

**ISP FIBERBOND®**

**GRP Piping System**

**“EXCELLENCE PROVEN  
BY  
IT’S PERFORMANCE”**



**May. 2019**

**ISP Co., Ltd.**

**www.isppiping.com Tel. +82-55-355-1391 Fax. +82-55-355-1357**

# ISP Co., Ltd.

□ **Location** : #293, Yongjeonsaneopdanji-gil, Samnangjin-eup, Miryang-si, Gyeong Nam, South KOREA

Homepage : [www.isppiping.com](http://www.isppiping.com)

□ **Major Products**

- FIBERBOND® Composite Piping System
- Heatband® Cargo Heating Coil Unit System
- Surejacket™ GRP Jacketing

□ **Major Customers**

- Samsung Heavy Industry (SHI)
- Hyundai Heavy Industry (HHI)
- Daewoo Shipbuilding & Marine Engineering (DSME)
- Imabari Shipbuilding Co., Ltd.

□ **Sister Company**

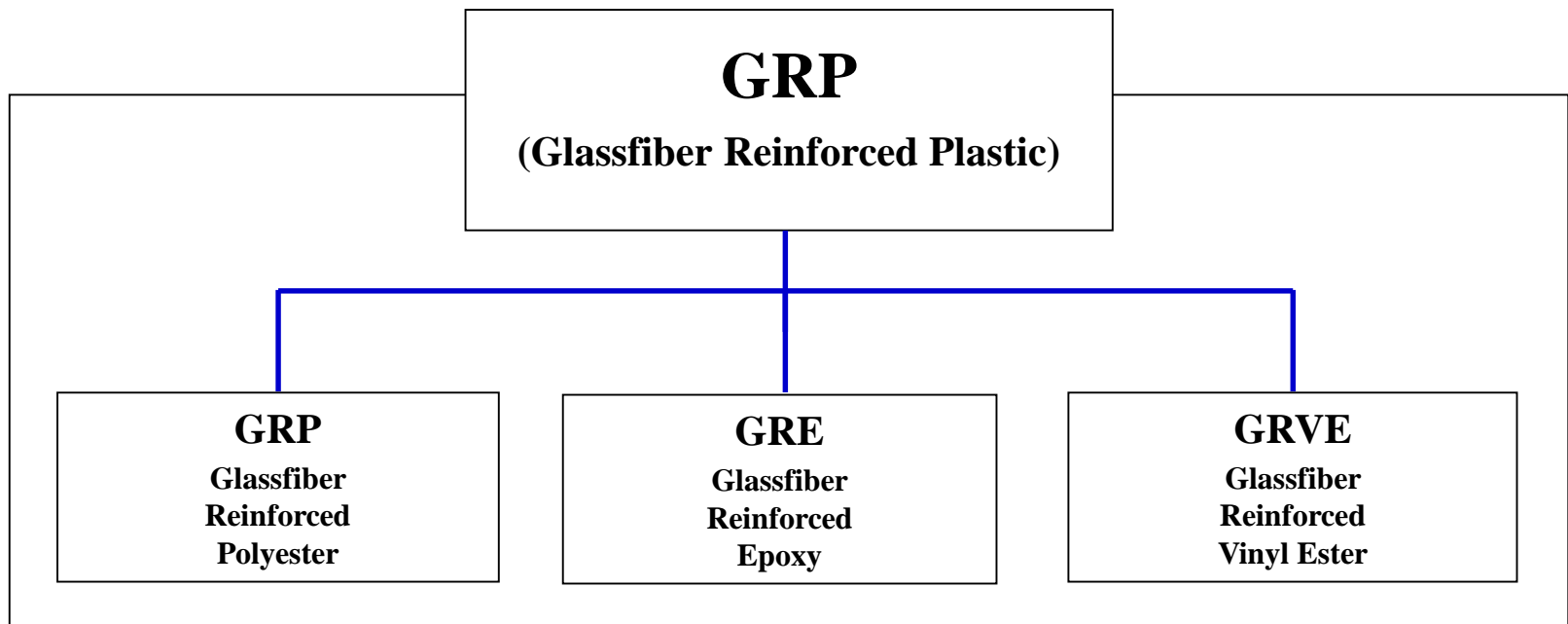
- EMEC Co., Ltd. : Ship Design, BWMS & Scrubber Retrofit Engineering in Busan, Korea

Homepage : [www.emec.co.kr](http://www.emec.co.kr)



# GRP(Glassfiber Reinforced Plastic)

GRP refers to a glass fiber composite which is combination of high mechanical strength glass fiber and corrosion resistance resin. It also called RTRP(Reinforced Thermoset Resin Pipe) or FRP(Fiberglass Reinforced Plastic).



