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Individualized Instructional Units for Estimating in the Construction Field

Robert P. Rosendahl

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INDIVIDUALIZED INSTRUCTIONAL UNITS

FOR ESTIMATING IN THE CONSTRUCTION FIELD

Approved by

Graduate Committee Chairman

Dec. 20, 1976

Date

INDIVIDUALIZED INSTRUCTIONAL UNITS FOR ESTIMATING IN THE CONSTRUCTION FIELD

A REPORT

PRESENTED TO

DR. W. E. LUCK

INDUSTRIAL TECHNOLOGY

UNIVERSITY OF NORTHERN IOWA

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BY

ROBERT R. ROSENDAHL

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TABLE OF CONTENTS

LIST OF TABLES

Chapter 1

INTRODUCTION

In the past decade the construction industry costs have spiralled unbelievably. Construction work performed in Canada in 1965 amounted to nearly ten billion dollars. Ten years later in 1975 this total jumped to over twenty-eight billion dollars. (Statistics Canada, 1975 cat. 64-201 - Construction in Canada.) Construction is the largest and fastest changing industry in Canada and the demand for qualified estimators increases each year.

The availability of estimating courses to assist construction personnel, engineers, retail lumber dealers, consumers and other personnel in related fields, is minimal or non-existant.

This investigator's primary interest is in the development of units on estimating that could be used individually or in groups for seminars, workshops, or regular classes. A construction technology course in industrial arts is incomplete without an estimating section.

STATEMENT OF PROBLEM

The purpose of this study was to investigate the development, production, and use of individualized instructional units for construction estimating for the purpose of incorporating a section on estimating into the construction technology course of the industrial arts program. These units should be equally valuable in seminars, workshops, and courses set up for construction personnel, engineers, retail lumber dealers, and university or technical students.

IMPORTANCE OF THE STUDY

It is impossible to embark on a planned construction project, big or small, without first estimating the cost of labour, materials, equipment, overhead, and profit. The continuous change in available materials and prices makes estimating more important and more difficult. These individualized instructional units on estimating in the construction field were developed to meet relatively simple needs (a high school industrial arts program) as well as complex business needs (construction or engineering firm estimators). With the tremendous increase in the construction industry, estimating education becomes very important to consumers and businesses alike.

LIMITATIONS OF THE STUDY

Literature available at libraries dealing with estimating in the construction field was limited to very general information. Much of the detailed information in these units was a result of contributions from my associates in the construction industry and from my experience in the teaching and construction fields. In order to satisfy the complex requirements of construction and engineering industries the study units are very detailed. This may mean that for the high school industrial arts class some choices of topics will have to be made according to interest and usage.

DEFINITION OF TERMS

Aggregate - any of several hard materials used for mixing with cement and water to form concrete.

Board Feet - = 12" wide x 12" long x 1" thick.

Brick Work - common bond - header every 6th course.
english bond - full header every other course.

Built up Forms - when it is convenient to use on the job site materials to construct forms.

Centre Line Method - is the lineal feet of footing measured down the centre.

Earth Swell - when earth and rock are loosened during excavation, they assume a larger volume. This increase in volume is known as "Swell".

Flemish Bond - full header every course.

Panel Forms - a manufactured type of form with interlocking

		devices to fasten together. Made from steel, wood or plastic materials.
Re-Bar	-	a preformed round bar of steel designed to use in concrete.
Subfloor	-	boards or panels laid directly on floor joists over which a finished floor will be laid.
Studs	-	one of a series of vertical wood or metal structural members in walls and partitions.
Wainscot	-	a lower interior wall surface that contrasts with the wall surface above.

Chapter 2

HISTORICAL AND TECHNICAL INFORMATION

Vocational education in Canada can be traced back to the seventeenth century when Bishop Laval established a trade school at St. Joachin. The growth of vocational education was slow and sporadic because the bulk of jobs available required unskilled labour and because Canada was essentially an agrarian nation. Rapid expansion and development of technical vocational education was the result of the financial commitment of the Federal Government in 1913 (Glendenning, 1964). Federal legislation in 1960 stimulated intense provincial activity and resulted in tremendous steps forward in terms of vocational facilities, programs, and philosophy.

Before the establishment of Manitoba's manual training centre in 1900, the only vocational education available in the province was a commercial course first offered in 1899 in Winnipeg (Simon, 1962, page ten). Since 1961 Manitoba has constructed three post secondary vocational training centres: Red River Community College, Winnipeg, 1963, Assiniboine Community College, Brandon, 1965, and Keewatin Community College, The Pas, 1966. (Bock (1970 pp 7-8). These vocational training centres all offer building construction courses with a view of turning out skilled carpenters. There is a definite need for more instruction in the field of estimating. Every woodworker must know how to estimate the materials he needs and how to plan the method of doing the job. (Feirer, 1963). Estimating proves or disproves the budget and is, in turn, proven or disproven when the project is bought. (Architectural Record, Oct. 74). Without good estimating, there is no scale to measure against, and knowledgeable purchasing becomes virtually impossible.

The successful builder depends on accurate estimates of construction costs. Estimating these costs is an exacting process based on a thorough knowledge of the various trades involved in the construction industry (Steinberg 1965). Most large construction companies use computers to facilitate the estimating process. The computer however, is not the key to successful estimating. The key lies in the experience and judgement of the estimator or data operator.

It is important to be knowledgeable about all construction building materials and procedures whether the estimator is working with a bid, a contract, or a small personal project. Estimators must figure the following costs in order to prepare a viable estimate: materials, labour, equipment, subcontracts, overhead, and profit. (Betts 1976).

One further consideration deserves mention here. I have been dwelling heavily on the cost factor of building construction. Can something so intimately related to a building's design as the control of its cost and time of delivery be successfully separated from the design approach? (Heery, 1975). Clearly architectural design and construction management are indigenous parts of the process that creates successful architecture. This means architecture that is visually successfully but that also fulfills its social, economic, and environmental requirements. It is important to keep up with new building developments in order that the estimator does not lose touch with current trends, materials, and practices. (Wass, 1970).

Because the building construction industry covers a wide variety of materials, methods and procedures, these programmed instructional units are designed to instruct in ten separate areas with appendices to cover other considerations. The units have been used individually and in a group situation. The instructor chooses to present all the units or only the area that fits the specific need of his class or student. With the broad spectrum of competencies to be covered in the vocational training carpentry program and the limit of time available to industrial arts teachers in a high school program, these instructional units have proven highly successful.

Industrial studies (Hughes 1963) have proven that by using programmed instruction the material can be taught to all ability groups with greater content retention in less time than is the case with convential instruction.

Chapter 3

PROJECT ACTIVITY INFORMATION

Evaluative results from the jury of experts listed in this chapter would indicate the need for informational units to cover estimating in the building construction field. The units needed to be flexible enough to meet the needs of individuals or class groups. They needed to allow all estimating students to progress at their own rate in a general overall course or in specialty areas according to individual need. Individualized programmed instructional units on specialty areas within the building construction field met the overall requirements better than any other instructional method.

The content to be included in these instructional units was predetermined directly by the necessary components in the build-ind trade and by the opinions of the jury of experts.

RESULTS OF EVALUATIVE QUESTIONNAIRE

QUESTIONS	YES	NO	UNDECIDED
1	4		
2	3	1	
3	2	1	1
4	3	1	
5	4		
6	-	3	1
7	2		2
8	3	1	
9	3		1
10	3	1	
11	4		
12	4		

JURY OF EXPERTS

Mr. Gilbert Russell
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Chapter 4

INTRODUCTION TO INSTRUCTIONAL UNITS

With construction being Canada's largest industry the demand for qualified estimators increases each year. The availability of estimating courses to assist construction personnel, engineers, retail lumber dealers, consumers and other personnel in related fields, is minimal or non-existant. Over the years an attempt has been made to assemble some type of self-instructional packages that would provide construction personnel with the necessary knowledge for a career in the estimating field.

The following individualized estimating units are a result of contributions from many of my associates in the construction industry.

UNIT I

EXCAVATION

Objectives

Following the completion of this unit, a student will be able to:

1.1 Calculate cubic yards of earth to be excavated for:

- removal of top soil
- general excavation of basements
- excavation for foundation wall footings
- excavation for trenches
- excavation for piles

1.2 Complete a quantity take-off sheet

1.3 Describe earth swell and earth shrinkage

1.4 Explain cut and fill

Excavation is defined as a cavity or hole made by digging out the earth to provide room for engineering improvements. The estimator, prior to his actual quantity take-off, should make a careful study of the drawings and specifications with attention paid to the general conditions.

1. Removal of Topsoil:

In most cases the contractor is required to excavate the top layer of soil on the site to a depth of from 6 to 15 inches. This soil will then be stock piled and later used for the final topping, provided the soil is suitable for this purpose. In some cases if this topsoil is not needed, it can be sold to other contractors or landscapers - in certain areas topsoil is a very valuable substance. The Specifications generally give the dimensions of the topsoil to be removed beyond the exterior walls of the proposed building.

Example:

Remove the topsoil 20'-0" beyond the exterior walls of the building shown in the plan Figure 1.1. Excavation is to be 15 inches deep. Calculate the cubic yards of topsoil to be removed. The topsoil removed will also include the area taken up by the proposed building.

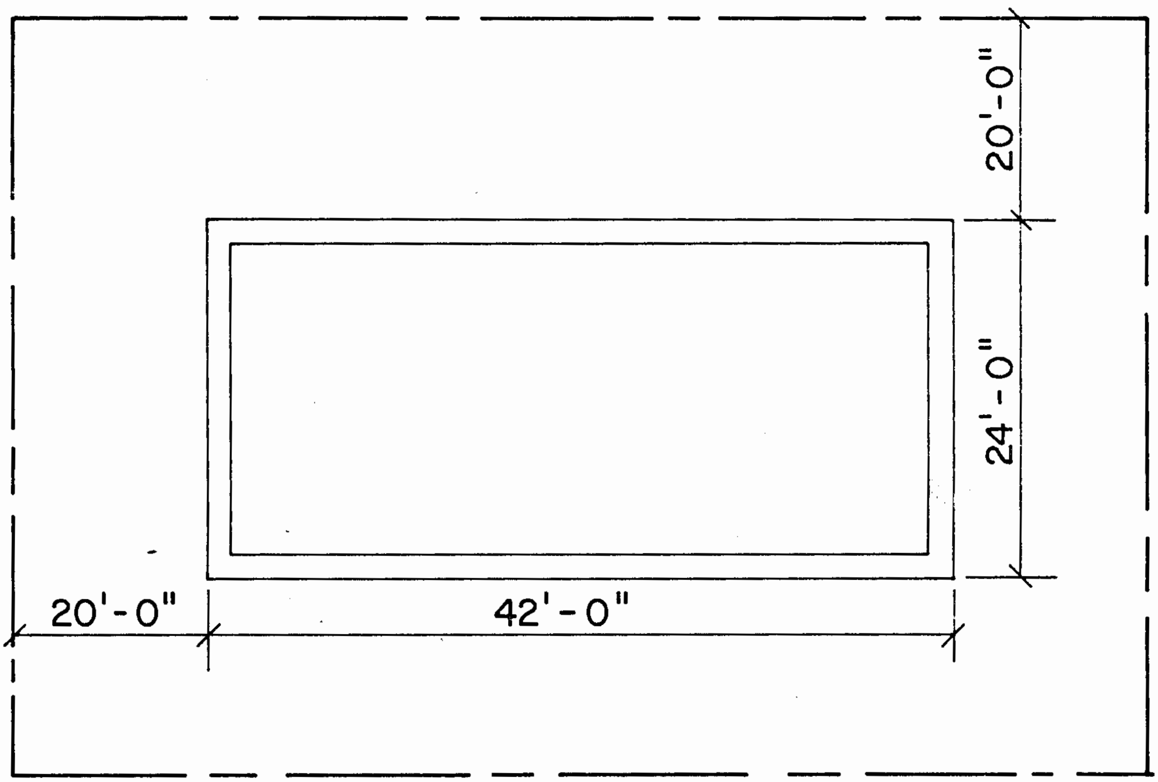
The length of the excavation is 82'-0". The width of the excavation is 64'-0". Multiply 82'-0" x 64'-0" = 5248 square feet.

Next multiply the area (5248 square feet) by the depth of the excavation which is 15 inches. (Before multiplying we will change the 15 inches into feet and decimal parts of a foot. 15 inches = 1'-3" or 1.25 feet).

Therefore 5248 x 1.25 = 6,560 cubic feet.

Then 6,560 - 27 = 242.96 cubic yards of topsoil to be removed.

The method of taking off this quantity with the use of Quantity Take-Off Sheets is the procedure you will use throughout. With the use of Quantity Take-Off Sheets you will find it simpler, and errors are less likely to occur. These Quantity Take-Off sheets are more or less a work up sheet, they are used by the estimator to show how he arrived at his calculations.



PLAN

This Quantity Take-Off Sheet must be neat and self-explanatory so that at any future time another person could follow the computations. From this Quantity Take-Off Sheet the quantities are transferred to the General Estimate Sheet. When using the Quantity Take-Off Sheets the following points are most important:

(i) The job number must appear on each sheet.

(ii) Place the date on each sheet.

(iii) Number each sheet. If there are 30 sheets in the series, the first one would be 1 of 30 and on up to 30 of 30.

The removal of the topsoil would appear on the Quantity Take-Off Sheet as shown in Figure 1.2

JOB NUMBER ______________

--- QUANTITY TAKE-OFF ---

DATE ______________

SHEET NO. 1 OF ______________

ITEM	UNIT	LENGTH	WIDTH	DEPTH			CUBIC YARDS	
EXCAVATION								
TOPSOIL -	1	82	64	1.25	=	6,560 cu.	ft.	
		6560	÷ 27	= 242.96			242.96	

Figure 1.2

In Figure 1.2 the table headings consist of the "Item" under which the type of excavation is indicated. Under the heading "Unit" is given the number of rectangular units to be excavated. In this case one rectangular unit is shown. The units mutliplied by the length, by the width, by the depth will give the total cubic feet to be excavated. Then the total cubic feet when divided by 27 will give the cubic yards.

2. GENERAL EXCAVATION:

This type of excavation will be done with the use of heavy mechanical equipment. Here the contractor is required to excavate the large area of a basement. From the plans the estimator will determine from the elevations, how far below the existing grade the excavation is to be carried. The estimator must make necessary allowances for the sloping of the banks if the excavation is in loose soil. He must also allow room in the excavation for the forming crew to set footing forms and the foundation wall forms. Under normal conditions the excavation will be carried out a distance of 2'-0" beyond the foundations walls. To calculate the cubic yards of earth excavation for a basement, multiply the length, by the width, by the depth of the excavation. (When calculating the depth, deduct the depth of the excavation for the removal of the topsoil has been removed.) The result will be in cubic feet then divide by 27 to find the cubic yards.

Example:

Given the length of an excavation in Figure 1.3 of 46'-0", the width as 28'-0" and a depth of 4'-0" determine the cubic yards to be excavated.

Multiply 46'-0" x 28'-0" x 4'-0" = 5152 cubic feet.

Divide 5152 - 27 = 190.81 cubic yards.

NOTE: in the above example, the excavation was carried 2'-0" beyond the exterior walls.

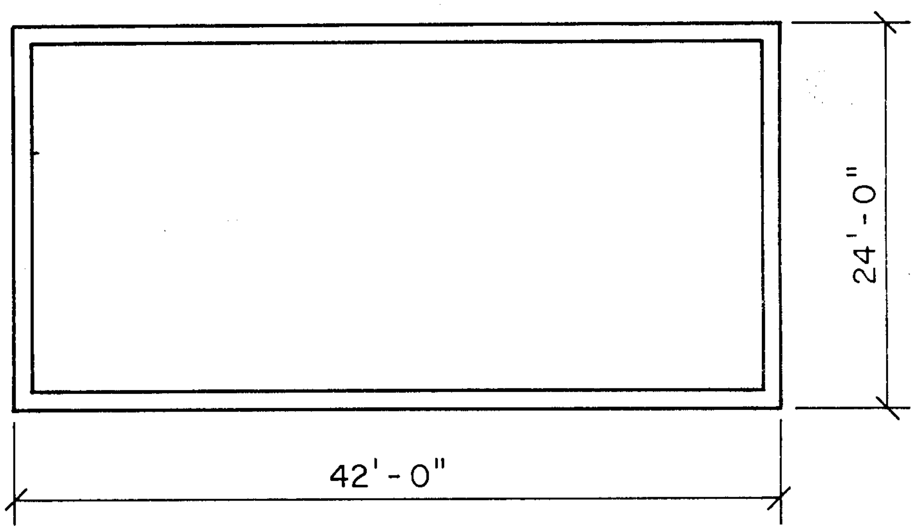


Figure 1.3

With the use of the Quantity Take-Off Sheets this item would appear as seen in Figure 1.4.

--- QUANTITY TAKE-OFF ---

JOB NUMBER ______ ____________

DATE ____________

SHEET NO. ______ OF ______

ITEM	UNIT	LENGTH	WIDTH	DEPTH			CUBIC YARDS						
GENERAL EXCAVATION	1	46	28	4	= 5152								
		5152	— 27	= 190.81					1	9	0.	81	

Figure 1.4

3. EARTH SWELL

When earth and rock are loosened during excavation, they assume a larger volume. This increase in volume is known as "Swell" and is normally expressed as a percentage gain when compared to the original volume. This swell factor must be taken into consideration by the estimator to determine the number of truck loads of earth to be removed from the building site.

EARTH SHRINKAGE

When earth is placed in a fill and compacted with modern equipment, it will displace a smaller volume than it did in its natural state. This decrease in volume is known as "Shrinkage" and will be expressed as a percentage of the original volume. The estimator must also take this factor into consideration when earth is to be hauled onto the site.
The following table in Figure 1.5 indicates the percentage of swell and shrinkage for various types of soil.

PERCENTAGE OF EARTH SWELL & SHRINKAGE		
MATERIAL	SWELL	SHRINKAGE
Sand or Gravel	14% to 16%	12% to 14%
Loam	20%	17 %
Common Earth	25 %	20 %
Dense Clay	33 %	25 %
Solid Rock	50 % to 75 %	---

Figure 1.5

4. HAND EXCAVATION FOR FOOTINGS:

This is rather difficult to estimate due to the following factors, the type of earth, the height it must be lifted and the climatic conditions. Excavation with hand tools is usually figured as the amount of earth which a man can shovel in approximately one hour. One man digging in soft ground can remove approximately one cubic yard of earth in an hour. This is true for footing trenches and utility trenches. On a rough average 150 to 200 shovels of earth will equal one cubic yard in its natural state. When backfilling by hand one man shovel about 3 cubic yards in one hour, this applies to loose earth, sand, gravel, etc.

Example: -

Determine the cubic yards of earth to be hand excavated for the footings shown in Figure 1.6.

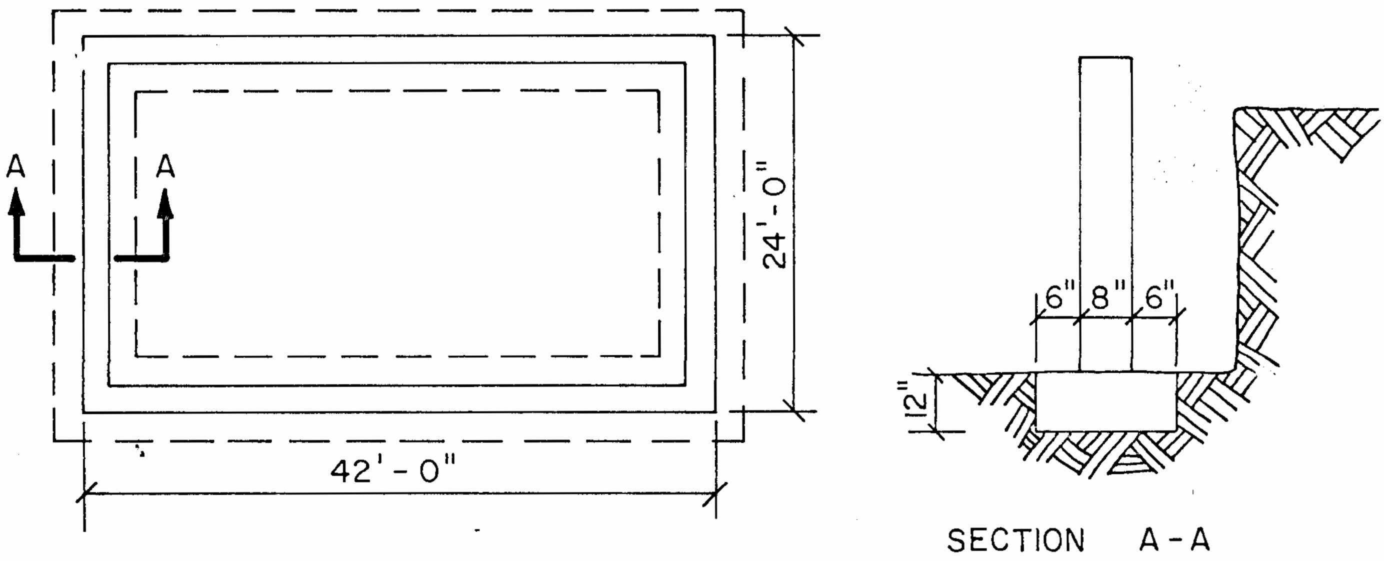


Figure 1.6

The plan shown in Figure 1.6 gives the dimensions of the foundation walls. When we examine Section AA we see that the footing protrudes 6 inches beyond the walls. Therefore, the length of the footing trench for the 42'-0" wall will be 6 inches longer on each end, making a total length of 43'-0"

North Wall Footing = 43'-0" long

South Wall Footing = 43'-0" long

The East Wall has a dimension of 24'-0", however the length of the footing trench will be 24'-0" less twice the wall thickness (8"x 2 = 16") less twice the amount the footing protrudes (6" x 2 = 12") 16" + 12" = 28" = 2'-4" therefore the East Wall footing is equal to 24'-0" - 2"-4" = 21'-8".

The total lineal feet of footing to be excavated then is equal to 43' -0" + 43'-0" x 21'-8" x 21'-9" = 129'-4"

Centre Line Method:

This is a quicker way to determine the total lineal feet of footing - basement walls, etc. and the method we will use in our estimating. In this example

example under discussion take the perimeter of the building 42'-0" + 42'-0" + 24'-0" + 24'-0" = 132'-0". Then deduct four times the wall thickness 8" x 4 = 32" or 2'-8". Therefore centre line length is equal to 132'-0" - 2'-8" = 129'-4".

Total length then is 129.33 times the width of the footing 20 inches or 1.67 times the depth of 1'-0".

129.33 x 1.67 x 1 - 215.98 cubic feet
215.98 ÷ 27 - 7.99 cubic yards or 8 cy.

In this example we have not allowed for the formwork we would use the earth as our form. On the Qunatity Take-Off Sheet our calculations would appear as shown in Figure 1.7

--- QUANTITY TAKE-OFF ---

JOB NUMBER ______________
DATE ______________
SHEET NO. ______ OF ______

ITEM	UNIT	LENGTH	WIDTH	DEPTH		CU. FT.	CUBIC YARDS	
FOOTING EXCAVATION								
NORTH & SOUTH FTGS.	2	43	1.67	1	=	143.62		
EAST & WEST FTGS.	2	21.67	1.67	1	=	72.38		
				TOTAL:		216.00		
		216 ÷	27 =	8			8	
FOOTING EXCAVATION	1	129.33	1.67	1	=	215.98		
		215.98 ÷ 27		= 8			8	

Figure 1.7

5. TRENCH EXCAVATION:

Here again this type of excavation will be done with the use of mechanical equipment, however, the estimator will have to determine the amount of earth in cubic yards to be excavated. Trench excavations are usually a different price from the general or mass excavations and there is always some hand work to be done in cleaning out and trimming. Most juridictions state that where a trench exceeds 4'-0" in depth, shoring shall be placed. In such a case the estimator will have to allow for this extra material and labour.

Example:

The contractor is required to excavate a service trench from the building to the street a distance of 32'-0". The trench is 2'-0" wide and has a depth at the building of 7'-0" sloping to a depth of 12'-0" at the street. In this case we take the length of 32'-0" times the width of 2'-0" multiplied by the average mean depth (12'-0" + 7'-0" = 19'-0" divided by 2 = 9'-6" 32'-0" x 2'-0" x 9.5 = 608 cubic feet - by 27 = 22.52 cubic yards).

On the Quantity Take-Off Sheet it would be shown as in Figure 1.8

JOB NUMBER __________

--- QUANTITY TAKE-OFF ---

DATE __________

SHEET NO. _____ OF _____

ITEM	UNIT	LENGTH	WIDTH	DEPTH		CU. FT.	CUBIC YARDS	
SERVICE TRENCH	1	32	2	9.5	= 608			
		608	÷ 27	= 22.	52		22.52	

Figure 1.8

6. CUT AND FILL:

This can best be explained by using an example such as a large area for a shopping plaza and parking lot. If, for example, this complex is to cover four city blocks then portions of the land will be high and other portions may be low, therefore, the area will have to be cut or (excavated) or filled as the case may be in order to bring the entire area to a uniform grade. In order to estimate this project you must use a topographical site map and divide it into small grids or squares. This operation is called gridding. The size of the grid is determined largely by the nature of the terrain. If the area is gradually sloped, the grids might represent squares of 100 feet on each side, however, if the area is very irregular these squares may be only 25 feet square. The smaller the squares the more accurate will be the cut and fill for the site.

In Figure 1.9 we will assume that the length and width of each grid is 25 feet, therefore each grid is 25 x 25 = 625 square feet in area.

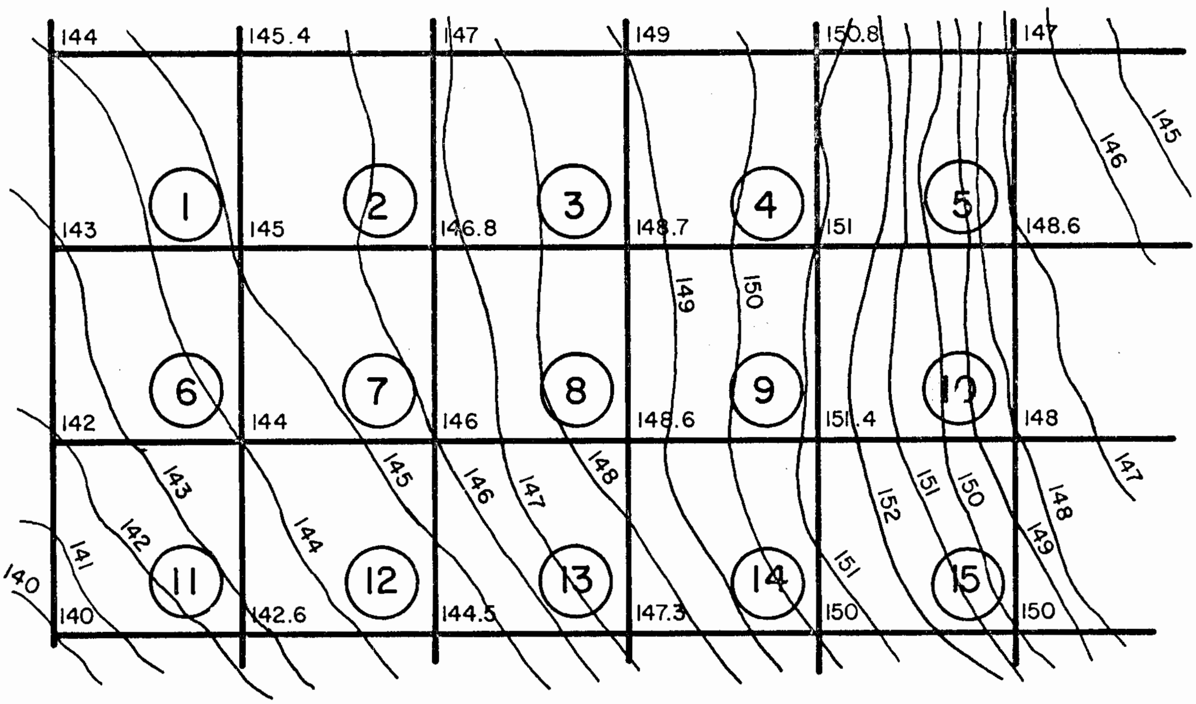


Figure 1.9

The approximate elevation at each corner of a grid is established by using the nearest contour line. (The elevations are shown on the drawing). Study grid 11 and note which contour lines pass close to the corners of the grid. These corners are approximately at elevations 140.0', 142.0', 142.6' and 144.0'. Adding these together we have 568.6 and then dividing by 4 gives us the mean, or the average elevation for this grid 142.15'. The final rough grade is to be 144.0', therefore the existing grade for this grid is at an average of 1.85' below the final grade. The contractor must fill 1.85 x 625 = 1156.25 cubic feet for this grid. Figure 1.10 shows the cut or fill required for each grid. The difference of the totals for the cut and fill will indicate how much material (if any) must be hauled onto the site or hauled away.

--- QUANTITY TAKE-OFF ---

JOB NUMBER ____________

DATE ____________

SHEET NO. ______ OF ______

CUT & FILL NAL GRADE 144.0'	AVER. ELEV. FT.	AVER. CUT	QTY. CU.FT.	AVER. FILL	QTY. CU.FT.		TOTAL CUT	TOTAL FILL
GRID 1	144.35	.35	219					
2	146.05	2.05	1281					
3	147.9	3.9	2437					
4	149.9	5.9	3688					
5	149.35	5.35	3344					
6	143.5			.5	313			
7	145.45	1.45	906					
8	147.53	3.53	2206					
9	149.93	5.93	3706					
10	149.75	5.75	3594					
11	142.15			1.85	1156.25			
12	144.28	.28	175					
13	146.6	2.6	1625					
14	149.33	5.33	3331					
15	149.85	5.85	3656				30168	1469

Figure 1.10

7. DRILLED PILES:

The plans and specifications will give the estimator the required information as to the location, the number of piles, the diameter and in most cases the depth of the pile. Specifications will usually state that piles are to be drilled down to hardpan if the depth of the pile is not stated.

Example:

Calculate the cubic yards of earth to be excavated for the following piles:

12 piles 16" to a depth of 20'-0".
14 piles 16" to a depth of 16'-0".
In this problem we can calculate the total depth of all the piles
12 @ 20'-0" = 240 feet
14 @ 16'-0" = 224 feet

Total: = 464 lineal feet

Formula: volume = πr^2 x depth.
3.14 x (.67 x .67) x 464 = 654.24 feet
655 - 27 = 24.26 cubic yards

The earth removed from the piles would be shown on the Quantity Take-Off Sheet as seen in Figure 1.11.

JOB NUMBER ____________

--- QUANTITY TAKE-OFF ---

DATE ____________

SHEET NO. ______ OF ______

ITEM	UNIT	LENGTH	π	r^2	CU.	FT.	CUBIC YARDS	
DRILLED PILES	1	464	3.14	.67x.67	=	2575		
			2575	÷ 27	=		24.26	

Figure 1.11

8. <u>ASSIGNMENT</u>:

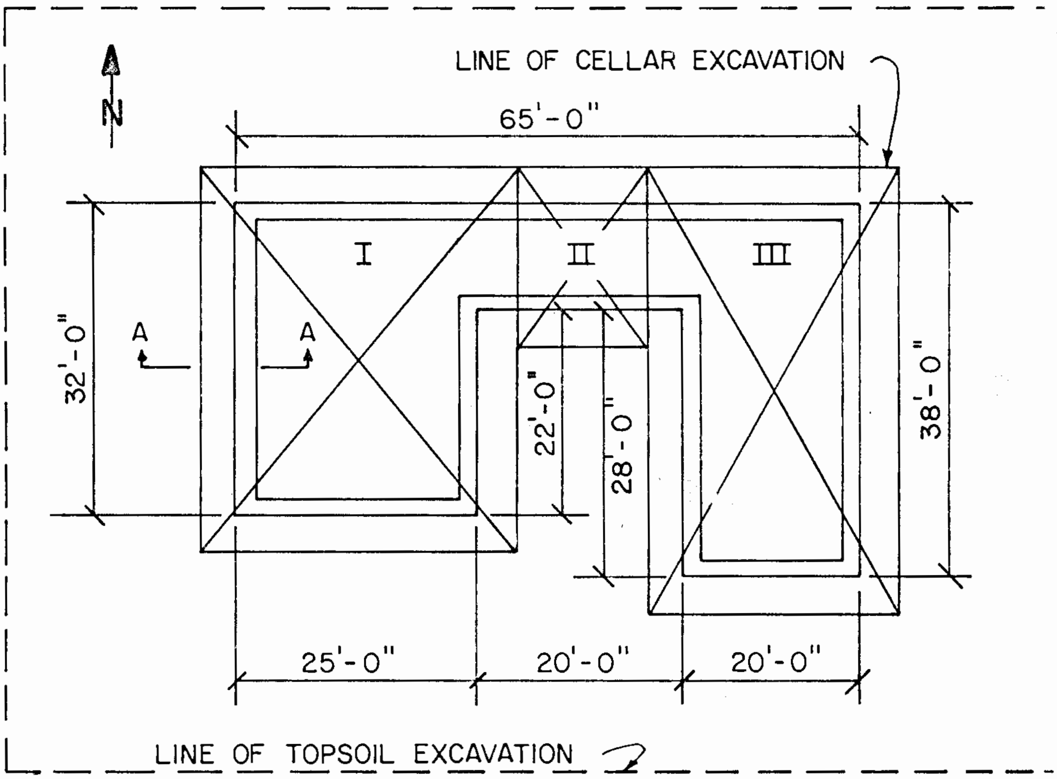
Problem (1): -

(a) Take-off the topsoil for the following plan in Figure 1.12. Topsoil is to be removed 25'-0" beyond the exterior walls, forming a rectangle as shown by the dash lines. Topsoil is to be taken off to a depth of 6 inches.

(b) Take-off the general excavation for the basement, 2'-0" beyond the exterior alls, forming rectangular areas I, II and III as shown on the plan. Depth of the excavation is 4'-0" as shown on Section "AA".

(c) Take-off the excavation for footing trenches. Trenches are to be of the same dimensions as the footings.

(Use Quantity Take-Off Sheet)



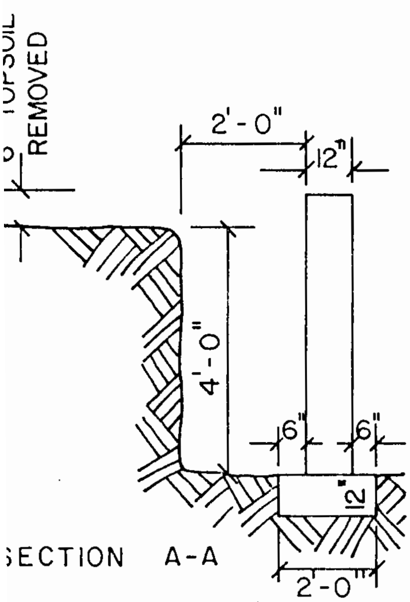


Figure 1.12

Problem (2): -

(a) Take-off the quantity of earth to be excavated for the basement in plan Figure 1.13.

(b) Take-off the quantity of earth to be excavated for the footing trenches in Plan Figure 1.13.

(c) On the plain sheet of paper sketch the plan and the section shown in Figure 1.13.

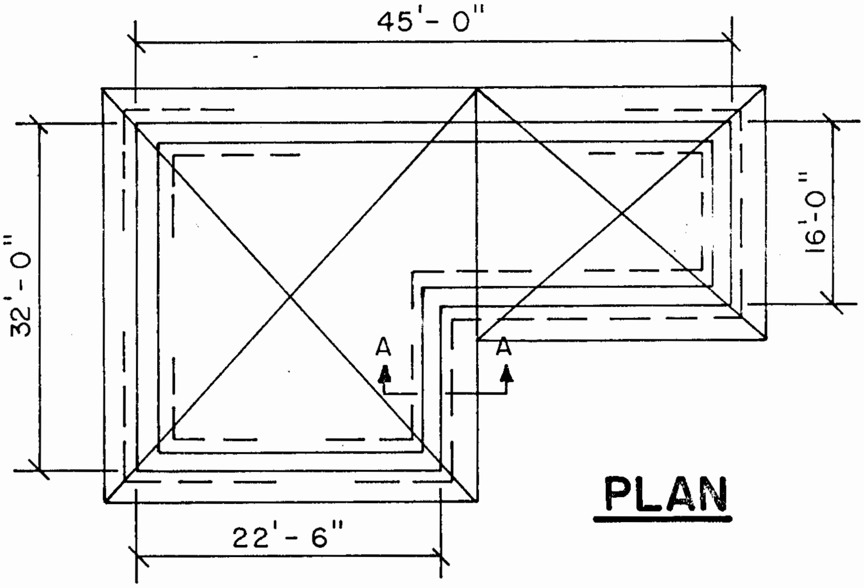
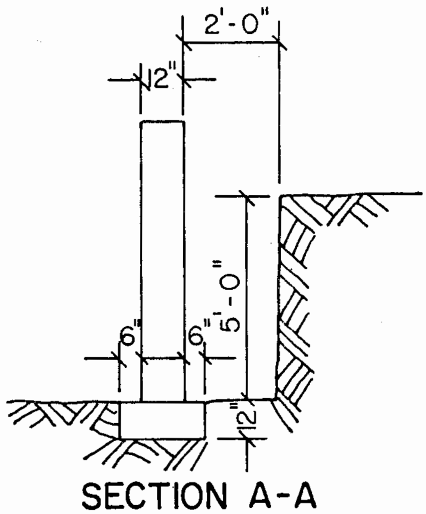


Fig. 1.13



--- QUANTITY TAKE-OFF SHEET ---

Date ______________________ Assignment ______________ Name ________________________

Class ____________________________________ Sheet No. ______________ of __________

DESCRIPTION	DIMENSIONS						EXTENSIONS	EXTENSIONS

UNIT II - CONCRETE

1. STRETCH OUT METHOD
2. CENTRE LINE PERIMETER METHOD
3. FOOTINGS
4. FOUNDATION WALLS
5. BASEMENT FLOOR SLAB
6. CONCRETE PILES
7. CONCRETE AGGREGATES
8. ASSIGNMENTS

UNIT II - CONCRETE

Objectives:

Following the completion of the unit a student will be able to:

2.1 Describe the

- stretch out method
- centre line method
- percentage method

2.2 Calculate cubic yardage of concrete required

2.3 Explain "Fuller's Rule" to determine concrete ingredients

2.4 Complete all assignments correctly

This job concerns itself with the quantity take-off of concrete required for footings, foundation walls, floor slabs and piles.

Technical Knowledge: -

To calculate the cubic yards of concrete required for a foundation wall, multiply the length of the wall in feet by its width in feet by the depth in feet. This will give you cubic feet of concrete. Then divide by 27 to obtain the cubic yards.

1. STRETCH OUT METHOD: -

In the first illustration Figure 2.1 you can see that 30'-0" + 20'-0" + 30'-0" + 20'-0" = 100'-0". This would only represent the outside perimeter of the building and not the stretch out of the walls. Now examine the second illustration Figure 2.2. Here 30'-0" + 30'-0" + 18'-0" + 18'-0" = 96'-0" which is the actual and correct stretch out of the basement walls. In other words, when you take the two 30'-0" lengths of the walls you are also taking away from the 20'-0" lengths of wall an amount equal to the thickness of the wall.

Therefore, in the drawing Figure 2.3 the shaded parts are the 30'0" lengths. To find the other two lengths it is necessary to subtract the thickness of the wall at both ends of the 20'-0" wall.

