Construction
Solutions

DOW CORNING

Dow Corning® brand Construction Chemicals

Water Repellent Selection Guide

Performance aspects of silicone protection

Silanes and siloxanes are capable of penetrating and forming a protective, repellent layer several millimeters deep ***within a substrate****, with little appreciable effect on the water vapor transmission rate through pores and capillaries. Because the treatment is deep within the substrate, surface abrasion has little or no effect on performance. Other repellency treatments can block or seal pores and capillaries, resulting in less vapor transmission and loss of performance after surface abrasion.*

Benefits of using silanes and siloxanes in construction applications

All construction materials are exposed to damaging environments ranging from water ingression, to abrasion by airborne particles and attack by organisms, to accidental spills. Dow Corning produces a range of products for use in formulations applied to a variety of substrates:

- Structural concrete
- Pavers and flagstones
- Sandstone
- Limestone and marble
- Brick and tile
- Wood

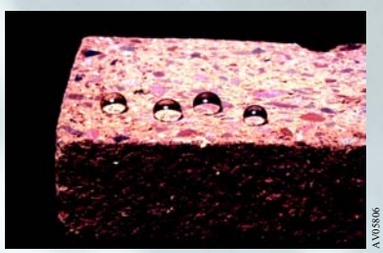
The formulations are used as preventive or remedial treatments for structural concrete, building facade and OEM substrates and provide a variety of features and benefits:

- Improved long-term protection
- Reduced maintenance time and costs
- Reduced efflorescence
- Reduced spalling (freeze-thaw damage)
- Improved strength of fragile masonry
- Reduced staining and easier cleaning
- Improved dimensional stability of wood
- Reduced chlorine ion ingression and corrosion

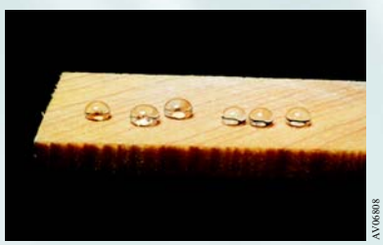
Silicone-based technology ensures:

- Repellency to water and water-soluble agents
- Permeability to water vapor
- Durability: chemically bonded with the substrate
- Deep penetration with silanes
- Low surface tension
- UV stability

Concrete protected with Dow Corning® *Z-6689 Water Repellent.*



Brick protected with Dow Corning® *Z-6689 Water Repellent.*



Wood protected with Dow Corning® *2-9034 Emulsion.*

Dow Corning® *MH-1109 Fluid protects against efflorescence in limestone.*

Physical and chemical properties of silicones

Silicones are present in many forms and are often used in combination to give the specific properties required for effective treatments.

Silanes

Silanes are the smallest silicone molecules, which ensures deep penetration into substrates. Silane treatments are well-established examples for nanotechnology. They react with themselves and any hydroxy (OH) groups within the substrate when moisture is present, forming a silicone resin network. This formation of strong chemical bonds provides the durability characteristic of silicone treatments. See Figures 1 and 2.

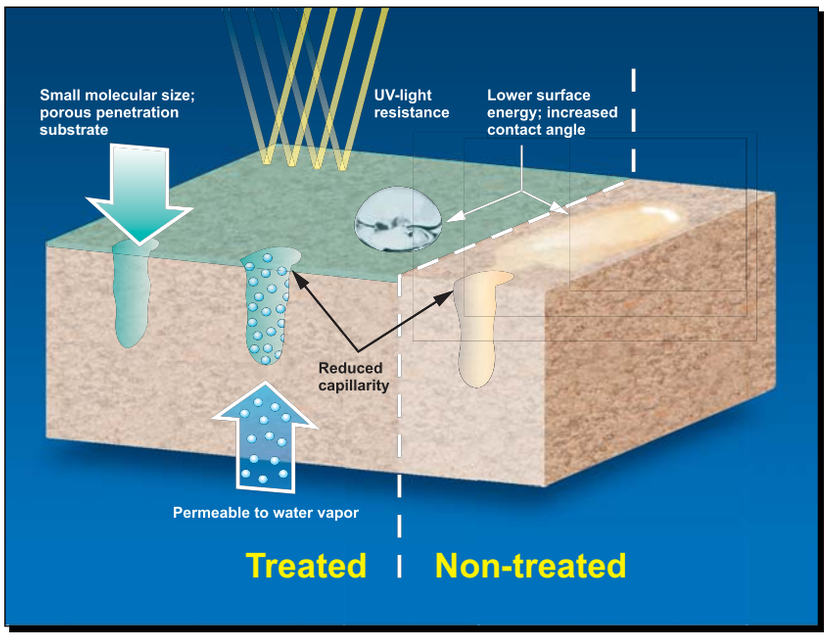
Siloxanes

Individual water vapor molecules can pass through, while water droplets are repelled by the hydrophobic chemical groups that remain on the outside, resulting in water beading. See Figure 3.

