

# Freeze-Thaw Durability for Force 10,000<sup>®</sup> Concrete

A series of tests was conducted to examine the freeze-thaw durability characteristics of Force 10,000<sup>®</sup> concrete. Force 10,000 concrete was evaluated at two different addition rates: 7.5% and 15% silica fume by weight of cement. Each Force 10,000 concrete was then produced with and without intentional air entrainment. The concrete was sampled and specimens were prepared, cured and tested according to ASTM C666 Procedure A.

The results of this evaluation indicate that Force 10,000 concrete must be air entrained if it is to be exposed to freeze-thaw conditions. ACI 234, "Guide for the use of Silica Fume in Concrete" recommends that "currently recommended values of air entrainment be used to provide adequate resistance to freezing and thawing."

## Mix Proportions, per m<sup>3</sup> (yd<sup>3</sup>)

<b>Cement, kg (lbs):</b>	356 (600)
<b>Water/cement:</b>	0.47
<b>Daracem<sup>®</sup> 19, mL/100 kg (oz/100 lbs):</b>	1043 (16)
<b>Daravair<sup>®</sup> AEA:</b>	as required

## Concrete Properties

Mix Description	Reference	Non-Air Entrained		Air Entrained	
% Silica fume/wt cement	—	7.5	15.0	7.5	15.0
Slump, mm (in.)	165 (6.5)	89 (3.5)	108 (4.25)	140 (5.5)	165 (6.5)
Plastic air content, %	6.9	2.0	2.3	6.0	6.4
28 day compressive strength, MPa (psi):	38.8 (5630)	58.4 (8470)	60.3 (8750)	50.6 (7340)	53.3 (7730)
Relative durability factor	99	15	71	98	99

ASTM C494 requires a minimum relative durability factor of 80.

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