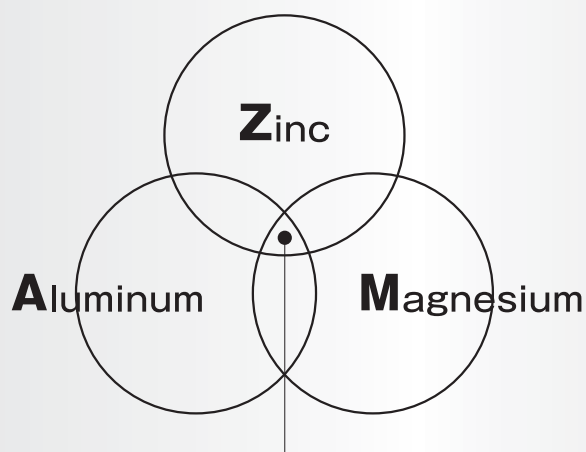


Nisshin Steel Quality Products



**ZAM®** is a highly corrosion-resistant hot-dip coated steel sheet that has a coating layer of zinc, 6% aluminum, and 3% magnesium.

# 1 What is **ZAM**® ?

## What is **ZAM**® ?

ZAM® is a highly corrosion-resistant hot-dip Zinc-Aluminum-Magnesium alloy coated steel sheet that Nisshin Steel has succeeded in launching on the market for the first time in the world.

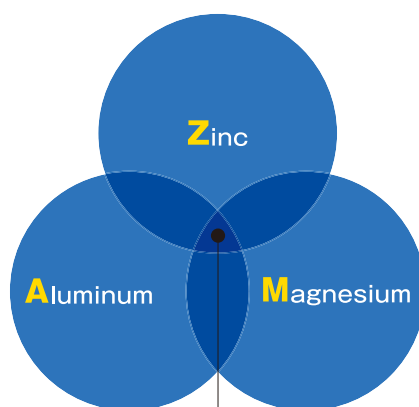
Due to the effects of magnesium and aluminum, ZAM® has excellent corrosion resistance, scratch resistance as well as formability, and can be applied in a wide range of fields.

Nisshin Steel has provided not only steel products but also various solutions for our customers.

We aim to create new market opportunities along with supplying high-value-added products, which we have developed with our advancing technologies based on our worldwide research and development.

ZAM® is a registered trademark of Nisshin Steel Co., Ltd.  
Patents have been registered for the product and its manufacture.

# Nisshin Steel Quality Products



**ZAM**® is a highly corrosion-resistant hot-dip coated steel sheet that has a coating layer of zinc, 6% aluminum, and 3% magnesium.

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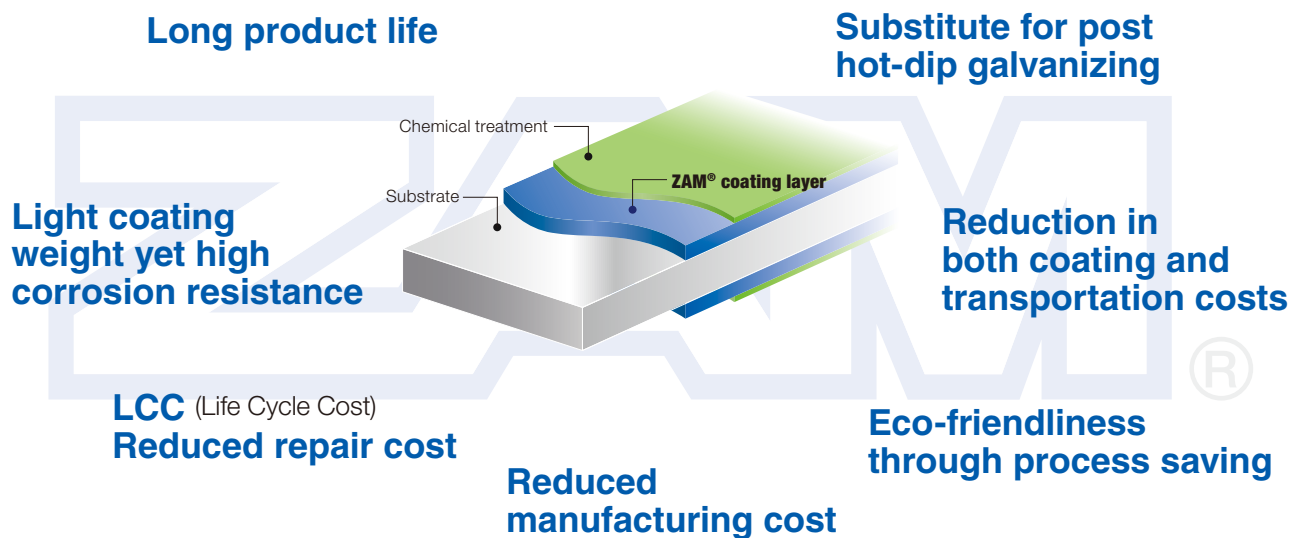
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# 1 What is ZAM® ?



■ A new hot dip coated steel sheet that has a coating layer of zinc, 6% aluminum, and 3% magnesium.

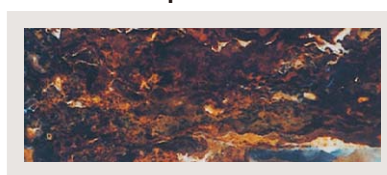
## Superior corrosion resistance - 1

In terms of corrosion resistance, ZAM® is 10 to 20 times better than hot-dip zinc-coated steel sheets\*<sup>1</sup> and 5 to 8 times better than hot-dip zinc-5%aluminum alloy coated steel sheets\*<sup>2</sup>.

\*1, \*2: Estimated by salt spray test

### ■ Comparison of corrosion resistance of flat sections

Hot-dip zinc-coated



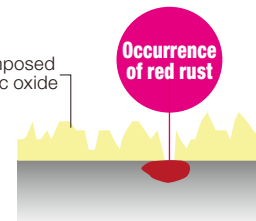
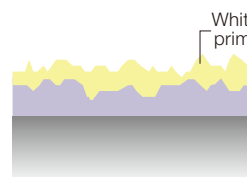
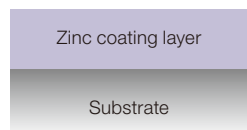
ZAM®



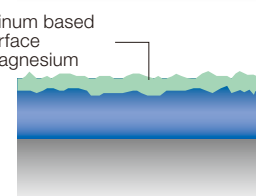
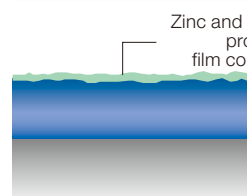
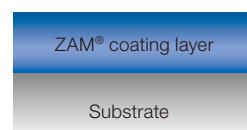
● After 2,500 hours of salt spray test, the surface appearances of the samples were compared (coating weight: 90/90 g/m<sup>2</sup>).

### ■ Corrosion mechanisms of flat sections

Hot-dip zinc-coated



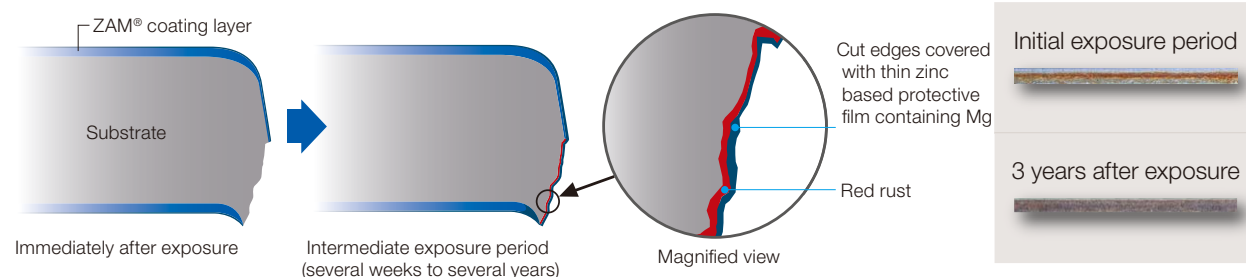
ZAM®





## Superior corrosion resistance - 2

Excellent corrosion resistance is achieved on cut edge of ZAM® with a fine zinc-based protective film that contains Al and Mg leaching from the coating layer.



## Superior press formability

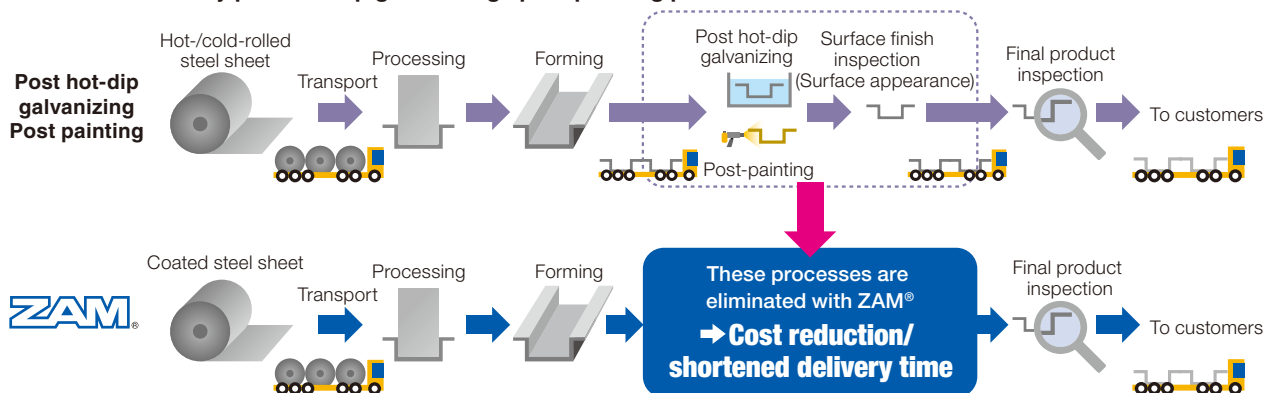
With a harder and smoother coating layer than hot-dip zinc-coated steel sheets, ZAM® shows excellent press formability contributing to higher productivity.

### Comparison in drawing properties



## Cost reduction through eliminating post hot-dip galvanizing process.

### Cost reduction by post hot-dip galvanizing / post painting process omission



ZAM® can contribute to reducing costs significantly - for instance, it enables initial cost reduction through process omission and life cycle cost reduction thanks to its superior corrosion resistance.

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# 2 Production process

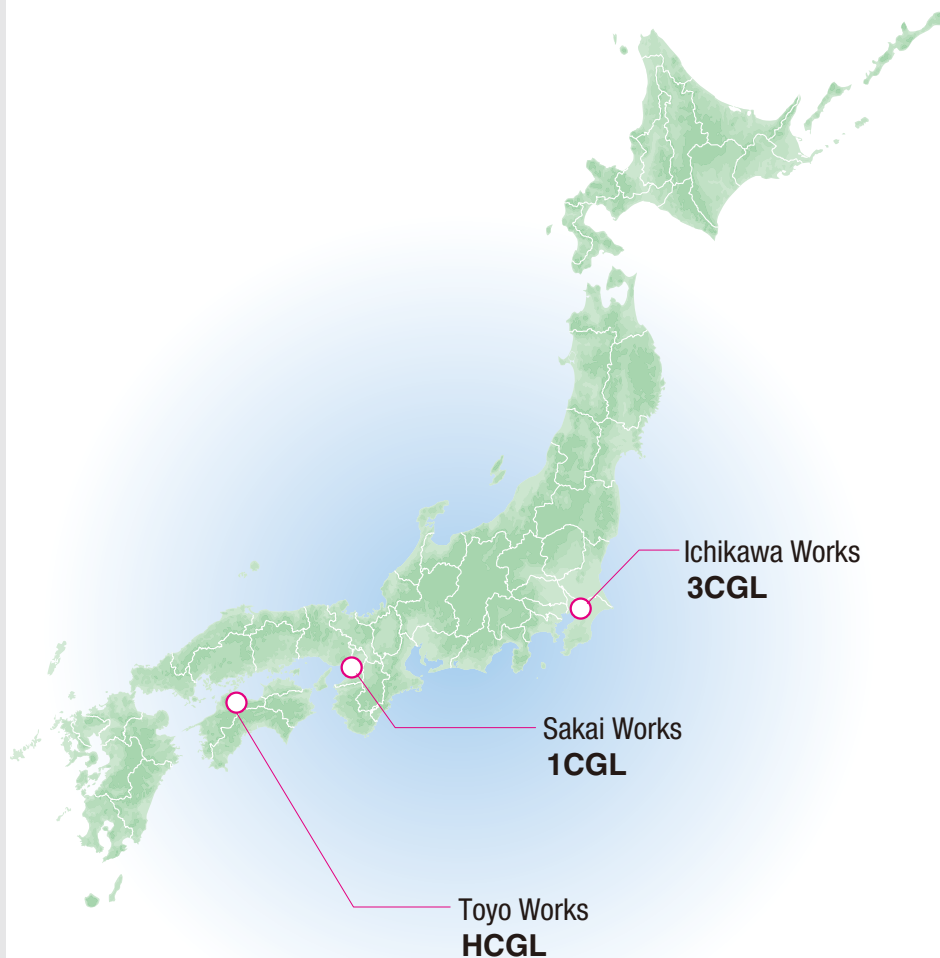
## Production bases

### ZAM® is

produced with HCGL in Toyo Works (Ehime), 1CGL in Sakai Works (Osaka), and 3CGL in Ichikawa Works (Chiba).

### Production range

	Sheet thickness (mm)
Toyo Works	0.8 - 6.0
Sakai Works	0.25 - 1.2
Ichikawa Works	0.25 - 2.3



#### Toyo Works

962-14 Hojo, Saijo-City,  
Ehime, 799-1354 Japan



#### Sakai Works

5 Ishizunishimachi, Nishi-ku, Sakai-City,  
Osaka, 592-8332 Japan



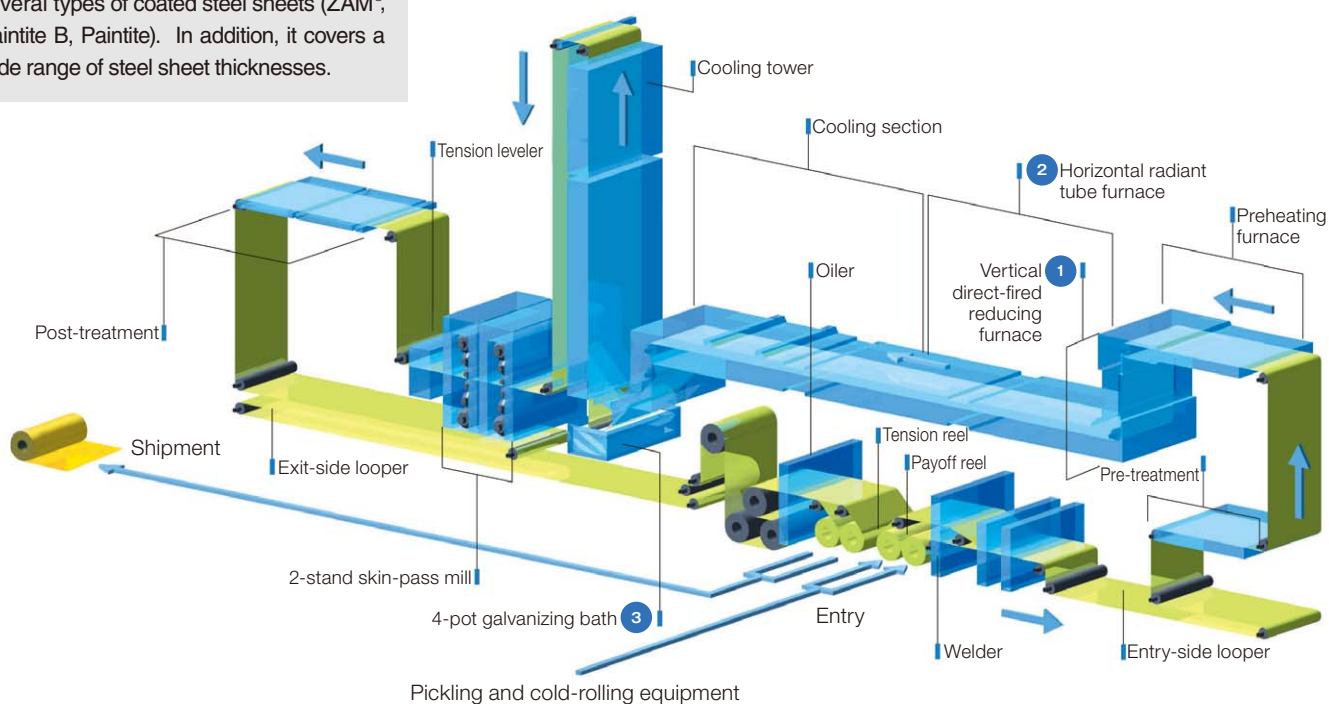
#### Ichikawa Works

7-1 Koyashinmachi, Ichikawa-City,  
Chiba, 272-0011 Japan

## ZAM® production line

### Toyo Works HCGL (hot dipping line)

In this hot dipping line (HCGL), a vertical direct-fired reducing furnace and a horizontal radiant tube furnace are combined to achieve improvement in both annealing furnace operation and product quality. Incorporating four pots, this production line is capable of making several types of coated steel sheets (ZAM®, Paintite B, Paintite). In addition, it covers a wide range of steel sheet thicknesses.



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1

**HCGL annealing furnace  
(Vertical direct-fired reducing furnace)**



2

**HCGL annealing furnace  
(Horizontal radiant tube furnace)**



3

**Galvanizing pot**

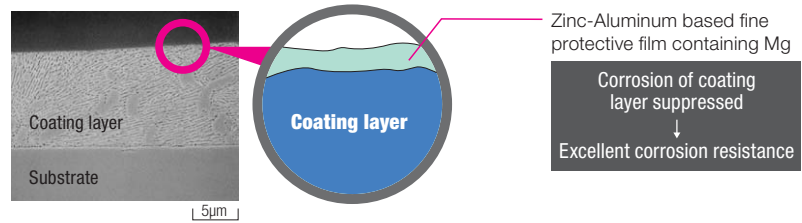


# 3 Quality characteristics

## Corrosion resistance mechanism of ZAM®

### Mechanism of corrosion resistance on flat section

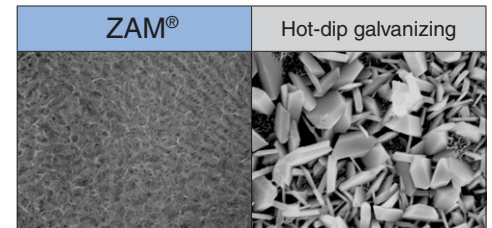
Al and Mg in the coating layer of ZAM® combine to form a fine, tightly adhered zinc-based protective film on its coating surface as time passes. This protective film suppresses corrosion of the ZAM® coating.



● Galvanized coating layer also forms a protective film on the surface. This protective film, however, is not as fine as in ZAM®, and less adhesive (see photo at right). In contrast, the protective film formed on the coating surface of ZAM® is excellent in both fineness and adhesion, and consequently it inhibits permeation of corrosion factors, preserving high corrosion resistance over a long period.

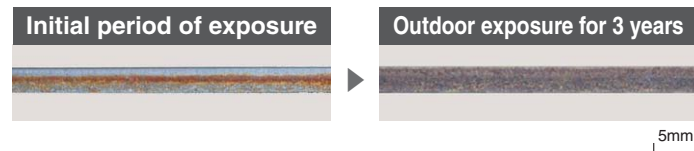
### Protective film formed on the coating surface after salt spray test (4 hours)

(Thickness: 0.8 mm, coating weight: 90/90 g/m², untreated)



### Mechanism of corrosion resistance on cut edge

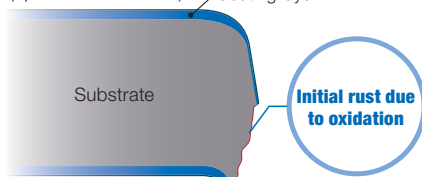
Excellent corrosion resistance is achieved on cut edge parts by covering the ends with a fine zinc-based protective film that contains Al and Mg leaching from the coating layer.



(Thickness: 3.2 mm, coating weight: 150/150 g/m², post-treatment: chromate 50 mg/m²)

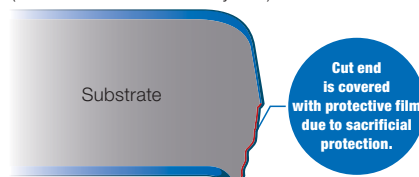
Note: The color and the speed of change in color depend on sheet thicknesses and exposure environments (region, installation location, aspect, etc.).

#### Initial exposure period (up to several weeks)



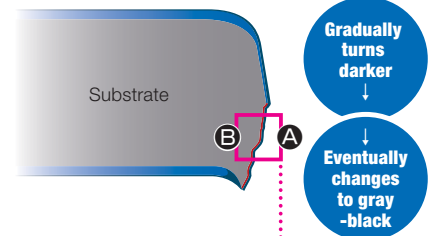
The exposed cut edge of substrate is oxidized due to rain, condensation, etc.