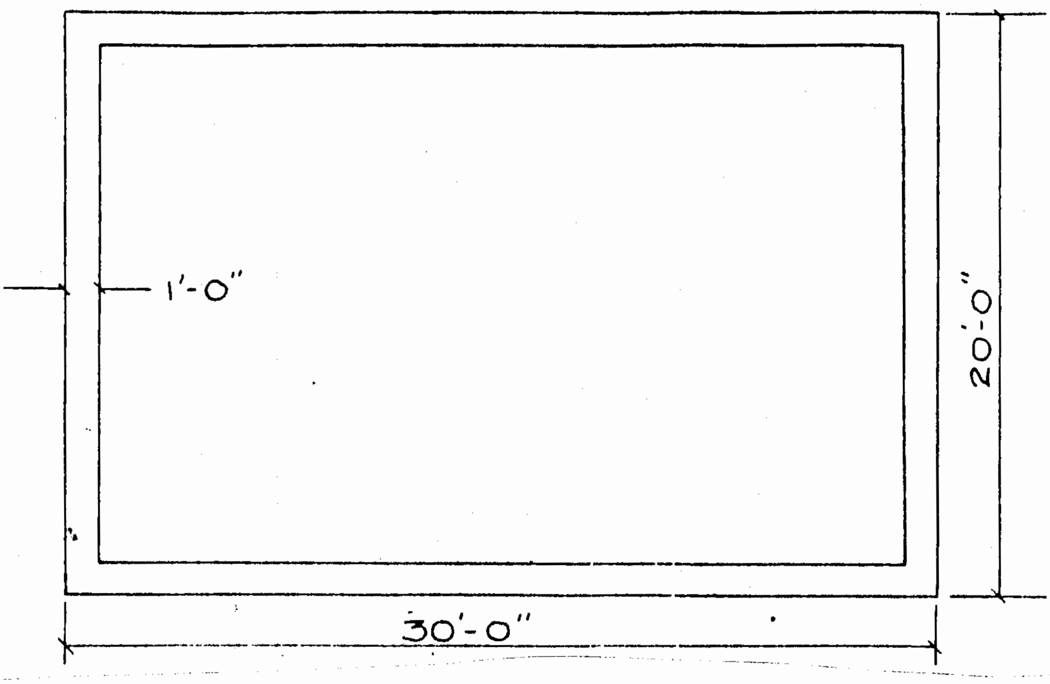


FIGURE 2.1

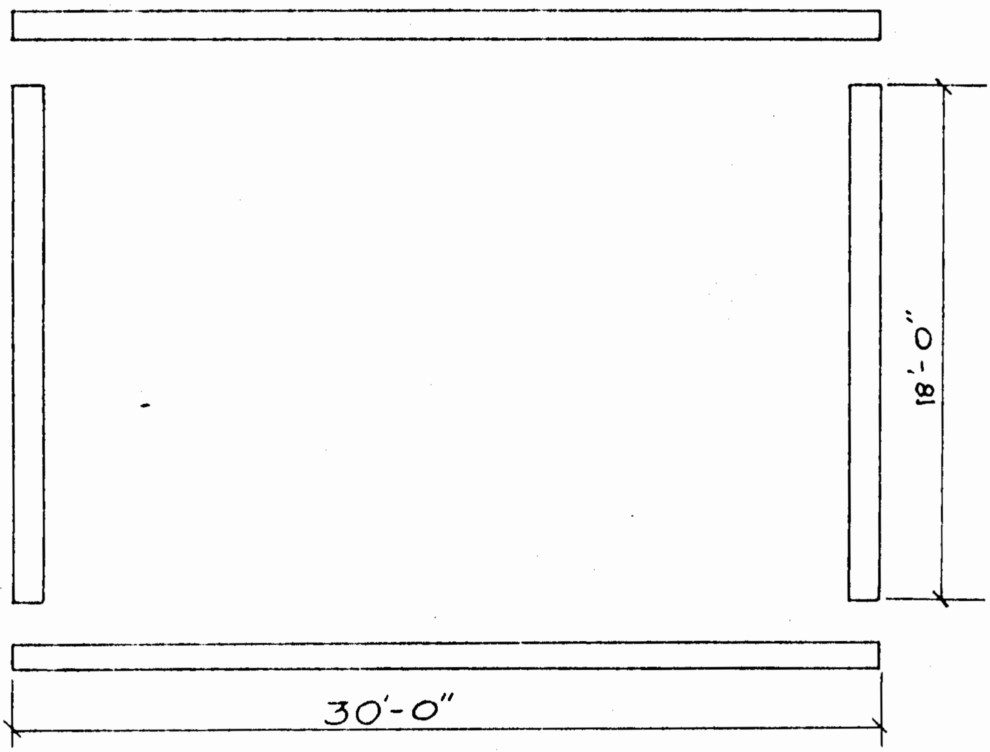


FIGURE 2.2

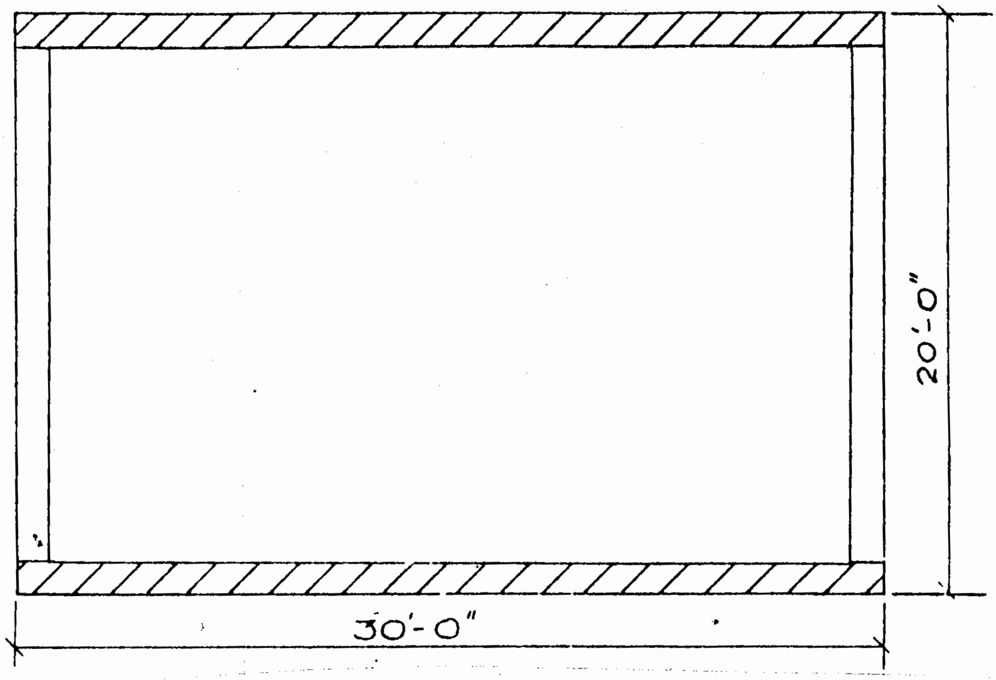


FIGURE 2.3

Now we have two units of wall 30'-0" long and two units of wall 18'-0" long.

Therefore 2 x 30 = 60

2 x 18 = 36

96'-0" of wall stretch out.

2. <u>CENTRE LINE METHOD</u>: -

This was briefly brought out in the previous unit on Excavation, however, we will deal with it in more detail. The plan shown in Figure 2.4 is 30'-0" x 20'-0" outside dimension. The centre line of the 30'-0" wall is 29'-0" long because it is 6 inches shorter on each end (wall thickness 12 inches). Therefore 29'-0" + 29'-0" + 19'-0" + 19'-0" = 96'-0".

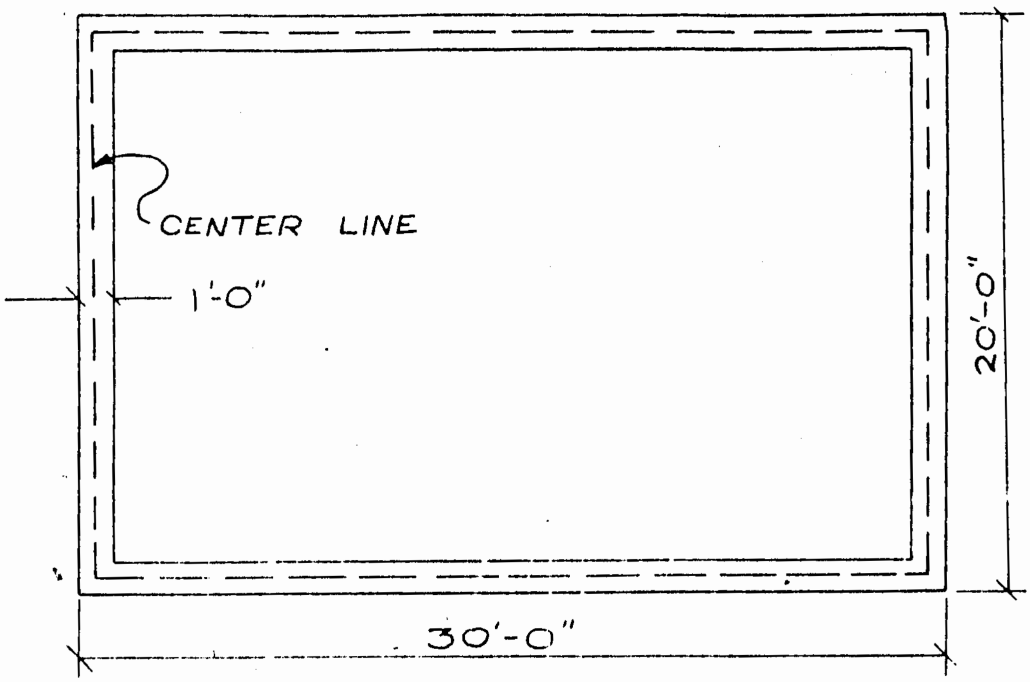


FIGURE 2.4

To clarify the centre line method, study the illustration in Figure 2.5.

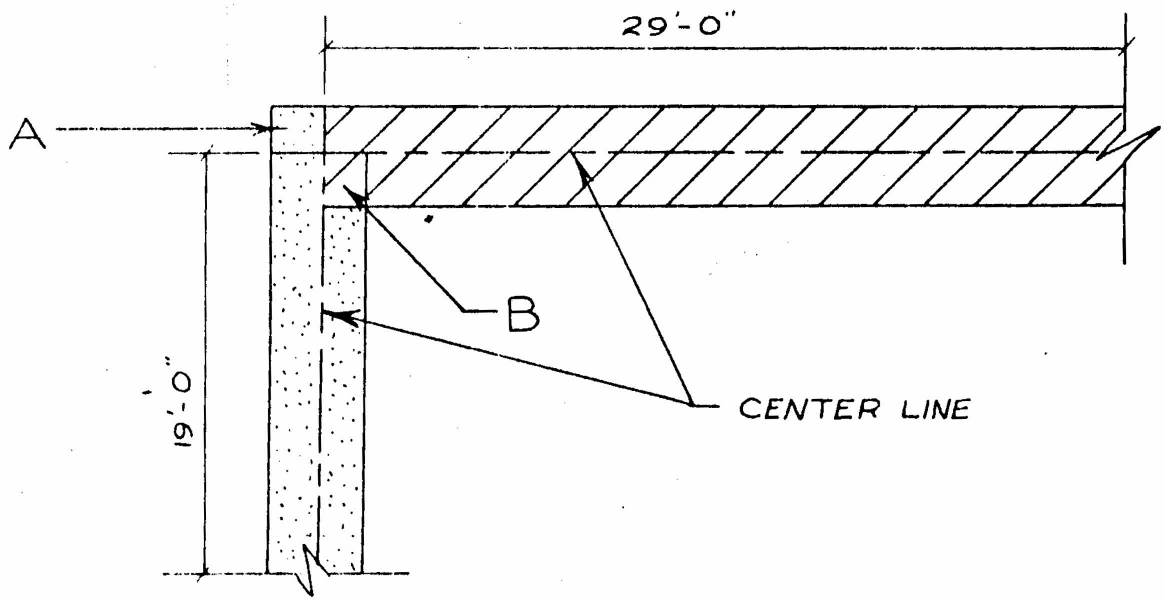


FIGURE 2.5

The 29'-0" dimension is taken to the centre line of the wall shaded by dots' whereas the 19'-0" dimension is taken to the centre line of the wall shaded by lines. If we multiply the 29'-0" length by the width of the wall 1'-0" by the height of the wall, we arrive at the cubic feet of concrete for that wall. Similarly if we multiple the 19'-0" wall by the width and by the height we will arrive at the concrete required for this short wall. Now it is evident that the volume of the concrete at "B" was included for both lengths of wall, while the volume of concrete at "A" was omitted when calculating the volume for both walls. Since volumes "A" and "B" are the same, the doubling of the volume at "B" takes care of the omitted volume at "A".

You will discover that in some cases it is necessary to take-off material separately for each wall while in other cases you can take the centre line and calculate all the walls. Provided a foundation wall is centred on the footing, the Perimeter centre line of the foundation walls will also be the Perimeter centre line of the foundation footings. It is preferred to work by the centre line method when possible as there is less calculation involved, therefore less chance of errors.

3. CONCRETE REQUIREMENTS FOR FOOTINGS: -

The estimator is required to calculate the cubic yards of concrete required to pour the footings.

Example: -

Study the plan in Figure 2.6 and the Section AA.

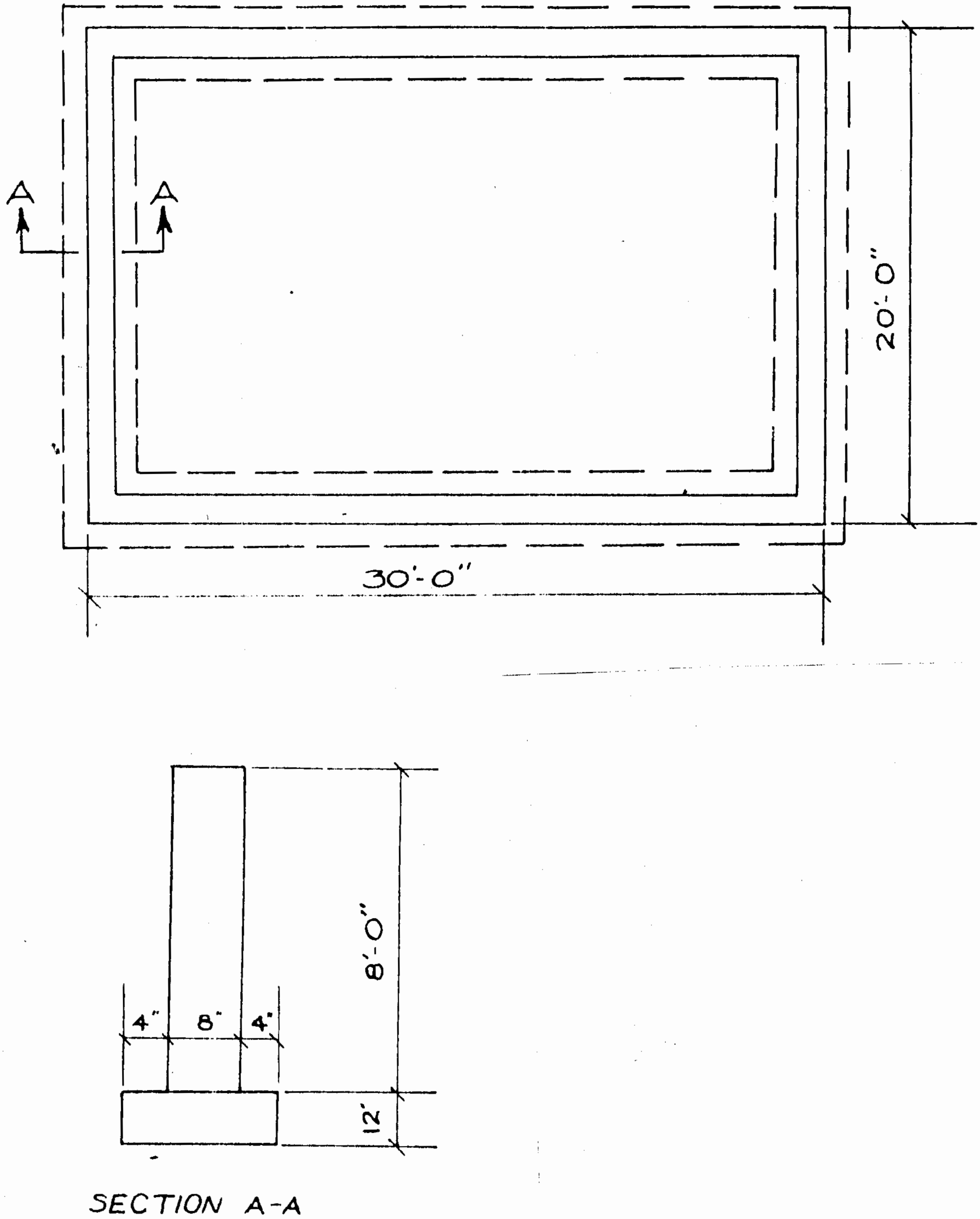


FIGURE 2.6

Determine the centre line perimeter of the footings. Here we can take the perimeter which is 100'-0" less four times the wall thickness (8" x 4" = 32") 2'-8" = 97'-4". (Check this if you wish with the stretch out method).

Once we have the centre line of the footing, we multiply it by the width of the footing, and by the depth.

97.33 x 1.33 x 1 = 129.45 cubic feet

129.45 ÷ 27 = 4.79 cubic yards

It is advisable to add 5% to this figure for waste in this case.

4.79 x 1.05 = 5.03 cy.

JOB NUMBER ______________

--- QUANTITY TAKE-OFF ---

DATE ______________

SHEET NO. ________ OF ______

CONCRETE	UNIT	LENGTH	WIDTH	DEPTH		TOTAL CUBIC YARDS
FOOTINGS	1	97.33	1.33	1	= 129.45	
	129.45 ÷ 27 = 4.79					
	Add 5%		.24			
			5.03			5.03
FOUNDATION	1	97.33	.67	8	= 521.68	
WALLS	521.68 ÷ 27 = 19.32					
	Add 5%		.97			
			20.29			20.29
FLOOR	1	28.67	18.67	.33	= 176.64	
	176.64 ÷ 27 = 6.54					
	Add 5%		.33			
			6.87			6.87
PILES 16" Ø	1	240	3.14	(.67 x 67)	= 339	
20" Ø	1	48	3.14	(.83 x .83)	= 104	
					443	
	443 ÷ 27 = 16.4					
	Add 5%		.82			
			17.22			17.22
					TOTAL	449.41

FIGURE 2.7

4. CONCRETE REQUIREMENTS FOR FOUNDATION WALLS: -

Calculate the cubic yards of concrete required to pour the foundation walls.

Example: -

Study the plan and section shown in Figure 2.6.

In this case we can use the same centre line due to the fact that the foundation wall is centred on the footings. Our centre line is 97'-4" multiplied by the width of the wall (8") = .67 multiplied by the height 8'-0".

97.33 x .67 x 8 = 521.68

521.68 ÷ 27 = 19.32 cu. yards

Plus 5% = .97

20.29 cu. yards

This would appear as shown on the Quantity Take-Off Sheet Figure 2.7.

5. BASEMENT FLOOR SLAB: -

In estimating the cubic yards of concrete required for a basement floor slab, it is necessary to consult the plans for the necessary dimensions - depth of slab to be 4 inches.

Example: -

Using plan in Figure 2.6 we will assume that the basement floor slab rests on top of the portion of the foundation wall footing which protrudes into the basement. This being the case, we must determine the dimensions inside the foundation walls.

The longest wall is 30'-0" less twice the wall thickness (8" x 2 = 16") 1'-4". 30'-0" - 1'-4" = 28'-8". =

The short wall then is 20'-0" - 1'-4" = 18'-8".

Cubic yards required will be

28.67 x 18.67 x .33 = 176.64 cubic feet

176.64 ÷ 27 = 6.54 cubic yards

Plus 5% = .33

66.87 cubic yards

This is shown on the Quantity Take-Off Sheet Figure 2.7.

6. <u>CONCRETE PILES POURED IN PLACE</u>: -

When calculating the concrete required for poured in place piles, the estimator must check for the number of piles, the diameter of the piles and the depth of the piles.

<u>Example</u>: -

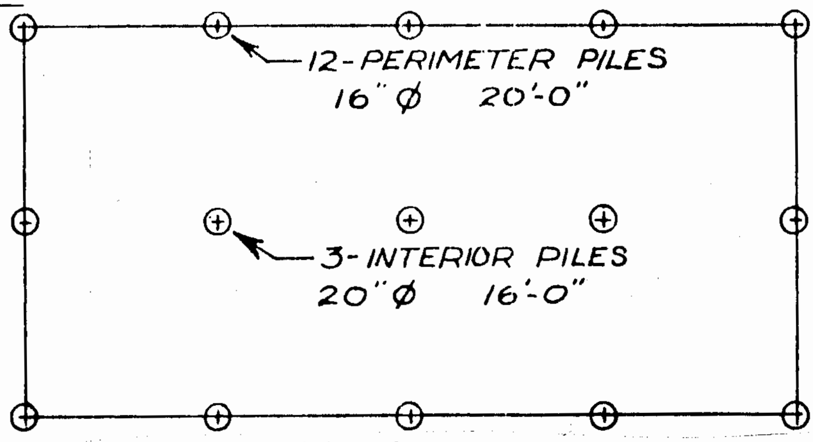


FIGURE 2.8

From Figure 2.8 we determine there are 12 piles 16" in diameter and 20'-0" deep 3 piles 20" in diameter and 16'-0" deep. First we will take-off the 16" Ø piles. Formula $\pi r^2 h$ = volume of a cylinder. Total depth of all 16" Ø piles is 12 x 20 = 240'.

Therefore $\pi = 3.14$ and $r = .67$ we have

$3.14 \times (.67 \times .67) \times 240 = 339$ cubic feet.

Then we will take-off the 3 piles 20" Ø by

16'-0" depth. $3.14 \times (.83 \times .83) \times 48 = 104$

cubic feet. Total $339 + 104 = 443$ cubic feet.

$443 \div 27 = 16.4$ cubic yards

Add 5% = .82

17.22 cubic yards

This would appear on the Quantity Take-Off Sheet as seen in Figure 2.7.

7. CONCRETE AGGREGATES: -

In most cases our concrete is purchased from a Redi-Mix concrete company where all that is required of the estimator is to determine the cubic yards of concrete required. However, in cases where we are required to purchase the aggregates and mix the concrete on the site of the estimator must be able to determine the quantity of cement, sand (fine aggregate) grave or crushed rock (coarse aggregate) and the amount of water. According to Fuller's Rule, in order to obtain 1 cubic yard of mixed concrete or 27 cubic feet you will require 42 cubic feet of ingredients (Cement-Sand-Gravel). Therefore using this rule it is necessary to add 42/27 to the exact volume of concrete you would require in order to have the amount of aggregates required. However, for estimating purposes most estimators will simply add 50% as shown in the following example:

Example: -

Our take-off shows we require 32 cubic yards of concrete. The mix is 1 · 2 · 4 meaning 1 part cement - 2 parts fine aggregates and 4 parts coarse aggregates.

Simply take the 32 cubic yards, add 50% (32 + 16) = 48 cubic yards of dry materials.

48 cubic yards = 1296 cubic feet.

Mix design is 1 · 2 · 4 = 7 parts. Therefore:

1/7 = cement

2/7 = fine aggregates

4/7 = coarse aggregates

Cement	1296 ÷ 7 = 185 cubic feet	= 185 bags
Fine Aggregates	185 x 2 = 370 cubic feet	= 13.7 cubic yards
Coarse Aggregates	185 x 4 = 740 cubic feet	= 27.4 cubic yards
	TOTAL:	48 cubic yards

These amounts of dry aggregates would produce the 32 cubic yards of mixed concrete of 1 · 2 · 4 design.

<u>NOTE</u>: The estimator must remember that on all estimates for volume mix concrete, half as much more material in the dry state by volume than the capacity of the finished volume of concrete.

Problem 1: - Consult the plan shown in Figure 2.9

(a) Sketch the plan and section on the blank sheet provided.

(b) On the Quantity Take-Off Sheet provided calculate the cubic yards of concrete for the footings and the foundation walls (add 5%).

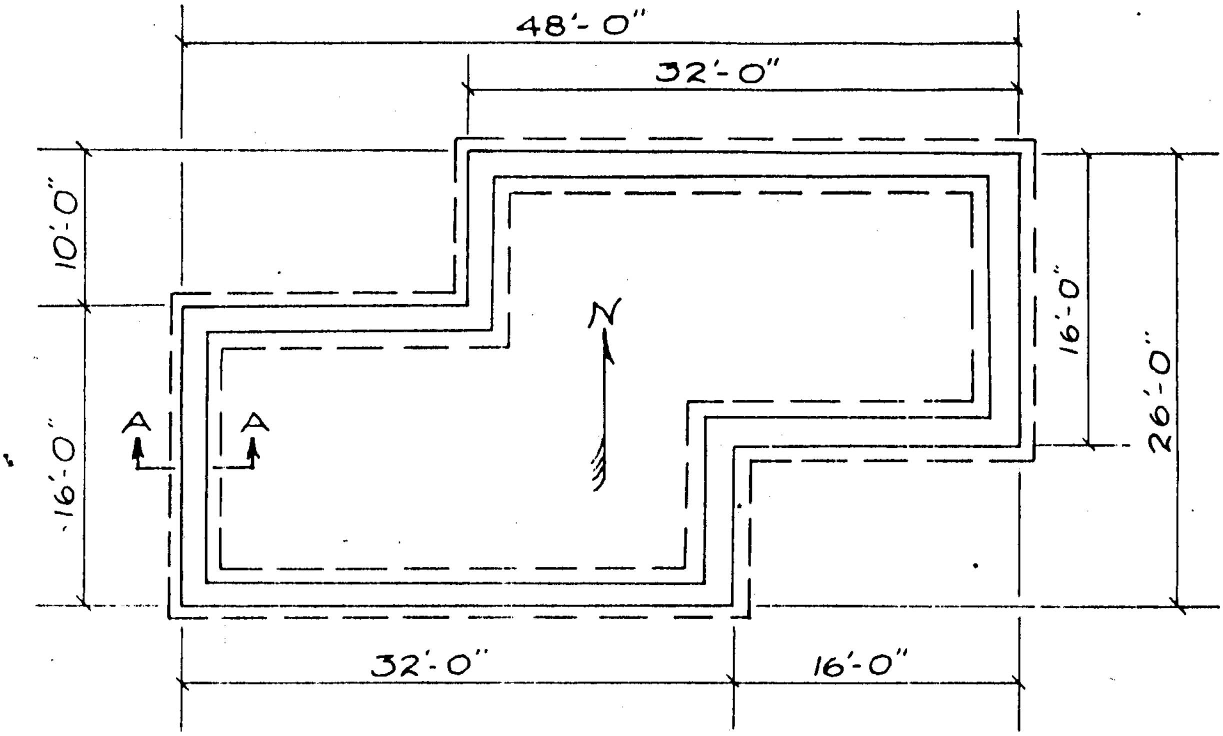
Problem 2: -

(a) Determine the number of bags of cement, the cubic yards of sand and the cubic yards of gravel required to field mix the concrete for the footings and foundation walls of the plan in Figure 2.8. Use a mix design 1 · 3 · 5.

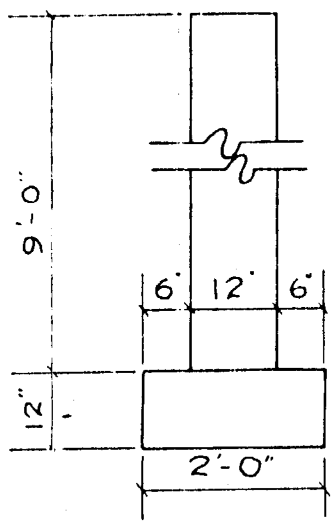
(b) Using an 11S mixer (11 cubic foot capacity) calculate the time required to mix the concrete for the footings and walls in Figure 2.8. (Base your calculations on 2 1/3 minutes per batch).

Problem 3: -

Estimate the cubic yards of concrete required to pour the basement floor slab. Depth of the slab is to be 5 inches. The slab will rest on the foundation wall footings.



PLAN



SECTION A-A

FIGURE 2.9

--- QUANTITY TAKE-OFF SHEET ---

Date ______________________ Assignment ______________ Name ______________________

Class ____ Sheet No. ______________ of ______________

DESCRIPTION	DIMENSIONS						EXTENSIONS	EXTENSIONS

UNIT III - FORMWORK

1. CONCRETE FOOTINGS

2. FOUNDATION WALLS

   (a) BUILT-UP FORMS

   (b) PREFABRICATED PANEL FORMS

3. COLUMN FORMS

4. BEAM FORMS

5. ASSIGNMENTS

UNIT III - FORMWORK

Objectives:

Following the completion of this unit a student will be able to:

3.1 Explain forming procedures for:

- footings
- walls
- steps
- slabs

3.2 Calculate forming materials

3.3 Correctly complete all assignments

Formwork is measured by the square feet of contact area (S.F.C.A.) but since this is universally understood, the symbol S.F. is all that is used. A good way to think of what contact area includes is to think of the form material in direct contact with the wet surface area of the concrete. In this section you will learn how to take off the necessary material required to form foundation footings, foundation walls, columns, and beams.

1. FORMWORK FOR CONCRETE FOOTINGS: -

The material required to construct footing forms is arrived at by calculating the amount of lumber in contact with the concrete (contact area), plus the necessary stakes and spreaders required to brace the formwork.

Example: -

Estimate the material requirements for the foundation wall footings shown in Figure 3.1.

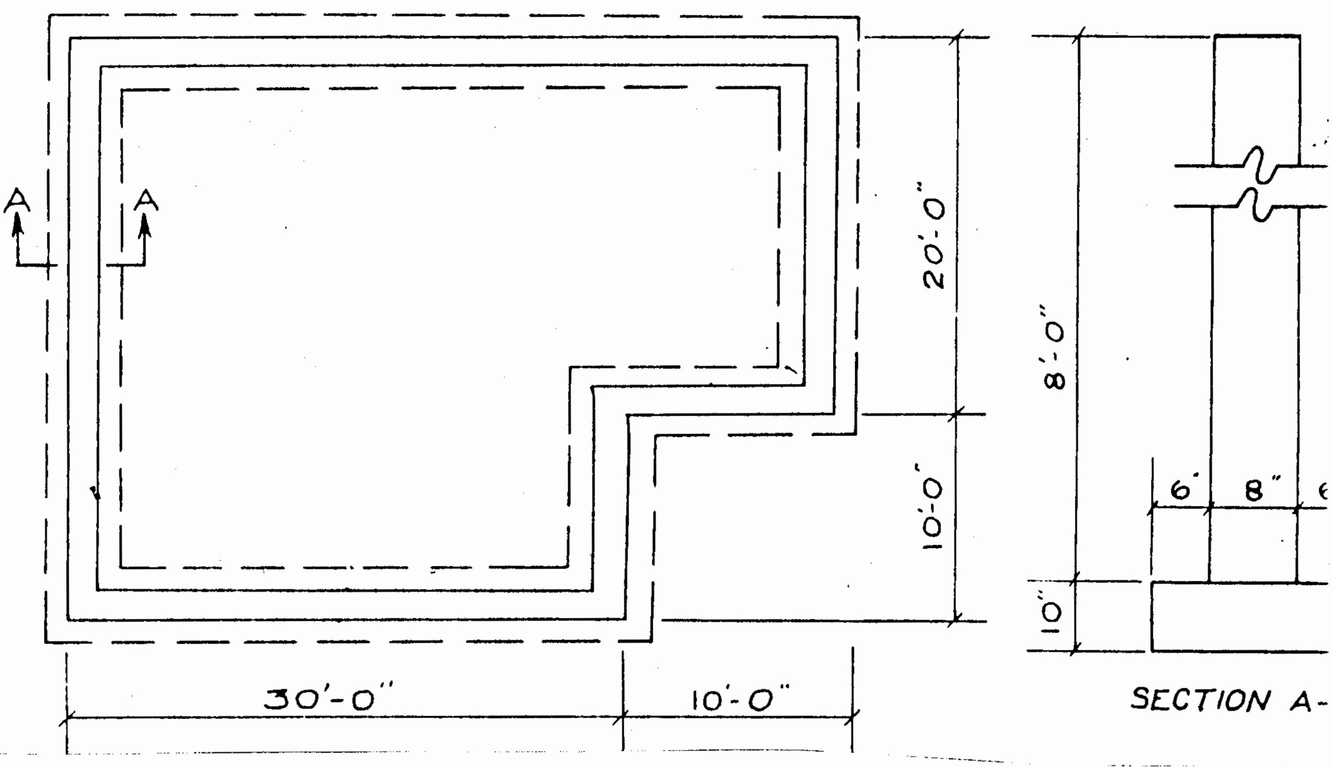


FIGURE 3.1

From the plan you determine that the footing is 10 inches deep by 20 inches wide. You will use 2" x 10" material for the forms. These will be supported in place by 2" x 4" stakes at 6'-0" on centre with a piece of 1" x 4" material used for spreader ties every 6'-0" on centre.

First you calculate the lineal feet of 2" x 10" material in contact with the concrete. The simplest method is to find the Perimeter centre line length then double it for the inside and outside forms.

Perimeter of the building is 140'-0".

Centre line of the Perimeter = 140'-0" - 2'-8" = 137'-4".

Double this dimension 137'-4" x 2 = 274'-8" total length of contact area, or in other words, we will require 274'-8" of 2" x 10" material (exact measure).

To this amount is added 5% for cutting and waste.

274'-8" plus 5% = 288 lineal feet.

If we purchase 16'-0" lengths we require 18 pieces

2" x 10" = 16'-0"

Then you calculate the 2" x 4" material required for

stakes placed at 6'-0" O.C.

Centre line length = 137'-4" ÷ 6 = 21 plus 1 for the

start = 22 which must be doubled for the inside and

the outside form 22 x 2 = 44 stakes @ 2'-0" long.

88 lineal feet 2" x 4"s Plus 5% for waste

92 lineal feet 2" x 4"s

Material required for spreaders will be 22 pieces of

1" x 4"s - 2'-0" long

44 lineal feet plust 5% = 46 lineal feet 1" x 4"s

On the Quantity Take-Off Sheet these items would appear as seen in Figure 3.2.

--- QUANTITY TAKE-OFF ---

JOB NUMBER ____________

DATE ____________

SHEET NO. ______ OF ______

FORMWORK	UNIT	LENGTH	WIDTH	DEPTH	MATERIAL FEET BOARD MEASURE
FOOTINGS:	1	137'-4"	20"	10"	
(1) Stringers	2 @ 137'-4" = 274'-8"				
	Plus 5% 288 ÷ 16 = 18				
	18 - 2" x 10" x 16'-0"				480
(2) Stakes	137'-4" ÷ 6 = 21 add 1 = 22				
	22 x 2 = 44 @ 2'-0" = 88 lin. ft.				
	Plus 5% 92 feet				
	92 lineal feet 2" x 4"s =				62
(3) Spreaders	22 pieces @ 2'-0" = 44'				
	Plus 5% 46 feet				
	46 lineal feet 1" x 4"s =				16

FIGURE 3.2

2. <u>FORMWORK FOR FOUNDATION WALLS:</u>

There are several types of manufactured forms and forming systems on the market to be used for foundation walls. In this unit you will study two types: (a) Built Up Forms and (b) Prefabricated Panel Forms.

A. Built Up Forms

This type of formwork is used on a job where it is convenient and economical to make use of materials present for the construction of the building itself. After the forms have been constructed and the foundation wall poured, the forms are stripped, the materials cleaned and made ready to be re-used. If care is taken in the stripping, approximately 85% of this material may be salvaged.

Example:

Determine the amount of 1" x 8" shiplap required to construct the foundation wall forms for the plan in Figure 3.1. Studs will be placed at 16" O.C.

We will first calculate the SFCA by using the centre line perimeter method.

Centre line length of wall = 137'-4".

Double this dimension 137'-4 x 2 = 274'-8" which is the total length of contact area to be multiplied by the height of 8'-0:

274'-8" x 8 = 2197.36 SFCA

To this amount must be added 25% (This allowance is made for shiplap plus cutting and waste).

2197.36 plust 25% = 2,746.7 square feet contact area which is also equal to 2,746.7 fbm of 1" x 8" shiplap.

In order to calculate the studs, braces, stakes, wire and nails necessary to construct a built up wall form, multiply the square feet of contact area by the factors given in the table in Figure 3.2.

ITEM	FACTOR	SFCA	TOTAL
Sheathing 1" x 8"	1.25	2198	2748 F.B.M.
Studs 2/4 @ 16" O.C.	.60	2198	1320 F.B.M.
Stakes & Braces, etc.	.30	2198	660 F.B.M.
Wire	.02	2198	44 lbs.
2 1/2" Nails	.04	2198	88 lbs.
3 1/2" Nails	.01	2198	22 lbs.

FIGURE 3.2

The above factors are the material requirements per square foot of contact area. If, for example, you were to calculate the exact number of 2" x 4" studs used on the forms you will discover that it works out to approximately .6 feet board measure of stud material per square foot of contact area.

From the example shown you could salvage approximately 85% of the sheathing.

85% of 2198 = 1868 f.b.m.

Also 85% of the studs.

85% of 1320 = 1122 f.b.m.

There would be very little salvage from braces, stakes, etc. therefore, it is not taken into consideration.

On a Quantity Take-Off Sheet this example would appear as seen in Figure 3.3.

--- QUANTITY TAKE-OFF ---

JOB NUMBER ____________

DATE ____________

SHEET NO. ________ OF ________

ITEM				
FORMWORK:				
(1) Foundation Walls	2	137'-4 x 8'-0"	= 2198 sq. ft.	
Sheathing 1" x 8"		2198 x 1.25 =	2748 fbm	
Less Salvage		2198 x .85 =	1868 fbm	
			880	880 fbm
Studs 2"x4"@16"O.C.		2198 x .6 =	1320 fbm	
Less Salvage		2198 x .85 =	1122 fbm	
			198	198 fbm
Stakes & Braces		2198 x .3 =	660	660 fbm
Wire		2198 x .02 =	44	44 lbs
2 1/2" Nails		2198 x .04 =	88	88 lbs.
3 1/2" Nails		2198 x .01 =	22	22 lbs.

FIGURE 3.3

B. Prefabricated Panel Forms

There are the most frequently used types of forms for foundation walls and they have many advantages. The initial cost of these can be offset by the number of times they are used. The number of uses will depend on th type of work, the care taken when setting and stripping the forms, the maintenance such as piling them and the proper piling when not in use. In common practice I would recommend that you should recover your cost of the forms after ten uses on residential work. In other words, after estimating your cost of the form material plus the labour to construct them, charge out 10% of this cost to each job. For commercial type work charge out 25% of the cost based on replacement of the forms after four uses.

Example:

Using the plan shown in Figure 3.1 calculate the total cost of Panel Wall Forms for the foundation walls built to the following specifications: 4'-0" x 8'-0" panel forms of 3/4" fir plywood with 2" x 4" top and bottom plate and 2" x 4" studs at 16" O.C.

The centre line perimeter of the foundation walls was determined to be 137'-4" which must be doubled therefore we have 274'-8" being the total lineal feet of foundation wall (inside and outside).

This length is then divided by 4'-0" (being the width of tne panel form.)

274'-8" ÷ 4 = 68.5 panels

Allowing for some waste at the corners add 5%

68.5 plus 5% = 72 panels required.

Then calculate the 2" x 4" material required to frame one panel.

2 x 4 plates	- 2 pieces 4'-0"	= 8'-0"
2 x 4 studs	- 4 pieces 8'-0"	= 32'-0"
	TOTAL:	40'-0"

72 panels @ 40'-0" per panel = 2880 lineal feet or 1920 f.b.m. of 2" x 4" material.

Nails - 10 lbs. 3 1/2" Common per 1000 fbm of 2 x 4s

20 lbs. 2 1/2" Common Per 1000 sq. ft. Plywood

3 1/2" Nails = 10 lbs. per 1000 f.b.m. (19.20) = 20 lbs.

2 1/2" Nails = 20 lbs. per 1000 sq. ft. (2304) = 46 lbs.

Labour can be determined at a rate of 20 hours per 1000 sq. ft. of forms.

2304 sq. ft. x 20 hrs. = 46 hours.

These items would be shown on the Quantity Take-Off Sheet as seen in Figure 3.4.

--- QUANTITY TAKE-OFF ---

JOB NUMBER ____________

DATE ____________

SHEET NO. ______ OF ______

ITEM		
PANEL FORMS:		
(1) Plywood	137'-4' x 2 = 274'-8"	
	274'-8" ÷ 4 68 1/2	
	Plus 5% = 72	
	3/4" x 4'-0" x 8'-0" fir plywood	72 sheets
(2) Framing 2 x 4s	Plates - 8'-0"	
	Studs - 32'-0"	
	40'-0" x 72 = 2880 lin. ft.	
	$2880 \times 2 \times \frac{4}{12} =$	1920 fbm
(3) Nails		
3 1/2"	1920 @ 10 lbs. per M =	20 lbs.
2 1/2"	2304 @ 20 lbs. per M =	46 lbs.
(4) Labour	2304 sq. ft. @ 20 hrs. per M =	46 hrs.

FIGURE 3.4

In the example shown, all the panel forms were made up into 4'-0" x 8'-0" panels, however, the contractor would assemble a few panels 2'-0" x 8'-0" and a number of 1'-0" x 8'-0" panels as these would be required in order to work in the foundation dimensions. For purposes of taking off the material requirements, the example given is sufficiently accurate.

3. COLUMN FORMS:

In order to determine the material requirements for columns it is necessary to take the perimeter of the column (each side of a column requires formwork) multiplied by the height of the column. If the colunns are all the same dimension, multiply the perimeter of the column by the total height of all the columns.

Example:

The plan shows we have 14 columns 9'-6" high by 1'-6" x 1'-6"

Perimeter = 1'-6" x 4 = 6'-0"

Total height = 14 x 9'-6" = 133'-0"

S.F.C.A. therefore is 133'-0" x 6'-0" = 798 sq. feet.

If 2" x 4" material is to be used for yokes, cleats and bracing you will require approximately 1.5 board feet for each sqare foot of contact area.

Therefore, 798 x 1.5 = 1197 fbm of 2/4's.

4. BEAM FORMS:

When taking off material requirements for Concrete Beam Forms it is usually broken down into two parts: (a) Beam Sides and (b) Beam Bottoms.

(a) Beam Sides - here the depth of the beam must be determined then multiplied by the length of the beam times 2 for each side.

(b) Beam Bottom - Width of the beam multiplied by the length.

SECTION III - FORMWORK ASSIGNMENT

Problem 1: -

Calculate the material required to form a concrete wall 80'-0" long by 8'-0" high with Built Up Forms.

