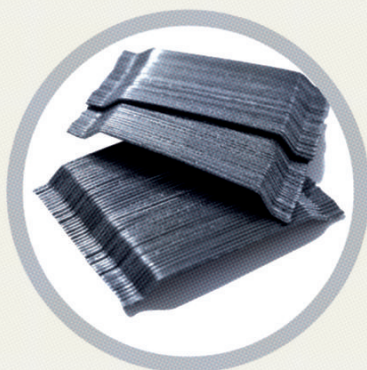






Kosteel has been a leader in the steel fiber industry and is now looking to the world with its cutting-edge technology.

A top player in korean domestic market, Kosteel will continue its efforts to make the best products. With our world-class technology through continuous research, we manufacture the best steel fiber, a new standard for concrete reinforcement.



History

2001

October Established Steel Fiber Korea Co., Ltd

2003

June Registered of Trademark for **BUNDREX®**
November Registered of Trademark for
Steel Fiber Korea Co., Ltd

2002

April Registered of Industrial
Design for Steel Fiber Reinforced Concrete

2005

February Obtained the Patent on Manufacturing Device
of **Rigid and Ductile Wire for Concrete Reinforcement**

A new history of steel fiber begins with Kosteel.

Kosteel is the most reliable company among steel fiber manufacturers in Korea for its wire-manufacturing technologies and is positioned as a leading player in global market.

2006

- February Obtained the Patent on Steel Fiber Glue and its Manufacturing Method
- November Obtained Patent on Cement Material Containing Reinforced Fiber and its Composite
- December Obtained Certificate of Technology Innovation Type SME from SMBA Administrator

2008

- April Registered of Trademark for Hybrid fiber

2009

- March Export to Japan
- May Complete the research of SOG

2010

- June Obtained CE Certification
- July Obtained ISO 9001: 2008 certification
- August Conducted Refractory Test on Prototype of Hybrid Fiber Reinforced Segment

2011

- December Steel Fiber Korea co., ltd. Merged into Kosteel. co. ltd.

2012

- June Obtained CE cortification "R" Grade

Bundrex Steel Fiber

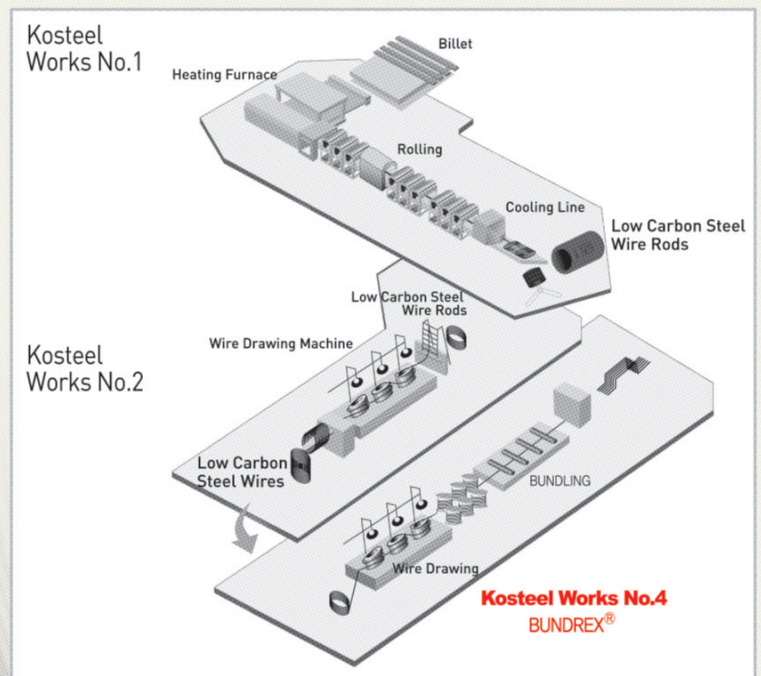
BUNDREX[®] is a superior steel fiber technology that ensures reliability and cost-effectiveness

BUNDREX[®] steel fiber technology compensates for the weaknesses of standard concrete and has already been proven in various applications, including buildings and special structures.

Raw Material of BUNDREX[®] Steel Fiber

We use low carbon steel wire rods of high-quality made by our own wire-rod factory located in Pohang, a producer of highest-quality wire material with a wide range of product lineup. To maintain the best quality, we use top quality low carbon steel wires, produced through systematic processing management and strict quality control in conformity with ISO and KS standards.

