



www.nipponsteel.com



Steel
Plates

CORSPACE™

Corrosion Resistance Steel
for Repainting Cycle Extension

NETIS registration : KK-150056-VR

Notice: While every effort has been made to ensure the accuracy of the information contained within this publication, the use of the information is at the reader's risk and no warranty is implied or expressed by NIPPON STEEL CORPORATION with respect to the use of the information contained herein. The information in this publication is subject to change or modification without notice. Please contact the NIPPON STEEL CORPORATION office for the latest information. Please refrain from unauthorized reproduction or copying of the contents of this publication. The names of our products and services shown in this publication are trademarks or registered trademarks of NIPPON STEEL CORPORATION, affiliated companies, or third parties granting rights to NIPPON STEEL CORPORATION or affiliated companies. Other product or service names shown may be trademarks or registered trademarks of their respective owners.

NIPPON STEEL CORPORATION

2-6-1 Marunouchi, Chiyoda-ku, Tokyo 100-8071 Japan
Tel: +81-3-6867-4111

CORSPACE™

A104en_05_202409f

© 2019, 2024 NIPPON STEEL CORPORATION



NIPPON STEEL CORPORATION



CORSPACE™

Necessity and expected effect

CORSPACE enables you to extend the coating cycle when compared with conventional steel, thereby reducing the life cycle cost.



Bridges are usually assumed to be in service for 100 years, and appropriate maintenance is required during the period. The major control item of the maintenance items is the progress of corrosion from the deteriorated part of the coating film, and periodical recoating is necessary. Recoating accounts for a large portion of the maintenance cost, and the reduction of the number of recoatings is desired from the viewpoint of reducing the environmental load.



Durability of coating pinhole part, coating defect part and round edge part

Insufficient cleaning during maintenance and repair (narrow part, etc.)

Repainting coat

Reinforcing surface preparation

Corrosion resistance steel for repainting cycle extension developed

Effect expected using CORSPACE

Issues

- Corrosion from coating pinhole part and deteriorated part
- Corrosion from sharp edge part of element

In a severe salt damage environment, the maintenance cost and environmental load can be reduced by extending the recoating cycle.

CORSPACE

Advantages

Advantages in maintenance (Example of steel bridge LCC calculation)

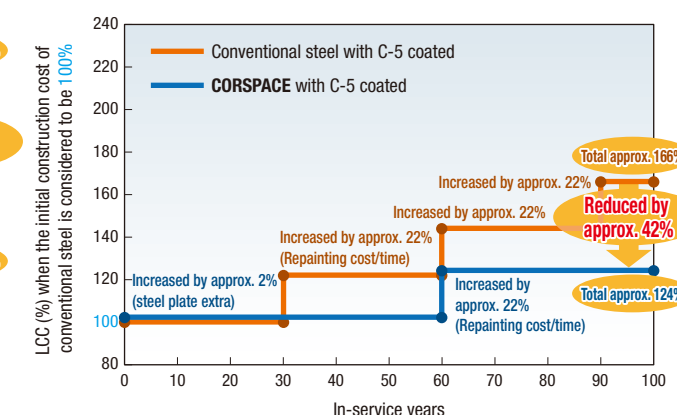
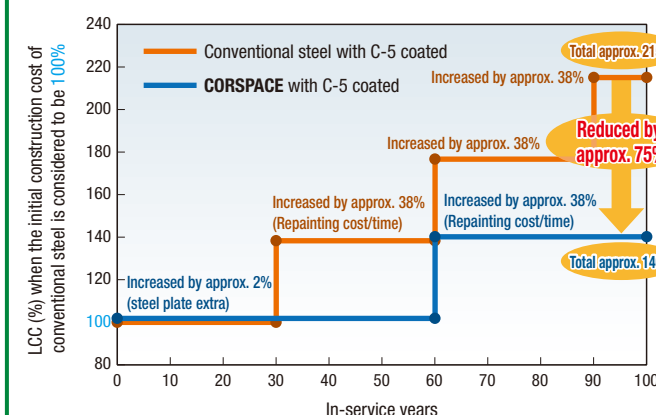
CORSPACE can extend the coating cycle to about double that compared with conventional steel under the same coating/installation environment. Therefore, while conventional steel needs coat repainting three times every 100 years, CORSPACE can reduce it to once and approximately halve the cost for repainting maintenance cost. Furthermore, reducing the number of times of coat repainting will contribute to VOC discharge control, and thus the environmental load can be reduced.

