ESTIMATING CONCRETE BUILDINGS

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Aberthaw Texts

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By

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PREFACE

THE process of building, in the time-honored acceptation of the term, consists of the assembling of units already manufactured, and the fitting of them into their appointed places. Methods of accomplishing these things have been developed through the successive experience of generations of builders until they have crystallized into a traditional practice the cost of which may be prejudged with reasonable accuracy.

Concrete construction, on the other hand, is less a process of building than it is of manufacturing. Cement, sand, stone, water and steel are brought together under conditions which produce a chemical action that fuses these elements into a whole quite different from the sum of its constituent parts. The consideration that this occurs on the spot where the unit produced is to remain as part of the finished structure, in no wise alters the essential fact that the process is one of manufacture. The traditional operations of the builder come into play mainly in the placing of subsidiary or subordinate units, and in supplying necessary fittings.

The actual procedure of concrete construction is still very far from approximating standard practice. Still less has there emerged any generally accepted system for keeping track of the individual cost of the innumerable items that enter into this type of work. Hence no satisfactory basis has been supplied for making estimates in advance of the actual undertaking.

Estimates are made, of course; but in the great majority of instances they are little more than the shrewd guess of one whose cost instinct has been sharpened by experience. Few are the estimators of concrete construction whose computations follow any scientific plan, or whose results are capable of analysis. Indeed, it may be said of estimators, as of poets, that they are seldom able to explain their figures once these have been allowed to cool.

The nature of the special responsibility which the Aberthaw Construction Company has assumed in the field of building has necessitated the evolution of a highly exact system of cost accounting. Upon this, in turn, it has been possible to establish similarly thorough-going methods of drafting estimates. Years of study have at length produced a satisfactory Company practice, which Mr. Mayers has so clearly outlined in his treatise that it has seemed well worth while to publish it. It should prove an authoritative text, helpful alike to students and to practitioners of concrete construction.

ABERTHAW CONSTRUCTION COMPANY

Boston, January, 1920.

ESTIMATING CONCRETE BUILDINGS

INTRODUCTORY

MAKING an estimate for a reinforced concrete building involves much more labor than is required in that for buildings constructed of structural steel, brick, wood or a combination of these materials. This becomes obvious when we consider that a reinforced concrete beam is composed of certain quantities of cement, sand, crushed stone, water, reinforcement, formwork and labor, whereas a steel I beam in place in a building represents, insofar as we are concerned, only a certain amount of structural steel and labor.

In order to estimate the cost of a reinforced concrete beam, column, floor slab or wall it is necessary to determine the quantities of concrete, steel reinforcement, formwork and labor involved, and to these quantities affix proper unit prices. In arriving at proper unit prices, we must still further sub-divide the amount of concrete into its constituent parts of cement, sand and crushed stone. We must likewise determine the amount of lumber necessary properly to form the concrete, before a correct unit price for formwork may be decided upon. Again, the necessary amount of plant equipment, and the labor incidental to its installation and removal, must be carefully considered and the cost determined before the estimate is complete.

Compare with this the process of estimating the cost of a steel member in a building, which consists of so many pounds of steel and so much labor, and we may readily appreciate that accurately to estimate all the structural members of a reinforced concrete building requires much more detail work than is called for in estimating most other types of building construction.

PART I
QUANTITIES

I. GENERAL PROCEDURE

Scaling

In estimating the cost of a reinforced concrete building, it is essential to make a complete list of all materials and labor arranged in a convenient form, in accordance with methods which will involve the least amount of labor. In making this list, it is necessary to consider every structural member in the building from the footings to the roof slab. The quantities will be determined by carefully scaling, or making a quantity survey of the plans of the proposed building. The estimated quantities will then be priced; and the sum of the extended totals, to which have been added the cost of superintendence, liability insurance, profit and other items common to all building operations will, if correctly figured, closely approximate the final cost of the work.

Stationery Forms

Making a scaling of the plans, as it is commonly called, is the first step in preparing an estimate. In order to perform this work rapidly and with the least possible chance for error, properly ruled stationery is essential. Paper (8½ inches x 11 inches) ruled like the copy shown below has been found of convenient design. Its use is recommended.

Col. No. 1	Col. No. 2	Col. No. 3	Col. No. 4	Col. No. 5	Col. No. 6.	Col. No. 7.	Col. No. 8	Col. No. 9
"Description"	"times"	"length"	"width"	"height"	"quantity"	"Summary"	"Unit Price"	"totals"

Column No. 1 is the *description* column. It is used to note briefly the location and character of the work being scaled in order that future identification may easily be made.

Column No. 2 is the *times* column. In this column should be noted the number of pieces or duplicate members which are being scaled from the plans, as exactly alike. If no duplicate pieces are shown on the drawing, this column is not used and it is understood that but one member or unit is to be estimated.

Column No. 3 is the *first dimension*, or *length*, column.

Column No. 4 is the *second dimension*, or *width*, column.

Column No. 5 is the *third dimension*, or *height*, column.

Column No. 6 is the *quantity* column, and should contain the extended quantity only.

Column No. 7 is the *summary* column, in which the total of the *quantity* column is shown reduced to the unit of measure generally accepted as the standard measure ready for pricing; — as cubic yards of concrete, tons of steel reinforcement, etc.

Column No. 8 is for the *unit price*.

Column No. 9 is the *total* column, for the product obtained by multiplying the summarized quantity by the unit price. This product is carried out in even dollars.

The Order of Scaling

On account of the comparatively large number of details involved in estimating the cost of reinforced concrete construction, it is important that a definite system, or *order of scaling*, be laid out and carefully followed. When this is done, the work of scaling the plans is greatly simplified and the liability to error is reduced to a minimum. In preparing the list, or *order of scaling*, the items to be scaled should, with one or two exceptions mentioned later on, be considered in the order of actual job construction. For the convenience of the reader, a list is given below which fulfills this requirement and is easily remembered.

AREA AND CUBE

CONCRETE

- Exterior and interior footings
- Foundation walls
- Exterior columns and brackets
- Interior columns and heads
- Floor slabs and roof slab
- Drop panels
- Wall beams, parapet beams, and curtain walls
- Interior floor beams
- Partitions
- Window sills (including forms and reinforcement)
- Copings (including forms and reinforcement)
- Stairs and stair landings (including forms and reinforcement)
- Paving
- Granolithic finish
- Carborundum rubbing

FORMS
- Exterior and interior footings
- Foundation walls
- Exterior columns and brackets
- Interior columns and heads
- Floor slabs and roof slab
- Drop panels
- Wall beams, parapet beams, and curtain walls
- Interior floor beams
- Partitions
- Window sills, copings, stairs and landings, etc.

REINFORCEMENT
- (See list for forms)

EXCAVATION
- General or steam shovel
- Hand work
- Backfill
- Sheeting

MASONRY
- Brick work
- Brick veneer
- Terra cotta partitions
- Plastering

STEEL SASH

GLASS AND GLAZING

DOORS, FRAMES, HARDWARE, ETC.

LIGHT IRON WORK AND MISCELLANEOUS IRON

ROOFING AND FLASHING

PAINTING
- Walls and ceilings
- Sash and doors
- Light iron

ENGINEERING, PLANS, ETC.

CLEAN UP JOB AT COMPLETION

LIABILITY INSURANCE

WATCHMAN

SUPERINTENDENCE, JOB OVERHEAD, OFFICE, STATIONERY, TELEPHONE, ETC.

SUNDRIES

PROFIT

This list is by no means exhaustive but it will serve as a sufficient outline, which may be elaborated by the addition of special items as they occur. As it stands, however, the list includes the items usually found in a typical reinforced concrete building.

The proper method of scaling the quantities in each element of the list as given is briefly discussed in the pages which follow.

II. PRELIMINARIES

Area and Cube

Preliminary to any estimate for a building there should be noted the square foot area of the floors of the building and the cubical contents of the structure.

This is done in order that the estimator may, with practice, learn to judge the cost of the work quite closely on a square and cube foot basis before the estimate is begun. Practice of this kind, checked up after the estimate is completed, will be very helpful in developing the estimator's judgment.

In determining the area, the floors (including basements) should be measured and the dimensions taken "out to out." For instance, the area of a building two stories high, 160 feet long and 60 feet wide should appear on the estimate sheet as follows: — 2 x 160 x 60 equals 19,200 square feet.

The cubical contents of the building should be figured from the same length and width dimensions; the total height being measured from the bottom of the basement floor to the top of the roof slab. The cubical contents, or *cube*, as it is commonly called, should then appear as follows: — 160 x 60 x $23\frac{2}{3}$ equals 227,200 cubic feet.

III. CONCRETE

Concrete Exterior and Interior Footings

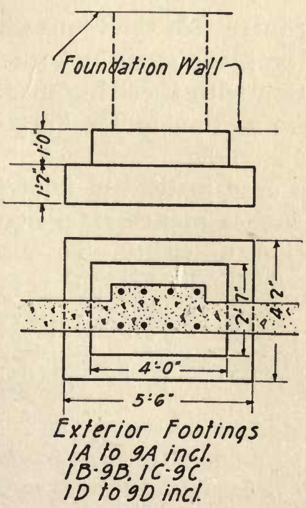


FIG. 1

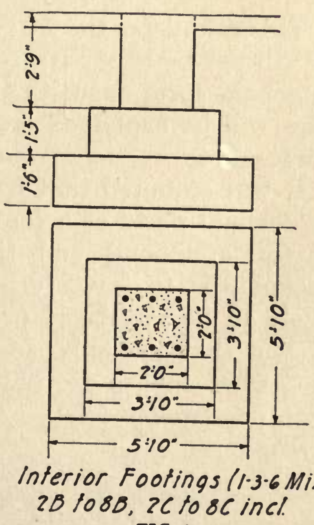


FIG. 2

In scaling the quantities of a concrete footing, it is necessary first to determine the amount of concrete in the footing by tabulating in the proper column of the estimate sheet the dimensions of the footing.

For example, Fig. 1 represents one of twenty-two typical exterior column footings for a reinforced concrete building.

First describe the footings in column No. 1 as follows:

Footing No. 1A to 9A inclusive, 1B and 9B, 1C and 9C, 1D to 9D inclusive. Next in column No. 2 note the number of footings which are alike (in this case 22). In the *length* column note the length of the lower block ($5\frac{1}{2}$ feet), following with the width and height dimensions ($4\frac{1}{6}$ feet and $1\frac{1}{6}$ feet, respectively). Thus the concrete contained in the lower blocks of these 22 footings is tabulated as $22 \times 5\frac{1}{2} \times 4\frac{1}{6} \times 1\frac{1}{6}$.

On the line below tabulate the upper block of the footings, which will appear $22 \times 4 \times 2\frac{7}{12} \times 1$. The scaling of the quantities in the interior footings (Fig. 2) is handled in the same way and, when properly tabulated on the estimate sheet, appears as follows: —

Concrete Exterior footings (1-3-6 Mix)								
1A to 9A incl.								
1B and 9B	22	x 5½	x 4⅙	x 1⅙	=			
1C and 9C	22	x 4	x 2 7/12	x 1	=			
1D to 9D incl.								
							+	c.y.
Concrete Interior footings			(1-3-6 Mix)					
2B to 8B incl.	14	x 5⅚	x 5⅚	x 1½	=			
2C to 8C incl.	14	x 3⅚	x 3⅚	x 1 5/12	=			
	14	x 2	x 2	x 2¾	=			

This completes the scaling of the concrete in the footings. It will not be necessary to refer to the plans again in order to get the form quantities in connection with these footings. This will be explained later on in the section under *Formwork.*

It will be noted that fractions are used instead of inches or decimal parts of a foot. To use inches makes extension of totals difficult and the tabulation unwieldy. To use decimals is to invite error, as the decimal point is very likely to be misplaced or omitted. Years of practice have proved that the only safe method is to use fractions of a foot when inches are indicated; no fraction to be smaller than one-twelfth ($\frac{1}{12}$).

