

# VI Iron and Steel Slag as an Environmental Material Trusted by Society

## 1 Conformity with Environmental Standards

### ① Quality of Iron and Steel Slag Products for Environmental Safety

In 1979, a JIS standard for road focusing on the physical properties of iron and steel slag for road use was established. Since then, various product standards for use as civil engineering materials have been developed, and iron and steel slag products have been used in a wide range of civil engineering applications. The standardization of environmental safety and quality took much longer, but following the establishment of the Test Methods for Chemicals in Slags (JIS K 0058-1 and -2) in 2005 as official environmental safety and quality test methods, the Nippon Slag Association has been working to incorporate environmental safety and quality requirements into the JIS standards for iron and steel slag products. The environmental safety

and quality of iron and steel slag products are defined to ensure that soil, groundwater, seawater, and other environmental media in the exposure environment during product use meet relevant environmental standards.

The environmental safety and quality requirements were incorporated into the JIS standards “Iron and steel slag for road construction (JIS A 5015)” and “Slag aggregate for concrete (JIS A 5011-1 and -4)” in the 2013 revision. Furthermore, the January 2015 revision of the “Guidelines for the Management of Iron and Steel Slag Products” clarified and organized the applicable environmental safety and quality requirements according to use locations and purposes.

**Environmental Safety and Quality Standards in Iron and Steel Slag for Road Construction (JIS A 5015)**

Item	Elusion amount mg/L	Content <sup>a)</sup> mg/kg
Cadmium	0.01 or less	150 or less
Lead	0.01 or less	150 or less
Hexavalent chromium	0.05 or less	250 or less
Arsenic	0.01 or less	150 or less
Mercury	0.0005 or less	15 or less
Selenium	0.01 or less	150 or less
Fluorine	0.8 or less	4,000 or less
Boron	1 or less	4,000 or less

**Environmental Safety and Quality Standards for Slag Aggregate for Concrete (JIS A 5011-1 and -4)**

**General use**

Item	Elusion amount mg/L	Content <sup>a)</sup> mg/kg
Cadmium	0.01 or less	150 or less
Lead	0.01 or less	150 or less
Hexavalent chromium	0.05 or less	250 or less
Arsenic	0.01 or less	150 or less
Mercury	0.0005 or less	15 or less
Selenium	0.01 or less	150 or less
Fluorine	0.8 or less	4,000 or less
Boron	1 or less	4,000 or less

**Port use**

Item	Elusion amount mg/L
Cadmium	0.03 or less
Lead	0.03 or less
Hexavalent chromium	0.15 or less
Arsenic	0.03 or less
Mercury	0.0015 or less
Selenium	0.03 or less
Fluorine	15 or less
Boron	20 or less

Note a): It should be noted that the term “content” as used here differs from the general meaning of “total content.”

## ② Environmental Safety and Quality Requirements According to Use Locations and Purposes

Iron and steel slag products used on land are classified into seven categories: roads and railways, concrete aggregates, ground improvement materials, civil engineering and onshore construction, hydrated matrix, fertilizer raw materials, and other. The applicable environmental safety and quality test methods, evaluation criteria, and testing frequency are specified based on factors such as whether the product conforms to JIS standards or equivalent specifications, and whether its use can be distinguished from soil. On the other hand, iron and steel slag products used in port

and marine areas are classified into four categories: concrete aggregates, ground improvement materials, port and marine construction, and hydrated matrix. The applicable environmental safety and quality test methods, evaluation criteria, and testing frequency are specified based on factors such as whether the product conforms to JIS standards or equivalent specifications, and whether its use is subject to the elution standards for port use or the environmental quality and quality standards for marine sediments.

### Example of Elution Test Results for Iron and Steel Slag Products Using the Test Methods for Chemicals in Slags (JIS K 0058-1)

(Unit: mg/L)

Item	(Reference standards) Environmental quality standards for soil	Blast furnace slag product		Steelmaking slag product	
		Air-cooled slag	Granulated slag	Converter slag	Electric arc furnace slag
Cadmium	0.003 or less	< 0.001	< 0.001	< 0.001	< 0.001
Lead	0.01 or less	< 0.001	< 0.001	< 0.001	< 0.001
Hexavalentchromium	0.05 or less	< 0.02	< 0.02	< 0.02	< 0.02
Arsenic	0.01 or less	< 0.001	< 0.001	< 0.001	< 0.001
Mercury	0.0005 or less	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Selenium	0.01 or less	0.001	< 0.001	< 0.001	< 0.001
Fluorine	0.8 or less	0.2	0.1	< 0.1	< 0.1
Boron	1 or less	< 0.1	< 0.1	< 0.1	< 0.1

Note: The less than symbol (<) indicates a value below the lower limit of quantification.