(a) Feet Board Measure of 1" x 8" shiplap sheathing = ________

(b) Feet Board Measure of 2" x 4" studs @ 16" O.C. = ________

(c) Feet Board Measure of 2" x 4" stakes & braces = ________

(d) Total pounds of wire = ________

(e) Total pounds of 2 1/2" nails = ________

(f) Total pounds of 3 1/2" nails = ________

(g) Total Feet Board Measure of 1" x 8" shiplap sheathing which could be salvaged = ________

(h) Total Feet Board Measure of 2" x 4" studs which could be salvaged = ________

Problem 2: -

With reference to the plan shown in Figure 3.5 take off the material required to construct 4'-0" x 8'-0" panel forms of 3/4" Plywood with 2" x 4" top and bottom plates and studs of 2" x 4"s @ 16" O.C. Use the Quantity Take-Off Sheet provided and list the following items:

(a) Plywood

(b) 2" x 4"'s

(c) 2 1/2" nails

(d) 3 1/2" nails

(e) Labour

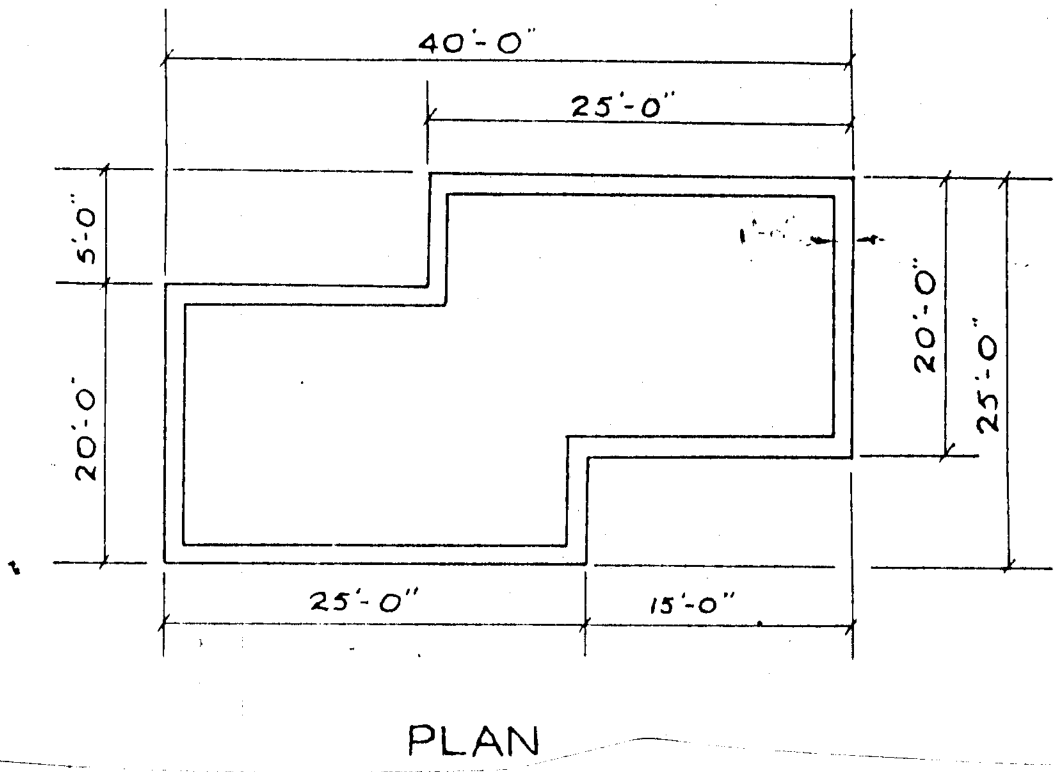


FIGURE 3.5

Problem 3: -

From the column schedule given in Figure 3.6 calculate the following material for the columns shown:

a) S.F.C.A. ______________________

b) Feet Board Measure of 2" x 4" material required for yokes, cleats and bracing ______________________.

COLUMN SCHEDULE		
Column Number	Column Size	Column Height
C-1, C-2, & C-3	18" x 18"	9'-3"
D-1, D-2	20" x 20"	9'-3"
E-1, E-2	22" x 22"	9'-3"
G-4, G-5	26" x 22"	9'-0"

FIGURE 3.6

--- QUANTITY TAKE-OFF SHEET ---

Date ______________________ Assignment ______________ Name ______________________

Class ______________________________________ Sheet No. ______________ of ____________

DESCRIPTION	DIMENSIONS						EXTENSIONS	EXTENSIONS

UNIT IV - REINFORCING STEEL

1. REINFORCED CONCRETE FOOTINGS
2. REINFORCED CONCRETE PILES
3. REINFORCED CONCRETE SLABS
4. REINFORCED CONCRETE WALLS
5. REINFORCED CONCRETE COLUMNS
6. REINFORCED CONCRETE BEAMS
7. REINFORCED CONCRETE LINTELS
8. SUMMARY
9. ASSIGNMENTS

UNIT IV - REINFORCING STEEL

Objectives

Following the completion of this unit a student will be able to:

4.1 explain how reinforcing steel is sized

4.2 calculate requirements of reinforcing steel

4.3 calculate quantities of reinforcing steel for
- piles
- slabs
- walls
- beams

4.4 correctly complete all assignments.

SECTION IV - REINFORCING STEEL

Concrete is strong in compression, however, comparatively weak in tension, therefore reinforcing steel or wire mesh is used to increase the tensile strength. In this section you will learn how to estimate quantities of reinforcing steel required for footings, piles, slabs, columns, foundation walls, beams and concrete lintels. In most cases reinforcing steel will be purchased from a steel company who will quote a firm price for the reinforcing steel delivered to the jobsite cut, bent, bundled and tagged, along with placement drawings. The general contractor will place the steel and will therefore be concerned with the labour cost of placing the steel.

1. REINFORCED CONCRETE FOOTINGS:

The steel rods (rebar) in concrete footings are calculated by their actual length and the diameter of the rebar. The estimator will add all the rebar lengths of equal diameters and then the total length is multiplied by the weight per foot in order to determine the total weight in pounds. This is in turn converted to tons.

Example: Calculate the total tonnage of #5 reinforcing rods in the footings shown on the plan and section in Figure 4.1.

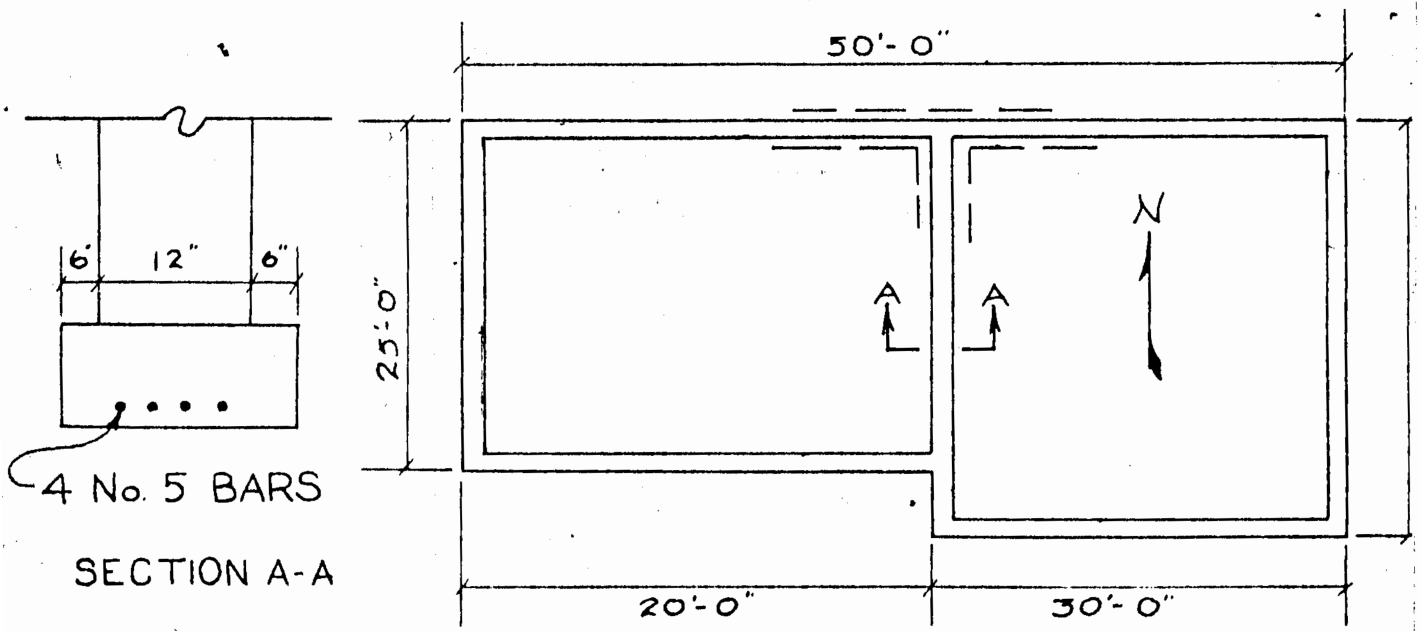


FIGURE 4.1

First we add the outside perimeter of all the footings. This will allow an overlap of the rebar in the footings at each corner. The north wall dimension of 50'-0" becomes 51'-0" because the footing protrudes 6 inches at both ends of the wall as seen in Figure 4.1 Section AA. Similarly, the east wall dimension of 30'-0" becomes 31'-0". The centre wall running north and south becomes 31'-0". The west wall dimension 25'-0" becomes 26'-0", south wall dimension 20'-0" becomes 22'-0" and the 30'-0" south wall becomes 31'-0". To tabulate these figures with their overlaps at the corners we have:

51" + 31 + 31 + 26 + 22 + 31 = 192 feet.

The footing plan calls for 4 rods therefore we multiply 192' x 4 = 768 lineal feet.

To this length an additional 5% is added for overlaps within the footing. 768 plus 5% = 806.4 or rounded off to 807 lineal feet.

According to the table on "Standard Sizes and Weights of Concrete Reinforcing Bars," Figure 4.2, we see that a #5 rod is 5/8" in diameter and the weight os 1.043 pounds per lineal foot. Therefore 807 lineal feet times 1.043 will give us 841.701 or 842 pounds. Then 842 ÷ 2000 = .42 tons.

STANDARD SIZES AND WEIGHTS OF
CONCRETE REINFORCING BARS

New Designation No.	Unit Weight Lb. Per Foot	Diameter (Round Sections)
2	.167	1/4"
3	.376	3/8"
4	.668	1/2"
5	1.043	5/8"
6	1.502	3/4"
7	2.044	7/8"
8	2.67	1"
9	3.4	1 1/8"
10	4.303	1 1/4"
11	5.313	1 3/8"

FIGURE 4.2

This would be taken off on the Quantity Take-Off Sheet as shown in Figure 4.3.

---QUANTITY TAKE-OFF---

JOB NUMBER ______________

DATE ______________

SHEET NO. ________ OF ____

ITEM	UNIT	SIZE	LENGTH	TOTAL LENGTH	LBS.		TONS
Reinforcing Steel:							
1. Footings -							
North Wall	4	#5	51'-0"	204'			
East Wall	4	#5	31'-0"	124'			
Centre Wall	4	#5	31'-0"	124'			
South Wall "A"	4	#5	22'-0"	88'			
South Wall "B"	4	#5	31'-0"	124'			
West Wall	4	#5	26'-0"	104'			
		TOTAL:		768'			
		Plus	5% :	39			
				807'			
		807	x 1.043	=	842		
#5		842	÷ 2000	=			.42 TONS

FIGURE 4.3

2. REINFORCED CONCRETE PILES:

The piles referred to under this heading are poured in place reinforced concrete cast in holes drilled into the earth. Reinforcing cages shall be carefully installed into the excavation and held in place until concrete is poured.

Example: Estimate the reinforcing steel required for the piles shown in

Figure 4.4.

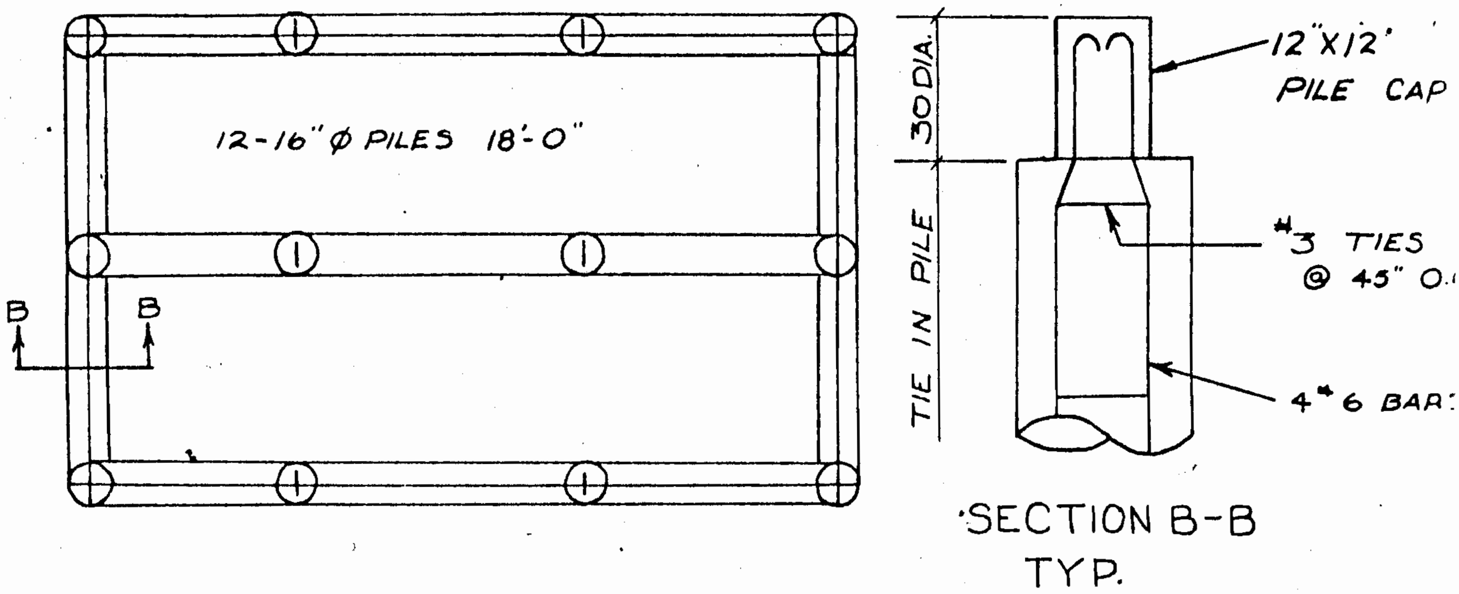
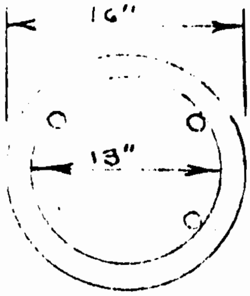


FIGURE 4.4

Specifications - All piles shall be 16" diameter, drilled in place to the length indicated on the plan. They shall be reinforced with 4 - #6 x 20'-0" bars and #3 ties @ 48" O.C. anchor into pile caps. The lap of all spliced bars shall be 30 bar diameters.

The plans shows 12 piles 16" in diameter drilled to a depth of 18'-0". First we take off the total length of #6 rods required. In this example, 20'-0" = 80 feet times 12 piles = 960 lineal feet #6 rod. Refer back to the weight table in Figure 4.2. #6 rod weighs 1.502 lbs. per lineal foot. 960 x 1.502 = 1442 lbs. Ties are #3 rod @ 48" O.C. We will require 5 ties per pile (12 @ 5 =) 60 ties required. The length of the #3 rod for the tie will be 4'-4". This length is arrived at by determining the diameter of the tie. The pile is 16 inches and the reinforcing must be set back a minimum of1-1/2 inches from the face of the concrete. This makes the tie diameter 13 inches. The circumference of the tie is then 13 x 3.14 = 40.82 inches to this is added 30 bar



diameters for the lap 30 x 3/8 = 11 1/4 inches. 40.82 + 11.25 = 52.07 or 52 inches (4'4"). Therefore 60 ties 4'4" 260 lineal feet #3 rod. 260 lineal feet @ .376 lbs. per foot = 98 lbs.

Total Reinforcing Steel for the Concrete Piles then is #6 = 1442 lbs.
#3 = 98 lbs.
1540÷ 2000
= .77 tons

This would appear on the Quantity Take-Off sheet as seen in Figure 4.5.

JOB NUMBER ____________

DATE ____________

--- QUANTITY TAKE-OFF ---

SHEET NO.______ OF ______

ITEM	UNIT	NO. OF PIECES	SIZE	LENGTH	TOTAL	LBS.	TONS
EINFORCING STEEL							
PILES -							
Vertical	12	4	#6	20'-0"	960		
#6	960 x	1.502				1442	
Ties	12	5	#3	4'-4"	260		
#3	260 x	.376 =				98	
						1540	
		1540	÷	2000			.7 7 TONS

FIGURE 4.5

3. REINFORCED CONCRETE SLABS:

In taking off the reinforcing required for reinforced concrete slabs the plans will give us the slab dimensions, the size of the reinforcing bars and the spacing of the bars.

Example: From the plan and section shown in Figure 4.6 we determine that the slab requires #4 reinforcing bars @ 12" O.C. both ways.

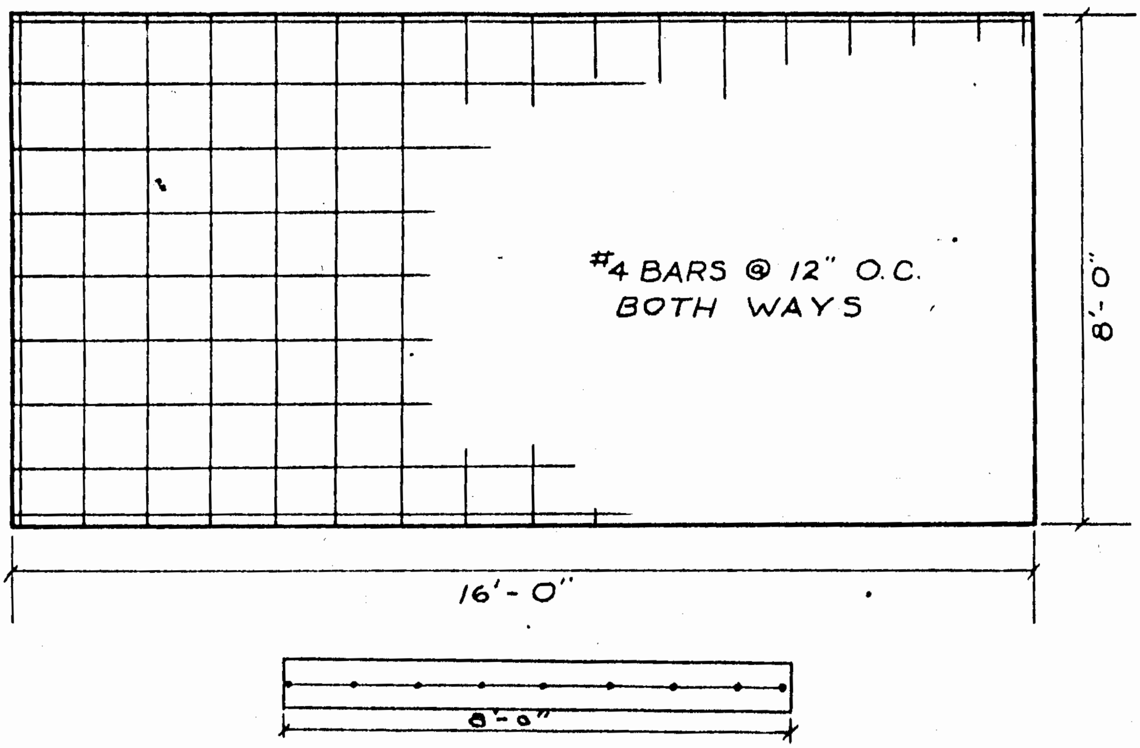


FIGURE 4.6

We will calculate the number of 16'-0" bars required at

12" O.C. = 9 bars

8'-0" bars required at --- 12" O.C. = 17 bars

∴ 9 @ 16'-0" = 144'

17 @ 8'-0" = 136'

Total 280 lineal feet @ .668 pounds per foot

280 x .668 = (186.67) 187 pounds

This is shown on the Quantity Take-Off sheet in Figure 4.7.

JOB NUMBER ______________

DATE ______________

----- QUANTITY TAKE-OFF -----

SHEET NO. _____ OF _____

	SIZE OF OF BARS	NO. OF BARS	LENGTH OF BARS	TOTAL LENGTH		LBS.
REINFORCING:						
1. Slab:	#4	9	16'-0"	144		
	#4	17	8'-0"	136		
				280		
	280	x	.668	=		187

FIGURE 4.7

4. <u>REINFORCED CONCRETE WALLS</u>:

In taking off the reinforcing steel required for reinforced concrete walls the steel will be classed as horizontal bars and vertical bars. From the plans we can determine the dimensions of the walls and the size of the rebars as well as the spacing of the bars.

<u>Example</u>: From the plan shown in Figure 4.8 estimate the reinforcing steel required for the walls of the cistern. The plan calls for #4 bars at 12" O.C. both ways.

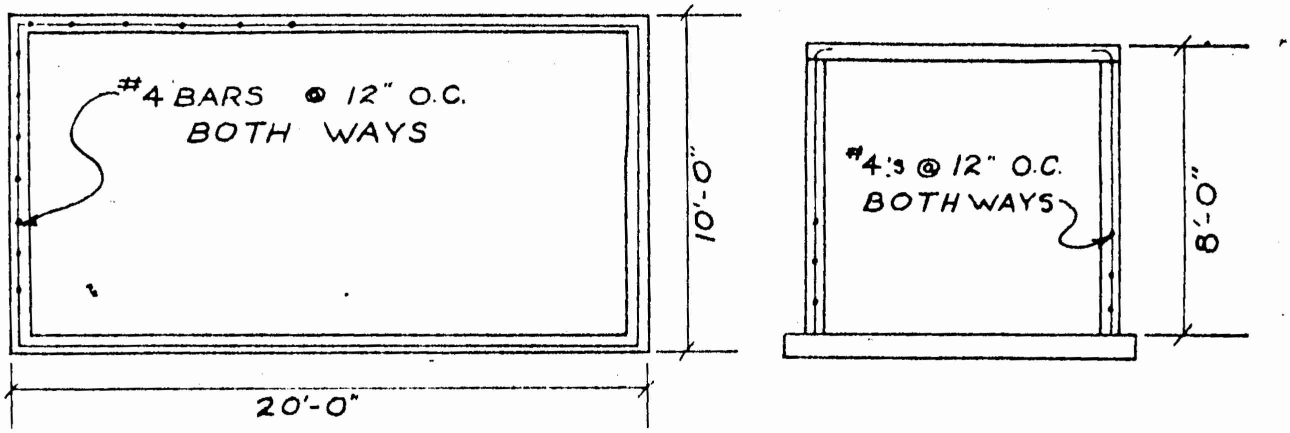


FIGURE 4.8

First we will take off the horizontal bars. Here we can take the outside perimeter which is 60'-0" multiplied by the number of horizontal bars. (Walls are 8'-0".) We require 9 rows therefore 60'-0" x 9 = 540 lineal feet plus 5% for laps within the walls - 540 + 27 = 567 lineal feet.

Vertical bars - We will require 60 verticals which will be 8'-0" long, plus 30 bar diameters to tie in the reinforcing steel in the concrete cistern top -

8'-0" + (30 x 1/2) 1'-3" = 9'-3" x 60 = 565 lineal feet.

Total #4 reinforcing steel for the cistern walls - 567 feet + 565 feet = 1132 lineal feet. 1132 x .668 = 756.176 or 757 pounds.

This is shown on the Quantity Take-Off sheet Figure 4.9.

JOB NUMBER ______________

DATE ______________

----- QUANTITY TAKE-OFF -----

SHEET NO. _____ OF ______

ITEM	UNIT	NO. OF BARS	SIZE	LENGTH	TOTAL LENGTH	LBS.						
REINFORCING STEEL:												
CISTERN:												
WALLS												
VERTICAL	1	60	#4	9'-3"	565							
HORIZONTAL	1	9	#4	60'-0"	540							
	Plus	5%			27							
					1132							
#4	1132	x ..668	=			757						

FIGURE 4.9

5. REINFORCED CONCRETE COLUMNS:

To determine the length of the vertical bars in a column you must first calculate the height of the column. The Column Schedule will give the location of the columns, the size and number of vertical bars required, the size and numbers of ties required. Taking off the reinforcing steel for columns is similar to the take off for cast in place reinforced concrete piles.

Example: Study the Column Schedule as seen in Figure 4.10.

	COLUMN SCHEDULE				
ROOF	COLUMN MARK	2.6.11	3.4	1.5	7
	Column Size	12 x 12	14 x 14	16 x 16	14 x 16
	Ties @ 12" O. C.	#3 (9 x 9)	#3 (11 x 11)	#3 (13 x 13)	#3 (11 x 13)
1st Fl.	VERTICAL	4 - #6	4 - #6	4 - #8	4 - #8
	Column Size	14 x 14	16 x 16	18 x 18	16 x 18
	Ties @ 12" O. C.	#3 (11 x 11)	#3 (13 x 13)	#3 (15 x 15)	#3 (13 x 15)
GROUND	VERTICAL	4 - #7	4 - #7	4 - #8	4 - #8

FIGURE 4.10

In this example using the Column Schedule in Figure 4.10 we will take off the reinforcing steel for Columns #2, #6, and #11 from the ground floor to the first floor. From the prints we have determined the column height to be 9'-0". The length of the vertical bars will therefore by 9'-0" plus the thickness of the floor which is 8 inches plus 30 bar diameters as these vertical bars must extend up into the column above which is between the 1st floor and the roof. This extension of the bars will be tied to the vertical bars in the column above.

Therefore, 9'-0" plus 8" plus 30 x 7/8 = 26"

Length of verticals - 9'-0" + 8" + 2'-2" = 11'-10". This would be rounded off at 12'-0".

Total of #7 vertical bars will be three columns #2, #6, and #11 and 4 bars in each = 12 pieces #7 rod 12'-0" long. Total length = 12'-0" x 12 = 144'-0". 144'-0" @ 2.044 lbs. per foot = 295 pounds.

Ties required will be 10 when placed at 12" O.C. therefore three columns will require 30 ties. The length of each ties will be (11" x 4) = 44" plus 30 bar diameters 30 x 3/8 = 11". Total length of each tie = 44" + 11" = 55" or 4'-7" x 30 = 138'.

138 lineal feet @ .376 = 52 pounds.

This is shown on the Quantity Take-Off Sheet in Figure 4.11.

JOB NUMBER ______________

DATE ______________

----- QUANTITY TAKE-OFF -----

SHEET NO. ______ OF ______

ITEM	UNIT	NO. OF BARS	SIZE	LENGTH	TOTAL	LBS.								
REINFORCING STEEL:														
3. COLUMNS														
1st FLOOR:														
#2, #6, #11														
Vertical	3	4	#7	12'-0"	144'0"									
#7	144	x	2.044	=		295								
Ties	3	10	#3	4'-7"	138'0"									
	138	x	.376	=		52								

FIGURE 4.11

6. REINFORCED CONCRETE BEAMS:

As was previously stated, concrete is strong in compression but weak in tension. The basic principle of a reinforced concrete beam is shown in Figure 4.12.

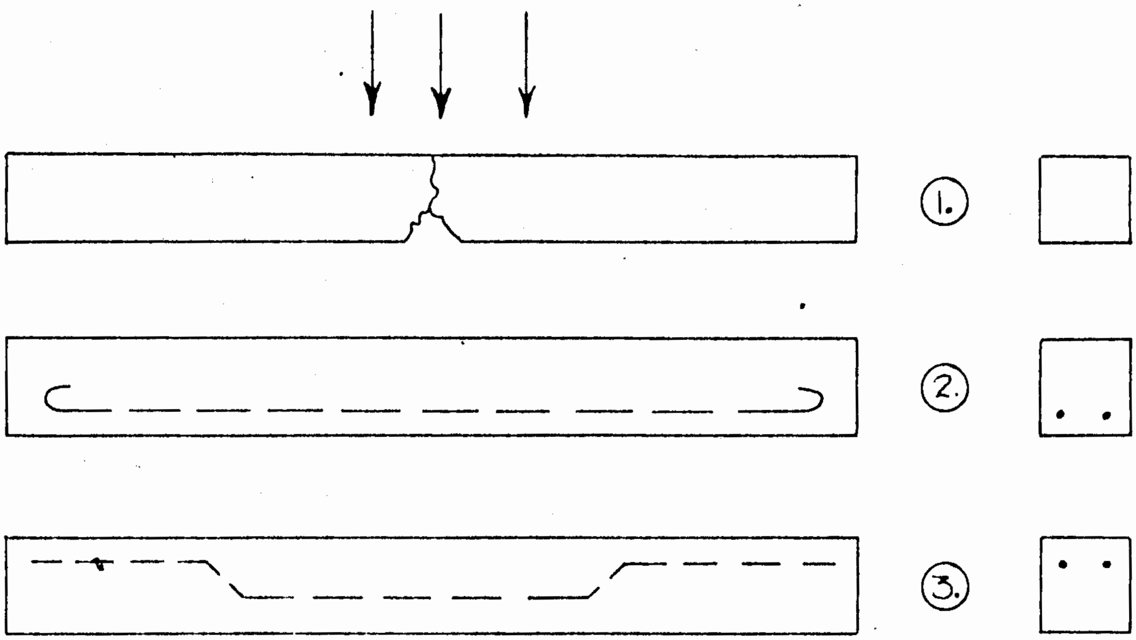


FIGURE 4.12

When a heavy load is placed on a concrete beam the load tends to bend the beam. Under excessive load, the bottom of the beam pulls apart and the top of the beam cracks and crumbles as shown in Figure 4.12.- (1). If steel reinforcing rods are placed near the botton of the beam as in Figure 4.12 - (2), the steel strong in tension prevents this damage. To assure a strong bond between the steel and the concrete the ends are often hooked to give the bar a better grip or they may be bent into the position as seen in Figure 4.12 - (3) which also increases the friction between the steel and the concrete.

When taking off the reinforcing steel for beams it is necessary to examine the plans to determine the length of the beam, the size of the reinforcing bars and the number of bars required. The plans will also give the size of bar used for the stirrups and the location and spacing of the stirrups in the beam.

7. REINFORCED CONCRETE LINTELS:

It is necessary for the estimator to determine the number of openings requiring reinforced concrete lintels. Find the width of each opening and then allow an additional six inches on each side for end bearing of the lintel, this will be the length of the reinforcing steel required. Multiply this length by the number of bars required in the lintel.

Example: Take off the quantity of reinforcing rods required for the lintels over the openings shown on the plan in Figure 4.13. Exterior openings require 6 - #4 Ø rods. Interior openings require 4 - #4 Ø rods.

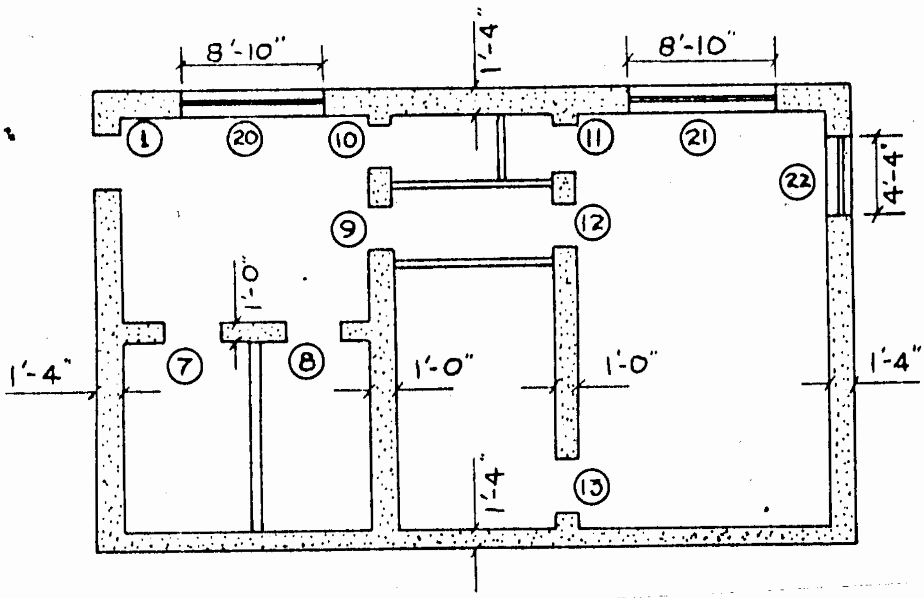


FIGURE 4.13:

OPENING NO.	SIZE OF OPENING
1	3'-0" x 7'-0"
7	3'-0" x 7'-0"
8	3'-0" x 7'-0"
9	3'-0" x 7'-0"
10	2'-6" x 7'-0"
11	2'-8" x 7'-0"
12	3'-0" x 7'-0"
13	3'-0" x 7'-0"

First we will take off the Exterior openings #1, #20, #21, and #22.

2 openings #20, #21 are 8'-10" wide plus 1'-0" = 9'-10".

.˙. 2 @ 9'-10" = 19'-8" x 6 = 118 lineal feet

1 opening #1 is 3'-0" wide plus 1'-0" = 4'-0"

.˙. 1 @ 4'-0" x 6 = 24 lineal feet

1 opening #22 is 4'-4" plus 1'-0" = 5'-4".

.˙. 1 @ 5'-4" x 6 = 32 lineal feet

Total lineal feet Exterior Openings: 174 lineal feet

Interior Openings #7, #8, #9, #10, #11, #12, #13.

5 openings (#7, #8, #9, #12, #13) are 3'-0" wide plus 1'-0" = 4'-0".

.˙. 5 @ 4'-0" = 20 x 4 80 lineal feet

1 opening #10 is 2'-6" wide plus 1'-0" = 3'-6".

.˙. 3'-6" x 4 = 14 lineal feet

1 opening #11 is 2'-8" wide plus 1'-0" = 3'-8".

.˙. 3'-8" x 4 = 14' - 8"

108' - 8"

Plus: 174' - 0"

Total: 282' - 8"

Round this off at 283 lineal feet times the weight per lineal foot of #4 rod.

283 x .668 = 189 pounds.

On a Quantity Take-Off Sheet it would be as seen in Figure 4.14 on the following page.

--- QUANTITY TAKE-OFF ---

JOB NUMBER ____________

DATE ____________

SHEET NO. ______ OF ____

ITEM	SIZE OF BARS	NO. OF OPENINGS	BARS PER OPENING	LENGTH OF BARS	TOTAL LENGTH	TOTAL LBS.
REINFORCING STEEL:						
1. LINTELS:						
Exterior						
#20 , #21	#4	2	6	9'-10"	118'-0"	
#22	#4	1	6	5'-4"	32'-0"	
#1	#4	1	6	4'-0"	24'-0"	
Interior						
#7, #8, #9, #12, &						
#13	#4	5	4	4'-0"	80'-0"	
#10	#4	1	4	3'-6"	14'-0"	
#11	#4	1	4	3'-8"	14'-8"	
					282'-8"	
	283	x	.668	=		189

FIGURE 4.14

8. SUMMARY:

In this section you have learned how to take off the quantities of reinforcing steel required in various reinforced concrete structural members however to further your knowledge of reinforcing steel, I recommend that you read the manual "Concrete Reinforcing Steel Institute, Recommended Practice for Placing Reinforcing Steel."

9. ASSIGNMENT:

Problem 1: -

Using the plan shown in Figure 4.15 take off the reinforcing bars required for the footings. Use the Quantity Take-Off Sheet provided.

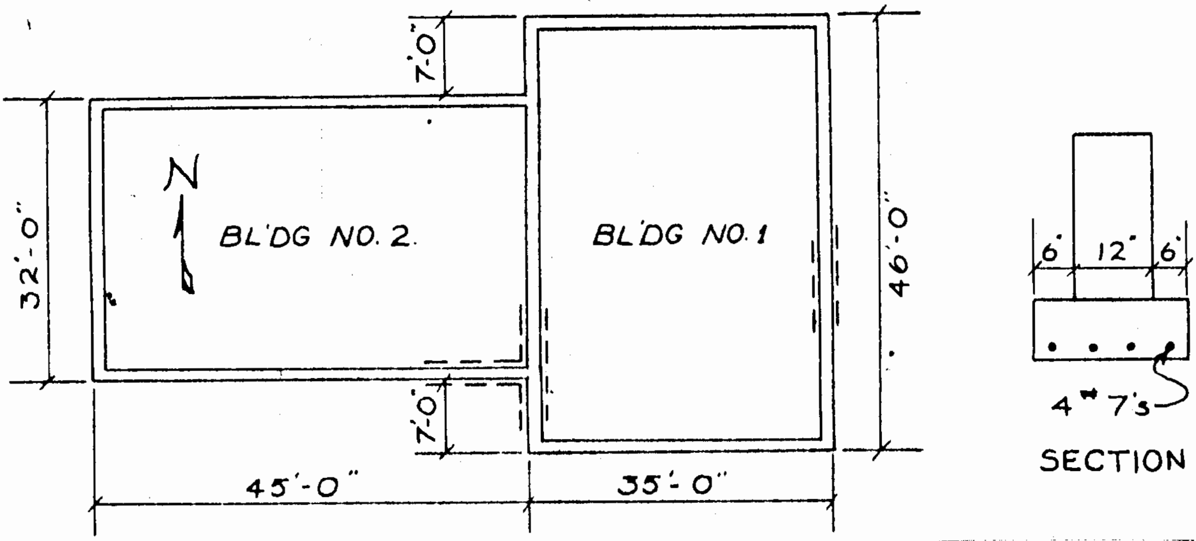


FIGURE 4.15

Problem 2: -

Using the plan shown in Figure 4.16 take off the reinforcing bars required for the footings and the foundation walls. Walls are 8'-0" high to be reinforced with #4 bars at 12" O.C. both ways. Use the Quantity Take-Off Sheet provided.

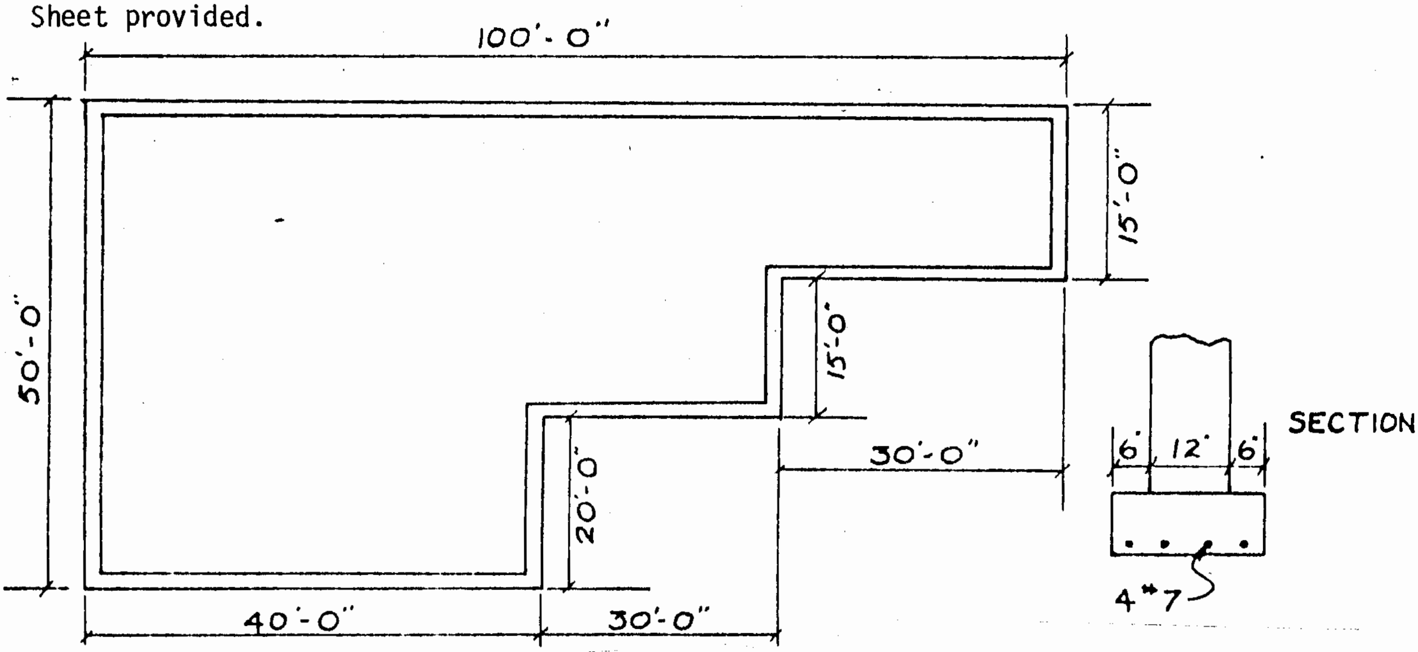


FIGURE 4.16

Problem 3: -

Using the elevation drawing of the column in Figure 4.17 take off the reinforcing steel required for footing and the column. Use the Quantity Take-Off Sheet provided.