Thus: —

3 feet 5 inches = $3\frac{5}{12}$ feet
6 feet 9 inches = $6\frac{3}{4}$ feet
8 feet 10 inches = $8\frac{5}{6}$ feet

Where half inches are involved in concrete work (except in the thickness of floors), the fraction should be equivalent to the next higher even inches. For example:—

6 feet 5½ inches = 6½ feet
7 feet 2½ inches = 7¼ feet

This ruling can be safely followed without danger of gross error except in the case of floor thickness, which will be discussed under *Concrete Floor Slabs.*

As all hand books show the weights of steel bars in decimal parts of a pound, it will be necessary to use decimals in computing the tonnage of steel reinforcement.

The slide rule will be found of great value in extending quantities, and its intelligent use will result in both speed and accuracy. All arithmetical computations should be checked by a second person before the estimate is submitted.

Certain abbreviations are generally used to simplify the scaling of reinforced concrete. In these it will be found that reversing the order of the letters in some of the abbreviations reduces the liability to errors due to mistaking carelessly made letters placed next to figures for figures themselves. The following abbreviations have been used extensively and are recommended:—

c.y. — cubic yards
s.y. — square yards
f.c. — cubic feet
s.f. — square feet
f.l. — linear feet
sqs. — squares (100 sq. ft.)
— when placed before stands for the number of units
— when placed after stands for pounds
Ddt. — deduct

Concrete Foundation Wall

Under this heading, generally speaking, should be included all concrete walls below grade. In scaling such walls the quantity scaled should include all concrete above grade which can be correctly classed as a part of the foundation wall.

For example, a cellar wall may extend a foot or more above grade before reaching the level of the first floor, yet the part above grade will be classed as foundation wall along with the part of this wall which is built below the grade level. It is the usual practice to include under the term *foundation walls* all the concrete walls which are below the level of the first floor, and to include area walls, pit walls, etc.

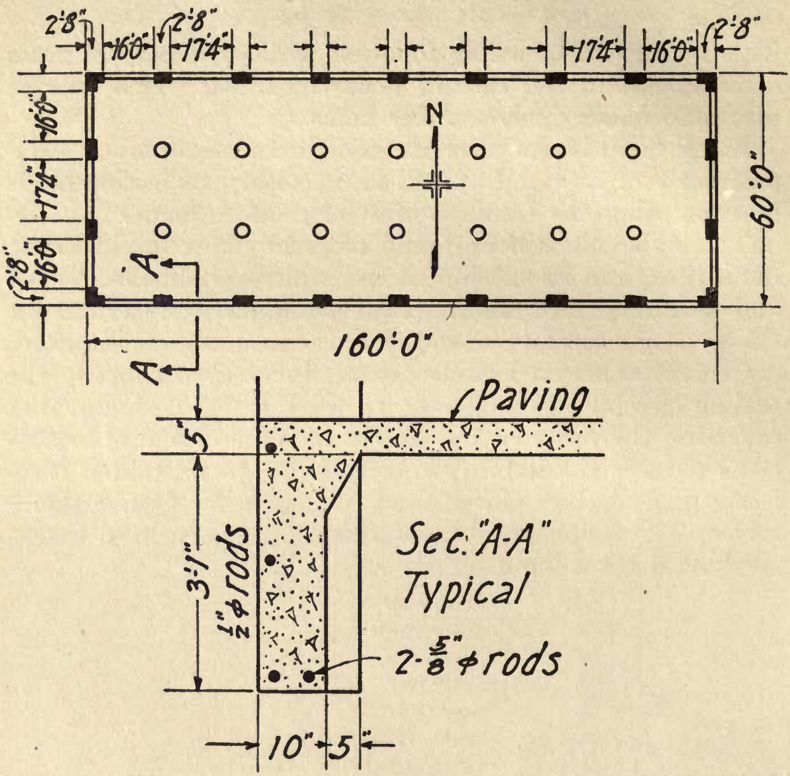


FIG. 3

Fig. 3 represents a cross section and plan of the foundation wall extending around a reinforced concrete building having a length of 160 feet and a width of 60 feet. In scaling the quantity of concrete in this foundation wall the sections or pieces of wall should be considered by elevations as follows: —

Concrete-Foundation Walls							
South elev.	160	×	5/6	×	3 1/12	=	
Splayed top	[160 - (9 × 2 2/3)]	×	1/4 av.	×	5/6	=	
pilasters	7 × 2 2/3	×	5/12	×	3 1/12	=	
East elev.	(60 - 1 2/3)	×	5/6	×	3 1/12	=	
Splayed top	[60 - (4 × 2 2/3)]	×	1/4 av.	×	5/6	=	
pilasters	2 × 2 2/3	×	5/12	×	3 1/12	=	} = C.Y.
North elev.	160	×	5/6	×	3 1/12	=	
Splayed top	[160 - (9 × 2 2/3)]	×	1/4 av.	×	5/6	=	
pilasters	7 × 2 2/3	×	5/12	×	3 1/12	=	
West elev.	(60 - 1 2/3)	×	5/6	×	3 1/12	=	
splayed top	[60 - (4 × 2 2/3)]	×	1/4 av.	×	5/6	=	
pilasters	2 × 2 2/3	×	5/12	×	3 1/12	=	
corner pieces	4 × [(1 5/6 × 1 5/6) - (1 5/12 × 1 5/12)]			×	3 1/12	=	

It will be noted that in scaling the concrete foundation wall shown above, the wall on the side, or south, elevation is scaled for the full length of the elevation. The quantity of concrete in the splayed part is added as part of the foundation wall. The concrete in the 7 piers or pilasters is then added, the dimensions always being given in the order of length, width and height. Next the east or end wall is scaled (progressing anti-clockwise).

In the case of the ends, in order to avoid doubling the amount of material in the corners, the inside dimension is scaled instead of the outside "over all" dimension. This dimension should be set down in the length column to read (60–1⅔). The concrete in the two piers or pilasters is next added. The north wall is scaled similar to the south, and the west similar to the east. The concrete in the 4 corner piers is then added and the scaling for the foundation wall is complete.

Concrete Exterior and Interior Columns

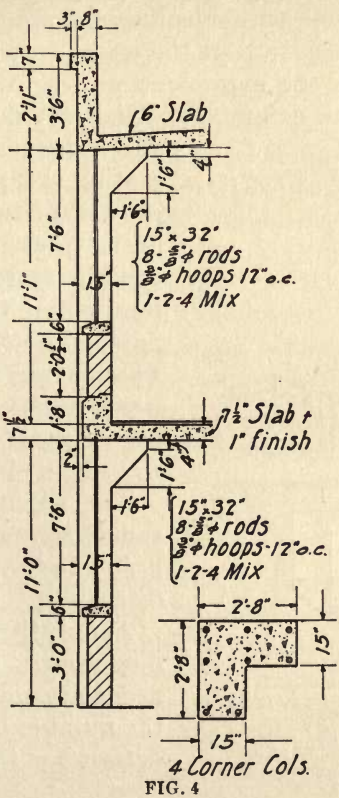


FIG. 4

Fig. 4 represents a part cross section showing the typical exterior columns of a building 160 feet long and 60 feet wide.

Assuming these typical columns to be spaced 20 feet apart, there will be 18 such columns in the building and 4 corner columns. The scaling of the quantity of concrete in these columns will appear as follows: —

Concrete Exterior Cols (1-2-4)									
1st story									
2A to 8A incl. }	18	×	2 2/3	×	1 3/4	×	11	=	} = cy
1B, 9B, 1C, 9C }									
2D to 8D incl. }									
Corner cols	4	×	[(2 2/3 × 2 2/3) - (1 5/12 × 1 5/12)]			×	11	=	
Mullion			1 1/4	×	1 1/2	×	11	=	
Col. brackets	18	×	4 1/3		cubic feet			=	
2nd story (1-2-4)									
Same as 1st story	18	×	2 2/3	×	1 3/4	×	11 1/2	=	
Corner cols	4	×	[(2 2/3 × 2 2/3) - (1 5/12 × 1 5/12)]			×	11 1/2	=	
Mullion			1 1/4	×	1 1/2	×	10	=	
Col. brackets	18	×	4 1/3		cubic feet			=	

Following through this scaling we have in the *times* column the number 18, which denotes the number of typical exterior columns in each story. In the next three columns of the estimate sheet are placed the length, width and height respectively of the columns being scaled.

Each of the four corner columns has both exterior faces of the same dimension, but the inside corner is notched out. This complicates the expression representing the cross sectional area of the column, which is set down in the *length* and *width* columns of the estimating sheet. This expression consists of two parts. The first part represents a rectangular column and the second part represents the area of the notched portion of the column which is to be deducted from the larger area. Corner columns, or any irregular columns should always be scaled in this manner.

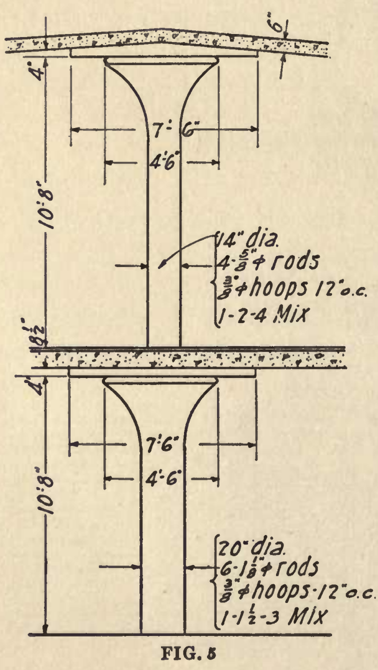


FIG. 5

The second story columns should be scaled similar to the first story columns above discussed.

As only the concrete brackets now remain to be scaled, it is necessary merely to count up the number of brackets and to determine the approximate number of cubic feet of concrete in one bracket. This completes the scaling of concrete in the exterior columns.

The scaling for the interior columns should be done in a similar manner, unless they happen to be round instead of square.

Assume that Fig. 5 represents a typical interior first and second story column of a building in which there are 14 such columns. The scaling for these 14 first story and 14 second story columns should appear as follows:—

Concrete - Interior Cols (1 1/2-3)							
1st story							
2B to 8B, 2C to 8C	14	× (20" dia)	2 1/5 s.f. ×	10 2/3	=	} =	cy
Col heads	14	× 13	cubic feet		=		
2nd story	(1-2-4)						
same as 1st sty	14	× (14" dia)	1 1/2 s.f. ×	11 2/3 avg	=	} =	cy
Col heads	14	× 19	cubic feet		=		

In scaling the interior columns, the second column on the estimate sheet should contain the number of identical members being scaled (14 in this case). As these interior columns are round, it is not possible to use the *length* and *width* columns exactly as outlined at the beginning of this chapter. These two columns should contain, however, figures which represent the cross sectional area of the member. It is best to do this by noting the diameter of the column, enclosing same in parentheses. Immediately following should be noted in square feet the cross sectional area of the column. The *height* column should contain the length of the member from the floor to the level of the bottom of the drop panel. Next is noted in the *times* column the number of column heads (usually the same as the number of columns) and in the *length* and *width* columns the approximate number of cubic feet of concrete in the head which is in excess of the shaft already scaled. The similar tabulation of the upper story columns completes the scaling of interior column concrete.

Concrete Floor Slabs and Roof Slab

Scaling the quantity of concrete in floor and roof slabs is very simple. As in scaling the concrete for beams and columns, the dimensions should be taken off in the order of length, width and height.

