



Designation: C 956 – 97 (2002)<sup>ε1</sup>

## Standard Specification for Installation of Cast-In-Place Reinforced Gypsum Concrete<sup>1</sup>

This standard is issued under the fixed designation C 956; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

<sup>ε1</sup> NOTE—Specification A 525 was editorially corrected to Specification A 653/A 653M in 2.1 and 7.2.

### 1. Scope

1.1 This specification covers the minimum requirements for the installation of cast-in-place reinforced gypsum concrete over permanent formboard.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 The text of this standard references notes which provide explanatory material. These notes shall not be considered requirements of the standard.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

A 82 Specification for Steel Wire, Plain, for Concrete Reinforcement<sup>2</sup>

A 185 Specification for Steel Welded Wire Reinforcement, Plain, for Concrete<sup>2</sup>

A 499 Specification for Steel Bars and Shapes, Carbon, Rolled from “T” Rails<sup>3</sup>

A 568 Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for<sup>4</sup>

A 653/A 653M Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process<sup>5</sup>

C 11 Terminology Relating to Gypsum and Related Building Materials and Systems<sup>6</sup>

C 317 Specification for Gypsum Concrete<sup>6</sup>

C 726 Specification for Mineral Fiber Roof Insulation Board<sup>7</sup>

E 72 Methods of Conducting Strength Tests of Panels for Building Construction<sup>8</sup>

2.2 American Concrete Institute Standard: ACI 318 Building Code Requirements for Reinforced Concrete<sup>9</sup>

2.3 American Welding Society Standard: D1.1 Structural Welding Code Steel<sup>10</sup>

### 3. Terminology

3.1 Definitions shall be in accordance with Terminology C 11.

#### 3.2 Definitions:

3.2.1 *primary framing, n*—structural members provided to support the reinforced gypsum concrete roof deck assembly.

3.2.1.1 *purlin, n*—a secondary structural member that spans the primary framing members and provides support for subpurlins.

3.2.2 *subpurlin, n*—a steel member applied transversely to the primary framing and purlins to support the formboards and to transmit the dead and live loads from the gypsum concrete slab to the primary framing.

3.2.2.1 *bulb tee, n*—a subpurlin, hot-rolled formed steel, rail-shaped section.

3.2.2.2 *truss tee, n*—a subpurlin fabricated from steel wire and strip, tee-shaped section.

3.2.3 *cross tee, n*—a steel tee-shaped section used to support a formboard end at right angles to the subpurlins where a formboard end does not occur over the purlin or primary framing.

3.2.4 *formboard, n*—sheet material used as a permanent form to support the gypsum concrete.

3.2.5 *reinforcement, n*—steel wire mesh or fabric used within the gypsum concrete slab to provide longitudinal and transverse strength.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C11 on Gypsum and Related Building Materials and Systems and is the direct responsibility of Subcommittee C11.03 on Specifications for the Application of Gypsum and Other Products in Assemblies.

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<sup>2</sup> Annual Book of ASTM Standards, Vol 01.04.

<sup>3</sup> Annual Book of ASTM Standards, Vol 01.05.

<sup>4</sup> Annual Book of ASTM Standards, Vol 01.03.

<sup>5</sup> Annual Book of ASTM Standards, Vol 01.06.

<sup>6</sup> Annual Book of ASTM Standards, Vol 04.01.

<sup>7</sup> Annual Book of ASTM Standards, Vol 04.06.

<sup>8</sup> Annual Book of ASTM Standards, Vol 04.07.

<sup>9</sup> Available from the American Concrete Institute, P.O. Box 19150, Detroit, MI 48219.

<sup>10</sup> Available from the American Welding Society, 550 N.W. La Jeune Rd., P.O. Box 351040, Miami, FL 33135.

3.2.6 *double-pouring, n*—the application of gypsum concrete in more than one layer to complete the full slab thickness. See 8.7.4.3.

3.2.7 *ribbon-pouring or strip-pouring, n*—the application of narrow ribbons of gypsum concrete, about 10 to 12 in. (254 to 305 mm) wide by 1 to 1½ in. (25.4 to 38.1 mm) deep, across the width of the formboard at center of span between purlins.

#### 4. Delivery of Materials

4.1 Materials shall be delivered in original packages, containers, or bundles bearing the brand name and name of producer or seller. Bulk materials shall be delivered with the brand name and name of the producer or seller shown on the accompanying bills of lading.

#### 5. Storage of Materials

5.1 All materials shall be stored in a manner that prevents damage before use. When stored under tarpaulins, ventilation shall be provided to prevent moisture accumulation under the tarpaulin.

5.2 Formboard shall be stored flat and off the ground. Handling and stacking shall be done in such a manner to prevent damage to face, ends, and edges and keep dry until use.

5.3 When it is necessary to store gypsum concrete at the job site, the gypsum concrete shall be stored off the ground and kept dry until use.

