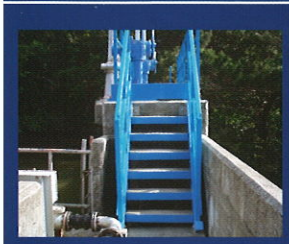
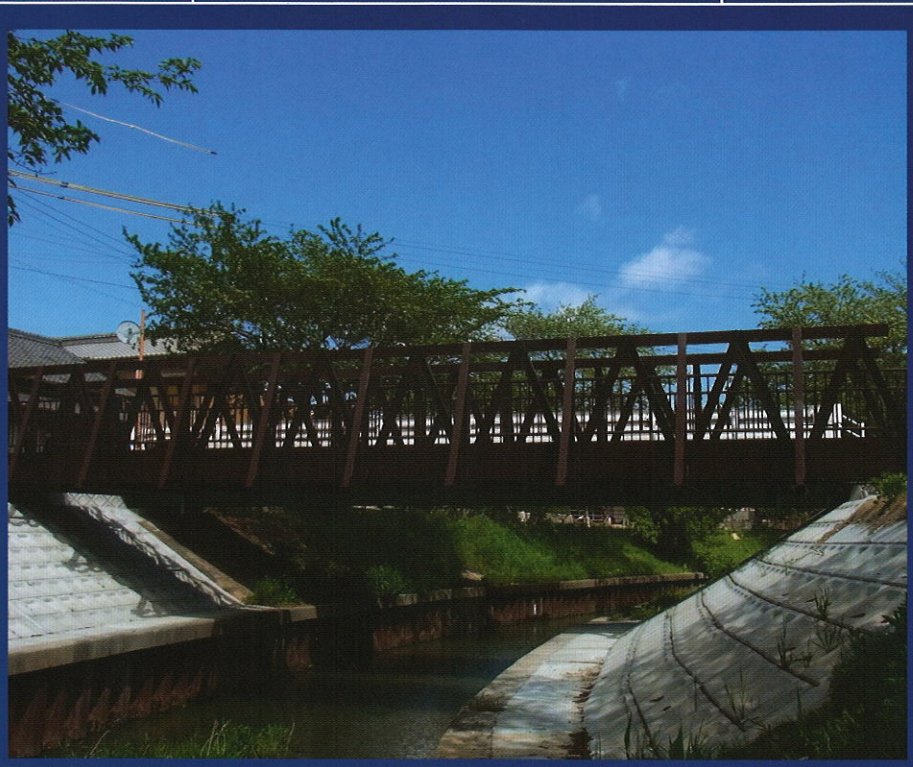
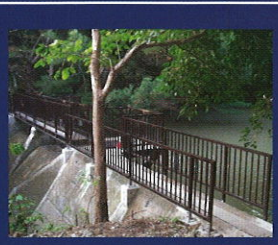
Fiber Reinforced Polymer Bridges

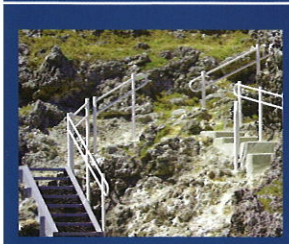
FRP BRIDGES

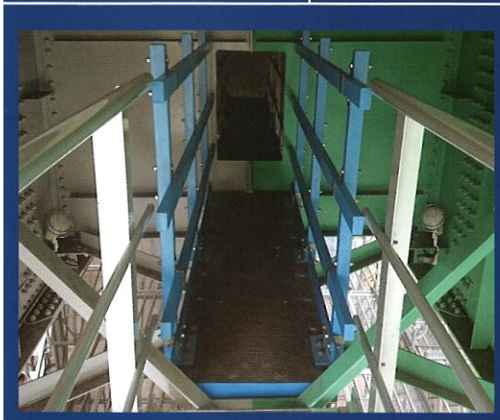
Lightweight, sturdy, and maintenance-free



