World Leading Composite(FRP) Bridge Deck – DeltaDeck ®

Light, Strong, Rust-free, Rapid Installation, Long Service Life

Modular Prefab FRP Walkway Deck

EJtech Co., Ltd.
www.ejtech.net

World Leading Composite(FRP) Bridge Deck – DeltaDeck®

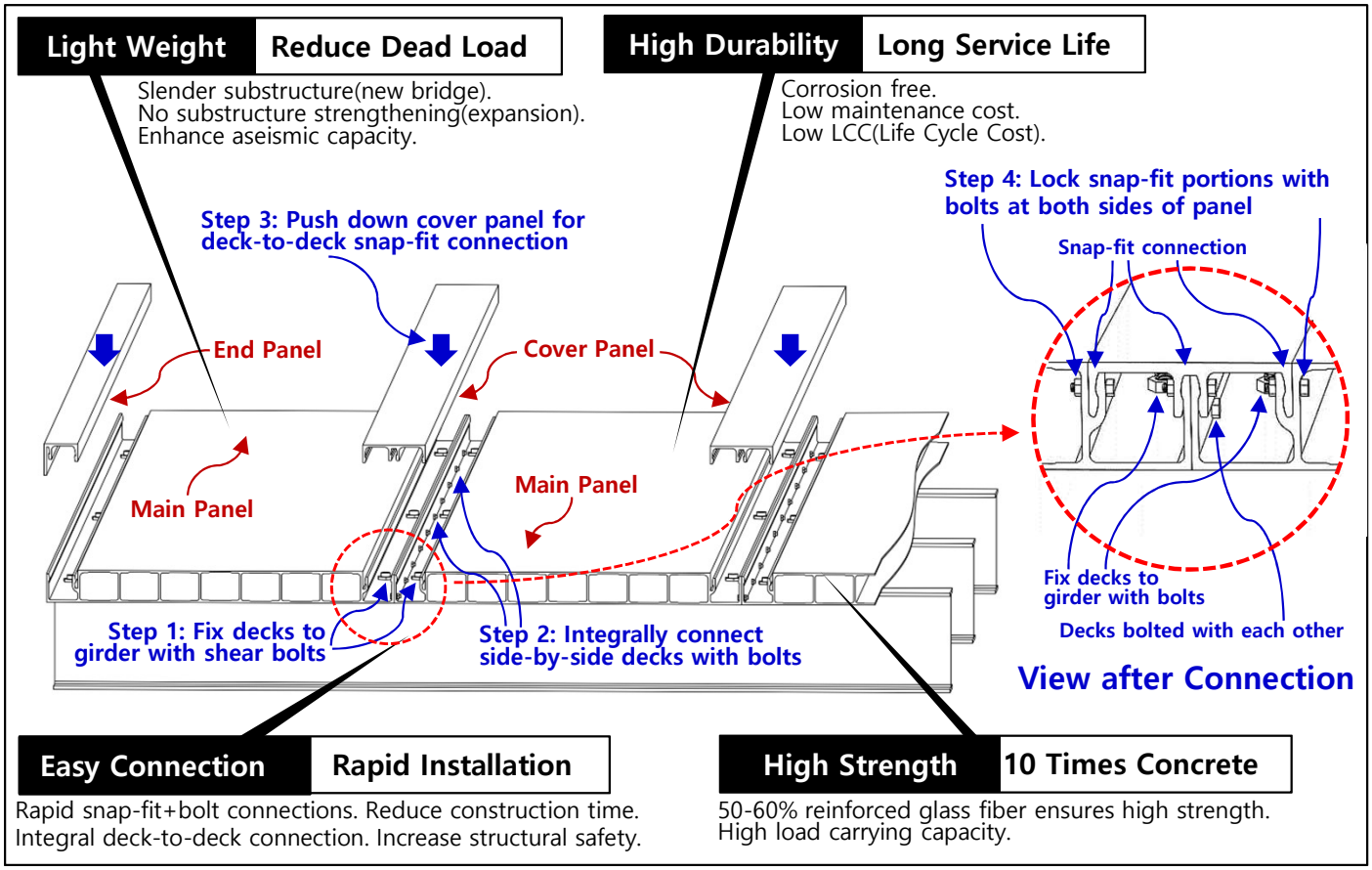
Modular Prefab FRP Bridge Deck of Snap-Fit Connection

- **DeltaDeck® is glass fiber reinforced plastic(GFRP) composite bridge deck having characteristics of light weight, high strength and high durability.**
- **Modular Prefab Integral Snap-Fit(ISF) DeltaDeck® is well proven, most economical and fast solution for bikeway/walkway of footbridges, bridge sidewalks and bridge expansions with 25-years of extraordinary experiences.**

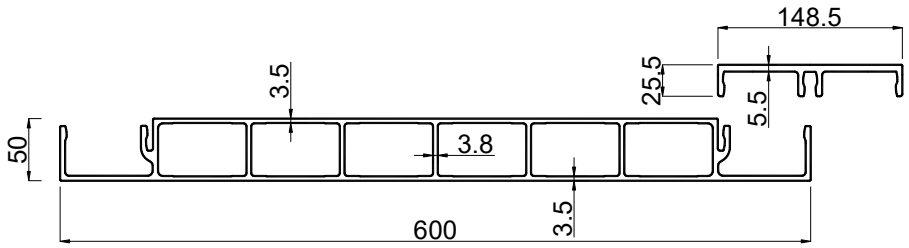
Patents:
- US: Patent(US 7,131,161 B2), Patent Pending(US 17/197,482)
- Korea: Patents(10-2178271, 10-1991765, 10-2373054, 10-0604251)
  Design Patents(30-0991661, 30-1032551, 30-1129204)
- China: Patent Pending(China 202110355423.5) • Vietnam: Patent Pending(Vietnam 1-2021-01634)