#### 6. Environmental Conditions

6.1 The minimum temperature at which gypsum concrete is mixed and placed is not specified. Gypsum concrete shall not be mixed with water containing ice crystals.

NOTE 1—An exothermic reaction during setting ensures complete hydration before freezing.

#### 7. Materials

##### 7.1 Subpurlins:

7.1.1 Subpurlins shall be designed to support live and dead loads of the roof deck.

7.1.2 Hot-rolled and cold-rolled steel shapes other than bulb tees or truss tees shall meet the requirements of this specification for subpurlins.

7.2 *Cross Tees*, shall be not less than 1¼ in. (31.75 mm) wide by ½ in. (12.7 mm) high, fabricated from not less than 26 gage zinc-coated steel conforming to Specifications A 653/A 653M or A 568.

##### 7.3 Formboard:

7.3.1 *Mineral Fiber Formboard*, Specification C 726, not less than ¾ in. (19.0 mm) thick nor more than 3 in. (76 mm) thick. It shall sustain a uniform load of 20 lb/ft<sup>2</sup> (97 kg/m<sup>2</sup>).

7.3.1.1 Mineral fiber formboard shall be tested in accordance with the transverse loading test of Methods E 72.

7.3.1.2 The test specimen shall be uniformly loaded and supported at both edges and ends. The test specimens shall be supported at the perimeter with a frame providing 1 in. (25.4 mm) bearing on ends and ½ in. (12.7 mm) bearing on edges and 7 in. (177.8 mm) nominal clearance from the bed of the apparatus.

7.3.1.3 For formboards ¾ in. (19.0 mm) thick, test specimens shall be 48 in. (1200 mm) long by 24 in. (600 mm) wide.

7.3.1.4 For formboards 1 in. (25.4 mm) thick or greater, test specimens shall be 48 in. (1200 mm) long by 32 in. (800 mm) wide.

7.4 *Reinforcement*, Specification A 82, shall be fabricated from zinc-coated (galvanized) welded or woven steel wire mesh or fabric having an effective cross-sectional area of not less than 0.026 in.<sup>2</sup> (16.77 mm)<sup>2</sup> per foot of slab width. Reinforcement shall be free of rust, scale, or other materials that reduce bond to the gypsum concrete.

7.4.1 *Hexagonal Reinforcing Mesh*, shall be fabricated from 2 in. (50.8 mm) hexagonal mesh formed of not less than 0.0410 in. (1.04 mm) diameter wires with longitudinal wires not less than 0.0625 in. (1.59 mm) in diameter, spaced not more than 3 in. (76.2 mm) on centers. Steel wire for fabricating wire mesh and fabric—Specification A 82.

7.4.2 *Rectangular Reinforcing Fabric*, Specification A 185, shall be fabricated from longitudinal wires not less than 0.1055 in. (2.68 mm) in diameter spaced not more than 4 in. (102 mm) on centers and transverse wires not less than 0.0800 in. (2.03 mm) in diameter spaced not more than 8 in. (203 mm) on centers.

7.5 *Gypsum Concrete*, Specification C 317, Class A.

7.6 *Water*, shall be potable and free of substances that could adversely affect the gypsum concrete.

7.7 *Expansion Filler Strip*, shall be not less than ¾ in. (19 mm) thick and equal in height to the abutting gypsum concrete and of the type specified by the producer of the gypsum concrete.

#### 8. Installation

##### 8.1 Installation of Subpurlins:

##### 8.1.1 Installation, Normal:

8.1.1.1 *Subpurlins*—The subpurlins shall be placed transversely to the purlins and primary framing and shall be spaced to suit the size of the formboards specified. Subpurlins shall be of sufficient length so that their joints occur over purlins or primary framing. Subpurlin joints shall be alternated so that the joints are staggered one purlin space.

8.1.1.2 Subpurlins shall be welded to purlins and steel primary framing with ⅛ in. (3.2 mm) fillet welds not less than ½ in. (12.7 mm) long on alternate sides of the subpurlin at each intersection with purlins. Except as otherwise specified, welding shall be in accordance with AWS D1.1. Where primary framing is of wood, nails not less than 16d shall be used on each side of the subpurlins at each intersection. The nails shall be bent over approximately ¾ in. (19 mm) to securely clinch the flange of the subpurlin.

##### 8.1.2 Installation Seismic:

8.1.2.1 *Subpurlins*—The subpurlins shall be welded at each intersection with the purlins with ⅛-in. (3.2-mm) fillet welds not less than 1 in. (25.4 mm) long, on one side. Both sides of the subpurlin shall be welded with ⅛-in. fillet welds not less than 2 in. (50.8 mm) long where subpurlin joints occur over the purlin. Both sides of the subpurlin shall be welded with ⅛-in. fillet welds not less than 2 in. long at shear transfer points and at intersections with exterior frame.

8.1.3 *Maximum Spans*—Refer to X2.1.3.

8.2 *Cross Tees*—Cross tees shall be provided where formboard ends are supported by purlins or the primary framing.

