



CONCRETE IN PRACTICE

CIP
8

What, Why & How **Discrepancies in Yield**

WHAT is Concrete Yield?

Concrete yield is defined as the volume of freshly mixed concrete from a known quantity of ingredients. Ready mixed concrete is sold on the basis of the volume of fresh, unhardened concrete—usually in cubic yards (yd³).

The basis for calculating the volume is described in the American Society for Testing and Materials, ASTM Specification C 94 for Ready Mixed Concrete. The volume of freshly mixed and unhardened concrete in a given batch is determined by dividing the total weight of the batch by the average weight per cubic foot of the concrete determined in accordance with ASTM C 138. Three unit weight tests must be made, each from a different truck using a ½ ft.³ container.

ASTM C94 notes: "It should be understood that the volume of hardened concrete may be, or appears to be, less than expected due to waste and spillage, overexcavation, spreading forms, some loss of entrained air, or settlement of wet mixtures, none of which is the responsibility of the producer."

Sample 3 Truck Mixers
Run Unit Weight on Each Sample

ASTM C138 Test for Unit Weight—Fill ½ Cu. Ft. Bucket in 3 Layers, Rod Each Layer 25 Times and Rap Side with Mallet, Strike Off with Flat Plate. Clean Outside Surfaces and Weigh.

Unit Weight = Net Concrete Wt. ÷ Bucket Vol. = lb per Cu. Ft.
Avg. Unit Wt = (UW1 + UW2 + UW3) ÷ 3 = lb per Cu. Ft.
Batch Yield (Cu. Ft.) = Weight of Batch ÷ Avg. Unit Wt.
Batch Yield (Cu. Yd.) = Yield (Cu. Ft.) ÷ 27

WHY do Yield Problems Occur?

Most yield complaints concern an imagined or real deficiency of concrete volume. Apparent under yield develops when insufficient concrete is ordered to fill the forms and to take care of contingencies discussed below. An actual under yield should be corrected using unit weight measurements and yield calculations. An over yield can, also, be an indication of a problem if the excess concrete is caused by too much air or aggregate, or if the forms have not been properly filled.

Apparent concrete shortages are sometimes caused by the following:

a. Miscalculation of form volume or slab thickness exceeding the assumed thickness by a fraction of an inch. A $\frac{1}{8}$ inch error in a 4-inch slab would mean a shortage of 3 percent or 1 yd³ in a 32 yd³ order.

b. Deflection or distortion of the forms by the pressure of the concrete.

c. Irregular subgrade, placement over granular fill, and settlement of subgrade prior to placement can increase slab thickness.

d. Over the course of a large job, the small amounts of concrete returned each day or used in mud sills or incidental footings can accumulate.

b. Measure formwork accurately. Near the end of large pours, carefully measure the remaining volume so that the amount in the last 2 or 3 trucks can be adjusted to provide the required concrete. This can prevent waiting for an extra $\frac{1}{2}$ yd³ after the plant has closed or the concrete trucks have been scheduled for other jobs.

c. Estimate extra concrete needed for waste and increased placement dimensions over nominal dimensions. Include an allowance of 4 to 10 percent over plan dimensions for waste, overexcavation and other causes. Repetitive operations and slip form operations permit more accurate estimates of the amount of concrete that will be needed. On the other hand, sporadic operations involving a combination of concrete uses such as slabs, footings, walls, and as incidental fill around pipes, etc. will require a bigger allowance for contingencies.

d. Construct forms so that they can withstand the pressure of the concrete without deflection or distortion.

e. For slabs on grade the subgrade should be accurately finished and compacted to the proper elevation.

HOW to Prevent Yield Discrepancies

To prevent or minimize concrete yield problems:

a. Check concrete yield by making ASTM C 138 concrete unit weight tests early in the job. Repeat these tests if a problem arises. Be sure that the scale is accurate, that the unit weight bucket is properly calibrated and that a flat plate is used for strike off. Concrete yield volume in cubic feet is total batch weight in pounds divided by unit weight in pounds per cubic foot. The total batch weight is the sum of the weights of all ingredients from the batch ticket. As a rough check the mixer truck can be weighed empty and full. The difference is the total batch weight.

References

1. ASTM C 94, Standard Specification for Ready Mixed Concrete, American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.
2. ASTM C 138, Standard Test Method for Unit Weight, Yield and Air Content of Concrete, American Society for Testing and Materials.
3. "An Analysis of Factors Influencing Concrete Pavement Cost," by Harold J. Halm, Portland Cement Association, 5420 Old Orchard Road, Skokie, Illinois 60077.

Follow These Rules to Avoid Under Yield

1. Measure volume needed accurately.
2. Estimate waste and potential increased thickness—order more than required by at least 4 to 10 percent.
3. To check yield use the ASTM C 138 unit weight test method on three samples from three different loads—yield is the total batch weight divided by the average unit weight.

