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SPECIFICATION FOR MASONRY STRUCTURES

TEK 1-2B
Codes & Specs (2004)

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INTRODUCTION

Specification for Masonry Structures (ref. 2), is a national consensus standard developed for incorporation by reference into the contract documents of masonry construction projects. Compliance with this specification is mandatory for structures designed in accordance with *Building Code Requirements for Masonry Structures* (ref. 1). The specification covers material requirements, storage and handling of materials, construction, and cleaning, as well as provisions for quality assurance, testing, and inspection. Construction includes requirements for the placement, bonding, and anchorage of masonry, and the placement of grout, reinforcement, and prestressing tendons. The document is formatted to allow the designer to modify those provisions for which a choice of alternatives is indicated. Thus the standard specification may be tailored to meet the specific needs of a project. Any modifications would be considered a supplemental specification to the standard.

The advantage of a standard specification is consistency, coordination, and understanding among all parties involved. The duties and responsibilities of the contractor, designer, and owner are detailed in the standard. A commentary, which accompanies the specification, explains the mandatory requirements and further clarifies the specification's intent.

SPECIFICATION CHECKLISTS

To assist the designer in the preparation of the contract documents, specification checklists are included which identify the decisions to be made during the preparation of any supplemental specifications. Several articles of the standard are prefaced with the phrase, “when required...” These articles do not become a part of the contract documents unless action is taken by the designer to include a requirement in the supplemental specifications. Other articles of the standard are prefaced by the phrase, “unless otherwise required...” These articles are a part of the contract documents unless the designer takes specific action to modify the article in the supplemental specifications.

MASONRY STRUCTURES SPECIFICATION CONTENTS

THE SPECIFICATION

The document is divided into three main sections, with subsections as indicated above. Excerpts of significant provisions are as follows:

Definitions

Area, gross cross-sectional—The area delineated by the out- to-out dimensions of masonry in the plane under consideration.

Area, net cross-sectional—The area of masonry units, grout, and mortar, crossed by the plane under consideration based on out-to-out dimensions.

Collar joint—Vertical, longitudinal joint between wythes of masonry or between masonry and backup construction which is permitted to be filled with mortar or grout.

Mean daily temperature—The average daily temperature of temperature extremes predicted by the local weather bureau for the next 24 hours.

Partition wall—An interior wall without structural function.

Running bond—The placement of masonry units such that head joints in successive courses are horizontally offset at least one-quarter the unit length.

Specified compressive strength of masonry, f'_m—Minimum compressive strength, expressed as force per unit of net cross-sectional area, required of the masonry used in construction by the project documents and upon which the project design is based.

Stack bond—For the purpose of this Specification, stack bond is other than running bond. Usually the placement of masonry units is such that head joints in successive courses are vertically aligned.

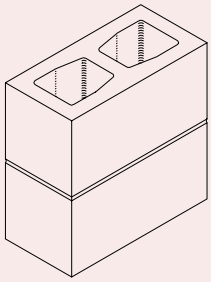
Wall—A vertical element with a horizontal length to thickness ratio greater than 3, used to enclose space.

Wall, loadbearing—A wall carrying vertical loads greater than 200 lb per lineal foot (2918 N/m) in addition to its own weight.

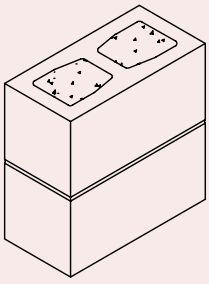
Wythe—Each continuous vertical section of wall, one masonry unit in thickness.

COMPRESSIVE STRENGTH DETERMINATION

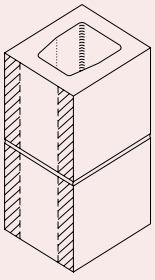
Prism Test Method (ref. 5)



Hollow unit—ungrouted prism



Hollow unit—grouted prism



Prism reduced by saw cutting

- Construct prisms in stack bond, one unit long and thick with a full mortar bed.
- Construct concrete masonry prisms with height to thickness ratios in the range from 1.33 to 5.0.
- Provide a minimum of one joint in hollow unit masonry prisms.

Table 1—Height to Thickness Correction Factors for Masonry Prism Compressive Strength (ref.5)

h_p/t_p [A]	1.3	1.5	2.0	2.5	3.0	4.0	5.0
Correction factor	0.75	0.86	1.00	1.04	1.07	1.15	1.22

[A] h_p/t_p-Ratio of prism height to least lateral dimension of prism.