# Material Comparison - Resin

<b>Properties</b>	<b>Polyester</b>	<b>Epoxy</b>	<b>Vinyl Ester (FIBERBOND®)</b>
Tensile Strength	50-70 MPA	65-80 MPA	65-75 MPA
E-modulus	90-100 MPA	100-150 MPA	100-115 MPA
Elongation	1.5%	2 to 5%	1.7%
Shear Strength	10-20 MPA	30-50 MPA	30-40 MPA
Heat Distortion in °C	60 to 80	180	135
Max. Allowable Temp. in °C	60 to 80	110 to 130	110 to 115
Shrinkage During Curing, %	7 to 10	1 to 3	5
Chemical Resistance	Fair	Good	Excellent

# Excellent Chemical Resistance

(Unit : wt%)

Chemical Name	Resin Type	Vinyl Ester Resin		Epoxy Resin-BPA Type	
		10 Days	30 Days	10 Days	30 Days
Hydrochloric Acid 10%		0.07	0.15	0.66	1.51
Hydrochloric Acid 37%		0.21	0.57	1.01	1.38
Sulfuric Acid 10%		0.12	0.38	0.87	1.42
Nitric Acid 5%		0.05	0.11	1.21	2.30
Nitric Acid 40%		0.38	1.53	6.38	X
Acetic Acid 10%		0.75	1.32	2.80	6.09
Citric Acid 25%		0.08	0.11	1.10	1.16
Sodium Hydroxide 50%		0.57	0.86	1.32	2.51
Salt Brine30%		0.06	0.15	0.75	1.53
Ethyle Alcohol 95%		0.08	0.19	0.26	0.29
Gasoline		0.01	0.01	0.02	0.03
Benzene		0.03	0.05	0.03	0.07
Toluene		0.02	0.05	0.05	0.09
Calcium Chloride		0.08	0.11	0.16	0.32
Diesel Fuel		0.01	0.02	0.03	0.05

※ Weight increase(%) by Immersion Test ("**Low value means better performance**")