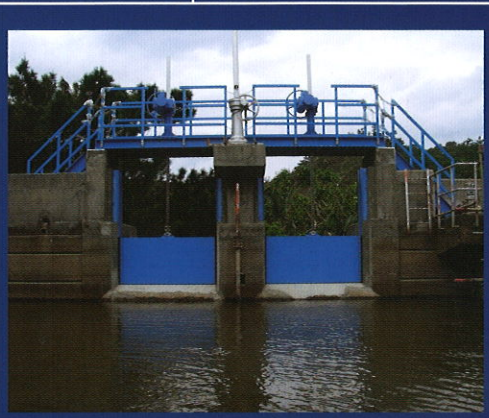








COMPANY PROFILE



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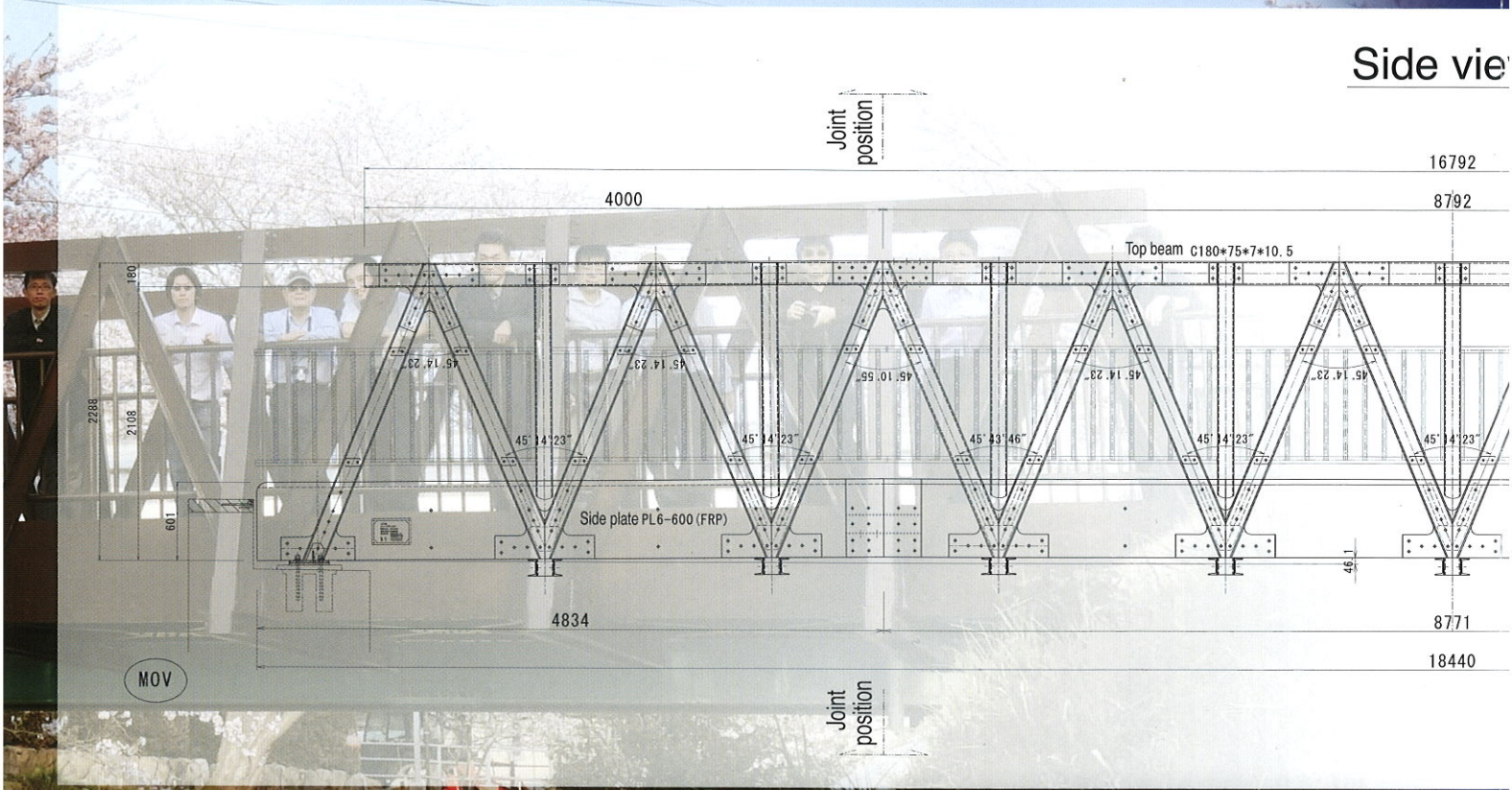
Examples of Construction

