SECTION 03333
SHOCK ABSORBING CONCRETE (SACON®)
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PART 1 GENERAL

1.1 SUMMARY

Shock absorbing concrete (SACON®) is a construction material system designed for constructing bullet traps and live-fire facilities. The design concept of SACON® is its unique air void structure within a portland cement concrete matrix that allows projectiles, 5.56-mm rounds and hand grenade fragments, to penetrate the surface of the SACON® and become embedded or trapped within the concrete surface. Fiber reinforcements are added to the mixture to reduce spalling of the SACON® and to hold the concrete matrix intact as these projectiles impact and travel through the SACON®. The alkalinity of portland cement concrete with additional patented calcium phosphate compounds and aluminum hydroxide compounds react with the lead and copper fragments to produce a coating that passivate the lead and copper and prevent further corrosion thus allowing immediate disposal in conventional landfills.

1.2 REFERENCE STANDARDS

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI) STANDARDS

ACI 117	(1990) Standard Specifications for Tolerances for Concrete Construction and Materials
ACI 211.2	(1998) Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 301	(1999) Standard Specification for Structural Concrete
ACI 304R	(2000) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	(1999) Hot Weather Concreting
ACI 306R	(1997) Cold Weather Concreting
ACI 308	(1997) Standard Practice for Curing Concrete
ACI 523.1R	(1992) Guide for Cast-In-Place Low Density Cellular Concrete
ACI 523.2R	(1996) Guide for Low-Density Precast Concrete Floor, Roof, and Wall Units
ACI 523.3R	(1993) Guide for Cellular Concretes Above 50 pcf and for Aggregate Concrete Above 50 pcf with Compressive Strengths Less Than 2500 psi
ACI 544.1R	(1996) State-of-the-Art Report in Fiber Reinforced Concrete
ACI 544.2R	(1999) Measurement of Properties of Fiber Reinforced Concrete
ACI 544.3R	(1998) Guide for Specifying, Proportioning, Mixing, Placing, and Finishing Steel Fiber Reinforced Concrete
ACI 544.4R	(1999) Design Considerations for Steel Fiber Reinforced Concrete

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M-182	(1991) Standard Specification for Burlap Cloth Made from Jute or Kenaf

American Society for Testing and Materials (ASTM)

ASTM C 31	(2000) Standard Practice for Making Curing Concrete Test Specimens in the Field
ASTM C 33	(2001) Standard Specification for Concrete Aggregate
ASTM C 39	(2001) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 94	(2000) Standard Specifications for Ready-Mixed Concrete
ASTM C 109	(2002) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
ASTM C 138	(2001) Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C 144	(2002) Standard Specification for Aggregate for Masonry Mortar
ASTM C 150	(2002) Standard Specification for Portland Cement
ASTM C 171	(1997) Standard Specification for Sheet Materials for Curing Concrete
ASTM C 172	(1999) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 309	(1998) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 567	(2000) Standard Test Method for Unit Weight of Structural Lightweight Concrete
ASTM C 796	(1997) Standard Test Method for Foaming Agents for Use in Producing Cellular Concrete Using Pre-Formed Foam
ASTM C 869	(1999) Standard Specification for Foaming Agents Used in Making Pre-Formed Foam for Cellular Concrete
ASTM C 1116	(2002) Standard Specification for Fiber-reinforced Concrete and Shotcrete
ASTM A 820	(2001) Standard Specification for Steel Fibers for Fiber-reinforced Concrete

US ARMY CORPS OF ENGINEERS HANDBOOK FOR CONCRETE AND CEMENT (CRD)

CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete

NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA QC 3	(Jan 1990; 9th Rev) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready-Mixed Concrete Production Facilities
NRMCA CPMB 100	(Jan 1990; 9th Rev) Concrete Plant Standards
NRMCA TMMB 1	(1989; 13th Rev) Truck Mixer and Agitator Standards

1.3 SUBMITTALS

Submit the following in accordance with section 03330, “Submittal Procedures.”

SD 01 Preconstruction Submittals

The qualifications of the testing agency conducting and evaluating the aggregate and testing the SACON® mixture shall be evaluated.