※ Curing Condition : 25°C 24Hr + 100°C 1Hr

Data : Aekyung Chemical

# Failure Distribution – GRE Piping System by DNV

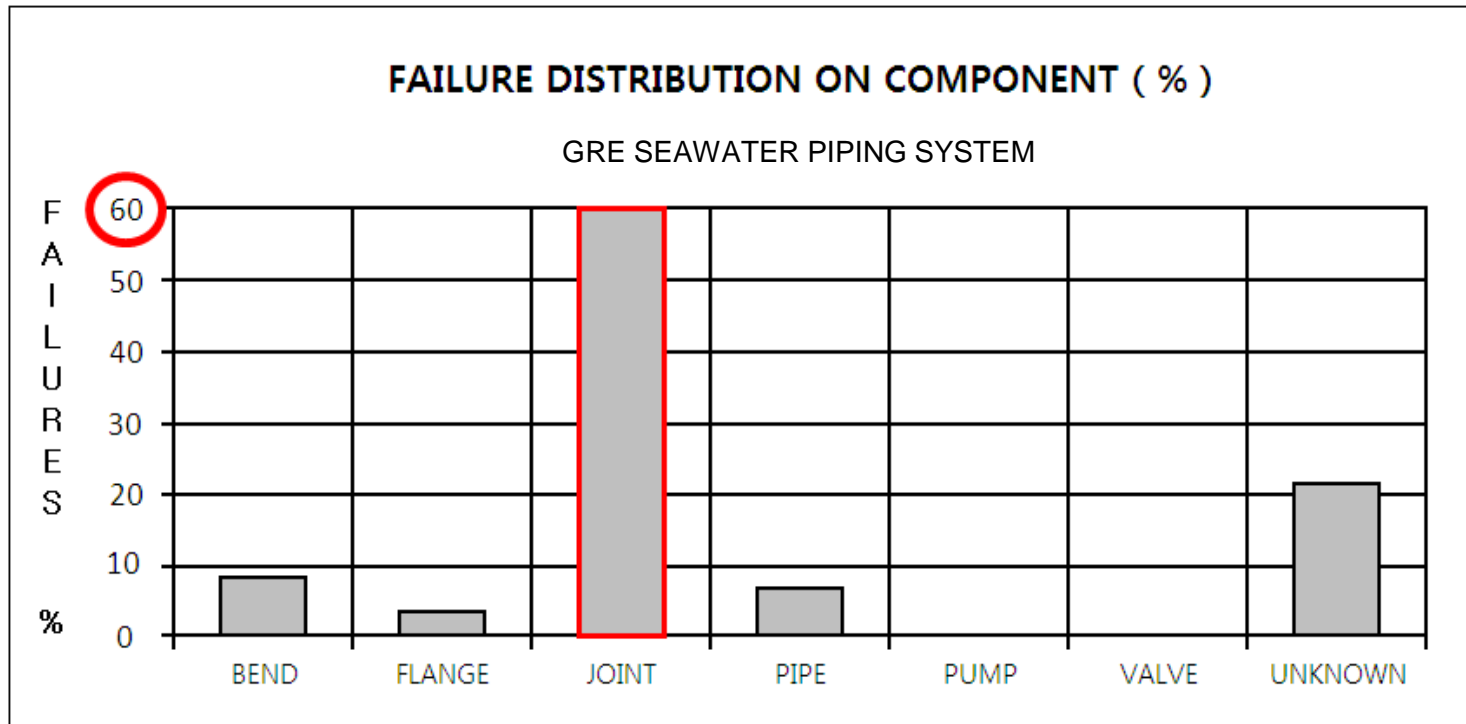


Figure 3. Recorded distribution of failure for different components in GRE seawater piping systems.

The failure in joints represent 60% of all failures in GRE piping systems.



MANAGING RISK

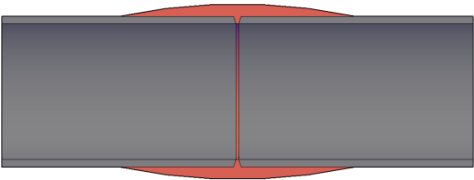
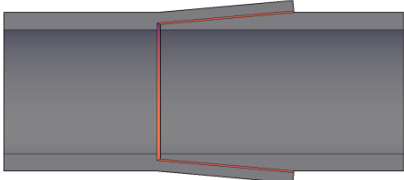
# Joining Method – API Recommendation

American Petroleum Institute (API) 14G document third edition, “Recommended practice for fire prevention and control on open type offshore production platform”, spring, 1993

- “Adhesive bonded joints are generally the weak link within the fiberglass piping system”
- Consideration should be given to using a “*Butt and Strap*” joint design which is more reliable than the adhesive bonded joint

# FIBERBOND® GRP Joining Method Development History

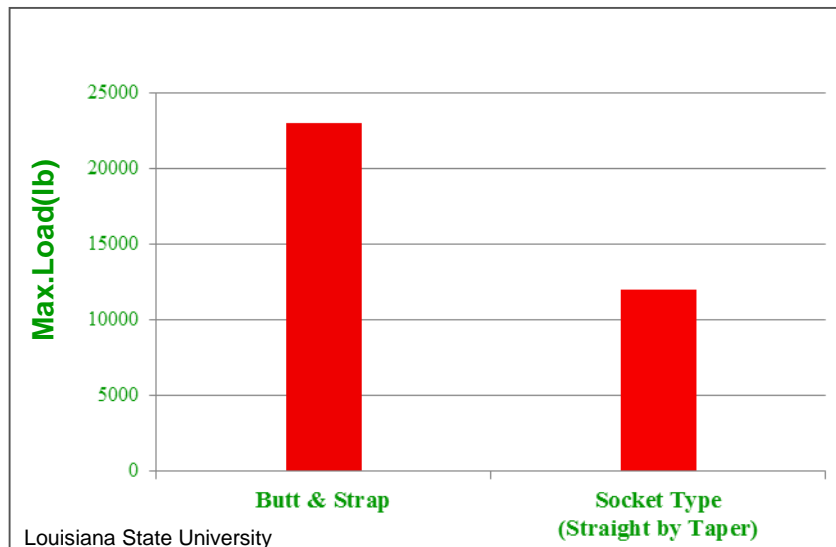
- First composite pipe system approved by U. S. Coast Guard for use on Deepwater Projects in Gulf of Mexico
- In cooperation with U. S. Navy, Louisiana State University, and Shell Deepwater USA, the *TigerWrap*™ Butt & Strap joining method was developed in 1988 under an Advanced Technology Program sponsored by U. S. Department of Commerce.