For instance, assume that it is necessary to scale the concrete in the second floor slab and roof slab of a reinforced concrete building 160 feet long and 60 feet wide. The second floor slab is 7½ inches thick, and the edge of the slab is set back 2 inches from the line of face of the building. There is a stair well opening in the slab 18¼ feet long and 10 feet wide. The roof slab is 6 inches thick and has no opening. The quantities of concrete would appear as follows: —

Concrete-Floor slab							
2nd floor-	159⅔ ×	59⅔ ×	15/24	=		} =	Cy.
deduct opening	18¼ ×	10 ×	15/24	Ddct. =			
roof slab	160 ×	60 ×	½	=			

It will be found in first practice that it is the natural tendency to put down the thickness of the slab in the *width* column instead of in the last or *height* column. This tendency will be overcome quickly if the estimator remembers that whether it is beam, column or floor slab, the order of scaling dimensions of concrete should always be length, width, and height. The thickness of the slab is a very important dimension and should be accurately tabulated on the estimate sheet. If the slab thickness is 5½ inches, the fraction tabulated in the *height* column should be $\frac{11}{24}$. This is one of the very few instances which occur in scaling concrete work when fractions having denominators larger than 12 are recommended.

Concrete Drop Panels

Drop panels which occur over the column heads of flat slab designs should be considered as small floor or roof slabs when being scaled for estimate purposes.

The quantity of concrete in the drop panels shown under the floor slab and roof slab in Fig. 5 would appear on the estimate sheet as shown below.

Concrete Drop Panels							
2nd floor	14 ×	7½ ×	7½ ×	1/3	=	} =	Cy.
roof	14 ×	7½ ×	7½ ×	5/12 ea	=		

Concrete Wall Beams

Under the heading wall beams should be included the curtain walls, parapet beams, and other similar structural members. In Fig. 4 is shown a typical wall beam and parapet beam in a building 160 feet long and 60 feet wide. The exterior columns are 20 feet apart. The concrete in the wall beams and parapet beams will appear as follows: —

Concrete—Wall beams						
2nd floor	{[(2×160)+(2×60)]−(26×2⅔)}	× 1⅙	× 1½	=	} =	c.y.
roof parapet	[(2×160)+(2×58⅔)]	× ⅔	× 2⅚	=		
coping projection	{[(2×160)+(2×60)]	× ¼	× 7/12	=		

The expression within the braces above represents the total actual length of wall beam. Within the braces we find two expressions; the first enclosed in brackets, and the last in parentheses only. The first of these represents the perimeter of the building, and the second the total length of column faces, which should be deducted from the perimeter in order to arrive at the actual total length of wall beam. The parapet is scaled in a similar manner, but no deductions are made except for overlapping corners. It will be found that errors will be avoided if wall beams, parapets, etc., are scaled in this manner. If the beams are considered individually, omissions of entire beams are very likely to occur and the error may easily be passed unnoticed.

Interior Floor Beams

Interior floor beams are usually scaled by simply noting in the *description* column the location or index number of the beam or beams.

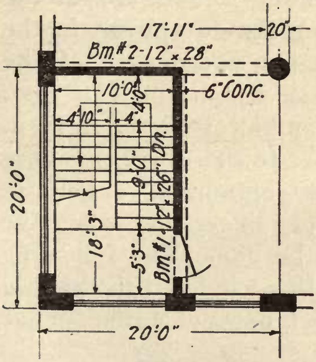


FIG. 6

The *times* column contains the number of identical beams, and the *length, width* and *height* columns are used according to the method set forth throughout the preceding pages.

The height of a beam should always be taken exclusive of the slab thickness. Beams around stair openings should be treated in the same way, except that sketches of the cross section of the beam should usually be made in the *description* column as a help in determining the formwork as indicated in the illustration below. For instance, if we have two stair well beams as shown in Fig. 6, the quantities of concrete will appear as follows:—

Concrete—Interior floor beams						
2nd fl. at stairs						
Bm #1 7½" 12"×26"	18¼	× 1	× 1½	=	} =	c.y.
same Bm #2 12"×28"	10	× 1	× 1⅔	=		
Bm #2 7½" 12"×28"	7½	× 1	× 1⅔	=		

Partitions

Concrete partitions are scaled in the same manner as interior concrete beams.

In the *description* column should be noted the approximate location or character of the partitions. The remaining columns of the estimate sheet are to be used as hereinbefore set forth. It should always be borne in mind that, in this case, the thickness of the partition is the *width* or second dimension scaled. The concrete quantities appear below for the 6-inch concrete partitions shown in Fig. 6 and occurring on the first and second floors of a building having a story height of about 11 feet.

Concrete Partitions										
around stairs etc.	(10 + 18¾)	×	½	×	11		=	}	=	Cuf
deduct for door	3	×	½	×	7	Ddt	=			
2nd story	(10 + 18¾)	×	½	×	11½	avg	=			
deduct for doors	3	×	½	×	7	Ddt	=			

Window Sills and Copings

Concrete window sills and copings are scaled by the linear foot. In taking off the quantity of each the work proceeds by elevations.

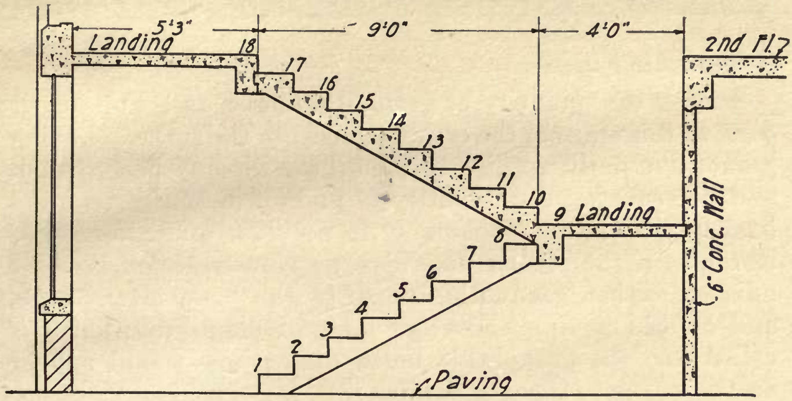
For instance, in the *description* column should appear the words "south elevation," after which should appear, in the *times* and *length* columns, the number and length of the window sills or coping on the south elevation. The east, north and west elevations should then be considered in turn. A cross-sectional sketch or notation as to size of sill or coping should be made in the *description* column, as a help in determining the correct unit price per linear foot when the work of pricing the estimate is to be done. The following illustrates the proper method of scaling window sills. Should concrete copings occur on top of brick parapet walls, similar methods should be observed.

Concrete Window sills (only forms and reinf.)						
13"×6" [illegible]	12	×	17⅓	=	}	
4½" [illegible]	2	×	16	=		
	2	×	6¾	=		
	1	×	8	=	=	ft.
	2	×	17⅓	=		
	4	×	16	=		
	12	×	17⅓	=		
	4	×	16	=		
	2	×	17⅓	=		
	4	×	16	=		

Stairs and Landings

Fig. 7 represents the flight of reinforced concrete stairs shown in Fig. 6.

In order to scale the stairs, count the number of nosings (18 in this case), and set the number down in the *length* column. The *width* column should contain the length of each



Section thru Stairs

FIG. 7

nosing from wall to outer edge. The product of the two dimensions will give the linear feet of nosing which should be taken as the standard of measure for concrete stairs.

Landings are measured by the square foot and the landing beams may be neglected, as in pricing out the cost of the landing per square foot proper allowance is made for the extra cost of the landing beam. The thickness of the landing slab may also be neglected as in the case of the stairs. Concrete stairs and landings, unless of special design, may be considered in this manner without appreciable error in cost estimating. Below is given the proper scaling of the concrete stairs and landing shown in Fig. 7 and Fig. 6.

Concrete Stairs & Landings						
stair nosings	18	× 4 5/6	=			ft.
landings	10	× 4	=		} =	
	10	× 5½	=			s.f.

Paving

Concrete paving is a term applied to an unreinforced concrete slab resting on earth fill, such as a basement floor or the first floor of a building where no basement is called for. In scaling the quantity of concrete in concrete paving the same rules are observed as are laid down for a concrete slab. The concrete in a piece of paving 5 inches thick and

160 feet long by 60 feet wide would appear on the estimate sheet as follows: —

Concrete Paving	160	× 60	× 5/12	=	c.y.

Granolithic Finish

Scaling the quantity of granolithic finish in a building is done at this stage of the estimate because the surfaces having granolithic finish applied to them have already been scaled, and determining the quantity of granolithic finish required is simply a matter of referring to previous dimensions. For instance, if the second floor slab previously scaled is to be finished with a granolithic finish of the "laid after" type, and on the paving above an integral granolithic finish is called for, the granolithic finish dimensions would appear on the estimate sheet as follows: —

Granolithic finish (laid after)				
2nd fl.	(159 2/3 - 2 1/2)	× (59 2/3 - 2 1/2) =	}	s.f.
deduct	10	× 18 3/4 Ddt =		
Granolithic finish (laid integral)				
paving	(159 2/3 - 2 1/2)	× 59 2/3 - 2 1/2) =		s.f.

Carborundum Rubbing

The area of the surfaces to be treated with carborundum rubbing can be more easily determined if left until the formed surfaces have been determined. This will be taken up in another part of the chapter.

IV. FORMS

If the foregoing rules have been carefully followed in regard to scaling concrete, the work of determining the amount of formwork necessary to mould the concrete may be very easily accomplished with virtually no further reference to the drawings.

In writing out the form dimensions, it is necessary to refer to the concrete dimensions and copy such figures as indicate the formed surfaces. As but three columns of the estimating sheet are needed in tabulating the dimensions for formwork, the second, or *times*, column is left blank and the remaining three columns used for this work. Very little *description* is needed in writing out formwork dimensions, since, in order to learn the character of the work formed, it is necessary only to turn back to the concrete scaling corresponding to the formed surfaces in question. Enough description should be given in the *description* column to make it easy to identify the form dimensions with the concrete scaling.

Forms for Exterior and Interior Footings

The form dimensions for the concrete footings as scaled from Fig. 2 are shown properly written out below.

Forms-Exterior footings								
	22	×	19⅓	×	1⅙	=		
	22	×	13⅙	×	1	=		
Interior footings	14	×	23⅓	×	1⅓	=	} =	sf.
	14	×	15⅚	×	1 5/12	=		
	14	×	8	×	2¾	=		

The first number written out is 22, and represents the number of footings being formed. The second dimension is $19\frac{1}{3}$, and represents the perimeter of the lower block. The third dimension is $1\frac{1}{6}$, and represents the height, in feet, of the lower block. On the next line below occur the dimensions of the formed surfaces of the upper block of the exterior footings treated in the same manner. The interior footings are treated in the same way. The product of these figures as shown will give the surfaces of concrete in the footings which must be provided with forms, and is to be priced out in the estimate as "surface measurement."

Forms for Foundation Walls

In scaling the forms for foundation walls it must be remembered that both sides of the wall are to be formed, hence the first figure written down must be the figure 2. The figures shown below represent the correct tabulation of the form dimensions for the concrete foundation wall as scaled from Fig. 3.

Forms-Foundation walls								
South	2	×	160	×	3 1/12	=		
pilasters (sides)	(2×7)	×	5/12	×	3 1/12	=		
East	2	×	(60-1⅔)	×	3 1/12	=		
pilasters	(2×2)	×	5/12	×	3 1/12	=		
North	2	×	160	×	3 1/12	=	} =	sf.
pilasters	(2×7)	×	5/12	×	3 1/12	=		
West	2	×	(60-1⅔)	×	3 1/12	=		
pilasters	(2×2)	×	5/12	×	3 1/12	=		
edge of paving	[(2×160) + (2×60)]			×	5/12	=		

First the figure 2 denotes that two sides are formed. Next in order is stated the length of the wall to be formed, and last the height of the formwork. Both the length and height dimensions of the wall are taken directly from the concrete scaling. The piers are projections on the face of the wall; and, as the face of the pier is already measured when the face of the wall is taken, it is necessary to add only the surfaces of the edges of the piers to complete the foundation wall forms. The corner piers do not increase the amount of formed surface and may be neglected in writing out the form dimensions.