Form raw material to final products



Overview of BUNDREX[®]

- Material : ASTM 510M
- Tensile Strength : 700 ~ 1,300Mpa
- Appearance : END HOOK TYPE / BUNDLE TYPE
- Product TYPE: Bundle(Glue) and End hook type
 - Bundle makes steel fiber dispresed more evenly without fiber ball
 - End hook acts as an anchor inside concrete.



Advantages of BUNDREX® Steel Fiber

- Reducing the number of workers: no additional workers are needed to prevent fiber ball when mixing and placing concrete
- Reducing working hours: fast mixing is possible without fiber ball; No pipeline or nozzle clogging when pouring shotcrete
- Streamlining B.P. equipment: steel fiber dispersion equipment is needed when installing B.P.
- Superior dispersability
- Higher Efficiency in mixing with concrete

BUNDREX® Reinforced Concrete

Concrete reinforced with BUNDREX® technology is more than just concrete.

It is the superior-quality concrete with long durability, high cost-effectiveness, and superior safety.

Characteristics of BUNDREX®-Reinforced Concrete

STEEL FIBER REINFORCED CONCRETE

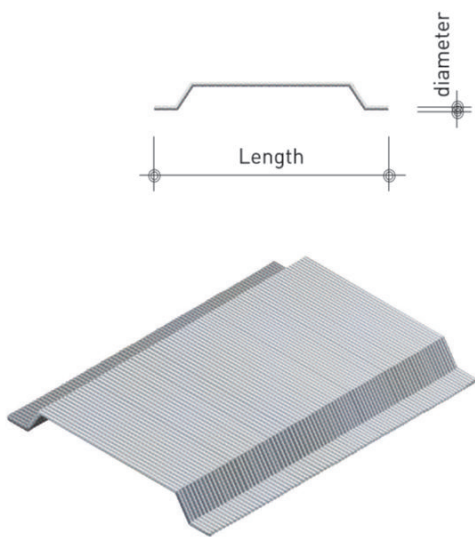
- Increased fatigue resistance, flexural toughness, shear force, flexibility, impact resistance, and fracture resistance of concrete
- Increased resistance to drying shrinkage
- High in abrasion durability, resistance to erosion, corrosion resistance
- Enhanced physical properties of concrete leading to decrease in thickness of concrete section
- Reinforced cohesion of concrete with even dispersion of steel fiber
- Three-dimensional reinforcement effects inside concrete
- Effective prevention of structural member corrosion by blocking negative ionization

Expected Effects of Reinforced Concrete

Physical Properties of Concrete	BUNDREX® Effects
Modulus of Rupture	3 times increase
Shear Strength	2 times increase
Torsional strength	2 times increase
Fatigue Resistance	1.8 times increase
Abrasion and Corrosion	1.4 times increase
Shock absorption	15 times increase

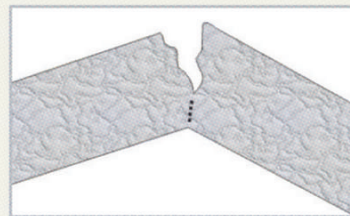
Bundrex Steel Fiber

BUNDREX® leads standards of steel fiber through unlimited passion for quality.



Change in Physical Properties of Concrete when reinforced with BUNDREX®

When concrete is reinforced with BUNDREX®, brittleness, one of the major weaknesses of concrete, leads to enhanced ductility and toughness.



Brittleness



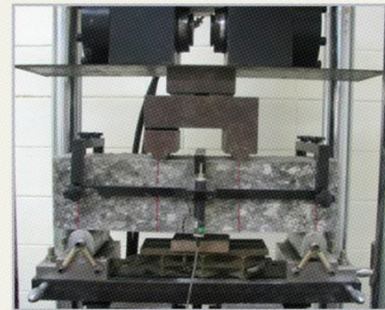
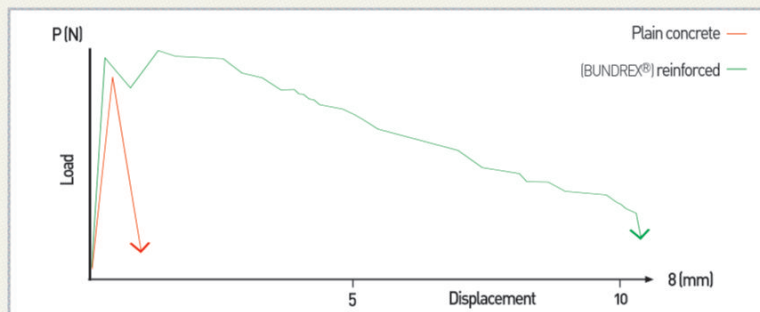
Ductility

