SuperDyma™
Catalog Series Materials

NIPPON STEEL & SUMITOMO METAL
http://www.nssmc.com/
SuperDyma is a new type of highly corrosion-resistant coated steel sheet with a coating composition consisting of zinc as the main substrate in combination with aluminum (about 11%), magnesium (about 3%) and a trace amount of silicon.

**Exceptional Resistance to Rust!**
- Not only rust resistant on flat surfaces
- But also highly rust resistant on cut-end surfaces
- In addition, extremely high alkaline resistance

The corrosion resistance of SuperDyma is enhanced by the composite effect of adding aluminum, magnesium and silicon to the conventional zinc coating. Silicon, among other elements, is highly effective in inhibiting corrosion when combined with Mg.

**High Workability**
- Strongly resistant to rust at bends and in cylindrically-drawn sections; fine finishes with fewer scratches after fabrication
- Distinguished weldability and paintability

SuperDyma offers high coating adherence that can withstand severe fabricating processes. The coating has a high degree of hardness, thus offering excellent scratch resistance.

**New Steel Materials Excellent in Value Analysis**
- Reductions in cost and delivery time due to the elimination of post-coating and post-painting
- Proposal to replace stainless steel and aluminum

In contrast to fabricated products using post-coated and post-painted steel sheets, the total cost and delivery time associated with fabricated products using SuperDyma can be greatly reduced. Furthermore, due to its resistance to red rust, SuperDyma can be used as a substitute material for stainless steel and aluminum products.
Why Does Steel Rust?

Twenty-one percent of the air is oxygen. That is why it is virtually impossible for any metal to exist in pure form. Metals combine with atmospheric oxygen to form oxides. Iron in its natural state exists as iron ore, an oxide, and steel is produced by using coke to reduce the iron ore. The resulting steel tends to react again with the oxygen in the air to cause oxidation—this oxidation of steel is a phenomenon called “rusting.”

Corrosion Mechanism

When iron is exposed to rain and water, moisture is adsorbed onto iron’s surface.

1. Iron (steel) is composed of Fe and electrons (\( \text{Fe} + \text{e}^- \)).

2. Because moisture on iron’s surface is exposed to the atmosphere, oxygen in the atmosphere is absorbed into moisture.

3. The occurrence of rust can be prevented by forming a barrier on the surface of the iron and suppressing the chemical reaction that causes rust.

4. Hence, the rust prevention method —

   - OH\(^-\) and Fe\(^{3+}\) bond together to generate Fe(OH)\(_3\), and then moisture (H\(_2\)O) runs out to generate rust (Fe\(_2\)O\(_3\)). This is the mechanism whereby rust occurs.

   - The occurrence of rust can be prevented by forming a barrier on the surface of the iron and suppressing the chemical reaction that causes rust.

   - Accordingly, iron is given surface treatments as a means to prevent rust from developing.
Surface treatments are roughly classified into two types: coating and painting. There are two kinds of coating: pre-coating in which the steel is coated prior to fabrication, and post-coating in which the coating is applied afterwards. Further coating is classified into two: electro-coating whereby electrolytic coating is provided, and hot-dip coating whereby the steel is dipped into a molten coating material.

Most steel sheets are put on the market after receiving treatments for corrosion resistance and decorativeness.

**Annual Corrosion Rate**

The annual corrosion rates for iron and zinc are compared at the right. In rural environments, while iron oxidizes to a depth of 20 microns, zinc demonstrates much better corrosion resistance by oxidizing to only 1.5 microns. Utilizing this superior performance, zinc is an effective material for surface treatment.

**Service Life of Steel**

An example of the service life of hot-dip galvanized (Zn-coated) steel sheet (thickness: 3.2 mm, Z27) is shown below. This galvanized steel sheet offers an 11-year service life when provided with a 19-micron coating of zinc. However, once the zinc coating is lost, the steel still has a service life of three years, for a total service life of 15 years.

By providing coatings with higher corrosion resistance, the service life of steel as a whole can be prolonged.
Corrosion Protection Mechanism on Flat Surfaces

SuperDyma is produced by coating aluminum, magnesium and silicon to the conventional zinc coating, thereby using the composite effect of these added elements to derive its high corrosion resistance. That is, SuperDyma’s capacity to protect against corrosion is enhanced by adding silicon and magnesium, whose beneficial effect is demonstrated by Nippon Steel & Sumitomo Metal’s hot-dip Zn-5%A\text{R}alloy coated sheets and DYMAZINC\text{TM} (Zn-Mg alloy-coated steel), to the conventional additive aluminum. Silicon is effective in improving the workability of coatings containing aluminum and at the same time enhances corrosion suppression through composite action with magnesium.

Corrosion Protection Mechanism on Cut-end Surfaces and at Welded Sections

Because the cut-end surface of SuperDyma’s base metal is exposed, red rust sometimes occurs during the initial stage of application. However, the composition of the coating around the cut-end surface is such that it leeches out to form a tight protective film composed mainly of zinc hydroxide (Zn(OH)\text{\textsubscript{2}}), basic zinc chloride (\text{Zn}Cl\text{\textsubscript{2}}\cdot4\text{Zn(OH)}\text{\textsubscript{2}}) and magnesium hydroxide (\text{Mg(OH)}\text{\textsubscript{2}}). This tight film covers the cut-end surface within several months. It is low in electric conductivity and effective in suppressing the development of corrosion at the cut-end surface. Further, the silicon contained in the coating acts to accelerate the formation of the protective film described above.

Corrosion Resistance of Flat Surfaces

The corrosion resistance of SuperDyma (assessed by salt-spray tests to determine corrosion rate) is extremely high — about 30 times that of hot-dip Zn-coated sheets and about 5 times that of hot-dip Zn-5%A\text{R}alloy-coated sheets.

Note: GALVALUME\text{TM} is a trademark of BIEC International Inc.
Comparison with Conventional Hot-dip Zinc-coated Sheets

**Corrosion Resistance of Flat Surfaces**

Conventional hot-dip Zn-coated steel sheets also produce a protective film. However, this film is rough in texture, allowing the penetration of moisture and oxygen and a resultant growth of corrosion.

By contrast, the dense protective film formed on the surface of SuperDyma arrests the corrosion process and stabilizes corrosion behavior.

### Corrosion Resistance of Flat Surfaces (Salt Spray Tests)

<table>
<thead>
<tr>
<th>Test time</th>
<th>Before test</th>
<th>500 hours</th>
<th>1,000 hours</th>
<th>2,000 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>SuperDyma</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness: 3.2 mm</td>
<td>Coating mass: K12</td>
<td>Special chromate treatment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Corrosion Resistance of Flat Surfaces (Results of JASO)**

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Type of coating</th>
<th>Coating mass</th>
<th>Surface treatment</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot-dip Zn-coated sheet</td>
<td>Zn</td>
<td>237</td>
<td>Special chromate treatment</td>
<td>1.6mm</td>
</tr>
<tr>
<td>SuperDyma</td>
<td>Zn-11.5%Al-3%Si-0.2%Mg</td>
<td>K18</td>
<td>Special chromate treatment</td>
<td>1.6mm</td>
</tr>
<tr>
<td>GALVALUME STEEL SHEET</td>
<td>Zn-55%Ai</td>
<td>A2100</td>
<td>Special chromate treatment</td>
<td>1.6mm</td>
</tr>
</tbody>
</table>

Results of Outdoor Exposure Tests

- In the actual exposure environment outdoors, a slight degree of initial rust occurs on cut-end surfaces, but, after a while, a stable protective film covers the cut-end surface, thus virtually arresting further progress of corrosion in the long run.
- Red rust which occurs in the initial phase is arrested in progress, with time, by the effect of the protective film and, soon entirely covered by the film, becomes quite inconspicuous.

### Corrosion Resistance at Cut-end Surfaces

SuperDyma has superb corrosion resistance at its cut-end surfaces.