The low surface tension of siloxanes enables them to spread easily, forming a molecular layer that penetrates into the substrate.

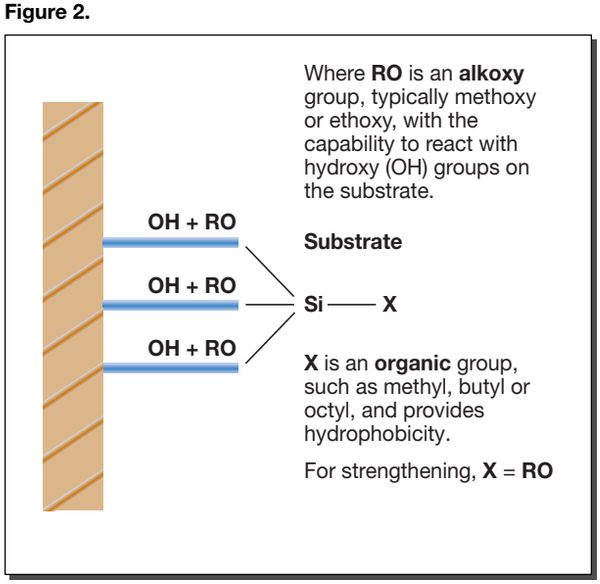
Various groups can be substituted onto the polymers, enabling chemical reactivity with the substrate and other siloxane molecules. See Figure 4.

Figure 1. Silicone-based products penetrate deeply, forming a repellent layer within the substrate.



Most siloxanes, especially silanes, are very small molecules, and when applied to the surface of a suitable substrate, penetrate deeply. They react with the substrate and themselves to provide durability. When cured, they allow water vapor transmission while preventing liquid water, which could contain dissolved chloride ions or acids, to pass into the substrate.

Figure 2.



The New Severn Bridge joining England and Wales, treated since 1992 with silanes from Dow Corning.

Figure 3. The open dimethyl siloxane.