A 3 span continuous twin plate-girder

Bridge type	3 span continuous twin plate-girder
Bridge length	121.0 m (37.0 + 46.0 + 37.0 m)
Total width	11.5 m
Total steel weight	187.3 t
Coated area	3,541 m ² (Repainting specification: Rc-I)

B 3 span continuous narrow box-girder

Bridge type	3 span continuous narrow box-girder
Bridge length	211.0 m (65.0 + 80.0 + 65.0 m)
Total width	11.5 m
Total steel weight	761.7 t
Coated area	14,370 m ² (Repainting specification: Rc-I)



When the in-service years of the conventional steel with C5 coated in a salt damage environment is set to 30 years.
When the repair/repainting is conducted for Rc-I coating on outer side of the girder.

The life-cycle cost can be decreased by reducing the coat repainting to once every 100 years.

Advantages in order reception, design and manufacturing

- We can serve you with the NETIS registration technology (KK-150056-VR certified in January 2021), technical proposals and construction performance rating.
- The standard extras are described as "Corrosion Resistance Steel for Repainting Cycle Extension" in the Kensetsu Bukka (Construction Research Institute) and Sekisan Shiryou (Economic Research Association).
- CORSPACE is listed as a "tin added steel" that can be used in Hanshin Expressway Company Limited "Part 2 Structural Design Standards (Bridge Edition)" (January 2021) and Metropolitan Expressway Company Limited "Bridge Structure Design/Construction Procedure" (June 2015).
- CORSPACE conforms to all the JIS standards of steel plates used for bridges, and the plate manufacturable range is equivalent to that of conventional steel.
- Various types of workability such as cutting, bending, and welding are equivalent to that for conventional steel.
- We are lining up exclusive weld materials and bolts.

The Ministry of Land, Infrastructure, Transport and Tourism
New Technology Information System (NETIS)

NETIS
KK-150056-VR

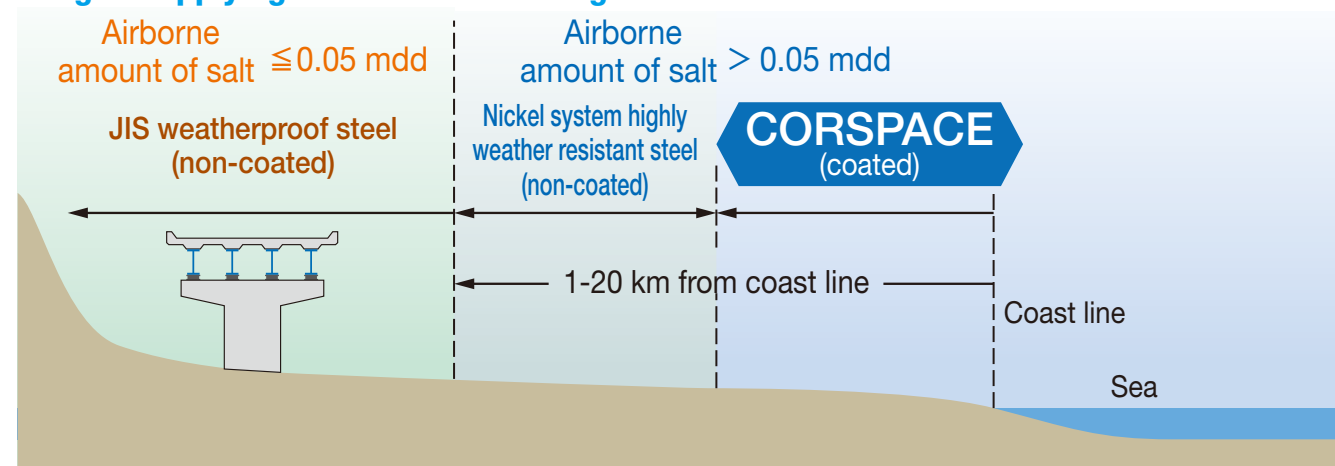
Point-adding factors in evaluation during proposal and after completion.

CORSPACE

Features

Adding a fine amount of tin significantly reduces the corrosion mass. It produces an effect in coastal areas where salt damage is severe.