Technology Brief and Advantages

- DeltaDeck® is a modular prefab composite deck panel having Integral Snap-Fit(ISF) connections, fabricated by pultrusion with glass fiber and polymers.
- Entire bridge decks can be rapidly completed by assembling such factory-manufactured deck panels together, and installation can be done only at areas over the girders.
- Integral Snap-Fit(ISF) Delta Deck provides advantages such as **light weight; high strength; rust-free; long service life; rapid installation; easy disassembly for repair and reuse.**
- ISF Deck connects deck to girder with bolts; neighboring decks with bolts and interlocking snap-fit with cover panel(or upper panel for trail deck); snap-fit portions with lock-bolts, thereby ensures robust structural integrity at connections with entirely closed-sectional form.



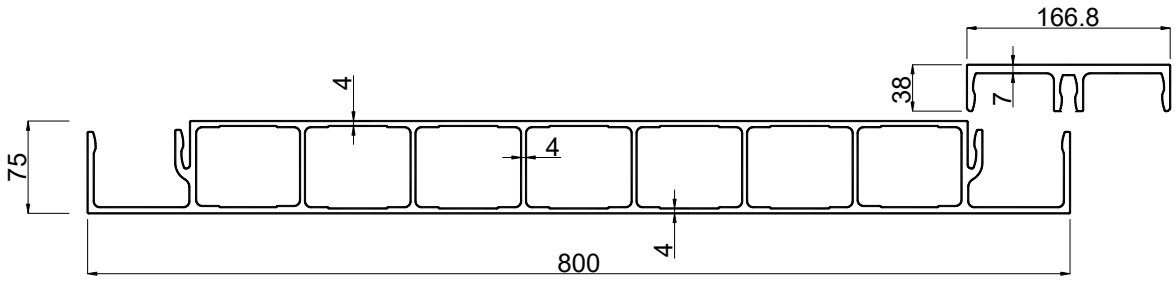
ISF50 Composite DeltaDeck for Bikeway/Footbridge



Fabrication of ISF50 Main Panel by Pultrusion

Fabrication of ISF50 Cover Panel by Pultrusion

ISF75 Composite DeltaDeck for Auto-bikeway/Walkway

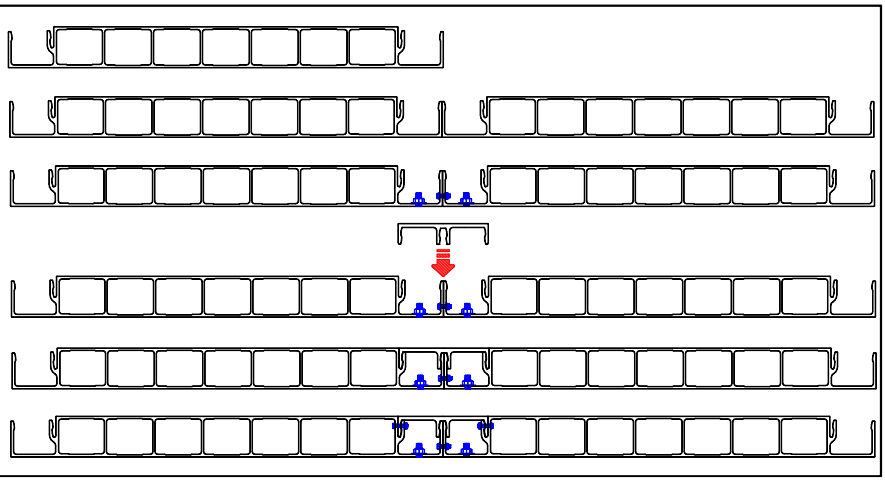


Fabrication of ISF75 Main Panel by Pultrusion

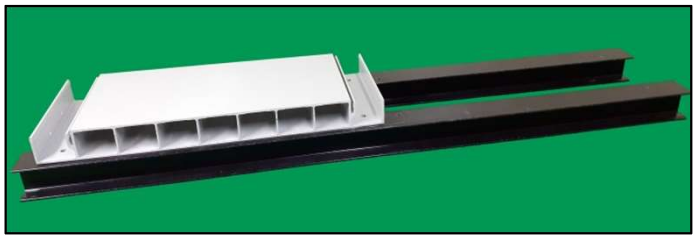
Fabrication of ISF70 Cover Panel by Pultrusion

Connection Procedure of ISF75 Deck for Bike/Walkway

1. A Main Panel Placed over the Girder
2. Main Panels Placed Side-by-Side for Connection
3. Main Panels Are Fixed to the Girder Followed by Bolt Connection with Each Other
4. Pushdown Cover Panel for Interlocking Snap-Fit Connection
5. Neighboring Main Panels are Concavo–Convex Interlocking Snap-Fit Connected with Cover Panel
6. Fasten Lock-Bolts at Snap-Fit Connected Portions