#### Intermediate exposure period (several weeks to several years)



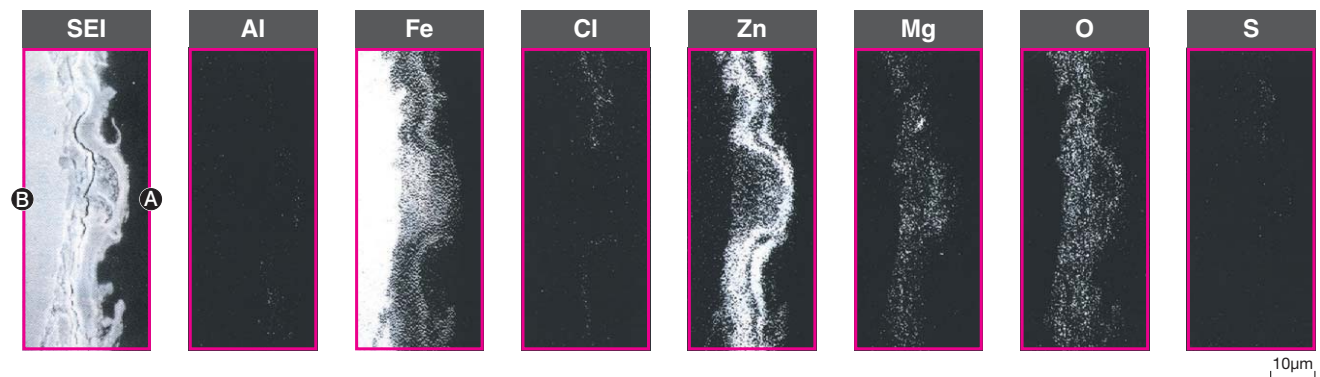
The fine zinc-based protective film containing Mg covers the cut edge with leaching of Zn, Al, and Mg from the coating layer.

#### Long exposure period



### Cross-sectional structure and distribution of elements formed on cut edges after 18 months of outdoor exposure test

(Thickness: 2.3 mm, coating weight: 130/130 g/m², post-treatment: chromate 50 mg/m²)

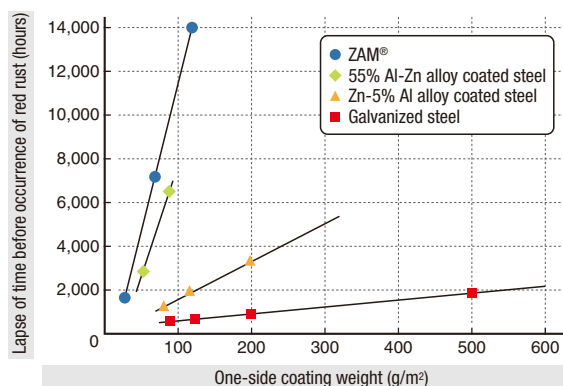


# Comparison of properties with various types of coated steel sheets

## Corrosion resistance on flat parts

ZAM® has better resistance to red rust than galvanized and hot-dip zinc-5% aluminum alloy coated steel sheets.

Red rust occurrence after salt spray test (untreated)



## Corrosion resistance on cut edge

ZAM® shows better red-rust resistance (durability) on cut edge than any other coated steel sheet.

Appearances of cut edges after salt spray test

(Thickness: 3.2 mm, coating weight: 120/120 g/m², untreated)

Lapse of time	100h	1,000h	5,000h
ZAM®			
55% Al-Zn alloy coated steel			
Zn-5% Al alloy coated steel			
Galvanized steel			

Results of salt spray test (SST: JIS Z 2371)  
Appearances of specimens after salt spray test

(Coating weight: 90/90 g/m², untreated)

Lapse of time	500h	1,200h	2,500h
ZAM®			
55% Al-Zn alloy coated steel			
Zn-5% Al alloy coated steel			
Galvanized steel			

Red rust occurred.

Red rust occurred.

10mm

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# 3 Quality characteristics

## Comparison of properties with various types of coated steel sheets

### Change in the appearance of cut edge during outdoor exposure test

The cut edge of ZAM® will be covered with a protective film and change to a subdued color as time passes.

Appearances of cut edge sections after outdoor exposure test (testing location: seaside industrial area in Sakai)

(Thickness: 2.3 mm, coating weight: 90/90 g/m<sup>2</sup>, chromate treatment: 50 mg/m<sup>2</sup>)

Lapse of time	After 2 weeks	After 3 months	After 6 months
ZAM®			
55% Al-Zn alloy coated steel			
Zn-5% Al alloy coated steel			
Galvanized steel			

### Corrosion resistance of bent sections

ZAM® shows better corrosion (red-rust) resistance even in bent sections than any other coated steel sheets.

Appearances of 1t bent section after salt spray test

(1t, 180° bending, thickness: 3.2 mm, 120/120 g/m<sup>2</sup>, untreated)

Lapse of time	100h	1,000h	4,000h
ZAM®			
55% Al-Zn alloy coated steel			
Zn-5% Al alloy coated steel			
Galvanized steel			

5mm

### Change in appearance at bent section during outdoor exposure test

ZAM® shows almost no change in appearance at the bent section.

Appearances of 1t bent section after outdoor exposure test

(1t, 180° bending, thickness: 3.2 mm, 120/120 g/m<sup>2</sup>, untreated)

Lapse of time	30 days	90 days
ZAM®		
55% Al-Zn alloy coated steel		
Zn-5% Al alloy coated steel		
Galvanized steel		

10mm

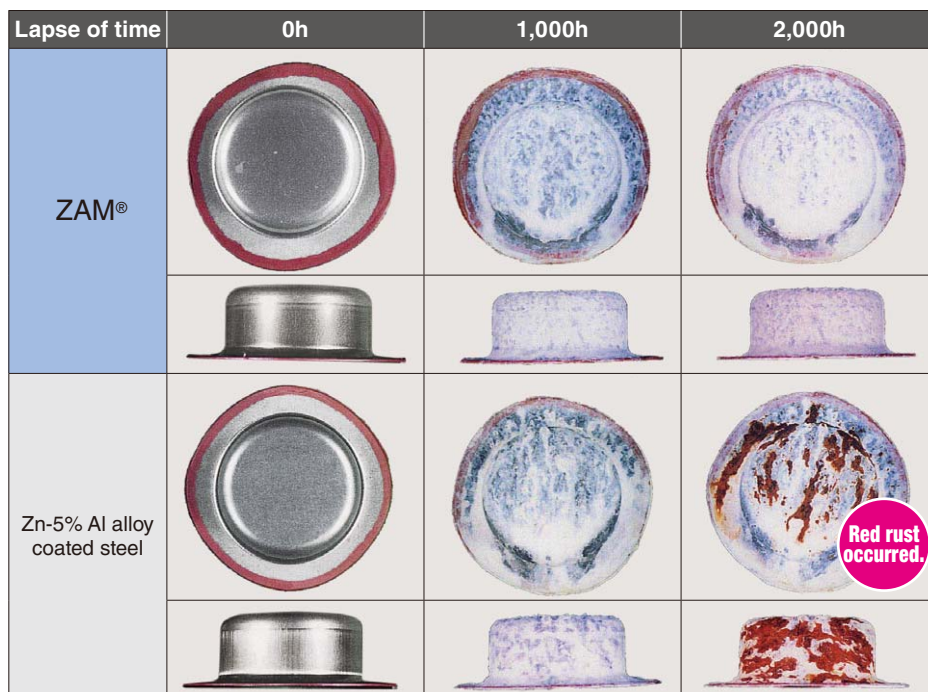


## Corrosion resistance of drawn sections

ZAM® shows better corrosion resistance on drawn parts compared to hot-dip zinc-5% aluminum alloy coated steel sheets.

### Appearances of drawn parts after salt spray test

(drawing height: 25 mm, thickness: 0.8 mm, coating weight: 70/70 g/m<sup>2</sup>, untreated)



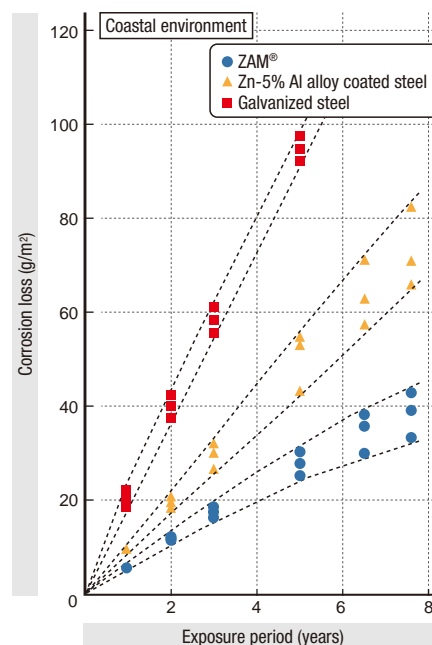
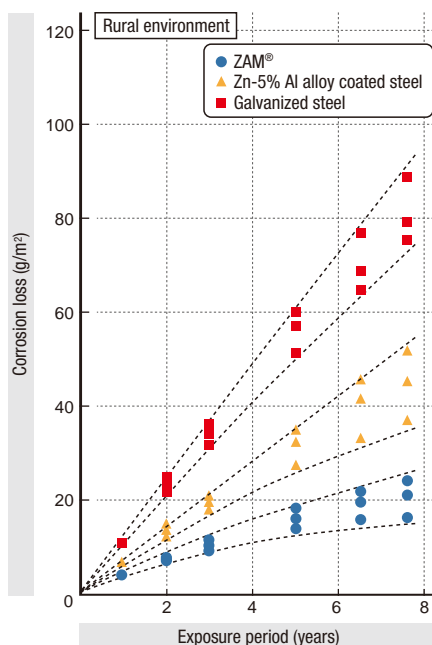
## Outdoor exposure test results

### Corrosion loss of coating layers after outdoor exposure test

ZAM® shows approximately four times higher corrosion resistance than hot-dip zinc-coated (according to the results of 8 years of exposure test)

#### Outdoor exposure test site

	Exposure site
Rural environment	Kyiryu-City, Gunma
Coastal environment	Nakagusukuson, Okinawa (approx. 30m from the seashore)



# 3 Quality characteristics

## Chemical resistance

### Acid/alkali resistance

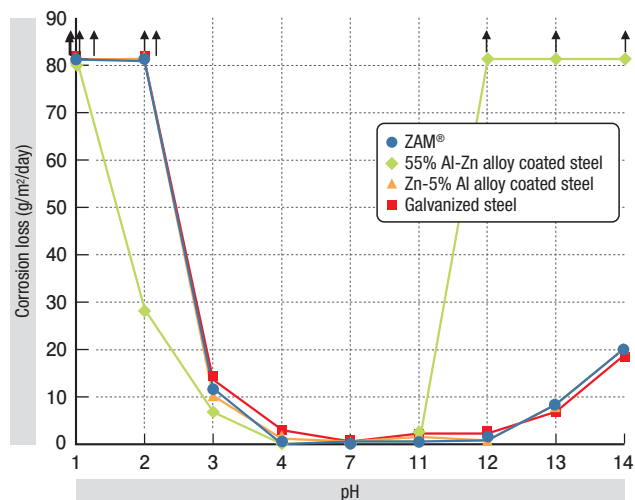
In acidic and alkaline aqueous solutions, ZAM® shows the same corrosion behavior as other zinc-based coated steel sheets.

#### Test method

- Solution: Starting with an aqueous solution containing 1 g/L  $\text{Na}_2\text{SO}_4$  as the base mix, its pH was varied from 1 to 14 by adding  $\text{H}_2\text{SO}_4$  on the acidic side and  $\text{NaOH}$  on the alkaline side.
- To determine corrosion loss test pieces ( $n = 3$ ) were immersed for 24 hours in a solution adjusted to each pH at 30°C, and the corrosion loss was determined. The cut edges and bottom surfaces of the test pieces were sealed.

Corrosion weight losses of coated steel sheets in acidic and alkaline aqueous solutions

(Thickness: 2.3 mm, coating weight: 80/80 g/m<sup>2</sup>, untreated)



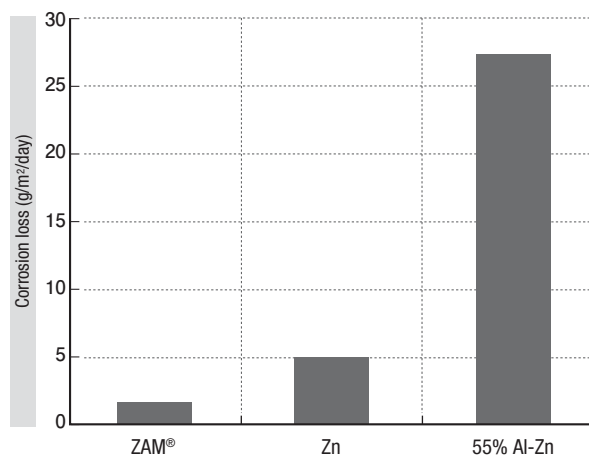
### Ammonia resistance

ZAM® shows better resistance to ammonia than hot-dip zinc-coated and hot-dip 55% aluminum-zinc alloy coated steel sheet

#### Test method

After immersion for 24 hours in 5% ammonia water at 22°C, the corrosion loss of each test pieces were measured. The cut edges and bottom surfaces of the test pieces were sealed.

Corrosion weight loss of coated steel sheets in ammonia water

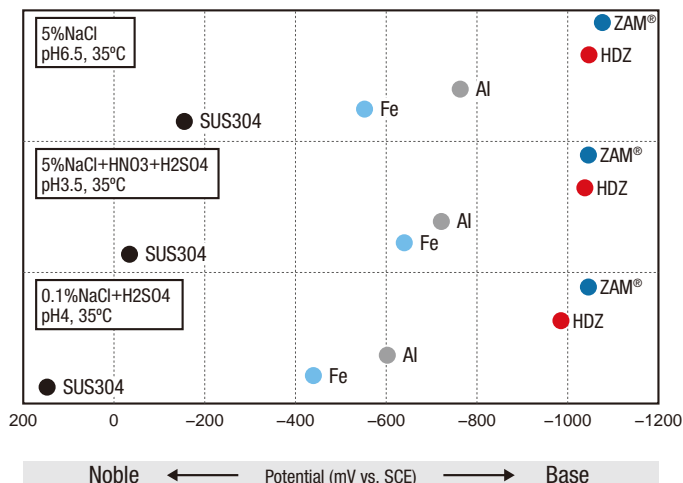




# Corrosion potential

ZAM<sup>®</sup> and post hot-dip galvanized product (HDZ) show nearly the same level of corrosion potential.

Corrosion potential in different solutions (after immersion for an hour)



Corrosion potential test solutions

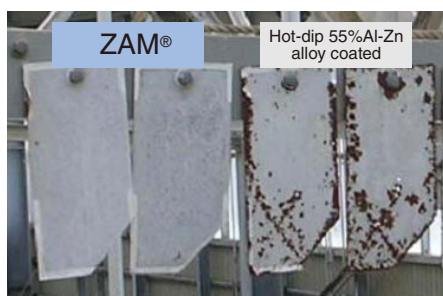
Solution	pH	Temperature (°C)	Remarks
5% NaCl	6.5	35	Solution specified in JIS Z2371 (salt spray test)
5% NaCl + HNO <sub>3</sub> + H <sub>2</sub> SO <sub>4</sub> <sup>*1</sup>	3.5	35	Solution specified in JIS H8502 (cyclic artificial acid rain test)
0.1% NaCl + H <sub>2</sub> SO <sub>4</sub> <sup>*2</sup>	4	35	Solution specified in acid rain simulated combined-cycle corrosion test (see page 14)

Measurement was taken after the specimen was immersed in water solution for an hour and its corrosion potential was found fairly stable.

\*1: 5% NaCl (10 L) + HNO<sub>3</sub> (12 mL) + H<sub>2</sub>SO<sub>4</sub> (17.3 mL), pH adjusted by NaOH

\*2: H<sub>2</sub>SO<sub>4</sub> is added to 0.1% NaCl solution to adjust pH to 4.

## <Reference> Results of exposure test in a closed compost house (5 years)



Exposure test in a compost house (Shibetsu-City, Hokkaido)

ZAM<sup>®</sup> showed better corrosion resistance than hot-dip 55%Al-Zn alloy coated sheet.  
(No red rust occurred in any of the flat sections bent sections, and cut edges.)



	Flat part	2t bent sections	Cut edge
ZAM <sup>®</sup> K27 ZG treatment			
Hot-dip 55%Al-Zn alloy coated AZ150 Organic chromate treatment			

# 3 Quality characteristics






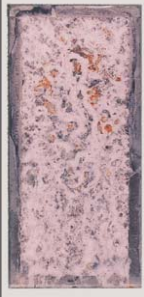


## Results of corrosion resistance comparison with post hot-dip zinc-coated steel sheets

### Corrosion resistance comparison with post hot-dip zinc-coated steel sheets (HDZ55: JIS H8641)

With only 1/6 of the coating weight of post hot-dip zinc-coated steel sheets, ZAM® exhibits corrosion resistance equal to or better than theirs. The following examination certifications admit that ZAM® may replace post hot-dip galvanized steel. (see page 39).









- Construction technology examination certification (building technology) Building Center of Japan
- Construction technology examination certification Public Works Research Center

Appearances of flat parts after salt spray test

Lapse of time	500h	1,000h	2,000h	4,000h
<b>ZAM®</b> Thickness: 2.3 mm 90/90 g/m <sup>2</sup>				
Post hot-dip galvanized product (HDZ55) Thickness: 2.3 mm 560/560 g/m <sup>2</sup>				

20mm

Appearances of cut edges after salt spray test

Lapse of time	500h	1,000h	2,000h	4,000h
<b>ZAM®</b> Thickness: 2.3 mm 90/90 g/m <sup>2</sup>				
Post hot-dip galvanized product (HDZ55) Thickness: 2.3 mm 560/560 g/m <sup>2</sup>				

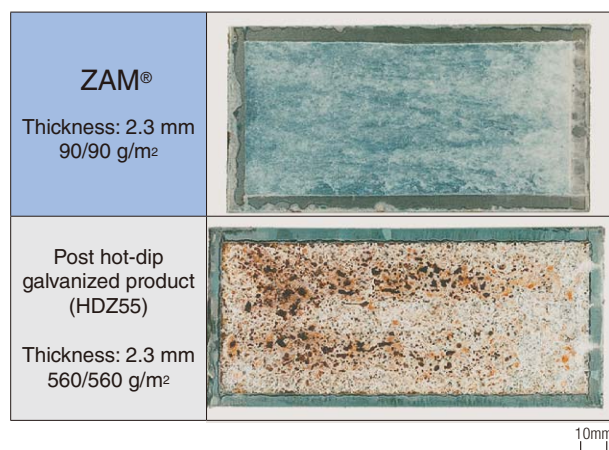
5mm

\*Post hot-dip products are first cut to shape and then coated.

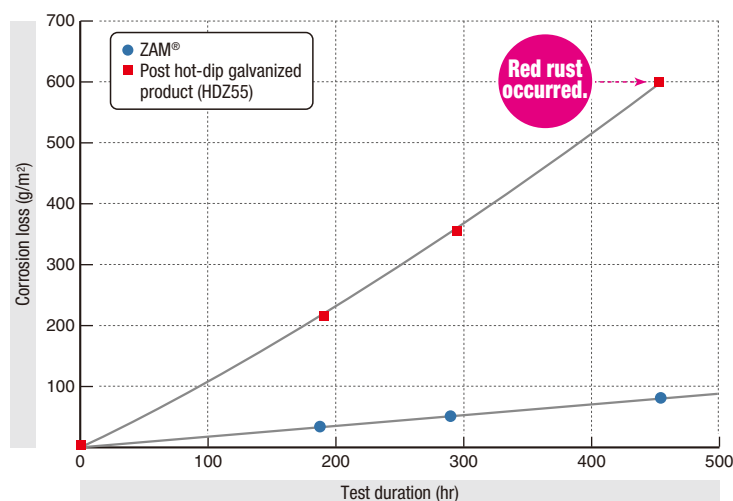
## Corrosion resistance comparison in a sulfur dioxide environment

ZAM® shows better corrosion resistance compare to post hot-dip zinc-coated steel sheets (HDZ55) in a sulfur dioxide (sulfurous acid gas) environment.

### Appearances after 450 hours of sulfur dioxide test



### Corrosion loss of ZAM® and post hot-dip galvanized product in sulfur dioxide test



#### Test conditions

Sulfur dioxide concentration: 100 ppm  
 Testing temperature: 40°C  
 Relative humidity: 98% or more

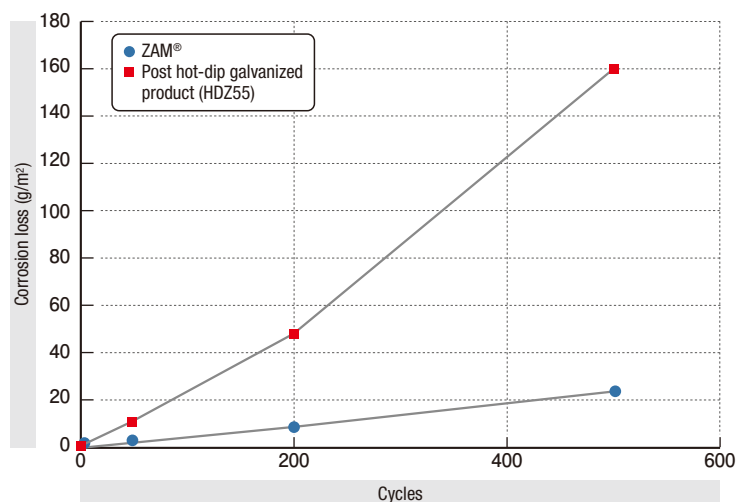
## Corrosion resistance comparison in acid rain simulated combined-cycle corrosion test

ZAM® shows better corrosion resistance compare to post hot-dip zinc-coated steel sheets (HDZ55) in an acid rain environment.

