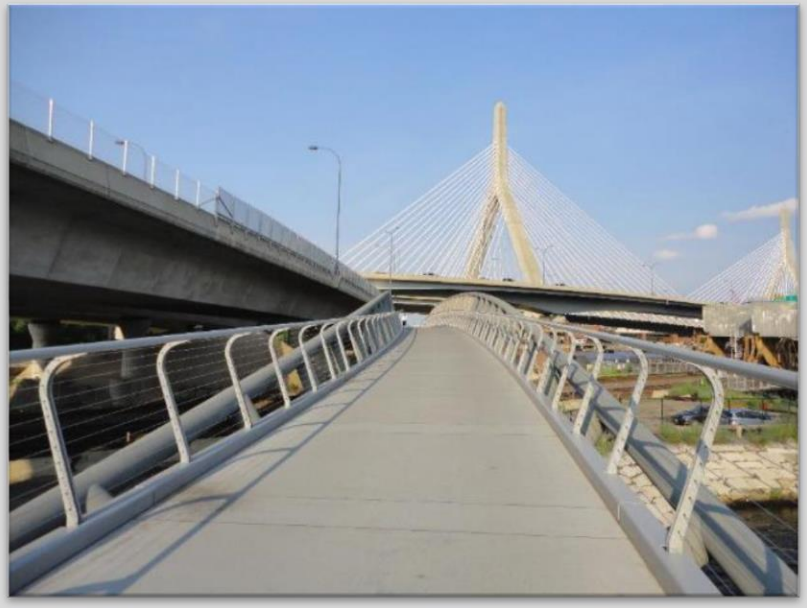
Fiber Reinforced Polymer (FRP) Panels for Rail Station Platforms

Introduction

- Scott Reeve, President, Composite Advantage
- Dayton, Ohio
- Engineered Solutions and Products for Infrastructure
  - Large parts
  - High structural loads
  - Design, manufacture, installation support
- Taking FRP composites into new markets
  - Displacing traditional materials (steel, wood, concrete)
  - Value from FRP technology
- Domestic source materials

Bridge Decks: Vehicle, Pedestrian, Cantilever Sidewalks



Waterfront Infrastructure

Navy Berthing Equipment

Fenders and Guide Walls

Outline

1. FRP Benefits
2. FRP Materials
3. Panel Manufacturing
4. Case Study: Above Grade Platform - Chicago METRA
5. Design Details
6. Case Study: Mini-High Access Platform – MBTA
7. FiberSPAN Rail Product
8. Cost Study
9. Fire Hazard Analysis
10. Heated Platform Panels
11. Design and Cost Estimates

Fiber Reinforced Polymer (FRP) Benefits

- Light Weight
  - Only 20% of reinforced concrete panels
  - Pedestrian and rail decking weights are 6 to 12 psf
  - Panel weights for longer span are 15 to 22 psf
  - Simpler installation
  - Faster installation
  - Reduced cost of superstructure and substructure
- Prefabricated Structures
  - Accelerated construction
  - Incorporate features in shop fabrication
  - Lower cost; higher quality
- Corrosion Resistance to chemicals and water
  - Low to No Maintenance
  - Expect life over 100 years