#### Corrosion Resistance at Cut-end Surfaces: Initial Period (Results of Salt Spray Tests)

<table>
<thead>
<tr>
<th>Specimen conditions</th>
<th>Thickness: 3.2 mm</th>
<th>Surface treatment: No treatment</th>
<th>Salt spray test: 500 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot-dip Zn-coated sheet</td>
<td>Coating mass: 100 g/m²/side</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SuperDyma</td>
<td>Coating mass: 90 g/m²/side</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GALVALUME STEEL SHEET</td>
<td>Coating mass: 90 g/m²/side</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Corrosion Resistance at Cut-end Surfaces: Middle and Latter Periods (Results of Outdoor Exposure Tests)

<table>
<thead>
<tr>
<th>Specimen conditions</th>
<th>SuperDyma</th>
<th>Thickness: 3.2 mm</th>
<th>Coating mass: 90 g/m²/side (K12)</th>
<th>Surface Treatment: No treatment</th>
<th>Exposure site: Nippon Steel &amp; Sumitomo Metal's weathering site at Futtsu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side view of cut-end surfaces</td>
<td>Upward</td>
<td>7 days</td>
<td>14 days</td>
<td>1 month</td>
<td>2 month</td>
</tr>
<tr>
<td>Downward</td>
<td>8 months</td>
<td>20 months</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Comparison with Post-coated Steel Sheets**

**Corrosion Resistance at Flat Surfaces**

In the case of fabricated post-coated products with heavy zinc coatings of 550 g/m² per side (HDZ55, according to JIS H8641), the protective film has a coarse texture that over time allows corrosion to progress until red rust forms.

SuperDyma even with a coating of only 90 g/m² per side (coating mass symbol: K18) is quite free of red rust, thus offering corrosion resistance equal or superior to that of HDZ55.

**Test Method**

1. After coating of one side of cut-end surfaces with corrosion-protection agent, the specimen was exposed outdoor (see the figure below)
2. Exposure site: Ichikawa, Chiba Prefecture (rural environment)
3. Exposure period: August 8, 2001~

**Corrosion Resistance at Cut-end Surfaces (Results of Salt Spray Tests)**

<table>
<thead>
<tr>
<th>Test time</th>
<th>1,000 hours</th>
<th>2,000 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SuperDyma K18</strong> (Thickness: 1.6 mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Post-coated sheet HDZ55</strong> (Thickness: 6.0 mm)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Repair Coating at Cut-end Surfaces (Results of Salt Spray Tests)**

- **SuperDyma**
  - Thickness: 4.5 mm, 6.0 mm, 9.0 mm
  - Coating mass: K18
  - Surface treatment: Special chromate treatment (Y treatment)

- **Breton R143-C**
  - Product of Sugimura Chemical Industry Co., Ltd.

- **SuperDyma K18** (Repair-coated for cut-end surface; test time: 2,000 hours)
  - Thickness: 4.5 mm
  - Thickness: 6.0 mm
  - Thickness: 9.0 mm

**Corrosion-protection Treatment at Cut-end Surfaces**

<table>
<thead>
<tr>
<th>Exposure period</th>
<th>Coating of corrosion-protection agent</th>
<th>No coating of corrosion-protection agent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 week</td>
<td><img src="image" alt="Coating of corrosion-protection agent" /></td>
<td><img src="image" alt="No coating of corrosion-protection agent" /></td>
</tr>
<tr>
<td>1 month</td>
<td><img src="image" alt="Coating of corrosion-protection agent" /></td>
<td><img src="image" alt="No coating of corrosion-protection agent" /></td>
</tr>
</tbody>
</table>

The results of a 2,000-hour salt spray test on SuperDyma K18 show that red rust does not occur on cut-end surfaces. (The specimen installation angle conforms to JIS Z2371 “Methods of salt spray testing”.)
Comparison with Stainless Steel, Aluminum and GALVALUME STEEL SHEET

It is true that stainless steel offers superb corrosion resistance thanks to the passivated film that forms on its surface. However, it has the disadvantage of being vulnerable to corrosion caused by salt. Meanwhile, the protective film that forms on the surface of SuperDyma provides a strong and effective barrier against salt corrosion. In terms of resistance to pitting corrosion and other properties that affect the "service life of steel" and are of key importance when steel is used as a structural material, stainless steel is superior. SuperDyma, on the other hand, is far more advantageous in applications such as panel surfaces where "resistance to red rust" is paramount.

The exceptional corrosion resistance of aluminum also derives from the passivated film on its surface. GALVALUME STEEL SHEET, with an alloy coating that is 55% aluminum, demonstrates a similar effectiveness. However, aluminum exhibits poor alkali resistance.

### Corrosion Resistance of SuperDyma and Stainless Steel at Flat Surfaces (Results of JASSO)

**Test conditions:** Cyclic corrosion test (JASSO M609) Repetition of 30 cycles as a cycle:
- Salt spray: 2 hours (5% NaCl, 35°C)
- Drying: 4 hours (80°C, humidity 30%)
- High-temperature wetting: 2 hours (150°C, humidity 98%)

**SuperDyma K18** (Special chromate treatment)

**Stainless steel SUS304**

### Corrosion Resistance at Cut-end Surfaces (Results of Salt Spray Tests)

**Specimen conditions:** Thickness: 3.2 mm Surface treatment: No treatment
- Salt spray test: 500 hours

**SuperDyma**
- Coating mass: 90 g/m²/side

**GALVALUME STEEL SHEET (Laboratory trial-made sample)**
- Coating mass: 90 g/m²/side

**Weak resistance to chlorine and alkali**

**Strong resistance to chlorine**

**Stainless steel**

**Aluminum**

**GALVALUME STEEL SHEET**

**Weak to alkali**

Under alkaline conditions with a relatively high pH, GALVALUME STEEL SHEET corrodes very quickly while SuperDyma shows less susceptibility to corrosion and remains virtually intact.

In alkaline environments (cattle and compost sheds, mortar and concrete), the quality of SuperDyma remains high.

Under severer conditions requiring the immersion of steel sheets in an alkaline solution with a strong pH of 12.5, ordinary metallic-coated steel sheets experience rapid corrosion over a period of 100 hours. But, SuperDyma keeps the corrosion to a minimum and remains stable after 300 hours.

*GALVALUME STEEL SHEET is a product sold and registered trademark in Japan.*

![Image of corrosion resistance tests](image-url)
**Excellent Quality Characteristics**

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### Corrosion Resistance of Bends

- **SuperDyma** shows the same excellent corrosion resistance at bends as it does on flat surfaces.

### Corrosion Resistance of 11t Bends (Results of Salt Spray Tests)

<table>
<thead>
<tr>
<th>Specimen conditions</th>
<th>Thickness: 0.8 mm</th>
<th>Salt spray test: 1,000 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot-dip Zn-coated sheet</td>
<td>Coating mass: 135 g/m²/side</td>
<td></td>
</tr>
<tr>
<td><strong>SuperDyma</strong></td>
<td>Coating mass: 90 g/m²/side</td>
<td></td>
</tr>
<tr>
<td><strong>GALVALUME STEEL SHEET</strong></td>
<td>Coating mass: 75 g/m²/side</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Post-coated sheet was coated after bending

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### Corrosion Resistance of Cylindrically-drawn Sections

- **SuperDyma** shows the same excellent corrosion resistance in cylindrically-drawn areas as it does on flat surfaces.

### Corrosion Resistance of Cylindrically-drawn Sections (Results of Cyclic Corrosion Tests)

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Thickness (mm)</th>
<th>Coating mass/side (g/m²)</th>
<th>Crinkle mass/side (g/m²)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>SuperDyma</td>
<td>1.0</td>
<td>95 g/m²</td>
<td>40 g/m²</td>
<td>Test-made product for practical use</td>
</tr>
<tr>
<td>Hot-dip Zn-coated sheet</td>
<td>1.0</td>
<td>130 g/m²</td>
<td>15 g/m²</td>
<td>Product for practical use</td>
</tr>
</tbody>
</table>

**Deep-drawing test conditions**

- Punch dia. 50
- Die shoulder R10
- Punch shoulder R10
- Drawing ratio 2.0
- Blank holding pressure 0.5 tons

**Test time**

- Before test
- 30 cycles
- 60 cycles

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### Scratch Resistance

- The coating layer of SuperDyma is hard, thus offering high scratch resistance.

**Scratch Resistance**

- **SuperDyma**
- **Hot-dip Zn-coated sheet**
- **GALVALUME STEEL SHEET**

**Vicker’s hardness (Hv)**

- Load: 0.098 N

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**TM**
Weldability

- As thin-coat SuperDyma exhibits high corrosion resistance, impediments brought about by heavier coating thicknesses are not presented.
- A variety of welding methods (lapped fillet arc welding, spot welding) can be applied to SuperDyma.

