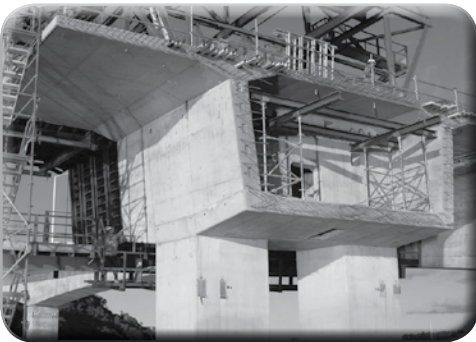




## Industrial & Commercial Floors



A Natural Pozzolan for High Performance Concrete



Microsilica 600

# MICROSILICA 600 – for Industrial & Commercial Floors

The fundamental requirement for any concrete structure is to meet performance expectations over the intended service life. Floors are one of the most valuable assets within the building frame and are frequently not given the due consideration they deserve.

When Microsilica 600 is included in the concrete mix, floor slabs will provide the following properties:

- High abrasion resistance
- Increased inherent strength
- Improved resistance to chemical and acid attack
- Minimal surface cracking

However, the overall performance of the floor will depend on how well the placement, finishing and curing of the slab is carried out.

## Abrasion Resistance

Microsilica 600, as part of the concrete mix, penetrates the full depth of the concrete slab. Compared with proprietary surface coatings it does not rely on the continual performance of bonding between the layers.

Two types of tests clearly show the superior resistance of MS 600 concrete to abrasion forces and in general terms, wear and tear.

### TEST 1

Opus International Ltd - Tumbler test in accordance with AS 4456.9 Test developed to compare the performance of segmental pavers. Performance level is based on loss of mass and reported as Abrasion Indexes (Table 1).

16 pavement segments (binder content 400Kg/M<sup>3</sup>) were subject to a prolonged tumbling action. Specimens were wet cured for 7 days and air cured for 21 days.

Control	2.6
5% MS600	2.3

**Table 1.** Test AS4456.9 - Abrasion indexes reported.

For hardstand areas and heavy duty pavements a minimum index value of 3.3 is targeted.

### TEST 2

BRANZ (Building Research Association of New Zealand) in-house test, using the Aston University accelerated abrasion machine, produced the results as shown in Table 2. The machine rotates in a circular motion producing a groove in the concrete surface. The depth of the groove is measured and average depth reported (table 2).

Binder content—330 kg per M<sup>3</sup>.

Water/Binder –.0.50

Mix type	Wear Depth 15min	Wear Depth 30min
GP Cement	.08 mm	.15 mm
Silica Fume (10%)	.05 mm	.10 mm
Slag (65%)	.22 mm	.33 mm
MS600 (10%)	.04 mm	.05 mm

**Table 2.** Abrasion test for floors. Result at 56 days show Microsilica 600 provides the highest performance of all cement systems.

The superior performance of Microsilica 600 concrete is attributed to its refined pore structure and reduced bleeding relative to conventional concrete. This leads to higher surface strength.

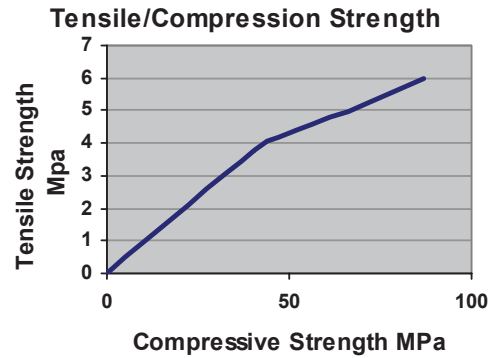
**Figure 1.** Microsilica 600 was used for the Titirangi Skate Park for ease of placing and superior abrasion resistance.



## Inherent Strength

The efficient design of modern concrete pavements and heavy-duty floors relies on achieving high flexural strengths. Principle factors affecting this are cement matrix strength, aggregate strength, aggregate orientation and the aggregate/matrix interaction. The addition of Microsilica 600 increases the cement matrix strength and the aggregate bonding at the cement paste interface.

**Figure 2.** Relationship between MS600 concrete's tensile and compressive strengths. Microsilica dosage - 10%, W/CB - 0.4.



