

# Technology in Practice

## What, Why & How?



### TIP 8 - Concrete Yield

*This TIP outlines process for determining yield of concrete and evaluating problems with yield*

#### WHAT is Yield?

The basis of sale for ready mixed concrete is by volume (yield) and its estimation is stated in ASTM C94/C94M, *Specification for Ready-Mixed Concrete*. Ready mixed concrete is batched by weight and sold on a volumetric basis, either as a cubic yard or a cubic meter. If the mixture proportions for concrete mixtures are not established for the required unit volume or if concrete ingredients are not batched accurately, the combined materials may produce either more or less than the desired volume. Yield is the actual volume of concrete produced. An over-yield occurs when more concrete is delivered than is ordered by the customer. An under-yield is when less concrete is delivered than ordered by the customer.

#### WHAT Is An Appropriate Yield?

Even when concrete mixtures are designed to achieve the required volume, actual yield during production can vary slightly due to changes in characteristics of the ingredients (like relative density or specific gravity), batching accuracy, variable air contents and changes in water content that are not accounted for – aggregate moisture or added mixing water. Incorrect estimation of yield can also result from improper performance of the fresh concrete density test, since this value is used in the calculation. There is no published tolerance for yield in industry standards, but a practical tolerance can be estimated.

Concrete batch weights are permitted to vary by  $\pm 1\%$ , on average. Aggregate moisture changes may result in as much as a 30 lb. variation in water content. Entrained air tolerances allow for as much as  $\pm 1.5\%$  of the mix volume. Under ideal conditions the tolerance for yield is about  $\pm 1\%$  for non-air entrained concrete and  $\pm 2\%$  for air entrained concrete, but can approach  $\pm 3\%$  for concrete containing higher air contents.

There are various reasons why the customer may perceive a discrepancy of yield as furnished compared to the calculated volume of the concrete member that was used in the order. These are suggested in ASTM C94/C94M and include waste, spillage, loss of air content, settlement, deflection of forms, over-excavation of subgrade, etc. Also, there will be some retention of concrete in the mixer drum that needs to be accounted for when batching concrete. The customer should be informed to order more than the calculated volume from the form dimensions and for contingencies. The customer could be provided a copy of NRMCA CIP 8 on *Discrepancies in Yield*.

#### WHY Does Tracking Yield Matter?

If concrete under-yields:

- It can impact the composition and resulting properties of the mixture furnished. A 2% under-yield may result in 2% higher cementitious content per cubic yard.
- It may result in having to deliver clean-up or short loads involving additional truck and personnel time at an increased cost.
- It can increase the standard deviation of strength tests, thereby impacting quality and increasing the cost of all concrete produced.
- It can lead to a potential loss of business if the condition is not corrected quickly.