Image of applying CORSPACE to a bridge



- CORSPACE has a function to inhibit corrosion of steel at the parts where the coating film is deteriorated or the film is thin.
- It delivers a much wider effect in a place where salt damage is severe, so its application to an environment to which a weather-resistant steel bridge cannot be applied is effective.
- The effect of application in an antifreezing agent spraying area can also be expected.

Conforming to all JIS standards required for bridges.

(corresponding to the tensile strength of class 400-570 N/mm²)

Conforming to three standards (steel plate)

- JIS G3101 Rolled steels for general structure (SS)
- JIS G3106 Rolled steels for welded structure (SM)
- JIS G3140 High yield strength steel plates for bridges (SBHS)

A fine amount of Tin (Sn) is added within the range of chemical components permitted by the above JIS standards.

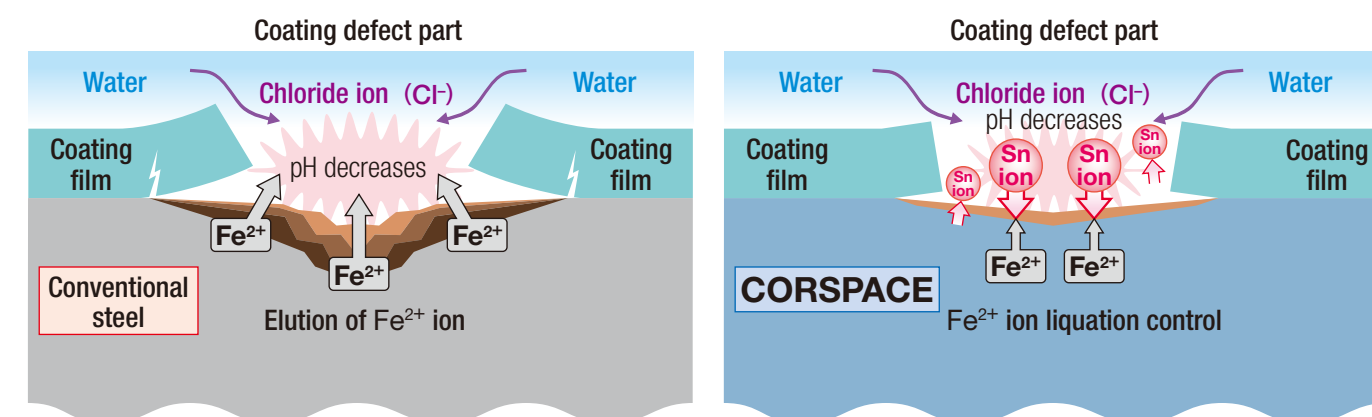
Symbol of type	Applied plate thickness (mm)	Chemical component / Mechanical property
SS400 -CORSPACE	6-100	In compliance with JIS G3101 SS400
SM400 -CORSPACE	6-100	In compliance with JIS G3106 SM400
SM490 -CORSPACE	6-100	In compliance with JIS G3106 SM490
SM490Y -CORSPACE	6-100	In compliance with JIS G3106 SM490Y
SM520 -CORSPACE	6-100	In compliance with JIS G3106 SM520
SM570 -CORSPACE	6-100	In compliance with JIS G3106 SM570
SBHS400 -CORSPACE	6-100	In compliance with JIS G3140 SBHS400
SBHS500 -CORSPACE	6-100*	In compliance with JIS G3140 SBHS500

*SBHS500-CORSPACE: For plate thicknesses exceeding 50 mm, please consult us in advance.

CORSPACE

Mechanism

Corrosion of conventional steel progresses due to anode/cathode reaction. In the coating defect part of thin film under water, chloride ions condense and pH decreases, so the progress of corrosion is accelerated. Meanwhile, with CORSPACE, Sn also liquates out at the same time as the anode reaction of Fe (dissolution reaction), and the eluted Sn ions inhibit the elution of Fe ions, thereby preventing the progress of corrosion.



