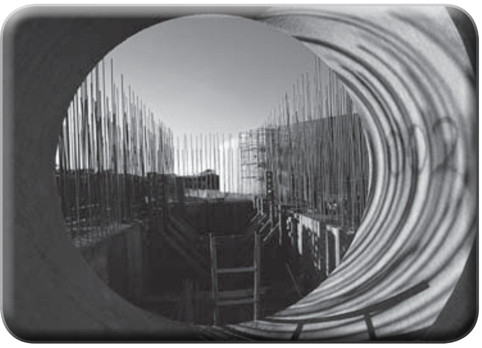

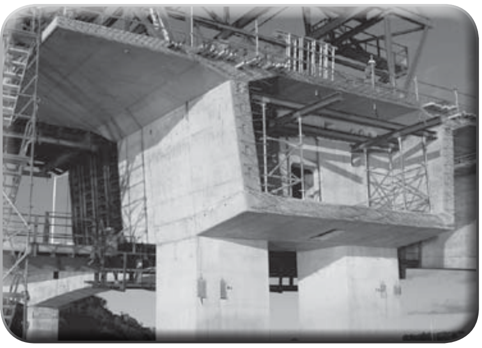

Microsilica
NEW ZEALAND

Chemical Resistant Concrete

A Natural Pozzolan for High Performance Concrete

Microsilica 600

MICROSILICA 600 – for Chemical Resistant Concrete

Concrete is a very resilient material. There are, however, certain chemical exposures under which useful life will be shortened unless specific measures are taken. These include:-

- Alkali aggregate reactivity (AAR)
- Acid attack
- Sulphate attack
- Aggressive substances

The addition of Microsilica 600 significantly improves the performance of concrete exposed to aggressive chemicals and negates the effects of AAR.

Alkali Aggregate Reactivity

Expansive reactions occurring, when reactive siliceous constituents present in the aggregates and sands react with alkalis (Na_2O and K_2O), can result in unacceptable concrete distress. Distress may manifest itself by way of concrete cracking, concrete spalling, foundation settlement, misalignment of machinery, pavement upheaval etc.
The source of alkalis is normally the cement although concrete additives have been known to be a major contributor. Recent reports suggest that certain Auckland basalt aggregates can release significant quantities of alkalis and that these would be available to take part in the chemical reaction. In New Zealand, the Waikato river sands and the Taranaki andesites are known to be very reactive.

The ASTM C1260 - 94 test, accelerates the AAR reaction at temperatures well in excess of those that exist at ambient conditions. While differentiating innocuous behavior by using this test is reliable, classifying the sand/aggregate combination as being susceptible to AAR may not necessarily be correct.

Independent tests (figures 2 & 3), in accordance with ASTM C1260-94. show that Microsilica 600 is one of the most efficient materials to reduce AAR expansion.

Figure 1. *The typical AAR Map cracking shown here could have been avoided by utilising 10% Microsilica 600*

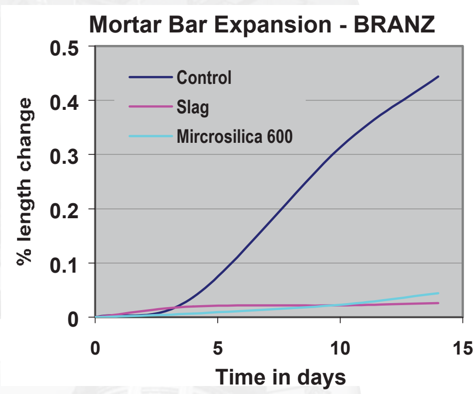

Figure 2. *Microsilica 600 concrete has excellent resistance to AAR and can make the use of reactive aggregates feasible.*

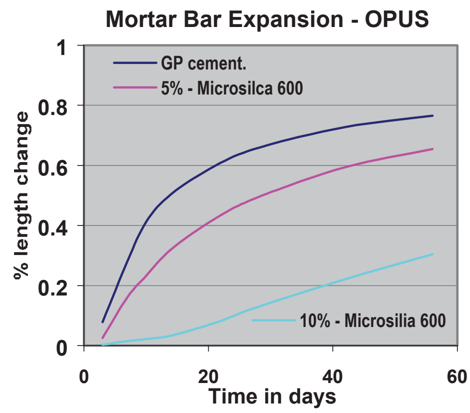

Figure 3. *Tests to ASTM C1260-94 with different MS600 dosages identifies what is required to prevent potential expansion with reactive aggregates.*

Microsilica 600

Acid Resistance

Eventually all Portland concretes will break down under organic acid attack.
Table 1 below shows the improved resistance to acid attack when concrete containing Microsilica 600 is exposed to acids commonly found in industrial and commercial environments.

