CHAPTER 2

QUALITY ASSURANCE IN MASONRY

2-1. Introduction. This chapter provides guidance for quality assurance in masonry. Quality assurance in masonry starts with the design engineer' s preparation of the plans and specifications. These documents must contain adequate information for the contractor to construct a quality masonry product. In addition, the field quality assurance staff must have the support of engineering during the construction period to assure that the design intent is being accomplished. The design engineer must recognize that engineering support is required on a continual basis from the onset of the design through the completion of construction. Masonry is a field-assembled product that requires exacting construction control in order to ensure satisfactory performance. To achieve a high quality product, all participants in the design/construction process must know their role and must communicate their needs to the other participants. To this end; guidance is provided herein for contract drawings, shop drawings, instructions to the field, and site visits.

2-2. Design/construction process overview. The design process begins with communication among the members of the design team, including the architect, and the structural, mechanical and electrical engineers, to plan the layout of the masonry features of the building. Careful planning to achieve modular dimensions in masonry walls, both the total wall dimensions and the sizes and locations of openings (including the location and sizing of large openings for ducts and utilities), to eliminate excessive masonry unit cutting is a very important step in the process. The concept of modular coordination in masonry is an attempt to increase productivity and reduce costs in construction by adoption of coordinated masonry units and masonry panel sizes which are as standardized as is practical. A 4-inch module has been widely accepted by producers of building materials. However, for reinforced concrete masonry unit (CMU) walls, establishing an 8-inch module will eliminate or greatly reduce the field cutting of masonry units and will allow a standardized 8-inch pattern of reinforcing placement. Thus, for convenience and economy, an 8-inch module should be used in structural CMU walls and wythes whenever possible. Once the layout is developed, the contract plans must show sufficient details to adequately communicate to the contractor and the field quality assurance staff the intent of the designer. When detailing of the masonry is not completed on the contract drawings, it is very important to complete this detailing process on the shop (detail) drawings, which then become extensions of design. To achieve an understanding among all participants in the process and to provide the contractor and the quality assurance staff all needed information, it is most important that the shop drawings be approved prior to commencing masonry construction. Although all material and execution items in the contract documents are important, it is most helpful to the field quality assurance staff that the designer indicate those few items which can be termed "critical" to the achievement of the intent of the design. This can best be done with "Instructions to the Field", which are not a part of, but which supplement the construction contract documents. The last major item in the design/construction process, and the item most often missing from the process, is the designer visits to the field during periods critical to masonry construction. These visits can be an educational experience for both the designer and field personnel. Aside from the obvious benefit of direct communication on site, it has been shown that site visits can open a line of communication between field and office personnel. This develops the necessary contacts for effective communication should problems arise during construction.

2-3. Role of design engineers. The major items in the design engineer's role in the design/construction process are the following:

a. *Approaches to masonry design/detailing.* The designers will use the masonry details that have been developed for Corps-wide application as the basis for development of contract documents. These masonry details will be modified and supplemented as needed to fit the project requirements. Several approaches concerning the level of completeness of contract drawing detailing can be used by designers.

(1) One approach is to show typical details, tables of reinforcement, and other minimal information on the contract drawings. This approach requires that the masonry detailing be completed on the shop (detail) drawings, thus the shop drawings become a very important and critical extension of design. It is therefore very important that the structural design engineer not only provide a very

careful and complete review of the masonry details provided on the shop drawings-but must also make certain that the shop drawing details are coordinated with all architectural and mechanical needs. Of particular concerns is assurance that mechanical openings which penetrate structural masonry walls are included. With this detailing approach, constructing masonry walls without approved shop drawings can lead to numerous construction problems.

(2) Another detailing approach is to provide greater amounts of masonry detailing, including numerous section cuts and typical wall elevations. This is an intermediate approach that would still require a very careful review of the shop drawings by the designer; since, as described above, the shop drawings would still be a very important extension of design.

(3) On the opposite extreme to the first approach above, the structural designer may provide essentially every masonry detail; including all masonry wall elevations with every rebar, every masonry unit, and all masonry openings including every mechanical opening; on the contract drawings. Although showing every detail of every structural and nonstructural masonry wall and partition is clearly excessive, the more complete the development of details of the contract drawings, the higher the assurance that shop drawings are done correctly and thus the more expedient the approval should be.

b. Minimum contract drawing details requirements. The extent of detailing needed on the contract drawings is different for every building. The level of development of masonry contract drawings versus reliance on shop drawing details is a matter of efficiency and must be based on the judgement of the design office. In most situations, providing masonry wall elevations which show all wall openings, including ducts and piping, provides the greatest assurance for eliminating conflicts during construction. Whatever detailing approach is used, complete designs that give a clear understanding of the most critical features of construction is imperative to assure a quality constructed product. In all cases, the shop drawings must be approved by a structural engineer. Although the level of masonry detailing needed is different for every building, there are minimum contract drawing details that are required for all masonry construction. Therefore, the contract drawings for all masonry construction should contain minimum masonry details as follows —

(1) Typical details for piers, columns and pilasters and their location. It must be clear how the typical details are to be applied to all required locations for these elements.