CORSPACE

Corrosion-resistant properties
(acceleration test)

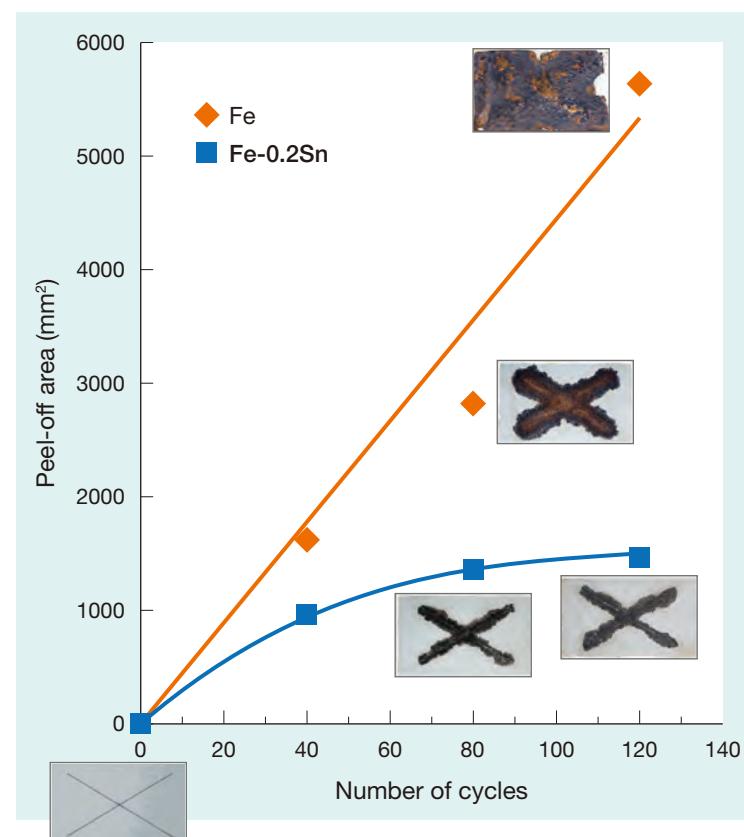
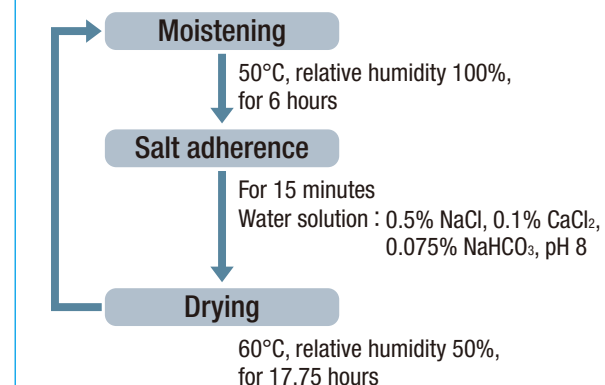
Evaluation by acceleration test (SAE J2334 test)

〈Coating specifications〉

	Coating material	Film thickness
	Inorganic zinc rich paint	—
First layer	General-purpose epoxy resin coating	160 μm

〈Test conditions〉

- SAE J2334



CORSPACE

Corrosion-resistant properties
(actual environment exposure test)

Evaluation after outdoor exposure test (Higashi-Kobe Bridge)

(Place) ● Adjacent to the pier of the Higashi-Kobe Bridge of Hanshin Highway Route 5 Bayshore Line
(Environment) ● Amount of airborne salt: 0.04 to 0.07 mdd (Public Works Research Institute method)

(Coating specifications)	Coating material	Film thickness
	Inorganic zinc rich paint	—
First layer	Fluorine resin coating material	30 μm
Second layer	Fluorine resin coating material	25 μm
	Total	55 μm

