

National Concrete Masonry Association
an information series from the national authority on concrete masonry technology

CONCRETE MASONRY INSPECTION

TEK 18-3B

Quality Assurance & Testing (2006)

Keywords: construction, inspection, inspector, quality assurance, quality control, testing

INTRODUCTION

Concrete masonry is a popular building material in part because of its strength, versatility, durability, economy and resistance to fire, impact, noise and termites. To function as designed, however, concrete masonry buildings must be constructed properly.

Concrete masonry is used in projects ranging from small single story buildings to multistory loadbearing projects and is used in every building type and occupancy, including institutional, residential, commercial and manufacturing facilities. Because of the varying nature of these facilities, masonry construction continues to evolve, becoming more detailed and multifaceted. Reinforced masonry requires masons to not only lay masonry units, but to also properly place reinforcing steel and grout. As the intricacy and variety of masonry systems continues to expand, so does the need for educated and knowledgeable inspectors to verify that masonry is being constructed as designed. Likewise, ensuring that the physical properties of the masonry materials comply with project specifications requires detailed knowledge of testing procedures.

Many masonry projects of substantial size requires the implementation of a quality assurance program. A quality assurance program includes the owner's or designer's efforts to require a specified level of quality and to determine the acceptability of the final construction. As part of a quality assurance program, inspection includes the actions taken to ensure that the established quality assurance program is met. As a counterpart to inspection, quality control includes the contractor's or manufacturer's efforts to ensure that the final properties of a product achieve a specified goal under a quality assurance program. Together, inspection and quality control comprise the bulk of the procedural requirements of a typical quality assurance program.

INSPECTION

Inspection is one part of a quality assurance program, which are the administrative and procedural requirements set up by the architect or engineer to assure the owner that the project is constructed in accordance with the contract documents. Inspection is one means of verifying that the project is constructed as designed using the specified materials.

Inspection assures that masonry materials and construction practices comply with the requirements of the contract documents. Inspectors, the inspection program, and inspection records should be addressed in the quality assurance program. Local municipalities may have minimum inspection requirements that augment or complement minimum code requirements to ensure the safety of the public. Additionally, the amount of inspection required depends on the owner's needs. The architect or engineer will typically specify the degree of inspection necessary to meet the owner's quality assurance program, local ordinances and code requirements. (See *Required Levels of Inspection* below.)

Concrete Masonry Inspectors

A variety of individuals may review the progress of masonry construction. The mason, general contractor, and often the architect, engineer and owner will periodically observe the progress to verify that the masonry construction is proceeding as planned. Municipal or jurisdictional building inspectors may also be required to verify that the constructed project meets local building code requirements. In addition to these individuals, special masonry inspectors are sometimes required by the local building code or by the owner through the architect or engineer.

Each of these "inspectors" tends to look at the masonry construction differently. For example, architects, owners, and masons and general contractors may focus on aesthetic aspects of the masonry, such as color of units, color and size of mortar joints, tolerances, etc. Municipal building inspectors and engineers may concentrate more on verifying structural-related items, such as proper connections, reinforcing steel size and location and connec-

tor spacing. Individuals designated as masonry inspectors also closely inspect structural-related items but may also inspect aesthetic, weatherproofing and serviceability aspects of the masonry project as outlined in the contract documents.

The following helps address the level of inspection that may be required by masonry inspectors. It can also serve as a guide for engineers, architects, contractors and building officials engaged in masonry construction or inspection.

Required Levels of Inspection

Local municipalities may have minimum inspection requirements to ensure public safety. Additionally, the amount of inspection required depends on the owner’s needs. The architect or engineer will typically specify the degree of inspection necessary to meet the owner’s quality assurance program and local code requirements.

How long an inspector should be on a job site and what should be inspected has, however, been a source of confusion in many areas of the country. To clarify how much inspection should be required on masonry projects, *Specification for Masonry Structures* (ref. 1) includes detailed inspection guidelines that provide an excellent basis for the degree of inspection that should be provided on masonry projects.

The 2003 *International Building Code* (IBC) (ref. 2) Section 1704.5 inspection requirements are virtually identical to those in *Specification for Masonry Structures*. The corresponding designations are:

- IBC special inspection Level 1 requirements correspond to *Specification for Masonry Structures* Level B.
- IBC special inspection Level 2 requirements correspond to *Specification for Masonry Structures* Level C.
- Although there is no special inspection requirement corresponding to *Specification for Masonry Structures* Level A, this basic requirement is covered in IBC section 109.