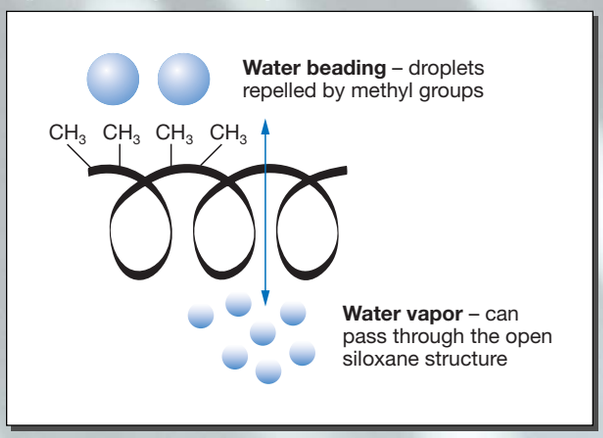
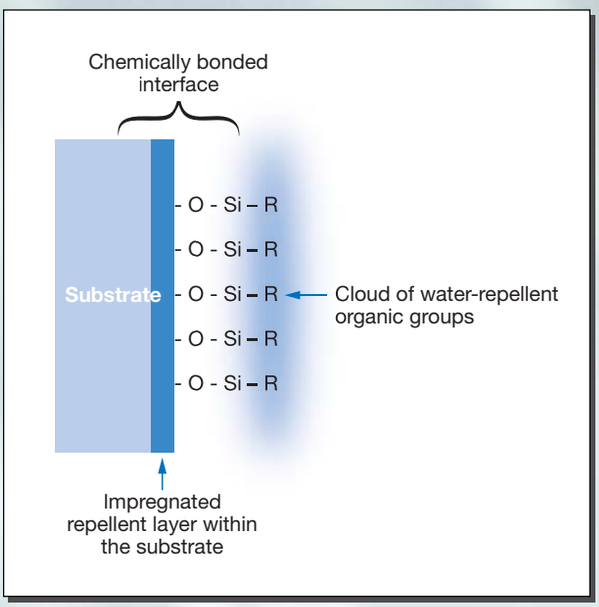
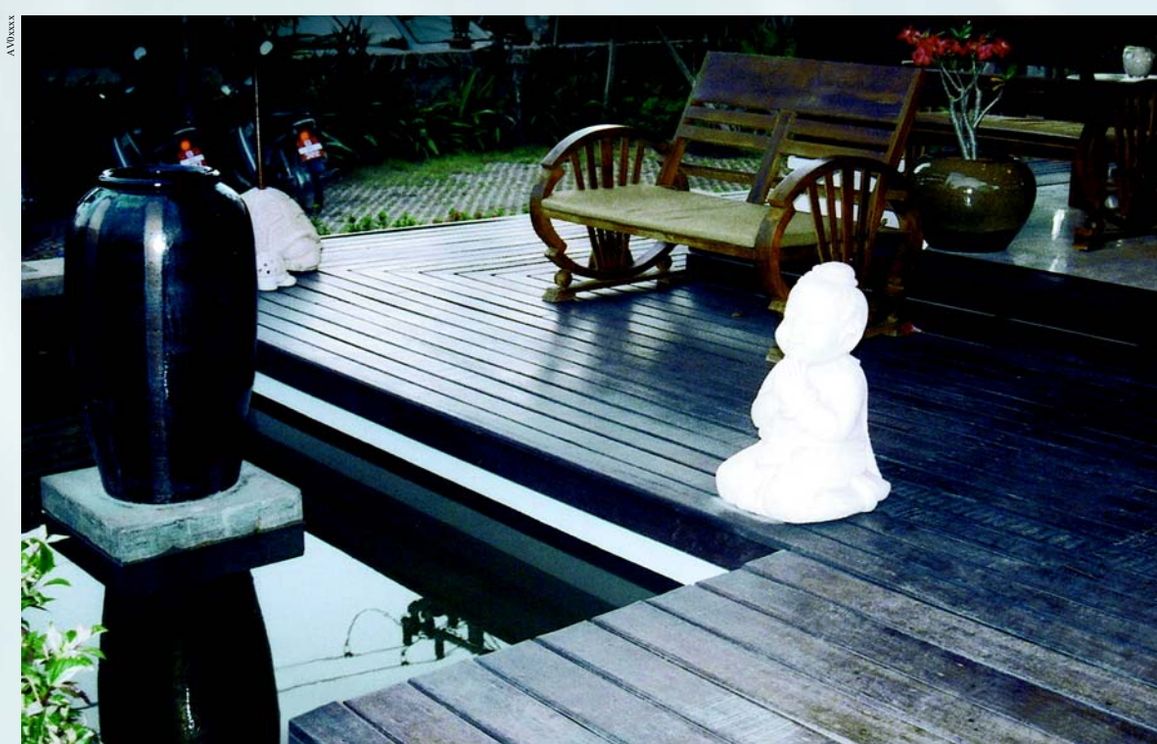


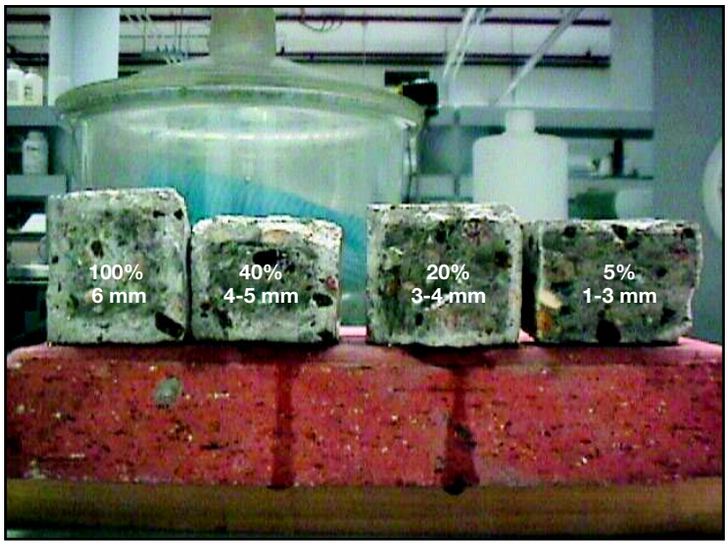
Figure 4.



