

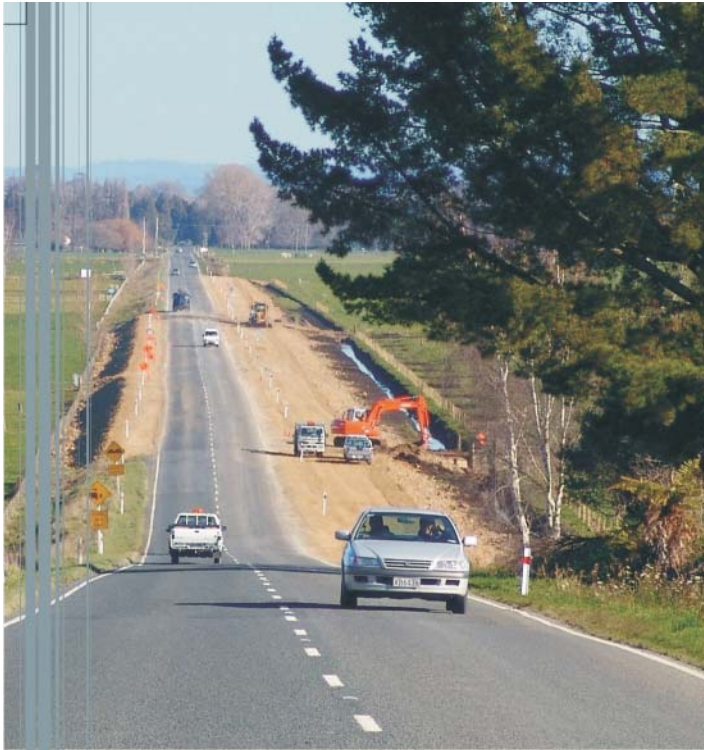


Paving the Way for Nanotechnology
Road to Progress



Nanotechnology for Asphalt Roads

- Improved Strength
- Improved Flexibility
- Waterproofed Asphalt Concrete



Introduction

Rains, Seasonal changes coupled with increasing traffic volumes, vehicle loads and tyre pressures cause accelerated degradation of pavements.

The principle of sustainability in the 21st century dictates the need of conserving resources such as stones, asphalt and cement. Durability is the key parameter at acceptable serviceability index (2-4).

Nanotechnology

Zycosoil nanotechnology is a patented breakthrough to address these issues at an economic cost. It reacts with the aggregates and acts as a bonding agent to asphalt binder. The technology offers 35-45 % compressive higher strength and increased flexibility in asphaltic pavements at similar binder content.



Zycosoil Benefits

Antistripping

The reactive chemistry of Zycosoil improves antistripping performance by a order of magnitude.

The polar surface of aggregates gets converted to nonpolar surface by Zycosoil reactive modification. These nonpolar aggregates can bond with 95 % of the nonpolar asphalt composition, contrary to 5 % of the polar asphalt composition bonding to polar aggregates. This results into 15-20 fold improved antistripping performance and will lead to improved service life of the road.

Zycosoil is directly added to hot asphalt binder, mixed and then used.

Aggregates Susceptible To Stripping

Aggregates that are very susceptible to stripping like Quartzite's, can give excellent antistripping performance by using 0.2 - 0.4 % Zycosoil on the weight of asphalt binder as an antistripping agent. Tests were carried as per AASHTOT182 at 60°C.

Ecology

Soil dust and stone dust do not affect the performance of asphalt concrete composition when Zycosoil is used in Asphalt. Zycosoil nanotechnology can convert soil dust and stone dust hydrophobic (asphalt loving) and resolve the reverse emulsification of asphalt binder due to clay particles.

World over poor quality aggregates are used due to local availability and cost considerations.



