

# The Benefits of Pumice as an SCM



Pumice-Blended Cement is the  
Pozzolan: Economical, Consistent,  
and Highly Effective



# Pumice vs. Fly Ash



Fly ash has long been used as a cheap by-product pozzolan in concrete and has proven effective at mitigating ASR. Tightening EPA regulations on the coal-fired power industry are disrupting the supply of class F fly ash and driving the need to identify a viable SCM alternative.



# The Ideal SCM



Pumice is a pozzolan, igniting a secondary reaction within curing concrete that consumes trouble-making CH and repurposes it into a chemical compound (CSH) that fortifies and densifies the concrete matrix. Win-win: ASR is flatlined and overall concrete performance is significantly improved.



“Pozzolans are made up of siliceous or siliceous and aluminous materials that, in finely divided form, will react with calcium hydroxide to form cementitious materials.”

— American Concrete Institute

CH is a deleterious compound that fuels the alkali-silica reaction.

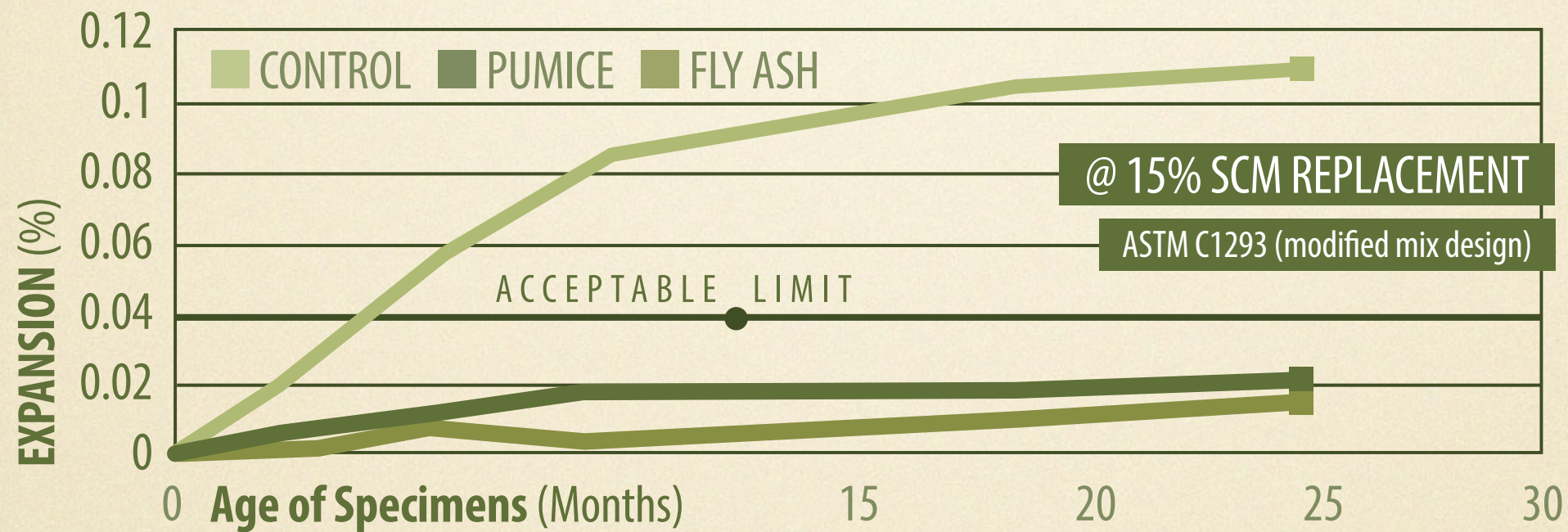
more of this (CSH) means stronger, denser concrete.

less CH means the alkali-silica reaction is short-circuited.



# ASR Mitigation

The pumice SCM **concrete mixture** kept expansions below the 0.04% limit of ASTM C1293, validating the results found from ASTM C1567 Accelerated Mortar Bar Test for ASR.



