



TECHNICAL NOTES on Brick Construction

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Technical Notes 9B - Manufacturing, Classification, and Selection of Brick, Selection, Part 3 Revised December 2003

Abstract: This *Technical Notes* addresses the selection of brick. Evaluation of the properties and applications of brick determines the durability, appearance, and impression of a project. Information is provided regarding aesthetics, cost and availability.

Key Words: abrasion, absorption, aesthetics, availability, brick, color, compressive strength, cost, durability, size, texture.

INTRODUCTION

The selection of brick is important in that it determines a project's durability and appearance, and results in a lasting impression. It is necessary to identify which qualities and properties of brick are appropriate to consider in selecting a brick. Brick with a wide variety of strength, color, texture, size, shape and cost are available. The owner or designer must decide which characteristics of brick are most critical. This selection process can dictate the success of any project.

This *Technical Notes* addresses the properties and characteristics which must be considered in the selection of the appropriate brick for a project. Other *Technical Notes* in this series provide the fundamentals of brick manufacturing and classification of brick.

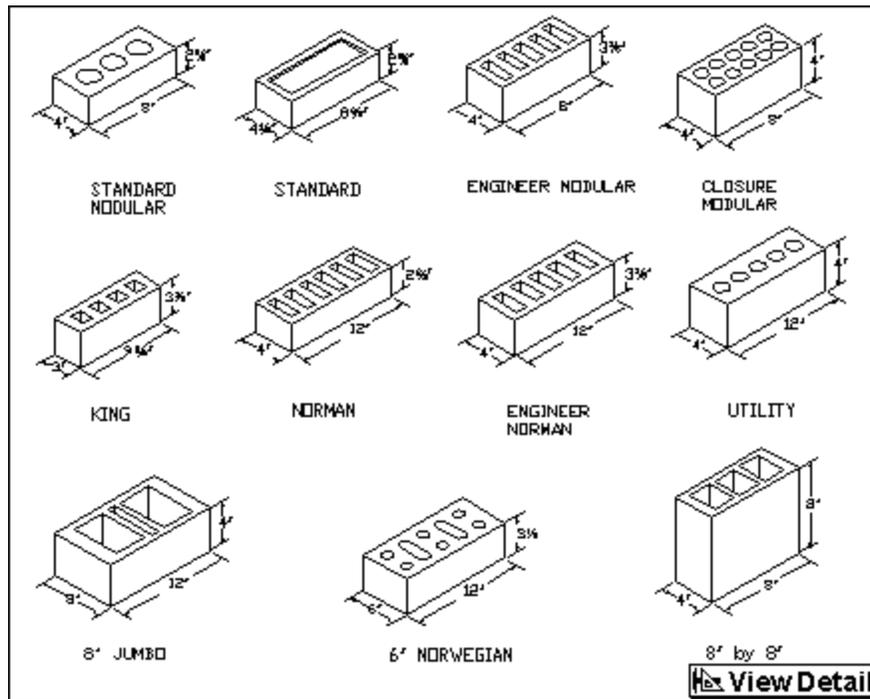
GENERAL

Brick selection is based on a number of factors. Not only are aesthetics and durability important, but strength, absorption, availability and cost are important to the owner, designers and contractors. The selection process can be difficult since each group is trying to satisfy different requirements. Typically, the final selection is based on a compromise from all parties involved.

Aesthetics

The use of brick as a building material dates back centuries. Because of brick's enduring qualities and limitless appearances, designers can satisfy their creative styles with brick. Brick is readily available in many sizes, colors, textures and shapes. These can be adapted to achieve virtually any desired style or expression.

A variety of common brick sizes are shown in Figure 1. Brick's small module can be related to the scale of the wall. These sizes can be combined in such a way as to create different appearances and patterns. Not only does brick size influence scale and appearance, but the size of brick influences wall cost because larger units require fewer brick, normally resulting in less labor. When specifying the size of units, dimensions should be listed in the following order: thickness (width) by height by length.



Brick Sizes (Nominal Dimensions)
FIG. 1

Brick manufacturers also offer a wide variety of colors to choose from. Units whose colors range from reds and burgundies to whites and buffs are manufactured today. Many manufacturers produce over 100 colors. Many of these color variations are created during the firing process. Temperature variations and the order in which the units are stacked in the kiln determine shades of light and dark. Ceramic glazes, slurries or sand coatings can be applied to the surface to achieve colors not possible with some clays. The possibilities of using units of contrasting colors in bands or other patterns are endless. Sample panels, or mockups, can aid in selecting the desired color by showing the finished appearance.