Zycosoil Features

Zycosoil is a water soluble reactive organo-silicon compound. It forms Si-OH silanol groups upon hydrolysis. These silanols are reactive and can form Si-O-Si siloxane bonds with surface silanol groups of inorganic substrates. Zycosoil nanotechnology offers :

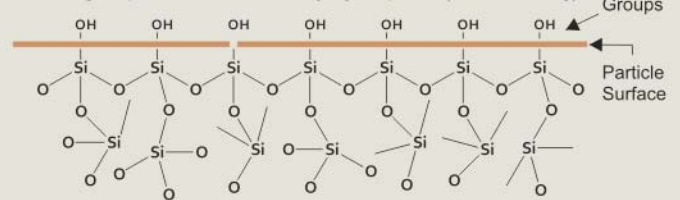
- Permanent water repellent nano layer on all types of soil, aggregates & other inorganic road construction materials
- Reaction leads to permanent nano silicization of the surfaces by converting the water loving silanol groups to water repellent siloxane bonds
- The Si-O-Si Siloxane bond is Mother Nature's strongest bond which survives for centuries
- Substantial reduction in soil water infiltration and erosion
- Has ultraviolet and thermal stability for 20 plus years
- Is non leachable as it chemically binds to surfaces permanently

Zycosoil's reactive bonding with the aggregates and asphalt helps to reduce incompatibility with aggregates:

- Minimum loss of compressive strength and flexibility of asphalt concrete under wet conditions
- Stripping and hydraulic scouring due to bond failure of asphalt binder with aggregates under wet conditions

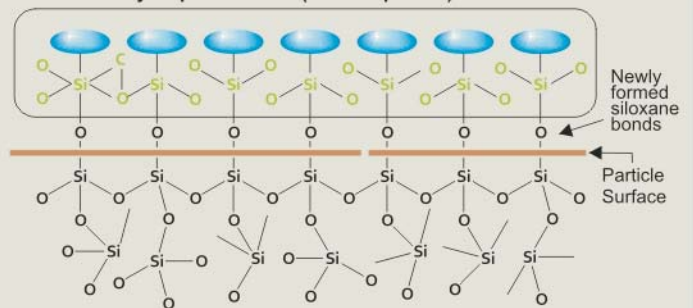
Zycosoil Reaction With Silicate Containing Surfaces

Silanol groups make surface very hydrophilic (water Loving)



Typical Soil and Aggregates surface structure

Zycosoil molecules create molecular level hydrophobic zone (water repellent)



Soil and Aggregates surface structure after Zycosoil reaction

Technology at work



Anti Stripping Performance

ASTM 1664 / AASHTO T182 at 60°C

Basalt Aggregate (DBM) : 45% 20 mm, 10% 10 mm, 45% less than 6 mm with stone dust

Asphalt Grade : AC-20 (VG-30, 60-70 penetration grade)

Test Sample By weight of mix	24 hr %	48 hr %	120 hr %	360 hr %
4.5% asphalt binder	95	85*	25*	20*
4.5% asphalt binder with 2% hydrated lime	98	90*	55*	30*
4.5 asphalt binder containing 0.5% amine	96	88*	50*	25*
4.5% asphalt binder containing 0.1% Zycosoill	98	98	98	97

* Less than 95% → Fail, (as per specified standards)

ASTM 3625 Boiling Test

Basalt Aggregate (DBM) : 45% 20 mm, 10% 10 mm, 45% less than 6 mm with stone dust

Asphalt Grade : AC-20 (VG-30, 60-70 penetration grade)

Test Sample By weight of mix	10 min %	30 min %	1 hour %	6 hours %
4.5% asphalt binder	40	Total Failure	Total Failure	Total Failure
4.5% asphalt binder with 2% hydrated lime	82	45*	Total Failure	Total Failure
4.5 asphalt binder containing 0.5% amine	80	42*	Total Failure	Total Failure
4.5% asphalt binder containing 0.1% Zycosoill	98	98	96	95

* Less than 75% → Fail, (as per specified standards)

All control samples showed significant amount of stripped asphalt binder floating in water. Asphalt binder containing Zycosoill samples showed, if any, very little amount floating in water during boiling. Control samples were completely stripped in the boiling water test, while Zycosoill containing asphalt binder remained adhered to the aggregate surface even after six hours in boiling water.