Unit Strength Method (ref.2)

Table 2—Compressive Strength of Masonry Based on the Compressive Strength of Concrete Masonry Units and Type of Mortar Used in Construction (ref. 2)

Net area compressive strength of concrete masonry units, psi (MPa)		Net area compressive strength of masonry, psi (MPa)[1]
Type M or S mortar	Type N mortar	
1250 (8.62)	1300 (8.96)	1000 (6.90)
1900 (13.10)	2150 (14.82)	1500 (10.34)
2800 (19.31)	3050 (21.03)	2000 (13.79)
3750 (25.86)	4050 (27.92)	2500 (17.24)
4800 (33.10)	5250 (36.20)	3000 (20.69)

[1] For units of less than 4 in. (102 mm) height, 85 percent of the values listed.

INSPECTION

A. Prior to the start of masonry construction, the contractor shall verify:

1. That foundations are constructed with tolerances conforming to the requirements of ACI 117 (ref. 4).

2. That reinforcing dowels are positioned in accordance with the Project Drawings.

ACI 117 Section 3—Foundations (ref. 4)

3.2—Lateral alignment
3.2.1 Footings
As cast to the center of gravity as specified; 0.02 times width of footing in direction of misplacement but not more than ..... 2 in. (51 mm)
Supporting masonry ..... ½ in. (13 mm)

3.3—Level alignment
3.3.1 Footings
Top of footings supporting masonry ... ½ in. (13 mm)
Top of other footings +½ in. (13 mm), -2 in. (51 mm)

3.4—Cross-sectional dimensions
3.4.1 Footings
3.4.1.1 Horizontal dimension of formed members .....
..... +2 in. (51 mm), -½ in. (13 mm)
3.4.1.2 Horizontal dimension of unformed members cast against soil, 2 ft (0.6 m) or less .....
..... +3 in. (76 mm), -½ in. (13 mm)
greater than 2 ft (0.6 m) but less than 6 ft (1.8 m).....
..... +6 in. (152 mm), -½ in. (13 mm)
over 6 ft (1.8 m) ..... +12 in. (305 mm), -½ in. (13 mm)
3.4.1.3 Vertical dimension (thickness) ..... -5 percent

SITE TOLERANCES

Erect masonry within the following tolerances from the specified dimensions (ref. 2):

1. Dimension of elements
   a. In cross-section or elevation .....
      ..... -1/4 in. (6.4 mm), +1/2 in. (13 mm)
   b. Mortar joint thickness
      bed ..... ± 1/8 in. (3.2 mm)
      head ..... -1/4 in. (6.4 mm), +3/8 in. (9.5 mm)
      collar ..... -1/4 in. (6.4 mm), +3/8 in. (9.5 mm)
   c. Grout space or cavity width .....
      ..... -1/4 in. (6.4 mm), +3/8 in. (9.5 mm)
2. Elements
   a. Variation from level:
      bed joints ..... ±1/4 in. (6.4 mm) in 10 ft (3.1 m)
      ..... ±1/2 in. (13 mm) maximum
      top surface of bearing walls .....
      ..... ±1/4 in. (6.4 mm) in 10 ft (3.1 m)
      ..... ±1/2 in. (13 mm) maximum
   b. Variation from plumb ..... ±1/4 in. (6.4 mm) in 10 ft (3.1 m)
      ..... ±3/8 in. (9.5 mm) in 20 ft (6.1 m)
      ..... ±1/2 in. (13 mm) maximum
   c. True to a line ..... ±1/4 in. (6.4 mm) in 10 ft (3.1 m)
      ..... ±3/8 in. (9.5 mm) in 20 ft (6.1 m)
      ..... ±1/2 in. (13 mm) maximum
   d. Alignment of columns and walls (bottom versus top)
      ..... ±1/2 in. (13 mm) for bearing walls
      ..... ±3/4 in. (19 mm) for nonbearing walls
3. Location of elements
   a. Indicated in plan ..... ±1/2 in. (13 mm) in 20 ft (6.1 m)
      ..... ±3/4 in. (19 mm) maximum
   b. Indicated in elevation .. ±1/4 in. (6.4 mm) in story height
      ..... ±3/4 in. (19 mm) maximum

SITE TOLERANCES FOR PLACING REINFORCEMENT

1. Tolerances for the placement of steel in walls and flexural elements shall be ±1/2 in. (13 mm) when the distance from the centerline of steel to the opposite face of masonry, *d*, is equal to 8 in. (203 mm) or less, ±1 in. (25 mm) for *d* equal to 24 in. (610 mm) or less but greater than 8 in. (203 mm), and ±1 1/4 in. (32 mm) for *d* greater than 24 in. (610 mm) (ref.2).
2. In walls, for vertical bars, 2 in. (51 mm) from the location along the length of the wall indicated on the Project Drawings.