#### Test conditions

Acid rain simulated solution spraying 1 hr, 35°C, pH:4  
 (0.1%NaCl+H<sub>2</sub>SO<sub>4</sub>)  
 ↓  
 Drying 4 hrs, 50°C, relative humidity: 30%  
 ↓  
 Moistening 3 hrs, 50°C, relative humidity: 98%

### Corrosion loss of ZAM® and post hot-dip galvanized product in acid rain simulated combined-cycle corrosion test



### Corrosion rates of ZAM® and post hot-dip galvanized product in acid rain simulated combined-cycle corrosion test

	Corrosion rate
<b>ZAM®</b> 90/90 g/m <sup>2</sup> , untreated	0.05 g/m <sup>2</sup> /cycle
Post hot-dip galvanized product 560/560 g/m <sup>2</sup> , untreated	0.32 g/m <sup>2</sup> /cycle

Note: Mean value during 500 cycles

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# 3 Quality characteristics

## Comparison in characteristics with post galvanized (Electrogalvanized) and after-painted (cathodic electrodeposition coating) products

### Results of combined-cycle corrosion tests of flat parts and cut edges

ZAM® shows better corrosion resistance than post hot-dip galvanized and after-painted products.

#### Test conditions

JASO M609-91



















Salt spray 2 hrs, 35°C, 5%NaCl

Drying 4 hrs, 60°C, relative humidity: 30%

Moistening 2 hrs, 50°C, relative humidity: 95%

### Appearances of flat parts and cut edges after combined-cycle corrosion test

Thickness: 2.3 mm

	Before test		60 cycles		120 cycles	
	Flat section	Cut edge	Flat section	Cut edge	Flat section	Cut edge
ZAM® 90/90 g/m <sup>2</sup> ZC treatment						
Post galvanized (Electrogalvanized) 100/100 g/m <sup>2</sup> Chromate 100 mg/m <sup>2</sup>						
Post-painted (Cathodic electrodeposition coating) Film thickness: 15μm						

\*Post galvanized and post-painting were also provided on the cut edges.


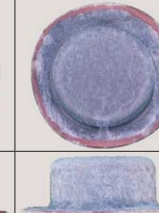
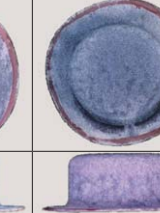

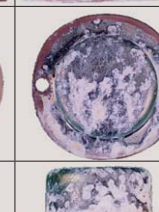
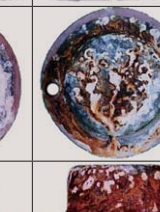
Red rust occurred

### Results of combined-cycle corrosion tests of drawn section

Drawn sections of ZAM® exhibit better corrosion resistance than those of post galvanized steel (galvanized after processing).

### Appearances of drawn section after combined-cycle corrosion test

Drawing height: 25 mm, thickness: 0.8 mm

	Before test	60 cycles	120 cycles
ZAM® 90/90 g/m <sup>2</sup> ZC treatment			
Post galvanized (Electrogalvanized) 100/100 g/m <sup>2</sup> Chromate 100 mg/m <sup>2</sup>			

\*Post galvanizing was conducted after processing. The cut edges were sealed.



## Post-paintability

### Results of corrosion tests of painted materials

ZAM® is superior to other coated steel sheets in terms of corrosion resistance after painting.

#### Test conditions

- ①SST: JIS Z2371 (neutral salt spray test)  
35°C, continuous spraying with 5% NaCl
- ②CCT: JASO M609-91  
(combined-cycle corrosion test)  
SST (2 hrs) → Drying (4 hrs) → BBT (2 hrs)

Material tested: Untreated material of each coated steel sheet

Pre-treatment: Zinc phosphate treatment (PALBOND 138)

Paint: Acrylic resin Super Lac F-50  
Film thickness: 30 µm

Appearances of coated materials after corrosion test (cross cut sections)

	SST 500h	CCT 62 cycles
ZAM®		
Zn-5% Al alloy coated steel		
Galvanized steel		

#### • Precautions

- (1) As with Hot-dip Zn-5%Al alloy coated, it is recommended to control the concentrations of treatment solutions because aluminum contained in the coating layer dissolves into pre-treatment (zinc phosphate treatment) solutions and lessens their effects.
- (2) The above painting data is an example. It is recommended that each customer test and check the paintability beforehand.
- (3) When chemically-treated substrate is used, application of adequate primer is recommended.

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# 3 Quality characteristics

## Weldability

As with other zinc-based coated steel sheets, weldability of ZAM® is affected by its coating layer which is a metal with a low melting point. In arc welding, ZAM® is more susceptible to spatters, blow holes, crack-induced decline in joint strength and other defects than hot-rolled and cold-rolled steel sheets. However, ZAM® can be welded into joints with adequate strength under proper conditions. Even in spot welding, adequate strength can be obtained under proper conditions. Since factors including types of welding machines and shapes of joints influence the quality of welds, tests should be carried out beforehand to establish optimal welding parameters and procedures. If you have any questions, please feel free to contact us.

\*In arc welding, high tensile stress may be caused around the weld beads depending on shapes and compositions of materials and procedures. When zinc coated steel sheets including ZAM® are welded, coating layer melted by the heat of welding may penetrate the grain boundary and cause cracks in the zones affected by such high tensile stress.

### Arc welding

#### 1. Welding machine

ZAM® can be welded with a off-the-shelf welding machine. Welding environment can be improved with the use of inverter-controlled welding machines developed by equipment manufacturers to reduce spatters.

#### 2. Welding wire

Welding wires for carbon steel and structural steel can be used. However, to reduce spatters, blow holes, pits, and other defects, it is advisable to use welding wires developed specially for galvanized steel. Recommended wires are shown on the right.

#### 3. Shielding gas

The third-class carbon dioxide stipulated in JIS K 1106 is used. (The combination of pulse current and Ar+20% CO<sub>2</sub> gas will tend to decrease spatters to a greater extent.)

#### 4. Welding current and voltage

When welding ZAM® at the same speed as in the case of hot- or cold-rolled steel sheets, the initial welding temperature should be set slightly higher as more heat is absorbed by the evaporation of coating material (current to be raised by 5%-10%).

#### 5. Welding speed

When such defects as blowholes or pits are found, the welding speed should be set lower than in the case of hot- or cold-rolled steel sheets. Good beads can be made if weld speed is slow enough to release zinc vapor from the surface of the molten metal pool.

#### 6. Installation of gaps

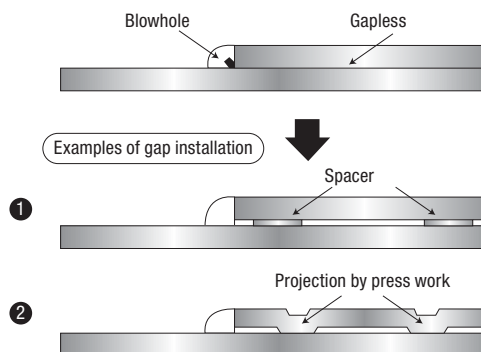
Lap fillet welding tends to cause such defects as blowholes or pits frequently. The most effective countermeasure is to set up gaps between steel sheets. A gap of 0.6 mm or wider helps substantially reduce these defects.

### Recommended welding wires for class 400N substrates

	Recommended welding wire brand (shielding gas: Carbon dioxide)
General-purpose wire	Kobe Steel: MG50T, Nippon Steel & Sumikin Welding Co., Ltd.: YM28, Daido Steel: DS1A, etc. (equivalent to YGW12)
Wire for coated steel sheets	Kobe Steel: MG1Z (G49A0C12), Nippon Steel & Sumikin Welding Co., Ltd.: YM28Z (G49A0C0), Daido Steel: DS1Z (equivalent to YGW12)
Flux-cored wire	Kobe Steel: DW-Z100 (T49J0TI-ICA-U), Neis: GC 2Z-2, etc., Nippon Steel & Sumikin Welding Co., Ltd.: SM-1 (T49J0T15-OCA-G-UH5), SM-1F (T49J0TI-OCA-UH5),

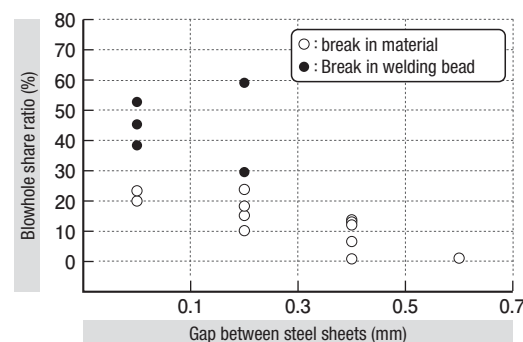
● Please consult us when welding wires for steel sheets other than class 400N are used.

### Examples of gaps for blowhole countermeasures (lap-fillet welded joint)



### Decrease of welding defects with gaps

(ZAM® Thickness: 2.3 mm, symbol; 90, lap-fillet welded joint)











## Spot welding


When a coated steel sheet is spot-welded, the energizing path expands due to melting of the coating layer, resulting in a decrease in electric current density. It is therefore necessary to use a greater welding current than in the case of cold-rolled steel sheets.


The zinc contained in the coating layer reacts with the copper alloy used for the electrodes, which causes the electrodes to wear rapidly, shortening their life. For this reason, grasp the life of the electrodes in advance and periodically dress or replace them.


Examples of spot welding conditions for various types of coated steel sheets

Type of steel sheet	Welding current (kA)												
	5	6	7	8	9	10	11	12	13				
ZAM® (60/60)													
Hot-dip zinc-coated (40/40)													
Zn-5% Al alloy coated steel sheet (75/75)													
Hot-dip 55%Al-Zn alloy coated sheet (60/60)													
Galvanealed steel sheet (40/40)													
Aluminized steel sheet (30/30)													
Cold-rolled steel sheet													

 Share fracture

 Optimum

 Expulsion

 Sticking

Test conditions

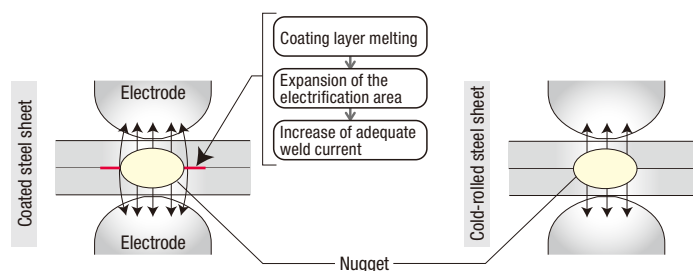
Electrode pressure : 200 kgf

Electrode tip shape: CF type, 6 mm in diameter

Weld time : 12 cycles

Thickness: 0.8 mm

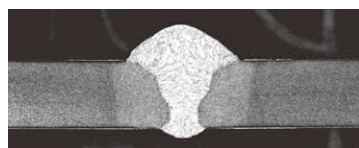
Spot welding of coated steel sheet (schematic)



## Quality of welds

To obtain defect-free joints with sufficient weld strength and a desirable internal sectional structure, it is essential to conduct welding under appropriate conditions.

Condition of an arc weld zone



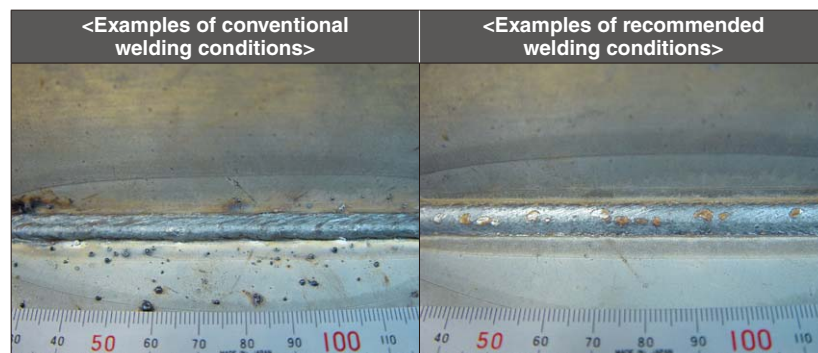
Sectional structure  
3.2 mm, coating weight: 145/145 g/m<sup>2</sup>

Condition of a spot weld zone



Sectional structure  
1.6 mm, coating weight: 70/70 g/m<sup>2</sup>

Photos of bead appearances



Conventional welding conditions  
Inverter type CO<sub>2</sub> arc welding machine  
Wire: YGW12  
Shielding gas: Carbon dioxide gas

Recommended welding conditions  
Pulse MAG welding machine  
Wire: YGW12  
Shielding gas: Ar + 20%CO<sub>2</sub>

Sputter and other problems can be prevented by conducting under appropriate conditions.

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# 3 Quality characteristics

## Corrosion resistance of weld zones

### Corrosion resistance of weld zones (as welded)



Generally, the heat affected area on coated steel by arc welding or spot welding reduces corrosion resistance because the coating layer is melted or vaporized. The welded portion on ZAM, however, is less likely to suffer from red rust than other types of coated steels.

Appearances of arc weld zones after salt spray test

Lapse of time	2,000h	4,000h
<b>ZAM®</b> Thickness: 2.3 mm 90/90 g/m <sup>2</sup>		
Zn-5% Al alloy coated steel Thickness: 2.3 mm 90/90 g/m <sup>2</sup>		

↑  
Weld beads

Appearances of spot weld zones after salt spray test

Lapse of time	Before test	2,000h	4,000h
<b>ZAM®</b> Thickness: 2.3 mm 90/90 g/m <sup>2</sup>			
Zn-5% Al alloy coated steel Thickness: 2.3 mm 90/90 g/m <sup>2</sup>			



## Touch-up painting (solvent)

A Zn-Al based paint is recommended for touch-up of weld zone and cut ends.

### Examples of touch-up paints

Paint name	Manufacturer	Type of paint	Color
Royal Silver	Royal Corporation	Zn-Al based	Silver
Zinky special	Nippon Paint Anti-corrosive Coatings Co., Ltd.	Zn-Al based	Silver
O-well Mekki Silver (ZAM® color)	Nihon Ruspert Co., Ltd.	Zn-Al based	Silver

#### Notes

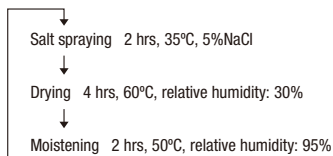
- Details of touch-up paints including their proper use, quality characteristics, and compatibility with environmental regulations should be checked with respective makers.
- In some cases, painting is not possible over touch-up paints. Be sure to check beforehand.

## Corrosion resistance of weld zones after touch-up

Satisfactory corrosion resistance can be obtained by touching up the weld zones in an appropriate manner.

### Test conditions

JASO M609-91



### Appearances of touch-up painted areas after combined-cycle corrosion test

Thickness: 2.3 mm, coating weight: 85/85 g/m<sup>2</sup>

Paint	Cycles			
	0	100	150	200
Zn based				
Zn-Al based				

### Sample of welding method

- Welding method: CO<sub>2</sub> arc welding
- Joint shape: Butt welding

### Painting method

- Pre-treatment: Wire brush
- Degreasing: Organic solvent
- Painting: Brushed on
- Drying: 60°C, 10 min
- Film thickness: Approx. 40 μm

## Corrosion resistance of cut edges after touch-up

Additional corrosion resistance can be obtained by touching up the cut edge.

### Appearances of touched-up cut edges after combined-cycle corrosion test

Thickness: 2.3 mm, coating weight: 85/85 g/m<sup>2</sup>

Paint	Cycles	
	100	200
Zn-Al based		

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## Touch-up painting

### Other touch-up items

Various methods of touch-up are available in addition to those with general solvent-based touch-up paints. (Before using any of the methods described in this section, necessary prior confirmation should be made by the user.)

#### ① Touch-up painting can be easily conducted without drying.

Item	Crayon containing Zn powder
Name	Zinc Rich Pen
Advantages	<ul style="list-style-type: none"> <li>Can be applied only to necessary areas.</li> <li>No drying is required.</li> </ul>
Distributor	Sanyu Chemical Industry Co., Ltd.



Zinc Rich Pen

#### Appearance after one year of exposure test

ZAM 150/150 g/m<sup>2</sup>, 6.0mm thick, Ichikawa-city, Chiba

#### Touch-up with Zinc Rich Pen



#### No touch-up



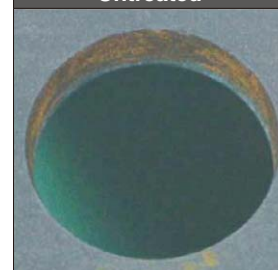
#### ② Even materials with many end faces can be easily touched up at one time.

Item	Phosphate solution for cut edge treatment
Name	ET Coat
Usage	Immersion (Brushing is also possible.)
Advantages	<ul style="list-style-type: none"> <li>Materials with many end faces can be touched up at one time by immersing them in this solution.</li> </ul>
Distributor	Sanyu Chemical Industry Co., Ltd.

#### Appearance after one month of exposure test

ZAM 70/70 g/m<sup>2</sup>, 6.0 mm thick, Sakai-city, Osaka

#### Untreated



#### With ET Coat



#### ③ Can be touched up in a color approximate to that of ZAM®

Item	ZAM - approximate color paint
Name	#6900 Silver
Usage	Spray
Advantages	<ul style="list-style-type: none"> <li>The color close to ZAM makes the touched-up area unnoticeable.</li> </ul>
Distributor	Daiho Paint Co., Ltd.

#### Comparison in appearance after touch-up

#### #6900 Silver



#### General touch-up paint



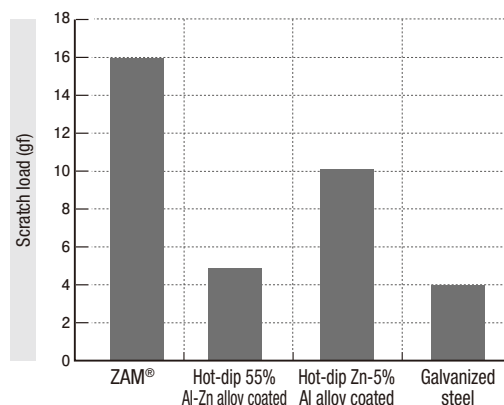
## Scratch resistance of the coating layer

ZAM® has a harder coating layer than hot-dip galvanized or aluminum-zinc alloy coated steel sheets. Thus, ZAM offers better scratch resistance and can be used in applications where it is subjected to scratching and repeated friction during processing.

### <Reference> Hardness of the coating layer (Vickers hardness (HV) measurement examples)

ZAM®	140 ~ 160
Hot-dip 55% Al-Zn alloy coated	100 ~ 110
Hot-dip Zn-5% Al alloy coated	80 ~ 100
Galvanized steel	55 ~ 65

Scratch resistance of various types of coated steel sheets (scratch test)

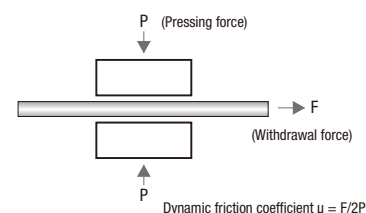
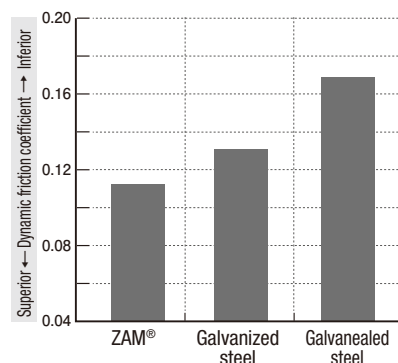


## Sliding characteristics/Workability

### Sliding characteristics

Having a coating layer with high surface hardness and smoothness, ZAM® exhibits superior sliding characteristics.

Dynamic friction coefficients of various types of coated steel



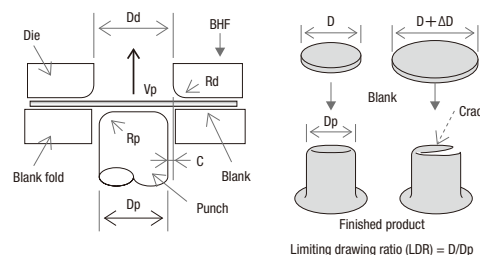
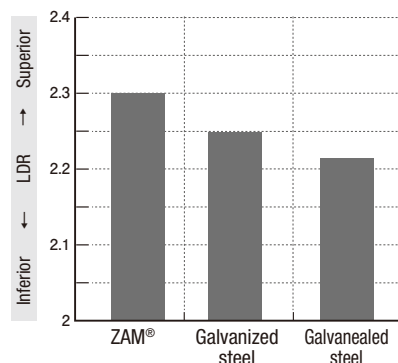
Sliding test conditions

Sample size	0.8 mm (thickness) x 30 mm (width) x 300 mm (length)
Press oil	Z5 (Idemitsu Kosan)
Pressing pressure	0.72, 1.45, 2.90N/mm²
Pressing force	1, 2, 4kN
Pressing area	46 × 30mm²
Withdrawal rate	1000mm/min
Mold surface roughness	#1000 (Polishing for each session)
Mold material	SKD11

### Workability

ZAM® has better drawing characteristics than other types of coated steel sheets.

