ESTIMATING BUILDING COSTS

BY

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PREFACE

A great teacher of languages once wrote, "Take a small grammar, for instance, when learning a language, rather than a big one."

Learning to estimate buildings is not quite the same as learning a language, but it is often better to begin with a little book rather than a large one.

This is a small book as compared with "The New Building Estimator," of which twelve editions were issued up to date, but will be of great service to thousands who might at first consider the larger work too comprehensive. This book will act as a feeder to the other. An endeavor has been made here to present facts in plain language.

I gained my knowledge of estimating through experience; but on looking back I can see how much time and guesswork would have been saved had I simply had a small reliable manual to give a fair idea of what others had accomplished in a certain number of hours; and what amount of material is required for the different parts of a building.

The book is especially written for building tradesmen, contractors, material men, and technical students, but will be useful to all connected in any way with the construction of homes, barns, stores, and small manufacturing establishments. The heavier buildings are dealt with in the "New Building Estimator."

A series of questions is put at the end of each chapter, as the book is meant to serve classes in Y. M. C. A.'s, and in architectural and engineering schools and colleges. One of the earlier editions of the first little "Building Estimator" was largely sold to students in Y. M. C. A. and other classes. The "Key" is at the end of the book.

Like the larger work, this one is used only for estimating. Nothing is said about plain construction. But my "Contractors' and Builders' Handbook" has about a third of its space devoted to the kind of architectural designing that ordinary builders and small investors are apt to need. It is written for them, and is plain enough to be easily understood. The "Handbook" is supplemented by my other work, "The Home Builders' Guide," in which the construction of houses and ordinary buildings is dealt with in all its aspects. There is thus no necessity of saying anything here about planning buildings, or the practical way to erect them.

Unless otherwise stated the cost figures are given net without profit, which must be added in its proper place at the end of the total estimate.

The best friends and advertisers of a book are its readers; and this "Estimator" would soon become a universal helper of building tradesmen and young contractors if those who use it would tell of its merits to their acquaintances in the building business. For draftsmen, for classes in

Y. M. C. A.'s, students for civil service positions in government, state, and municipal offices, enough is presented to make this most important branch of technical work clear and of practical service.

We live in an era of high and changing prices in all lines, building included. In the Physical Valuation chapter of The New Building Estimator this matter is fully discussed, and the United States figures for all commodities and for building materials given in graphic and ordinary forms. Great changes are shown there from 1890 to 1910, and since then we all know how the price lists and the wage list have risen. To forestall all changes, up or down, the figures in this book are usually given in actual quantities required and in actual hours of labor necessary to put them in place. Costs can then be adjusted to suit local conditions and all prices. The idea is thus to make the book what the engineers call a "constant" and not a "variable."

Finally, the caution is given again that the figures never include profit, unless mentioned. Add profit at the end of the general estimate.

WILLIAM ARTHUR.

December, 1916.

TABLE OF CONTENTS

CHAPTER I

PAGE

Excavation and Piling 9

Measurement; Rate per Hour; Time; Rock Excavation; Back Filling; Spreading; Trench Work; Irregular Ground; Caissons; Piling; Concrete Piles; Review.

CHAPTER II

Concrete 16

Measurement; Voids; Proportion of Voids; Mixtures; Quantities; Packed Barrel; Bank Mixing; Quality; Weight of Concrete, etc.; Cinder Concrete; Heating; Labor; Mixing and Placing by Hand; Machine Mixing; Mixing Platforms; Caisson Concrete; Forms; Labor; Material; Average Cost of Forms; Time of Removing Forms; Exposure; Details of Cost; Sand; Floors and Sidewalks; Costs; Cinders; Surfacing; Review.

CHAPTER III

Brickwork 34

Measurement; Constant Rule; Size of Brick; Footings; Brick Required in Wall Measure and in Actual Measure; Chimneys; Mantels; Pilasters and Cornices; Hollow Walls; Pressed Brick; Shoved Work; Struck Joints; Estimating Footings; Changes; Pressed Brick; Wages; Mortar Allowance; Fireproofing Work; Brick Cisterns; Cesspools; Pointing; Unloading; Review.

CHAPTER IV

Stonework 58

Measurement; Allowance for Rubble; Mortar; Labor; Cost; Ashlar; Setting; Cement Stone; Labor Making Blocks; Labor Laying; Drayage; Material; Water; Data; Number of Blocks Required for a House of any Dimension; Review.

CHAPTER V

PAGE

Plastering 65

Measurement; Kind of Work; Three Coat Dry; Metal Lath Work; Cost of Plaster Per Yard; Wages; Material; Cost of Lath; Nails and Staples; Finish; Cost of 100 Yds. of Lime Plaster; Sand; Labor on Lath; Labor on Plaster; Heating; Sackett Board; Compo Board; Portland Cement Plaster; Cellar Plaster; Review.

CHAPTER VI

Woodwork 70

Posts, Girders and Sills; Square Method; Floors; Actual Cost per Square; Bridging; Anchors; Labor on Posts, Sills and Girders; Building Paper; Flooring; Ceiling; Allowances per Square for Material; Labor on Covering for 2 Men in 8 Hours; Carpenter Labor; Labor on Floors; Labor on Ceiling, Wainscoting and Siding; Labor on Shingling; Labor on Base; Labor on Doors, Windows and Blinds; Labor on Shelving and Sideboards; Labor on Stairs; Ferges Tables Giving the Quantity and Price per Square of Lumber; Lineal Feet of Joists to the Square; Sleepers; Walls; Studs; Measuring Roof; Rule to get Area of Roof; Pitch; Change of Pitch; Use of Board Measure; Cost of a Square of Roofing; Quantity of Shingles per Square; Cost of Roof per Square; Partitions; Cost of Ten Squares of Partition; Grounds; Furring; Porches; Cornice; Smoothing Floors by Machines; Pantries; China Closets; Cost of a Sun Parlor; Enclosing Porches; Review.

CHAPTER VII

Millwork and Glass 107

Glass Prices; Setting; Plate Glass; Leaded Glass; Plain Wire Glass; Ribbed Skylight; Window Frames; Complete Cost of a Plain Window; Storm Sash; Cost of Doors; Cost of Special Doors; Extras; Detailed Cost of an Inside Door; Hardwood Flooring; Casings; Base; Stair Newels; Stairs; Cellar Stairs; Counters; Review.

CHAPTER VIII

PAGE

Solid and Sheet Metal 120

Classification; Tables; Weight; Details; Standard Table of Weights; Labor Setting; Heavy Structures; Anchors, etc.; Weight of Plate Iron per Superficial Foot; Weight of Flat Bar Iron; Weight of Square Iron; Weight of Round Iron; Wall Hangers; Beam Hangers; Square Foot Measurement; Sheet Metal Work; Metal Ceilings; Furring; Labor; Labor for Two Men in 8 Hours; Cornices; Setting; Skylights; Ventilators; Downspouts; Gutters; Plain Work; Cost of Roofing per Square; Review.

CHAPTER IX

Roofing 129

Measurement; Cost per Square of 100 Sq. Feet of Roofing; Slate; Tile; Canvas; Shingle; Certainteed Roofing; Asbestos Shingles; Flex-A-Tile Shingles; Review.

CHAPTER X

Painting 132

Measurement; Material; Zinc; Enameling; Price per Yard; Plaster; Inside Work; Natural Finishes per Yard; Cold Water Paint; Labor; Material Required for 100 Yards; Special Painters' Materials; Carbolineum; Shingle Stains; "Conservo" Wood Preservative; Graphite; Covering Capacity of Graphite; Blanchite; Red Lead; Alabastine; Cementico; Kalsomining; Ready Mixed Paints; Wall Paper;; Review.

CHAPTER XI

Plumbing and Heating 139

Water Supply; Flow of Water Through Pipes; Labor Laying Pipes; Tanks; Lead Pipe; Sewers; Soil Pipe; Vent Pipes; Fixtures; Cost of Soil Pipe; Wrought Iron Pipe; Water-Closets; Urinals; Sinks; Baths; Boiler; Gas Piping; Acetylene Piping; Furnaces; Labor Setting; Steam Heating; Review.

CHAPTER XII

PAGE

Miscellaneous 147

Hardware; Nails Required for Material; Sash Weights; Sash Cord; Barn Door Hangers; Sliding Door Hangers; Butts or Hinges; Surface Butts; Double Acting Hinges; Locks; Trimmings; Brackets; Electric Wiring; Floor Tiling; Terrazo; Ceramic Tile; Rubber Tiling; Mineral Wool; Liability Bonds; Bids; Repairs; Standard Sizes; Weight of Lumber; Lumber Measurement Tables; Moldings; Keeping Costs; Checking the Length of a Rafter; Water Supplies; Data; Capacity of Round Tanks; Circular Cisterns; Square Cisterns; Weight of Various Substances per Cubic Foot; Circumferences and Areas of Circles; Comparison of Frame and Brick Construction; Cost of Wall; Furring; Plastered Exteriors; Brick Walls; Paintings; Cost of Common Brick Wall; Pressed Brick; Review.

CHAPTER XIII

Hints on Drawing 164

Materials; Triangles; Curves; T-Square; Drawing Board; Thumb Tacks; Erasers; Shield; Pencils; Ink; Pens; Paper; Tracing Cloth; Cost; Methods of Using Instruments; Using Triangles; Lettering; Single Stroke System; Dimensions; Sectioning; Making Changes; Dotting; Symmetry; Centers; Breaking Lines; Dimensions; Repeating; Glass; Direction of Timbers; Tracing; Lines; Erasing; Inking; Titles of Work; Dimension Lines; Conventional Signs; Coloring Blue Prints; Blue Printing; Architect's Charges; Time of Payment; Sizes of Drawings; Numerous Examples of Floor Plans, etc.

Key to Reviews 200

Gives the answers to the 126 questions that are given in the review sections of Chapters 1 to 12.

LIST OF TABLES

TABLE	PAGE
1. Quantity of Materials Required for Concrete	20
2. Materials for 1 Cubic Yard of Concrete......	20
3. Sq. Ft. Costs of Forms in Cents and Cubic Ft. Costs of Mixing and Placing Concrete.....	25
4. Detailed Cost of 1 Cubic Yard of Concrete at 1:3:6 Proportions	27
5. Detailed Cost of 1 Cubic Yard of Concrete at 1:2:4 Proportions	27
6. Detailed Cost of 1 Cubic Yard of Concrete at 1:4:8 Proportions	28
7. Detailed Costs of Concrete..................	28
8. Surfacing Table for Concrete, Giving Cement and Sand Quantities for 100 Sq. Yds.......	31
9. Table of Brick Required in Wall Measure and in Actual Measure........................	36
10. Cost of Chimneys..........................	39
12. Estimating Footings	43
13. Number of Actual Brick Laid by one Bricklayer and 1¼ Laborers per Hour..........	48
14. Detailed Cost of Brick Work................	50
15. Detailed Cost of Brick Work................	51
16. Labor on Brick Work......................	51
17. Mortar Allowance per 1000 Actual Bricks....	52
18. Cost of a 40 Barrel Brick Cistern Lined 1 in.:	54
19. Cost of a 100 Barrel Brick Cistern Lined 4 in..	56
20. Cost of 1 Cubic Yard of Ordinary Rubble in Cement and Lime........................	59
21. Cost of Cement Blocks........................	62
22. Cost of Plaster per Yard with a Profit........	66
23. Hard Wall Plaster Table for 100 Yards......	66
24. 100 Yards of Lime Plaster..................	67
25. Actual Cost per Square of 2 x 10 Joists Set 16 in.	72
26. Detailed Cost of 22 Squares.................	73
27. Detailed Cost of 22 Squares.................	74
28. Allowances per Square for Material..........	76

TABLE	PAGE
29. Allowances for Extras in Flooring, Ceiling, etc.	76
30. Labor on Covering for 2 Men in 8 Hours	76
31. Carpenter Labor	78
32. Labor on Floors	79
33. Labor on Ceiling, Wainscoting and Siding	80
34. Labor on Shingling	80
35. Labor on Base	80
36. Labor on Doors, Windows and Blinds	80
37. Labor on Shelving and Sideboard	81
38. Labor on Stairs	82
39. Quantity and Price per Square of Lumber,	83, 84, 85
40. Lineal Feet of Joists to the Square	86
41. Cost of a Square of 2 x 4 Studs at 16 in. Centers	89
42. Cost of 1 Square of Wall with 2 x 4 Studs Set 16 in. Centers	90
43. Board Measure to Square of Roof for 2 x 4 Rafters	96
44. Cost of a Square of Roofing	97
45. Shingle Quantities per Square	97
46. Cost of Roof per Square	97
47. Cost of 10 Squares of Partition	98
48. Detailed Estimate of Cost of Sun Parlor	101-102
49. Cost of Enclosing a Porch 8 x 21 Ft. with Glass	104
50. Glass Prices	107
51. Sand Blast Art, Colored and Fancy Glass	108-109
52. Sash Prices for Cellars, Attics, Transoms, etc.	109
53. Cost of Ordinary Check Rail Windows, 2 Lights,	109-110
54. Cost of Ordinary Check Rail Windows, 4 Lights	110
55. Cost of Ordinary Check Rail Windows, 8 Lights	110
56. Special Cottage Front Check Rail Windows	111
57. Window Frames	112
58. Complete Cost of a Plain Window	113
59. Cost of Special Doors	114
60. Veneered Door Extras	116
61. Veneered Doors	116

TABLE PAGE
62. Detailed Cost of an Inside Door............ 116
63. Hardwood Flooring 117
64. Weight of Plate Iron per Superficial Foot.. 122
65. Weight of Flat Bar Iron..................... 123
66. Weight of Square Iron per Lineal Foot....... 123
67. Weight of Round Iron per Lineal Foot....... 124
68. Labor on Sheet Metal Work, 2 Men in 8 Hours 126
69. Cost of Tin Roofing per Square.............. 128
70. Cost per Square of 100 Square Feet of Roofing 129
71. Painting: Price per Yard at 40c. per Hour, Not Including Profit...................... 134
72. Painting, Natural Finishes, per Yard......... 134
73. Material Required for Painting 100 Yards... 135
74. Flow of Water Through Pipes.............. 140
75. Cost of Sewer Pipe......................... 142
76. Cost of Soil Pipe........................... 142
77. Cost of Wrought Iron Pipe.................. 142
78. Common Nails, Size, Length, Number to Pound and Price 146
79. Weight of Lumber........................... 152
80. Hardwood Flooring 152
81. Dressed and Matched Stock................. 152
82. Lumber Measurement Table.................. 153
83. Capacity of Round Tanks per Foot Deep...... 156
84. Capacity of Circular Cisterns............... 156
85. Capacity of Square Cisterns.................. 156
86. Weight of Various Substances per Cubic Ft. in Pound 157
87. Circumferences and Areas of Circles........158-159
88. Cost of Wall with 2 x 4 Studs............... 160
89. Cost of Wall with 2 x6 Studs, Angle Covering. 160
90. Plastered Exteriors 161
91. Common Brick Wall......................... 163

CHAPTER I

Excavation and Piling

Measurement.—Excavation is measured by the cubic yard of 27 cu. ft. In this book the actual amount of material displaced only is allowed, and the price raised to suit difficult work. The other system, used too often, increases the quantities instead of the price for extra depth and other conditions where less work can be done.

An Example.—Take a space 20 x 30 x 10 ft. deep. There are 6,000 cu. ft., and dividing by 27, 222 cu. yds.

Extra.—An allowance of about a foot outside the walls must be made all around. When the footings extend only 6 in., less than this is made to serve, and some masons in fair soil excavate to the exact size and cut under the bank for the extension of the wall. In rainy sections, however, the outside of the masonry ought always to be plastered with Portland cement mortar to keep out the damp, and the excavation ought to be wide enough to let the men handle trowels. The neglect of this simple and cheap precaution has spoiled many an otherwise good foundation. It pays to use Portland cement mortar below grade.

In bad soils 50 per cent. of the contents for piers and such constructions has to be allowed extra for caving in. The banks in such soils must either be sheet piled or cut to an angle as far back from the outside line of the wall as the depth is from grade. This applies to the main building excavation, and not merely to piers.

Rate per Hour.—A low rate is given, as 20 cents per hour is a common standard on many railroads, and in the South; it is easy to add 50 per cent. to suit the local rate, or to double the amount. The main thing is to watch the quantity, and multiply by whatever the local rate may be in cents per hour.

Time.—On thousands of yards in a very wet soil a fair average for one man to a cubic yard is 2½ hours. This is in summer; in winter, 4¼. The material displaced is estimated simply thrown around the bank, and not carted away.

On a large contract about 20 ft. below grade, in very wet soil also, each yard took 8 hours for one man. This included loading on wagons and taking away. The haul for about half a mile is included. That is, the total cost of the excavation is divided by the number of yards, and, the teaming being included, the rate per yard is $1.60, or 8 hours for one man at 20 cents per hour. A common price with a steam excavator is 70 cents on good soil.

This $1.60 is a very high unit price, but the teams could not get down in the excavation, and the material had to be hoisted up part of the way.

On another contract about 4,000 yds. were dug and taken away half a mile, at an average cost of 1.4 yds. for one man per hour. That is

28 cents, which shows the difference between good soil easily taken out and the wet kind. Allow 56 cents on a 40 cent per hour basis.

On another building without any hauling and in good soil the cost was 1.2 cu. yds. for one laborer per hour. Much of this work was taken out by scrapers. This makes a still more reasonable price of 24 cents per yard, at 20 cents per hour; and 56 at 40 cents.

Where teaming was done the cost for man and team was about $4.50 per day. In some places teams can be had for $3.50; in others they cost $6 in busy years. With low wages, cheap teams, and short hauls, excavation is sometimes done for 15 to 25 cents per yard.

Rock Excavation.—The average runs to 1/6 cu. yd. for one laborer per hour. In some situations only half of this would be done. When there is a large body of rock to excavate men accustomed to the work are set at it, and good results are obtained; but when there is only a small job to handle, and ordinary laborers are used, it is certain to cost more.

Average.—A fair allowance in an ordinary soil for an ordinary building would be 6 cu. yds. for 1 man in 8 hours. This does not include hauling away from the premises.

Backfilling.—For this work and for spreading common earth allow from two to three times as much per man as above, depending upon hardness of soil and other conditions. It is easy to forget that frost means extra expense.

Spreading stone and gravel, unfrozen, with laborers' wages at 20 cents per hour, amounts to 7 or 8 cents per cubic yard; at 40 cents per hour, 14 to 16 cents.

Trench work costs more than large excavations—50 per cent., as a rough average. This is especially the case if the work is deep. With a double throw, 75 per cent. more is not too much to estimate. A man can work to a depth of 6 ft. Below that a platform is required, and the dirt has to be handled twice. If the ground is good there is no danger; if not, it has to be shored, and sometimes sheet piled at a cost of 15 to 20 cents per square foot of bank of earth protected. The Chicago rule as to deep excavations adds 75 per cent. extra for pier holes and pits from 5 to 10 ft. deep; 150 per cent. more from 10 to 15 ft.; and 450 from 30 to 35. If ordinary excavation is set at 50 cents, the rate deeper than 30 would be $2.75.

Irregular Ground.—Engineer's levels are often given for sites that are irregular, and the various depths can be had from them. If they are not supplied the contractor has to measure the ground at various points and strike an average. Thus, if a site slopes evenly from front to rear of an excavation 20 x 40, with a depth of excavation at 5 ft. in front and 2 ft. in rear, the average is 3 ft. 6 in. over the entire area to be excavated. If irregular slopes in various ways are encountered sufficient measurements have to be taken to form an average.

All excavations below the general level for boilers, pits, stairs, etc., have to be watched. Subbasements are sometimes used, tunnels, etc., and all such extras have to be carefully included.

Caissons.—In New York and Chicago especially these pits are sunk to bed rock, which is from 60 to 100 ft. deep. The system is used in many cities; in others, again, it is scarcely ever seen. In Omaha, for example, with 175,000 people, very few of the buildings are supported by caissons. The First National Bank there, erected in 1916, has 37 running down 100 ft. Thick maple lagging was used as a "form." On a 40 cent basis for carpenters' wages it is worth $10 per 1,000 ft. board measure, to place this material.

The cost of the excavation depends upon the size of the well and other conditions; in a narrow space the digging is difficult. With laborers' wages at 40 cents an hour for this special work the cost of average excavation alone in a wide well and to a depth of 70 ft. should not be estimated at less than $3 per cubic yard. In some cases twice this amount might be required, as with extra depth, narrow well, wet soil, or rock not strong enough to support the building being encountered.

As a rough average each man digging may be allowed 4 cu. yds. in an 8-hour day; but a man is required to hoist the material, and laborers to take it away.

Piling.—In ordinary soils the cost of driving wood piles with laborers' wages at 20 cents per hour is from 10 to 12 cents per lineal foot. This includes pointing and cutting off the heads below the water level. Sometimes the cost rises from 20 to 50 per cent. more on account of frost, bad conditions, few piles at a time, or other causes. To cut off the head alone is worth from 40 to 50 cents a pile.

Concrete Piles run from $1.25 to $1.75 per lineal foot in place, but this is on the basis of a reasonable number. It is with them as with wood piles in this respect. It takes about the same time to erect and take down a driver for two piles as for a hundred.

Wood coping, or grillage, as it is called, for piles should be estimated for labor at $12 per 1,000 ft. board measure for ordinary work with rough carpenters' wages at 40 cents per hour. This means under the usual surroundings. Down in the worst kind of mud holes the cost might be doubled.

Once when laying the foundation for a steeple scaffold, that went 200 ft. in the air, we had to walk over the feet in mud. Naturally the work does not go so fast under such conditions; and in making up a bid the estimator has to see that the surroundings are to be about the average, or make an extra allowance.

Review

Name the important factors in an excavation contract relating to,

1. The nature of the soil.
2. The season of the year.

3. The grade.
4. What kind of excavation takes about five times as much as the ordinary?
5. What part of ordinary excavation takes most time?
6. What is the best unit of measurement?
7. How much is allowed beyond the building line for excavation?
8. In wet soils how much extra is sometimes required for caving in?
9. What is a caisson; and about how much per cubic yard is the excavation worth?
10. What is an approximate price for driving a large number of wood piles?
11. How much per M is the labor on grillage timbers worth?

CHAPTER II

Concrete

Measurement.—Only actual quantities are considered in this book. There is no allowance for doubling corners, extras at intersections, or anything of that kind. The price should be raised to suit expensive work. Cubic feet or cubic yards are used. Some use cubic feet only, and on small work this suits, but yards are more convenient on heavy undertakings.

Voids.—To begin with, an estimator should understand some facts about that mixture which we call concrete. Suppose you have a glass filled with small shot you can see that there is room for sand in between, and after the sand is in, for water. There are voids between the shot which the sand fills; and between the sand which the water fills; and thus a glass full to the brim with shot can take in sand and water without overflowing. It is the same with concrete.

Proportion of Voids.—There are many theoretical discussions of voids which we need not consider here. One authority gives 53 per cent. of stone and 47 of space; but with gravel and ¾ in. stone, probably 42 per cent. of voids is about right. Sand has about 65 solid to 35 of space or voids, according to some United States experiments. Other figures are from 31 to 38. These figures are sufficient for our purpose.

Stone for the heaviest kind of work is from to 2½ in. diameter; for reinforced concrete and waterproof structures it is best at not more than ¾ in. Chips are used for fine work.

The voids between the stone are filled up with sand, but those between the sand are filled up with fine cement. This makes the mass solid. The more cement the better the concrete, and the heavier. Water will go through an ordinary mixture, but 1 part cement, 1½ to 2 parts of sand, and 4 of ¾ in. stone will be water-tight, although even the best concrete sucks in water—not so much as a soft brick, but still more than is agreeable at times. Waterproofing is used to keep it back.

Mixtures.—The right kind of concrete should have the voids completely filled so that one stone should not touch another, and one grain of sand should be separated from the next by the fine cement.

The proportion for ordinary work is 1:3:6; for the best work 1:2:4. But 1:1½:4 is used for tanks, etc. The units are taken by measure and not by weight.

Quantities.—Stone is usually crushed in three sizes—about 2 in., 1 in., and chips. Gravel is also used, and that is not always of the same kind. The amount of sand required to fill the voids therefore varies. A fair idea of the quantity may be obtained thus: Make a water-tight measure to contain 1 cu. ft. Fill it with the stone to be used. Then pour in water to the top, measuring as it goes in. The amount of water gives the proportion of sand.

The quantity of cement to suit the sand may be found by the same method. Sand may be coarse or fine, and the voids thus require more or less cement. The cement is ground so fine that it has practically no voids.

Packed Barrel.—This kind of a barrel has always to be understood when dealing with the experts. That is, a certain number of cubic feet are set for the contents of a barrel, and the sand and stone have to be arranged to suit. Just as earth taken out of a pit occupies more room, so does cement when it is unloosed from a tight barrel. Of course it comes in sacks, but the contents of a sack are rated on the packed barrel basis. Naturally contractors want to measure cement like sand—unpacked, as less is thus used.

Four sacks are equal to 1 bbl. of Portland cement, which is the only kind considered here, and a barrel contains 3.8 cu. ft. For those who do not know decimals we may say this is $3\frac{8}{10}$, or $3\frac{4}{5}$ cu. ft. This $\frac{1}{5}$ of a cubic foot we are short of 4 cu. ft. has to be taken into account when mixing, but just for even figures now let us assume that a barrel has 4 cu. ft. In a 1:3:6 mixture there would be 1 bbl. cement, 12 cu. ft. of sand, and 24 cu. ft. of stone. In a 1:2:4 there would be 1 bbl. cement, 8 cu. ft. of sand, and 16 of stone.

Bank Mixing.—Sometimes the sand and gravel can be taken out of the bank in such proportions that they are ready to mix with the cement. In this case the amount must be regulated by the stone proportion alone. Thus, on a 1:3:6 mixture there would be taken 1 part of cement and 6 parts of the mixed sand and gravel; not 1 and 9, as some might think. For 1:2:4 the proportion would be 1 cement, and 4 of the "aggregate," as the materials other than the cement are called.

The reason is, as already explained, that the sand merely fills up the voids in the stones, and is already mixed. All that is now required is the cement to fill the sand. If in the first case we took 1 of cement and 9 of the aggregate the mixture would not be 1:3:6, but a good deal weaker. The required proportion is really 1 to 6, if we assume the sand to be already mixed with the stone; but it would be 1 to 9 in the other case.

This means, as will be seen, that the amount of the finished concrete is just about equal to the amount of the stone. It must not be supposed that the cubic yards of the concrete will equal the total of the stone, sand, and cement. When a glass is filled with shot, then sand, then water, there is only a glassful, after all, and not the sum of the three added together. This is where many get "fooled" on concrete. For the average cubic yard of concrete (27 cu. ft.) there are from 37 to 39 cu. ft. of materials required.

Quality.—The mixture has to be regulated by the nature of the work. As already noted, 1:3:6 is a good ordinary mixture. But for heavy mass footings, where the strain is evenly distributed, the proportions are often made 1:4:8. It is thus important for an estimator to see what is specified. Much more cement is needed for 1:1½:4 than 1 :4 :8; and cement is what costs.

On some work, like concrete-cement blocks, for example, an ordinary mixture is made for the body, and a much richer one for the face

A good mixture for the heaviest work may be had by using 2,300 lbs. of stone, ⅗ cu. yd. of sand, and 1⅒ bbl. of Portland cement to the cubic yard of work in the foundations.

The following tables will be useful for the ordinary proportions.

TABLE ONE

Quantity of Materials Required for Concrete

Mix	Bags Cement	Sand	Gravel	Concrete Made. Cu. Ft.
1:1½:3	2	2.8 cu. ft. or ¾ bbl.	5.6 cu. ft. or 1½ bbl.	7.0
1:2 :4	2	3.8 cu. ft. or 1 bbl.	7.6 cu. ft. or 2 bbl.	9.0
1:2½:5	2	4.8 cu. ft. or 1¼ bbl.	9.6 cu. ft. or 2½ bbl.	10.9
1:3 :6	2	5.8 cu. ft. or 1½ bbl.	11.6 cu. ft. or 3 bbl.	12.8

TABLE TWO

Materials for One Cubic Yard of Concrete

Proportions by Parts			Bbls. Cement in 1 Cubic Yard	Bbls. Sand in 1 Cubic Yard	Bbls. Gravel or Stone in 1 Cubic Yard
Cement	Sand	Stone or Gravel			
1	1½	3	2.00	3.00	6.00
1	2	4	1.57	3.14	6.28
1	2½	5	1.29	3.23	6.45
1	3	6	1.10	3.30	6.60

Weight.—The weight of average concrete is usually taken at 140 to 150 lbs. per cubic foot. It depends upon density, for 1:2:4, for example, weighs more than 1:4:8.

Crushed rock with the dust taken out is about 89 lbs. to the cubic foot; stone passed through a 2 in. ring and retained in 1 in., 87 lbs.

Portland cement weighs from 376 to 380 lbs. net to the barrel, and this makes the sacks 94 to 95 lbs. each.

Cinder Concrete.—This material is only 75 to 90 lbs. to the cubic foot, but many architects and engineers object to using it. Others, again, say that it is best for floor slabs. The Chicago ordinance allows it, but no cinders are to be more than 1 in. in size. The mixture of sand and cinders must not exceed 8 times that of cement. In other words, it is 1 cement to 8 of the aggregate, or like the sand and gravel dug out of the bank already referred to—1:2:6 about.

Heating.—Another factor that affects price is freezing weather. It is better not to put in concrete while the thermometer is down near the zero line; but we are in such a hurry in these days that it is often done. If the work is carefully put in, however, by those who are accustomed to it, there is no particular danger. The sand and water must be heated.

A price set on railroad work shows the difference between concrete mixed under ordinary conditions and that heated. For ordinary concrete 50 cents extra is allowed per yard; and the same for reinforced work. This is for work of some size, and not for a little job where it would take more time to get ready than to do the heating.

Labor.—With laborers' wages at 20 cents per hour the average cost of mixing and placing concrete by hand for ordinary work is set at $1 per cubic yard. This is so close to $\frac{1}{6}$ yd. per hour that if we put the cost at $1.05 the figures will be even. Arrange price to suit local wages, but even with wages twice as high the $1 rate may be had on plain work if the men are experts and properly directed.

A good rule is to allow 50 per cent. of the wages paid to a laborer for 8 hours for the cost of mixing and placing a yard. Some go as high as 90 per cent., but this should not be required for common work, with which we are dealing here.

Raw laborers do not make such good time as those accustomed to the methods of mixing.

On several thousands of yards that I estimated, the cost was 95 cents put in place with hand mixing, at 18 to 20 cents per hour for laborers. This was for heavy foundations. On complicated machine foundations the cost ran from $1.50 to $3. The average all through on this latter kind of work was $2.05, or more than twice as much as the main foundations. This shows that the character of the design has to be considered.

Machine Mixing.—With the machine, a Chicago contractor did the same foundation work on large shops for 75 cents. The machine cost runs from 50 cents to $1. If there is much work to be done a machine pays; but an ordinary contractor does not care to buy one and let it lie idle most of the time. Machine mixing is generally considered better than mixing by hand. But even if a machine is owned it does not pay to start it for small amounts under 100 yds., unless everything is in good shape, so that a large expense will not be entailed by making runs, etc.

Mixing.—For an ordinary job a platform 10 x 10 ft. is used. A smaller one may be made to serve when there are only a few yards. It should be made of matched boards—shiplap at the least, to keep the water from washing away the cement. A small strip should be nailed around the edges for the same reason. The cement and sand are mixed dry. They should be turned over 3 or 4 times till a complete mixture takes place. Then the stone should be wetted with a hose either in the pile or the wheelbarrow, and thrown on top of the sand and cement. It is then all mixed. Do not put on too much water at once, but gradually. Do not wash the sand and cement away with a hose. Some will not allow one to be used, but insist on pails. Use the concrete as soon as mixed. There may be a delay in some cases, but no concrete should be used after it is mixed more than an hour.

Caisson Concrete.—At ordinary city wages allow from $1.10 to $1.35 for mixing and placing. This does not include any work on steel reinforcing that may be used. Allow, as a fair average, $10 per ton for unloading and placing this.

Forms.—The additional cost of forms has to be taken into account for some kinds of work. If the concrete cannot be held in place by the soil there must be a wooden "box" or form made to hold it until it hardens. All piers, for example, with tapered shapes must have a form.

Labor.—On several thousands of yards of large piers the cost of labor on forms was 28 cents per cubic yard of concrete in the wall, with carpenters' wages at 30 cents. This is practically the form labor for a yard per hour, but many of them were used several times over.

On machine foundations the cost was $1.42. There are more angles to be made, and as each machine is different no form can be used twice.

But on long walls the cost might be reduced to from 15 to 20 cents per yard in the wall. It must be remembered, however, that carpenters' wages are low in these calculations, and the local rate must be used. If wages were 35 cents instead of 30 the yd. unit would be 33 cents.

On one building with 700 yds. the total cost of unloading the material, making forms, mixing and placing the concrete was $2 per yard.

Material.—Each 1,000 yds. of pier and foundations required 7,000 ft. B. M. of plank and 3 kegs of spikes.

General Rule.—Get the number of finished square feet of concrete to be covered with forms and allow three times as much for the lumber in board measure. In some cases where the lumber can be used several times over this allowance would be too much.

The proper way to estimate forms is by the number of square feet laid against the concrete, for it is clear that a wall 12 in. thick does not need any more plank than another 24 in.; and thus the cubic foot measurement is not a safe guide, although it sometimes serves.

Average Cost of Forms.—Under this square feet method, and as an average over a vast amount of reinforced and ordinary concrete work the following figures are taken from the detailed tables in "The New Building Estimator," and at ordinary city wages. In the country, and with laborers unaccustomed to the work the cost would likely run higher, even with lower wages per hour. The figures are from the records of The Aberthaw Company, and inexperienced contractors could not ordinarily get down so low. Multiply the concrete figures by 27 to get the cost per yard. It runs from 81 cents to $6.75. This is for actual labor only, and does not include "overhead," such as expense for plant, teaming, etc. Fortunes of reasonable size have been lost in reinforced concrete construction. It is like gold mining.

TABLE THREE

Square Foot Costs of Forms in Cents and Cubic Foot Costs of Mixing and Placing Concrete (Labor only)

	Forms	Average	Concrete	Average
Footing and mass work	2 to 12	6	3 to 10	5
Foundation walls	4 to 14	7	5 to 25	9
Concrete columns	6 to 14	8	7 to 23	13
Walls above grade	5 to 14	9	5 to 20	11
Slab floors	7 to 8	7½	5 to 17	11
Slabs between beams	3 to 11	6	8 to 20	12
Beam floors, reinforced	4 to 17	7	5 to 22	13

Time of Removing Forms.—For heavy mass work, 1 to 3 days. Thin walls, 2 days in summer, 6 in winter. Slabs up to 6 ft., 6 days in summer, 12 in winter. Beams and structural members, 10 to 14 days in summer, 20 in winter. Columns, 2 and 4, but the weight of the beams must not be allowed to come on them. They have to be shored up independently. Removing forms too soon means danger.

Exposure.—For heavy foundations the sun is allowed to have its way, but thin walls and such structures should be protected from the heat, and sprinkled to keep from drying too soon.

Details of Cost.—The system of arriving at the cost must now be given according to the mixture used. Taking the quantities set forth in the table we have 1.10 bbls. cement, 3.30 bbls. sand, 6.60 bbls. stone. But in all work there is more or less waste. One large meeting of men who use much cement recommended an allowance of 5 per cent. extra of this material—but they did not have to pay for it themselves. Sand is easily wasted, and being cheaper is more popular for filling voids than cement; and stone needs an extra allowance. Watch concrete proportions.

The cubic feet in the table are 4.18 for cement; 12.54 for sand, and 25.98 for stone. Another table gives 26.2 cu. ft. for stone, so that no exact figures are to be found. Still another with gravel gives 22.68. At 90 lbs. to the cubic foot for stone and ½ yd. for sand we should have according to the table already given:

TABLE FOUR

Detailed Cost of a Cubic Yard of Concrete at 1:3:6 Proportions.

Cement, 1.10 bbl., or 4.18 cu. ft., $1.75 per bbl.,	$1.92
Sand, 3.30 bbl., or 12.54 cu. ft., allow ½ cu. yd.	.50
Stone, 6.60 bbl., or 25.08 cu. ft., 2,234 lbs.@5c. per 100	1.18
Labor, at 30 cents per hour	1.50
Water	.15
	$5.25

The weight of the stone selected might affect the total; and the local prices of material and labor have to be put in the place of those given above; but the experience of a large company in building in all parts of the United States has been that high priced labor is often as cheap in the end as the low kind; and that local prices do not affect the total so much as might be supposed. One item that is high is often balanced by another that is low. A fair average for ordinary concrete is given in the tables as $1.50. In many cases $1 would be enough.

Water is often cheaper than in the table. In Chicago, for example, it is 8 cents for 100 cu. ft. of concrete; 6 cents for 100 cu. ft. of rubble; 5 cents per 100 brick in wall measure; 5 cents per 100 cu. ft. of hollow tile, and 15 cents for plaster per sq. yd. But if a well has to be sunk?

