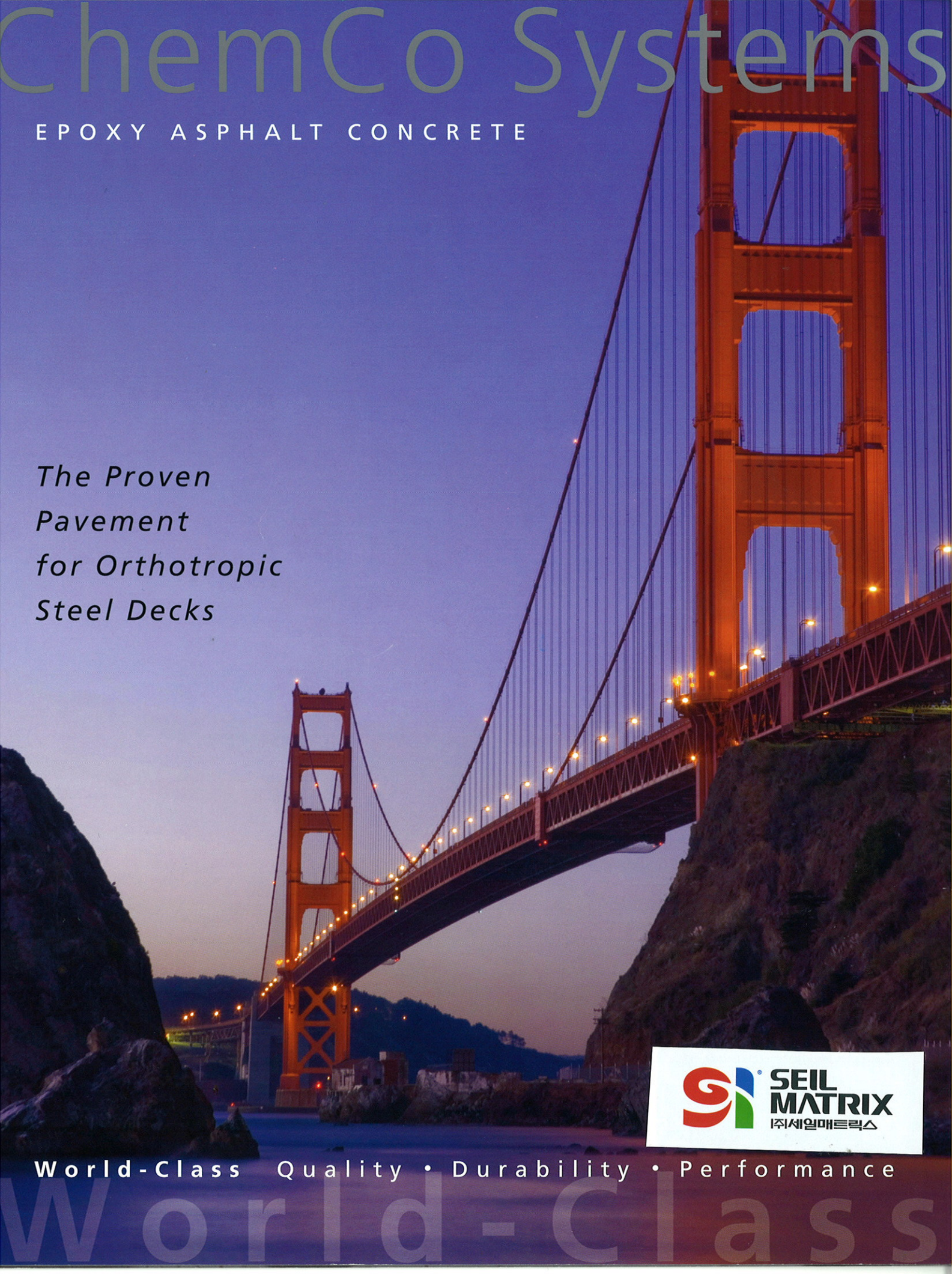
ChemCo Systems

EPOXY ASPHALT CONCRETE

The Proven Pavement for Orthotropic Steel Decks



SEIL MATRIX
㈜세일매트릭스

World-Class Quality • Durability • Performance

World-Class

CHEMCO SYSTEMS

en Franklin Bridge

Runyang Suspension Bridge

Dagu Bridge

Lions Gate Bridge

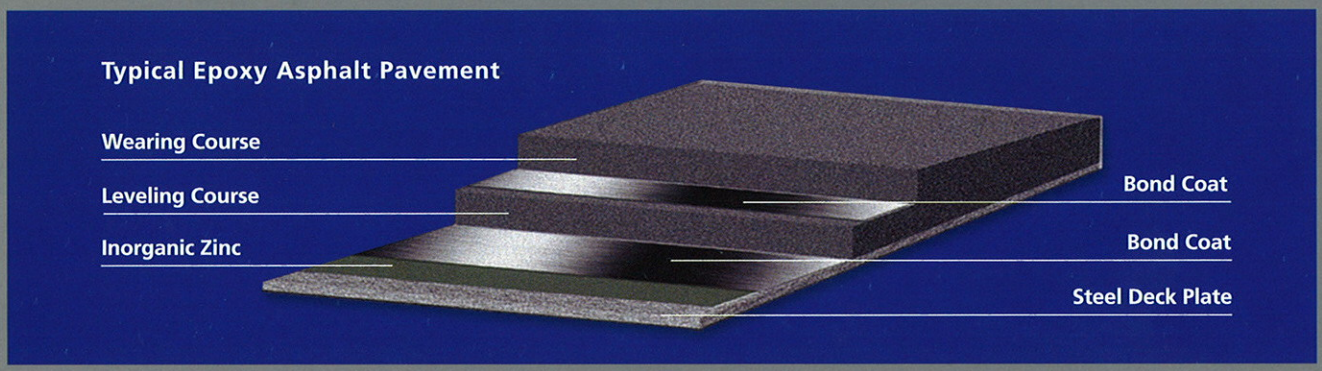
Proven Durability of More Than 40 Years

Outstanding Fatigue Resistance Performance

Excellent Results in Extreme Temperatures

Corrosion Protection without a Membrane

Epoxy Asphalt Concrete is a polymer concrete with over 40 years of successful performance as an extremely durable surfacing for orthotropic bridge decks. Since 1967, more than 250 million pounds have been installed on bridge decks totaling more than 85 million square feet.



What is Epoxy Asphalt? *The two-component Epoxy Asphalt binder, when cured, becomes a two-phase epoxy polymer that contains an asphalt extender. The continuous phase is an acid cured epoxy and the discontinuous phase is a mixture of asphaltic materials. It is a thermoset polymer – it will not melt. This binder, combined with high quality standard asphalt paving aggregates, forms a tough polymer concrete called Epoxy Asphalt Concrete. A hot spray application of an Epoxy Asphalt bond (tack) coat precedes the laying of the Epoxy Asphalt Concrete.*

ADVANTAGES

Fatigue Resistance The excellent fatigue resistance of Epoxy Asphalt enables it to maintain its integrity on orthotropic steel bridge decks without cracking even after the deflections caused by millions of wheel loads. The composite action of the Epoxy Asphalt, unlike that of more flexible pavements, increases the fatigue life of the steel deck and structure by reducing deflection, and thus strain, in the steel.

Corrosion Protection Epoxy Asphalt provides another layer of corrosion protection for the steel deck in addition to the primary corrosion protection coating because of its low void content of less than 3%. The voids that do exist are not interconnected. The result is an impervious pavement with extreme resistance to penetration of water and chloride ions.

Resistance to Rutting and Shoving Because Epoxy Asphalt binder is a thermoset polymer (as opposed to a thermoplastic polymer such as conventional and rubber-modified asphalt), it provides excellent resistance to rutting and shoving even under high wheel loads in warm or hot climates.

Skid Resistance Epoxy Asphalt pavements include high quality, polish resistant aggregates that provide outstanding skid resistance throughout their life. The Epoxy Asphalt binder does not "bleed" as do thermoplastic bituminous paving materials when the pavement gets hot. As soon as the binder on the aggregate exposed to traffic wears off, vehicle tires contact only the aggregate.