Higashi-Kobe Bridge

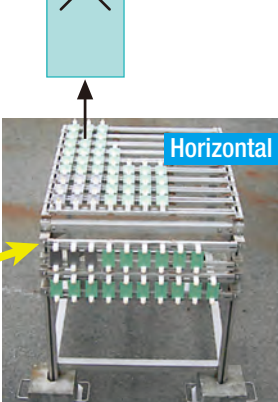


Higashi-Kobe Bridge



100×60×3mmt

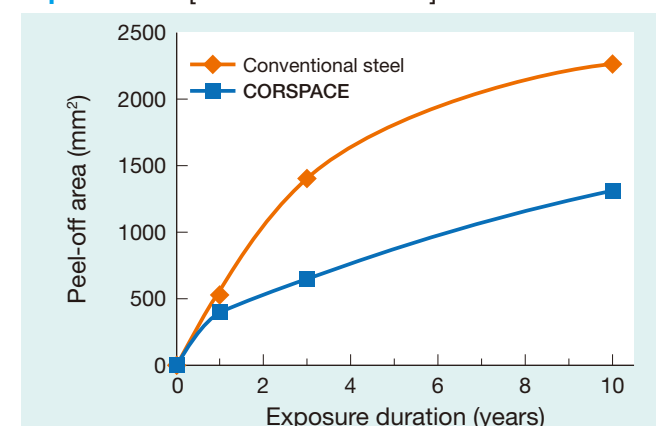
Cross-cut



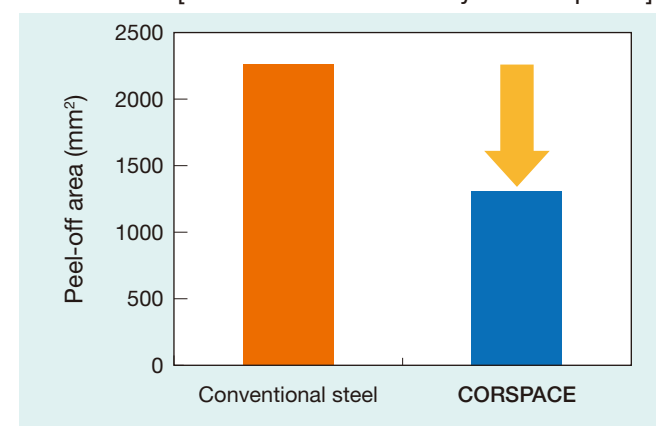
Coating film peel-off status around scratched part of horizontal exposure material

	Exposed for 1 year	Exposed for 3 years	Exposed for 10 years
Conventional steel			
CORSPACE			

Exposure test [horizontal bottom face]



Peel-off area [horizontal bottom face/10 years of exposure]



CORSPACE

Corrosion-resistant properties
(actual environment exposure test)

Evaluation after outdoor exposure test (Hasaki-city, Ibaraki)

(Place) ● Hasaki-city, Ibaraki
(Environment) ● Amount of airborne salt 0.4 mdd (Public Works Research Institute method)

(Coating specifications)	Coating material	Film thickness
	Inorganic zinc rich paint	—
First layer	Epoxy resin coating	120 μm
Second layer	Fluorine resin coating material	30 μm
Third layer	Fluorine resin coating material	25 μm
	Total	175 μm

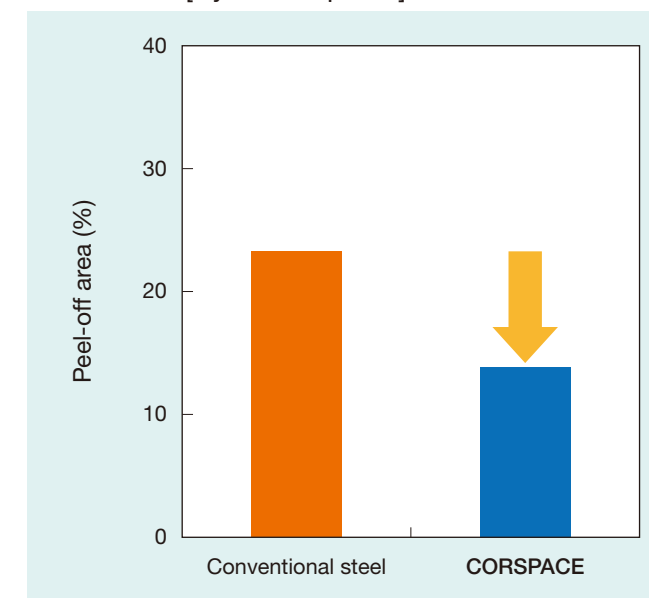
Exposure to atmosphere (with rain wash effects)