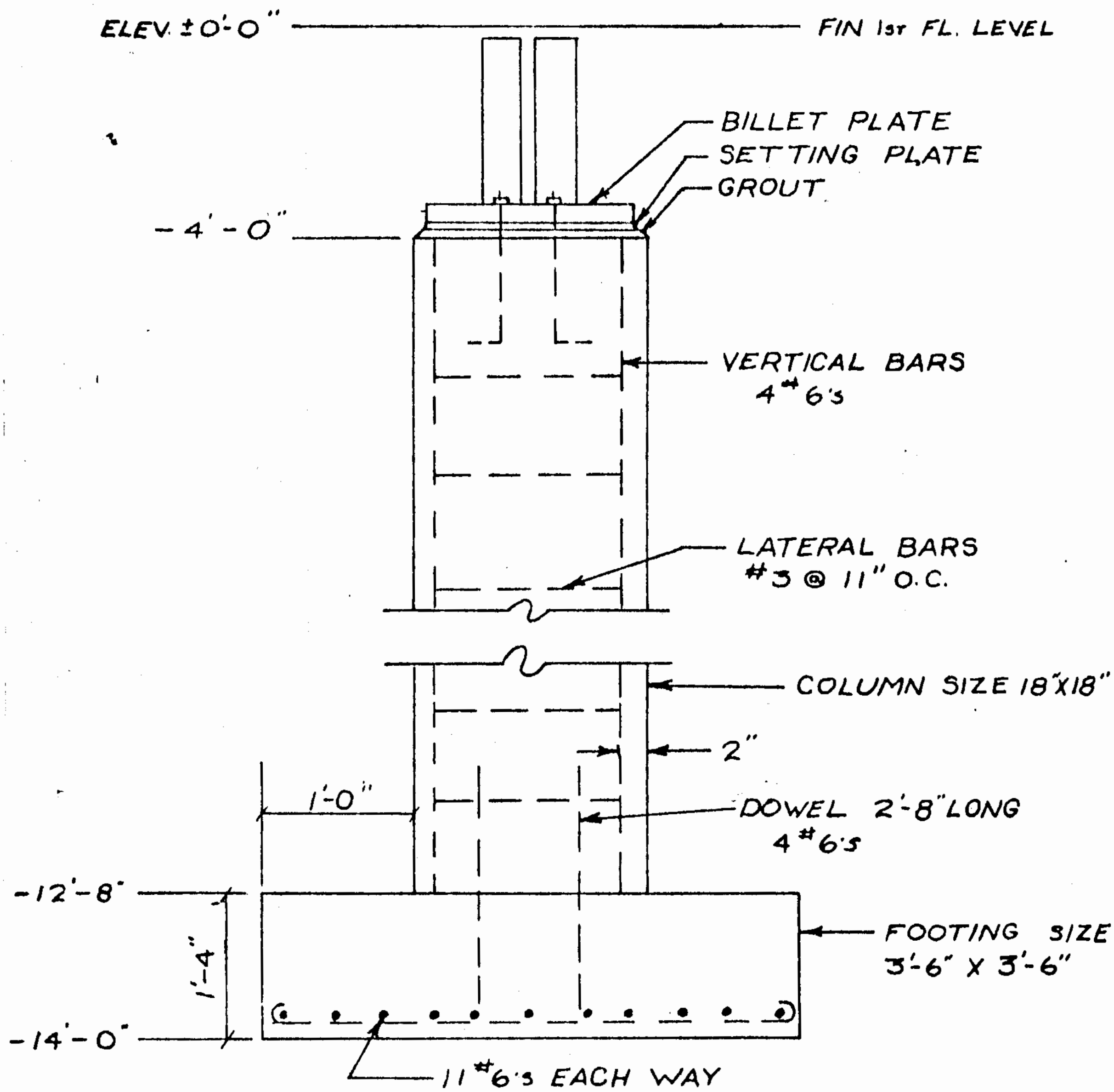


FIGURE 4.17

--- QUANTITY TAKE-OFF SHEET ---

Date ______________ Assignment ______________ Name ______________

Class ______________ Sheet No. ______________ of ______________

DESCRIPTION	DIMENSIONS						EXTENSIONS	EXTENSIONS

UNIT V. BRICKWORK

1. COMMON BOND
2. ENGLISH BOND
3. FLEMISH BOND
4. COMPOSITE WALL
5. MORTAR REQUIREMENTS
6. ASSIGNMENTS

UNIT V. BRICKWORK

Objectives:

Following the completion of this unit, a student will be able to:

5.1 Explain three common bonds used in brickwork.

5.2 Calculate all brick requirements for
- walls
- columns

5.3 List four types of bricks used in construction.

5.4 Correctly complete all assignments.

UNIT V. BRICKWORK

In this section you will learn the methods of estimating the amount of brick required for various types of construction, as well as the amount of mortar for the brick.

Conventional standard brick (non-modular), either face or common is approximately 8" x 2 1/4" x 3 3/4". There are many other sizes of brick identified under such trade names as Roman, Norman, and SCR. Brick manufactured in the same size molds may differ in size due to the variation in the amount of shrinkage of different clays in burning. Also, specified dimensions of bricks marketed under the same trade names may vary with different manufacturers.

A nominal brick dimension is a dimension which differs from the actual or specified dimensions by the addition of the mortar joint thickness. In modular size brick, nominal dimensions are used. These dimensions are taken from centre line to centre line of the mortar joints. For example, a modular brick of 7 5/8" x 2 1/4" x 3 5/8" (actual size) with a 3/8" mortar joint would have a nominal modular dimension of 8" x 2 5/8" x 4".

The estimator should know the exact size of the brick that is specified and the size of the mortar joint required, both bed and end joints, in order to calculate the number of bricks required for a wall.

The following table in figure 5.1 gives the number of bricks required per square foot of wall surface with 3/8", 1/2", and 5/8" mortar joints. These figures are for a 4" wall or a wall one brick thick. For an 8" wall, the number of bricks shown would be doubled and for a 12" wall, the figures given would be multiplied by three.

STANDARD BRICK PER SQ. FT. (8" x 2 1/4" x 3 3/4")			
Joint	3/8"	1/2"	5/8"
Number of bricks per sq. ft.	6.54	6.16	5.8

FIG. 5.1

The number of brick can be found in the following manner, and may be applied to any size brick and mortar joint.

Assume a brick size 7 5/8" long x 2 1/4" high (see figure 5.2) with a bed and end joint of 3/8"

The length of the brick is 7 5/8" + 3/8" = 8 inches

The height of the brick is 2 1/4" + 3/8" = 2 5/8 inches

Multiply the length by the height -- 8" x 2 5/8" = 21 square inches being the area of the brick and mortar joint. To determine the number of bricks with a 3/8" mortar joint per square foot of wall, we can divide one square foot by 21 square inches (144 sq. inches - 21) = 6.857 or 6.86 bricks in one square foot of wall surface.

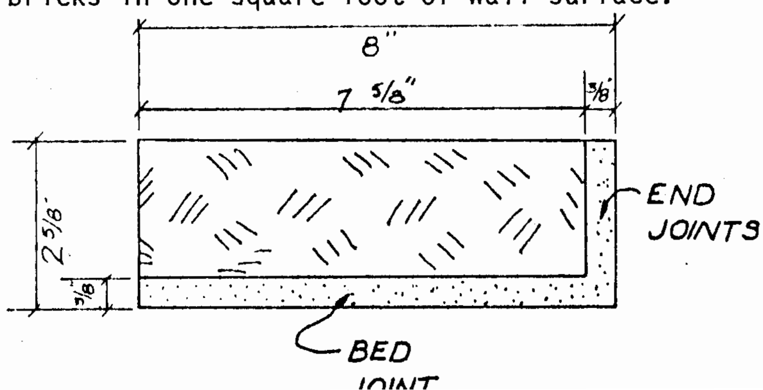


FIG. 5.2

If the net area of the wall is 240 square feet, and there are 6.86 bricks in one square foot of wall, the total number of bricks in the wall is 240 x 6.86 = 1646.4 or 1647 bricks.

In calculating the net square feet of wall for an entire job, deduct the square feet taken up by window and door openings. Then simply multiply the net area of the wall by the number of bricks in one square foot (bearing in mind the wall thickness).

When considering face brick only, add 3 percent for waste to the total face brick. If common brick are used, add 2 percent for waste.

1. Common Bond:

   Common bond provides a header course every sixth course while the intervening course are stretcher courses. Study figures 5.3 and 5.4.

   Masons may vary this Common Bond by placing a header course every fourth, fifth, or even every seventh course.

2. English Bond:

   This bond is a very popular bond and is used especially for residential walls. This bond is made by alternating a course of stretchers with a course of headers. Study figure 5.5

   It is common practice to use half brick (blind headers) for the header courses, except every sixth course full headers are used.

COMMON BOND

8" brick wall

Header every 6th course.

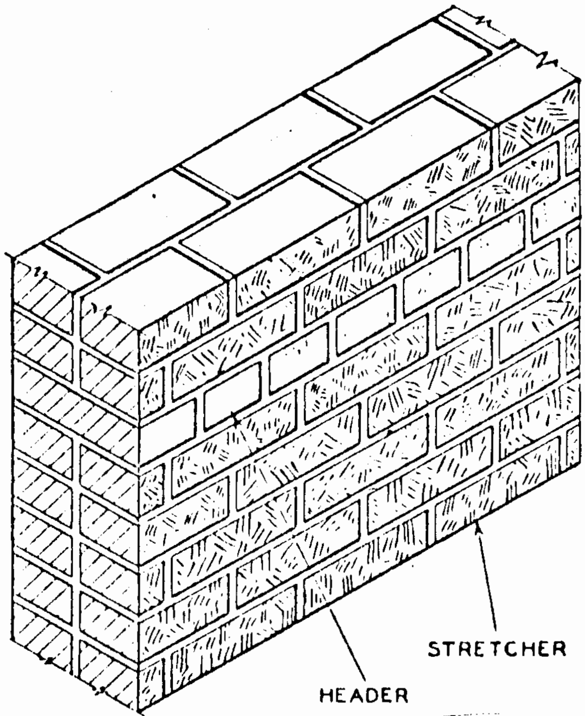


FIG. 5.3

COMMON BOND

12" brick wall

Header every 6th course

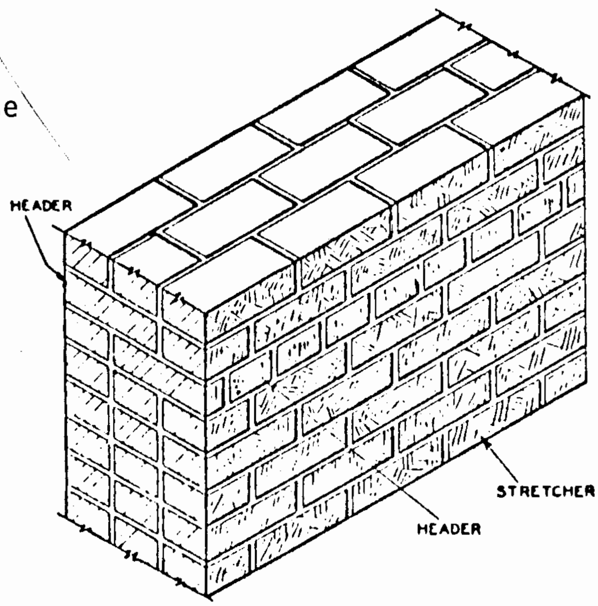


FIG. 5.4

ENGLISH BOND

Full header every other course.

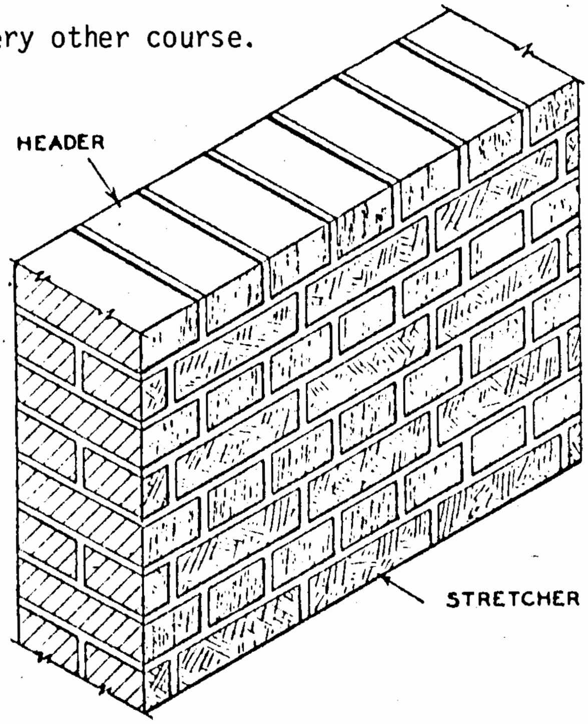


FIG 5.5

3. Flemish Bond:

This bond has alternate headers and stretchers in every course. Blind headers are often used in every course, except every sixth course where full headers are used. See figure 5.6

The table in figure 5.7 gives the percentages that must be added to the face brick (when backed up with common brick or block) for the type of bond specified.

FLEMISH BOND

Full header every course.

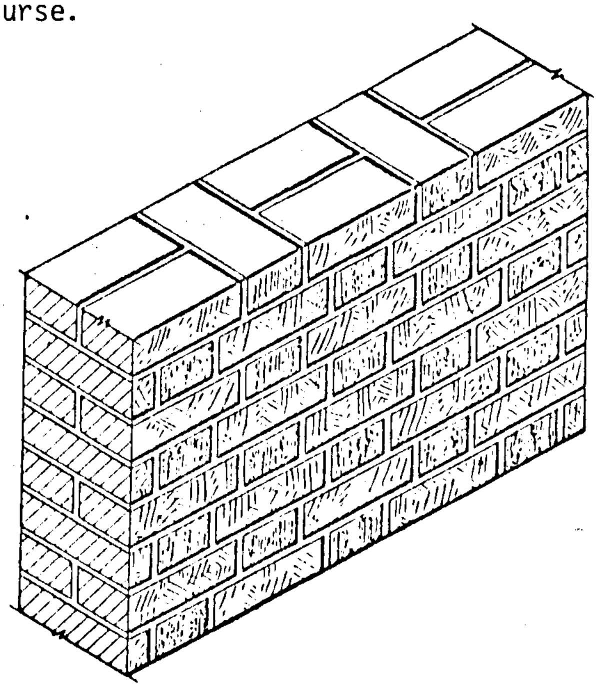


FIG. 5.6

4. Composite Wall:

Many constructions today provide for a masonry wall with a face brick bond backed with header blocks.

In the composite wall, as in figure 5.8, every sixth course of face brick is a full header course bonded to the backup header block.

In calculating the number of face brick backed with concrete blocks, a simple method is illustrated in figure 5.9. Six bricks are required for each stretcher block and eight bricks for each header block.

PERCENTAGES ADDED TO FACE BRICK FOR VARIOUS BONDS		
Type of Bond	Full Headers	Percentages to be added
Common	Every 5th course	20% or 1/5
Common	Every 6th course	16.7% or 1/8
Common	Every 7th course	14.3% or 1/7
English	Every 6th course	16.7% or 1/6
English	Every other course	50% or 1/2
Flemish	Every 6th course	5.6% or 1/16
Flemish	Every course	33.3% or 1/3

FIG.5.7

For 100 square feet of composite wall 57 stretcher blocks and 57 header blocks are required. Then 57 x 6 = 342 bricks plus 57 x 8 = 456 bricks for a total of 798 brick for 100 square feet of composite wall. The quantities per 100 square feet of face brick, header block, stretcher block, and mortar for this composite wall are given in the following table, figure 5.1 page 9.

6th course bonding

Composite wall

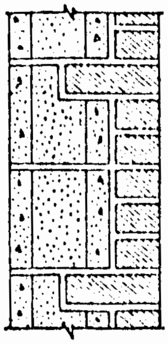


FIG. 5.8

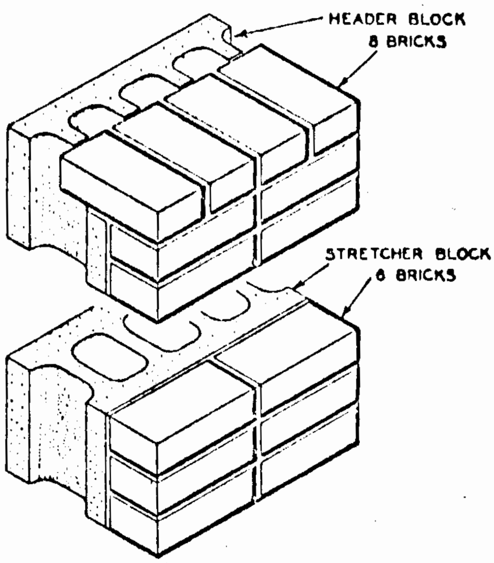


FIG. 5.9

Example --

Estimate the number of double common brick in the plan and section shown in figure 5.11

QUANTITIES FOR 100 SQ. FT OF COMPOSITE WALL	
*Number of Stretcher Block	57 Blocks 8" x 8" x 16" (nominal)
*Number of Header Block	57 Blocks 8" x 8" x 16" (nominal)
*Number of Brick	798 7 5/8" x 2 1/4" x 3 5/8"
Mortar -- based on 3/8" joint (Block and brick combined)	13.4 cu. ft. Waste included

*Quantities are Net -- Allow for waste:
3% for face brick
2% for 100 blocks or more
Less than 100 blocks, add 2 blocks

FIG. 5.10

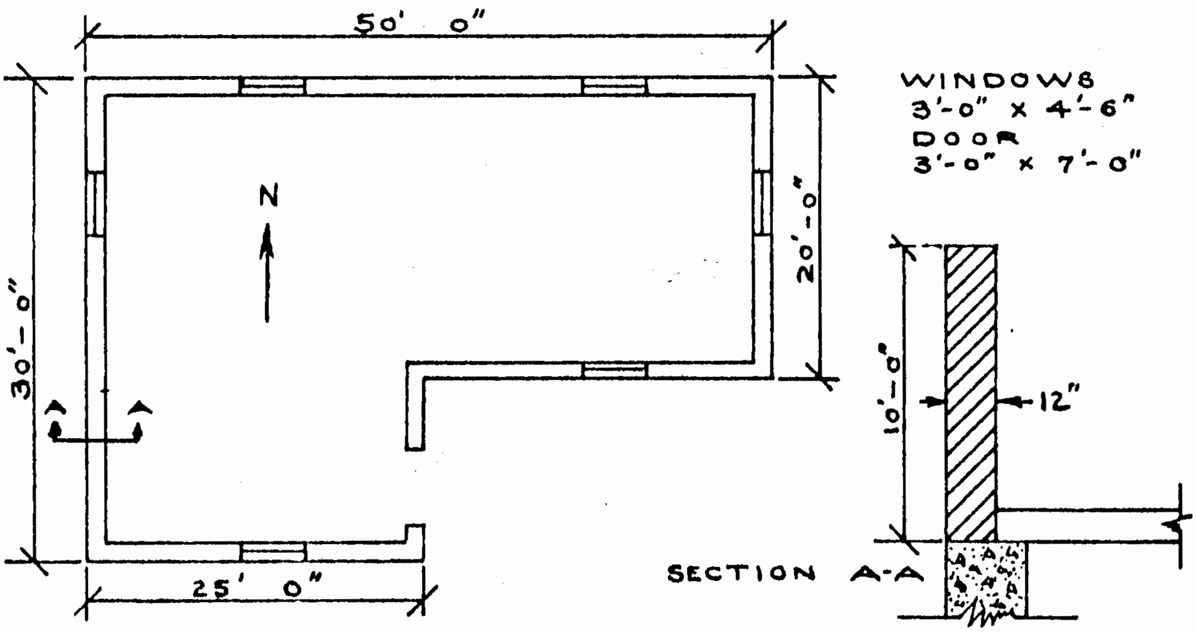


FIG. 5.11

We will assume a brick size 8" x 5" x 3 3/4" (a double common) where the actual length of the brick is 8 inches and the actual height is 5 inches. (The thickness of the brick need not be considered.) We will assume a bed and end mortar joint of 1/2 inch. The brick are laid in common bond with a header every fifth course.

Note -- Openings	Windows	3'-0" x 4'-6"
	Door	3'-0" x 7'-0"

The brick size with the mortar joints will measure 8½" by 5½", see figure 5.12.

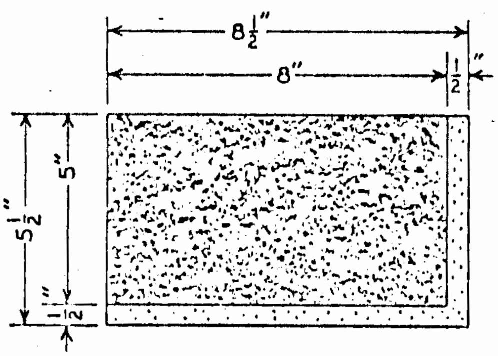


FIG. 5.12

Therefore, the face area of the brick including the mortar joint is 8½" x 5½" = 46 3/4" or 46.75 square inches. We know that one square foot of wall surface contains 144 square inches. Therefore, we will divide 144 by 46.75 and determine that we will require 3.1 brick for a 4 inch wall. This wall is a 12 inch wall so we will multiply by 3 and determine that we require 9.3 bricks per square foot of wall.

Our next step will be to determine the net square feet of wall surface area which will be multiplied by 9.3 (the bricks per square foot) to arrive at the total number of brick required.

I will use the centre line perimeter method to determine the total length of walls. Perimeter - 160'-0" less 4 times the wall thickness (4 x 1'-0") = 4'-0". Centre line = 156'-0" times the wall height which is 10'-0" = 1560 square feet of wall. From this figure we deduct for the window and door openings.

6 windows 3'-0" x 4'-6" = 81 square feet

One door 3'-0" x 7'-0" = 21 square feet

Total deduction 102 square feet. Therefore, 1560 - 102 = 1458 square feet of net wall area. 1458 times 9.3 - 13,560 brick required plus 2% for waste. 13,560 plus 272 - 13,832 total bricks.

On a quantity take-off sheet this would be as shown in figure 5.13. For your convenience, the number of double common brick per square foot for various wall thicknesses and mortar joints is given in the table figure 5.14.

-- QUANTITY TAKE-OFF --

JOB NUMBER ___________

DATE ___________

SHEET NO. _______ OF ___

ITEM	UNIT	LENGTH	HT.	SQ. FEET	SQ. FT. OUT	TOTAL BRICK	
BRICK:							
1. WALLS	1	156.0"	10'0"	1560			
Windows	6	3' 0"	4'6"		81		
Door	1	3' 0"	7'0"		21		
					102		
				1560			
				102			
			NET	1458			
	1458 x	9.3 =	13,	560			
	Plus	2%		272			
			13,	832			
					13,832 brick		

FIG. 5.13

NUMBER OF DOUBLE COMMON BRICK (8" x 5" x 3 3/4") FOR ONE SQUARE FOOT OF BRICK WALL					
Thickness of Wall	Number of Brick Thick	Mortar Joints (Bed and End)			
		1/4"	3/8"	1/2"	5/8"
4"	1"	3.32	3.2	3.08	2.96
8"	2"	6.64	6.4	6.16	5.92
12"	3"	9.96	9.6	9.3	8.88

FIG. 5.14

5. Mortar Requirements:

In order to determine the cubic feet of mortar, divide the total number of brick by 1,000, and multiply by the factor given in the following table, figures 5.15 and 5.16

CUBIC FEET OF MORTAR REQUIRED FOR 1000 STANDARD BRICK (10% allowance for Waste Included)					
Joint Thickness	Various Wall Thicknesses				
	4"	8"	12"	16"	20"
1/4"	6.2	9.5	10.6	11.2	11.5
3/8"	9.5	12.9	14.1	14.7	15.0
1/2"	12.8	16.5	17.8	18.4	18.8
5/8"	16.2	20.1	21.4	22.1	22.5

FIG. 5.15

CUBIC FEET OF MORTAR REQUIRED FOR 1000 BRICK (One brick thick 10% waste included)		
Type of Brick (Actual size)	Joint Thickness	Cubic Feet
Roman 11 5/8 x 1 5/8 x 3 3/4	3/8	11.1
Norman 11 5/8 x 2 1/4 x 3 3/4	3/8	11.6
S C R 11 1/2 x 2 x 5 1/2	1/2	34.2

FIG. 5.16

Example --

Assume we have an 8" wall containing 12,500 standard brick (8" x 2 1/4" x 3 3/4") and a 3/8" mortar joint. We have 12.5 thousand brick. From the table given in figure 5.15 we find the factor 12.9 cubic feet per 1000 brick, therefore, 12.5 x 12.9 = 161.25 cubic feet of mortar is required.

The following table, figure 5.17 gives the percentages that must be added to the face brick (when backed up with common brick or block) for the type of bond specified.

PERCENTAGES ADDED TO FACE BRICK FOR VARIOUS BONDS		
Type of Bond	Full Headers	Percentages to be added
Common	Every 5th course	20% or 1/5
Common	Every 6th course	16.7% or 1/6
Common	Every 7th course	14.3% or 1/7
English	Every 6th course	16.7% or 1/6
English	Every other course	50% or 1/2
Flemish	Every 6th course	5/6% or 1/18
Flemish	Every course	33.3% or 1/3

FIG. 5.17

Now that we have covered this section on Brickwork, follow through the following example given using the plan and section in figure 5.18 and the quantity take off sheet shown in figure 5.19.

Example --

Estimate the total number of Standard Common Brick (motar joint 1/2 inch) required for the plan and section in figure 5.18

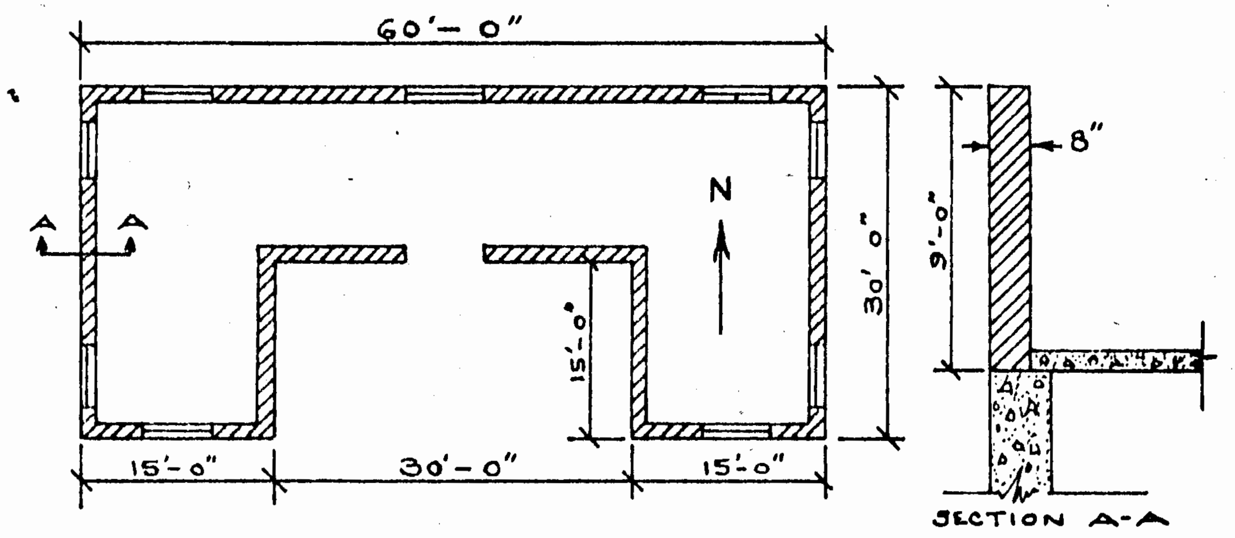


FIG.5.18

NOTE

Window Openings	2'-6" x 4'-0"
Door Openings	3'-0" x 7'-0"

Now assume that the wall on the plan in figure 5.18 is laid in common bond with the exterior face of the wall standard face brick. The face brick is bonded to the back up standard common brick with a full header every 6th course.

-- QUANTITY TAKE-OFF --

JOB NUMBER ______________

DATE ______________

SHEET NO. ________ OF ______

ITEM	UNIT	LENGTH	HGT.	TOTAL SQ.FT.	SQ. FT. OUT	NET SQ.FT.	TOTAL BRICK
BRICK:							
standard common							
1/2" mortar joint							
1. Walls	1	207'4"	9'0"	1866			
windows	9	2' 6"	4'0"		90		
doors	1	3' 0"	7'0"		21		
					111		
						1755	
	1755	x 12.32	=	21,622			
	Plus	2% 21,622 + 433					22055

FIG. 5.19

We can say that one half of the total brick found, without waste included, will be face brick and the other half brick every sixth course displace an amount of common brick, it can be seen that an additional amount of face brick will be required and this same amount will have to be deducted from the common brick.

When face brick (or the same kind of brick) is used on both sides of an 8 inch wall, no additional percentage is required for the various bonds.

The percentage table given in figure 5.17 gives the percentages that must be added to the face brick (when backed up with common brick or block) for the type of bond specified.

Example --

The total brick (without the waste allowance) in figure 5.19 is 21,622. One half of this is 10,811 face brick. To this figure we will add 16.7 percent (see table in figure 5.17) for a full header every 6th course.

Therefore: 16.7% of 10,811 = 1806 brick. 10,811 + 1806 = 12,617 face brick. For face brick add 3% for waste, the total face brick required is then 12,996. From the common brick of 10,811, we must subtract the 16.7 percent that displaced the common brick. Then, 10,811 - 1806 = 9,005 common brick. To common brick, add 2% for waste so we have a total of common brick 9,186.

6. Assignment:

Problem 1:

Prepare a quantity take-off (on the quantity take-off sheets provided) of the following materials from the plan and section in figure 5.20. If you have difficulty review Section II.

Take off the following:

(a) Concrete required for the footings.

(b) Concrete required for the walls

(c) Concrete required for the floor slab

(d) Cinders required for the 6" fill.

(e) Standard face brick and standard common brick (8" x 2¼" x 3 3/4") common bond with header every fifth course. Allow for waste. The mortar joint is 1/2 inch.

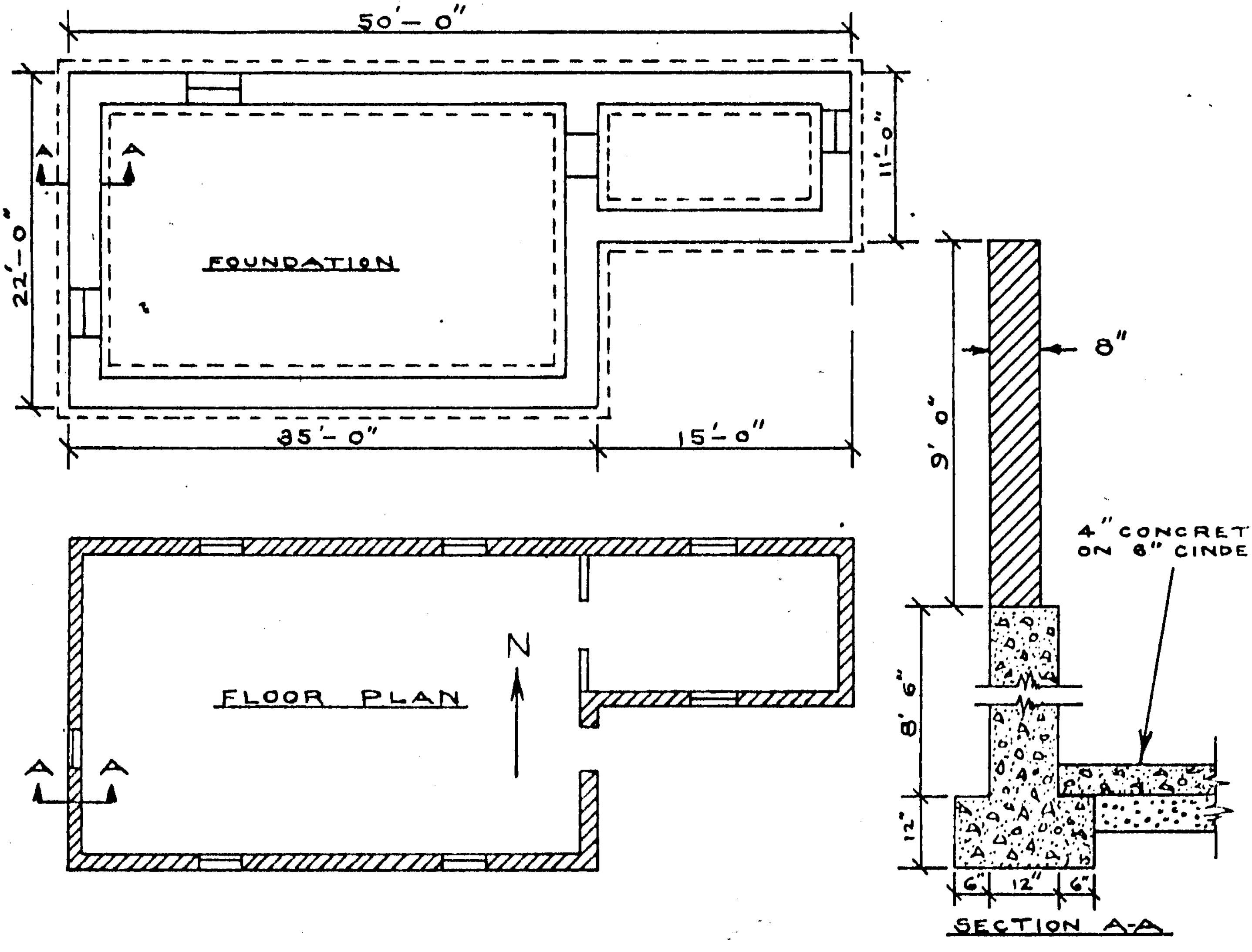


FIG. 5.20

Note --

Openings - Windows (basement) 3'-0" x 2'-0"

Door (basement) 3'-0" x 7'-0"

Windows (brick wall) 3'-0" x 5'-0"

Door (brick wall) 3'-0" x 7'-0"

Problem 2:

On the quantity take-off sheet provided take-off the quantity of face brick required from the plan and section in figure 5.21 which shows a composite wall backed with header blocks. The face brick are (7 5/8" x 2¼" x 3 5/8") actual size. The mortar joint is 3/8 inch. The brick is laid in English Bond with a full header every sixth course. Allow for waste.

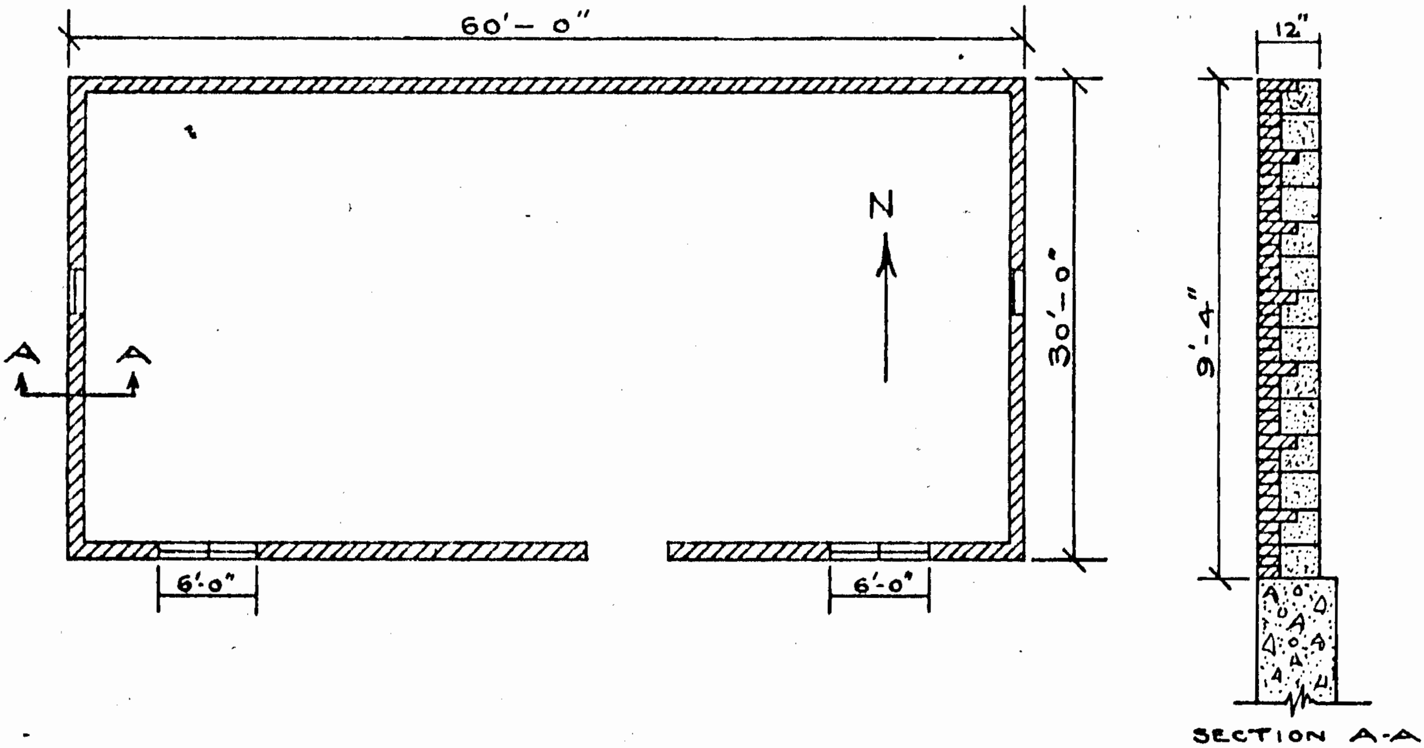


FIG. 5.21

Openings - Windows - 3'-0" x 5'-0"

6'-0" x 5'-0"

Door - 3'-0" x 7'-0"

--- QUANTITY TAKE-OFF SHEET ---

Date ________________ Assignment ____________ Name ________________

Class ______________________________ Sheet No. ____________ of ________

DESCRIPTION	DIMENSIONS						EXTENSIONS	EXTENSIONS

UNIT VI. CONCRETE BLOCKS

1. CALCULATING WALL AREAS
2. BLOCKS PER SQUARE FOOT
3. ESTIMATING CORNER BLOCKS
4. ESTIMATING JAMB BLOCKS
5. ESTIMATING JOIST BLOCKS
6. MATERIAL REQUIREMENTS FOR MORTAR
7. ASSIGNMENTS

UNIT VI CONCRETE BLOCKS

Objectives:

Following the completion of this unit a student will be able to:

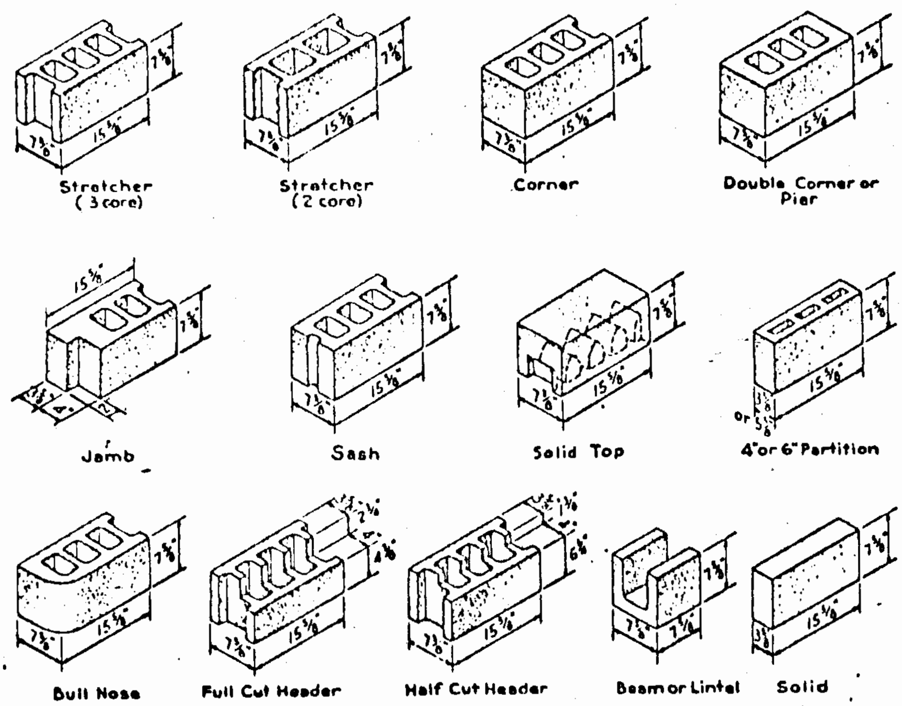
6.1 Calculate wall areas and block requirements

6.2 Estimate corner blocks, jamb blocks and joist blocks

6.3 List the ingredients required for a strong mortar mix

6.4 Correctly complete all assignments

In this section you will learn how to estimate the commonly used types of concrete blocks, stretcher blocks, corner blocks, jamb blocks and joist blocks. Figure 6.1 shows typical shapes and sizes of concrete blocks. These blocks are manufactured to the dimensions shown. However, a block 7 5/8" x 7 5/8" x 15 5/8" (actual size) is commonly called a 8" x 8" x 16" concrete block.



—*Courtesy Portland Cement Association*

FIGURE 6.1

Concrete blocks are usually referred to by their nominal dimensions (actual size of the block plus the mortar). The first dimension is the thickness, then the height and the third dimension is the length. The nominal size of the block is based on a 3/8 inch mortar joint. In addition to the common 8" thick blocks shown in figure 6.1, sizes of 4", 6", 10" and 12" are manufactured.

1. Calculating Wall Areas:

Concrete blocks are estimated by the number of each type required. Find the total square feet of wall surface area then deduct the area of all openings to determine the net wall area. Then from the net wall area you determine the number of blocks of the various types required.

I recommend using the centre line perimeter method. Take the outside perimeter of the building less four times the wall thickness and then multiply by the height of the wall. This gives the total area of the wall for masonry unit estimating, and avoids doubling of corners.

Example--

Calculate the area of the wall in the plan and section in figure 6.2. The outside perimeter of the walls is 60'-0" less four times the wall thickness (1'-0" x 4) = 4'-0". Therefore, the centre line perimeter of the walls is 56'-0" multiplied by the height of the walls (12'-0"). This gives us a total amount of 672 square feet of surface wall area.