Limiting drawing ratios (LDRs) of various types of coated steel sheets



Conditions for deep drawing test

Diameter of punch (Dp)	40mm
Diameter of die (Dd)	42mm
Shoulder radius of punch (Rp)	5mm
Shoulder radius of die (Rd)	5mm
Stroke speed (Vp)	60mm/min
Press forming oil	Z5 (Idemitsu Kosan)

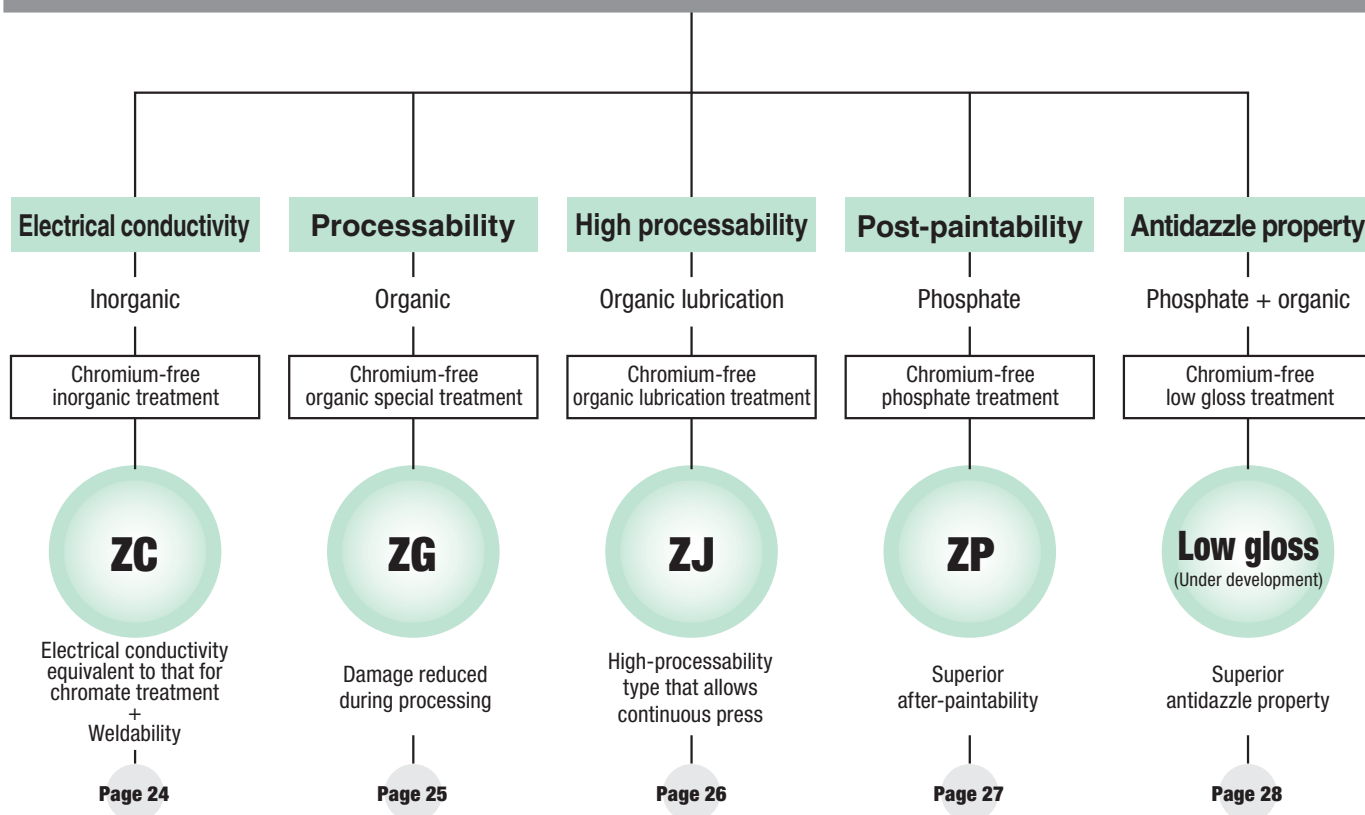
Samples

	Coating mass	Material	Post-treatment
ZAM®	70/70 g/m²	Deep drawing quality	ZC treatment
Galvanized steel	60/60 g/m²	Deep drawing quality	ZC treatment
Galvanealed steel	45/45 g/m²	Deep drawing quality	ZC treatment

# 4 Chromium-free treatment

## Five different types of chromium-free treatments

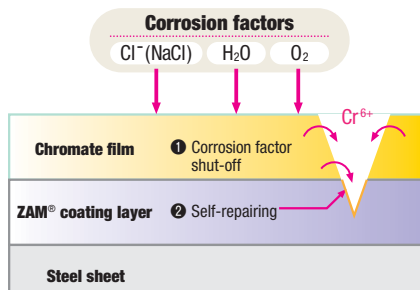
With the superior corrosion resistance of ZAM® maintained, five different types of chromium-free treatments are available to suit various applications. All of these treatments conform to the environmental regulations, including RoHS and ELV.



### ■ Anticorrosion mechanism of films

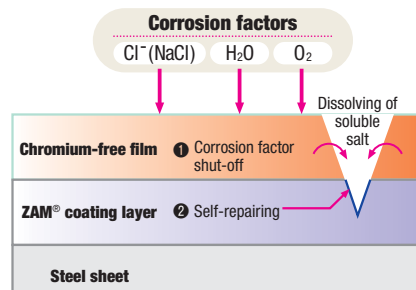
#### Mechanism of corrosion control by chromate film

- (1) Corrosion control with environmental deprivation
  - The chromate film covers the coating layer uniformly to prevent direct contact with corrosion factors.
- (2) Corrosion control with self-repairing function
  - If the chromate film is damaged due to processing for instance, hexavalent chromium dissolves in a moist environment to form an oxide film for self-repairing.



#### Mechanism of corrosion control by chromium-free film

- (1) Corrosion control with environmental deprivation
  - The chromium-free film covers the coating layer uniformly to prevent direct contact with corrosion factors.
- (2) Corrosion control by self-repairing function
  - If the chromium-free film is damaged due to processing for instance, soluble salt dissolves under a moist environment to form insoluble salt at the damaged area for self-repairing.



# ZC treatment Chromium-free inorganic treatment

Electrical conductivity

## ① Excellent electrical conductivity

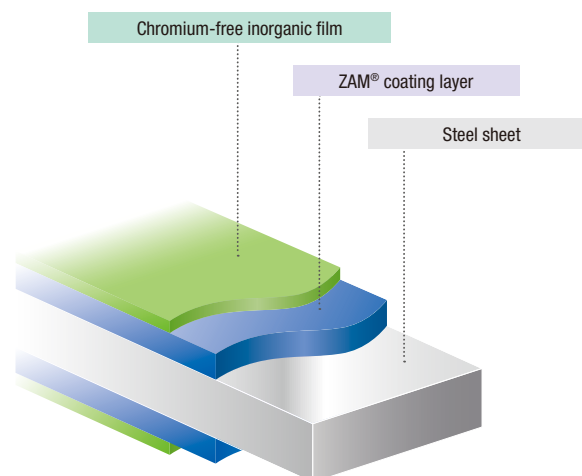
The inorganic film has low electrical resistance and excellent surface conductivity (spot weldability).

## ② Corrosion resistance

The resultant film has corrosion resistance equivalent to that obtained in the case of chromate treatment (A treatment).

## ③ Superior compatibility with the environment

The resultant material is friendly to the environment because its film is entirely free of chromium.



## Quality characteristics

Treatment	Elution of chromium	Corrosion resistance (SST72h)	Contact resistance value (grounded)	Fingerprint resistance	Alkali resistance	Solvent resistance	
						Ethanol	Acetone
ZC treatment	No elution	White rust occurrence 10% or less	$10^{-5} \sim 10^{-4} \Omega$	$\Delta L \leq 1.0$	○	○	○
Chromate treatment (A treatment)	Elution	White rust occurrence 10% or less	$10^{-5} \sim 10^{-4} \Omega$	$\Delta L \leq 1.0$	○	○	○

Elution of chromium: Amount of chromium elution measured after the specimen has been immersed for 3 minutes in boiling water

Corrosion resistance: Salt spray test (JIS Z2371)

Contact resistance value: Measured by the four-terminal, four-probe method (Dia Instruments MCP-TPO3P)

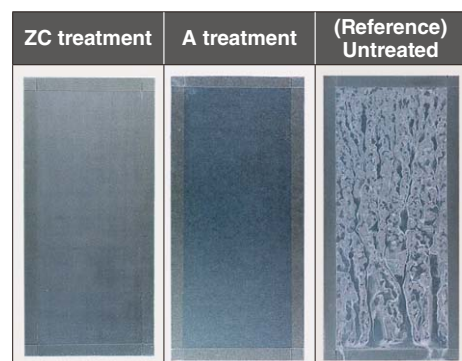
Fingerprint resistance: Difference in brightness ( $\Delta L$ ) before and after impression with artificial finger-smudge solution (JIS K2246)

Alkali resistance: Appearance after immersion for 2 minutes in alkali degreasing agent (Nippon Paint SD-270) adjusted to pH of 12 and a temperature of 40°C

Solvent resistance: Appearance after rubbing 5 times with gauze impregnated with the solvent

(Evaluation standard/ ○ : no change, △ : some discoloration, × : film peeling)

## Corrosion resistance of flat part



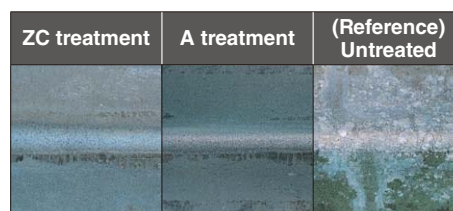
Appearances after 72 hours of salt spray test (SST)

• No significant change in appearance was found in the ZC-treated material even with SST lasting 72 hours.

## Test pieces

- ZC treatment: Coating weight symbol 90, thickness: 0.8 mm
- A treatment: Coating weight symbol 90, thickness: 0.8 mm
- Untreated: Coating weight symbol 90, thickness: 0.8 mm

## Corrosion resistance of bent part



Appearances of bent parts

after 24 hours of humidity cabinet test (BBT)

(90°C bend, bending radius: 1 mmR)

• No significant change in appearance was found in the ZC-treated material even with BBT lasting 24 hours.

## Product shape



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# 4 Chromium-free treatment

## ZG treatment chromium-free organic special treatment

Processability

### ① Reducing damage during processing

It is expected that this processing reduces damage to the coating layer during roll forming or press working.

### ② Superior corrosion resistance

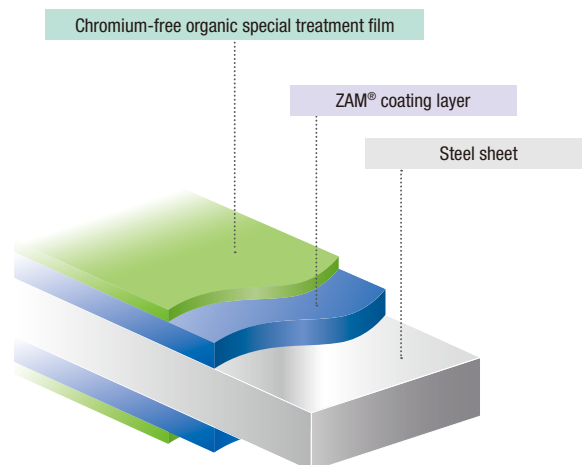
The special film provides better corrosion resistance both on flat and bent parts.

### ③ Excellent fingerprint resistance

Fingerprints left during handling are hardly noticeable.

### ④ Superior compatibility with the environment

The resultant material is friendly to the environment because its film is entirely free of chromium.



### Quality characteristics

Treatment	Elution of chromium	Corrosion resistance	Scratch resistance	Contact resistance (grounded)	Fingerprint resistance	Alkali resistance	Solvent resistance
ZG treatment	No elution	SST240h, white rust occurrence 10% or less	○	∞	$\Delta L \leq 0.5$	○	○
ZC treatment	No elution	SST72h, white rust occurrence 10% or less	△	$10^{-5} \sim 10^{-4} \Omega$	$\Delta L \leq 1.0$	○	○

Elution of chromium: Amount of chromium elution measured after the specimen has been immersed for 3 minutes in boiling water

Corrosion resistance: Salt spray test (JIS Z2371)

Scratch resistance: Appearance of the coating layer during processing

Contact resistance value: Measured by the four-terminal, four-probe method (Dia Instruments MCP-TPO3P)

Fingerprint resistance: Difference in brightness ( $\Delta L$ ) before and after impression with artificial finger-smudge solution (JIS K2246)

Alkali resistance: Appearance after immersion for 2 minutes in alkali degreasing agent (Nippon Paint SD-270) adjusted to pH of 12 and a temperature of 40°C

Solvent resistance: Appearance after immersion for 2 minutes in acetone

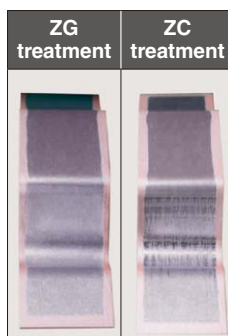
(Evaluation standard for alkali resistance and solvent resistance/ ○ : No change, △ : Some discoloration, × : Film peeling)

### Corrosion resistance of flat section



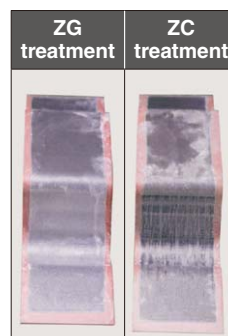
Appearances after salt spray test

### Scratch resistance of bent section



Appearances after processing

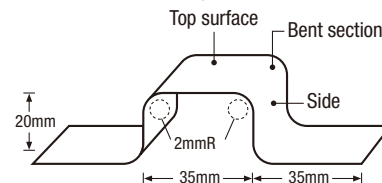
### Corrosion resistance of bent section



After 72 hours of salt spray test (SST)

### Product shape

• Drawn into a hat-shaped section



### Test pieces

- ZG treatment: Coating weight symbol 90, thickness: 0.8 mm
- ZC treatment: Coating weight symbol 90, thickness: 0.8 mm



# ZJ treatment Chromium-free organic lubrication treatment

High formability

## ① Good formability

The coefficient of friction is reduced by the addition of special wax so that the product exhibits excellent formability and allows elimination of additional forming lubricants.

## ② Superior corrosion resistance

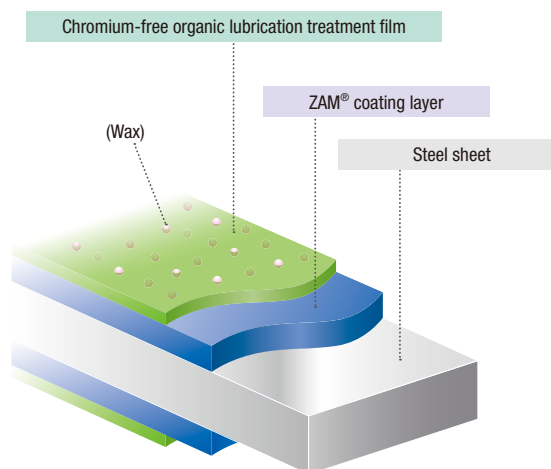
Flat and bent sections show superior corrosion resistance.

## ③ Excellent fingerprint resistance

Fingerprints left during handling are hardly noticeable.

## ④ Superior compatibility with the environment

The resultant material is friendly to the environment because its film is entirely free of chromium.



## Quality characteristics

Treatment	Type	Elution of chromium	Corrosion resistance	Coefficient of dynamic friction	Contact resistance (grounded)	Fingerprint resistance	Alkali resistance	Solvent resistance
ZJ treatment	Organic	No elution	SST240h, white rust occurrence 10% or less	0.1	$\infty$	$\Delta L \leq 0.5$	○	○
ZG treatment	Organic	No elution	SST240h, white rust occurrence 10% or less	0.2	$\infty$	$\Delta L \leq 0.5$	○	○
ZC treatment	Inorganic	No elution	SST72h, white rust occurrence 10% or less	0.3 ~ 0.4	$10^{-5} \sim 10^{-4} \Omega$	$\Delta L \leq 1.0$	○	○

Elution of chromium: Amount of chromium elution measured after the specimen has been immersed for 3 minutes in boiling water

Corrosion resistance: Salt spray test (JIS Z2371)

Coefficient of dynamic friction: Reference sheet: SUS304BA, load: 0.98 N, sliding rate: 150 mm/min

Contact resistance value: Measured by the four-terminal, four-probe method (Dia Instruments MCP-TPO3P)

Alkali resistance: Appearance after immersion for 2 minutes in alkali degreasing agent (Nippon Paint SD-270) adjusted to pH of 12 and a temperature of 40°C

Fingerprint resistance: Difference in brightness ( $\Delta L$ ) before and after impression with artificial finger-smudge solution (JIS K2246)

Solvent resistance: Appearance after immersion for 2 minutes in acetone

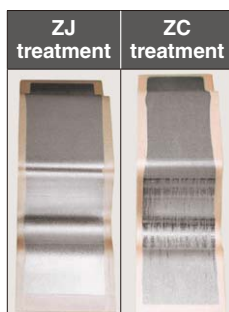
(Evaluation standard for alkali resistance and solvent resistance/ ○ : No change,  $\Delta$  : Some discoloration,  $\times$  : Film peeling)

## Corrosion resistance of flat section

After 72 hrs of SST		After 240 hrs of SST	
ZJ treatment	ZC treatment	ZJ treatment	ZC treatment

Appearances after salt spray test

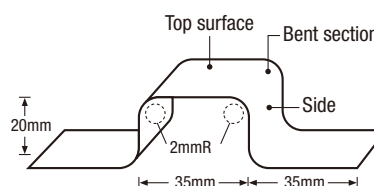
## Scratch resistance of bent section



Appearances after processing

## Product shape

• Drawn into a hat-shaped section



## Test pieces

- ZJ treatment: Coating weight symbol 90, thickness: 0.8 mm
- ZC treatment: Coating weight symbol 90, thickness: 0.8 mm

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# 4 Chromium-free treatment

## ZP treatment Chromium-free phosphate treatment

### ① Superior paintability

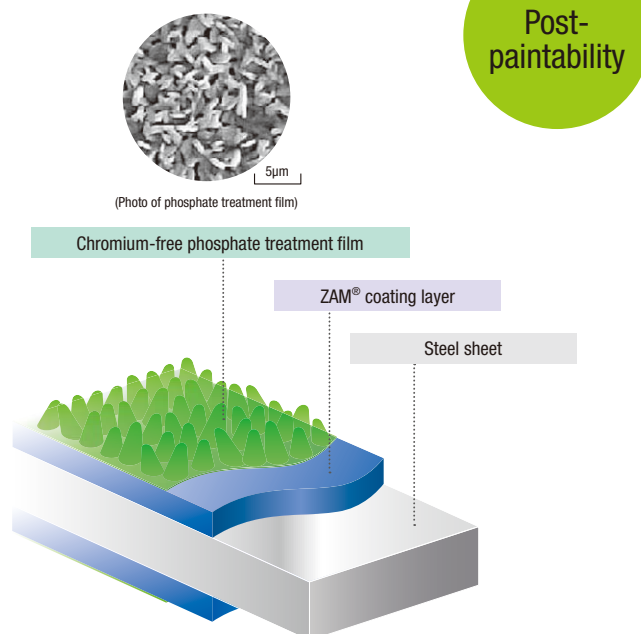
This material has superior paint adhesion, making it possible to omit the process of pre-paint surface preparation.

### ② Excellent corrosion resistance after painting

Processed and spot welded parts of the material also exhibit excellent corrosion resistance after painting.

### ③ Superior compatibility with the environment

The resultant material is friendly to the environment because its film is entirely free of chromium



### Quality characteristics

Sample		Elution of chromium	Corrosion resistance (before painting) (8 hrs of SST)	Paint adhesion		Corrosion resistance after painting (150 cycles of CCT)
Name	Treatment			Primary adhesion	Secondary adhesion	
ZAM®	ZP treatment	No elution	○	○	○	◎
Paintite	Chromate treatment	Elution	○	○	○	○
Moonstar Zinc	Phosphate treatment	No elution	○	○	○	△

(Paintite : Product name of Nisshin Steel's galvanealed steel sheet, Moonstar Zinc: Product name of Nisshin Steel's Electrolytic Zinc coated steel sheet)

Elution of chromium: Amount of chromium elution measured after the specimen has been immersed for 3 minutes in boiling water

Corrosion resistance: Salt spray test (JIS Z2371) 8 hrs (○ : White rust occurrence 10% or less, × : white rust occurrence more than 10%)

Paint adhesion: Primary adhesion: Lattice pattern (1 mm) cutting and cellophane tape peeling test (○ : no peeling, × : peeling)

Secondary adhesion: After immersion for 2 hours in hot water (90°C), lattice pattern cutting and cellophane tape peeling test (○ : no peeling, × : peeling)

Corrosion resistance after painting: Combined-cycle test (JIS G0594) 150 cycles (superior ◎ ○ △ inferior)

### Paint adhesion for ZP treatment

Sample	ZAM® ZP treatment	Paintite Chromate treatment	Moonstar Zinc Phosphate treatment
Secondary adhesion			

<Painting conditions>

Acrylic paint (30μm: spraying + baking finish)

<Samples>

- ZAM® - ZP treatment: Thickness: 0.8 mm, one-side coating weight: 47 g/m<sup>2</sup>
- Paintite - Chromate treatment: Thickness: 0.8 mm, one-side coating weight: 40 g/m<sup>2</sup>
- Moonstar Zinc - Phosphate treatment: Thickness: 0.8 mm, one-side coating weight: 10 g/m<sup>2</sup>

<Paintability evaluation>

- Secondary adhesion: After immersion for 2 hours in hot water (90°C), lattice pattern cutting and cellophane tape peeling test

<Corrosion resistance evaluation>

- Combined-cycle test (JIS G0594)  
1 hr of SST → 4 hrs of drying (50°C) → 3 hrs of BBT (50°C, 95%RH or higher)

### Corrosion resistance after painting (after 150 cycles of CCT)

Sample	ZAM® ZP treatment	Paintite Chromate treatment	Moonstar Zinc Phosphate treatment
Cross-cut section			
Spot welded section			



## Chromium-free low-gloss treatment

### ① Excellent antidazzle property

This material features low metallic luster, reducing reflection of sunlight.