<b>FIBERBOND® System</b>	<b>Other Supplier</b>
<p data-bbox="220 865 865 901">■ <i>TigerWrap</i>™ BUTT &amp; STRAP JOINT</p>  <p data-bbox="195 1222 838 1268">➤ <b>Easy &amp; Robust Joint method</b></p>	<p data-bbox="1164 865 1682 901">■ SOCKET ADHESIVE JOINT</p>  <p data-bbox="1064 1222 1763 1268">➤ <b>Skillful Workmanship Required</b></p>



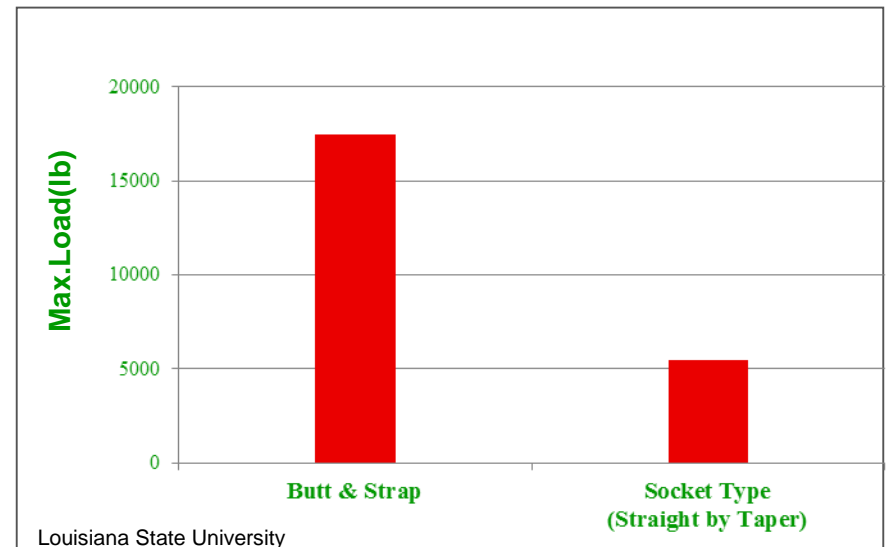
# Comparison with Joint Test

## MAXIMUM TENSILE LOADS



< Tensile Load Test Result >