Minimal Traffic Delay Epoxy Asphalt ensures minimal delays for repaving existing bridges under traffic. An Epoxy Asphalt pavement is ready for traffic in its partially cured state once it has cooled to ambient temperature. It fully cures over two to six weeks depending on average daily temperatures.

Local Paving Crew Labor Local paving crews using conventional asphalt paving equipment install the Epoxy Asphalt. ChemCo engineers provide training and technical support during the project and ChemCo supplies the special blending equipment for the two Epoxy Asphalt components. This special equipment is operated by local labor – there is no need to import labor.

Bond Coat

Batch Plant

Loading

Placement

Compaction

INSTALLATION

Bond Coat A Spray Distributor machine, supplied by ChemCo, heats, mixes and sprays an Epoxy Asphalt bond coat onto the zinc rich epoxy painted steel at about 300˚F (149˚C). Depending on job requirements, the paint may be either shop or field applied. The bond coat is about 0.68 mm thick.

Batch Plant At a standard asphalt batch plant, a "Meter/Mix" machine, supplied by ChemCo, proportions and mixes the two binder components and injects into the pug-mill the exact amount of mixed hot Epoxy Asphalt binder required for each batch of Epoxy Asphalt Concrete.

Loading The batch plant discharges the approximately 250˚F (120˚C) Epoxy Asphalt Concrete mix into haul trucks for transport to the bridge deck.

Placement An asphalt paving machine distributes the paving for the leveling course of Epoxy Asphalt at the required thickness to achieve an approximately 1 inch (25 mm) compacted layer. Average paving rates exceed one mile per lane in an 8-hour shift.

Compaction A combination of pneumatic tire and 10 ton steel rollers provides the compaction, which is completed before the temperature of the mat has dropped below 150˚F (65˚C). An application of Epoxy Asphalt bond coat onto the leveling course precedes the laying of the 1 inch (25 mm) wearing course. The bond coat is about 0.45 mm thick.

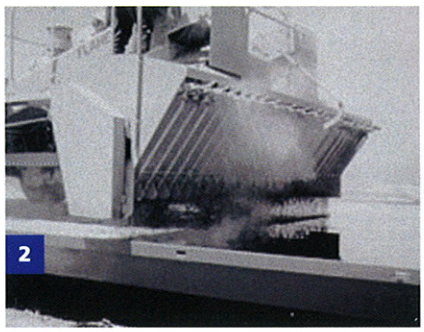
Epoxy Asphalt paving projects use standard asphalt batch plants, paving machines and rollers. ChemCo provides the special equipment required to process the two-component Epoxy Asphalt bond coat and binder. This paving system allows short turn-around cycles.

Outstanding Applications *Epoxy Asphalt has been used on orthotropic steel decks ranging from the San Mateo-Hayward Bridge in California, paved in 1967, to the Sutong Bridge in Nanjing, China, opening in 2008. The San Mateo-Hayward pavement is in excellent condition today after more than* ***40 years of service*** *with minimal maintenance. Around the world, applications on orthotropic decks include bridges paved in Australia, Brazil, Canada and China, and we anticipate new projects in Korea, Taiwan and Thailand. Two bridges have been paved with Epoxy Asphalt and then, after 20 years of sound service, repaved with the same material due to the installation of new wider decks. Epoxy Asphalt has been used in climates with winter temperatures well below 0°F and summer deck temperatures reaching 170°F. Epoxy Asphalt is currently being investigated by the highway research groups in a multinational governmental consortium, OECD, as a long life pavement with the potential for 40+ years of service.*

Epoxy Asphalt — A Proven Pavement System for Deck Replacements with Orthotropic Plates

Epoxy Asphalt helps meet the challenge of replacing old concrete bridge decks with orthotropic steel decks while minimizing traffic interruption. Shop applied Epoxy Asphalt chip seal provides a durable skid-resistant surface that protects each steel plate from wear and corrosion until all plates are in place and welded together. Epoxy Asphalt Concrete provides a long-term wearing surface when it is installed after all deck plates are in place. Both the Golden Gate Bridge in San Francisco and the Lions Gate Bridge in Vancouver use this system. The concrete deck of the heavily traveled Golden Gate Bridge was replaced and paved with no daytime lane closures. Lane shutdown began at 8 p.m., paving began at 10 p.m., and all lanes were opened at 5 a.m. the next morning. Throughout the night at least one lane was always open in each direction for traffic.


