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■ Sand Wave G—Manufacturing company

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(As of July 2023)

Naturetec Kushiro Co., Ltd.	Phone: +81 154-57-7766	
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Towa Industry Co., Ltd.	Phone: +81 439-53-0134	http://www.towakogyo.co.jp
TAKENAKA Road Construction Co., Ltd.	Phone: +81 3-6458-6850	https://www.takenaka-douro.co.jp
YOSHIDA General Construction Co., Ltd.	Phone: +81 79-236-1548	https://yoshida-gumi.co.jp
Hokko Trading Co., Ltd.	Phone: +81 256-34-5865	https://www.hokkou-eco.com/
YUTAKA CONSTRUCTION CO., LTD.	Phone: +81 29-309-7266	https://yutaka-k-k.com/
Wakachiku Construction Co., Ltd. Technical research institute	Phone: +81 438-38-4601	https://www.wakachiku.co.jp
Nariko Co., Ltd.	Phone: +81 476-35-5325	https://www.narikoh.co.jp/
Isizu Kenzai Co., Ltd.	Phone: +81 478-54-3195	http://isizu.co.jp/
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Ver.4

Recycled Granular Glass Sand Association

Introduction

Glass products that are familiar to our lives. Glass is not only used for bottles for various containers, but also for tableware, window glass, fluorescent lamps, and televisions, etc. It is said that glass has a history of about 5,000 years on Earth. A 2,000-year-old glass furnace has been discovered in Japan, demonstrating a very long history, and glass has been used mainly in glass bottles as a safe and stable container.

In addition, used transparent bottles and brown bottles have been used as raw materials for glass bottles (glass cullet), but other colored bottles could not be recycled.

After the enactment of the Act on the Promotion of Sorted Collection and Recycling of Containers and Packaging in 1995, other colored bottles have been recycled into blocks and tiles for other purposes, but the status of recycling was far from the ideal of "dispose of, recycle, and distribute" due to issues of cost and penetration.

With the concept of "developing applications for difficult-to-use products from the perspective of users and making them highly versatile," we developed the recycled granular glass sand "Sand Wave G" by using glass bottles derived from sand as the main raw material. We eliminated the "piercing and cutting" qualities of glass through a special crushing processing for various types of glass, and established a technology for mass processing as a replacement material for natural sand.

After nearly ten years of use, mainly in application development and public works, Recycled Granular Glass Sand Association was established in December 2008, consisting of a number of companies that use granular glass sand and manufacturing companies. Since December 2009, Recycled Granular Glass Sand Association has been continuously published in the "Integrated Document SUPPORT," and recycling and product distribution have become possible across almost the whole of Japan. Going forward, the Association will propose utilization methods that take advantage of the characteristics of recycled granular glass sand, take countermeasures against global warming that is believed to be the cause of recent abnormal weather, and propose applications that can help with disaster recovery and reduction.

In addition, our wish is to shift from waste disposal to consignment processing. We hope that the use of glass bottles discharged from municipalities will be studied so that they can be reused by the municipalities, and that this will help to form a recycling-oriented society that incorporates environmental measures.

Recycled Granular Glass Sand Association

Current status of glass recycling and recycled granular glass sand "Sand Wave G"

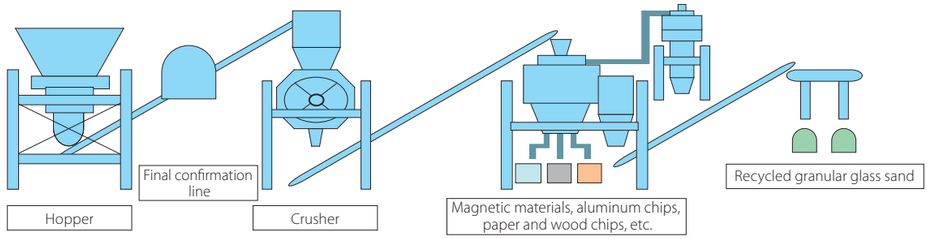
Current Status of Glass Bottles

Currently, about 1 million tons of glass bottles are made in Japan. 95% of the raw material is a recycled resource called cullet. In addition, bottles such as sake, soy sauce, milk, and beer are used repeatedly, and these bottles are "star pupils" of recycling. However, bottles with colors such as blue and green are difficult to recycle, and about 270,000 tons are landfilled every year.
The Association considers this to be wasteful and has made efforts to develop recycling applications for these materials. One such achievement is Sand Wave G. The main raw material of recycled granular glass sand Sand Wave G is glass bottles that are difficult to recycle, such as colored bottles, discharged from general households.