Photos for Connections of ISF75 Deck for Bike/Walkway



A Main Panel Placed over Girder for Connection

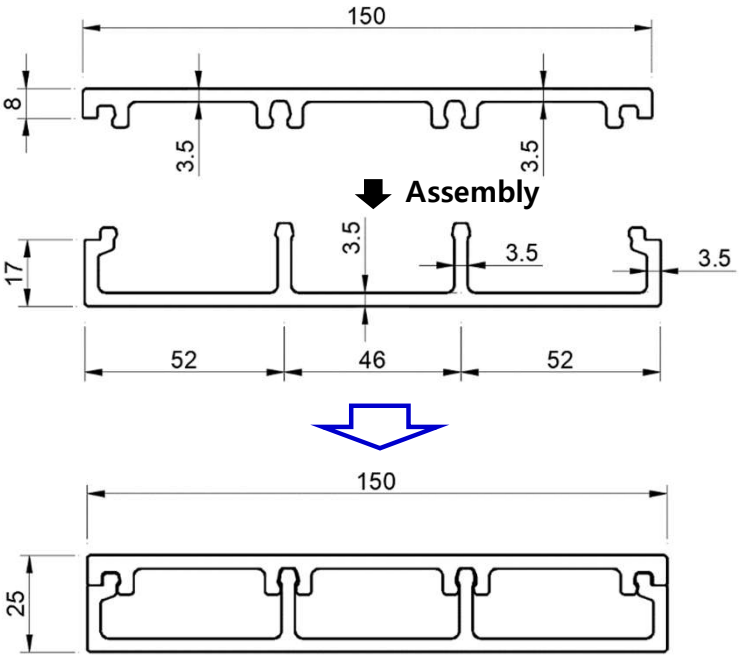
Panels Fixed to Girder and Bolted with Each Other

Main Panels Snap-Fit Interlocking with Cover Panel

Bolted at Snap-Fit(Prevent Gap-Opening & Disconnections)

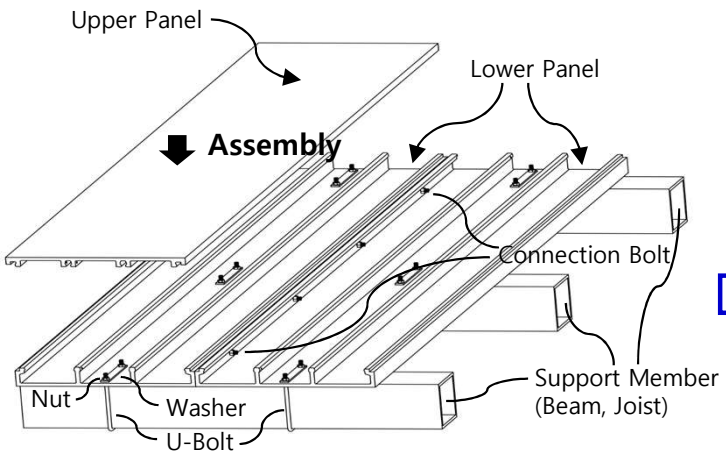
Main Panels Fixed at Girder, Bolted Each Other, Snap-Fit Interlocking with Cover Panel, Bolted at Snap-Fit, Thereby Integrally Connected in Closed-Sectional Form. Can Be Disassembled in Reverse Order

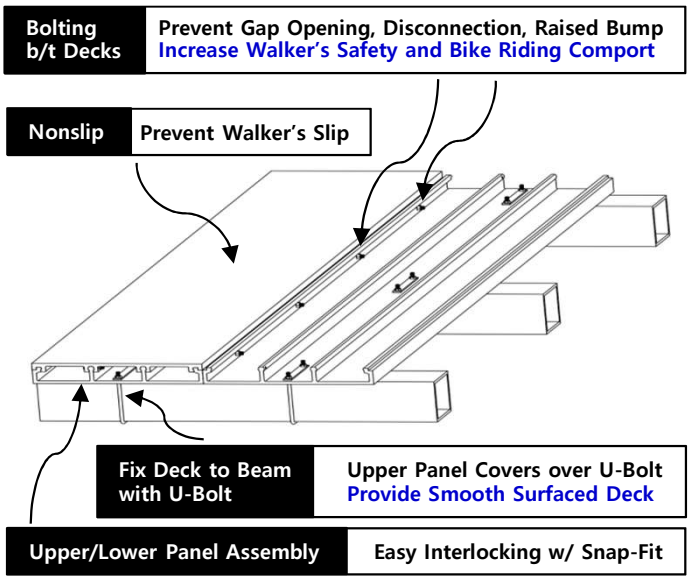
ISF25 Composite DeltaDeck for Trail/Sidewalk/Bikeway