1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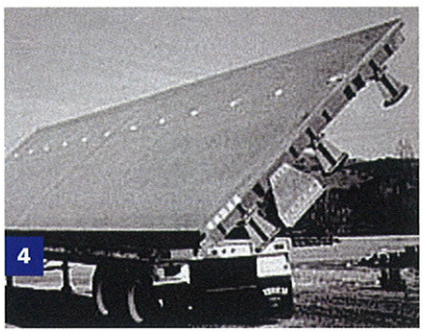
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Photo Captions

1 Epoxy Asphalt bond coat is sprayed onto the zinc rich epoxy paint coated deck plates. The bond coat is about 1.13 mm thick.

2 Chip spreader applies 1/8 inch (3.2 mm) max. aggregate onto the uncured bond coat.

3 Aggregate chips are rolled into the bond coat to provide maximum adhesion and long-term durability.

4 Completed deck plate. More than 800 of these panels were installed on the Golden Gate Bridge over a two-year period.

5 Deck plates in place, welded together and under traffic. Chip seal surface will be paved over and remain as part of the long-term protection of the orthotropic deck.

6 Installation of the final wearing course of 1.63 inches (41 mm) of Epoxy Asphalt Concrete.

PHYSICAL PROPERTIES OF EPOXY ASPHALT

Dynamic Testing

has shown that Epoxy Asphalt pavements resist fatigue cracking over a wide range of conditions.

Asphalt Concrete vs. Epoxy Asphalt Concrete

Property	Test Method (ASTM)	Asphalt Concrete	Epoxy Asphalt Concrete
Marshall Stability @ 140°F, lb.	D1559	2,500	8,000 to 14,000
Marshall Stability @ 400°F, lb.	D1559	melts	4000
Flow Value @ 140°F, inch	D1559	0.11	0.08
Recovery % min.	D1559	0	60
Comp. Strength @ 77°F, psi	D695		3400
Comp. Modulus of Elasticity @ 77°F, psi	D695		167,000
Flex. Modulus of Rupture @ 77°F, psi	D293	81	640
Flex. Modulus of Elasticity @ 77°F, psi	D293		380,000
Max. Deflection, inch	D293	0.1	0.15
Air Voids, %	D2041	3 to 5	1 to 2

Epoxy Asphalt Binder and Bond Coat (neat)

Property	Test Method (ASTM)	Binder	Bond Coat
Tensile Strength, psi	D412	300	1300
Tensile Elongation, %	D412	300	225
Heat Deflection Temperature	D648	-20	-14

Epoxy Asphalt Concrete/Binder – Bond Strength

Property	Test Method	Value	Failure Location
Tensile Bond Strength to Inorganic Zinc Coated Steel, psi	ACI 503R	300 to 500	Bond Coat
Tensile Bond Strength to Portland Cement Concrete, psi	ACI 503R	250 to 350	Portland Cement Concrete

Fatigue Resistance Properly designed Epoxy Asphalt pavements for orthotropic steel bridge decks provide a durable surface that resists fatigue cracking in the pavement in the negative moment area above the longitudinal stiffeners. Additionally, the pavement, acting as one element in the composite deck system, reduces deck deflection under load and thus increases the fatigue life of the steel deck plate itself.

Dynamic testing conducted in independent civil engineering laboratories has shown that Epoxy Asphalt pavements resist fatigue cracking over a wide range of conditions. The following tables summarize test results.