The relationship between the earth and glass bottles

The five major elements that make up Earth's crust are oxygen (49.5%), silicon (25.8%), aluminum (7.56%), iron (4.70%), and calcium (3.39%).
Glass bottles were born 5,000 years ago out of human wisdom. Their main components are silicon (62.7%) and calcium (32.4%). Now, glass bottles that are no longer used can be returned to Earth in their original form. That is Sand Wave G. It is an environmentally friendly product.

Production process



(General product)

(Special order product)
* The photo shows a 5-10 mm product

Transforming glass bottles and glass scraps into granular sand with water permeability and compaction characteristics that go beyond natural sand.

Sand Wave G is a granular sand made from colored glass bottles and glass scraps that were previously disposed of and landfilled because they are difficult to recycle as the only raw material. It has good water permeability and compaction characteristics due to the manufacturing process that crushes the glass and makes it edgeless.
It has the same or higher performance as natural sand (mountain sand, river sand, sea sand) and can be used as an alternative material for sand. It can be widely used as an alternative material for all kinds of sand, including sand drain and sand compaction sand pile materials and sand mat materials for soft ground improvement that require especially good quality sand.

Advantages of using "Sand Wave G"

◆ Reduced environmental impact at the production stage

Effective use of waste glass
Extends the working life of landfill sites
Reduced CO_2

◆ Reduction of environmental impact at the use stage and disaster prevention

Reducing flood damage	Ground water conservation
Heat island suppression	"Guerrilla rainstorm" countermeasure
Liquefaction prevention countermeasure	Weed prevention countermeasure

Sand Wave G—particle diameter 0-5 mm

There are no sharp facets, eliminating "cutting and piercing" and ensuring safety

Eco-Products Award

(Sponsored by the Eco-Products Award Promotion Council and supported by the Ministry of Finance, the Ministry of Health, Labour and Welfare, the Ministry of Agriculture, Forestry and Fisheries, the Ministry of Economy, Trade and Industry, the Ministry of Land, Infrastructure, Transport and Tourism, and the Ministry of the Environment)
November 2005 2nd Eco-Products Award
Received the Chairman's Award (Excellence Award) of the Eco-Products Award Promotion Council

Commendation for Resource Circulation Technology/System

(Sponsored by the Clean Japan Center Foundation, supported by the Ministry of Economy, Trade and Industry)
October 2010 Received the Chairman's Award of the Clean Japan Center Foundation

Eco-Products Commendation

Certificate of Commendation for Resource Circulation Technology/System

Promoting the formation of a recycling-oriented society

What is a recycling-oriented society?

❶ Control of waste generation, etc.

❷ Circular use of recycled resources

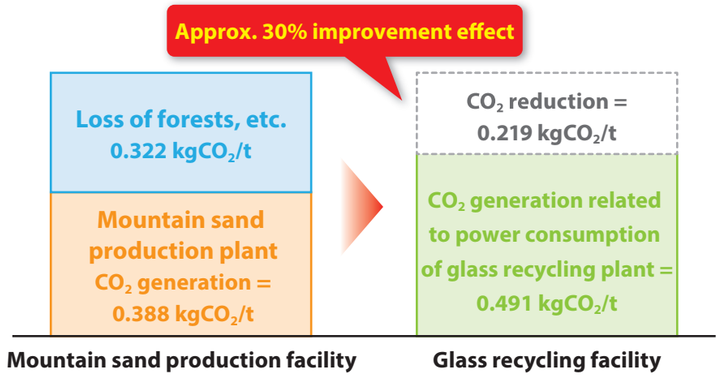
❸ Ensuring proper disposal of items that cannot be recycled

As a result, **the consumption of natural resources is suppressed and the burden on the environment is reduced as much as possible.**

Initiatives that lead to CO_2 reductions

1. Reducing the environmental impact of Sand Wave G (CO_2 reduction effect)

By using Sand Wave G instead of mountain sand, CO_2 is reduced by 0.219 kg per ton. (Refer to figure below)



2. Satoyama Regeneration Project

GLASS RESOURCING CO., LTD. has been regenerating a ruined mountain sand collection site as a Satoyama (forest park) since 2008, and carries out forest conservation activities to ensure the annual absorption of about 2t-CO_2 by trees.