8.3 *Formboards*—Formboards shall be located face down on the flanges of the supporting members and with the ends on top of the purlins.

8.3.1 Gypsum concrete shall not be poured over formboards which have been wetted by rain or snow.

8.3.2 The gypsum concrete shall be poured on the same day the formboards are installed.

8.4 *Reinforcement*—The mesh of wire fabric shall be located with the main longitudinal wires at right angles to the subpurlins and adjacent to the formboard at midspan between the purlins. Ends of the reinforcement shall be lapped not less than 4 in. (102 mm) or one mesh, whichever is greater.

8.4.1 Edges shall be butted, not lapped, unless required for fire rated or horizontal diaphragm construction. Reinforcement shall be cut to fit at walls, curbs, and openings, folded over on to itself, and extended into all areas when gypsum concrete is to be placed.

8.5 *Expansion Filler Strips*—Expansion filler strips shall be placed continuously against the walls, curbs, nailers, or other rigid surfaces that gypsum concrete will abut.

8.6 *Expansion Joints*—Expansion joints shall be located at expansion joints found in the main structure, at a maximum of 200 ft (61 m) on center in a direction parallel to the subpurlins on large buildings, at intersections of wings on L-, U-, T-, and H-shaped buildings and, wherever the roof framing changes direction. See X1.5.5.

#### 8.7 *Gypsum Concrete Mixing and Placement:*

8.7.1 *General*—All equipment, including mixers, pumps, hoses, tools, and screeds shall be kept clean and free of set gypsum concrete throughout the placement operation.

8.7.2 *Proportioning*—The ratio of water to gypsum concrete shall be that specified by the producer of the gypsum concrete; additional water is prohibited. Volumetric or metering devices shall be used to ensure accurate measurement.

8.7.3 *Mixing*—Mixing shall be thorough but not overmixed. The slurry shall be discharged into placement equipment immediately after completion of mixing to avoid buildup of set material.

8.7.3.1 Calcium chloride or other admixtures shall not be added to the gypsum concrete.

#### 8.7.4 *Placement:*

8.7.4.1 *General*—To avoid exposure to inclement weather and physical abuse, gypsum concrete shall be placed the same day as the installation of the formboard and reinforcement materials.

8.7.4.1.1 The deck shall be poured in sections of similar size.

8.7.4.2 *Screeds Grounds*—Screeds, such as metal bars or wood strips, shall be spaced approximately 10 ft (3050 mm) apart at right angles on top of the subpurlins at a height that will allow the gypsum concrete slurry to be leveled at the specified thickness.

8.7.4.2.1 Gypsum concrete cants, curbs, and drainage slopes shall be placed to the design thickness. Curbs around openings shall be permitted to be formed with the formboard.

8.7.4.3 The gypsum concrete shall be discharged into placement equipment immediately after completion of mixing.

8.7.4.3.1 The slurry shall be poured or discharged not more than 24 in. (600 mm) off the formboard to minimize impact and allowed to build to full thickness in one continuous operation. Double pouring shall not be permitted.

8.7.4.3.2 As soon as the slurry has stiffened enough to hold a full level, it shall be screeded to a true, even surface using a smooth, rigid straight-edge.

8.7.4.4 Place gypsum concrete cants, curbs, and drainage slopes to the design thickness. Curbs around openings shall be permitted to be formed with the formboard.

8.8 *Roof Overhangs*—Gypsum concrete shall not be placed on roof overhangs, eaves, or other similar locations, on formboards unless the underside is protected against direct wetting by a suitable fascia drip cap overhang.

8.9 *Drying*—Construction moisture shall be removed from the building to permit drying of completed gypsum concrete slab, providing heat and ventilation where required. See X1.3.

8.10 *Protection of Completed Slab*—Gypsum concrete is not a finished traffic or weather protective surface. The top side of the completed gypsum concrete slab shall be protected with a permanent waterproof covering.

## 9. Keywords

9.1 calculation of diaphragm shear; gypsum concrete; gypsum roof deck

## APPENDIXES

### (Nonmandatory Information)

#### X1. GENERAL INFORMATION

##### X1.1 Limitations of Use

X1.1.1 *Roof Shapes and Designs*—Gypsum roof decks meeting this specification can be installed on flat, warped, sawtooth, curved, or pitched roofs.

NOTE X1.1—On flat roofs, a minimum pitch of 1/8 in./ft (10.4 mm/m) is recommended.

X1.1.2 *Moisture Exposure*—Cast-in-place gypsum concrete is not recommended for general use in occupancies where it

may be exposed to sustained relative humidity greater than 90 % or condensing moisture. The producer of the gypsum concrete should be consulted regarding limitations of use in high humidity occupancies.

X1.1.3 *Temperature Exposures*—Where intermittent or extended exposures to high temperatures are to be expected, such as in slabs directly exposed to radiant heat over furnace breachings, the gypsum concrete producer should be consulted for specific recommendations.