Forms, however, must be provided for the edge of the paving concrete and this is usually added to the foundation wall forms.

Forms for Exterior and Interior Columns

In writing out the form dimensions for exterior columns, and other rectangular or notched columns, the same rules are followed as have been laid down for footing forms. There are but three dimensions or numbers to write down on the estimate sheet, viz., number of columns, perimeter of column and height of the surface formed. These dimensions may be taken directly from the concrete scaling.

The forms for round columns and column heads are usually made of sheet steel or iron. Hence, instead of determining the square feet of formed surface, it is necessary only to list the number of columns formed, their diameter and height.

The forms for the brackets are determined by simply listing the number of brackets and determining the approximate number of square feet in one bracket. The formed surface of the bracket should be kept separate from the main column forms, as the unit price of labor is at least double for this work. Below will be found the form dimensions for the exterior and interior columns as taken from the concrete scaled from Fig. 4 and Fig. 5.

Forms-Exterior columns				
1st story	18 ×	7 5/6 ×	11	=
corner cols	4 ×	10 2/3 ×	11	=
Mullions		4 2/3 ×	11	=
brackets	18 ×	9 sq ft		= s.f.
2nd story	18 ×	7 5/6 ×	11 1/2	=
corner cols	4 ×	10 2/3 ×	11 1/2	=
Mullions		4 2/3 ×	10	=
brackets	18 ×	9 sq ft		=
Forms-Interior columns and heads				
Steel forms 20" dia 10'-8" long				# 14
" 14" dia-11'-2" "				# 14

Forms for Floor Slabs and Roof Slab

In writing out the forms for flat slabs, it is necessary only to determine the area of the slab. The length and width dimensions of the slab are taken directly from the scaled dimensions of the concrete without reference to the plans. The areas of the bottoms of the drop panels should be deducted after reference to the scaling of the concrete in the drop panels. If the slab forms are for the beam and girder type of floor, the area of the slab is determined as above and then the beam bottoms are deducted from the slab areas.

To deduct the beam bottoms it is necessary to refer to the scaled dimensions of the floor beams and girders and select those dimensions which represent the bottom surfaces of all beams occurring in the floors. Deductions for openings are made from form quantities only when the area equals or exceeds 25 square feet. Even in the latter case, the full opening should not be deducted, since an allowance must be made for the formwork required to form the concrete at the edge of the opening. The forms for the concrete floor and roof slab scaled on page 7 have been properly written out below, and comparisons should be made with the concrete scaling in order fully to understand the method.

Forms: Floor slabs and roof slab									
2nd floor		159 2/3	×	59 2/3		=	}	=	s.f.
deduct stairway		17	×	8 3/4	Ddt.	=			
deduct drop panels	14 ×	7 1/2	×	7 1/2	Ddt.	=			
roof		160	×	60		=			
deduct drop panels	14 ×	7 1/2	×	7 1/2	Ddt.	=			

Forms for Drop Panels

Drop panels are part of the floor slab concrete, and, as the areas of the bottoms of the drop panels have been deducted from the floor slab, it is necessary to restore this area again under this heading. The formed areas of the edges are also to be added to the area of the bottoms. No deduction is made for the opening in the bottom of the drop panel form where the column head joins the drop panel. The dimensions written out below represent the formed areas of the concrete in the drop panels as scaled from Fig. 5.

Forms: Drop panels.								
2nd floor	14	×	7 1/2	×	7 1/2	=	}	= s.f.
edge	14	×	30	×	1/3	=		
roof	14	×	7 1/2	×	7 1/2	=		
edge	14	×	30	×	5/12	=		

Forms for Wall Beams

Properly to write out the forms for wall beams, curtain walls, parapet beams, etc., it is necessary to observe the rules laid down for foundation walls.

Both sides are formed, hence the necessity for placing the figure 2 before the dimension representing the linear feet of wall beam. The height of a wall beam is figured from the inside vertical height. As this leaves the outside edge of the floor slab without forms, it is necessary to add an area of formed surface equal to the perimeter of the building multiplied by the thickness of the floor slab. This takes account of all exposed surfaces to be formed, except the projecting sides of the concrete in the columns at the floor level for a height equal to the thickness of the floor slab only. This is so slight that it may be neglected. The forms for the parapet are written out following the principles outlined for wall beams. The forms for the wall beams and parapet in Fig. 4 have been properly shown below and comparisons with the corresponding concrete scaled from Fig. 4 should be made.

Forms—Wall beams					
2nd floor	2	× {370 2/3} ×	1 1/2	=	} = s.f.
edge of slab	[(2×160) + (2×60)] ×		2/3	=	
roof parapet	2	× 437 1/3 ×	2 5/6	=	
projections		440 ×	1/4	=	
edge of slab	[(2×160) + (2×60)] ×		1/2	=	

Forms for Interior Floor Beams

If no sketches appear in the *description* column of the scaling of the concrete in the floor beams,* it is assumed that a slab of uniform thickness rests upon the beams.

The number of beams and the length of each are first written down as for other concrete members of similar structure. As the scaled dimension of the beam height is taken to the bottom of the slab only, it is quite simple to compute mentally the sum of the two side dimensions plus the bottom dimension. This represents the formed area of one linear foot of beam and should be written in the fourth, or *width* column of the estimate sheet. The product of these dimensions will give the area of the formed surfaces of the interior floor beams.

If accompanying sketches show that other formwork is necessary completely to form the beam, proper additions should be made to take care of it. The formed surfaces of

*See *Interior Floor Beams*, p. 17.

the concrete as scaled in the floor beams shown in Fig. 6 are somewhat irregular, as they occur at stair openings. The quantities of this formwork appear below.

Forms Interior floor beams					
2nd fl. Bm. #1	1	18¾ × 4 2/3	=	}	s.f.
" #2		10 × 5	=		
" #2		7 1/12 × 4 1/4	=		

Forms for Partitions

In writing out the formed areas of concrete partitions, the same rules are observed as for other wall forms.

Openings are not deducted unless the area of the opening equals or exceeds 25 square feet. The formed areas for the concrete partitions shown in Fig. 6 are given below.

Forms-Partitions				
1st story	2 × (28¾) × 11	=	} =	s.f.
2nd "	2 × (28¾) × 11½	=		

Forms for Window Sills, Copings, Stairs and Landings

No formed areas are written out for window sills, copings, stairs or landings. This departure from the usual practice is justified because the unit prices per linear foot of this work are made up to include the cost of concrete, forms, reinforcement and finish. This unit price is usually a standard one for each type of work, and is applied directly to the linear feet of work as scaled under the heading of *concrete* on the estimate sheets.

Formed Surfaces — Carborundum Rubbed

Referring again to the subject of carborundum rubbing, — when the form dimensions are written out, it is very simple to determine the square feet of surface to be rubbed.

This may be done very quickly by picking out from the formed areas the surfaces which, according to specification, must be treated with carborundum. It will be found most convenient to leave the work of determining the area of concrete surfaces to be rubbed until after the extension of the form dimensions has been completed. The surface measurements of all formed surfaces will then be found in the *quantity* column reduced to square feet, and the total area of the rubbed surfaces may be quickly determined.

V. REINFORCEMENT

Scaling the quantity of reinforcement in a concrete building is a process by which the tonnage of steel bars is obtained.

It is not necessary to make a schedule of the bars in the entire building, a process entailing a large amount of tedious work. Footing reinforcement is usually scaled by listing the size of the bars first, then the number of bars needed, and finally the length of the bar itself. Oftentimes it will be found convenient to compute the number of pounds of reinforcement in a footing and then multiply by the number of footings.

Reinforcement in foundation walls may be figured at the number of pounds per square foot of wall. Column reinforcement is usually taken off the plans in detail; the size, number of bars and the length of the bars being taken off in regular order. Slab reinforcement is almost always computed on the square foot basis, and all beam reinforcement by the number of pounds per linear foot of beam. Curtain wall and partition reinforcement is computed by the number of pounds per square foot of reinforced surface.

In computing reinforcement on the square foot and linear foot basis, care must be taken to allow for all secondary steel, laps for bond, stirrups, construction bars, waste, etc. It will require careful practice to scale reinforcement accurately by this method, which, however, once thoroughly understood, will be found very reliable and rapid.

Reinforcement is listed in the same order as the forms. The different types may be easily grouped for pricing. The fac-simile of an estimate reproduced farther on gives a correct representation of the manner in which reinforcement should be scaled for estimating purposes.

VI. EXCAVATION

General or Steam Shovel Excavation

General excavation is the term applied to the process of removing the earth for basements, or cutting down the grade to the paving level.

General excavation does not include the excavation for footing holes below the paving level, or other small excavated areas where hand work entirely must be used. Steam shovels, scraper diggers, or hand work may be used in general excavation; and when the quantity is scaled for estimating purposes, notation should be made of the probable method to be employed in doing the work. In scaling dimensions for general excavation, the order should be the same as for scaling concrete work, viz., length, width and height; and these should be written down in the proper columns of the estimate sheet. Proper allowance should also be made for slope of the earth work outside of the exterior footings when the length and width dimensions are scaled. If the general excavation is done by hand, vertical sheeting may be used instead of excavating to a slope. All these conditions should be noted in the *description* column when the scaling is done.

Footing Excavation

The labor of removing earth for footing holes, pits, trenches, etc., is nearly always done by hand and should be described on the estimate sheet as *footing excavation.*

In scaling the quantities for footing excavation, the nature of the soil to be removed should be noted as well as the location of the footing hole in respect to the plans. Footing holes excavated to a depth exceeding 4 feet should be scaled net; that is, add but 6 inches to the length and width dimensions of the footing for the size of the excavated hole. This allows for the thickness of the sheeting lumber generally used in connection with footing excavation exceeding 4 feet, but not exceeding 10 feet, in depth. In scaling footing excavation when the depth is less than 4 feet, no sheeting is used; but proper allowance is made in scaling dimensions to allow for the slope of the earth work. When sheeting is used for footing excavation, the sheeting usually serves as formwork for the lower block of concrete in the footing.

Backfill

Backfill is a term applied to the labor of rehandling excavated material after the footings have been placed and it becomes necessary to fill in around the footing, wall or other foundation work.

This quantity usually equals the amount of earth removed in excavating for the footing, as the amount of earth which is left after the footing hole is properly backfilled must be rehandled and disposed of in some other way. Where the earth work is a large part of the job operations, the backfill and general disposition of excavated material should be carefully considered.

Sheeting

Sheeting is estimated by the square feet of surface measurement of earth retained. As the form dimensions are written out from the scaled dimensions of the concrete work, so are the sheeting dimensions written out from the scaled dimensions of the excavation. No allowance is made for the distance the sheeting penetrates the ground below the bottom of the excavated hole or for the distance above the top of the earth work retained.

VII. MASONRY

Brick Work

Brick work, where more than 4 inches thick, is estimated by the cubic foot.

In order to determine the cubic feet of brick work in a wall, the dimensions are scaled in the same manner as outlined for *Concrete Partitions*. In scaling the brick work in the exterior walls of a building, the work should be done by elevations, and adequate description be given to make it easy to check over the work to determine whether any part has been omitted. The quantities should contain the actual number of cubic feet of brick work to be built and no more. All openings should be deducted exactly as they are shown, and no allowances made in the quantity to take care of work which may be more or less expensive to construct than the average unit price will pay for. After the actual cubic feet of brick work in a building is determined, the unit price should then be made up to correspond with the class of work to be built.

Brick Veneer

Brick veneer is usually laid up 4 inches thick, and is so noted in the *description* column, together with other notations regarding the character and location of the work.

As brick veneer is estimated by the square foot in scaling the quantity, it is necessary to determine the length and height only of the work, using columns Number 4 and Number 5 in which to write down these dimensions. The work should proceed by elevations, as in the case of scaling other classes of brick work.