(Note)

In the case of arc welding, while the weld bead will generally show shrinkage, large internal tension force is at work on the base metal in the vicinity of the bead, depending on the structure of the members to be welded. (Example: Circumferential fillet welding, see figure at right).

When coated steel sheets such as SuperDyma are applied in such welding, there are cases in which the base metal in the vicinity of the bead may crack*, and thus prior confirmation is recommended before application.

*Liquid metal embrittlement phenomenon: Embrittlement caused by penetration into the grain boundary of iron upon which tensile stress is at work. Also called arc embrittlement.

Corrosion Resistance of Spot Welds

In the case of SuperDyma, the protective film covers the weld as the cycle increases, thus suppressing the development of red rust.

Corrosion Resistance of Spot Welds (Results of Salt Spray Tests)

<table>
<thead>
<tr>
<th>Specimen conditions</th>
<th>Coating material: SuperDyma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness: 0.8 mm</td>
<td>Coating mass/side: 180 g/m²</td>
</tr>
<tr>
<td>Post-treatment: Y treatment</td>
<td></td>
</tr>
</tbody>
</table>

Test method

- After high-frequency butt welding, the weld is repaired by coating zinc-rich paint (see the figure below).
- Film thickness in repair coating is shown below.

Assessment Results for Corrosion Resistance of Repaired Welds (Results of Salt Spray Tests)

<table>
<thead>
<tr>
<th>Specimen conditions</th>
<th>Coating material: SuperDyma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness: 0.8 mm</td>
<td>Coating mass/side: 180 g/m²</td>
</tr>
<tr>
<td>Post-treatment: Y treatment</td>
<td></td>
</tr>
</tbody>
</table>

Test method

- Welding and repairing of welds

Results of repair using zinc-rich paint

<table>
<thead>
<tr>
<th>Coated sheet</th>
<th>Repair film thickness (μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SuperDyma</td>
<td>16.6</td>
</tr>
</tbody>
</table>

Graph showing corrosion resistance over time.
### SuperDyma

**Excellent Quality Characteristics**

**Paintability**
- Super Dyma has excellent pre-treatability for painting.
- Painted Super Dyma has superb corrosion resistance, with little susceptibility to corrosion-induced rises of the coating film in cut-end surfaces and cross-cut parts.

**CCT 30 Cycles of Structural Materials**

<table>
<thead>
<tr>
<th>Specimen conditions</th>
<th>Test conditions</th>
<th>Repetition of a-c as a cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness: 0.8 mm</td>
<td>Salt spray: 4 hours (0.5% NaCl, 35°C)</td>
<td>x</td>
</tr>
<tr>
<td>Coating conditions: Pretreatment – Chromate treatment</td>
<td>Drying: 4 hours (10°C, humidity 35%)</td>
<td>x</td>
</tr>
<tr>
<td>Primer coat – Epoxy P-01 coating film thickness 5 μm</td>
<td>High-temperature setting: 4 hours (25°C, humidity 98% or more)</td>
<td>x</td>
</tr>
<tr>
<td>Top coat – Polyester NSC300HQ coating film thickness 15 μm</td>
<td>Drying: 4 hours (70°C, humidity 35%)</td>
<td>x</td>
</tr>
</tbody>
</table>

### Corrosion Potential (Contact Corrosion with Different Metals)

- A certain metal comes into contact with another metal, where corrosion is accelerated. This phenomenon is called contact corrosion with different metals.
- In case of contact of two kinds of metals, the metal having low electric potential (less precious metal) causes corrosion. (Refer to the table below: for example, in case when iron contacts with zinc, zinc corrodes.)

**Standard Electrode Electric Potential (Hydrogen Electrode as Parameter)**

<table>
<thead>
<tr>
<th>Metal</th>
<th>Electric potential (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen</td>
<td>0.000</td>
</tr>
<tr>
<td>Nickel</td>
<td>-0.250</td>
</tr>
<tr>
<td>Iron</td>
<td>-0.440</td>
</tr>
<tr>
<td>Zinc</td>
<td>-0.763</td>
</tr>
<tr>
<td>Aluminum</td>
<td>-1.682</td>
</tr>
<tr>
<td>Magnesium</td>
<td>-2.363</td>
</tr>
</tbody>
</table>

**Cold-rolled sheet**

**Super Dyma**

**GALVAMILE STEEL SHEET**

- Because SuperDyma has higher corrosion resistance than conventional zinc-coated sheets, the degree of corrosion due to contact with different metals seems low.
- However, the phenomenon of contact corrosion occurs, and accordingly when bolts, rivets and other members are used in contact with SuperDyma, it is recommended to use those bolts and rivets with the electric potential to that of SuperDyma (post-coated and other similar products) or provided with coating treatment.

### Results of 3-year Exposure of Unpainted SuperDyma in Okinawa

- When the results of 3-year exposure of SuperDyma and other test specimens are examined, red rust does not occur in SuperDyma, showing fine surface appearance.
- Further, occurrence of white rust is less for SuperDyma, compared to hot-dip Zn-coated sheets.
- Corrosion loss of SuperDyma after removal of white rust is about 25% that of hot-dip Zn-coated sheets.

#### Specimen

- SuperDyma
- Hot-dip Zn-coated sheet

#### Coating mass (one side)

- SuperDyma: 90 g/m²
- Hot-dip Zn-coated sheet: 150 g/m²

#### Post-treatment

- No treatment

#### Exposure site: Okinawa


**SuperDyma Catalog**
Chromate-free treatment of SuperDyma is attained by providing a special film to SuperDyma and features the following characteristics.

1. It contains no chromate at all.
2. SuperDyma is coated with a special film that does not contain any chromate.
3. The special film ensures corrosion resistance equal or superior to that of the conventional normal chromate-treated steel sheets.
4. The special film provides workability equal or superior to that of conventional chromate-treated steel sheets thanks to the effects of the special film.
5. The special film has workability comparable to that of the conventional chromate-treated steel sheets.
6. The QFK type features a low coefficient of friction. Thus, it is more workable than the conventional chromate-treated steel sheets.

**Corrosion Resistance Mechanism of Conventional Chromate Treatment and Chromate-free Coating Film**

Chromate Coating Film

- Shutting out of corrosion factors
- Coating film
- Zinc coating layer
- Steel sheet

Chromate-free Coating Film

- Shutting out of corrosion factors
- Coating film
- Zinc coating layer
- Special coating film (barrier effect)
- Self-restorative function

When this film is injured, soluble hexavalent chromium leaches out to offer a "self-restorative function" that repairs the film.

**Surface Insulation Resistance Test (JIS C 2550)**

- Total area of contacts: 10 cm²
- Standard test pressure: 2 N/mm² ± 5 %
- Surface area of contact: 1 cm² × 10
- Test voltage: 0.5 V
- Current measuring range: 0–1 A
- Test duration: 80 h
- Surface insulation resistance value (Ω cm²/sheet)
- Test piece: Coated steel sheet

**Battery**

- Approx 30 V
- Output: 2 A

**How to Interpret the Results**

- A value of 10 cm²/sheet or more is considered acceptable.
Chromate-free treatment of SuperDyma

Conductivity (grounding property)

**LORESTA (4-probe type)**

Conceptual diagram showing the contact resistance (LORESTA 4-probe type) measuring system

- **Tester:** LORESTA MP-type of Dia Instrument Co., Ltd.
- **Test current:** 1 μA → 100 μA
- **Resistance measuring range:** $10^0 \sim 10^7$ Ω
- **Surface area of contacts:** $2 \text{mm} \times 4$, Interprobe distance 5 mm
- **Contact load:** 1.5 N
- **Evaluation:** Continuity rate (%) = number of continuity / 20 tests × 100

![Conductivity diagram]

An example of the contact resistance (LORESTA 4-probe type) test results (conductivity)

Coating Property

**Coat adherence**

An example of paint adhesion test results

<table>
<thead>
<tr>
<th>Coating conditions</th>
<th>Type of coating material</th>
<th>Thickness of coat</th>
<th>Baking conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>Melamine alkyd type</td>
<td>20 μm</td>
<td>120°C × 20min</td>
</tr>
<tr>
<td>Testing method</td>
<td>Cross-cut test</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Erichsen test</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Judgment**

- No change
- Slight peeling
- Considerable peeling
- Complete peeling

Primary: Evaluation after top coating.