SD 03 Product Data

Aggregate; G

The fine aggregate shall be masonry sand (ASTM C 144). The preferred mineral composition is limestone; natural quartz sand or another manufactured sand may be substituted for the manufactured limestone sand. Fine aggregate meeting the ASTM C 33 (general concrete sand) requirements may be substituted for the ASTM C 144 (masonry sand) material if the producer can provide historical records indicating the largest particle is less than 9.5-mm (3/8-in.).

Fiber reinforcement; G

The preferred fiber composition is polypropylene or steel otherwise the fiber may be composed of any fiber reinforcement provided the fiber has shown to minimize spalling in similar SACON® mixtures.

Foaming agent; G

The preferred foaming agent is a closed cell structure foam otherwise the foam may be open cell if durability data can be provided to indicate no increased durability problems and long term wear and resistance to weathering specifically freezing and thawing susceptibility.

Stabilizing agent; G

SD 04 Samples

SACON® test panels; G

The results of the trial mixtures along with a statement giving the proportions of all ingredients that will be used in the manufacture of SACON® shall be provided, prior to commencing SACON® placing operations. Aggregate weights shall be based on the saturated surface dry condition. No substitutions shall be made in the materials used in the manufacturing of the SACON®.

Forms; G

The contractor shall provide a sketch or drawing indicating the formwork dimensions and shape.

SD 06 Test Reports

Aggregate

Admixtures

Curing compound

The contractor shall provide certified copies of laboratory test reports, including all test data. These tests shall be made by an approved commercial laboratory or by a laboratory maintained by the manufacturers of the materials.

SD 07 Certificates

Cementitious materials

The contractor shall maintain manufacturer's certifications of compliance for portland cement, accompanied by mill test reports attesting that the materials meet the requirements of the specifications under which it is furnished. No cement shall be used until notice of acceptance has been given. The cement may be subjected to check testing by the Government from samples obtained at the mill, at the transfer points, or at the project site.

1.4 GENERAL REQUIREMENTS

Tolerances for concrete construction and materials shall be in accordance with ACI 117.

1.4.1 Shock Absorbing Concrete (SACON®)

SACON® is comprised of a portland cement slurry, an air void system of pre-formed foam, mineral admixtures (if required), and fiber reinforcement.

1.4.1.1 Strength Requirements

SACON® for all work shall have a 28-day unconfined compressive strength of 6.89 ± 3.45 MPa (1,000 ± 500-psi).

1.4.1.2 Freshly Mixed SACON® Density

SACON® shall have a pre-fiber density of 1442 ± 48 kg/m³ (90 ± 3-pcf). The post polypropylene fiber density shall be 1458 ± 48 kg/m³ (91 ± 3-pcf) and the post steel fiber density shall be 1554 ± 48 kg/m³ (97 ± 3-pcf) as determined in accordance with ASTM C 138.

1.4.1.3 Slurry

SACON® slurry shall be pre-mixed in the mixer. The slurry mixture shall consist of portland cement, masonry fine aggregate, potable water, foam stabilizer, calcium phosphate, aluminum hydroxide, and concrete color pigments (if required). The slurry shall a density of 2099 ± 48 kg/m³ (131 ± 3-pcf). The check of slurry density provides a quality control tool for the mixing action of the mixer and the introduction of foam into the mixer.

1.4.1.4 Air Void Structure

SACON® mixtures shall contain from 32 to 34 percent of preformed foam. SACON® shall not be tested for a air content value. The foam shall be obtained from an aqueous solution of concentrated foaming agent, water, and air. A foam generating apparatus called a Foam Generator shall be used to produce the pre-formed foam.

1.4.1.5 Slump

SACON® shall not be tested for a slump value. Slump extenders or high range water reducers may be used in SACON® when the haul distances or ambient temperatures are extreme. These should be included in the trial batching if any consideration of use is considered to determine compatibility with the other ingredients primarily the pre-formed foam.

1.5 MIXTURE PROPORTION

1.5.1 Trial Batching

Trial batches shall contain materials proposed for use on this project. Trial mixtures having densities, proportions, and consistencies suitable for the work shall be made. Trial mixtures shall be proportioned to produce the SACON® properties specified up to and including the location point of conveyance into the formwork. The density of the SACON® shall be the primary property that controls the mixture proportioning. The density of freshly mixed SACON® without fibers shall be 1442 ± 48 kg/m³ (90 ± 3-pcf) as determined in accordance with ASTM C 138.