Terra Cotta Partitions

Partitions built from hollow terra cotta blocks are estimated by the number of blocks laid up in a wall.

As nearly all hollow terra cotta blocks have a face measurement of one square foot each, the number of blocks in the terra cotta wall corresponds to the number of square feet in the face of the partition. In scaling the square feet of terra cotta partition it is necessary to observe the same methods as were laid down for scaling *Concrete Partitions.* Notation should always be made in the *description* column regarding the type of block specified and the thickness of the partition. All deductions should be accurately made. It may be stated here that the mortar joints in the work offset the usual breakage of the blocks in transit and no allowance, therefore, need be made for either mortar joints or breakage.

VIII. PLASTERING

Plastering is measured by the square yard of surface measure.

The dimensions making up the quantity are usually taken directly from the scaled dimensions of the terra cotta partitions, ceilings, walls, or other surfaces in a manner similar to that in which carborundum rubbed surfaces are determined. In the *description* column are noted the number of coats called for, the kind of cement specified, and other items helpful in deciding upon proper unit prices.

IX. STEEL SASH

In estimating steel sash, the important points to consider are size of opening, uniformity of size and type, percentage of ventilation, and operation.

The *description* column should contain information relative to all these points. In scaling the size of the opening the number of identical sash should first be listed in the second column of the estimate sheet. The length and height of the openings should follow in the third and fourth columns respectively. The sash openings should be scaled by elevations, since, by this method, omissions of any magnitude are quickly noted when the dimensions are extended.

X. GLASS AND GLAZING

After noting in the *description* column the kind and size of glass specified, it is a simple matter to determine the number of square feet of glass required to glaze the sash.

For estimating purposes, it is sufficiently close to assume that 90% of the sash area is made up of glass. Accordingly, the glass required is usually carried out on the estimate sheet as 90% of sash area.

XI. DOORS, FRAMES AND HARDWARE

In listing the doors, frames and hardware in a building, the doors should be considered individually or by types.

The location and character of the door should be noted in the *description* column together with notations as to frame and hardware. In writing down the size of the door, the width should be first considered and the height last. For instance, a door 2 feet and 8 inches wide by 6 feet and 8 inches high should appear on the estimate sheet as $\frac{2}{8}$ x $\frac{6}{8}$. The number of doors of a kind is written down in the *summary* column as the scaling is done.

XII. LIGHT IRON WORK AND MISCELLANEOUS IRON

No special ruling can be set down governing the scaling of light iron work for general estimating purposes.

The estimator should list intelligently all such material, and at the same time endeavor to scale the dimensions in a manner which will result in the quantity being reduced to the proper basis for pricing out. Pipe hand rails should be in linear feet; safety stair treads in linear feet; steel inserts by the piece; cast iron scuppers by the piece; and curb angle guards in linear feet at so many pounds per foot, etc., etc. It is also customary to carry out in the *total* column a certain sum of money decided upon in the judgment of the estimator as adequate to cover miscellaneous iron work which is not shown or called for on plans or in specifications, but which must inevitably be supplied by the builder.

XIII. ROOFING AND FLASHING

The roofing dimensions are usually taken directly from the scaling of the concrete for the roof slab.

This is generally full measure, since the parapet beams reduce the roofing area slightly below the slab area. But, as roofing is measured in units of squares (100 square feet), the result is sufficiently accurate. In scaling the roofing area, it is first necessary to note in the *description* column the kind of roofing required, and the guarantee.

Flashings are a part of the roofing contract and should be scaled immediately following the roofing. Base and cap flashings are estimated by the linear foot, and notation should be made of the kind of metal specified together with the number of inches in width required to flash one linear foot. Metal *gravel strip* should be scaled in the same manner. Conductor boxes are estimated by the piece and should be listed in the *summary* column accompanied by proper description.

XIV. PAINTING

Painting of walls and ceilings is measured by the square yard, and, as in estimating the amount of carborundum rubbing, the painted surfaces may be determined by referring to the extended dimensions of the form areas of the concrete work.

Other painted work such as brick walls, terra cotta walls, etc., may be determined readily by referring to the quantities already scaled for this work and the total painted areas then reduced to square yards and written down in the *summary* column.

Painting steel sash and doors is also measured by the square yard. To determine the amount of painting on the steel sash and doors of a building, reference should be made to the scalings for the sash and doors, and the flat areas should be added together just as if the entire areas were to be painted like a door. Double these areas, since doors and sash are painted both sides. Then divide this amount by 9. The result will be the square yards of painting which should appear in the *summary* column of the estimate sheet.

Painting light iron, miscellaneous iron, etc., is usually a small item and is not figured on a square yard basis, but rather by the judgment of the estimator. The amount of money allowed for this depends entirely upon the miscellaneous iron to be painted, and each job must be considered individually.

XV. ENGINEERING, PLANS, ETC.

Sometimes the builder is called upon to include in his estimate the cost of preparing designs and plans for the work to be estimated. The percentage of cost varies with the type of building and the skill of the engineers doing the work. Ordinarily the plans of a regular reinforced concrete factory can be prepared, from the surveys to the finished drawings and details, for 3% of the net cost of the completed structure.

XVI. CLEAN UP THE JOB AT COMPLETION

The estimator must allow a sum of money sufficient to cover the cost of cleaning up the job at completion, removing debris from the site, washing windows, and leaving the job "broom clean."

XVII. LIABILITY INSURANCE

An item should be included in the estimate which will cover the cost of carrying liability insurance for the period of the job.

The rate for this varies in different localities and with different contractors. The percentages may run as low as 3% of the amount expended for labor; or, on the other hand, it may run as high as 12 or 14% of the labor costs. As the labor expense involved in constructing a regular reinforced concrete building amounts to about one-third of the total cost of the building, the amount of money to be allowed for liability insurance premiums is easily determined when the rate is known. For instance, assume that the rate is 6% of the labor and the total estimate amounts to $62,000 without profit. If this building is a regular reinforced concrete factory, the labor involved would be about one-third of $62,000, or approximately $21,000. Computing 6% of $21,000, we have $1,260. The amount of money carried in the estimate for liability insurance premiums could well be taken at $1,250.

XVIII. WATCHMAN

In order to estimate the cost of employing a watchman while a building operation is going on, it is first necessary to determine approximately the number of weeks required to construct the building. This decided upon, it is a matter of computing the expense of employing a watchman for this length of time at a proper weekly wage.

XIX. SUPERINTENDENCE, JOB OVERHEAD, OFFICE EXPENSES, ETC.

Under this head must be included all the expense attached to maintaining a job office, including the job superintendent. It is usual custom to determine the amount of this expense for one week and to multiply this amount by the number of weeks the office must be maintained. Under the head of superintendence, office, etc., must be figured the wages of the following men:

Job superintendent
Timekeeper
Chief office clerk
Tool boy

On unusually large jobs, the office force will consist of more men than above listed, while on a very small job the personnel may be cut down by arranging to have the chief clerk act as timekeeper in connection with his other duties. The cost of telephones, stationery, railroad fares, freight on supplies, building and dismantling office, etc., must be considered. These are items which may be easily estimated at too low a figure. Proper consideration should be given to every expense entering into overhead if the estimate is to be an accurate one in which allowance has been made for proper and competent job management.

XX. SUNDRIES

It often occurs that estimates are made from plans not completely finished or from poorly prepared drawings. The uncertainty attached to making estimates from such plans makes it advisable to conclude the estimate with an item for sundries, the amount of which should be determined in the estimator's judgment as being adequate to protect his estimate against over-runs due to his having omitted some work implied but not shown or called for. The amount of this item should be based on a percentage of the total estimated cost not including profit, and usually runs from 2% to 5%, according to the condition of the plans. It is very seldom that an estimate should be prepared without any allowance for over-runs due to unforeseen conditions.

XXI. PROFIT

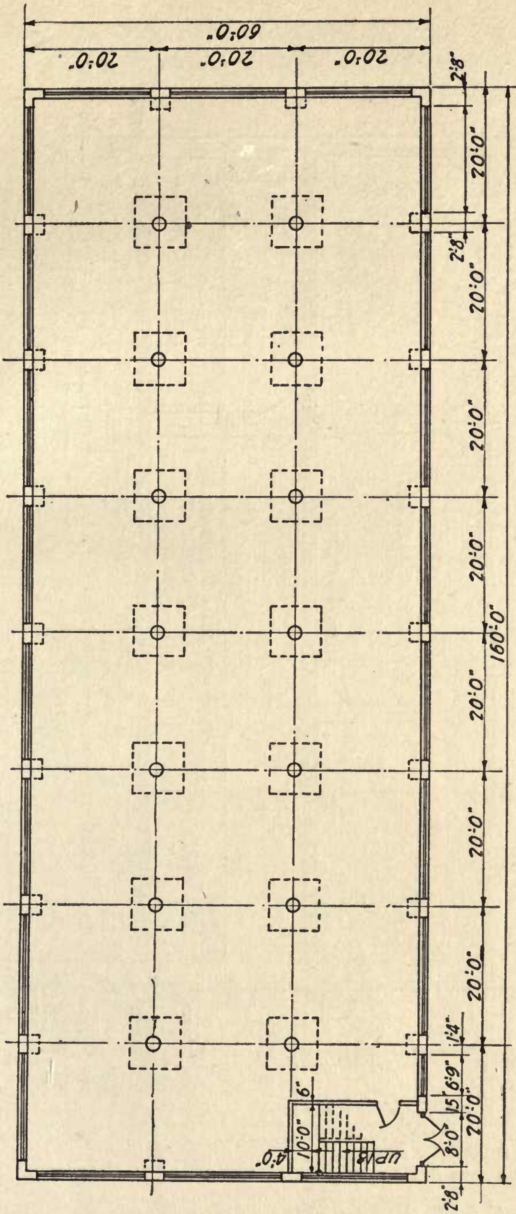
The percentage of profit is figured on the total cost of the work including labor, materials, etc.

It may be a very low percentage or it may be very high, depending entirely on the basis on which the contractor is operating his business.

Eight per cent is considered a very low profit, and the contractor must do a large volume of business and keep his hired organization well employed in order to be successful at this rate. Percentages of profit will run from 8% to 15%, and sometimes higher. For ordinary estimating purposes, 10% may be assumed as a fair profit for the builder of reinforced concrete buildings, unless the estimated total cost runs under $50,000, in which case 12% profit should be added to the estimate.