Palais de l'Equilibre, Expo 2002 Switzerland. Treated with Dow Corning *2-9034 Emulsion.*

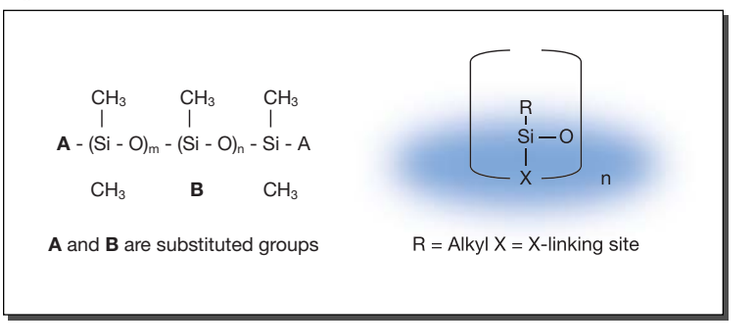


Silane emulsion water repellents can be used to protect wood substrates.



Dow Corning® *Z-6341 Silane: depth of penetration at various concentrations.*

Figure 5.



Polymers can be linear or cyclic, with various groups substituted into the positions shown.

Group	Position	Reactive	Function
Alkyl	A or B	N	Water repellency
Amino	A or B	N	Catalytic
Alkoxy	A or B	Y	X-linking
Hydroxyl	A	Y	X-linking
Hydrogen	B	Y	X-linking

Changi Port in Singapore.

Tanjong Rhu Suspension Bridge, Singapore.

Recommendations of suitability of products for use on various substrates on the following pages are based on consideration of the polymer type and blend required to achieve optimum performance.

Products and Benefits

Products[1]	Chemistry	Dilution System	Substrate	Benefits
Z-2306 and Z-6403 Silanes	Silane	Solvent-based or pure	Concrete	Protect reinforced concrete from chlorine attack.
Z-6697 Silane TEOS	Tetraethoxysilane	Solvent-based or pure	Natural stone and neutral substrates	It is of similar chemistry to the natural stone substrates, which makes it ideal as a stone strengthener. The product does not change the aesthetics and breathability of the substrate.
Z-6689 Water Repellent	Silane/siloxane blend + catalyst	Solvent-based	Neutral and moderately alkaline substrates such as brick, stone, concrete and all types of porous substrates	Quick-forming and enduring beading effect; bonds chemically to the surface.
1107 Fluid	Fluid	Pure	Gypsum	Hydrophobing treatment for plasterboard, plaster blocks, powders and granular materials.
MH-1109 Fluid	Fluid	Solvent-based	Natural stones: limestone, sandstone, marble and granite	Unique product provides excellent hydrophobicity on difficult substrates. Does not migrate, giving outstanding durability and protection.
***Dri-Sil*™ 55 (Z-6184)**	Siloxane	Water-based	Neutral substrates, brick, limestone, sandstone; cementitious joins for DPC substrates	Self-catalyzing after application. Dilute in water 1:7 to 1:17. Can be stored for up to one year in diluted form.
520 Dilutable Water Repellent	Silane/siloxane emulsion	Water-based	Alkaline or neutral substrates such as concrete, mortar and brick, stone	Deeply penetrates the surface without changing the appearance of the substrate.
Z-6341 Silane	Silane	Solvent-based	Alkaline substrates such as new concrete	Contains small molecules that allow deep penetration; provides water repellency by bonding chemically with the substrate.
2-9034 Emulsion	Nonionic organo-silicone emulsion	Water-based	Pretreated or untreated wood, and formulations used in pressure-treatment processes	High and enduring level of water repellency. Low vapor permeability.
772 Water Repellent	Siliconate	Water-based	Neutral, bricks, ceramics	Water-dilutable solution gives water repellency to a variety of substrates.
777 Water Repellent	Siliconate	Water-based	Neutral, bricks, ceramics	Water-dilutable solution gives water repellency to a variety of substrates.
Z-60 Emulsion	Aqueous hydroxy-terminated polydimethylsiloxane emulsion	Water-based	Hydrophobic additive in cementitious-based materials	Good dilution stability, up to 1:300 with water. Hydroxy sites can be reacted with substrates.
Z-6688 Silane Gel	Silane Gel	Water-based	Concrete, bricks, pavers, flagstones, mortar, grout	Thixotropic material can be applied onto any surface including overhead, vertical and horizontal, without run-off. The silane gel remains on the surface for up to 60 minutes ensuring deep and even penetration into the substrate. The high penetration depths achieved are due to the low volatility of the silanes, combined with the long contact time with the surface.
Z-6704 Silane Stain Repellent	Silane/Fluoro Compound	Solvent-based	Concrete, pavers, flagstones, natural stones, granites, marbles	Hydrophobic and oleophobic. Protects substrates against oil- and water-based stains. Long-lasting protection and does not change the surface appearance. Easy to use and apply.
2-1251 Emulsion	Emulsion	Water-based	Mineral substrates such as brick, stone, concrete and mortar that require additional water repellency	Deep penetration, reduction in water absorption, reduction in spalling due to freeze-thaw and efflorescence, thereby increasing substrate life. Will not change substrate appearance and is stable at low solids levels.