## MAXIMUM BENDING LOADS

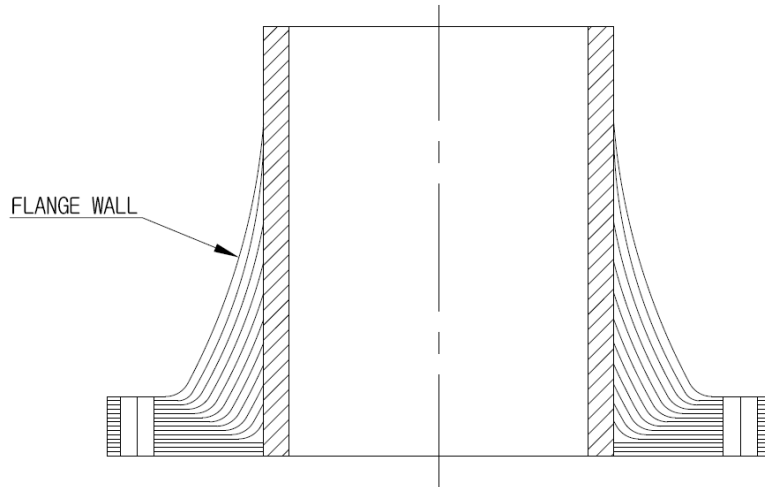


< Bending Load Test Result >

# Stronger One-Piece Type Flange

## FIBERBOND® System

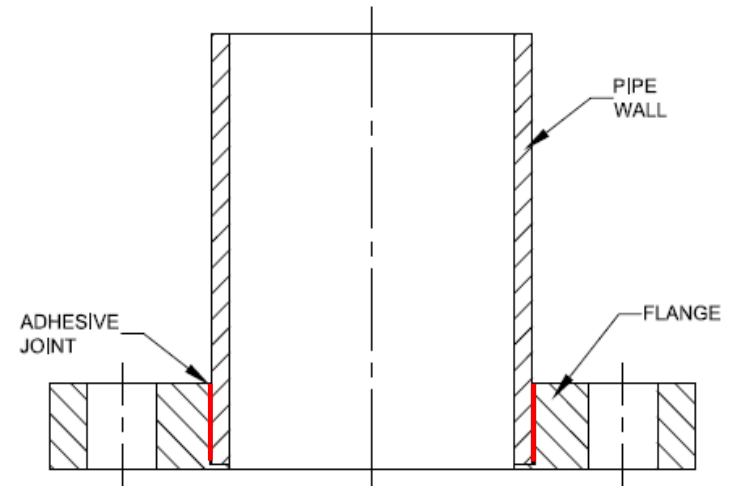
### ■ LONG NECK TYPE FLANGE



➤ **Stronger One-Piece Flange**

## Other Supplier

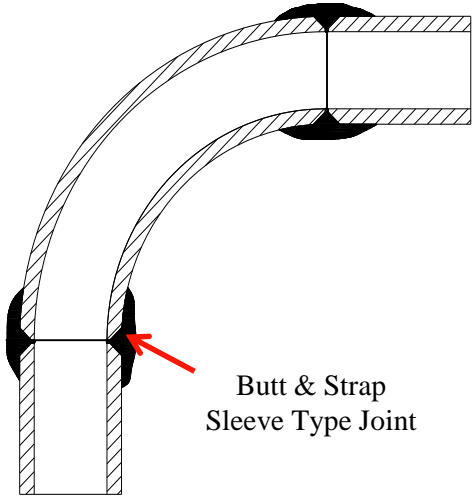
### ■ SOCKET TYPE FLANGE



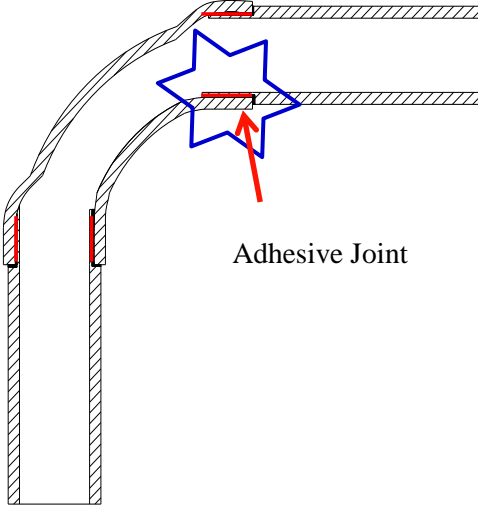
➤ **Less Area Contact  
Root cause Failure**