Performance effects of BUNDREX® - Reinforced Concrete by Type

Characteristics	Tunnel	Dam	Road Pavement	Bridge Deck	Inclined	Factory Flooring	Building	Secondary product
Crack Resistance	○	○	○	○	○	○	○	○
Impact Resistance	▲	○	○	○	●	●	▲	●
Abrasion Resistance	▲	○	○	○	■	●	▲	▲
Freeze/Thaw resistance	○	○	○	○	○	○	○	○
Fatigue Resistance	■	■	●	○	■	○	■	●
Refractoriness	●	■	■	▲	■	●	●	●
Shear Resistance	○	■	●	○	○	●	●	●
Weight, Thickness Decrease	○	▲	●	●	●	▲	○	○
Cost-effectiveness	●	■	●	▲	●	○	●	●

○ Very Good ▲ Average
 ● Good ■ N/A

Graph of equivalent flexural strength of SFRC containing BUNDREX®

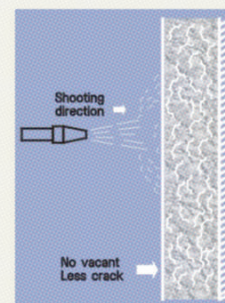


Features of BUNDREX® - Reinforced Shot Concrete

Wire Mesh Reinforcement	BUNDREX® Reinforcement
<ul style="list-style-type: none"> • Difficult to install wire mesh in case of back break from excavation; decreased reinforcement effects • Decreased adhesion, layer splitting, hollowing-out due to vibration on wire mesh when placing shotcrete • High frequency of cracking in shotcrete and decreased reinforcement effects in case of cracking • Shotcrete reinforcement needed right after excavation due to risk of cave-in disasters; decreased reinforcement effects due to delay of reinforcement • Low constructability and complex work process • Increased construction costs due to longer working hours 	<ul style="list-style-type: none"> • Increased reinforcement effects with wall of even thickness on a rugged surface • Increased tensile strength, bending strength, shear strength of concrete; no hollowing-out; reduction of wall thickness (20%) • High resistance to cracking; increase in toughness (residual strength) after cracking • Shotcrete construction possible right after excavation; drop in risk of cave-in disasters; rise in reinforcement effects and safety of permanent structures • Streamlined work process; rise in quality and safety • Reduced working hours and construction costs



Wire Mesh Reinforcement



BUNDREX® Reinforcement

Bundrex Steel Fiber



Production Process of BUNDREX® Steel Fiber



CE



ISO 9001:2008

BUNDREX® Steel Fiber Table ←Unit: mm, %→

Specification		Diameter	Length (L)	Aspect Ratio (L/D)
BUNDREX®	KF6030	0.5	30	60
	KF7035	0.5	35	70
	KF5030	0.6	30	50
	KF5835	0.6	35	58
	KF7050	0.7	50	70
	KF5550	0.9	50	55

* As customer's request, diameter and Length are adjustable

Flow Chart of BUNDREX® Steel Fiber Input

• Draw Construction Plan



Supply System



Packing of 1 Ton Bag

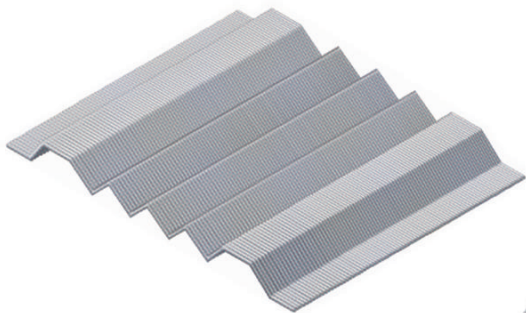
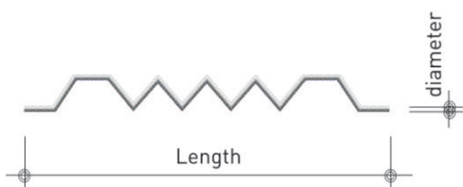


Placing of Concrete

Slab - on- Grade

Buildings and structures stand firm based on the slab-on-grade

Steel fiber-reinforced slab-on-grade has already been used for large warehouses, factories, superstores, and so forth. Reducing construction costs, it ensures safety, easy constructability, and even high toughness.