TABLE FIVE

Detailed Cost of 1 Cu. Yd. of Concrete at 1:2:4 Proportions

Cement, 1.57 bbls. or 6 cu. ft. at $1.75 per bbl.	$2.75
Sand, ½ yd.	.50
Stone, 2,160 lbs. at 5 cents	1.08
Labor at 30 cents per hour	1.50
Water	.15
	$5.98

This shows the difference in cost, and it all practically lies in the cement. On 1,000 yds. it would amount to $730. It is not a wise proceeding, therefore, to lump all "concrete" as the same, without seeing what the proportions are.

Let us now take a weaker proportion of 1 : 4 : 8. The regular tables give 0.81 cement barrel; ½ yd. sand; 1 yd. stone.

TABLE SIX

Detailed Cost of 1 Cu. Yd. of Concrete at 1 : 4 : 8 Proportions

Cement,	$1.42
Sand, ½ yd.	.50
Stone, 2,430 lbs. at 5 cents	1.22
Labor and water	1.65
	$4.79

This makes the last proportion cost $1.19 less per cubic yard than the 1 : 2 : 4 one.

Examples.—The following figures show the costs of work actually done. They are higher than the detailed examples above, owing to local demands. But they show that "concrete" may mean from 14 to 32 cents per cubic foot. The figures multiplied by 27 give price per yd.

TABLE SEVEN

Detailed Costs of Concrete

Ratio of cement, sand, and stone	Bbls. of cement per cu. yd.	Cost per cu. ft. of broken stone concrete	Cost per cu.ft. of gravel concrete
1 :1 :2	2.8	$0.314	$0.274
1 :2 :4	1.73	.264	.214
1 :3 :6	1.2	.23	.18
1 :4 :8	.9	.21	.16
1 :5 :10	.71	.20	.15
1 :6 :12	.6	.192	.141

Cautions.—Once more, the caution is given that no profit is included, and that local weights and prices must be watched. Gravel weighed 98 lbs. and crushed stone 84 in some experiments. More or less would therefore be required according to weight depending upon the kind chosen. Take time, and figure out the proportions before setting a price.

Sand is usually bought by weight instead of measure, and there is a good deal of difference between wet and dry. The average weight is about 2,600 lbs. to the cubic yard; but it may run from 2,400 to 3,500. When buying by weight the contractor may not always get the measure he expects.

Floors and Sidewalks.—The best way to estimate them is by the square yard. This is complete with top surfacing included.

But for some of special thickness we can take the concrete base by the cubic yard, and add the top. On large surfaces the mixing by machine for the base is done for 50 cents per cubic yard. Small work costs more, for machines cannot be economically used on it. In a street there is some chance of doing work with a machine.

Example.—Suppose we have a space 40 x 40 ft. to be covered with a 6 in. base and a 1 in. top surface, a total of 7 in. In the base there are close to 30 cu. yds. The price must be arranged to suit the quality of the mixture—probably, 1:3:6. In some sections of the country concrete is taken by the cubic foot, and generally this is the best method, although the yard is the unit on heavy work—on railroads especially.

After the base comes the top. How many barrels of cement are required? We have 40 x 40 x 1 in. or 1,600 sq. ft. an inch thick. By referring to the table on page 31, we find that the proportion of 1 to 2 x 1 in. thick takes 9.2 cement barrels for 900 sq. ft. In the same proportion 16½ bbls. would be required for this surface. But the mixture has to be watched. It might be 1 to 1; 1 to 1½; 1 to 2. The amount of sand is also given in the table.

On a large floor I put down the detailed cost was, sand and stone, 10 cents; cement, 30 cents; labor, 26. But the base was only 2 in. thick. Wages were 17½ cents for the 2 laborers, and 35 for the cement worker per hour. This was in a country town and at a time when wages were low. The top surface was included in this total. It is lower than such work is usually done for. Top surfacing is worth from 15 to 20 cents for labor alone per square yard. A fair allowance in 8 hours is 70 yds. for 3 men.

Cost.—In cities ordinary work in basements with a 4 in. base and ½ in. top is laid for $1 per square yard, including profit. Sidewalks run to $1.35. Where there are gutters and such extras, as in cow barns, from $1.75 to $2.25 is nearer the mark than the ordinary figure. All on the basis of 20 cents for laborers per hour, cement $1.80; sand, $1 per cubic yard, and stone, $1 per ton. In many small towns, and on nearly all railroads in the southern part of this wide continent, such wages are standard; but in most cities, and generally in the north, they are only half as much as the ordinary rate. The totals in such cases should be increased; but what has been already said should be remembered—that low wages do not always mean proportionate results: the finished work is often turned out as cheap, and even cheaper, where wages are highest.

Cinders must be included extra for a base, if they are specified.

Surfacing.—The following table gives the amount required for the various mixtures. It is made out for 100 sq. yds. or 900 sq. ft. For larger or smaller surfaces the quantities can be reduced in proportion.

TABLE EIGHT

Surfacing Table for Concrete, Giving Cement and Sand Quantities (For 100 sq. yds.)

Proportion	Thickness inches	Cement bbls.	Sand cu. yds.
1 to 1	½	6.6	.9
1 to 2	½	4.6	1.3
1 to 1	¾	10.0	1.4
1 to 1½	¾	8.1	1.7
1 to 1	1	13.0	1.8
1 to 1½	1	10.8	2.3
1 to 2	1	9.2	2.6

Review

1. What are voids in crushed stone and in sand?
2. Approximately, how are voids determined?
3. What is meant by a mixture of 1:3:6, or any other proportion?
4. What is a packed barrel of cement?

5. State the proportions for an ordinary mixture, and for a waterproof one.
6. How many sacks are in a barrel of Portland cement?
7. How many cubic feet are in a barrel of Portland cement?
8. Explain the proportions for bank mixing on, say, a 1 : 3 : 5 concrete.
9. About how many cubic feet of materials are required to make a cubic yard of finished concrete?
10. How many pounds of (a) crushed stone, (b) cubic yards of sand, and (c) barrels of cement are required for 1 yd. of average concrete?
11. What is the weight of a cubic foot of average concrete?
12. What is the net weight of a barrel of Portland cement?
13. As Portland always comes in sacks, what is the weight of a sack?
14. What is the weight per cubic foot of cinder concrete?
15. About how much extra is required per cubic yard if sand and water have to be heated?
16. About what proportion of a laborer's wages for 8 hours is required to mix by hand a cubic yard of concrete?
17. How much a yard is it worth to mix, place, and smooth the concrete for machine foundations?
18. What are forms?

19. Why are forms for machine foundations expensive?

20. What is one of the worst risks in reinforced concrete work?

21. Why should a 1:3:6 proportion be listed at $5.25 net in this book, on the basis of the unit prices given, and a 1:2:4 be $5.98?

22. Does the proportion of the mixture heavily affect the total cost?

23. If one sidewalk has a 2 in. base and another a 5 in., both with the same surfacing, how is the estimate made?

24. What is the proper system of measurement for concrete work?

CHAPTER III

Brickwork

Measurement.—Wall measure is always 22½ brick to the cubic foot, but kiln or actual count may run from 16 to 20, depending upon the size and quality of the brick.

Wall measure is one of the trade rules that has a good base to stand on. Except as to this rule all measurements here are for actual quantities only. Corners are not doubled, openings are deducted, no allowance is made for intersections in measurement, piers and chimneys are not measured on two or three sides, and pilasters and cornices are taken as if they were walls of a certain thickness. The allowance for difficult work is made in the price and not in the measurement. "The customer is always right," and for long years he has imagined himself to be cheated with trade rules. Quite often he has been.

The trade rules vary in different states, and in cities of the same state even. Railroads run everywhere, and necessarily stick to actual quantities. All specifications should be made out to suit the actual quantity system only, especially for concrete, brickwork and plaster.

Constant.—This 22½ rule is a "constant," and works with any size of brick. It is so high that no bricks are made small enough to suit it, therefore it never needs to be changed. It is like the high price lists of millwork or glass arranged by a discount sheet.

Size.—The national and recommended size of brick is 8¼ x 4 x 2¼ in. Allowing 2 per cent. for waste this takes from 16½ to 17 for an actual cubic foot of wall. Having figured the building on a 22½ basis we have to reduce in the proportion of 22½ to 16½, or 15 to 11. For 100,000 brick wall measure we thus need only 73,333, or 74,000, as a contractor would order. But Chicago brick take 18; some sizes with large joints take only 15½.

Example 1.—Take a brick wall 40 ft. long by 10 ft. high, and 17 in. thick. In this thickness there are 30 brick to the square foot in wall measure. In our surface of 400 sq. ft. there are therefore 12,000 brick. This is really all there is to estimating plain brickwork. The rest is a matter of detail.

Example 2.—But suppose that in this wall there is an opening 4 x 7 ft., another 2 x 2 ft., and 2 at 3 x 6 ft. The total is 68 sq. ft. of openings, which subtracted from 400 leaves 332 at 30 brick, equals 9,960. This is on the standard basis of 22½ brick to the cubic foot in wall measure.

Example 3.—Assuming that the 40 ft. long is only one side of a house, and that it measures 20 ft. across the end, we should have a total around the walls of 120 ft. But we have to deduct the 4 corners at 17 in. thick to get the actual length of the wall. This leaves 114 ft. 4 in. Multiplying this by the height of 10 ft. we get a trifle over 1,143 sq. ft. Deducting, say, 200 for openings, which must be figured for each plan, we get 943 sq. ft. x 30=29,290 brick in wall measure.

Rule.—Figure the brick at 22½ to the cubic foot, no matter what the size of them is. If they are large the price of labor may be set a little lower than when they are small.

The ordinary walls do not have to be reduced to cubic feet, for the following table is made out to suit the various thicknesses. The figures in the last column may be more or less, depending upon size of brick.

TABLE NINE

Table of Brick Required in Wall Measure and in Actual Measure

	Wall Measure	Actual
Per sq. ft. 1 course or 4½" thick	7½ brick	6
Per sq. ft. 2 courses or 9" thick	15 brick	12
Per sq. ft. 3 courses or 13" thick	22½ brick	18
Per sq. ft. 4 courses or 17" thick	30 brick	24
Per sq. ft. 5 courses or 21" thick	37½ brick	30
Per sq. ft. 6 courses or 25" thick	45 brick	36

In some cities the thicknesses are given in even figures instead of odd, as 4, 8, 12, 16, 20, etc. But a cubic foot is taken at either the 12 or 13 in. thickness.

Example 4.—Taking again a wall 40 x 10 ft. we can see how many brick are required at the various thicknesses. At 9 in., 6,000; at 13 in., 9,000; at 25 in., 18,000. But this does not deduct any openings, which must be done on an actual plan.

Footings.—Plain walls as above are easily figured, but the footings give a little more trouble.

In many building codes these have to be at least 12 in. wider than the width of the wall that rests upon them. In the Underwriters' code the offsets must not be more than 1½ in. for a single course of brick, and 3 in. for a double one. If a concrete base is used, the first line of the brick may be back half the thickness; that is, on a base 12 in. thick the brick could be set back 6 in.

Example 5.—If we take a 9 in. wall and extend it 6 in. on each side there is a base of 21 in. wide. The usual custom is to allow only 17 in., but the Underwriters want 21 in. Sometimes a double course is laid to start with, and on good soils it is occasionally omitted. Let us figure the single course here.

The first layer would be 21 in. wide, the second 17 in., the third, 13 in., and the 9 in. wall above. As will be noted the offsets are made 2 in. and not 1½ in. according to the Underwriters.

Here, then, are 3 courses of brick, and the average thickness is 17 in. Instead of figuring on the flat let us suppose that the work is turned up on edge, and that it is to be 40 ft. long as before. We have a wall, 40 ft. x 17 in. high x 9 in. thick. According to the table we have 855 brick in wall measure, for the 57 sq. ft. It is taken at 9 in. thick, for the 3 courses would be close enough to use that figure, unless the brick were very small, in which case allowance would have to be made.

If necessary each course may be taken by itself. It would be 3 in. high, or ¼ foot, and would thus contain ¼ of the number to the square foot of the thickness of 21 in., 17 in., or 13 in., as the case might be.

The easiest way is to average the footings by taking the width about the center and the thickness. The table may be used, or the whole turned into cubic feet and multiplied by 22½.

Chimneys.—Allow flue linings if they are called for; and they should be.

For solid heavy chimneys laid in common brick where the bricklayer gets a chance to move around the cost need not be much more than for a 9 in. wall. Thus one sees chimneys from 6 to 8 ft. wide laid up about as fast as ordinary work. But in small corners and with pressed brick one has to allow anywhere from twice to five times as much as for a common job. It all depends upon the detail. The number of pressed brick and the price must be figured out. Then the best judgment has to be used as to the time that will be required to lay the work. This has to include scaffolding and laborers' time. If there is no other work going on the laborers will be likely to work only half the time on the first story, but the whole time has to be paid for. The worst danger is the mason's time at 60 to 85 cents per hour. On some fine chimneys it occasionally seems as if a bricklayer wastes time.

Ordinary chimneys are often taken by the lineal foot. A few prices are given here. Flue lining and profit are included. No flue should be made less than 8 x 8 in., unless for a gas stove, where a 4 x 8 in. may be used.

TABLE TEN

Cost of Chimneys

17" x 17" chimney, 1 flue	8" x 8",	per lin. ft.	$1.15
17" x 29" chimney, 2 flue	8" x 8",	per lin. ft.	1.60
17" x 21" chimney, 1 flue	8" x 12",	per lin. ft.	1.40
21" x 21" chimney, 1 flue	12" x 12",	per lin. ft.	1.60

Mantels.—An inside ordinary brick mantel and fireplace may be averaged at $25 for labor alone. An architect could easily detail one that would cost several times as much.

Pilasters and Cornices.—Figure a plain pilaster in the same way as a wall of 4½ in., 9 in., 13 in., or whatever the projection is. Thus, taking a pilaster 2 ft. wide, 20 ft. high, and standing out 4½ in. from the face of the wall, how many brick does it contain in wall measure? There are 40 sq. ft. at 7½=300. No returns are figured, but only the plain face measurement. If the thickness were 9 in. the quantity would be 600.

The same method is followed with cornices. But in this case there may be many offsets like those of a footing. Get the average and the cubic feet, and multiply by 22½, or take each course separately, as a wall of so many square feet at 4½ in. thick, containing 7½ brick to the square foot. A cornice 20 ft. long by 2 ft. wide by 1 course is really the same as a pilaster, only the one is plumb and the other level. If several layers of brick are under this 2 ft., or on the face, the square feet of each must be taken.

On a plain pilaster or cornice the labor is lumped in with the rest of the work, just as the extra time for laying the last board of a floor by a carpenter is put in with the general average; but for the "fancy" kind of cornices and the recessed detailing an extra allowance has to be made. It is all a matter of judgment and experience. I know of one building with two brick fronts that were spoiled with all manner of recessed panels, detailed pilasters and buttresses, angled brick and every ornament that an architect could devise or plaster on. The bricklayer lost $1,800 on the job.

Hollow Walls.—Figure these the same as ordinary walls of equal thickness, and allow $1.50 extra per 1,000 brick wall measure, when both walls are 9 in., and $1 for 13 in. There is time taken binding them together.

Pressed Brick.—For ordinary pressed brick figure out the wall as if it were all of common brick, at full thickness, and then add the price of the pressed brick without making any deduction. This gives a good profit on plain work. For example, if we have a wall 40 x 10 x 17 in., no openings, there are 12,000 common brick in wall measure in it. If it is lined on the face with pressed brick at $20 per 1,000, get the **actual** number, not the **wall measure** number, at 6 to 7 per square foot and add to the total. Allowing 2,800, this would be $56 extra. The common brick left will be only 13 in. thick, and the number be 9,000 instead of 12,000. Thus a saving of the course of common brick is made in addition to the $56. At openings with more than a 4 in. reveal add the extra surface.

This is for plain work. When we get among fancy fronts with recessed panels, projecting brick, and all the detailed work that an architect sometimes puts on, the cost may run up out of all proportion to what is expected.

This rule gives more on a high priced brick. Instead of $56 we should have twice as much if the brick cost $40, but the quality of the work has usually to be better for an expensive front.

Shoved Work.—If well done this costs $1 more per 1,000, wall measure, than the common kind, but 50 to 75 cents is sufficient under the ordinary method of giving "a lick and a promise." The mortar is placed on the wall and the brick laid in it and shoved against the other already laid. This insures a full joint.

Struck Joints require an extra allowance of ½ cent per square foot of surface, outside or inside—if the work is well done.

Details.—An example is said to be better than a precept, and a drawing often helps the beginner—and also the "ender." Fig. 1 shows an ordinary basement plan, with some special features. The thickness, or section, is shown at Fig. 2. The first two courses are 24 inches, the next course, 20, and the one just below the wall, 16. On some plans these sizes are marked 25, 21, 17, and the wall above 13, instead of 12, but the brick are figured the same for both sizes.

The easiest way is to average the footings and multiply by the length. Adding together two at 24, one at 20, and another at 16 we have 84.

Dividing this by 4 we have an average of 21 in., or 1¾ ft. The actual length is 116 ft. Multiplying 116 by 1¾ makes 203 cu. ft., which at 22½ each gives a total of 4,568 in wall measure for the footing. It is thus seen to be a wall 116 ft. long x 1¾ ft. high x 1 thick, for each course in a footing may be set at 3 in., although it is often a trifle less. Depending upon the thickness of the

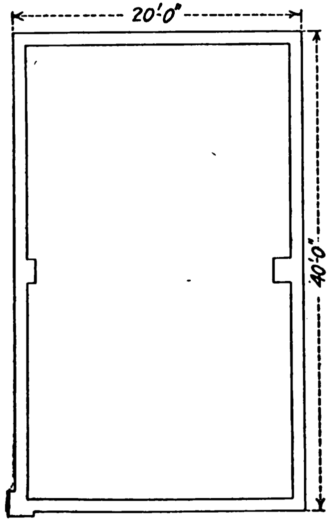


FIG. 1. BASEMENT PLAN.

brick the 4 courses might be only 10½ in. in all. Nice exact measurement is not taken with this part, where there is more than usual trouble in some of the work, getting started, etc.

Detailed out we have the lower two courses extending 6 in. on each end. This makes them

41 ft. long. The ends, in between the side layers, are in all 17 ft. The total actual length is 116. The actual length of the two upper courses is the same.

TABLE TWELVE

Estimating Footings

Two courses 116′ x 2′ x 6=116 cu. ft. at 22½=2,610 in wall measure.	
The next course is 116′ x 1′ 8″ x 3″=116 x 1⅔ ft.= 194 cu. ft. x 22½=4,343, but divided by 4, as the height is only 3 in. instead of a foot, the number of brick is 1,086 in wall measure.	
The top course 116′ x 1′ 4″ x 3″=116 x 1⅓ ft.=155 x 22½=3,488, but divided by 4 again= in wall measure.	872
The total brick in wall measure is	4,568

The main wall above is the easiest part. The actual length is 116 x 8 x 12 in., or 13 in., as it is often called. Here we have 928 sq. ft., and as each square foot is a foot thick, we multiply by 22½, giving a total of 20,880 in wall measure. With the footing this makes 25,448. To get the actual number required, for average sized brick, reduce in the proportion of 16½ actual to 22½ as figured, and the result is 18,662.

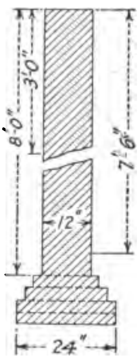
By taking 16½, or 16.5, we find that 11 and 15 can be used to get actual quantities, for 16.5 and 22.5 stand to each other in this relation. By setting the figures to the left it is easy to multiply by 11. Thus,

```
     25,448
    254,48
  ---------
15)279,928(18,662
```

But the brick may be very large and have wide joints so that 15½ would serve; or they may be very small and 19 or 20 be necessary. The average is given at 16½ to 17.

Change.—Had the main wall been only 7 ft. 6 in., as shown on one side, the figures would have been 116 x 7 ft. 6 in., or 870 sq. ft. at 22½= 19,575 in wall measure.

But in this foundation, it will be observed, there are some pilasters—all of which have the accent on the second syllable. They are shown for estimating purposes only. The outside corner



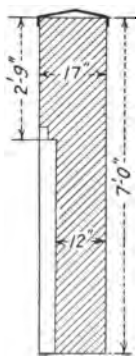


FIG. 2. SECTION OF WALL. FIG. 3. SECTION OF CORNICE.

ones project one course, or 4 in., and are 2 ft. wide. Here, then, we have a "wall" of one brick thick x 4 ft. x 8 ft. high. This is 32 sq. ft. x 7½= 240 brick in wall measure. Really the width is only 3 ft. 8 in. in all, but in such a case the width of both faces is taken. It does not do to get even the actual quantity method "down too fine."

Inside there is one pilaster at 9 in. projection from the wall 2 ft. wide x 8 ft. high, or 8 ft. x 2= 16 sq. ft. at 15 brick=240, again in wall measure. On the other side the pilaster extends 17 in. x 2 ft. wide x 8 ft. high, or 8 x 2 x 30 brick=480 in wall measure.

These pilasters are here figured only to the top of the footings, but, as may be seen, they ought to go further down, especially the last one, which also requires an extended foundation. The principle only is illustrated here.

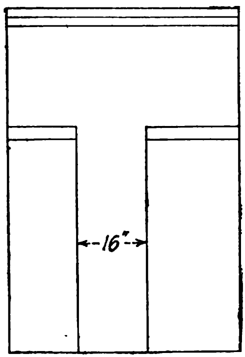


FIG. 4. ELEVATION, SHOWING PILASTER AND CORNICE

There are no openings shown in the plan. If there were, they would have to be deducted under the actual quantity system.

The wall shown in section at Fig. 3, and in elevation at Fig. 4, should be easily figured. In Fig. 3 it is a wall 1 ft. thick x 7 high, by whatever length may be chosen; and on the face of this wall there is another 4 in. thick, or one course, x 2 ft. 9 in. high.

In Fig. 4 the same wall is seen looked at from the front. The pilaster—always with the accent on the second syllable—is 4 in. x 1 ft. 4 in. x whatever the height of the building may be. It is figured as a "wall" put on the front of the main one. The length is not given, but is cut off by the two lines.

The wall is covered with terra cotta wall coping, costing about 35 cents per foot.

Pressed Brick.—If pressed brick are used above grade in Fig. 1, we have to multiply 120 by 3 ft., supposed to be distance above the ground, and then by 6 to 7 to the square foot of the ordinary kind. About 2,200 would be ordered. Openings are deducted unless very small. But brick must also be estimated for the "reveals," or return of the wall into the window or door frames, when these are more than 4 in. back.

Custom.—The old system of measurement is so well known, especially among the "old timers," that the modern one is not much admired. As an illustration of what the old one would do, take the basement of Fig. 1:

The length of the foundation would be girted, and would be 124 x 1¾ x 1=4,878 in wall measure.

The main wall above would be 120 x 8 x 1= 21,600, a total of 26,478. This is about 1,000 more, but in putting in a bid the cost per 1,000 is set a little lower to suit the measurement.

It is when we come to the extras, however, that the two systems part company. The outside pilasters would be measured 4 ft. 8 in. for width; the inside 9 in. one 3 ft. 6 in. instead of 2 ft., for the face and two ends are figured for width; and the large one, 3 ft. 6 in. instead of 2, thus taking in the face and one end. There is no end to the jumble. The full instructions are given in my "New Building Estimator." The best system is to take actual measurements and raise the price instead of the quantity for difficult work.

What has been shown here is a trifle; on some large buildings with many corners, cross walls, pilasters, cornices, panels and angles the difference is serious. Naturally the "customer" objects when the bill is sent in and he finds double measurement. Instead of frankly charging for silk an extra measurement of cotton is put in the bill.

Wages.—Bricklayers' wages run all the way from 50 to 85 cents, and even $1 per hour. This being so, it is not a question of how much a thousand it costs to lay brick, as expressed in dollars, but of how many a bricklayer lays in an hour, and this will give the unit price for the selected locality.

Example 6.—On the extra heavy footings of a large basement each bricklayer laid 400 per hour for an 8-hour day. This made a big day's work that is seldom equaled, and it was in Portland cement mortar. Allowing 1¼ laborers to each bricklayer, with 25 cents per hour for the one and 65 cents for the other, the total is 96¼ cents per hour for 400 brick. The rate is $2.41 per 1,000 for labor. This is the lowest limit on the plainest and heaviest work. Few contractors ever expect it. With 40 and 80 cents wages the rate per 1,000 actual or kiln count, as these figures are, would be $3.25; with 30 and 70 cents, $2.69.

The following table gives actual quantities laid:

TABLE THIRTEEN

Number of Actual Brick Laid by 1 Bricklayer and 1¼ Laborers per Hour

Plain, heavy, common cement work in basement	350 to 400
Heavy engineering work in cement mortar	300
Warehouse common work in half and half mortar, heavy walls above grade	220
Same on 13″ walls	160
Railway shops, manufacturing buildings, 13″ and 17″ high walls 20′ to 40′	120
Stores and Flats not more than 3 stories high. com. brick	130
Stores and Flats with pressed brick and ornamental fronts	90
Heavy walls faced with pressed brick not more than 1 story	160
Veneering	40
Fine pressed brick work with panels, buttresses, projecting brick, etc.	40
Small passenger stations with fair pressed brick	60

Note.—The pressed and common brick are allowed together, as it is easier figuring in this way. The cost of the laborers' wages is included, allowing 1¼ laborer to each bricklayer. Sometimes 2 laborers to 3 tradesmen, or even 4 to 5 is the proportion.

Example 7.—Cost: To arrive now at the cost of common brick let us again take a wall 40 x 10 x 17 in.=12,000 in wall measure. The common way when wages are about 70 cents for tradesmen and 30 cents for laborers is to allow from $3.50 to $4 extra in wall measure on the cost of the brick laid down. Thus brick at $7.50 delivered would be put in the wall for $11.00 to $12.00 per 1,000 wall measure, depending upon the kind of the work. When brick are low in price a higher figure should be used to keep clear of danger; for with a low priced brick there is not so much gain on the difference between wall measure count and actual number used. This difference is required for mortar, profit, etc. Thus, using the figures in the next paragraph, we have 12,000 and 8,800, with 3,200 not required. With $6 brick the contractor has a margin of only $19.20; with $8 brick, $25.60. On a large building this mounts up.

The 12,000 in **wall measure** would at national size require only about 16½ **actual** to the cubic foot instead of 22½. Reducing in the proportion of 15 to 11, we have 8,800. At $7.50 the cost is $66. Further on the mortar allowance is given. Let us now allow a little less than 1 bbl. of lime at 90 cents. If to each barrel of lime there is a quarter barrel of Portland cement, for example, we must add this to the total given below. The cement would probably cost 50 cents, and we should save 25 cents on the lime.

We have then the actual cost without profit as follows:

TABLE FOURTEEN

Detailed Cost of Brickwork

8,800 brick laid down at the building, $7.50 per M	$66.00
8 bbls. of lime delivered@90 cents	7.20
5 cu. yds. sand (½ to ⅝ yd. to M)@$1	5.00
Labor on ordinary stores and flats in common brick 130 per hour=68 hours at $1.07½	73.10
	$151.30

The wages for bricklayers are assumed at 70 cents, and for laborers at 30 cents, with 1¼ to the bricklayer, or 37½ cents.

There are 12,000 in wall measure. Dividing $151.30 by 12 we have an actual cost of $12.61 per 1,000 laid in the wall.

There is no gain with openings or corners under this system, and the figure runs higher than the ordinary price. As a matter of fact a small brick contractor would take such a building for that price and make a profit out of it. The chances are that he would work himself, and that more than 130 brick would be laid. There is water that runs up to a little, insurance, and other incidental expenses. Scaffolding has to be considered also, but the ordinary way is to make no allowance for this, and when the old planks wear out buy new ones.

Example 8.—But if we take the heaviest kind of basement work as given in the first rate of 400 per hour, laid in cement mortar, the total would be changed—and it must be remembered that brick laid in Portland cement means $1 per 1,000 extra. The gain here is owing to the heavy footings and basement walls, and the number laid:

TABLE FIFTEEN

8,800 hard brick at $8 delivered	$70.40
12 bbls. Portland cement at $2	24.00
5 cu. yds. sand	5.00
Labor, 22 hours at $1.07½	23.65
	$123.05

This is a cost price of $10.25 per 1,000 wall measure. But just as a contractor would probably expect his men to lay more than 130 brick each per hour on the other class of work, so he would be inclined to doubt if the rate of 400 per hour would be kept up all through on a large basement, although this record was from actual work done.

The following figures are from actual records. They are made out for 1 bricklayer and 1¼ laborers in 8 hours, and actual or kiln count.

TABLE SIXTEEN

Labor on Brickwork (AB)

Flats, 4 stories with pressed brick	1,200
Four story bldg., 4 fronts, pressed brick	1,240
Heavy walls, ground level, pressed brick	1,450
Heavy footings, warehouse basement walls	3,200
Heavy warehouse work on an average all through	1,800 to 2,000
Plain work on buildings on 13″ and 17″ walls	1,000 to 2,000

To get the rate per 1,000 according to the wages paid allow 1 bricklayer and 1¼ laborers. Thus, if the one is getting 70 cents per hour, and the other 30 cents, we have for the 8 hours a total of $8.60. At 1,200 actual brick in a day the cost for labor alone would be $7.17 per 1,000 kiln count; at 3,200, $2.69.

An Example.—On a 4-story plain building with 750,000 actual brick, and shoved joints, the labor cost \$5.50 per 1,000 kiln count. The wages were 45 cents for bricklayers per hour and 17½ to 20 cents for laborers. The first ran to \$3.50 per 1,000, and the laborers' to \$2. On a basis of 70 cents for masons and 30 cents for laborers the unit price would be \$8.83—which is different from \$5.50. The front was of common brick selected.

On the (AB) buildings already given the pressed brick work ran to 15 or 20 per cent. of the total. On a 13 in. wall it would be ⅓.

TABLE SEVENTEEN

Mortar Allowance Per 1,000 Actual Brick

Portland cement, 1½ bbls. to 1¼.

Best lime, ⅞ bbl.

Mortar color, 50 lbs. to 1,000 brick, ½ in. joints.

Fire clay, 40 lbs. to 100 brick.

Mortar color is priced according to shade. Red is about 1½ cents per pound, and black, 3 cents.

Sand.—Allow ½ to ⅝ yd. for each 1,000 brick.

Fireproofing Work.—This is gone into in "The New Building Estimator," for floors, partitions and ceilings, both tile and reinforced concrete.

Brick Cisterns

They are often built complete for 90 cents a barrel of 32½ gallons. Excavation is included, a 4 in. brick arch, and iron cover, and the hard earth well plastered with Portland cement mortar.

The estimate can be worked out in the usual detailed way; and then we can get the cost of any size.

Let us take one 6 ft. inside diameter x 6 ft. deep from the bottom to the spring of the arch. We shall suppose it is to be as just described—plastered on the hard earth, and holding 40 bbls.

We require a space of 6 ft. 2 in., allowing for about an inch of plaster all around. Looking in a table of areas of circles we see that a 6 ft. diameter has 28.27 sq. ft. Circles are to each other as the square of their diameters. A diameter of 6 ft. is 72 in., and what we need is 74. Squaring 72 we get 5,184; and 74 gives 5,476. Therefore the area we require will be to 28.27 as 5,476 is to 5,184. This is 29.86 or just about 30 sq. ft.

Generally speaking an excavator does not need to figure this up, as he knows what the work costs. Here the principle of getting the area is set forth, for this use and for others also.

Allowing for neck and arch we require a depth of about 8 ft. 3 in. At 30 sq. ft. this gives a total of 9 yds. excavation, which at 50 cents comes to $4.50. But, as we have seen under Excavation, the Chicago rule is to add 75 per cent. extra for holes and pits from 5 to 10 ft. deep. Here the figure is set at 75 cents.

To build the arch and neck should not take a bricklayer and laborer more than 7 hours, but for cleaning up, etc., allow 8. At 70 cents and 30 cents per hour this is $8.00.

For 250 brick at \$7 allow \$1.75; ⅓ bbl. cement, 65 cents; sand, 15 cents; cast iron rim and cover, \$4.

Plastering 20 sq. yds. at 50 cents, \$10, for labor and material.

TABLE EIGHTEEN

Summary of the Cost of a 40 Bbl. Cistern Brick Lined 1 In.

Excavation	\$6.75
Wages	8.00
Material	2.50
Cast iron cover	4.00
Plastering	10.00
Hauling	1.00
Total	\$32.25

For such cisterns the price used to be from \$35 to \$40. There is a profit in the plastering at \$10, and thus \$40 may be considered a reasonable price. This does not include pipe connections to downspouts, or anything of that kind. At the rate of 90 cents per barrel the total would be about \$36. With a brick lining on sides and bottom the figure would have to be raised to suit.

Assume now that a cistern for 100 bbls. is required. This is 3,150 gals. Any diameter may be chosen, and the depth has to be made to correspond. In this case, 9 ft. 6 in. inside size is taken. In the cistern table on page 156 the capacity per foot deep for this diameter is given at 530 gals. A depth of 6 ft. is therefore necessary. This is on the basis that the water comes only to the spring of the arch, although there is room for a good deal between that and the overflow pipe.

Allowing for a brick lining and plaster the total diameter of the excavation has to be 10 ft. 4 in.

For the arch and neck allow 3 ft. 3 in. down from the surface, and 3 in. for the bottom lining of brick, thus making the total depth 9 ft. 6 in.

The area of a circle 10 ft. 4 in. in diameter, or 124 in., as given in the table on page 159 is 84 sq. ft., which multiplied by the depth, and divided by 27, gives approximately 30 cu. yds., which at a unit price of 75 cents per cu. yd. makes the cost of excavation $22.50.

The paving on the bottom, laid flat, may be put at 8 cents per square foot, or $6.72.

To the center of the brick the distance is 10 ft., or 120 in. Looking in the circumference table at 120 the distance around is set at practically 377 inches, or close enough to 31 ft. 6 in. to call it that. This makes 186 sq. ft. of wall lining, which has to be considered.

For the cistern neck and arch an allowance of 80 is sufficient. This with the wall lining makes a total of 266 sq. ft. at 7½ brick for a single lining, or 2,000 brick in wall measure. Laid in Portland cement mortar, as such work should be, at $18 per 1,000, the cost is $36.

Put cover and ring delivered at $4, as before.

The plastering of 30 yds. of wall, and 9 of bottom, at 40 cents per yard, comes to $15.60. The cost is less on brick than on earth.

TABLE NINETEEN

Summary of the Cost of a 100 Bbl. Cistern, Brick Lined 4 In.

Excavation	$22.50
Brick on bottom	6.80
Brick on sides and arch	36.00
Cover	4.00
Plastering	15.60
Hauling	1.00
	$85.90

This would be actual cost without any profit. Of course there should be a margin in the brick and plaster.

Large cisterns holding from 100 to 3,000 bbls. rels are usually built without an arch. A low roof is put over the top. If a solid top is required a slab of expanded metal and concrete is often used.

Cesspools may be figured out in the same way as the above cistern. They are usually deeper, and the labor costs more, especially on excavation. (See Chicago rule.) The labor on brick may be set at from $12 to $17 actual 1,000.

Pointing.—For cleaning and pointing fine fronts allow from 1½ to 3 cents per square foot.

Unloading.—Allow from 40 to 50 cents per 1,000 from the cars to the building when close to the tracks. This at ordinary city rates.

Review

1. An important distinction, not nearly so well known as it ought to be, is made in brick-

work between **wall measure** and **kiln** or **actual count.** What is the difference?

2. What difference is there between trade rules and the actual quantity system?
3. How many brick in wall measure are there in 100 sq. ft. at 13 in. thick, or 12 in., as in some building codes?
4. How are footings figured?
5. How are pilasters and cornices figured?
6. How is a plain pressed brick front figured?
7. Explain how mortar and brick are shoved.
8. How many brick do a bricklayer and 1¼ laborers lay in an hour?
9. There is a danger in estimating brickwork that many are not aware of. What is it?
10. What is required to mix mortar?
11. About how much (a) Portland cement, (b) lime, (c) mortar color, (d) or fire clay are required for 1,000 actual brick? How much (e) sand?
12. Can you make a detailed estimate of a cistern of any size?
13. What items outside of the ordinary estimate ought to be included by brick and other contractors?
14. Is profit, as a rule, included in the calculations throughout this book?
15. What is a constant in brickwork measurement?

CHAPTER IV

Stonework

Measurement.—Take only the actual quantities. Do not allow anything extra for corners, and take out openings. Raise the price a little higher to make up.

Use only cubic feet or yards. It is much better to get accustomed to this system rather than to use cords, although this is the Chicago unit; or perches, which differ so much in various parts of the country. It is dangerous to estimate on perches unless we know how much to allow, but cubic feet and yards are always safe.