(2) Concrete masonry unit control joint (CJ) and brick expansion joint (BEJ) details. Both plan and elevation views .are normally needed to clearly locate and dimension, throughout the structure, all CJ's and BEJ's.

(3) Details of horizontal and sloping tops of walls. Include control joints, beam pocket openings and method of anchorage for the roof system as applicable.

(4) Typical details of reinforcement around openings. It must be clear how the typical details are to be applied at all openings.

(5) Details showing continuity of structural bond beams. Particular attention must be given to achieving continuity in stepped structural bond beams at the tops of sloping walls. Sloping continuous bond beams have a higher assurance of satisfactory performance.

(6) Details showing intermediate bond beams and how continuity is provided when it is interrupted by openings and corners.

(7) Details of mechanical openings that may have a significant structural impact.

c. Instructions to the field. Often, the best way to provide the field quality assurance personnel the information they need to identify the critical masonry construction features, details, etc.; which must be present to carry out the intent of the designer; is with instructions to the field. Masonry construction includes a wide variety of materials including brick, CMU, mortar, grout, flashing, reinforcing steel, joint reinforcement, CJ keys, BEJ materials, anchor bolts, etc.; all of which are assembled by a mason to form walls, columns, piers, and pilasters. Although any or all of these items may be contained in the contract documents for a masonry building, and thus all are important, the quality assurance program does not allow for continuous observation by Corps field personnel. Instructions to the field, which identify those items that are most critical to constructing quality masonry, will allow the field quality assurance personnel to maximize the limited inspection time available. The following items, which represent areas that have caused significant problems on a repetitive basis, are not all inclusive, however, should be identified as critical items in all "Instructions to the Field" lists:

(1) *Mortar proportions* must be in accordance with the contract. Strength, resistance to water permeance, protection of reinforcement and durability are derived by the proper mixture.

(2) *Grout slump* must be in the range specified, usually 8-10 inches, and must be mechanically vibrated as specified to assure complete filling of cells. Mortar or concrete must not be used in lieu of grout.

(3) *Reinforcing steel* must be properly positioned and held in place for grouting and mechanical vibration. Lap lengths must be as required by the contract drawings. Unapproved interruptions of reinforcing steel for openings must not be allowed. The structural engineer should be contacted when conflicts arise.

(4) *Air spaces* in anchored veneer walls must be kept free of excessive mortar droppings. This will allow water that passes through the outer masonry wythe to proceed downward in the air space to reach the flashing and exit through the weepholes.

(5) *Brick expansion joints,* both vertical and horizontal, must be kept free of all material, including mortar, and then sealed with backer rods and sealant. Compressible material that is installed in the expansion joint for the purpose of keeping mortar out of the joint, etc., should not be used.

(6) *Masonry bonding* at the corners is required. This detail is needed to provide adequate lateral support to corners of walls during and after construction.

(7) *Joint reinforcement* must be the type specified, usually the ladder type, and must be properly placed. One longitudinal wire will be installed in each mortar bed. This normally requires two longitudinal wires per concrete masonry unit (CMU) wythe and one longitudinal wire per brick wythe. Truss type joint reinforcement should not be used. Factory fabricated intersections and corners are required. Longitudinal wires should be properly located within mortar beds to provide needed corrosion protection.

(8) *insulation* panels used in cavity wall construction must be in close contact at all pane] edges and must be tightly adhered to the backup wythe to achieve the assumed U-value.

(9) *Flashing* must be installed so that cells to be grouted are not blocked. Thus, flashing that is identified as “thru-wall” should not extend further into the masonry backup wythe than the first mortar bed. Joints in flashing must be lapped and sealed. Properly sealed joints are especially critical in wall systems with steel stud backup. Partial panel length flashing for lintels, etc., should be turned up to form dams at the ends.

(10) *Ceramic glazed and prefaced masonry units* should be set level and true so that the glazed and prefaced facing will present true planes and surfaces free of offsets or other distortions.

(11) *Masonry unit protection.* Tops of masonry that are exposed to rain or snow, while being stored and in partially constructed walls, must be covered with nonstaining waterproof covering or membrane when work is not in progress. Covering must extend a minimum of 2 feet down on each side and be held securely in place. The covering should allow air movement so that the masonry can reach ambient moisture equilibrium.

(12) *Other items critical to the specific project* should also be included, such as, prism testing of high strength masonry, etc.

d. Site visits. The final step in the design/construction process to achieve quality masonry construction is site visits by the designer. The purposes of these visits by the designer are:

(1) To see that the design intent is being reflected in the construction.

(2) To facilitate discussion between the construction field office personnel and the designer on special features of the design and critical construction items.

(3) To provide feedback on construction problem areas and to develop design improvements.

(4) To open the lines of communication between the designer and field personnel so that problems and concerns will be more freely discussed. Although it is recognized that the degree of engineering support during construction is under continual time and cost constraints, the need and value of site visits by the designer has been clearly established in published guidance. Every effort to implement a program of site visits during critical phases of masonry construction should be made. The designer should not make field visits only in response to field problems. Note that the “Instructions to the Field” given above provide an excellent short checklist both for the field quality assurance staff and for the designer during routine field visits to masonry construction.