**Example of Elution Test Results for Iron and Steel Slag Products Using the Environmental Quality Standards for Soil (Ministry of the Environment Notification No. 46)**

(Unit: mg/L)

Item	Environmental quality standards for soil	Blast furnace slag product		Steelmaking slag product	
		Air-cooled slag	Granulated slag	Converter slag	Electric arc furnace slag
Cadmium	0.003 or less	< 0.005	< 0.005	< 0.005	< 0.005
Lead	0.01 or less	< 0.001	< 0.001	< 0.001	< 0.005
Hexavalent chromium	0.05 or less	< 0.01	< 0.01	< 0.01	< 0.02
Arsenic	0.01 or less	< 0.001	< 0.001	< 0.001	< 0.005
Mercury	0.0005 or less	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Selenium	0.01 or less	0.004	< 0.002	< 0.002	< 0.005
Fluorine	0.8 or less	0.26	0.16	0.62	0.32
Boron	1 or less	0.12	0.10	0.02	0.3

Note: The less than symbol (<) indicates a value below the lower limit of quantification.

**Example of Elution Test Results for Iron and Steel Slag Products Using the Environmental Quality Standards for Marine Sediments (Ministry of the Environment Notification No. 14)**

(Unit: mg/L)

Item	Determination criteria concerning marine sediments	Blast furnace slag product		Steelmaking slag product	
		Air-cooled slag	Granulated slag	Converter slag	Electric arc furnace slag
Mercury or its compounds	0.005 or less	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Cadmium or its compounds	0.1 or less	< 0.001	< 0.001	< 0.001	< 0.001
Lead or its compounds	0.1 or less	< 0.05	< 0.05	< 0.05	< 0.005
Hexavalent chromium or its compounds	0.5 or less	< 0.4	< 0.4	< 0.4	< 0.01
Arsenic or its compounds	0.1 or less	< 0.005	< 0.005	< 0.005	< 0.002
Fluoride	15 or less	0.3	0.26	0 ~ 4.4	< 0.2
Selenium or its compounds	0.1 or less	< 0.1	< 0.1	< 0.1	< 0.002

Note: The less than symbol (<) indicates a value below the lower limit of quantification.

① Production Management of Iron and Steel Slag Products

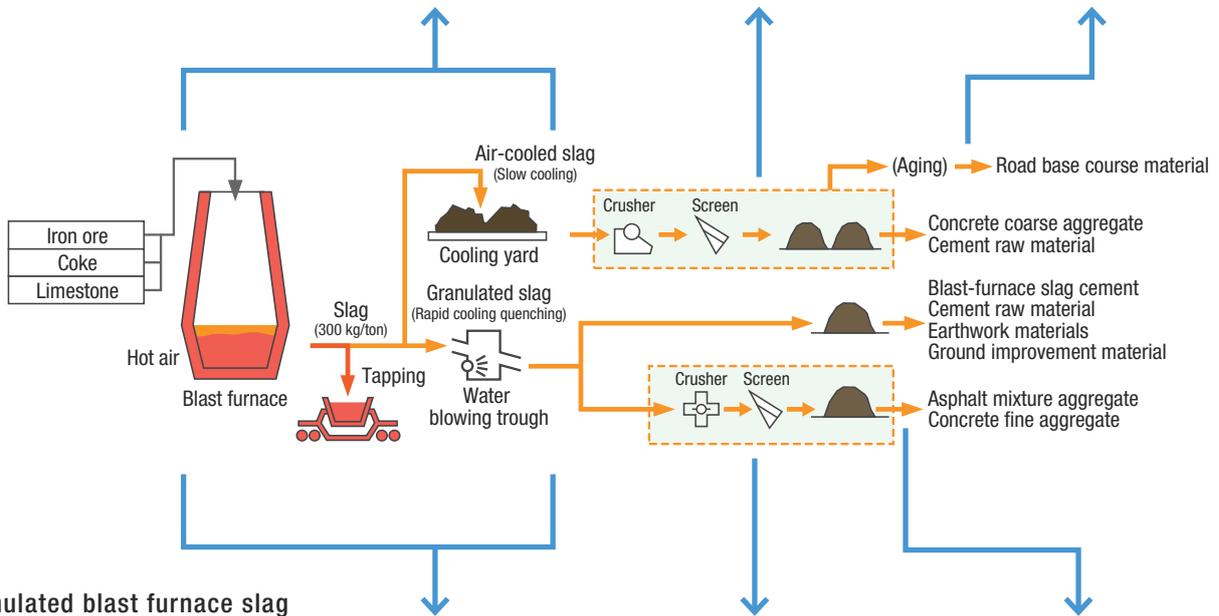
Steelmaking processes were originally designed to produce pig iron and steel. However, today, the production of high-quality iron and steel slag products is also regarded as an important element in the operation and facility design of steel production. Each steel company takes

measures at every stage of the process and implements strict production management to produce iron and steel slag products that meet quality specifications such as JIS standards, according to their intended applications.