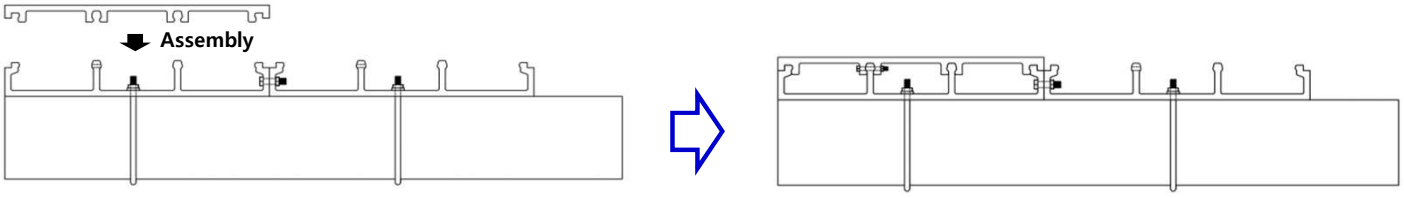


Fablication of ISF25 Lower Panel by Pultrusion

Perspective and Sectionals Views of ISF25 DeltaDeck

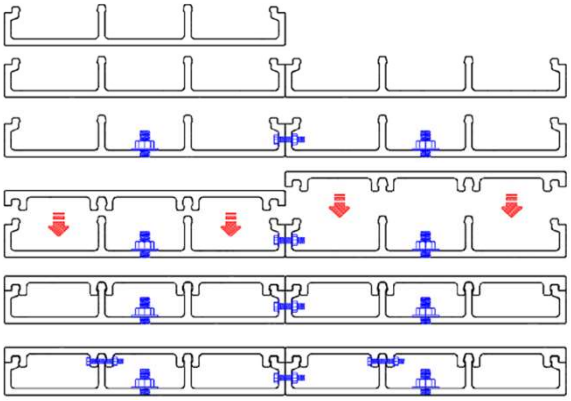




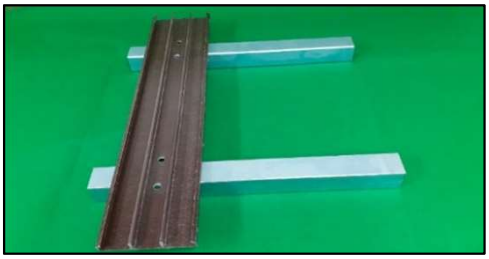


Connection Procedure of ISF25 Composite DeltaDeck

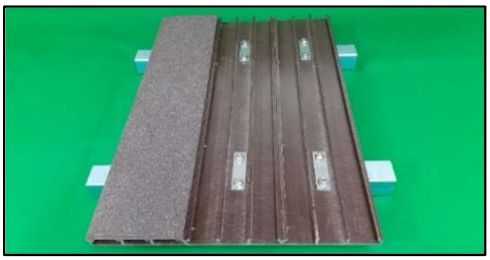
1. A Lower Panel Placed over the Beam(Joist)
2. Lower Panels Placed Side-by-Side for Connection
3. Lower Panels are Fixed to the Beam(Joist) with U-Bolts, Followed by Bolt Connection with Each Other
4. Pushdown Upper Panels for Interlocking Snap-Fit Connection
5. Side-by-Side Lower Panels Are Concavo-Convex Interlocking Snap-Fit Connected with Corresponding Upper Panels
6. Fasten Lock-Bolts at Snap-Fit Connected Portions



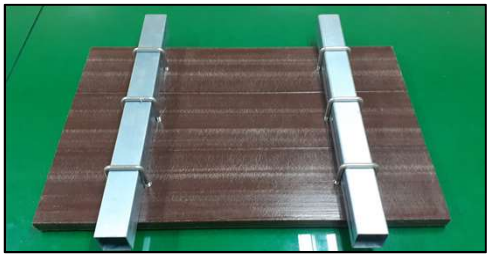
Photos of Each Connection Step of ISF25 DeltaDeck



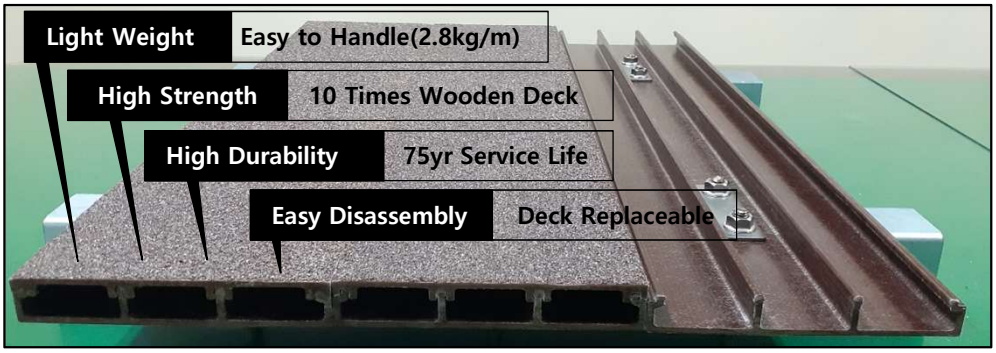
A Lower Panel Is Placed over the Beams(Joists) for Connection



Fix Lower Panel to Beam, Followed by Snap-Fit Connection w/ Upper Panel



Under Side View of Lower Panels, Fixed to the Beams(Joists) with U-Bolts



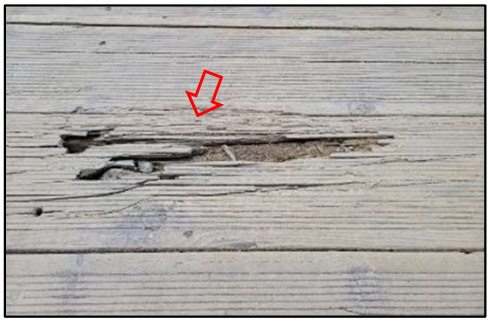
After Bolt Connections between Neighboring Lower Panels, Succeeding Lower Panel Consecutively Interlocking Snap-Fit Connected with Upper Panel

Three ISF25 Decks Consecutively Connected with Each Other w/o Gap

Problems of Wooden Deck(Replaceable with ISF25 Deck)