# Elbows – Butt & Strap Joint

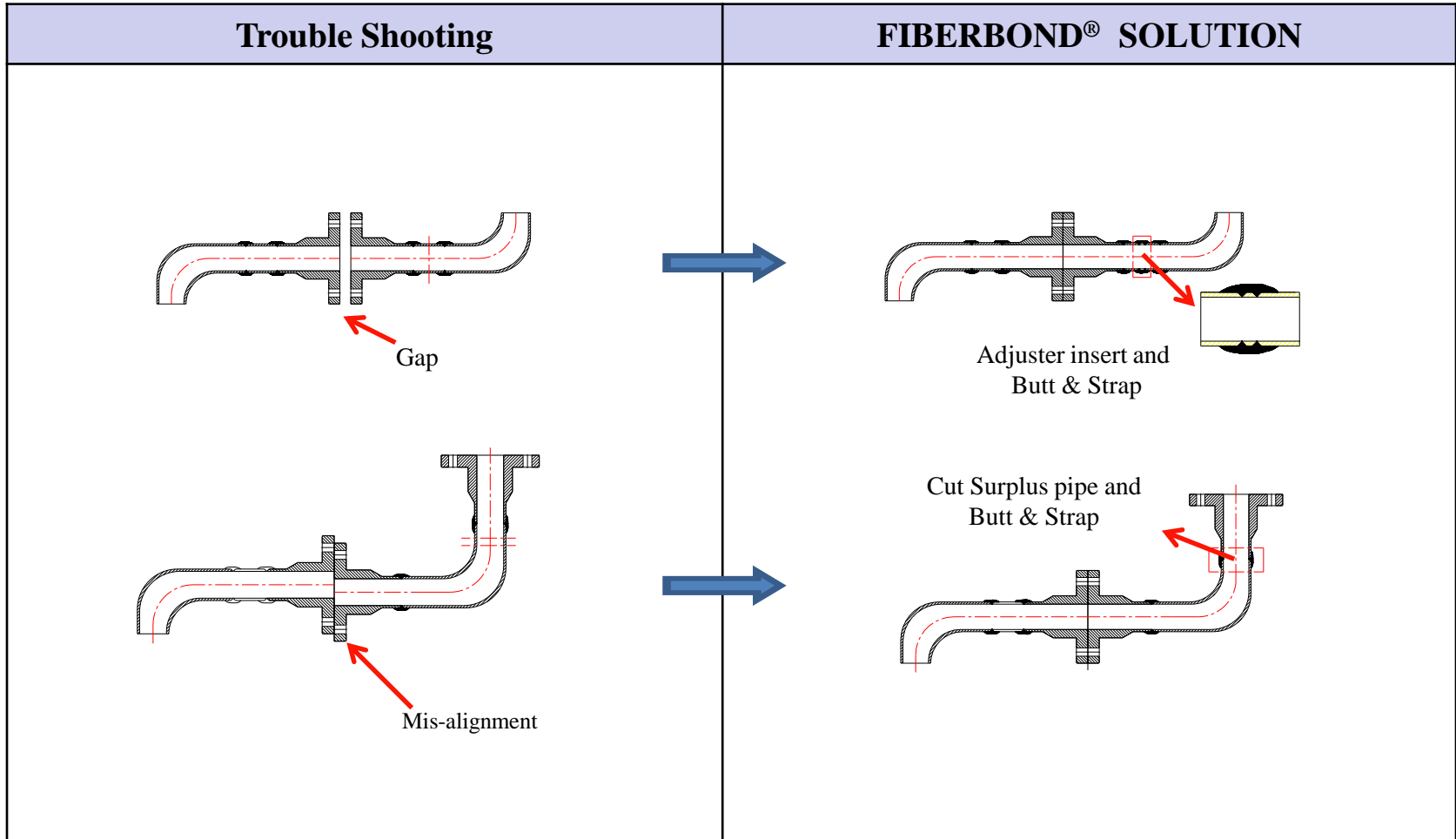
**FIBERBOND® System**



**Other Supplier**

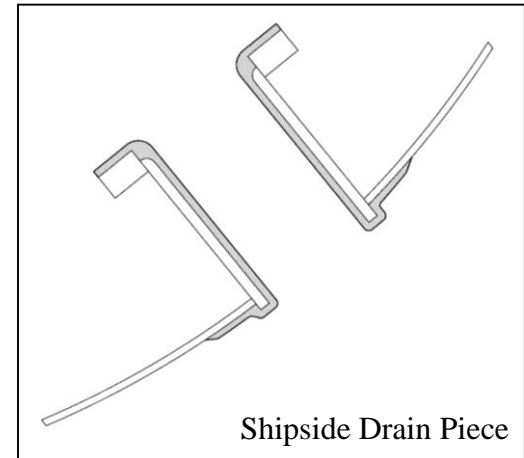


# Repair Method



# ISP Other Products – GRP Lining

- For Bulk Head Penetration Piece
- For Shiplside Drain Piece of SOx Scrubber Line



## Advantage of ISP FIBERBOND® GRP Lining

<b>Corrosion Resistance</b>	Improved by GRP Lining on Steel Pipe
<b>Bonding &amp; Tensile Strength</b>	Superior to P.E. coating
<b>Repair</b>	Quick and Easy Repair at site

# Comparison Summary(GRP Vs. GRE)

	GRE	FIBERBOND® GRP
Resin	Epoxy	Vinyl Ester
Joining Method	Socket Type / Adhesive	Butt and Strap with same Material of Pipe
Curing System	Using a Heat Blanket	Curing at Ambient Temperature
Modification	Difficult	Reproducible

“Consideration should be given to the joint area which is the **weakest point** in the Fiberglass Piping System instead of pipe itself to verify stability and durability.”

