masonry skills

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Albany, New York 12212

LIBRARY OF CONGRESS CATALOG CARD NUMBER: 80-70701
ISBN: 0-8273-1958-4 Soft cover 10 9
ISBN: 0-8273-2153-8 Hard cover 10 9
Printed in the United States of America
Published simultaneously in Canada
by Nelson Canada,
A Division of International Thomson Limited

Preface

Masons are highly skilled people who use specialized equipment to mix mortar, bond materials, and lay out and construct masonry walls and other important features of buildings. This requires both classroom and on-the-job training if the mason is to keep pace with the constant developments of the trade. This completely revised edition of MASONRY SKILLS provides the necessary material to guide students through a secondary or vocational-technical program in the study of masonry basics. It also may act as a guide during an apprenticeship program and as a handbook for use on the job.

This edition of MASONRY SKILLS retains the major textbook features that made the former edition a trade standard. These include:

- performance objectives which tell both the student and instructor what information is to be learned through careful study of the material.
- an easy-to-follow format high in illustrations and hands-on application.
- safety features integrated throughout the text.
- skill checklists which explain specific skills that each student should have mastered up to that point in study.
- achievement review questions following each unit which allow students to evaluate their own comprehension of the unit. Questions after each section similarly allow the students to gauge their own understanding of section material.
- projects which guide the student through actual masonry construction in a step-by-step procedure.
- an Instructor's Guide which includes a lesson plan for each unit, complete answers to review questions, a pretest to be given before study of the text is begun, a comprehensive final test, and sources of audio-visual aids.
- an extensive Glossary which lists definitions of terms with which the masonry student should be familiar.
- technical reviews of text material by field experts, including the Brick Institute of America and the National Lime Association. The material on metrics was reviewed for accuracy by the National Bureau of Standards.

Also included in this edition is new material reflecting the latest developments in masonry, such as the installation of flues for wood-burning stoves.

THE MASONRY APPRENTICESHIP

The study of MASONRY SKILLS in the vocational-technical or secondary school program develops skills required for work with the masonry contractor. After completion of this study, students may enter into a masonry apprenticeship to refine their skills and to further their knowledge of trade practices. To review suitable apprenticeship programs, the Bureau of Apprenticeship and Training, U.S. Department of Labor, may be contacted.

A typical apprenticeship program lasts three or four years. Credit for previous experience is given in most programs after evaluation by the apprenticeship committee and a thirty-to-sixty-day tryout on the job. If the apprentice meets contractor requirements, he or she may very well begin at a pay scale that is higher than average. The credit given for previous experience varies according to locality and individual contractor, but previous training is sure to help the apprentice.

Apprentice wage rates, either union or nonunion, are based on a progressively increasing schedule tied to the journeyman rate. This could mean a raise every three or six months, depending upon the agreement. For the pay raise to be in order, of course, the apprentice must produce good work and show constant improvement.

A good program requires the apprentice to complete at least 144 hours of classroom study each year. The training must be done under the supervision of a journeyman bricklayer, who usually teaches in the evening. Attendance is required at all classes.

Union apprentices must have a sponsoring bricklayer before they can enter the program. It is the responsibility of the bricklayer foreman to see that the apprentice receives experience in the various aspects of the trade as the job progresses. A set number of hours' training on the job is required before the apprentice becomes a journeyman bricklayer. The actual number is determined by the apprenticeship committee in that locality.

During the working day, the apprentice is supervised by bricklayers on that particular job. They are responsible for such things as pointing out correct methods of laying units and correcting any errors. This is stated in the agreement between the apprenticeship committee and the contractor. There are usually a limited number of apprentices for each bricklayer on the job to be sure that the apprentice receives adequate instruction. When work becomes scarce, the contractor always attempts to keep the apprentice working as long as possible before any layoffs. This stipulation, stated in the agreement, acts as protection for the apprentice.

RELATED SKILLS

The mason apprentice must develop certain skills in on-the-job training. These include:

- proper care and use of tools.
- study of mortar types and mixing of mortar.
- trowel skill development.
- building of foundations and parging.
- laying of brick, concrete block, tile, and other units.
- cutting of masonry materials and walling around openings.
- laying brick to form arches.
- laying bond patterns.
- construction of fireplaces and chimneys.
- cleaning of masonry work.
- safety practices and accident prevention.
- reading of mason's folding rules.
- construction of various types of walls.

Related technical information taught in the classroom includes plan reading, trade-related math, responsibilities of the apprentice to the contractor, and other information that cannot be covered on the job during the day.

At the completion of the apprenticeship program, the apprentice becomes a journeyman mason and is entitled to full-scale wages. After completing the program and reaching journeyman status, many masons continue their study and become company foremen. This, in turn, means a raise in pay. Still others eventually start a business of their own after a number of years of experience.

Because new techniques are being constantly developed, masons should continually read trade materials, attend trade meetings, and study new methods and products on their own.