Typical FRP Construction

Fiberglass Fabric

+

Core Material

+

Resin

Strong, stiff fibers

surrounded by

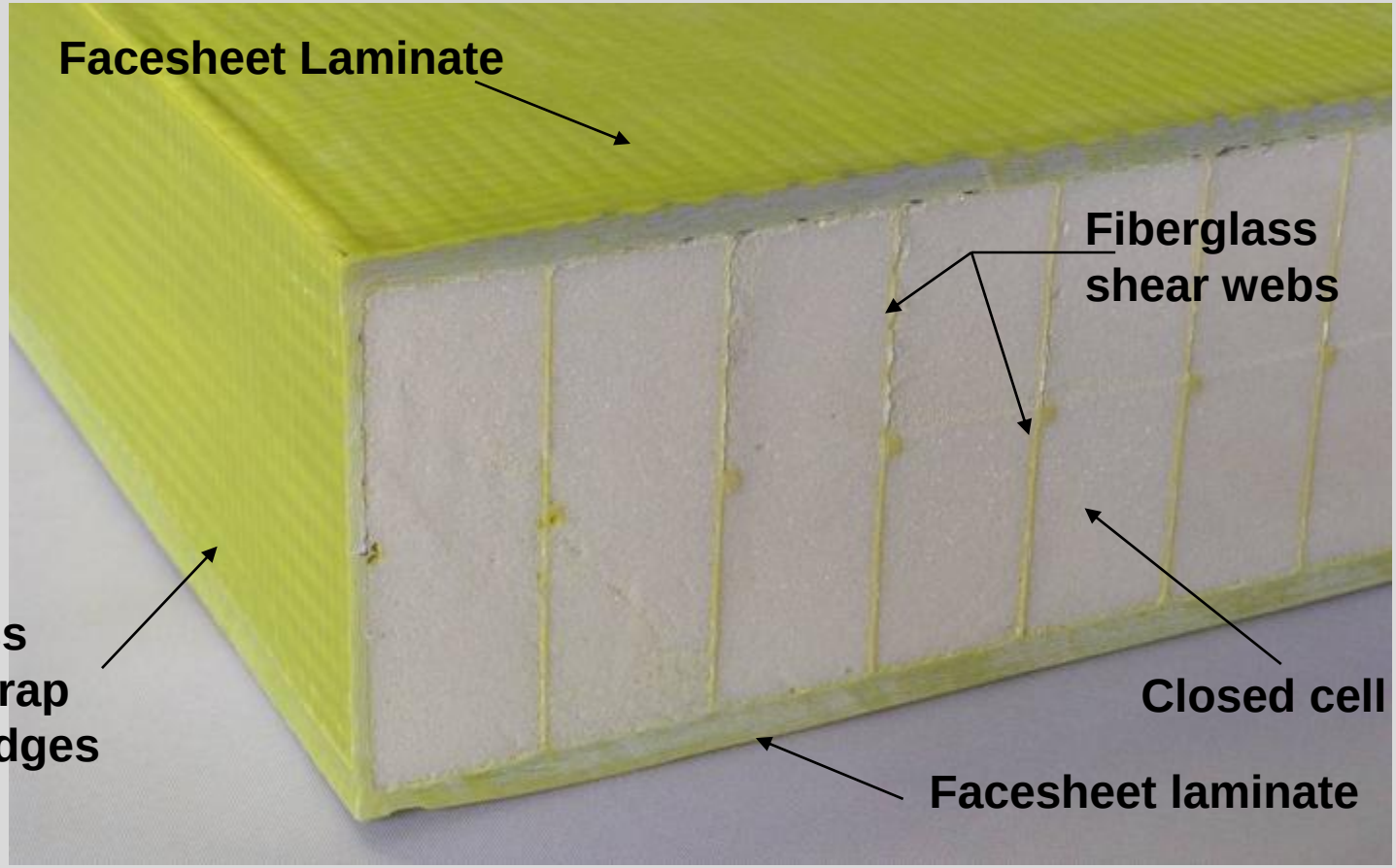
Tough, environmentally resistant, polymers

Materials Comparison

		Material		
Property	**Unit**	**FRP**	**Concrete**	**Steel**
Tension Strength	psi	40,000 to 50,000	500	50,000
Tension Modulus	msi	3 to 5.5	2 to 6	29
Coeff of Thermal Expansion	x 10^-6 in/in/^{o}F	6.5 to 10.5	5.5	6.5
Density	lb/cu.in.	0.072 for laminate; 0.014 for panel	0.088	0.29

FRP Composite Sandwich Construction

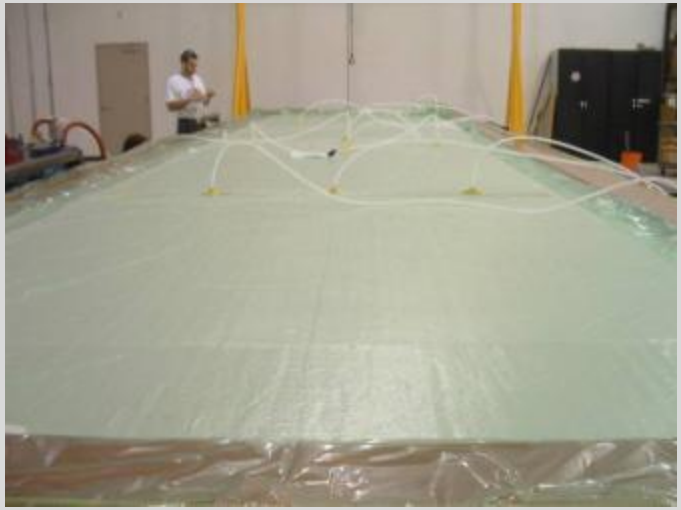
- Consists of fiberglass facing skins on fiberglass webs in foam core
- Design flexibility (stiffness, strength, size)
- Embedded steel for concentrated loads and attachments