Another aesthetic feature to consider when selecting brick is the texture. Textures on brick can be smooth, wirecut (velour), stippled, tumbled, brushed, rolled, and more. The texture interacts with light and creates differing and interesting shadows.

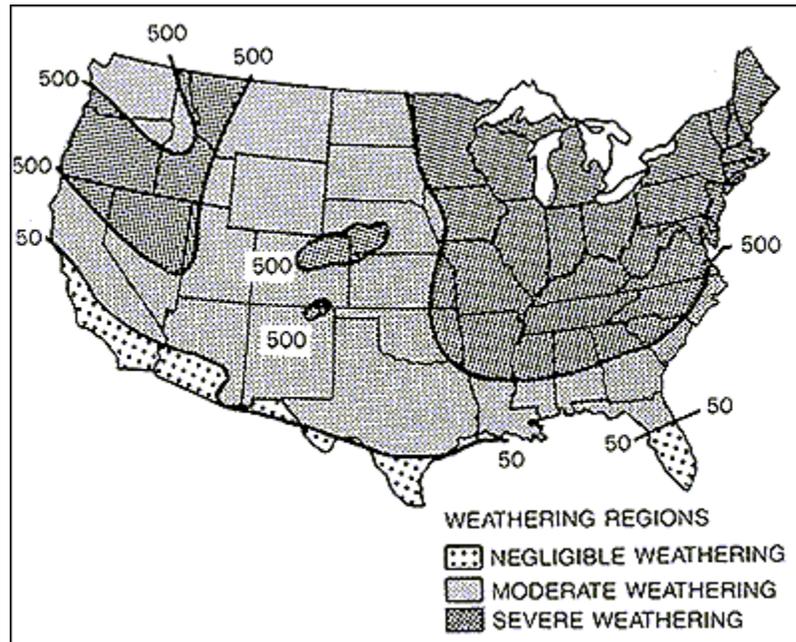
Unique design features can easily be achieved by using special brick shapes. Brick can be molded and formed into any shape, from simple sloped sill shapes to fancy watertable brick. For most manufacturers, molded shapes are easier to produce than extruded shapes, because the molded, or soft-mud process is more adaptable to making brick shapes than the extruded process. Making very large shapes can be difficult in either process because of problems with proper drying and firing.

Physical Properties

There are many physical properties which may influence the selection of brick. Some of these include durability, absorption, compressive strength and abrasion resistance. This *Technical Notes* will provide a basic understanding of these properties to aid in selection of the proper brick. Physical properties required for proper performance are given in the appropriate American Society for Testing and Materials (ASTM) specification for brick.

Durability. Currently, there are two accepted methods for demonstrating durability under ASTM standards: 1) durability as predicted by compressive strength, absorption, and saturation coefficient, or 2) durability as determined by compressive strength and passing 50 cycles of the freeze and thaw test. Criteria in each ASTM specification determine grade or class designations. Because of the varying climates and applications of brick, specific physical properties are required. Brick are classified into these grades or classes according to their resistance to freezing when wet. Table 1 gives the recommended grade of facing, building and hollow brick, based on weathering index and exposure. Fig. 2 indicates the approximate weathering indices of areas across the U.S. *Technical Notes* 9A describes this in more detail. Most manufacturers make brick to meet the designation for the most severe weathering exposure, SW or SX, so

they may ship brick to all parts of the country. Some manufacturers produce brick complying only with the designation for moderate weathering, MW or MX. Grade NW or NX brick are typically confined to interior applications, or where they are protected from water absorption and freezing. Brick manufacturers can furnish certification that their product will meet a certain grade or class.



Weathering Indices in the United States
FIG. 2

TABLE 1

Recommended Minimum Grade for Face Exposures

Exposure	Weathering Index	
	Less than 50	50 and greater
In vertical surfaces:		
In contact with earth	MW	SW
Not in contact with earth	MW	SW
In other than vertical surfaces:		
In contact with earth	SW	SW
Not in contact with earth	MW	SW

Absorption. Absorption can be broken into two distinct categories – absorption and initial rate of absorption (IRA). Both are important in selecting the appropriate brick. Absorption of a brick is expressed as a percentage, and defined as the ratio of the weight of water that is taken up into its body divided by the dry weight of the unit. Water absorption is measured in two ways: 1) submerging the test specimen in room temperature water for a period of 24 hours, and 2)

submerging the test specimen in boiling water for five hours. These are known as the 24 hour cold water absorption, and the 5 hour boiling water absorption, respectively. These two are used to calculate the saturation coefficient by dividing the 24 hour cold water absorption by the 5 hour boiling. The saturation coefficient is used to help predict durability.