Vulnerable Connection of Wooden Deck

Gap Opening, Bumps on Wooden Decks



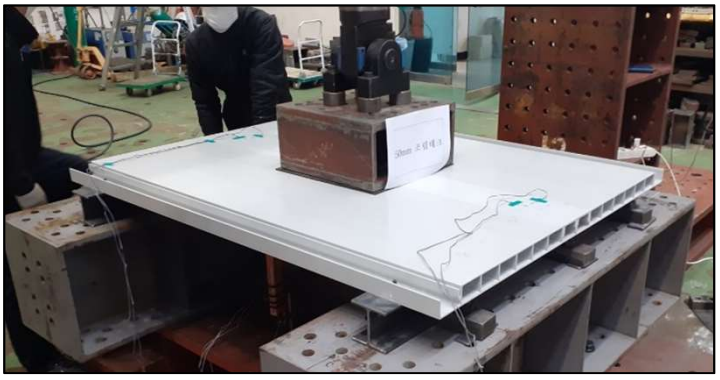
Rot and Segregation of Wooden Deck

Applications of Snap-Fit Composite Bridge Deck

- Walkway/bikeway/auto-bikeway expansions of traffic bridges without strengthening.
- Walkway/bikeway/auto-bikeway for new traffic bridges to reduce self-weight.
- Decks for new footbridges at waterfront or freezing area of high corrosive environments.
- Decks for new footbridges at mid. of cities or mountains requiring rapid installation.
- Decks on temporary bridges for disaster relief, construction and military, requiring rapid assembly and disassembly.
- Decks for new footbridges/sidewalk requiring minimum maintenance and long service life.
- Decks for trail/bikeway requiring prevention of gap opening, raised bump and disconnection.
- Partially replacing wooden deck panels in repair/maintenance works of wooden decks.

Material Properties and Experimental Verifications

Mech./Physical Properties	Specification	Test Results	
		ISF50	ISF75
Tensile Strength(L-dir))	KSF 2241	411 Mpa	382 Mpa
Compressive Strength(L-dir)	ASTM D 695	499 Mpa	449 Mpa
Shear Strength (In-plane)	KSM 3019	206 Mpa	191 Mpa
Young's Modulus	KSF 2241	31.6 Gpa	26.9 Gpa
Thermal Expansion Coefficient	KSM 3015	$5.0x10^{-6}$(1/°C)	
Fiber Weight Fraction	KSF 2244	55.2%	46.8%
Flammability	KSM 3015	Self Extinguishing	
Unit Weight	-	1.95 ton/m^3	



Flexural Test of Connected ISF50 Delta Deck

- Test results of 1.2m span ISF50 for Pedestrian Load(5 KN/$m^{2)}$): Satisfy 2.3 times of deflection serviceability limit(L/425). Satisfy 29 times of allowable stress. Max applicable span=2.4m.
- Test results of 1.5m span ISF75 for Pedestrian Load: 2.7 times of serviceability limit. 30 times of allowable stress. Max applicable span=2.9m.

Types of ISF Delta Deck for Auto-bike/Bike/Walkway

Description	ISF25	ISF50	ISF75
Applications	Decks for Trail/Sidewalk/Bikeway	Decks for Footbridge/Bikeway	Decks for Bridge Walkway/Auto-bikeway/Bikeway
Height(mm)	25	50	75
Width(mm)	150	600	800
Weight(㎏/㎡)	19	25	30
Recommended Span(m)	0.7	1.2	1.5

Girder Connection, Drainage Pit and Expansion Joints

Deck to Girder Connection

Welding Stud Bolts to the Girder with Stud Gun

Connecting Deck to Girder with Welded Stud Bolts

Drainage Pit

Installing Drainage Pit

Expansion Joints

Installing Expansion Joints

Pavement of Composite Deck for Walkway/Bikeway

Cases for Elastic Pavements

Gyulhyun Br. Walkway(Gimpo, 2011)

Haknarae Br. Walkway(Sejong, 2012)

Geumnam Br. Walway(Sejong, 2015)

Cases for Nonslip Treatment

Wolchul Footbridge(Yeongam, 2006)

Sangju Footbridge (Sangju, 2007)

Chungyang Footbridge(Bongwha, 2007)

Cases for Pavement with Sidewalk Block

Walkway around Gochuck Skydome Baseball Stadium(Seoul, 2015)

Case for Asphalt Paving

Kiheung Lake Walkway(Kiheung, 2010)