FRP Panel Manufacturing

Fiberglass layers in molding tool

Internal core with fibers for shear



Sealed and ready for resin infusion

Solid part removed from mold

Flexible Panel Sizes to Meet Job Needs

- Up to 50’ x 12’
- Typically covers transverse width
- Large is less joints
- Have to fit with job site and contractor

Case Study: FiberSPAN Decking for Above Grade Platform

- Chicago METRA New Lenox Station
- Long lasting; no maintenance
- Fast installation
- Light weight to reduce support structure requirements

- Features
  - Crown for water drainage
  - Non-slip wear surface
  - Warning tiles shop applied
  - Railing attachment points

Chicago Metra Installation

- Platform added across from station
- Wetland area and slope required lightweight elevated platform
- Curved to match track radius

- Supported by two steel beams
- Load Requirement
  - 125 psf
  - 10,000 lb vehicle

Installation

- 254’ long platform consisting of 67 panels
- Installed in less than 3 days by 3 people in below 0°F temperatures
- Light equipment since panels weigh less than 400 lb/each

Functional Features

- Crowned top surface with slopes for water runoff and ADA compliance
- Warning tiles are bonded to deck
- Non-slip wear surface
- Embedded steel plates for bolting on railing

Design Details

FRP Deck Features

Scupper – Bottom View

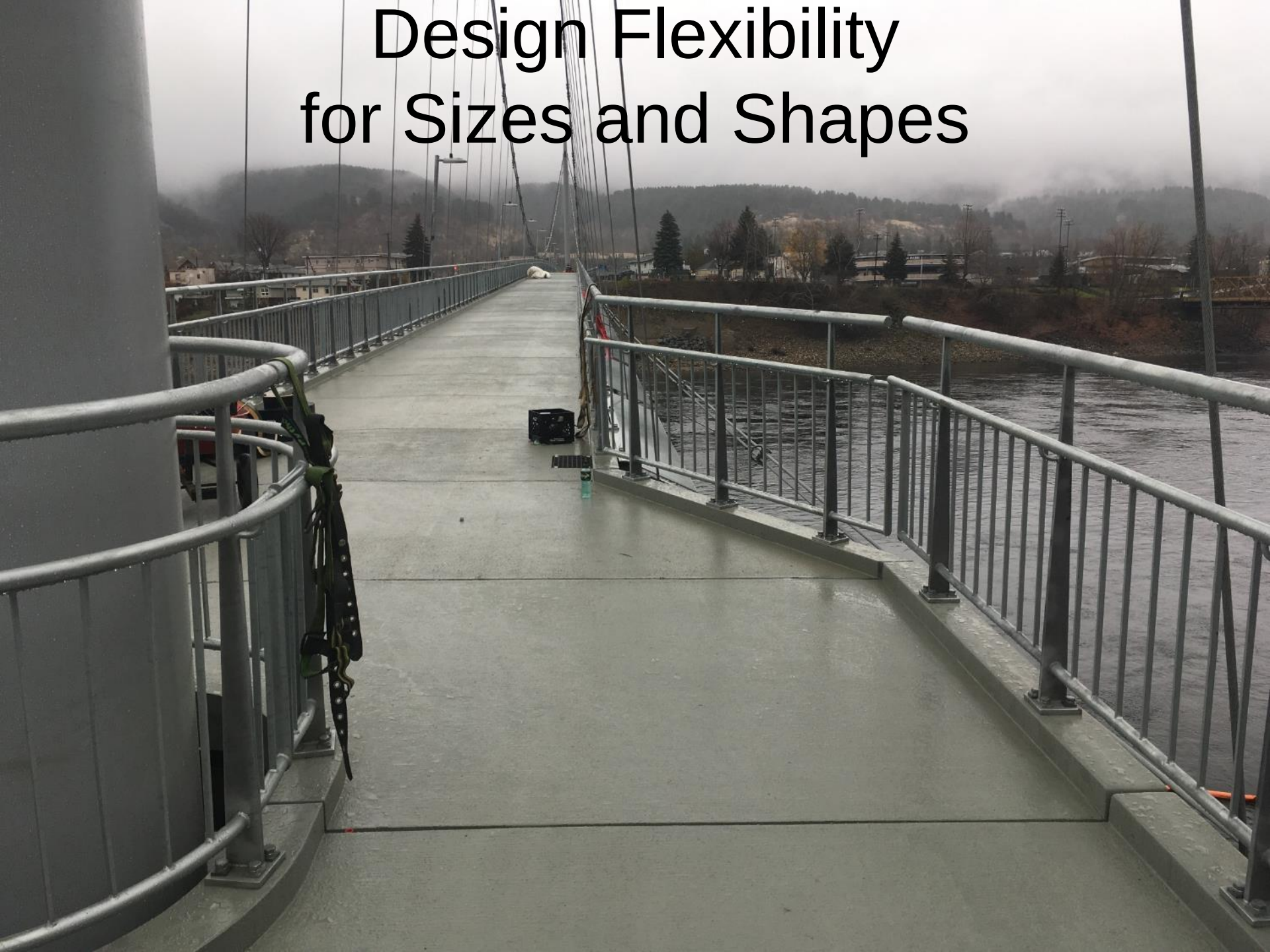
Light Post Base

Electrical Box

Conduit Attachment

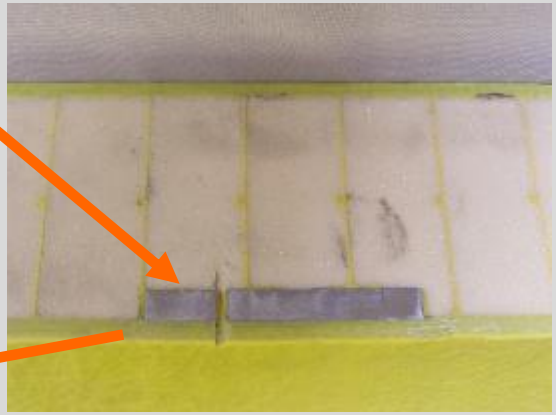
Crown or Cross Slope

Design Flexibility for Sizes and Shapes



Deck Connection: Clips

- Mechanical connection
- Clips to capture any type of beam
- Provides vertical constraint; allows for longitudinal thermal expansion
- Bolted into embedded steel that is drilled and tapped



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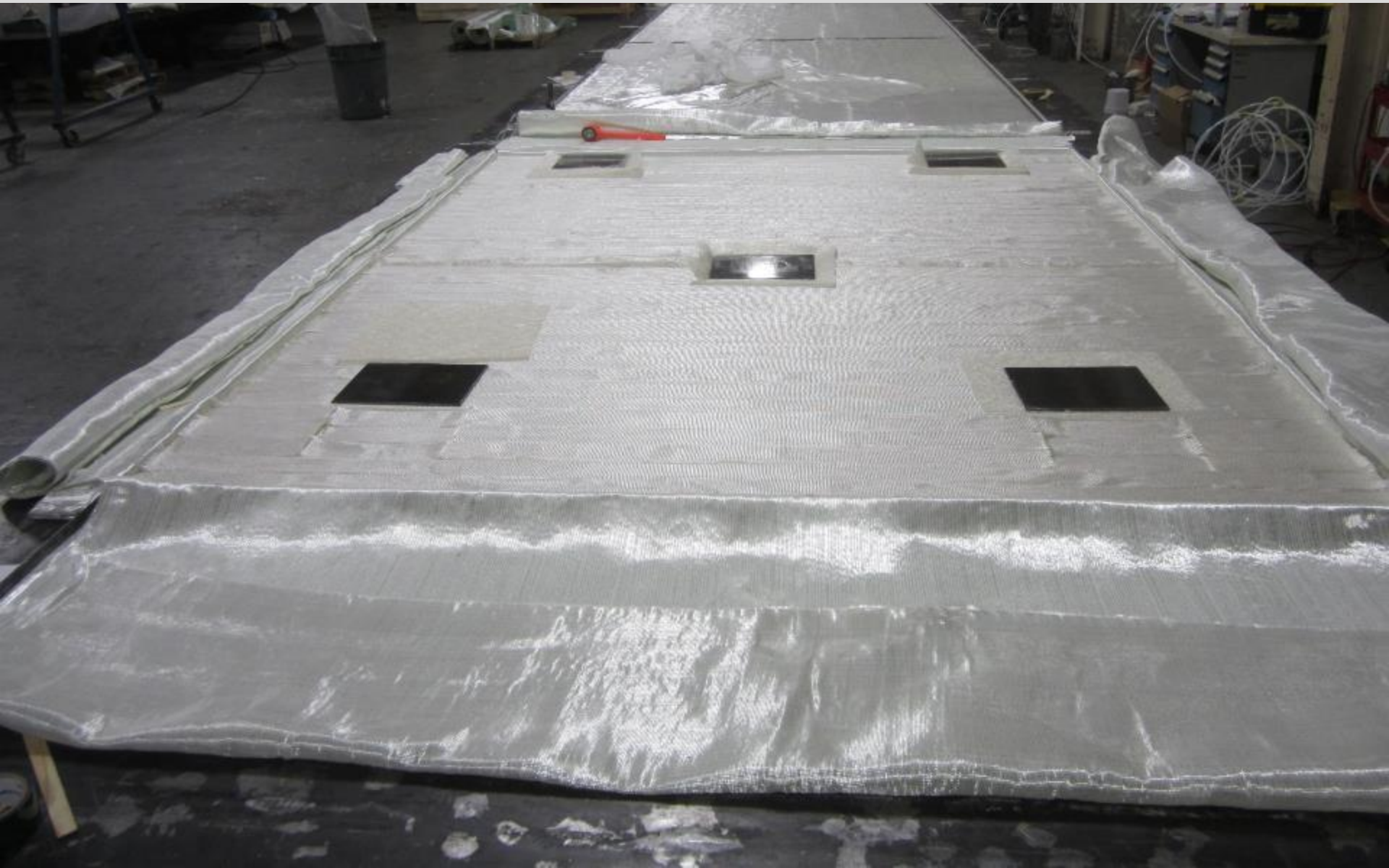
Embedded Steel in Bottom of Deck Panel