BUNDREX® - reinforced slab-on-grade is more cost-effective and structurally stable

Characteristics of BUNDREX® - reinforced slab-on-grade

- Superior resistance to cracking
- Increased toughness (residual strength)
- Increased bending strength
- Increased ductility (durability) of concrete



Expected Effects of BUNDREX® - reinforced slab-on-grade

Pavement

Performance

- Decreased cracking
- Increased joint spacing
- Increased load carrying capacity of concrete pavement
- Extended pavement lifespan

Application

Expressway, road, parking lot, bridge deck, new pavement, repair and reinforcement work

Cast-in-place concrete

Performance

- Reinforcement of bending stress and tensile force

Application

Machine foundation, structural panels, shell structure, silos, intake tubes, deck slab

Dams and hydraulic structures

Performance

- Impact resistance
- Resistance of toughness, tension, deformation
- Fracture resistance

Application

Spillway of dam, water pressure tunnel, reservoir around river or reinforced erosion control dam

Tunnel lining

Performance

- Improved bending strength and crack resistance
- Improved crack restraint
- Improved durability
- Improved safety

Application

Tunnel lining

Comparison of Properties Between Ordinary Slab and BUNDREX® - Reinforced Slab-On-Grade

Index	Ordinary Slab	Steel Fiber-Reinforced Slab-On-Grade
Constructability	Decline in constructability	Improvement in constructability
Initial dry shrinkage crack control	Dry shrinkage cracking of upper base	Decrease in dry shrinkage crack of upper base
Initial cracking strength and strongest internal force	Average	Superior
	Unreinforced Concrete Slab ← Reinforced Concrete Slab ← Steel Fiber-Reinforced Slab on Grade	
Failure aspects	Brittle Behavior	Ductile Behavior

Hybrid Fiber

Kosteel leads the sector of refractory explosive spalling-resistant fiber in Korea with its cutting-edge technology

Our Kosteel Hybrid Fiber is specially manufactured for improving explosive spalling resistance and refractory performance of high-strength concrete.



Background of Hybrid Fiber Development

Hybrid fiber, an explosive spalling reducer, was developed to prevent explosive spalling of concrete resulting from large tunnels, underground space, high-rise buildings, and super high-strength concrete. Hybrid fiber ensures durability performance, including structural performance and refractory performance.

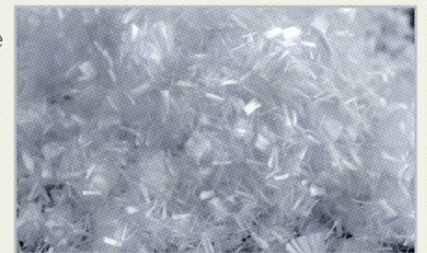
- Verification test by the Korea Institute of Construction Technology (engineering) & (construction)

Overview of Hybrid Fiber

It was designed to generate superior refractory effects by mixing more than two types of fiber for optimum effects.

Product Description of Hybrid Fiber(|)

- Color : White
- Specification : 5~10mm hybrid type
- Material : polypropylene
- Packing : 0.9kg/bag
- Design Mixing Proportion : according to each mixing design



Mixing of Hybrid Fiber(II)

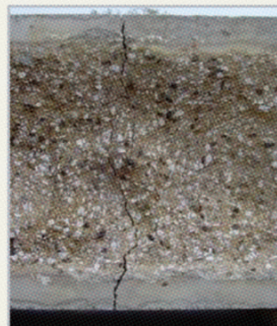
- TYPE1: P.P+P.P(P.P fiber+P.P fiber)
- TYPE2: P.P+STEEL FIBER(P.P fiber+steel fiber)

	Strength of Concrete	Hybrid Type
Hybrid Fiber I	$\leq 60\text{Mpa}$	Polypropylene + Polypropylene
Hybrid Fiber II	$\geq 80\text{Mpa}$	Polypropylene + Steel Fiber