Genjaku Bridge FRP Warren pony truss bridge

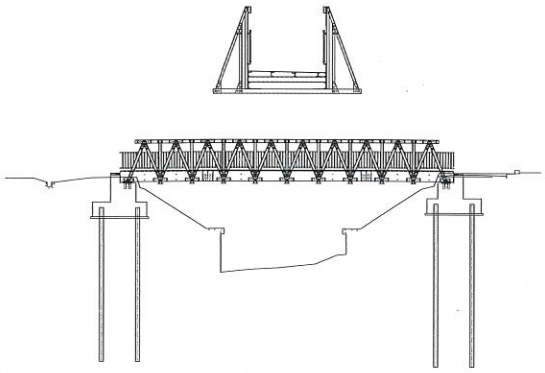
In addition to serving as a local road for a residential area, the main road is the route by which children go to and from school, so the traffic volume is particularly large during morning and evening hours. The road width on the existing bridge at the site is only 2.7 meters, making the risk of traffic accidents extremely high. Therefore, the construction of a new bridge was planned for the purpose of ensuring safety by separating pedestrian and bicycle traffic from automobile traffic.

Construction summary

Completed	March, 2013
Installation site	Kawashima-cho, Yokkaichi Mie Prefecture
Bridge type	Footbridge (roadside)
Molding method	High weather resistance hand lay-up molding method
Bridge length	18.5 meters
Effective road width	2.0 meters



Performance comparison

Bridge type	FRP truss bridge
Schematic view	
Weight	Approximately 5 metric tons
Features	Uses lightweight and highly durable FRP material. After trial assembly at the factory, the bridge is disassembled for transport to the installation site, where it is re-assembled and the complete bridge is installed.
Construction constraints	• The bridge is lightweight, so disassembly and re-assembly are easy, and the bridge can be installed within a limited work space. • The beams and the floor slab are manufactured as a single unit at the factory, reducing the time required for on-site installation.
Maintainability	• The use of highly weather-resistant FRP nearly eliminates the need for maintenance after installation.

Rationale for and appropriateness of FRP bridge

The FRP footbridge is much lighter than a conventional prestressed concrete or steel bridge, and its lighter weight made it a much more appropriate choice for the soft ground at the installation site. The bridge could also be installed quickly by a single rafter crane, so it was expected to minimize the inconvenience of halting traffic while the bridge was installed. (Once the bridge was assembled and hoisted by the crane, the actual time required for installation was less than 10 minutes.) Another major reason for using the FRP footbridge is that its superior corrosion resistance contributes to its life cycle cost performance.

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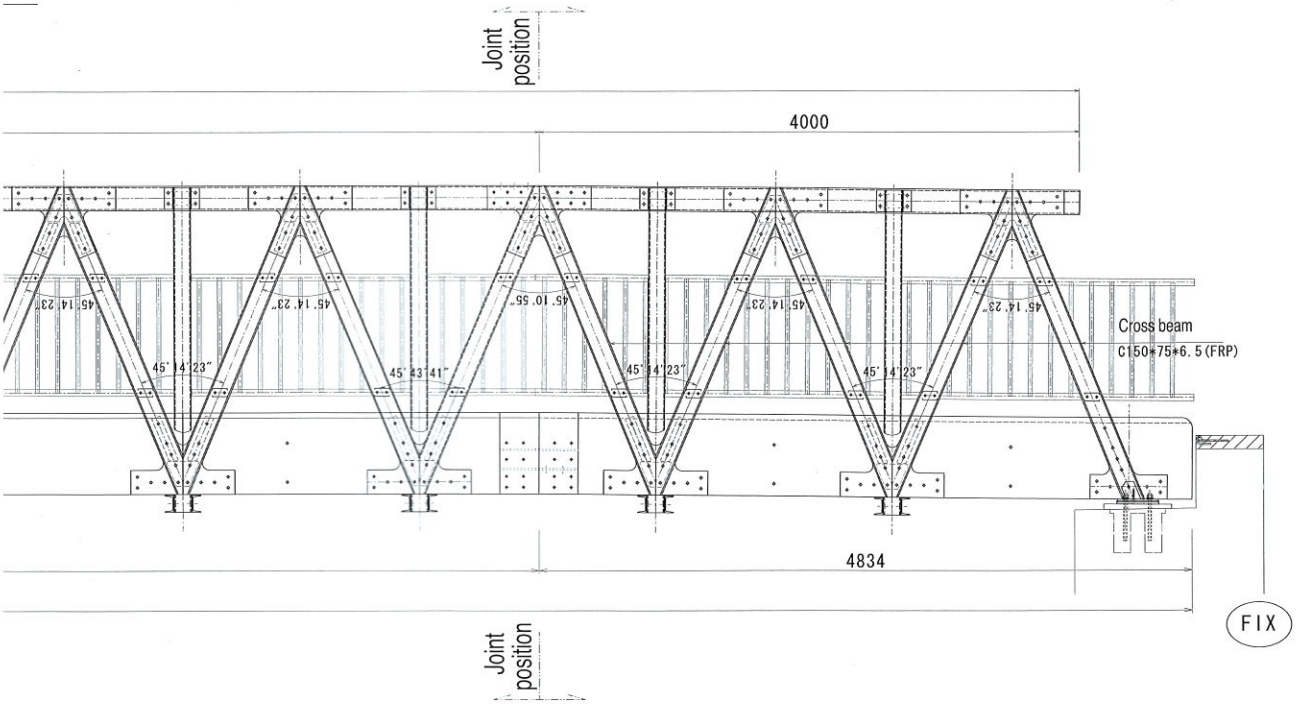
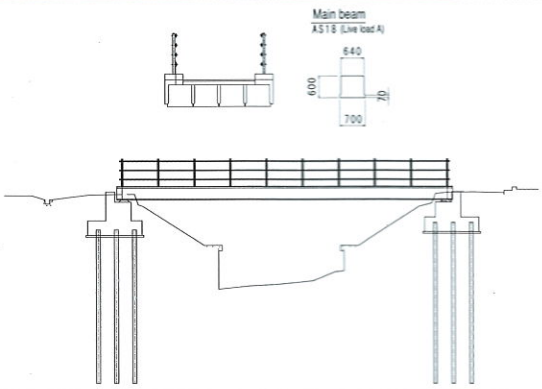
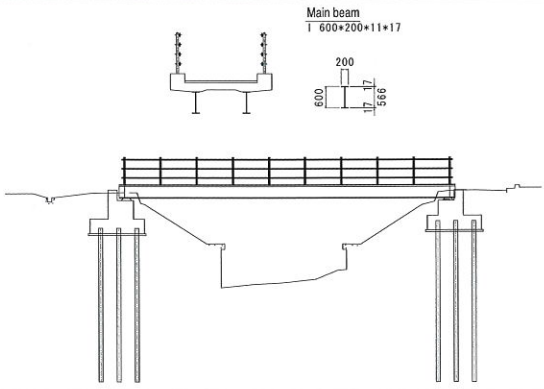