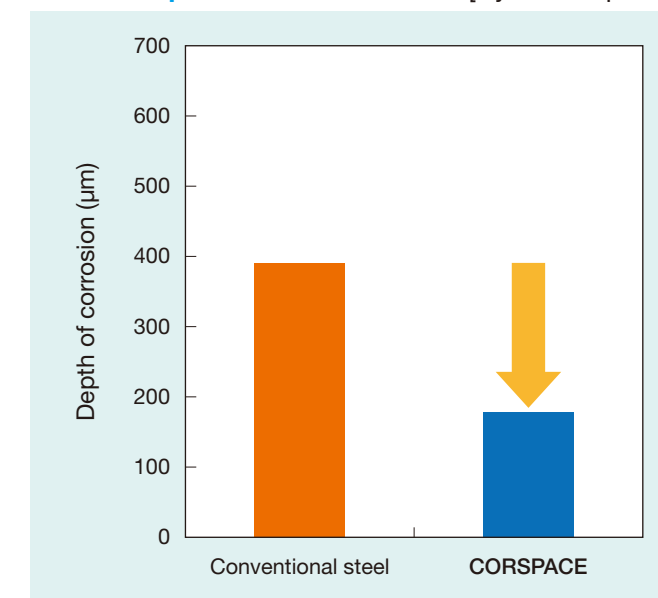
Results of 7-year exposure test

Legends	Conventional steel	CORSPACE

Peel-off area [7 years of exposure]



Corrosion depth in scratched coat area [7 years of exposure]



CORSPACE

Corrosion-resistant properties
(actual environment exposure test)

Evaluation after outdoor exposure test (Okinawa)

(Place)

(Environment)

(Test condition)

(Coating specifications)

- Waterfront of Okinawa prefecture
- Equivalent to C5 to CX, the corrosion categories in the ISO12944-2
- Size of the test piece: 100 x 60 x 3mm^l
- Posture during exposure: Horizontal
- C-5 specification for outer surface

Coating material	Film thickness
Inorganic zinc rich paint	75 μm
Under coat of epoxy resin coating material	—
Under coat of epoxy resin coating material	120 μm
Middle coat of fluorine resin coating material	30 μm
Top coat of fluorine resin coating material	25 μm

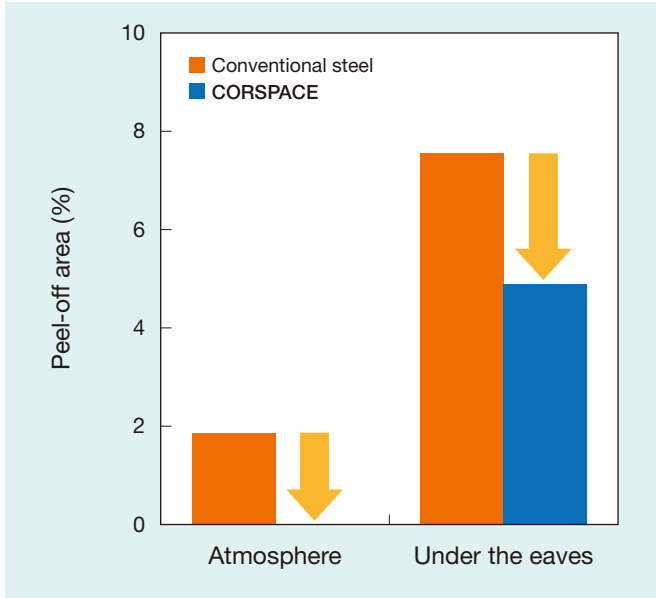
Exposure under the eaves
(without rain wash effects)



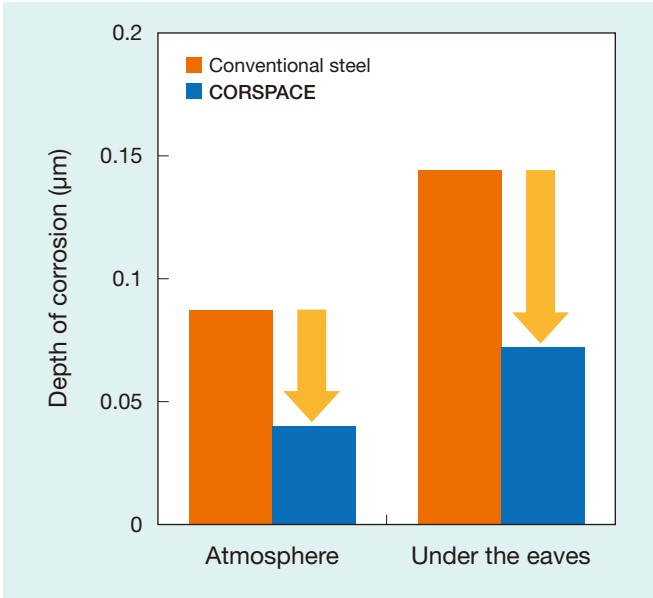
Results of 5-year exposure test

Legends	Exposure to atmosphere (with rain wash effects)		Exposure under the eaves (without rain wash effects)	
	Conventional steel	CORSPACE	Conventional steel	CORSPACE