1.5.2 Mixture Proportion

The mixture proportion of SACON® without color pigment and slump extender or high range water reducer shall be as follows:

Ingredient	Cubic Meter	Cubic Yard
Portland Cement	577 kg (1272 lbs)	972 lbs (441 kg)
Fine Aggregate (SSD)	577 kg (1272 lbs)	972 lbs (441 kg)
Water	277 kg (611 lbs)	466 lbs (211 lb)
Calcium Phosphate	5.78 kg (12.7 lbs)	9.72 lbs (4.4 kg)
Aluminum Hydroxide	5.78 kg (12.7 lbs)	9.72 lbs (4.4 kg)
Foam Stabilizer	0.15 kg (0.33 lb)	0.25 lbs (0.11 kg)
Foam (Void System)	0.33 m³ (11.7 cu ft)	9.0 cu ft (0.25 m³)

Fiber (choice of)		
Polypropylene	8.8 kg (19.4 lb)	14.8 lbs (6.7 kg)
Density		
(Without fibers)	1442 kg/m³	90-pcf
(With polypropylene fibers)	1458 kg/m³	91-pcf

The color pigments shall be added when a particular color configuration is needed to simulate the soil, rocks, trees, or buildings and only to the manufacturers' suggested amounts. Colors shall be as indicated on the drawings. A slump extender or high range water reducer may be added to extend the consistency of the SACON® for long haul or distance placements. The dosage rate shall follow the manufacturers' recommendations.

1.6 STORAGE OF MATERIALS

1.6.1 Cement

Cement shall be stored in weather-tight buildings, bins, or silos that will exclude moisture and contaminants.

1.6.2 Aggregates

Aggregate stockpiles shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of aggregates.

1.6.3 Admixtures and Agents

Admixtures, agents, and other materials shall be stored in such a manner as to avoid contamination and deterioration. Chemical admixtures shall be stored in such a manner as to prevent freezing.

PART 2 PRODUCTS

2.1 CEMENTITIOUS MATERIALS

Cementitious materials shall each be of one type and from one source when used in SACON® which will have surfaces exposed in the finished structure. The cement shall conform to ASTM C 150, Type I or II. Pozzolonic additives are not normally used in the manufacture of SACON® due to the length of curing required.

2.2 AGGREGATES

Aggregates shall conform to ASTM C 144. SACON® shall not contain aggregate particles greater than 2.36-mm (No. 8 sieve). The minimum grading requirements for the fine aggregate shall be those specified in ASTM C 144.

2.3 FIBER REINFORCEMENTS

Fiber reinforcement shall be polypropylene or steel as required in ASTM C 1116.

2.3.1 Polypropylene Fiber

Fiber shall be fully oriented, 100% virgin polypropylene, collated fibrillated fiber, 19.0 mm (3/4-in.) long, and shall comply with ASTM C 1116, Type III fiber requirement.

2.3.2 Steel Fiber

Fiber shall be made from cold rolled low carbon steel with a tensile strength in the range of 400 to 800 N/mm^2 (50- to 120-ksi) and have sufficient ductility to permit 180 degree bends without rupture. Fibers shall have an aspect ratio in the range of 40 to 50 and a minimum length of 25.0-mm (1-in.). Fibers shall comply with ASTM A 820 type II requirements and ASTM C 1116, Type I requirement.

2.3.3 Other Fiber Reinforcements

Fibers composed of other compositions reported in ACI 544.1R may be used if trial batches of the SACON® tested with the penetration of the M855 round do not exceed the penetration limits.

2.4 ADMIXTURES

2.4.1 Foaming Agents

Foaming agent shall comply with ASTM C 869, tested in accordance with ASTM 796.

2.4.2 Foam Stabilizing Agents

The stabilizing agent shall contain Hydroxypropyl methylcellulose powder limited shall be 19.0 to 24.0% methoxyl and 7.0 to 12.0% hydroxypropoxyl, similar to Dow Chemical Co. K100M.

2.4.3 Calcium Phosphate

Calcium phosphate additive shall contain a form of calcium phosphate carbonate to permit the formation of lead phosphate to reduce the corrosion of the lead and copper from the spent rounds. The calcium phosphate may be in any form such as granulated bone meal, bone ash, or precipitated calcium phosphate (technical grade or higher).