Allowances for Rubble.—The proportion of 128 at the quarry to 100 in the wall is allowed. The extra is required for waste. More stone is used on the best work, for the mortar joints are smaller, and there are fewer of them.

Mortar.—Allow 1¾ bbls. of Portland cement and 1 yd. of sand to each 100 cu. ft. of finished wall for a 1 to 4 mixture. For lime mortar use 1½ bbls., and 1 yd. sand for the same amount of wall. If water has to be paid for the cost should be noted. The amount is so small, as a rule, that it is included in the unit price established, just as with brickwork it is put in the $11 per 1,000, or whatever the price may be.

Labor.—A mason and a laborer will lay 3 cu. yds. of ordinary rubble in an 8-hour day; and in some kinds of walls below ground, 5 to 6. One laborer can attend 2 masons if everything is handy, but if much wheeling is required it takes about man to man.

Cost.—Ordinary rubble is laid at from $5.50 to $7 with masons' wages at 60 to 70 cents per hour; coursed rubble, $12 to $14. An ordinary profit is included at these figures. The difference in cost is owing to cheap material, etc. In some sections of the country stone may be had for almost nothing. To get the cost the material must be figured out according to the local standards, and the labor estimated to suit the class of work.

A wall with two exposed faces costs more than one laid against a bank. Thin walls cost a little more per cubic foot than thick ones, especially if there are two faces.

TABLE TWENTY

Cost of (1) Cubic Yard of Ordinary Rubble in Cement

35 cu. ft. of stone delivered at 7c per 100 lbs.	$2.45
½ bbl. Portland cement	.88
¼ cu. yd. sand	.25
Mason 3 hours@70c	2.10
Laborer 3 hours@30c	.90
Water	.02
	$6.60

Same in Lime

35 cu. ft. stone	$2.45
⅓ bbl. lime	.30
¼ yd. sand	.25
Labor and water	3.02
	$6.02

This is actual cost for good work. Good rubble work requires more stone than poor, and less mortar. An allowance of 33 cu. ft. is enough with the best stone. Experience and not the word of the quarryman has to decide this.

Ashlar

Ashlar.—Bedford (Ind.) stone is commonly used for good work from the Atlantic to the Middle West and beyond. For base courses, bands, sills, lintels, and plain trimmings allow 80 cents to $1 more per cubic foot than the material is delivered for at your job. This allows for a stone-cutter's profit.

For the whole front of a building, order the number of square feet from the quarry according to the thickness required, and the quarryman will allow for waste. Rock faced work requires 2 in. more than the thickness specified. This means that a 4 in. facing would really have to be figured at 6 in. for cubical contents. Coursed rock face, 90 cents per square foot. Flagstone, 4 in., 45 cents per square foot; 6 in., 83 cents.

A cutter will finish about 20 sq. ft. of broken ashlar in 8 hours, and 25 of coursed. When saws are used it is cut to thickness and pitched by hand, and a man can then handle about 100 sq. ft. With polished stone sawed, 125 sq ft. can be done. For plain cut stone allow 35 to 40 cents per cubic foot for labor.

Setting.—Allow from 20 to 30 cents per square foot at the thickness of 4 in.; for heavier stone about 5 cents more. Washing and pointing comes to 3 to 4 cents per square foot extra.

Price sills, lintels, steps and coping from $1.60 to $2.00 per cubic foot, unset, depending upon size, quantity, etc.

Cement Stone

Cost.—In general, good cement stonework costs more than common brickwork. A wall faced with a fair quality of pressed brick, and a rock faced cement stone one cost about the same. Where there is no brickyard but plenty of sand, gravel or stone the blocks have the advantage. The danger is that too much sand will be used and too little cement in making them.

Walls are put up complete with 8 in. blocks for 25 to 32 cents per square foot. Some dealers get the cost of a 12 in. wall down near the same figures, pointed and washed.

Each manufacturer usually gives a table of the materials required for his kind of block. With such tables it is possible to get the amount of cement, sand, and gravel or stone for any particular job.

Labor Making Blocks.—One large manufacturer allows 1.7 cents per block 8 in. thick; one owner who used 183,000 blocks in putting up a large factory found that a laborer made 300 in a 10-hour day. He must have been kept tolerably busy. At $2 per day this is only 7/10 cent per block. For making an 8 in., 5 cents seems a small figure; and 7 cents for a 12 in.

With hand mixing 3 men will make 75 8 in. or

50 12 in. blocks with ⅓ openings per day. With a mixer the cost is considerably less.

A standard table gives the cost as follows at factory:

TABLE TWENTY-ONE

Cost of Cement Blocks

	Material	Labor	Total
8 x 32 inch, ⅓ space	10.3	7	17.3 cents
8 x 32 inch, ½ space	7.7	6	13.7 cents
12 x 32 inch, ⅓ space	15.4	10.5	25.9 cents
12 x 32 inch, ½ space	11.6	9	20.6 cents

This is actual cost. The same writer gives the selling cost at 30 cents for 8 in. blocks and 40 cents for 12 in. blocks.

Labor Laying.—This is set at from 5 to 10 cents per block according to size and rate of wages.

Drayage.—For a reasonable distance a charge of from 2 to 5 cents per block is allowed.

Material.—It must not be supposed that blocks are stronger if made of sand and cement only. They require gravel or stone for strength. "A mixture of 1 to 12½ of properly proportioned sand and gravel is, in fact, stronger than 1 to 4, and nearly as strong as 1 to 3, of cement and sand only."

But with face work a finer mixture is required to keep out moisture. Dry slaked, or hydrate lime, is also used for the same purpose. If a richer face than 1 to 2 is used fine cracks are apt to appear. Machine mixed work is best, as it is more uniform than hand mixed.

A mixture of 1 cement to 5 of aggregate is about the poorest that should be used for the body. A safer proportion is 1 to 4.

Water.—Do not mix with too little water. This leaves the blocks too porous.

Data.—A barrel of Portland cement, or 4 sacks, contains 3.8, or, say, 3¾ cu. ft.; weight of material only, 380 lbs.

A cubic yard of sand contains about 7¼ bbls.

A yard of sand and 3⅝ bbls. of cement makes a 2 to 1 mixture.

A yard of sand and gravel and 1½ bbls. of cement makes a 5 to 1 mixture.

The above gives the quantities for face, and also for body of blocks.

An approximate allowance given by one manufacturer is this:

For 100 hollow blocks 8 x 8 x 16 take 2.24 bbls. cement, 0.68 yd. sand, and 1.06 cu. yds. of gravel. This is practically 2¼ bbls. 7/10 yd. of sand, and a yard of gravel or broken stone.

For facing alone, 1 cement to 2 sand, at ⅜ in. thick, allow ¼ bbl. of cement to 100 blocks 8 x 16.

To Find the Number of Blocks Required for a House of Any Dimensions

Find the number of feet around the walls, multiply by 3 and divide by 4. This will give approximately the number required for one course (not taking window or door openings into account). The height of wall, in inches, divided by 8, gives the number of the courses, which when multiplied by the number in one course, gives the number of blocks for the whole building. For example: A building 30 ft. square would be figured as follows: 30 x 30 equals 120 ft. around, times 3, divided by 4, equals 90 blocks in one course, 240 in. high, divided by 8, equals 30 courses. 30 times 90 equals 2,700 blocks.

Review

1. What is the best system of measurement for stonework?
2. About what weight of stone is required for a finished cubic yard of rubble wall?
3. How much mortar is required for 100 cu. ft. of finished rubble wall?
4. How many cubic yards of rubble can a mason and a laborer lay in an 8-hour day?
5. What is the best stone for ashlar?
6. How does the cost of cement stone compare with common brickwork?
7. Are cement blocks stronger or weaker when stone or gravel is added to the cement and sand?
8. Are cement blocks for fine face work made of the same proportions clear through the wall?

CHAPTER V

Plastering

Measurement.—In "The New Building Estimator" tables are printed giving the number of square yards in several thousand rooms of various sizes. This saves the trouble of measuring up plaster in the ordinary way.

The rule here is to get the exact number of square yards and deduct all openings. This is on the basis carried all through this book of dealing only with actual quantities. The price per yard has to be a little higher, depending upon the number of openings in the building.

Kind of Work.—Two coat work is the usual kind, but it is really 3 coat. The first part of the first coat is the one with fiber or hair to make the mortar stick, and the second part is the browning. These 2 coats are put on at the same time without letting the mortar dry, and are known as the first coat in 2-coat work. The last or finish coat is the usual white coat, or probably sand finish.

Three Coat Dry.—With this style of plaster each coat is allowed to dry before the next is put on. This makes excellent work if well done, either by the old lime system or the new hard wall plaster.

Metal Lath Work.—Three coats must be put on this lath, as the first coat has to be thin.

TABLE TWENTY-TWO

Cost of Plaster per Yard with a Profit.

2-coat work on wood lath	34 cents
3-coat dry on wood lath	38 cents
Metal lath work	65 cents

For sand finish add 3 cents per yard.

Wages.—For plasterers 65 cents per hour; for laborers, 35 cents. This is a fair allowance, but some cities list 50 cents for the first, and others, 87½ cents.

Material.—Allow 1,450 to 1,500 wood lath per 100 yds. This is for lath of the standard length of 48 in. to go over 3 spaces. There is also a 32-in. lath that spans 2 spaces. Allow 2,200 of this kind.

For metal lath get the exact number of yards and allow 3 per cent. for waste and laps on ordinary surfaces.

Cost of Lath.—Wood lath costs about 12 cents per yard nailed on; metal, from 23 to 26 cents.

Nails and Staples.—For wood lath at 16 in. centers allow 9 to 10 lbs. of 3d fine nails; at 12 in., 12 to 13 lbs. If the short lath are used a little extra allowance has to be made, for there are more joints.

For metal lath allow 9 lbs. of ¾ in. staples to the 100 yds. of plaster.

TABLE TWENTY-THREE

Hard Wall Plaster Table for 100 Yds.

For 2-coat work on wood lath allow	10 to 10½ sacks
For 3-coat on metal lath	20 to 24 sacks
For 3-coat on wood lath	15 to 16 sacks
For 3-coat on brick or tile	14 to 15 sacks

In the above the quantity required for a white finish is allowed—2 sacks.

The above is for white plaster. If the dark is used on wood lath 1 to 2 extra sacks are required; on metal, 2 to 3.

Finish.—For plaster of Paris finish allow 1 to 1½ sacks to the 100 yds., and a little less than a barrel of lime. When this is done deduct on the allowance of 2 sacks in the table.

TABLE TWENTY-FOUR

For 100 Yds. of Lime Plaster

3½ bbls. lime
1½ to 2 yds. sand
2 bushels hair
100 lbs. plaster of Paris.

Sand.—For metal lath, 2½ to 2¾ cu. yds. to 100 sq. yds. of plaster. For wood lath or brick walls from 1½ to 2 cu. yds. A good average for wood lath is 1¾ cu. yds.

Labor on Lath.—With lathers' wages at 45 cents wood lath costs from 3¼ to 3½ cents per square yard; and metal, 4 to 4½ cents. With 65 cents wages, 5 to 6 cents for wood; and 5½ to 6½ cents for metal.

Labor on Plaster.—On metal lath with wages at 55 and 25 cents per hour the rate of one large building was 4 cents per yard for the first coat, 7 for the second, and 4 for the finish, or 15 cents in all. The proportion of hours ran to 9 for a plasterer and 5 for a laborer. On a wage basis of 75 and 35 cents per hour the rate would be 24 cents per yard, and 6½, 11, and 6½.

Heating.—If this has to be done add from 3 to 4 cents per square yard according to price of coal, etc.

Sackett Board and finish is worth from 35 to 42 cents per yard on the wall; **Compo Board,** 39 cents.

Portland Cement plaster for outside work should be put at $1.25 to $1.75 per square yard, finished complete on metal lath. Some of the metal lath companies have records far lower, but they are not reliable. On a large surface the work is naturally done cheaper than on a small, as in a gable. On masonry or wood lath allow 80 cents to $1 for 2-coat work, and $1.10 to $1.25 for 3-coat.

These prices for outside plaster seem high, but it all depends upon the quality of the work done. About a generation ago the tin roofers began to economize in the quality of their tin. Poorer roofs were given to customers, and in time tin became unpopular. The roofers have repented, and now use good material. A tin roof may be so laid as to last for half a century.

So with stucco and other outside plaster: I have lived in a house with "rough-cast" on it that was probably a hundred years old, for this is an old-new outside covering. I see some buildings only five and ten years old with the outside plaster already worthless. The plasterers have a new and excellent development of their trade in their hands, and in an age when we are often told that the forests are disappearing this is worth much to them, but if they follow the methods of the tin trade they also will have to repent before this outside covering for walls comes back.

Cellar Plaster of Portland cement 1 to 3 sand, on hard earth, 1 in. thick, 55 cents per square yard; ¾, 45. On brick, 45 to 35 actual cost, for 1 to 2.

Review

1. How is plaster measured?
2. How many coats has the ordinary kind of plaster?
3. How many coats does metal lath require?
4. Does sand finish cost less or more than the ordinary white?
5. How many different lengths of wood lath are there?
6. How many wood lath are required for 100 yds. of ordinary work?
7. What is the difference in cost between wood lath and metal lath work?
8. How much sand is required for 100 yds. of plaster (a) on wood lath; (b) on metal lath?
9. How much extra is heating worth per yard?
10. How much per yard is cement plaster worth on the outside?

CHAPTER VI

Woodwork

Profit is not included; add at end of total estimate.

Posts, Girders, and Sills.—These are easily seen, and must be taken off and listed either separately, or so many lineal feet.

If the contractor is sure of getting the contract it is better to take off the exact lengths at first, in shape for the lumber yard; if not, the other method is much easier. Extra long lengths have to be watched on account of higher price.

The usual safe way for beginners is to take off every piece of timber in detail. I did this myself for years, but now I see that it was because I did not know any better. It is a very slow process, and men in the business should never need to do it unless in possession of the signed contract, and to make out the lumber bill. Beginners are apt to get the price per square too high or too low, however, and often feel safer if they get a figure on the lumber, and have the total labor itemized apart from that. On the other hand, the square method is sure to include everything in that square. If for a wall, the studs, sheeting, paper, labor and nails once figured out are sure; while if taken off separately one item might be forgotten. Either method works well with practice.

Square Method.—A square means 100 sq. ft. If the cost of a floor, a side wall, a partition, or a roof is figured out for one square it is only necessary to find the number of squares in the building and multiply by the unit figure. Use $1, for illustration, as the value of a square of some material set in place. If 20 squares are required the total figure is evidently $20. This system saves the time of taking off materials in detail.

Method.—With a plan, the best way is to take off all the lumber and then clear the table before beginning to figure up the cost; but here we can make up the total as we go along.

Floors.—In making up a price per square for joists we have to take them full length, for that is how they are paid for. Thus, we might need joists only 16 ft. 6 in., but we should have to allow at 18 ft. In "The New Building Estimator," where all sizes are detailed out for different centers, 2 x 10 joists are put at $6.80 per square, with lumber at $28, labor at 40 cents per hour, and everything in place, including bridging. When figuring out the tables a space of 22 squares was taken instead of 1, so as to get a fair allowance of doubles for stairs, wall joists, etc. It gives to each square a proportion of all such extras.

The number of feet board measure—which from this time on we shall call B. M.—required per square for 2 x 10 joists set 16 in. centers is 140; and 22 lin. ft. of bridging.

TABLE TWENTY-FIVE

Actual Cost Per Square of 2 x 10 Joists Set 16 In., Lumber, $28; and Labor, 40 and 50 Cents Per Hour

	40c	50c
Lumber 140 ft. B. M.	$3.92	$3.92
Labor	1.12	1.40
Anchors and nails	1.00	1.00
Bridging (including labor)	.76	.90
	$6.80	$7.22

As will be noticed the amount handled for $6.40, a day's wage for 2 carpenters, is 800 ft. B. M. per day. This is at the rate of $8 per 1,000, B. M. on a 40 cents basis.

Local rates of wages have to be used. The price of lumber is much cheaper in Washington or Georgia. The system only is shown, and the change can be made to suit. In the other "Estimator" the difference in cents is given for every dollar rise or fall in the price of lumber. In the above, for example, 16 cents have to be taken. With lumber for joists and bridging at $20 there would have to be a deduction of 16c x 8=$1.28.

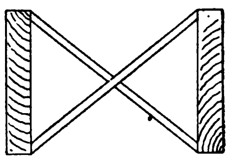


FIG. 5. JOISTS AND BRIDGING

Bridging runs from 70 cents to $1.00 per square, depending upon the kind and the centers of the joists. (See Fig. 5.)

Anchors are from 80 cents to $1.25 per square.

Let us now figure out another size so that any floor may be estimated. A basis of 22 squares will be taken for the sake of the extras. Take a store floor with 2 x 14 joists set 16 in. centers on a 22 ft. span. We have nothing to do with the girder below, but with joists only just now.

The space selected is 22 x 100. There are 75 spaces which require 76 joists. For doubling at stairs, partitions, elevators, wide chimneys, etc., an allowance of 7 extras is given all through the tables. Some floors would not require that many; others would need more. All we can take is an average.

This makes a total of 83 joists 2 x 14 x 22= 4,261 ft. B. M.

The allowance for bridging given in the table is 620 lin. ft. Roughly, 3 ft. to the foot is ample, and gives some material that is often used for other purposes, such as braces, ladders, etc. Joist lumber is put at $30 for this size.

TABLE TWENTY-SIX

Detailed Cost of 22 Squares

4,261 ft. B. M. at $30	$127.83
Anchors for store, $1.25 per square	27.50
Nails	.75
Labor on joists, $8 per M at 40c per hour	34.09
Bridging, 2 x 4, 660 lin. ft., 413 B. M. at $24	9.91
Bridging, labor at $30	12.39
	$212.47

Divided by 22 this gives a cost of $9.66 per square. The other "Estimator" table is $9.55.

The trifling difference is due to another allowance for anchors, or bridging.

On a frame building there would be no anchors required, but an extra allowance for spikes.

Change of Wage Rate.—The table is made out on a basis of 40 cents per hour for a carpenter, and 800 ft. B. M. handled by two men in a day of 8 hours. Their wage is $6.40. At the same rate it costs $8 to handle 1,000 ft. But $8 on a 40-cent basis would be $10 if 50 cents were paid.

TABLE TWENTY-SEVEN

Detailed Cost of 22 Squares

4,621 ft. B. M. at $30	$127.83
Anchors	27.50
Nails	.75
Labor on joists at $10	42.61
413 ft. B. M. of bridging at $24 (lumber)	9.91
413 ft. B. M., labor at $38	15.70
	$224.30

Dividing by 22 we find the cost of a square on this basis is $10.20. (But see main table of Carpenter Labor for bridging time, as it makes a difference when 1 in. material is used.)

Labor on Posts, Sills, and Girders.—When the lumber is all taken off the best way is to lump everything together at so much per 1,000—heavy timbers, joists, studs, sheeting, and all plain material. There is a distinction between heavy timbers, and joists, and light boards. There is often framing on the one and none on the other; but once an average is struck over a building less time is taken when the whole thing is lumped, and the method is just as safe for ordinary work.

But when work is taken by the square as above, the timbers have to be attended to separately. The following figures will give a fair idea of the cost, but on such work as cutting for joists in sills there might be considerable difference in results achieved by gangs. Wages for carpenters are put at 40 and 50 cents per hour.

On one building the oak posts and yellow pine bolted girders were put in place at the rate of 270 ft. B. M. in an 8-hour day by 2 men. They had to be dressed. This is the best kind of work that is apt to be called for in a warehouse. This is near $24 per 1,000 at 40 cents, but the timbers were comparatively light. Heavier ones would have been done at a cheaper rate, for the same chamfering would have served. On the 50-cent basis the figure is $30.

On ordinary work half that price is sufficient, if there is a reasonable quantity to be put into place, under fair conditions.

On sills for a frame house cut for joists at 16 in. centers and laid in place allow $30 and $38 per 1,000 B. M. For 12 in. centers, $36 and $45. In an ordinary sill for a house of the average size there are only about 500 ft. It is hard to set a price for such work, as bay windows and angles change the figures considerably. The above prices ought to do the sills with the most angles on a 40 and 50 cents per hour wage.

If the sill is not cut for the joists, it should not cost more than half of the price given.

It has often happened that contractors have lost money on account of cold weather that makes it hard for men to do a day's work.

TABLE TWENTY-EIGHT

Allowances Per Square for Material

Sheeting, 8", laid straight, 116 ft. B. M.
Sheeting, 8", laid on angle, 130 ft. B. M.
Sheeting, on roofs, plain and cut up, 120 to 140 ft. B. M.
Sheeting, on roofs, open joints, no extra.
Shiplap, add 10 per cent. to above allowances.
Plank, 2", double above allowances.

TABLE TWENTY-NINE

Flooring, Ceiling, Etc.

For 6" (5¼ face)	⅙ extra	For 2" (1¾ face)	5/12 extra
For 4" (3¼ face)	¼ extra	For 6" square edged	⅙ extra
For 3" (2¼ face)	⅓ extra	For 4" square edged	⅕ extra

(Compare the Ferge Tables as to flooring, etc.)

Sheeting, shiplap, flooring and milled stuff require an extra allowance to make up for ripping and matching.

Angle work requires more material if joists are close than if wide, for usually more joints are necessary. One building might require 7 per cent. for this waste, and another 10.

Building Paper is worth from 30 to 50 cents on the wall per square, according to quality. This does not include the expensive kinds.

TABLE THIRTY

Labor on Covering for 2 Men in 8 Hours

Sheeting	1,000 ft. B. M.
Shiplap	1,000 ft. B. M.
Both above on angle,	800 to 850 ft. B. M.
6" flooring, ⅞,	5 squares
4" flooring, ⅞ ,	3 squares
2¼" flooring, ⅞,	2 to 2½ squares
2 x 6" floorng, on floors,	1,500 to 2,000 ft. B. M.
2 x 6" flooring, on high roofs,	1,000 ft. B. M.

On joists the figure per square for labor can be easily found. On the 2 x 14, 16 in. centers already given, for instance, the cost is, at 40 cents, $1.55 per square, not including bridging. But if this method is followed the centers must be watched. At 12 in. the cost would be $2.05. At a 50-cent rate, $1.94 and $2.56.

On the maple flooring above the kind of work has to be considered. I have seen 2 men work hard and lay less than a square in a day. With a small room and crooked material no progress is made.

In the following figures, compiled from the data in my "New Building Estimator," labor is put at 40 and 50 cents per hour for an 8-hour day. The B. M. quantity is made out for one man and not for two, as elsewhere in the book; but the rate per 1,000 being given the cost is easily seen and changed to suit local prices.

If the rate per hour is 60 cents add the difference between 40 and 50 to the latter; if 45 or 55 take half. Thus No. 1 at 40 cents per hour gives $11.50 per 1000 ft. B. M.; at 50 cents, $14.50, or a difference of $2.90. At 60 cents the figure would thus be $17.40 per 1,000. A difference of 5 cents per hour would be $1.45 per 1,000 ft. B. M., up or down.

With No. 2 we have $8.50 and $10.65. For a 10 cents difference per hour this gives $2.15, and $1.08 for each 5 cents.

It is again worth while to add the caution that these are cost figures without profit.

TABLE THIRTY-ONE

Carpenter Labor

Description	Ft. B.M.	Cost per M 40c	Cost per M 50c
1. A block of (6) 2-story and basement flats, first story veneered with brick, rest covered with slate, with towers, dormers, and bays; all lumber	275	$11.60	$14.50
2. Same if with plain fronts	375	8.50	10.65
3. Two-story and basement brick schoolhouse, no flooring	400	8.00	10.00
4. Three-story business building	475	6.75	8.45
5. Heavy warehouse, mill construction	550	5.80	7.25
6. Plain 2-story warehouse, 2″ flooring on roof, and plank under floors, all lumber except ⅞ upper floors	385	8.30	10.40
7. A 6-story building with 3 x 14 x 22′ joists, and covered with sheeting—all lumber on first 3 floors	550	5.80	7.25
8. On 4th and 5th floors of same building with more framing to do, material hoisted with steam	400	8.00	10.00
9. Joists, including sizing on an electric light building (on above Nos. 7, 8 joists came sized)	400	8.00	10.00
10. Plank floor in a warehouse	500	6.40	8.00
11. Bridging, 2 x 4	150	21.30	26.65
12. Bridging, 1 x 4 or 1 x 3	75	42.60	53.20
13. Sleepers, 6 x 8 on 4 ft. centers, laid in sand in a shop 150 x 400′	750	4.25	5.30
14. Plank floor on above sleepers 3″	1000	3.20	4.00
15. Purlins on roof of same building,	400	8.00	10.00
	to		
60 ft. high	530	6.00	7.50
16. Plank flooring on same purlins, 2″	460	7.00	8.75
17. Sheeting for floors	800	4.00	5.00
	to		
	1000	3.20	4.00
18. Sheeting for roof of 6-story bldg.	500	6.40	8.00
19. Sheeting on frame buildings	500	5 40	8.00
" " " "	700	4.50	5.75
(If sheeting is laid diagonally add 15 to 20 per cent. to labor.)			
20. Rafters for plain gable roof, 2 x 6	300	10.70	13.40
21. Rafters for hip roof, 2 x 6	125	25.60	32.00
22. Roof boards on plain gable roof	600	5.35	6.70

Description	Ft. B.M.	Cost per M 40c	50c
23. Roof boards on hip roof	400	8.00	10.00
24. Studding, 2 x 4	250	12.80	16.00
25. Studding, 2 x 6	350	9.15	11.45
26. Sill and plates, plain 6 x 8	320	10.00	12.50
27. Sill gained for joists at 16" centers	107	30.00	37.50
28. Warehouse platform on posts with heavy girders and joists	400	8.00	10.00
	to		
	500	6.40	8.00
29. Board fence, 1750 ft. long, 8 high, 2 x 4 rails and sheeting—posts already in place	360	8.90	11.15

TABLE THIRTY-TWO

Labor on Floors

Description	Squares	Cost per sq.	
30. Yellow pine, 3¼ face, laid on sheeting, putting down paper, smoothing joints only	2	1.60	2.00
31. Same all through a 6-story bldg., but well smoothed and sandpapered	1¾	1.80	2.25
32. Same laid on bare joists, no smoothing	3	1.10	1.35
33. Square edged 3½ x ⅞ maple on large shop bldg.	2¼	1.40	1.75
34. Y. P. 3¼ face in warehouse	2½	1.30	1.65
35. Y. P. x 3¼ cut in between base, well smoothed and sandpapered	1½	2.15	2.70
36. Same in small rooms	1¼	2.60	3.25
(No quarter round used on 35 and 36)			
37. Maple tongued and grooved, warehouse, 2¼ face, no smoothing	2	1.60	2.00
38. For houses and offices, well smoothed 2¼	1	3.20	4.00
39. Same 1¾ face x ⅞	¾	4.30	5.40
40. Smoothing old maple by hand	1	3.20	4.00
41. Oak, best work, glued, smoothed and well laid with border	¼	12.80	16.00
42. Y. P. on under floor, 5¼ face, no smoothing	2½	1.30	1.65
43. Same laid on bare joists	3½	.90	1.15
44. Same on plain pitched roof	2	1.60	2.00

TABLE THIRTY-THREE

Labor on Ceiling, Wainscoting, and Siding

Description	Squares	Cost per sq.	
45. Wood ceiling on stores	1½	2.15	2.70
46. Wainscoting on schoolrooms, walls, 3′ high complete	1¾	1.80	2.25
47. Plain 6″ siding	2¼	1.40	1.75
48. Drop siding with casings and corners nailed on face	3½	.90	1.15
49. Same with joints butted against casings and corner bds.	2½	1.30	1.65

TABLE THIRTY-FOUR

Shingling: Labor

50.			
Plain roof	2½	1.30	1.65
Fancy roof	1¾	1.80	2.25
Plain side walls	1½	2.15	2.70
Difficult side walls	1	3.20	4.00

TABLE THIRTY-FIVE

Labor on Base

51. Description	Lin. ft. per man for 8 hours	Cost per lin. ft. in cents 40c	50c
In a bldg. with many pilasters y. p.	50	6½	8
3-member hardwood, average number of miters	50	6½	8
On 6-story bldg. scribed to floor, one piece only, y. p.	80	4	5
On 4-story bldg., birch, 1 piece, no fitting to floor which was cut in between	100	3¼	4
Plain quarter round base	100	3¼	4

TABLE THIRTY-SIX

Labor on Doors, Windows, and Blinds

52.	Time*	Cost of each 40c	50c
Window frames putting together on bldg.	1½	$0.60	$0.75
Window finishing complete, pine, frame bldg., plainest kind	5	2.00	2.50
Same in oak, plain	6½	2.60	3.25
Same in pine brick bldg., plain	6½	2.60	3.25

* Hours on each for 1 man.

	Time*	Cost of each 40c	50c
Same in oak brick bldg., plain	9	3.60	4.50
30-light, 10 x 14, no inside finish	7	2.80	3.50
60-light, 10 x 14, no inside finish	10	4.00	5.00
Transom fixed	1	.40	.50
Transom hung	1	.80	1.00
Door complete, including grounds, common style with transom	10	4.00	5.00
Door, birch, no transom	7	2.80	3.50
Door, pine, no transom, common 1⅜	5	2.00	2.50
Door, swinging, pine, no hardware except hinges	4	1.60	2.00
Door, pine, schoolhouse, high, wide panel jambs, inside, transom	10	4.00	5.00
Same in hardwood	13	5.20	6.50
Pair of sliding doors complete, no framing of partitions, pine	32	12.80	16.00
Same in oak	48	19.20	24.00
Pair outside doors, pine, 6 x 8 complete	10	4.00	5.00
Same in oak	14	5.60	7.00
Railroad shop double doors, 12′ 8″ x 18′ 4″	32	12.80	16.00
Sliding barn doors, 12 x 18, single	18	7.20	9.00
Outside blinds, if fitted before frames are set, per pair	¾	.30	.40
Same after frames are set	1	.40	.50
Plain inside blinds, pine	3	1.20	1.50
Same, hardwood	5	2.00	2.50

* Hours on each for 1 man.

TABLE THIRTY-SEVEN

Shelving and Sideboards: Labor

A large quantity of shelving in a storeroom ran to only 8 ft. per hour for 1 man. At least 12 should be done. This is on the basis of dadoing in small compartments. Ordinary shelving can be put in at the rate of 30 ft. in an hour.

53.

	Cost of each 40c	50c
Sideboard, ash, millwork in knock down, 8′ x 8′	$52.00	$65.00
Sideboard, oak, not so elaborate as first	40.00	50.00
Sideboard, pine	25.00	31.25
Sideboard, fine	80.00	100.00

TABLE THIRTY-EIGHT

Labor on Stairs

54.	Cost of each	
Two flights on schoolhouse 6′ wide, y. p. plain	$26.00	$32.50
Three flights, oak, 5′ wide, good stairs	94.00	117.50
Three flights, oak, 4′ wide, better quality	120.00	150.00
Box stairs, 1 flight, pine	10.00	12.50
Box stairs for cellar or attic with winders	11.00	13.75
Plain stairs for a 6 to 8 room house, pine	25.00	31.50
Same for a 9 room house in oak	40.00	50.00

The following useful tables were supplied me by Mr. Henry Ferge, contractor, Milwaukee. It will be noticed that there is no allowance for extra joists, or anything of that kind, but the exact amount is given. Thus, in a room 10 x 10 we need 11 joists at 12 in. centers, but there are only 10 in the table. Therefore allow doubles where required, as under partitions, at stairs and chimneys, and other extras. No labor is included, but material only. Allow labor at $8 to $10 on joists, for a 40 cents per hour rate; and $10 to $12.50 for 50 cents per hour. Quantities are given. Thus, a square of 2 x 10 set 20 in. centers has exactly 100 ft. board measure (B. M.) in it. A building 20 x 100, inside sizes, with 2 x 10 joists set 20 inches on centers would have 2,000 ft. B. M. But the joists would have to be longer to rest on the walls, and 22 is the next size. This means really 22 squares, so far as cost of lumber is concerned, or 2,200 ft. B. M. It is thus easy to get the exact number of feet for any size of building, but whatever extras are required for doubling, etc., have to be added. Prices are given from the lowest likely to be used to the highest.