MARSHALL STABILITY & FLOW VALUE ASTM D 1075 / AASHTO T165 at 60°C, 24 hrs.

Basalt Aggregate (DBM) : 45% 20 mm, 10% 10 mm, 45% less than 6 mm with stone dust

Asphalt Grade	4.5% asphalt binder by weight of mix		4.5% asphalt binder with 2% hydrated lime on weight on mix		4.5% asphalt binder containing 0.1% Zycosoil by weight of mix	
	Strength Kg	Flow Value mm	Strength Kg	Flow Value mm	Strength Kg	Flow Value mm
AC-10 (VG-10, 80-100)	1208	2.71	1465	2.85	2080	2.7
AC-20 (VG-30, 60-70)	1350	2.78	1655	2.95	2461	3.0
CRMB-60 *	1509	3.18	1794	3.14	2988	3.1
PMB-40**	1846	3.05	2346	3.09	2533	3.02

* CRMB-60 : Crumb Rubber Modified Bitumen ** PMB-40 : Polymer Modified Bitumen

Zycosoil containing asphalt concrete has a significant increase of 35 - 45 % in stability strength alongwith flow properties. This is expected to improve the load bearing strength of the asphalt pavement in wet condition.

Zycosoil addition of 0.04 - 0.1 % on weight of asphalt binder is recommended. Higher dosage of 0.2-0.4 % for aggregates susceptible to stripping should be used.

MARSHALL STABILITY STRENGTH ASTM D 1075 / AASHTO T165 at 60°C, 24 hrs.

Basalt Aggregate (DBM) : 45% 20 mm, 10% 10 mm, 45% less than 6 mm with stone dust

Asphalt Grade	Test Sample	Stability Strength		
		Dry	Wet	Ratio %
AC-20 (VG-30, 60-70)	Hydrated Lime (2%)	2056	1721	83.7
AC-20 (VG-30, 60-70)	Zycosoil (0.1%)	2512	2461	98.0
CRMB-60*	CRMB	2152	1794	83.4
PMB-40**	PMB-40	2442	2346	96.1

* CRMB-60 : Crumb Rubber Modified Bitumen ** PMB-40 : Polymer Modified Bitumen

The performance of Zycosoil is equal or slightly better than the polymer modified asphalt binder

MARSHALL STABILITY - VARYING BINDER CONTENT
ASTM D 1075 / AASHTO T165 at 60°C, 24 hrs. immersion

Basalt Aggregate : 33% 20mm, 24% 10mm, 41% less than 6mm with stone dust

Asphalt Binder Content in %	Strength KG		Flow Value mm	
	Control	Modified	Control	Modified
5.1	1140	1625	3	3.8
4.5		1467		3.35
4.0		1120		3.2
3.5		938		2.61

Zycosoil can enable a reduction in asphalt binder for maintaining same stability strength without compromising flow values.

Addition of 0.1 % Zycosoil in asphalt binder resulted in approx. 40 % increase in compressive strength of asphalt concrete mixture with 5.1 % asphalt binder.

Results indicated that 0.1 % Zycosoil addition at 4 % asphalt binder content matched the compressive strength of the controlled with 5.1 % asphalt binder content concrete mix.

Technical Specifications

Color	:	Clear to pale yellow
Solid content	:	41 +/- 2 %
Solvent	:	Ethylene glycol
Flash Point	:	80° C
Viscosity (25° C)	:	200-800 cps
Solubility	:	Soluble in asphalt

Application Process

- 1 Kg Zycosoil is mixed with 1 MT of Asphalt (0.1%)
- The Hot Molten asphalt is mixed with circulating pump for 20-30 min.
- The modified hot molten asphalt binder is mixed with aggregates by a spray technique as needed.