Coating property varies according to the type of coating material used and the method of coating employed. So, please make sure to check beforehand with the coating material to be used. Please also refrain from applying zinc phosphate for under-treating as it dissolves the coating film in some cases. (Please use untreated substrates which are easy to produce zinc phosphate film.)

Recommended Welding Conditions

A variety of welding methods (arc welding, spot welding, etc.) can be applied to SuperDyma by adjusting the welding conditions.

**Welding-applicable Coating Mass**

Welding-applicable coating mass symbols from K06 to K45. Meanwhile, for coated sheets with a coating mass symbol greater than K27, apply welding after decreasing or after reducing the coating thickness to the equivalent of K27 or under.

Note:

In the case of arc welding, there are cases in which the base metal in the vicinity of the bead may crack depending on the welding conditions, and thus prior confirmation is recommended before application. (For details, refer to note on page 16.)

**Recommended Welding Conditions**

- **Arc Welding**
  - Use CO2 or MAG welding machines
  - Application of the conditions listed in the following table for welding wire and shield gas is recommended.

<table>
<thead>
<tr>
<th>Welding machine</th>
<th>Kind of wire</th>
<th>Shield gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2 welder</td>
<td>JIS Z 3312 YGW14 equivalents</td>
<td>CO2</td>
</tr>
<tr>
<td>MAG welder</td>
<td>JIS Z 3312 YGW17 equivalents</td>
<td>80% argon + 20% CO2</td>
</tr>
</tbody>
</table>

- **Spot Welding**

It is necessary that the optimum conditions for spot welding be determined according to the plate thickness. For example, when spot welding coated sheets 3.2 mm in thickness, it is recommended that the electrode and welding conditions (welding pressure, welding time, welding current) shown in the following table be applied.

**Welding of SuperDyma**

A variety of welding methods can be applied to SuperDyma with coating mass symbols from K06 to K45. Meanwhile, for coated sheets with a coating mass symbol greater than K27, apply welding after decreasing or after reducing the coating thickness to the equivalent of K27 or under.

Note:

In the case of arc welding, there are cases in which the base metal in the vicinity of the bead may crack depending on the welding conditions, and thus prior confirmation is recommended before application. (For details, refer to note on page 16.)

**Recommended Welding Conditions**

- **Arc Welding**
  - Use CO2 or MAG welding machines
  - Application of the conditions listed in the following table for welding wire and shield gas is recommended.

<table>
<thead>
<tr>
<th>Welding machine</th>
<th>Kind of wire</th>
<th>Shield gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2 welder</td>
<td>JIS Z 3312 YGW14 equivalents</td>
<td>CO2</td>
</tr>
<tr>
<td>MAG welder</td>
<td>JIS Z 3312 YGW17 equivalents</td>
<td>80% argon + 20% CO2</td>
</tr>
</tbody>
</table>

- **Spot Welding**

It is necessary that the optimum conditions for spot welding be determined according to the plate thickness. For example, when spot welding coated sheets 3.2 mm in thickness, it is recommended that the electrode and welding conditions (welding pressure, welding time, welding current) shown in the following table be applied.

**Specifications:** NSDH400, Plate thickness: 3.2 mm, Coating mass symbol: K27

- **Strength of arc-welded section**
  - Standard test: Butt weld joint tensile test
  - Internal condition of arc-welded section
  - Internal condition of spot-welded section

![Welding diagram]

**Reference**

- **Assessment of Welds**

Welding is applied under the above-mentioned conditions, and it has been confirmed that there are no problems with regard to product quality vis-à-vis weld strength, internal weld conditions or others.

For details, refer to the catalog under SuperDyma—Welding.

![Welding diagram]
Production Process

SuperDyma Production Line at Hirohata Works

Payoff reel → Shear → Welder → Pickling tank → Pretreatment → Chemical treatment equipment → Heat treatment → Cooling device → Coating-weight adjusting device → Dryer → Exit-side looper

SuperDyma Production Line at Kimitsu Works

Payoff reel → Shear → Welder → Pre-heating furnace → Non-oxidizing furnace → Reducing furnace → Slow-cooling furnace → Rapid-cooling furnace → Zinc bath → Skin-pass mill → Tension leveler → Chemical-treatment equipment → Inspection table → Tension reel

Available Sizes

The range of manufacturable sizes is as shown below.

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>Width (mm)</th>
<th>Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>580</td>
<td>9.00</td>
<td>0.27</td>
</tr>
<tr>
<td>610</td>
<td>9.00</td>
<td>1.60</td>
</tr>
<tr>
<td>880</td>
<td>9.00</td>
<td>2.50</td>
</tr>
<tr>
<td>1,110</td>
<td>9.00</td>
<td>3.20</td>
</tr>
<tr>
<td>1,100</td>
<td>9.00</td>
<td>0.27</td>
</tr>
<tr>
<td>1,240</td>
<td>9.00</td>
<td>0.27</td>
</tr>
<tr>
<td>1,240</td>
<td>9.00</td>
<td>0.29</td>
</tr>
<tr>
<td>1,524</td>
<td>9.00</td>
<td>0.40</td>
</tr>
</tbody>
</table>

In the dotted line region, please contact us.
The available size shown above are for general-purpose specifications.
For other specifications and sizes surpassing those shown in table, please contact us.
Specifications

Kinds and Symbols
Thickneses from 0.27 mm to 9.0 mm are available.

<table>
<thead>
<tr>
<th>Nominal thickness (mm)</th>
<th>Thicknesses from 0.27 mm to 9.0 mm are available.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.60</td>
<td>For commercial use</td>
</tr>
<tr>
<td>2.50</td>
<td>For drawing use-1</td>
</tr>
<tr>
<td>4.00</td>
<td>For drawing use-2</td>
</tr>
<tr>
<td>6.00</td>
<td>For structural use</td>
</tr>
<tr>
<td>9.00</td>
<td>For structural use</td>
</tr>
</tbody>
</table>

Note: Minimum coating mass of Zn coating may be agreed upon between the parties involved with deliveries. For K06 and K45, please consult us.

Chemical Treatment
The kind and symbol of chemical treatment for plates/cut sheets and coils are as shown in Table 3.

<table>
<thead>
<tr>
<th>Symbol of kind</th>
<th>Nominal thickness (mm)</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSDCD</td>
<td>0.27 ± 0.05 ± 0.30</td>
<td>For commercial use</td>
</tr>
<tr>
<td>NSDCH</td>
<td>0.27 ± 0.10</td>
<td>For commercial use, hard class</td>
</tr>
<tr>
<td>NSDCH1</td>
<td>0.40 ± 0.2 ± 0.30</td>
<td>For drawing use-1</td>
</tr>
<tr>
<td>NSDCH2</td>
<td>0.40 ± 0.2 ± 0.50</td>
<td>For drawing use-2</td>
</tr>
<tr>
<td>NSDCH3</td>
<td>0.60 ± 0.2 ± 0.50</td>
<td>For drawing use 3</td>
</tr>
<tr>
<td>NSDC10</td>
<td>0.27 ± 0.2 ± 0.30</td>
<td>For structural use</td>
</tr>
<tr>
<td>NSDC20</td>
<td>0.27 ± 0.2 ± 0.30</td>
<td>For structural use</td>
</tr>
<tr>
<td>NSDC40</td>
<td>0.27 ± 0.2 ± 0.30</td>
<td>For structural use</td>
</tr>
<tr>
<td>NSDC60</td>
<td>0.27 ± 0.2 ± 0.30</td>
<td>For structural use</td>
</tr>
</tbody>
</table>

Note: 1) NSDC3 sheets and coils, when non-aging property is to be guaranteed, shall be subject to the kind and symbol of chemical treatment for plates/cut sheets and coils as shown in Table 3.

2) Kind of chemical treatment not shown in Table 3 may be agreed upon between the parties involved with deliveries.

Skin-pass Treatment
The skin-pass treatment for achieving a smooth surface may be specified in the order.

Coating Mass
The kind and symbol of coating mass are as shown in Table 2.

