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ABSTRACT

This manual brings together in one package basic knowledges and facts about estimating to assist the building trades instructor in developing his instructional program. Teaching estimating as a separate unit, or integrating it into a regular program are given as two different instructional approaches. After a description of the estimating process and its importance, the various aspects (36 in this manual) of estimating are discussed separately, e.g. expense sheets, concrete block, ceiling joist, wallpaper, strip or hard wood flooring. A bibliography, glossary of terms (Appendix A), and plans for a garage and workshop (Appendix B) are included. (WL)

LET'S BUILD: WHAT MATERIALS WILL BE NEEDED?

Instructors Manual

A Resource Unit on Materials Estimation

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HOW TO USE THIS MANUAL

This manual has been prepared for the building trades instructor. It has been designed to provide the basic estimating information necessary for on-going building trades programs.

An abundance of information is available on estimating for the building trades. This information, however, is scattered throughout text and reference books, technical manuals and papers, as well as thousands of brochures and other publications from commercial suppliers of building materials. This manual is not intended to replace such materials but rather to bring together in one package basic knowledges and facts about estimating to assist the instructor in developing his instructional program.

The material in this manual may be presented to students using either of two different instructional approaches. One approach would be to teach estimating as a separate unit. This would require blocking off a portion of time, perhaps two weeks, and devoting full attention to the study of estimating. In this approach it is suggested that such study be towards the end of the training program so students will be familiar with the terminology used in construction.

Another approach would be to integrate estimating into your regular instructional program and to teach it when applicable. For example, when teaching how to frame a wall section include how to estimate plate and stud requirements.

Regardless of the approach used, it is essential that the building trade instructor study the material contained herein carefully and plan his lessons. The time and efforts required to do this should result in an improved program producing students better prepared to enter into the building trade as productive workers.

INTRODUCTION

The inability to correctly determine material needs for a job is one of the primary causes of business failure in the construction trades. With labor often running as high as fifty percent of the total building cost, contractors can no longer afford to have workers idle while waiting for materials needed to complete a job. Being able to determine exactly what materials are needed, purchasing these materials at the best price, and having these materials at the construction site when needed by the workers are key ingredients to success in the building trade.

Determining the kinds and amounts of materials which will be required to build a house, or other structure, is called estimating. Large construction companies often have in their employ a staff of people devoting full time to estimating work. With their training and long work experience, these estimation specialists can compute almost to the last board or gallon of paint what material will be needed for a certain job.

It is the small contractor, the man building one house at a time, who seems to have the most difficulty in mastering the art of estimating. Often the small contractor has worked in the building trades for a few years as a craftsman before deciding to enter into business for himself believing he will get rich quick. More than likely he has not received any formal training in estimating and due to past work experience has little knowledge in this area. Quite often, unfortunately, the small contractor does not begin to realize the importance of proper estimation in the construction business until it is too late.

The purpose of a vocational building trade program is to prepare students, who upon completion, will enter the construction business as advanced learners in such jobs as carpentry, masonry, etc. It is a fact, however, that many students after completing the program and gaining a few years work experience, will venture into private contracting. This is a natural progression. Because of this, time devoted to study of estimation certainly can be justified in any building trades program.

Although learning is a continuous process for most students presently enrolled in vocational building trades programs, their formal education will end with graduation. If these students are to receive any formal, organized instruction in estimating it must be given now. Don't let your students, the contractors of tomorrow, make the same mistakes as the unsuccessful contractors of the past who agree that their failure was mainly due to their inability to estimate a job.

An estimator must know how to read blue prints, be knowledgeable about building construction procedures, be familiar with building materials, and be capable of performing simple mathematical calculations. These same knowledges and skills which are required of the estimator are identical to those being developed through the vocational building trade program in preparing students to enter the trades in carpentry, masonry, etc. It follows then that with the inclusion of basic estimation into the regular building trades program, students should pick it up rapidly. Without doubt, this added dimension to the program will produce graduates better prepared to enter the building trades.

Estimating

The successful builder depends on accurate estimating of construction costs. Estimating those costs is an exacting process based on a thorough knowledge of the various trades involved in the construction industry (Steinberg, 1965).

There are carpenters and tradesmen of other trades that after a number of years in the trade decide that they are going into business. There are those who succeed and there are those who fail. Many of those failing state that it was due to their lack of ability to estimate for the job being considered.

Estimating should be thought of as having two major areas: quantity take-off and labor take-off (Steinberg, 1965). Preparing the quantity take-off involves the estimating of the necessary materials needed to do the job. These include the cost of materials, equipment, blue prints, bonds, insurance, security and any other permits deemed necessary by law to do the job.

Labor prices would include paying the minimum wages deemed necessary to get the job done in the different areas. The two areas discussed above are totaled along with overhead and profit to conclude a total profit for a job being undertaken.

Expense Sheets

The following section should be considered by those contractors who are going into the business on a large scale.

The estimating of the cost of a particular job to be performed usually entails the cost of labor and material to be consumed. There are a number of other expenses that are sometimes overlooked by the beginning person in estimating that takes the form of neither labor or material but are thought of as general job expenses. Among these are working facilities, bonds, insurance, supervision, protection and profit.

The need for an experienced person with some knowledge of the jobs being done is usually required on any job. This person is referred to as a job superintendent and his salary, whatever the length of time of the job, should be considered in the final costs of the job. There is also the need for personnel to police the site where the job is being conducted. This person may be either a night or day watchman, whichever is needed.

The final estimate should include the cost of operating the main office for the particular length of the proposed job. Some authors give a rough estimate of about 15 to 20 percent of the job cost and others suggest that it should be an itemized estimate of each function deemed necessary to operate the office.

Working facilities, an important part of any job, should be included in any estimate. The contractor is usually held responsible for having available temporary office space, storage sheds, tool house, temporary toilets and any other convenience necessary to make the working condition conducive for working. The erecting of fences, stairways and platforms are also responsibilities of the contractors that should be included in the cost under general expenses. The health laws of most states require that there be fresh drinking water, temporary toilets, and other conveniences.

The installing and cost of such utilities as water, gas and electricity are also part of the general cost. Another expense that may at some time be included under general expense is the cost for surveys or other engineering work that sometime is not called for in the contract.

In most instances before a contractor is given permission to bid on a job most large cities require that he have or can post a bond. These bonds may be either a security bond, guarantee bond, performance bond and in some instances a deposit. The cost of such should be included in the estimate.

Concern for the health and safety of his workers is also another cost to be incurred by the contractor. This safeguard is known by many as insurance and may be seen in the following forms: Contractors Public Liability Insurance, Fire and Extended Coverage, Workmen's Compensation and Social Security Payments.

Profit on any job is the main idea in the world-of-work. The contractor is always concerned about the profit he can make. When you refer to profit consider what should be made after the job is completed. A survey of many authors and tradesmen stated that a good profit for any job is anywhere in the area of 10 and 12 percent of the final cost for labor, material, overhead and other general expenses.

The Mechanical Trades and Millwork

Although a house is built from the ground up the estimator goes about estimating the materials needed somewhat differently. The estimator should begin by deciding what he can do and what he will need other prople to do. The areas in which help is usually needed are the mechanical trades and millwork. Getting the necessary plans and specifications to these people as a first step will cut down on the chances of waiting. This way everyone is working at the same time.

The mechanical trades involve the following areas: plumbing, heating, electricity and air conditioning. Generally, when estimating for these areas the contractor takes the estimates from the specialist of the different areas as subcontracts and adds a percentage to the cost for profit and overhang in his favor. In most instances the percentage method is dangerous but for these areas it is more reliable than the item and detail method.