# ISP FIBERBOND® Sox Scrubber Line - Reference List

## 1. Scrubber Retrofit - Drain Line

NO.	Owner	Yard	Type	Delivery	Equipment Maker	Remarks
1	Navig8		45K PC	2018	Feen Marine	2 vessels
2	Matson	Nantong Cosco	2,000 TEU Container	2015	Alfa Laval	3 vessels
3	Hapag Lloyd	Beihai	13,200 TEU Container	2019	LAB	10 vessels
4	Syncro Shipping	Zhoushan Xinya	300K VLCC	2019	Alfa Laval	2 Vessels
5	GS Caltex	Yeosu Ocean	MR Tanker	2019		
6	Bokwang Shipping	Yeosu Ocean	36K Bulk Carrier	2019	Atics	
7	NYK	HRDD	VLCC	2019	CROcean	
8	Tsuneishi	Fukuyama	82K BC	2019	Panasia	

## 2. Hyundai Power Systems

NO.	Owner	Project	Type	Delivery	Equipment Maker	Remarks
1	Felix	PM2679		2018	HHI Scrubber	Internal Piping
2	Felix	PM2680		2018	HHI Scrubber	Internal Piping
3	Felix	PM2681		2018	HHI Scrubber	Internal Piping
4	Felix	PM2682		2018	HHI Scrubber	Internal Piping
5	OSG	PM2716		2018	HHI Scrubber	Internal Piping
6	SK	PM2713		2019	HHI Scrubber	Internal Piping
7	Andros	PG1826		2019	HHI Scrubber	Internal Piping
8	Pan Ocean	PG1803		2019	HHI Scrubber	Internal Piping
9	Capital	PG1810		2019	HHI Scrubber	Internal Piping
10	Capital	PG1811		2019	HHI Scrubber	Internal Piping
11	Capital	PG1812		2019	HHI Scrubber	Internal Piping
12	Capital	PG1813		2019	HHI Scrubber	Internal Piping
13	HMM	PG1832		2019	HHI Scrubber	Internal Piping
14	DHT	PI1801		2019	HHI Scrubber	Internal Piping
15	DHT	PI1802		2019	HHI Scrubber	Internal Piping

# ISP FIBERBOND® Sox Scrubber Line - Reference List

16	DHT	PI1803		2019	HHI Scrubber	Internal Piping
17	DHT	PI1804		2019	HHI Scrubber	Internal Piping
18	EUKOR	PG1827		2019	HHI Scrubber	Internal Piping
19	Andros	PG1842		2019	HHI Scrubber	Internal Piping
20	HISAMOTO	PMS464		2019	HHI Scrubber	Internal Piping
21	HMM	PG1833		2019	HHI Scrubber	Internal Piping
22	Lumos	PH3029		2019	HHI Scrubber	Internal Piping
23	Lumos	PH3030		2019	HHI Scrubber	Internal Piping
24	Lumos	PH3031		2019	HHI Scrubber	Internal Piping
25	Lumos	PH3032		2019	HHI Scrubber	Internal Piping
26	Lumos	PH3033		2019	HHI Scrubber	Internal Piping
27	Lumos	PH3034		2019	HHI Scrubber	Internal Piping
28	Lumos	PH3035		2019	HHI Scrubber	Internal Piping
29	Lumos	PH3036		2019	HHI Scrubber	Internal Piping
30	Capital	PG1816		2019	HHI Scrubber	Internal Piping
31	HAKUYO	PG1828		2019	HHI Scrubber	Internal Piping
32	JX OCENA	PG1844		2019	HHI Scrubber	Internal Piping
33	COSTAMARE	PG1834		2019	HHI Scrubber	Internal Piping
34	COSTAMARE	PG1835		2019	HHI Scrubber	Internal Piping
35	COSTAMARE	PG1836		2019	HHI Scrubber	Internal Piping
36	COSTAMARE	PG1837		2019	HHI Scrubber	Internal Piping
37	COSTAMARE	PG1838		2019	HHI Scrubber	Internal Piping
38	S&Y Shipping	PG1845		2019	HHI Scrubber	Internal Piping
39	Andros	PG1901		2019	HHI Scrubber	Internal Piping
40	Andros	PG1902		2019	HHI Scrubber	Internal Piping
41	Synergy	PG1843		2019	HHI Scrubber	Internal Piping
42	KSS LINE	PG1846		2019	HHI Scrubber	Internal Piping
43	Capital	PG1814		2019	HHI Scrubber	Internal Piping
44	Capital	PG1815		2019	HHI Scrubber	Internal Piping
45	Vitol	PH3091		2019	HHI Scrubber	Internal Piping