In addition, in the 2002 edition of *Specification for Masonry Structures* the three levels of quality assurance were designated Levels 1, 2 and 3, which were replaced by Levels A, B and C, respectively, in the 2005 edition. This change in nomenclature is wholly editorial and does not affect the requirements specified for each level.

Three levels of inspection are defined within *Specification for Masonry Structures*:

- Level A (IBC Basic) – These requirements are the least stringent, requiring verification that the masonry construction complies with the plans and specifications (see Table 1). This level of inspection can only be applied to empirically designed masonry, glass unit masonry and masonry veneer used in facilities defined as nonessential by the building code. When masonry is designed by engineered

methods or is part of an essential facility, Level B or C inspection is required.

- Level B (IBC Level 1) – These requirements provide a periodic-type inspection for engineered masonry used in nonessential facilities (as defined in the building code) and for empirically designed masonry, glass unit masonry and masonry veneer used in essential facilities. Key inspection items include assurance that required reinforcement, anchors, ties and connectors are in place and that appropriate grouting procedures are used (see Table 2).
- Level C (IBC Level 2) – The most comprehensive inspection procedures are required for essential facilities (as defined in the building code) that are designed by engineered design methods (see Table 3). Items inspected under a Level C quality assurance program are similar to those of Level B, with the added requirement that inspection be continuous during all phases of masonry construction.

These inspection levels are minimum criteria and may be increased when deemed necessary by the owner or designer. In this case, the contract documents must indicate the inspection level and tests that are required to assure that the masonry work conforms with the project requirements. Due to their relative importance or potential hazard, more significant inspection and quality assurance measures are required for essential facilities.

Responsibilities and Qualifications of Masonry Inspectors

Proper construction techniques are essential for a building to function as designed. Unfortunately, buildings are sometimes poorly constructed because of oversight, miscommunication, or occasionally because of unscrupulous behavior. Accordingly, inspection of the construction process can be vital to the success of a project.

An inspector’s main duty is to observe the construction to verify that the materials and completed project are, to the best of the inspector’s knowledge, in conformance with the contract documents and applicable building code. The inspector is not required to determine the adequacy of either the design or application of products and cannot revoke or modify any requirement nor accept or reject any portion of the work. To function effectively, the inspector must be familiar with proper construction techniques and materials, with the requirements of the local building codes, *Building Code Requirements for Masonry Structures* (ref. 3) and *Specification for Masonry Structures*. Although not required by *Specification for Masonry Structures* or the *International Building Code*, inspectors may be qualified or certified under nationally recognized education programs offered through such organizations as the International Code Council. Completion of such a program may be required by a local jurisdiction or by a building official.

Although vague, Section 1704.1 of the 2003 *International Building Code* provides general guidance on the minimum qualifications for inspectors, as follows:

“The special inspector shall be a qualified person who shall demonstrate competence, to the satisfaction of the building official, for inspection of the particular type of construction or operation requiring special inspection.”

The nonspecific nature of this code provision has been a

Table 1—Level A Quality Assurance (IBC Basic Inspection)

Minimum tests and submittals	Minimum inspection
Certificates for materials used in masonry construction indicating compliance with the contract documents.	Verify compliance with the approved submittals.

source of confusion on various construction projects due to the wide variety of interpretations of a ‘qualified person.’ Some equate qualification with a nationally recognized certification, while others have allowed a noncertified individual with sufficient experience to serve as an inspector.

As a minimum, however, a masonry inspector must be familiar with masonry construction and be able to read plans and specifications effectively in order to judge whether the construction is in conformance with the contract documents. As part of this task, an inspector should always review the contract documents thoroughly before construction begins.

Inspectors must keep complete and thorough records of observations regarding the construction process. An effective way to accomplish this is by keeping a daily log when the inspector visits the project. Items such as the date, weather, temperature, work in progress (location and what was accomplished), meetings (attendees and topics of discussion), as well as overall observations and test results should be recorded in a neat, orderly manner since these notes may be needed later.