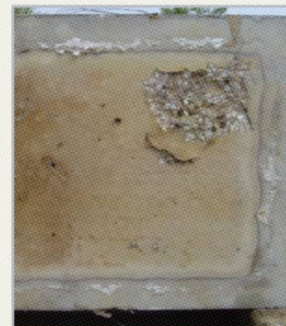
Effects of Hybrid Fiber

- 01 Resistance to explosive spalling of high-strength concrete (improved refractory performance)
- 02 Crack prevention (crack control) plastic shrinkage cracking
- 03 Increased durability
- 04 Increased toughness
- 05 Increased residual strength after fire exposure
- 06 Improved seismic resistance and fatigue resistance
- 07 Assured constructability

Fire Tests



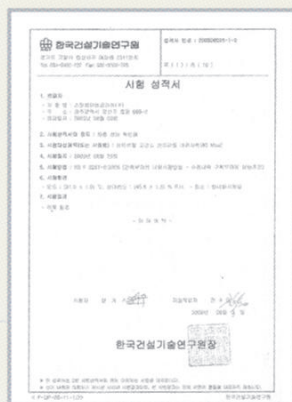
Control



Hybrid

Fire-resistance test by the Korea Institute of Construction Technology in 2009

Satisfactory fire-resistance performance (test records issued)



Fire Tests



Test result 1
(60Mpa)

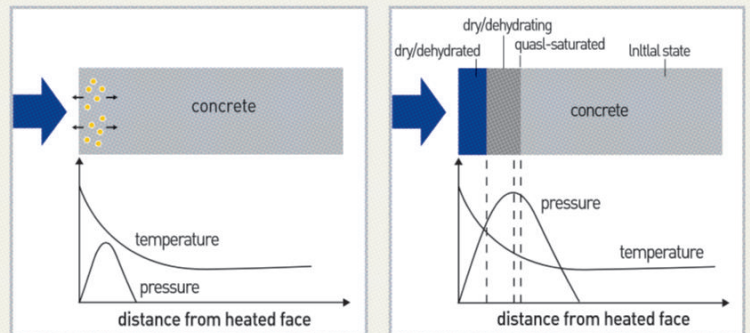


Test result 2
(80Mpa)

Hybrid Fiber



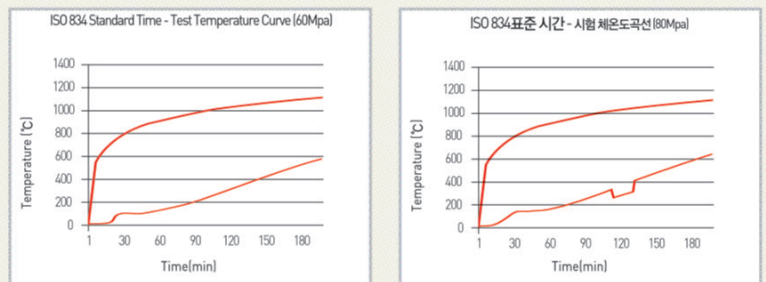
Thermal Stress and Pore Pressure



Korea's standard of unloading fire-resistance performance (KSF 2257-6.7)

- Refractory performance management of high-strength pillar and beam with over 50 MPa of standard compressive strength of design
- Based on time-temperature graph prescribed in KSF 2257-1
- Suitable to standard with average temperature of main reinforcement of 538°C, maximum of 649°C or lower

Time-Temperature Standard Curve of Hybrid Fiber in fire exposure



Refractory Performance Management standard of High-strength Concrete Columns and Beams (Ministry of Land, Transport, and Maritime affairs, Notification No. 2008-334)

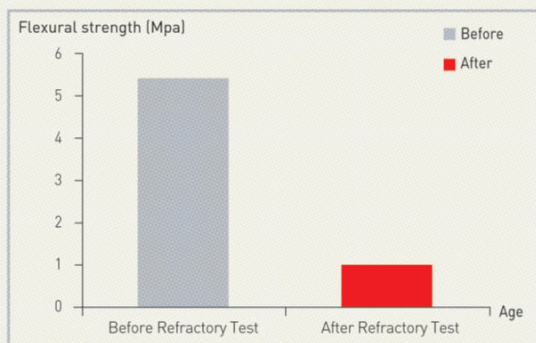
The Standards and rules on refractory structure, evacuation, and fire protection prescribed in the Article 2 of Enforcement Decree on Construction and in the Article 3, set out standards and methods to verify refractory performance of columns and beams made of concrete with over 50 MPa of standard compressive strength of design