In the estimating of millwork, the estimator or contractor takes a set of plans and specifications of the work to be done and sends them out to different millwork shops to receive bids in the form of subcontracts. After these bids are returned the estimator selects one and adds 90 to 120 percent of this cost received to provide for labor incurred during installation. The amount also covers cost for insurance and general expenses. If this method is not preferred and the contractor decides to build the cabinets and truss on the job he should go to the single unit method of estimating the material needs for the job. The single unit method is used by most small contractors because he does not deal in volume.

Concrete Foundations

Concrete, a mixture of cement, sand, gravel and water to a desired proportion, has become as common in today's world of construction as nails and wood. With the advent of platform framing, which is used in most of today's single-unit construction, the need for a stronger, more durable and easier working material for supporting and carrying large loads was desired. Concrete used in construction may be pur- chased in the following form: ready-mixed concrete; cinder concrete, reinforced concrete; and prestressed concrete.

Concrete requires forms for support until it hardens. Forms are usually built of wood, metal, and in some instances, earth that has been excavated. Reinforcement in the form of wire mesh or steel rods is necessary when working with concrete. These serve to make the concrete stronger and more durable.

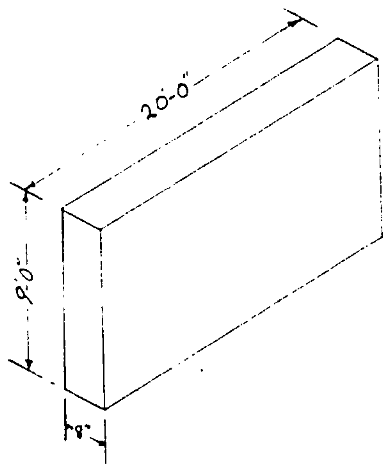
The footing for a building carries the entire load of the building and is located beneath the ground. The size, shape and depth is determined by the size of the building, the climate, the condition of the soil and the building codes of the particular area.

Many concrete manufacturers will give a bid on the complete job (forms, wire, steel rods, concrete bisqueen and finishing are considered). If this method is not preferred the following single-unit method is suggested. This method is not recommended for the small contractor unless a large amount of the material can be used on future jobs.

Estimating Form Work

The strength, rigidness and bracing of form is very important. Wall forms should be constructed to resist pressure of 145 lbs. per sq. foot for every foot of height. Materials for form boards are usually 7/8" thick with widths of 6 to 10 inches. The bracing is generally in sizes of 2" X 4"; 3" X 4"; 4" X 4" and 6" X 6". The amount of material needed for form construction is 1-1/2 to 3-1/2 board feet per square foot of form contact.

Example: How many board feet of 1" X 10" will be needed for the form-work of the following wall?



Sq. feet in wall

20'-0" X 9'-0" = 180 sq. ft.

20'-0" X 9'-0" X 2 = 360 sq. ft.

Change 8" to feet 8/12 = 2/3'

2/3' X 9'-0" X 2 = 36 sq. ft.

36 + 360 = 396 sq. ft.

396 X 3-1/2 = 396 X 7/2 = 1336 bd. ft. will be needed

Reinforcing Steel

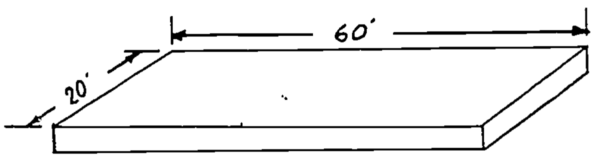
The amount of reinforcing steel is estimated by listing the number, size and length of bars desired. The specification is a good reference for obtaining information about the size and length of material to be used. Since steel is sold by the pound, the number of linear feet required is multiplied by the number of pounds a bar weighs per linear foot.

Example: A contractor needs 500 linear feet of no. 2 steel bars which weigh .17 lbs. per foot. How many pounds will he need?

500 X .17 = 85 lbs. will be needed

The amount of wire mesh for a given job is determined by finding the number of sq. feet to be covered and adding 10 percent for laping.

Example: The concrete floor shown below is 60'-0" long. Find the number of square feet of wire mesh needed.



60'-0" X 20'-0" = 1200 sq. ft. - without lap

1200 X .10 = 120 = Amount needed for lap

1200 + 120 = 1320 sq. ft. will be needed

Concrete

Concrete is sold by the cubic yard which is the standard unit of measure for concrete. One cubic yard contains 27 cubic feet. Below is a formula that can be used to determine the cubic yards for any square or rectangular area when all the dimensions are given in feet. An additional 5 to 10 percent should be added for waste.

$$\text{Cu. Yds.} = \frac{\text{Width X Length X Thickness}}{27}$$

Example: The concrete driveway is 110'-0" long X 8'-0" wide X 6" thick. Find the number of cu. yds. of concrete that will be needed.

$$\text{cu. yd.} = \frac{110 \text{ X } 8 \text{ X } 1/2}{27} = \frac{110 \text{ X } 4 \text{ X } 1}{27 \text{ X } 1} = \frac{440}{27} = 16\text{-}8/27 \text{ cu. yds. will be needed}$$

When considering the amount of concrete needed for a particular job, the estimator must consider the shape of the area where the concrete is to be used. There are a number of different shapes, among these are the cylinder, the rectangular prism, the triangle pyramid, the cone, and the frustums. The amount of material needed to fill these shapes should be figured as volume.

Below are formulas and examples for figuring the volume needed for the shapes mentioned in the preceding paragraph.

The Cylinder. The volume of a cylinder equals the area of its base multiplied by the height.

$$\text{Volume} = \frac{\text{Base Area X Height}}{27}$$

Example: The base of a cylinder is 8 feet in diameter and 10 feet long. Find the cubic yards of concrete needed to fill.

Base Area = π X r^2

Base Area = 3.1416 X 4^2

= 50.26 sq. ft.

Volume = 50.26 X 10 = 502.6 cu. ft.

$\frac{502.6}{27}$ = 18.61 cu. yds. will be needed

The Pyramid. The volume of a pyramid is equal to one third (1/3) the base area multiplied by its height.

$$\text{Volume} = \frac{\text{1/3 X The Base Area X The Height}}{27}$$

Example: What is the volume of a hexagonal pyramid whose height is 14 feet and one side of the base if 8 feet?

Base Area = 3 X S X r

= 3 X 8 X 6.93

= 166.28 cu. ft.

Volume = 1/3 X base area X height

= 1/3 X 166.28 X 14

= 775.97 cu. ft.

$\frac{775.97}{27}$ = 28.74 cu. yds. will be needed

The Cone: The volume of a cone equals one-third of the product of the base area and height.

$$\text{Volume} = \frac{1/3 \text{ X Base Area X Height}}{27}$$

Example: The circumference of the base of a cone is 14 feet and the slanted height is 10 feet. What is the volume?

$$\text{Base Area} = \pi r^2$$

$$= 3.146 \text{ X } 2.23^2$$

$$= 15.62 \text{ sq. ft.}$$

$$\text{Volume} = \frac{1/3 \text{ X } 15.62 \text{ X } 9.75}{27} = \frac{50.77}{27}$$

$$= 1.88 \text{ cu. yds. will be needed}$$

The Frustum. The volume of frustum equals the sum of the area of the two bases plus the square root of the product of the bases multiplied by one-third the height.