MIXTURE	AVERAGE ASR EXPANSION AT 24 MONTHS (%)
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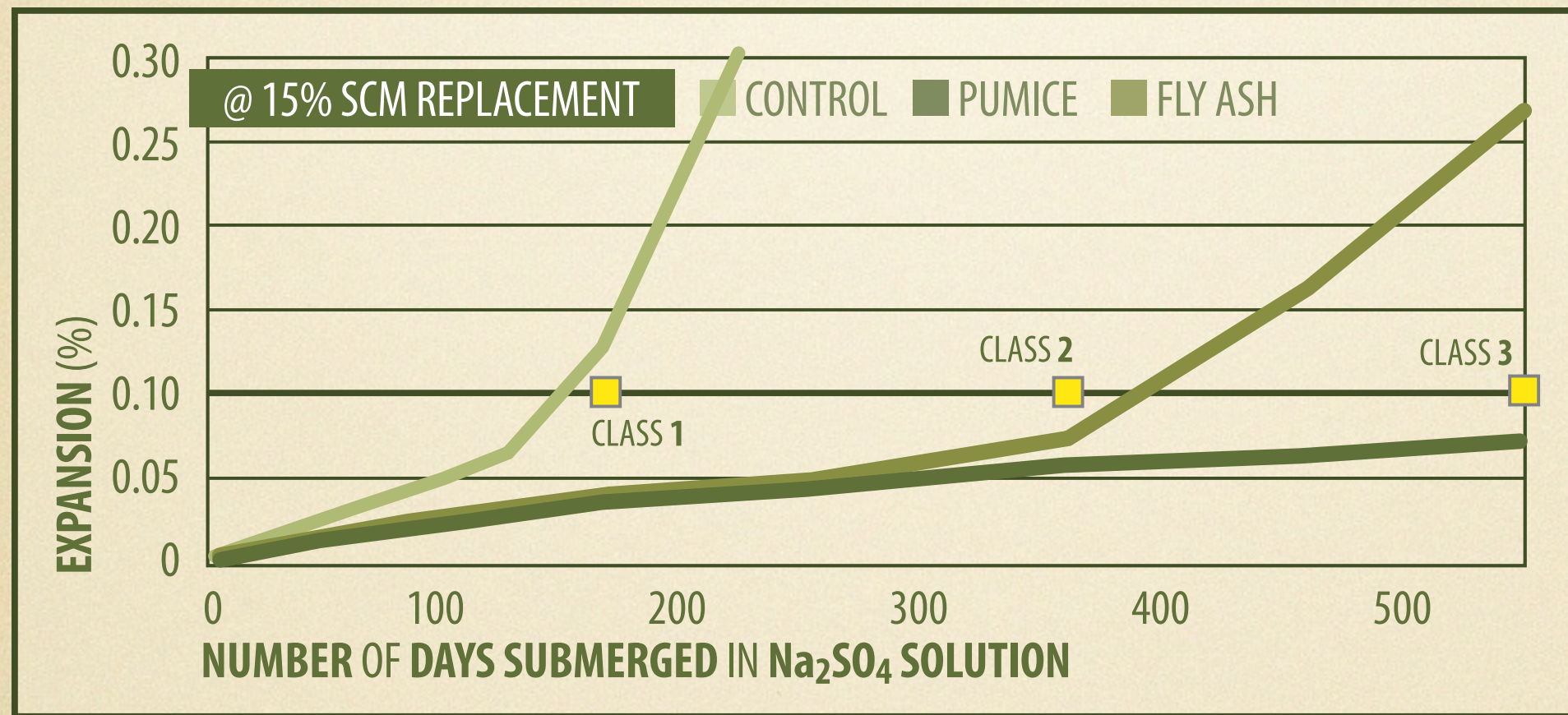
CONTROL	0.109 ± 0.020
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PUMICE (15%)	0.022 ± 0.007
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PUMICE (25%)	0.015 ± 0.001
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# Class 3 Sulfate Exposure Qualification





