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THE BUILDING ESTIMATOR'S REFERENCE BOOK

A Practical and Thoroughly Reliable
Reference Book for Contractors and Estimators
Engaged in Estimating the Cost of and Constructing
All Classes of Modern Buildings

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Practical Accounting and Cost Keeping
for Contractors

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readily, and with light spading or tamping will result in dense concrete. It should be neither too dry nor too wet. In a workable mixture there is sufficient sand-cement mortar to give good, smooth cement surfaces, free from rough spots, called honeycombing, and to bind the pieces of coarse aggregates into a mass so they will not separate in handling.

Classes of Concrete for Different Degrees of Exposure

Type of Structure	Degree of Exposure	U. S. Gal. of Water* per Sack of Cement	Class of Concrete (Expected Strength per Sq. in. at 28 Days)
Walls, dams, piers and other structures exposed to sea or alkali waters.	Extreme	5½	3500
Walls, dams, piers, reservoir linings, etc., exposed to alternate wetting and drying in fresh water in northern climate. Watertight structures. Sewers, pressure pipe, tanks, piles, athletic stadia, pavements, all thin structural members exposed to severe weather and frost action.	Severe	6	3000
Walls, dams, piers, reservoir linings exposed to fresh water in southern climate. Exterior columns and beams of reinforced concrete buildings. Basement walls. Thin structural members of all types exposed to moderate weather and frost action.	Moderate	6¾	2500
Ordinary enclosed structural members. Heavy piers and retaining walls in moderate exposure. Mass concrete, footings, etc., protected from alternate wetting and drying and from severe weather conditions.	Protected	7½	2000

*These quantities should not be exceeded even when resultant strength is higher than required for structural stability. Free water or moisture carried by the aggregate must be included as part of mixing water.

The amount of fine aggregate (sand) and coarse aggregate (gravel or stone) to be used in a mix will depend upon the grading of the combined aggregates. The amounts must be determined by trial mixing. Generally speaking, a well graded mixed aggregate (fine and coarse) will result in as good or better yield of concrete per bbl. of cement as concrete mixed according to the cement-sand-gravel method of proportioning. Some architects and engineers who specify concrete mixtures according to the water-cement ratio method, specify the amounts of fine and coarse aggregates for estimating purposes, and then insert a clause in the specifications allowing the contractor to adjust the amounts of aggregates as it seems advisable.

The proportion of fine to coarse aggregate in a mix will depend largely upon the size of the coarse aggregate used. The following table will serve as a guide in proportioning fine and coarse aggregates:

Approximate Proportions of Fine and Coarse Aggregates

Using Coarse Aggregates	Approximate Proportions
From ¼″ to ½″	Equal Parts of sand and stone
From ¼″ to ¾″	¾ as much sand as stone
From ¼″ to 1½″	½ as much sand as stone

The water-cement ratio proportions are based on the net amount of water in the concrete mixture. Aggregates, as used on the job, carry free water as surface moisture which must be deducted from the specified water-cement ratio to determine the amount of water to add at the mixer. The quantity of free water should be determined by test when possible, but the following table will serve as a guide in determining the amounts of free water carried in the aggregates.

Approximate Quantities of free Water carried by Average Aggregates*

Material	Gals. per Cu. Ft.
Very wet sand	0.75 to 1.00
Moderately wet sand	0.50
Moist sand	0.25
Moist gravel or crushed rock	0.25

*The coarser the aggregate the less free water it will carry.

Cement, Sand and Coarse Aggregate Required Per Cu. Yd. of Concrete, Laboratory Conditions