Example: What is the volume of the frustum of a square pyramid whose height is 24 feet? The sides of the bottom base is 10 feet and the top base is 4 feet.

$$\text{Volume} = \frac{(A_1 + A_2 \text{ X } \sqrt{A_1 + A_2})}{27} \text{ X } \frac{H}{3}$$

$$\text{Base Areas} = S^2$$

$$A_1 = 10 \text{ X } 10 = 100 \text{ sq. ft.}$$

$$A_2 = 4 \text{ X } 4 = 16 \text{ sq. ft.}$$

$$A_1 \text{ X } A_2 = 100 \text{ X } 16 = 1600$$

$$\sqrt{A_1 + A_2} = \sqrt{1600} = 40 \text{ sq. ft.}$$

$$V = (100 + 16 + 40) \text{ X } \frac{24}{3}$$

$$= 156 \text{ X } 8 = 1248 \text{ cu. ft.} \quad \text{(cont'd)}$$

$$= \frac{1248}{27} = 46.22 \text{ cu. yds. will be needed}$$

Gravel

Gravel to be used is estimated by the cubic yard method. Consider the following example when estimating gravel.

Example: There is an area beneath a slab that needs to be filled with 2" of gravel. The area is 40'-0" X 20'-0". How many cubic yards of gravel will be needed?

Step One: Determine the cubic feet in the area.

$$20'\text{-}0" \times 40'\text{-}0" \times \frac{1}{2} = \frac{800}{2} = 400 \text{ cu. ft.}$$

Step Two: Divide this area by 27 cu. ft. which equals one cubic yard.

$$400 \div 27 = 14\frac{22}{27} \text{ cu. yds.}$$

Step Three: $14\frac{22}{27}$ cu. yds. of gravel will be needed.

Remember: Sand and dirt to be used as a filler are also estimated by this method.

Bisqueen

Bisqueen, a plastic material used as a water barrier between the slab and the earth, is purchased by the roll. You should use the square foot method when estimating the amount needed for a certain job. The size of a roll of bisqueen varies according to width, length and thickness. Consider the following example.

Example: You have a floor area to be covered consisting of two sections. Section A if 40'-0" X 15'-0" and section B is 75'-0" X 20'-0". How many square feet of bisqueen will be needed?

Step One: Determine the area of section A.

40'-0" X 15'-0" = 600 sq. ft.

Step Two: Determine the area of section B.

75'-0" X 20'-0" = 1500 sq. ft.

Step Three: Combine the two areas to find the total amount of bisqueen needed for both areas.

1500 + 600 = 2,100 sq. ft. of bisqueen will be needed

Masonary Work

This section is designed to develop an awareness of estimating block and brick masonary work. There will be two sections - the first dealing with brick and the second with blocks.

There are a number of conditions that may effect the way a job is estimated. Wass (1970) states some conditions that may effect an estimate:

1. the type of brick and the type of backing leaf to the face wall - that is clay brick or large masonary units bonded with metal ties;

2. the type of masonary or metal bond in which the unit is "laid up;"

3. the type of mortar and the kind of joints specified - it is easier for a mason to "lay up" units with lime mortar than with cement mortar;

4. the thickness of the wall; the thicker the wall the less often the scaffold will have to be lifted and also the internal bricks will not require joints to be tooled by the mason;

5. the provision of adequate runways for buggier;

6. the weather; hot weather requires more careful attention to wetting the bricks and caring for the mortar; cold, freezing weather will slow down the mason and his helper, and also the bricks will have to be heated and so will the mortar;

7. the higher the wall, the fewer number of bricks will be laid up per 8-hour day;

8. the skill of the mason - when the industry is very busy, some less efficient mason may have to be employed;

9. the efficiency of the mason, foreman and the general foreman; and

10. the most important single item that can make or break a job is the superintendent.

The Common Brick

The standard size of a common brick is 2-1/4" X 3-3/4" X 8". Considering the square foot method of estimating there are eight bricks laid per square foot. The following is an example for determining the number of bricks that can be laid per square foot with 3/8" mortar joint.

Example: 2-1/4" X 8" = 18 square inches in the face of a brick;

144 square inches equals one square foot

144 ÷ 18 = 8 brick per sq. ft.

Consider the following problem:

Find the number of common bricks needed for a side wall that is 109'-0" long and 38'-0" high.

Step One: Find the number of square feet in the wall.

109'-0" X 38'-0" = 4,142 sq. ft.

Step Two: Multiply the number of squre feet in the wall by the number of bricks per square foot.

4,142 X 8 = 33,136 Bricks

Step Three: Deduct twelve percent for the mortar joint.

33,136 X .12 = 2,916

33,136 - 3,976 = 29,160 Bricks

Step Four: Add ten percent for waste

29,160 X .10 = 2,916

29,160 + 2,916 = 32,076 Bricks needed for wall

Remember: If the wall is 8" multiply final answer by 2.
If the wall is 12" multiply final answer by 3.

Example: What is the net number of bricks for a wall that is 42'-0" long 18'-0" high with two openings 3'-0" X 7'-0"?

Step One: Determine the number of square feet in the wall.

42'-0" X 18'-0" = 756 square feet

Step Two: Determine the area for the two openings

3'-0" X 7'-0" X 2 = 42 square feet

Step Three: Deduct square feet of openings from the total square feet of wall.

756 - 42 = 714 square feet

Step Four: Multiply the number of bricks per square foot by square feet in the wall.

714 X 8 = 5,712 Bricks without mortar

Step Five: Deduct for mortar joints.

5,712 X .12 = 685 Bricks

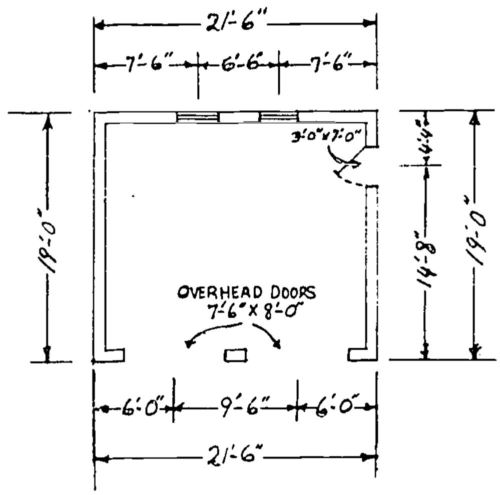
5,712 + 503 = 5,503 Bricks will be needed

Concrete Blocks

Concrete blocks are sold in different standard sizes depending on the job being considered or the area in which the block is to be used. The sizes of the concrete blocks are 8" X 8" X 16"; 4" X 8" X 16" and 12" X 8" X 16". When estimating the number of blocks for a job only the side that appears in the face of the wall should be considered

(8" X 16"). There are 112.5 blocks laid per 100 square feet of wall area. Since the actual size of a concrete block is 7-5/8" X 7-5/8" X 15-5/8" the mortar joint is figured in with the size of the block. Consider the following example.

Example: The block walls of the garage shown are 8" thick and 8'-0" high. The window openings at the rear are measured 3'-0" X 5'-0" and the door size is as indicated. Find the number of blocks required.



Step One: Determine the number of square feet in the building walls.

38 + 43 X 8 = 648 sq. ft. including openings

Step Two: Determine the area for the openings.

Side door = 3'-0" X 7'-0" = 21 sq. ft.

Windows = 3'-0" X 5'-0" X 2 = 30 sq. ft.

Overhead Doors - 8'-0" X 7'-6" X 2 = 120 sq. ft.

Total - 171 sq. ft.

Step Three: Substract total for openings from total in the wall

648 - 171 = 477 sq. ft.

Step Four: Multiply the number of blocks per 100 square feet by square feet in wall.

112.5 X 4.77 = 536.625 or 537 blocks

Alternate Method: There are 1.125 blocks for one square foot of wall space.