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Rail Post Attachments

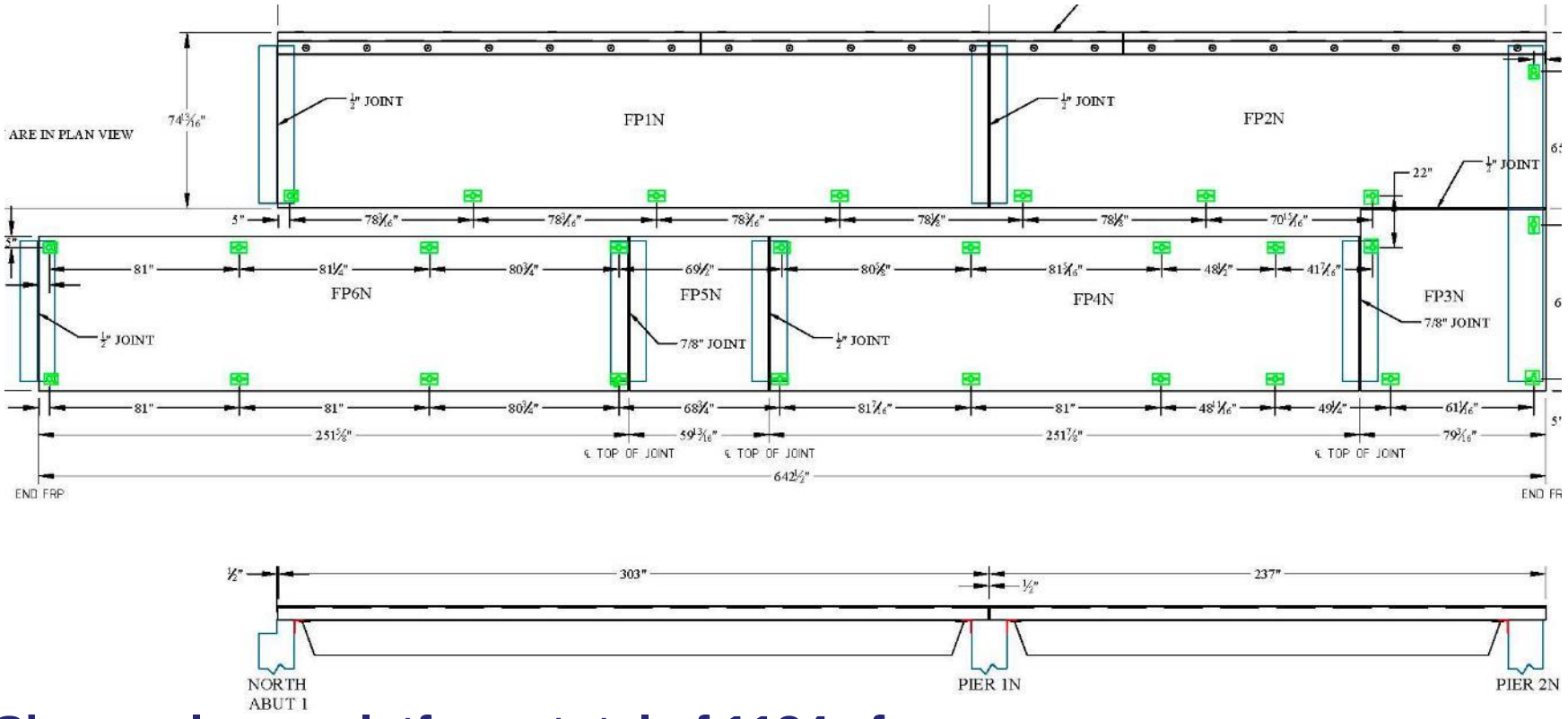
Non-Slip Polymer Aggregate Overlay

- Non-slip products used for vehicle decks, pedestrian decks and rail platforms
- Quartz aggregate in polymer
- High elongation (toughness); great adhesion to FRP
- Thickness of 1/8 inch
- High traffic
- Many standard colors; UV stable