<table>
<thead>
<tr>
<th>Symbol of coating mass</th>
<th>Average minimum coating mass in triple-spot test on both sides</th>
<th>Minimum coating mass in single spot on both sides</th>
</tr>
</thead>
<tbody>
<tr>
<td>K06</td>
<td>60</td>
<td>51</td>
</tr>
<tr>
<td>K08</td>
<td>80</td>
<td>68</td>
</tr>
<tr>
<td>K10</td>
<td>100</td>
<td>85</td>
</tr>
<tr>
<td>K12</td>
<td>120</td>
<td>100</td>
</tr>
<tr>
<td>K14</td>
<td>140</td>
<td>119</td>
</tr>
<tr>
<td>K18</td>
<td>180</td>
<td>153</td>
</tr>
<tr>
<td>K20</td>
<td>200</td>
<td>170</td>
</tr>
<tr>
<td>K22</td>
<td>220</td>
<td>187</td>
</tr>
<tr>
<td>K25</td>
<td>250</td>
<td>213</td>
</tr>
<tr>
<td>K27</td>
<td>275</td>
<td>234</td>
</tr>
<tr>
<td>K35</td>
<td>350</td>
<td>288</td>
</tr>
</tbody>
</table>

Chemical Treatment
The kind and symbol of chemical treatment for plates/cut sheets and coils are as shown in Table 3.

<table>
<thead>
<tr>
<th>Symbol of kind</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>No treatment</td>
<td>M</td>
</tr>
<tr>
<td>Special chromate treatment</td>
<td>Y</td>
</tr>
<tr>
<td>Corrosion resistant chromate treatment</td>
<td>ON</td>
</tr>
</tbody>
</table>

Note: 1) Kind of chemical treatment not shown in Table 3 may be agreed upon between the parties involved with deliveries.

2) For more details, please consult us.

Oiling
The kind and symbol of oiling for plates/cut sheets and coils are as shown in Table 4.

<table>
<thead>
<tr>
<th>Kinds of oiling</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy oiling</td>
<td>H</td>
</tr>
<tr>
<td>Ordinary oiling</td>
<td>N</td>
</tr>
<tr>
<td>Thin oiling</td>
<td>L</td>
</tr>
</tbody>
</table>

Note: Kinds of oiling not shown in Table 4 may be agreed upon between the parties involved with deliveries.

Mechanical Properties

Yield Point, Tensile Strength, Elongation, and Non-aging Property
Yield point, tensile strength, elongation, and non-aging property (in the case of using CR base sheets) of plates/cut sheets and coils are as shown in Tables 5 and 6.

<table>
<thead>
<tr>
<th>Symbol of kind</th>
<th>Yield point (N/mm²)</th>
<th>Tensile strength (N/mm²)</th>
<th>Elongation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSDCC</td>
<td>0.20 ± 0.05 ± 0.40</td>
<td>0.20 ± 0.05 ± 0.40</td>
<td>1.5 ± 1.0 ± 2.0</td>
</tr>
<tr>
<td>NSDCO1</td>
<td>0.27 ± 0.05 ± 0.50</td>
<td>0.27 ± 0.05 ± 0.50</td>
<td>2.0 ± 2.0 ± 3.0</td>
</tr>
<tr>
<td>NSDC40</td>
<td>0.27 ± 0.2 ± 0.30</td>
<td>0.27 ± 0.2 ± 0.30</td>
<td>3.0 ± 3.0 ± 4.0</td>
</tr>
</tbody>
</table>

Note: 1) In case when non-aging property is specified for plates/sheets and coils for NSDCC, non-aging property is guaranteed for 6 months after delivery from production plants. Non-aging property indicates the property of no occurrence of stretcher strains during fabrication.

2) Prior consultation is requested for every lot of orders for NSDCOH and NSDCOH370 products.

3) For more details, please consult us.
This product is intended for applications requiring corrosion resistance and paintability.

### Table 7-2 Thickness Tolerances (HR Base Sheets, For Commercial Uses)

<table>
<thead>
<tr>
<th>Nominal Thickness (mm)</th>
<th>W ≤ 1,250</th>
<th>W &gt; 1,250</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.60 ≤ t ≤ 2.00</td>
<td>± 0.12</td>
<td>± 0.18</td>
</tr>
<tr>
<td>2.00 ≤ t ≤ 2.60</td>
<td>± 0.19</td>
<td>± 0.26</td>
</tr>
<tr>
<td>2.00 ≤ t ≤ 3.25</td>
<td>± 0.20</td>
<td>± 0.27</td>
</tr>
<tr>
<td>2.50 ≤ t ≤ 3.25</td>
<td>± 0.21</td>
<td>± 0.30</td>
</tr>
<tr>
<td>3.15 ≤ t ≤ 4.00</td>
<td>± 0.22</td>
<td>± 0.34</td>
</tr>
<tr>
<td>4.00 ≤ t ≤ 5.00</td>
<td>± 0.25</td>
<td>± 0.39</td>
</tr>
<tr>
<td>5.00 ≤ t ≤ 6.00</td>
<td>± 0.27</td>
<td>± 0.44</td>
</tr>
<tr>
<td>6.00 ≤ t ≤ 8.00</td>
<td>± 0.30</td>
<td>± 0.56</td>
</tr>
<tr>
<td>8.00 ≤ t ≤ 10.00</td>
<td>± 0.33</td>
<td>± 0.80</td>
</tr>
</tbody>
</table>

### Table 7-3 Thickness Tolerances (HR Base Sheets, For Structural Uses)

<table>
<thead>
<tr>
<th>Nominal Thickness (mm)</th>
<th>W ≤ 1,250</th>
<th>W &gt; 1,250</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.60 ≤ t ≤ 2.00</td>
<td>± 0.20</td>
<td>± 0.28</td>
</tr>
<tr>
<td>2.00 ≤ t ≤ 2.60</td>
<td>± 0.23</td>
<td>± 0.32</td>
</tr>
<tr>
<td>2.00 ≤ t ≤ 3.25</td>
<td>± 0.25</td>
<td>± 0.34</td>
</tr>
<tr>
<td>2.50 ≤ t ≤ 3.25</td>
<td>± 0.27</td>
<td>± 0.41</td>
</tr>
<tr>
<td>3.15 ≤ t ≤ 4.00</td>
<td>± 0.28</td>
<td>± 0.45</td>
</tr>
<tr>
<td>4.00 ≤ t ≤ 5.00</td>
<td>± 0.30</td>
<td>± 0.52</td>
</tr>
<tr>
<td>5.00 ≤ t ≤ 6.00</td>
<td>± 0.34</td>
<td>± 0.62</td>
</tr>
<tr>
<td>6.00 ≤ t ≤ 8.00</td>
<td>± 0.39</td>
<td>± 0.80</td>
</tr>
<tr>
<td>8.00 ≤ t ≤ 10.00</td>
<td>± 0.44</td>
<td>± 1.00</td>
</tr>
</tbody>
</table>

### Table 8 Thickness Tolerances (CR Base Sheets)

<table>
<thead>
<tr>
<th>Nominal Thickness (mm)</th>
<th>W ≤ 500</th>
<th>500 &lt; W ≤ 1,000</th>
<th>1,000 ≤ W ≤ 1,250</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 1.25</td>
<td>± 0.04</td>
<td>± 0.04</td>
<td>± 0.04</td>
</tr>
<tr>
<td>0.35 ≤ t ≤ 0.40</td>
<td>± 0.06</td>
<td>± 0.06</td>
<td>± 0.06</td>
</tr>
<tr>
<td>0.40 ≤ t ≤ 0.60</td>
<td>± 0.07</td>
<td>± 0.07</td>
<td>± 0.07</td>
</tr>
<tr>
<td>0.60 ≤ t ≤ 0.80</td>
<td>± 0.07</td>
<td>± 0.07</td>
<td>± 0.07</td>
</tr>
<tr>
<td>0.80 ≤ t ≤ 1.00</td>
<td>± 0.09</td>
<td>± 0.10</td>
<td>± 0.11</td>
</tr>
<tr>
<td>1.00 ≤ t ≤ 1.25</td>
<td>± 0.11</td>
<td>± 0.12</td>
<td>± 0.13</td>
</tr>
<tr>
<td>1.25 ≤ t ≤ 1.60</td>
<td>± 0.13</td>
<td>± 0.14</td>
<td>± 0.15</td>
</tr>
</tbody>
</table>