477 X 1.125 - 536.625 or 537 blocks will be needed

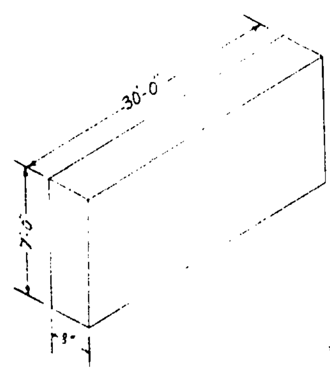
Mortar Mix and Sand

Mortar is a mixture of Portland cement, sand, and water to proportion. The usual mixture is 1:3. There is one part cement and three parts sand with the desired amount of water to gain plasticity. Cement is sold by the sack and sand is sold by the cubic yard.

One sack of Portland mortar mix using a 1:3 mix will lay 225 bricks and/or 455 blocks.

Consider the following problem.

Find the number of sacks of mortar and yards of sand needed to lay the bricks for the following 8" wall.



Step One: Determine the number of bricks needed to lay the wall.

Find sq. ft. 30'-0" X 7'-0" = 210 sq. ft.

Find Bricks 210 X 8 = 1,680 Bricks

Find Waste 1,680 X .10 = 168

1,680 + 168 = 1,848

1,848 X .12 = 222

1,848 + 222 = 2,070

Step Two: Determine the sacks of mortar needed; divide the total number of bricks needed to build the wall by the number of bricks that one sack of mortar will lay.

2070 ÷ 225 = 9.20 or 10 Sacks will be needed

Step Three: Determine the yards of sand needed. Multiply the total number of sacks of mortar needed time 3 (because of 1:3 mix) and divide by 27.

10 X 3 = 30 ÷ 27 = 1.1 cu. yds. of sand will be needed

Rough Carpentry

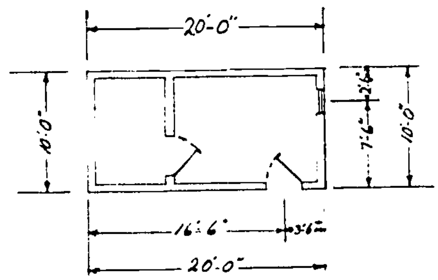
This section will deal with estimating material needed in the rough framing of wall construction. There are a number of different methods that may be considered, among these are the multiple unit, prefabricated engineered unit or the single unit method. Considering the methods listed above, the single unit method is the most effective, others may differ depending on the type of construction being considered.

Studs

The number of studs needed for a particular job being considered are determined by the number of lineal feet of wall space for interior and exterior wall. One stud for every lineal foot will also take into account those studs needed for corners, T's and any other partition post when studs are placed 16" on center.

Consider the following problem:

Find the number of studs needed for the storage house below.



Step One: Find the lineal feet in the walls

lineal feet = 70'-0" = 70 studs will be needed

Step Two: Add 5% for waste

70 X .05 = 3.50 or 4

Step Three: Add waste

70 + 4 + 74 Studs will be needed

<u>Plates</u>

The amount of plate needed for a particular job is also determined by the number of lineal feet. The sub-plate is located below the stud next to the floor and the top plate is located between the top of the stud and serves as a rest for the rafters and ceiling joist. The sub-plate is one 2 X 4 and the top plate is two 2 X 4's for a total of three. Plate is purchased in 12' lengths.

Consider the previous problem dealing with studs. Find the amount of plate material needed.

Step One: Determine the lineal feet of stud wall.

70'-0" = Amount of Stud Wall

Step Two: Multiply the lineal feet of stud wall times three.

70'-0" X 3 = 210 lineal ft.

27

Step Three: Determine waste: 5%.

210 X .05 = 10.50 or 11

210 + 11 = 221 lineal ft.

Step Four: Find the number needed by dividing total lin. ft. by 12.

221 ÷ 12 = 18.41 or 18 Studs will be needed.

Step Five: 18 pc - 2" X 4" X 12' will be needed.

Storm Board and Plywood

Storm board and plywood are usually sold by 1000 sq. ft. and are 4'-0" X 8'-0" in size. Although these are the sizes most often used, other sizes may be purchased. Fiber board and plywood is used in wall framing and subflooring. Estimating of the amount of fiber board needed for a job is determined by the square foot method. One board contains 32 square feet.

Consider the following problem:

Determine the number of sheets of fiber board needed to cover the walls of a building that is 20'-0" X 12'-0" and 8'-0" high. There is one window 2'-0" X 3'-0" and a door 3'-0" X 7'-0".

Step One: Determine the square feet in the walls.

64 X 8 = 512 sq. ft. in the wall

Step Two: Find the square feet in the openings.

Window: 2'-0" X 3'-0" = 6'-0"

Door: 3'-0" X 7'-0" = 21'-0"

Total: 21'-0" +6'-0" = 27'-0"

Step Three: Deduct area of opening from total area.

512 - 27 = 485 sq. ft.

Step Four: Find the number of sheets needed by dividing the total area by 32 sq. ft., the area of one sheet.

485 ÷ 32 = 15.15 or 16 sheets will be needed

Sheet rock to be used is estimated the same as demonstrated above.

Building Felt

Felt used in residential construction is shipped from the manufacturer in two weights, 15 pounds per square and 30 pounds per square. The amount of felt paper per roll is usually between 400 and 425 square feet. The amount of felt needed for a job is determined by the square foot method.

Sidings

Sidings used for residential construction may be purchased in a variety of colors, shapes and materials. The one discussed here will be of wood. The different shapes that siding may take are tongue and groove, shiplap, bevel or plain masonite. The thickness of siding ranges from 1/4" for masonite to 3/4" for others. The widths vary from four inches to twelve inches. Estimating the amount of siding needed is determined by the square foot method.

Consider the following steps.

Step One: Determine the number of square feet to be covered.

Step Two: Find the total area of an opening and subtract from total area.

Step Three: Add 5% for waste.

Step Four: Find the square feet in desired size of board to be used.

Step Five: Divide the total square feet by square feet in desired board size.

Baseboard, Ceiling and Corner Moulding

The estimating of moulding is a rather simple one but often overlooked by many beginning estimators. To estimate the amount of baseboard and ceiling moulding, determine the number of lineal feet in each room without deducting for openings. The ordering of baseboard and ceiling moulding may be in specified or random lengths.

The amount of corner mouldings, be it inside or outside, is determined by the height of the ceiling area to be used and the number of corners. Corner moulding is used in finishing panelled walls.

Insulation

Insulation is sold in different shapes and is known as water resistant paper backed blankets, batts and pouring wool.

Insulation is manufactured in modular size to fit between studs and joist 16", 20" and 24" on center (o.c.). The size required will be determined by the specifications for the job. The estimating of insulation is determined by the square foot method. When insulating exterior walls 3" thick, batts are used and 6" thick insulation is used between ceiling joist.

The following is to be considered when estimating blanket or batt insulation. One length of blanket insulation 8'-0" or a combination of batts will cover 10.66 square feet of area between studs.

Nails

Nails, which come in different lengths, are sold by the pennyweight which is abbreviated by (d). Estimating the number of nails for a given job you should allow 2 pounds of nails for every 100 board feet of lumber being used. Also in estimating nails, one should consider the different classifications of nails.

Below is a list and description of different nails used in construction. The list below is taken from Southerland Training Handbook by Robert D. Southerland.

Common Nails have a large head and a thick shank, and are used for dimension frame construction. This is the general purpose nail.

Box Nails have a large head, a small shank, and are used for siding and sheathing.

Casing Nails have a small tapered head and can be countersunk into woodwork or oak flooring.

Finish Nails have a brad head and are slimmer shank than casing nails. They may be countersunk, covered with putty, and painted over.

Plaster Board Nails are glued to prevent rust, and are also manufactured in galvanized, and ring shank.

Barbed Roofing Nails are sold by the inch and are galvanized to prevent rust. Always supply 1-1/2" or longer for nailing a new roof over an old one.