TABLE THIRTY-NINE

Quantity and Price Per Square of Lumber

PIECE-STUFF=12" CENTERS — *NET-AMOUNTS*

Size	No. Feet in 100 Sq. Ft.	$22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.
1 x 2	16⅔	.37	.39	.40	.42	.44	.45	.47	.48	.50	.52	.54	.55	.57	.59
2 x 2	33⅓	.73	.77	.80	.83	.86	.90	.93	.97	1.00	1.03	1.07	1.10	1.13	1.17
2 x 4	66⅔	1.47	1.53	1.60	1.67	1.73	1.80	1.86	1.93	2.00	2.07	2.13	2.20	2.27	2.33
2 x 6	100	2.20	2.30	2.40	2.50	2.60	2.70	2.80	2.90	3.00	3.10	3.20	3.30	3.40	3.50
2 x 8	133⅓	2.93	3.07	3.20	3.33	3.47	3.60	3.73	3.87	4.00	4.13	4.27	4.40	4.53	4.67
2 x 10	166⅔	3.67	3.83	4.00	4.17	4.33	4.50	4.67	4.83	5.00	5.17	5.33	5.50	5.67	5.83
2 x 12	200	4.40	4.60	4.80	5.00	5.20	5.40	5.60	5.80	6.00	6.20	6.40	6.60	6.80	7.00
2 x 14	233⅓	5.13	5.37	5.60	5.83	6.07	6.30	6.53	6.77	7.00	7.23	7.47	7.70	7.93	8.17
3 x 10	250	5.50	5.75	6.00	6.25	6.50	6.75	7.00	7.25	7.50	7.75	8.00	8.25	8.50	8.75
3 x 12	300	6.60	6.90	7.20	7.50	7.80	8.10	8.40	8.70	9.00	9.30	9.60	9.90	10.20	10.50
3 x 14	350	7.70	8.05	8.40	8.75	9.10	9.45	9.80	10.15	10.50	10.85	11.20	11.55	11.90	12.25

PIECE-STUFF=16" CENTERS — *NET-AMOUNTS*

Size	Sq. Ft.	$22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.
1 x 2	12½	.28	.29	.30	.31	.33	.34	.35	.36	.38	.39	.40	.41	.42	.43
2 x 2	25	.55	.58	.60	.63	.65	.68	.70	.73	.75	.78	.80	.83	.85	.88
2 x 4	50	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50	1.55	1.60	1.65	1.70	1.75
2 x 6	75	1.65	1.73	1.80	1.88	1.95	2.03	2.10	2.18	2.25	2.33	2.40	2.48	2.55	2.63
2 x 8	100	2.20	2.30	2.40	2.50	2.60	2.70	2.80	2.90	3.00	3.10	3.20	3.30	3.40	3.50
2 x 10	125	2.75	2.88	3.00	3.13	3.25	3.38	3.50	3.63	3.75	3.88	4.00	4.13	4.25	4.38
2 x 12	150	3.30	3.45	3.60	3.75	3.90	4.05	4.20	4.35	4.50	4.65	4.80	4.95	5.10	5.25
2 x 14	175	3.85	4.03	4.20	4.38	4.55	4.73	4.90	5.08	5.25	5.43	5.60	5.78	5.95	6.13
3 x 10	187½	4.13	4.31	4.50	4.69	4.88	5.06	5.25	5.44	5.63	5.81	6.00	6.19	6.38	6.56
3 x 12	225	4.95	5.18	5.40	5.63	5.85	6.08	6.30	6.53	6.75	6.98	7.20	7.43	7.65	7.87
3 x 14	262½	5.78	6.04	6.30	6.56	6.83	7.09	7.35	7.61	7.88	8.14	8.40	8.66	8.93	9.19

TABLE THIRTY-NINE—*Continued*

Quantity and Price Per Square of Lumber

PIECE-STUFF=20" CENTERS — *NET-AMOUNTS*

Size	No. Feet in 100 Sq. Ft.	$22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.
2 x 4	40	.88	.92	.96	1.00	1.04	1.08	1.12	1.16	1.20	1.24	1.28	1.32	1.36	1.40
2 x 6	60	1.32	1.38	1.44	1.50	1.56	1.62	1.68	1.74	1.80	1.86	1.92	1.98	2.04	2.10
2 x 8	80	1.76	1.84	1.92	2.00	2.08	2.16	2.24	2.32	2.40	2.48	2.56	2.64	2.72	2.80
2 x 10	100	2.20	2.30	2.40	2.50	2.60	2.70	2.80	2.90	3.00	3.10	3.20	3.30	3.40	3.50
2 x 12	120	2.64	2.76	2.88	3.00	3.12	3.24	3.36	3.48	3.60	3.72	3.84	3.96	4.08	4.20
2 x 14	140	3.08	3.22	3.36	3.50	3.64	3.78	3.92	4.06	4.20	4.34	4.48	4.62	4.76	4.90

BOARDS & EDGED STUFF

Boards Size	Sq. Ft.	$22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.
1 inch	105	2.31	2.42	2.52	2.63	2.73	2.84	2.94	3.05	3.15	3.26	3.36	3.47	3.57	3.68
Plank															
2 inch	210	4.62	4.83	5.04	5.25	5.46	5.67	5.88	6.09	6.30	6.51	6.72	6.93	7.14	7.35
3 inch	315	6.93	7.25	7.56	7.88	8.19	8.51	8.82	9.14	9.45	9.77	10.08	10.40	10.71	11.03
Edged															
1 x 3	114	2.51	2.62	2.74	2.85	2.97	3.08	3.19	3.31	3.42	3.54	3.65	3.76	3.88	3.99
1 x 4	112	2.46	2.58	2.69	2.80	2.91	3.02	3.14	3.25	3.36	3.47	3.58	3.70	3.81	3.92
1 x 6	107	2.35	2.46	2.57	2.68	2.78	2.89	3.00	3.10	3.21	3.32	3.42	3.53	3.64	3.75
1 x 8	105	2.31	2.42	2.52	2.63	2.73	2.84	2.94	3.05	3.15	3.26	3.36	3.47	3.57	3.68
2 x 6	214	4.71	4.92	5.14	5.35	5.56	5.78	5.99	6.21	6.42	6.63	6.85	7.06	7.27	7.49
2 x 8	210	4.62	4.83	5.04	5.25	5.46	5.67	5.88	6.09	6.30	6.51	6.72	6.93	7.14	7.35
3 x 6	320	7.04	7.36	7.68	8.00	8.32	8.64	8.96	9.28	9.60	9.92	10.24	10.56	10.88	11.20
3 x 8	315	6.93	7.25	7.56	7.88	8.19	8.51	8.80	9.14	9.46	9.77	10.08	10.40	10.71	11.03
3 x 10	312	6.86	7.18	7.49	7.80	8.11	8.42	8.74	9.05	9.36	9.67	9.98	10.30	10.61	10.92
4 x 8	420	9.24	9.66	10.08	10.50	10.92	11.34	11.76	12.18	12.60	13.02	13.44	13.86	14.28	14.70

TABLE THIRTY-NINE—*Continued*

Quantity and Price Per Square of Lumber

MATCHED-FLOORING — *NET-AMOUNTS*

Size	No. Feet in 100 Sq. Ft.	$22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.
1 x 2	146	3.21	3.36	3.50	3.65	3.80	3.94	4.09	4.23	4.38	4.53	4.67	4.82	4.96	5.11
1 x 2¾	138	3.04	3.17	3.31	3.45	3.59	3.73	3.86	4.00	4.14	4.28	4.42	4.55	4.69	4.83
1 x 3	134	2.95	3.08	3.22	3.35	3.48	3.62	3.75	3.89	4.02	4.15	4.29	4.42	4.56	4.69
1 x 4	124	2.73	2.85	2.98	3.10	3.22	3.35	3.47	3.60	3.72	3.84	3.97	4.09	4.22	4.34
1 x 6	115	2.53	2.65	2.76	2.88	2.99	3.11	3.22	3.34	3.45	3.57	3.68	3.80	3.91	4.03
1 x 8	111	2.44	2.55	2.66	2.78	2.89	3.00	3.11	3.22	3.33	3.44	3.55	3.66	3.77	3.89
2 x 4	247	5.43	5.68	5.93	6.18	6.42	6.67	6.92	7.16	7.41	7.66	7.90	8.15	8.40	8.65
2 x 6	230	5.06	5.29	5.52	5.75	5.98	6.21	6.44	6.67	6.90	7.13	7.36	7.59	7.82	8.05
2 x 8	221	4.86	5.08	5.30	5.53	5.75	5.97	6.19	6.41	6.63	6.85	7.07	7.29	7.51	7.73
2 x 10	212	4.66	4.88	5.09	5.30	5.51	5.72	5.94	6.15	6.36	6.57	6.78	7.00	7.21	7.42
3 x 6	345	7.59	7.94	8.28	8.63	8.97	9.32	9.66	10.01	10.35	10.70	11.04	11.39	11.73	12.08
3 x 8	332	7.30	7.64	7.97	8.30	8.63	8.96	9.30	9.63	9.96	10.29	10.62	10.96	11.29	11.62
3 x 10	318	7.00	7.31	7.63	7.95	8.27	8.59	8.90	9.22	9.54	9.86	10.18	10.49	10.81	11.13

SIDING

Inch-to Weather		$22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.
4¾"	127	2.79	2.92	3.05	3.18	3.30	3.45	3.56	3.68	3.81	3.94	4.06	4.19	4.32	4.45
4½"	134	2.95	3.08	3.22	3.35	3.48	3.62	3.75	3.89	4.02	4.15	4.29	4.42	4.56	4.69
2¾"	146	3.21	3.36	3.50	3.65	3.80	3.94	4.09	4.23	4.38	4.53	4.67	4.82	4.96	5.11
2½"	160	3.52	3.68	3.84	4.00	4.16	4.32	4.48	4.64	4.80	4.96	5.12	5.28	5.44	5.60

Note.—If material in these tables costs more than the rate of $35 the new total is easily found by simple proportion or by doubling. At $70 the total would be twice the $35 figure; and if $23, for example, costs $5.08 for a square, then $43 would run to $9.50.

See Index for joists, flooring, siding, etc., to get labor on tables, and allow anchors, nails and profit at the end of the final estimate.

Backward.—We have been anticipating a little, and putting down the oak floors, as it were, before the roof is on, but the idea was to put all the large tables together. We can now go back to the joists. The ordinary floor ones may be priced as already shown, but we have to consider ceiling joists, collar beams and such special members. If there is a good sized span of them the price can be figured out as for the floor joists. Or the lineal feet may be taken, and the lumber bill estimated.

There is a table in "The New Building Estimator" made out on the 22 square basis. Quoting from that we find as follows:

TABLE FORTY

Lineal Feet of Joists to the Square

At 12″ centers	108	At 20″ centers	68
At 16″ centers	83	At 24″ centers	58
At 18″ centers	75		

From this table the number of feet B. M. may easily be obtained according to size. For example, there might be 10 squares of collar beams, 2 x 4 set 16 in. centers. That would make up 830 lin. ft., or 554 ft. B. M.

	40 cents	50 cents
Lumber, 554 ft. at $24	$13.30	$13.30
Labor at $12 and $15	6.65	8.31
Nails	.20	.20
	$20.15	$21.81

This is a cost price without anchors or profit of $2.02 at a 40-cent rate; and $2.18 for 50 cents per hour. But it is for the plainest work.

With short cuts, angles and fitting the labor might easily be 50 to 100 per cent. higher. Nevertheless, no matter if the most difficult work was figured on this basis, some one would have a lower bid. It often seems that frame houses are taken at $1 a day for the contractor.

Sleepers.—The supports for the floor in the basement are joists, in a sense. The amount per day is set at 400 ft. B. M. for 2 x 4 stuff, and 1,000 for 6 x 8. This is for two men in an 8-hour day. But, as often happens, we have to qualify: In some cellars and basements 400 ft. would have to be cut in two.

The other side of the question comes with the 6 x 8's. We put them down on a shop 150 x 400 ft. at the rate of 1,500 to 1,600 ft. B. M. per day for two men, while only 1,000 is given above. But it is not often that a floor of such size and straightness has to be laid, and a small one could not be handled so quickly. Both with light and heavy sleepers the surroundings have to be considered, and a "gamble" made at the number of feet that can be put in place.

Walls.—By looking back at the labor table it will be noticed that No. 1 was put up at the rate of 550 ft. for 2 men in a day. This takes in all lumber. Possibly 600 might be done; and other contracts carried through in cold weather might total up only 450. For a general guide to walls, etc., this will serve. But with the square method we have to take the walls by themselves.

Studs.—Some of the difference in bids on frame houses would be done away with if all had to make solid corners around walls and ceilings. This takes lumber, and also labor. It is cheaper to let the lath run through.

On partitions it takes about a stud to the foot, when set at 16 in. centers, and plates besides. On walls, not quite so many are needed, but more than is generally allowed. The easiest way to figure 2 x 4 studs on outside walls, set 16 in. centers, is to get the exact surface of the wall in square feet, including gables, and everything else, and then allow 4/5 of that in Board Measure, for studs, plates, and ribbon strip, complete. Some go so far as to say that the whole surface should be considered covered with boarding, which should then be reduced to 2 x 4's. For ordinary work 4/5 will be enough.

Example.—Take a house measuring 124 ft. around the walls, and 22 ft. from the top of the sill to the top of the wall plate. The area is 2,728 sq. ft. Assuming that gables and dormers have 300 sq. ft. of walls, the total is 3,028 sq. ft., or 30.3 squares. Allowing 4/5 for studs gives 80 ft.

TABLE FORTY-ONE

Cost of a Square of 2″ x 4″ Studs, at 16″ Centers

	40 cents	50 cents
80 ft. B. M. at $24	$1.92	$1.92
Nails	.15	.15
Labor at $15 and $18.75	1.20	1.50
	$3.27	$3.57

This figure does not include any sill.

Average.—On some long plain walls a figure of $12 per 1,000 on a 40-cent rate is enough, and $15.00 at 50 cents; on the cut-up kind with bay windows, stair extensions, and projections at all corners, the cost might be $20 to $30 per 1,000. It should be remembered all through that on No. 1 with towers and dormers the cost per 1,000 for labor on a 40-cent basis was $11.60, but this was not for studding alone. All lumber was included. At 50 cents per hour the figure is $14.50.

If a wall is set at 12 in. centers the allowance should be increased in the proportion of 3 to 4. But this style can be handled a little easier, as there is less moving around. There is also a slight decrease with plates.

But there is a word of caution required here: The figures given above for wall studs, and for rafters and partitions farther on, are merely for the plainest work under the best conditions. As a matter of fact, the cost is so small in comparison to the total carpentry that one can allow a better price of the framework without getting far out of the way.

When I made valuations of all kinds of railroad buildings for the State Railway Commission of

Nebraska, and there was so much detail I had to follow the square method most of the time, except on the large and heavy shop structures. When I came to walls, roofs, and partitions I allowed a much larger unit price than is given here, especially on cut-up work.

I sent in valuations for over $5,000,000 worth of structures.

For a wall with 2 x 6 studs the figures should be increased about 45 per cent. The nailing is practically the same as for a 2 x 4 one, the ribbon strip is the same, and the material does not require quite 50 per cent. more time to handle it. When we come to sheeting, paper, siding, and paint the cost is the same for both.

TABLE FORTY-TWO

Cost of (1) Square of Wall with 2 x 4 Studs Set 16 In. Centers

	40 cents	50 cents
116 ft. B. M. sheeting at I27	$3.14	$3.14
Nails	.10	.10
Labor at $8 and $10, plain work	.93	1.16
Paper	.35	.35
Siding, 6", at $35 (120 ft.)	4.20	4.20
Siding, nails	.10	.10
Siding, labor with corner boards	2.13	2.67
Studding at 16" centers	3.27	3.57
	$14.22	$15.29

Changes.—If prices are different it is easy to fill in the figures to suit. If 4 in. siding is used the quantity may be found from the tables already given. The labor on the 4 in. is worth about $1 per square more than on the 6 in., and this is on the basis of corner boards above. If mitered corners are used add $1 more for labor on either style. If there are many corners this might not be enough. If sheeting is angled allow as already set down; if 2 x 6 studs are used, add for them. A really good frame wall is expensive. Paint is not included above.

Roofs

Method.—I have wasted a good deal of time in taking off roof areas in the common way of figuring each slope from the roof plan or the elevations. The roof plan is safer, as each plane can be seen and marked off. Much time and drudgery will be saved by using the method described below.

But the first thing in taking up a plan is to decide what the estimate is for—whether merely for a bid or with the certainty of getting the contract. If one is sure of the job, it is best to take the actual lengths of all dimension lumber and be done with it. If for a bid, the quicker method should be followed. Of course, here as all through a building, if any extra long lengths are required a special note has to be made to raise the price. For the ordinary roof, 12, 14, 16 and 18 ft. lengths suit, and the price is reasonable.

Rule to Get Area of Roof

Get the exact number of square feet over the walls and add percentages as follows:

For ½ pitch, 42%	For ⅜ pitch, 25%
For ⅓ pitch, 20%	For ⅝ pitch, 60%
For ¼ pitch, 12%	For ¾ pitch, 80%

Pitch.—The pitch of a roof is taken thus: A house 24 ft. wide over the walls and with a ridge 12 ft. high above the level of the wall plates, is said to have a half pitch; with 8 ft. of a rise the pitch is a third; with 6 ft. a fourth, and so on.

No matter how many slopes there are, or what is the size of them, the rule will hold.

If the projections are all regular on the main roof they can be taken in as well, to begin with, only they are sometimes not regular. The projections of the dormers or anything that cuts through the roof cannot be included. The main roof can be taken in one operation by measuring out to the level of the eaves, or the "plan," and also the overhang on the end.

The reason all through is that the slope on a certain pitch, no matter what, will cover a certain area on the level. Thus 100 sq. ft. on the level needs on a ½ pitch slope 142 sq. ft. to roof it over. This is a valuable rule to any builder, and it is always safe. Why trouble taking off areas in the old and slow way?

If there is a deck the area of the roof can be deducted in the proportion of 142 roof to 100 deck on a ½ pitch.

Example.—Suppose we have a plan 40 x 22 ft., and an L extension, 8 x 16 ft. The area is 1,008 sq. ft. The area of the roof strictly plumb with the outside of the walls will be for ½ pitch, 1,432 sq. ft.; for ⅓, 1,210; for ¼, 1,129; for ¾, 1,815. Add projections. But now let us take a ½ pitch to illustrate the deck area.

If there is a deck on this house 7 x 8 ft., that means 56 ft. on the level and, in the required proportion, 80 sq. ft. on the rake. Therefore 80 must be deducted from the shingle or slate surface before adding the projections.

Example 2.—But take again, a building 60 x 24 ft., with a ½ pitch roof. Assume that the cornice projects 2 ft. on the level over the side walls, and also over the gables. The total area on the plan would be 64 x 28, or 1,792 sq. ft. Adding 753 sq. ft., for the 42 per cent., makes the total roof area 2,545 sq. ft., or 25½ squares, as it would be figured. This includes all offsets, gables, and angles, even on a cut-up roof, but does not include projections of dormers, etc., because a double roof is used there—the one projecting over the walls of the dormer, and the main roof directly below, running in to the walls. In other words, this system, for any pitch, will include the total surface **once,** clear out to the edge of the cornice all around, regardless of shape of plan, **but will not take in any duplications.**

Any pitch of a roof may be treated in the same way. Find out how much on the rake 12 in. on the level needs, and arrange in the required proportion. A carpenter sees that when he sets up a square and finds that from 12 to 12, which is a ½ pitch, the distance is 17; and 142 is to 100 as 17 is to 12. Of course, fractions are not given nor required. The length from 12 to 12 is really 16.97, but all carpenters use 17 in.

The Figs. 6 to 10 will help some to understand the principle better. Fig. 6 represents the plan of the plain ordinary roof on a house with a gable at each end. The house inside of the dotted line is 26 x 30, or 780 sq. ft. But the cornice projects 2 ft. at each end, and also the same on the level at the eaves—on the level, not the rake. This makes the entire roof 30 x 34 looking down upon it from above, or in plan, as it is said. The total area is therefore 1,020 sq. ft. Adding 42 per cent.

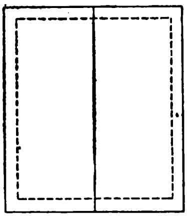
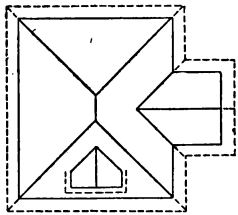


FIG. 6. PLAN OF ROOF



FIGS 7. PLAN OF ROOF

for a ½ pitch we get 1,448 for the complete roof. By the square root method the total is 1,442. No one expects mathematical exactness in taking off such areas. The method given above is much more exact than the detailed one is likely to be. Of course, on such a plain roof the best way is just to measure the length of the sides and multiply by the 34 ft.

On the third pitch we have to add 20 per cent., or 204 sq. ft., making in all 1,224. We get the same figures by square root.

On the fourth pitch we add 12 per cent., or 122 sq. ft., equals in all an area of 1,142 sq. ft. The square root total is 1,139.

Fig. 8 shows the three pitches.

Coming to Fig. 7 we see the advantage of this method of taking off areas. It is not really required on such a roof as shown in Fig. 6. In this plan the building line is shown solid, and the

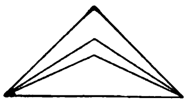


FIG. 8. PITCHES

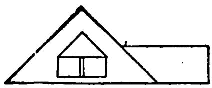


FIG. 9. ELEVATION

projections are dotted. The dotted projection at the dormer shows why all such duplications have to be added extra. The main roof directly below the dormer projections is necessarily included in the first total, and when a roof above a roof is built it has to be added extra. Fig. 10 shows this

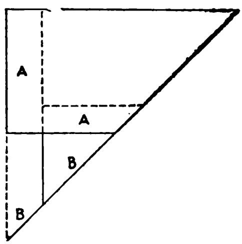


FIG. 10. SIDE ELEVATION

at A and B. The slopes at B are taken in by the first main estimate, for 42 per cent.—in the case of a ½ pitch roof—is added for all the area, and therefore the dormer projections at Fig. 10 must be included in addition.

Fig. 7 shows the same plan, 26 x 30 inside the wall line, and 30 x 34 over the cornice. There is also an L, 8 x 12 wall line, and 8 x 16 over the cornice. Fig. 9 shows the elevation without the cornice. A contractor taking off the area for a ½ pitch, as shown here, and following the foregoing method, would simply multiply 30 x 34=1,020, and add 8 x 16=128, making a total of 1,148, plus 42 per cent. for the rise, 482 sq. ft., equals in all, 1,630 sq. ft. Adding 36 ft. for a narrow cornice at the dormer the roof area for this pitch is 1,666.

Change of Pitch.—But some roofs have a regular pitch almost down to the wall plate, and then change to a flatter one, and for this reason it is sometimes better to estimate the area strictly to the wall line and add the projections of the main and dormer cornices separately. This is especially the case with wide cornices, if they are not regular in pitch.

TABLE FORTY-THREE.

Board Measure to Square of Roof for 2 x 4 Rafters

12″ centers 81 ft.	20″ centers 51 ft.
16″ centers 68 ft.	24″ centers 41 ft.
18″ centers 58 ft.	

The table includes rafters only—no ties or anything else. It is made out for ordinary roofs to save the trouble of taking off the lumber. If the 40 slope kind are being figured, the best way is to suppose the entire roof covered with board measure. There is a good deal of waste in this kind. The plainest plan really requires only half the area covered with board measure for 2 x 4 set 16 in. centers. There is no doubling of studs for corners or openings, no wall plates doubled, and no solid corners for lath, as in a wall.

TABLE FORTY-FOUR

Cost of a Square of Roofing

	40 cents	50 cents
2" x 4" set 16", 68 ft. B. M., at $24	$1.63	$1.63
Nails	.15	.15
Labor at $18 and $22.50	1.23	1.53
	$3.01	$3.31

This is for a plain ordinary roof. The one with 40 slopes cost $6 per square for rafters only, but they were 2 x 6. This would put the 2 x 4 style at $4, and this shows that there is a difference between roofs. It must be remembered that this is for rafters only.

Extras.—Collar beams, ties, and such members have to be added. Allow at $15 and $20 per 1,000.

TABLE FORTY-FIVE

Shingle Quantities per Square

At 4"	to weather	990 and	1012
At 4½"	to weather	880 and	900
At 5"	to weather	790 and	800

The first allowance is for the plainest roofs; the second for cut-up ones. There are many qualities of wood shingles, and two thicknesses—the ordinary one of 6 to 2 in. at butt, and the 5 to 2 in.

TABLE FORTY-SIX

Cost of Roof Per Square

	40 cents	50 cents
2" x 4" rafters, as per table	$3.01	$3.31
116 sheathing at $27	3.14	3.14
Nails	.15	.15
Labor at $10 and $12	1.16	1.40
Wood Shingles, 880 at $5 per M	4.40	4.40
Labor (2 squares in 8 hours, 1 man)	1.60	2.00
Nails, galvanized or zinc coated	.20	.20
	$13.66	$14.60

This is for a plain roof, and without profit. Instead of $3.31 for the rafters a figure of $4 is not so very high. A house 30 x 30 over the walls has about 17 squares on a ½ pitch; this makes a difference of only $12 on the entire rafters.

On the roofs of 40 slopes the labor would run from 50 to 75 per cent. more than on the $3.31 roof. Change for any other roof covering.

Partitions

Take off the lineal feet from the plan, and check each one with a light pencil mark to show that it is included; or take them the long way of the building first and then the short way.

Reduce the lumber to board measure, one stud to the foot, for 16 in. centers, and add the labor at from $8 to $10 on a 40-cent basis, and $10 to $12 at 50 cents per hour wages, depending upon the angles, etc.

Example.—Take a partition 100 ft. x 10. There would be 100 studs 2 x 4 x 10, and 200 lineal for plates on an ordinary partition, not supporting joists. This is a total in B. M. of 800 ft.

TABLE FORTY-SEVEN
Cost of Ten Squares of Partition

	40 cents	50 cents
800 ft. B. M. at $24	$19.20	$19.20
Nails, 20 lbs.	.60	.60
Labor at $9 and $11	7.20	8.80
	$27.00	$28.60

This is $2.70 and $2.86 per square. Some common partitions would cost less. With long straight stretches, $7 to $9 would be enough for labor. Much depends upon the quality of the work. When doubling is done, openings trussed, corners made solid, and base nailings put in, it takes much more time to put up a partition than when the work is done in the way we see too often.

Grounds.—Allow 2½ cents per lineal foot for labor and material on wood studs; and 4 cents for brick. For wainscoting allow from 3½ to 4 squares per 8-hour day for 2 men for labor, when the plugging is done in masonry. On wood, 5 squares can be done.

Furring.—For 1 x 2 set on 16 in. centers allow 4 squares per day for 2 men. On ceilings, 1 x 2, 12 to 15 squares; 2 x 2, 10 to 12. The lumber is easily figured at whatever centers it is at. On the 1 x 2 allow 10 per cent. for waste, unless the material is sound.

Porches.—Some take them by the square feet, and others take off the lumber in the usual way. Whichever way is adopted it is best to put the plain work in with the rest of the house, and then make an extra allowance for the special work in a lump. A contractor who has had some experience among porches can make a good guess at how long it will take to put on the extras.

On one 6 x 22 ft. without rail 2 men worked 5 days, but this included making all the posts, and getting out the cornice lumber. The floor was already in place. This porch was of the plainest description.

On another 6 x 30 ft. the time was 7 days. The square paneled posts on it were made by hand.

Figure up everything that can be figured, and then guess at the rest.

Cornice.—It used to be that a fair width was 2 ft.; now we have 4 ft. Before deciding how long a time is required the width must be first settled on.

For the ordinary cheap cornice, known from the Atlantic to the Pacific, set the labor for 2 men at 40 to 50 lin. ft. in an 8-hour day. For the wide ones, take off the ceiling underneath and allow 2 squares per day for 2 men. If above the rafters, take ⅔ of the flooring time. By detailing out the work in this way a fair idea of the hours can be arrived at.

Smoothing Floors by Machines.—In the tables the time is given for this work by hand. Here, we shall say a little about the machines.

There are two kinds—hand power, and motor or gasoline driven. The hand power ones for 1 man can clean from 6 to 10 squares per day; the others from 20 to 30. A lower rate should be figured on: From 2 to 3 cents per square foot for machines.

The hand machines cost about $50; the others from $200 to $600.

Pantries.—There are many different rooms and fittings known under this name. Allow from 1 to 4 days for 2 men.

China Closets from 2 to 6 days. Neither on pantries nor china closets can any guess be made without knowing what the details are.

Cost of a Sun Parlor 8 x 12 Ft.

Sun parlors are often built against the side of an existing house, and only 3 new walls are needed. This one is figured on such a basis. The door is supposed to be already in place, and is therefore not allowed. If a new door is required it must be added to the total. For the door, jambs, casings, hardware, labor and painting at least $12 would have to be allowed; and such a door might be chosen as would cost $60. If the studs came in the right place a day would be enough to cut out the opening, and another to put in new studs, trim up the siding for the jambs, and make all secure. But there might be so much plaster knocked off as would mean patching, and an entire room to be repapered. Say, $12 for door, and $8 for cutting wall.

The parlor is supposed to stand out 8 ft. from the house, and the 12 ft. run the long way. On each side two full hung windows are put in, and four on the front.

TABLE FORTY-EIGHT

Detailed Estimate of Cost of Sun Parlor

Excavation, 6 yds. at 40 cents		$2.40
Brick, 2400@$12		28.80
Sill, 6 x 6 x 28=84 ft. $25 and $25 (Material and Labor per M)		4.20
5 joists 2 x 8 x 12 40 lin. ft. 2x4 plate 24 lin. ft. 1x4 bridging, 115′	$24 & $11 (M. & L. per M)	4.03
Shiplap for angle under floor, 120 ft., $24 and $6		3.60
50 lbs. tar paper and laying		1.20
13 studs 2 x 4 x 10 150 lin. ft. plate 2 x 4 80 lin. ft. studs, 2 x 4, 240 ft.	$24 and $12	8.64
1 square of 2 x 4 ceiling joists		2.00

Detailed Cost—Continued

1.8 sqs. of roof, rafters, sheeting, shingles, $14	25.20
64 sq. ft. of ceiling soffit, 80 ft. B. M. $35	6.00
36 lin. ft. of cornice	7.20
180 ft. B. M. sheeting on walls $24 and $6	5.40
30 lin. ft. outside base and watertable	3.00
30 lin. ft. window sill and mold below	3.00
30 lin. ft. window lintel band	1.50
2 pr. corner bds., and 2 half cor. bds., $3 and $2	5.00
85 sq. ft. flooring	9.00
8 window frames and sash for oil finish	48.00
8 sides of finish for same	6.00
Labor on above	16.00
40 ft. of picture mold	1.20
40 ft. lin. of base	4.00
Furring old wall	2.00
Plastering, inside, 35 yds. at 40 cents	14.00
Painting, including floor, but no plaster	14.00
Hardware for windows, etc.	10.10
Plastering, outside, on expanded metal lath, 18 yds.	23.50
	$258.97

After allowing a profit one might say that $300 is about right. It seems a high price. I have built a little cottage for $500, with a shingle roof, three or four rooms with pantry, set on a light brick foundation, plastered, painted and finished. We became so accustomed to low prices that we are still astonished at the present high ones. Lumber was $15 instead of $25 and up, carpenters' wages were 30 cents instead of 45 to 55 cents and bricklayers got 35 to 40 cents instead of 65 to 80 cents.

In order to keep down the total the 40-cent rate of wages per hour is used, as much of this work is done in country towns and in the South, where wages are lower than in northern cities, but even thus "cut to the bone" we see a higher price than is desirable. If masons, plasterers, carpenters, painters and others get the highest wages, what then? The labor might be increased from 50 to 75 per cent.

But that is not all for this modern luxury—we still require fly screens. I like the ones that cover the entire window. Unpainted, the cost is about 8 cents per square foot delivered. Each window would cost $3.50 or $28.00 additional to the total.

Electric light or gas would also have to be extended. With a "stylish" fixture this means more money. If a rug is bought to correspond another dip is made in the bank account.

Then the finish of the old room has to be considered if a new opening is cut. It may be that the style of casings, etc., is not now sold, and a special running has to be made.

A yellow pine floor was figured. If an oak one is wanted, that means more expense. If pressed brick are put on the outside the cost has to be added. So on it goes. A plasterer and painter, for example, have to make two or three attacks on this little fort, for they have to wait till their work dries. Thus their price has to be higher per yard than for a large building.

Putting the cost at $300 this is $3.13 per square foot of floor, and 76 cents per square foot of wall surface. It would be the easiest thing in the world to make even such a small parlor cost $400 at city rates of wages now. The cornice might be run over 4 ft. instead of 2, and oak floors, pressed brick, plate glass, and shades to match would do the rest. Our modern high prices are discouraging; customers think they are robbed, but contractors know better.

Enclosing Porches.—This method of getting a sun parlor is becoming very fashionable. It is a good plan. It really makes a new room.

The old style porch is too narrow for this room. At least 6 ft. is required, and 8 ft. is much better. Many porches are now built 10 ft. wide.

One of the great advantages of square hollow posts is that they can be used for window boxes without change.

Let us assume that we have a porch 8 ft. wide by 21 ft. long with 8 in. square posts on the corners and one in the center. How much will it cost to enclose it with glass?

On the ends we can use 2 full windows, and on the front 3 to a space. The door space has to be divided differently. We can put in a sash and a door.

TABLE FORTY-NINE

Cost of Enclosing a Porch 8 x 21 Ft. with Glass

36 ft. of continuous sill 2 x 10	$3.00
72 ft. mold below same	1.00
36 ft. lin. plain band on inside below sill	.60
2 square door posts	4.00
9 window frames and sash complete, with stops, oil finish	50.00
1 glass door with transom, tr. bar, and stops	6.00
6 ft. porch rail at sides of door	2.40
100 ft. B. M. ceiling for present rail on outside	3.60
Hardware for doors, windows, etc.	12.00
Painting new work only	15.00
Carpenter labor complete	36.00
Profit	26.40
	$160.00

The rail is supposed to be in place, but open. We have to ceil it up.

The carpenter labor and profit are too low, but such work is often done by a carpenter himself, who makes wages out of it at a lower price, but the owner has to watch that no helpers are hired. In case of accident or death this might mean a verdict of $5,000 to $40,000. In my "Contractors' and Builders' Handbook" there are several of that size noted. The owner is held liable as well as the carpenter who employs the men.

The cost per square foot of wall is about 54 cents in this case, and $1 per square foot of floor. A much larger surface is obtained for less money than on the sun parlor. Electric light and screens are not included.

Review

1. Why do extra long timbers have to be listed separately?
2. What is the safest way of estimating labor on ordinary lumber?
3. Name another system.
4. What labor time is required on the various parts of woodwork in a building?
5. An important difference is made between the actual surface covered, and the amount ordered from the lumber yard or mill? Why is this?
6. If a space is 21 ft 4 in. what length has to be ordered for a joist?
7. What are solid corners in walls, partitions, ceilings, etc.?

8. How is the area of roofs found? Is there a short rule for this?
9. Can the number of feet in board measure be approximately determined for rafters?
10. What is board measure?
11. How many shingles are required to a square?
12. What is a square in building measurement?
13. Which is the better way of smoothing floors?
14. State the cost of a sun parlor, and the length of a string.
15. Is liability insurance now more necessary than ever in building work?
16. Should the labor figures in this chapter ever be changed?
17. Where should profit be put in an estimate?
18. What decides the "pitch" of a roof?

CHAPTER VII

Millwork and Glass

The estimator should have a millbook and a discount sheet. Most wholesale dealers hand out books to contractors. The mail order houses also send out catalogs and price lists.

Glass.—The prices of some selected lights are given here. They are without putty, and unset. S. S. means single strength, and D. S. double strength.

TABLE FIFTY

Glass Prices

Size	Price S.S.
8 x 12	5 cents
10 x 18	10 cents
10 x 24	13 cents
12 x 16	10 cents
12 x 24	17 cents
12 x 32	24 cents
14 x 16	12 cents
14 x 30	27 cents

Size	Price S.S.	Price D.S.
16 x 20	$0.18	$0.26
16 x 30	.31	.46
18 x 32	.36	.53
18 x 52	.68	.95
20 x 36	.50	.71
26 x 28	.50	.71
30 x 36	.78	1.09
32 x 40	1.03	1.39
36 x 36	1.03	1.39
40 x 40		1.66
44 x 46		2.48
48 x 52		3.90
50 x 54		4.91

Setting.—About 20,000 lights on large railroad shops were set for the low price of 1½ cents each. The man who set them supplied no material, like putty or points. For every 25 lin. ft. of putty allow ¼ lb.

Plate glass is set for about one-tenth of cost. For a single light of glass 50 cents might be required for labor setting. Then, it might be several miles away from the shop. It is more than the actual cost that has to be considered.

Plate.—Cost of a plate 10 x 24 is 50 cents; 10 x 72, $2.53; 36 x 72, $9.51; 48 x 48, $8.27; 60 x 96, $22.00, all unset—say, 55 cents per square foot on average sizes.

Leaded Glass.—Common, no color, from 50 cents to $1.00 per square foot; leaded beveled plate from $1.50 to $3.

Plain Wire Glass 20 to 23 cents per square foot; polished wire like plate, 60 cents on small sizes to $1.25 on large.

Ribbed Skylight 10 to 15 cents per square foot, ¼ in. thick.

TABLE FIFTY-ONE

Sand Blast Art Lace Designs

22 x 58 to 20 x 56	each, $2.25
20 x 42 to 24 x 46	each, 2.00
22 x 30 to 28 x 34	each, 1.75

Geometric Chipped and Ground Glass

Per square foot	45 cents

Colored and Fancy Glass

Chipped, single process, per sq. ft.	15 cents
Chipped, double process, per sq. ft.	18 cents
Rolled Cathedral, per sq. ft.	18 cents

Radiant, per sq. ft.	25 cents
Maze, per sq. ft.	18 cents
Moss or Syenite, per sq. ft.	18 cents
Ondoyant or Riffled, per sq. ft.	18 cents
Irridescent, per sq. ft.	25 cents

Enamel Glass

Semi-Obscure, per sq. ft.	20 cents
Full-Obscure, per sq. ft.	25 cents

TABLE FIFTY-TWO

Sash Prices

(For Cellars, Attics, Transoms, etc.)

The ordinary sash come glazed single strength. The size is given over all, and not the glass size. The thickness is 1⅜; for 1¾ add 75 per cent. of the open price.

ONE LIGHT

Size	Open	Glazed
30 x 16	$0.26	$0.55
32 x 20	.32	.70
34 x 24	.45	1.10
42 x 20	.47	1.15
34 x 36	.60	2.55 D.S.
40 x 44	1.00	3.20 D.S.

TWO LIGHT

Size	Open	Glazed
48 x 14	$0.53	$0.95
54 x 20	.65	1.50
60 x 24	.75	1.85
66 x 18	.75	1.70
66 x 30	.87	2.55 D.S.
72 x 34	1.10	3.40 D.S.

TABLE FIFTY-THREE

Cost of Ordinary Check Rail Windows

2-Light, 1⅜, No Frames

Size	Open	Glazed	
16 x 30	$0.50	$1.00 S.S.	$1.40 D.S.
18 x 40	.75	1.90 and	2.45 D.S.

22 x 48........	1.05	.... 2.85 and	3.60 D.S.
26 x 30........	.55	.... 1.50 and	1.95 D.S.
28 x 36........	.65	.... 1.95 and	2.55 D.S.
28 x 48........	1.15	.... 3.80 and	4.80 D.S.
30 x 50........	1.25	.... 3.85 and	4.90 D.S.
34 x 36........	1.00	....	4.30 D.S.
36 x 50........	1.65	....	7.55 D.S.

TABLE FIFTY-FOUR

4-Light, as above

Size	Open	Glazed	
10 x 16........	$0.40	........$0.75 S.S.	
12 x 24........	.47	.... 1.05 S.S.	
12 x 48........	1.15	.... 2.85 S.S.	
14 x 32........	.65	.... 1.55 and	$2.30 D.S.
15 x 34........	.80	.... 2.25 and	3.05 D.S.
15 x 48........	1.25	.... 3.65 and	4.80 D.S.

TABLE FIFTY-FIVE

8-Light, as above

Size	Open	Glazed	
9 x 12........	$0.45	........$0.85 S.S.	
10 x 20........	.80	.... 1.80 S.S.	
12 x 14........	.55	.... 1.12 and	$1.45 D.S.
14 x 24........	1.20	.... 2.90 S.S.	

For 1¾ add 75 per cent. of the price of the open 1⅜ window to either open or glazed, but 10 per cent. additional to the total for a glazed window. For oil finish work add 20 per cent. to the total.

Example.—A 16 x 30, 2-lt., 1⅜ is listed above at $1 glazed. For an open 1¾ add 75 per cent. of the open 1⅜, which is 37½ cents. Allowing 38, the amount is 88 cents open, $1.38, plus 10 per cent. (14 cents, in even figures), $1.52, for 1¾ glazed. For oil finish add 30 cents, $1.82. "Oil finish" means left "in the white," ready for painter. Ordinary sash get one coat of paint at mill. They would not suit an "oil finish" job.

TABLE FIFTY-SIX

Special Cottage Front Check Rail Windows, 1⅜ In. Thick, Bottom Plain D. S.