Prestressed concrete bridge	Plate girder bridge
	
Approximately 80 metric tons	Approximately 47 metric tons
Prestressed concrete beams are manufactured at a factory or in a yard close to the installation site. The bridge is constructed by transporting the girders to predetermined positions. The prestressed concrete bridge is the most common form of bridge.	After trial assembly at the factory, the main girders are disassembled into individual members for transport to the installation site, where they are re-assembled. The floor slab is built at the installation site.
• Because the girders are made as individual units, a large work space is required. • Because the girders are heavy, large, heavy equipment is required for construction. • Conditions at the work site can make it difficult to ensure a transport route for the main girder.	• Because the girders can be installed separately, the installation requires only a comparatively small work space.
• Because the material is concrete, there is no need to paint it after installation.	• Periodic re-painting is required after installation.

FRP Roadside bridge

Footbridge

Bridge No. 3 FRP Simple girder bridge

Installation in progress

Construction summary

Completed	February, 2016
Installation site	Oato, Yoro-cho Yoro-gun, Gifu Prefecture
Bridge type	Footbridge (roadside)
Molding method	High weather resistance hand lay-up molding method
Bridge length	9.16 meters
Effective road width	2.0 meters
Weight	Approximately 2.1 metric tons

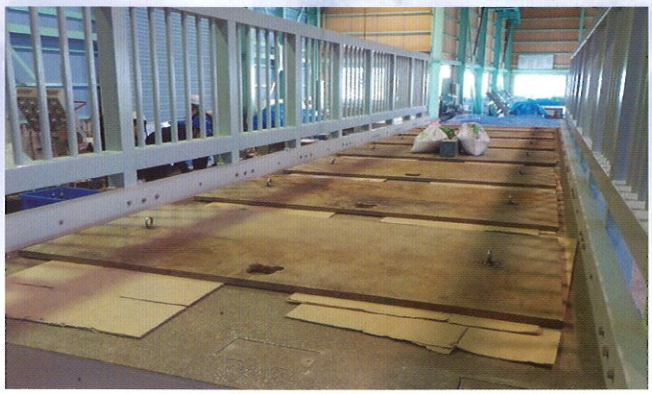
Rationale for and appropriateness of FRP bridge

The main road has a comparatively high traffic volume and does not have a dedicated pedestrian walkway, so the installation of a roadside bridge was planned for the purpose of ensuring the safety of pedestrians. The area gets considerable snowfall in the winter, making it necessary to spread melting agents on the roadways, so the bridge was required to withstand salt. It was also necessary to reduce the weight of the superstructure in order to lighten the burden on the drainage channels that are located in the substructure. These were major reasons for using FRP material, with its superior corrosion resistance and light weight.