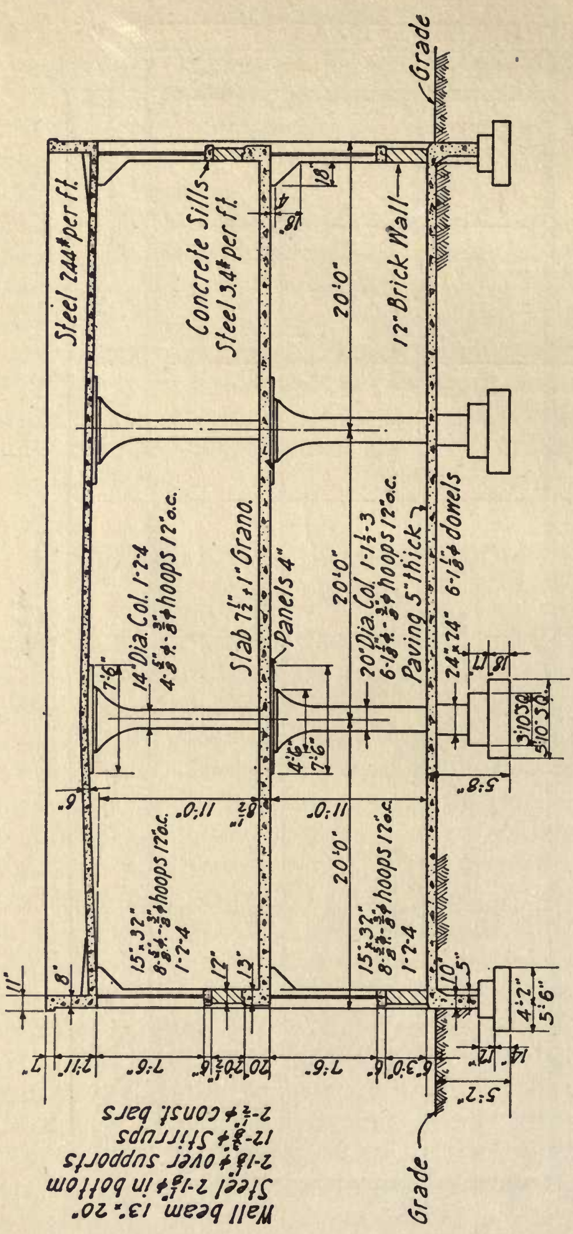
EXEMPLIFICATION OF PRECEDING PRINCIPLES

Figures 8a and 8b present the plan and cross section of a typical, small, reinforced concrete factory, the parts of which have been already scaled in detail in the previous pages of this chapter. The necessity for condensation has made the explanations brief. Hence the reader's initiative must be depended upon for further study of the subject at hand and for the discovery of the best ways of attacking problems in estimating not here covered. The principles outlined, however, have been tested by many years of use in a large Boston Company operating extensively in the reinforced concrete field. The many advantages to be gained by their application have been conclusively proved. A fac-simile of the completed estimate for the building illustrated in Figures 8a and 8b is shown herewith. It will be noted that the scalings are identical with those discussed on the previous pages. The quantities have been extended, unit prices affixed, and the totals carried out, thus constituting as a whole the finished estimate for the construction of the building proper. The determination of unit prices is considered in Part II.



FIRST FLOOR PLAN

FIG. 8a



CROSS SECTION

FIG. 8b

FAC-SIMILE OF THE COMPLETED ESTIMATE FOR A CONCRETE BUILDING

(Compare Figures 8a and 8b)

Estimate #63 — Sheet No 1

Estimate for
New Manufacturing Building
-for-
John Jones and Company
Hartford, Conn

John Smith, Archt

Area = 2 × 160 × 60 = 19200 sq. ft.
Cube = 160 × 60 × 23 2/3 = 227,200 cu. ft.

Item	Computation		Cu. ft.	Quantity	Rate	Amount
Concrete - Exterior footings (1·3·6 Mix)						
1 A to 9 A incl. / 1 B and 9 B	22 × 5 1/2 × 4 1/2 × 1 1/2	=	588			
1 C and 9 C / 1 D to 9 D incl.	22 × 4 × 2 1/2 × 1	=	227			
Concrete Interior footings (1·3·6 Mix)				= 73 cy. (1-3-6)	11^{50}	840
2 B to 8 B incl.	14 × 5 5/6 × 5 5/6 × 1 1/2	=	714			
2 C to 8 C incl.	14 × 3 5/6 × 3 5/6 × 1 5/12	=	292			
	14 × 2 × 2 × 2 3/4	=	154			
			1975			
Concrete - Foundation walls						
South elev.	160 × 5/6 × 3 1/2	=	411			
Splayed top	[160 − (9 × 2 2/3)] × 1/4 × 5/6	=	28			
pilasters	7 × 2 2/3 × 5/12 × 3 1/12	=	24			
East elev.	(60 − 1 2/3) × 5/6 × 3 1/12	=	150			
Splayed top	[60 − (4 × 2 2/3)] × 1/4 × 5/6	=	10			
pilasters	2 × 2 2/3 × 5/12 × 3 1/12	=	7	= 47 cy. (1-2-4)	13^{00}	611
North elev.	160 × 5/6 × 3 1/2	=	411			
Splayed top	[160 − (9 × 2 2/3)] × 1/4 × 5/6	=	28			
pilasters	7 × 2 2/3 × 5/12 × 3 1/12	=	24			
West elev.	(60 − 1 2/3) × 5/6 × 3 1/12	=	150			
Splayed top	[60 − (4 × 2 2/3)] × 1/4 × 5/6	=	10			
pilasters	2 × 2 2/3 × 5/12 × 3 1/12	=	7			
Corner pins	4 × [(1 5/6 × 1 5/6) − (1 5/12 × 1 5/12)] × 3 1/12	=	17			
			1277			
Concrete Exterior Cols. (1-2-4)						
1st story						
2 A to 8 A incl. / 1 B, 9 B, 1 C, 9 C / 2 D to 8 D incl.	18 × 2 2/3 × 1 1/4 × 11	=	660			
Corner cols	4 × [(2 2/3 × 2 2/3) − (1 5/12 × 1 5/12)] × 11	=	224			
Mullion	1 1/4 × 1 1/2 × 11	=	15	= 73 cy. (1-2-4)	13^{00}	949
Col. brackets	18 × 4 1/3 cubic feet	=	78			
2nd Story (1-2-4)						
same as 1st Story	18 × 2 2/3 × 1 1/4 × 11 1/2	=	665			
Corner cols.	4 × [(2 2/3 × 2 2/3) − (1 5/12 × 1 5/12)] × 11 1/2	=	226			
Mullion	1 1/4 × 1 1/2 × 10	=	14			
Col. brackets	18 × 4 1/3 cubic feet	=	78			
			1960			
Concrete Interior Cols.						
1st Story (1-1 1/2-3)						
2 B to 8 B, 2 C to 8 C	14 × (20 dia.) 2 2/5 sf × 10 2/3	=	329	19 cy. (1-1 1/2-3)	14^{00}	266
Col. heads	14 × 13 cubic feet	=	182			
			511			
2nd Story (1-2-4)						
same as 1st Story	14 × (14 dia.) 1 1/2 sf × 11 1/6	=	169	16 cy. (1-2-4)	13^{00}	208
Col. heads	14 × 19 cubic feet	=	266			
			435			

THE COMPLETED ESTIMATE (*Continued*)

Item	Dimensions	Quantity	Total / mix	Unit price	Amount
Estimate #63 contd				Sheet No. 2	
Concrete Floor-slab					
2nd floor	159 2/3 × 59 2/3 × 15/24 =	5955	= 394 cy. (1-2-4)	13.00	5122
deduct opening	18 1/4 × 10 × 15/24 Ddt =	114			
roof slab	160 × 60 × 1/2 =	4800			
		10755			
		114			
		10641			
Concrete Drop Panels					
2nd floor	14 × 7 1/2 × 7 1/2 × 1/3 =	263	= 22 cy. (1-2-4)	13.00	286
roof	14 × 7 1/2 × 7 1/2 × 5/12 =	328			
		591			
Concrete Wall beams					
2nd floor	{[(2×160)+(2×60)] − (26×2 1/3)} × 1 1/2 × 1 1/2 =	433	= 49 cy. (1-2-4)	13.00	637
roof parapet	[(2×160)+(2×58 2/3)] × 2/3 × 2 5/6 =	826			
add for coping projection	[(2×160)+(2×60)] × 1/4 × 7/12 =	64			
		1323			
Concrete Interior floor beams					
2nd flat stairs, 7 1/2" Bm #1, 12"×26"	18 1/4 × 1 × 1 1/2 =	27	= 2 cy. (1-2-4)	13.00	26
Same 12"×28" Bm #2	10 × 1 × 1 2/3 =	17			
7 1/2" Bm #2	7 3/4 × 1 × 1 2/3 =	13			
		57			
Concrete Partitions					
Around stairs 1 st.	(10 + 18 3/4) × 1/2 × 11 =	158	= 11 cy. (1-2-4)	13.00	143
deduct for door	3 × 1/2 × 7 Ddt = 11				
2nd story	(10 + 18 3/4) × 1/2 × 11 1/6 avg =	161			
deduct for door	3 × 1/2 × 7 Ddt = 11	319			
		22			
		297			
Concrete Window Sills (incl. forms and reinf.)					
13"×6" Sq., 4 3/8"	12 × 17 1/3 =	208	= 732 ft.	.72	527
	2 × 16 =	32			
	2 × 6 3/4 =	14			
	1 × 8 =	8			
East	2 × 17 1/3 =	35			
	4 × 16 =	64			
North	12 × 17 1/3 =	208			
	4 × 16 =	64			
West	2 × 17 1/3 =	35			
	4 × 16 =	64			
Concrete Stairs & Landings					
Stair Nosings	18 × 4 5/6 =	87	87 ft.	1.50	131
landings	10 × 4 =	40	= 93 sf.	.75	70
	10 × 5 1/4 =	53			
Concrete Paving	160 × 60 × 5/12 =	4000	= 148 cy. (1-2-4)	12.50	1850
Granolithic finish (laid after)					
2nd fl.	(159 2/3 − 2 1/6) × (59 2/3 − 2 1/6) =	9060	= 8877 sf.	.11	976
deduct	10 × 18 1/4 Ddt =	183			
		8877			
Granolithic finish (laid integral)					
paving	(159 2/3 − 2 1/6) × (59 2/3 − 2 1/6) =	9060	= 9060 sf.	.06	544
Cinder Concrete for Crickets on roof			20 cy.	9.00	180
Carborundum rubbing (exterior only)			4500 sf.	.07 1/2	338

THE COMPLETED ESTIMATE (*Continued*)

Item	Computation	Deduct	Area	Total	Unit Price	Amount
Estimate #63 contd.						Sheet No. 3.
Forms: Exterior footings.						
	22 * 19 1/3 * 1 1/2		(Sheeting instead)			
	22 * 13 1/6 * 1		290			
Interior footings	14 * 23 1/3 * 1 1/2		(Sheeting instead)	= 902 sf.	.17	153
	14 * 15 1/3 * 1 4/15		304			
	14 * 8 * 2 3/4		308			
			902			
Forms: Foundation Walls						
South	2 * 160 * 3 1/2		985			
pilasters (sides)	(2*7) * 5/12 * 3 1/2		18			
East	2 * (60-1 2/3) * 3 1/2		359			
pilasters	(2*2) * 5/12 * 3 1/2		5			
North	2 * 160 * 3 1/2		985	= 2918 sf.	.18	525.
pilasters	(2*7) * 5/12 * 3 1/2		18			
West	2 * (60-1 2/3) * 3 1/2		359			
pilasters	(2*2) * 5/12 * 3 1/2		5			
edge of paving	[(2*160) + (2*60)] * 5/12		184			
			2918			
Forms: Exterior Columns						
1st story	18 * 7 5/6 * 11		1551			
Corner cols.	4 * 10 2/3 * 11		468			
Mullion	4 2/3 * 11		52			
brackets	18 * 9 sq. feet	= 162		= 4154 sf.	20 1/2	852.
2nd story	18 * 7 5/6 * 11 1/2		1563			
corner cols.	4 * 10 2/3 * 11 1/2		473	Brackets		
Mullion	4 2/3 * 10		47	324 sf.	.34	110.
brackets	18 * 9 sq. feet	= 162	4154			
		324				
Forms – Interior Columns and heads						
steel forms 20" dia. 10'-8" long.				= #14	20.00	280
" " 14" dia. 11'-2" long.				= #14	20.00	280
Forms – Floor slabs and roof slab						
2nd floor	159 2/3 * 59 2/3		9525			
deduct stair op.	17 * 8 3/4 Ddt	= 149		= 17400 sf.	16 1/2	2871.
deduct drop panels	14 * 7 1/2 * 7 1/2 Ddt	= 788				
roof	160 * 60		9600			
deduct drop panels	14 * 7 1/2 * 7 1/2 Ddt	= 788	19125			
		1725	1725			
			17400			
Forms: Drop panels						
2nd floor	14 * 7 1/2 * 7 1/2		788			
edge	14 * 30 * 1/3		140	= 1891 sf.	.21	397.
roof	14 * 7 1/2 * 7 1/2		788			
edge	14 * 30 * 5/12		175			
			1891.			
Forms: Wall beams						
2nd floor	2 * {370 2/3} * 1 1/2		803			
edge of slab	[(2*160) + (2*60)] * 2/3		294			
roof parapet	2 * 437 1/3 * 2 5/6		2480	= 3907 sf.	18 1/2	723
projection	440 * 1/4		110			
edge of slab	[(2*160) + (2*60)] * 1/2		220			
			3907			
Forms: Interior floor beams.						
2nd fl. Bm. #1.	18 1/4 * 4 2/3		85			
" #2.	10 * 5		50	= 169 s.f.	.19	32
" #2.	7 1/2 * 4 1/4		34			
			169			
Forms – Partitions						
1st story	2 * (28 3/4) * 11		632	= 1274 s.f.	22 1/2	287.
2nd "	2 * (28 3/4) * 11 1/4		642			
			1274			