It may be worth mentioning that the rule for finding the centre line perimeter of the walls (Perimeter less four times the wall thickness) applies not only to a simple four corner building but also to buildings with more than four corners.

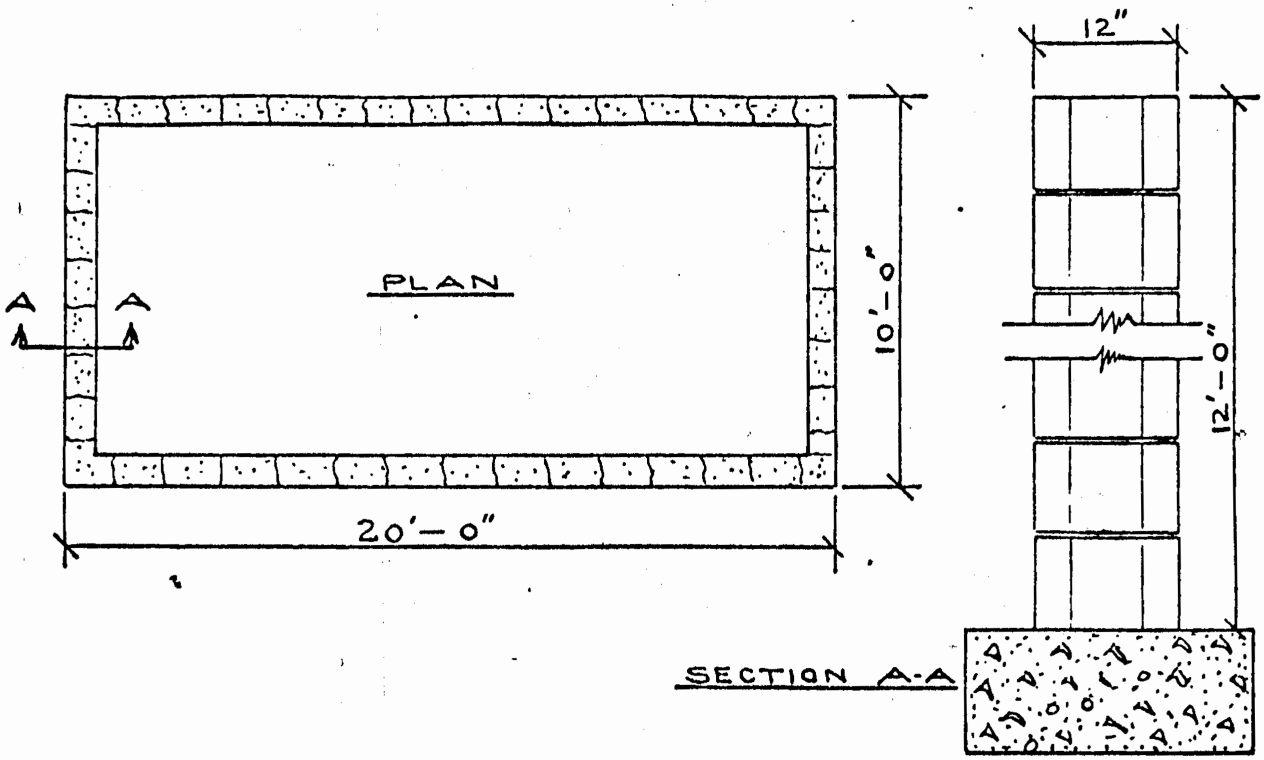


FIGURE 6.2

2. <u>Blocks per Square Foot</u>:

To calculate the number of blocks in one square foot you divide one square foot (144 sq. inches) by the nominal face area of one block. A block of nominal dimensions, 12" x 8" x 16", will have a face area of 8" x 16" = 128 square inches. Therefore, 144 ÷ 128 = 1.125 blocks per square foot.

The total number of square feet for the walls in figure 6.2 was 672 square feet. Then 672 ÷ 1.125 would give us a total of 756 blocks of this face size (8" x 16") required.

Note--

It is recommended that you increase by 2 percent any number of blocks over 100 to allow for wast or breakage. For an amount less than 100 it is advisable to add a block or two for waste.

We estimated 756 blocks were required for the plan in figure 6.2 so we will add 2 percent to this figure for a total of 772 blocks. (The allowance of 2 percent for waste and breakage could be less depending on the design of the building.)

3. Estimating Corner Blocks:

We will refer back to the plan in figure 6.2 where the height of the wall is 12'-0" or 144 inches. In order to determine the number of corner blocks required we simply divide this wall height by the height of the block (8") 144 ÷ 8" = 18 corner blocks are required for each corner. Therefore, 18 x 4 = 72 corner blocks. These would be subtracted from the total number of blocks estimated (772) and the remainder would be stretcher blocks 772 - 72 = 700 (including waste blocks).

4. Estimating Jamb Blocks:

Here we must determine the height of the window openings. We will assume there are two windows where the masonry opening measures 4'-0" wide by 4'-8" high. Using blocks 8" high, how many jamb blocks will be required for the two windows. Consult diagram in figure 6.3. The height of the rough opening is 4'-8" or 56 inches divided by 8" will give us 7 blocks. Each window will require two rows, one on each side for a total of 14 jamb blocks per window. The two windows then will require 28 jamb blocks.

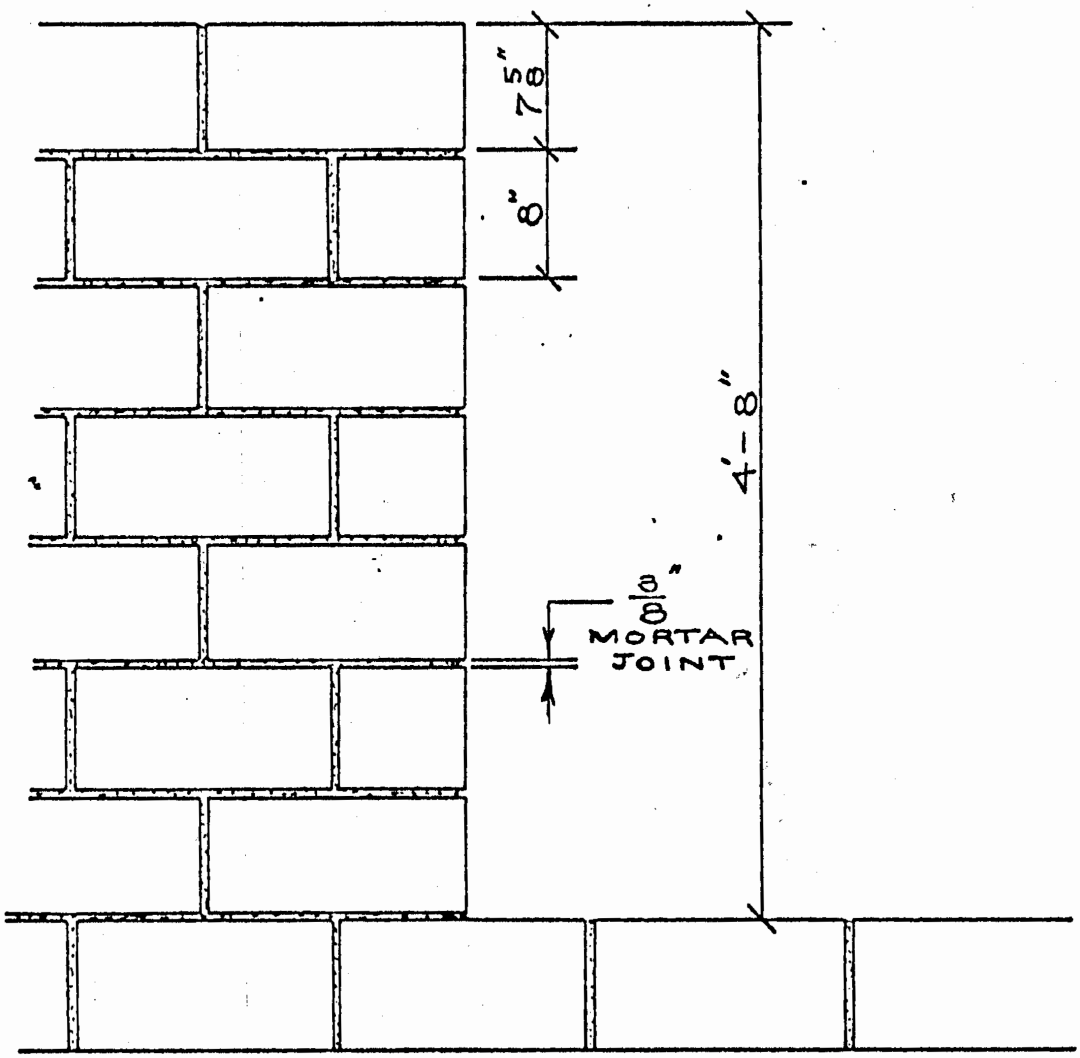


FIGURE 6.3

5. <u>Estimating Joist Blocks</u>:

The joist block is used where the wood joists are set into a concrete block wall. A joist block is of the same size and shape as a jamb block. See figure 6.4. To estimate the number of joist blocks required it is necessary to determine the number of joists bearing on the wall. The number of joist bearings will be the same as the number of joist blocks required.

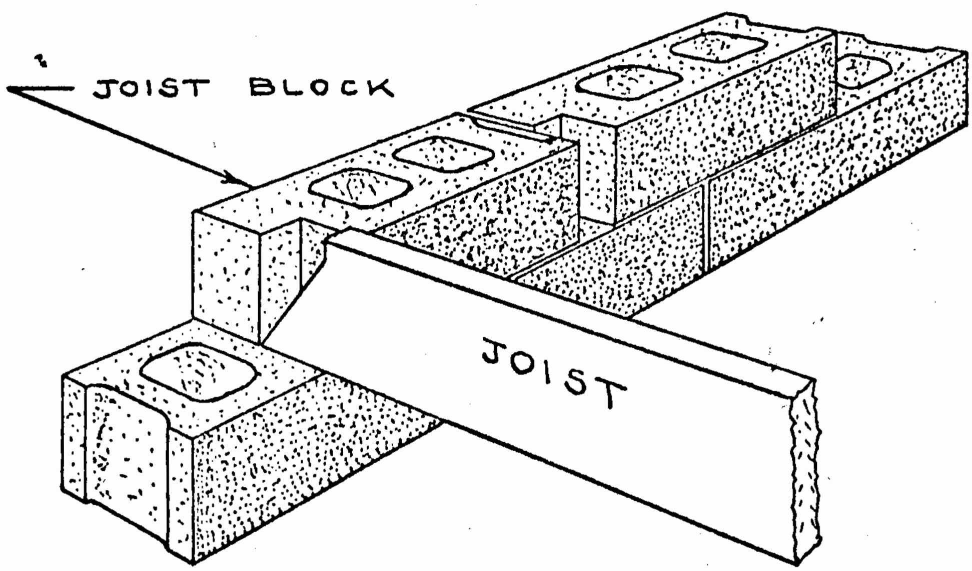


FIGURE 6.4

Example--

A basement foundation concrete block wall is 36'-0" long by 20'-0" wide (outside dimensions). The blocks are 8" wide, which makes the inside basement dimension 34'-8" by 18'-8". The joists at 16" o.c. will span the 18'-8" dimension. The number of joists bearing on the 34'-8" wall will then be 34'-8" x .75 = 26. Here I multiplied by .75 which is the joist factor per foot at 16" o.c. The joists will have bearing on both walls; therefore, 26 x 2 = 52 joist blocks are required for this foundation.

6. Material Requirements for Mortar:

The table given in figure 6.5 gives the quantities of mortar for various sizes of concrete blocks.

QUANTITIES OF MORTAR FOR CONCRETE BLOCKS			
Nominal size of block (thickness, height, length)	Cubic yards mortar per 1000 blocks (Approx. 20% for waste included.) Mortar Joint		
	1/4"	3/8"	1/2"
8" x 5" x 12"	0.65	0.85	1.10
8" x 8" x 16"	0.80	1.10	1.40
12" x 8" x 16"	0.86	1.20	1.54

FIGURE 6.5

In figure 6.2 we estimated 756 actual blocks required (no allowance for waste) 12" x 8" x 16" with a mortar joint of 3/8 inch is 756 blocks at 1.20 cubic yards or mortar per 1000 blocks (see figure 6.5). Therefore, 756 blocks of this size would require .756 x 1.2 = .9072 or rounded off at .91 cubic yards of mortar.

Lime for mortar--

The lime used in making masonry mortar is available as lump quicklime, pulverized quicklime or hydrated lime. It may be purchased in bags, barrels or in bulk. Before quicklime can be used in making mortar, it must be hydrated, or slaked by mixing it with water in the proper proportions and allowing it to season for several days.

Let us assume the mortar mix for the 756 blocks which required .91 cubic yards of mortar is 1:1:6 which is one part hydrated lime, one part cement and six parts sand. How much of each material would be required for the .91 cubic yards of mortar?

The quantities of material required for one cubic yard of mortar are given in the table figure 6.6 for various mortar mixes.

QUANTITY OF MATERIALS REQUIRED FOR ONE CUBIC YARD OF MORTAR					
Proportions by Volume (Mix)			Quantity		
Dry Lime	Cement	Sand	Lime (Lbs.)	Cement (Sacks)	Sand (Cu. Yd.)
1	0	3	450	0	1
2	1	9	300	3	1
1	1	6	225	4.5	1
0.5	1	4.5	150	6	1
0.2	1	3	90	9	1
0.1	1	3	45	9	1

FIGURE 6.6

From the table in figure 6.6 we see that for one cubic yard of mortar for a 1:1:6 mix we require 225 pounds of lime, 4.5 sacks of cement and one cubic yard of sand. From these figures then we can calculate the quantities of each required for .91 cubic yards of mortar.

Lime -- 225 x .91 = 204.75 pounds

Cement -- 4.5 x .91 = 4.095 sacks of cement

Sand -- 1 x .91 = .91 cubic yards sand

We have now covered this Section on concrete blocks, follow through the following examples given using the plan and section in figure 6.7 and the quantity take-off sheet shown in figure 6.8.

Example --

From the basement plan and section in figure 6.7 take off the following:

a) Number of stretcher blocks

b) Number of corner blocks

c) Number of window jamb blocks

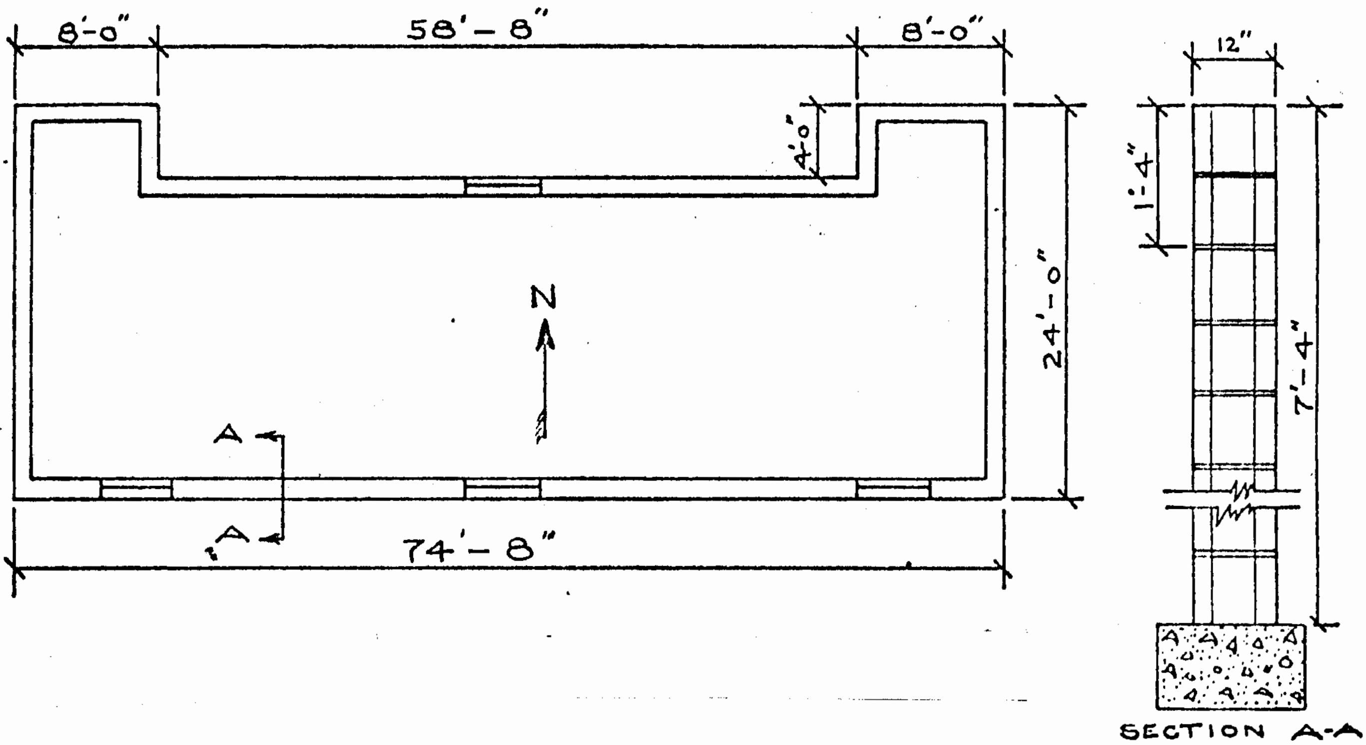


FIGURE 6.7

Note --

Blocks are 12" x 8" x 16" with a 3/8 inch mortar joint.

Window openings 2'-8" wide by 1'-4" high.

JOB NUMBER ____________

--- QUANTITY TAKE-OFF --- DATE ____________

SHEET NO. ________ OF ______

ITEM	UNIT	LENGTH	HEIGHT	SQ. FEET	SQ. FT. OUT	NET SQ. FEET	NO. OF BLOCKS
Concrete Blocks:							
Walls	1	201'4"	7'4"	1475.75			
Windows	4	2'8"	1'4"		14.2		
						1462	
	1462	x 1.125	= 1645	Blocks			
		Plus 2%	= 33				
		TOTAL	1678				
1. Corner Blocks	88"	÷ 8" = 11					
	11	x 8 = 88					88
2. Jamb Blocks	16"	÷ 8" = 2	x 2 = 4				
	4	x 4 = 16					16
3. Stretcher Blocks		1678 less (88 + 16) =					1574

FIGURE 6.8

7. Assignment:

Problem 1. From the plan and section shown in figure 6.9 estimate the following on the quantity take-off sheet.

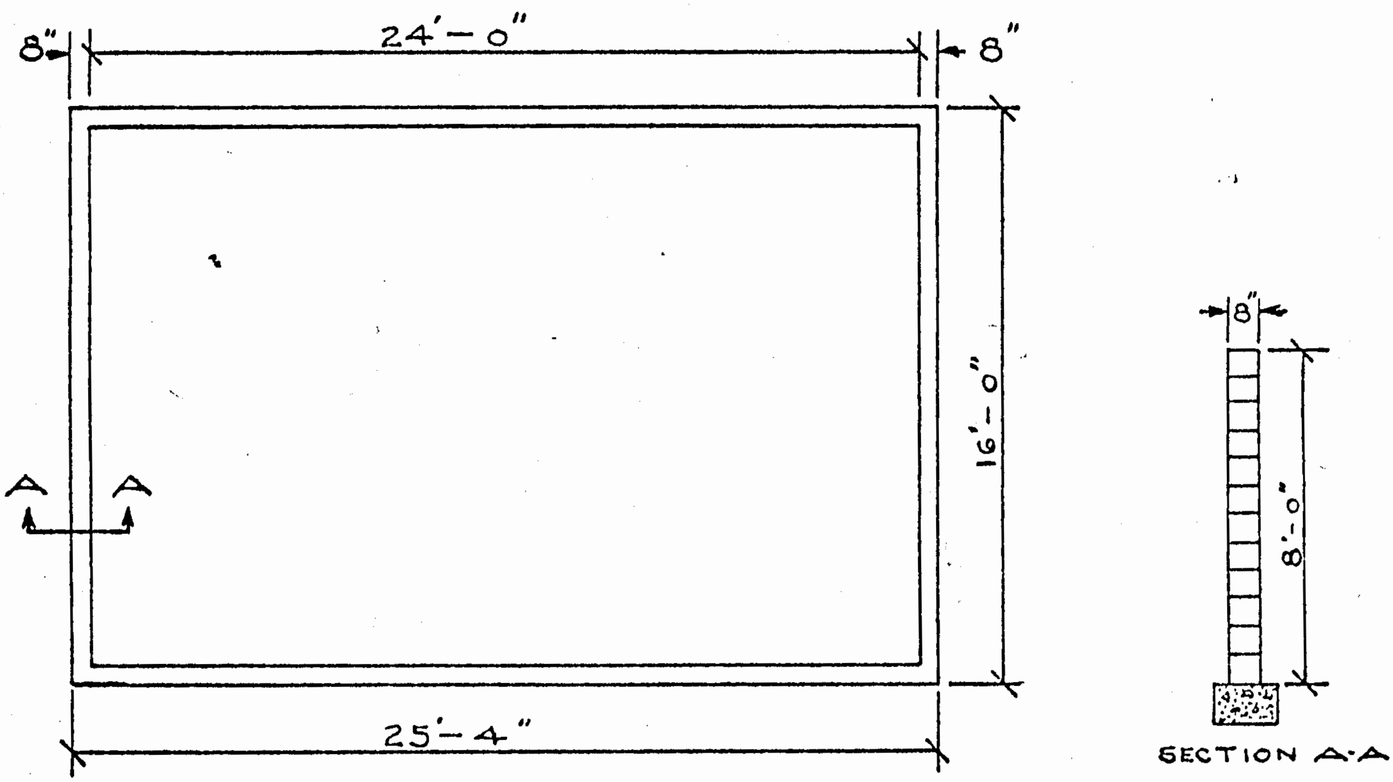


FIGURE 6.9

a) Area of the walls

b) Total number of concrete blocks, when the block size is 8" x 8" x 16". Mortar joint is 3/8 inch. Add 2% for waste and breakage.

c) Number of corner blocks required.

d) Number of joist blocks, when the joists are 16" o.c.

e) Total number of stretcher blocks.

f) Exact quantities of lime, cement and sand when a mix of 1:1:6 is used.

Problem 2. From the plan and section shown in figure 6.10 take off the following on the quantity take off sheet.

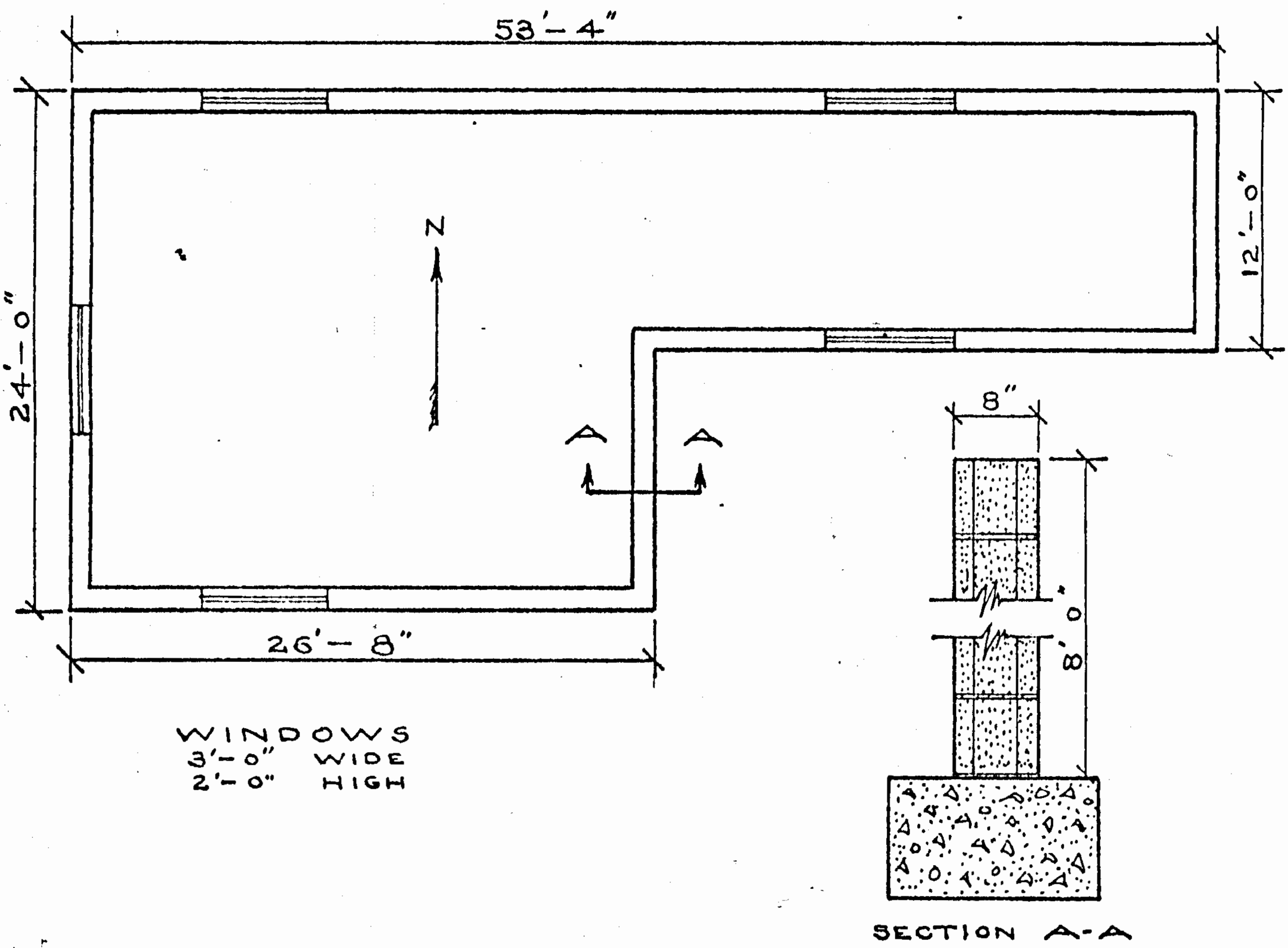


FIGURE 6.10

a) Determine the net square feet of surface wall area.

b) Estimate the total number of blocks (allow 2% for waste and breakage). Block size 8" x 8" x 16" with 3/8" mortar joints.

c) Find the number of corner blocks.

d) Find the number of jamb blocks.

e) Find the number of stretcher blocks.

f) Determine the cubic yards of mortar when 0.5:1:4.5 mix is used (mortar joint 3/8 inch)

g) Find the following:

1.) Pounds of lime

2.) Sacks of cement

3.) Cubic yards of sand

--- QUANTITY TAKE-OFF SHEET ---

Date ______________________ Assignment ______________ Name ___________________________

Class ____ Sheet No. ______________ of __________

DESCRIPTION	DIMENSIONS						EXTENSIONS	EXTENSIONS

UNIT VII - STEEL

1. COMMON STRUCTURAL STEEL MEMBERS
2. ESTIMATING STEEL LINTELS OVER OPENINGS
3. ESTIMATING STEEL BEAMS AND GIRDERS
4. ESTIMATING BEARING PLATES AND BILLET PLATES
5. ASSIGNMENT

UNIT VII STEEL

OBJECTIVES

Following the completion of this unit a student will be able to:

7.1 List the common structural steel members.

7.2 Calculate steel Lintels for:

- window openings
- door openings

7.3 Compare "Bearing Plates" to Billet Plates.

7.4 Define by use of tables of angles, the required weights of steel.

7.5 Correctly complete all assignments.

UNIT VII STEEL

Heavy structural steel construction is a specialized field, however it is necessary for the estimator to be familiar with most of the common steel members. In all estimates you will run across some areas where miscellaneous steel is required. In this section you will learn how to take-off the quantities of steel required for steel beams, the angle iron used for lintels over masonry openings, bearing plates for steel beams, as well as billet plates to which steel columns are bolted or welded.

When estimating the weight of structural steel required for a job, the estimator will determine from the plans the total lineal feet for each shape by size or weight. Structural Steel Handbooks will provide you with the nominal weights, variations in weights, amounting to 2 1/2 percent above or below the nominal weights are permissable and may occur. In estimating the weight of a steel plate having an irregular shape, the weight of the rectangular plate from which the shape is cut should be used. Steel weighs 490 pounds per cubic foot or .283 pounds per cubic inch.

1. COMMON STRUCTURAL STEEL MEMBERS:

We will review some of the most common structural steel members used on a job before we begin the actual take-off of the various steel items.

(a) Structural Shapes:

The products of the rolling mills uses as structural steel members are knows as sections or shapes and are identified by the shape of their cross sections.

Regular Sections - are those in constant demand and are the most commonly used; these are readily obtainable.

Special Sections - are those less frequently used and are rolled only by special arrangement.

(b) Standard I-Beams:

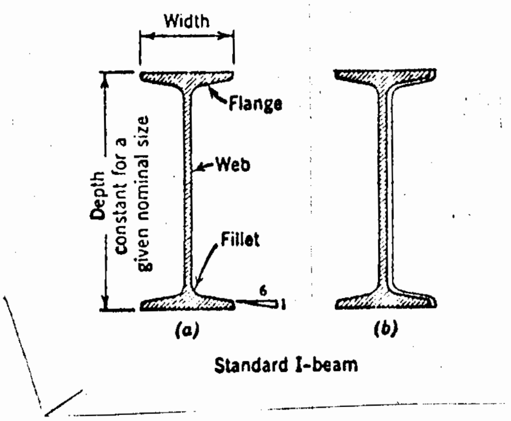


FIGURE 7.1

The Standard I-Beam shown in Figure 7.1 may be identified in this manner 12" I 31.8#. This abbreviation shows that the section is a Standard I-Beam having a depth of 12 inches and weighing 31.8 pounds per lineal foot. On drawings, the symbols for inches and pounds are omitted and the I-Beam will be indicated as 12 I 31.8.

(c) Standard Channels:

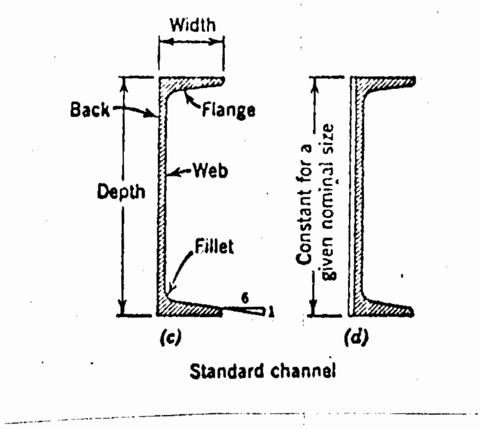


FIGURE 7.2

A standard channel section is seen in Figure 7.2 and will be identified as 10 ⊏ 15.3 which indicates that the channel has a depth of 10 inches and weighs 15.3 pounds per lineal foot. The absence of the flange on one side of a channel section makes them particularly suitable for framing around floor openings, spandrels and lintels.

(d) Wide Flange Sections:

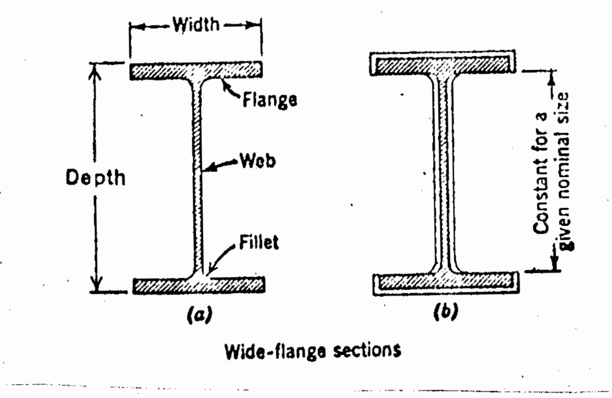


FIGURE 7.3

In general a wide flange section see Figure 7.3 will have a greater flange width and less material in the web than the Standard I-Beams. They are designated 12WF27 which indicates that the wide flange section has a depth of 12 inches and it will weigh 27 pounds per lineal foot. A wide flange section is more efficient with regard to bending than the Standard I-Beam.

(e) Miscellaneous Column Sections:

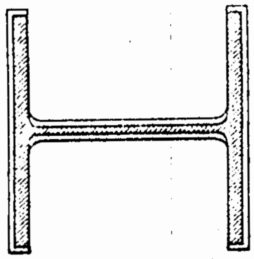


FIGURE 7.4

These sections have depth of webs and widths of flange more nearly equal as in Figure 7.4. Miscellaneous column sections will be designated as 8 x 8 M 34.3 which indicates the depth is 8 inches and the width of the flange is 8 inches. The weight will be 34.3 pounds per lineal foot.

(f) Angles:

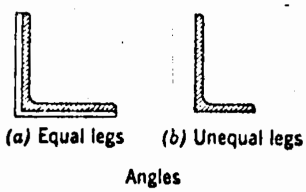


FIGURE 7.5

Structural angles in Figure 7.5 are rolled sections in the form of the letter "L". There are two classes, equal leg and unequal leg angles. One has both legs the same length and the other will have one leg of greater length than the other Figure 7.5 (b). The thickness of both legs will be the same dimension. Angles are designated as L 4 x 4 x 3/8 which would mean both legs are 4 inches and the thickness is 3/8 inches. An unequal leg angle would be designated as L 5 x 3 1/2 x k/2 neabubg ibe keg us 5 inches, the other 3 1/2 inches, and the thickness 1/2 inch. Angles are frequently used as lintels and light steel trusses will have members formed of pairs of angles.

(g) Structural Tees and Z Sections:

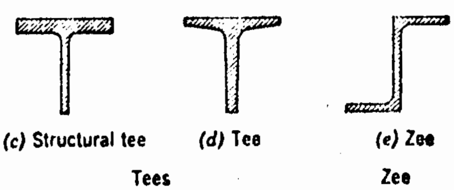


FIGURE 7.6

Both of these sections are classified as "Special Sections" and are therefore rolled only be special arrangement. A T section is designated 4 x 4 x 13.5 which means it measures 4 inches by 4 inches and weight 13.5 pounds per lineal foot. A Z section would be designated 4 x 3 1/16 x 8.2 meaning the depth of the Z is

4 inches and the flange is 3 1/16 with the weight being 8.2 pounds per lineal foot.

(h) Plates and Bars:

Flat steel for structural use is generally classified as: Bars - up to 8 inches in width and over .230 inches in thickness. Plates - over 8 inches in width and over .230 inches in thickness. Over 48 inches in width and more than .180 inches in thickness.

Bars - with 1/4 inch widths and 1/8 inch increments in thickness are the usual practice.

Plates - the preferred widths are even inches and the thickness of plate is as follows:

1/32 inch up to 1/2 inch

1/16 inch over 1/2 inch to 2 inches

1/8 inch over 2 inches to 6 inches

1/4 inch increments over 6 inches

Example:

A typical concrete floor slab with steel members is shown in Figure 7.7. The three steel members are:

(a) Two 9 inch channels used around a well opening within the slab.

(b) A Wide Flange Beam used as a floor beam.

(c) An I Beam used as a spandrel beam at an exterior wall.

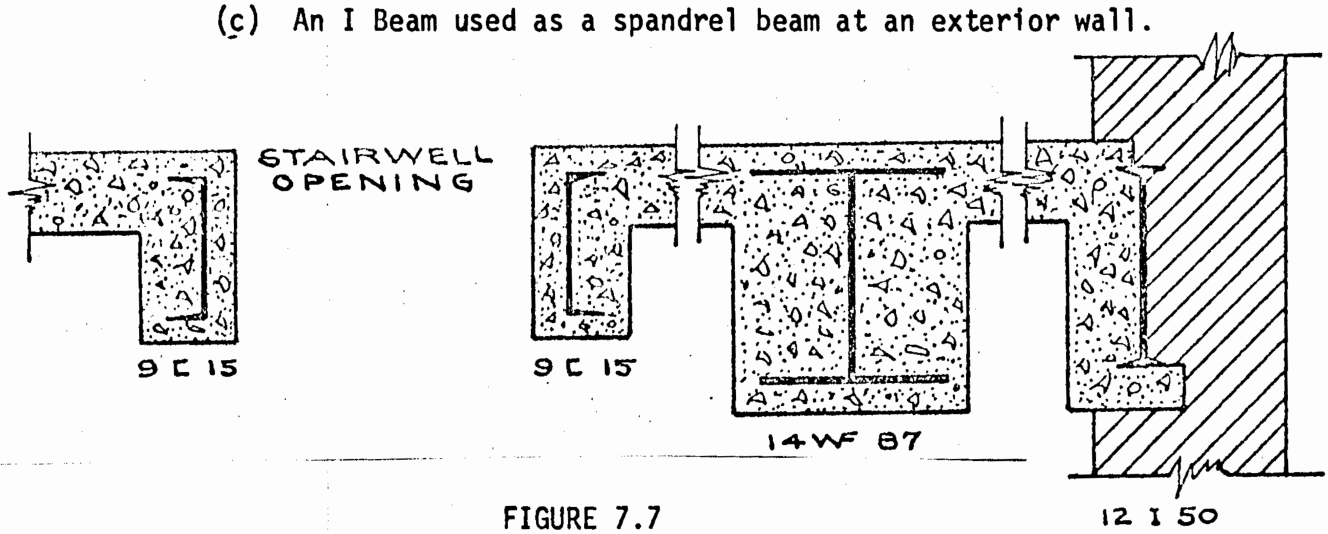


FIGURE 7.7

You will note that the principle difference between the I-Beam and the Wide Flange Beam is in the difference in the width of the flange. The flange of the Wide Flange Beam is much wider than the flange of the I-Beam.

The notation 9 [15 in Figure 7.7 means that the depth of the steel member is 9 inches, the steel member is a channe., and the weight of the channel is 15 pounds per lineal foot. The notation 14 WF 87 means that the depth of the member is 14 inches, it is a Wide Flange Beam and weighs 87 pounds per lineal foot.

2. ESTIMATING STEEL LINTELS:

Steel lintels in the form of angle iron used over window and door openings in a brick wall as seen in Figure 7.8 will give you an idea of how these members support the brick over the opening. Section AA of the pictorial drawing is shown in B. Other steel lintels in section view are shown in C. D, and E.

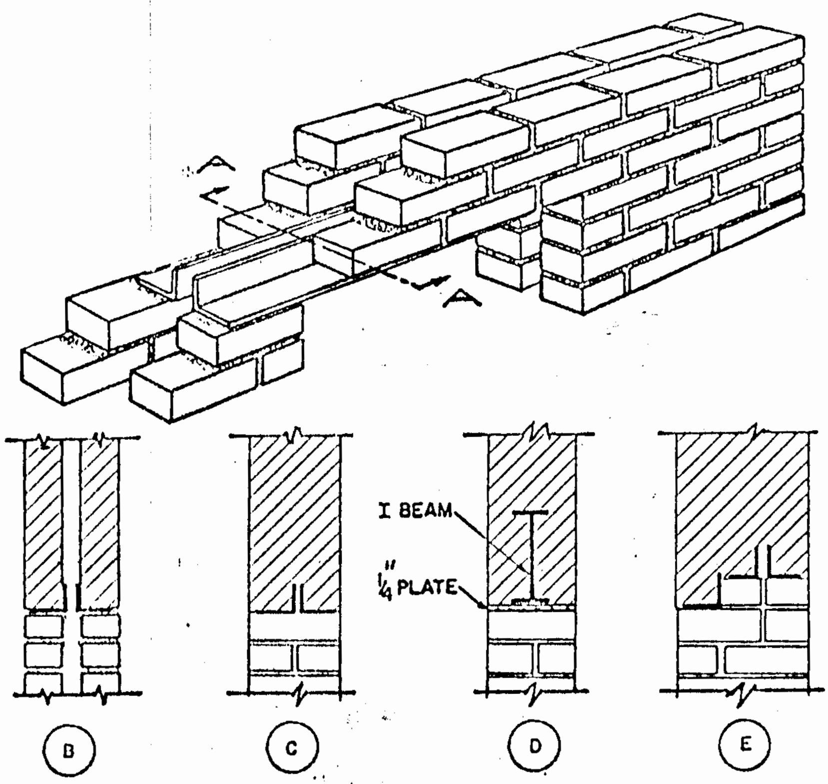


FIGURE 7.8

Steel lintels over window and door openings in masonry walls are calculated by multiplying the number of lintels over the openings by the length of the lintel by the weight of the lintel per lineal foot to get the weight in pounds.

<u>Example</u>:

Determine the total lineal feet of angle iron lintels used over the windows and door openings on the plan Figure 7.9. The lintels are 4" x 3" x 5/16" over windows and door, and 6" x 4" x 7/16" steel angles over the 6'-8" window opening, having a bearing surface of 4 inches at both ends.