### Table 9 Equivalent Coating Thickness

<table>
<thead>
<tr>
<th>Symbol of coating thickness</th>
<th>Equivalent coating thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>K06</td>
<td>0.016</td>
</tr>
<tr>
<td>K08</td>
<td>0.021</td>
</tr>
<tr>
<td>K10</td>
<td>0.027</td>
</tr>
<tr>
<td>K12</td>
<td>0.033</td>
</tr>
<tr>
<td>K14</td>
<td>0.038</td>
</tr>
<tr>
<td>K18</td>
<td>0.044</td>
</tr>
<tr>
<td>K20</td>
<td>0.051</td>
</tr>
<tr>
<td>K22</td>
<td>0.054</td>
</tr>
<tr>
<td>K25</td>
<td>0.062</td>
</tr>
<tr>
<td>K27</td>
<td>0.068</td>
</tr>
<tr>
<td>K35</td>
<td>0.082</td>
</tr>
<tr>
<td>K45</td>
<td>0.101</td>
</tr>
</tbody>
</table>

### Table 10 Width Tolerances

<table>
<thead>
<tr>
<th>Width (mm)</th>
<th>W ≤ 500</th>
<th>500 &lt; W ≤ 1,000</th>
<th>1,000 ≤ W ≤ 1,500</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 25</td>
<td>± 1.0</td>
<td>± 1.0</td>
<td>± 1.0</td>
</tr>
<tr>
<td>25 &lt; W</td>
<td>± 1.0</td>
<td>± 1.0</td>
<td>± 1.0</td>
</tr>
</tbody>
</table>

### Table 11 Length Tolerances

<table>
<thead>
<tr>
<th>Length (mm)</th>
<th>L ≤ 2,000</th>
<th>2,000 &lt; L</th>
</tr>
</thead>
<tbody>
<tr>
<td>± 15</td>
<td>± 15</td>
<td>± 15</td>
</tr>
</tbody>
</table>
### Table 3 - Chemical Requirements

<table>
<thead>
<tr>
<th>Designation</th>
<th>C</th>
<th>Mn</th>
<th>P</th>
<th>Si</th>
<th>Cu</th>
<th>Ni</th>
<th>Mn+Ni</th>
<th>Fe</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS Grade</td>
<td>0.02</td>
<td>0.10</td>
<td>0.04</td>
<td>0.20</td>
<td>0.02</td>
<td>0.04</td>
<td>0.20</td>
<td>0.02</td>
</tr>
<tr>
<td>0.04</td>
<td>0.06</td>
<td>0.08</td>
<td>0.06</td>
<td>0.08</td>
<td>0.06</td>
<td>0.08</td>
<td>0.06</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4 - Mechanical Property Requirements, Base Metal (Longitudinal)

<table>
<thead>
<tr>
<th>Designation</th>
<th>Grade</th>
<th>Yield Strength, min ksi</th>
<th>Tensile Strength, min ksi</th>
<th>Elongation in 2 in., %</th>
<th>Grade</th>
<th>Yield Strength, min ksi</th>
<th>Tensile Strength, min ksi</th>
<th>Elongation in 2 in., %</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS</td>
<td>333</td>
<td>33 45 20</td>
<td>230</td>
<td>340 450 20</td>
<td>333</td>
<td>33 45 20</td>
<td>230</td>
<td>340 450 20</td>
</tr>
<tr>
<td>HSLAS</td>
<td>57</td>
<td>37 52 18</td>
<td>205</td>
<td>340 450 20</td>
<td>57</td>
<td>37 52 18</td>
<td>205</td>
<td>340 450 20</td>
</tr>
<tr>
<td>HSLAS-P</td>
<td>37</td>
<td>37 52 18</td>
<td>205</td>
<td>340 450 20</td>
<td>37</td>
<td>37 52 18</td>
<td>205</td>
<td>340 450 20</td>
</tr>
</tbody>
</table>

### Table 5 - Typical Ranges of Mechanical Properties (Nonmandatory)

<table>
<thead>
<tr>
<th>Designation</th>
<th>Yield Strength</th>
<th>Elongation in 2 in.</th>
<th>N Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS Type A</td>
<td>20ksi</td>
<td>20ksi</td>
<td>1</td>
</tr>
<tr>
<td>CS Type B</td>
<td>30ksi</td>
<td>30ksi</td>
<td>1</td>
</tr>
<tr>
<td>FS Type A</td>
<td>25ksi</td>
<td>25ksi</td>
<td>1</td>
</tr>
</tbody>
</table>

### Table 6 - Coating Bend Test Requirements

<table>
<thead>
<tr>
<th>Coating Designation</th>
<th>Through 1.0 mm</th>
<th>Over 1.0 mm to 2.0 mm</th>
<th>Over 2.0 mm</th>
<th>Over 2.0 mm to 3.0 mm</th>
<th>Over 3.0 mm</th>
<th>Over 3.0 mm to 4.0 mm</th>
<th>Over 4.0 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS, FS, DS, EDSS</td>
<td>1, 2, 3, 4</td>
<td>2, 3, 4, 5, 6</td>
<td>3, 4, 5, 6, 7</td>
<td>4, 5, 6, 7, 8</td>
<td>5, 6, 7, 8, 9</td>
<td>6, 7, 8, 9, 10</td>
<td></td>
</tr>
</tbody>
</table>

### Table 7 - Typical Ranges of Mechanical Properties (Normandy)**

<table>
<thead>
<tr>
<th>Designation</th>
<th>Yield Strength</th>
<th>Elongation in 2 in.</th>
<th>N Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS Type A</td>
<td>20ksi</td>
<td>20ksi</td>
<td>1</td>
</tr>
<tr>
<td>CS Type B</td>
<td>30ksi</td>
<td>30ksi</td>
<td>1</td>
</tr>
<tr>
<td>FS Type A</td>
<td>25ksi</td>
<td>25ksi</td>
<td>1</td>
</tr>
</tbody>
</table>

**No typical mechanical properties have been established.

---

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.

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.

Prior consultation is requested for every lot of orders for SS80 (550), HSLAS60 (410), MSLAS70 (480), HSLAS80 (550) and HSLAS-F products.
SuperDyma has obtained special approval as a durable structural material for housing construction according to the provisions of the Law Concerning Promotion of Securament of Housing Quality.

SuperDyma has obtained special approval as a structural material specified by the Minister of Land, Infrastructure, and Transport according to the provisions of the Building Standard Law, Article 37, No. 2.
Coated steel sheets are packaged and then shipped to protect them against damage that can be caused by normal handling and storage during the period from manufacture to practical application. A marking label is attached to each package to indicate the details of the content. Further, an inspection sheet is sealed inside the package to guarantee the product. Please use these label and sheet to check receipt of the product. The items described on these label and sheet are as follows.

## Indication of Specifications

### Products Conforming to ASTM Specifications

**ASTM A1046M (CS Type B) - 06**: S Z QN X

- Brand name
- A12303
- Inspector mark
- Shanghai
- Specifications
- Coating
- Size
- Inspection side
- Net mass
- Gross mass
- IWG net mass
- Sheets
- Coils
- Length (and Bundling Number)
- Cast number
- Contract No.
- Case No.
- Inspection No.

### Products Conforming to Nippon Steel & Sumitomo Metal's Own Specifications

**NSDCC: S Z QN X**

- Type designation
- Surface treatment symbol
- Skin-pass rolling symbol
- Oiling symbol (in the case of oiling: ON)
- Skin-pass rolling symbol
- Surface treatment symbol
- Type designation
- Surface finish symbol
- Oiling symbol

Note: If skin-pass rolling is not specified, the items after surface finish symbol are indicated by moving these items to the left.

### Example of Packaging

**Cut-length Sheet**

- Wooden pad
- Seal protector
- Lateral skid
- Packing label
- Product
- Longitudinal skid

**Coil**

- Hoop
- Packing paper
- Label
- Outer ring
- V.C.I. paper
- Steel cover
- Inside angle

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### Contents of the Package Label

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Brand name</td>
</tr>
<tr>
<td>1</td>
<td>A12303</td>
</tr>
<tr>
<td>2</td>
<td>Inspector mark</td>
</tr>
<tr>
<td>3</td>
<td>Shanghai</td>
</tr>
<tr>
<td>4</td>
<td>Specifications</td>
</tr>
<tr>
<td>5</td>
<td>Coating</td>
</tr>
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<td>6</td>
<td>Size</td>
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<tr>
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<td>Inspection side</td>
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<td>Net mass</td>
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<td>Gross mass</td>
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<td>11</td>
<td>Sheets</td>
</tr>
<tr>
<td>12</td>
<td>Coils</td>
</tr>
<tr>
<td>13</td>
<td>Length (and Bundling Number)</td>
</tr>
<tr>
<td>14</td>
<td>Cast number</td>
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<tr>
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<td>Contract No.</td>
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<tr>
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<td>Case No.</td>
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<td>Inspection No.</td>
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<td>18</td>
<td>Coil No.</td>
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<tr>
<td>19</td>
<td>Production date</td>
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<tr>
<td>20</td>
<td>Shipping mark</td>
</tr>
<tr>
<td>21</td>
<td>Maker's name</td>
</tr>
<tr>
<td>22</td>
<td>Works</td>
</tr>
<tr>
<td>23</td>
<td>Country of origin</td>
</tr>
</tbody>
</table>

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### Packaging and Marking

When inappropriate handling and application methods are used, SuperDyma cannot demonstrate its characteristic properties. It is recommended that attention be paid to the following precautions regarding use.