## Chemical and Acid Resistance

Concrete floors, tanks and storage areas are often subject to corrosive chemical attack. This will reduce service life. Acid attack can be particularly severe at high concentration but weak acids can be accommodated when using Microsilica 600. The results below (table 3) show material loss when concrete specimens, with and without Microsilica 600, were exposed to acids.

**Table 3.** Microsilica 600 provides a 30-40% reduction in weight loss in acid exposure tests. As weight loss is proportional to the square root of time, a much greater (70% approx) increase in life expectancy would be anticipated.

Acid	Specimen weight loss (gsm)		
	Control	10% MS600	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 pH=1.51	4.1	2.8	31.7%



**Figure 3.** Wine is mildly aggressive to concrete. Extended service life and improved hygiene can be achieved with the use of Microsilica 600.

Microsilica 600 is often used to give concrete adequate resistance to weak acids. The performance depends on the mix, acid type and concentration.

For further details on aggressive substances (including acid attack) refer to the Microsilica 600 brochure on "Chemical Resistant Concrete"

## Minimal Surface Cracking

Concrete has a relatively low tensile strain capacity. As a consequence, concrete elements which are restrained will crack when the shrinkage process commences. The presence of reinforcing steel does not eliminate concrete cracking but merely dictates the size and location of the cracks within the concrete element.

In the majority of cases, cracking of structural members due to deformations brought about by dead and live loads, is an acceptable aspect of engineering design. However, the presence of cracks can be both aesthetically unacceptable and undesirable from a long-term durability aspect. Besides the effects of structural deformation, cracking can result from:-

- Plastic shrinkage & settlement
- Thermal movements
- Drying shrinkage
- Autogenous shrinkage
- Poor finishing techniques

Delamination results from excessive bleed water, high air content and poor finishing techniques. Including Microsilica 600 in concrete mixes will tend to minimise cracking and reduce the tendency for delamination to occur.

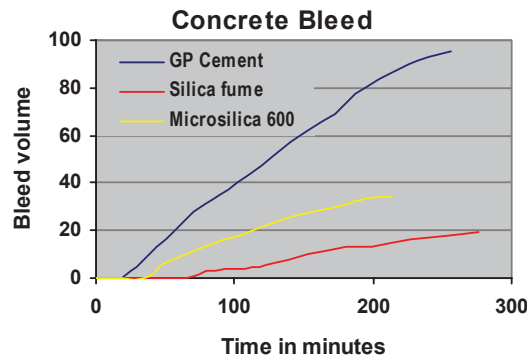
## Plastic Shrinkage & Settlement

Cracking due to plastic shrinkage and settlement occurs in freshly placed concrete.

The high bleed of conventional concrete can lead to plastic settlement cracking over reinforcing bars and a high water content/low durability surface.

By contrast, plastic shrinkage cracking in very low bleed concrete occurs when there is insufficient bleed water to replace water that is evaporating. Microsilica 600 provides the optimum solution, concrete with high durability and strength but with just sufficient bleed to minimise the risk of plastic cracking.

Microsilica 600 helps eliminate plastic cracking but appropriate placing, finishing and curing is essential. Refer to Microsilica NZ Operational Guidelines for further information.



**Figure 4.** Conventional concrete has high bleed and potential problems with plastic settlement, a low performance surface etc. Fine powders that virtually eliminate bleed lead to plastic cracking problems. Microsilica 600 provides the optimum bleed.

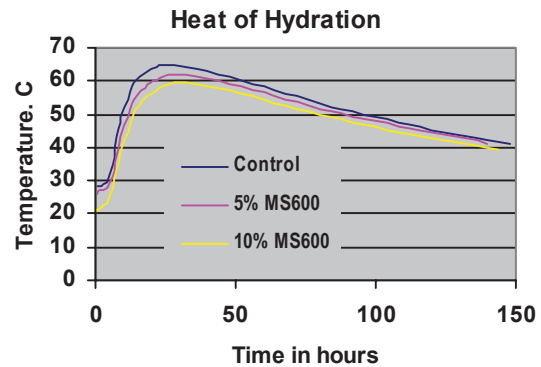
## Reduced Thermal Problems

During the cement hydration process, heat is produced which causes concrete to expand. If the concrete beam, column or slab is restricted as it contracts when cooling, cracking is likely to occur. Concrete is more vulnerable at an early age when the internal strain capacity is low. This is exacerbated if concrete is poured or placed at high ambient temperatures.