THE AUTHOR OF MASONRY SKILLS

The author of MASONRY SKILLS, Richard T. Kreh, Sr., is an instructor of masonry and building trades at Middletown High School in Middletown, Maryland. He is a member of several professional organizations, including the National Education Association, Maryland State Teachers Association, American and Maryland Vocational Associations, Masonry Instructors of Maryland, and the Iota Lambda Sigma Fraternity of Professional Educators. Mr. Kreh is the author of ADVANCED MASONRY SKILLS and SAFETY FOR MASONS. He offers over thirty-three years of experience as a mason and teacher.

FOR ADVANCED STUDY

As masonry students progress to more advanced masonry practices, they will find a need for study materials which explain these advanced skills and practices in more detail. For this purpose, Delmar has developed ADVANCED MASONRY SKILLS. The following are other textbooks which the masonry student might find useful.

- SAFETY FOR MASONS
- BASIC CONSTRUCTION BLUEPRINT READING
- BLUEPRINT READING FOR COMMERCIAL CONSTRUCTION
- WORKING DRAWINGS FOR COMMERCIAL CONSTRUCTION—ARCHITECTURAL AND STRUCTURAL
- ESTIMATING FOR RESIDENTIAL CONSTRUCTION
- CONSTRUCTION ESTIMATING
- CONCRETE TECHNOLOGY
- PRACTICAL PROBLEMS IN MATHEMATICS FOR MASONS

Contents

Section 1
Development and Manufacture of Brick and Concrete Block

Unit 1
Development of Clay and Shale Brick

OBJECTIVES

After studying this unit, the student will be able to

- describe the development of brick.
- discuss how brick is used in a modular building system.
- list some of the characteristics of the modern brick.

THE DEVELOPMENT OF BRICK

Brick is one of the oldest manufactured building materials. Recent excavations have uncovered remains of brick walls dating back 6000 years. Considering their age, the walls were in surprisingly good condition.

Greek historians of the fifth century BC relate accounts of the splendid wonders of the city Babylon. These include striking descriptions of immense walls and temples, many of which were built of brick. In Dashur, Egypt, two ancient pyramids of sun-dried brick still stand as monuments to the craft of bricklaying.

Highly respected in early civilizations, masons not only laid bricks but made them, as well. Kings often gave their support to masons by having a royal seal molded into bricks when they were made. This practice continues today as some brick manufacturers mold the name of their company into the bottoms of the bricks.

The recessed panel in the bottom of bricks manufactured today is called a *frog*, Figure 1-1A. It has several purposes:

- To lock the mortar into the depression for a better grip
- To create special effects when the brick is laid on its side as in decorative walls
- To save on the cost of materials

Bricks also sometimes have holes in the bottom. These holes help provide a better bond. Such bricks are called *cored bricks,* Figure 1-1B.

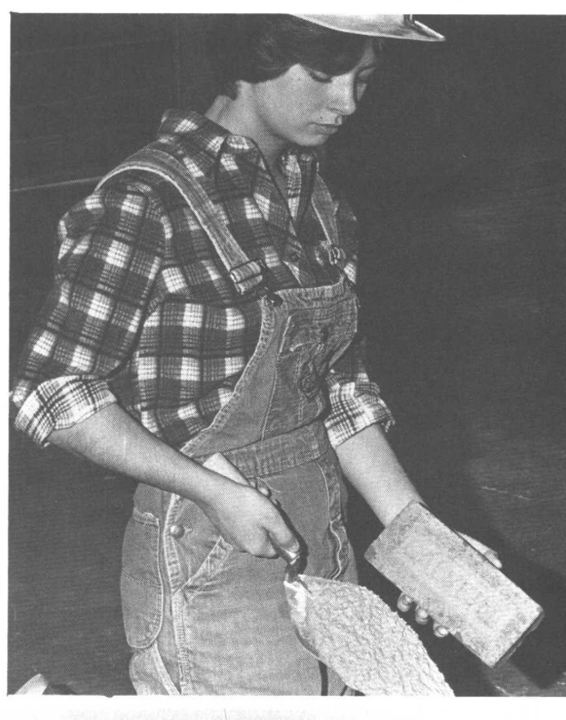

Fig. 1-1A Frogged brick

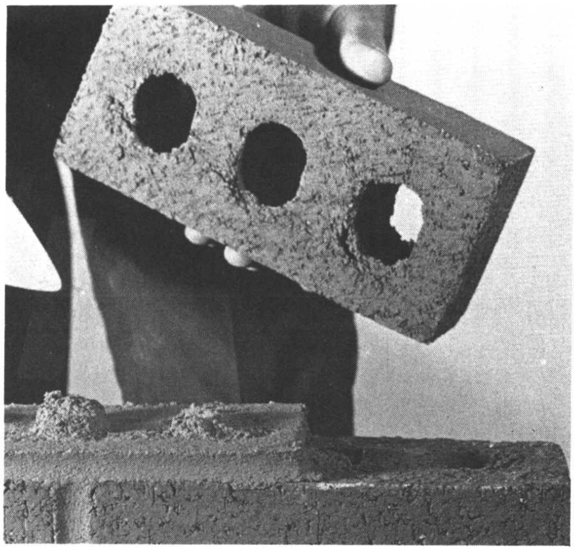

Fig. 1-1B Cored brick

One of the earliest types of brick and one still used in many countries today is a clay or shale sun-dried brick called *adobe brick.* These bricks contain straw for greater strength, just as steel rods reinforce modern concrete.