2.4.4 Aluminum Hydroxide

Aluminum hydroxide shall contain a form of aluminum to permit the formation of lead aluminum phosphate hydrate to further reduce the corrosion of the lead and copper by precipitating an insoluble lead compound as a coating. The aluminum phosphate may be in any form such as metakaolinite or precipitated aluminum hydroxide (technical grade or higher).

2.4.5 Color Pigments (if required)

Color pigment material shall have manufacturer's certification for usage in concrete, and shall have no deleterious effects to the SACON®. Carbon black and other pigments containing carbon or heavy metal components shall be prohibited from use.

2.4.6 High Range Water Reducing Admixtures (if required)

High range water reducing admixtures (slump extenders or super plasticiers) material shall have manufacturer's certification for usage in concrete, and shall have no deleterious effects to the SACON®. If a high range water reducing admixture is being considered due to extended haul distance, longer casting periods, or higher ambient temperatures, then the admixture shall be tested in a trial batch of SACON® to determine the compatibility with the other ingredients primarily the pre-formed foam.

2.5 WATER

Water shall be potable, except that non-potable water may be used if it complies with the requirements of CRD-C 400. Water for curing shall not contain any substance injurious to concrete, or which causes staining.

2.6 FORMS

Wall panels shall be constructed with pre-cast units of specified shapes and dimensions. Live-fire target and bullet traps shall be constructed with pre-cast units of specified shapes and dimensions. Floor blocks or slabs shall be constructed with pre-cast units of specified shapes and dimensions. Alternative shapes and dimensions may be allowed pending prior Government approval.

2.6.1 Form Release Coatings

Form release coatings may be used to serve as a bond breaker between the form surface and the SACON®. Such form release agents shall be tested to assure that they do not cause collapse of the aqueous foam used to control the density of SACON®.

2.6.2 Silicone Coating

A silicone coating, if used, shall be sprayed onto the form surfaces that are to be in contact with the SACON®. No petroleum products of any kind other than the silicone shall be used. Petroleum products have shown a great tendency to collapse the pre-formed foam in SACON®.

2.6.3 Polyethylene Sheeting

Polyethylene sheeting, if used, shall cover the individual form pieces. The form pieces shall be individually wrapped and stapled or bonded with an epoxy or glue adhesive prior to assembly. Sheeting shall be a minimum of 6-mils in thickness.

2.7 EMBEDDED ITEMS

Embedded items shall be as indicated, and shall be secured firmly in the forms to prevent movement during SACON® placement.

2.8 CURING MATERIALS

2.8.1 Burlap

AASHTO M 182, Class 3 or 4.

2.8.2 Impervious Sheets

ASTM C 171, type optional, except that polyethylene film, if used, shall be white opaque.

2.8.3 Membrane-Forming Compounds

ASTM C 309, Type 1-D, Class A or B, if used, shall be clear except when surface color is not required, white may be used.

PART 3 EXECUTION

3.1 PREPARATION OF SURFACES

Surfaces to receive SACON® shall be clean and free from frost, ice, mud, water, and other contaminants.

3.2 BATCHING, MIXING AND TRANSPORTING SACON®

SACON® mixed in ready-mixed concrete trucks shall be batched, mixed, and transported in accordance with ASTM C 94, except as otherwise specified. Truck mixers, agitators, and non-agitating units shall comply with NRMCA TMMB 1. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA QC 3. Site-mixed concrete shall be mixed in accordance with ACI 301. On site plant shall conform to the NRMCA CPMB 100.

3.2.1 Cement Slurry

The cement slurry, comprised of portland cement, fine aggregate, water, foam stabilizer, calcium phosphate, aluminum hydroxide, and concrete color pigment (if used), shall initially be batched in a stationary mixer or transit (ready-mix) truck and delivered to the casting site for addition of the other ingredients. The mixer configuration shall be such as to allow adequate mixing with a minimum of cement balling and lumping. The foam stabilizer shall be pre-blended with a minimum of equal cement volume prior to addition into the mixer.

3.2.2 Air Void Structure

The void material, pre-formed foam shall be added to the cement slurry to obtain the required density. The material shall be added in increments to reduce the possibility of exceeding the SACON® density tolerances. The recommended procedure is to add the foam in half increments, i.e. add half of the foam initially by time of insertion and calculate the density; if density remains above the upper tolerance, add half of the remaining foam and re-calculate the density; if density remains above the upper tolerance, then add half of remaining foam until the density tolerance of $\pm$ 48 kg/m³ (3-pcf) has been achieved.