Photo of recycling in Satoyama

Environmental characteristics of Sand Wave G

1 Rainwater storage and infiltration facilities

What is a rainwater storage and infiltration facility?

In recent years, flood damage due to torrential rains has been occurring frequently. A rainwater storage and infiltration facility temporarily stores rainwater and infiltrates it underground over time, helping to reduce flood damage and protect groundwater. It is classified as a storage facility/infiltration facility.

Rain that falls infiltrates the ground or passes across the surfaces of pavements and flows from gutters into rivers. However, urbanization is progressing, and torrential rains are causing river flooding, residential flooding, and road surface flooding. There are various construction methods for rainwater storage and infiltration facilities, such as setting up a storage tank underground and infiltrating rainwater into it, or building a room with crushed stone filling, concrete, or plastic structure. These facilities are exactly what is needed right now as we face the challenges of responding to climate change.

Construction method for rainwater storage and infiltration facility using Sand Wave G

Installation is easy: The ground is excavated and replaced with Sand Wave G, and water-permeable asphalt or another permeable object is applied to the surface.
(For structural examples, refer to the structural drawings)

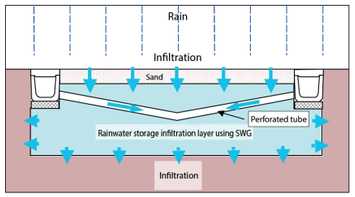
Sand Wave G storage capacity

Approximately 300 tons of rainwater can be stored using 1000 m³ of Sand Wave G

This is because even if Sand Wave G is laid down and rolled, the volume ratio (porosity) is about 30% compared to a filled material due to the total volume of the particle gaps, and because of this good permeability, rainwater can be stored evenly in the gaps without stagnation.

Construction photo

Construction photo (Rainwater storage and infiltration facility, Chiba Prefectural Sakura High School)

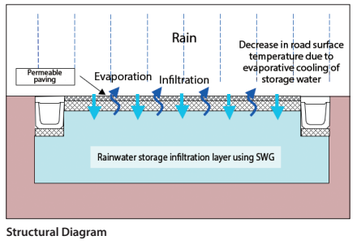


Structural Diagram

2 Heat island suppression

What is a heat island?

The phenomenon whereby temperatures in urban areas are abnormally high compared to surrounding suburbs. The heat is caused by the lack of green spaces and the large number of buildings and roads. Since high temperatures affect both the natural environment and the lives and health of residents, the heat island effect has come to be regarded as a problem in recent years. If countermeasures are not taken, this phenomenon will always occur in places with high population density, and the larger the city, the greater the impact of the heat island effect.



Structural Diagram

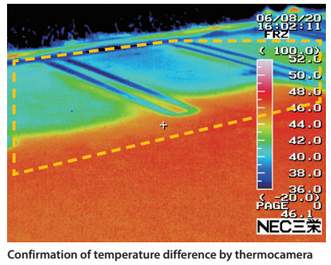
Heat island suppression with Sand Wave G

The surface temperature of pavements rises to around 60℃ in good weather in summer, and this rise in road surface temperature is one of the causes of the heat island effect.

By using Sand Wave G as a rainwater reservoir under a permeable asphalt pavement, evaporative cooling from the stored rainwater can reduce the road surface temperature by about 5-10℃, resulting in the same effect as spraying water. It is easy to install and can be used for parking lots (effective land use) and sidewalks.
(Refer to the structural diagram for how to use)

Area where SWG is used in the road bed to form a rainwater reservoir

Construction photo (Town Hall Parking Lot, Higashiura-cho, Aichi Prefecture)



Confirmation of temperature difference by thermocamera

3 Guerrilla rainstorm countermeasure

What is a Guerrilla rainstorm?

A sudden, localized downpour that is difficult to predict. Although there is no clear definition in meteorology, it is characterized by (1) extremely localized rainfall range, (2) short rainfall time, (3) extremely high rainfall per unit of time, and it can occure anywhere. Heavy rainfall concentrated in a very limited area can adversely affect the ground or cause a sudden increase in river water, leading to flooding damage.

It is also believed that global warming and the heat island effect are one cause. When the air near the ground surface is warm and humid, and the upper air is cold and dry, active cumulus clouds form, the atmosphere becomes unstable, and large amounts of localized rainfall occur intensively.