Comparison of Composite Deck with Concrete Deck

Description	Composite Delta Deck®	In-situ Concrete Deck
Technology Brief	Assemble and install factory-manufactured composite deck over the girders.	Concrete decking work consists of false work, form work, rebar installation, concrete placing and curing.
Materials Used	Fiber Reinforced Composites (Glass fiber +Unsaturated polyester)	Reinforced Concrete (Rebar+Aggregate+Cement+Water)
Cost Comparison	• Shorten construction time due to rapid installation. Reduce direct costs. • Long service life(over 75 years) due to high durability. Reduce Life Cycle Cost(LCC). • Slender substructure for new bridge due to light weight deck. Reduce direct costs. • No strengthening substructure for expansion of bridge due to light weight deck. Reduce direct costs. • Corrosion free. Reduce maintenance cost.	• Complicated field works require high labor costs. • Higher substructure costs due to heavy weight concrete deck. • Medium service life(20~30 years). Require higher repair and maintenance costs. Increase LCC. • Redecking after service life requires high costs. Also increase indirect costs due to long-period traffic congestion. • Advantage of low initial costs.
Structural Performance	• High strength(8-10 times of concrete strength). High load carrying capacity. • Light weight. Reduce self-weight. Enhance aseismic capacity. • Robust and integral connection. Ensure structural integrity of connected decks with closed section	• Far higher dead load due to heavy weight concrete. Reduce aseismic capacity. • Shorten service life due to fatigue, concrete deterioration. • Reduce load carrying capacity due to rebar corrosion.
Constructability	• Excellent constructability. Easy transportation and rapid installation. • Good quality control. • Minimize traffic blocking during construction. • Minimize misc. works.	• Abundant construction experiences. • Good constructability. • Difficulties in quality control at field. • Concerns for defective construction.
Maintenance	• Minimum maintenance due to high durable materials. • Easy disassembly for repair/reuse	• Long maintenance experiences. Established maintenance rules. • Uncertain performances after repair and reinforcement.
Environmental Friendliness	• Not induce pollution due to chemical resistant materials. • Good appearance due to cleanly maintained surface.	• Induce acidic materials and dust due to rebar corrosion and concrete deterioration. • Bad appearance for aged concrete.
Remark	**Composite bridge decking is considered cost-effective method considering better structural performance, non-strengthening existing structure for expansion, longer service life, good constructability, shortening construction period, lowering maintenance costs and reducing life cycle cost.**	

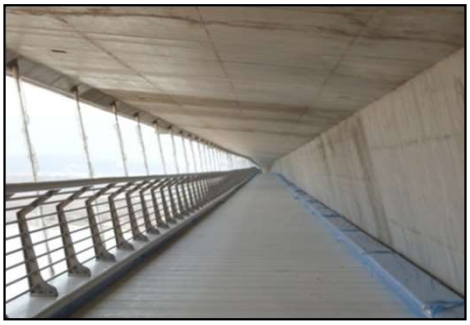
Construction Records of SF Delta Deck for Bike/Walkway

Bridge Name	Bridge Owner	Construction Year	Bridge Type	Length (m)	Width (m)
Biwoodang Bridge, Walkway	Seoul Metropolitan City	2004	Arch + St. Plate Girder	44.5	9.0
Wulchulsan Footbridge	Wulchulsan National Park	2006	Suspension	53.1	1.0
Osanchun Footbridge	Ministry of Transport	2006	Arch/ St. Box	140.0	5.0
Ponam Footbridge	Kangneoung City	2007	St. Plate Girder	50.0	5.0
Giheung Lake Footbridge (Phase 1 & 2)	Yongin City	2007 2010	St. Plate Girder	772.0 892.0	3.5 3.5
Sangju Footbridge	Sangju City	2007	Suspension	30.0	2.0
Bonghwa Footbridge	Bonghwa-gun	2007	Suspension	90.0	2.2
Samsung Shipyard Catwalk	Samsung Heavy Industries	2008	St. Plate Girder	82.0	5.0
Hangang Bridge (Walkway Expansion)	Seoul Metropolitan City	2008	Arch, St. Plate Girder	1,681.8	4.5
Shinchun Footbridge	Dongducheon City	2009	St. Plate Girder	70.0	5.0
Gwangju Jeungsim Footbridge	Gwangju City	2009	St. Plate Girder	18.0	3.0
Yongin Dodam Footbridge	Yongin City	2009	St. Plate Girder	32.0	3.0
Gunsan Seonyoo-do Road Mat	Gunsan City	2009	Road Mat Use	92.0	3.0
Jukdosan Park Footbridge	Yeongdeok-gun	2009	Cable Stayed	140.0	1.5
Sinjeom Bridge (Walkway Expansion)	Yangpyung-gun	2009	RC Slab	47.0	2.2
Johyun Bridge (Walkway Expansion)	Yangpyung-gun	2009	RC Rahmen	41.5	2.5
Geumchun Bridge (Walkway Expansion)	Korea Land & Housing Corp.	2009	PSC Girder	197.5	3.3
Paju-Wunjung Footbridge	Paju City	2009	St. Plate Girder	190.0	4.5
Saewul Bridge (Walkway Expansion)	Haeundae-gu, Busan City	2009	St. Plate Girder	77.0	3.0
Onchun-chun Bridge (Walkway Expansion)	Dongnae-gu, Busan City	2009	FRP Bracket	144.0	3.0
Youngdo Julyoung-ro (Walkway Expansion)	Youngdo-gu, Busan City	2010	FRP Bracket	830.0	2.0
Sinchun Bridge	Gimpo City	2011	St. Plate Girder	232.0	2.0
Gyulhyun Bridge, Walkway	K-Water Corp.	2011	Concrete Box Girder	585.0	4.0
Joadong Bridge	Haeundae-gu, Busan City	2011	St. Plate Girder	45.0	2.3
Sejong Haknarae Bridge, Bike/Walkway	Korea Land & Housing Corp.	2011	Cable Stayed	700.0	9.0
Swinging Footbridge	Suwan Kwangju City	2011	Cable Stayed	67.1	4.0
Bonap-Neupsan Footbridge	Gapyung-gun	2011	Suspension	55.4	2.3
Dojang Port Footbridge	Ministry of Transport	2011	Cable Stayed	41.0	2.1
Sasang-gu Riverside (Walkway Expansion)	Sasang-gu, Busan City	2012	St. Plate Girder	50.7	4.8
Busan North Port Haedoji Footbridge	Busan Port Corp.	2012	Cable Stayed	76.4	7.0
Busan North Port Noyeul Footbridge	Busan Port Corp.	2012	Cable Stayed	145.0	10.0
Daedunsan Park Footbridge	Geumsan-gun	2012	Suspension	58.0	1.5
Gochuk Bridge (Walkway Expansion)	Seoul Metropolitan City	2015	St. Plate Girder	406.0	5.6
Gochuk Skydome Baseball St. (Expansion & Footbridge)	Seoul Metropolitan City	2015	St. Plate Girder	410.0	7.4
Umgoong Grand Bridge, Bike/Walkway(Under Design)	Busan City	2021	Cable Stayed Br. Steel Box Girder	2,056	4.1