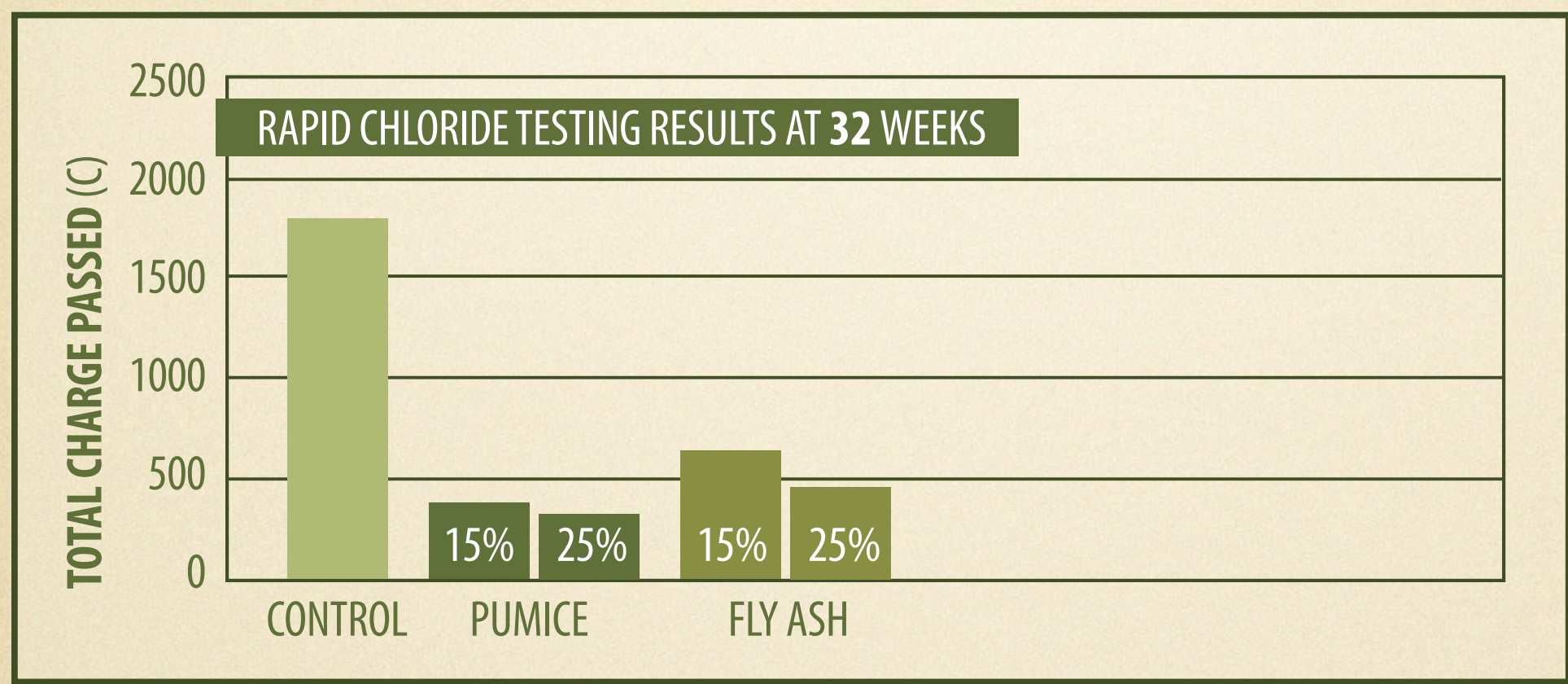
# Class 3 Sulfate Exposure Qualification

## SULFATE EXPOSURE QUALIFICATION AND MORTAR BAR EXPANSION

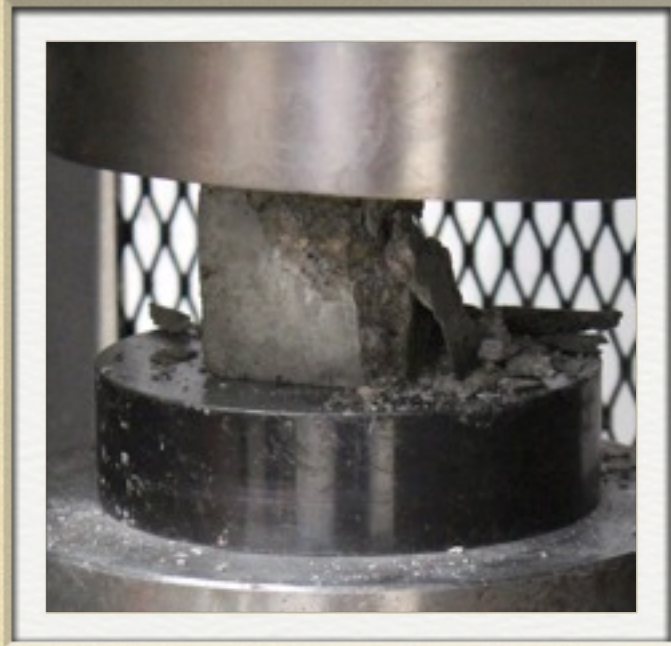
Mortar Mixture	w/cm	Sulfate Exposure	Expansion (%) of
CONTROL	0.485	Inadequate for sulfate attack	Exceeds 0.1 at 6 months
	0.51	Inadequate for sulfate attack	Exceeds 0.1 at 6 months
PUMICE (15%)	0.50	Qualifies for Class 3	0.068 ± 0.009 at 18 months
FLY ASH (15%)	0.46	Qualifies for Class 2	0.083 ± 0.016 at 12 months
	0.51	Qualifies for Class 1	0.090 ± 0.033 at 6 months
PUMICE (25%)	0.51	Qualifies for Class 3	0.076 ± 0.016 at 18 months
FLY ASH (25%)	0.45	Qualifies for Class 3	0.065 ± 0.009 at 18 months
	0.51	Qualifies for Class 1	0.059 ± 0.008 at 6 months