#### Storage and Loading/Unloading

1. Water leakage during loading/unloading and storage constitutes a cause of corrosion. Strictly avoid loading/unloading during rain and prevent exposure to seawater and dew condensation. Also, avoid storage in atmospheres of high humidity or sulfur dioxide. Indoor storage under dry, clean conditions is recommended.
2. Broken or torn packaging paper must be repaired.
3. When coils and cut-length sheets are stored in piles for an extended time, the coated surfaces may become blackened. Because of this, early application is recommended.

#### Handling

- Handle products carefully so as not to damage coatings or surface treatment films.
- Perspiration and fingerprints impair paintability and corrosion resistance. If either occurs, appropriate post-treatment and repair are required.

#### Precautions in Use

When removing (cutting) coil binding hoops (bands) for use, make certain that the end of the coil is directly beneath the coil center in order to prevent the end of the coil from sudden springing out of the coil end; or, be certain to conduct the removal in a place where safety can be assured and no danger is posed if the coil end were to spring out upon release.

#### Press Forming

1. The application of certain kinds of extreme pressure agents as lubricants during press forming can cause corrosion of the coating layer. Prior confirmation is requested when such agents are used. When such agents must be used, degreasing and other post treatments should be conducted thoroughly and quickly.
2. Broken or torn packaging paper must be repaired.
3. When coils and cut-length sheets are stored in piles for an extended time, the coated surfaces may become blackened. Because of this, early application is recommended.

#### Welding

- Failing and rolling coils are very dangerous, as is the collapse of piled sheets. To prevent such accidents during storage, due care should be paid to storing products in a stable, secure state.
- When removing (cutting) coil binding hoops (bands) for use, make certain that the end of the coil is directly beneath the coil center in order to prevent the end of the coil from sudden springing out of the coil end; or, be certain to conduct the removal in a place where safety can be assured and no danger is posed if the coil end were to spring out upon release.
- Coils are formed by winding flat sheets. When the binding hoops or other external forces that keep the sheet in coil form are removed and the coil end is freed, the coil end will spring outward to return to a flat state. Further, there are also cases when the coil bindings become loose, allowing the coil to spring out. Such cases may endanger nearby workers and cause damage, so careful attention must be paid when removing the coil binding hoops (bands).
When placing orders, confirmation is required for the following items per each intended application.

**Standards**
Select the most suitable material quality from among the standards described in this catalog according to the severity and methods of fabrication.

**Coating Mass**
Select the most suitable coating mass according to the required corrosion resistance, application conditions, and fabrication methods.

**Sizes**
The size of galvanized steel sheets (thickness, width and length) is the basic condition for product yield. Design the product referring to the range of available sizes described in this catalog. Sizes are available in 0.05-mm increments for thickness and 1-mm increments for width and length.

**Coils**
Select coils or cut-length sheets according to shear and fabrication conditions. The selection of coils will effectively improve product yield by allowing continuous and automated operation. In the case of coils, however, some defective parts may unavoidably be included because their removal based on inspection is impossible.

**Edge Finish**
Specify either mill edges or slit edges according to the application conditions.

**Surface Treatment**
Select the most suitable surface treatment from among those described in this catalog according to the treatment method after fabrication and the application conditions.

**Oiling**
The decision whether or not to apply rust-preventive oil can be made separately from the kind of surface treatment. Oiling is recommended in order to improve intermediate rust resistance, to mitigate fingerprints and damage during handling, and to maintain lubrication during press forming. Meanwhile, oiling is indispensable for galvanized sheets lacking surface treatment.

**Package Mass**
Specify the package mass according to the local loading/unloading capacity and work efficiency. The heavier the coil mass, the higher the work efficiency. In the case of coils, specify the maximum mass (unit minimum mass if necessary). The average package mass of actual shipments is determined by the relation between the maximum mass and the size to divide the manufacturing mass.

**Inside and Outside Coil Diameters**
In the case of coils, specify the inside and outside coil diameters according to the specifications of the uncoilers on the shearing line. When selecting inside diameters, it is necessary to consider the occurrence of break and reel marks on the area of the inside diameter, depending on the thickness.

**Dimensional Accuracy (Thickness, Width and Length)**
Dimensional accuracy of thickness, width and length is guaranteed within the range of sizes described in this catalog. However, there are cases that require strict size specifications with respect to assembly accuracy and dimensional accuracy of the parts, depending on the application conditions of the finished products. In such cases, consult us in advance to clarify the specifications.

**Applications, Fabrication Methods and Others**
Nippon Steel & Sumitomo Metal implements quality control to better suit the intended application. For that purpose, it is requested that the intended application, fabrication method, and other requirements be clearly indicated.
“Super Fabricated Products” Employing Super Dyma of Nippon Steel & Sumitomo Metal

SuperDyma: “The Right Material” — Promotes Cost Cutting

SuperDyma vs. Stainless and Aluminum Products

- Is it true that such superior corrosion resistance is necessary?
- Aren’t you resigned to the fact that steel is prone to rust?

>>> Allows cost cutting in applications where the corrosion resistance offered by stainless and aluminum products is not required.

SuperDyma vs. Post-coated and Post-painted Sheets

- Metallic coating plus painting: Is this time-consuming and costly processing truly necessary?
- Don’t you adopt a heavier-than-needed sheet thickness just because of the difficulty involved in the coating of steel sheet?

>>> Highly effective in reducing the inevitable “coating expense + transport cost” issues associated with post-coated and post-painted sheets

>>> Target applications: Thickness range of 3.2 mm or less for post-coated sheets

- Beautiful manufactured surface texture: How would you like this type of decorativeness?

>>> Enhanced decorative freedom obtained by fully utilizing metallic materials

SuperDyma: “The Right Place” — Meeting the Need for Corrosion Resistance

Application Environments That Require Higher Corrosion Resistance

Areas of salt damage
- Areas within 2 km of a coast line: Environments subject to flying particles of sea salt (pea-sized rock)
- Highways, bridges and surrounding areas in cold regions: Environments where agents used to treat ice and snow are dispensed to prevent freezing
- Multi-storied parking garages, factory buildings, plants, warehouses, bridges, highway- and shore-related facilities, other cost engineering/maintenance steel structures

Swimming pools, hot springs, underground sites and tunnels
- Swimming pools, bathrooms, hot spring underground structures, tunnels, underground multi-purpose duct inside

Highways, bridges and surrounding areas in cold regions: Environments where agents used to melt ice and snow are dispersed to prevent freezing

Aren’t you resigned to the fact that steel is prone to rust?

>>> Areas of salt damage
- Swimming pools, hot springs, underground sites and tunnels

Environments subject to high humidity and temperature, where temperature differences are large and condensation is likely to occur

Environments with a strong alkaline atmosphere and where gases are generated from livestock feed, manure, etc.

Environments with heat, high humidity, and condensation

Environments where agents used to melt ice and snow are dispersed to prevent freezing

Light-gauge shapes, pipe (round, square), steel-backing materials for ceiling, shade nets, deck plates, steel fences, lathes, various panel members, gratings

For improving VA proposal image

Matrix for corrosion resistance and cost

[Flow for fabrication and distribution cost]

Facilities and compost plants related to agriculture and dairy farming

- Environments subject to high humidity and temperature, where temperature differences are large and condensation is likely to occur
- Environments with a strong alkaline atmosphere and where gases are generated from livestock feed, manure, etc.