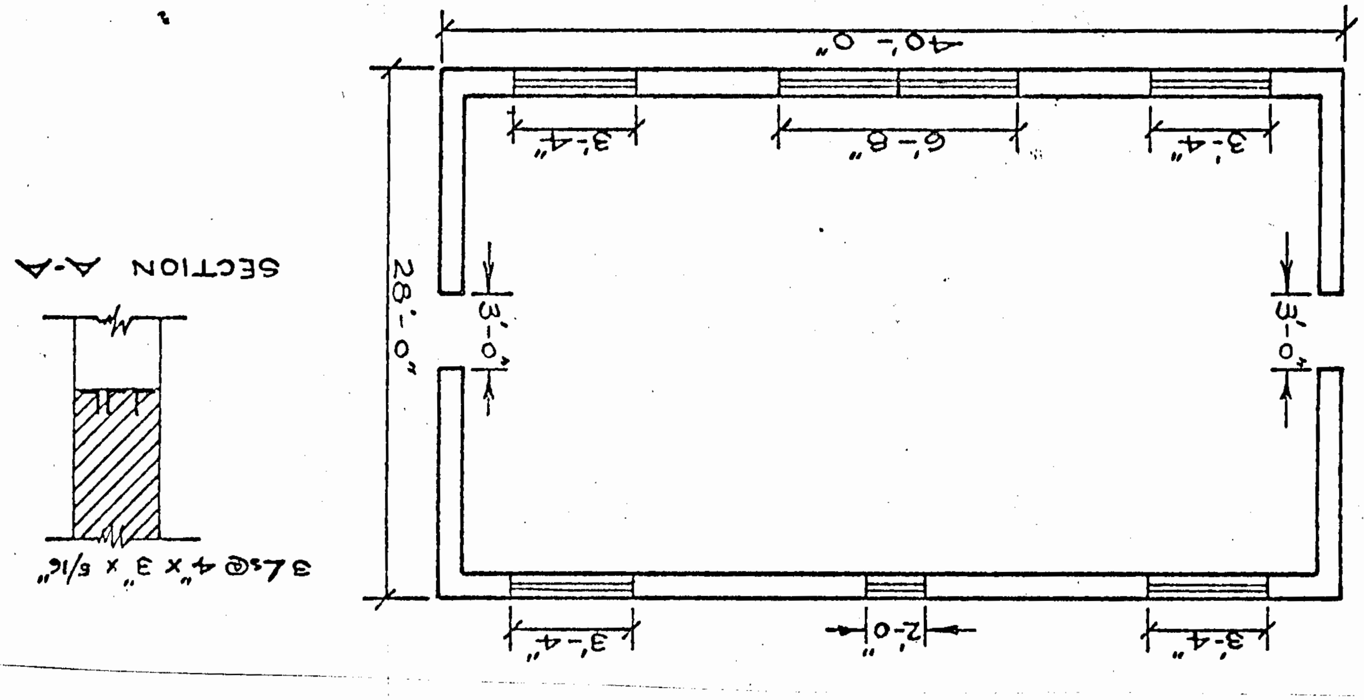


FIGURE 7.9

The detail drawing in Section AA Figure 7.9 shows three lintels over each window opening. Four windows with a masonry opening of 3'-4" and a lintel bearing of 4 inches at each end will make an angle length of 3'-4" + 8" = 4'-0".

One window with a masonry opening of 2'-0" plus the 4" of bearing on each end gives us a length of 2'-8" or (2.67 feet).

One window with an opening of 6'-8" plus 8 inches will give you 7'-4' or (7.33 feet).

Two doors with a 3'-0" opening plus 8 inches = 3'-8" or (3.67 feet).

Therefore we have 4" x 3" x 5/16 angles over the following openings:

4 windows x 3 angles x 4 feet 48 ft. of angle iron

1 window x 3 angles x 2.67 feet = 8.01 ft. of angle iron

2 doors x 3 angles x 3.67 feet = 22.02 ft. of angle iron

Total Length: 78,03 ft. of angle iron

The weight of a 4" x 3" x 5/16" steel angle is 7.2 pounds per lineal foo
foot (see table Figure 7.10). Then 78.03 x 7.2 = 561.82 pounds.

6" x 4" x 7/16" angles are required over the following opening.

1 window 6'-8" plus 8" = 7'-4" or (7.33 feet).

1 window x 3 angles x 7.33 = 21.99 feet of angles.

The weight of 6" x 4" x 7/16" is 14.3 pounds.

Then 21.99 x 14.3 = 314.46 pounds.

Therefore the total weight required is

561.82 pounds plus 314.46 pounds = 876.28 or 876.28 ÷ 2000 = .438 tons.

These quantities would appear on the Quantity Take-Off Sheet as shown in Figure 7.11.

TABLE OF STEEL ANGLES AND THEIR WEIGHTS PER LINEAR FOOT					
Length of Legs (Inches)	Thickness (Inches)	Weight Per Foot (Lbs.)	Lenght of Legs (Inches)	Thickness (Inches)	Weight Per Foot (lbs)
4 x 3	1/4	5.8	6 x 4	3/8	12.3
	5/16	7.2		7/16	14.3
	3/8	8.5		1/2	16.2
	1/2	11.1		5/8	20.0
4 x 3 1/2	1/4	6.2	7 x 3 1/2	3/8	13.0
	5/16	7.7		7/16	15.0
	3/8	9.1		1/2	17.0
	1/2	11.9		5/8	21.0
5 x 3 1/2	5/16	8.7	6 x 6	3/8	14.9
	3/8	10.4		1/2	19.0
	1/2	13.6		5/8	24.2
	5/8	16.8		7/8	33.1

FIGURE 7.10

JOB NUMBER ______________

DATE ______________

SHEET NO. _______ OF ____

--- QUANTITY TAKE-OFF ---

STEEL	UNITS	LENGTH	TOTAL LENGTH	FOOT	POUNDS		TONS
LINTELS:							
(1) Windows							
4" x 3" x 5/16"	12	4'	48'				
4" x 3" x 5/16"	3	2.67'	8.01'				
(2) Doors							
4" x 3" x 5/16"	6	3.67'	22.02'				
			78.03	7.2	561.82		
(3) Window							
6" x 4" x 7/16"	3	7.33	21.99	14.3	314.46		
				Total:	876.28		4 3 8 TONS

FIGURE 7.11

3. ESTIMATING STEEL BEAMS AND GIRDERS:

To estimate beams and girders you must determine the total length of beams of the same size then multiply by the weight per foot to get the total pounds. Then we divide by 2000 to determine the tons.

Example:

On the plan in Figure 7.12 as shown the following steel sections:

1 - 18 WF 85 girder

7 - 10 WF 21 beams

4 - 6 I 12.5 beams

All steel members will have a six inch bearing surface. Take-off the total tonnage of steel required.

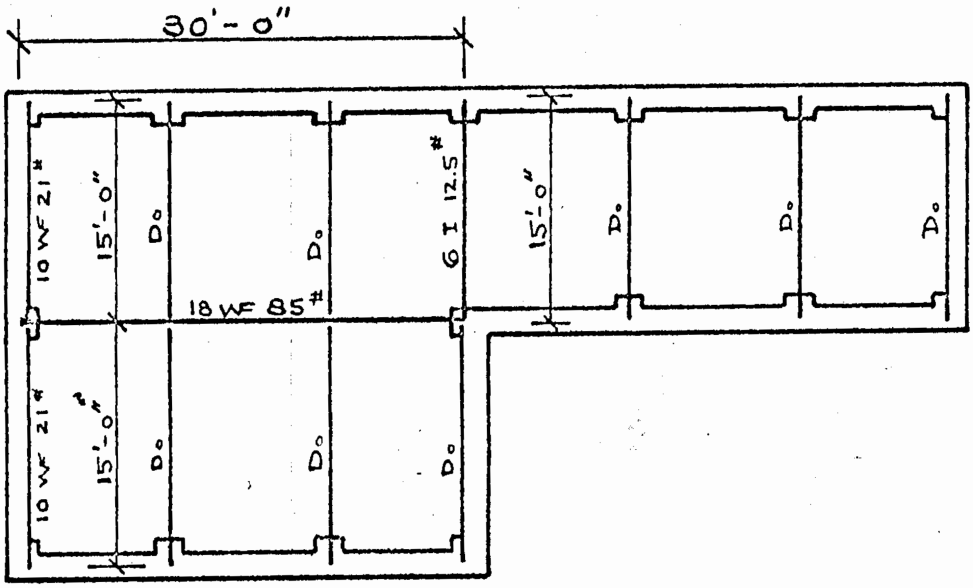


FIGURE 7.12

This example would be as seen on the Quantity Take-Off Sheet in Figure 7.13.

JOB NUMBER ____________

--- QUANTITY TAKE-OFF --- DATE ____________

SHEET NO. ______ OF ______

STEEL	UNIT	LENGTH	TOTAL LENGTH	WEIGHT Per FOOT	TOTAL POUNDS		TONS
(1) Girder -							
18 85	1	30.0	30.0	85	2550		
(2) Beams	7	15.0	105.0	21	2205		
10 21							
(3) I-Beams							
6 I 12.5	4	15.0	60.0	12.5	750		
					5505		2 .7 5 TONS

FIGURE 7.13

4. ESTIMATING BEARING PLATES AND BILLET PLATES:

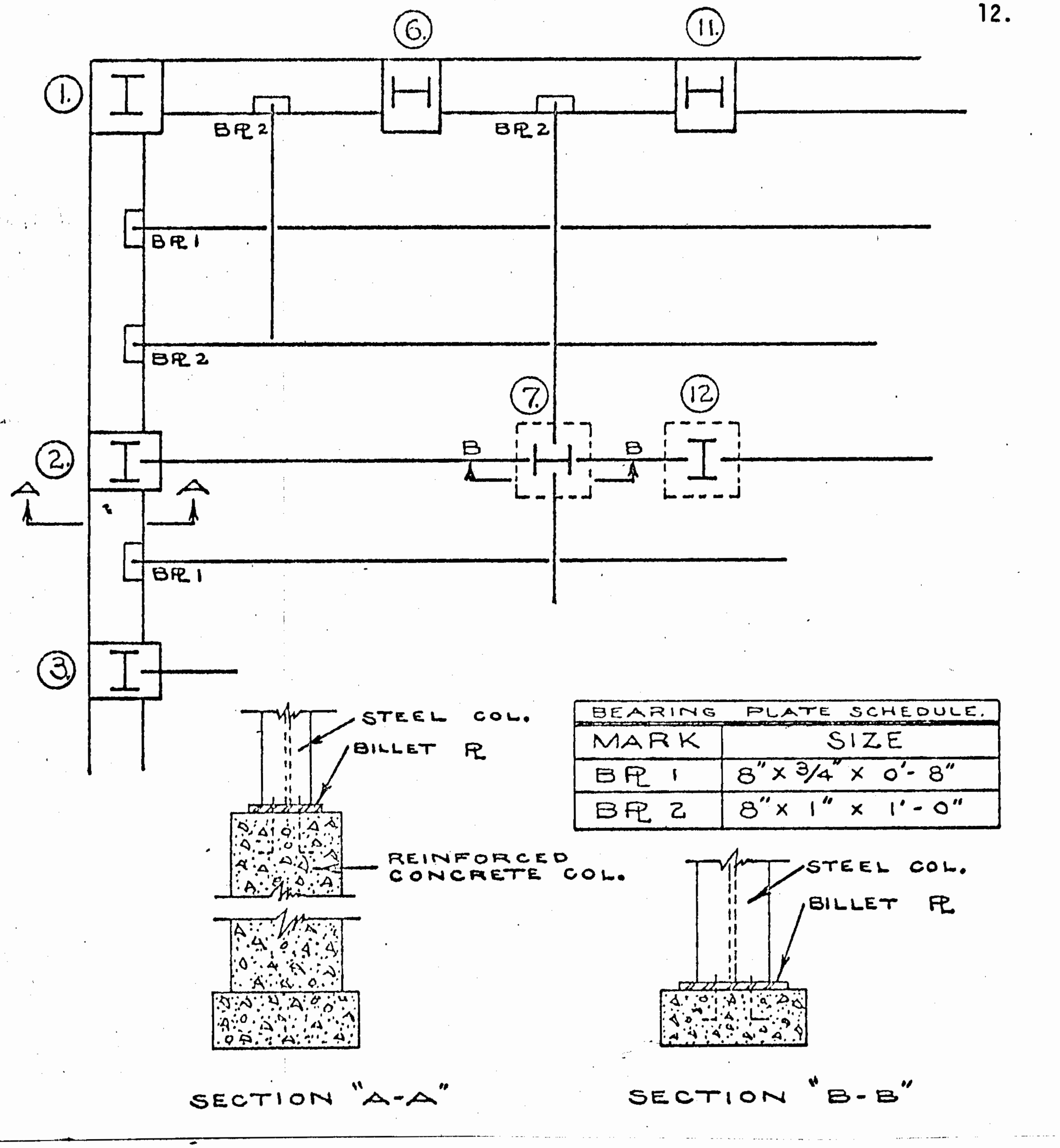
Steel bearing plates are used under the bearing ends of steel beams and girders where they rest on the foundation walls. Billet plates are used on top of reinforced concrete columns and footings to receive the steel columns. The columns are usually welded to the billet plates.

To estimate the weight of these plates, it is a case of multiplying the width of the plate in inches by the length of the plate in inches by the thickness of the plate in inches this will determine the cubic inch.

Then you multiply the total cubic inches by .283 pounds (the weight of the steel per cubic inch). This sum can then be converted to tons by dividing by 2000. This will give you the total tons of steel plate required.

Example:

Determine the total weight of steel plates required under the bearing ends of beams and on top of the reinforced concrete columns shown on the plan in Figure 7.14



BEARING PLATE SCHEDULE.	
MARK	SIZE
BPL 1	8" x 3/4" x 0'- 8"
BPL 2	8" x 1" x 1'- 0"

FIGURE 7.14

The size of billet plates for the columns are shown on the following Billet Plate Schedule in Figure 7.15 and the suzes of the bearing plates for the beams are indicated on the Bearing Plate Schedule Figure 7.14.

BILLET PLATE SCHEDULE	
Column No.	Billet Plate Size
1	14" x 1 1/4" x 1'-2"
2	32" x 3 1/2" x 1'-0"
3	24" x 2 1/2" x 1'-0"
6	14" x 1" x 1'-0"
7	14" x 1 1/4" x 1'-0"
11	33" x 4" x 1'-0"
12	29" x 3" x 2'-5"

FIGURE 7.15

First you must determine the cubic inches of steel in each billet plate and bearing plate. This can be done on the Quantity Take-Off Sheet as shown in Figure 7.16. Once you have the total cubic inches it is a simple operation to convert this to pounds and then to tons.

JOB NUMBER ____________

DATE ____________

SHEET NO. ______ OF ____

STEEL	UNIT	WIDTH	THICK-NESS	LENGTH	CUBIC INCHES	POUND	TONS
(1) Billet Plates:							
Column No. 1	1	14	1.25	14	245		
No. 2	1	32	3.5	12	1344		
No. 3	1	24	2.5	12	720		
No. 6	1	14	1	12	168		
No. 7	1	14	1.25	12	210		
No. 11	1	33	4	12	1584		
No. 12	1	29	3	29	2523		
(2) Bearing Plates:							
No. 1	2	8	.75	8	96		
No. 2	3	8	1	12	288		
					7178		
						2031.37	1 TON

FIGURE 7.16

5. ASSIGNMENT:

Problem 1:

On the Quantity Take-Off Sheet estimate the steel lintels required over the window and door openings shown on the plan in Figure 7.17. The lintels are steel angles 4" x 3" x 3/8" (two over each opening). The bearing of the lintels is 4 inches.

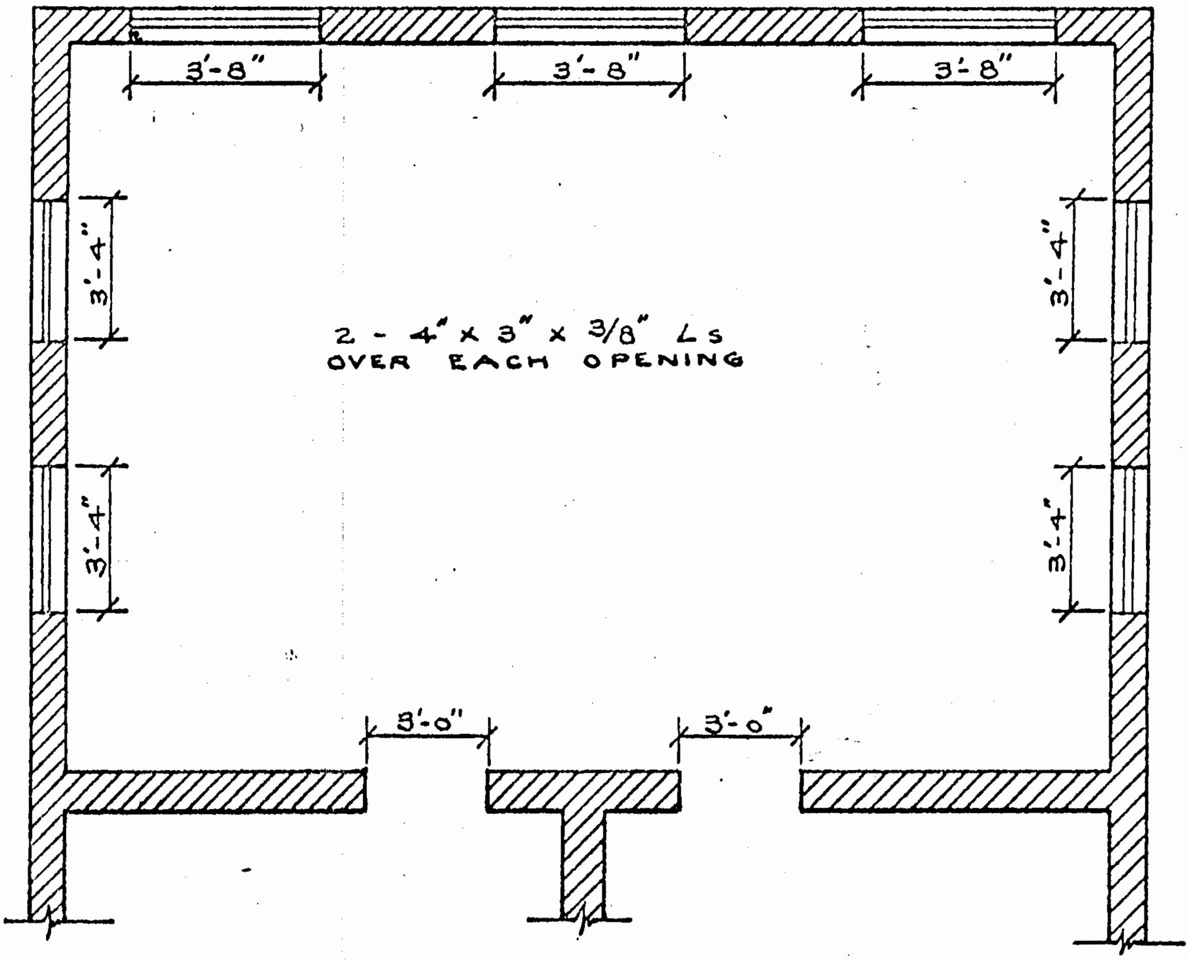


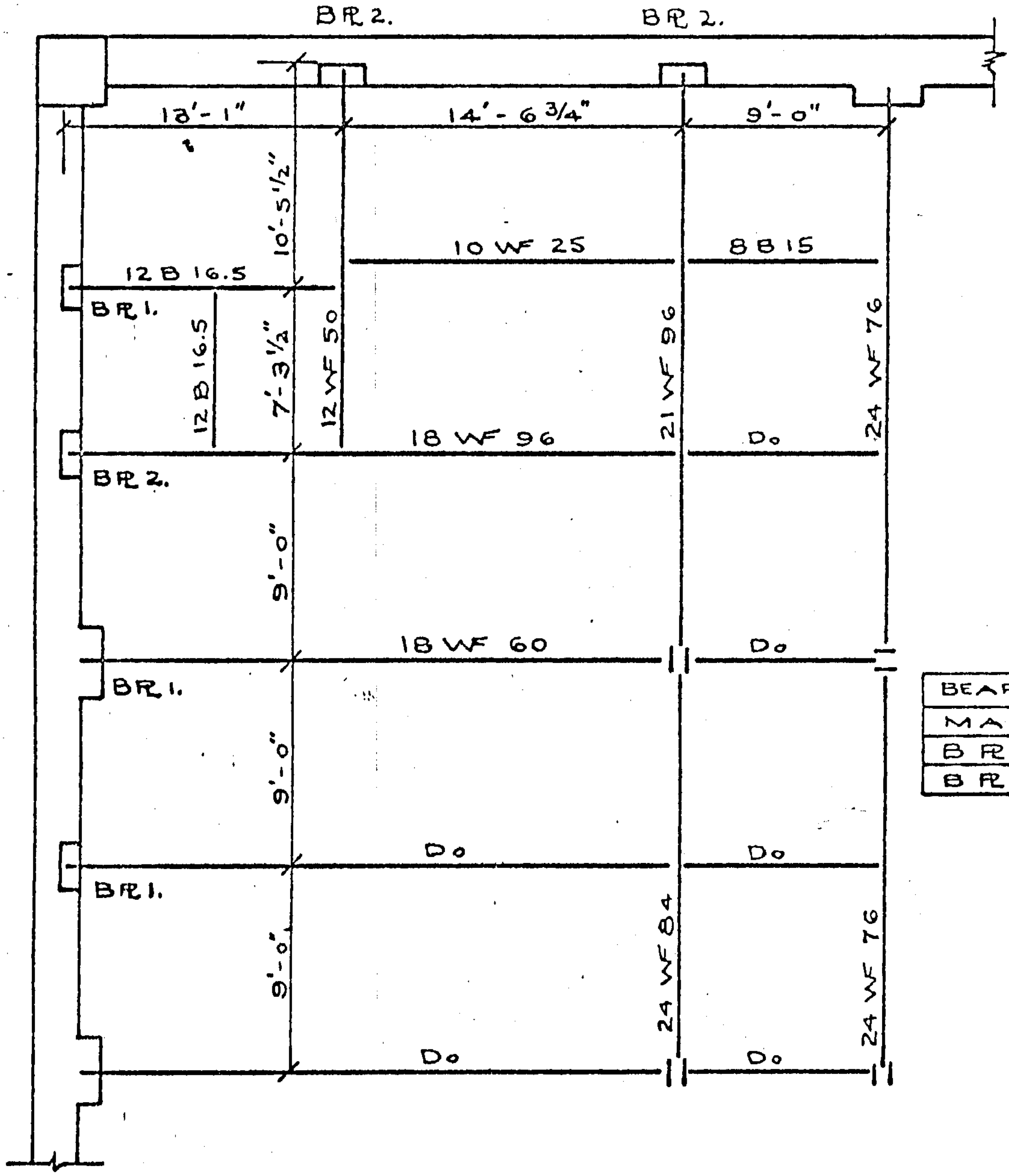
FIGURE 7.17

Problem 2:

In this problem refer to the plan in Figure 7.18.

(a) On the Quantity Take-Off Sheet estimate the beams. Show the item, unit, length, total length, weight per lineal foot, total weight in pounds and the total tonnage.

(b) On the Quantity Take-Off sheet estimate the Bearing plates and show the mark, unit, width, thickness, length, cubic inches, pounds and the tons.



BEARING PLATE SCHEDULE.	
MARK	SIZE
B R 1	8" x 3/4" x 1'-0"
B R 2	8" x 1" x 1'-2"

FIGURE 7.18

--- QUANTITY TAKE-OFF SHEET ---

Date ______________ Assignment ______________ Name ______________

Class ______________ Sheet No. ______________ of ______________

DESCRIPTION	DIMENSIONS						EXTENSIONS	EXTENSIONS

UNIT VIII - LUMBER

1. DETERMINING COST PER BOARD FOOT

2. CALCULATING NUMBER OF PIECES FROM BOARD FEET

3. CALCULATING LINEAL FEET FROM BOARD FEET

4. ESTIMATING LAMINATED WOOD BEAMS

5. ESTIMATING WOOD JOISTS

6. ESTIMATING BRIDGING

7. ESTIMATING WALL PLATES AND PARTITION PLATES.

8. ESTIMATING WALL STUDS AND PARTITION STUDES

   A) HEADERS
   B) GIRTHS

9. ESTIMATING COMMON RAFTERS

   A) RIDGE BOARD
   B) COLLAR TIES

10. ESTIMATING GABLE END STUDS

11. ESTIMATING SHEATHING

    A) FLOORS
    B) WALLS
    C) GABLE ENDS
    D) ROOF

12. ASSIGNMENTS

UNIT VIII - LUMBER

OBJECTIVES:

Following the completion of this Unit a student will be able to:

8.1 - calculate board feet

8.2 - determine the correct size and spacing of floor joist

8.3 - estimate within five percent the number of: joist
bridging
plates
studs
headers
girths

8.4 - correctly complete all assignments

UNIT VIII - LUMBER

In this section our estimating will be confined to the take-off of the rough lumber or framing lumber by the board foot for beams, joists, plates, studs, rafters, sheathing, etc.

1. DETERMINING THE COST PER BOARD FOOT:

Lumber will usually be priced at so many dollars per thousand board feet, or per hundred board feet. When it is priced by the thousand you must divide the cost by 1000 to obtain the cost per board foot or if the price is per 100 board feet then divide the cost by 100 to obtain the cost per board foot.

Example: Determine the cost of 80 pieces of 2" x 8" x 16'-0" at \$170.00 per thousand board feet. Here our cost per board foot is \$170.00 ÷ 1000 = .17 per board foot. We simple move the decimal point three places to the left. We have $\frac{80 \times 2 \times 8 \times 16}{12}$ = 1708 feet board measure @ .17 = \$290.36, the cost of 1708 feet board measure.

Find the cost of the following lumber:

20 pieces 2" x 8" - 10'-0" @ $180.00 per 1000

60 pieces 2" x 8" - 8'-0" @ $180.00 per 1000

30 pieces 2" x 8" - 12'-0" @ $180.00 per 1000

Prices given are not necessarily correct for all parts of the country and are used for illustration only.

Solution - 20 pieces 10'-0" = 200 lineal feet

60 pieces 8'-0" = 480 lineal feet

30 pieces 12'-0" = 360 lineal feet

Total lineal feet of 2"x88"s 1040

Feet Board Measure = $\frac{2 \times 8}{12} \times 1040 = \frac{4160}{3}$ = 1386 2/3 or 1387 f.b.m.

Cost per board foot = $180.00 ÷ 1000 = .18

1387 x .18 = $249.66 total cost.

2. DETERMINING THE NUMBER OF PIECES WITHIN A GIVEN NUMBER OF BOARD FEET:

In several instances you will find a job calls for a given number of board feet of lumber and you will have to determine the number of pieces of a certain size. For example if a job called for 2700 feet board measure of 2" x 10"s - 18'-0" we would be required to determine how many actual pieces. In this case we can determine the number of feet board measure in one piece of 2" x 10"s - 18'-0". This comes to $\frac{2 \times 10 \times 18}{12}$ = 30 feet board measure. Therefore 2700 ÷ 30 = 90 pieces of 2" x 10"s - 18'-0" long.

3. DETERMINING LINEAL FEET WHEN WE HAVE A GIVEN AMOUNT OF BOARD FEET:

In most cases material dealers will figure the smaller sizes of lumber by the lineal foot. For example, we require 165 feet board measure of 1" x 3" material for cross bridging. Here it is necessary to determine how many lineal feet are contained in the 165 f.b.m. We will determine the feet board measure in one lineal foot of 1" x 3" material $\frac{1 \times 3}{12}$ = 1/4 or .25 f.b.m. in one lineal foot of 1" x 3". Therefore, 165 ÷ .25 = 660 lineal feet.

4. ESTIMATING LAMINATED WOOD BEAMS:

In order to estimate the material requirements for a laminated wood beam we must determine from the plans the number of laminations and the total length of the beam. For example the plan calls for a beam 36'-0" long of 4 - 2" x 10"s meaning it is made up of 4 pieces of 2" x 10" material. From this information we calculate the nominal dimensions of the beam to be 4 x 2" = 8 inches wide by 10 inches in depth by 36'-0" in length. Therefore a beam 8" x 10" x 36'-0" will contain $\frac{8 \times 10 \times 36}{12}$ = 240 feet board measure of 2" x 10" material. It is advisable to add an additional 5% to allow for waste in cutting and trimming of the laminations 240 x 1.05 = 252 f.b.m. required.

5. ESTIMATING WOOD FLOOR JOISTS:

(a) Header Joists - the material required for header joist material will equal the perimeter of the building. This will give you the lineal feet which will be converted to feet board measure. (Allow 5% for trimming and waste for Header Joists.)

(b) Regular Joists - To determine the number of regular joists over a certain area, a simple method is to figure the equivalent number of joists per foot. If the joists are at 12" O.C. there is no problem as we know there is one joist for every foot. In most casts the joists will be at 16" O.C., there are 12/16 = 3/4 or .75 joists per foot. At 20" O.C. you would have 12/20 = 3/5 or .6 joists per foot.

Example: From the plan shown in Figure 8.1 determine the material required for the regular joists @ 16" O.C.

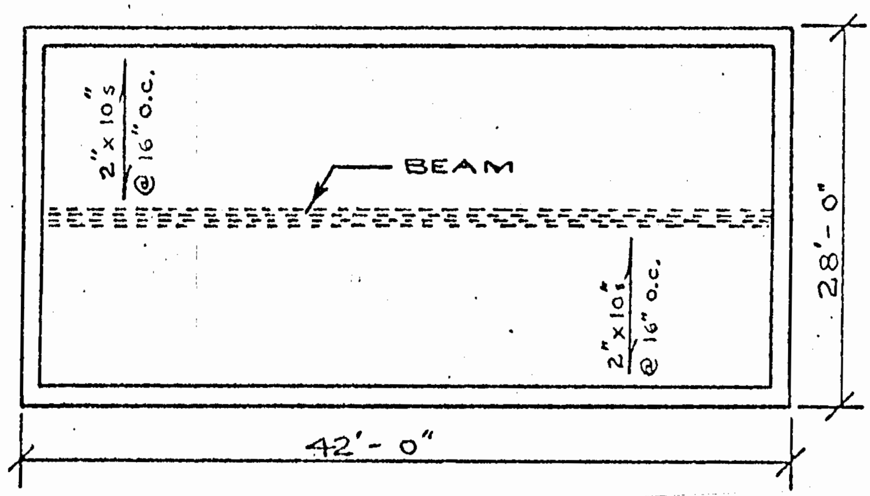


FIGURE 8.1

From the plan in Figure 8.1 we determine that the joist length will be 14'-0" one end supported at the foundation wall and the other on the beam. The length of this building is 42'-0" and the joists are placed at 16" on centre. Therefore we can multiply the length 42'-0" by the joists per foot .75. 42 x .75 = 31.5. Whenever a fraction of a space results, it is necessary to carry this to the next whole number so we will have 32 plus 1 = 33. This extra one is the joist at the end of the covered distance. We have 33 joists down one side and 33 down the other side for a total of 66 joists of 2" x 10" x 14'-0". Convert to f.b.m.

(c) Extra Joists - Additional regular joists will have to be added for each and every partition (over 6'-0" in length) running parallel to the floor joists. Each side of large openings will also require trimmer joists and allowances will have to be made for header joists at any floor openings.

6. ESTIMATING BRIDGING:

The National Building Code of Canada (1965) states that unless ceiling furring or plywood is installed to the underside of floor joists, floor joists shall be restrained from twisting at the end supports and at intervals between supports not exceeding 7'-0". This restraint at the intermediate locations may be provided by not less than 1" x 3" or 1 1/2" x 2" cross bridging or 1 inch by 1/8 inch steel or 1" x 4" continuous wood strapping nailed to each joist and fastened at each end to the header or sill to prevent overall movement. Blocking tightly fitted between joists and securely nailed in place is also acceptable.

(a) Cross Bridging - Cross Bridging material is usually 1" x 3" or 2" x 2", Figure 8.2. The total lineal feet of cross bridging required can be determined by multiplying the length in feet of the bridging in one joist space by the number of joist spaces. The length of the bridging in one joist space for various spacings and joist sizes is given in the table Figure 8.3.

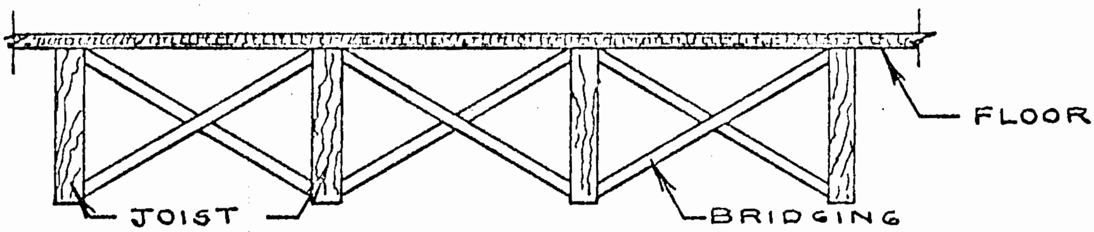


FIGURE 8.2

NUMBER OF LINEAL FEET OF BRIDGING REQUIRED FOR EACH SPACE BETWEEN JOISTS

Center to Center	Size of Joists				
	2" x 6"	2" x 8"	2" x 10"	2" x 12"	2" x 14"
12"	2	2 1/2	2 1/2	3	3
16"	3	3	3	3 1/2	3 1/2
20"	3 1/2	3 1/2	3 1/2	4	4
24"	4	4	4 1/2	4 1/2	4 1/2

FIGURE 8.3

Example: In the table Figure 8.3 it states 2" x 8" joists @ 16" O.C. will require 3 lineal feet of bridging, 2" x 12" joists spaced @ 24" O.C. will require 4'-6" of bridging.

Refer back to the diagram in Figure 8.1 and calculate the total lineal feet of cross bridging 1" x 3" required for this plan. 2" x 10" joists @ 16" O.C. Multiply the length of the distance covered by the joists (not the span) times the equivalent number of joists per foot 42 x .75 = 31.5 or 32 spaces. The table states 2" x 10" @ 16" O.C. require 3 lineal feet of bridging between joists. Therefore 32 x 3 = 96 lineal feet x 2 (rows) = 192 lineal feet of 1" x 3" required. (Add 5% waste for cross bridging). 202 total including 5% waste.

(b) Solid Bridging - In estimating the amount of solid bridging simply take the length of the building multiplied by the number of rows required. In the example used from Figure 8.1 the length of the building is 42'-0" and we would require 2 rows so 42'-0" = 84 lineal feet of solid bridging would be required.

(c) Strapping - The same procedure would apply in estimating the amount of strapping as we used to determine the amount of solid bridging.

7. ESTIMATING WALL PLATES:

All load bearing walls and partitions will usually require a sole plate and a double top plate.

The total length of the exterior walls of the building plus the total lineal feet of all partitions will determine the lineal feet of plates required. This length will then be multiplied by 3 to determine the total lineal feet of sole plate and double top plates required.

When you wish to obtain the amount of plates required in feet board measure for 2" x 4" sole plate and double top plate take the length of exterior walls plus the lineal feet of partitions and multiply by 2. This will equal the feet board measure.

Example: Using the floor plan shown in Figure 8.4 estimate the 2" x 4" material required for sole plate and double top plates.

In taking-off the lineal feet of plates on the plan in Figure 8.4 the circled numbers 1 to 8 will identify the partitions and walls running East and West, while the circled letters A to F will identify the walls and partitions running North and South. The length of these walls and partitions may be calculated as follows:

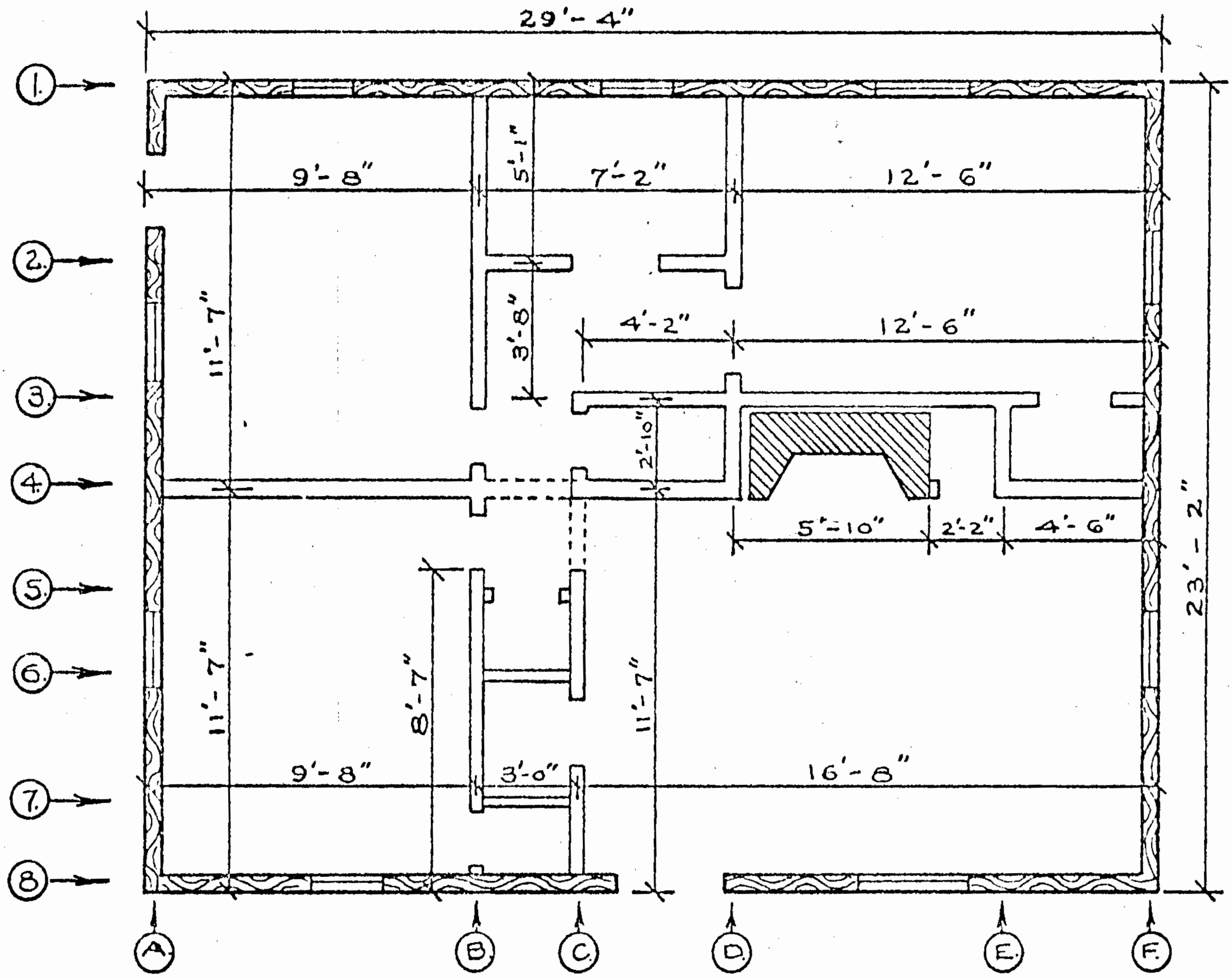


FIGURE 8.4

1.	29'-4"	A.	23'-2"
2.	7'-2"	B.	23'-2"
3.	16'-8"	C.	14'-5"
4.	23'-6"	D.	11'-7"
5.	3'-0"	E.	2'-10"
6.	3'-0"	F.	23'-2"
7.	3'-0"		98'-4"
8.	29'-4"		
	115'-0"		

115'-0" plus 98'-4" = 213'-4" which will be rounded off at 214 lineal feet of walls and partitions.

Therefore:

214 x 3 = 642 lineal feet of 2" x 4"s or

214 x 2 = 428 feet board measure of 2" x 4"s.

8. ESTIMATING STUDS:

Some estimators (studs @ 16" O.C.) will simply allow one stud for every lineal foot of exterior walls and partitions to determine the number of wall studs required. However in this section we will take a more detailed approach to determining the studs required.

Example: -Using the plan in Figure 8.4 we estimated 214 lineal feet of exterior walls and interior partitions. If our studs are 2" x 4" placed at 16" O.C. we multiply the 214 by .75 = 160.5 or 161 plus 1 for the end = 162 studs. To this number you add an additional 2 studs for each corner and 2 studs for each wall and partition opening.

No. of corners = 26
No. of openings= 23
49 x 2 = 98

162 plus 98 = 260 studs required.

If the studs are 8'-0" we will have $260 \times \frac{2 \times 4}{12} \times 8 = 1387$ feet board measure.

(a) Headers - Headers will equal the width of the opening plus one foot, headers are constructed of two pieces of 2" stock therefore in determining the material required you take the width of the opening plus one foot multiplied by two.

Note: The depth of stock used for all headers for the exterior walls will equal the size of header stock required for the largest opening.

(b) Girths - Material required is equal to the perimeter of the exterior walls plus the lineal feet of partitions.

9. ESTIMATING COMMON RAFTERS:

To determine the number of common rafters required multiply the length of the distance to be covered (not the span) by the equivalent number of rafters per foot then add one rafter. Then this amount must be doubled for the other slope of the roof. An additional allowance will also have to be considered if the roof has an overhang at the gable ends. In most cases this will mean an additional 2 rafters for each gable end of the roof. To calculate the length of the rafters plus the overhang you can use the rafter tables from a framing square, or calculate by square root, however, an estimator will simply scale the length from the blueprints.

Example - Determine the number of 2" x 6" rafters required for the plan and section shown in Figure 8.5., on the following page.