# High Resistance to Chloride Ion Penetration







# Compressive Strength

	<b>7 DAYS</b>	<b>28 DAYS</b>	<b>56 DAYS</b>	<b>90 DAYS</b>
100C (CONTROL)	5700 (PSI)	6800 (PSI)	7100 (PSI)	7400 (PSI)
<b>SCM @ 15%</b>				
PUMICE	5200 (PSI)	6100 (PSI)	6600 (PSI)	7050 (PSI)
CLASS F FLY ASH	5250 (PSI)	6650 (PSI)	7900 (PSI)	8100 (PSI)
<b>SCM @ 25%</b>				
PUMICE	4500 (PSI)	6200 (PSI)	6800 (PSI)	7400 (PSI)
CLASS F FLY ASH	4600 (PSI)	6300 (PSI)	7300 (PSI)	7700 (PSI)



# Coefficient of Thermal Expansion\*

Concrete Description	Cylinder 1 $\mu$ - strain/ $^{\circ}$ F	Cylinder 2 $\mu$ - strain/ $^{\circ}$ F	Average $\mu$ - strain/ $^{\circ}$ F	Difference from Control $\mu$ - strain/ $^{\circ}$ F
CONTROL	3.61	3.56	3.59	—
PUMICE (25%)	4.16	4.15	4.16	0.57
FLY ASH (25%)	4.06	3.56	3.81	0.23

\* These experiments were conducted to ensure that the pozzolans did not have any detrimental effects on the CoTE value of concrete.



# S U M M A R Y O F Pumice as an SCM

Sulfate Exposure Level		Strength Relative to OPC Control at 28 Days		Approx. Price per Ton	Workability Problems at High Dosages?	Minimum Replacement for ASR (%)
15%	25%	15%	25% (replacement)			

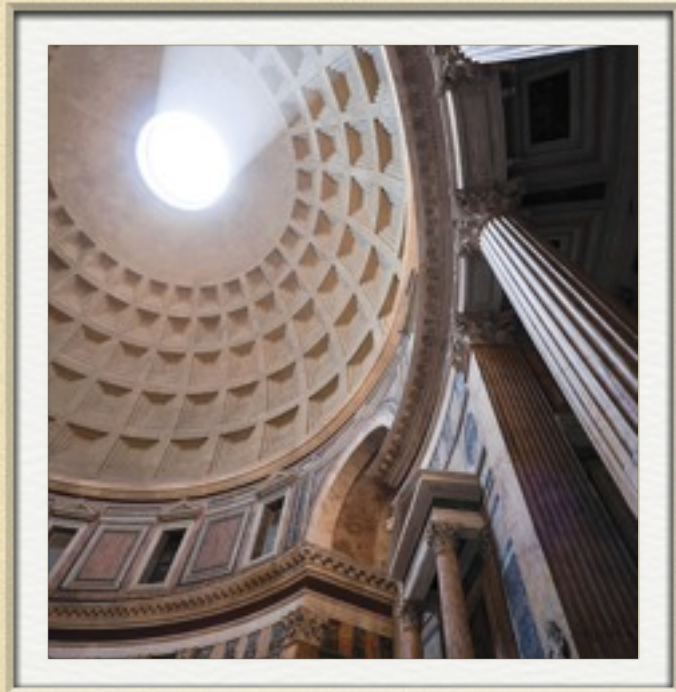
<b>PUMICE</b>	Class 3	Class 3	90%	91%	\$126	NO	15%
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## Average ASR Expansion at 24 months

15%	25% (replacement)
0.022±0.007	0.015±0.001



# Pumice is the Original Pozzolan



The Romans made impressively strong and enduring concrete—stuff with a lifespan of centuries instead of mere decades, like our modern concrete. The magic performance ingredient in Roman Concrete? Pumice.





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