THE COMPLETED ESTIMATE (*Continued*)

Item	Calculation	Quantity	Total	Rate	Amount
Estimate #63 contd					Sheet No. 4.
Reinforcement Footings					
Exterior footings					
5/8" ⌀ dowels & bars	22 × 8 × 6¼ × 1.04# =	1144			
3/8" ⌀ hoops	22 × 3 × 8 .375# =	198			
Interior footings					
1¼" ⌀ dowels	14 × 6 × 7½ × 3.4# =	2142			
3/8 ⌀ hoops	14 × 3 × 8 × .375# =	126	= 10340 lbs.	.04¼	439.
Foundation Walls					
South	160 × 3½ × 5 lbs. sq. ft. =	2465			
East	(60-1⅔) × 3½ × 5 " " " =	900			
North	160 × 3½ × 5 " " " =	2465			
West	(60-1⅔) × 3½ × 5 " " " =	900			
		10340			
Reinforcement Columns					
Exterior Col. 1st story					
5/8" ⌀ vert. steel	22 × 8 × 14½ × 1.04# =	2610			
3/8" ⌀ hoops	18 × 11 × 8 × .375# =	594			
" "	4 × 11 × 11 × .375# =	182			
Mullions 5/8" ⌀	4 × 13⅔ × 1.04# =	57			
3/8" ⌀ hoops	11 × 4¾ .375# =	20			
2nd story					
5/8" vert. steel	22 × 8 × 11½ × 1.04# =	2105			
3/8" ⌀ hoops	18 × 10 × 8 × .375# =	540	= 11614 lbs.	.04¼	494.
	4 × 10 × 11 × .375# =	165			
Mullions 5/8 ⌀	4 × 10½ × 1.04# =	44			
3/8 ⌀ hoops	10 × 4¾ × .375# =	18			
Interior Cols. 1st story					
1¼" ⌀ vert. steel	14 × 6 × 14½ × 3.4# =	4140			
3/8" ⌀ hoops	14 × 10 × 5¼ × .375# =	276			
2nd story					
5/8" ⌀ vert. steel	14 × 4 × 11½ × 1.04# =	670			
3/8" ⌀ hoops	14 × 10 × 3⅔ × .375# =	193			
		11614			
Reinforcement Slabs					
2nd floor slab	159⅔ × 59⅔ × 3.4# sq. ft. =	32400	= 55200. lbs.	.04¼	2346.
deduct opening	18¼ × 10 × 3.4# " deduct	620			
roof slab	160 × 60 × 2.44# " " =	23420			
Reinforcement Beams					
Wall beams 2nd fl.	370⅔ × 14½# lin. ft. =	5375			
roof parapet	437⅓ × 8½# " " =	3720	= 9745 lbs.	.04¼	414.
Int. floor Beams Bm. #1	18¼ × 16# =	292			
Bm. #2	17½ × 20# =	358			
Reinforcement-Partitions					
partitions	28¾ × 11 × 1¼# sq. ft. =	395	= 796 lbs.	.04¼	34.
2nd story	28¾ × 11¼ × 1¼# " " =	401			
General Excavation (Scraper and hand work)					
general leveling of site (no earth removed from site)			10,000 sq. ft.	.02	200.
Footings Excavation (hand work, sandy loam)					
Exterior footings	22 × 6 × 4⅔ × 5¼ =	3235			
Int. footings	14 × 6⅓ × 6⅓ × 5¼ =	2950			
Foundation Wall					
South (trench)	[160 - (9×6)] × 2 × 3½ =	653	= 295 cy.	1.65	487.
East	{60-[(2×6)+(2×4⅔)]} × 2 × 3½ =	238			
North	[160 - (9×6)] × 2 × 3½ =	653			
West	{60-[(2×6)+(2×4⅔)]} × 2 × 3½ =	238			
		7967			
Backfill-rehandle and grade excav'd material (like hand work)			= 295 cy.	.45	133.
2" sheeting for footing holes -					
	22 × 20⅓ × 5¼ =	2350	= 4140 sq. ft.	.20	828.
	14 × 24⅓ × 5¼ =	1790			

THE COMPLETED ESTIMATE (*Concluded*)

Estimate #63—contd. Sheet No. 5.

Item	Calculation		Quantity	Price	Amount
Masonry—Brick curtain walls					
South elev.	160 − [(9 × 2⅔) + 1½] × 1 × 3 =	404	1850 cu. ft.	.80	1480.
	[160 − (9 × 2⅔)] × 1 × 2 =	272			
East	[60 − (4 × 2⅔)] × 1 × 3 =	148			
	[60 − (4 × 2⅔)] × 1 × 2 =	99			
North	[160 − (9 × 2⅔)] × 1 × 3 =	408			
	[160 − (9 × 2⅔)] × 1 × 2 =	272			
West	[60 − (4 × 2⅔)] × 1 × 3 =	148			
	[60 − (4 × 2⅔)] × 1 × 2 =	99			
Steel Sash—erected and painted (30% pivot vent)					
South elev. 1st Story	6¾ × 7½ =	51.	= 5491 sq. ft.	.35	1922.
	3 × 16 × 7½ =	360			
	12 × 17⅓ × 7½ =	1560			
East	4 × 16 × 7½ =	480			
	2 × 17⅓ × 7½ =	260			
North	4 × 16 × 7½ =	480			
	12 × 17⅓ × 7½ =	1560			
West	4 × 16 × 7½ =	480			
	2 × 17⅓ × 7½ =	260			
Glass and Glazing—factory ribbed glass (12" × 18") set including putty	90% area of sash =		4942 sq. ft.	.25	1236.
Doors, frames and hardware					
Dbl. Swing Wood entrance doors, wood frame, transom & C. I. sill	8/0 × 11/0		# 1	150.00	150.
Single swing tin clad doors to stair halls, angle iron frame & C. I. sill	3/0 × 7/0		# 2	45.00	90.
Light Iron and Steel—					
2" pipe hand rail (2 lines) at stair edge			28 ft.	2.00	56.
2" " " single line at wall side			20 ft.	1.25	25.
3½" safety stair treads	18 × 4½ =		78 ft.	.45	35.
Slotted inserts in ceiling			# 1200	.20	240.
C. I. Scuppers			# 10	4.50	45.
Iron ladder to roof (12 feet long)			# 1		25.
Sundry Miscellaneous iron					150.
Roofing and flashings—					
5 ply Tar and Gravel roofing—	160 × 60 =		96 sqs.	14.00	1344.
Tincan metal base and cap flashing (16")	(2 × 158⅔) + (2 × 58⅔) =		435 ft.	.35	152.
" " Scuttle cover & frame	(3 ft. × 4 ft.)		# 1		35.
4 Conductor Boxes—			# 6	15.00	90.
Painting—					
Walls and Ceilings—(2 coats Mill white)			2800 sq. y.	.35	980.
Sash and doors—(2 coats)			1250 sq. y.	.45	563.
Misc. iron					25.
Engineering, plans, details, etc.					750.
Clean up job at completion & clean glass					125.
Liability Insurance					750.
Watchman 7 weeks @ $30.00					210.
Superintendence, Job overhead, office, stationery, etc. 7 weeks @ $150.					1050.
Sundries					750.
	Net Cost			$	37867.
	Contractor's profit, 12%			=	4544.
	Total Estimate			$	42411.

Items Not included
(1) Heating & Boilers
(2) Plumbing & Conductors, drains, etc.
(3) Electric Wiring
(4) Sprinklers
(5) Land

PART II

DETERMINING UNIT PRICES

I. GENERAL CONSIDERATIONS

The two principal elements which control unit prices in general are labor and material.

In order to arrive at a correct unit price for a certain building operation, it is essential to know very closely how much labor is involved in performing a unit of this work, and also how much material will be required. The items of labor and material must be estimated separately and then combined, the two together constituting the unit price to be used in the estimate. Every step involved should be carefully analyzed and correct values calculated for the labor and material in each one.

The unit prices used in the estimate sheets which have been illustrated in this text have been based on the labor rates and material costs prevailing in New England at the time of its preparation (August, 1919). Since, however, costs vary greatly in different localities and with changing markets for labor and material, the unit prices shown here should be viewed with caution for estimating purposes. They are given for showing method, not as offering a table of results. The volume of material and labor being priced has, too, an important bearing on the unit price. In short, it should always be borne in mind that a correct unit price for estimating purposes should be established after study of the circumstances and conditions peculiar to the particular job under consideration. It cannot be obtained in any other manner.

At the time when this paper goes to press, common laborers receive an average wage of 50 cts. per hour. Carpenters, masons and other skilled building workers receive 90 cts. per hour. The unit costs shown on the accompanying estimate sheets are made up in accordance with the above labor rates. Adjustments should be made accordingly.

II. CONCRETE

Foundation Concrete

The unit price for the concrete in foundations is reached by first ascertaining the amount of material and labor necessary to make one cubic yard of concrete mixed, in this case, in the proportion of 1-3-6.

Experience has shown that to estimate the quantity of cement, sand and crushed stone from the tables set forth in text books, which seldom allow for waste, is to encounter a shortage of materials. It will be noted that in working out the amounts of material in the following calculation, proper allowance has been made for inevitable waste.

***Concrete — per cubic yard* (1-3-6 *mix*)**

Cement, $1\frac{1}{10}$ bbls.	@	$2.77	=	$3.05
Sand, ½ cu. yd.	@	1.95	=	.98
Cr. stone, $1\frac{3}{10}$ tons	@	2.75	=	3.58
Plant				2.10
Labor, mixing and placing				1.75
Total cost per cu. yd.				$11.46

(Use $11.50 for unit price.)

The price of cement above is that obtained from cement dealers ($2.84 per barrel *f.o.b. cars, job*). In this price is an allowance for 4 cement bags which, if returned to the dealer in good condition, will be credited at 10 cts. each or 40 cts. per barrel. A cash discount of 5 cts. per barrel is also allowed if payments are promptly made. If advantage of both these credits (45 cts.) is taken, the net cost of the cement becomes $2.39 per barrel.

Unloading and storing the cement in a cement shed costs usually 25 cts. per barrel. Tests must be made by the Cement Testing Bureau to ascertain the quality of the cement, for which an average charge of 3 cts. per barrel is made. The loss of credits due to injury to bags in transit and to the cost of freight on returned bags amounts to about 10 cts. per barrel of cement purchased. Allowance being made for the above charges, the price of cement becomes $2.77 per barrel and it is this figure which is used in working out the cost of concrete.

The following calculation shows in detail how this price is determined.