Cement Coated Nails are coated with resin which melts from friction as the nail is driven, thus holding the nail in place. They are used in underlayment for better holding power.

Lead Head Nails. The large lead head is flattened around the hold in galvanized metal to make a water tight roof.

Galvanized Shingle Nails are commonly used for wood shingle roofs only 3d for new roofs, 5d for reroofing jobs.

Cedar Shake Nails are galvanized, electro plated, ring shanked, small diameter head, various lengths, standard 2".

Brick Siding Nails are enameled nails. Generally black and less visible when applied in the mortar joints.

Screw Shank Floor Nails. These screw down tight and are used for oak floors. Use box or 8d casing nails for pine or fir porch floors and nail at a 45 degree angle above the tongue.

Aluminum Wood Siding Nails are approximately 550 per pound, one pound sufficient amount to nail 500 square feet of siding. They are generally stocked in 7d and won't rust.

Concrete Nails are designed to hold tight in concrete walls and are case hardened. Concrete nails are used to fasten base plate to the slab.

Floor Joist

Floor joists are those framing members turned on edge in floor construction that carry the weight of different areas of the floor to the girders and the sills. These members are usually of 2" material ranging in width from 10 to 12 inches. The size (span) of the construction often determines the width to be used.

When estimating the number of floor joists needed for a floor, you should determine the length of the building and multiply it times 3/4 for joists 16" o.c., 3/5 for joists 20" o.c., and 1/2 for 24" o.c. To this amount add one for the header or beginner. Floor joists are not estimated when the construction is built on a concrete slab.

Ceiling Joist

Ceiling joists are those framing members just below the roof that carry the material of the ceiling surface. The size and spacing of these members is usually determined by the type and weight of the ceiling material. The most common spacing of ceiling joists is 12 and 16 inches on center. Although these two are the most recommended, others may be used.

When estimating the ceiling joist needed, you should multiply the length of the building times 3/4 and add one for the beginner (sometimes called zero).

Example: Find the number of ceiling joist for a building

30'-0" X 3/4 + 1. The joist are 16" o.c.

Step One: 30'-0" X 3/4 + 1 = 23.5

Step Two: Make out order sheet.

24 pcs. 2" X 8" X 16'-0" will be needed.

Roof Framing

This section is designed to give the estimator a better understanding of roof framing as it relates to the estimating of the number of rafters needed in the different styles of roofs. There are a number of different shapes and sizes of roofs used in construction today. Among the most commonly used are the flat roof, the shed or lean-to roof, the hip, the gable and the gambrel roof which is sometimes called the barn roof.

When estimating rafters for the gable and hip roof, one should keep in mind some basic numbers. These numbers are 3/4 for spacing 16" o.c., 3/5 for spacing 20" o.c. and 1/2 for spacing 24" o.c. When determining the number of rafters for a gable roof, multiply the length of the roof by the predetermined fraction for the spacing of the rafters, add one and multiply this answer by two for both sides of the roof.

One way to estimate the number of rafters for a hip roof is to draw a scaled down model of the roof plan and count the rafters. The simpliest way is to treat the roof as though it was a common or gable roof and add extra rafters for the number of hips that will be needed in the construction of the roof. The length of the rafters are then determined and an overhang of 18" to 24" is added to get the overall length of the materials needed.

Consider the following problem.

There is a building 30'-0" X 50'-0" with a pitch of 6 and 12 and the rafters are spaced 20" o.c. with an overhang of 2'-0". How many rafters will be needed to frame a hip roof? What should be the length of the material?

Step One: Estimate the number of rafters needed by multiplying the length of the building times the predetermined fraction for rafters spaced 20" o.c.

$$50 \text{ X } 3/5 = \frac{150}{5} = 30$$

Step Two: Add one (1) and multiply by two.

$$2(30 + 1) = 62$$

Step Three: Add one extra rafter for each hip rafter needed.

In this case there are four hip rafters.

62 + 4 = 66 Rafters will be needed

Step Four: Find the length of the rafters by multiplying the length per foot run for a 6 and 12 pitch times the run of the building. Divide this answer by 12 and add the overhang.

13.41 X 15 = 201.25

201.25 ÷ 12 = 16.77 = 16'-9 1/4" Length of rafter

16'-9 1/4" + 2'-0" = 18'-9 1/2" Length of rafter with overhang

Step Five: Determine material to order for common rafters.

62 pcs. 2" X 8" X 20'-0" will be needed

Step Six: Determine material needed for hip rafter. Determine the length per foot run for hip rafter with 6 and 12 pitch and proceed as though working for a common rafter.

18.00 X 15 = 270

270 ÷ 12 = 22.53 = 22'-6 3/8" Length of rafter

Add overhang. 22'-6 3/8 " + 2'-6" = 25'-3/8"

4 pcs. 2" X 8" X 26'-0" will be needed

Total 62 pcs. 2" X 8" X 20'-0"
4 pcs. 2" X 8" X 26'-0"

<u>Roofing and Sheeting Materials</u>

The materials used in roofing and sheeting of a roof is determined by the square foot method. Materials used for roofing usually come in the form of wood, metal and asphalt. Shingle made of asphalt can be purchased in the following form: roll roofing, three in one strip asphalt shingle, and roofing felt. Wood shingles are made into slates and metal roofing comes in sheets. Asphalt roofing material is usually purchased by the square ranging in sizes from 210# per square to 235# per square. One square will cover 100 square feet or an area ten feet square.

Sheeting material for roofs are usually 4'-0" X 8'-0" plywood ranging from 1/2" to 3/4" in thickness, depending on the spacing of the rafters. If rafters are 16" o.c., you can get by with thinner decking. Rafters placed 24" o.c. require thicker decking or the roof will not support its weight.

When determining the amount of sheeting and roofing needed, estimate the area of the roof and use the same procedure for estimating the amount of siding. To determine the area of a common roof, find the area of one side by multiplying the length of ridge board times the length of the common rafter to obtain one side. Then double to get the entire area of the roof. The area of a hip roof is determined by multiplying the length of the common rafter by the length of the house plus twice the overhang.

Example: There is a building 15'-0" X 30'-0" with common rafters placed 16" o.c. and an overhang of 2'-0". How many square of roofing and sheets of plywood sheeting will be needed. The length of the common rafter including the overhang is 10'-4 11/16".

Step One: Multiply the length of the ridge board times the length of the comon rafter.

Length of Ridge = 30'-0" + 4'-0" = 34

34 X 10'-4 3/4" = 353.6

Step Two: Double this amount.

353.6 X 2 = 707.2 sq. ft. of area

Step Three: Divide total area by area that one square of roofing will cover.

702.2 ÷ 100 = 7.072 Squares

Step Four: Add 10% waste.

7.072 X .10 = .7072

7.072 + .7072 = 7.7792 or 8 Squares will be needed

Step Five: For sheeting divide total area by square area of one sheet of sheeting and add 5% waste.

707.2 ÷ 32 = 22.1

Waste: 22.1 X .05 = 1.105

22.1 + 1.105 = 23.205 or 23 Sheets will be needed.

Doors and Windows

When estimating the size, number and kind of doors and windows needed for a given job, one needs only to refer to the specification sheet or to the door and window schedule of any set of drawings to get the needed information. The plans are also needed to determine if the door is a right or left hand door. The type of door needed for a given job depends on the design of the structure being constructed.

Wall Finish: Paint

The estimating of paint to be used is determined by the square foot method. One gallon of paint is estimated to cover an area of 425 to 450 square feet.

Example: How many gallons of paint is needed to cover the walls of two rooms that contain 288 sq. ft. of wall area each.