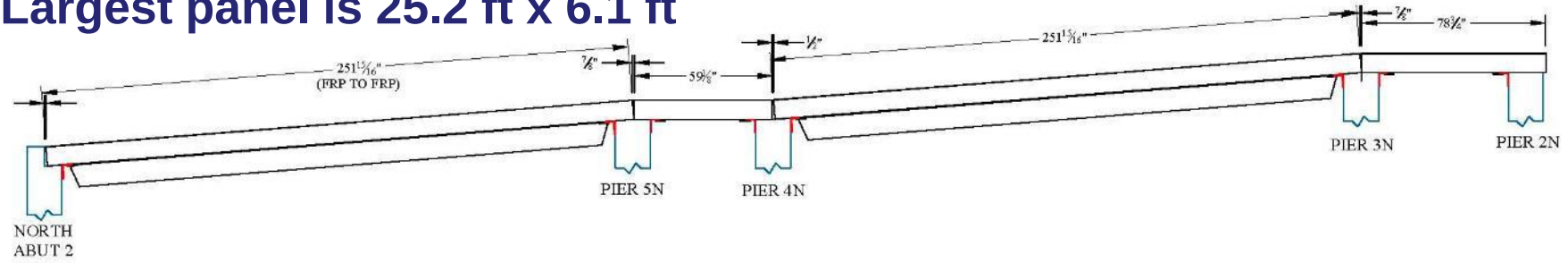
Case Study 2:
Mini-High Platforms for Accessibility

- MBTA West Natick Station
- North and South platforms
- Closed due to concrete deterioration

Mini-High Platform



- **Six panels per platform; total of 1134 sf**
- **Slab panels at landings; Double Tee panels for long spans**
- **Largest panel is 25.2 ft x 6.1 ft**



Light Weight Panels

- All 12 panels for both platforms delivered on one truck
- Largest panel at 25 by 6 ft weighs only 3100 lb

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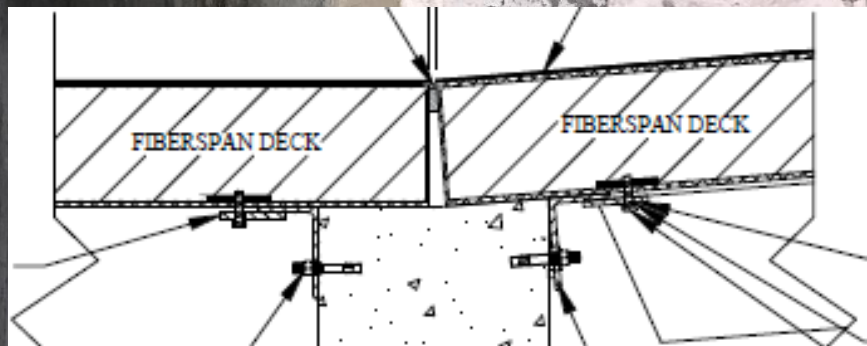
Concrete Pier Caps Rebuilt