O. S. Measure	3-8x5-2 40 x 16 40 x 40	3-8x5-6 40 x 16 40 x 44	3-8x5-10 40 x 16 40 x 48	3-8x6-2 40 x 16 40 x 52	4-0x5-2 44 x 16 44 x 40	4-0x5-6 44 x 16 44 x 44	4-0x5-10 44 x 16 44 x 48	4-0x6-2 44 x 16 44 x 52	4-0x6-6 44 x 16 44 x 56
1.	4.00	4.20	4.40	5.00	4.50	4.70	5.50	5.70	6.00
2.	4.50	4.80	5.10	5.50	5.00	5.30	6.00	6.30	6.60
3.	6.00	6.30	6.60	7.00	6.90	7.20	7.70	8.20	8.50
4.	6.50	6.80	7.10	7.60	7.40	7.70	8.30	8.90	9.20
5.	3.65	3.90	4.10	4.60	4.00	4.30	4.85	5.30	5.50
6.	3.65	3.90	4.10	4.60	4.00	4.30	4.85	5.30	5.50
7.	3.65	3.90	4.10	4.60	4.00	4.30	4.85	5.30	5.50
8.	3.80	4.00	4.20	4.70	4.10	4.40	5.00	5.40	5.70
9.	3.80	4.00	4.20	4.70	4.10	4.40	5.00	5.40	5.70
10.	9.30	9.50	9.80	10.20	10.40	10.80	11.30	11.80	12.00
11.	7.80	8.00	8.20	8.80	9.00	9.30	9.70	10.00	10.30
For Bottom Plate Add	4.25	4.50	5.00	5.00	4.50	5.00	5.00	5.25	5.75

For 1¾ inches thick add 60 cents. For Single Sash add 10 cents.

The above openings may be filled in the regular way with 2 hung sash to an opening, or the whole window may be in one piece with a division bar in place of the check rail. The single sash style costs from 10 to 15 cents more than the usual style. (Table 56.)

In all cases the large light is plain D. S. glass. If plate is wanted add as noted.

The variation in price is owing to the style of finish usually in the upper sash. Thus, Nos. 1 and 2 have leaded glass divided into 57 pieces, the first one straight and the second curved; 3 and 4 have art glass; 5, 6, 7, 8, 9, have lace glass; 10 and 11 have beveled plate set in lead. The prices are for sash only, and not for frames.

TABLE FIFTY-SEVEN

Window Frames, 1⅛ Casings, 1⅜ Sash (Not nailed together)

Opening	Price	Box Frames
2—4⅛ x 5—8 and under	$1.65	$2.35
2—8⅛ x 8—8 and under	2.15	3.00
3—0⅛ x 5—8 and under	1.85	2.50
3—6⅛ x 8—8 and under	2.25	3.10
4—8⅛ x 6—8 and under	2.20	3.10
6—0⅛ x 8—8 and under	2.65	3.80

Window frames are nailed together at the mill for about 30 cents each. Elsewhere allow 60 cents for a frame building, and 80 cents for a box window.

If the sash are 1¾ instead of the standard thickness of 1⅜ add from 15 to 25 cents per window, for the frames only.

No pulleys are included with the frames. The plainest kind cost 25 cents per frame at the mill; but much more if set by hand.

Plain drip caps are figured. If molded ones are wanted add 20 cents.

TABLE FIFTY-EIGHT

Complete Cost of a Plain Window

1 Window frame for 1⅜ sash	$1.73
Extra for 1¾ plain drip cap frame	.15
Extra for 1⅛ outside casings	.15
Extra for ordinary pulleys and setting at mill	.25
Nailing frame together at mill	.25
Sash, 1⅜	3.28
Sash, extra for 1¾	.97
Sash, extra for oil finish, 20 per cent.	.85
Inside casings, stool, apron, and stops	1.00
Hardware complete	1.00
Carpenter labor complete, 5 hours@50c	2.50
	$12.13

Data.—A window, 2-lt., 32 x 36, D. S., is given. Profit is not allowed here any more than anywhere else unless stated. For a box frame the difference would have to be added. Pine sash are allowed.

Storm Sash are the same price as the 1⅜ windows to which they correspond in size—that is, the one storm sash, 1⅛ thick, costs the same as the two sash 1⅜.

Cost of Doors

For ordinary doors a square foot price is given below that will serve if the regular millbook is not at hand; there are 40 "extras" in the millbooks, and they must be consulted for the various styles and finishes.

OG, 4-panel, 1⅜, 17 to 18 cents per square foot; 20 cents for the largest.

OG, 4-panel, 1¾, 26 to 28 cents; largest, 30 to 35 cents.

OG, 5-panel, 1⅜, 16 to 18 cents; largest, 20 to 22 cents.

OG, 5-panel, 1¾, 26 to 27 cents; largest, 30 to 35 cents.

Doors with raised moldings one side, 35 cents; both sides, 40 cents.

TABLE FIFTY-NINE

Cost of Special Doors

Made-to-Order Veneered Doors

Net prices per square foot surface measure, not over 2 in. thick, flat panels, either four panel, five panel, or five cross panel, Cove and Bead, or O. G. Sticking, or flush molded.

Note.—No door figured as containing less than 17½ square feet.

White Pine (for paint) Yellow Pine Cypress Plain Oak Unselected Birch Ash Maple	Bracket No. 1. Per sq. ft...30c.
Red Birch Quarter Sawed Red Oak Sycamore Sawed White Maple White Pine (for oil)	Bracket No. 2. Per sq. ft...37c.
Quarter Sawed White Oak Quarter Sawed Sycamore	Bracket No. 3. Per sq. ft...40c.

Curly Yellow Pine Curly Birch Cherry Walnut	Bracket No. 4. Per sq. ft...55c.
Curly Maple Birds Eye Maple Mahogany	Bracket No. 5. Per sq. ft...70c

All veneered doors are made with flat panels unless otherwise specified.

TABLE SIXTY

Veneered Door Extras

For raised panels add....per panel..............	.15
For doors over two inches thick, for each ¼ inch, add	$0.50 net.
For doors over 3 feet 6 inches wide, for each 6 inches, add..................................	.50 net.
For doors over 8 feet high, for each additional 6 inches, add..................................	.30 net.
For doors, veneered with two kinds of wood, figure at price of more expensive wood used, and add..................................	.50 net.

For Extra Panels Over 5		For Front Door Astragal	
To Bracket No. 1....	$0.10	To Bracket No. 1....	$0.60
To Bracket No. 2....	.15	To Bracket No. 2....	.75
To Bracket No. 3....	.20	To Bracket No. 3....	1.00
To Bracket No. 4....	.25	To Bracket No. 4....	1.10
To Bracket No. 5....	.35	To Bracket No. 5....	1.25

For Raised Molding

Add per Panel

Bracket No. 1, molded one side.....................	$0.20
Bracket No. 1, molded two sides....................	.30
Bracket No. 2, molded one side.....................	.22
Bracket No. 2, molded two sides....................	.32
Bracket No. 3, molded one side.....................	.25
Bracket No. 3, molded two sides....................	.35
Bracket No. 4, molded one side.....................	.27
Bracket No. 4, molded two sides....................	.37
Bracket No. 5, molded one side.....................	.30
Bracket No. 5, molded two sides....................	.40

TABLE SIXTY-ONE

Veneered Doors
Unselected Birch and Plain Red Oak
Six Cross Panels, Cove and Bead

	Birch.	Oak.
2-0 x 6-8 1⅜, to 2-6 x 6-6	$2.40	$3.00
2-0 x 6-8 1⅜, to 2-8 x 6-8	2.50	3.10
2-0 x 7-0 1⅜, to 2-6 x 7-0	2.90	3.60
2-8 x 7-0 1⅜	3.00	3.80
3-0 x 7-0 1⅜	3.20	4.00
2-8 x 6-8 1¾	2.90	3.60
2-4 x 7-0 1¾, to 2-6 x 7-0	3.40	4.10
2-8 x 7-0 1¾	3.50	4.20
2-10 x 7-0 1¾, to 3-0 x 7-0	3.60	4.40
2-6 x 7-6 1¾	3.80	4.60
2-8 x 7-6 1¾	3.90	4.80
3-0 x 7-6 1¾	4.20	5.10

Sash Door Open

	Birch.	Oak.
2-8 x 6-8 1¾	3.10	3.80
2-8 x 7-0 1¾	3.70	4.40
3-0 x 7-0 1¾	3.80	4.60

TABLE SIXTY-TWO

Detailed Cost of an Inside Door

1 set pine door jambs for a 6″ partition	$0.63
Stops	.15
2 sets casings and plinth blocks	.90
1 door 2′ 8″ x 6′ 8″ x 1⅜, 4-pan y. p.	2.60
Extra for ordinary oil finish work	.40
Hardware complete	1.25
Carpenter labor, 6 hours@50c	3.00
	$8.93

If there is a transom the bar has to be added at, say, 30 cents, and the extra allowed for length of jambs; also the sash; and $1 for labor.

This is only for a fair door; from $10 the cost might run to $50 and up.

TABLE SIXTY-THREE

Hardwood Flooring

Maple

3/8 x 1 1/2 and 2 in. face, clear	$50.00
13/16 x 2 1/4 in. face, clear	70.00
13/16 x 2 1/4 in. face, selected	60.00
13/16 x 2 1/4 in. face, factory	38.00

Plain Red Oak

3/8 x 2 in. face, clear	52.00
13/16 x 2 1/4 in. face, clear	68.00
13/16 x 2 1/4 in. face, selected	56.00

Plain White Oak

3/8 x 2 in. face, select	50.00
13/16 x 2 1/4 in. face, clear	68.00

Quartered Red Oak

3/8 x 1 1/2 and 2 in. face, clear	67.00
13/16 x 2 1/4 in. face, clear	95.00

Quartered White Oak

3/8 x 1 1/2 and 2 in. face, clear	67.00
13/16 x 1 1/2 and 2 1/4 in. face, clear	105.00

Birch Flooring

Clear red 3/8 x 1 1/2 and 2 in.	50.00
13/16 x 2 1/4 in.	70.00

Casings in stock patterns $36 to $38 per 1,000 ft. B. M., or 1,000 ft. board measure, for those who forget.

Base, 8 in. and 10 in., yellow pine, $40 per 1,000 ft. B. M.

Stair Newels, ordinary patterns, $3 to $6 in yellow pine; $1 extra for oak. From this the price might run to $50.

Stairs.—The prices of the various parts of a stair are now given per step.

For a figure set complete allow per step for the average pine stair, one side against the wall, and a rail on the other, $3.50 to $4.00. For the same in oak, $5 to $7. Some oak stairs would cost double; and others several times as much.

For the millwork part alone, allow for a pine box stair of the average width, $1.40 per step; in plain oak, $2.10. For an open pine stair of the same width, $1.75 to $2.00; in plain oak, $2.30 to $2.60. Add, if there is a paneled string, 75 cents per step.

Rail, straight, yellow pine, 18 cents per lineal foot; oak, 28 cents. For each crook add $3.50 to $4.00, when made at the mill.

Paneling in y. p., 25 to 30 cents per square foot; in plain oak, 30 to 40 cents, and 40 to 50 cents for quartered white. For paneling on the rake add 20 per cent.

Winders in pine, 50 cents extra; in oak, 70 cents.

Starting step, large circle, $5; for the largest, $7. This is for a single end rounded.

Cellar plank stairs of cheap variety, $1 per step in place. With risers and of better quality. $2.

Outside plank stairs, $1.50 to $2.00 in place.

The labor setting is given in the Table, page 82.

Special.—For stairs of great width and thick material the right way is to be sure of the material by taking it all off in detail. Then the labor for millwork and setting has to be allowed. Carriages have also to be included for most stairs—2 x 10 in. plank.

Counters.—Take off all the lumber in detail and price in the regular way. Estimate as much of the plain work as possible separate from the special designs.

Counters of the ordinary make in pine are worth from $2 to $3 per lineal foot. In plain oak, $4 to $5; for quartered oak, $10 if the design is good; and any architect could design a $20 counter in this wood if he wanted to.

Damp.—It is unfair to a contractor to force him to put kiln dried millwork in a building that has not dried out. The material swells, the grain rises if the filling and one coat of finish has not been applied, and when the heat is turned on there is a shrinkage of both doors and floors.

Review

1. What is the difference between S. S. and D. S. glass?
2. How thick are ordinary sash?
3. How does the cost of 1⅛ in. storm sash compare with that of 1⅜ in. windows?
4. What is the cost of a door per square foot delivered at building?
5. What kind of oak floor is the most expensive?
6. What is the easiest way of approximating the cost of a stair?
7. What is the chief danger to millwork delivered at a building?
8. What is the chief danger from improperly dried flooring, and inside finish?

CHAPTER VIII

Solid and Sheet Metal

Classification.—Cast iron columns, steel and wrought iron come under the head of solid metal; and galvanized iron, tin, and copper are sheet metal products.

Tables.—In my "Contractors' and Builders' Handbook" tables of cast and wrought iron and steel are printed.

Weight.—If no book is at hand find out how many cubic inches there are in cast iron, and multiply by .26 for the weight in pounds. This is just a trifle over a quarter of a pound to the cubic inch. The price runs from 2¼ cents per pound on plain work, where special patterns do not have to be made, to 3½ cents on small orders like sill plates. An expensive pattern that has to be made for only one casting naturally costs much more than when 100 castings can be run from it.

Example.—Suppose we have a plate of cast iron 47 in. long, x 9½ in. wide, x ⅞ in. thick, how heavy is it? We have 47 x 9.5 x 7÷8=391 cu. in. x .26=101.66, or 102 lbs. as a contractor would put it.

But suppose this plate is perforated with 20 holes, as fire escape plates often are, for example. Allowing the holes 1 in. in diameter we find by looking in a table of areas of circles that 1 gives .7854 sq. in. We thus have .7854 x 20=15.7 sq. in. x 7÷8=13.74 cu. in. x .26=3.57 lbs. to be deducted from the former figure.

Details.—The lugs and seats of columns, ribs of base plates and every little detail has to be figured out, unless the pattern is standard and the weight known. The shafts of columns are easily estimated, but the caps and bases have to be watched, for each one might be different from another.

The weight of a few columns are given here per lineal foot, but this is for the plain part only.

For 6 in., ½ metal, 26.95 lbs., or practically, 27; 6 in., ¾, 38.6; 6 in., ⅞, 44; 6 in., 1 in., 49; 7 in., 1 in., 59; 8 in., ¾ in., 53.3; 9 in., ¾ in., 60.65; 10 in., 1 in., 88.3. This is for the outside diameter. The decimals are not given in some cases.

For any special column get the exact number of cubic inches and multiply by .26 lb. Everybody should understand simple decimals, for they are easy and useful, but for those who do not, figure ¼ lb. to every cubic inch, and allow an extra pound for every 100 cu. in.

Standard Table of Weights

Cast iron 450 lbs. to the cubic foot, or .26 to cubic inch.

Wrought iron, 480 and .28.

Steel, 490 and .28.

The exact figures given by Jones and Laughlin are .263, .281, and .283. Contractors do not require such exactness.

Labor Setting.—Allow $5 per ton for ordinary work like store fronts, girders below floors, and such construction. Plain work can sometimes be set for as low as $3 with laborers' wages at 20 cents per hour and everything handy. This means that a derrick is used. If only a couple of beams are set and the hoisting has to be done by hand $10 might not be enough.

Heavy Structures.—The actual cost of setting about 2,000 tons of steel is given in the "New Building Estimator" and the matter gone into in detail, but such construction is outside the province of this book.

Anchors, etc.—This light wrought iron work is usually priced at 5 to 6 cents per pound; and 7 cents is sometimes paid for it.

With all building materials distance from mills and factories affects price.

Find out the number of square inches and multiply by the weights in the following tables:

TABLE SIXTY-FOUR

Weight of Plate Iron per Superficial Foot

Thickness in inches.	Weight lbs.	Thickness in inches.	Weight lbs.
1/32	1.25	5/16	12.58
1/16	2.519	3/8	15.10
3/32	3.788	7/16	17.65
1/8	5.054	1/2	20.20
5/32	6.305	9/16	22.76
3/16	7.578	5/8	25.16
7/32	8.19	3/4	30.20
1/4	10.09	7/8	35.30
9/32	11.38	1	40.40

TABLE SIXTY-FIVE

Weight of Flat Bar Iron

Thickness in Inches.

W'th Inch.	1/16 lbs.	1/8 lbs.	3/16 lbs.	1/4 lbs.	5/16 lbs.	3/8 lbs.	7/16 lbs.	1/2 lbs.	5/8 lbs.	3/4 lbs.	7/8 lbs.	1
1/2	.11	.21	.31	.42	.52	.63	.73	.84				
5/8	.13	.26	.40	.53	.66	.79	.92	1.06	1.32			
3/4	.16	.32	.47	.63	.79	.95	1.11	1.26	1.58	1.89		
7/8	.18	.37	.55	.74	.92	1.11	1.29	1.48	1.85	2.22	2.58	
1	.21	.42	.63	.84	1.05	1.26	1.47	1.68	2.11	2.53	2.95	3.37
1/8	.24	.47	.71	.95	1.18	1.42	1.66	1.90	2.37	2.84	3.32	3.79
1/4	.26	.53	.79	1.05	1.32	1.58	1.84	2.11	2.63	3.16	3.68	4.21
3/8	.29	.58	.87	1.16	1.45	1.74	2.03	2.32	2.89	3.47	4.05	4.63
1/2	.32	.63	.95	1.26	1.58	1.90	2.21	2.53	3.16	3.79	4.42	5.05
5/8	.34	.68	1.03	1.37	1.71	2.05	2.39	2.74	3.42	4.11	4.79	5.47
3/4	.37	.74	1.11	1.47	1.84	2.21	2.58	2.95	3.68	4.42	5.16	5.89
7/8	.40	.79	1.18	1.58	1.97	2.37	2.76	3.16	3.95	4.74	5.53	6.32
2	.42	.84	1.26	1.68	2.11	2.53	2.95	3.37	4.21	5.05	5.89	6.74

TABLE SIXTY-SIX

Weight of Square Iron per Lineal Foot

Inches.	Pounds.	Inches.	Pounds.
3/16	.1184	1 5/16	5.802
1/4	.2105	3/8	6.368
5/16	.3290	7/16	6.960
3/8	.4736	1/2	7.578
7/16	.6446	9/16	8.223
1/2	.8420	5/8	8.893
9/16	1.066	3/4	10.31
5/8	1.316	7/8	11.84
11/16	1.592	2	13.47
3/4	1.895	1/8	15.21
13/16	2.223	1/4	17.05
7/8	2.579	3/8	19.00
15/16	2.960	1/2	21.05
1	3.368	5/8	23.21
1/16	3.803	3/4	25.47
1/8	4.263	7/8	27.84
3/16	4.750	3	30.31
1/4	5.263		

TABLE SIXTY-SEVEN

Weight of Round Iron per Lineal Foot

Inches.	Pounds.	Inches.	Pounds.
3/16	.0930	2 1/8	14.92
7/32	.1266	1/2	16.53
1/4	.1653	5/8	18.23
9/32	.2093	3/4	20.01
5/16	.2583	7/8	21.87
11/32	.3126	3	23.81
3/8	.3720	1/4	27.94
13/32	.4365	1/2	32.41
7/16	.5063	3/4	37.20
1/2	.6613	4	42.33
9/16	.8370	1/4	47.78
5/8	1.033	1/2	53.57
11/16	1.250	3/4	59.69
3/4	1.488	5	66.13
13/16	1.746	1/4	72.91
7/8	2.025	1/2	80.02
15/16	2.325	3/4	87.46
1	2.645	6	95.23
1/16	2.986	1/4	103.3
1/8	3.348	1/2	111.8
3/16	3.730	3/4	120.5
1/4	4.133	7	129.6
5/16	4.557	1/4	139.0
3/8	5.001	1/2	148.8
7/16	5.466	8	169.3
1/2	5.952	1/2	191.1
9/16	6.458	9	214.3
5/8	6.985	1/2	238.7
3/4	8.101	10	264.5
7/8	9.300	1/2	291.6
2	10.58	11	320.1
1/8	11.95	1/2	349.8
1/4	13.39	12	380.9

Wall Hangers, Beam Hangers.—All such special work is best estimated from the catalogs of the manufacturers, or priced at the local store.

Square Foot.—An easy rule to remember is that wrought iron 1 in. thick weighs 40 lbs. to the square foot, or 480 to the cubic foot. This means that when it is ½ in. thick it weighs 20 lbs.; and ¼ in., 10 lbs. Steel is 10 lbs. more to the cubic foot, but for a rough figure the same weight of 40 lbs. may be used.

Another rule that is convenient to carry around is that a bar of square iron, 1 x 1 in. x 3 ft. weighs 10 lbs. It is really $10\frac{1}{10}$, but the even figure is used.

Sheet Metal Work

Number.—The standard kind of galvanized iron is No. 26; No. 28 is lighter; No. 24 heavier. A high number means a light iron. The innocent who took a sixth part rather than a fourth because it sounded larger is matched by his brother who takes a galvanized iron with a high number.

Metal Ceilings.—There is a good deal of difference in price of the raw material. Some kinds run from $4 to $5 per square, and others to $9. The figures do not include cornice, center pieces, or ornamental work. Much of the material is manufactured in Ohio, and the prices are naturally lower there.

Furring.—The ceiling has to be furred with wood strips. Some one has to supply this. Allow $1 to $1.50 per square complete in place.

Labor.—On ordinary work with wages at 40 cents per hour for tradesmen, allow $1.50 to $1.75 per square. On good work a man and a helper will not put on more than 3 or 4 squares in a day; on large surfaces and plain designs 6 to 8 squares may be done.

TABLE SIXTY-EIGHT

Labor for Two Men in 8 Hours

Plain tin roof	4 squares
Hanging ordinary gutter	200 ft.
Lining box gutter	150 ft.
Flashing and counter-flashing	150 ft.
Downspouting	200 to 400 ft.
Ridge	100 to 200 ft.
Corrugated iron roof	12 to 15 squares
Steel siding	9 to 12 squares
Wainscoting	7 to 8 squares

Cornices.—The standard weight of iron used is No. 26.

Price.—There are so many designs that the detail has to be seen before a price can be set. For straight moldings alone allow from 1¼ to 2 cents per inch of width for each foot. Thus, if a cornice went into the wall 2 in. at bottom, then measured 28 in. by exactly following the curves of the molding, and had 13 in. from the outside edge back to the wall, with a turn up of 3 in., and 2 in. more into the masonry, the total would be 48 in., and the cost unset 60 to 96 cents per lineal foot, depending upon wages and material.

All extras, like end trusses and ornaments, would have to be added.

Setting of cornices might be done for 15 cents per foot, and it might cost 50. An average cornice, 24 in. high and 12 in. out from the wall, should be set on straight work for about 25 cents with city wages. But this would mean that all soldering of miters and such work was already done at the shop. On a building with many angles and soldering to be done while erecting the cost might be doubled.

Skylights.—There are several styles of these—the ordinary single slope; the kind with two slopes and two gables; and the 4-slope ones with hips. Taking the single slope one as a basis, the gable style runs to about 50 per cent. more in price; and the 4-slope ones about twice as much as the single slopes.

As a fair estimate take the size of the hole in the ceiling and multiply by 65 to 70 cents for the price of a single slope skylight set in place. As the size gets larger the price is cut down to probably 55 cents, depending upon style and requirements. This is on the basis of using ordinary ¼ in. glass, and not the wired article at 18 to 20 cents per square foot. Near the manufacturers the prices can be cut. Large skylights, 20 x 500 ft., are discussed in the "New Building Estimator."

Ventilators.—For a 4 in., $1; 6 in., $2; 9 in., $3; 12 in., $4. But different makers give prices that vary.

Downspouts.—In place, 2 in., 12 cents per foot; 3 in., 17; 4 in., 23; 5 in., 28, all of No. 26 corrugated iron.

Gutters.—These cost about 2 cents per inch of girt hung in place. Thus, if the exact measurement of a gutter is 8 in. around, the price would be 16 cents for good No. 26 iron painted one coat of mineral. Some grades are set at 12 cents.

Plain Work.—For valleys, window caps, flashing, etc., allow 10 to 14 cents per square foot put in place, of No. 26 galvanized iron. This material seems to have taken the place of the tin that was always used in past years.

TABLE SIXTY-NINE

Cost of Roofing per Square

No. 26 galv. iron	$9.00
I C common tin	10.00
I X common tin	11.00

For Old Style and the best brands add $1. On large surfaces the tin prices can be cut.

A first-class tin roof well laid and painted every four years or so will last half a century. Tinners themselves did more than any one else to kill the popularity of this roof by using poor material and doing poor work.

Review

1. What is the weight per cubic inch of cast iron?
2. How much a ton is it worth to set ordinary store front columns and steel beams?
3. What is the weight of (a) a cubic foot of cast iron; (b) wrought iron; (c) steel?
4. What is the weight of a square foot of wrought iron, 1 in. thick?
5. What is the weight of a bar of iron 1 in. x 1 in. x 3 ft. long?
6. What is the cost of an average metal ceiling?
7. What number of galvanized iron is mostly used to make cornices?
8. Is No. 28 heavier or lighter than No. 24?

CHAPTER IX

Roofing

Measurement.—Take actual area only.

TABLE SEVENTY

Cost per Square of 100 Sq. Ft. of Roofing

Gravel	for ordinary	$3.50 to $5.00
Gravel	for the very best	6.00 to 7.00
Slate		10.00 to 20.00
Tile		16.00 to 28.00
Copper		35.00 to 40.00
Tin and galv. iron		9.00 to 12.00
Carey		4.00 to 4.50
Ruberoid		3.00 to 4.50
Elaterite		3.25 to 4.50

The last 3 are patent roofs. For labor on small flat roof buildings allow about 6 squares in a day for one man; on large ones, 10. Some of the manufacturers claim that 20 squares is a day's work on large surfaces, but that is far too much to figure on. As a rough figure 50 cents per square is often allowed. The price shows that there are different qualities.

Slate differs considerably as to size and quality. Large slates are easier laid than small, and naturally cost less. The best sizes are 8 x 16, 10 x 16 and 9 x 18. The weight runs from 650 lbs. to 800 lbs. to the square. Distance from Vermont and Pennsylvania affects the price a good deal, for the freight costs about $1.50 per 1,000 miles per square.

Tile requires even a better framework for a roof than slate, for it weighs more. The ordinary kinds run from 900 to 1,350 lbs. Some of the heaviest varieties when laid in mortar weigh from 2,000 to 2,500 lbs.

Green tile cost about $5 per square extra above red. Glass tile cost about 60 cents a piece. They match with the ordinary tile in the roof.

Labor.—On Spanish tile allow from 8 to 10 squares in a day for 2 men. On a 40-slope roof half of this would be enough. Shingle tile go on a little faster. On the 40-slope roof 2 men laid 3.6 squares of slate, while on a plain straight roof twice that much could be done.

Canvas.—This kind of roofing is not much used in the western part of the country, but it is popular in the East. It should weigh about 1 lb. to the square yard. The edges are lapped about an inch and nailed down with 17 oz. tinned carpet tacks. It is then wetted and afterwards given several coats of linseed oil and white lead paint. Price from $7 to $10 per square.

Shingle roofs are attended to elsewhere. Probably we are living in the decline of the Wood Shingle Age.

(See also Chapter VIII for tin roofing.)

Barrett Specification Roofs are in a special class. They are gravel roofs, but superior to the ordinary kind. More material is used than on an ordinary gravel roof, and better workmanship. The cost is naturally higher, say, from 25 to 35 per cent. The company has its headquarters in

New York. The safest way to estimate on this class of roofing is to send for the latest specification to get quantities and conditions of Surety Bond. Different specifications are used on wood and on concrete. It is unsafe to make an estimate without knowing all details.

Certainteed roofing runs from $1.25 for one ply, $1.55 for two, and $1.90 for three unlaid.

Asbestos shingles run from $8 to $11 at the Keasby Mattison factory, Ambler, Pa. Freight and laying must be included. Allow about two-thirds of the time required for wood shingles.

For Flex-A-Tile shingles write the Heppes Company, Chicago. It is a good idea to subscribe for one of the building trade journals and watch the advertising of roofing materials.

Review

1. How many squares of prepared roofing can one man lay in an 8-hour day?
2. How many square feet are in a square of building work?
3. How heavy is a square of ordinary slate roofing?
4. What is the weight of a tile roof per square?
5. Next to a good foundation, what is the most important feature in a building?

CHAPTER X

Painting

Measurement.—Only actual surfaces are taken, and the price raised to suit. But this does not mean that balusters, grilles, and such "gingerbread" work is all figured accurately. Such work will always be figured solid, and even then one has to make a guess at what it is worth.

There would be less difference in estimates if good work was insisted on.

Material.—For work both outside and inside white lead and linseed oil have long held sway. Generally speaking, this is the best paint mixture. The French government passed a law forbidding the use of white lead paint on buildings, inside or outside; the Austrian law allows it outside. This is on account of health requirements.

Zinc.—As the result of experiments that lasted for a year between lead and zinc it was found as follows with tests on 162 specimens, or "exhibits":

"The lead priming and zinc coating is generally good for tin, galvanized iron, poplar and white pine.

"Sheet iron showed up best with both coats of mixed paints.

"Yellow pine appeared best with the first coat of lead and the second coat of lead and zinc mixed.

"Poplar retains paint better than white pine.

"Black iron seems to retain the paint better than either tin or galvanized iron."

The manufacturers of zinc paints assert that they will last from 10 to 20 years.

In view of the action of the French government, and the fact that many object to using so much lead, a few notes on zinc paints will be of service here. The New Jersey Zinc Co., New York, has made the following combinations:

	Primer	2nd coat	3rd coat
A	Pure lead	Pure zinc	Pure zinc
B	Pure lead	⅓ zinc, ⅔ lead	pure zinc
C	Pure lead	½ of each	⅔ zinc, ⅓ lead
D	½ of each	½ of each	½ of each

For E, straight zinc, 4-coat work, the primer should be pure zinc with a pint of turpentine to a gallon of paint; 2nd coat, pure zinc with ½ pint of turpentine to the gallon of paint; 3rd coat, pure zinc with 1 gill turpentine to the gallon; 4th, pure zinc ground in pure linseed oil without turpentine. This is for a pure white color.

Tints may be made with 1 per cent. of lampblack, ochre, or umber in oil.

Enameling.—First coat pure lead and linseed oil; 2nd, ½ lead and ½ zinc; 3rd, ⅓ lead and ⅔ zinc with sufficient varnish to make a gloss. But the best enameling requires more coats than this.

A common way of finishing the bed room floor of an ordinary house is to have enameled trim with mahogany stained doors. In making an estimate of this kind of work painters should be careful, for the best enamel costs heavily.

TABLE SEVENTY-ONE

Price per Yard at 40 Cents per Hour, Not Including Profit

Ordinary painting on wood, lead and oil, 1-coat	10 cents
Ordinary painting on wood, lead and oil, 2-coats	18 cents
Ordinary painting on wood, lead and oil, 3-coats	26 cents
Sizing on plaster	3 cents
Stippling	3 cents
Mineral paint, 1-coat	6 cents
Mineral paint, 2-coat	11 cents

Plaster can be done for 20 per cent. less on very large surfaces.

Inside work should be figured 10 to 15 per cent. higher if a good job is to be done. Sometimes we see work both outside and inside that does not look worth 10 cents a yard, no matter how many coats it has.

TABLE SEVENTY-TWO

Natural Finishes per Yard

Finest work	$1.50
2 coats floor finish	.25
Varnishing paint	.10
Graining	.40
Rubbing down extra	.10 to .20
Rubbing down slightly	.08
3 coats white shellac	.40
Ordinary 1-coat inside natural color finish	.40

Cold Water Paint.—In "The New Building Estimator" actual quantities required and labor are given on 33,500 yds. of large railroad shops. The average quantity was ½ lb. to the yard for 2-coat work. It seems a good deal of material. On speaking to a painter he told me that on 400 squares, or 4,444 yds., he had just used 1,100 lbs.

for 1 coat. This is practically the same as the other allowance. The second coat takes a little less in proportion.

The manufacturers' catalogs are not reliable as to quantities. They mix too much water with the powder for good work. One at hand gives 1 lb. for 50 to 75 sq. ft., 1 coat on wood; on stone and brick, 25 to 40.

The shops referred to were nearly all on wood and metal. And the actual measurements of joists were taken, not merely the squares of roof. Taken by the square the bottom only of the joist is included; but the sides are forgotten. The bottom takes the place of the straight ceiling.

Labor.—With laborers' wages at 30 cents the labor on the 2-coat work ran to 4½ to 7 cents. Much of it was done with compressed air; but also large surfaces with brushes, and by painters.

TABLE SEVENTY-THREE

Material Required for 100 Yards

	lbs.	gals.
Lead and oil priming	40	2½
Same and 1 coat	60 to 80	3½ to 5
Same and 2 coats	100	6¼
For brick allow from 7 to 10 per cent. more		
Mineral on rough surfaces, 1 coat	21	2
Same on smooth surfaces, 1 coat	16	1½
Same on tin	13	1¼
Putty	2½ to 3	
Paste filler	20 to 25	
Water stain		1½
Spirit stain		2½
Varnish, 1 coat		1½ to 2
Varnish, 2 coats		3½ to 4
Varnish, 3 coats		5½

It should be remembered that varnishes for exterior work cost $4.50 to $5 per gallon. This is twice the price of some inside ones.

One large company gives the following quantities as the result of experience:

100 lbs. white lead.
4 gallons pure linseed oil.
1 gallon turpentine.
1 pint turpentine drier.

This makes 8 gallons genuine old-fashioned paint.

Special Painters' Materials

Carbolineum.—On shingles, 1 gal. to 1 square, 2 coats.

One coat covers 200 sq. ft. of rough lumber, and 250 of smooth. Some kinds are advertised at 250 for rough and 350 smooth. The price is 80 to 90 cents per gallon.

Shingle Stains.—1 brush coat 1 gal. to 150 sq. ft.; 2 brush coat 1 gal. to 100 sq. ft.

Dipping and applying 1 brush coat after shingles are laid, 3 gals. to 1,000; dipping alone, 2½ to 2¾. Price from 65 to 90 cents per gallon. Beware of the cheap greens. Green is the most expensive.

"Conservo" Wood Preservative.—1 gal. to 200 sq. ft. of dressed lumber. Price, 40 cents per gallon in Boston.

Graphite.—This paint is used for steel and iron work. The cost is from $1 to $1.25 per gallon, depending upon color and quantity.

Covering Capacity.—A large firm of steel makers gives 1 gal. for 360 sq. ft., 1 coat. Some manufacturers allow 1 gal. for the first coat to 500 ft.; and 550 to the second. Others give 600 to 800 on metal and 550 on wood, 1 coat.

The material comes ready for use by stirring, and must not be thinned. Two coats should be used. The manufacturers mix it with linseed oil.

Blanchite is another good material. It was largely used in the New York subway on iron and steel. For 2 coats, 1 gal. covers 300 sq. ft.

Red Lead.—Steel and iron work should receive 2 coats of this paint, if it is selected. The mixture should be from 30 to 33 lbs. to 1 gal. of pure linseed oil. Mixing should be done 24 hours before using. The 2 coats are put on in places that can not be easily reached after the steel is erected; otherwise the ordinary process is followed.

Fire escapes, smokestacks, gutters and such exterior metal work should receive 3 coats—the last one with a pound of pure lampblack mixed with every 28 lbs. of the red lead.

Alabastine.—A 5-lb. package covers from 350 to 450 sq. ft., depending upon surface. It costs 50 cents for the white, and 55 cents for the tints. There are 15 shades.

Cementico is another product for tinting walls. It also is sold in 5-lb. packages. The covering capacity on a smooth wall is 500 sq. ft., 2 coats; on a rough wall, 400. On a brown coat of plaster, stippled, 250 sq. ft.

Kalsomining.—Allow from 65 to 85 cents per square for 1 coat of size and 1 of kalsomine.

Ready Mixed paints, as a rule, are not very good; but such of them as the established, standard manufacturers sell are reliable. The cheap ones are cheap in other respects than the price. This runs from 40 cents per gallon for barn paint up. Good paint costs $2 per gallon.

Wall Paper.—Find the exact number of square feet in a room, deduct 20 for each ordinary side of a door or window, then divide by 30 to get the number of single, or 60 to get the number of double rolls required. A double roll covers 72 sq. ft., but the extra is allowed for waste. The ceiling has to be taken separately, for different paper. Double rolls of paper are not cut, so anything over the measurement means an extra roll.

For border, if there is any, take the distance around in feet and divide by 3 for yards.

Wall paper is printed on stock 19½ wide, and for border the roll has to be cut in the middle.

Do not mistake a double roll for a single one.

Review

1. How is painting work measured?
2. What is the best paint, as a rule, made of?
3. What other base than white lead may be used?
4. What kind of material is used for shop walls, etc.?
5. How does the cost of exterior varnishes compare with that of interior ones?
6. Is ready mixed paint reliable?
7. How is wall paper measured?

CHAPTER XI

Plumbing and Heating

There are chapters on plumbing, gasfitting and heating in "The New Building Estimator," and only a few notes are required in such a book as this. The common practice is to let the contracts for plumbing and heating to contractors for these branches, and this is best for all.

Water Supply.—Sometimes an ordinary, every day contractor has to play engineer as far as to say what size of a pipe has to be put in to serve so many families.