576 ÷ 450 = 1.28 gals. or 1-1/4 gal. will be needed

Wallpaper

Wallpaper, a very common wall covering material, is estimated by the square foot method. The number of square feet per roll depends on the type and texture of the paper.

Example: There is a wall with 900 square feet of area, determine the rolls of paper needed to cover the wall, if one roll contains thirty sq. ft. of paper.

Step One: Divide the area of wall by the number of feet in one roll.

900 ÷ 30 = 30

Step Two: Add 5% for waste.

30 X .05 = 1.5

30 + 1.5 = 31.5 Rolls of wallpaper will be needed

Ceiling Tile and Floor Tile

The estimating of ceiling tile and floor tile is also estimated by the square foot area method. One bundle will cover 64 sq. ft.

Example: Determine the amount of ceiling tile needed for a ceiling 20'-0" X 15'-0".

Step One: Find the area of the ceiling.

20' X 15 = 300 sq. ft.

Step Two: Determine the number of bundles needed.

300 ÷ 64 = 4.687 or 5 Bundles will be needed

Carpet

The estimating of carpet is derived by using the square yard method. One square yard of carpet will cover an area of nine (9) square feet.

Example: You have a floor area consisting of 1500 square feet. How many yards of carpet is required to cover this floor.

Step One: Divide the total floor area by nine (9).

1500 ÷ 9 = 166 2/3 or 167 cubic yards

Step Two: Add 3% for waste.

167 X .03 = 5.10

Step Three: Add waste to get total.

167 + 5 = 172 yd. of carpet will be needed

Strip or Hard Wood Flooring

The estimating of the amount of strip flooring needed is determined by the square area method. The following table taken from Modern Carpentry by Wagner should also be considered when estimating strip flooring.

Percentage to Add for Different Sizes	Size of Flooring
55% for	25/32" X 1-1/2"
41-1/2% for	25/32" X 2"
38-1/3% for	25/32" X 2-1/4"

(cont'd)

29% for	25/32" X 3-1/4"
38-1/3% for	3/8" X 1-1/2"
30% for	3/8" X 2"
38-1/3" for	1/2" X 1-1/2"
30% for	1/2" X 2"

There are 24 board feet per bundle.

Example:

Step One: Total Square Area = 1000 Square Feet

Step Two: Flooring Size = 25/32" X 2"

Step Three: Floor Needed = 1000 + 41-1/2 or

Step Four: 1000 + 415 = 1415 Bd. Ft. will be needed

Cost; Material

What will this material (supplies) cost? This question is always in the mind of the contractor when he begins to develop a profile for a job. This question can be answered in two ways. Consider the first answer. The contractor may keep an up-to-date price list of building materials available in his area. From this list he is able to take the prices of the materials needed for this particular job and enters it in the summary sheet to get a total cost.

The second method deals with receiving bids on the materials. Through the bidding process the contractor prepares a detail list of the materials needed to do the job. Copies of this list are sent to different building supply merchants, asking for a total price (bid) on the materials listed. This list should have all of the specifications necessary for the bidder to give an accurate cost. When these bids are returned, the contractor decides which is best and accepts it.

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APPENDIX A

Glossary of Terms
(Takén from Modern Carpentry by Wagner)

GLOSSARY OF TERMS[1]

Air Conditioning: Control of temperature, humidity, movement, and purity of air in buildings.

Anchor Bolts: Bolts embedded in concrete used to hold structural members in place.

Asphalt: A residue from evaporated petroleum. It is insoluble in water but is soluble in gasoline and melts when heated. Used for waterproofing roof coverings, exterior wall coverings, and flooring tile.

Basement: The base story of a house, usually below grade.

Base Shoe: Small narrow molding used around the perimeter of a room where the base meets the finish floor.

Batter Board: A temporary framework used to assist in locating corners when laying out a foundation.

Bevel Siding: Used as finish siding on the exterior of a structure. It is usually manufactured by "resawing" dry, square surfaced boards diagonally to produce two wedge-shaped pieces.

Bid: An offer to supply, at a specified price; materials, supplies, and equipment; or the entire structure or sectinos of the structure.

Brick Veneer Construction: A type of construction in which a wood-frame construction has an exterior surface of single brick.

Cabinet: Case or box-like assembly consisting of shelves, doors and drawers, used primarily for storage.

Casing: The trimming around a door or window, either outside or inside, or the finished lumber around a post or beam.

Door Frame: An assembly of wood parts that form an enclosure and support for a door. Door frames are classified as exterior and interior.

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[1]Wagner, Willis H., Modern Carpentry, The Goodheart-Willcox Company, 1969.

Dry Wall: Materials used for wall covering which do not need to be mixed with water before application.

Face Nail: A nail driven perpendicular to the surface of a piece.

Fiber Board: A broad term used to describe sheet material of widely varying densities; manufactured from wood, cane, or other vegetable fibers.

Flat Roof: A roof which is flat, or which is pitched only enough to provide for drainage.

Footing: The spreading course or courses at the base or bottom of a foundation wall, pier, or column.

Foundation: The supporting portion of a structure below the first-floor construction, or grade, including the footings.

Framing: The timber structure of a building which gives it shape and strength; including interior and exterior walls, floor, roof and ceilings.

Gable: That portion of a wall contained between the slopes of a double-sloped roof or that portion contained between the slope of a single-sloped roof and a line projected horizontally through the lowest elevation of the roof construction.

Interior Trim: General term for all the molding, casing, baseboard and other trim items applied within the building by finish carpenters.

Insulation: (Thermal) Any material high in resistance to heat transmission that is placed in structures to reduce the rate of heat flow.

Jack Rafter: A short rafter framing between the wall plate and a hip rafter; or a hip or valley rafter and ridge board.

Joist: One of a series of parallel framing members used to support floor and ceiling loads, and supported in turn by larger beams, girders, or bearing walls.

Lineal Foot: Having length only, pertaining to a line one foot long -- as distinguished from a square foot or cubic foot.

Lumber: The product of the saw and planing mill not further manufactured than by sawing, resawing, passing lengthwise through a standard planing machine, and crosscutting to length. Some matching of ends and edges may be included.

Masonry: Stone, brick, hollow tile, concrete block or tile, and sometimes poured concrete and gypsum block, or other similar materials, or a combination of same, bonded together with mortar to form a wall, pier, buttress, etc.

Millwork: The term used to describe products which are primarily manufactured from lumber in a planing mill or woodworking plant; including moldings, door frames and entrances, blinds and shutters, sash and window units, doors, stairwork, kitchen cabinets, mantels, cabinets and porch work.

Molding: A relatively narrow strip of wood, usually shaped to a curved profile throughout its length. Used to accent and emphasize the ornamentation of a structure and to conceal surface or angle joints.

On Center: A method of indicating the spacing of framing members by stating the measurement from the center of one member to the center of the succeeding one.

Particleboard: A formed panel consisting of particles of wood flakes, shavings, slivers, etc., bonded together with a synthetic resin or other added binder.

Partition: A wall that subdivides space within any story of a building.

Penny: Term used to indicate nail length; abbreviated by the letter d. Applies to common, box, casing, and finishing nails.

Pitch: Inclination or slope, as of roofs or stairs. Rise divided by the span.

Plan: A drawing representing any one of the floors or horizontal cross sections of a building, or the horizontal plane of any other object or area.

Plate: A horizontal structural member placed on a wall or supported on posts, studs, or corbels to carry the trusses of a roof or to carry the rafters directly. Also a sole or base member of a partition or other frame.

Platform Framing: A system of framing a building where the floor joists of each story rest on the top plates of the story below (or on the foundation wall for the first story) and the bearing walls and partitions rest on the subfloor of each story.