45,299 m^2 of composite bridge decks are applied on bikeway/walkway /bridge sidewalk(35 bridges installed, 1 bridge under design) till 2022.

Applications to New Footbridges/Bikeways/Walkways

Bansong-Kiheung Walkway(1,664x3.5m)



Sejong Haknarae Br. Walkway(Cable Stay Br., Under Conc. Box Girder, 700x9.0m)

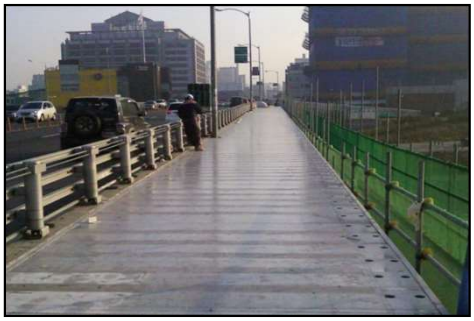
Gyulhyun Br. Walkway(293x4.0m)

Walkway around Gochuck Skydome Baseball Stadium(Plate Girder Br., 410x7.4m)

Applications to Walkway/Bikeway Expansions of Bridges

Onchunchun Br. Walkway Exp.(144x3.0m)

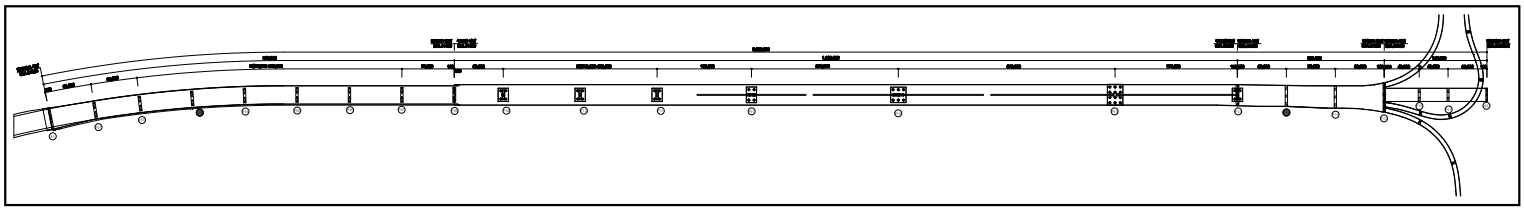
Hangang Br. Walkway Exp.(Both Sides of Arch Br. & Plate Girder Br.,1,680x4.5m)

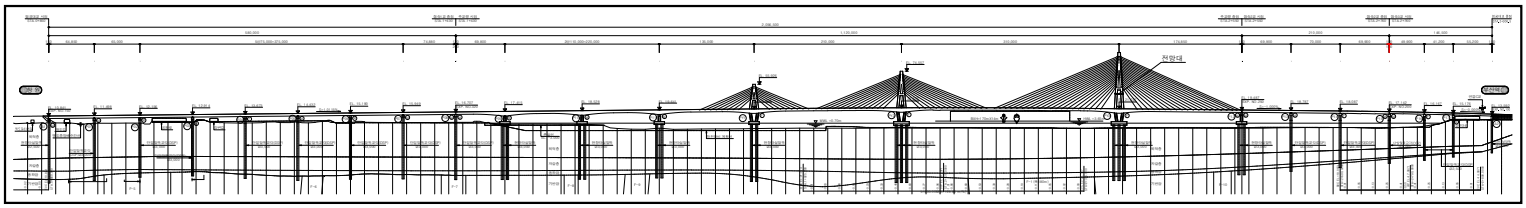


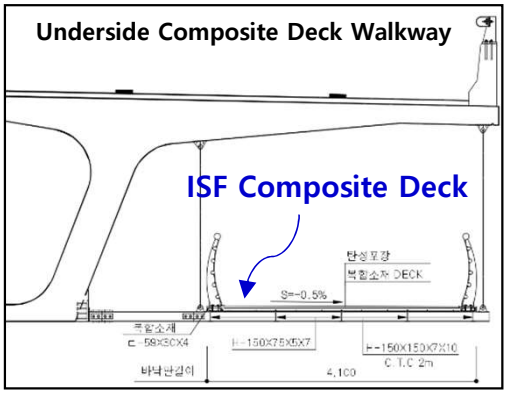
Keumchun Br. Walkway Exp.(198x3.3m)