Contact with cement-rich concrete

Wall, floor structures and metal fixtures that contact with concrete

O T H E R S

For improving VA proposal image

Matrix for corrosion resistance and cost

[Flow for fabrication and distribution cost]
### No Hesitation in Selection! **Matrix for Selecting Super Fabricated Products**

<table>
<thead>
<tr>
<th>Right Materials</th>
<th>Post-coating and post-painting defamation</th>
<th>Replacement use for stainless steel and aluminum products</th>
<th>Salt damage area</th>
<th>Alkaline environment</th>
<th>High-humidity environment</th>
</tr>
</thead>
</table>

#### Right Places

- **Building construction**
  - Office house member (window frames, shutters)
  - Office house member (doors, windows)
  - Office house member (doors, panels)
  - Office house member (doors, buildings)
  - Office house member (doors, workspaces)
  - Office house member (doors, warehouses)
  - Office house member (doors, facades)

- **Civil engineering**
  - Office house member (doors, buildings)
  - Office house member (doors, structures)
  - Office house member (doors, components)
  - Office house member (doors, frameworks)

- **Housing structural members**
  - Office house member (doors, buildings)
  - Office house member (doors, structures)
  - Office house member (doors, components)
  - Office house member (doors, frameworks)

- **Agriculture and livestock farming**
  - Office house member (doors, buildings)
  - Office house member (doors, structures)
  - Office house member (doors, components)
  - Office house member (doors, frameworks)

- **Highways and railways**
  - Office house member (doors, buildings)
  - Office house member (doors, structures)
  - Office house member (doors, components)
  - Office house member (doors, frameworks)

- **Electricity and communications**
  - Office house member (doors, buildings)
  - Office house member (doors, structures)
  - Office house member (doors, components)
  - Office house member (doors, frameworks)

- **Electric machines, metal fillings, automobiles and others**
  - Office house member (doors, buildings)
  - Office house member (doors, structures)
  - Office house member (doors, components)
  - Office house member (doors, frameworks)

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**SuperDyma**

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Super Fabricated Products  Application field: Building Construction
Application field in which high decorativeness in addition to high corrosion resistance of SuperDyma is fully utilized

- Tochigi Plant of Meiji Kogyo (Light-gauge shape)
- Warehouse of Nippon Steel Logistics (Light-gauge shape /Square pipes)
- Mito Crystal Hotel (Exterior finish material /Fine floor)
- Noise-insulation wall at waste treatment plant (Punched metal)
- Semiconductor plant (Deck with reinforcement)
- Multi-storied parking garage at Chubu International Airport (Composite slab deck)
- Passenger terminal building at Chubu International Airport (Punched metal/Ceiling noise-absorption panel /Duct)
- Office building (Flat deck)
Building Construction

- Multi-storied parking garage at Okinawa Phoenix Hall (Composite slab deck)
- Kimitsu Works of Nippon Steel & Sumitomo Metal (Exterior wall /Steel sheet panel)
- Show room (Entrance/Panel border)
- Fire & Disaster Management Agency building (Cable rack)
- Swimming pool (Steel backing material for ceiling)
- University facility (Refrigerant pipe /Cable rack)
- Hospital facility (Cable rack)
- Office building (Cable rack)
- Waste treatment plant (Cable rack)
- Office building (Cable rack)
- KANEYASU Co. (Shutter)
- Noise-reduction equipment (Silencer/Looper)
- Toyota Stadium (Spectator seat framing)
Civil Engineering

Even in the application field where contact with earth and mortar concrete is unavoidable, SuperDyma demonstrates its inherent characteristic performances.

Excavation revetment work at Koyoshigawa/Sanjo area, Akita Prefecture
(E frame/Steel slope frame for nature-oriented revetment)

Construction of Sports Park Stadium of Chiba City
(E-PANET/Steel forms for concrete placement)

Wind-breaking fence (Punched metal)

Wind-breaking and snow-protection fences (Steel fence)

Earth-retaining fence (Expanded metal)

Punched metal

Super Fabricated Products Application field:

Civil Engineering

Even in the application field where contact with earth and mortar concrete is unavoidable, SuperDyma demonstrates its inherent characteristic performances.
**Super Fabricated Products**

**Application field:** Housing Structural Members

Application field where excellent workability and decorativeness can fully be utilized

- Round and square pipe
- Punching metal
- Sheet wall
- Metal fabrication
- Prefabricated house

- Gutter fixture
- Floor joist
- Living room partition
- 3-story steel-framed house (exterior finish panel)

- Metal fixture
- Multi-storied house (Fence)
- Multi-storied house (Door)
Super Fabricated Products Application field:

Agriculture and Livestock Farming

In the application field of agriculture and livestock-farming, excellent alkaline resistance of SuperDyma is demonstrated to the maximum.

- Agricultural house
  (Light-gauge shape+Component)

- Stock-farm cattle shed
  (Roof)

- Henhouse
  (Framing)

- Agricultural ventilation fan
  (Framing)

- Greenhouse
  (Framework member+Component)

- Compost house
  (Roof)

- Roof wall
Highways and Railways

In the field of highways and railways—the infrastructure field requiring high durability, high corrosion resistance of SuperDyma is highly assessed.

- Yokohama Bay Bridge (Cable rack)
- Musashino Bridge at Route 16 (Optical fiber protecting board)
- Moriya Station at Tsukuba Express (Stair fascia board)
- Station building at Taiwan Superexpress (Ceiling panel)
- Tunnel (Cable rack)
- Parking lot (U-shaped channel protecting cover)
- Highway noise barrier
- Tokyo Outer Loop Expressway (Rear-surface sound-absorption panel)
- Station platform (Main house member/Light-gauge shape)
Comparison of corrosion resistance (occurrence of red rust) for hot-dip galvanized steel sheet (GI) and SuperDyna (SD)

1. Comparison of corrosion resistance for GI and SD

1-1. Comparison of exposure test

Corrosion loss of plating after exposure in Okinawa is shown in Chart 1. When compared SuperDyna (SD) with hot-dip galvanized, corrosion loss of plating is 1/4. Therefore, when compared SD with GI, as it shows that SD has extremely high corrosion resistance, so it takes longer time (4 times) until the plating corrodes, plating layer disappears and red rust occurs.

Chart 1. Result of exposure test (Exposure site: Okinawa, Exposure period: 3 years)

1-2. Corrosion resistance at cut-end surfaces of SD

SD is also superior for the corrosion resistance at cut-end surfaces than GI. When cut-end is exposed to rain, at the initial period, red rust will occur at the cut-end surfaces just like GI, but in case of SD will gradually be covered as white rust (the stable film) and be suppressed the development of corrosion (Please see Diagram 1).

Diagram 1. Corrosion protection mechanism at cut-end surface of SD
1. Comparison of corrosion resistance for GI and SD under alkaline environment SD does not limit to only neutral area, even under strong alkaline environment it has high corrosion resistance when compared to GI (Please see Diagram 2).

![Diagram 2](image)

Diagram 2. Result of corrosion resistance test under alkaline environment. Soaking in the strong alkaline of PH: 12.5

2. Correlation of coating mass for GI and SD (from the point of view for corrosion resistance)

As shown in Chart 1, from the exposure test in Okinawa, SD has 4 times of corrosion resistance when compared to GI.

Therefore, from the point of view of corrosion resistance,

- **SD-K08 (8g/m²)** : equivalent to GI-Z27 (275g/m²) – Z35 (350g/m²)
- **SD-K12 (120g/m²)** : equivalent to GI-Z45 (450g/m²) – Z50 (500g/m²)
  (out of production corresponding)
- **SD-K18 (180g/m²)** : equivalent to or more GI-Z60 (600g/m²)
  (out of production corresponding)

* Average minimum coating mass in triple-spot test on both sides.

In other words, for GI which is used currently for duct, when compared to GI-Z27 which is the standard of coating mass, SD-K12 has higher corrosion resistance.

3. Conclusion (recommended material)

From the above, SD has higher corrosion resistance than GI. Currently, as for steel material for duct, GI-Z27 which is the standard specification, equivalent corrosion resistance which guarantees is SD-K08. However, the actual environment which is used in different area from Okinawa environment, as for SD used for duct, K12 is the standard because there are a lot of actual results, so we recommend SD-K12.

Nippon Steel & Sumitomo Metal Corporation
Flat Steel Division, Flat Steel Sheet
General Manager: Shinichi MURAKAMI