After the sun-dried adobe brick had been in use for some time, a discovery was made. It was found that a brick subjected to fire in a closed area such as a *kiln,* or oven, for a definite period of time became very hard and highly fire-resistant. The fired brick resisted erosion far better than unfired bricks. Some of the bricks were coated with a thick enamel or glaze. The glazes were commonly red, yellow, green, or a combination of these colors. When subjected to heat in the kiln, the color hardened and developed a glass-like finish. Some of these glazed bricks, recovered from old buildings, still retain their original color after 2000 years. Glazed bricks are made today but have limited use. This is because they are costly to manufacture.

Brickmaking and bricklaying were regarded by many of the old world craftspersons as secret processes. To keep them secret and confined to their own groups, masons banded together in organizations called *guilds.* These specialized guilds were the forerunners of modern unions.

In 1666, a great fire changed London, England from a city of wooden buildings to a city of brick construction. The manufacture of brick attained a high degree of excellence and dominated the building field in this period of history.

Early records indicate that the first bricks manufactured in the United States were made in Virginia in 1611 and in Massachusetts in 1629. The bricks were made by hand using very simple methods and tools. Many of the bricks used in construction in the early American settlements were brought from England as ballast in sailing ships. Some of these bricks can still be found in the foundations and walls of the remaining original houses in the eastern part of the United States, Figure 1-2.

The invention of the steam engine in 1760, and the subsequent Industrial Revolution, brought a change from manual labor to the use of power-driven machinery to make bricks. This change started the true development of the brick industry in America. The first brickmaking machine was patented in 1800.

THE MODERN BRICK

The term *brick* as used today denotes a solid masonry rectangular unit formed in a plastic state from clay and shale and burned in a kiln. The United States Federal Trade Commission has ruled that no product made from materials other than clay or shale can be called brick. The exception to this is if the name includes the material from which the unit is manufactured, such as cinder brick, sand lime brick, or concrete brick.

Raw Materials

Clay and shale are the principal materials used to make bricks. Usually concentrated in large deposits, these materials are found all over the world.

Clay is a natural product formed by the weathering of rocks. Shale is made in very much the same way and from the same material. However, shale is compressed into layers in the ground. Shale is very dense and is more difficult to remove from the ground than clay. As a result, shale is a more costly raw material.

Two or more kinds of clay and shale may be mixed together to obtain a material having the proper consistency and composition. Good raw material is the backbone of the brick industry. The following are several forms of clay. They have a similar chemical composition but different physical characteristics.

Surface clays are found near the surface of the earth. They may be offshoots of old deposits or the result of more recent weathering of rocks. *Shales* are clays that have been formed by natural conditions under high pressure until they resemble slate. *Fire clays* are mined from a greater depth than are the other

Fig. 1-2 Early brick row houses that have been restored to their original beauty in an urban renewal project

clays. They have fire-resistant qualities (ordinary brick is also fire resistant). They contain fewer impurities and have more uniform chemical and physical properties than shales or surface clays.

Although surface clays and fire clays differ in physical structure from shale, the three types of clay are chemically similar. All three are made of silica and alumina with varying amounts of metallic oxides and other impurities.

Metallic oxides act as fluxes and promote fusion at lower temperatures. The amount of iron, magnesium, and calcium oxides in the clays influences the color of the finished product. The material from each deposit of clay and shale has chemical characteristics which may be uniform for that deposit but may differ from the characteristics of material in other deposits. The changes in characteristics from deposit to deposit are due to differences in the relative amounts of the chemical components. As a result, brick made from the material in one deposit will have one set of characteristics for color, finish, and texture. Brick made from material in another location may look different because the chemical composition of the material varies slightly from that at the first location. In addition, all clay and shale do not react in the same manner to processing methods.

Building Brick and Face Brick

There are many different kinds of brick available today for use in construction. There are several factors to be considered when selecting brick. These factors include composition, the manufacturing method, strength, appearance, color, special effects, and economy. There are two types of bricks: the building brick and the face brick.

Building Brick. The *building* (or *common*) *brick* is formed in a plastic state from clay and shale and then burned in a kiln. Common bricks do not have to meet special standards for color, design, or texture. Because of this, common bricks usually cost less than face brick or select brick.