Use of Hybrid Fiber

- 01 Open a bag and put it on a B/P conveyer belt or in a mixer
- 02 Concrete mixing: insert according to the optimum mix proportion
- 03 Mixing time: same as mixing time for plain concrete

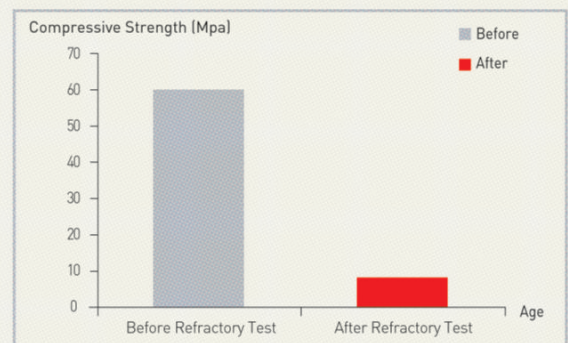
Flexural strength of Hybrid Fiber-reinforced concrete before and after refractory test

Refractory Test	1	2	3	Average
Before	5.2	5.6	5.4	5.4
After	0.81	0.78	0.72	0.77



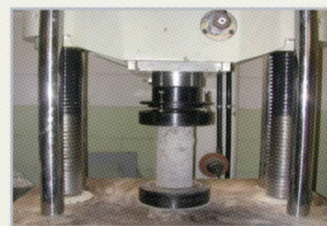
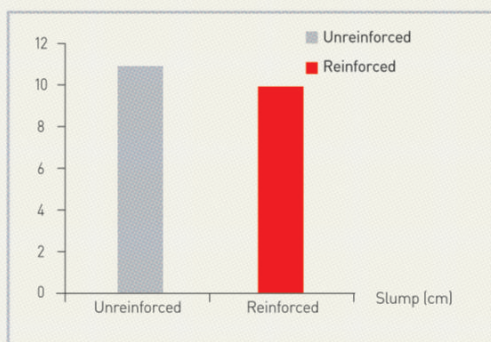
Compressive strength of Hybrid Fiber-reinforced concrete before and after refractory test

Compressive Strength (Mpa)	1	2	3	Average
Before	62.4	60.3	59.1	60.6
After	8.6	8.3	8.9	8.6



Slump by reinforcement with Hybrid Fiber

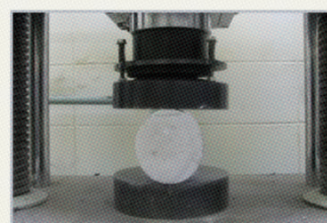
With or without Hybrid Fiber	1	2	Average
Hybrid Fiber Unreinforced	10.5	11.5	11.0
Hybrid Fiber Reinforced	9.5	10.5	10.0



Compressive Strength Test



Flexural Strength/Toughness Test



Tensile Strength Test

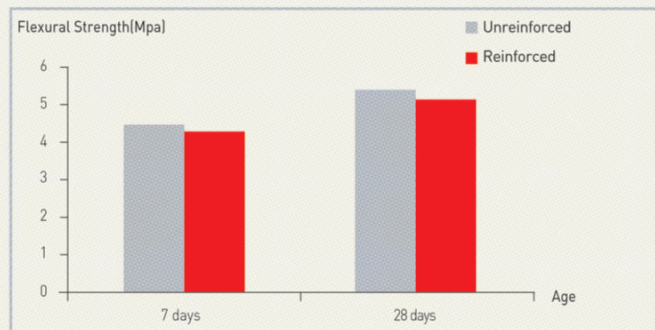
Hybrid Fiber

Kosteel's exceptional technology is spreading out globally for customers' satisfaction



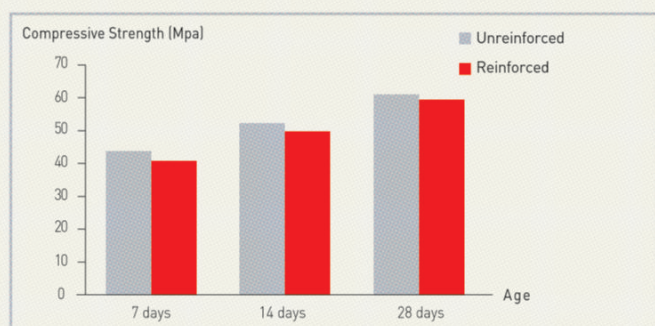
Flexural Strength by Hybrid Fiber Reinforcement