COLD WEATHER CONSTRUCTION

When the ambient temperature falls below 40°F (4.4°C) implement the following (ref. 2): Do not lay masonry units having a temperature below 20°F (-6.7°C). Remove visible ice on masonry units before the unit is laid in the masonry. Heat mortar sand or mixing water to produce mortar temperatures between 40°F (4.4°C) and 120°F (48.9°C) at the time of mixing. Maintain mortar above freezing until used in masonry. In addition:

1. When ambient temperature is 32°F (0°C) or below, heat grout aggregates and mixing water to produce grout temperatures between 70°F (21.1°C) and 120°F (48.9°C) at the time of mixing. Maintain grout temperature above 70°F (21.1°C) at time of grout placement.
2. When ambient temperature is 25°F (-3.9°C) or below, heat masonry surfaces under construction and masonry to be grouted to 40°F (4.4°C). Install wind breaks when wind velocity is in excess of 15 mph (24.1 km/hr).
3. When ambient temperature is below 20°F (-6.7°C), provide an enclosure for the masonry under construction and use heat sources to maintain temperatures above 32°F (0°C) within the enclosure.
4. When mean daily temperature is between 40°F (4.4°C) and 32°F (0°C), protect completed masonry from rain or snow by covering with a weather resistive membrane for 24 hr after construction.
5. When mean daily temperature is between 32°F (0°C) and 25°F (-3.9°C), completely cover completed masonry with a weather resistive membrane for 24 hr after construction.
6. When mean daily temperature is between 25°F (-3.9°C) and 20°F (-6.7°C), completely cover completed masonry with insulating blankets or equal protection for 24 hr after construction.
7. When mean daily temperature is below 20°F (-6.7°C), maintain masonry temperature above 32°F (0°C) for 24 hr after construction by enclosure with supplementary heat, by electric heating blankets, by infrared heat lamps, or by other acceptable methods.
8. Do not lay glass unit masonry during cold weather construction periods as defined in Article 1.8c.1a or 1.8c.1.b. Maintain temperature of glass unit masonry above 40°F (4.4°C) for the first 48 hr after construction.

HOT WEATHER CONSTRUCTION

Implement approved hot weather procedures and comply with following provisions (ref. 2):

1.Preparation—Prior to conducting masonry work:
   a. When the ambient air temperature exceeds 100°F (37.8°C), or exceeds 90°F (32.2°C) with a wind velocity greater than 8 mph (12.9 km/hr):
      1) Maintain sand piles in a damp, loose condition.
      2) Provide necessary conditions and equipment to produce mortar having a temperature below 120°F (48.9°C).
   b. When the ambient temperature exceeds 115°F (40.6°C) with a wind velocity greater than 8 mph (12.9 km/hr), implement the requirements of Article 1.8 D.1.a and shade materials and mixing equipment from direct sunlight.

2.Construction—While masonry work is in progress:
   a. When the ambient air temperature exceeds 100°F (37.8°C), or exceeds 90°F (32.2°C) with a wind velocity greater than 8 mph (12.9 km/hr):
      1) Maintain temperature of mortar and grout below 120°F (48.9°C).
      2) Flush mixer, mortar transport container, and mortar boards with cool water before they come into contact with mortar ingredients or mortar.
      3) Maintain mortar consistency by retempering with cool water.
      4) Use mortar within 2 hr. of initial mixing.
   b. When the ambient temperature exceeds 115°F (46.1°C), or exceeds 105°F (40.6°C) with a wind velocity greater than 8 mph (12.9 km/hr), implement the requirements 2.a above and use cool mixing water for mortar and grout. Ice is permitted in the mixing water prior to use. Do not permit ice in the mixing water when added to the other mortar or grout materials.