Verifying the performance of the actual bridge

Vertical load test of main girder

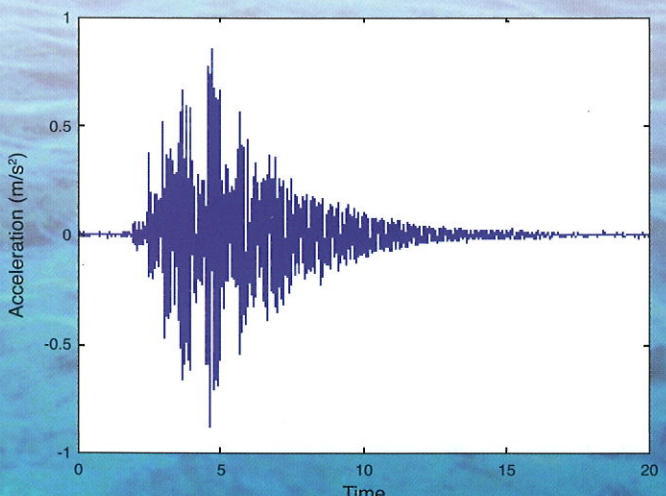
A steel plate dummy weights equal to the maximum design load were placed on the bridge, and the deflection was measured. The result confirmed that the response performance was adequate. Under the maximum live load, the displacement in the center of the bridge length was approximately 6 mm, a result that easily satisfied the designed deflection of span/400. It was also confirmed that there was no detrimental residual deflection after the weights were removed.



Steel plate loading

Horizontal load test of guardrail

A concentrated load in the outward direction was applied at midspan horizontal of the guardrail, and the resulting displacement was measured. The result confirmed that the rail has sufficient strength. When a concentrated load of 2.5 kN was applied, the outward deflection was only about 5.8 mm (1/200 of the guardrail height), indicating that no detrimental displacement occurred.



Example of acceleration time history during walking test

Walking tests

Vibration was measured during ordinary walking, and the results did not indicate any vibration that was detrimental to pedestrians. Resonance did not occur during walking at a constant speed with a frequency of 2 Hz, and no residual vibration was found immediately after the cessation of walking. Detrimental vibration that caused pedestrians to feel discomfort did not occur.

Dynamic vibration tests

On the assumption that an impact would actually be imposed on the bridge by human users, the residual vibration that is generated when a person jumps onto the surface of the floor slab from a height of 40 cm was measured. The results indicated that the vibration diminished immediately after the impact, confirming that the damping characteristics of the bridge are adequate.

FRP Kensaro

Kensaro (Inspection Passage)

Example of installation

Construction summary

Completed	October, 2016
Installation site	Nagoya University N2U-BRIDGE facility
Bridge type	Kensaro
Purpose	Training facility exhibit

Features

Safety, durability

The durability of the FRP Kensaro is far superior to that of conventional products. In particular, it has demonstrated more than adequate performance in areas with severely corrosive environments due to salt exposure and the like, and it maintains its initial properties over many years. FRP members that have been treated for high weather resistance are incredibly resistant to deterioration from reflected ultraviolet light.

With conventional steel products, fall accidents have been known to occur due to deterioration caused by rusting. For the very reason that the Kensaro is used for the purpose of inspections, a highly safe product with superior durability is required. The highly weather-resistant FRP Kensaro, with its excellent corrosion resistance, makes it possible to do inspection work safely, without any concerns about its performance diminishing over the years. The walking surface of the floor slab has also been treated to prevent slipping.

Reduced weight

The lightweight FRP Kensaro can expand the scope of manual construction. Even in a case where construction equipment is required for transport and installation, equipment that is more compact and consumes less power can be used, thereby easing the constraints on construction. Reducing the weight of the Kensaro also reduces the load on the structure.

FRP Kensaro: Front view

Kensaro tests

The FRP Kensaro has passed all of the tests in the NEXCO test procedure.

Kensaro static load test

Confirms whether the deflection and the maximum strain are within tolerance under the maximum design live load.