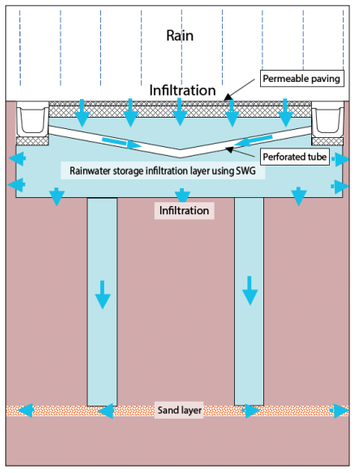
Photo of flood damage caused by a "Guerrilla rainstorm"

(From the website of the Association for Rainwater Storage and Infiltration Technology)

Outcomes that can be expected from the use of Sand Wave G

Damage can be reduced by installing a rainwater storage and infiltration layer using Sand Wave G in areas that are prone to flooding. In addition, by installing a vertical drain down to the sand layer, it is possible to infiltrate a large amount of rainwater underground.
(Cross-sectional view ①)

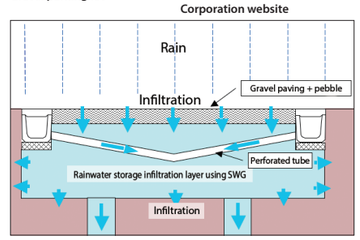
Further, in places other than public roads such as parking lots, by devising water-permeable pavements, it is possible to increase the infiltration capacity and also reduce the road surface temperature.



Cross-sectional view ①

Gravel parking lot

Photo from Shikoku Chemicals Corporation website



Cross-sectional view ②

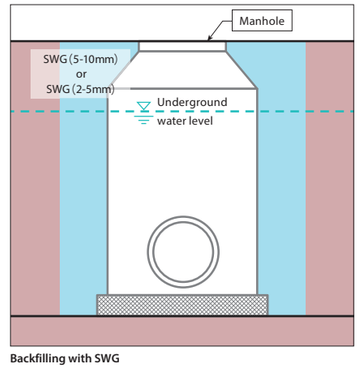
4 Liquefaction prevention countermeasure

What is the liquefaction phenomenon?

A phenomenon in which sand beds with high groundwater levels become liquid due to vibration during an earthquake. As a result, structures with high specific gravity sink and fall, and structures with light specific gravity in the ground (sewer pipes, etc.) rise up.
(Refer to photo)

Liquefaction prevention countermeasure using Sand Wave G

As one of the measures to prevent liquefaction, it has been confirmed that lifting and sagging can be prevented by sufficient compaction with highly permeable materials. (Refer to the Urban Lifeline Handbook (published by the Japan Society of Civil Engineers))
As highly permeable materials, it is believed that Sand Wave G (SWG5-10 mm), which has been adjusted to increase particle size, and Sand Wave G (SWG2-5 mm), which has been adjusted to increase water permeability, can be expected to have a high effect, and these products have been featured at geotechnical research conferences.



Backfilling with SWG

5 Weed prevention countermeasure

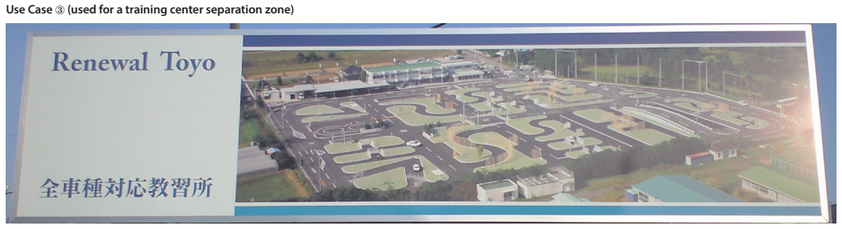
Sand Wave G offers good drainage and contains no nutrients, making it less susceptible to weeds compared to soil. In addition, because there is no adhesion, weeds are easy to remove even if they grow, and by using Sand Wave G in separation zones and gardens, it is possible to reduce the amount of weeds and reduce maintenance costs related to weed treatment.

■ Anti-weed effect

Use Case ① (PV power plant - used under the solar panels)

Use Case ② (used for separation zone)

Use Case ③ (used for a training center separation zone)



Use Case ④ (used in private home garden)

6 In addition, Sand Wave G can be used for construction work as an alternative to natural sand

Features of Sand Wave G (SWG)

- Since the SWG particles have no adhesion, workability is good.
- SWG is less susceptible to moisture content than natural sand, making it possible to continue working even in rainy weather. In addition, it can be compacted even in a wet state, so construction can progress without the need to wait for drying. This leads to shortening the work period and reducing the work cost.
- SWG has a good drainage capacity, so it can be compacted by watering in a narrow area where other compaction techniques may be ineffective.
- SWG is less susceptible to water content and has good water permeability, meaning that it can be used as a backfill material in places with a high groundwater level or spring water.