The initial rate of absorption (IRA) or suction is the rate of how much water a brick draws (sucks) in during the first minute after contact of the bed surface with water. The suction has a direct bearing on the bond between brick and mortar. It has been shown by test results that when a brick has high suction (over 30 grams/min/30 in² [30 grams/min./194 cm²]), a strong, watertight joint may not be achieved. Therefore, high suction brick should be wetted prior (3 hrs to 24 hrs) to laying to reduce the suction and allow the brick's surface to dry. Very low suction brick should be covered and kept dry on the jobsite. Brick manufacturers can furnish values of IRA and saturation coefficient of the selected units. The material specifier or supplier should inform the mason contractor about the suction of the brick prior to construction.

Compressive Strength. The strength of a unit is used to determine durability and also compressive strength of the resulting brick masonry. Typically, most materials are judged on the basis of strength. However, it is important not to sacrifice properties of durability and bond for higher compressive strengths. Most brick currently produced have strengths ranging from 3,000 psi (20.7MPa) to over 20,000 psi (138 MPa), averaging around 10,000 psi (68.9 MPa). Achieving sufficient compressive strength with brick is seldom a problem.

Abrasion Resistance. This property is important when brick is used as paving. The resistance to abrasion is affected by the degree of firing and by the nature of the raw material. Abrasion resistance is predicted in two manners. It is evaluated in terms of cold water absorption and compressive strength. These two properties produce an abrasion index which is used to determine the type of traffic which is suitable for a particular brick. Alternately, volume loss is determined by sand blasting the paver surface.

Application

A building must perform the functions for which it is designed. The materials selected for a project must also perform as intended. The designer must consider all factors which a wall or material must withstand. Some of the more important factors include moisture penetration, temperature variations and structural loads. No one standard assembly is suitable for all localities, occupancies, or designs; therefore, the designer must evaluate each factor and its relative effect on the selection of a material or assembly.

Moisture Penetration. The use of quality materials and workmanship is essential in obtaining a satisfactory degree of water resistance. When water passes through brick masonry walls, it invariably does so through separations or cracks between the brick units and the mortar. It is virtually impossible for significant amounts of water to pass directly through a brick unit. Therefore, brick units which develop a complete bond with mortar offer the best moisture resistance. Brick and mortar properties should be compared to provide compatible materials which result in more watertight walls. Currently, there are no requirements for the degree of water resistance of a wall.

Temperature Variations. Brick must withstand daily temperature cycles and seasonal extremes (-30°F to 120°F [-34°C to 49°C]) depending on location, throughout its life. Thermal expansion and contraction of brick is not critical to the selection of brick, but it is important to designers and this movement should be provided for in design and construction. Brick also withstands temperature extremes in fires. Since brick is a fired material, it will not burn and acts as an excellent barrier to fire because it is non-combustible.

Structural Loads. Ability to withstand either gravity or lateral loads relies heavily on brick strength, mortar strength and dimensions of the wall assembly. Compressive strength requirements found in the ASTM specifications for brick are based on durability performance. Structural analysis may require a higher compressive strength in order to resist the applied loads. Compressive strength of masonry may be a governing criterion in loadbearing or reinforced brick masonry projects.

Cost

Material selection is often based on cost, usually initial cost only. Although initial cost is important, lifecycle cost is a better tool for making critical decisions. When deciding between different materials, all costs involved including labor and maintenance costs, future value and life expectancy should be considered.

The selling price of brick is governed by many factors, including manufacturing methods and appearance of the unit. When considering different brick, one must take into account shipping costs. Since most prices quoted are plant prices, distance between the manufacturing plant and the jobsite is a major determinant of these shipping costs. Brick manufacturers and distributors can supply brick prices and shipping prices. Brick price is only one part of the in-place costs. Labor and overhead costs are approximately twice the brick and mortar costs. Many of the Masonry Institutes throughout the country provide cost comparisons between different materials.

Availability

The availability of brick fluctuates with the time of the year and current construction trends and demands. On the average, brick production time runs about 5 days, from pugging of the clay to the finished, fired product. This can change depending on many factors such as variations in raw materials, forming process, and kiln types. Many brick manufacturers have stockpiles of brick, but usually only a small quantity of each brick type. This may satisfy smaller jobs, but for large projects requiring large quantities of brick, a special production run must be made for the job. Most manufacturers have a set schedule as to when they produce a certain brick shade. It is at this time that the size of the run will be increased to accommodate the large order. It is wise to determine the brick's availability from the manufacturer.