Example of Quality Control in the Production Process of Blast Furnace Slag Products (Table)

Air-cooled blast furnace slag

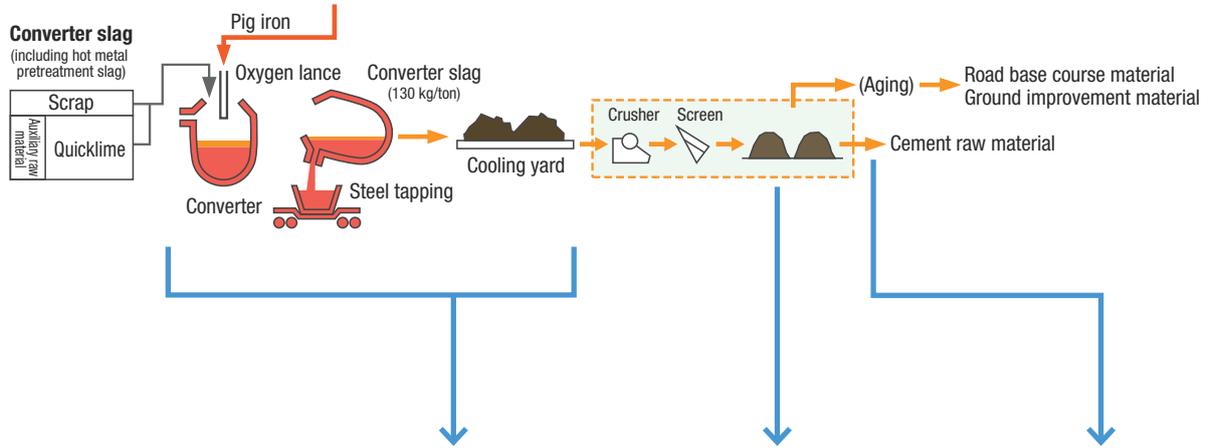
Process	Raw material, dissolution, cooling	Process	Shipping
Quality control method	Raw material mix Dissolved slag temperature Water spraying method	Crushing and classification Aging	Inspection and analysis
Quality control item	Chemical component Porosity	Grading Modified CBR Abrasion value Density in oven-dry condition Bulk density Fineness modulus	Environmental safety and quality Standards by application (Yellow leaching test for blast furnace slag, etc.)