Handrail static load test (vertical load)

Confirms that no problems occur in the handrail and support posts in terms of the maximum strain that is generated under the maximum design live load in the vertical direction on the top rail of the handrail.

Kensaro dynamic load test

Confirms that no damage is incurred at the natural frequency when a free falling dummy weight falls on the Kensaro.

Handrail static load test (horizontal load)

Confirms that no problems occur in the handrail and support posts in terms of the maximum strain that is generated under the maximum design live load in the horizontal direction on the top rail of the handrail.

Handrail impact load test (top handrail)

Confirms that no breakage occurs to the handrail's top rail and support posts when a dummy weight attached to the rail by a safety strap falls freely.

Handrail impact load test (middle handrail)

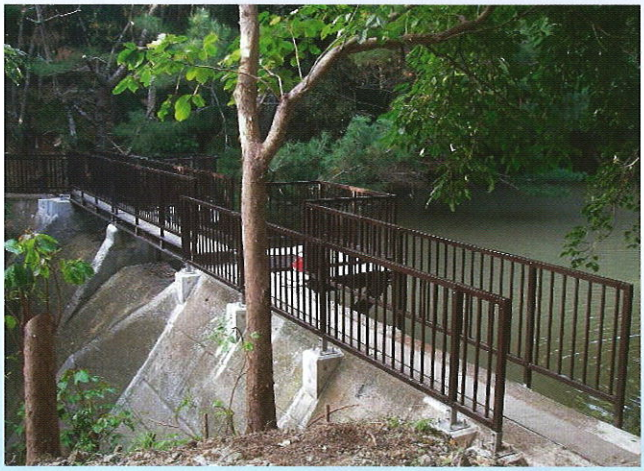
Confirms that no breakage occurs to the handrail's middle rail and support posts when a dummy weight attached to the rail by a safety strap falls freely, in the same manner as in the top rail test.

FRP Products

Hydraulic gate · Operation bridge

Management bridge

Guardrail



Handrail

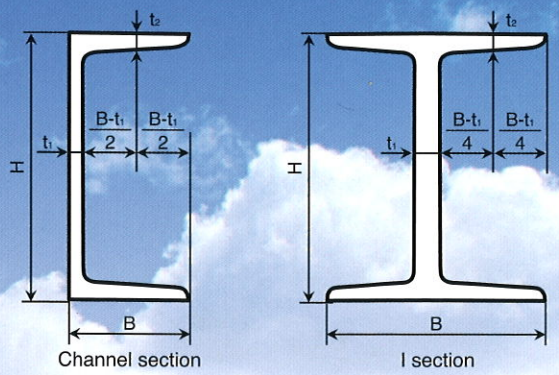
Footbridge stairway

Stairway

FRP member standard sizes

Sizes

Outdoor exposure test stand



Product name	Model	Dimensions (mm)				
		H	B	t_1	t_2	L
Channel section	FCH-100	100	50	5	6.5	4,000
	FCH-125	125	65	6	7	4,000
	FCH-150	150	75	7	7.5	4,000
	FCH-180	180	75	7	9	9,500
	FCH-200	200	90	8	14	9,500
	FCH-250	250	90	9	11	4,000
	FCH-300	300	90	14	10.5	6,500
	FCH-380	380	95	12	16	8,500
			100	17		

Product name	Model	Dimensions (mm)				
		H	B	t_1	t_2	L
I section	FI-100	100	100	10	6.5	4,000
	FI-125	125	130	12	7	4,000
	FI-150	150	150	14	7.5	4,000
	FI-180	180	150	14	9	9,500
	FI-200	200	180	16	14	9,500
	FI-250	250	180	18	11	4,000
	FI-300	300	180	28	10.5	6,500
	FI-380	380	190	24	16	8,500
			200	34		

Product name	Plate thickness (mm)		Maximum dimensions (mm)	
			w	d
Flat plate	FPL-6	6	3,500	5,500
	FPL-8	8		
	FPL-10	10		
	FPL-12	12		
	FPL-16	16		

The plate thicknesses that are shown for the flat plate are the thicknesses that are commonly used for the skin plates of hydraulic gate doors, but thicknesses up to 30 millimeters are available in 1 millimeter increments.

FRP Footbridge Design and Construction Guidelines (Draft)

Japan Society of Civil Engineers

Committee on Hybrid Structures
Subcommittee on Guidelines for Design and Construction of FRP Footbridges (Editing)

We pledge that bridges made in accordance with these guidelines will be highly reliable in design, manufacture, and installation.

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