# ISP FIBERBOND® Sox Scrubber Line - Reference List

46	Vitol	PH3092		2019	HHI Scrubber	Internal Piping
47	Capital	PG1818		2019	HHI Scrubber	Internal Piping
48	Capital	PG1819		2019	HHI Scrubber	Internal Piping
49	Capital	PG1820		2019	HHI Scrubber	Internal Piping
50	Capital	PG1821		2019	HHI Scrubber	Internal Piping
51	Capital	PG1822		2019	HHI Scrubber	Internal Piping
52	KOREA LINE	PJS997		2019	HHI Scrubber	Internal Piping
53	KOREA LINE	PJS998		2019	HHI Scrubber	Internal Piping
54	MASUMOTO	PMS460		2019	HHI Scrubber	Internal Piping
55	Vitol	PH3093		2019	HHI Scrubber	Internal Piping
56	Vitol	PH3094		2019	HHI Scrubber	Internal Piping
57	MASUMOTO	PMS461		2019	HHI Scrubber	Internal Piping

### 3. Samsung Heavy Industries

NO.	Owner	Project	Type	Delivery	Equipment Maker	Remarks
1	MSC	SN2248	22,000TEU CONT	2018	Yara	
2	MSC	SN2249	22,000TEU CONT	2018	Yara	
3	MSC	SN2250	22,000TEU CONT	2018	Yara	
4	MSC	SN2251	22,000TEU CONT	2018	Yara	
5	MSC	SN2252	22,000TEU CONT	2019	Yara	
6	MSC	SN2253	22,000TEU CONT	2019	Yara	
7	Evergreen	SN2263	12,000TEU CONT	2019		
8	Evergreen	SN2264	12,000TEU CONT	2019		
9	Evergreen	SN2265	12,000TEU CONT	2019		
10	Evergreen	SN2266	12,000TEU CONT	2019		
11	Evergreen	SN2267	12,000TEU CONT	2020		
12	Evergreen	SN2268	12,000TEU CONT	2020		
13	Evergreen	SN2269	12,000TEU CONT	2020		
14	Evergreen	SN2270	12,000TEU CONT	2020		

# ISP FIBERBOND® Sox Scrubber Line - Reference List

## 4.Imabari Shipbuliding

NO.	Owner	Project	Type	Delivery	Equipment Maker	Remarks
1		S1878	20,000TEU CONT	2018	Alfa Laval	
2		S8193	20,000TEU CONT	2018	Alfa Laval	
3		S1837	20,000TEU CONT	2018	Alfa Laval	
4		S8194	20,000TEU CONT	2018	Alfa Laval	
5		S1760	207,600MT BC	2018	Wartsila	
6		S2657	207,600MT BC	2018	Wartsila	
7		S2588	241K Ore Carrier	2018	Wartsila	
8		S2586	180K BC	2018	Fuji Electric	
9		S2630	241K Ore Carrier	2018		
10		S2627	241K Ore Carrier	2018		
11		S8195	182.2K BC	2019		
12		S0957	2,880 TEU	2019		
13		S8167	182.2K BC	2019		
14		S8208	207.6K BC	2019		
15		S1764	207.7K BC	2019		
16		S1741	88K BC	2019		
17		SZ533	63K BC	2019		
18		S0958	2,880 TEU	2019		
19		S8197	207.6K BC	2019		
20		S8230	207.6K BC	2019		
21		S1766	81K BC	2019		
22		S0959	2,880 TEU	2019		
23		S2602	182.2K BC	2019		
24		S0961	1,900 TEU	2019		

# ISP FIBERBOND® Sox Scrubber Line - Reference List

## 5. Hyundai Mipo Dockyard

NO.	Owner	Project	Type	Delivery	Equipment Maker	Remarks
1	Solvang	8258	21K PC	2018	Wartsila	
2	Solvang	8259	21K PC	2018	Wartsila	
3	Solvang	8260	21K PC	2018	Wartsila	
4	Solvang	8261	21K PC	2018	Wartsila	
5	Time Shipping	8220	50K PC	2017	Wartsila	
6	Time Shipping	8221	50K PC	2018	Wartsila	

## 6. Daehan Shipbuilding

NO.	Owner	Project	Type	Delivery	Equipment Maker	Remarks
1	TSAKOS	HN5033	115K PC	2018	Alfa Laval	
2	TSAKOS	HN5036	115K PC	2018	Alfa Laval	
3	Capital	HN5041	115K COT	2018		
4	Capital	HN5042	115K COT	2018		