With or without Hybrid Fiber	Age	1	2	3	Average
Hybrid Fiber Unreinforced	7 days	4.8	4.3	4.4	4.5
	28 days	5.2	5.6	5.4	5.4
Hybrid Fiber Reinforced	7 days	4.5	4.1	4.3	4.3
	28 days	5.2	5.5	5.2	5.2



Compressive Strength by Hybrid Fiber Reinforcement

With or without Hybrid Fiber	Age	1	2	3	Average
Hybrid Fiber Unreinforced	7 days	43.8	41.6	43.9	43.1
	14 days	52.4	50.3	52.7	51.8
	28 days	62.4	60.3	59.1	60.6
Hybrid Fiber Reinforced	7 days	41.5	40.8	39.2	40.5
	14 days	51.2	48.4	50.7	50.1
	28 days	60.1	60.8	58.2	59.7



■ Performance of BUNDREX® Steel Fiber

For Domestic

Client	Title of work	Constructor	Construction Type
Korea Highway Corporation	Expressway work section 4 (Daejeon-Dangjin)	GS Engineering & Construction	Tunnel shotcrete
Korea Rail Network Authority	Jungang Line work section 3 (Deokso-Wonju)	Samsung C&T Corp.	Tunnel shotcrete
Korea Water Resources Corporation	Sihwa Tidal Power Plant	Daewoo Engineering & Construction Co., Ltd	Tunnel shotcrete
Korea Western Power Co., Ltd	Cheongsong Pumped Storage Power station (Cheongsong dam)	Samsung C&T Corp.	Lining of Hydraulic pressure
Korea High Speed Rail Construction Authority	KTX Work section 13-3 SK	Engineering & Construction	Tunnel shotcrete
Iksan Regional Construction Management Office	National Bypass in Jeongup	NamKwang Engineering & Construction	Tunnel shotcrete
Seoul Metropolitan City	Seoul Subway Line 7 Extension Work section 702	Hyundai Engineering & Construction	Tunnel shotcrete

For Overseas

Location(Country)	Title of work	Constructor	Construction Type
Japan	Yokohama Circle North Line	Obayashi	RC Segment
Japan	Kawajiri Tunnel Shield Works	Obayashi	RC Segment
Japan	NO.25th Mido-Suji Shield Works	Taisei	RC Segment
Japan	Yamato River Shield Works	Kajima	RC Segment