High temperatures can also lead to strength loss and delayed ettringite formation (DRF).

Thermal cracking can be reduced by lowering cement contents. This can be achieved by taking advantage of the efficiency performance of Microsilica 600.

A phenomena known as thermal shock can be a concern. This occurs when excessive temperature gradients exist within the slab. This is more likely to occur during winter when, at night time, there is a significant drop in ambient temperatures.

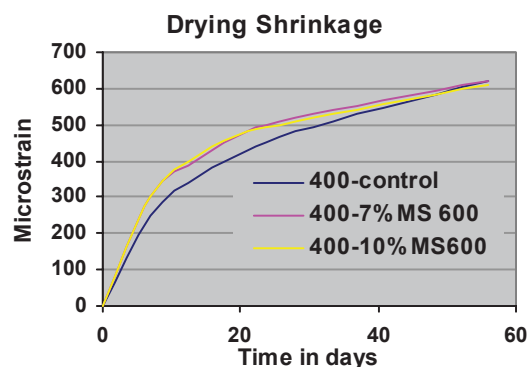


**Figure 5.** Temperature rise of concrete with constant binder content and w/b ratio show similar thermal properties for GP cement and Microsilica 600 concrete.

## Drying Shrinkage

Drying shrinkage occurs when there is a loss of water from the hardened concrete. It is the removal of the "absorbed water" (eg the water absorbed into the surface of the cement gel) rather than the free water found in the capillary pores.

The quantity of "absorbed water" relates directly to the amount of water added to the concrete mix to provide for workability. A 25% increase in water content is likely to double the amount of shrinkage. At similar binder and water contents, Microsilica 600 concrete has similar shrinkage properties (Figure 6). However, Microsilica 600 has a higher strength to resist the internal stresses and therefore the overall risk of shrinkage cracking is less. Standard crack control measures should be used.



**Figure 6** Shrinkage of Microsilica 600 concrete is similar to conventional concrete

## Autogenous Shrinkage

Autogenous shrinkage only occurs in high performance concretes – concrete in the strength range of 50 Mpa to 100Mpa.

Autogenous shrinkage is relatively large and happens in the early stages of cement hydration. To reduce autogenous shrinkage and minimise potential cracking, water curing should start 3 to 6 hours after concrete pouring.

Reducing cement contents by the use of Microsilica 600 will reduce the likelihood of cracking brought about by autogenous shrinkage.

## Poor Finishing Techniques

### Crazy cracking

The development of a network of fine randomly spaced cracks is referred to as "crazing". The cracks are shallow – typically 1mm to 2mm deep – and do not normally threaten the structural integrity of the element or structure.

Generally this type of cracking results from poor finishing techniques such as excessive working of the surface, rapid surface drying and the use of wet concrete mixes.

### Delamination

Delamination results from the formation of a weak zone of mortar located just below the slab surface. The weakened mortar is attributed to a build up of trapped bleed water and a high concentration of entrained air.

Delamination arises from a phenomena referred to as "directional stiffening behaviour".

Concrete that stiffens from the bottom up is less likely to entrap water and air. If the concrete surface seals prematurely because of early trowelling or because of the influence of ambient conditions – wind, temperature and humidity – the concrete will stiffen from the top down.

Concrete that stiffens from the top down is more likely to result in delamination occurring.

With the exception of eliminating the air entrainment, there appears little can be achieved by altering concrete mix designs. It may not be prudent to eliminate the entrained air if there is a risk of the concrete being exposed to freeze/thaw conditions.

Delamination can be minimised by adopting good finishing practices. (Refer to the guidelines on Concrete Placement, Curing & Finishing Procedures.)

## MICROSILICA 600 APPLICATIONS & INFORMATION

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

- Chemical Resistant Concrete
- Low Heat Concrete
- High Strength Concrete
- Waterproof Concrete
- Marine Concrete

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

### Product Note

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Microsilica 600