Common brick is sometimes known as *kiln run brick.* It is used as a filler brick or backing material on many construction jobs. This does not mean that common brick is inferior or lacks durability. Architects often specify common brick for residences. This is because interesting effects are possible due to the various colors and textures resulting from the manufacturing process. This type of brickwork is sometimes called *rustic.* It presents a roughly finished appearance and is meant to resemble old colonial brickwork.

If a brick is overburned because it is placed too close to the highest temperature areas of a kiln, it is known as a *clinker.* The clinker brick is very hard and usually dark in color. Clinker bricks are often warped or twisted as a result of the intense heat. This type of brick can also be used for special effects in construction.

Older styles of kilns did not always provide uniform heat to all of the bricks due to the design of the kiln, differences in the fuel used, and the location of the brick in the kiln. As a result, bricks fired in the same batch often had different characteristics, depending on their location in the kiln.

Because these variations appeared in each batch fired, each variety of brick received a name such as clinker, red, soft, salmon, rough hard, straight hard, and bloat. As brick kilns improved and the control of heat became more uniform in the burning area, many of the old types of common brick were no longer made. The less expensive common brick, however, is still used in masonry work today when face brick is not needed.

Face brick. The term *face brick* comes from the fact that the brick is used in the front or face side of a wall. The material used and the burning of the bricks must meet controlled specifications if the bricks are to be used as face bricks. The size of the face brick must also be within the tolerances established by the American Society for Testing and Materials (ASTM). All face bricks must meet standards for absorption, uniformity, and strength.

The color and texture must meet the specifications of the range number established for the variety of brick being made. The *range number,* an identifying number or letter, means the blend, texture, and color assigned by manufacturers to each of their products. The bricks made for a range number must conform to a sample brick produced earlier for the same coded numbers or letters. The user of the brick is then assured that bricks of the same range number will always match the original sample selected for the job. If it becomes necessary to build an addition to a structure, a match of the brick can be obtained by consulting the range number.

Brick Sizes

One of the most important recent developments in the brick industry is the range of sizes of available brick. The greater number of sizes means that brick laying can be more economical. The mason can cover more area using a brick larger than the standard size. Oversized bricks are popular in construction today since with their use, jobs progress faster and production increases.

Until recently, only three sizes of bricks were available: *Standard, Norman,* and *Roman.* Bricks now can be obtained in the following sizes:

- The thickness or bed depth may range from a nominal 3″ up to 12″.
- The height may range from a nominal 2″ to 8″.
- The length may be up to 16″. An average standard brick weighs about 4 1/2 pounds (lb).

Before starting any job, the mason should consult with the local brick manufacturer or supplier to be sure that the brick selected is available in that area.

The names for the different brick sizes are not the same throughout the industry (with the exception of the Standard, Roman, and Norman sizes). Individual manufacturers often give names to their own lines of brick sizes. To avoid confusion and the risk of getting the wrong size, it is good practice to identify the brick first by its dimensions and then by its name.

The modern brick is made for use in the *modular grid system* of building. The main reason for making a brick on a modular grid is for economy purposes. Standards for modular dimensions have been approved by the American Standards Association for all building materials. These dimensions are based upon a 4″ unit of measure called the *module.* This module is used as a basis for the grid system which must be used when two or more different materials are to be used in a construction job. Any building construction in which the size of the building materials used is based on the 4″ grid system is called *modular design.*

Most masonry materials will tie and level off together at a height of 16″ vertically (16″ is a multiple of the 4″ grid system). For example, 2 *courses* (layers) of block for a wall including the mortar joint will equal 16″ vertically. Six courses of standard brick in mortar will also equal 16″ vertically. As a result, the wall can be tied together at 16″ intervals or at multiples of 16″. Masons should learn early in their work how various building materials tie together on the job.

Most modern bricks are produced in modular sizes. Figures 1-3A and 1-3B indicate the sizes available for both modular and nonmodular bricks. In modular design, the *nominal* dimension of a masonry unit (such as a brick or a block) means the specified or manufactured dimension plus the thickness of the mortar joint to be used. That is, the brick size is designed so that when the size of the mortar joint is added to any of the brick dimensions (thickness, height, and length), the sum will equal a multiple of the 4″ grid. For example, a modular brick whose *nominal length is 8″* will have a manufactured dimension of 7 1/2″ if it is

