temperature of the concrete may reasonably be expected to exceed 90 degrees Fahrenheit at the time of delivery to the worksite or during the placement operations, the following provisions shall apply:

- a. The contractor shall maintain the temperature of the concrete below 90 degrees Fahrenheit during mixing, conveying, and placing.
- b. Exposed concrete surfaces that tend to dry or set too rapidly shall be continuously moistened using fog sprays or other means to maintain adequate moisture during the time between placement and finishing. Water shall not be sprinkled or added directly to the surface of the concrete before finishing.

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- c. Finishing of slabs and other exposed surfaces shall be started as soon as the condition of the concrete allows and shall be completed without delay. Water shall not be sprinkled or added to the surface of the concrete during the darbying, bull floating, floating, or other finishing operations to facilitate finishing.
- d. Formed surfaces shall be kept completely and continuously wet from the time the concrete takes initial set to when the forms are removed. After the forms are removed, the concrete surfaces shall be kept completely and continuously wet for the duration of the curing period or until curing compound is applied in accordance to section 21.
- e. Exposed and unformed concrete surfaces, especially flat work placed with large areas of surface, shall be kept completely and continuously wet for the duration of the curing period or until curing compound is applied in accordance to section 19. The concrete shall be protected against thermal shock from rapid cooling (5 °F per hour or more than 40 °F per 24-hour period) of the concrete by application of curing water or temperature changes during the first 24 hours of the curing period.
- f. When any single or combination of conditions may result in very rapid setting or drying of the concrete, extreme conditions exist. For flat work and slab construction, extreme conditions exist when the evaporation rate exceeds 0.2 pound per square foot per hour. The NRCS representative may:
  - (1) Restrict placement to the most favorable time of the day.
  - (2) Restrict the depth of layers to assure coverage of the previous layer while it will still respond readily to vibration.
  - (3) Suspend placement until conditions improve.
  - (4) Restrict the removal of forms, repair, and patching to small areas that can be protected with curing compound immediately.

The evaporation rate for flat work and slab construction may be determined by calculating the evaporation rate from a shallow cake pan having a surface area of at least 1 square foot.