MAXIMUM CAPACITY KG. 7700
PORTATA MASSIMA KG. 7700
VAIA CAR
V804


FRAGILE

Connection at Piers

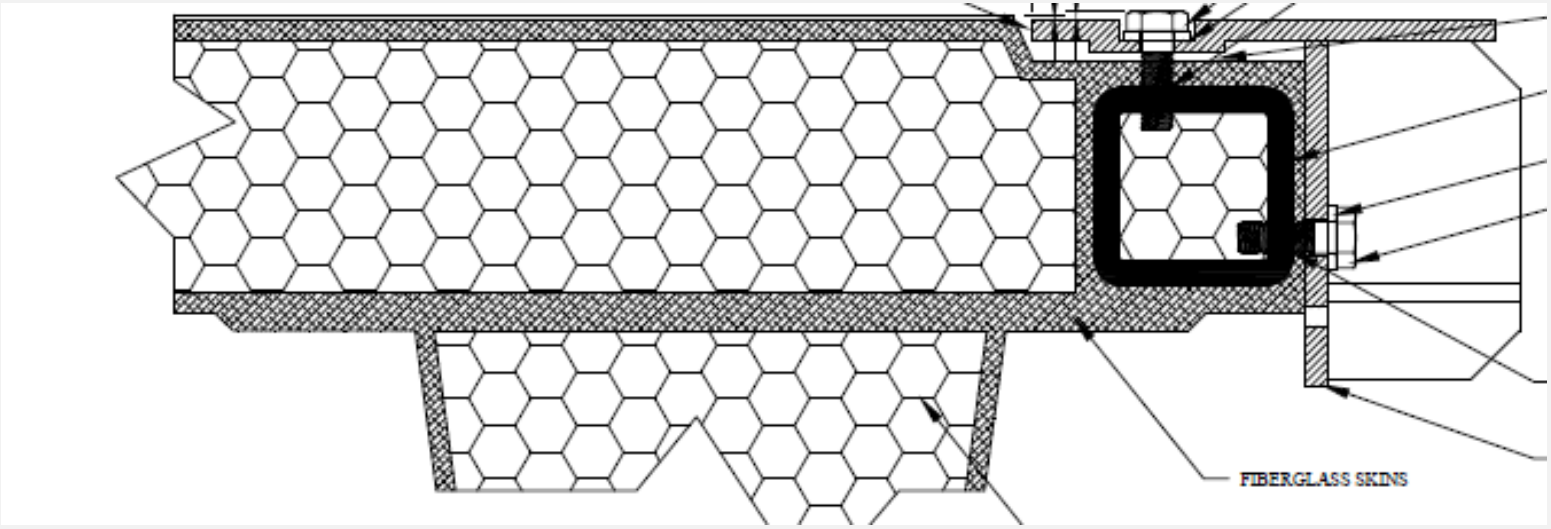
- Stainless steel angles anchored to concrete piers
- Clip plates were bolted



Retractable Edges

- Panels accommodate a retractable edge
- Down position allows passengers to board
- Hinged up position permit wider freight trains to pass

Retractable Edge Bracket Attached in Shop



Light Weight Installation

- Concrete pier caps repaired
  - Elevations and angles for FRP panels
- All 12 panels for both platforms delivered on one truck.
- Largest panel at 25 by 6 ft weighs only 3100 lb
- Installed on the weekend to avoid busy commuter times
  - North platform on Saturday; South platform on Sunday

- Installation Process
  - Panels were set on the piers
  - Stainless steel angles were anchored to concrete piers to provide support and an easy connection point.
  - Clip plates were bolted to the bottom of the FRP panels.
  - Grouted any gaps between panel and pier
  - Retractable edges were fastened to the platform panels.

Rail Platform Panel Product

- Two panel types (lightweight precast)
  - Slab for spans up to 15 ft
  - Tee panels for 15 to 50 ft
- Standard product sizes
  - Size, drawings, details in product package
- Custom panels available
- Product includes:
  - Panel
  - Non-slip overlay
  - Warning tactiles
  - Cross-slope or crown
  - Features (curbs, drainage scuppers, access hatches)
  - Embedded steel for attachments (rail posts, signage, benches, rub strip, connection clips)
  - Connection hardware
  - PE stamped design submittal

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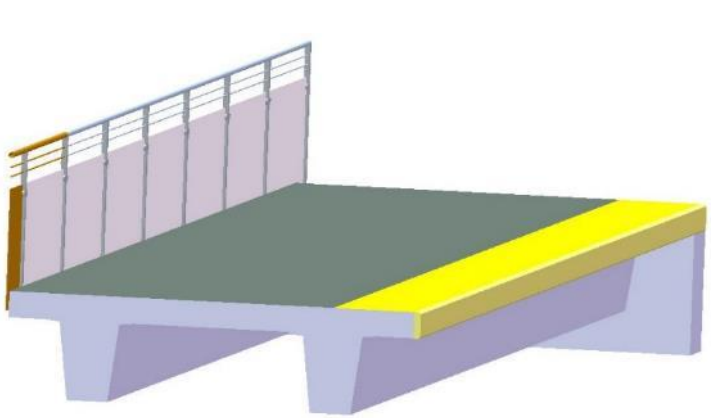
FRP Tee Panels



FRP Tee Panels

- Similar to precast double tees
  - FRP weight is 15 to 22 psf
  - Concrete weight is 120 to 130 psf
- Deck and beam are molded as one piece
  - Beam can transition to slab depth at piers
- Sized for load and spans