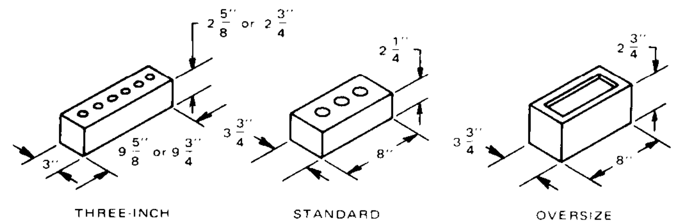

Fig. 1-3A Nonmodular brick with actual dimensions shown

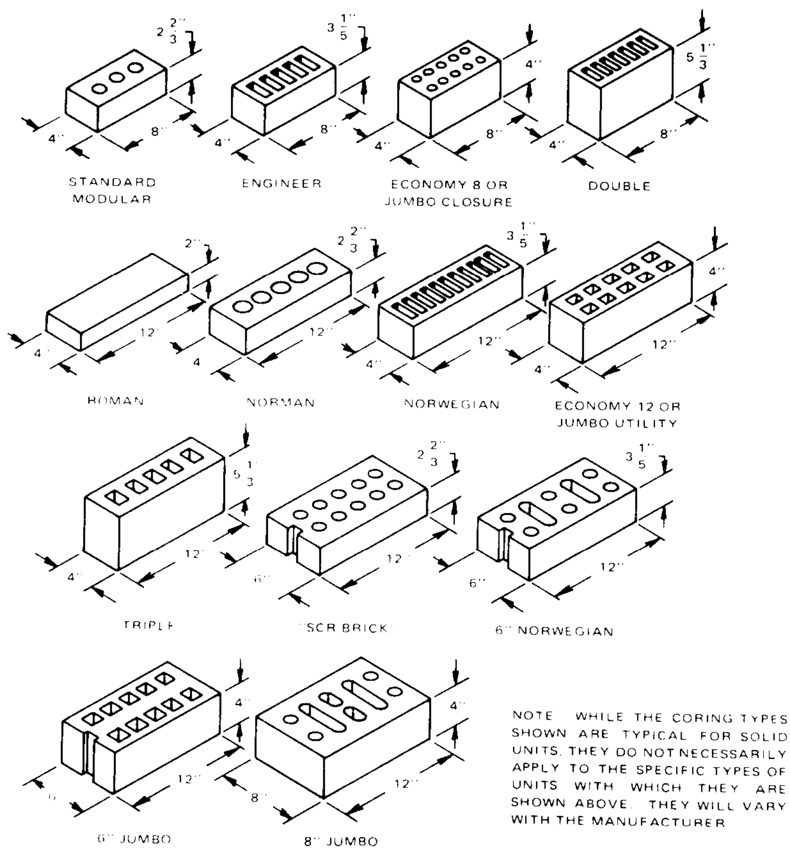

Fig. 1-3B Sizes of modular bricks available

designed to be laid with a 1/2" mortar joint. The same 8" brick will have a manufactured dimension of 7 5/8" if it is designed to be laid with a 3/8" joint.

Figure 1-4 shows nominal and actual manufactured dimensions plus the planned joint thickness for a number of basic modular brick sizes. The last column of the chart indicates the number of courses required for each type of brick to equal a 4" grid unit or a multiple of this unit. For example, for the standard modular brick, 3C = 8. In other words, 3 times the nominal height of 2 2/3" equals 8, or twice the basic 4" grid unit.

Mortar Joints

Masons form mortar joints by using the trowel to place mortar between and under the brick being laid. The two most basic joints are the *head joint* and the *bed joint,* Figure 1-5. Student masons should become familiar with these widely used terms.

SIZES OF MODULAR BRICK								
Unit Designation	Nominal Dimensions, in. T	Nominal Dimensions, in. H	Nominal Dimensions, in. L	Joint Thickness, in.	Manufactured Dimensions, in. T	Manufactured Dimensions, in. H	Manufactured Dimensions, in. L	Modular Coursing, in.
Standard Modular	4	2 2/3	8	3/8	3 5/8	2 1/4	7 5/8	3C = 8
				1/2	3 1/2	2 1/4	7 1/2	
Engineer	4	3 1/5	8	3/8	3 5/8	2 13/16	7 5/8	5C = 16
				1/2	3 1/2	2 11/16	7 1/2	
Economy 8 or Jumbo Closure	4	4	8	3/8	3 5/8	3 5/8	7 5/8	1C = 4
				1/2	3 1/2	3 1/2	7 1/2	
Double	4	5 1/3	8	3/8	3 5/8	4 15/16	7 5/8	3C = 16
				1/2	3 1/2	4 13/16	7 1/2	
Roman	4	2	12	3/8	3 5/8	1 5/8	11 5/8	2C = 4
				1/2	3 1/2	2 1/4	11 1/2	
Norman	4	2 2/3	12	3/8	3 5/8	2 1/4	11 5/8	3C = 8
				1/2	3 1/2	2 1/4	11 1/2	
Norwegian	4	3 1/5	12	3/8	3 5/8	2 13/16	11 5/8	5C = 16
				1/2	3 1/2	2 11/16	11 1/2	
Economy 12 or Jumbo Utility	4	4	12	3/8	3 5/8	3 5/8	11 5/8	1C = 4
				1/2	3 1/2	3 1/2	11 1/2	
Triple	4	5 1/3	12	3/8	3 5/8	4 15/16	11 5/8	3C = 16
				1/2	3 1/2	4 13/16	11 1/2	
SCR brick	6	2 2/3	12	3/8	5 5/8	2 1/4	11 5/8	3C = 8
				1/2	5 1/2	2 1/4	11 1/2	
6-in. Norwegian	6	3 1/5	12	3/8	5 5/8	2 13/16	11 5/8	5C = 16
				1/2	5 1/2	2 11/16	11 1/2	
6-in. Jumbo	6	4	12	3/8	5 5/8	3 5/8	11 5/8	1C = 4
				1/2	5 1/2	3 1/2	11 1/2	
8-in. Jumbo	8	4	12	3/8	7 5/8	3 5/8	11 5/8	1C = 4
				1/2	7 1/2	3 1/2	11 1/2	