Cement — Dealer's quotation, f.o.b. cars job		$2.84
Credit for bags	.40	
Cash discount	.05	.45
		$2.39
Unloading and storing cement		.25
Testing cement		.03
Loss and freight on empty bags		.10
Total cost per bbl.		$2.77

Sand — Dealer's quotation, f.o.b. cars job	$1.75
Unload and handle into bins	.20
Total cost per cu. yd.	$1.95

Crushed stone — f.o.b. cars job	$2.50
Unload and handle into bins	.25
Total cost per ton	$2.75

Plant Cost

As a certain amount of machinery, chutes, runways, towers, etc., are required in the process of placing concrete, an allowance must be made in the unit price for the labor of erecting and dismantling this "plant work," as it is commonly called. Allowance must also be made for plant material purchased or rented for the duration of the job. This item varies with the size and type of the job. It may run as low as $1.00 per cubic yard, and, in especially difficult jobs, may run as high as $3.00 or more per cubic yard of concrete placed. A plant cost of $2.10 per cubic yard has been included in the unit price of the concrete estimated herein, and the sub-divisions of this cost are listed below.

Plant cost per cubic yard of concrete:

	Labor	*Material or rental charge*	
Towers	$00.20	$00.20	
Temporary bldgs.	.12	.15	
Bins for aggregate	.10	.20	
Mixer and motor	.06	.14	
Canvas and chutes	.05	.35	
Runway, staging and small tools	.14	.24	
Fuel, power and water		.15	
Labor	$00.67	*Material and Rentals* $1.43	*Total per cu.yd.* $2.10

The average labor cost of mixing and placing concrete in a reinforced concrete building with common labor at 50 cts. per hour is about $1.75 per cubic yard when modern plant equipment is used on the job. A saving of 25 cts. on the labor cost and 25 cts. on the plant cost per cubic yard is usually made in placing paving concrete, making the unit for this class of work, 50 cts. less than for other concrete work of a similar mix.

Column and Slab Concrete

The unit price of concrete mixed in the proportions of 1-2-4 and 1-1½-3 is made up in a similar way. No change is made in the quantity of sand, crushed stone, labor and plant. The cement quantity alone is changed. The computation for 1-2-4 and 1-1½-3 concrete follows.

Concrete, per cubic yard (1-2-4 mix)			
Cement, 1⅔ bbls.	@ $2.77	=	$4.62
Sand, ½ cu. yd.	@ 1.95	=	.98
Cr. stone, 1 3/10 tons	@ 2.75	=	3.58
Plant			2.10
Labor mixing and placing			1.75
Total cost per cu. yd.			$13.03
			(Use $13.00 for unit price.)

Concrete, per cubic yard (1-1½-3 mix)			
Cement, 2 bbls.	@ $2.77	=	$5.54
Sand, ½ cu. yd.	@ 1.95	=	.98
Cr. stone, 1 3/10 tons	@ 2.75	=	3.58
Plant			2.10
Labor mixing and placing			1.75
Total cost per cu. yd.			$13.95
			(Use $14.00 for unit price.)

Window Sills

The unit price of concrete window sills of approximately standard size usually runs close to 72 cts. per linear foot, including concrete forms, reinforcement and finish. The price of 72 cts. per linear foot is made up as follows:

Concrete	@ 50 cts. cu. foot	=	$00.27½
Formwork	@ 25 cts. sq. foot	=	.25
Reinforcement	@ 5 cts. lb.	=	.07½
Carborundum rubbing (outside)			.12
Total cost per lin. ft.			$00.72

Stairs and Landings

The cost of constructing reinforced concrete stairs, using rates of labor and materials as previously noted, is about $1.50 per linear foot of nosing. Landings will cost about 75 cts. per square foot. These unit prices include all concrete, forms, reinforcement and cement finish necessary to complete the stairway. No safety treads or hand rails are included.

Granolithic Finish

Granolithic finish 1 inch thick laid after the slab concrete has set will cost about 11 cts. per square foot for material and labor. The unit price is made up as follows:

1-*inch Granolithic finish, laid after, — per* 1,000 *sq. ft.*

Cement, 12½ bbls.	@ $2.77 =	$34.63
Peastone, 4 tons	@ 3.00 =	12.00
Labor to pick and clean floor preparatory to laying finish, mix and lay grano. finish including plant costs and protect while drying		65.00
Total cost per 1,000 *sq. ft.*		$111.63

(Use 11 cts. per sq. ft. for unit price.)

Note: No sand is required in granolithic finish.

If the granolithic finish is laid before the concrete in the slab has become thoroughly dried out, the finish is called an integral finish. In estimating a finish of this kind, since the thickness of the granolithic finish is included in the slab concrete quantities, the unit price should contain only the labor cost of the cement finisher's time and the cost of the extra cement used in the top part of the slab which forms the finish, and the increased cost of using peastone instead of ordinary crushed stone. The unit price for integral granolithic finish is made up as follows:

1-*inch Granolithic finish — laid integral — per* 1,000 *sq. ft. per bbl.*

Extra cement, 10 bbls.	@ $2.77 =	$27.70
Labor, finisher's time		30.00
Extra cost of peastone, 4 tons	@ .25 per ton =	1.00
Total cost per 1,000 *sq. ft.*		$58.70

(Use 6 cts. per sq. ft. for unit price.)

Cinder Concrete

The unit of cinder concrete crickets placed on the roof to form proper slope to downspouts has been worked out in detail as follows:

Cinder Concrete — per cu. yd.		
Cement, 1 bbl.	@ $2.77 =	$2.77
Cinders, 1 cu. yd.		1.50
Plant costs		2.50
Labor, mix and place to slope		2.25
Total cost per cu. yd.		$9.02
		(Use $9.00 for unit price.)

Carborundum Finish

The cost of finishing concrete surfaces with carborundum stone and cement varies greatly with different contractors. A good finish may be obtained by going over the surface of the concrete twice at a total cost of about 7½ cts. per square foot of surface treated. The unit price is made up as follows:

Carborundum rubbing — 2 coats — per 1,000 sq. ft.		
Labor, 1st rub		$40.00
Labor, 2nd rub		30.00
Cement used, ½ bbl.	@ $2.77 =	1.38
Total cost per 1,000 sq. ft.		$71.38
		(Use 7½ cts. per sq. ft. for unit price.)

III. FORMS

General

In working out a unit price for formwork it is very important to know how many times the forms can be used without remaking. If it is possible to use the forms twice, one-half the cost of the lumber should be charged against the unit for each use. If the forms are used three times, a lumber charge of one-third the cost of the lumber is included in the unit price, and so on. The cost of erection and stripping the formwork remains uniform for each use, but some saving is made on making when the forms are used more than once. In forming one square foot of concrete surface, about 3 board feet of lumber are used in building the formwork. Hence, if the forms are used but once, the material charge in the unit price will be the cost of 3 board feet of lumber. If the formwork is used twice, it will be necessary to make a material charge of only 1½ board feet of lumber, and so on. Some salvage of the lumber is usually made at the completion of the job, except where the formwork is very complicated and lumber is virtually ruined, in which case no salvage is realized. Ordinarily, however, a saving of about 15% of the cost of the lumber is realized at the close of a job.

A certain amount of machinery is required with which the formwork is constructed on the job. This consists principally of a saw mill and motor, small tools, nails, etc. This is the "plant cost," and seldom amounts to more than 1 ct. per square foot of concrete surface formed. The labor involved in making, erecting and stripping the formwork varies with the complexity of the work, but seldom costs less than 7 cts., or more than 15 cts., per square foot of concrete surface formed. The cost of the labor of forming a concrete cornice or other similar work will be much more than this maximum.

Form Lumber

The unit costs for the formwork on the estimate sheets shown herewith have been worked out with lumber at $60 per M, f.o.b. cars at the job. Adding to this $2.50 per M to cover the cost of unloading and handling the lumber at the job, the price becomes $62.50 per M. The building will probably require a set of forms for one complete story, and, with a small amount of remaking, these forms may be used for forming the second or top story. This having been decided upon, it follows that the unit price should contain a material charge equal to the cost of 1½ board feet of lumber. This material charge is maintained throughout the unit prices for formwork so long as two uses are reckoned on. The determination of unit prices for the formwork used in the illustrative estimate are shown below.

The common labor is figured at 50 cts., and carpenters' work at 90 cts. per hour.

Footing Forms

Lumber: 1½ board feet . @ $62.50 per M =	$00.0938	
Deduct salvage	.0150	.0788
Plant cost		.0100
Labor, make, erect and strip		.0800
Total cost per sq. ft.		$00.1688

(Use 17 cts. for unit price.)

Foundation Wall Forms

The unit price for foundation wall forms may be figured similar to footing forms, with the exception that the labor will cost about 9 cts. instead of 8 cts. per square foot. This change adds 1 ct. per square foot to the unit price, making the unit price for foundation wall forms 18 cts. per square foot.

Exterior Column Forms

Lumber: 1½ board feet . @ $62.50 per M =	$00.0938	
Deduct salvage	.0150	.0788
Plant costs		.0100
Labor, make, erect and strip		.1175
Total cost per sq. ft.		$00.2063

(Use 20½ cts. for unit price.)

Bracket Forms

Lumber: 1½ board feet . . . . . @ $62.50 per M = (no salvage allowed)	$00.0938
Plant	.0100
Labor, make, erect and strip	.2350
Total cost per sq. ft.	$00.3388

(Use 33½ cts. for unit price.)

Interior Column Forms (Round Steel)

Rental of steel column forms, each	$15.00
Labor, erect, strip and handle	5.00
Total unit cost, each	$20.00

Flat Slab Floor and Roof Forms

Lumber: 1½ board feet . @ $62.50 per M =	$00.0938	
Deduct salvage	.0150	.0788
Plant		.0100
Labor, make, erect and strip		.0775
Total cost per sq. ft.		$00.1663

(Use 16½ cts. for unit price.)

Drop Panel Forms

Lumber: 1½ board feet . . . . . @ $62.50 per M	=	$00.0938
(no salvage allowed)		
Plant		.0100
Labor, make, erect and strip		.1075
Total cost per sq. ft.		$00.2113

(Use 21 cts. for unit price.)

Wall Beam Forms

Lumber: 1½ board feet . @ $62.50 per M =	$00.0938	
Deduct salvage	.0150	.0788
Plant		.0100
Labor, make, erect and strip		.0975
Total cost per sq. ft.		$00.1863

(Use 18½ cts. for unit price.)

Floor Beam Forms

The unit cost of floor beam forms works out quite closely to the cost of the wall beam forms, the only difference being an increase of about ½ ct. per square foot in the labor charge. This increase makes it necessary to use 19c as a unit price for floor beam forms. Should the floor be what is known as a beam and slab type of floor the average labor cost of making, erecting and stripping the forms, measuring beams and slab together will be about 8½ cts. per square foot. This would make the unit cost of beam and slab floor forms about 17½ cts. per square foot if the forms are used twice.

Partition Forms

Lumber: 1½ board feet . @ $62.50 per M =	$00.0938	
Deduct salvage	.0150	.0788
Plant		.0100
Labor, make, erect and strip		.1375
Total cost per sq. ft.		$00.2263

(Use 22½ cts. for unit price.)

IV. REINFORCEMENT

The labor of cutting, bending and placing reinforcement will cost from $8.00 to $20.00 per ton, depending upon the size of the bar, the amount of bending required, and the position in which the bars must be finally placed. In the average concrete building it is safe to assume that a flat rate of $14.00 per ton will cut, bend and place the reinforcement in the building. The unit price used in the accompanying estimate of 4¼ cts. per pound is made up as follows:

Steel Reinforcement

Reinforcement f.o.b. cars, job, per ton	$68.00
Unload and pile on job	3.00
Cut, bend and place, including wire, etc.	14.00
Total cost per ton	$85.00

(Use 4¼ cts. per lb. for unit price.)

CONCLUSION

It should be borne in mind that the preceding brief discussion of methods of determining unit prices makes no pretense of being other than an outline sketch of a subject whose exhaustive treatment might well occupy a good-sized volume. Its aim has been to indicate the proper direction of methods to be used, and to supply a sufficient number of illustrations to offer a clear exemplification throughout. The judgment and experience of the estimator, in any given instance, must be relied upon to evaluate the influence of modifying elements of time, place and special circumstance.