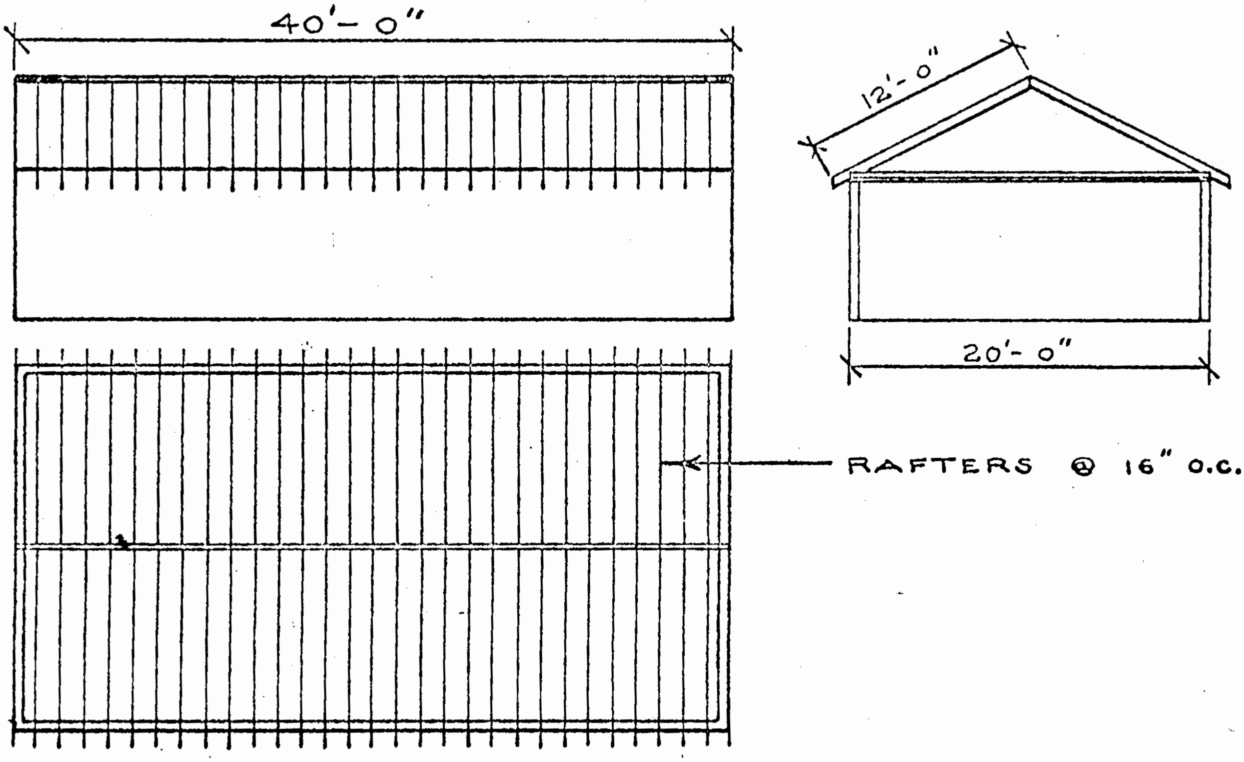


FIGURE 8.5

The building in Figure 8.5 is 20'-0" x 40'-0". The rafters are spaced at 16" O.C. and the section view shows the rafter length as 12'-0". Number of rafters required is 40'-0" multiplied by .75 (rafters per foot) = 30 plus 1 = 31 down the one side multiplied by 2 equals 62 rafters required. There is no overhang at the gable ends therefore we do not require any additional rafters. We have 62 pieces 2" x 6" - 12'-0" which is 62 x $\frac{2 \times 6 \times 12}{12}$ = 744 feet board measure.

(a) Ridge Board - The ridge board for a gable roof will equal the length of the building plus the overhang.

(b) Collar Ties - If collar ties are required for roof support, each pair of rafters will require one collar tie. The number of collar ties may be calculated by taking the length of the building multiplied by the number of collar ties per foot at 16" O.C. This will be .75 then subtract one.

Example - Using the roof plan in Figure 8.5 the collar ties required would be 40 x .75 = 30 minus 1 = 29. We subtract one as a collar tie is not required at the gable end. The length of the collar tie will be 1/2 the span of the building. In this case where the span is 20'-0" the collar tie length would be 10'-0".

10. ESTIMATING GABLE END STUDS:

The number of gable end studs is calculated by taking the span of the building multiplied by the number of gable end studs per foot, if at 16" O.C. This will be .75 then subtract one.

Example - Using the plan in Figure 8.5 the span is 20'-0" multiplied by .75 = 15 minus 1 = 14 gable end studs.

To determine the length we must find the total rise of the roof. This again may be scaled or calculated from the blueprints from the roof pitch. From our plan in Figure 8.5 we will say the total rise is 4'-0" then this being the case we would have 14 gable end studs 4'-0" long. This would give us the material necessary for both gable ends.

11. ESTIMATING SHEATHING:

(a) Floor Sheathing - Calculate the floor area in square feet. If the floor is to be sheathed with shiplap the square feet will also be the board feet required, plus an additional allowance for cutting, waste and for diagonal sheathing. This allowance will vary depending upon the width of the boards used. The National Building Code of Canada (1965) states the maximum width of boards is 8 inches and they are to be laid at an angle of not less than 45^{0}. This being the case you can safely add 20% for 1" x 8" shiplap subfloor sheathing, and 25% if using 1" x 6" shiplap sheathing.

Where plywood sheathing is specified simply divide the total area by the square feet contained in one sheet to determine the number of sheets required.

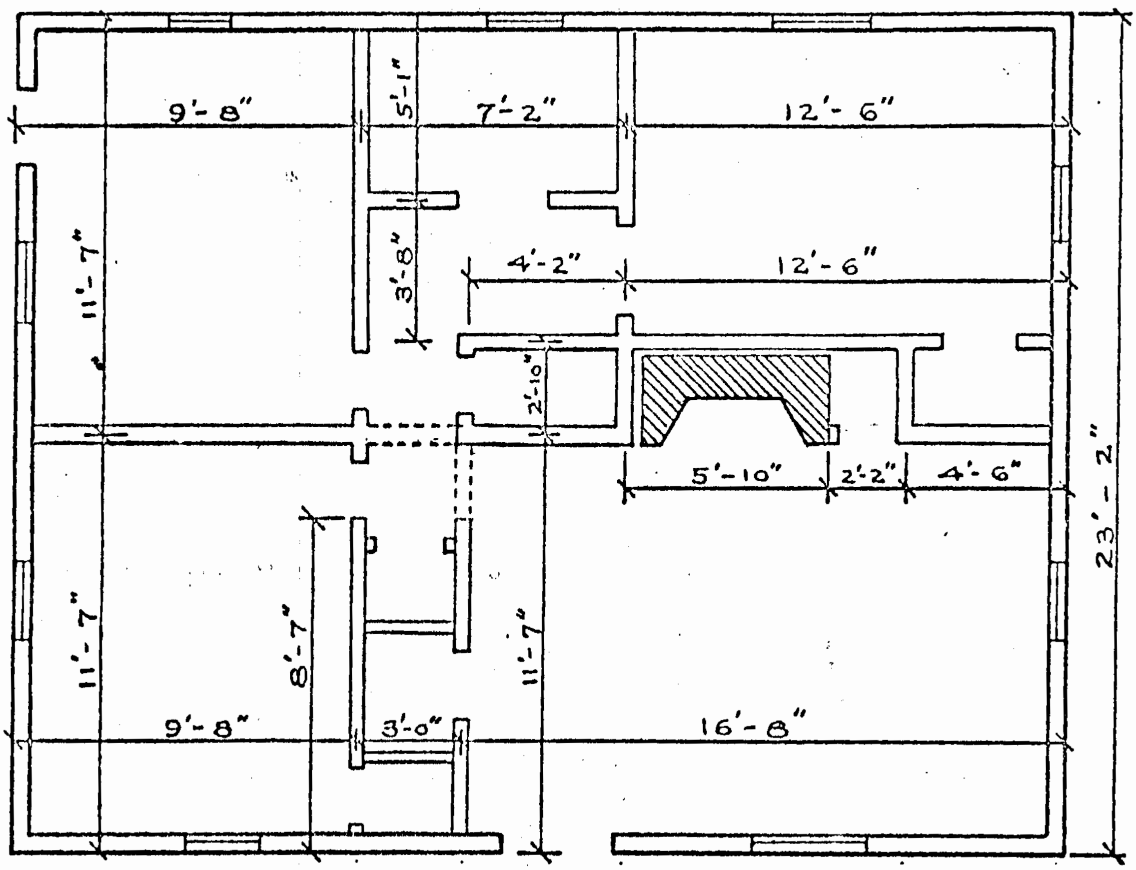


FIGURE 8.6

Referring to Figure 8.6: The dimensions of the building are 23'-2" x 29'-4" = 679.57 or 680 square feet. If we were to use 1" x 8" shiplap for the sub floor we would take 680 square feet (plus 20%) = 136 square feet - for a total of 816 square feet. The surface area of one board foot and one square foot are exactly the same so we can say we require 816 feet board measure of 1" x 8" shiplap to sheath the sub floor of the building in Figure 8.6.

The above floor sheathed with 5/8" = 4'-0" x 8'-0" plywood would require 680 square feet ÷ (4 x 8) 32 = 21.25 (plus 5%) 22.31 sheets or 23 sheets 5/8"

- 4'-0" x 8'-0" plywood.

(b) Wall Sheathing - Determine the total surface area of the exterior walls, which is the perimeter multiplied by the height of the walls. When determining the wall height it is good construction practice to allow the wall sheathing to extend down below the sole plate to the depth of the header joist. The next step is to determine the area of all wall openings for windows and doors, this amount is then subtracted from the total wall area. If the walls are to be sheathed with shiplap, the same percentages as used for floor sheathing must be added to the net surface area. See Table in Figure 8.7.

PERCENTAGE TO BE ADDED FOR SHIPLAP SHEATHING		
Size	Square Application	Diagonal Application
1" x 6"	20%	25%
1" x 88"	15%	20%
1" x 10"	13%	17%

FIGURE 8.7

For plywood sheathing determine the net surface area in square feet then determine the number of sheets required. Then to this figure add 10% consult the table in Figure 8.8

PERCENTAGE TO BE ADDED		
Sub-Floor	Walls	Roof
5%	10%	5%

FIGURE 8.8

(c) Gable End Sheathing - In order to calculate the surface area of the gable ends we determine the total rise and multiply by the span of the roof. By taking the rectangle in Figure 8.9 both ends of the gable area are included. The two shaded triangles, A and B are of the same area as the gable C and would therefore give you the area for both gable ends.

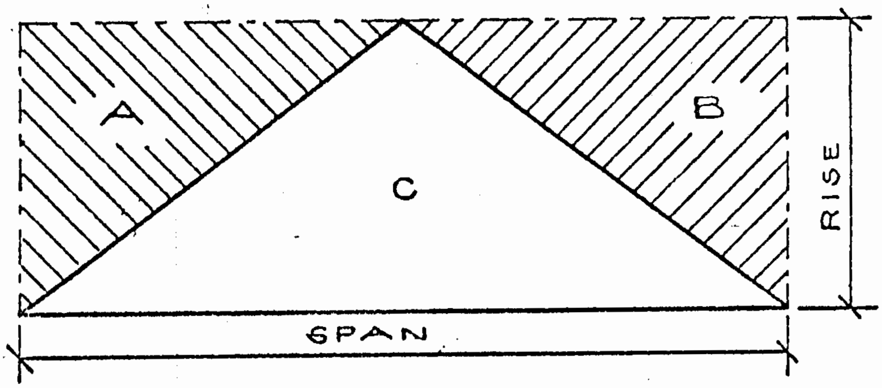


FIGURE 8.9

Example - From the elevation drawings of the house in Figure 8.10 estimate the number of sheets of 5/16" plywood 4'-0" x 8'-0" required to sheathe the exterior walls and gable the ends.

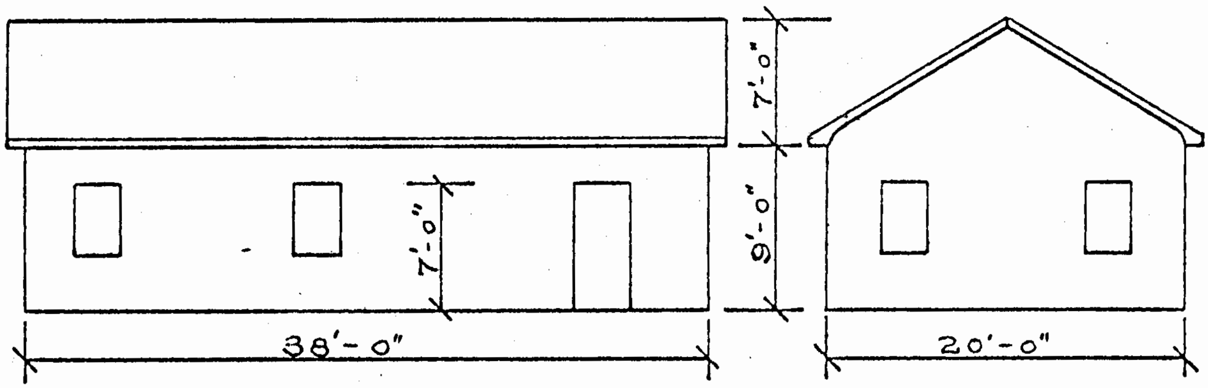


FIGURE 8.10

Note: Window sizes are 2'-6" x 4'-0"

Door size 3'-0" x 7'-0"

There are two windows in each side elevation and three windows on the rear elevation.

Perimeter of the house is 116'-0" multiplied by the height = (116 x 9) = 1044 square feet of wall area less the openings.

9 windows (2.5 x 4) = 10 x 9 = 90 square feet

1 door (3 x 7) = 21 x 1 = 21 square feet

Total area of openings - 111 square feet to be deducted from the wall area of 1044 - 111 = 933 square feet net area.

Gable ends, total rise is 7'-0" and the span is 20'-0" (20 x 7) = 140 square feet in the gable ends.

Total net area of wall and gable ends is 933 + 140 = 1073 square feet. Number of sheets of 5/16" plywood 4'-0" x 8'-0" required is 1073 ÷ 32 = 33.53 plus (10% for waste and cutting) 3.35 sheets. Total 33.53 + 3.35 = 36.88 or 37 sheets.

This would be shown on the Quantity Take-Off sheet as shown in Figure 8.11.

--- QUANTITY TAKE-OFF ---

JOB NUMBER ____________

DATE ____________

SHEET NO. ______ OF

PLYWOOD SHEATHING	UNIT	LENGTH	HEIGHT	SQUARE FEET	SQUARE FEET OUT	NET SQUARE FEET	NUMBER OF SHEETS
(1) Walls	1	116	9	1044			
Windows	9	2.5	4		90		
Door	1	3	7		21		
					111		
						933	
(2) Gable Ends		20	7			140	
						1073	
	1073	÷ 32	= 33.53				
	Plus	10%	3.35				
			36.88				37

FIGURE 8.11

(d) Roof Sheathing - In order to determine the total surface area of the roof you calculate the length of the roof from the ridge to the eaves, this can be done in the same manner as in calculating the rafter length including any overhang. Most estimators will scale this from the plans. This length is then mulipIied by the total overall length of the roof including any overhang to arrive at the area for one side of the roof then double this quantity for the total surface area.

Example - Using the plan in Figure 8.12 estimate the number of 3/8" plywood 4'-0" x 8'-0" sheets required for the roof.

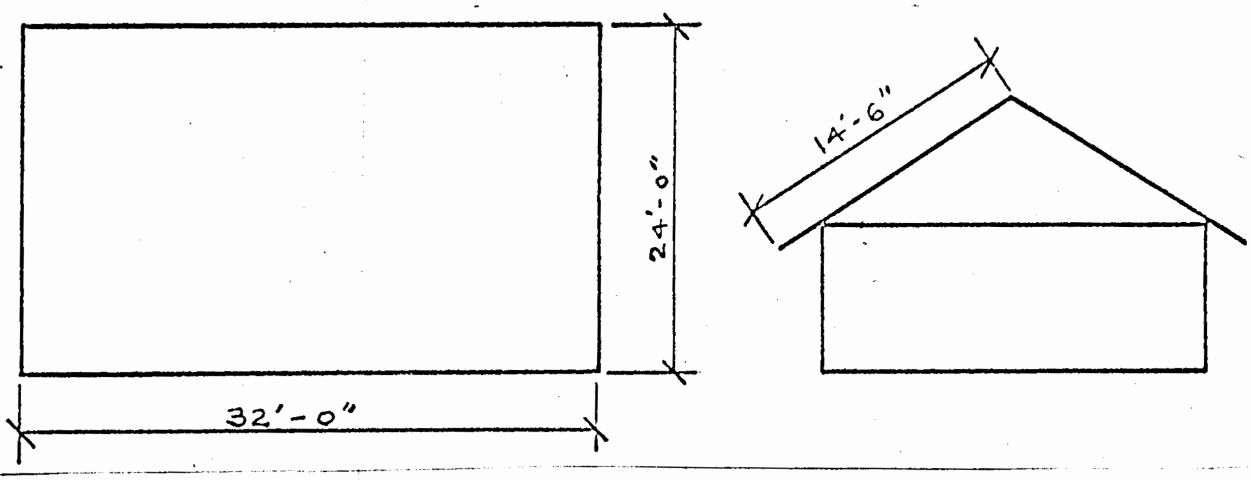


FIGURE 8.12

Note: In the above plan Figure 8.12, the roof has a 2'-0" overhang at the gable ends.

Surface area is 14'-6" multiplied by the total length (32'-0" + 2'-0" + 2'-0") 36'-0" (14.5 x 36) = 522 square feet in one side of the roof therefore 522 x 2 = 1044 square feet of total surface area.

1044 ÷ 32 = 32.62 sheets (plus 5%). 1.63 sheets = 34.25 or 35 sheets required.

12. ASSIGNMENTS:

To be completed and handed to the Instructor for evaluation.

Problem 1:

From the plan and section in Figure 8.13 take-off the following material requirements:

(a) Sill Plates 2" x 6"s

(b) Built up Girder 2" x 8"s

(c) Floor Joists and Headers 2" x 8"s

(d) Bridging 1" x 4" (Cross Bridging)

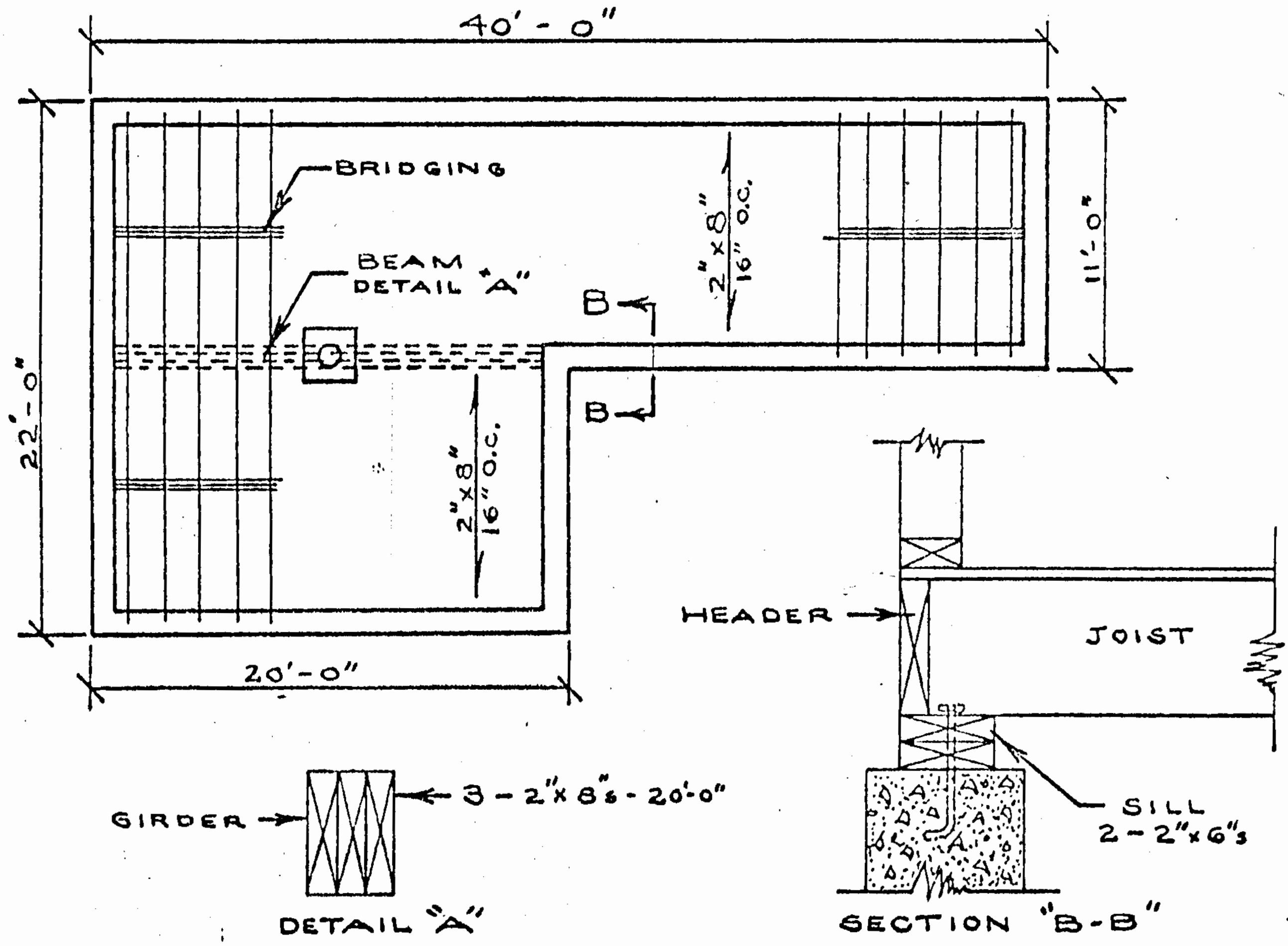


FIGURE 8.13

Use Quantity Take-Off sheets provided.

Problem 2: Price the material estimated in problem (1) at the following prices:

2" x 6"s @ $165.00 per 1000 fbm

2" x 8"s @ $172.00 per 1000 fbm

1" x 4"s @ $138.00 per 1000 fbm

Problem 3: Using the floor plan shown in Figure 8.14, estimate the total 2" x 4"s required in feet board measure to frame the exterior walls and partitions (single sole plate and double top plates). Studs are 2" x 4"s @ 16" O.C. Wall height is 8'-0".

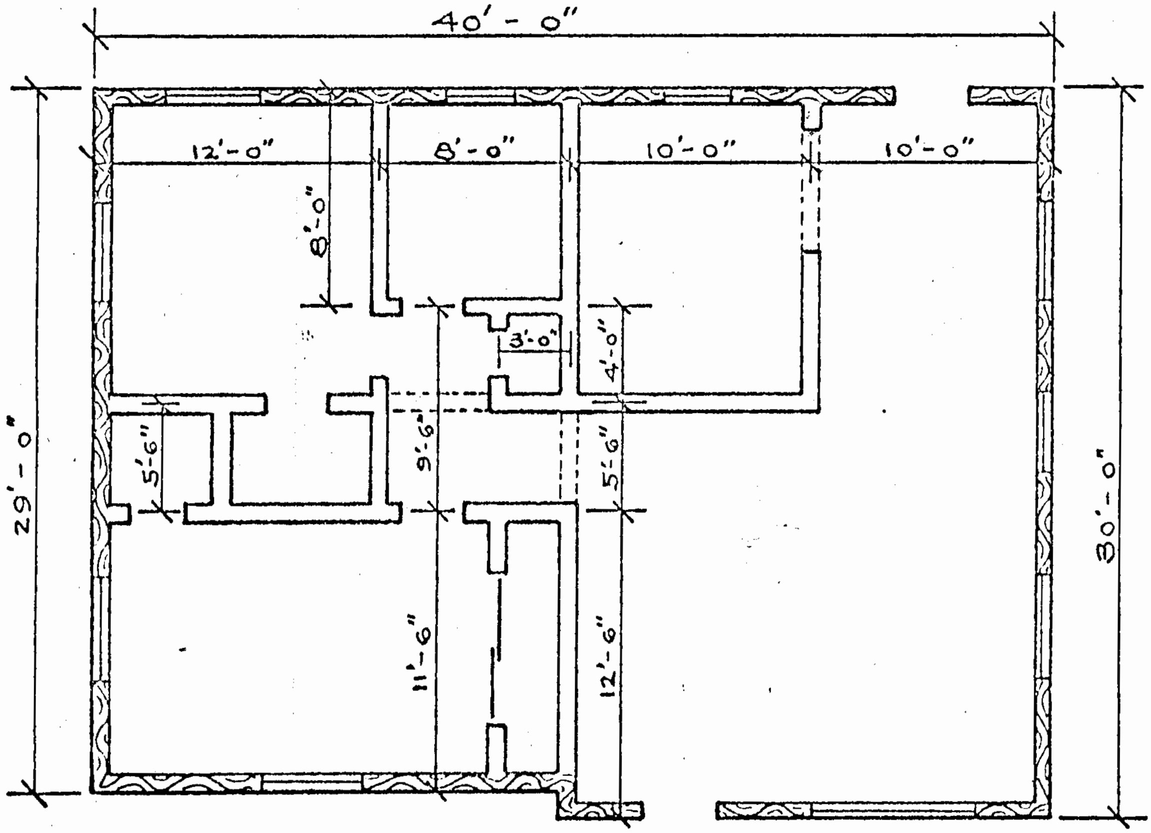


FIGURE 8.14

Price out the material in Probelm (3) @ $165.00 per 1000 fbm

Problem 4:

Estimate the hours required to frame the walls and partitions in Problem (3) at the following rates:

Skilled labour	20 hours per 1000 fbm
Unskilled labour	4 hours per 1000 fbm

Problem 5:

Estimate the amount of 5/8" plywood 4'-0" x 8'-0" sheets required for the sub-floor for the plan shown in Figure 8.14.

--- QUANTITY TAKE-OFF SHEET ---

Date ____________ Assignment ____________ Name ____________

Class ____________ Sheet No. ____________ of ____________

DESCRIPTION	DIMENSIONS						EXTENSIONS	EXTENSIONS

UNIT IX - FLOORING & TILE:

1. HARDWOOD STRIP FLOORING
2. PARQUET FLOORING
3. FLOOR TILE
4. FLOOR FELT
5. FLOOR TILE ADHESIVES
6. LINOLEUM
7. WALL TILE
8. ASSIGNMENT

Unit IX **Flooring and Tile**

Objectives

Following the completion of this unit a student will be able to:

9.1 List the most common types of floor coverings.

9.2 Calculate floor area.

9.3 Compare types of floor adhesives.

9.4 Correctly complete all given assignments.

UNIT IX FLOORING AND TILE

In this section you will learn how to estimate quantities of materials used for finished floor coverings; such as, hardwood, floor tile, linoleum as well as baseboards, and trim for door and window casings.

1. HARDWOOD FLOORS:

We will cocern ourselves with the common types of hardwood used for floors, which is made from oak, maple, birch and beech. Hardwood flooring is manufactured in a variety of widths and thicknesses. The common face widths of hardwood flooring are 1 1/2", 2", 2 1/4" and 3 1/4". Flooring of these widths is made in thicknesses of 3/8", 1/2", 5/8", and 25/32 of an inch. The 1 1/2 inch and 2 inch widths are generally available in 3/8" and 1/2" thicknesses. Where hardwood flooring is used, oak seems to be the preference of most homeowners. Oak flooring is available in several grades: Clear, Select, Number 1 Common and Number 2 Common. The Number 1 Common seems to be the most popular grade; however, it does contain more imperfections than the Clear or Select grades but will make a good sound hardwood floor.

Oak flooring boards are purchased in bundles; the bundle will be marked, showing the average length of pieces in the bundle; such as, 2', 3', 4', 5', etc. A bundle may include pieces from 6 inches under to6 inches over the nominal length of the bundle.

Estimating Hardwood Flooring

To determine the board feet of flooring required to cover a given area, first find the area in square feet, then add to it a percentage of that figure which applies to the size of flooring to be used, as indicated in Table 9.1. These additions in the table provide an allowance for side matching, plus an additional 5% for end matching and normal waste.

ALLOWANCES TO BE ADDED FOR ESTIMATING QUANTITIES OF HARDWOOD FLOORING	
Nominal Size (Actual Face Width)	Percentages To Be Added
3/8" x 1 1/2"	38%
3/8" x 2"	30%
1/2" x 1 1/2"	38%
1/2" x 2"	30%
25/32" x 1 1/2"	55%
25/32" x 2"	42%
25/32" x 2 1/4"	38%
25/32" x 3 1/4"	29%

FIGURE 9.1

Example--

Estimate the board feet of Number 1 Common Oak flooring for the living room, dining room, and bedrooms (including closets) for the following plan in figure 9.2 on the following page. The flooring used will be 1/2" x 1 1/2".

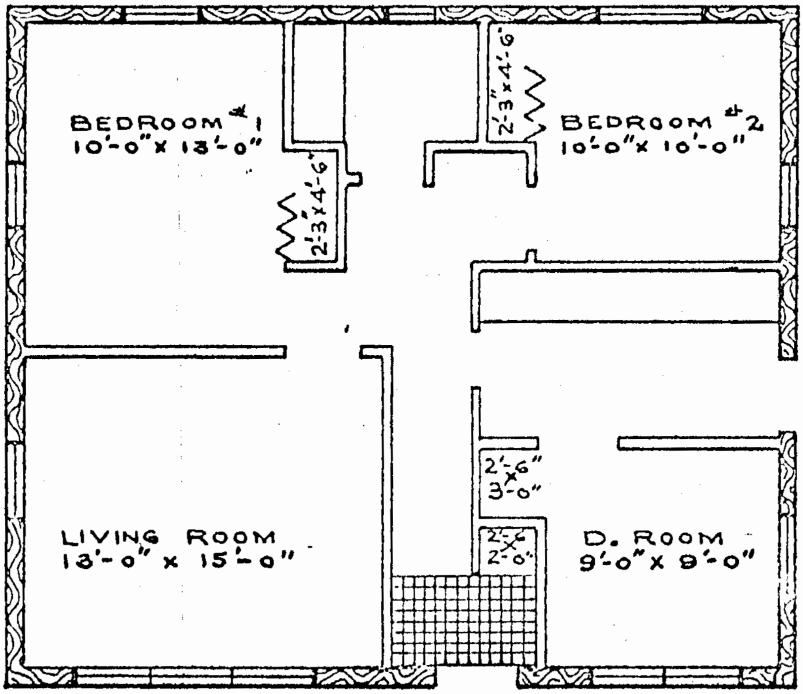


FIGURE 9.2

Living Room	13'-0" x 15'-0"	=	195	square feet
Hall Closet	2'-0" x 2'-6"	=	5	
Dining Room	9'-0" x 9'-0"	=	81	
Alcove	2'-6" x 3'-0"	=	7.5	
Bedroom #1	10'-0" x 13'-0"	=	130	
Closet	2'-3" x 4'-6"		10.125	
Bedroom #2	10'-0" x 10'-0"	=	100	
Closet	2'-3" x 4'-6"	=	10.125	
			538.750	square feet.

The figure would be rounded off at 539 square feet.

Therefore: 539 square feet of area plus the percentage to be added when using 1/2" x 1 1/2" flooring. Table in figure 9.1 shows you must add 38%.

539 x 1.38 = 743.82 or 744 square feet of flooring.

In calculating board feet of flooring 1/2" thickness is considered as 1 inch thick. Therefore, 744 square feet is equal to 744 feet board measure.

These calculations would appear on the quantity take-off sheet as shown in Figure 9.3

JOB NUMBER__________

--- QUANTITY TAKE-OFF ---

DATE __________

SHEET NO. _____ OF _____

Item	Unit	Length	Width	Square Feet	% Added	Total FBM
Hardwood Flooring						
1/2" x 1 1/2"						
1. Living Room	1	15'0"	13'0"	195		
2. Hall Closet	1	2'6"	2'0"	5		
3. Dining Room	1	9'0"	9'0"	81		
4. Alcove	1	3'0"	2'6"	7.5		
5. Bedroom #1	1	13'0"	10'0"	130		
6. Bedroom #2	1	10'0"	10'0"	100		
7. Bedroom Closets	2	4'6"	2'3"	20.25		
				538.75		
		Plus 38%			204.82	
						744 FBM

FIGURE 9.3

2. PARQUET FLOORING:

Unit block flooring is made up of three or more strips bound together. It is sold on a square foot of coverage basis and no addition to the floor area footage is needed. This type of flooring is available in various sizes as seen in Figure 9.4. When estimating this type of flooring, simply go by the square feet of surface area to be covered. Due to the wide variety of this type of wood floor covering being manufactured, it is advisable to contact the supplier for specifications regarding any one special installation.

FLOORING (PARQUET SIZES)			
Strip Width	1/2" Thick	25/32" Thick	33/32" Thick
1 1/2 inch	7 1/2" x 7 1/2" 9" x 9" 6" x 12"	7 1/2" x 7 1/2" 9" x 9" 6" x 12"	7 1/2" x 7 1/2" 9" x 9" 6" x 12"
2 inch	8" x 8" 10" x 10" 6" x 12"	8" x 8" 10" x 10" 6" x 12"	8" x 8" 10" x 10" 6" x 12"
2 1/4 inch		6 3/4" x 6 3/4" 9" x 9" 11 1/4" x 11 1/4" 6 3/4" x 13 1/2"	6 3/4" x 6 3/4" 9" x 9" 11 1/4" x 11 1/4" 6 3/4" x 13 1/2"
3 1/4 inch		6 1/2" x 13"	6 1/2" x 13"

FIGURE 9.4

3. FLOOR FELT:

Usually floor felt is desirable under hardwood strip flooring. When estimating allow an additional 10% to the surface area.

4. FLOOR TILE:

When estimating the number of floor tiles, you must determine the surface area in square feet. Then you can multiply this area by the number of tiles required to cover one square foot.

Example--

We have a room measuring 12'-0" x 10'-0" = 120 square feet. Number of tile per square foot equals tile size 9" x 9" = 81 square inches. One square foot 144" ÷ 81 = 1.77 tile required per square foot.

Therefore, 120' x 1.77 = 212.4 tile plus an additional percentage for waste, which is given in Table 9.5.

TILE WASTE ALLOWANCE			
1 To 50 sq. feet	14%	200 TO 300 sq. feet	7%
50 To 100 sq. feet	10%	300 To 1,000 sq. feet	5%
100 To 200 sq. feet	8%	Over 1,000 sq. feet	3%

FIGURE 9.5

In this example we would add 8%

212.4 plus 8% = 230 tile

Vinyl, Rubber and Asphalt floor tile are furnished in cartons containing 80 pieces of 9" x 9" tile. One carton covers 45 square feet of surface area.

5. FLOOR TILE ADHESIVES:

Type	Uses	Coverage Sq. Ft. Per Gal.
PRIMER	for treating on or below grade concrete floors before installing asphalt floor tile.	250 to 350
ASPHALT CEMENT	for asphalt tile over primed concrete in direct contact with the ground. Also used above grade over lining felt and directly over plywood sub-floors.	200
BRUSH ON EMULSION ADHESIVE	for vinyl asbestos or asphalt tile installed above or below grade over concrete, felt or wood.	150
LINING PASTE	for cementing lining felt to wood floors.	160

Type	uses	Coverage Sq. Ft. Per Gal.
FLOOR AND WALL SIZE	used to prime chalky or dusty suspended concrete sub-floors before installing floor tiles other than asphalt.	
WATERPROOF CEMENT	for installing linoleum tile, rubber and cork tile over any type of suspended sub-floor in areas where surface moisture is a problem.	130 tO 150

6. LINOLEUM AND VINYL FLOOR COVERING:

This material is estimated by the number of square yards. It is available in widths of 6'-0", 9'-0", and 12'-0". For a wide floor area you will have one or more joints in the material.

In order to estimate the amount of material required, the area of the floor is found; however, the shape of the area to be covered must also be considered because in many cases the total yards purchased will be in excess of the actual floor area owing to irregularities of shape.

Example --

Estimate the linoleum required for the floor in Figure 9.6. The material is available in 6'-0" widths.

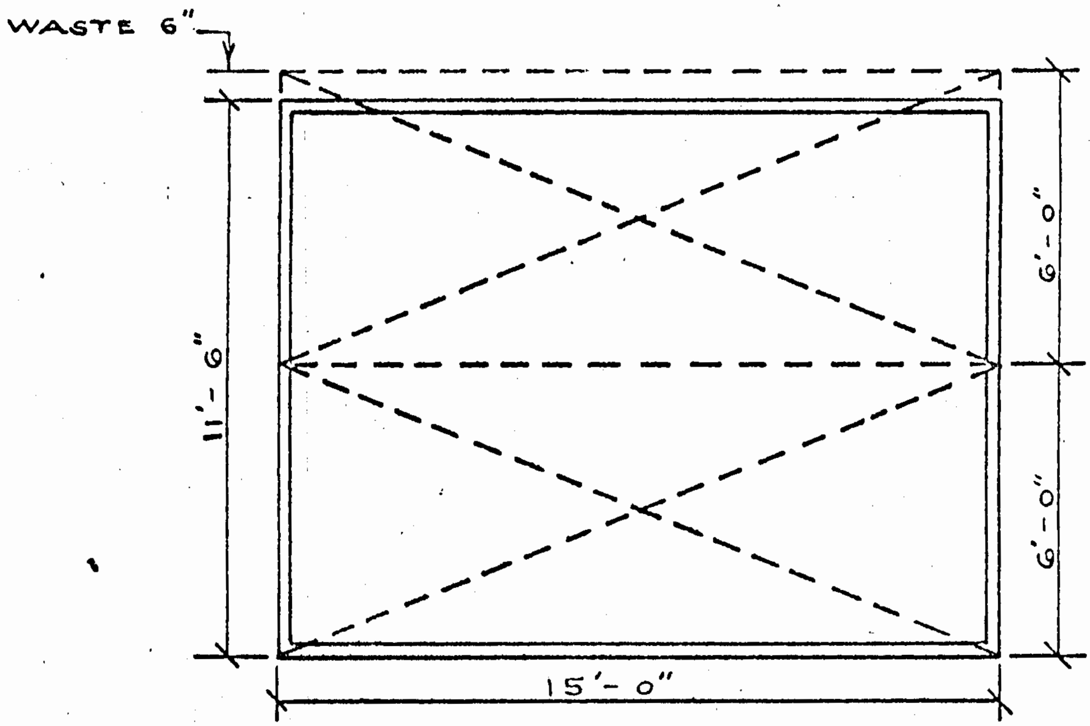


FIGURE 9.6

The rectangles shown in Figure 9.6 show the plan for laying the material on the floor. It will require two strips 6'-0" wide by 15'-0" in length. There will be a strip 6" wide by 15'-0" long, which will be waste material.

Therefore, the amount of material required will be 2 pieces 6'-0" x 15'-0" or 180 square feet ÷ 9 = 20 square yards.

7. WALL TILE:

Wall tile is estimated by the square feet of surface area. Where the walls are irregular in shape, they can be divided into squares or rectangles. Then the areas are calculated to determine the total area.

Example --

Estimate the square feet of ceramic tile 4 1/4" x 4 1/4" required for the walls of the bathroom shown in the elevation drawings in Figure 9.7.

Also calculate the lineal feet of tile cap 2" x 6" and base tile 4" x 6".