3.2.2.1 Pre-Formed Foam

The foam shall be pre-formed through a foam generator. A concentrated foaming agent shall be mixed with potable water into an aqueous solution in accordance with manufacturer specifications. The solution is pulled into the generator by a vacuum and is expanded into a foam as it passes through a cylinder of glass beads that introduces air into the solution. The foam generator transforms the solution into foam at an expansion rate of 30 to 1. The foam shall be added to the slurry in increments. The foam output from the foam generator shall be verified prior to each day's batching. The output time shall be calculated by determining the time required to fill a known volume container with a minimum volume capacity of 0.056-m³ (15-gal). A flow rate in cubic meters per second (cubic feet per second) shall be calculated.

3.2.3 Fiber Reinforcement

The fibers shall be the final ingredients added to the SACON® mixture following the final density determination. Fibers shall be introduced into the mixture in such a fashion as to minimize clumping or balling.

3.2.3.1 Polypropylene Fibers

Polypropylene fibers shall be added by any means into the mixer, but shall not be added in bulk volume where the fibers have tendencies to ball. Water-soluble bags shall not be tossed directly into the mixer; without any coarse aggregate in the SACON®, these bags will not disintegrate.

3.2.3.2 Steel Fibers

Steel fibers may be added by a conveyor belt system when authorized by prior approval. The fibers shall be placed on the conveyor belt, physically loosened and separated from balling, and added to the mixture. The fibers may also be added by hand. Fibers shall not be added in bulk volumes where the fibers have tendencies to ball.

3.2.4 Control of Mixing Water

No water from the truck system or elsewhere shall be added to the cement slurry or the SACON® mixture after the initial introduction of mixing water for the batch.

3.3 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor, unless stated otherwise, and shall be performed by an approved testing agency.

3.3.1 Aggregates

Aggregates for SACON® shall be sampled and tested in accordance with ASTM C 144. Gradation tests shall be performed twice on the first day and every other day thereafter during SACON® construction.

3.3.2 SACON® Mixture Sampling

Initial sampling of SACON® to control the density shall be performed on the initial portion of each batch. Additional sampling shall be performed as often as needed to obtain the specified density. SACON® samples shall not be rodded or vibrated; the sides of the molds shall be lightly tapped to obtain a smooth surface and screeded to the top of the mold rim.

3.3.2.1 Density

Tests for density of freshly mixed SACON® shall be performed on the initial portion of each batch. Tests shall be conducted as often thereafter as needed to control the density. The 0.0142-cubic meter (0.5-cubic feet) cylindrical sample molds (ASTM C 138) filled with SACON® shall be weighed for density measurement and then returned to the mixer (if desired). The sample used for density determinations may be returned to the mixer for further use or may be discarded. Following the final density determination, the batch shall be sampled twice for continuity. The density of freshly mixed SACON® shall not vary more than $\pm$ 48 kg/m³ (3-pcf) from the corresponding density of the approved proportions. The fiber reinforcement shall be added after the final density determination. Additional samples of SACON® for hardened SACON® density and unconfined compressive strength tests shall be taken in accordance with ASTM C 172. All strength test cylinder samples shall be taken at the point of SACON® delivery into the formwork.

3.3.3 Evaluation and Acceptance of SACON®

The initial evaluation and acceptance of SACON® shall be by the density determination. If the density of any batch of SACON® is less than the required density, that batch shall be immediately discarded without any attempts to increase the density. Densities higher than the required limit may be reduced to acceptable limits by foam addition.

3.3.3.1 Frequency of Testing

Each batch of SACON® shall be sampled and tested for freshly mixed density and unconfined compressive strength.

3.3.3.2 Testing Procedures

Cylindrical test specimens of SACON® for testing shall be molded in accordance with ASTM C 31 except the rodding procedure shall not be performed. The specimens shall be cured identically to the cast SACON® objects. They shall be stored at the casting site and protected from disturbance. Cylinders shall be tested for density and unconfined compressive strength determination in accordance with ASTM C 39.

3.3.4 Evaluation and Acceptance of SACON® Panels and Objects

SACON® density and compressive strength shall be determined to verify the structural stability of the wall panels and other cast objects and to determine the date on which the objects can be placed into the structure. In addition, each SACON® wall panel and cast object shall be penetration tested to determine when the panels can be placed into service. Testing and evaluation of the SACON® shall be completed within 30 calendar days after the panels and objects have arrived at the testing site.