3. Protection—When the mean daily temperature exceeds 100°F (37.8°C) or exceeds 90°F (32.2°C) with a wind velocity of 8 mph (12.9 km/hr), fog spray all newly constructed masonry until damp, at least three times a day until the masonry is three days old.

WALL TIES

1. Embed the ends of wall ties in mortar joints. Embed wall tie ends at least 1/2 in. (13 mm) into the outer face shell of hollow units. Embed wire wall ties at least 1 1/2 in. (38 mm) into the mortar bed of solid masonry units or solid grouted hollow units.
2. Unless otherwise required, bond wythes not bonded by headers with wall ties as follows:

Wire size	Minimum number of ties required
W1.7	One wall tie per 2.67 ft^2 (0.25 m^2)
W2.8	One wall tie per 4.50 ft^2 (0.42 m^2)

The maximum spacing between wall ties is 36 in. (914 mm) horizontally and 24 in. (610 mm) vertically.
3. Unless accepted by the Architect/Engineer, do not bend wall ties after being embedded in grout or mortar.
4. Unless otherwise required, install adjustable ties in accordance with the following requirements:
   a. One tie for each 1.77 ft^2 (0.16 m^2) of wall area
   b. Do not exceed 16 in. (406 mm) horizontal or vertical spacing
   c. The maximum misalignment of bed joints from one wythe to the other is 1 1/4 in. (32 mm)
   d. The maximum clearance between connecting parts of the ties is 1/16 in. (1.6 mm)
   e. When pintle legs are used, provide ties with at least two legs made of wire size W2.8 (MW32).
5. Install wire ties perpendicular to a vertical line on the face of the wythe from which they protrude. Where one-piece ties or joint reinforcement are used, the bed joints of adjacent wythes shall align.
6. Unless otherwise required, provide additional unit ties around all openings larger than 16 in. (406 mm) in either dimension. Space ties around perimeter of opening at a maximum of 3 ft (0.9 m) on center. Place ties within 12 in. (305 mm) of opening and unsupported edges.

GROUT POUR HEIGHT

Table 3—Grout Space Requirements (ref. 2)

Specified grout type [1]	Maximum grout pour height, ft (m)	Minimum width of grout space, in. (mm) [2,3]	Minimum grout space dimensions for grouting cells of hollow units,[3,4] in. x in. (mm x mm)
Fine	1 (0.30)	3/4 (19.1)	1 1/2 x 2(38.1 x 50.8)
Fine	5 (1.52)	2 (50.8)	2 x 3(50.8 x 76.2)
Fine	12 (3.66)	2 1/2 (63.5)	2 1/2 x 3(63.5 x 76.2)
Fine	24 (7.32)	3 (76.2)	3 x 3(76.2 x 76.2)
Coarse	1 (0.30)	1 1/2 (38.1)	1 1/2 x 3(38.1 x 76.2)
Coarse	5 (1.52)	2 (50.8)	2 1/2 x 3(63.5 x 76.2)
Coarse	12 (3.66)	2 1/2 (63.5)	3 x 3(76.2 x 76.2)
Coarse	24 (7.32)	3 (76.2)	3 x 4(76.2 x 102)

[1] Fine and coarse grouts are defined in ASTM C 476 (ref. 3). Grout shall attain a minimum compressive strength of 2000 psi (13.76 MPa) at 28 days.
[2] For grouting between masonry wythes.
[3] Grout space dimension is the clear dimension between any masonry protrusion and shall be increased by the diameters of the horizontal bars within the cross section of the grout space.
[4] Area of vertical reinforcement shall not exceed 6 percent of the area of the grout space.

REFERENCES

1. *Building Code Requirements for Masonry Structures*, ACI 530-02/ASCE 5-02/TMS 402-02, reported by the Masonry Standards Joint Committee, 2002.
2. *Specification for Masonry Structures*, ACI 530.1-02/ASCE 6-02/TMS 602-02, reported by the Masonry Standards Joint Committee, 2002.
3. *Standard Specification for Grout for Masonry*, ASTM C 476-02, American Society for Testing and Materials, 2002.
4. *Standard Specifications for Tolerances for Concrete Construction and Materials*, ACI 117-90, reported by ACI Committee 117, 1990.
5. *Standard Test Method for Compressive Strength of Masonry Prisms*, ASTM C 1314-03b, American Society for Testing and Materials, 2003.