It is necessary to estimate the amount of water required. When meters are used and people have to pay for waste it is cut off. From 40 to 25 gals. have proved to be sufficient under this system per family. In general from 50 to 100 are allowed. One city used 220. Meters would change that state of affairs.

Allowing 80 gals. per family per day as a fair average, and 20 families on a branch line, what bore of a pipe would be required? All that can be given is an average figure, for fall, velocity, and other factors change the total discharge. The table is made out for a pipe 500 ft. long, and a "head," or height, above discharge, of 10 ft. The table is made out for 24 hours, but all of the demand usually comes inside of 12. We can therefore double the allowance.

TABLE SEVENTY-FOUR

Flow of Water through Pipes

3/8″ bore	576 gallons	3/4″ bore	3,200 gallons
1/2″ bore	1,150 gallons	1″ bore	6,624 gallons
5/8″ bore	2,040 gallons	1 1/4″ bore	10,000 gallons

A 3/4 in. pipe would thus suit us. But in course of time pipes may clog up a little and the discharge be lessened. The cost of an 1 in. pipe is only a few cents more per foot, and the capacity is 50 per cent. greater. Even an 1 1/4 in. pipe is not much more expensive than a 3/4 in. one—perhaps about 4 cents per foot. Digging and everything else is the same.

The pipe should be galvanized to avoid rust.

Labor.—I kept time on 3/4 in. pipe, and found that 300 ft. were laid in 36 hours for a laborer, and 3 for a plumber to make connections. Only about 1/4 of the line is dug, and the rest is bored. This was in good soil that did not require bracing. In the north, the pipe must be laid from 3-6 in. to 4 ft. deep.

Tanks.—On lines with little pressure a tank is often set in the attic to help out. They are made to hold about 150 gals. for ordinary requirements.

Much depends upon the family. If there is a horse, cow, or automobile, more water has to be provided for. The trouble with many private lines is that when several faucets or garden hose are going at the same time the force is not strong enough to do much good. The situation is like that on the steamboat we have heard of. There was force enough to keep the boat moving until the whistle began to blow, but it had to stop till the tooting was over.

Lead Pipe.—This was formerly almost exclusively used for supply, but now galvanized iron has taken its place solely on account of cheapness. Where the pressure is heavy, extra strong lead should be used, if that material is selected.

Sewers.—Allow about 8 to 15 cents per lineal foot for digging and backfilling for ordinary work and sizes in ordinary soil, and 6 cents per foot for laying the pipe itself. For 10 in. and 12 in. pipes set the laying figure at a cent an inch—10 cents for 10 in., and 12 cents for 12 in.

In good soil the digging should not run to more than 50 cents per cu. yard. One actual cost was 30 cents for 14 ft. deep, with wages at 20 cents, but this could not often be safely figured on, for wages are much higher in cities.

Soil Pipe.—Allow for labor 40 to 100 ft. per day of 8 hours for a plumber and helper.

Vent Pipes.—For the small sizes, set the labor at 75 to 100 ft. per day for a man and boy; and 35 to 40 cents for the larger. It depends upon how many angles there are for soil pipe and vent pipe. These figures might be easily doubled on straight work.

Fixtures.—The average fixture can be set for $4 to $5, but it is better to allow a little more when wages are high. A plumber can easily run up a bill of $8 on a fixture. This is not for putting the supply and waste pipes in place, but for the work around the fixture itself.

TABLE SEVENTY-FIVE

Material

Sewer pipe 4″, 8 cents per ft.
Sewer pipe 6″, 12 cents per ft.
Sewer pipe 8″, 18 cents per ft.
Sewer pipe 10″, 25 cents per ft.

The curves cost from 3 to 4 times as much as the straight pipe per foot. The traps about 10 times as much. But while the straight pipe is figured on the basis of the lineal foot, the whole curve or trap is taken, and this would cut the cost about in two, if considered on the basis of 12″.

TABLE SEVENTY-SIX

Cost of Soil Pipe

Soil pipe, cast iron, single hub	4″	6″	8″	10″
Extra heavy	$0.23	$0.36	$1.15	$1.50
Standard	.16	.26	.65	1.00

Extra heavy should be used so that the pipe will not burst when calking is done.

TABLE SEVENTY-SEVEN

Wrought Iron Pipe.—

Inside diam.	Standard Wt. per ft. in lbs.	Price	Extra strong Wt. per ft. in lbs.	Price
½″	.84	4 cents	1.09	7 cents
¾″	1.12	5 cents	1.39	7 cents
1″	1.67	6.6 cents	2.17	9 cents
1¼″	2.24	9.0 cents	3.00	12 cents
1½″	2.68	11.0 cents	3.63	15 cents

Water Closets.—In place they cost from $25 up to any price desired. This does not include the supply or waste pipes.

Urinals.—In ordinary styles they cost from $4 to $6. Allow for the setting and the pipes extra.

Sinks.—For the ordinary enameled cast iron kitchen sink allow from $3 up. Roll rim and back, $10; with drain board and back extending clear across, $20. This is for material only. Allow $6 to set, and all pipe extra. Proper height from floor, 2 ft. 10 in. Back-breaking height, 2 ft. 6 in.

Baths.—Unset, they run in price from $20 up as high as any one wants. Get all the pipe as well as the fixture proper. There are sewer, supply, waste, and vent to consider.

Boiler.—A 30-gal. costs about $8; a 40-gal., $10. With coils about 20 per cent. extra. But this price is for ordinary boilers; the extra strong ones are higher and must be watched if specified.

Gas Piping costs from 12 to 15 cents per foot put in the building. It is sometimes figured at $1.60 to $1.80 per outlet.

Acetylene piping costs the same as that for gas. This light piping amounts to so little in comparison with the total cost of a building that it should be put in all buildings if there is any prospect of gas or acetylene being installed afterwards. Villages grow; and farmers are using acetylene everywhere.

Heating

Furnaces.—Allow from $18 to $20 per room to be heated for a complete approximate price. Close to the foundry, where there are no freight rates to consider, this price can be cut to some extent.

Allow in detail $4 for all pipes to first floor level; and $9 for all to second. This is in place, including box and shoe, but no registers.

Labor.—Allow from $20 to $30 for all labor in connection with a furnace.

Give the pipes as much slope as possible. No pipe should have less than 1½ in. to the foot. Make the pipes as short as can be done. The heat rises easier in an upright pipe than in a level one.

Steam Heating.—For an approximate figure on a plain building 2 cents per cubic foot of space is often found about right. Large manufacturing buildings are heated for less than half of this, not including boiler and supply pipes.

For ordinary buildings get the cubic feet inside the rooms, divide by 45 to get the square feet of radiation and multiply this by 85 cents for the cost complete without boiler, and $1 with the boiler. This is for direct radiation. The indirect requires about 50 per cent. more square feet of radiation.

Hot water heating, both direct and indirect, needs from 20 to 25 per cent. more area of radiation than steam.

In all cases the glass exposure has to be considered. It requires about 8 times more heat for glass than for wall space.

Hot water is higher in cost than either steam or furnace. It takes less fuel to run the plant after it is installed.

Low ceilings are much more popular than they used to be. Water run into a building rises from the floor; but heat goes to the ceiling first and falls. It is thus always warmer at the ceiling than the floor until the room gets heated. Therefore high ceilings mean a corresponding coal bill.

On the first floor 9 ft., and on the second, 8 ft. 6 in., are now common heights, instead of 10 and 9, and even 11 and 10. Some come lower than even 9 ft. on the first floor, but that is low enough.

The best way for a contractor who is figuring on a building where the heating is included, is to get a bid from a heating firm. There are many rules for getting radiation, and the cost is seriously affected by the one adopted. Thus, while 45 cu. ft. is given above as an average, there are some places where 40 would be taken; and others where 100 to 150 might serve. It is seen therefore that the radiator work might cost several times as much in one place as in another, and this would also affect the size of the boiler.

Review

1. About how many gallons of water per capita are required for a town?
2. When pressure or supply is limited what is used to help?
3. Why does extra heavy have to be used for soil pipe?
4. How high should a sink be set from the floor?
5. About how much a foot is gas piping worth?
6. How much heat does glass require as compared with blank wall?
7. What is the difference between water flowing into a building from the end of a hose, and heat from the end of a pipe?
8. How many radiators are required in a building?

CHAPTER XII

Miscellaneous

Hardware.—The following nail allowances are required to make up quantities. No two tables are alike as to number to the pound, but a fair idea is given in them all. From 20d to 60d is what is called "base" as to price, which runs from 5 cents per keg extra up to 70 for the smaller sizes. Galvanized nails cost about $1.25 per keg extra. The base naturally differs according to freight rate from mills, and thus a local price has to be filled in. Taking $2.75 for a base, to illustrate the principle, a 2d keg would cost $3.45; a 6d, $2.95; an 8d, $2.85; and so on. Wire nails are used now; cut nails are seldom seen.

TABLE SEVENTY-EIGHT

Common Nails

Size	Length	Approx. No. to Lb.	Advance over Base Price per 100 Lbs.
2d	1 inch	876	$0.70
3d	1¼ inch	568	.45
4d	1½ inch	316	.30
5d	1¾ inch	271	.30
6d	2 inch	181	.20
7d	2¼ inch	161	.20
8d	2½ inch	106	.10
9d	2¾ inch	96	.10
10d	3 inch	69	.05
12d	3¼ inch	63	.05
16d	3½ inch	49	.05
20d	4 inch	31	....
30d	4½ inch	26	....
40d	5 inch	20	....
50d	5½ inch	14	....
60d	6 inch	12	....

Nails Required for Material

Note.—In the following figures as to quantity of nails required it should be noticed that different centers are specified. More nails are used at 12″ than at 16″, yet this is often forgotten. The number used to each bearing also changes the total.

For 1,000 ft. B. M. of 3 in. plank with two nails at bearings, 36 in. centers, 50, 40, 30 lbs. of 60d for 3 x 6, 3 x 8, 3 x 10.

For 1,000 ft. B. M. of 2 in., two nailings at 16 in. centers, 50, 40, 30 lbs. of 20d.

For 1,000 ft. B. M. of joists on frame buildings, 16 in. centers, 16 lbs. of 20d; on brick, 10 lbs.

For 1,000 ft. B. M. of studs, walls, partitions, 16 in. centers, 12 lbs. of 20d, and 4 lbs. of 8d or 10d.

For 1,000 ft. B. M. of sheeting or shiplap, 20 lbs. of 8d at 16 in. centers.

For furring 1,000 lin. ft. of 1 x 2 at 16 in. centers, 6 to 7 lbs. of 8d.

For 1,000 ft. B. M. of 6 in. siding, 18 lbs. of 6d; 4 in., 25 lbs.

Shingles, 4½ lbs. per 1,000 of 4d; 3½ lbs. of 3d.

Flooring, 6 in., 16 in. joist centers, 13 lbs. of 8d; 20 lbs. of 10d.

One square of thin oak flooring, 2½ lbs. of 1¼ finishing brads.

Ceiling, ¾ in., 16 in. centers, 11 lbs. of 6d.

Sash Weights.—These cost about 1½ cents per pound for ordinary sizes. Lead weights run as high as 7 to 8 cents.

Sash Cord.—Hanks weigh from 2 to 5 lbs. according to their diameter. A 3/16 weighs 1½ lbs., and a ⅜, 5 lbs. The price is 25 to 30 cents per pound.

Barn Door Hangers.—Put at $2.25 each without track for the Coburn. The track costs 10 cents per foot.

Sliding Door Hangers.—From $4.50 to $5.50 complete. For a Coburn, single door, $2.60.

Butts or Hinges.—Japanned, 3 in., 15 cents per pair; 3½ in., 17 cents; 4 in., 22 cents. The finer finishes of the same size run from 21 to 30 cents.

Surface Butts.—These are popular, but they are a little more expensive than the edge kind. The saving is in the labor of putting them on.

Double Acting Hinges, per pair, japanned, $1.30 to $3. Bronze, $2 to $5.75.

Locks.—Rim lock, 35 cents, with plain trim.

Inside, complete, $1 to $1.50.

Front and vestibule doors, $3.50 to $5.00.

Sliding door, $1.50 to $3.00.

Unit lock, $8 to $10.50.

Store door, $6 to $8.

Store door, dead lock, no trimmings, $1 to $1.50.

Master key, no trimmings, $1.50 to $3.00.

Drawer locks, 20 cents to 60 cents.

Trimmings.—Push plates, imitation, each, 50 to 75 cents; real bronze, each, $1.75 to $2.00.

Door knobs, cheap, 10 cents each; bronze, 40 to 75 cents.

Door springs and checks, $2.25 to $7.00.

Transom lifts, 30 to 60 cents.

Coat and hat hooks, per dozen, 50 to 75 cents.

Brackets.—Light, 4 x 5 in., 5 cents per pair; 10 x 12 in., 15 cents per pair, heavy, 5 x 6 in., 12 cents per pair; 12 x 14 in., 35 cents per pair.

Electric Wiring

For each light allow $2.50 to $2.75 complete. This is per light, and not per outlet, and for open work, weatherproof wire; for concealed work, rubber covered wire, $3 to $4.

Push button switches cost $1 each extra. It is generally advisable to use them, as it is hard to find a bracket in a dark room, while the switch can always be located.

If conduit work is used, that is, with the wires run inside of light pipes, allow $6 per outlet. This is the safest kind of electric wiring, as the rats can not gnaw the covering of the copper and so make the fire risk greater. Some cities make it compulsory. It is best, but costs money.

A house of 7 or 8 rooms costs from $45 to $60 for ordinary wiring. The ordinary switches control only one outlet, but there are 2-way and 3-way ones used for dwellings. The light is controlled from 2 or 3 stations as the case may be. Thus, standing in the lower hall we can light the upper one, or vice versa. For each duplex switch of this kind add about $6.

Floor Tiling

Terrazo floors are worth from 25 to 35 cents per square foot without the cement base. This base is worth about 8 cents per square foot.

Ceramic Tile.—Allow from 40 to 60 cents per square foot without base.

Rubber tiling is worth from 85 cents to $1 laid without base.

For hearth tile of a common pattern estimate from 80 cents to $1 per square foot laid. This does not include preparation for hearth. The rough concrete must be in place for the tiler.

For floors of marble tile of the black and white variety, 50 to 60 cents per square foot in place. Tennessee marble, 6 x 6 in., about the same. In both cases the under concrete has to be ready for the tiler.

There is no end to the variety in tile work, and prices have to be secured locally.

Mineral Wool.—Deduct all openings and allow 1 lb. per square foot for each 1 in. in thickness. The different qualities run all the way from 6 to 12 lbs. per cubic foot. As far west as Omaha the ordinary material used in building costs $17 per ton, and about 12 cents per cubic foot to put in place.

Liability Bonds.—In my "Contractors' and Builders' Handbook" there is a chapter on bonds of the various kinds—surety and liability. The latter are to protect the contractor from damage suits and verdicts due to accidents on building work. In the state of New York alone quite a number of verdicts have been rendered for $5,000 up to $40,000. This means that no contractor can afford to go without such insurance; and the cost should be added to the estimate.

So with fire insurance also, but the danger is not so great with fire as with accident. Many do not know this.

Bids.—In the "Handbook" there is also a chapter on Builders' Law. Contractors are not aware, as a rule, that a bid is a contract as soon as it is accepted. They can not back out, no matter what mistake has been made, unless the owner is willing. All the owner, or architect as his agent, has to do is to give the contractor the work on the basis of the bid, or mail a letter in the United States mail box or chute, and that settles the matter. The mailing of the letter decides it, and not the time the contractor gets it.

Repairs.—Do not agree to keep a building in repair for a year or any time after it is finished without a clear understanding as to what the repairs are to consist of. A judge once ordered a builder to replace a building that had been burned because of the "repair" clause. If you agree to keep up a building for a time after the work is done you may find that the damage by a flood, or fire, or anything else may have to be made good by you. Another judge said that a bridge contractor had to put back the bridge washed away by a flood. He had agreed to keep it in "repair." The $2 "Handbook" warns contractors away from danger.

Standard Sizes.—If lumber has to be the full size the extra cost must be put down in the estimate. Everybody knows that market sizes are less than the exact figures.

TABLE SEVENTY-NINE

Weight of Lumber

(Yellow Pine in pounds per 1,000 Ft. B. M.)

Flooring, 13/16, plain back	2,000
Flooring, 13/16, hollow back	1,900
Ceiling, 3/8	1,000
Drop siding	1,800
Shiplap	2,300
Common boards	2,500
2 x 4, to 2 x 8, rough,	3,200
2 x 10, 2 x 12, S. 1 S. 1 E.	2,600
4 x 4, to 8 x 8, rough,	4,000

(Some lists give a little heavier weights.)

Northern Lumber

Pine and hemlock	2,500 to 3,000
Norway	3,000 to 5,000
Oregon and Washington fir	2,800 to 3,300
(The difference is between green and dry.)	
Siding	800
Ceiling, 3/8	800
Boards, rough,	2,400
Shingles, per M	240
Lath, per M pcs.	500

TABLE EIGHTY

Hardwood Flooring

3/8	1,000
7/8	2,500

TABLE EIGHTY-ONE

Dressed and Matched Stock

All dressed and matched stock is sold strip count. To find the number of feet required for face measure, observe the following:

For each 100′ 2 inches wide, worked from 2¾, add 38′
For each 100′ 2¼ inches wide, worked from 3 , add 34′
For each 100′ 2½ inches wide, worked from 3¼, add 30′
For each 100′ 3 inches wide, worked from 3¾, add 25′

For each 100′ 3¼ inches wide, worked from 4 , add 24′
For each 100′ 3½ inches wide, worked from 4¼, add 22′
For each 100′ 4¼ inches wide, worked from 5 , add 18′
For each 100′ 5¼ inches wide, worked from 6 , add 15′
For each 100′ 7¼ inches wide, worked from 8 , add 11′
For each 100′ 9¼ inches wide, worked from 10 , add 9′

TABLE EIGHTY-TWO

Lumber Measurement Table

SIZE IN INS.	LENGTH IN FEET.											
	10	12	14	16	18	20	22	24	26	28	30	32
2 x 4	6⅔	8	9⅓	10⅔	12	13⅓	14⅔	16	17⅓	18⅔	20	21⅓
2 x 6	10	12	14	16	18	20	22	24	26	28	30	32
2 x 8	13⅓	16	18⅔	21⅓	24	26⅔	29⅓	32	34⅔	37⅓	40	42⅔
2 x10	16⅔	20	23⅓	26⅔	30	33⅓	36⅔	40	43⅓	46⅔	50	53⅓
2 x12	20	24	28	32	36	40	44	48	52	56	60	64
2 x14	23⅓	28	32⅔	37⅓	42	46⅔	51⅓	56	60⅔	65⅓	70	74⅔
2 x16	26⅔	32	37⅓	42⅔	48	53⅓	58⅔	64	69⅓	74⅔	80	85⅓
2½x12	25	30	35	40	45	50	55	60	65	70	75	80
2½x14	29⅙	35	40⅚	46⅔	52½	58⅓	64⅙	70	75⅚	81⅔	87½	93⅓
2½x16	33⅓	40	46⅔	53⅓	60	66⅔	73⅓	80	86⅔	93⅓	100	106⅔
3 x 6	15	18	21	24	27	30	33	36	39	42	45	48
3 x 8	20	24	28	32	36	40	44	48	52	56	60	64
3 x10	25	30	35	40	45	50	55	60	65	70	75	80
3 x12	30	36	42	48	54	60	66	72	78	84	90	96
3 x14	35	42	49	56	63	70	77	84	91	98	105	112
3 x16	40	48	56	64	72	80	88	96	104	112	120	128
4 x 4	13⅓	16	18⅔	21⅓	24	26⅔	29⅓	32	34⅔	37⅓	40	42⅔
4 x 6	20	24	28	32	36	40	44	48	52	56	60	64
4 x 8	26⅔	32	37⅓	42⅔	48	53⅓	58⅔	64	69⅓	74⅔	80	85⅓
4 x10	33⅓	40	46⅔	53⅓	60	66⅔	73⅓	80	86⅔	93⅓	100	106⅔
4 x12	40	48	56	64	72	80	88	96	104	112	120	128
4 x14	46⅔	56	65⅓	74⅔	84	93⅓	102⅔	112	121⅓	130⅔	140	149⅓
6 x 6	30	36	42	48	54	60	66	72	78	84	90	96
6 x 8	40	48	56	64	72	80	88	96	104	112	120	128
6 x10	50	60	70	80	90	100	110	120	130	140	150	160
6 x12	60	72	84	96	108	120	132	144	156	168	180	192
6 x14	70	84	98	112	126	140	154	168	182	196	210	224
6 x16	80	96	112	128	144	160	176	192	208	224	240	256
8 x 8	53⅓	64	74⅔	85⅓	96	106⅔	117⅓	128	138⅔	149⅓	160	170⅔
8 x10	66⅔	80	93⅓	106⅔	120	133⅓	146⅔	160	173⅓	186⅔	200	213⅓
8 x12	80	96	112	128	144	160	176	192	208	224	240	256
8 x14	93⅓	112	130⅔	149⅓	168	186⅔	205⅓	224	242⅔	261⅓	280	298⅔
10 410	83⅓	100	116⅔	133⅓	150	166⅔	183⅓	200	216⅔	233⅓	250	266⅔
10 x12	100	120	140	160	180	200	220	240	260	280	300	320
10 x14	116⅔	140	163⅓	186⅔	210	233⅓	256⅔	280	303⅓	326⅔	350	373⅓
10 x16	133⅓	160	186⅔	213⅓	240	266⅔	293⅓	320	346⅔	373⅓	400	426⅔
12 x12	120	144	168	192	216	240	264	288	312	336	360	384
12 x14	140	168	196	224	252	280	308	336	364	392	420	448
12 x16	160	192	224	256	288	320	352	384	416	448	480	512
14 x14	163⅓	196	228⅔	261⅓	294	326⅔	359⅓	392	424⅔	457⅓	490	522⅔
14 x16	186⅔	224	261⅓	298⅔	336	373⅓	410⅔	448	485⅓	522⅔	560	597⅓

Moldings

Moldings are usually made in ripping width, or ¼ in. larger than finished width. A ⅞ in. thick panel molding if made to finished 1¾ in. wide should be ordered as 2 in., to allow for ripping; to finish full 2 in. it should be ordered as 2¼ in.

Keeping Costs.—Every contractor should keep a reasonable account of the cost of a building, and especially the time taken to do work. A simple system of bookkeeping should also be learned. There is one set forth in my "Handbook" that is made to fit the wants of those who have not time to give to double entry systems.

How to Check the Length of a Rafter.—The steel square is a splendid tool—if it is not overworked. There are some who are so enamored over it that they would make it the Universal Problem Solver.

But having laid out the length of a rafter by the square how can we check it? If there are only so many hip or valley rafters, and the lumber yard is in the next county, it is rather provoking to cut one short. We can make sure by square root.

Take the figures that all carpenters know—12 and 12 on the square, and 17 is the distance across the corner, or the hypotenuse, as the learned call it. The theory rests upon a very simple picture problem: Make two squares upon the two sides of 12 in., and one square on the 17 in. side, and the area in the two is the same as in the one. Thus a square of 12 in. has 144 sq. in., and 2=

288; while one of 17 in. has 289 or practically the same. The real distance is 16.97 in., but no carpenter uses this, as 17 is close enough for all practical purposes.

Suppose we have a ½ pitch roof with 12 ft. on the run and 12 ft. on the rise, how long would the rafter have to be? We all know, 17. Why? Because the length must be equal to some number which when multiplied by itself will give the same number of square inches as the squares of the other two sides hold. We square the two sides at 12, add the total and get 288. What we need now is the square root of this number. The method is given in any arithmetic, and is very simple when once learned.

Take 20 and 20 instead of 12 and 12, and we get 28.28 ft. Multiplying the .28 by 12 to get inches we get 3.36 in.; and the .36 by 16 to get 16ths of an inch the answer is 6/16 or 3/8. The total length is thus 28 ft. 3 3/8 in.

The method suits for any kind of a pitch or length.

Houses are squared by the same system. We take 6, 8, and 10 across the corner, because 6 x 6=36, and 8 x 8=64. Added together these make 100. We have now to find the square root of 100, which is 10.

Water.—A cubic foot of water weighs about 62½ lbs.; a gallon nearly 8½ lbs. There are nearly 7½ gals. in a cubic foot. If tanks are used above joists they have to be strengthened unless there is a partition below.

The following table gives the capacity of tanks in gallons. Decimals are not used.

TABLE EIGHTY-THREE

Capacity of Round Tanks per Foot Deep

Diam. in ft.	Gallons	Diam. in ft.	Gallons
2—0"	23	6—6"	248
3	53	7	288
3—6"	72	7—6"	330
4	94	8	376
4—6"	119	9	476
5	147	9—6"	530
5—6"	178	10	587
6	211		

TABLE EIGHTY-FOUR

Circular Cisterns

5 ft. diameter, 1 ft. deep, holds	4.66 Bbls.
6 ft. diameter, 1 ft. deep, holds	6.71 Bbls.
7 ft. diameter, 1 ft. deep, holds	9.13 Bbls.
8 ft. diameter, 1 ft. deep, holds	11.93 Bbls.
9 ft. diameter, 1 ft. deep, holds	15.10 Bbls.
10 ft. diameter, 1 ft. deep, holds	18.65 Bbls.

TABLE EIGHTY-FIVE

Square Cisterns

5 x 5 ft., 1 ft. deep, holds	5.92 Bbls.
6 x 6 ft., 1 ft. deep, holds	8.54 Bbls.
7 x 7 ft., 1 ft. deep, holds	11.63 Bbls.
8 x 8 ft., 1 ft. deep, holds	15.19 Bbls.
9 x 9 ft., 1 ft. deep, holds	19.39 Bbls.
10 x 10 ft., 1 ft. deep, holds	23.74 Bbls.

Note.—A barrel holds 31½ gallons.

General.—A cubic foot of water is 7.48 U. S. gallons and weighs 62.5 pounds; a cylindrical foot of water is 5.89 gallons or 49.1 pounds.

For square or rectangular tanks decide first of all how many gallons are required and arrange the size to suit 7½ gals. to the cubic foot. Suppose we require 300 gals. That means 40 cu. ft. If we make the tank inside 3 x 4 ft. the depth would have to be close to 3 ft. 6 in. As it would not be desirable to let the water come clear up to the top a few inches extra would be given above the overflow pipe.

But if we made the inside size 4 x 4 ft. the exact depth would be 2 ft. 6 in., and a few more inches above the overflow. For either square or rectangular tanks the method is easy.

TABLE EIGHTY-SIX

Weight of Various Substances per Cubic Foot in Pounds

Material	Pounds
Brass, cast	504
Brass, rolled	524
Brickwork ordinary	112
Brickwork, pressed	140
Cement, natural,	50 to 55
Cement, Portland,	94
Concrete	140
Granite	170
Gravel, same as sand	
Iron, cast,	450
Iron, wrought,	480
Lead	711
Lime	55 to 75
Limestones and marbles	168
Lumber (see Table on page 152)	
Masonry, rubble	154
Plaster of Paris	74
Sand, dry, loose,	90 to 106
Sand, perfectly wet,	120 to 140
Sandstones, building,	151
Slate	175
Snow	5 to 40
Steel	490
Tar	62
Water	62½

In Table 87 the Dia., Circ. and Area may be used for inches, feet or yards. Thus, if 12 is taken for the Dia. in inches, the Circ. is 37.699 inches, or 37.7 is close enough. This means 37 ft., 8½ in. nearly. The Area is 113.1 sq. in.

TABLE EIGHTY-SEVEN

Circumferences and Areas of Circles

Dia.	Circ.	Area.	Dia.	Circ.	Area.
1	3.1416	.7854	39	122.52	1194.59
2	6.2832	3.1416	40	125.66	1256.64
3	9.4248	7.0686	41	128.81	1320.25
4	12.5664	12.5664	42	131.95	1385.44
5	15.7080	19.635	43	135.09	1452.20
6	18.850	28.274	44	138.23	1520.53
7	21.991	38.485	45	141.37	1590.43
8	25.133	50.266	46	144.51	1661.90
9	28.274	63.617	47	147.65	1734.94
10	31.416	78.540	48	150.80	1809.56
11	34.558	95.033	49	153.94	1885.74
12	37.699	113.1	50	157.08	1963.50
13	40.841	132.73	51	160.22	2042.82
14	43.982	153.94	52	163.36	2123.72
15	47.124	176.71	53	166.50	2206.18
16	50.265	201.06	54	169.65	2290.22
17	53.407	226.98	55	172.79	2375.83
18	56.549	254.47	56	175.93	2463.01
19	59.690	283.53	57	179.07	2551.76
20	62.832	314.16	58	182.21	2642.08
21	65.973	346.36	59	185.35	2733.97
22	69.115	380.13	60	188.50	2827.43
23	72.257	415.48	61	191.64	2922.47
24	75.398	452.39	62	194.78	3019.07
25	78.540	490.87	63	197.92	3117.25
26	81.681	530.93	64	201.06	3216.99
27	84.823	572.56	65	204.20	3318.31
28	87.965	615.75	66	207.34	3421.19
29	91.106	660.52	67	210.49	3525.65
30	94.248	706.86	68	213.63	3631.68
31	97.389	754.77	69	216.77	3739.28
32	100.53	804.25	70	219.91	3848.45
33	103.67	855.30	71	223.05	3959.19
34	106.81	907.92	72	226.19	4071.50
35	109.96	962.11	73	229.34	4185.39
36	113.10	1017.88	74	232.48	4300.84
37	116.24	1075.21	75	235.62	4417.86
38	119.38	1134.11	76	238.76	4536.46

TABLE EIGHTY-SEVEN—*Continued*

Circumferences and Areas of Circles—Continued

Dia.	Circ.	Area.	Dia.	Circ.	Area.
77	241.90	4656.63	102	320.44	8171.28
78	245.04	4778.36	103	323.58	8332.29
79	248.19	4901.67	104	326.73	8494.87
80	251.33	5026.55	105	329.87	8659.01
81	254.47	5153.	106	333.01	8824.73
82	257.61	5281.02	107	336.15	8992.02
83	260.75	5410.61	108	339.29	9160.88
84	263.89	5541.77	109	342.43	9331.32
85	267.04	5674.50	110	345.58	9503.32
86	270.18	5808.80	111	348.72	9676.89
87	273.32	5944.68	112	351.86	9852.03
88	276.46	6082.12	113	355.	10028.75
89	279.60	6221.14	114	358.13	10207.03
90	282.74	6361.73	115	361.28	10386.89
91	285.88	6503.88	116	364.42	10568.32
92	289.03	6647.61	117	367.57	10751.32
93	292.17	6792.91	118	370.71	10935.88
94	295.31	6939.77	119	373.85	11122.02
95	298.45	7088.22	120	376.99	11309.73
96	301.59	7238.23	121	380.13	11499.01
97	304.73	7339.81	122	383.27	11689.87
98	307.88	7542.96	123	386.42	11882.29
99	311.02	7697.69	124	389.56	12076.28
100	314.16	8853.98	125	392.70	12271.85
101	317.30	8011.85	126	395.84	12468.98

Comparison of Brick and Frame Construction

We have to include the sill to make a fair comparison, for that is not required in a brick building, but is a part of a frame one. On the wall, page 90, the figures for a 40 and 50 cents per hour wage are $14.22 and $15.29. This is with 6 in. siding and corner boards, the ordinary construction, although 4 in. is more common now, except with some bungalows that have 8 in. and 10 in. x ⅞ in. There appears to be no reason thus why 6 in. should not be used if made thicker than 4 in.

TABLE EIGHTY-EIGHT

Cost of Wall with 2 x 4 Studs

	40 cents	50 cents
1 square of wall complete (see page 90)	$14.22	$15.29
Painting, 3 coats	2.86	2.86
Sill	.80	1.00
Cost of wall	$17.88	$19.15
For 6″ siding, mitered corners, extra labor, compared with corner bds	.80	1.00
	$18.68	$20.15
Cost of wall given above	$17.88	$19.15
For 4″ siding and corner boards, extra material	1.00	1.00
Extra labor, compared with 6″ with corner bds.	1.25	1.50
	$20.13	$21.15
Cost of 4″ siding and corner bds	$20.13	$21.15
For 4″ siding and mitered corners, extra labor as compared with corner bds	1.00	1.25
	$21.13	$22.40

If sheeting is angled add from 75 cents to $1 per square for material and labor.

TABLE EIGHTY-NINE

Wall with 2 x 6 Studs, Angle Covering

(See page 90.)

	40 cents	50 cents
Studs, 2 x 4 figure, plus 45 per cent	$4.75	$5.18
Angle boarding, $4.17, plus 25 cents for material, 50 for labor; and 25 and 62	4.92	5.27
Paper	.35	.35
Sill	.80	1.00
Siding, 4″ mitered corners, $6.43 and $6.97, plus $3.25 and $3.75	9.68	10.72
Painting	2.86	2.86
	$23.36	$25.38

Cases have been known where 2 x 6 studs were set at 12 in. centers instead of 16 in., and this would make another increase. If the house is 2-story, each square of wall does not require the allowance of sill.

Furring.—The difference in plaster on the inside is not considered. The frame building must be lathed, but the masonry ones need either waterproofing in rainy climates at 25 cents per yard extra, or furring and wood lath. If the plaster is done in dry climates directly on the brick there is a saving of a little as compared with the wood lath. Furring on walls is worth about $2 per square, so that if this were done there would have to be an allowance for it in the comparison. Roughly speaking, in most parts of the country 3 cents per square foot would have to be allowed for either waterproofing or furring on the brick buildings.

If better building were done houses would last twice as long, the consumption of lumber would be decreased, and fire risk cut down. There should be at least 10 ft. between all houses.

TABLE NINETY

Plastered Exteriors

	40 cents	50 cents
1 square of 2 x 4 wall and sill without siding page 90	$8.59	$9.32
Furring at 10″ centers	1.50	1.75
Plaster on metal lath, 11 yds., at $1.25	13.75	13.75
	$23.84	$24.82

The plaster might cost more or less—principally more at city prices, if the work is well done.

For angle boarding, 2 x 6 instead of 2 x 4, and all other extras add to suit.

Brick Walls

Taking a square for a basis of calculation we have 1,500 brick in wall measure at 9 in. thick. At $12 per 1,000 this is $18.00 or 18 cents per square foot. But this is for common brick. If well burnt it is as good as pressed brick so far as lasting quality goes; and there are architects who say that it looks better. But 3 cents ought to go on to this either for furring or waterproofing, if in a rainy section.

Painting is sometimes done on both brick and cement work, so the gain in this item is not always pocketed.

But the thickness of brick walls has to be considered. We can not use 9 in. walls in some cities at all. In others they are allowed on the top stories.

There is always a good deal of wrangling among dealers as to the lasting qualities of their materials. The brick men are not very fond of frame buildings, while the lumber dealers like them; the cement mills turn out an excellent binding for reinforced concrete and artificial stone, yet we hear the natural stone workers express unfavorable opinions of their rival. But it is not so much the nature of any fair material of which a wall is composed that gives it lasting qualities as the way it is put together. Naturally wood does not last like stone, but it lasts for a century if it is used in a right way. The colonial houses stood for generations. Our frame houses are built for a short life. They ought to last at least 75 years. Why do many of our brick buildings have a life period of only twenty years? Brickwork may be laid to endure for centuries. We need better walls in all kinds of materials. This means conservation of lumber.

TABLE NINETY-ONE

Common Brick Wall.—

	Per sq. ft.
1 story on top of ground, 9″,	18 cents
Moisture proofing,	3 cents
	21 cents
Basement, 8′ high, 13″, 1st story 13″, 2nd, 9″,	24½ cents
Moisture proofing on living rooms,	3 cents
	27½ cents
8′ basement, 13″, and 1 story 9″,	23½ cents
Moisture proofing,	3 cents
	26½ cents

Pressed brick will run up the cost 15 to 22 cents more per square foot for a good quality of material, making the finished wall 40 to 50 cents.

Review

1. Why is conduit or armored work best?
2. Why is liability insurance necessary?
3. When is a bid binding upon a contractor?
4. What are "repairs"?
5. Do you understand how to work out square root?

CHAPTER XIII

Hints on Drawing

Many students, contractors and mechanics occasionally have to draw plans, and most of them find the work rather difficult at first. With this, as with almost everything else, practice is necessary. A wagon load of books of instruction will not do so much good as actual work. At the best, it is not to be expected that a tradesman will draw with the same finish as a draftsman.

Materials.—In the first place, buy a reasonable set of drawing instruments. A set may be had for as low as $5.

In the next place, stop using a 2-ft. rule, and get an architect's scale. The boxwood ones cost from 45 to 50 cents; the celluloid white edged ones, $1.50. The mail order houses sell them at a low price. A triangular scale is better than the flat kind, as it has more sides.

Triangles.—Two triangles should also be procured—one with two angles of 45 degrees, and the other with 60 and 30. Unless for large work a 6 in., 45 is about the right size, and the other somewhat longer.

Curves.—At least one French curve is useful to make lines that turn into all kinds of round shapes.