[1]All products are *Dow Corning*® brand unless otherwise noted.

Selection by Properties

Chemistry	Products[1]	● Solvent ● Water	Chemistry	Substrate pH/Type
Silanes	**Z-6403**	●	Butyltriethoxysilane	12 to 14
	Z-6341	●	Octyltriethoxysilane	12 to 14
	Z-2306	●	Butyltrimethoxysilane	12 to 14
Silane Gel	**Z-6688**	●	Silane gel	12 to 14
Silane/Fluoro Compound	**Z-6704**	●	Silane/fluoro compound	Neutral to 14
TEOS	**Z-6697**	●	Tetra ethoxysilane	Neutral to 10
Silane/Siloxane Blend (solvent-dilutable)	**Z-6689**	●	Solventless silane/siloxane blend	Neutral to 10
Amino Silicone Fluid (water-dilutable)	***Dri-Sil* 55 (Z-6184)**	●	Amino silsesquioxane	Neutral to 10
Silane/Siloxane	**520**	●	Silane/siloxane emulsion blend	Slightly alkaline to 12
Emulsions (water-dilutable)	**Z-60**	●	Hydroxy functional emulsion	Neutral to 10/admixture
	2-1251	●	Emulsion	Slightly alkaline to 12
Siliconates	**772**	●	Sodium methyl siliconate	Neutral to 10
	777	●	Potassium methyl siliconate	Neutral to 10
Specialty Fluids	**MH-1109**	●	Functional methyl siloxane	Neutral to 12
	1107	●	Polymethylhydrogen siloxane	Admixture
Silicone/Organic Blend	**2-9034**	●	Organo-siloxane emulsion	N/A

[1]All products are *Dow Corning*® brand unless otherwise noted.

Selection by Substrate

Chemistry	Products[1]	Concrete			DPC
		New	Old	Blocks	
Silanes	**Z-6403**				
	Z-6341				
	Z-2306				
Silane Gel	**Z-6688**				
Silane/Fluoro Compound	**Z-6704**				
TEOS	**Z-6697**				
Silane/Siloxane Blend (solvent-dilutable)	**Z-6689**				
Amino Silicone Fluid (water-dilutable)	***Dri-Sil* 55 (Z-6184)**				
Silane/Siloxane	**520**				
Emulsions (water-dilutable)	**Z-60**				
	2-1251				
Siliconates	**772**				
	777				
Specialty Fluids	**MH-1109**				
	1107				
Silicone/Organic Blend	**2-9034**				