It is best to purchase all brick from the same production run because there are typically slight color variations between runs. All manufacturers have quality controls to keep this at a minimum.

SUMMARY

This *Technical Notes* has described which characteristics of brick are important in selecting a particular unit. There is a wide selection of brick from which to choose. Selecting the appropriate material is important to the project's longevity and appearance.

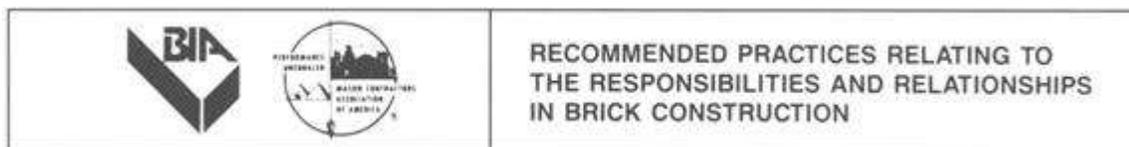
The remainder of this *Technical Notes* is "Recommended Practices Relating to the Responsibilities and Relationships in Brick Construction". This document, developed jointly by the Brick Industry Association and the Mason Contractors Association of America, explains some potential problems that may occur during and after the selection process, and how to avoid them.

The information and suggestions contained in this *Technical Notes* are based on the available data and the experience of the technical staff of the Brick Industry Association. The information and recommendations contained herein must be used along with good technical judgment and a basic understanding of the properties of brick masonry. Final decisions on the use of the information discussed in this *Technical Notes* are not within the purview of the Brick Industry Association and must rest with the project architect, engineer and owner.

REFERENCES

More detailed information on subjects discussed here can be found in the following publications:

1. Brick Industry Association *Technical Notes* 7 Series - Water Resistance of Brick Masonry
2. ASTM Standard Specifications for Brick.



Most brick construction projects are completed with the result that the building owner, architect, general contractor, mason contractor, brick distributor, and brick manufacturer are completely satisfied with the final product. On rare occasions, however, a mistake is made or a misunderstanding occurs that spoils what would otherwise be a rewarding and profitable experience for all concerned.

Recognizing this fact, representatives from the manufacturing, sales and distribution, and installation segments have developed these "Recommended Practices" which identify the areas in which misunderstandings are most likely to occur and suggest procedures to be followed that will minimize the effects when mistakes do occur.

The "Recommended Practices Relating to the Responsibilities and Relationships in Brick Construction" was developed through the cooperative efforts of the Brick Industry Association and the Mason Contractors Association of America. Draft copies of the complete document were distributed to other construction industry associations for review and, where appropriate, their advice was included in these final "Recommended Practices".

INTRODUCTION

The purpose of these recommended practices is to prevent misunderstandings that might result from improper sampling procedures, ordering, or examination of the field work.

As in all business relationships, there are responsibilities among all parties involved - manufacturers, distributors, general contractors, mason contractors, construction managers, architects, engineers, owners and/or their respective representatives or agents - in producing an acceptable masonry project. It is to the mutual advantage of all concerned that problems, when encountered, be identified and addressed in a timely manner.

Contract Allowances

The practice of using only dollar value allowances for brick in construction documents is not recommended because this method does not provide sufficient information to make an informed bid. Items such as special shapes often are too complicated to use an allowance. However, if an allowance is used, the following variables should be included: unit specification (ASTM standard), grade, type and size (width by height by length). The construction documents should clearly state whether taxes, delivery, handling, and/or installation are included in the allowance. In the initial establishment of an allowance, the parties should take into consideration the extra cost of special shapes and any other special units required by the project.

Ordering

All brick orders should be submitted in writing by the purchaser to the distributor or manufacturer, whichever is appropriate. The order should include and clearly identify the following:

- A. Job name and type;
- B. Location;
- C. Owner;
- D. Architect;
- E. General contractor and/or mason contractor;
- F. Material quantities, including types and quantities of special or non-standard items, should be accurately determined so that the order may be shipped in its entirety. Brick should be described by specified dimensions (width by height by length) rather than by generic or trade name;
- G. Unit prices, including conditions such as escalation of prices, freight rates and terms;
- H. Delivery schedules, including anticipated start date and quantity of each shipment;
- I. Other information pertinent to the order, such as a copy of that portion of the specifications which applies to the brickwork.

If special shapes are required, detailed large-scale drawings should be supplied by the purchaser through appropriate channels at the earliest possible time.