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Standard Product

- Design for standard loads and sizes
- Drawings, details in product package

Product	Deck Thickness (inch)	Overall Thickness (inch)	Max Span (inch)	Max Span (feet)	Panel Width (inch)	# T Sections	Weight (psf)	EI per width (lb-in^2)
Slab								
S4	4.75	4.75	101	8.4	-	-	11	1.27E+08
S7	7.75	7.75	180	15.0	-	-	12.5	3.72E+08
Tee Panel								
T15-2	7.75	15.5	272	22.7	120	2	15	1.09E+10
T15-3	7.75	15.5	282	23.5	144	3	16	1.46E+10
T23-2	7.75	23.25	366	30.5	120	2	16	2.66E+10
T23-3	7.75	23.25	382	31.9	144	3	17	3.64E+10
T31-2	7.75	31	468	39.0	120	2	18	5.55E+10
T31-3	7.75	31	489	40.8	144	3	20	7.62E+10
T38-2	7.75	38.75	562	46.8	120	2	20	9.63E+10
T38-3	7.75	38.75	600	50.0	144	3	22	1.33E+11

- Uniform live loading of 100 psf; deflection less than L/500
- Vehicle loading of 10,000 lb

Cost Study

- Platform with 25 panels at 32’ x 10’
- West Natick installation process
- Costs in $/sf

	FRP Double Tee	Precast Concrete
Panel to Site	$ 85	$ 70
Installation	$ 20	$ 30
Total	$ 105	$ 100

FRP Fire Resistance

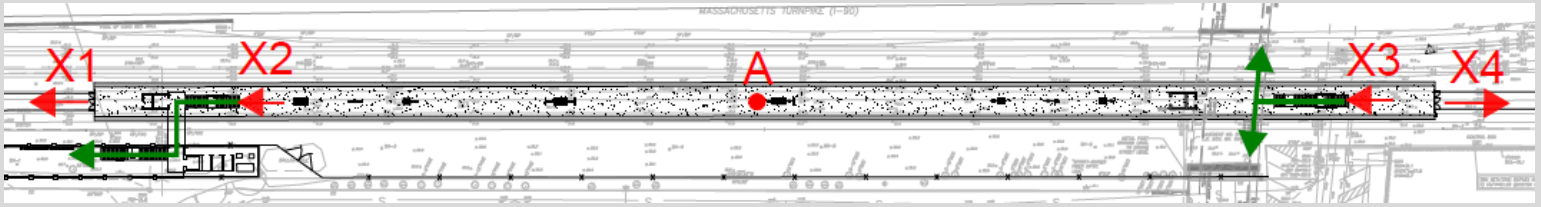
- NFPA 220 “Standard of Type of Building Construction”
  - FRP is a Type III Standard Material
  - Fiberglass/polymer used for rail platforms is “Limited Combustible Material” due to low flame spread
  - Self-extinguishing when flame source is removed
- Flame Spread Index (FSI)
  - Rated on scale of 0 for cement to 100 for oak wood
  - Tested per ASTM E 84
  - FiberSPAN rail platform is Class A / Class 1 (FSI < 25)
  - Smoke generation index is Class 1 (<450)
- Heat Release
  - Meets NFPA 259 for release less than 3500 Btu/lb

Fire Requirements for Rail Platforms

- NFPA 130 -2010 “Standard for Fixed Guideway Transit and Passenger Rail Systems”
- Enclosed stations shall be not less than Type I or II noncombustible construction as defined in NFPA 220, Section 5.2.2.1
- Other types of construction as defined in NFPA 220 Section 5.2.2.2 shall be permitted for open stations
- Allows FRP usage for open stations now that the 2010 revision is being incorporated in local codes

Fire Hazard Analysis

- From codes to real world scenarios
- Hazard analysis in accordance with NFPA 130
  - Open air station does not trap smoke or hot gas
  - Time to egress platform is determined



- Example of platform that is 780 ft x 22 ft
  - 1700 occupants can clear the platform in 4 minutes (using 4 egress points)
  - Pedestrian walking speed of 2.5 mph
  - Flame spreads at 0.01 mph
  - Flame travels less than 6 feet from ignition source during the 4 minute egress

Heated Platform Panels

- Resistive heating elements embedded in top surface
- Sensors for temperature and moisture
- Programmable controller turns on heating elements when precipitation occurs at temperatures below 38F
- Remains on for an adjustable hold time after precipitation to ensure complete ice and snow melting
- Heated zones for energy efficiency
- Deployed in Missoula, Montana pedestrian bridge

Design & Cost Estimates

- Composite Advantage's in-house design team will provide design, price and weight estimates
- Platform Decking and Panels
  - Load requirements (uniform, vehicle)
  - Support spacing
  - Overall platform size
  - Design features (crown, attachments)
  - Location
- Request a Quote form on website

FiberSPAN Offers Excellent Solution for Station Platforms

- Pre-fabricated and lightweight platform for fast installation
- Long-lasting corrosion resistance
- Design features

- www.compositeadvantage.com
- For more information, contact:
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Thank you