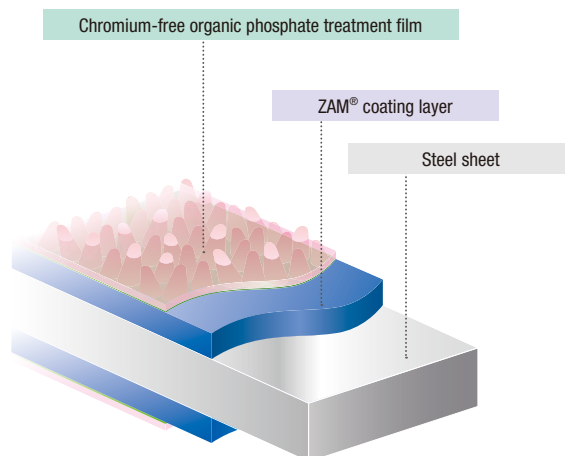
### ② Superior corrosion resistance

Sealed with an organic film, this material has superior corrosion resistance.

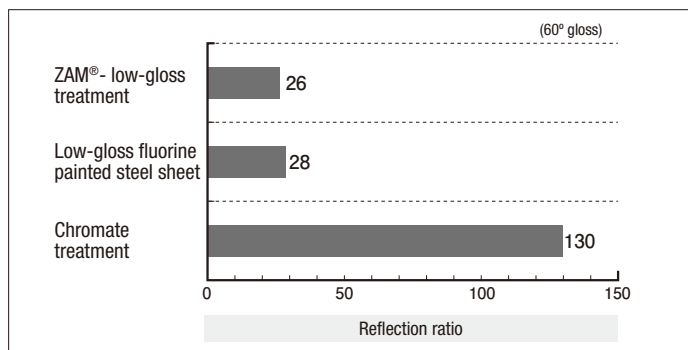
### ③ Superior compatibility with the environment

The resultant material is friendly to the environment because its film is entirely free of chromium.

Antidazzle  
property



60° specular gloss (10 points on average) JIS Z8741



Comparison between chromate and low-gloss treatments



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# 5 Standards

## Nisshin Steel Standard

### Types and symbols

See the following tables for the types of sheets and coils available.

#### Types and symbols (in the case of hot-rolled base sheets)

Type			Application
Product symbol	Base sheet classificatio	Application symbol	
MSM	H	C	General use
MSM	H	D *	Drawing
MSM	H	K370	Class 370N for structural use
MSM	H	K390	Class 390N for structural use
MSM	H	K400	Class 400N for structural use
MSM	H	K440 *	Class 440N for structural use
MSM	H	K490 *	Class 490N for structural use
MSM	H	K540 *	Class 540N for structural use
MSM	H	K590 *	Class 590N for structural use

#### Remarks

:Contact us for the products marked with an asterisk (\*) and other grades not listed here.

:If no hot-rolled sheet is designated for a thickness between 1.6mm and 3.2mm, there may be cases where cold-rolled sheets satisfying the hot-rolled base sheet specifications are used.

#### Types and symbols (In the case of cold-rolled base sheets)

Type			Application
Product symbol	Base sheet classificatio	Application symbol	
MSM	C	C	General use
MSM	C	D	Drawing
MSM	C	E	Deep drawing
MSM	C	U *	Ultra-deep drawing
MSM	C	K370	Class 370N for structural use
MSM	C	K390	Class 390N for structural use
MSM	C	K400	Class 400N for structural use
MSM	C	K440	Class 440N for structural use
MSM	C	K490 *	Class 490N for structural use
MSM	C	K540 *	Class 540N for structural use
MSM	C	K570 *	Class 570N for structural use
MSM	C	K590 *	Class 590N for structural use

### Surface finish

The standard surface finish is skin-passed (symbol: D).

### Coating mass

Products can be manufactured with the coating weights listed in the following table.

#### Minimum coating mass (total mass on both sides)

Symbol (Nisshin standard 1)	Minimum average coating mass at triple-spot test (g/m <sup>2</sup> )	Minimum coating mass at a single spot (g/m <sup>2</sup> )	Symbol (Nisshin standard 2)	Minimum average coating mass at triple-spot test (g/m <sup>2</sup> )	Minimum coating mass at a single spot (g/m <sup>2</sup> )
K 06 *	60	51	45	70	60
K 08	80	68	60	90	77
K 10	100	85	—	—	—
K 12	120	102	—	—	—
K 14	140	119	90	140	119
K 18	180	153	120	190	162
K 20	200	170	—	—	—
K 22	220	187	150	230	196
K 25	250	213	—	—	—
K 27	275	234	190	290	247
K 35 *	350	298	—	—	—
K 45 *	450	383	300 *	500	425

Notes 1: Coating weight can be specified by Nisshin Standard 1 or 2.

2: The coating weight symbol in Nisshin's Standard 2 represents the coating weight on one side (g/m<sup>2</sup>).

3: For items marked \*, contact us for information.

### Chemical treatments and oiling

Chemical conversion treatments and oiling are performed according to the following tables.

#### Chemical conversion treatment types and symbols

Chemical conversion treatment	Symbol
Chromium-free inorganic treatment	ZC
Chromium-free organic special treatment	ZG
Chromium-free organic lubrication treatment	ZJ
Chromium-free phosphate treatment	ZP
High corrosion-resistance chromate	A
Untreated	M

Remarks: For items not listed above, contact us.

#### Oiling types and symbols

Type of oiling	Symbol
Oiling	O
No oiling	No symbol

## Mechanical properties

### (1) Bendability

When the bendability of flat sheets and coils is tested according to the following table, coating peel-off, cracking of the base sheet (to the extent it can be confirmed with the naked eye), or ruptures should not occur on the surface (measured at min. 7 mm from each longitudinal edge of the test piece).

#### Bendability

Symbol of the type (Cold- or hot-rolled base sheet)	Bending angle of 180°								
	Nominal thickness Under 1.6 mm			Nominal thickness 1.6 mm or more, less than 3.0 mm			Nominal thickness 3.0 mm and over		
	Coating weight symbol (Upper: Nisshin's Standard 1, lower: Nisshin's Standard 2)			Coating weight symbol (Upper: Nisshin's Standard 1, lower: Nisshin's Standard 2)			Coating weight symbol (Upper: Nisshin's Standard 1, lower: Nisshin's Standard 2)		
	K27 or lower 190 or lower	K35	K45 300	K27 or lower 190 or lower	K35	K45 300	K27 or lower 190 or less	K35	K45 300
General use	1	1	2	1	2	2	2	2	2
Drawing	1	—	—	1	—	—	—	—	—
Deep drawing / Ultra-deep drawing	0	—	—	0	—	—	—	—	—
Class 370N for structural use	1	1	2	1	1	2	2	2	3
Class 390 / 400N for structural use	2	2	2	2	2	2	3	3	3
Class 440 / 490 / 500 / 540N for structural use	3	3	3	3	3	3	3	3	3
Class 590N for structural use	—	—	—	—	—	—	—	—	—

Remarks 1: In the case of hot-rolled sheets, nominal thicknesses of 1.6 mm and over apply.

2: The figures in the table are the numbers of sheets of the nominal thickness at the inside spacing of the bend.

3: The deep drawing and ultra-deep drawing columns apply only to cold-rolled sheets.

### (2) Tensile tests

The following table shows the yield point, tensile strength, and elongation of flat sheets and coils.

#### Yield point, tensile strength, and elongation

Application	Yield point (N/mm <sup>2</sup> )	Tensile strength (N/mm <sup>2</sup> )	Elongation	
			Nominal thickness (mm)	(%)
Drawing application	—	Min. 270	0.4 incl. to under 0.6	Min. 34
			0.6 incl. to under 1.0	Min. 36
			1.0 incl. to under 1.6	Min. 37
			1.6 incl. to 2.3 incl.	Min. 38
Deep drawing application	—	Min. 270	0.4 incl. to under 0.6	Min. 36
			0.6 incl. to under 1.0	Min. 38
			1.0 incl. to under 1.6	Min. 39
			1.6 incl. to 2.3 incl.	Min. 40
Ultra-deep drawing application	—	Min. 270	0.6 incl. to under 1.0	Min. 40
			1.0 incl. to under 1.6	Min. 41
			1.6 incl. to 2.3 incl.	Min. 42
Class 370N for structural use	Min. 265	Min. 370	Applies to 0.4 mm and over Reference value for under 0.4 mm	Min. 18
Class 390N for structural use	Min. 285	Min. 390		Min. 18
Class 400N for structural use	Min. 295	Min. 400		Min. 18
Class 440N for structural use	Min. 335	Min. 440		Min. 18
Class 490N for structural use	Min. 365	Min. 490		Min. 16
Class 540N for structural use	Min. 400	Min. 540		Min. 16
Class 570N for structural use	Min. 560	Min. 570		—
Class 590N for structural use	Min. 560	Min. 590		—

Remarks: Deep drawing and ultra-deep drawing columns apply only to cold-rolled sheets.

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## Size tolerances

### (1) Thickness tolerances

In the case where base sheet thicknesses are indicated, the following coating weights should be added to such respective thicknesses to identify the applicable size tolerances. (before coating thickness)

In the case where coated sheet thicknesses are indicated, size tolerances for such thicknesses apply. (after coating thickness)

The thickness tolerance is according to the following table. The thickness is measured at any point no less than 25 mm from the edge.

#### Thickness tolerances Cold-rolled base steel

(Unit: mm)

Nominal thickness \ Width	Under 630	630 to under 1,000	1,000 to under 1,250	1,250 to 1,325 incl.
0.25 incl. to under 0.40	± 0.05	± 0.05	± 0.05	± 0.06
0.40 incl. to under 0.60	± 0.06	± 0.06	± 0.06	± 0.07
0.60 incl. to under 0.80	± 0.07	± 0.07	± 0.07	± 0.07
0.80 incl. to under 1.00	± 0.07	± 0.07	± 0.08	± 0.09
1.00 incl. to under 1.25	± 0.08	± 0.08	± 0.09	± 0.10
1.25 incl. to under 1.60	± 0.09	± 0.10	± 0.11	± 0.12
1.60 incl. to under 2.00	± 0.11	± 0.12	± 0.13	± 0.14
2.00 incl. to 2.30 incl.	± 0.13	± 0.14	± 0.15	± 0.16

Thickness is measured at any point no less than 25 mm from the edge.

#### Hot-rolled base steel

(Unit: mm)

Nominal thickness \ Width	600 to under 1,200	1,200 to under 1,325
1.60 incl. to under 2.30	± 0.17	± 0.18
2.30 incl. to under 2.50	± 0.18	± 0.20
2.50 incl. to under 3.20	± 0.20	± 0.22
3.20 incl. to under 4.00	± 0.22	± 0.24
4.00 incl. to under 5.00	± 0.25	± 0.27
5.00 incl. to under 6.00	± 0.27	± 0.29
6.00	± 0.30	± 0.31

Thickness is measured at any point no less than 25 mm from the edge.

### Corresponding coating thickness

Coating mass symbol Nisshin's Standard 1	K06	K08	K10	K12	K14	K18	K20	K22	K25	K27	K35	K45
Equivalent coating thickness (mm, total of both sides)	0.015	0.020	0.025	0.031	0.034	0.041	0.048	0.051	0.059	0.064	0.076	0.094

Coating mass symbol Nisshin's Standard 2	45	60	—	—	90	120	—	150	—	190	—	300
Equivalent coating thickness (mm, total of both sides)	0.015	0.020	—	—	0.030	0.040	—	0.050	—	0.063	—	0.100

● The coating density of ZAM<sup>®</sup> for calculating thickness of coating layer : 6.0g/cm<sup>3</sup>

### (2) Width and length tolerances

The width and length tolerances are shown in the following tables.

#### Width tolerances

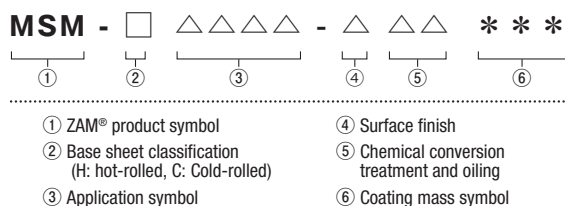
Product shape	Width tolerance
Wide coils and flat sheets	+ 25mm, -0
	+ 10mm, -0
	+ 7mm, -0
	+ 3mm, -0
Slit coils	± 0.5mm
	± 0.3mm

#### Length tolerance (flat sheets)

Length tolerance (mm)
+ X, -0

Remarks: X may be set anywhere in the range of 2 to 15.

## Standard labeling method



## Label examples

Example 1

**MSM - CC - DZC 90**

Type: Cold-rolled base sheet  
for general use

Post-treatment: Chromium-free  
inorganic treatment

Coating mass: 140 g/m<sup>2</sup> (minimum  
value on both sides)

Example 2

**MSM - HK400 - DZG K27**

Type: Class 400N hot-rolled sheet  
for structural use

Post-treatment: Chromium-free  
organic special treatment

Coating mass: 275 g/m<sup>2</sup> (minimum  
value on both sides)

## Chemical composition

Hot-rolled sheet

(Unit: wt%)

Application symbol	C	Si	Mn	P	S
C	Max. 0.15	—	Max. 0.80	Max. 0.05	Max. 0.05
K400	Max. 0.25	—	Max. 1.70	Max. 0.20	Max. 0.05
K440	Max. 0.25	—	Max. 2.00	Max. 0.20	Max. 0.05
K490	Max. 0.30	—	Max. 2.00	Max. 0.20	Max. 0.05
K540	Max. 0.30	—	Max. 2.50	Max. 0.20	Max. 0.05

Cold-rolled sheet

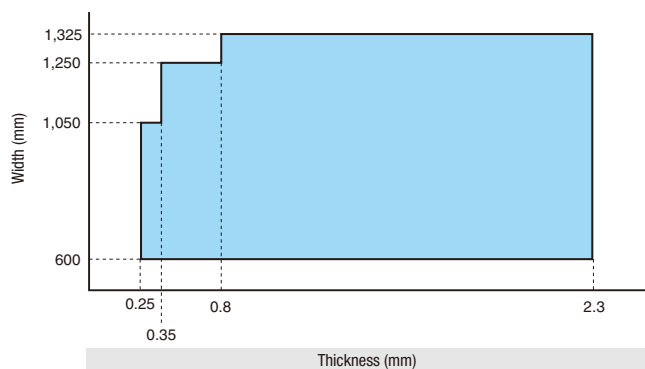
(Unit: wt%)

Application symbol	C	Si	Mn	P	S
C	Max. 0.15	—	Max. 0.80	Max. 0.05	Max. 0.05
D	Max. 0.12	—	Max. 0.60	Max. 0.04	Max. 0.04
E	Max. 0.10	—	Max. 0.45	Max. 0.03	Max. 0.03
U	Max. 0.08	—	Max. 0.45	Max. 0.03	Max. 0.03
K400	Max. 0.25	—	Max. 1.70	Max. 0.20	Max. 0.05
K440	Max. 0.25	—	Max. 2.00	Max. 0.20	Max. 0.05
K490	Max. 0.30	—	Max. 2.00	Max. 0.20	Max. 0.05
K570	Max. 0.30	—	Max. 2.50	Max. 0.20	Max. 0.05

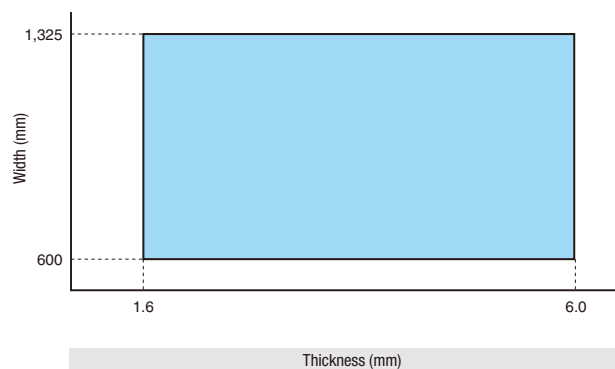
## Available sizes

- The production range varies depending on the specifications. For details contact us.
- For sizes other than those shown in the figure below, consult us.

Cold-rolled sheet



Hot-rolled sheet



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## ASTM A 1046/A1046M (Excerpts From ASTM Standard)

### Standard Specification for Steel Sheet, Zinc-Aluminum-Magnesium Alloy-Coated by the Hot-Dip Process

This specification is applicable to orders in either inch-pound units (as A 1046) or SI units (as A 1046M).

Values in inch-pound and SI units are not necessarily equivalent.

Within the text, SI units are shown in brackets. Each system shall be used independently of the other.

#### 1. Weight (Mass) of Coating

Weight [Mass] of Coating Requirement<sup>A</sup>

Coating Designation	Inch-Pound Units	
	Minimum Requirement	
	Triple-Spot Test Total Both Sides, oz/ft <sup>2</sup>	Single-Spot Test Total Both Sides, oz/ft <sup>2</sup>
ZM20	0.20	0.16
ZM30	0.30	0.25
ZM40	0.40	0.30
ZM60	0.60	0.50
ZM75	0.75	0.65
ZM90	0.90	0.80
ZM115	1.15	1.00
ZM140	1.40	1.20
ZM165	1.65	1.40
ZM210	2.10	1.80

Coating Designation	SI Units	
	Minimum Requirement	
	Triple-Spot Test Total Both Sides, g/m <sup>2</sup>	Single-Spot Test Total Both Sides, g/m <sup>2</sup>
ZMM60	60	50
ZMM90	90	75
ZMM120	120	90
ZMM180	180	150
ZMM220	220	190
ZMM275	275	235
ZMM350	350	300
ZMM450	450	385
ZMM500	500	425
ZMM600	600	510

<sup>A</sup> The coating designation number is the term b which this product is specified. Because of the many variables and changing conditions that are characteristic of continuous hot-dip coating lines, the weight[mass] of the coating is not always evenly divided between the two surfaces of a sheet, nor is the coating evenly distributed from edge to edge. However, it can normally be expected that not less than 40% of the single-spot test limit will be either surface.

#### 2. Chemical Composition

Chemical Requirements<sup>A</sup>

Composition, %-Heat Analysis Element max (unless others shown)													
Designation	C	Mn	P	S	Al, min	Cu	Ni	Cr	Mo	V	Cb	Ti <sup>B</sup>	N
CS Type A <sup>C, D, E</sup>	0.10	0.60	0.030	0.035	—	0.20	0.20	0.15	0.06	0.008	0.008	0.025	—
CS Type B <sup>C, F</sup>	0.02 to 0.15	0.60	0.030	0.035	—	0.20	0.20	0.15	0.06	0.008	0.008	0.025	—
CS Type C <sup>C, D, E</sup>	0.08	0.60	0.100	0.035	—	0.20	0.20	0.15	0.06	0.008	0.008	0.025	—
FS Type A <sup>C, G</sup>	0.10	0.50	0.020	0.035	—	0.20	0.20	0.15	0.06	0.008	0.008	0.025	—
FS Type B <sup>C, F</sup>	0.02 to 0.10	0.50	0.020	0.030	—	0.20	0.20	0.15	0.06	0.008	0.008	0.025	—
DDS <sup>D, E, H</sup>	0.06	0.50	0.020	0.025	0.01	0.20	0.20	0.15	0.06	0.008	0.008	0.025	—
EDDS <sup>H, I</sup>	0.02	0.40	0.020	0.020	0.01	0.20	0.20	0.15	0.06	0.10	0.10	0.15	—

<sup>A</sup> Where an ellipsis (—) appears in this table, there is no requirement, but the analysis shall be reported.

<sup>B</sup> For steels containing more than 0.02% carbon, titanium is permitted to 0.025% provided the ratio of % nitrogen does not exceed 3.4.

<sup>C</sup> When a deoxidized steel is required for the application, the purchaser has the option to order CS and FS to a minimum of 0.01% total aluminum.

<sup>D</sup> Steel is permitted to be furnished as a vacuum degassed or chemically stabilized steel, or both, at the producer's option.

<sup>E</sup> For carbon levels less than or equal to 0.02%, vanadium, columbium, or titanium, or combinations thereof are permitted to be used as stabilizing elements at the producer's option. In such cases, the applicable limit for vanadium and columbium shall be 0.10% max, and the limit for titanium shall be 0.15% max.

<sup>F</sup> For CS and FS, specify Type B to avoid carbon levels below 0.02%

<sup>G</sup> Shall not be furnished as a stabilized steel.

<sup>H</sup> Minimum Al content is not required if agreed to by purchaser and supplier.

<sup>I</sup> Shall be furnished as a stabilized steel.