T-Square.—The fixed kind is better than the one that works on a swivel.

Drawing Board.—All sizes are made. The size required depends upon the nature of the work. A board about 28 x 40 in. is easily handled, and suits a 24 x 36 drawing.

Thumb Tacks are cheap and required to hold down the paper.

Erasers are also necessary. The best kind for ordinary use are Emerald or Corona. For cleaning tracings get Art Gum. One brand of it is known as Eagle Cleaner.

An Ink Eraser is also required to rub out lines on tracings. There are few that do not require some changes.

A Shield is useful. It is a thin brass plate with slits and small apertures in it for laying over the marks on a tracing it is desired to rub out. This saves the other parts. It is against the rules to use a knife to take out any marks, but if carefully done no one is the wiser. There are places where the point of a knife will go and do the work neatly while an eraser would take out more than can be restored in an hour.

Pencils.—A 6-H pencil is used for ordinary work. There is a 7-H which is even better. These hard pencils are expensive, but last a long while. For detail work 3-H or 4-H are better to work with, as they are softer.

Ink.—India ink must be used for tracing. It costs about 25 cents per bottle. Higgins makes a good article.

Pens.—A few small pen points are necessary. Some prefer to use good stiff ordinary pens, and do excellent work with them. More depends upon the man behind the pen than the article itself. A ruling pen comes in the set of drawing instruments.

Paper.—For ordinary work duplex paper is used to make the drawing ready for the tracing. There are many kinds of paper of this kind that will serve.

Temporary work is often done with a pencil on tracing paper instead of cloth.

Manila paper is sometimes used for drawings that have to stand a good deal of usage, and are not meant to be traced. The lines may be inked in if desired. Some do this on cloth also, but it is better to use paper first.

Tracing Cloth.—When the drawing is finished this cloth is laid over the top and the tracing done. It is glazed on one side and dull on the other. Any side may be used, but the dull one seems to be the better. It is easier on the eyes, for one thing.

Cost.—The foregoing outfit does not cost so very much. For $12 or so one may have instruments and supplies enough for years. This does not include any paper. On the other hand, $200 can be expended for stylish instruments and equipment.

Methods.—Suppose you have to draw a plan of a house 22 x 40 ft. Use the scale of ¼ in. to the foot. This is the best one for general use, unless the building is to be long, and the sheet not easily handled.

There are to be plans of the basement, first, and second floors. We draw a line along the T-square at the bottom of the board at a workable height to give us the front line of the main part of the house. In general keep the front of the building to the bottom of the board for a dwelling.

Measure 40 ft. back from this line and draw another line parallel to the first. This gives the front and back of the house, and saves measuring on any of the three plans for this part.

In using the hard pencil do not bear too heavily upon the paper, as the marks may have to be erased.

Next draw up, from bottom to top direction, a line on the extreme left to represent the side of the house on the basement plan. Measure 22 ft. to the right and draw another. The other two plans should also be blocked out on the board to give room for any projections such as porch piers, steps, etc.

The basement plan can be laid off on the left, then the first floor, and after that the second. Of course on large houses there is often only one floor put on the board at a time, but for a small size like this all of the plans can be attended to.

The first floor is usually most important, however, and it is best to arrange it first, and make the others to suit. Each floor has to be "humored" to suit the others.

Triangles.—Put the triangle on the square and work from the left to the right. Do not follow the beginner's way of working from the right to the left. Near the right hand edge of the board when there is not room for the triangle it may be reversed, but not otherwise, as a rule.

There are several good reasons for placing the triangle in this way. One is that the tracing has to be done from left to right, and just as this is the best method for the pen so it is for the pencil after a little practice. Another reason is that no matter how nicely triangles are squared they sometimes get a little out of "true," and when work is done both ways—from left to right, and vice versa—the lines diverge enough to make trouble, especially on a large drawing. Then when the tracing is begun the trouble increases, for the pen work must be from left to right to prevent smearing, for one thing, and the ink line does not come directly over the one in pencil. The only rule to follow is to use the triangles in the same way for pencil as they must be used for ink. A number of small lines might connect with an upright line, and if this one had to be inked in, say, $1/32$ in. further to the left on a wide drawing than the pencil line below, all the connecting lines would be too far to the right.

In almost all lines there are certain ways of doing work that are so advantageous they are standard. This "backhanded" way of drawing is one, and it is worth some patience and work to learn it correctly. Many a woman has learned to cook by trying, but few without practice. Success is won through failure. So with drawing.

Using Triangles.—A 45 degree triangle is shown in black. To get an upright line at A the triangle must be moved as dotted, and the line drawn in what at first may seem to be a back-

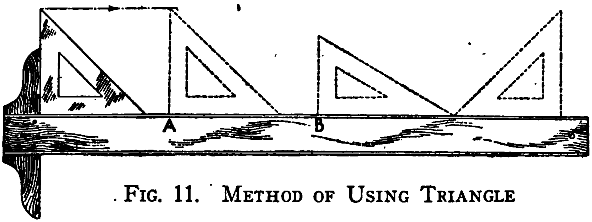


FIG. 11. METHOD OF USING TRIANGLE

handed way of working. Another upright is shown at B with a 60 and 30 triangle. Only when there is not room on the board is the triangle reversed, as shown at end of the blade of the square.

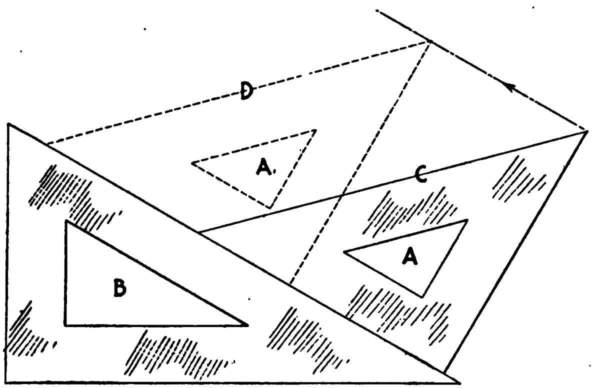


FIG. 12. MAKING PARALLEL LINES

Parallel Lines.—Suppose it is desired to make a line parallel to D at C. It cannot be made with the T-square, nor with an upright triangle resting on the square, for it is neither plumb nor level, as would be said on a building. A triangle of any kind—in the illustration a 45 is used—is laid down as dotted and marked A. Another triangle, B, or a straight edge of some kind, is laid down against A. A is slid down on B until the point C is reached, and C and D are parallel.

Exactness.—It should not be necessary to say that accurate measurement is essential to make a good drawing. Using a ¼ in. scale the drawing is just 1/48 part the size of the building, and any mechanic knows how a trifling error of measurement sometimes makes trouble on even that. It is much more so on the paper, for the proportion is greater. With an architect's scale and a sharp pencil there is little excuse for getting out of the way. One error usually leads to several before the drawing goes far, and for this reason the main outlines especially should be carefully laid down first.

But sometimes the outside dimensions are changed to reduce the cost, or for some other purpose after the drawings are finished. To save the expense of making a new set of drawings the figures are merely altered. This is one good reason for marking all the main dimensions in figures. The ordinary architect cannot afford to make drawings twice for the small price he too often gets. For practical purposes a plan of this kind is as good to work from as one that is accurately scaled, but figures only have to be relied on. Those who have had anything to do with drawings of machinery know that they are purposely made out of scale, or "distorted," just to keep any one from scaling them. Figures only have to be relied on, and they are usually in inches, and not in feet and inches. Railroad engineers also make distorted scales; and when these two classes get along on this basis there is no reason for an architect to make up an entire set of new drawings just because a few feet have been added to or taken from the dimensions. Any mechanic who can measure work on a building with a rule need have no trouble when he turns to paper and a scale. Most of the difficulty is from the want of perseverance and not the want of ability. Can a man learn a trade in a few weeks? Or make good workmanship without practice? Why, then, expect a good drawing unless you serve a reasonable apprenticeship?

Lettering.—One of the troubles of the student is the lettering of a drawing. There are whole volumes devoted to this subject, and nine-tenths of what they say is useless to the man who has only a plain drawing to make.

There is one good system of lettering that all builders and tradesmen should follow, because it is the easiest to learn, the easiest to use, it takes less time than the others, and looks best. This is the single line slanting system, as shown under "Dimensions." The Roman, or capital letter kind, should not be attempted by the ordinary man who only occasionally makes a drawing. An otherwise fair drawing is often spoiled as to looks with capital lettering. The wrong system is followed, the difficult system, the one that trained draftsmen can use well enough, but that almost everybody else finds difficult and tedious.

The slanting, single stroke system is in use over many railroads on account of its manifest advantages. What is good enough for engineers and architects is surely suitable for tradesmen and contractors.

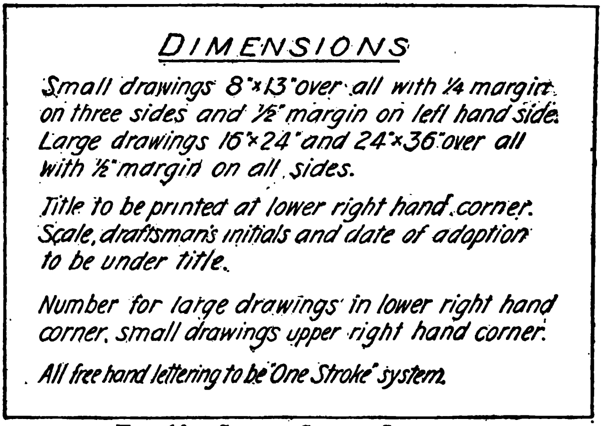


Fig. 13. Single Stroke Lettering

Before you start lettering draw a line with the T-square or triangle where desired, and another about an eighth of an inch from it, depending upon the size of the letters required. Do not attempt to make letters without these two lines. They are the guides. One advantage of this slanting system is that if the letters are all kept inside of the lines they look fairly well even if not regular. When learning to sharpen a saw the beginner is always warned not to make "sheep and lambs" of the teeth. Without the guide lines the amateur, or even the expert, is likely to mix his live stock in the same way with the letters.

Many draw a third line on top for the heads of the letters, and this is a good plan to follow, but it is not always necessary.

For the encouragement of beginners I may say that I have seen trained draftsmen make such poor lettering that almost any one could equal it. As a matter of fact, it is often the youngest and poorest paid boys who do the tracing. While good workmanship is desired, and in the best offices insisted on, it is recognized that figures and construction are what count, and that the lettering is only a secondary matter. It should be readable, and fairly regular, and with practice any one can make his style serve that far.

The lettering is first done in pencil, and can be erased and changed if desired before it is traced. Draftsmen sometimes make their first drawing on the tracing, but the beginner should not follow this system.

The names of rooms, such as Parlor, Kitchen, and so forth, should be put about the center of the space, or in such a place that they will look well. A little taste will help anyone to decide such minor points better than a page of instructions. A line of figures is usually put below to give the size of the room. Draw the guide lines for the figures as well as for the lettering.

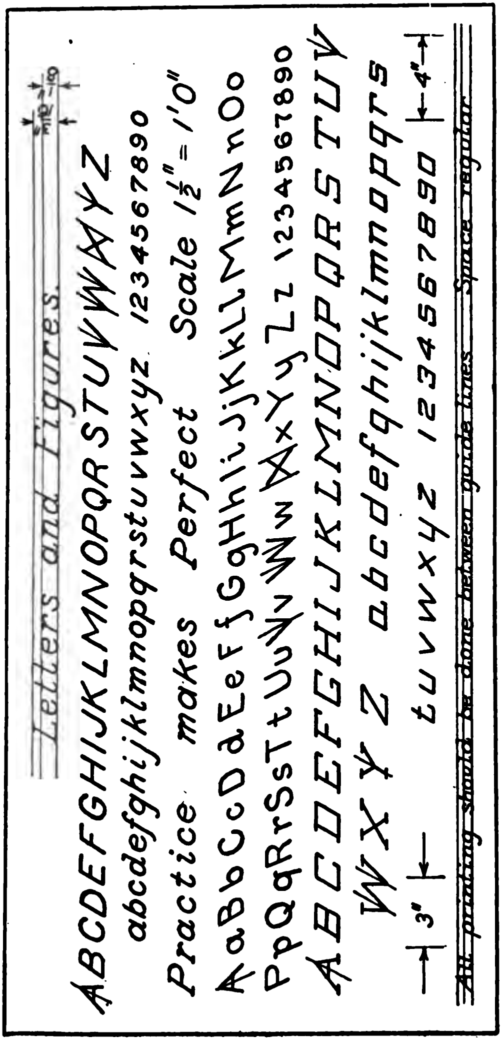


FIG. 14. SINGLE STROKE LETTERING

The samples Figs. 13 and 15 are given to draftsmen on several western railroads as standards to copy from. The perpendicular style is more difficult than the slanting, and defects of workmanship are easily seen. Keep to the slanting style. The figure 9 is often made in the ordinary way rather than as it shows in the samples, as this is easier.

Millions of dollars worth of work, engineering and building, has been done from drawings lettered according to these two samples, and most of it as shown under "Dimensions." It is thus suitable enough for any drawings that may be made by readers of this book. But as an illustration of theory contrasted with practice the sample from "The Building Age" is given. It is the work of E. H. Bentzel, Instructor in Drafting, Hampton Institute, Va. It is the best of various samples submitted by experts. The value of the guide lines is clearly shown. Both for size and style the line at top—Letters and Figures—is best for general use. The line at bottom is too small for the beginner, but has to be used in some parts of a drawing. The sloping lines of the capitals are made with a 60 degree triangle, regular or reversed.

It may be noticed that the samples give the same slope for all the letters, and the same spacing between the words. This means practice.

Of course the guide lines have to be put also on the tracing before the inking is done. This is as important as to put them on the paper draw-

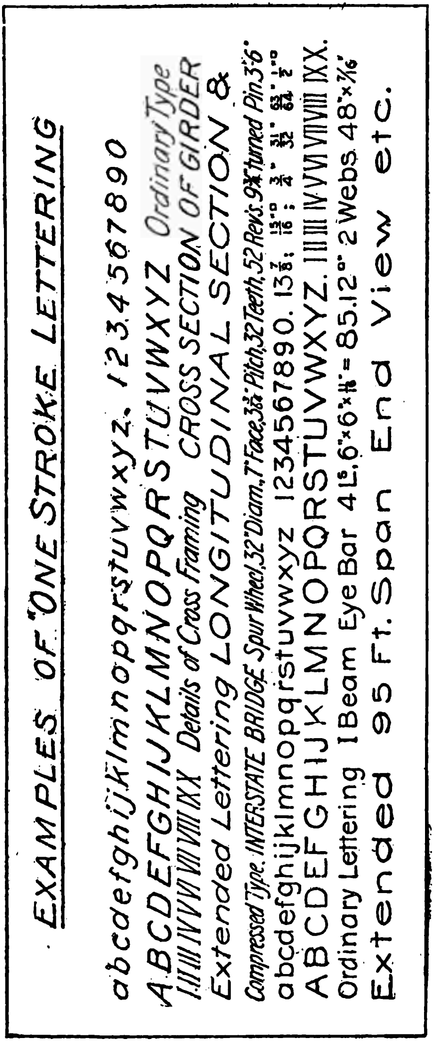


Fig. 15. Single Stroke Lettering

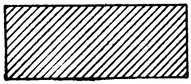
ing, for while the latter is thrown away the former is kept, and the work is seen as it shows there. The lines are made with a pencil, and are just clear enough to be seen. After the tracing is done they are erased. Under the title of the drawing, however, and often under the names of rooms, etc., a line is occasionally drawn in ink closely below the lettering. This hides some defects.

Heads Up.—Do not stand the letters upon their heads. Running across the board the words should be put just as they are in this book; that part is clear enough; but it is often forgotten that running the other way the heads should always be to the left. Some letter the left end of the drawing the right way, and when they turn to the right end head the words reversely, and thus put their soldiers feet to feet, as it were, rather than all facing in the one direction.

Section.—When the floor plans are finished in the rough it is best to make a section next. Do not make the elevations before the section. When that is made the heights can be easily run across to the elevations by the T-square. If the elevations are made first the cornice or other features are apt to be too high or too low. It would be bad practice to make the elevations first and square across from them to make the section, because the latter is laid out to scale more accurately than the former can be without too much trouble. For some cheap plans the section is often dotted in on the elevations to save expense.

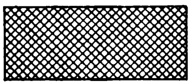
Sectioning.—Where walls are shown in section they are usually marked in some way. There is no fixed rule, for the various materials, and some offices follow a style that would not be permitted in others. The following standards are about as good as any.

1: Metal



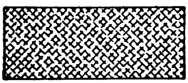
This style of sectioning should be used for all metals except when they belong to Class 2.

2: Poured into place hot



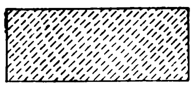
For materials that are to be melted and poured into place hot, and that set solid when cool. Babbit metal and similar alloys, lead, solder, sulphur, wax, paraffin and pitch are examples. It is also used for materials that are to be sofened by heat and squeezed into place.

3: Poured into place cold



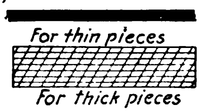
This will generally mean some kind of cement, as Portland and other hydraulic cements, Plaster of Paris, concrete, mortar. It should also be used for pasty or plastic materials, as tallow, putty, etc. when squeezed into place without being heated.

4: Fibrous or Flexible



This method is used for such materials as leather, leatheroid, rawhide, fibre, asbestos, felt, rubber, gutta-percha, ivory, bone, etc.

5: Flexible Insulation

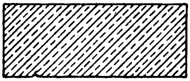


This style is intended for use especially in connection with electrical apparatus. Materials that would mechanically belong to the preceding class should have this sectioning when they are used for insulating purposes. Mica, paper, cloth, fibre, fullerboard and rubber are examples.

6: Wood. It is often desirable to imitate the grain

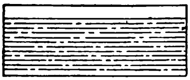
of wood whether in section or not.

7: Stone Glass



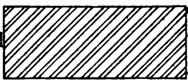
This sectioning should be used for materials that belong to the same general class as stone, marble, slate, soapstone, brick, terra-cotta, porcelain and glass.

8: Liquid



For all liquids that do not set solid at ordinary temperatures, as oil, water, alcohol, glycerine, turpentine.

9: Special



This sectioning should be used for materials that are entirely special, or that do not belong to one of the above classes.

FIG. 16. HOW TO DETAIL VARIOUS MATERIALS

There is a difference between a section and an elevation that some do not understand. The ends of open or exposed rafters on a bungalow roof are shown in elevation and not in section. They should not be sectioned. But when a line is cut back on the roof they show in section. On a finished house a photographer takes everything in elevation, and therefore no sectioning can be done on anything that shows in his picture; but if a part of the house were cut away and the ends of the timbers shown the sectioning should be done.

Changes.—Many changes have to be made to suit plans, elevations or sections. The floor plans being the most important and practically fixed as to size have to be laid out first, but when a rough idea of what is wanted is gained many factors have to be modified to make the work go forward as a whole. The chimney that comes in the right place in the first floor might cut through the best bedroom on the second, and land in the center of the attic stair.

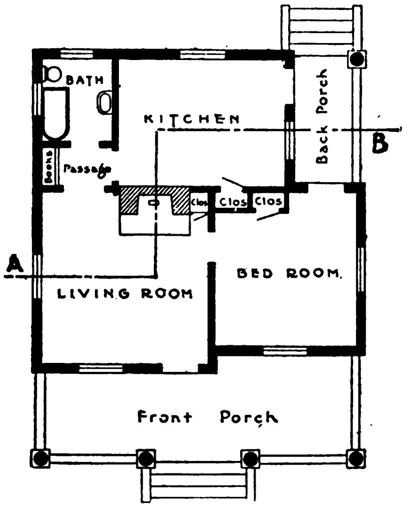


FIG. 17. SHOWING SECTION LINE A. B.

The sectional line is sometimes made with a "jog" in order to show what would not be seen on a straight line. The line A B shows how this may be done. At A the section through a room may be given on the same sheet that shows the interior of another room at B.

Dotting.—What comes above or below the floor is dotted. Thus, the beam design of a dining room ceiling may be, and often is, shown on the first floor plan. Footings, girders, and pipes are laid out in this way. (See Fig. 18.)

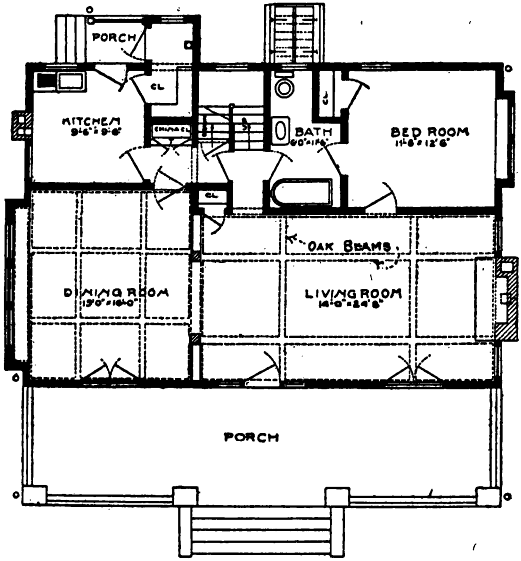


FIG. 18. METHOD OF DOTTING

Symmetry.—A draftsman will save himself much trouble and do just as good work if he will remember that a plan is always symmetrical unless otherwise cxpressed. He can reverse the maxim if he likes and say that a plan is never symmetrical unless clearly shown to be so, but by doing this he will land himself into unnecessary trouble. Many a man would save himself some of that if he would only give builders credit for knowing a good deal about their own business.

If you saw a door or window in a gable and no distance was marked, where would you put it if it looked to be in the center? Properly, the distance to center should be marked, but if not, would you assume that the idea was to make the center of the window coincide with the center of the gable? Or if two windows were shown and the distance of one only happened to be marked 24 in. from the corner, would you assume that the other was the same distance if there were no figure, and it looked to be about the same place?

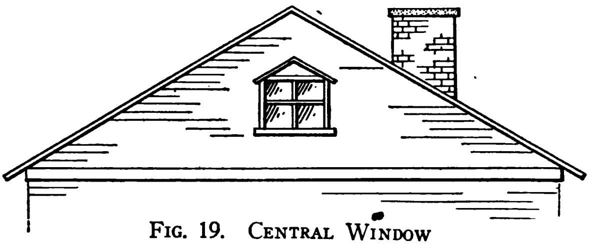


FIG. 19. CENTRAL WINDOW

If not, why not? Or if you saw a chimney breast with the usual pier on each side and the size of the opening and one pier marked, would you not take it for granted that the other pier was the same size?

I have seen drawings so plastered over with useless figures that they should have been exhibited as curiosities. Most of the waste work came from the acceptance of the wrong theory that a plan is unsymmetrical unless it is otherwise shown. There is sometimes "nothing to show" that such and such things are so, except common sense.

Centers.—In general, the best way to mark distances of windows and openings is to the center. Then if the millwork comes too wide, or narrower than is expected, there is no trouble. In the main plans window boxes should not be drawn. A line should be drawn across at each end and two or

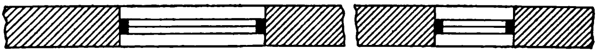


FIG. 20. WINDOW BOXES

three lines between. Everyone in the business knows what this means. It is a waste of time to make boxes. Even with details for ordinary work it is not necessary, as all the mills follow the standards. In detail drawing no scale less than ½ in. to the foot should be used.

The accompanying illustration shows a wide and narrow window in a clear enough way.

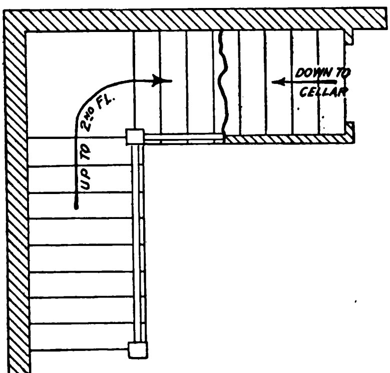


FIG. 21. DIAGRAM ILLUSTRATING USE OF "BREAK" LINE

Breaking.—When it is not desired or necessary to show a wall, stair, or other feature of a building in full, the lines are broken, as shown. By this method it is possible to show parts of two stairs on the same drawing—the one going up and the other down, with the lines broken where they meet.

Dimensions.—In general, the distances on the level should be given on the plan, and the heights on the section only, and not on elevations.

Do not be too theoretical. Building is not exactly like watchmaking. Some of the office men would faint if they knew how their nice little figures are handled to suit unwieldy stones, coarse brick and dirty mortar. I once worked from a drawing sent out from a large railroad on the Pacific Coast where the brickwork was figured to 1/64 of an inch. That was in the office; on the building I have seen a brick wall laid up two inches out of plumb without anyone being the wiser. We are all in the same business; let us make a compromise: If the office will agree not to get lower than the 1/8 inch unit, the men on the wall will guarantee not to swing over more than an inch.

Lumber lists and millbooks should be consulted in order to keep to standard sizes. They cost much less, and for general purposes are better than some of the special designs.

Repeating.—Where there are many windows and doors on plain buildings, show a few detailed out with the lights or panes on an elevation, and leave the others in outline only.

Glass.—The size of glass should be marked whenever it is possible to do so. This is in justice to the millman who has had to suffer too often. It is easy to measure 2 in. or even 4 in. too narrow on an eighth scale drawing, and this counts, in plate glass especially. It must be remembered that the width of glass is always marked first, and the height next. Thus a sash would be 32 x 30 when it was to be wider than high, and 30 x 32 when narrower than high. Wider than high costs a little more, so in general it is better to keep the width not more than the height.

Direction of Timbers.—If there is any chance of mistake on floors or roof the direction of the timbers should be marked with an arrow. For cut-up roofs a plan should be made. It may be dotted on the second floor plan to save expense on a cheap house. If four elevations are given the style of the roof is seen at a glance, but two are usually made to serve for an ordinary dwelling.

Tracing.—After the paper drawing is finished it has to be traced. There is nothing very difficult about the process of tracing.

With thumb tacks fasten the cloth down upon the paper with the dull side up. Then take white chalk, magnesia, or some powder that is sold by the dealers, and rub the cloth all over with it. If magnesia is used the better way is to scrape some of it off with a knife and thus make a powder that will not injure the surface of the tracing cloth. After rubbing it all over wipe it clean, so as to leave no grit to run into the pen, and it is ready for inking.

There are many who have trouble in making ink flow on the tracing cloth. They sometimes forget to use chalk, but usually the difficulty arises from an unclean pen. The drawing pen must be kept clean with a piece of cloth. The pen is not dipped in the ink, but filled from the quill.

Lines.—Do not make fine hair lines. It is easy enough to do this, but the blue print made from the tracing is not so good. Plans are made for use, and not for exhibition. A clear bold line should be made, not too heavy, but rather that than too light. When working around a building, or in a dark corner, there is no satisfaction but considerable provocation in having a print that cannot be easily seen.

If any circle work is shown always make it first and join the straight line to it. This is much the easier way. If the straight line is drawn it is not so easy to make the circle strike it.

Erasing.—If a mistake is made or a change considered necessary after the tracing is done the only way is to rub out the ink. Draftsmen say that it is a poor kind of a tracing that does not have some erasures. The work should be gone about in a reasonable way, and the rubbing should not be done too hard or hurriedly. Above all, the cloth should not be ruffled. It is easy enough to erase the lines, and the patching can be done without showing. There are draftsmen who rub a hole in the cloth through carelessness.

Method.—In general, begin inking at the top of the drawing and work down. Make all the lines that can be made with the T-square, running from left to right, and then take the triangle and work from the left-hand side of the board to the right, cleaning up the main lines as you go.

Title.—There are various styles of titles. The following will give a suggestion for one:

Plan of House for
J. B. Allen
Scale ¼″=1 ft.
Date, Dec. 13, 1916
Drawing No. 23
C. Inigo Wren, Architect,
Ithaca, N. Y.

Under each plan or elevation a small sub-title, or legend, is put, such as, First Floor Plan, Front Elevation, Section, or whatever it may be.

Where there are several draftsmen, the one who made the drawing, the tracer, and the checker have to put their initials near the title, so that the responsibility for mistakes may be properly placed.

Dimension Lines.—Sometimes diluted ink is used for these instead of the common black. Water is added to the India ink until the right shade is obtained. This gives a distinction between the lines of the building proper and the working lines of the drawing. The figures are put in black.

Conventional Signs.—The man for whom this chapter is written is not at first likely to need many standard working signs, but it is easy enough to find them if desired. The sectioning has been already given. The steel handbooks, such as Carnegie's, will give the signs for riveting, and standard connections for all sizes of beams, etc.; the National Electrical Contractors' Association of the United States has issued two large pages of symbols for their work and rubber stamps to save lettering. The following colors are used for heating plans:

Air

Fresh cold air.................................Light Green
Fresh warmed air (warm air chambers).........Carmine
Mixed air (warm and cold)......................Yellow
Vitiated air (ventilating flues).......................Blue
Circulating or reheated air..........................Violet
Cross sections in dark tones, vertical sections in lighter tones.

Constructive Parts

All iron parts, such as boilers, doors, stairs, engines, blowers, dampers, chains, registers, heating pipes, traps, expansion tanks, etc.................Blue lines
Steam radiators..............Blue edge filled with Green
Water radiators................Blue edge filled with Blue
Direct indirect radiators. ....Blue edge filled with Yellow
Low pressure steam pipes........................Orange
High pressure steam pipes.......................Carmine
Return steam pipes..........................Dark Green
Hot water flow pipes............................Sienna
Hot water return pipes.............................Blue
Air vent pipes.......................................Blue
Cold water supply pipes..........................Violet
Overflow pipes.....................................Brown

Coloring Blue Prints.—Use Windsor and Newton's materials mixed with water. Put on the lines with a drawing pen the same as for ink.

The color must be thin enough to flow. Red is the standard color for brick and yellow for wood. Some architects take a brush after the lines are put on and fill in the wall with the color.

Blue Printing.—Send to any of the manufacturers of drawing materials for instructions, and so get the experience of others for nothing. Some of them are Eugene Dietzgen and Co., Chicago and New York; Keuffel and Esser Co., Chicago, New York, St. Louis, San Francisco; and the two great mail order houses of Chicago.

Architect's Charges.—The usual charge for ordinary work is five to six per cent. upon the total cost of the work for plans, specifications, and superintendence; or three and one-half to four per cent. for plans and specifications alone. Because of the increase for office expenses the New York Chapter of the American Institute of Architects raised their minimum from five to six %.

For fine residence work some architects get ten per cent.; but quite a good deal of residence architecture is done for five. For alterations ten per cent. is the charge by some, and five by others. It all depends upon how the finances are. A rich man can refuse what a poor man is glad to get. Somehow, architects do not like those who cut below the prevailing rates. This cutting is pardonable, even commendable, quite a few of them think, for bricklayers, and other tradesmen, but not for the quality.

Traveling expenses are charged in addition to the percentages.

The drawings and specifications are the property of the architect when the work is finished. The house or building belongs to the owner, but the plans and specifications are not his any more than the hammers, saws, and trowels that it took to build it. In other words, the plans and specifications are only tools or instruments belonging to the architect that he has to use to construct a building for the owner. Every owner should take care, however, to get a set of blue prints in case of any alterations, fire, or other contingency, but with the understanding that he was not to use the plans to build another house from them without paying the architect.

Time of Payment.—When the first sketches are finished the architect gets one-fifth of the entire fee; when all the plans and specifications are ready, two-fifths; and the other two-fifths from time to time as the work goes on.

Sizes of Drawings.—The left hand margins of the sheets is made wider than the others to allow for bindings. An endeavor has been made by trade papers to have manufacturers adopt the standard sizes for catalogues and pamphlets. The market used to be filled with dozens of various shapes and sizes. It is just as desirable for those who make drawings to adopt a set of standard sizes instead of working on scraps of tracing cloth. Drawings should be preserved in case of fire, valuations, or alterations, or to show to a client who may want a house like another already built.

Several illustrations will now be given of actual plans to show how the various parts of a building are drawn. Two floor plans for a house designed by T. P. Walker, Hingham, Mass., and taken from "The Building Age," are first presented:

The lettering system is different from the one recommended, but is common among architects. The windows are drawn in the proper way without showing boxes, which is unnecessary even on

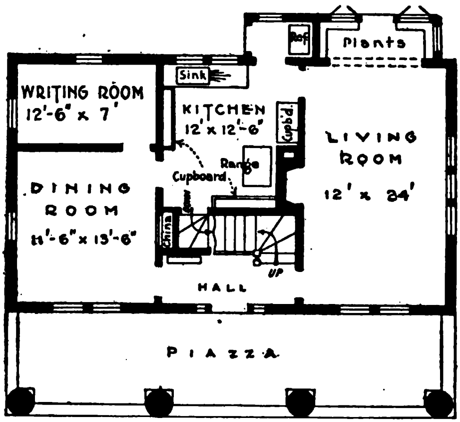


FIG. 22. MAIN FLOOR PLAN

a large scale drawing. The broken line, already referred to, is seen at the stairs. This shows part of both stairs on the same floor plan—the one going up and the other going down. The arrow points the direction. The method of showing French windows, which open like a door, it seen at Plants. The sink is drawn in the usual manner. The walls and partitions of such ordinary houses, on a ¼ in. scale, are ordinarily shown with two lines only, and not solid, although this is customary in drawings on a small scale for books and magazines.

The second floor is laid out in the same way as the first. The arrow shows the main stair going down, consequently the one without an arrow must go up. The broken line is again seen. The bathroom is detailed in the common way, and the

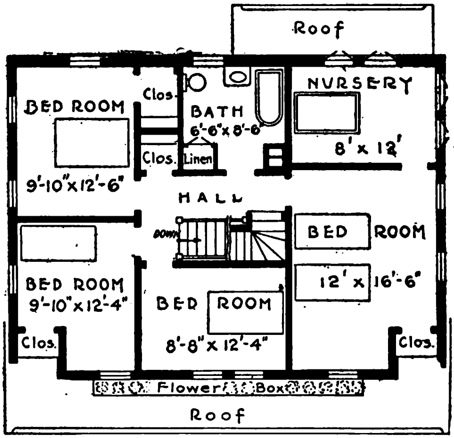


Fig. 23. Second Floor Plan

end of the tub gives an illustration where the circle has to be drawn first and the straight lines joined afterward to it, as already cautioned.

The method of indicating the names of rooms and the sizes is clear. In a working plan a short straight line is always drawn to show the doors and the side upon which they are hinged, just as with the windows in the Plant room. An arrow is used to call attention to a certain feature, as at cupboard in the kitchen, where one lettering serves for two cases.

The vertical section through the piazza gives an illustration of detailing and lettering. In both

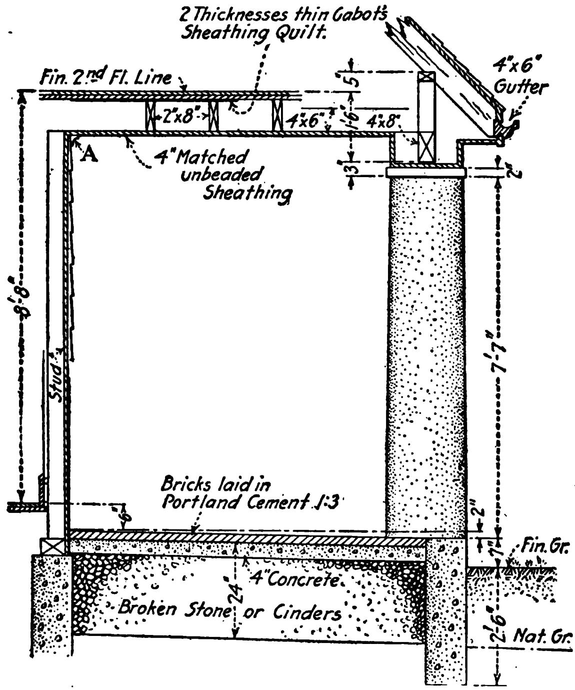


Fig. 24. Vertical Section Through Piazza

floor plans and this one the scale is made small to suit the page, and the drawings are clear enough without taking up too much room. In actual practice the floor plans are made ¼ in. to the foot, and the details at least ¾ in.

A bungalow floor plan from "The Building Age" is now presented. The entire blue prints of plans, elevations, constructive details, and type-written specifications for this design, No. 680,

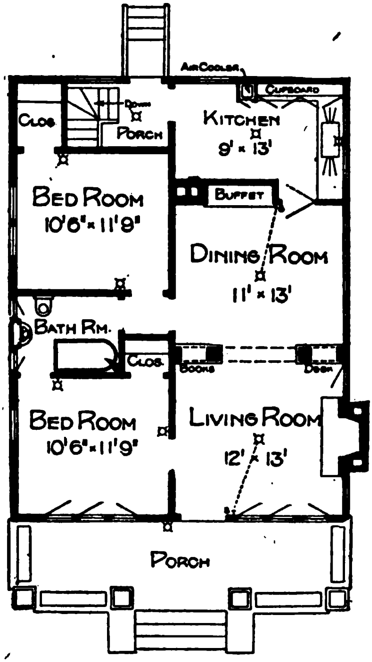


Fig. 25. Floor Plan of Bungalow

may be had from David Williams Company, New York, for $10. It is a good idea for beginners to purchase such a set and see how the actual work is done.