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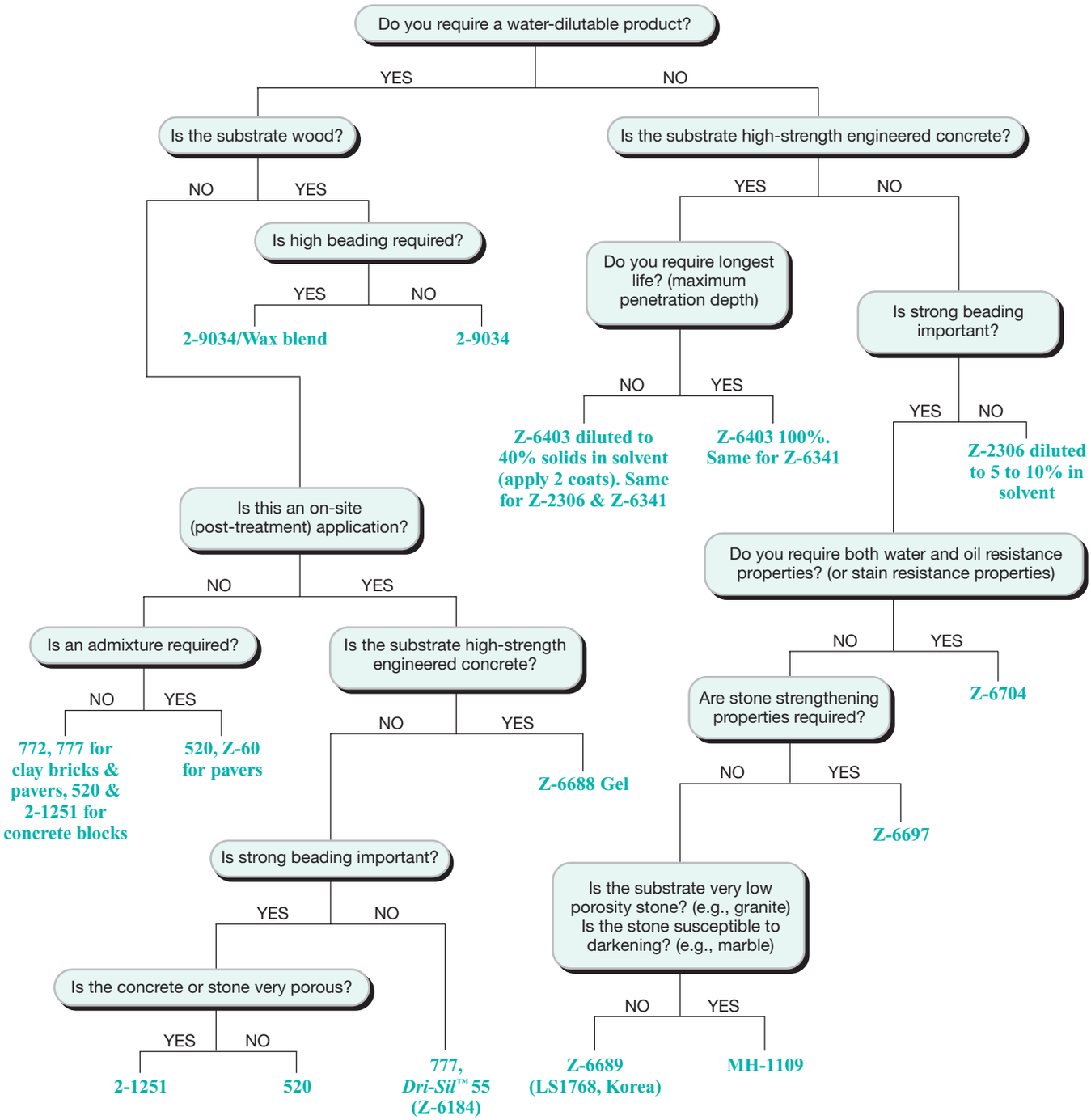
Main Application
Secondary Application
OEM Use
OEM or Main Post-Treatment

Active Ingredients, %	Typical Active Usage Level, %	Specific Gravity, kg/L	Flash Point, ºC (ºF)	Official Tests and Approvals
98	40 or 100	0.88	31 (88)	Meets NCHRP 244 Series II and IV and Alberta Testing requirements
98	40 or 100	0.88	63 (145)	Aproved at Swedish National Road Administration for surface treatment of concrete according to “Bro 2002”
96	40 or 100	0.92	35 (95)	The Department Transport (UK), Technical Report No. 20002 (1991) BE28/14/026
80	80	0.9	> 61	Approved to Swedish Bridge Norm 2002
50	50	0.85	8	CSTC (Belgian Building Research Institute) “Initial effectiveness, secondary effects and durability of water repellents” HD-340/133-134
>99	70 to 100	0.93	46 (115)	
98	5 to 15	0.96	65.5 (150)	CSTC (Belgian Building Research Institute) “Initial effectiveness, secondary effects and durability of water repellents” HD-340/133-143
65	3.5 to 7.5	1.05	27 (81)	Rising moisture in masonry test. WBA at IBAC, Aachen, Germany
40	5 to 20	0.99	>100 (212)	Meets ASTM E-514 Requirements
60	0.15 to 0.5	0.99	>101 (214)	
53	5 to 10	1	>100	
40	0.5 to 3	1.29	>93 (199)	
40	0.5 to 3	1.29	>93 (199)	
100	5 to 30	0.98	30 (86)	CSTC (Belgian Building Research Institute) “Initial effectiveness, secondary effects and durability of water repellents” HD-340/133-142
100	0.05 to 1	1	93 (199)	
50	2 to 8	0.94	100 (212)	

Wall, Bricks	Roof Tiles	Floor Tiles, Terracotta	Pavers, Flagstones	Sandstone	Limestone	Mortar, Grout	Marble	Granite	Gypsum	Perlite	Wood

Formulator Product Selection Guide[1]



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Silane water repellents can be used on various types of natural stone on building façades to prevent water ingress.

Dow Corning® brand Construction Chemicals

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