## Chemical Requirements <sup>A</sup>

Composition, %-Heat Analysis Element. max (unless otherwise shown)												
Designation	C	Mn	P	S	Cu	Ni	Cr	Mo	V <sup>A</sup>	Cb <sup>B</sup>	Ti <sup>B C D</sup>	N
SS Grade												
33[230]	0.20	—	0.04	0.040	0.20	0.20	0.15	0.06	0.008	0.008	0.025	—
37[255]	0.20	—	0.10	0.040	0.20	0.20	0.15	0.06	0.008	0.008	0.025	—
40[275]	0.25	—	0.10	0.040	0.20	0.20	0.15	0.06	0.008	0.008	0.025	—
50[340] Class1. 2 and 4	0.25	—	0.20	0.040	0.20	0.20	0.15	0.06	0.008	0.008	0.025	—
50[340] Class3	0.25	—	0.04	0.040	0.20	0.20	0.15	0.06	0.008	0.008	0.025	—
80[550]	0.20	—	0.04	0.040	0.20	0.20	0.15	0.06	0.008	0.015	0.025	—
HSLAS <sup>E</sup>												
40[275]	0.20	1.50	—	0.035	—	0.20	0.15	0.16	0.01min	0.005min	0.01min	—
50[340]	0.20	1.50	—	0.035	0.20	0.20	0.15	0.16	0.01min	0.005min	0.01min	—
60[410]	0.20	1.50	—	0.035	0.20	0.20	0.15	0.16	0.01min	0.005min	0.01min	—
70[490]	0.20	1.65	—	0.035	0.20	0.20	0.15	0.16	0.01min	0.005min	0.01min	—
80[550]	0.20	1.65	—	0.035	0.20	0.20	0.15	0.16	0.01min	0.005min	0.01min	—
HSLAS-F <sup>F</sup>												
40[275]	0.15	1.50	—	0.035	—	0.20	0.15	0.16	0.01min	0.005min	0.01min	—
50[340]	0.15	1.50	—	0.035	0.20	0.20	0.15	0.16	0.01min	0.005min	0.01min	—
60[410]	0.15	1.50	—	0.035	0.20	0.20	0.15	0.16	0.01min	0.005min	0.01min	—
70[490]	0.15	1.65	—	0.035	0.20	0.20	0.15	0.16	0.01min	0.005min	0.01min	—
80[550]	0.15	1.65	—	0.035	0.20	0.20	0.15	0.16	0.01min	0.005min	0.01min	—

<sup>A</sup> Where an ellipsis(—)appears in this table there is no requirement, but the analysis shall be reported.

<sup>B</sup> For carbon levels less than or equal to 0.02%, vanadium, columbium or titanium, or combinations thereof, are permitted to be used as stabilizing elements at the producer's option. In such cases, the applicable limit for vanadium and columbium shall be 0.10 % max. and the limit for titanium shall be 0.15 % max.

<sup>C</sup> Titanium is permitted for SS steels to 0.025% provided the ratio of % titanium to % nitrogen does not exceed 3.4.

<sup>D</sup> For steels containing more than 0.02 % carbon, titanium is permitted to 0.025%, provided the ratio of % titanium to % nitrogen does not exceed 3.4.

<sup>E</sup> HSLAS and HSLAS-F steels commonly contain the strengthening elements columbium, vanadium, and titanium added singly or in combination. The minimum requirements only apply to the microalloy elements selected for strengthening of the steel.

<sup>F</sup> The producer has the option to treat HSLAS-F steels by means of small alloy additions to affect sulfide inclusion control.

## 3. Mechanical Properties

### Mechanical Property Requirements, Base Metal (Longitudinal)

Inch-Pound Units				
Designation	Grade	Yield Strength min, ksi	Tensile Strength min, ksi <sup>A</sup>	Elongation in 2 in.. min.% <sup>A</sup>
SS	33	33	45	20
	37	37	52	18
	40	40	55	16
	50 Class1	50	65	12
	50 Class2	50	—	12
	50 Class3	50	70	12
	50 Class4	50	60	12
	80 <sup>B</sup>	80 <sup>C</sup>	82	—
HSLAS	40	40	50 <sup>D</sup>	22
	50	50	60 <sup>D</sup>	20
	60	60	70 <sup>D</sup>	16
	70	70	80 <sup>D</sup>	12
	80	80	90 <sup>D</sup>	10
HSLAS-F	40	40	50 <sup>D</sup>	24
	50	50	60 <sup>D</sup>	22
	60	60	70 <sup>D</sup>	19
	70	70	80 <sup>D</sup>	14
	80	80	90 <sup>D</sup>	12

SI Units				
Designation	Grade	Yield Strength min, MPa	Tensile Strength min, MPa <sup>A</sup>	Elongation in 50 mm, min.% <sup>A</sup>
SS	230	230	310	20
	255	255	360	18
	275	275	380	16
	340 Class1	340	450	12
	340 Class2	340	—	12
	340 Class3	340	480	12
	340 Class4	340	410	12
	550 <sup>B</sup>	550 <sup>C</sup>	570	—
HSLAS	275	275	340 <sup>D</sup>	22
	340	340	410 <sup>D</sup>	20
	410	410	480 <sup>D</sup>	16
	480	480	550 <sup>D</sup>	12
	550	550	620 <sup>D</sup>	10
HSLAS-F	275	275	340 <sup>D</sup>	24
	340	340	410 <sup>D</sup>	22
	410	410	480 <sup>D</sup>	18
	480	480	550 <sup>D</sup>	14
	550	550	620 <sup>D</sup>	12

<sup>A</sup> Where an ellipsis (—) appears in this table there is no requirement.

<sup>B</sup> For sheet thickness of 0.028 in.[0.71 mm] or thinner, no tension test is required if the hardness result in Rockwell B 85 or higher.

<sup>C</sup> As there is no discontinuous yield curve, the yield strength should be taken as the stress at 0.5 % elongation under load or 0.2 % offset.

<sup>D</sup> If a higher tensile strength is required, the user should consult the producer.

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# 5 Standards

## Typical Ranges of Mechanical Properties (Nonmandatory) <sup>A, B</sup>

Designation	(Longitudinal Direction)			f <sub>m</sub> Value <sup>c</sup>	N Value <sup>d</sup>
	Yield Strength		Elongation in 2 in. [50mm]%		
	Ksi	MPa			
CS TypeA	25/55	[170/380]	≥ 20	E	E
CS TypeB	30/55	[205/380]	≥ 20	E	E
CS TypeC	25/60	[170/410]	≥ 15	E	E
FS TypesA and B	25/45	[170/310]	≥ 26	1.0/1.4	0.17/0.21
DDS	20/35	[140/240]	≥ 32	1.4/1.8	0.19/0.24
EDDS <sup>e</sup>	15/25	[105/170]	≥ 40	1.6/2.1	0.22/0.27

<sup>A</sup> The typical mechanical property values presented here are nonmandatory. They are intended solely to provide the purchaser with as much information as possible to make an informed decision on the steel to be specified. Values outside of these ranges are to be expected. The purchaser may negotiate with the supplier if a specific range or a more restrictive range is required for the application.

<sup>B</sup> These typical mechanical properties apply to the full range of steel sheet thicknesses. The yield strength tends to increase and some of the formability values tend to decrease as the sheet thickness decreases.

<sup>C</sup> r<sub>m</sub> Value – Average plastic strain ratio as determined by Test Method E 517.

<sup>D</sup> N Value-Strain-hardening exponent as determined by Test Method E 646.

<sup>E</sup> No typical mechanical properties have been established.

<sup>F</sup> EDDS Sheet will be free from changes in mechanical properties over time, that is, nonaging.

## 4. Bend Test

### Coating Bend Test Requirements

inch-pound Units Ratio of the Bend Diameter to Thickness of the Specimen (Any Direction)														
Coating Designation <sup>A</sup>	CS, FS, DDS, EDDS Sheet Thickness			SSGrade <sup>B</sup>			HSLAS <sup>B</sup>			HSLAS-F				
	Through 0.039 in	Over 0.039 Through 0.079 in	Over 0.079 in	33	37	40	40	50	60	40	50	60	70	80
ZM20	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZM30	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZM40	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZM60	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZM70	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZM90	0	0	1	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZM115	0	0	1	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZM140	1	1	2	2	2	2½								
ZM165	2	2	2	2	2	2½								
ZM210	2	2	2	2	2	2½								

SI-Units Ratio of the Bend Diameter to Thickness of the Specimen (Any Direction)														
Coating Designation <sup>A</sup>	CS, FS, DDS, EDDS Sheet Thickness			SSGrade <sup>C</sup>			HSLAS <sup>C</sup>			HSLAS-F				
	Through 1.0mm	Over 1.0 Through 2.0mm	Over 2.0mm	230	255	275	275	340	410	275	340	410	480	550
ZMM60	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZMM90	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZMM120	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZMM180	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZMM210	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZMM275	0	0	1	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZMM350	0	0	1	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZMM450	1	1	2	2	2	2½								
ZMM500	2	2	2	2	2	2½								
ZMM600	2	2	2	2	2	2½								

<sup>A</sup> If other coatings are required the user should consult the producer for availability and bend test requirements.

<sup>B</sup> SS Grade 50 and 80 and HSLAS Grade 70 and 80 are not subject to bend test requirements.

<sup>C</sup> SS Grade 340 and 550 and HSLAS Grade 480 and 550 are not subject to bend test requirements.

● The coating density of ZAM<sup>®</sup> for calculating thickness of coating layer : 6.0g/cm<sup>3</sup>



# AS 1397 (Excerpts From Australian Standard)

## Continuous hot-dip metallic coated steel sheet and strip –Coatings of zinc and zinc alloyed with aluminum and magnesium

### 1. Chemical Composition

#### Requirements For Chemical Composition

Steel grade designation AS1397	Chemical composition (cast analysis), % max.			
	Carbon	Manganese	Phosphorus	Sulfur
G450, G500, G550	0.20	1.20	0.040	0.030
G300, G350 (see Note)	0.30	1.60	0.100	0.035
G250, G1	0.12	0.50	0.040	0.035
G2	0.10	0.45	0.030	0.030
G3	0.08	0.40	0.020	0.025

NOTE: For grade G300, nitrogenized steel may be used for sections greater than 1.00mm thick.

### 2. Mechanical Properties

#### Mechanical Property Requirements For Formability Grades

Steel grade designation	Transverse tensile test (see Note 1)		Transverse bent test	Thickness range for lock seam (see Note 2) mm
	Min. elongation, %		Degree of bend	
	on 50mm	on 80mm		
G1	—	—	180°	—
G2	30	27	180°	≤ 1.60
G3	35	32	180°	All

NOTES 1: Applies to test pieces equal to or greater than 0.60mm thick. Refer to supplier for typical yield and tensile strengths for design purposes.

2: The ability of grades to lockseam is dependent on recognized profiling practices and machine settings to avoid excessive stretching of the product.

#### Mechanical Property Requirements For Structural Grades

Steel grade designation	Longitudinal tensile test				Transverse bend test	
	Min. yield strength (Note 1)	Min. Tensile strength	Min. elongation, % (Note 2)		Angle of bend	Diameter of mandrel in terms of test piece thickness (t)
			MPa	MPa		
degrees						
G250	250	320	25	22	180	0
G300	300	340	20	18	180	t
G350	350	420	15	14	180	2t
G450 (Note 3)	450	480	10	9	90	4t
G500 (Note 4)	500	520	8	7	90	6t
G550 (Note 5)	550	550	2	2	—	—

NOTES 1: The yield strength is the lower yield stress. If well-defined yielding is not obvious, the 0.2% proof stress should be determined.

2: Applies to test pieces equal to or greater than 0.6mm in thickness. For material up to 0.6mm in thickness, the minimum elongation values in the table are not covered by this standard.  
L<sub>0</sub> = original gauge length.

3: Applies to recovery annealed, i.e. not recrystallized after annealing, material equal to or greater than 1.50mm thick.

4: Applies to recovery annealed, i.e. not recrystallized after annealing, material between 1.00mm and 1.50mm thick.

5: Applies to recovery annealed, i.e. not recrystallized after annealing, material up to and including 1.00mm thick; the values of yield strength, 0.2% proof stress and tensile strength are, for practical purposes, the same.

### 3. Coating Mass

#### Coating Mass Requirements : Type 'ZM' Coatings

Coating class designation	Minimum coating mass, g/m <sup>2</sup>		
	Total both surfaces		One surface
	Triple spot	Single Spot	Single spot
ZM60	60	54	24
ZM90	90	80	35
ZM120	120	110	50
ZM150	150	135	60
ZM180	180	160	70
ZM220	220	200	90
ZM275	275	250	110
ZM350	350	315	140
ZM450	450	405	180

### 4. Coating Adhesion

#### Coating Adhesion (180° Bend Test) Requirements

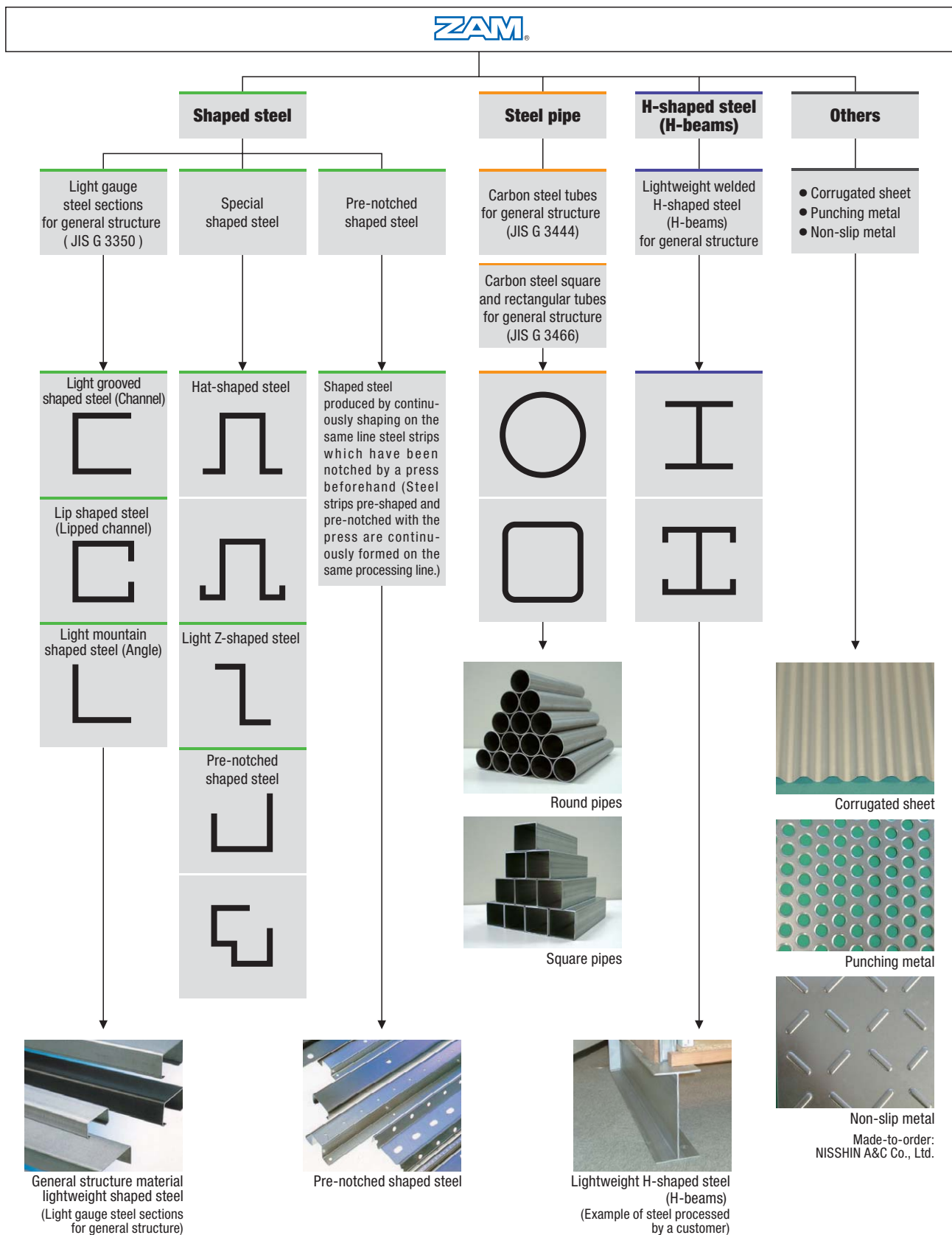
Steel grade designation	Diameter of mandrel in terms of thickness of product (t)			
	Coating class			
	ZM90, ZM120, ZM150, ZM180,	ZM220, ZM275	ZM350	ZM450
G250	0	0	0	t
G300	0	t	t	t
G350	0	t	t	t
G450	t	2t	2t	2t
G500	2t	2t	2t	2t
G550	2t	2t	2t	2t
G1	0	0	0	t
G2	0	0	0	t
G3	0	0	0	t

NOTE : 0 indicates that the coated steel is bent flat on itself

● The coating density of ZAM® for calculating thickness of coating layer : 6.0g/cm<sup>3</sup>

# 6 Examples of processed products

(Examples of processing performed by our company and its subsidiary companies)



# 7 Acquired certifications

## List of building work technology/technology examination certifications

Certifications	Explanation	Certification number	Acquisition date
Architecture execution technology and technology examination certification	A "Construction execution technology and technology examination certificate" has been obtained from the Building Center of Japan.	BCJ Examination certificate No.85	October 2, 2000 Renewed March 1, 2008
	As for chromium-free after-treatment, "Construction execution technology and technology examination certificate" has also been obtained from the Building Center of Japan.	BCJ Examination certificate No.138	January 31, 2008
Construction technology examination certification	"Construction technology examination certification" has been obtained from the Civil Engineering Research Center.	Examination certificate No.0122	March 18, 2002 Renewed March 18, 2012
Law concerning promotion of housing quality assurance, etc.	Under the provisions of the "Quality Assurance Law," we have obtained certification by the Minister of Land Infrastructure and Transport for special evaluation methods for degradation measure classes (structures, etc.) to be displayed in accordance with the Japan housing performance labeling standards.	Certification No.618	June 7, 2005
Architecture standards law	Certification by the Minister of Land Infrastructure and Transport has been obtained as a product conforming to the provisions of Item 2 of Article 37 of the Building Standards Act.	Toyo Works MSTL-0064 Sakai Works MSTL-0065	December 21, 2001
NETIS (New Technology Information System)	The product is registered as "ZAM <sup>®</sup> , high corrosion resistance hot-dip coated steel sheet" in NETIS, a database managed by the MLIT that compiles new technologies developed by the private sector. "ZAM <sup>®</sup> " was upgraded to "evaluated technology" on November 16, 2010.	KT-010029-V	May 10, 2001 Renewed December 20, 2006  Upgraded to evaluated technology November 16, 2010
Nippon Expressway Company Limited New technology and new building methods	The product is registered in a database of new technologies and new construction methods of expressways managed by NEXCO, Nippon Expressway Company Ltd.	200100085	April 20, 2001
New technology for Tokyo expressways	The "high-durability hot-dip steel sheet ZAM <sup>®</sup> " is mentioned on the Metropolitan Expressway CO., Ltd. and in "Systems using new technology" (internal company database).	—	November 20, 2007

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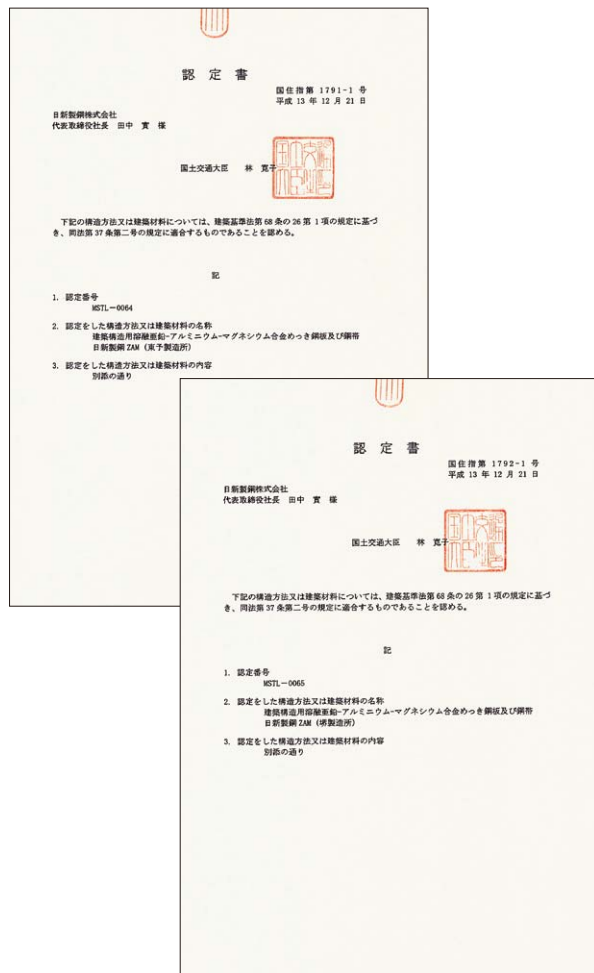
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# Architecture Standards Law certificate

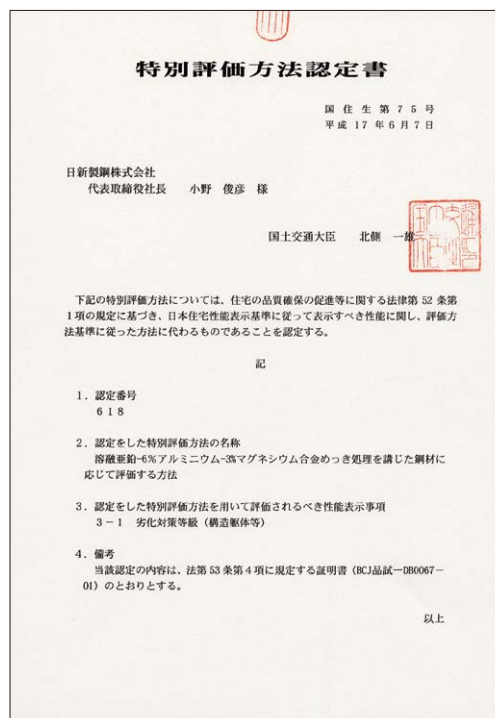
Issued on December 21, 2001



Certification by the Minister of Land, Infrastructure and Transport has been obtained proclaiming the product's compliance with the provisions of the Architecture Standards Law, article 37, number 2.