3.3.4.1 Penetration Test

All SACON® wall panels and other cast objects shall be individually tested with a live-fire test of an M855 round fired from an M16A2 rifle at a distance of 25-m and measured for penetration depth to the back of the bullet. Any penetration depth less than 25-mm (1-in.) or greater than 125-mm (5-in.) shall constitute a failure. Those objects failing to meet the penetration depth requirement shall be discarded without further testing or modifications. Penetration tests may be conducted from any safe distance equivalent to the final usage distances (i.e. test fire from 300-m (984-ft) or from 2-m (6.5-ft) if the SACON® will be live-fired from that distance); the penetration depths shall be within the same bullet depth requirements.

3.4 CONVEYING

3.4.1 Requirements

SACON® shall be conveyed from mixer to forms as rapidly as possible and within 60 minutes after the fibers have been added by methods that will prevent segregation, loss of ingredients, or changes in density.

3.4.2 Chutes

When SACON® can be placed directly from a transit mixer or other transporting equipment, chutes attached to this equipment may be used.

3.4.3 Buckets

Bucket design shall be such that SACON® can be discharged without loss of materials. Bucket gates shall be essentially water tight when closed. The bucket shall provide means for positive regulations of the amount and rate of deposit of SACON® in each dumping position. The bucket shall be of such design as to allow no more than a 0.6-m (2 ft) drop into the forms.

3.4.4 Belt Conveyors

Belt conveyors shall be designed for conveying grouts and shall be operated to assure a uniform flow of SACON® to the final place of deposit without segregation or loss of material. Conveyors shall be provided with positive means for preventing segregation of the SACON® at transfer points and point of placement.

3.4.5 Pumps

Pumping SACON®, if approved, shall be conveyed by positive displacement pumps. Pumps shall be the piston or squeeze pressure type. Pipelines shall be steel pipe or heavy-duty flexible hose. If a reducer is required from the

pump to the hose, then a cone reducer with a one-inch reduction for each twelve inches of reducer shall be used. The pump and hose size shall be matched to eliminate unnecessary backpressures and flow constraints. Distance to be pumped shall not exceed the limits recommended by the pump manufacturer. SACON® shall be supplied to the pump continuously. When pumping is completed, the SACON® remaining in the pipeline shall be ejected without contaminating the SACON® already in place. After each use, the equipment shall be thoroughly cleaned. Flushing water shall be wasted outside the forms.

3.5 SETTING MISCELLANOUS MATERIALS

Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before SACON® placement. Temporarily fill voids in sleeves with readily removable material to prevent the entry of SACON®.

3.6 PLACEMENT

SACON® which is transported in transit mixers or agitators or SACON® which is truck mixed, shall be discharged within 1-hr or before the drum has revolved 300 revolutions, whichever comes first after the introduction of the fibers to the mixture. When the SACON® temperature exceeds 30°C (85°F), the time shall be reduced to 45-min. SACON® shall be placed in the forms within 15-min after it has been discharged from the truck.

3.6.1 Placing Operation

SACON® shall be handled from the mixer to forms in a continuous manner until the approved batch of SACON® has been placed. Adequate scaffolding, ramps, and walkways shall be provided so that personnel and equipment are not supported by in-place reinforcement. Placing shall not be permitted when the sun, heat, wind, or limitations of facilities furnished by the Contractor prevent proper consolidation, finishing, and curing. SACON® shall be deposited as close as possible to its final position in the forms, and there shall be no vertical drop greater than 0.6-m (2-ft) except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the SACON® shall be so regulated that it will be effectively consolidated in horizontal layers not more than 0.6-m (2-ft) thick, except that all slabs shall be placed in a single layer. Fiber dispersion in the mixture shall be monitored continuously at the point of discharge into the forms. Should fiber clumping or balling be observed, the SACON® placement operation shall be temporarily suspended until the fibers are thoroughly dispersed in the mixture.

3.6.2 Consolidation

SACON® shall be consolidated by means of a screed vibrated very slightly to smooth the surface or lightly tapping of the formwork with a mallet. Excessive vibration of SACON® may result in the collapse of the pre-formed foam, and shall not be allowed.