Deck Deflection Comparison[1]

Load, kN	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0
Deflection, Bare Steel Plate, mm	0.06	0.16	0.26	0.36	0.46	0.57	0.67	0.78
Deflection, Epoxy Asphalt/ Steel Composite, mm	0.03	0.12	0.18	0.26	0.34	0.42	0.51	0.60

Fatigue Test Results of Epoxy Asphalt – Steel Deck Composite[1, 2]

Temperature, °C	Static Deflection, mm	Dynamic Deflection, mm	Cycles to Failure
0	0.25	0.02	$12x10^6$ with no failure
18	0.35	0.18	$12x10^6$ with no failure
60	0.61	0.58	$12x10^6$ with no failure

Above test results from study conducted by Transportation College of Southeast University, Nanjing, China, 2000.
1 Test specimen: 14 mm plate 100 mm wide, center point load from underside. 2 Test load: 5kN load @ 10 Hz frequency

Fatigue Comparison Test by Rutgers University[3]

Tensile Strain (μ – strain)	Air Voids		Cycles to Failure		Initial Stiffness	
	Epoxy Asphalt	1-5, 6.3% Asphalt Concrete	Epoxy Asphalt	1-5, 6.3% Asphalt Concrete	Epoxy Asphalt	1-5, 6.3% Asphalt Concrete
200	1.3	5.2	225,194,016	6,123,983	10,571	4,483
400	1.8	5.1	159,818,123	1,216,219	10,261	4,237
900	1.4	5.1	16,626,222	17,712	7,917	2,804

3 Above test results from Rutgers University study in 2007 comparing Epoxy Asphalt vs. Superpave standard HMA specimens.

EPOXY ASPHALT

Zhanjiang Gulf Bridge

Taoyaomen Bridge

Fenghua Bridge

Coronado Bridge

Installs Quickly with Standard Paving Equipment

Extreme Rut Resistance Even with Wheel Overloads

Not Subject to Oxidation or Loss of Plasticity

Maintains Skid Resistance Over Life of Pavement

At ChemCo Systems we believe that expertise makes all the difference to our customers.

Our staff engineers and chemists average more than 25 years of industry experience, and many participated in the original development of structural adhesives for concrete repair and restoration. Their original research and testing into the behavior of adhesives under sustained stress led to the adoption of minimum test standards by ASTM. Today we remain active in the standards and technical committees of ACI, ICRI, ASTM, ACS and CSI.*

Founded in 1994 by the team that developed the SCB®† system of structural crack repair, ChemCo manufactures a diverse selection of polymer systems for use in construction applications. Our products are designed to install, protect or repair architectural and structural concrete, steel and wood, as well as both carbon and glass fiber composite systems. Over 100 ChemCo products are available for structural crack repair, anchor bolts, coatings and sealants, machine bases, old-to-new pours, seismic upgrades, plate bonding reinforcement, spall repair, underwater (marine) and extreme environments. In addition, ChemCo offers custom formulation, compounding, toll manufacturing and product testing services using ASTM and ACI standards.

*ACI = American Concrete Institute, ASTM = American Society for Testing and Materials, ACS = American Chemical Society, CSI = Construction Specifications Institute, ICRI = International Concrete Repair Institute †SCB® Process = Structural Concrete Bonding® Process, developed at Adhesive Engineering.

Worldwide Installations of Epoxy Asphalt Pavement

Brazil
Costa de Silva (Rio-Niteroi)

Canada
Champlain
Lions Gate
MacDonald
McKay
Mercer

China
2nd Nanjing
3rd Nanjing
Chi Feng
Ci Hai
Dagu
Fenghua
Fu Min
Hangzhou Bay
Houhai
Huangpu Cable Stay
Huangpu Suspension
Li Gong
Nanhuan
Pingsheng
Runyang Cable Stay
Runyang Suspension
Sutong
Taoyaomen
Yangluo
Zhanjiang Gulf

United States
I-94 Bridges
Ben Franklin
Evergreen Point
Fremont
Golden Gate
Luling
Maritime Off-Ramp
Queensway A
Ross Island
San Diego-Coronado
San Francisco-Oakland
San Mateo-Hayward
Sellwood

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