Fig. 1-4 Table showing the thickness, height, and length of each modular brick unit

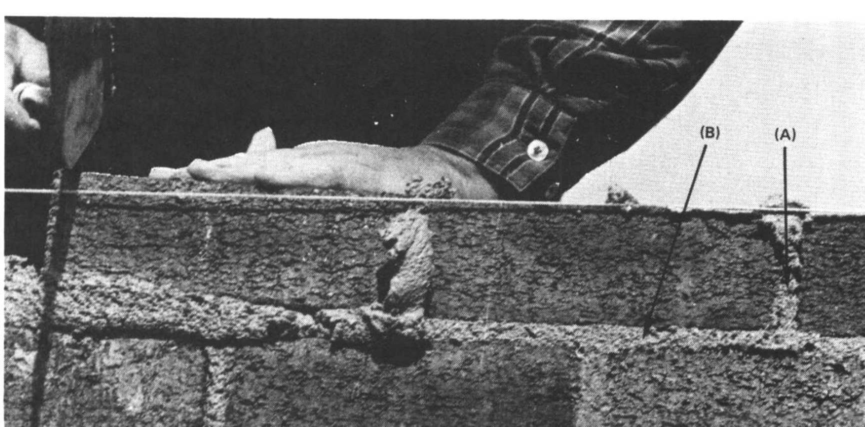

Fig. 1-5 Two basic types of mortar joints are (A) the head joint and (B) the bed joint.

ACHIEVEMENT REVIEW

Select the best answer from the choices offered to complete the statement or answer the question. List your choice by letter identification.

1. Many ancient bricks had an unusual feature called a frog. Which of the following describes a frog?
   a. A very hard red brick burned in the center of the kiln
   b. Brick with a recessed panel
   c. Brick with holes to lock the mortar in
   d. Glazed brick made for decorative work
2. One of the earliest types of brick was called
   a. a cinder brick.
   b. a salmon brick.
   c. a sand lime brick.
   d. an adobe brick.
3. Many years ago, masons formed into groups to guard their trade secrets and manufacturing processes. What term was applied to these groups?
   a. Unions
   b. Guilds
   c. Craftspeople
   d. Manufacturers
4. Bricks are
   a. made from cement and clay material.
   b. formed in a plastic state from clay and shale and then burned in a kiln.
   c. formed from a sand and lime mixture.
5. Clay is a natural product which is formed by
   a. earth and sand mixed together.
   b. weathering of rocks.
   c. decomposed vegetation and minerals.
   d. cement and sand mixture pressed into a mold.
6. Fire clays have a high resistance to heat and thereby can be used in fireplaces and smokestacks. When the raw material is taken from the ground, it is always found
   a. near the surface.
   b. on hillsides and in outcroppings of ground.
   c. deeper in the ground than other clays.
   d. on the surface.
7. Kiln run bricks are
   a. bricks that do not meet standards for uniformity, color, and texture.
   b. bricks made in special kilns to withstand heat and moisture.
   c. red bricks made for the front of buildings and face work in walls.
   d. bricks costing much more than common bricks.
8. The brick manufacturer's range number indicates
   a. the hardness of the brick.
   b. the size of the brick.
   c. the blend, texture, and color of the brick.
   d. the degree of water resistance the brick shows under controlled test conditions.
9. The modular system of measurement for the building industry is based on the module. The module unit measures
   a. 16".
   b. 8".
   c. 12".
   d. 4".
10. The principal reason for making a brick on a modular grid is for
    a. beauty and design.
    b. economy.
    c. ease in manufacturing.

Unit 2
Manufacture of Brick

OBJECTIVES

After studying this unit, the student will be able to

- list the various steps in modern brick making.
- describe briefly each of the basic brick production steps listed.
- describe various kilns used in brick making.

INTRODUCTION

Technological developments during the last century have helped to make the manufacture of brick a very efficient and productive process. More complete knowledge of the characteristics of the raw material, improved kiln designs, controlled heat in the kilns, and extensive mechanization have all played important roles in modernizing brick manufacturing.

There is such a tremendous demand for bricks that they are used faster than they can be manufactured. The modern brick plant meets the challenge of in-increasing production, while retaining a high quality for the final product, by using computerized manufacturing methods and highly skilled workers.