Peel-off area [5 years of exposure]



Corrosion depth in scratched area [5 years of exposure]



CORSPACE

Recoating time extension effect

(Steel Highway Bridge Anticorrosion Handbook in March 2014)

■ Evaluation of peel-off

Evaluation	JIS K 5600-8-5:1999 Designation of degree of flaking	Peel-off area (%)
1	0	0
2	3	1
3	4	3
4	5	15

■ Evaluation of corrosion

Evaluation	Generation area (%)	Appearance status	JIS K 5600-8-3 Designation of degree of rusting (corrosion area %)
1	X < 0.05	No corrosion is found, and coating film is in a sound state.	Ri1 (0.05%)
2	0.05 ≤ X < 0.5	Slight corrosion is found, but the coating film is maintaining the corrosion resistant function.	Ri2 (0.5%)
3	0.5 ≤ X < 8.0	Corrosion is visible, and the corrosion resistant function is impaired at part of the coating film.	Ri3, Ri4 (1.0%, 8.0%)
4	8.0 ≤ X	Corrosion has progressed, and the coating film has lost the corrosion resistant function.	Ri4 or more (8.0% or more)

① Recoating is unnecessary for the for the time being
② Recoating after a couple of years is planned
③ Early recoating is examined

■ Recoating time judgment

		Degree of peel-off			
		1	2	3	4
Degree of corrosion	1	①		②	
	2				
	3	②			
	4			③	

Corrosion generation limit standard diagram

Coating film peel-off area of CORSPACE and conventional steel

(Test conditions)

- Coating that simulates the C5 system
- Foundation exposed by incising the coating film in an X-shaped state
- Cyclic corrosion test (SAE J2334)
- Evaluation of coating film peel-off area

(Coating specifications)

	Coating material	Film thickness
First layer	Inorganic zinc	15 μm
Second layer	Back coat of epoxy resin coating material	60 μm
Third layer	Back coat of epoxy resin coating material	60 μm
Fourth layer	Middle coat of fluorine resin coating material	30 μm
Fifth layer	Middle coat of fluorine resin coating material	25 μm
	Total	190 μm

Time for the peel-off area
to become 15%
(recoating time judgment ③)

=

For CORSPACE, approximately twice
that of conventional steel

CORSPACE

Examples of applications



Kesennuma Bay Crossing Bridge



Yodogawa Bridge on National Route 2 (Deck Slab Replacement)



Makiminato Elevated Bridge (Okinawa Prefecture)



Hanshin Expressway Sambo JCT



Higashi-Harima Nanboku Road (Mizuashi Shintsuji No. 5 Viaduct)



Unloader

Breakdown by order of CORSPACE bridges (calculated by us) as of the end of March 2024

● Ministry of Land, Infrastructure, Transport and Tourism (Regional Development Bureaus, Hokkaido Regional Development Bureau)	
	: 51 cases (Chubu: 20 cases, Tohoku: 15 cases, Kinki: 6 cases, Kyushu: 4 cases, Hokuriku: 3 cases, Kanto: 2 cases, Hokkaido: 1 case)
● Okinawa General Bureau, Cabinet Office	: 2 cases
● Local governments, etc.	: 24 cases
● Road companies	: 4 cases
Total	: 81 cases

Bolt

■ Applicable sizes : M22 (Twist Off type)

Chemical Composition (Standard Values)

Chemical Composition (mass%)									
Material	C	Si	Mn	P	S	Cu	Ni	Mo, Sn	B
Development Metals	COR-BOLT	0.20-0.25	≤0.25	0.70-0.90	≤0.030	≤0.020	0.30-0.50	0.30-0.50	add
	COR-NUT								
	COR-BT								

*Contact information: **NIPPON STEEL BOLTEN CORPORATION** 4-16 Midorigi 1-chome, Suminoe-ku, Osaka-shi, Osaka Prefecture, 559-0022 JAPAN
TEL: 06 (6682) 3261 FAX: 06 (6682) 3270

Weld material

We are offering various types of weld material that correspond to the grades of CORSPACE at NIPPON STEEL WELDING & ENGINEERING CO.,LTD.*