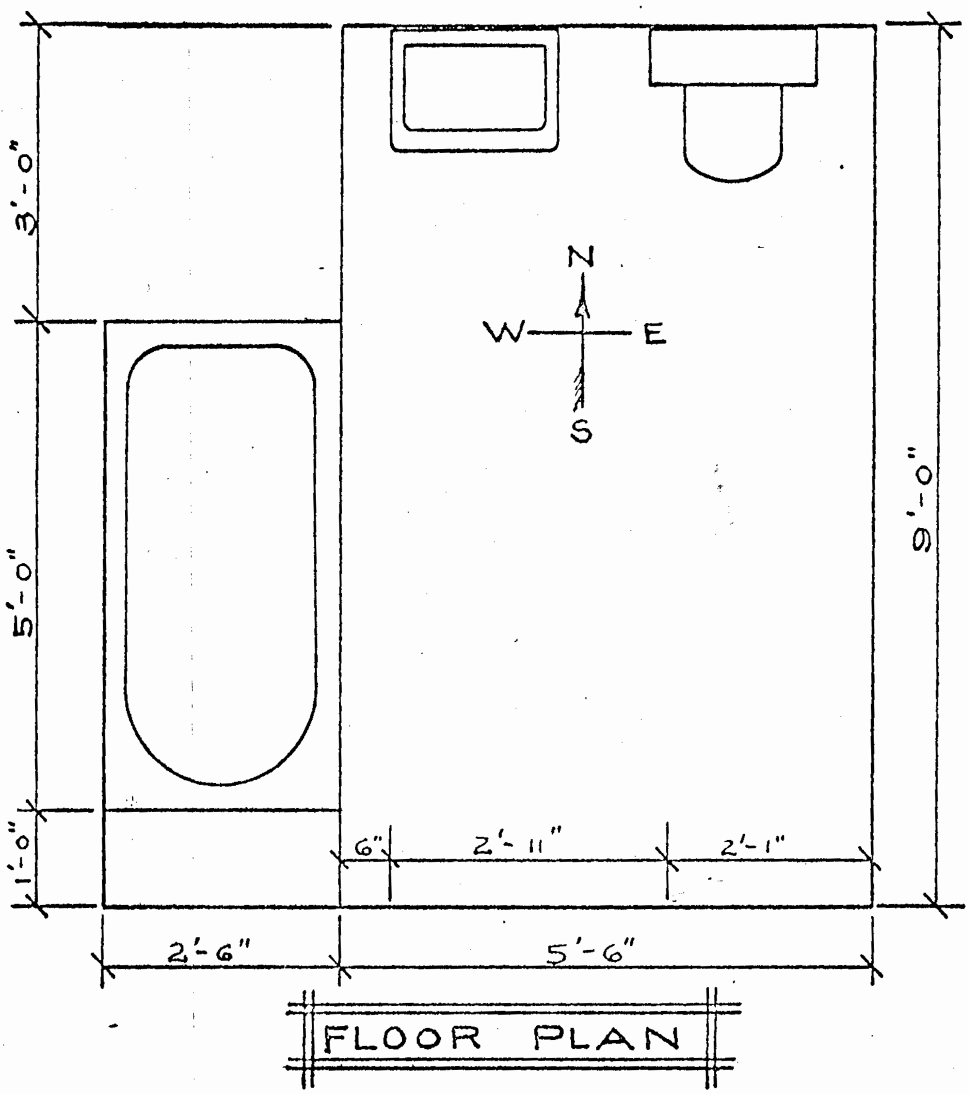


FIGURE 9.7

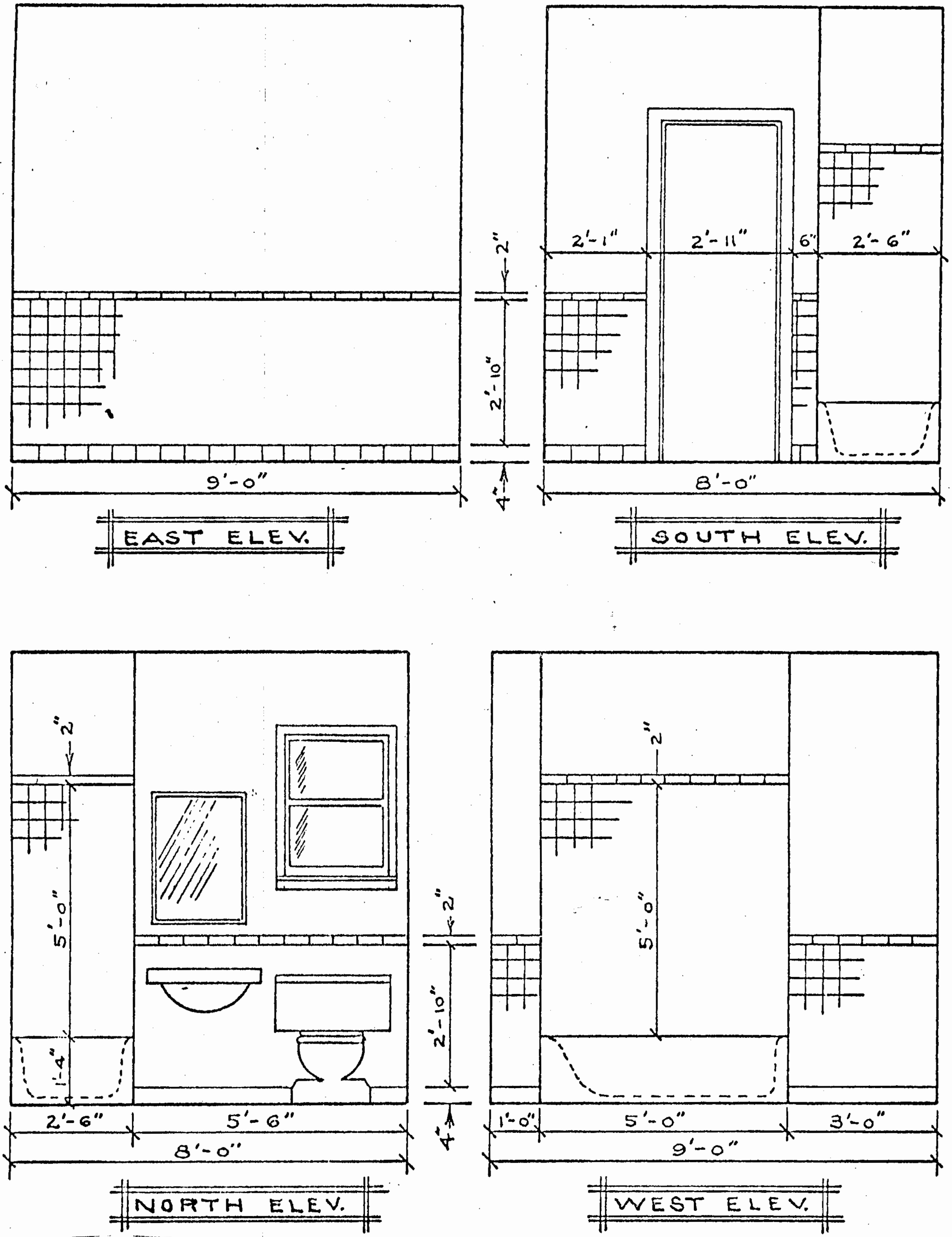

2"
2'-10"
4"
9'-0"
EAST ELEV.
2'-1"
2'-11"
6"
2'-6"
8'-0"
SOUTH ELEV.
2"
5'-0"
1'-4"
2'-6"
5'-6"
8'-0"
NORTH ELEV.
2"
2'-10"
4"
2"
5'-0"
1'-0"
5'-0"
3'-0"
9'-0"
WEST ELEV.

FIGURE 9.7

Wall Tile 4 1/4" x 4 1/4"

East Wall	9'-0" x 2'-10"	=	25.47 sq. feet
South Wall	2'-1" x 2'-10"	=	5.89
	6" x 2'-10"	=	1.41
	2'-6" x 5'-0"	=	12.5
West Wall	1'-0" x 2'-10"	=	2.83
	5'-0" x 5'-0"	=	25
	3'-0" x 2'-10"	=	8.49
North Wall	5'-0" x 2'-6"	=	12.5
	5'-6" x 2'-10"	=	15.56
	TOTAL	=	109.65 square feet

Add 5% for cutting and waste = 115 square feet total area.

Tile Caps

South Wall	=	5'-1"	
West Wall	=	9'-0"	
North Wall	=	8'-0"	
East Wall	=	9'-0"	
		31'-1"	lineal feet
Add 5%	=	33	lineal feet of tile caps.

Base Tile

South Wall	=	2'-7"	
West Wall	=	4'-0"	
North Wall	=	5'-6"	
East Wall	=	9'-0"	
		21'-1"	lineal feet
Add 5%	=	22	lineal feet of base tile.

8. ASSIGNMENT

Problem 1.

a) Estimate the number of floor tiles 9" x 9" required for the kitchen in Figure 9.8. Use the quantity take-off provided.

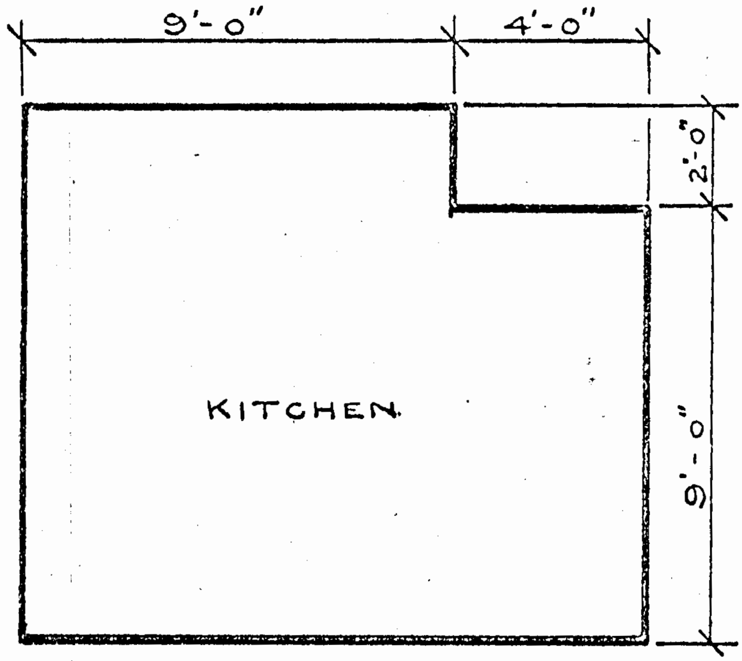


FIGURE 9.8

b) Estimate the amount of 6 foot width linoleum required for the kitchen in Figure 9.8.

Problem 2.

a) Estimate the board feet of oak flooring required for the bedrooms and closets, living room and the dining room on the plan in Figure 9.9. Flooring size is 1/2" x 2" oak.

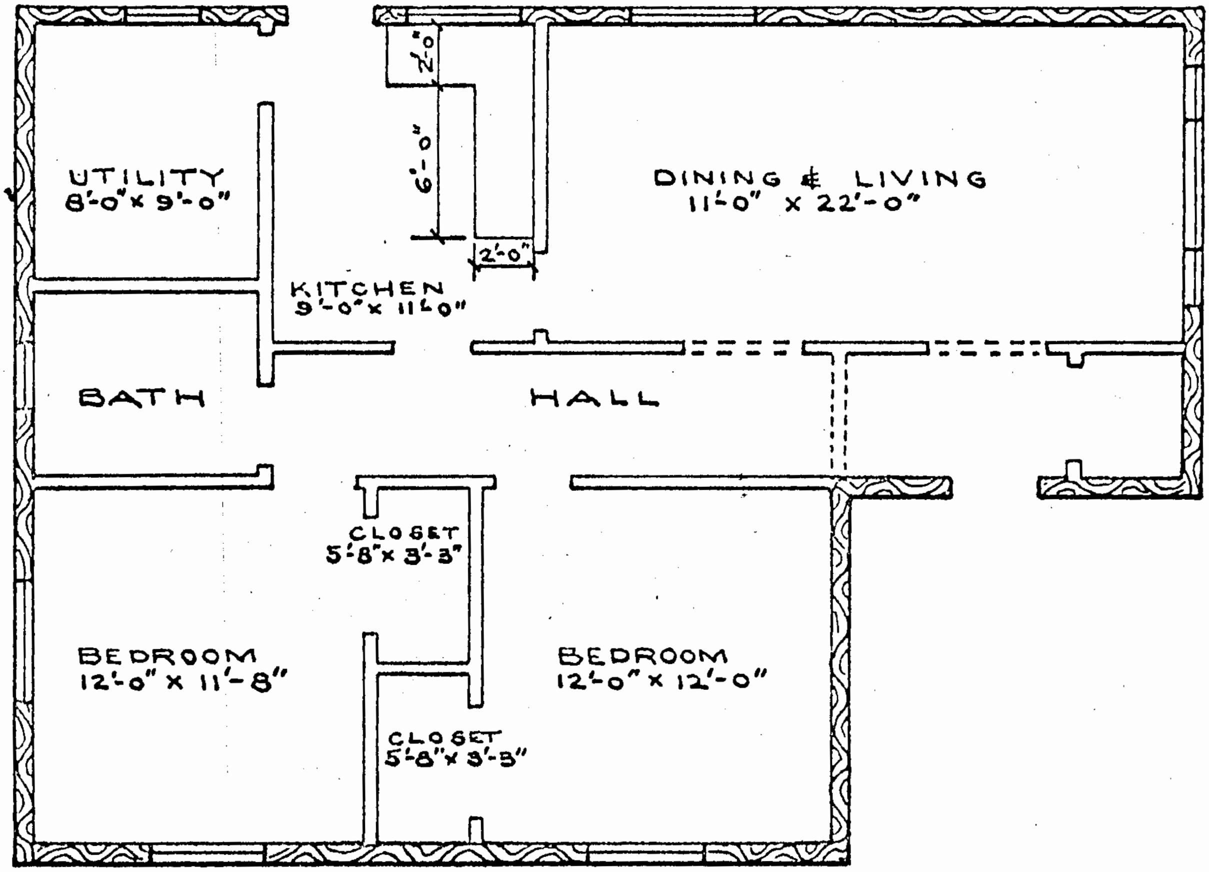


FIGURE 9.9

b) Estimate the amount of floor felt needed under the hardwood flooring in part (a) of this problem.

c) Estimate the amount of vinyl floor tile 9" x 9" required for the kitchen in Figure 9.9.

d) Estimate the labour cost to install the hardwood flooring in part (a) at the following rates:

Carpenter labour	35 hours per 1,000 square feet
Helper labour	6 hours per 1,000 square feet
Carpenter wages	\$4.88 per hour
Labour wages	\$4.07 per hour

--- QUANTITY TAKE-OFF SHEET ---

Date ______________________ Assignment ______________ Name ___________________________

Class ____ Sheet No. ______________ of ________

DESCRIPTION	DIMENSIONS						EXTENSIONS	EXTENSIONS

UNIT X - WET AND DRYWALL FINISHES

1. ESTIMATING METAL LATH

2. GYPSUM LATH

3. CORNER BEAD

4. GYPSUM WALLBOARD (GYPROC)

5. TAPE AND JOINT FILLER

6. ESTIMATING QUANTITIES OF PLASTER

   (a) SCRATCH COAT

   (b) BROWN COAT

   (c) FINISH COAT

7. ASSIGNMENTS

UNIT X - WET AND DRYWALL FINISHES

Objectives:

Following the completion of this unit a student will be able to:

10.1 Distinguish between wet and dry finishes

10.2 Calculate correct quantities of:

- metal lath
- gypsum lath
- corner bead, filler and tape
- gypsum wallboard

10.3 Estimate within five percent of quantities of plaster:

- scratch coat
- brown coat
- finish coat

10.4 Correctly complete all assignments.

Wall coverings or wall finishes are divided into two major sections. Under the heading of Wet Wall you have Plaster and Stucco finishes, and under Drywall you have plaster board and wood panelling. It is difficult to explain all of the various wall coverings and finishes in this section; therefore, we will cover Plaster and the Plaster Board applications so that you will learn how to estimate the quantities required.

1. Metal Lath:

There are many varieties of metal lath manufactured; the most common is diamond metal lath, and is used for all types of plastering. Diamond metal lath is packed in bundles of ten sheets, and each sheet is 27 inches wide by 96 inches long. Each sheet contains 18 square feet; therefore, we have 180 square feet to the bundle, or 180 ÷ 9 = 20 square yards.

In order to estimate the amount of metal lath required for a room, multiply the total lineal feet of the walls around the room by the height of the wall to determine the total square feet of the surface wall area. Do not deduct for windows and doors as this extra amount will replace the waste in cutting. However, for large areas of picture windows a deduction should be made. For the ceilings, multiply the length by the width. Once we have the total square feet or surface to be covered by metal lath, divide by nine to obtain the square yards. Once we have the total number of square yards, you can arrive at the number of bundles of metal lath (20 square yards per bundle).

Example:

Estimate the bundles of metal lath required in order to plaster the walls and the ceiling of the room shown on the plan in Figure 10.1.

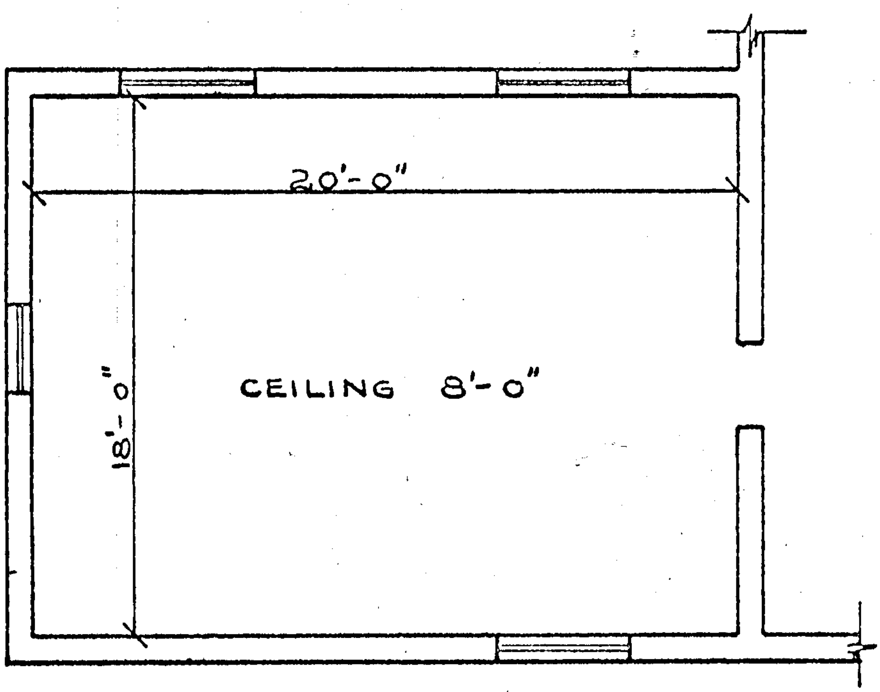


FIGURE 10.1

Area of walls 18'-0" + 20'-0" + 18'-0" + 20'-0" = 76 lineal feet

by 8'-0" high for a total wall area of 608 square feet.

Area of the ceiling 18'-0" x 20'-0" = 360 square feet.

Total surface area = 968 square feet.

Number of square yards 968 ÷ 9 = 107.5 square yards.

Number of bundles required 107.5 ÷ 20 = 5.375 or 6 bundles required

This would appear on a quantity take-off sheet as seen in Figure 10.2.

JOB NUMBER ____________

--- QUANTITY TAKE-OFF --- DATE ________________

SHEET NO. _____ OF _____

Item	Unit	Length	Width	Height	Sq. Ft.	Sq. Yds.	No. of Bundles
Metal Lath:							
20 sq. yds. = 1 bd							
Walls	1	76'0"		8'0	608		
Ceiling	1	20'0"	18'0"		360		
					968		
	968	÷ 9 =	107.5			107.5	
	107.5	÷ 20 =	5.375				6

FIGURE 10.2

Example:

From the floor plan in Figure 10.3 estimate the number of bundles of metal lath required for all the rooms shown on the plan. Check your answer with the solution shown on the quantity take-off sheet given in Figure 10.4.

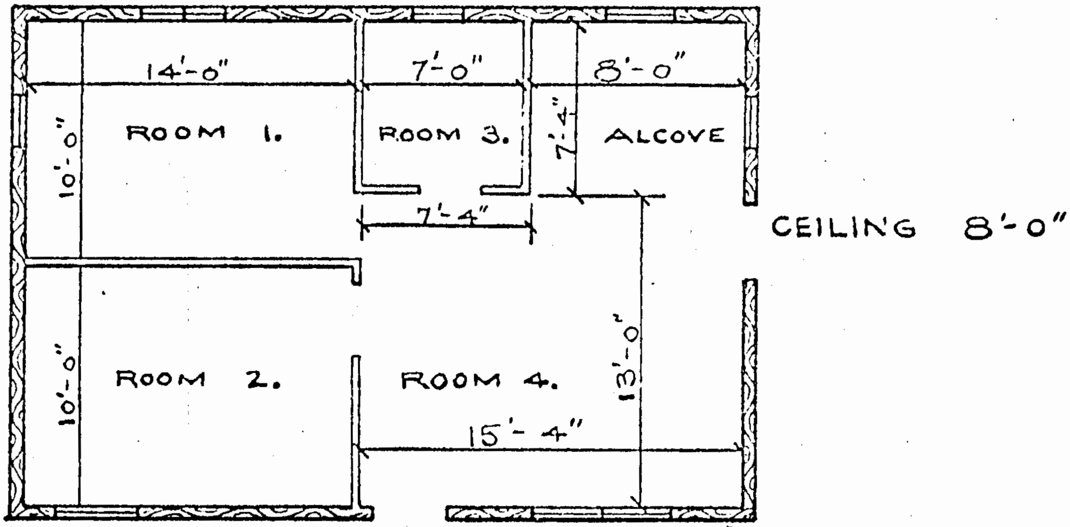


FIGURE 10.3

JOB NUMBER __________

--- QUANTITY TAKE-OFF --- DATE __________

SHEET NO. _____ OF _____

Item	Unit	Length	Width	Height	Sq. Ft.	Sq. Yds.	No. of Bundles
Metal Lath:							
Ext. Walls	1	98'0"		8'0"	784		
Partitions	2	97'4"		8'0"	778.64		
Ceiling	1	20'0"	29'0"		580		
					2142.64		
	2142.64 ÷ 9 =					238	
	238 ÷ 20 =						12

FIGURE 10.4

2. Gypsum Lath:

There are three types of gypsum lath used; namely Plain, Perforated, and Insul ting. Plain gypsum lath is manufactured in 3/8" and 1/2" thicknesses, in panels 16" x 48".

To estimate gypsum lath, determine the total net surface area (deduct window and door openings). Then divide the net surface area by the area of one panel to determine the number of panels required. (5.33 square feet in one 16" x 48" panel). (Add 5% for waste).

Example:

Estimate the number of gypsum lath panels required to lath Room #2 shown on the plan in Figure 10.3.

Walls 10'-0" + 14'-0" + 10'-0" + 14'-0" = 48'-0" x 8'-0" = 384 sq. ft.

Ceiling 10'-0" x 14'-0" = 140 square feet.

Total area = 524 sq. ft. less one door opening 3'-0" x 7'-0" = 21 sq. ft

Two windows 2 x 3'-0" x 5'-0" = 30 sq. ft

Total openings = 551 sq. ft

Therefore, 524 - 51 = 473 square feet.

473 ÷ 5.33 = 89 panels 16" x 48"

Plus 5% = 5

Total panels 94

3. Corner Bead:

It is used around openings and at corners of plastered walls to prevent chipping. It is available in lengths of 8', 9', 10', and 12 feet.

To estimate the amount of corner bead, find the total length of all outside corners to be plastered. Where two rooms are connected by a plastered archway, multiply the distance around the archway by two and add this number of lineal feet of corner bead to any previously found.

Example:

Estimate the lineal feet of corner bead required for the corners and the archway openings as shown in the plan in Figure 10.5. The archways at "B" are 3'-0" x 7'-0" and the archway at "C" is 2'-8" x 7'-0". The ceiling height is 8'-0".

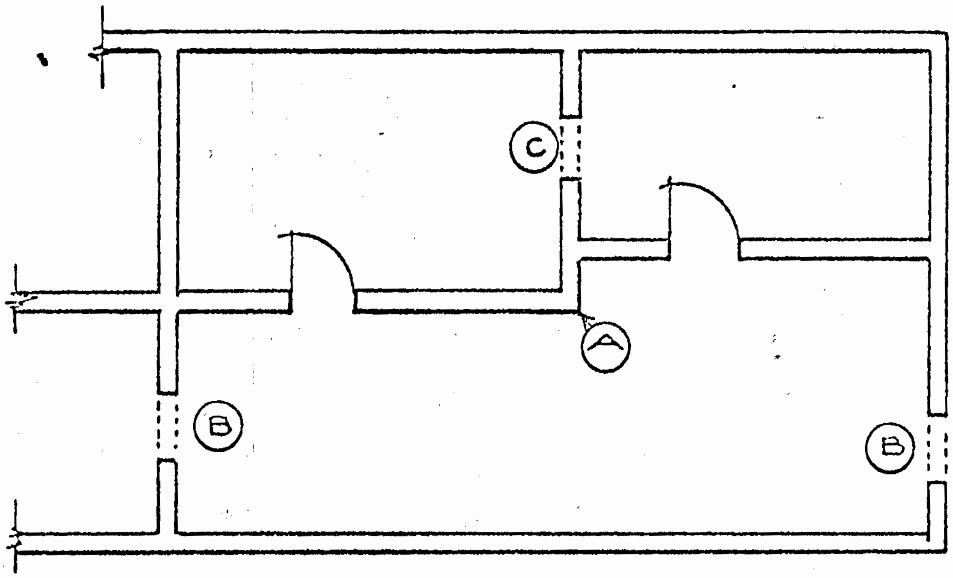


FIGURE 10.5

Corner at "A" is 8'-0"

The distance around the archway at "B" (3'-0" + 7'-0" + 7'-0") x 2 = 34 feet, and there are two of these archways 34 x 2 = 68 lineal feet.

Archway at "C" is (2'-8" + 7'-0" + 7'-0") x 2 = 33'-4" taken up to the next foot = 34'-0".

Total length required will be 8'-0" + 68'-0" + 34'-0" = 110 lineal feet of corner bead.

4. Gypsum Wallboard:

This product takes the place of a plastered finish. The panels are available in thicknesses of 1/4", 3/8", 1/2", and 5/8"; panel widths are 4'-0" and lengths of 6, 7, 8, 9, 10, 12 and 14 feet are available. For most installations with studs at 16" o.c., the 3/8" panels are used. Where studs are at 24" o.c., it is necessary to use 1/2" or 5/8" panels. The 1/4" panels are not recommended for new construction; they are used as a finish material over existing surfaces and available in only 8'-0" or 10'-0" lengths. For further information regarding installation specifications, consult the National Building Code of Canada.

To estimate the number of sheets required, determine the total surface area of the walls and ceilings, then deduct all windows and door openings to obtain the total net square feet of surface area. Then divide this new area by the area of one panel to arrive at the number of panels or sheets required. To this amount add 5% for waste allowance.

Example:

Estimate the number of sheets of 3/8" x 4'-0" x 8'-0" Gypsum wallboard required for a room measuring 22'-0" x 16'0" with an 8'-0" ceiling. The room has two windows measuring 4'-0" x 5'-6" and one door 3'-0" x 7'-0".

Area of ceiling, 22'-0" x 16'-0" = 352 square feet.

Area of walls (22'-0" + 10'-0" + 22'-0" + 16'-0") x 8'-0" = 608 sq. ft.

Less window openings 4'-0" x 6'-6" x 2 = 44 sq. ft.

Wall opening 3'-0" x 7'-0" = 21 sq. ft.

Total openings = 65 square feet.

Therefore 352 + 608 = 960 - 65 = 895 square feet of net surface area.

Panel size 4'-0" x 8'-0" = 32 square feet

895 ÷ 32 = 28 panels plus 5%

28 x 1.05 = 29.4 or 30 panels of 3/8" x 4'-0" x 8'-0" gypsum wallboard.

This would be calculated on the quantity take-off sheet as seen in Figure 10.6.

--- QUANTITY TAKE-OFF ---

JOB NUMBER ______

DATE ______

SHEET NO. ______ OF ______

ITEM	Unit	Length	Width	Height	Sq. Ft.	Sq. Ft. Out	Net Area	Total No. of Sheet
Gypsum Wallboard:								
Ceiling	1	22'0"	16'0"		352			
Walls	1	76'0"		8'0"	608			
					960			
Windows	2	4'0"	5'6"			44		
Door	1	3'0"	7'0"			21		
						65		
							895	
	895 ÷ 32 = 28							
	Plus 5%	2						
		30						30

FIGURE 10.6

5. Tape and Crackfiller:

Tape used for taping the joints of gypsum wallboard is obtained by the roll, which will contain 500 lineal feet. For estimating purposes, allow 400 lineal feet per 1000 square feet of gypsum wallboard.

Crackfiller or Joint Cement used for the joints is obtainable in 25 pound bags. For estimating, allow 50 pounds for 1000 square feet of gypsum wallboard.

6. Estimating Quantities of Plaster:

Plaster work will be calculated by the square yard of surface area regardless of whether it is a one-, two-, or three-coat application. You must first determine the area of the walls and ceilings to be plastered, then deduct 7% of the area for window and door openings. If there are large picture windows or window alls, these should be deducted from the total area before the 7% deduction is made for smaller openings and waste. Methods used will vary among estimators; however, for our purpose, this approach is simple and widely used.

Example:

A room measure 18"-0" x 22'-0" with a ceiling height of 8'-0"

Area of the ceiling = 18 x 22 = 396 square feet

Area of the walls = 80 x 22 = 640 square feet

Total area = 1036 square feet

Less 7% of the area 1036 x .07 = 72.52 square feet

Calculated area = 963.48

Total square yards 963.48 ÷ 9 = 107 square yards

All plaster will contain at least one cementitious substance, such as lime, gypsum or portland cement. Most plaster is made by mixing one or two of these substances with sand.

A distinction must be made between lime, gypsum and cement plaster. While gypsum plaster is used on gypsum blocks and plaster boards, cement plaster is used in places where five resistance or water resistance is required. Although lime was formerly used along with sand in preparing plaster, it is now more commonly used along with other cementitious materials. The first plaster coat, called the scratch coat, consists of gypsum and sand which is forced into the metal lath so that some of the material goes through to form a key. The metal lath will be covered to a thickness of approximately 1/4 inch; then before it hardens, it is roughened with a stiff wire brush in order to provide a very rough surface. This rough surface will help to bond the next coat, called the brown coat. The brown coat is the thickest of the three coats and will be applied to a depth of 3/8 inch to 1/2 inch; it consists of gypsum cement plaster and sand troweled to a true surface and then finished with a float. The final finish coat consists of lime and gauging plaster applied to a thickness of 1/8 inch, troweled with a steel trowel to a hard, smooth finish ready for painting.

Scratch Coat Material Quantities. The scratch coat for metal lath generally requires ten 1-pound bags of gypsum cement plaster and one yard of sand per 100 square yards of surface area.

The scratch coat for gypsum lath requires five 100-pound bags of gypsum cement plaster and one-half yard of sand per 100 square yards of surface area.

Brown Coat Material Quantities. The brown coat is usually in the proportions of one part plaster to three parts sand. Material required for the brown coat will be seven 100-pound bags of gypsum cement plaster and 21 cubic feet of sand per 100 square yards of surface area.

Finish Coat Material Quantities. The finish coat is in the proportions of one bag (50 pounds) of lime and 21 1/2 pounds of gauging plaster. For 100 square yards of surface area you will require seven bags of lime (350 pounds) and 150 pounds of gauging plaster.

The quantities of plaster per 100 square yards for the various applications is shown in Figure 10.7.

100 SQ. YDS. OF PLASTER FOR VARIOUS APPLICATIONS			
Type of Application	Gypsum Cement Plaster	Sand	Surface
Scratch Coat	10 bags	1 yd.	Metal Lath
Scratch Coat	5 bags	1/2 yd.	Gypsum Lath
Brown Coat	7 bags	21 c.f.	Scratch Coat
Finish Coat	7 bags lime	150 lbs. gauging plaster	Brown Coat

FIGURE 10.7

Example:

From the plan shown in Figure 10.8, estimate the following quantities-of materials.

1. Scratch coat of metal lath
2. Brown coat on scratch coat.
3. Finish coat on brown coat.

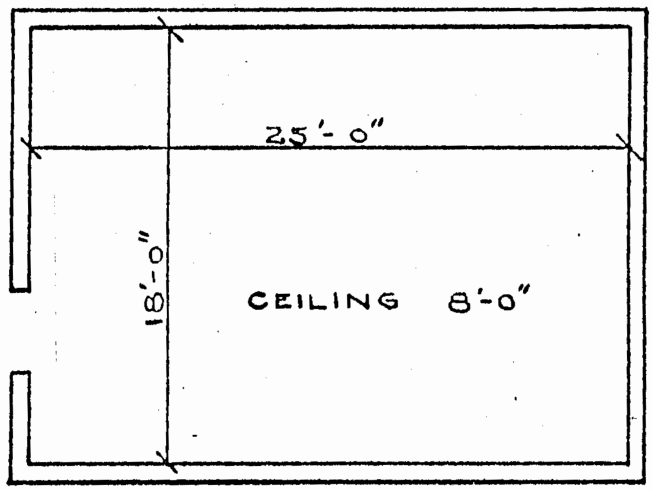


FIGURE 10.8

Area of the ceiling = 18'-0" x 25'-0" = 450 feet.

Area of the walls = (18 + 25 + 18 = 25) x 8 = 688 square feet.

Total area = 1138 square feet.

Less 7% of the area 1138 x .07 = 79.66

1058.34

Net area in square yards 1058.34 ÷ 9 = 11.76 or 118 square yards.

Therefore: (refer to Figure 10.7)

Scratch Coat: 10 bags x 1.18 = 11.8 or 12 bags of gypsum cement

Plaster 1 x 1.18 = 1.18 cubic yards of sand

Brown Coat: 7 bags x 1.18 = 8.26 or 9 bags of gypsum cement

Plaster 21 x 1.18 = 24.78 or 25 cubic feet of sand

Finish Coat: 7 bags lime x 1.18 = 8.26 or 9 bags of lime.

150 lbs. of plaster x 1.18 = 177 pounds of guaging plaster.

This would be shown on the quantity take-off sheet in Figure 10.9.

	JOB NUMBER ________
--- QUANTITY TAKE-OFF ---	DATE ________
	SEEET NO. ______ OF ______

Item	Unit	Length	Width	Height	Sq. Ft.	Sq. Yds.	
Plaster:							
Ceiling	1	25	18		450		
Walls	1	86		8	688		
					1138		
	Less 7% 1138 - 79.66 = 1058.34						
	1058.34 ÷ 9 = 117.6						
						118	
1. Scratch Coat							
Gypsum cement							
plaster	10 x 1.18 = 11.8		100 lb. bags				12 bags
Sand	1 x 1.18 = 1.18		cubic yards				1.18 cubic yds.
2. Brown Coat							
Gypsum cement							
plaster	7 x 1.18 = 8.26		100 lb. bags				9 bags
Sand	21 x 1.18 = 24.78		cubic feet				25 cubic ft.
3. Finish Coat							
Lime	7 x 1.18 = 8.26		50 lb. bags				9 bags
Guaginc Plaster	150 x 1.18 =		177 pounds				177 pounds

FIGURE 10.9

7. Assignments:

Problem 1:

From the plan in Figure 10.10 take off the following material required for the two bedrooms and the kitchen (excluding the closets). Ceiling height is 8'-0".

a. Number of bundles of metal lath

b. Scratch coat materials

c. Brown coat materials

d. Finish coat materials

Use the quantity take-off sheets provided.

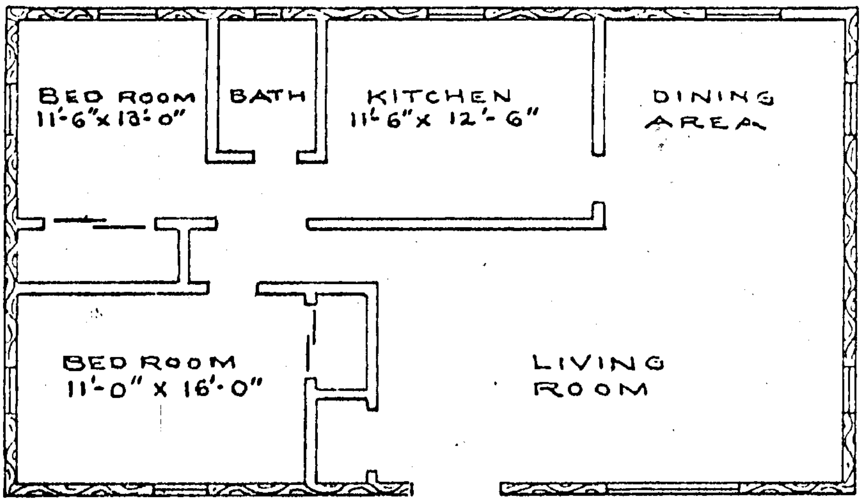


FIGURE 10.10

Problem 2:

Find the material requirements to plaster the living room, dining room, kitchen and bedroom (exclude closet) for the plan shown in Figure 10.11. The ceiling height is 8'-0".

a. Bundles of metal lath

b. Scratch coat materials

c. Brown coat materials

d. Finish coat materials

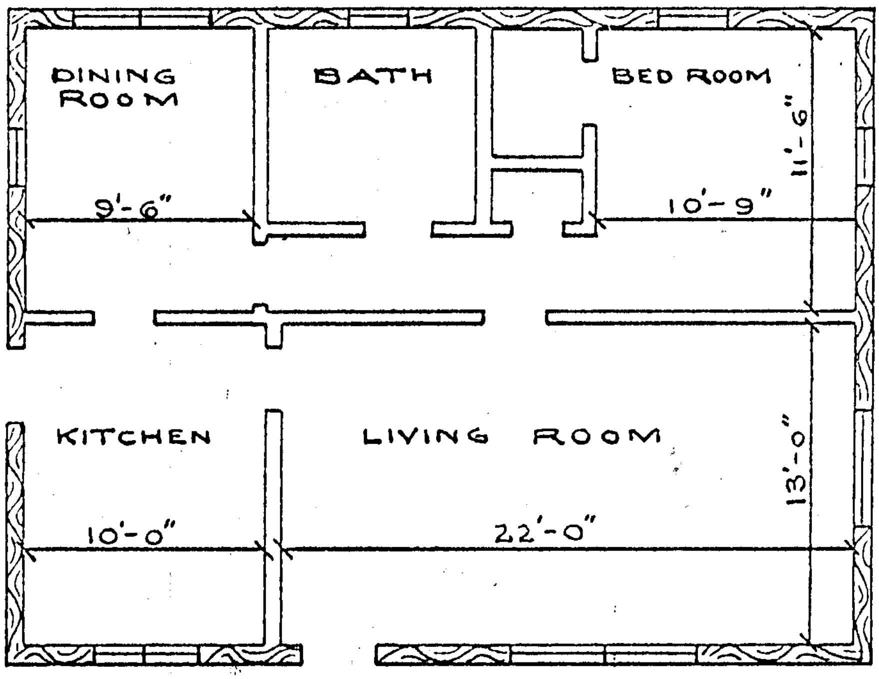


FIGURE 10.11

Problem 3:

Determine the number of sheets of 3/8" gyproc 4'-0" x 8'-0" required to finish the walls and the ceilings for the living room and both the bedrooms including the closets in the plan shown in Figure 10.12. Ceilings are 8'-0" high.

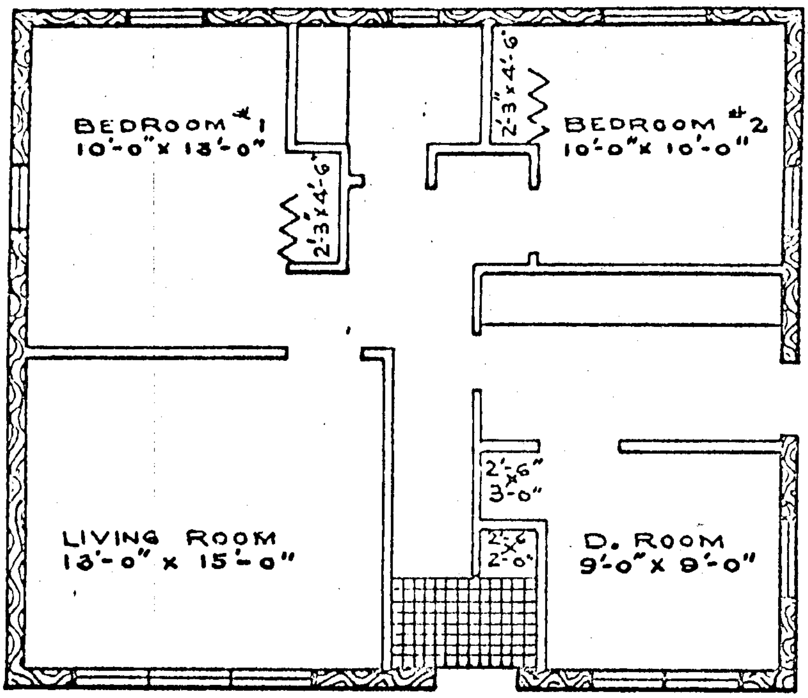


FIGURE 10.12

4 windows	3'-0" x 3'-6"
2 windows	2'-0" x 4'-6"
1 window	4'-0" x 4'-6"
3 Door Openings	3'-0" x 7'-0"

--- QUANTITY TAKE-OFF SHEET ---

Date ______________________ Assignment ______________ Name ______________________

Class ______________________________________ Sheet No. ______________ of __________

DESCRIPTION	DIMENSIONS						EXTENSIONS	EXTENSIONS

Chapter 5

CONCLUSION

There is a definite need in vocational and high school programs for estimating instruction in the building field.

The writer has achieved tremendous satisfaction from the enthusiastic acceptance of these instructional packages by people in the construction industry, lumber trade, and vocational education programs.

It is felt that the purposes of this study have been achieved and the following list of recommendations indicate further considerations and areas that could extend this research.

RECOMMENDATIONS AND COMMENTS

As a result of comments from my jury of experts and my own personal experiences I offer the following recommendations:

1. That the program be tried at a high school level being part of a construction program.

2. That the program be made available to the retail lumbermans association.

3. That the program be continually updated to include all new construction materials and processes. e.g. Foam form basement forms.

4. That the program be revised to meet the metric standards in conjunction with the national metric deadlines.

5. The format was found to be useful to all educational and construction personnel.

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Appendix A

EVALUATIVE INSTRUMENT

Programmed instructional units for estimating in the construction field.

1. Would you recommend these units for your associates?

Yes ________ No ________ Undecided ________

2. Do you think that all construction personnel should have an opportunity to take this course?

Yes ________ No ________ Undecided ________

3. Do you feel that students would gain a good understanding of construction estimating.

Yes ________ No ________ Undecided ________

4. Would you be interested in having your employees take this estimating course.

Yes ________ No ________ Undecided ________

5. Were you able to adequately understand all directions and assignments?

Yes ________ No ________ Undecided ________

6. Would you prefer to see more detail in the units.

Yes ________ No ________ Undecided ________

7. Do you think that the overall program is appropriate for high school students?

Yes __________ No __________ Undecided __________

8. Do you think that sub-contractors would benefit from those units pertaining to their specialty.

Yes __________ No __________ Undecided __________

9. Do you feel these programmed units would be of value to apprentices.

Yes __________ No __________ Undecided __________

10. Do you feel that architects and engineers would benefit from these units.

Yes __________ No __________ Undecided __________

11. Do the units cover the estimating field adequately.

Yes __________ No __________ Undecided __________

12. Did you find the format of the programmed units easy to understand?

Yes __________ No __________ Undecided __________

Do you have any recommendations or comments?