3.6.3 Cold Weather Requirements

Cold weather concreting shall be performed in accordance with ACI 306R except as specified herein. Special protective measures shall be taken to protect freshly mixed SACON® if freezing temperatures are anticipated before the expiration of a specified 14-day initial curing period. The ambient temperature of the air where SACON® is to be placed and the temperature of surfaces to receive SACON® shall be not less than 4.5°C (40°F). The temperature of SACON® when placed shall be not less than 10°C (50°F) or more than 24°C (75°F). The mixing water shall be heated, if necessary, to regulate the SACON® placing temperature. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals or other material admixtures shall not be incorporated in SACON® in an attempt to prevent freezing.

3.6.3.1 Special Protective Measures

In the event that freezing temperatures are likely to occur during the initial 14-day curing period, the forms shall be placed in an area protected from the freezing temperatures. The area shall be protected by means of heaters and

may include storage buildings, tents, warehouses, etc. The initial curing period of SACON® shall not be less than 14 days. The forms shall not be stacked to gain space nor moved to a protected area after placement and prior to the full initial curing period.

3.6.4 Hot Weather Requirements

Hot weather concreting shall be performed in accordance with ACI 305R except as specified herein. The placing of SACON® during the daylight hours of warm weather shall be limited by the maximum atmospheric temperature and wind velocity. The temperature of SACON® placed during warm weather shall not exceed 29.5°C (85°F). The mixing water and fine aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. In no case shall the placing temperature exceed 35°C (95°F). Wind velocities shall be limited to prevent blowing dust from contaminating the materials, the SACON®, or the forms.

3.7 FINISHING

3.7.1 Formed Surfaces

The formed surfaces of SACON® shall be as smooth and flat as the formwork except where large protrusions may occur that shall be sanded or ground to an even finish.

3.7.2 Unformed Surfaces

The unformed surfaces of SACON® shall not be finished other than screeding to a level surface. Any additional finishing to the surface may cause the surface of the SACON® to be excessively hard.

3.8 CURING AND PROTECTION

3.8.1 General

SACON® shall be initially cured for a period not less than 14 days with no movement, de-forming, or freezing temperatures. Sides of the forms that will be reused may be removed after 3 days. Immediately after placement, SACON® shall be protected from premature drying extremes in hot temperatures and high winds, rapid temperature changes, mechanical injury, and injury from rain and flowing water. Air and forms in contact with SACON® shall be maintained at a temperature above freezing for the first day and at temperatures above 0°C (32°F) for the remainder of the initial 14-day curing period. Exhaust fumes from combustion heating units shall be vented to the outside of the enclosure and heaters and ducts shall be placed and directed so as not to cause areas of overheating and drying of SACON® surfaces or to create fire hazards. All materials and equipment needed for adequate curing and protection shall be available and at the site prior to placing SACON®. No fire or excessive heat shall be permitted near or in direct contact with SACON® at any time. Curing shall be accomplished by any of the following methods, or combination thereof, as approved.

3.8.2 Moist Curing

SACON® to be moist-cured shall be maintained continuously wet for the entire initial 14-day curing period. When wooden forms are left in place during curing, they shall be kept wet at all times. If the forms are removed before the end of the curing period, curing shall be carried out as on the unformed surfaces, using suitable materials. Horizontal surfaces shall be cured by water ponding, by covering with a 50-mm (2-in.) minimum thickness of continuously saturated sand, or by covering with waterproof paper, polyethylene sheet, polyethylene-coated burlap or saturated burlap.

3.8.3 Membrane Curing

The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing or flooring specified. Membrane curing compound shall not be used on surfaces that are maintained at curing temperatures

with free steam. Curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. Surfaces shall be thoroughly moistened with water and the curing compound shall be applied to slab surfaces as soon as the bleeding water has disappeared, with the tops of joints being temporarily sealed to prevent entry of the compound and to prevent moisture loss during the curing period. Compound shall be applied in a one-coat continuous operation by mechanical spraying equipment, at a uniform coverage in accordance with the manufacturer's printed instructions. SACON® surfaces that have been subjected to rainfall within 3 hours after curing compound has been applied shall be re-applied by the method and at the coverage specified. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

3.9 ERECTION

The SACON® wall panels and objects shall be constructed and erected as pre-cast units. The units shall be supported during tilting and lifting operations to avoid cracking.

-- End of Section --