Exclusive weld material for CORSPACE

Steel type	Coated electrode	Solid wire	Wire with flux		Submerged arc weld material	
	All position		All position	Fillet	*Butt	Fillet
SS400 -CORSPACE SM400 -CORSPACE SM490 -CORSPACE SM490Y -CORSPACE SBHS400 -CORSPACE	L-55・PX	YM-26・PX	SF-1・PX	SM-1F・PX	YF-15 × Y-D・PX	YF-800 × Y-D・PX
SM520 -CORSPACE	—	YM-55C・PX	—	—	YF-15B × Y-DM3・PX	NF-820 × Y-D・PX
SM570 -CORSPACE SBHS500 -CORSPACE	L-60・PX	YM-60C・PX	SF-60・PX	SM-60F・PX	YF-15B × Y-DM・PX	NF-820 × Y-DM・PX

*If you are considering welding with heat input exceeding 7 kJ/mm, please inquire in advance.

Example of performance of deposit metal of exclusive weld material for CORSPACE

Brand	Chemical component (%)								Tensile performance		Impact performance	
	C	Si	Mn	P	S	Ni	Mo	Sn	Proof stress (MPa)	Tensile strength (MPa)	Temperature (°C)	vE (J)
L-55・PX	0.07	0.61	1.10	0.012	0.003	—	—	Add	503	607	-30	145
L-60・PX	0.07	0.56	1.07	0.010	0.006	0.70	0.24	Add	612	700	-20	126
YM-26・PX	0.08	0.39	0.97	0.005	0.011	—	—	Add	483	571	0	133
YM-55C・PX	0.06	0.46	1.02	0.004	0.010	—	0.22	Add	521	606	0	140
YM-60C・PX	0.05	0.48	1.06	0.004	0.010	—	0.23	Add	554	629	-5	127
SF-1・PX	0.06	0.44	1.19	0.013	0.006	—	—	Add	539	612	0	136
SM-1F・PX	0.05	0.54	1.46	0.018	0.014	—	—	Add	510	597	0	64
SF-60・PX	0.05	0.55	1.57	0.011	0.006	0.53	—	Add	595	665	-5	78
SM-60F・PX	0.05	0.57	1.80	0.014	0.010	—	—	Add	567	642	-5	81
YF-15 × Y-D・PX	0.07	0.45	1.54	0.016	0.006	—	—	Add	511	601	0	93
YF-800 × Y-D・PX	0.04	0.68	1.55	0.009	0.011	—	—	Add	415	534	0	49
YF-15B × Y-DM3・PX	0.08	0.31	1.76	0.013	0.006	—	0.21	Add	553	648	0	108
NF-820 × Y-D・PX	0.05	0.63	1.88	0.007	0.011	—	—	Add	478	588	0	81
YF-15B × Y-DM・PX	0.08	0.31	1.70	0.013	0.005	—	0.37	Add	595	699	-20	67
NF-820 × Y-DM・PX	0.06	0.59	1.81	0.005	0.011	—	0.40	Add	564	662	-5	70

*Contact information: **NIPPON STEEL WELDING & ENGINEERING CO.,LTD.**

Shingu Bldg., 4-2 Toyo 2-chome, Koto-ku,
Tokyo, 135-0016 JAPAN
TEL: 03 (6388) 9000 FAX: 03 (6388) 9160
www.weld.nipponsteel.com/en/



■ Mechanical Properties (Standard Values)

Bolts

Mechanical Properties of Test Pieces

Class by Mechanical Property	Yield strength N/mm ²	Tensile Strength N/mm ²	Elongation %	Reduction of area %
S10TCR	900 ≤	1000 ~ 1200	14 ≤	40 ≤

Nuts

Class by Mechanical Property	Hardness	Guaranteed load
F10CR	20 ~ 35HRC	Same as minimum tension load of bolt

Mechanical Properties of Bolts

Class by Mechanical Property	Minimum tension load kN	Hardness
	M22	
S10TCR	303	27 ~ 38HRC

Note, The figure in the table shows the minimum tension load that can withstand up to the bolt fracture when the tension test is conducted by inserting the wedge into the bearing surface of bolt and on the condition of no breakage of bolt head.

Washers

Class by Mechanical Property	Hardness
F35CR	35 ~ 45HRC