Plumbing: The work or business of installing in buildings the pipes, fixtures, and other apparatus for bringing in the water supply and removing liquid and water-borne wastes. This term is used also to denote the installed fixtures and piping of a building.

Prefabricated Construction: Type of construction so designed as to involve a minimum of assembly at the site, usually comprising a series of large units manufactured in a plant.

Rafter: One of a series of structural members of a roof designed to support roof loads. The rafters of a flat roof are sometimes called roof joists.

Reinformed Concrete Construction: A type of construction in which the principal structural members, such as floors, columns, and beams, are made of concrete poured around steel bars or steel meshwork in such manner that the two materials act together to resist force.

Roofing: The materials applied to the structural parts of a roof to make it waterproof.

Roof Ridge: The horizontal line at the junction of the top edges of two roof surfaces where an external angle greater than 180 deg. is formed.

Rough Opening: The opening formed by the framing members.

Scaffold: A temporary structure or platform used to support workmen and materials during building construction.

Sheathing: The structural covering. Consists of boards or prefabricated panels that are attached to the exterior studding or rafters of a structure.

Sheathing Paper: A building material used in wall, floor, and roof construction to resist the passage of air.

Shiplap: Lumber with edges that have been rabbeted to form a lap joint between adjacent pieces.

Sill: The lowest member of the frame of a structure, usually horizontal, resting on the foundation and supporting the uprights of the frame. Also the lowest member of a window or outside door frame.

Span: The distance between structural supports such as walls, columns, piers, beams, girders, and trusses.

Specification: A written document stipulating the kind, quality, and sometimes the quantity of materials and workmanship required for a construction job.

Square: Unit of measure -- 100 square feet -- usually applied to roofing material and to some types of siding.

Stud: One of a series of vertical wood or metal structural members in walls and partitions. Plural -- studs or studding.

Subfloor: Boards or panels laid directly on floor joists over which a finished floor will be laid.

Trim: The finish materials in a building, such as moldings applied around openings (window trim, door time) or at the floor and ceiling of rooms (baseboard, cornice, picture molding).

Truss: A structural unit consisting of such members as beams, bars, and ties; usually arranged to form triangles. Provides rigid support over wide spans with a minimum amount of material.

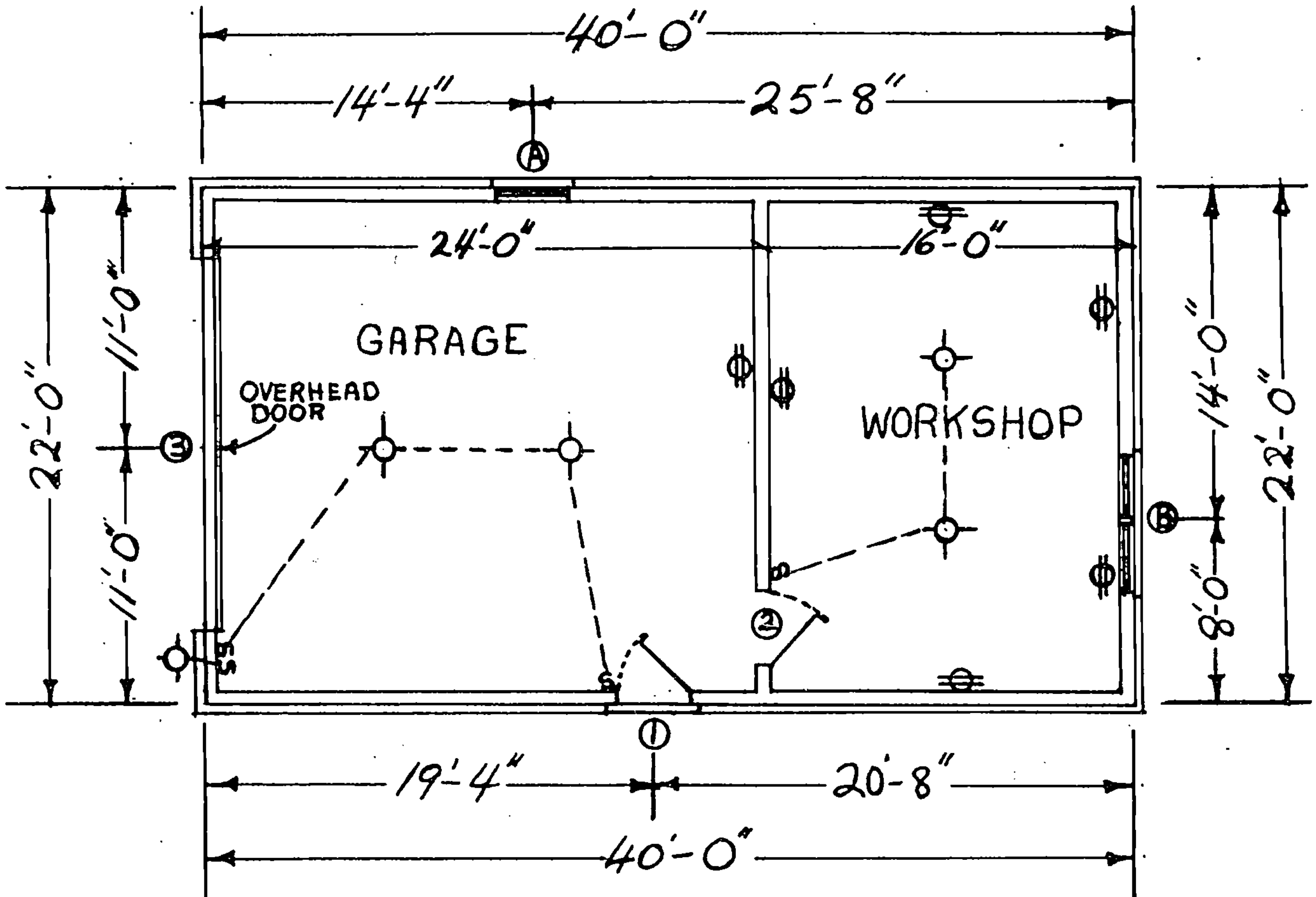
Valley: The internal angle formed by the two slopes of a roof.

Valley Rafter: A rafter which forms the intersection of an internal roof angle.

Veneered Wall: A frame building wall with a masonry facint (example -- single brick). A veneered wall is nonload bearing.