Basically, bricks are made by mixing a specified amount of water with finely ground clay or shale or a combination of both. The mixture is then formed into the desired shape, predried, and burned in a kiln for a predetermined time under carefully controlled conditions.

While the basic steps of brick manufacturing are standard throughout the industry, each brickmaking plant has minor variations to these steps due to local conditions. For example, one brick plant may be near the source of the raw material, while another plant may have to transport the material from a distant source. These two plants will have different ways of obtaining and stocking their raw materials. If possible, the plant should be build on the site where the raw material is obtained.

STEPS IN THE MANUFACTURING PROCESS

The following are the six major steps in the manufacture of brick:

1. Mining the raw clay or shale from the ground
2. Preparing the raw materials for use
3. Forming the raw materials into brocks
4. Predrying the bricks for burning
5. Burning the brick in the kiln under controlled heat
6. Storing and shipping

All other operations stem from these six major steps. Figure 2-1 shows, in schematic form, the basic steps in the manufacture of bricks.

Mining the Material

The removal of the raw material from the ground is called *mining*. Power equipment mines surface clay and shale in open pits. Power shovels or bulldozers work the raw material to the conveyor belts. The conveyor belts then transport the material to the brick plant's storage area where it is deposited on a pile. If the raw material is not mined near the site of the brick plant, trucks or railways bring the material to the storage piles.

Enough raw material is stored to assure plant operations for several days in the event that bad weather halts mining or shipping operations. Several storage areas are provided so that the clay and shale can be blended to yield material with a better composition.

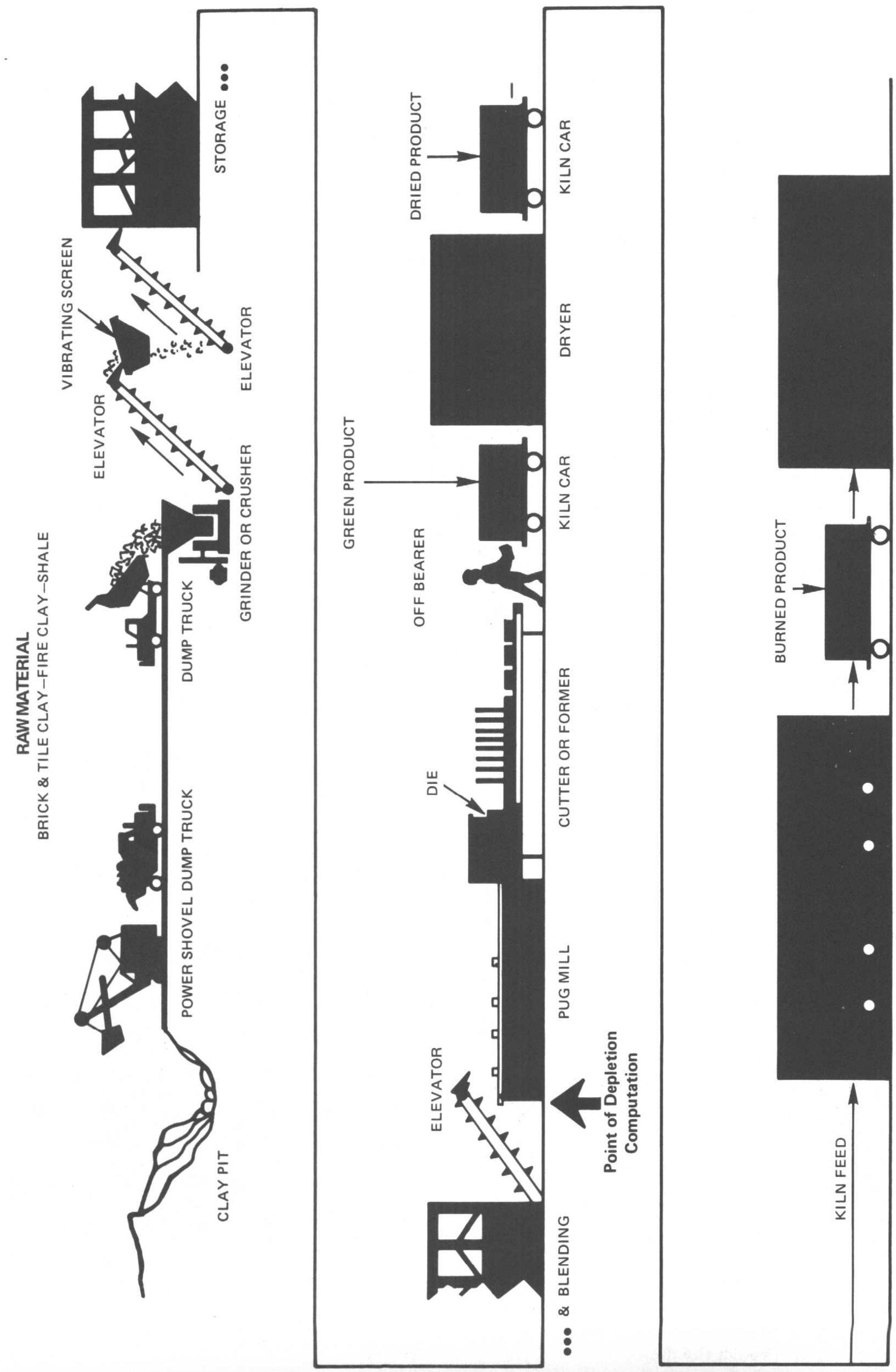

Fig. 2-1 The basic flow of materials in the manufacture of brick in a modern plant