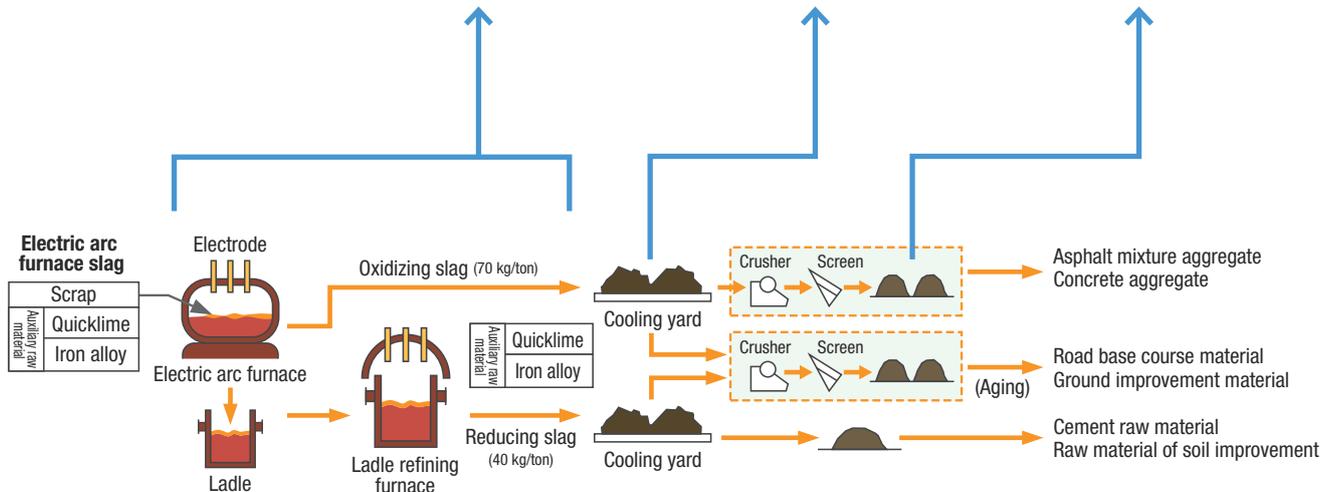
Granulated blast furnace slag

Process	Raw material, dissolution, cooling	Process	Shipping
Quality control method	Raw material mix Dissolved slag temperature Water blowing pressure	Crushing and classification Addition of anti-clumping agent	Inspection and analysis
Quality control item	Chemical component Percentage of glass content Porosity	Grading Density in oven-dry condition Bulk density Fineness modulus	Environmental safety and quality Standards by application (Storage stability test, etc.)

Quality Control in the Production Process of Steelmaking Slag Products



Process	Raw material, dissolution, cooling	Process	Shipping
Quality control method	Selection of scrap Selection of refining conditions • Quicklime usage • Dolomite usage • Amount of refining accelerators used Water spraying method	Crushing and sieving Magnetic sorting Aging	Inspection and analysis
Quality control item	Chemical component Expansion stability Basicity Powdering prevention	Iron content Grading Modified CBR Abrasion value Density in oven-dry condition Bulk density Fineness modulus	Environmental safety and quality Specification according to use (Immersion expansion test, etc.)



In 2005, the Nippon Slag Association established the “Guidelines for the Management of Iron and Steel Slag Products” (hereinafter referred to as the “Guidelines”), which specify the management items that member companies should implement at each stage of the process, from the production of iron and steel slag to its use by customers. The member companies of the Nippon Slag Association strive to enhance peace of mind and confidence for customers by managing each stage: production, quality inspection, transportation, off-site storage, and use of iron and steel slag products, based on the Guidelines.

Since their establishment in 2005, the Guidelines were revised nine times by 2022, reflecting ongoing efforts to

further strengthen the management system.

Each member company of the Nippon Slag Association has developed its own product management manual in compliance with the Guidelines and has established a system to ensure its implementation and control. Additionally, in order to enhance the reliability of iron and steel slag products for society, the Nippon Slag Association has introduced a third-party audit system to review the quality control status at each member company’s business establishment, based on their respective product management manuals. The Association also publishes a list of audit results to show that iron and steel slag products are being managed in compliance with the Guidelines.

## The Guidelines for the Management of Iron and Steel Slag Products

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(Revised on July 1, 2022 by the Nippon Slag Association)

## 4

**Environmental Measures in the Use of Slag Products**

The Guidelines require that, in order to enhance the understanding of customers regarding the potential environmental impacts of improper use, information on the quality characteristics of iron and steel slag products and precautions for their use (such as pH characteristics, dust characteristics, etc.) be provided to end users.

Additionally, the Guidelines require the voluntary determination of the necessity of field surveys before, during, and after construction, based on factors such as the construction volume, construction location, and intended uses of iron and steel slag and implementation of field surveys.

### The Precautions for pH Characteristics and Dust Characteristics as Described in the Guidelines (Excerpt from the Guidelines)

#### 1. pH Characteristics

##### (1) Precautions

###### ◎ [On-land Use]

- In cases where there is a risk that water in contact with iron and steel slag products may flow out of the site without passing through soil, it is necessary to implement measures such as covering the slag with soil that has a high alkali adsorption capacity or neutralizing the water with carbon dioxide before draining, similar to the use of recycled concrete base course materials or cement-stabilized soil.

###### ◎ [Offshore use]

- There is a possibility that seawater may become cloudy white due to the precipitation of magnesium hydroxide when iron and steel slag products are applied to seawater. Use this product only after confirming that it does not affect the environment through prior examination..

##### (2) Technical Information

- Due to the influence of lime content, iron and steel slag products cause the pH to increase to 10 to 12.5 when reacted with water and exhibit alkalinity similar to recycled concrete base course materials and cement-stabilized soil.
- As soil in Japan is generally acidic, alkali components leached from iron and steel slag products are absorbed and neutralized by the soil.

#### 2. Dust Characteristics

##### (1) Precautions

- Among iron and steel slag products, those that are not transported by bulk tank trucks or stored in silos may generate dust depending on the dryness and wind speed. Therefore, measures should be taken to prevent any environmental issues during transportation, storage, and construction using these products.