APPENDIX B

Plans for a Garage and Workshop

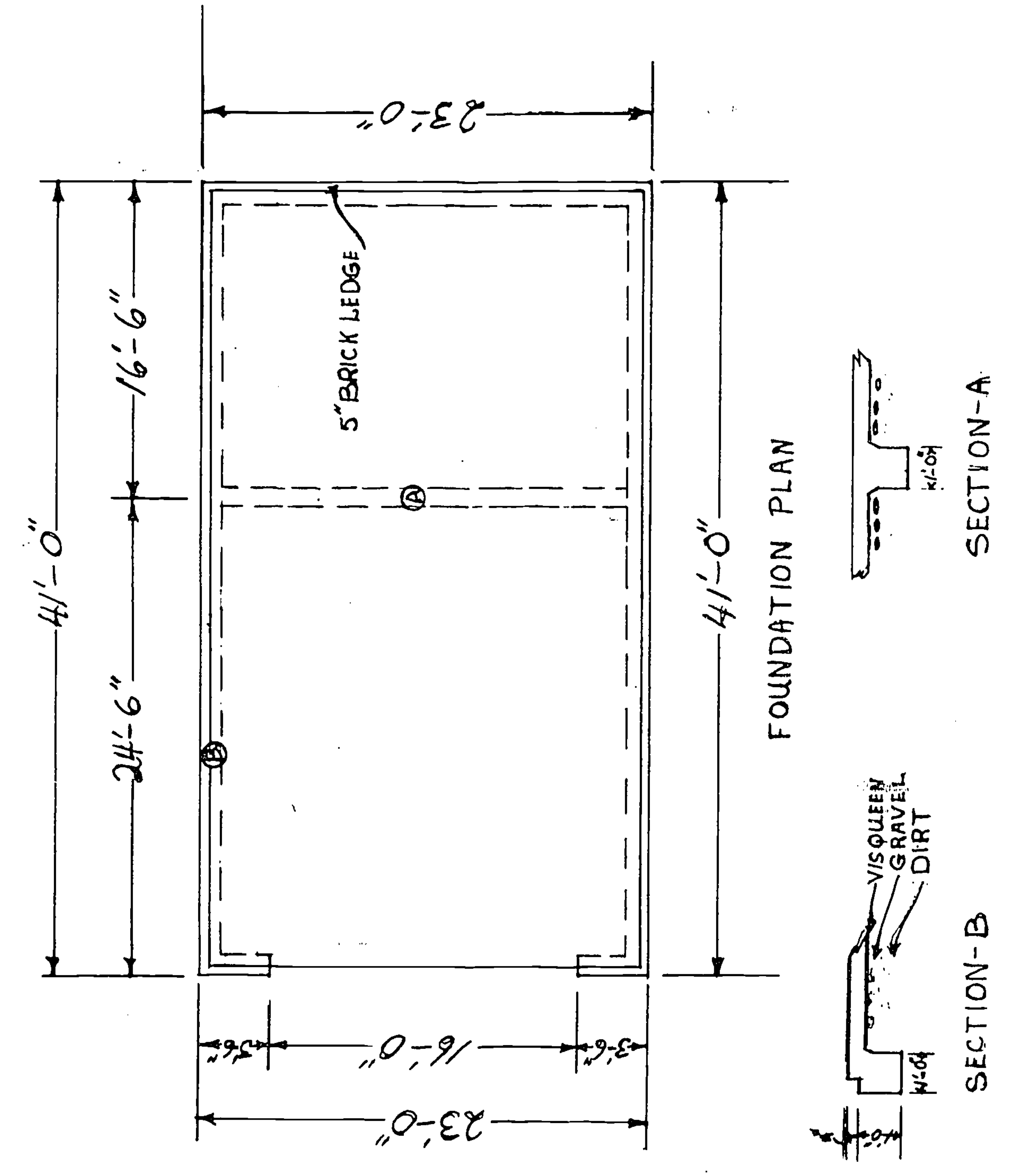


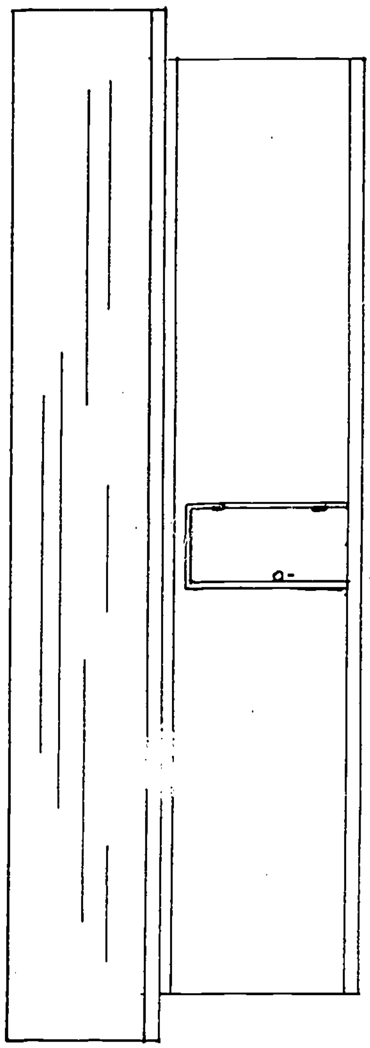
FLOOR PLAN

SCALE-1/8"=1'-0"

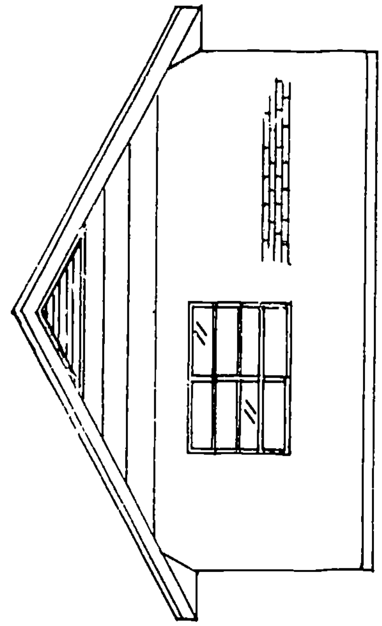
SCHEDULE

SYMBOL	DESCRIPTION	SIZE	SYMBOL	DESCRIPTION	SIZE
1	EXT. SOLID WOOD	3'-0"X6'-8"	A	SINGLE ALUM FRAME	3'-0"X4'-0"
2	INT. HOLLOW WOOD	3'-0"X6'-8"	B	Doub. ALUM. FRAME	4'-0"X6'-0"
3	OVERHEAD METAL	7'-0"X16'-0"			

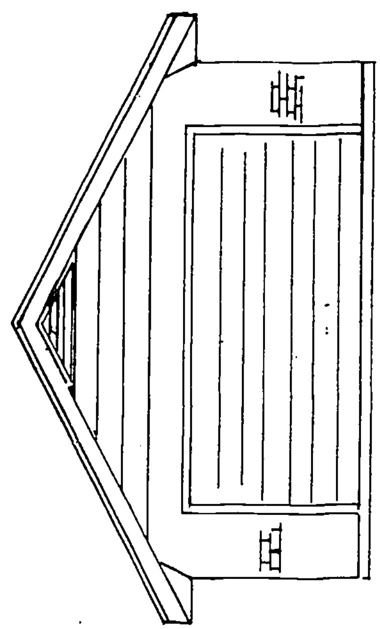

23'-0"
5" BRICK LEDGE
16'-6"
24'-6"
41'-0"
41'-0"
16'-0"
3'-6"
3'-6"
23'-0"
FOUNDATION PLAN
SECTION-A
VISQUEEN
GRAVEL
DIRT
SECTION-B



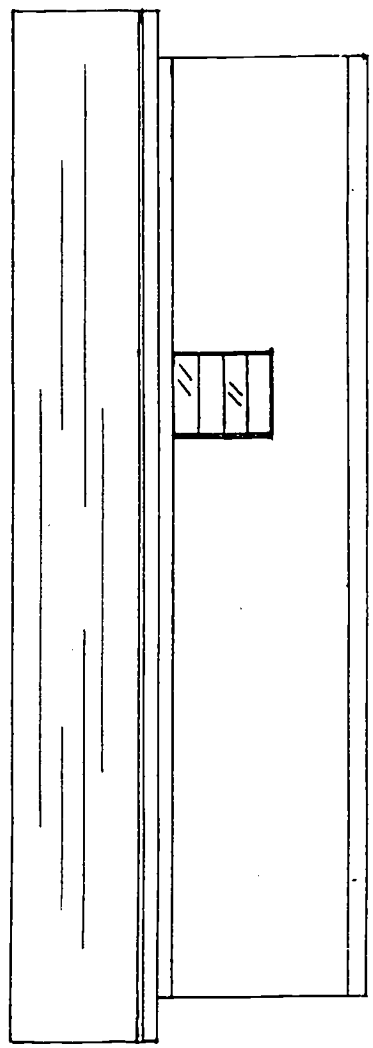
RIGHT VIEW



REAR VIEW



FRONT VIEW



LEFT VIEW