# Special evaluation certificate under the Law Concerning Promotion of Housing Quality Assurance, etc.

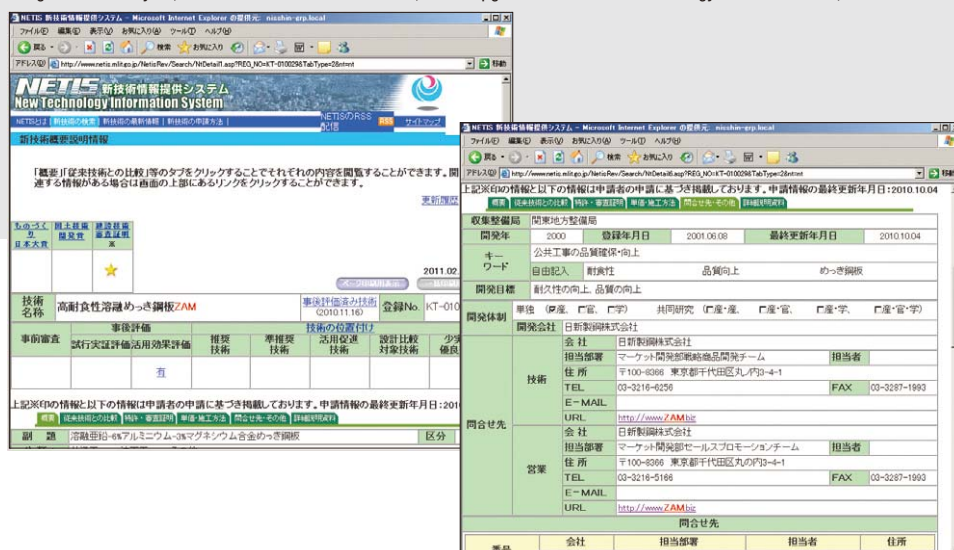
Issued on June 7, 2005



Under the provisions of the "Quality Assurance Law," certification by the Minister of Land, Infrastructure and Transport has been obtained for special evaluation methods to classify measures against degradation measures classes (structures, etc.) to be displayed in accordance with the Japan housing performance labeling standards. With acquisition of this certification, performance of ZAM® can be labeled according to these standards.

# NETIS (Registration No.: KT-010029-V)

Registered on May 10, 2001/Renewed on December 20, 2006 Upgraded to evaluated technology on November 16, 2010



# Registration of NETIS (New Technology Information System)

NETIS (New Technology Information System) is a database of new technologies developed by the private sector and is managed by the Ministry of Land, Infrastructure and Transportation so that useful new technologies may be proactively utilized and disseminated through public works and other means. ZAM® is registered in this database.

\*ZAM® was upgraded to "evaluated technology" on November 16, 2010.



# 8 Mass tables

## Mass of cut sheets

The mass of a cut sheet is expressed in kilograms and is stated as theoretical mass.

**ZAM® Mass table for coating mass symbol 60**

Coating mass symbol 60	Nominal size	3×6	4×8
	Width (mm)	914	1,219
	Length (mm)	1,829	2,438
	Area (m²)	1.672	2.972
Coating mass (kg/m²)	0.120		
Thickness (mm)	Unit mass (kg/m²)	Mass/sheet (kg)	Mass/sheet (kg)
0.27	2.240	3.75	6.66
0.3	2.475	4.14	7.36
0.4	3.260	5.45	9.69
0.5	4.045	6.76	12.0
0.6	4.830	8.08	14.4
0.8	6.400	10.7	19.0
1.0	7.970	13.3	23.7
1.2	9.540	16.0	28.4
1.6	12.68	21.2	37.7
2.0	15.82	26.5	47.0
2.3	18.18	30.4	54.0
3.2	25.24	42.2	75.0
4.0	31.52	52.7	93.7
4.5	35.44	59.3	105
6.0	47.22	79.0	140

**ZAM® Mass table for coating mass symbol 90**

Coating mass symbol 90	Nominal size	3×6	4×8
	Width (mm)	914	1,219
	Length (mm)	1,829	2,438
	Area (m²)	1.672	2.972
Coating mass (kg/m²)	0.180		
Thickness (mm)	Unit mass (kg/m²)	Mass/sheet (kg)	Mass/sheet (kg)
0.27	2.300	3.85	6.83
0.3	2.535	4.24	7.53
0.4	3.320	5.55	9.87
0.5	4.105	6.86	12.2
0.6	4.890	8.18	14.5
0.8	6.460	10.8	19.2
1.0	8.030	13.4	23.9
1.2	9.600	16.1	28.5
1.6	12.74	21.3	37.9
2.0	15.88	26.6	47.2
2.3	18.24	30.5	54.2
3.2	25.30	42.3	75.2
4.0	31.58	52.8	93.9
4.5	35.50	59.4	106
6.0	47.28	79.1	141

**ZAM® Mass table for coating mass symbol 120**

Coating mass symbol 120	Nominal size	3×6	4×8
	Width (mm)	914	1,219
	Length (mm)	1,829	2,438
	Area (m²)	1.672	2.972
Coating mass (kg/m²)	0.240		
Thickness (mm)	Unit mass (kg/m²)	Mass/sheet (kg)	Mass/sheet (kg)
0.27	2.360	3.95	7.01
0.3	2.595	4.34	7.71
0.4	3.380	5.65	10.0
0.5	4.165	6.96	12.4
0.6	4.950	8.28	14.7
0.8	6.520	10.9	19.4
1.0	8.090	13.5	24.0
1.2	9.660	16.2	28.7
1.6	12.80	21.4	38.0
2.0	15.94	26.7	47.4
2.3	18.30	30.6	54.4
3.2	25.36	42.4	75.4
4.0	31.64	52.9	94.0
4.5	35.56	59.5	106
6.0	47.34	79.2	141

**ZAM® Mass table for coating mass symbol 190**

Coating mass symbol 190	Nominal size	3×6	4×8
	Width (mm)	914	1,219
	Length (mm)	1,829	2,438
	Area (m²)	1.672	2.972
Coating mass (kg/m²)	0.380		
Thickness (mm)	Unit mass (kg/m²)	Mass/sheet (kg)	Mass/sheet (kg)
0.27	2.500	4.18	7.43
0.3	2.735	4.57	8.13
0.4	3.520	5.89	10.5
0.5	4.305	7.20	12.8
0.6	5.090	8.51	15.1
0.8	6.660	11.1	19.8
1.0	8.230	13.8	24.5
1.2	9.800	16.4	29.1
1.6	12.94	21.6	38.5
2.0	16.08	26.9	47.8
2.3	18.44	30.8	54.8
3.2	25.50	42.6	75.8
4.0	31.78	53.1	94.5
4.5	35.70	59.7	106
6.0	47.48	79.4	141

Coating mass symbol	45	60	90	120	150	190	300
Coating mass constant (kg/m²)	0.090	0.120	0.180	0.240	0.300	0.380	0.600

# Mass of cut sheets

**ZAM® Mass table for coating mass symbol K08**

Coating mass symbol K08	Nominal size	3×6	4×8
	Width (mm)	914	1,219
	Length(mm)	1,829	2,438
	Area (m²)	1.672	2.972
Coating mass (kg/m²)	0.120		
Thickness (mm)	Unit mass (kg/m²)	Mass/sheet (kg)	Mass/sheet (kg)
0.27	2.240	3.74	6.66
0.3	2.475	4.14	7.36
0.4	3.260	5.45	9.69
0.5	4.045	6.76	12.0
0.6	4.830	8.07	14.4
0.8	6.400	10.7	19.0
1.0	7.970	13.3	23.7
1.2	9.540	15.9	28.4
1.6	12.68	21.2	37.7
2.0	15.82	26.4	47.0
2.3	18.18	30.4	54.0
3.2	25.24	42.2	75.0
4.0	31.52	52.7	93.7
4.5	35.45	59.3	105
6.0	47.22	78.9	140

**ZAM® Mass table for coating mass symbol K14**

Coating mass symbol K14	Nominal size	3×6	4×8
	Width (mm)	914	1,219
	Length(mm)	1,829	2,438
	Area (m²)	1.672	2.972
Coating mass (kg/m²)	0.203		
Thickness (mm)	Unit mass (kg/m²)	Mass/sheet (kg)	Mass/sheet (kg)
0.27	2.323	3.88	6.90
0.3	2.558	4.28	7.60
0.4	3.343	5.59	9.94
0.5	4.128	6.90	12.3
0.6	4.913	8.21	14.6
0.8	6.483	10.8	19.3
1.0	8.053	13.5	23.9
1.2	9.623	16.1	28.6
1.6	12.76	21.3	37.9
2.0	15.90	26.6	47.3
2.3	18.26	30.5	54.3
3.2	25.32	42.3	75.2
4.0	31.60	52.8	93.9
4.5	35.53	59.4	106
6.0	47.30	79.1	141

**ZAM® Mass table for coating mass symbol K18**

Coating mass symbol K18	Nominal size	3×6	4×8
	Width (mm)	914	1,219
	Length(mm)	1,829	2,438
	Area (m²)	1.672	2.972
Coating mass (kg/m²)	0.244		
Thickness (mm)	Unit mass (kg/m²)	Mass/sheet (kg)	Mass/sheet (kg)
0.27	2.364	3.95	7.03
0.3	2.599	4.34	7.72
0.4	3.384	5.66	10.1
0.5	4.169	6.97	12.4
0.6	4.954	8.28	14.7
0.8	6.524	10.9	19.4
1.0	8.094	13.5	24.1
1.2	9.664	16.2	28.7
1.6	12.80	21.4	38.1
2.0	15.94	26.6	47.4
2.3	18.30	30.6	54.4
3.2	25.36	42.4	75.4
4.0	31.64	52.9	94.0
4.5	35.57	59.5	106
6.0	47.34	79.1	141

**ZAM® Mass table for coating mass symbol K27**

Coating mass symbol K27	Nominal size	3×6	4×8
	Width (mm)	914	1,219
	Length(mm)	1,829	2,438
	Area (m²)	1.672	2.972
Coating mass (kg/m²)	0.381		
Thickness (mm)	Unit mass (kg/m²)	Mass/sheet (kg)	Mass/sheet (kg)
0.27	2.501	4.18	7.43
0.3	2.736	4.57	8.13
0.4	3.521	5.89	10.5
0.5	4.306	7.20	12.8
0.6	5.091	8.51	15.1
0.8	6.661	11.1	19.8
1.0	8.231	13.8	24.5
1.2	9.801	16.4	29.1
1.6	12.94	21.6	38.5
2.0	16.08	26.9	47.8
2.3	18.44	30.8	54.8
3.2	25.50	42.6	75.8
4.0	31.78	53.1	94.4
4.5	35.71	59.7	106
6.0	47.48	79.4	141

Coating mass symbol	K06	K08	K10	K12	K14	K18	K20	K22	K25	K27	K35	K45
Coating mass constant (kg/m²)	0.090	0.120	0.150	0.183	0.203	0.244	0.285	0.305	0.350	0.381	0.458	0.565

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# 9 Typical applications



## Farming



▲ Greenhouse



▲▼ Henhouse roof

(Enlarged view)





## Construction



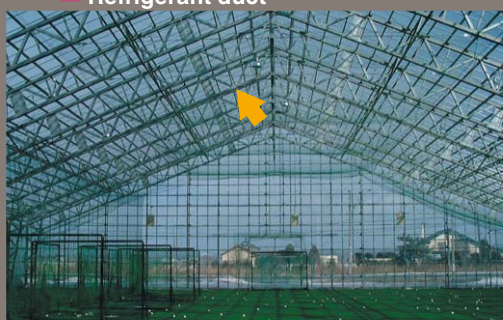
▲ Refrigerant duct



▲ Sound barrier louver



▲ Heavy-duty shutter



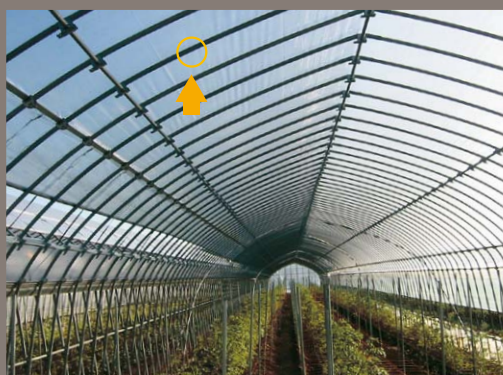
▲ Indoor baseball field



▲ Ceiling crosspiece



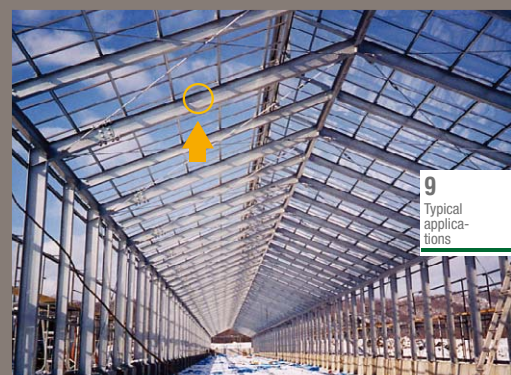
▲ House frame



▲ Greenhouse



▲ Compost house



▲ Compost house



▲ Cropper ① rotary case ② Front cover



▲ Grape arbor prop



▲ Fish preserve (frame)



# 9 Typical applications



▲ Bridge reinforcing plate (steel plate adhesion method)  
ZAM® ZKS processing, ZAM Grout®



▲ Sound barrier



▲ Snow fence



▲ Guardrail



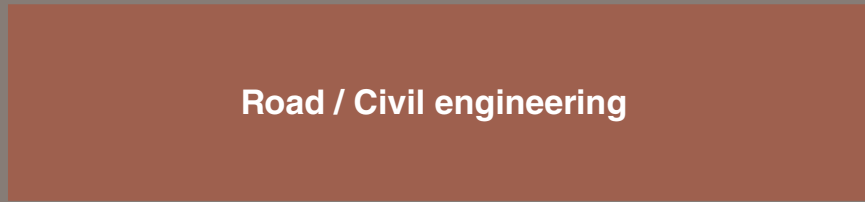
▲ Wind barrier panel



▲ Sound barrier member



▲ Bridge railing



Road / Civil engineering



## Change in appearance of actual constructions



Snow fence (Hokkaido)



No red rust was observed on its surface or end face even after the lapse of 10 years since construction.

Guardrail

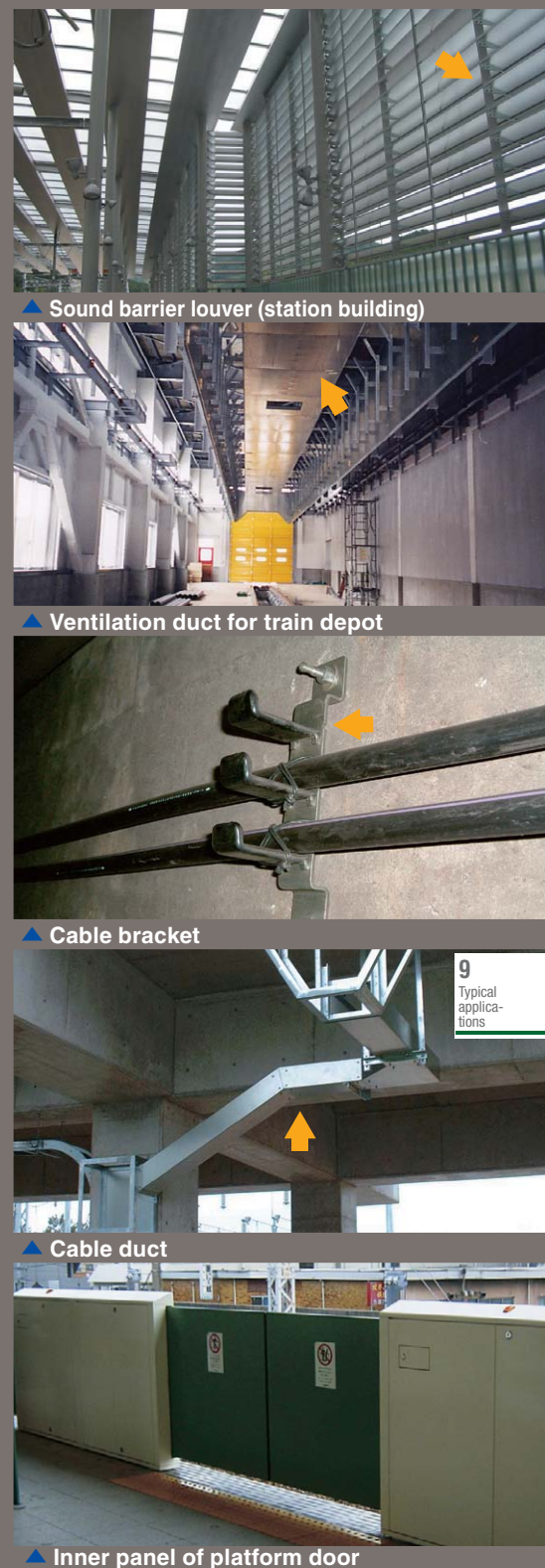


No red rust was observed on its surface even after the lapse of 5 years since construction.





## Railroad



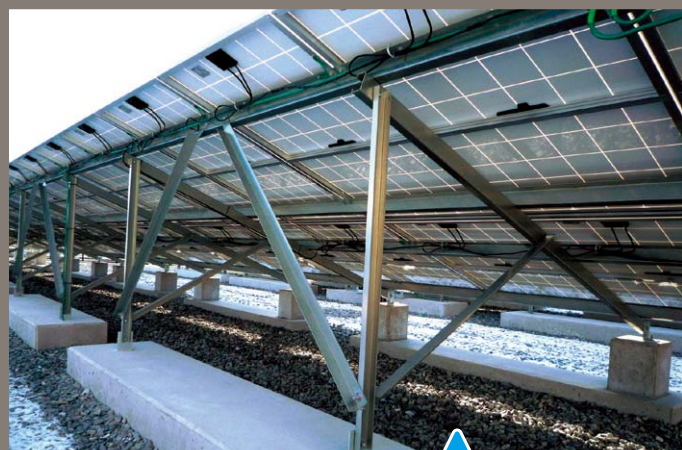


# 9 Typical applications

## Electric power and electric equipment



▲ Solar battery module frame



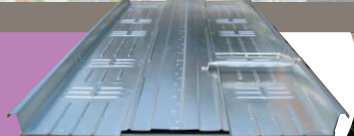
▲ Solar battery module frame



▲ Solar battery module frame



## Others



▲ Parking palette



▲ Multistory mechanical parking garage



▲ Bicycle racks





▲ Power control board



▲ Air conditioning unit



▲ Cable rack



▲ Cable rack



▲ Cable rack



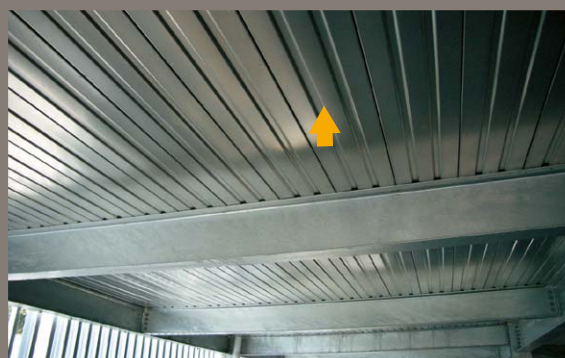
▲ Switchboard



9  
Typical  
applications



▲ Self-propelled multistory parking garage (distant view)



▲ Deck plate for parking lot (enlarged view)



▲ Fire-hydrant cabinet



# 9 Typical applications

**Housing**  
Electrical machinery/construction



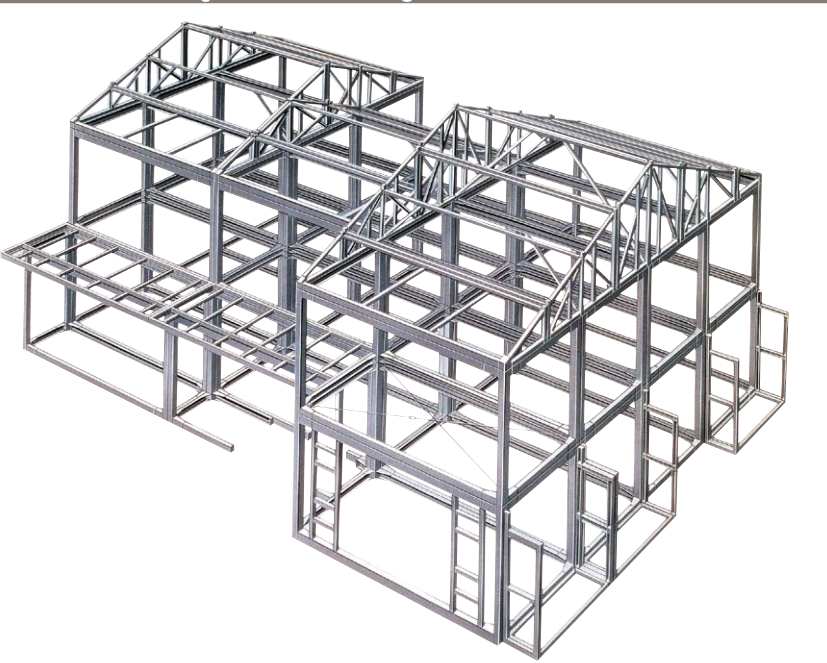
▲ Antenna mounting bracket



▲ Grounding rod



▲ EV charger



▲ Structural material for residential house



▲ Joint metal



▲ Structural material for housing (crossbeam)