At the completion of the project or at predetermined stages of construction, inspectors must submit a signed report

Table 2—Level B Quality Assurance (IBC Level 1 Special Inspection)

Minimum tests and submittals	Minimum inspection
<p>Certificates for materials used in masonry construction indicating compliance with the contract documents.</p> <p>Verification of specified masonry compressive strength (f'_m) in accordance with <i>Specification</i> Article 1.4 B (ref. 1) prior to construction, except where specifically exempted by the <i>Code</i> (ref. 3).</p>	<p>As masonry construction begins, verify the following are in compliance:</p> <ul style="list-style-type: none"> • proportions of site-prepared mortar • construction of mortar joints • location of reinforcement, connectors, and prestressing tendons and anchorages • prestressing technique <p>Prior to grouting, verify the following are in compliance:</p> <ul style="list-style-type: none"> • grout space • grade and size of reinforcement, prestressing tendons and anchorages • placement of reinforcement, connectors and prestressing tendons and anchorages • proportions of site-prepared grout and prestressing grout for bonded tendons • construction of mortar joints <p>Verify that the placement of grout and prestressing grout for bonded tendons is in compliance.</p> <p>Observe preparation of grout specimens, mortar specimens, and/or prisms.</p> <p>Verify compliance with the required inspection provisions of the contract documents and the approved submittals.</p>

Table 3—Level C Quality Assurance (IBC Level 2 Special Inspection)

Minimum tests and submittals	Minimum inspection
<p>Certificates for materials used in masonry construction indicating compliance with the contract documents.</p> <p>Verification of specified masonry compressive strength (f'_m) in accordance with <i>Specification</i> Article 1.4 B (ref. 1):</p> <ul style="list-style-type: none"> • prior to construction • every 5,000 ft² (465 m²) during construction <p>Verification of proportions of materials in premixed or preblended mortar, grout and prestressing grout as delivered to the site.</p>	<p>From the beginning of masonry construction and continuously during construction of masonry:</p> <p>a) Verify the following are in compliance:</p> <ul style="list-style-type: none"> • proportions of site-mixed mortar, grout, and prestressing grout for bonded tendons • grade and size of reinforcement, prestressing tendons and anchorages • placement of masonry units and construction of mortar joints • placement of reinforcement, connectors, and prestressing tendons and anchorages • grout space prior to grouting • placement of grout and prestressing grout for bonded tendons <p>b) Observe preparation of grout specimens, mortar specimens, and/or prisms.</p> <p>c) Verify compliance with the required inspection provisions of the contract documents and the approved submittals.</p>

stating whether the construction requiring inspection was, to the best of the inspector's knowledge, in conformance with the contract documents and applicable workmanship standards. Specific services and duties required by an inspection agency are outlined in Article 1.6 B of *Specification for Masonry Structures*.

TESTING AND QUALITY CONTROL

Material testing may be necessary either before, during or after the construction of a building. For example, preconstruction testing may be requested to verify compliance of materials with the contract documents and is typically the responsibility of the contractor or producer of the product. Testing during construction, as part of the owner's quality

assurance program, may also be required to ensure that materials supplied throughout the construction process comply with the contract documents. These tests are the owner's responsibility. Additionally, testing may be necessary to determine the in-place condition of the building materials after the building is complete or during the building's life.

Standards for sampling and testing concrete masonry materials and assemblages are developed by the technical committees of ASTM International in accordance with consensus procedures. These standards reflect the expertise of researchers, concrete masonry manufacturers, designers, contractors and others with an interest in quality standards for masonry.

Specific testing procedures for concrete masonry units and related materials are covered in detail in references 4 through 10.

REFERENCES

1. *Specification for Masonry Structures*, ACI 530.1-05/ASCE 6-05/TMS 602-05. Reported by the Masonry Standards Joint Committee, 2005.
2. *2003 International Building Code*. International Code Council, 2003.
3. *Building Code Requirements for Masonry Structures*, ACI 530-05/ASCE 5-05/TMS 402-05. Reported by the Masonry Standards Joint Committee, 2005.
4. *Inspection and Testing of Concrete Masonry Construction*, TR156A. National Concrete Masonry Association, 2005.
5. *Compressive Strength Evaluation of Concrete Masonry*, TEK 18-1A. National Concrete Masonry Association, 2004.
6. *Sampling and Testing Concrete Masonry*, TEK 18-2A. National Concrete Masonry Association, 2004.
7. *Masonry Mortar Testing*, TEK 18-5A. National Concrete Masonry Association, 2005.
8. *Compressive Strength Testing Variables for Concrete Masonry Units*, TEK 18-7. National Concrete Masonry Association, 2004.
9. *Grout Quality Assurance*, TEK 18-8B. National Concrete Masonry Association, 2005.
10. *Sampling and Testing Segmental Retaining Wall Units* TEK 18-10. National Concrete Masonry Association, 2005.

Disclaimer: Although care has been taken to ensure the enclosed information is as accurate and complete as possible, NCMA does not assume responsibility for errors or omissions resulting from the use of this TEK.