Kosteel Major Performances



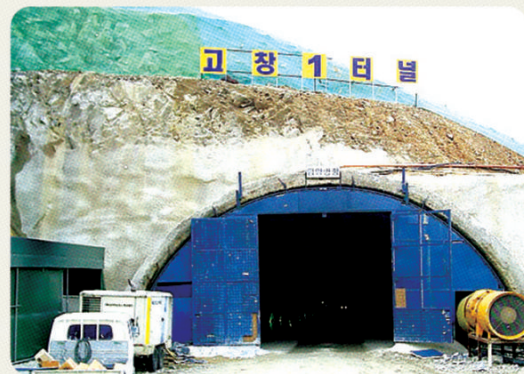
❖ Seocheon Tunnel



❖ Yeongam Tunnel No.1



❖ Kangjin Tunnel



❖ Gochang Tunnel No.1



❖ Gochang Tunnel



❖ Chimgok Tunnel



❖ Osan Tunnel



❖ Yulchi Tunnel



❖ Jeongok Tunnel No.2



❖ Nokmun Tunnel



❖ Ojeong Tunnel



❖ Yongdu Tunnel

Kosteel _ Major Performances



❖ Gochang Tunnel



❖ Munsusan Tunnel



❖ Munpyung Tunnel



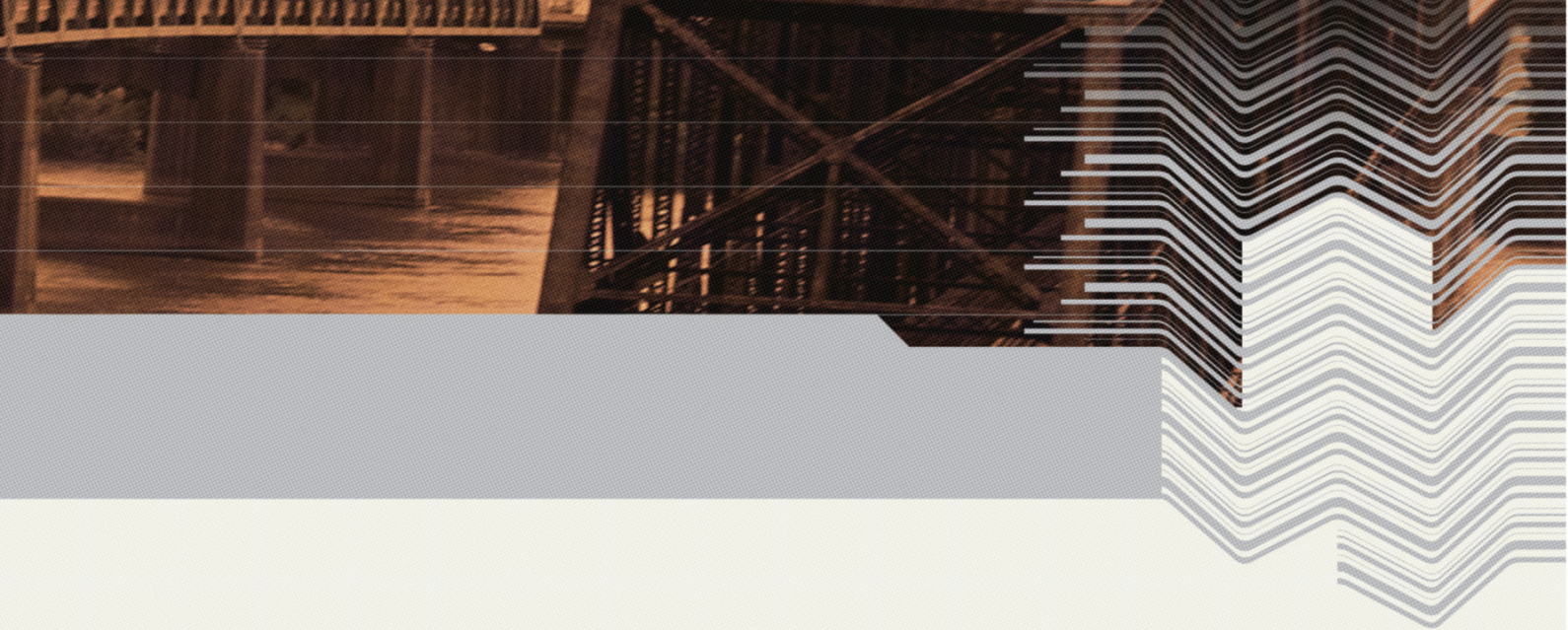
❖ Jangsung Tunnel



❖ Munju Tunnel



❖ Nabi Tunnel



❖ Farm Road Pavement



❖ Jungbu Inland Expressway



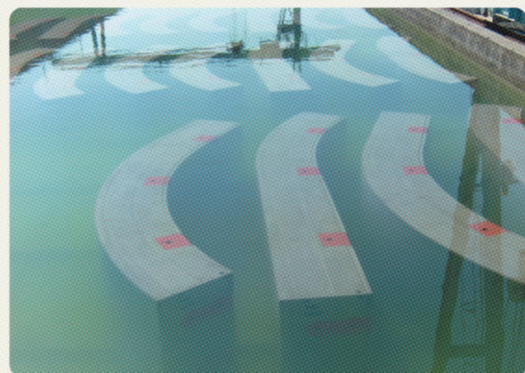
❖ Parking Lot Slab Construction



❖ Distribution Center
Flooring Construction



❖ Tunnel Segment



❖ Segment



Affiliated Company



Kosteel Works No. 1 - Pohang

- Address : 286, Ho-dong, Nam-gu, Pohang-si, Gyeongsangbuk-do, 790-380, Korea
- TEL : 82-54-278-0300
- FAX : 82-54-278-0307
- Production Capacity : 350,000 ton
- Major Products: wire and rebar
- KS items: deformed bar KSD3504, low carbon steel wire rods KSD3554



Kosteel Works No. 2 - Pohang

- Address : 594, Ho-dong, Nam-gu, Pohang-si, Gyeongsangbuk-do, 790-380, Korea
- TEL : 82-54-278-0314
- FAX : 82-54-278-0317
- Production Capacity : 100,000 ton
- Major products: low carbon steel wire, wire nail, annealed wire, flat tie, flat coil
- KS items: low carbon steel wire KSD3552, round wire nail KSD3553