▲ Fuel tank for oil fan heater



▲ Trestle for outdoor unit of air conditioner (unpainted)



▲ Trestle for outdoor unit of air conditioner (painted)



9  
Typical  
applications

▲ Bottom plate for outdoor unit of air conditioner



▲ Structural material for housing (crossbeam)



▲ Mounting strap



▲ Mounting strap



▲ Window anchor



▲ Door supporter



# 9 Typical applications

## Automobile parts

■ Wiper linkage



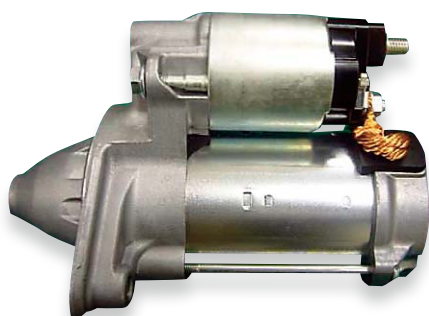
■ Filter case



■ Radiator fan motor cover



■ Starter motor yoke



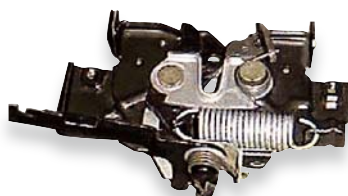
■ Horn



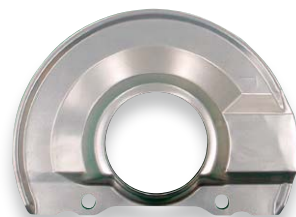
■ Pulley



■ Hood lock



■ Splash guard



▲ Engine room parts

▲ Car body parts



■ Battery module cover for HEV  
(Frame + cover)



■ Constant velocity joint cover



■ Tank heat protector



■ Latch



■ Lower sash



■ Window regulator motor yoke



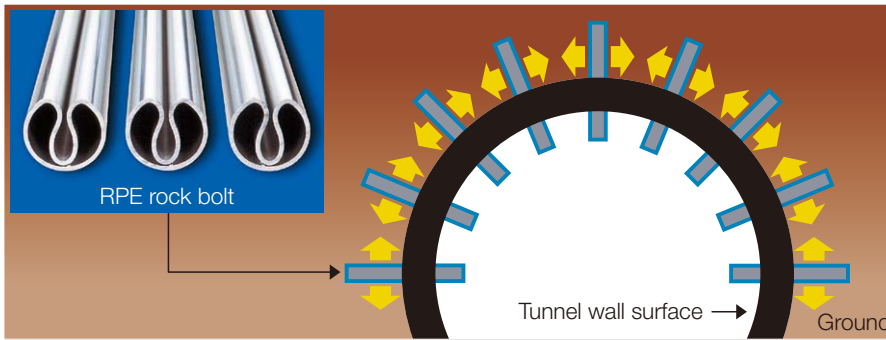
9  
Typical  
applica-  
tions



# 10 Affiliate companies' products

## RPE rock bolt

Nisshin Kokan Co., Ltd.



Mechanism of RPE rock bolt

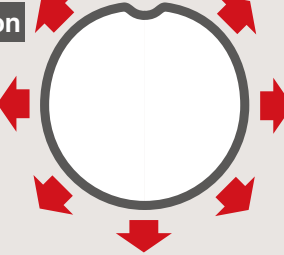
### Before expansion



(Diameter: 36.0 mm)

The ground is pressured by hydraulically expanding the steel pipe, thereby bringing about a clamping effect.

### After expansion



(Maximum diameter: 54.0 mm)

### Features

#### ① High corrosion resistant material

This product uses ZAM®, which is a prestress force-retaining elastic body and at the same time a high corrosion resistant steel sheet involving only a minimum of thickness reduction. It contributes greatly to the enhancement of long-term corrosion resistance of a tunnel.

#### ② High installation efficiency

Multiple (2 to 5) rock bolts can be installed at one time.

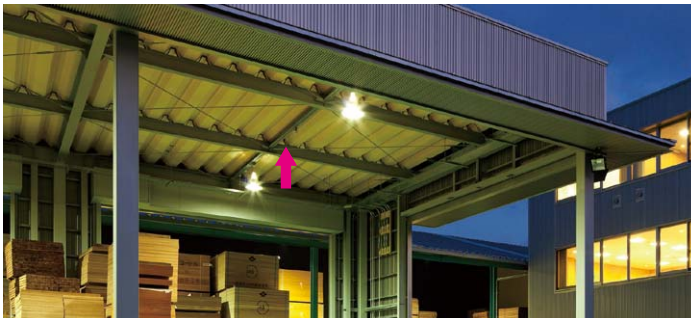
#### ③ Reduced environmental load

The compact and lightweight high pressure generator and the seal head lighten the work load.

Field	Application	Advantages	Coating weight symbol	Chemical conversion treatment	Thickness (mm)
Civil engineering	Rock bolt main body (12-ton proof strength)	High corrosion resistance, high concrete resistance	90	Untreated	54.0 mm in dia. X 2.0 (expanded)
	Rock bolt main body (18-ton proof strength)				54.0 mm in dia. X 2.3 (expanded)

■ For information on the product, contact: Sales Division of Nisshin Kokan Co., Ltd. (Tel: 03-3216-6315, <http://nisshin-kokan.co.jp>)

## Standing seam folded-plate roof HK-500 (ZAM® is used for its parts) Nihon Teppan Co., Ltd.



High corrosion resistance coated steel sheet ZAM® tight frame

Tsuzuki Corporation, Higashi Tokyo Office (Koto-ku, Tokyo)  
Designed by: City Architectural Planning Laboratory  
Installed by: Kanetomo Co., Ltd.  
Photographed by: Nobuaki Nakagawa



Double tight frame F type

Enhanced durability is assured through the adoption of ZAM®, a high corrosion resistant coated steel sheet having a zinc-6% aluminum-3% magnesium coating layer.

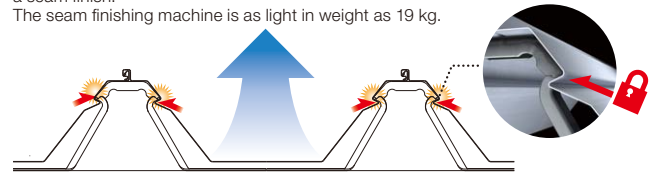
### Features

#### ① Excellent performance

- As fitting positions are provided on both sides of the main body, the product exhibits superior resistance to wind load.
- A layer of air formed after seam finish prevents capillary action, increasing water-tightness.
- A fitting rib is provided to improve bending rigidity.

#### ② High installation efficiency

- Without any need for a suspender, this product can be easily mounted to a tight frame.
  - Because of the plate shape characteristic of the HK Series, it is easy to provide a seam finish.
- The seam finishing machine is as light in weight as 19 kg.

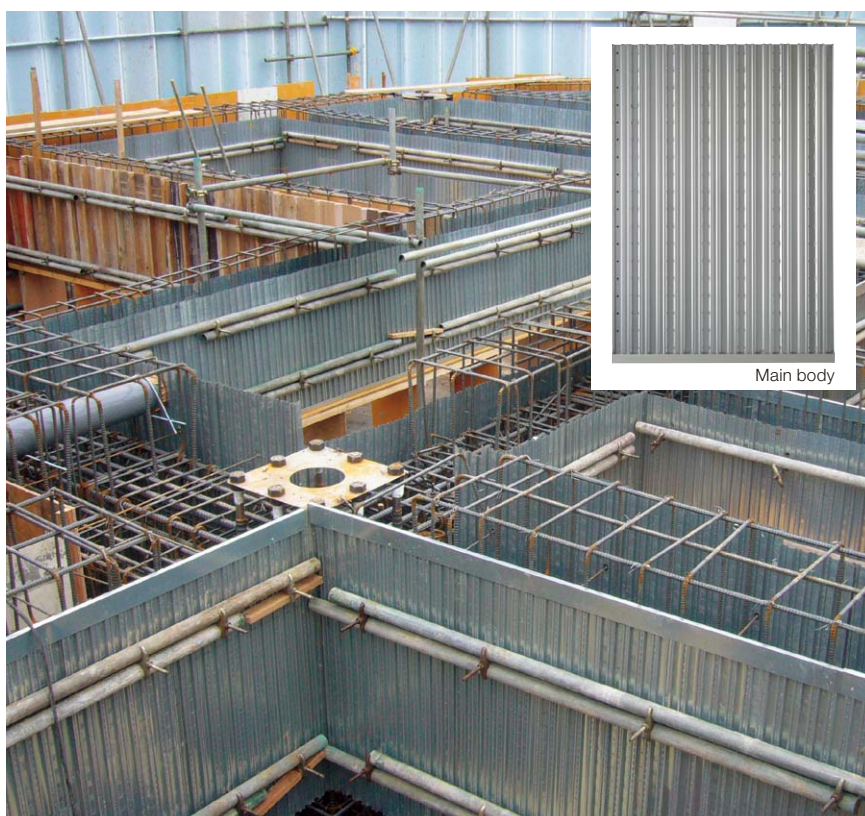


Field	Application	Advantages	Coating weight symbol	Chemical treatment	Thickness (mm)
Building material	Double tight frame F type	High corrosion resistance, high processability	90	A treatment	2.8
	Universal clamp				2.8
	Seam fitting spacer				1.6

■ For information on the product, contact: Exterior Building Material Sales Division of Nihon Teppan Co., Ltd. (Tel: 03-3272-5120, <http://www.np-nippan.co.jp>)

# Steel framework “Sepamate”

Nisshin A&C Co., Ltd.



## Features

### ① Lightweight, space-saving

This product is light in weight and easy to handle, contributing to the enhancement of work efficiency and the improvement of the work environment. Because the product is made of a light-gauge steel sheet of 0.4 mm, it can be stored in a narrow space to secure a wider work space. These features work to decrease the number of packages, lessen the amount of materials to be carried in and out, reduce the number of trucks, and shorten operation time of heavy machines.

### ② Process simplification, cost reduction

Since no form removal is necessary, the worker can proceed to backfilling only by removing reinforcing materials after concrete placement, making it possible to shorten the work period. With only horizontal reinforcing materials required, this product involves only a small amount of materials to be carried out, leaving practically no waste materials. Nearly free of incineration cost, it also cuts down cost.

### ③ Reduced environmental load

Since this product leaves practically no waste materials, unlike plywood forms, it promises to decrease environmental destruction like deforestation and significantly lessen the amount of carbon dioxide generated at the time of waste material incineration. Naturally, it is also expected that the decrease in the number of necessary vehicles and heavy machines will have the effect of reducing carbon dioxide emissions.

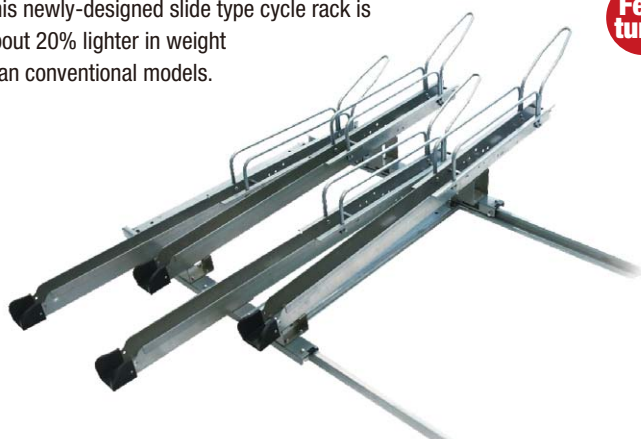
Field	Application	Advantages	Coating weight symbol	Chemical treatment	Thickness (mm)
Building material	Main body of Sepamate	High corrosion resistance, high concrete resistance	60	ZC treatment	0.4

■ For information on the product, contact: Steel Sheet Processing Division of Nisshin A&C Co., Ltd. (Tel: 03-5635-6123, <http://www.nisshin-aandc.co.jp>)

# Slide type bicycle rack

Shinwa Kigyo Co., Ltd.

This newly-designed slide type cycle rack is about 20% lighter in weight than conventional models.



## Features

### ① 1.5 times higher in capacity than conventional racks

• With 20 bicycles stowed, model H-2 has a width of 5,600 mm while front wheel model Z-1 has a width of 8,600 mm.

### ② Easy to take bicycles in and out

• The rack itself can be freely moved laterally for easy storage of bicycles.

### ③ Distinguished durability and environmental friendliness provided by ZAM®

• Employing ZAM®, Nisshin Steel's high corrosion resistant hot-dip coated steel sheet, this product requires no painting, contributing to resource saving.

### ④ Wide field of view to ensure security

• Even the upper rack of model H-2 has a height of 800 mm.  
• The capacity is nearly the same as that of double-deck type.

### ⑤ The parking lot for bicycles can be flexibly designed without any concern for the height of the ceiling height.

• Even in the presence of beams or ducts, this product can be installed without problems, thereby increasing the freedom of bicycle-parking area design.

Field	Application	Advantages	Coating weight symbol	Chemical conversion treatment	Thickness (mm)
Equipment	Main body	High corrosion resistance, high processability, process simplification	90	ZC treatment	1.6
	Tire guide				φ12.7×1.2
	Slider				2.3
	Rail				3.2
	Base				3.2

■ For information on the product, contact: Bicycle Parking Space Division of Shinwa Kigyo Co., Ltd. (Tel: 03-3553-8516, <http://www.shinwa-kigyo.co.jp>)

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## Precautions for use

### ● Use underwater or in flowing water

In applications underwater or with frequent exposure to flowing water, the stable protective film layer that is characteristic of ZAM<sup>®</sup> is difficult to form, so that sometimes ZAM<sup>®</sup> may gather red rust early without showing superiority to hot-dip zinc-coated steel sheets. Be aware of this when using it in such applications.

### ● Handling

- In order not to damage the coating surface, handle the product carefully and do not put any sweat or finger smudges on the surface.
- If the surface should become damaged, repair it.
- Be careful when removing a coil band because the end of the coil could spring up as it unwinds.
- Store products securely, so that coils do not tip over and stacked-up cut sheets do not topple.
- Be careful to prevent water stains and dew condensation.  
If packaging paper is damaged, repair it.

### ● Processing

- If the surface is damaged during processing, it could adversely affect corrosion resistance and paintability.  
In particular, some types of lubricating oil may corrode the coating layer during press working. It is therefore necessary to check the type of lubricating oil to be used. When lubricant is used, perform degreasing or other post-treatment after the processing.
- As time passes, a steel sheet tends to harden, resulting in a decrease in workability. To avoid this, use the steel sheet as soon as possible.

### ● Precautions to prevent galvanic corrosion

- (1) Avoid direct contact with lead or copper (or copper ion drops)
- (2) For metal fittings and attachments, use products made of stainless steel (SUS304) or aluminum or those which are painted or heavily coated with zinc for increased durability.
- (3) When using ZAM<sup>®</sup> in a salt-damaged or snow-covered area, use metal fittings and attachments made of a similar metal (aluminum, zinc-coated metal) or stainless steel insulated properly and treated with an anticorrosive (or a sealing material)
- (4) In such applications as lightning conductors where corrosion is likely to occur, insulation tape or aluminum wire should be used.  
(Source: Preventive measures of bimetallic corrosion of prepainted/zinc-based coated steel sheets: Hot-dip zinc-coated Committee, The Japan Iron & Steel Federation)

### ● Precautions to prevent corrosion due to contact with a preservative-treated or termite resistant wood

ZAM<sup>®</sup> should not be left in contact with wood containing preservative/ant repellent for an extended period of time.

Wood and laminated wood treated with preservatives and ant-repellants (primarily copper-based agents) adversely affect corrosion resistance property of coated steel sheets and prepainted steel sheets. Therefore, where these steel sheets are likely to come in contact with wood materials (parts of the roofs including eaves, roof edges and joints for example), insulation underthatch (roofing stock or butyl tape) should be used for rust prevention and steel-wood direct contact should be avoided.

(Source: Preventive measures of bimetallic corrosion of prepainted/zinc-based coated steel sheets: Hot-dip zinc-coated Committee, The Japan Iron & Steel Federation.)

### ● Welding

- When conducting resistance welding, proper care should be taken of the electrodes to remove zinc pickups.
- For coated steel sheets containing ZAM<sup>®</sup>, coatings evaporate due to heat from welding, so that greater amounts of sputtering and fume are generated than in the case of hot- or cold-rolled steel sheets. Take appropriate safety measures at the time of welding work.

#### <Safety measures for welding hot-dip zinc-coated steel sheets>

When welding hot-dip zinc-coated steel sheets, in addition to such common welding hazards as electrification, damage to the eyes caused by arc ray, burn caused by contact with hot objects and fire, be careful of;

1. increase in volume of fume generated by evaporating zinc, and
2. burns or fires due to larger volumes of spatters generated.

Especially, since fume is inevitable when welding hot-dip zinc-coated steel sheets, proper measures should be put in place. Health hazards of zinc are shown in the table.

Effects of zinc on the human body

Item	Effect
Carcinogenicity	Has not been confirmed at the present time
Acute toxicity	It is known that inhaling a large quantity of zinc fumes results in a fever several hours later (zinc fume fever). The affected person recovers naturally in about 24 hours. The mechanism by which this occurs is not understood.
Chronic toxicity	No evidence has been found that zinc causes symptoms of chronic toxicity.
Other effects	Zinc deficiency can cause delayed growth, reduced functioning of the gonads, depression, loss of appetite, and other symptoms.
Zinc, which is present in the human body in greater quantity than any other [metal] element except iron, which is an important essential element. Its harmfulness is thought to be low provided that protective measures are taken and a large quantity is not ingested.	

Source : Osamu Wada, "Metals and Man : Ecotoxicology and Clinical Practice," published by Asakura Shoten (1985)



# Phenomenon of darkening of hot-dip zinc-based coating

## ● Overview

- It is known that with the passage of time, hot-dip zinc-coated steel sheets are subject to what is called darkening, namely, decrease in surface glossiness. ZAM® may also suffer discoloration as with other hot-dip zinc-based alloy coated steel sheets.

## ● What is darkening?

- Darkening is a phenomenon in which the steel sheet appears gray due to the presence of a very thin oxide film on the zinc surface layer. In hot-dip hot-dip zinc-coated steel sheets, a very thin oxide film whose principal component is ZnO is formed on the zinc coating surface layer even immediately after manufacturing, and it has the property of changing and growing as time passes. From our experience to date, we infer that this phenomenon of darkening occurs by the following mechanism.

① An oxide film grows



② The structure and thickness of the oxide film change



③ The changed state of ② causes a change in the optical absorption coefficient



④ The surface takes on a gray appearance

## ● Characteristics of darkening

- In hot-dip zinc-based alloy coated steel sheet the zinc surface layer is covered with a very thin oxide film (mainly composed of ZnO). But the rate at which the oxide film changes and grows varies depending on such conditions as the structure and composition of the material as well as environmental factors, and the time until darkening becomes noticeable varies. This darkening is unavoidable, but it is known to occur more readily under conditions of high temperature and high humidity. Darkening is just an oxidation phenomenon on the zinc coating layer, thus the product quality is normal except for its gray appearance.
- This phenomenon develops when this material is stored either in the form of coil or cut sheet. It is therefore recommended to use the product as early as possible.

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## Guide to ordering

- Material, coating weight, chemical conversion treatment, oiling
  - Select steel grade, coating weight, and chemical treatment to fit your application. Apart from the type of chemical treatment, you can choose either antirust oiling or no oiling. Oiling is recommended to minimize lubrication during press processing, soiling, and scratching. Oiling is necessary when no treatment is made.
- Size
  - Design according to the production range described in this catalog. Contact us beforehand if your conditions for use require more stringent specifications.  
Please consult us for sizes outside the range.
- Product Shapes
  - Choose either mill edge or slit edge according to your application.  
Also, choose either coils or cut sheets according to your cutting and processing conditions.  
From the standpoint of promoting continuous, automated operations and optimizing yield, it is recommended to use coils.  
When using coils, be aware that sometimes defective parts may be mixed in (because such parts cannot be removed by the inspection).
- Inside diameter and outside diameter
  - In the case of coils, specify the inside diameter and outside diameter to fit the specifications of your equipment. In specifying the inside diameter, allow for possible buckling in inner laps of the coil depending on the sheet thickness.
- Packing mass
  - Specify the packing mass according to handling capacity, etc. For coils, specify the maximum mass (if necessary, the minimum unit mass). The greater the mass, the easier the operation will be.
- Applications and processing methods
  - Quality control better suited to your application and processing method can be applied if relevant information is timely provided.

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