Slump in Inches	Designed Strength Lbs. Sq. In.	1" Coarse Aggregate Proportions	Cement Bbls.	Sand Cu. Yds.	Coarse Aggreg. Cu. Yds.	2" Coarse Aggregate Proportions	Cement Bbls.	Sand Cu. Yds.	Coarse Aggreg. Cu. Yds.
Water-cement ratio 5½ gallons per sack.									
½–1	3,500	1:2 :3	1.55	0.46	0.69	1:2 :3½	1.44	0.43	0.75
3–4		1:1¾:2½	1.74	0.45	0.64	1:1¾:3	1.61	0.42	0.72
5–7		1:1½:2	1.97	0.44	0.58	1:1½:2½	1.81	0.40	0.67
Water-cement ratio 6 gallons per sack.									
½–1	3,000	1:2¼:3¼	1.42	0.47	0.68	1:2¼:4	1.30	0.43	0.77
3–4		1:2 :3	1.52	0.45	0.68	1:2 :3½	1.43	0.42	0.74
5–7		1:1¾:2½	1.70	0.44	0.63	1:1¾:3	1.58	0.41	0.70
Water-cement ratio 6¾ gallons per sack.									
½–1	2,500	1:2½:3½	1.31	0.49	0.68	1:2½:4	1.23	0.46	0.73
3–4		1:2¼:3¼	1.39	0.46	0.67	1:2¼:3¾	1.31	0.44	0.73
5–7		1:2 :3	1.49	0.44	0.66	1:2 :3½	1.40	0.41	0.72
Water-cement ratio 7½ gallons per sack.									
½–1	2,000	1:3 :4	1.14	0.51	0.68	1:3 :4¾	1.06	0.47	0.75
3–4		1:2½:3¾	1.25	0.46	0.68	1:2½:4¼	1.18	0.44	0.73
5–7		1:2¼:3½	1.32	0.44	0.68	1:2¼:3¾	1.29	0.43	0.71
Water-cement ratio 8½ gallons per sack.									
½–1	1,500	1:3 :4¾	1.05	0.47	0.74	1:3 :5¼	1.00	0.45	0.78
3–4		1:2½:4¼	1.16	0.43	0.73	1:2½:4½	1.13	0.42	0.75
5–7		1:2¼:3¾	1.26	0.42	0.70	1:2¼:4	1.22	0.41	0.73

water content and the proportions adjusted thereafter to give the desired workability, maintaining the specified water-cement ratio.

Quantity of Cement, Sand and Coarse Aggregate Required for One Cu. Yd. Concrete Using Water-Cement Ratio of Proportioning, and Based on Aggregate Measured Damp and Loose as Represented by Average Job Conditions

The water-cement ratios indicated include surface moisture on the aggregate.

Proportions are given by volume, aggregate measured damp and loose, as represented by average field or job conditions. Thus: 1:2.4:3.7 indicates 1 volume of cement, 2.4 volumes of sand and 3.7 volumes of coarse aggregate, measured damp and loose.

High Early Strength Concrete

Time is often an important factor in construction, or repair work or for winter construction. Ordinarily, concrete is allowed to stand several days before being used. There are now a number of methods by which strong concrete may be obtained in 1 to 3 days. Several high early strength cements are now on the market which develop the same compressive strength in 72 hours as is ordinarily obtained in 28 days by using ordinary Portland cement. Another method using ordinary Portland cement develops the same strength in 3 days as ordinarily requires 28 days to develop.

Some of the various cements and methods are listed below:

High Early Strength Concrete in 3 Days Using Ordinary Portland Cement.—Concrete as commonly used, with proportions, mixing water and mixing time as in line "A," has a strength of 2,000 lbs. or more in 28 days. By well-authenticated methods, a strength of 2,000 lbs. or more, can with standard Universal Atlas Portland cement, be obtained in 3 days. Using less mixing water and increasing the mixing time, greatly increases the strength of the concrete.

The following table gives the proportions of cement and aggregate, amount of water per sack of cement and mixing time per batch to obtain concrete of predetermined strength:

Cement, Sand and Coarse Aggregate Required Per Cu. Yd. Concrete, Job Conditions

Slump in Inches	Designed Strength Lbs. Sq. In.	1" Coarse Aggregate Proportions	Cement Bbls.	Sand Cu. Yds.	Coarse Aggreg. Cu. Yds.	2" Coarse Aggregate Proportions	Cement Bbls.	Sand Cu. Yds.	Coarse Aggreg. Cu. Yds.
Water-cement ratio 5½ gallons per sack.									
½–1	3,500	1:2.4:3.2	1.55	0.55	0.73	1:2.4:3.7	1.44	0.52	0.79
3–4		1:2.1:2.7	1.74	0.54	0.68	1:2.1:3.2	1.61	0.50	0.76
5–7		1:1.8:2.1	1.97	0.53	0.62	1:1.8:2.7	1.81	0.48	0.71
Water-cement ratio 6 gallons per sack.									
½–1	3,000	1:2.7:3.4	1.42	0.56	0.72	1:2.7:4.2	1.30	0.52	0.82
3–4		1:2.4:3.2	1.52	0.54	0.72	1:2.4:3.7	1.43	0.50	0.78
5–7		1:2.1:2.7	1.70	0.53	0.67	1:2.1:3.2	1.58	0.49	0.74
Water-cement ratio 6¾ gallons per sack.									
½–1	2,500	1:3.0:3.7	1.31	0.59	0.72	1:3.0:4.2	1.23	0.55	0.77
3–4		1:2.7:3.4	1.39	0.55	0.71	1:2.7:4.0	1.31	0.53	0.77
5–7		1:2.4:3.2	1.49	0.53	0.70	1:2.4:3.7	1.40	0.49	0.76
Water-cement ratio 7½ gallons per sack.									
½–1	2,000	1:3.6:4.2	1.14	0.61	0.72	1:3.6:5.0	1.06	0.56	0.79
3–4		1:3.0:4.0	1.25	0.55	0.72	1:3.0:4.5	1.18	0.53	0.77
5–7		1:2.7:3.7	1.32	0.53	0.72	1:2.7:4.0	1.29	0.52	0.75
Water-cement ratio 8½ gallons per sack.									
½–1	1,500	1:3.6:5.0	1.05	0.56	0.78	1:3.6:5.6	1.00	0.54	0.83
3–4		1:3.0:4.5	1.16	0.52	0.77	1:3.0:4.8	1.13	0.50	0.79
5–7		1:2.7:4.0	1.26	0.50	0.74	1:2.7:4.2	1.22	0.49	0.77

	Mix	Bbls. Cement Per Cu. Yd. of Concrete	Gallons Water Per Sack of Cement*	Approx. Slump. Inches‡	Lbs. CaCl2 Per Sack Cement†	Minutes Mixing Time	Compressive Strengths Pounds Per Square Inch°			
							1 Day	3 Days	7 Days	28 Days
A	1:2½:4	1.4	7.7*	6 to 8	0	1	240	750	1320	**2600**
B	1:2½:4	1.4	7.7*	6 to 8	0	5	340	910	1550	3030
C	1:2½:4	1.4	6.1*	½ to 1	0	1	520	1350	2090	3700
D	1:1½:2½	2.1	5.5*	6 to 8	0	1	560	1580	2530	4230
E	1:1½:2½	2.1	4.4*	½ to 1	0	1	880	**2410**	3630	5250
F	1:1½:2½	2.1	4.4*	1	0	5	1150	2860	4020	5740
G	1:1½:2½	2.1	5.5*	6 to 8	2†	1	930	1880	2610	3800
H	1:1½:2½	2.1	3.4*	0(Dry)"	2†	5	1910	3380	4200	5260

*Total water **including** the moisture in aggregates as used.
‡**Slump** indicates the consistency or workability of concrete. A **slump test** is made by molding the concrete in a sheet metal conical form (4" top diameter, 8" bottom diameter and 12" high) and then removing the form and measuring the settlement or **slump**. The more moist or workable the concrete the greater the settlement or **slump**, and the stiffer the concrete the less the **slump**.
"Stiff mixtures must be tamped into place.
°Concrete placed and maintained at 70°F. or higher for days indicated.
†In using Calcium Chloride (CaCl2), thoroly dissolve 100 lbs. CaCl2 in water so as to give a total of 50 gals. of solution. Replace 1 gal. of mixing water **per sack of cement** with 1 gal. of this solution.

Universal-Atlas Lumnite Cement

A hydraulic cement for concrete and mortar. Mixed with sand, stone and water only, it produces concrete, which has full 28-day strength within 72 hrs. No artificial accelerator is used to hasten the hardening and there is no admixture in Lumnite that might affect its permanence.

The rapid hardening of Lumnite cement concrete to its extraordinary high early strength is the result of a natural chemical action due to the use of aluminum ore (Bauxite) in manufacturing the cement.

Lumnite cement is not "quick setting." It allows ample time for mixing, placing and finishing the concrete; the concrete then hardens with great rapidity so that it attains 28-day strength within 72 hrs.

Lumnite cement may be used in the same proportions as ordinary Portland cement, so that the quantity required per cu. yd. of concrete remains the same; however, it costs 3 to 4 times as much as ordinary Portland cement because of the high cost of the principal raw material, which is high-grade aluminum ore (Bauxite) imported from Southern Europe. The