Blending may not be necessary if the shale alone is of sufficient quality that it can be used by itself. Blending produces more uniform raw material, helps control the color of the finished product, and permits some control over providing raw material suitable for manufacturing a given type of brick unit.

Preparing the Material

If the raw material is in large lumps, it may be crushed before it is placed on the storage pile. Crushing breaks up the large pieces and removes the stones. Next, 4-ton to 8-ton grinding wheels revolving in a circular pan grind and mix the material. It then passes through an inclined, vibrating screen which controls the particle sizes. The finely ground material is taken by a conveyor belt to the site where it is formed into single bricks.

Forming the Clay or Shale into a Brick Shape

Three methods of forming are used in the production of bricks: the *stiff-mud process,* the *soft-mud process,* and the *dry-press process.*

Stiff-Mud Process. The most frequently used process at present is the stiff-mud process. It produces a hard dense brick. A greater volume of bricks can be manufactured by this method to meet the growing demands of the construction industry.

The first step in the stiff-mud process is to add water to the raw material to make a plastic, workable mass suitable for molding. This is called *tempering.* The mixing is done in a machine called a *pug mill.* The pug mill has a mixing chamber which contains one or two revolving shafts which thoroughly mix the raw material and a measured amount of water.

After thorough mixing, the tempered clay goes through a machine which removes air bubbles, giving the clay increased workability and plasticity. In addition, a brick made from clay without air bubbles will have greater strength.

The clay is next forced through an opening called a *die,* a process much like toothpaste being forced from a tube. The long, formed ribbon of brick being extruded through the die is called the *column,* Figure 2-2. Texture may be applied to the face of the brick as it leaves the die, if so desired. As the column moves away from the die, it is cut into lengths which are either the height (*side cut*) or length (*end cut*) of the brick. The cutting is done automatically by a large, circular wire cutter which cuts each brick to the same size, Figure 2-3.

Upon leaving the wire-cutting machine, the bricks move to a conveyor for inspection. Bricks passing inspection are placed on the dryer cars. Imperfect bricks are returned to the pug mill for reprocessing. The soft bricks that have not yet been burned hard in the kiln are called *green bricks.*

Soft-Mud Process. This is the oldest way of making brick and was used before brickmaking machines were developed. Automated machinery is now used in this process, Figure 2-4.

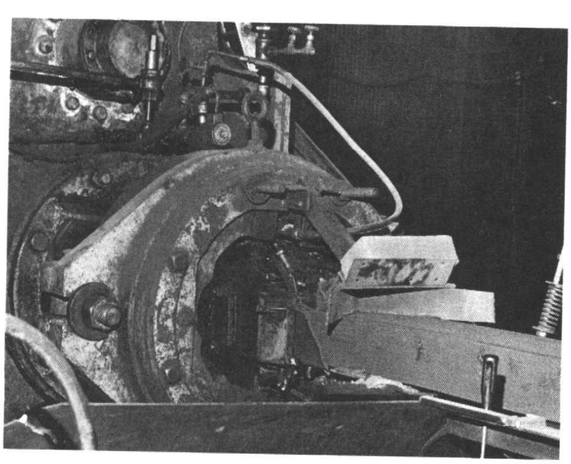

Fig. 2-2 A pug mill showing the column of brick after being forced through the die

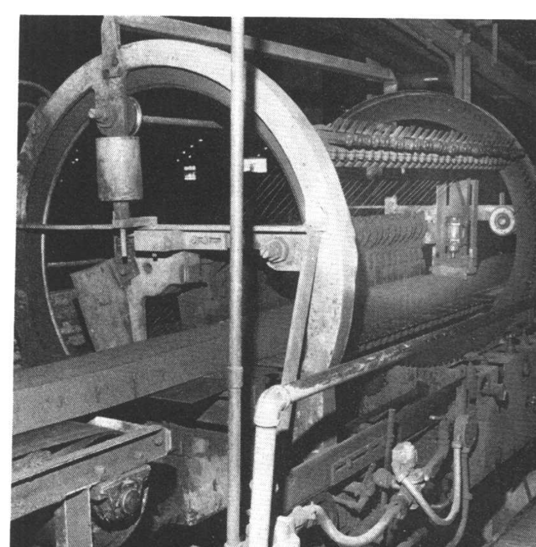

Fig. 2-3 Bricks are automatically cut to size by a wire cutter.