It may be seen that the French windows in this case open in instead of out, as in the other plan.

There is no stair except the one to the basement, with the usual arrow and Down marked. Up and Down must be marked to show direction. The sink has a double dripboard with the usual short angle lines. There is not a pantry in either house. The places for electric lights are marked on this plan by a small circle and four dots. Some are center lights, and others go at the wall.

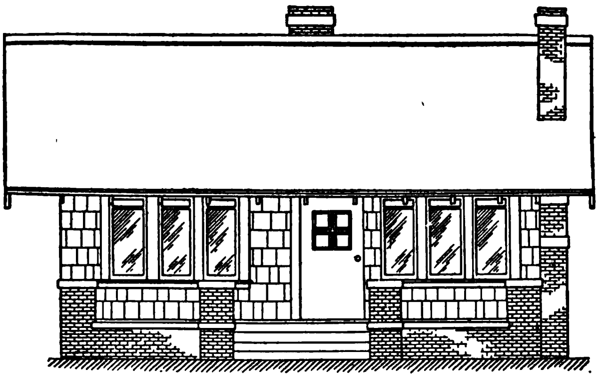


FIG. 26. FRONT ELEVATION

In a working plan the furnace outlets are also marked, or the radiators. The swinging door between the kitchen and the dining room is shown solid and dotted. The ordinary door is shown by a solid line only.

The front elevation is drawn in the ordinary maner, but lacks one feature that millmen especially like to see—the sizes of the window glass. which should always be marked. For ordinary purposes the brick are seldom detailed out, as on this elevation.

The section is now given to show how the heights are marked. When there is not room to make a clear figure of thickness in a wall, two arrows are used and the figure put outside, as 10 in the basement wall. Unless angle sheathing is

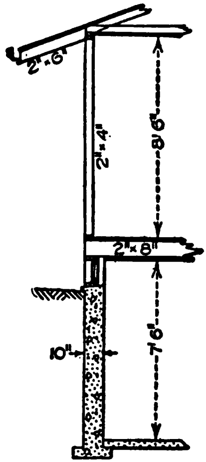


FIG. 27. SECTION THROUGH MAIN WALL

used the system of laying the plate on top of the joists, as here, is condemned in my "Home Builders' Guide," page 167, the Tornado chapter.

A drawing of another kind is now given. This is a floor plan and section of a large barn by W. E. Frudden in "The Building Age." The method of showing tile drains is indicated, and this suits for a cottage as well as for a barn or

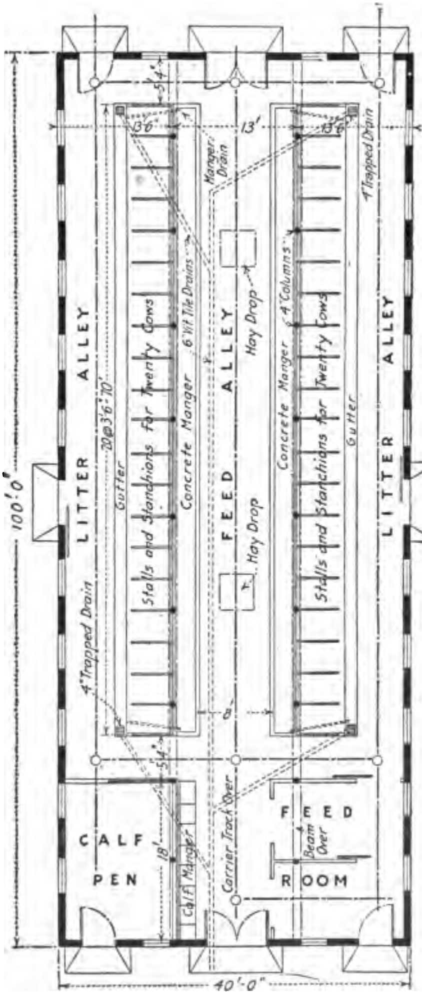


Fig. 28. Floor Plan of Barn

any building. They are dotted to show that they are below the floor level. The windows are not

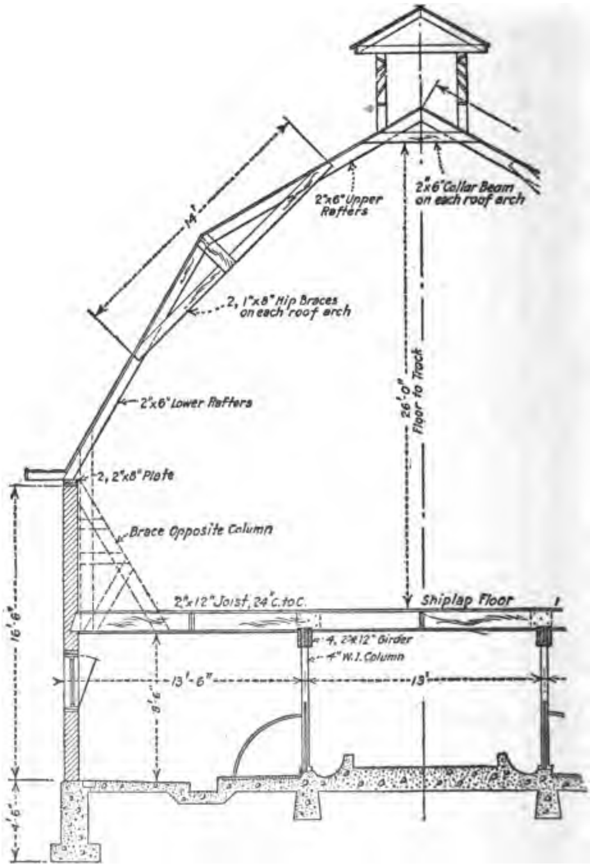


Fig. 29. Vertical Section Through Cow Stalls

of the ordinary hung kind, but in this case also they are properly drawn with plain lines. The excellent lettering should be noted. It is easily seen that such regularity would not be possible without guide lines, both on the paper and the tracing.

A cut of the section is given, with the sizes of the rafters, the detail of the concrete floor, and the joists above for the grain and hay floor. By photographing down these two drawings to suit the page size of this book the lettering is slightly reduced.

By paying attention to the principles upon which this and such drawings are made, and with continual practice the student or tradesman can soon learn to make a fair drawing—if "soon" seems long with some they should remember that the best piano players are those who have blistered their fingers. Drawing makes less noise.

One of the best and cheapest ways of gathering information and seeing excellent illustrations and detailed drawings every month, is to subscribe to a good building trade journal.

Therefore, in estimating and in drawing, persevere, for now as in the fable the tortoise often beats the hare.

KEY TO REVIEWS

CHAPTER I

1. It may be very wet, dry, or rock. **2.** It may be so hot that the men cannot do a full day's work, or so hard with frost that the labor bill runs beyond all reason. **3.** The deeper, the more expensive. **4.** Rock. **5.** Trenches, pits, and such features. **6.** The cubic yard. **7.** About a foot. **8.** As much as 50 per cent. at times. The nature of the soil has to be studied. **9.** A deep pit $3. **10.** From 10 to 12 cents per lineal foot. **11.** About $12 per 1,000 ft. board measure with wages at 40 cents per hour.

CHAPTER II

1. Air spaces. **2.** By pouring in water. **3.** A measure of 1 part cement, 3 sand, and 6 of crushed stone. **4.** The complete contents of a barrel, and not the number of cubic feet measured after the cement is spread out. **5.** 1:3:6 and 1:2:4 or even 1:1½:4. **6.** 4. **7.** 3.8. or 3⅘. **8.** 1 part cement to 5 of the aggregate. **9.** 37 to 39. **10.** 2,300, ⅗, 1$\frac{1}{10}$. **11.** 140 to 150 lbs. **12.** 376 to 380 lbs. **13.** 94 to 95 lbs. **14.** 75 to 90 lbs. **15.** 50 cents **16.** 50. **17.** 1.50 to $3. **18.** Molds to hold concrete, as a pail holds water. **19.** Owing to the many angles. **20.** Removing forms before concrete is properly hardened. **21.** Most of the extra lies in the cost of cement. **22.** Yes. There are differences in "concrete" the same as in clothes. **23.** By finding the number of cubic yards in the base, and adding the top surfacing. **24.** Actual contents only.

CHAPTER III

1. In wall measure a cubic foot has **always** 22½ brick, regardless of their size, while kiln count means the actual number. This, depending upon size, may be from 16 to 20. **2.** The trade rules—given in the "New Building Estimator"—double corners, allow extra at angles, include most openings, and have a score of exceptions to rule. Actual quantity measurement takes in nothing but what is laid in the wall. **3.** 2,250. **4.** Each course may be taken by itself, or several courses may be averaged and added together, or the cubic feet may be taken and multiplied by 22½ for the wall measure. **5.** As a wall, of whatever thickness they are: a 4½ pilaster is thus taken as a wall of that thickness. **6.** The wall is estimated full thickness in common brick, and the cost of the pressed brick delivered is added without deduction for the course of common not required. **7.** A bed of mortar is laid, and the brick pushed in it to its place. **8.** From 40 to 400. **9.** Cheap common brick. **10.** Cement or lime, sand, and water. This last item is usually easily obtained, but contractors have to watch to see if a well does not have to be sunk, or water hauled. **11.** One barrel of Portland cement, say the manufacturers, but this is too little; one barrel of lime is too much, half a yard of sand is usually too little: 50 lbs. mortar color; 400 lbs. fire clay. **12.** Anyone can do it after trying often enough. **13.** Profit, fire and liability insurance, wear and tear of scaffolding, etc., telephone, office rent, if any, and other expenses. **14.** No. **15.** Something that does not change, like the unit of 22½ in measuring brickwork for wall measure.

CHAPTER IV

1. Actual contents only. **2.** 3,456. **3.** 1¾ bbls. of Portland cement, or 1½ bbls. of lime, with a yard of sand to each. **4.** 3 to 6. **5.** Bedford, Ind. **6.** Usually a little higher. **7.** Stronger. **8.** Usually the face is made of a richer mixture, but if too rich fine cracks appear.

CHAPTER V

1. By the actual surface covered only. **2.** 2. **3.** 3. **4.** More. **5.** 2. **6.** 1,450 to 1,500 of the long; 2,200 of the short. **7.** About 12 cents per yard, but depending upon local prices and quality of metal. If plaster is included, 30 cents for a finished yard of wall. **8.** 1¾ and 2¾. **9.** 3 cents per yard. **10.** $1.25 to $1.75.

CHAPTER VI

1. Because the price per 1,000 rises after 16 ft. long, and is extra high on the longest lengths. **2.** By the 1,000 ft. board measure. **3.** By the square of 100 sq. ft. **4.** See the tables. **5.** To make allowance for matching the boards, and for waste. **6.** 22. **7.** Timbers laid and nailed so solid that lath cannot run from room to room. **8.** By figuring the number of square feet. Yes; by figuring on the level, and adding a percentage for the slope. **9.** Yes: see table. **10.** A system whereby all timbers are allowed at 1 in. thick. Thus, a timber 12 x 12 in. x 12 ft, long has 144 feet in board measure. **11.** 800 to 1,000. **12.** 100 sq. ft. **13.** By machine. **14.** Depends. **15.** Yes, for there used to be a limit for a death, but in some states there is no limit now. **16.** Yes, always to suit the local rates. **17.** Clear at the end. **18.** The proportion between the total width and the rise.

CHAPTER VII

1. The one is single thick, and the other double. **2.** 1⅜ in. **3.** The same. **4.** 17 to 40 cents. But this is only for common stock. **5.** Quarter sawed, narrow, white oak. **6.** At so much per step for ordinary work. **7.** Damp. **8.** Shrinkage.

CHAPTER VIII

1. .26 lb. to cubic inch. **2.** $5. **3.** a, 450 lbs., b, 480, c, 490. **4.** 40 lbs. **5.** 10 lbs. **6.** $4 to $9 per square of 100 sq. ft. **7.** 26. **8.** Lighter.

CHAPTER IX

1. 6 to 10. **2.** 100. **3.** 650 to 800 lbs. **4.** 900

to 2,500 lbs. **5.** A water-tight roof in regions where rain falls.

CHAPTER X

1. By actual surface. **2.** White lead and oil. **3.** Zinc. **4.** Cold water paint. **5.** Twice as much. **6.** Only the highest priced paints are. **7.** By getting the square feet, deducting for openings and dividing by 60 for double rolls.

CHAPTER XI

1. 80. **2.** A tank. **3.** To withstand the calking of the joints. **4.** 2 ft. 10 in. to top, unless the woman who is to use it requires a lower height. **5.** 15 cents. **6.** 8 Times as much. **7.** The water goes on the floor and rises, if all is water-tight, while the heat goes to the ceiling and falls. **8.** That depends upon the kind of building and the amount of heat required. The number of square feet is regulated to suit a warehouse, for example, that needs only the chill taken off the air, and an office that requires from 68 to 70 degrees.

CHAPTER XII

1. There is no chance for fire, owing to mice, rats, fraying, etc. **2.** Because verdicts run to very large sums for death or accident. **3.** Whenever he drops his bid in a mail chute, or post-office box the power of backing out is withdrawn from him. **4.** Anything that the court decides. **5.** If you don't you ought to.

INDEX

A — PAGE

Accidents 105
Actual quantities...... 34
Anchors 72, 122
Architects' charges 189
Areas of circles...158, 159
Asbestos shingles 131
Ashlar 60

B

Barn ....196 to 199
Barrel, capacity........ 156
Barrett roofing 131
Base 80, 107
Baths 143
Bids, no backing out.. 151
Blocks, cement ..61, 62, 63
Boiler, dwelling....... 143
Bonds, liability 150
Brass cast, weight of.. 157
Brass rolled, weight of. 157
Break lines 183
Brickwork 34
  basement plan....... 42
  cesspools 56
  chimneys 38, 39
  cisterns ....52 to 55
  coping 46
  cornices 39, 44, 100
  detailed cost.......49, 50
  footings 37, 44
  hollow walls......... 40
  labor on....47, 48, 50, 51
  measurement 34, 35, 39, 40, 42 to 47
  mortar 52
  number laid........48, 51
  pilasters 39, 44, 45
  pointing 56
  pressed 40, 46
  quantities required.36, 49
  rule 36
  sand 52

PAGE

Brickwork—
  shoved, struck........ 41
  size of brick........ 35
  unloading 56
  weight of 157
Brick vs. frame.159 to 161
Brick walls, cost per sq. 162, 163
Bridging 72

C

Caissons 13, 23
Canvas roofing 130
Capacities of
  barrel 156
  cisterns 156
  tanks 156
Carey roofing 129
Carpenter labor 78
Casings 117
Ceilings 76
Ceilings, height 144
Ceilings, metal 125
Ceiling wainscoting.... 80
Cellar plaster 68
Cement blocks....61, 62, 63
Cement, Portland...... 68
Cement, weight of 157
Centering drawings.... 183
Certainteed roofing.... 131
Cesspools 56
Charges, architects'.... 189
Chimneys 38, 39
China closets.......... 100
Cinder concrete 21
Circles, properties of 53, 54, 158, 159
Cisterns ....52 to 55
Clay 130
Closets, china.......... 100
  water 142
Cold water paints..... 134
Compo board 68

PAGE

Concrete 16
cinder 21
detailed 27, 28, 30, 31
floors, cost........29, 30
forms ....23 to 26
heating 21
labor on........22, 23, 24
material required..20, 30
measurement 16
proportions .....17 to 20
sidewalks 29, 31
voids 16, 17, 19
weight of 157
Coping, wall........... 46
Copper roofing 129
Cord, sash 148
Cornices 39, 44, 100, 126
Costs, detailed
brickwork 49, 50
brick walls per sq... 162
cement blocks 62
chimneys 39
cistern brick 54, 56
concrete floors 29, 30
concrete forms 25
concrete, 1:3:6 proportions 27
concrete, 1:2:4 proportions 27
concrete, 1:4:8 proportions 28
doors ....114 to 116
exteriors plastered . 161
floor joists 72, 73
floors ....
glass ....107 to 109
lime plaster 67
lumber 72
partition, 10 sqs. 98
painting 134
plaster 66
plastered exteriors . 161
porch enclosing 104
roofing, sq. of ...97, 128
rubble in cement and lime 59

PAGE

Costs, detailed—
sash ....109 to 111
sewer pipe 142
sheet metal work.... 128
soil pipe 142
stonework 59
wall 2 x 4 studs 160
wall 2 x 6 studs 160
wall, sq. of.......... 90
walls, brick, per sq.. 162
windows 109-111-113
wrought iron pipe... 142
Counters 119
Cost keeping.......... 154

D

Damp buildings 119
Danger 105
Doors and windows.... 81
Downspouts 127
Drafting ....164 to 199
architects' charges.... 189
breaking lines....... 183
centering 183
dimensions 184, 187
floor plans 180, 181, 191, 192, 197
glass 185
lettering ......172 to 177
materials .....164 to 166
methods ......167 to 171
sectioning ....177 to 179
sections 193, 196, 198
sizes of sheets....... 190
standards 188
symmetry 181, 182
titles 187
tracing ....185 to 187

E

Electric wiring, etc.... 149
Enamel paint 133
Excavation ....9 to 15
caisson 13
Chicago rule 12

PAGE

Excavation—
engineer's levels..... 12
rock 11
trenches 12

F

Ferge's lumber tables, quantity and price..82-85
Fire insurance......... 151
Flat bar iron weight... 123
Flex-A-Tile roofing.... 131
Flooring 76, 152
Floors, concrete....... 29
Floors, (see woodwork)
Floors, hardwood .117, 152
Floors, smoothing 100
Floor tiles.........149, 150
Floor plans ...180, 191, 197
Flow of water 140
Footings, brick.......37, 44
Forms, concrete 23, 25
Frame vs. brick....159, 161
Furnace heating 143
Furring 99, 125, 161

G

Galvanized iron roofing 128, 129
Galvanized sheets 125
Glass ......107 to 109, 130
Glass drawing 185
Glass setting.......... 108
Graining 134
Graphite paint 136
Gravel roofing 129
Granite, weight of 157
Grillage, wood......... 14
Grounds 99
Gutters, sheet metal.... 127

H

Hardware 146
nail tables.......146, 147
sash cord 148
sash weights 148
shelf hardware...... 148
Heating 143

PAGE

Heating—
concrete 21
furnace 143
hot water........... 144
plaster 68
steam 144, 145

I

Insurance fire 151
Iron and steel......... 120
anchors 122
cast, weight of 127
flat bar.............. 123
galv. roofing ...128, 129
plate 122
round 124
setting 122
square 123
weights 120-124, 157
wrought, weight 157

J

Joists to sq.....72, 73, 86

L

Labor
base 80
blinds 80
brickwork..47, 48, 50, 51
carpenter 78
ceiling 80
concrete 22, 23, 24
doors 80
floors 79
forms, concrete 25
grillage 14
per square 72
pipe laying 140
plaster 67
shelving 81
sheet metal work.... 125
shingling 80
sideboard 81
siding 80
stairs 82
stonework 58
wainscoting 80

PAGE

Labor—
windows 80
woodwork .....77 to 90
Lath 65, 67
Lettering ....172 to 177
Liability bonds........ 150
Lead, weight of 157
Lime plaster 67
Lime, weight of 157
Limestone and marble. 157
Lumber tables...83-85, 153
Lumber measurement 152
Lumber weight 152

M

Mantels 39
Masonry, weight of .. 157
Materials
concrete 20, 30
drawing ......164 to 166
paint 136
plaster 66
woodwork 70
Materials, weight of... 157
Measurement of
brickwork 34, 39, 42
concrete 16
lumber 152
painting 132
plaster 65
roofing ....91 to 95
stonework 58, 60
Metal ceilings 125
Metal lath 65
Metal work, sheet...... 125
Millwork 107
base 117
casings 117
counters 119
damp 119
doors, cost of.114 to 116
flooring, hardwood.. 117
glass prices ...107 to 109
glass setting 108
sash, cost of..109 to 111
stairs 117, 118
storm sash.......... 113

PAGE

Millwork—
window, detailed cost 113
window frames...... 112
Mineral wool.......... 150
Moldings 154
Mortar 52, 58

N

Nails 146, 147

P

Painting 132
brickwork 56
cold water.......134, 135
cost of.............. 134
enamel 133
graphite 136
measurement 132
quantities 135, 136
ready mixed......... 138
red lead............. 137
shingle stains........ 136
special materials..... 136
wall coverings....... 137
wall paper........... 138
Pantries 100
Partitions 98
Pilaster's brick..39, 44, 45
Piling 13, 14
Pitch roofing ...92, 94, 96
Plaster 65
cellar 68
Compo board........ 68
cost 66
exterior 68, 161
heating 68
labor on............. 67
lath 67
material required..66, 67
measurement 65
metal lath........... 65
number of coats..... 65
of Paris, weight of.. 157
Portland cement..... 68
Sackett board....... 68
sand 67
plate iron, weight of. 122

PAGE

Plumbing 139
  baths 143
  gas pipe............ 143
  labor laying pipe.... 140
  setting fixtures...... 141
  sewers 141, 142
  sinks 142
  soil pipe.........141, 142
  tanks 140
  urinals 142
  vent pipe........141, 142
  water closets........ 142
  water supply.....139, 140
  wrought iron pipe... 142
Porches 99, 104
Pressed brick 40, 46
Profits 4, 5, 29, 77
Proportions, concrete.. 17

Q

Quantities 34
  brick required 36, 49
  boards and edged
    stuff 84
  cement 31
  concrete ..20, 25, 27,
    28, 31
  flooring 76, 85
  flooring, matched ... 85
  lumber ....83 to 85
  paint 135, 136
  pieced stuff 83, 84
  sand 31
  shingles 97
  siding 85
  taking off 70
  woodwork ..76, 83 to 85

R

Rafters, length.....154, 155
Ready mixed paints.... 138
Red lead paints........ 137
Repairs, danger........ 151
Rock excavation 11

PAGE

Roofing 129
  asbestos shingles..... 131
  Barrett specification. 130
  B. M. to square..... 96
  canvas 130
  Carey, cost per sq. .. 129
  Certainteed 131
  copper, cost per sq... 129
  Elaterite, cost per sq. 129
  Flex-A-Tile 131
  gravel, cost per sq.. 129
  tin, cost per sq...... 129
  measurement rule 91 to 95
  pitch 92, 94, 96
  slate 129
  tile, cost per sq...... 129
  tile, clay, glass...129, 130
  Ruberoid, cost per sq. 129
Roofs, sheet metal.... 128
  labor on wood....... 91
Round iron, weight of. 124
Rubble 58
Ruberoid roofing 129

S

Sackett board 68
Sand ...29, 31, 49, 52, 157
Sandstone, weight of.. 157
Sash cord 148
Sash, weights 148
Sectioning drawings .. 177
Setting glass 108
Setting iron and steel.. 122
  plumbing fixtures ... 141
Sewers 141
Sheet metal........... 125
  ceilings 125
  cornices 126
  cost of sq........... 128
  downspouts 127
  galv. sheets.......... 125
  gutters 127
  labor 125, 126
  quality 128
  roofs 128, 129
  skylights 127
  ventilators 127

PAGE

Sheets of drawing paper, size of 190
Shelf hardware 148
Shelving, labor on..... 81
Shingle stains 136
Shingles, asbestos...... 131
Shingle quantities..... 97
Shingles, wood........ 80
Shoved brickwork 41
Sideboards 81
Sidewalks, concrete.... 29
Siding to square....... 85
Sinks 142
Size of brick.......... 35
Sizes, standard........ 151
Skylights 127
Slate, weight of 157
Slate roofing 129
Sleepers, labor on..... 81
Snow, weight of 157
Soil pipe 141, 142
Square iron and steel.. 123
Square root........... 154
Squaring a house...... 155
Stain, shingle 136
Stairs 82, 117, 118
Steam heating 144, 145
Steel and iron......... 120
Steel, weight of 157
Stonework 58
  ashlar 60
  cement blocks....... 60
  cost 59
  details 59
  labor 58
  measurement 58, 60
  mortar 58
  rubble 58
Studs 88
Sun parlor....101, 103, 104
Symmetry in drawing.. 181

T

Tanks 140
Tanks, capacity........ 156
Tar, weight of 157

PAGE

Tile roofing 129, 130
Tiling, floor.......149, 150
Tin roofing 128, 129
Tracing drawings 185 to 187
Trade rules, measurement ..9, 16, 34, 58, 65, 132
Trenches 12

U

Unloading brick....... 56
Urinals 142

V

Varnish 135
Vent pipe 141, 142
Voids, concrete...16, 17, 19
Ventilators, sheet metal 127

W

Wage rates 74
Wall coping........... 154
  coverings 137
  paper 138
Walls, brick cost...... 162
Walls, hollow......... 40
Walls, wood labor on 89, 90
Water closets 142
Water supply 139
Water 155, 156
Weight of materials... 157
  brass 157
  brickwork 157
  cement 157
  concrete 157
  granite 157
  gravel 157
  iron and steel..120 to 124
  iron, cast 157
  iron, wrought 157
  lead 157
  limestone 157
  lumber 152, 157
  marble 157
  masonry 157

PAGE

Weights of Materials—
plaster of Paris 157
sand 157
sandstone 157
slate 157
snow 157
steel 157
tar 157
water 157
Window frames 112
Wiring, electric 149
grillage 14
Woodwork, material... 70
anchors 72
boards, quantities.... 84
bridging 72
cost of sq. floor joists 72
cost of sq. wall...... 90
estimating by sq..71 to 73
floor joists, cost..... 73
flooring, quantity...76, 85
joists to sq.......... 86
quantities required
76, 83 to 85
siding to sq.......... 85
taking off quantities 70

PAGE

Woodwork, labor:
base 80
ceiling, wainscoating. 80
covering 76
dimension 74, 75, 77,
83, 84
doors and windows.. 81
floors 79
floors, maple......... 77
general 78
grillage 14
roofs 91
shelving 81
shingles 80
sideboards 81
siding 80
sleepers 87
stairs 82
studs 88
wage rate........... 74
walls 89
walls by square..... 90
Wool, mineral 150
Wrought iron pipe.... 142

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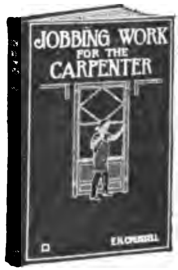
Carpentry and Building Construction

Jobbing Work for the Carpenter.—By E. H. Crussell. 273 pages. Size, 6 x 9 ins. 270 figs. Cloth. $1.50.

The carpenter, the builder, the student, or the craftsman who fails to read this new work is depriving himself of both pleasure and profit. For it supplies interesting reading from the author's experience during his 30 years at the trade in the city, on railroad work, and in the country, and, at the same time, furnishes simple short-cut methods for doing such things as: constructing a work bench, building a saw horse, making and fitting doors, window frames and sashes, crating furniture and household goods, cutting doorways through partitions, making counters, desks, bookcases, drawing boards, show cases, picture frames, regular, extension and rope ladders, fences of various design, etc.



Special attention is given to labor-saving tools and equipment which the author has found so serviceable and which cannot fail to be appreciated by practical men.

The information is presented so clearly and in such conversational style that the veriest novice can understand every detail, and the oldest mechanics will chuckle as suggestions or comments of the author bring to mind incidents in his own experience.

Details of Building Construction.—By W. A. Radford. 200 pages. Size, 9 x 12 ins. 184 plates. 600 figs. Cloth. $1.50.

A remarkable and unique collection of full-page plates accurately drawn and reproduced to exact scale, showing clearly every detail of modern building construction and finish for residences of every type. Houses of frame, brick, brick veneer, stucco, concrete, etc. Barn and farm buildings. Also miscellaneous buildings of every kind. Complete details for every style of interior trim, including special built-in features, dining-room buffets and side-boards, kitchen cabinets, cases and cupboards, window seats, wardrobes, linen closets, fireplaces, mantels, built-in bookcases, etc.

Details of Building Construction.—By W. L. Martin. 37 pages. 9¾ x 12½ ins. 33 full-page plates. Cloth. $2.00.

This is the standard authority on the detailing of wooden building construction. It only presents such details, however, as are in common use in domestic architecture and in smaller public buildings. Instead of having the text on separate pages, full information regarding all the details are given right on the plate in each case. The drawings have been carefully prepared and show the very best practice.

The book contains details of: An Ordinary Cellar Window in a Stone Wall; A Cellar Window With Screen and Iron Grille; Cellar Windows and Base Courses for Frame Cottages; A Typical Double-Hung Window; Double-Hung Windows With Inside Shutters; Windows With Outside Shutters; Counter-Balanced Windows With Mullions and Transoms; Windows in Frame Walls; Double-Hung Windows in Frame Walls; Double-Hung Windows; Bay Windows With Counter-Balanced Sashes; Casement Windows

Opening Outward; Casement Windows Opening In; A Casement Window With Mullions and Transoms and With Sashes Opening Outward; A Casement Bay Window; Pivoted Casements and Eyebrow Dormers; Storm-Resisting Windows; Types of Doors With General Dimensions; Examples of Doors in Various Styles; Outside Door Frames, Stone Sill, and Transoms; Interior Door Frames and Wooden Sills; Doors; Sliding Doors; Gutters, for Wood, Stone, and Terra-Cotta Cornices; Box Cornices; Open Timber Cornices; Miscellaneous Exterior Details; Kitchen and Pantry Dressers; Fireplace Details.

Contractors' and Builders' Handbook.—By Wm. Arthur. 384 pages. 5 x 8 ins. Illustrated. 114 tables. Cloth. $2.00.

A NEW work by the author of the "New Building Estimator," which is certain to save its user many times its cost, whether he be architect, builder, contractor or owner. It covers everything from the operation of the latest building law to the figuring of overhead expenses and best methods of insuring work against fire. There are hundreds of ways of losing money in building if one is not careful, and the information given in this book will enable you to avoid them. Much new matter on construction with especially prepared tables is included. It gives the latest data on figuring safe loads, mixing mortar and cement, sizes of wooden posts required to support various loads, slope of gravel or tin roofs, thickness of brick walls up to 12 stories in height, sizes of sewer pipe for given flow, safe loads on different soils, etc.

The information on concrete forms and work alone is worth the price of the book. It tells what kind of material to use, what to do to economize, when to remove forms, gives the proportions of concrete for different classes of work and the safe loads under varying conditions. These are just a few of the things included in this one chapter.

The two chapters on the superstructure should be read by every contractor and builder. They give reliable information on the safe construction of walls and masonry, safe loads per square foot, retaining walls, stone lintels, brick chimney stacks, etc.

A good system of bookkeeping is also outlined with valuable information on keeping costs, handling contracts, receipts, making bids, etc. The author has been actively engaged in the building business as architect, contractor, consulting expert and appraiser for many years, and has treated his subject simply and thoroughly. The young man just starting in business will find this book equal to years of experience.

CONTENTS.—Relations Between Contractor and Architect; Relations Between Contractor and Owner or Real Esate Agent; Relations Between the Contractor and Dealers and Subcontractors; Relations Between the Contractor and His Workmen; Reading Plans and Specifications; The Preparation of Estimates; Building Contracts; Nature of Contracts; General Contracting or Subletting; Method of Work; Buying of Material; Best Paying Work; Speculative Building or Ready-made Houses; Office Equipment; Bookkeeping; Keeping Costs; Builders' Law; Insurance and Bonds; Hand and Machine Labor; Weights, Measures, and Their Use; Foundations; The Superstructure: (1) Walls and Masonry; (2) Floor Loads; Loads Upon Posts, Columns, Lintels, Rods, and Ropes; Concrete Forms and Work; Construction Notes from the San Francisco Fire; Fire Loss and Safe Building; Where to Locate; The Ideal Education for a General Contractor; The High Schools, Libraries, and Tradesmen; A Little Library; Big Contracts; Miscellaneous.

Estimating and Specification Writing

The New Building Estimator.—By Wm. Arthur. 744 pages. 5 x 7 ins. Illustrated. Flex. Leather with Gilt Edges. $3.00.

A MODERN working guide for all who figure the cost of building construction, either in detail or approximately. It gives the actual time, labor and material required on every operation in all classes of residential and municipal work, as recorded and checked by the author and other experts on thousands of jobs, finished under varying conditions, in different sections of the country. Special stress is laid on those items that are affected by varying conditions and the reasons for the difference, as found by experience, are given, so the reader may profit. Every operation from the clearing of the site and excavation to the painting of the finished structure is covered in detail with time, labor and material figured chiefly in hours and quantities. It is an Estimator's Guide, based on work done, not on theory. Examples of work are presented in a systematic and clear manner, so as to give the idea at a glance. With it one may figure anything from a $500 cottage to a $500,000 structure.

Architects, Contractors and Engineers will find it indispensable in calculating costs, selecting types to fit specified prices, making up specifications, etc. It is to be found in the offices of the leading architects in New York, Boston, Chicago, San Francisco, etc.

The chapter on Reinforced Concrete work gives the actual cost, with illustrations, of all the latest types of construction used by the Abenthaw, Ferro-Concrete, Trussed Concrete Steel, Hy-Rib Hennebique and Roebling Construction Companies, with full information as to cost of forms, quantity of material, labor required, etc.

Estimating the Cost of Buildings.—By Arthur W. Joslin. 218 pages. 6 x 9 ins. Illustrated. Cloth. Price, $1.50.

This book presents in compact and handy form the author's method of taking off quantities and estimating the cost of residences, villas, schools and other public buildings.

There are five chapters on reading plans in which special attention is given to the methods now used to illustrate everything called for in the construction of a residence. They will help the student who wants to know how to draw plans as well as those who have to figure quantities from plans.

The work is practical, analytical and thorough in style. It will be an excellent prompter and guide to every one who has to do with building costs and superintendence constituting, as it does, a systematic treatise on the subject.

There are important chapters on "Estimating the Cost of Building Alterations" and on "Systems in the Execution of Building Contracts."

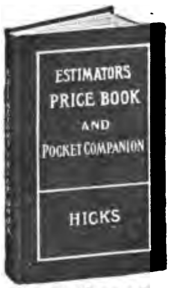
Hicks' Builders' Guide.—By I. P. Hicks. Revised 1916; twentieth thousand. 168 pages. Size, 5 x 6 3-4 ins. 114 illustrations. Cloth. Price, $1.00.

Presents a system of simple and practical application for estimating materials and labor chiefly as applied to suburban residential work. One of the most serviceable books for contractors and builders as well as for carpenters, who will find it to contain also a very complete treatment on framing roofs of all descriptions.

The "Guide" was designed by a man who understood the needs of the young carpenter and builder, and the knotty problems of the daily work are solved in the simplest and best ways.

Estimators' Price Book and Pocket Companion.—By I. P. Hicks. 218 pages. Size, 4 x 6 ins. 92 tables. Cloth. $1.00.

This, as its name indicates, is a guide to prices of all kinds of building materials, together with handy rules,



tables and general information for the architect and builder. Almost everything required in the construction of the ordinary building has been considered together with average market prices. The items have been arranged in such a way as to enable the estimator to readily find what is wanted both in regard to size, weight and prices. The work is designed to supplement that section of "Hick's Builders' Guide" relates to estimating with a more c hensive reference to prices and materi labor. Ample spaces have been left thro out the work for the insertion of l prices, memoranda, etc. It may, therefore, be used with equal advantage in any section of the country. The entire matter has been classified according to the nature of the work, and it will be found of unusual interest and value to the pratical estimator, contractor and builder.

Estimating Frame and Brick Houses, Barns, Stables, Factories and Outbuildings—New Edition, 1916.—By Fred T. Hodgson, architect. 248 pages. Size, 5 x 6 3-4 ins. Illustrated. Cloth. Price, $1.00.

The book aims to give a careful consideration to all the items and elements of cost in construction, beginning at the foundation of the building and progressing to the finished structure. Young contractors and builders especially will find it to cover the subject in a plain, practical way, with detailed consideration of cost factors, items and quantities.

There is a detailed estimate of a $5,000 house and additions; detailed estimates of kitchen, dining room, parlor, dens, halls, bedrooms, conservatory, basement, bath room, closets, etc., all figured out and measured by the quickest and simplest methods. The author also tells how to estimate by cubing, by the square of floors or walls, and by the process of comparison, and gives hints and practical suggestions for taking measurements and making tenders for work.

Specification Blanks for Frame or Brick Buildings.—By I. P. Hicks. 8 pages. Size, 7 x 10 ins. Heavy paper. 25 cents. $2.50 per dozen.

It pays to have definite specifications covering all details of the work when preparing your estimates. These new blanks are arranged to cover all the work apt to be called for in erecting residences, churches, schools, and other small public buildings in various sections of the country. All the user has to do is insert his sizes, quantities, etc., and cross out what he does not want. Plenty of space is left at the end of each specification for extra data.

It covers everything in the building: Carpenter's Work; Mason's Work; Plasterer's Work; Hardware Painting; Heating; Plumbing; Sheet Metal Work, and Electric Wiring.

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