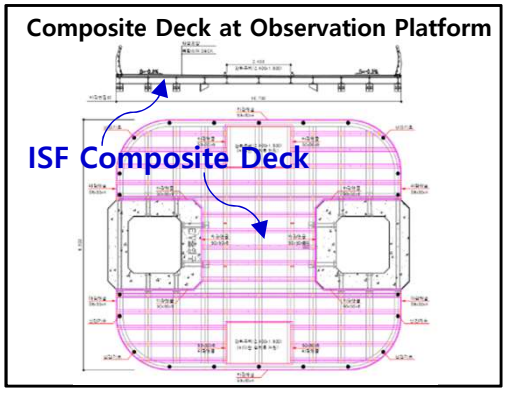
Walkway Expansion of Gochuck Bridge(South of Gochuck Skydome, 406x5.6m)

Application of ISF Deck on 2,056m Umgoong Grand Bridge









Economic Bike/Walkway Expansion with Light Composite Deck

11km Chunsa Grand Br.(Motorway w/o Walkway). **Underside Walkway Feasible w/ Composite Deck**

Sea-crossing Motorway Bridges(Rt. Yeosu-Goheung). **Light Composite Walkway Feasible at Bridge Side**

10km Bike&Ped. Path of Richmond-San Rafael Br. (California, 2019). **Light Composite Deck Feasible**

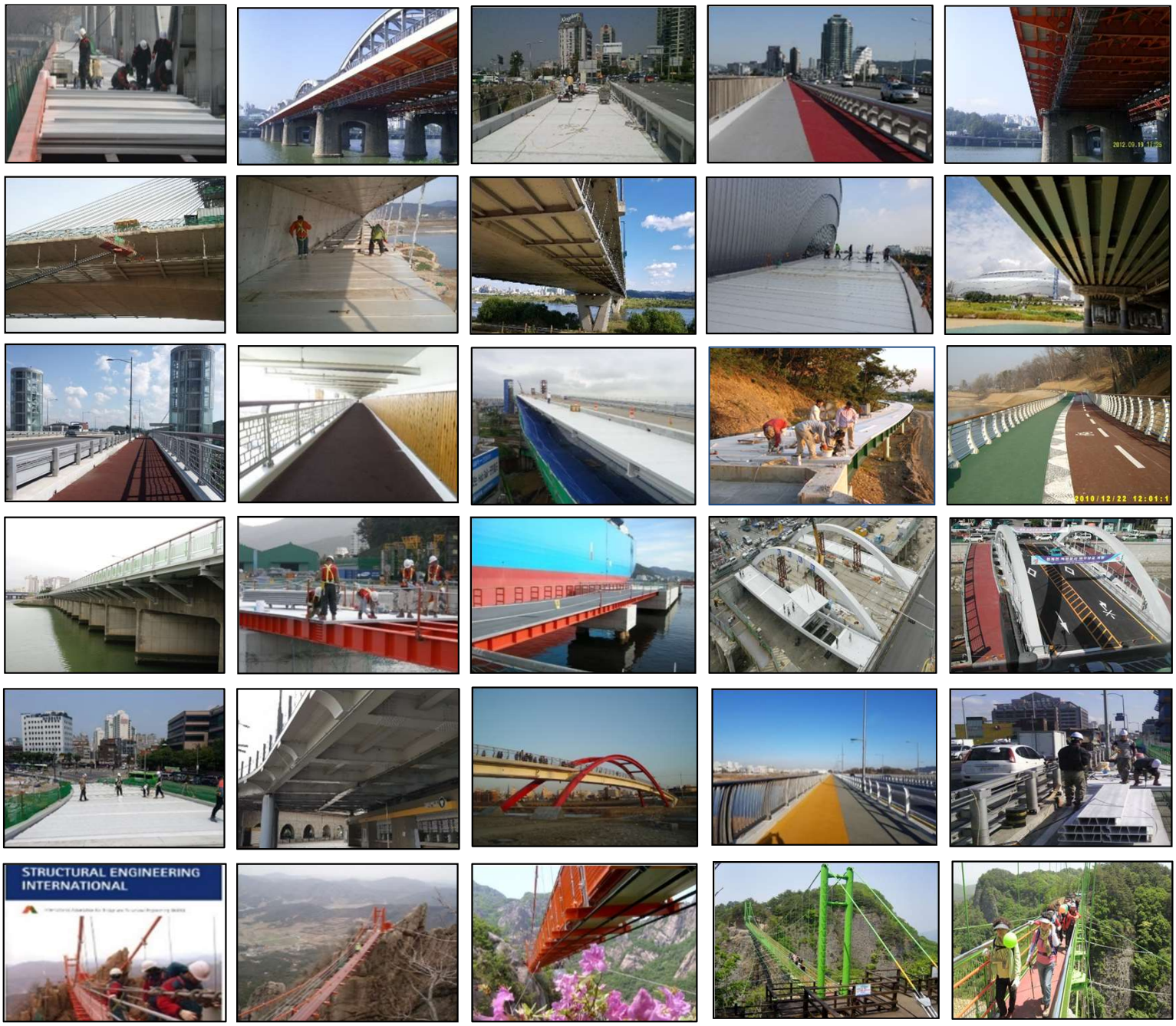
2km Bike Path of Brooklyn Br.(NY, 2021). **Economic, Rapid Construction Feasible with Composite Deck**

Rapid, Economic Auto-bikeway Expansion w/ Light Composite Deck

Serious traffic congestion of Vietnam. **Rapidly and economically resolve the problems and restoring traffic lanes by expanding auto-bikeway with lightweight composite deck without strengthening existing bridge**

DeltaDeck®

Light and Rapidly Installable GFRP Snap-Fit Deck



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