Acid	Specimen weight loss (grams).		
	Control	Microsilica +10%	Improvement
5% Acetic pH=2.40	1.9	1.2	36.8%
5% lactic pH=2.15	3.4	2.1	38.2%
2% Nitric pH=1.42	2.3	1.4	39.1%
3% Sulphuric H=1.51	4.1	2.8	31.7%

Table 1. *Microsilica 600 provides a 30-40% reduction in weight loss in acid exposure tests.*

The degradation brought about by acid attack may be very slight, virtually non detectable, ranging to very severe, obvious within days. The process can be slowed with the use of Microsilica 600. Table 2 provides recommendations for concrete mix designs for concretes exposed to acid attack.

Mix requirements for different exposures				
	Slight	Moderate	Severe	V.Severe
W/BC ratio	0.48	0.42	0.36	0.36
MS600 %	7.5	10	12.5	15
Maximum acid concentration for exposure condition				
Acetic	5%	100%	-	-
Fluoric	1%	2.50%	10%	20%
Formic	100%	-	-	-
Hydrochloric	0.10%	0.25%	1%	2%
Lactic	0.10%	1%	2%	10%
Nitric	0.10%	0.25%	1%	2%
Phosphoric	5%	100%	-	-
Sulphuric	0.10%	0.25%	1%	2%
Sulphurous	0.10%	0.25%	1%	2%
Tanic	100%	-	-	-

Table 2. *Recommended Microsilica 600 concrete mix designs for acid environments (after Papworth)*

Other Aggressive Substances

The table on the right gives guidance on mix designs for concrete exposed to various aggressive chemicals. Severity of exposure and duration are also considered.

Exposure class	Moderate	Severe	V Severe
Mix requirements for different exposures			
W/CB ratio	0.42	0.36	0.36
MS600(%)	7.50%	10%	15%
Cement	GP	<6% C3A	>6% C3A
Frequency of exposure for class			
10% Amm Nit	1	2	3
Amm.Nit.Prill	2	3	4
Animal fat	4	-	-
Amm. Sulphate	2	3	4
Butter milk	4	-	-
Cal.Chloride	1	2	3
Cal Nit Solution	1	2	3
Castor oil	3	4	-
Fish oil	4	-	-
Hyd.Sulphide	4	-	-
Mag.Chloride	3	4	-
Margarine	4	-	-
Petroleum oil	Not detrimental		
Phosphate	4	-	-
Potassium	3	4	-
Sewage	Not detrimental		
Silage	4	-	-
Sod.Nitrate	4	-	-
Sugar	3	4	-
Urea	3	4	-

1=Rare, 2=Occasional, 3=Frequent, 4=Continuous

Table 3. *Recommended Microsilica 600 concrete mix designs for chemical exposures. (after Papworth)*

Sulphate Resistance

Concrete is attacked by naturally occurring sulphates. The sulphates, dissolved in ground water, will tend to evaporate when in contact with concrete surfaces. The accumulation of sulphates at higher concentration levels increases the intensity of the reaction.
The attack mechanism involves the formation of ettringite and results in an increase in solid volumes i.e. expansion and disruption of the concrete.
As shown in figure 4, Microsilica 600 performs well compared with other supplementary cementitious materials.

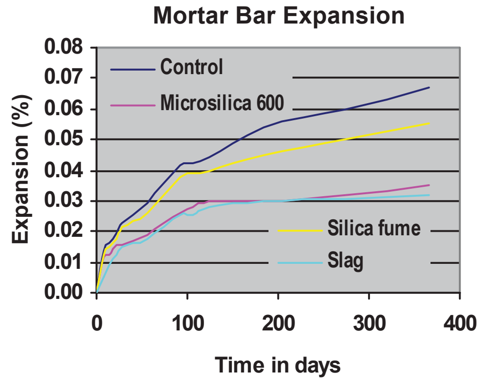

Figure 4. *8.5% Microsilica 600 provides adequate sulphate protection in many environments.*

It is not only the sulphate content that can cause concrete expansion and disruption; the presence of magnesium ions can also contribute. Magnesium sulphate is particularly aggressive.
Dosage rates of Microsilica 600 and W/CB ratios (table 4) depend on the concentration of both.

Class	S04 (pmm)	Mg (ppm)	Microsilica 600 dosage	V.Severe
1	<300	No special Measures		
2	300 to 1200		5.0%	0.50
3	1200 to 2500		7.50%	0.50
4a	2500 to 5000	<1000	7.50%	0.45
4b	2500 to 5000	>1000	10%	0.45
5a	>5000	<3000	10%	0.45
5b	>5000	>3000	10%+coating	0.4

Table 4. *Recommended Microsilica 600 concrete mix designs for various sulphate environments (after Papworth)*

MICROSILICA 600 APPLICATIONS & INFORMATION

Other Microsilica 600 applications for specialist concretes and high performance concrete are detailed in the following brochures:

- Industrial & Commercial Floors
- Marine Concrete
- High Strength Concrete
- Water Proof Concrete
- Shotcrete

Reference should also be made to the operational and safety requirements in the following documents:

- Health & Safety Data Sheet
- Concrete Mixing Instructions
- Concrete Placement & Finishing Procedures
- Plastic Properties of Microsilica 600 Concrete

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Microsilica 600