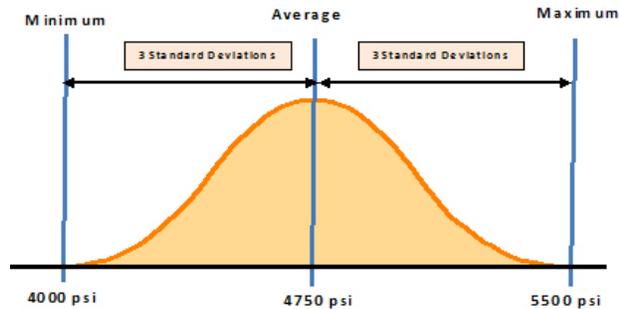


## Specification for Concrete Strength: Minimum 4000 psi – Maximum 5500 psi



A contractor recently called the Hotline about a project specification on which he wanted to bid. The specification required the concrete compressive strength at 28 days to be a minimum of 4000 psi and a maximum of 5500 psi, based on the average strength of three standard-cure 4x8-in. cylinders. The contractor asked one possible ready-mix concrete supplier if this was possible: the supplier said no. The contractor called the Hotline to see what might be possible.

The graph illustrating a normal distribution shows that, with the minimum at 4000 psi and the maximum at 5500 psi, the average would be 4750 psi. The average strength plus or minus three standard deviations would include virtually all of the possible test results, so three standard deviations would be equal to 750 psi and one standard deviation would be 250 psi. Can this standard deviation be achieved?

**Table 4.3—Standards of concrete control for  $f'_c \leq 5000$  psi (35 MPa)**

Class of operation	Overall variation				
	Excellent	Very good	Good	Fair	Poor
General construction testing	Below 400 (below 2.8)	400 to 500 (2.8 to 3.4)	500 to 600 (3.4 to 4.1)	600 to 700 (4.1 to 4.8)	Above 700 (above 4.8)
Laboratory trial batches	Below 200 (below 1.4)	200 to 250 (1.4 to 1.7)	250 to 300 (1.7 to 2.1)	300 to 350 (2.1 to 2.4)	Above 350 (above 2.4)

standard deviation. As shown in the table below, for overall variation of general construction testing, which includes the variability in materials, production, delivery, and testing of the concrete, a standard deviation of 400 psi or less indicates excellent quality control. In this case, the specifications requiring a standard deviation of 250 psi would be asking everyone involved to be almost double-excellent. We don't think this is possible.

In addition, we know there are various ways to increase the strength of a structure when compressive strength of cylinders, and possibly cores, is low, but are unsure as to what corrective actions would be needed if the 28-day compressive strength exceeds 5500 psi. If the specifier refuses to change this specification requirement, we suggest that contractors and ready-mix concrete suppliers should not submit a bid.

**Note:** The ACI document cited can be purchased at [www.concrete.org](http://www.concrete.org).

ACI 214R-11 “Guide to Evaluation of Strength Test Results” provides some assistance in quantifying the