Most orders are processed through a chain of purchasing which begins with the signing of the owner-general contractor agreement and ends with the receipt of an order by the manufacturer. Other parties may be involved in this process as intermediaries or secondary parties, including, among others, the owner's representative, the general contractor, the mason contractor and the distributor. Each party in the chain should endeavor to promptly process the order and give approvals as necessary so as to cause minimal delays in the schedule of the project. Upon receipt of the order, the manufacturer typically acknowledges the order and should promptly advise the parties through the chain of purchasing about any unacceptable or impractical terms. The acknowledgement should then be thoroughly scrutinized by the responsible parties.

It should also be understood by all parties that by the placement of a written order the purchaser incurs the specific payment responsibility for all special and/or non-standard items.

Certificates and Testing

Contract documents may require a letter of certification from the manufacturer to verify that the quality and characteristics of the brick meet ASTM standards. Test reports from an independent testing laboratory, supplied by the manufacturer, should be considered current if they are 24 months old or less. The cost of such tests is borne by the seller. If testing of the production run that is intended for shipment to the project is required, the cost of testing is typically borne as follows: if the results of the tests show that the brick do not conform to the requirements of the product specification, the cost is typically borne by the seller; if the results of the tests show that the brick conform to the requirements of the products specification, the cost is typically borne by the purchaser. The cost of any additional testing is typically borne by the purchaser.

All testing shall be done in accordance with ASTM procedures and specifications.

Selection and Sampling

Brick is subject to variations in color between production runs and occasionally within the same run. Modern manufacturing processes encompass the use of automatic equipment, which may also result in minor differences in color and texture of the brick.

The selection of the size, color, texture and type of brick is the responsibility of the owner and/or owner's representative. Usually, small samples are used for the preliminary selection and may not exactly represent the complete range of colors and textures encountered in production runs.

Sometimes, a small sample is sufficient for determining the final selection. However, when large quantities of brick are to be erected, the prudent owner, general contractor, mason contractor, distributor and/or manufacturer should direct or request that the final selection be made from a field panel (also known as a field sample or mock-up). A field panel is typically constructed as a freestanding element that will later be torn down when the project is complete. Usually, a quantity of brick equal to 100 modular-size brick (approximately 15 square feet) will be used for the construction of the freestanding field panel.

If an owner or the owner's representative requires the field panel, the distributor or manufacturer may not have control over the actual erection that is frequently performed by a mason contractor. The party or parties who have control over the work of the mason contractor (either by direct contract or by other powers) should take appropriate action during the erection of the field panel to assure that no additions or deletions are made to the brick supplied by the distributor and manufacturer, unless written approval has been received from the manufacturer for such a change.

Field panels should be constructed from the production run that is intended for shipment to the project. In the event that the field panel has to be constructed for inspection and final selection before the production run for that project, the owner and the manufacturer should agree in writing upon such a use. The manufacturer may reserve the right to resample from the actual run before shipment commences. The owner or owner's representative should inspect and approve the new panel.

When the field panel has been formally approved, it is the manufacturer's responsibility to provide brick as represented in the field panel. A strap or control sample may be retained at the plant.

Typically, the general contractor and mason contractor are responsible for preserving and maintaining the integrity of the field panel which is considered the project standard for bond, mortar, workmanship and appearance and as the standard for comparison until the masonry has been completed and accepted by the owner or the owner's representative. If the owner or owner's representative elects not to have a field panel erected, the first 100 square feet of actual construction shall serve as the field panel.

Inspection and Examination

The general contractor or mason contractor normally receives the brick when they are delivered to the job site. The general contractor or mason contractor should properly protect the brick from the weather and damage. It is critical that the contractor inspect the brick before they are placed in the wall. If there are any discrepancies, the manufacturer or distributor should be notified immediately.

The owner or the owner's representative is responsible for acceptance of the work and, therefore, should inspect, as necessary, while the work progresses. This is especially critical at the start of the project to ensure that the color, texture and workmanship are representative of the field panel and are acceptable.

The selling party, whether the manufacturer or distributor should visit the job site, as necessary, and, in addition, should be available for meetings and consultation in the event the owner or the owner's representative discovers a problem.

In the event the work does not meet with the approval of the owner or the owner's representative, the owner should immediately notify the general contractor, and appropriate action should be taken to correct the problem. If necessary, this may require that the work be stopped and that all interested parties meet to resolve the problem.

References

Brick Industry Association, 1850 Centennial Park Drive, Reston, VA 20191, (703) 620-0010, www.gobrick.com.

Mason Contractors Association of America, 33 S. Roselle Rd., Schaumburg, IL 60193, (800) 536-2225, www.masonryshowcase.com.