■ Comparison with mountain sand

Features		Sand Wave G	Mountain sand (production in Ibaraki Prefecture)
Particle density	(g/cm^3)	2.501	2.679
Moisture content ratio	(%)	1.9	14.7
Granularity	(2 mm pass ratio %)	65	98
Maximum dry density	ρ dmax (g/cm^3)	1.711	1.739
Optimal moisture content ratio	(%)	4.9	16.8
Water permeability	(cm/s)	1.3×10^{-2}	10^{-2} to 10^{-3}
Water absorption expansion ratio	(%)	0.0013	0.038
Repair CBR	(ρ dmax × 0.95)	20.3	16.3

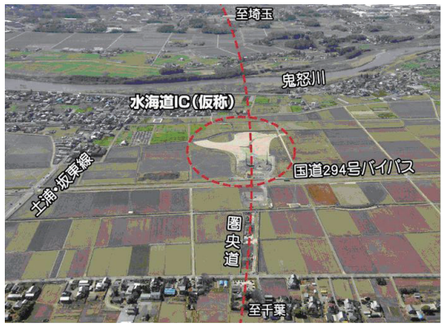
Use in sand drain construction method and sand compaction construction method

* With the sand drain (SD) construction method, sand piles with high water permeability are formed in the ground at a predetermined distance and depth, and sand is laid on top of them to promote pressure-tight settlement of viscous ground.
* With the sand compaction pile (SCP) construction method, sand is press-filled by vibration, etc. to form a compacted sand pile, and the bearing capacity of the sand pile is improved compared to the SD construction method.

Construction site

Use in sand mat construction method

* A highly permeable sand layer with a thickness of about 0.5 to 1.2 m is constructed on soft ground and used for loading for pressure-tight sedimentation on soft ground or ensuring the upper drainage layer of the vertical drainage method and the trafficability of construction machinery.



Aerial photograph (from the website of Josokokudo, Ministry of Land, Infrastructure, Transport and Tourism)

Mountain sand vs. Sand Wave G

Mountain sand	Sand Wave G
	
Collapse of the slope face is likely to occur due to rain	There is no collapse of the slope face due to good water permeability
	
Dust can easily blow around when there is a strong wind	Dust tends not to blow around even in strong winds

Ground formation


Construction site


Construction site

Preparation work culvert drainage


Construction site


Construction site

Underground burying backfill


Underground tank backfill

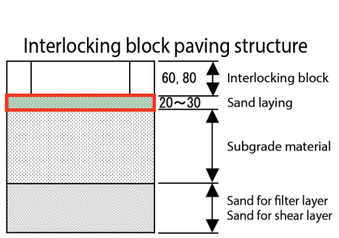

Hume pipe backfill


Common-use cable tunnel backfill


Retaining wall backfill

Interlocking block sand paving

Interlocking block paving structure

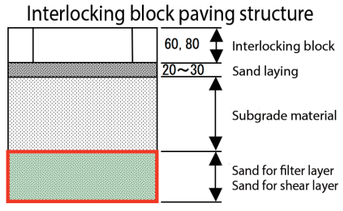



Construction site

Sand for shear and filter layer

* The shear layer is a sand layer placed under the subgrade to prevent road bed soil from infiltrating into the subgrade together with groundwater, weakening the subgrade
* The filter layer functions as a filter when rainwater infiltrates into the road bed and prevents the infiltration of road bed soil into the subgrade.

Interlocking block paving structure




Construction site

Road bed material/Road bed replacement material


Construction site


Construction site

Accreditation

■ Registration as a new material

Registration system	Registration number	Evaluation registration body	Applicant
New Technology Information System: NETIS	(Former) KT-010157-V	Kanto Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism	GLASS RESOURCING CO., LTD.
New Technology Information Database	1601015	Tokyo Metropolitan Government Bureau of Construction	GLASS RESOURCING CO., LTD.
New Technology・New Construction method information database	1400	Transportation Infrastructure Department, Shizuoka Prefecture	TOEI Co., Ltd.

*** It was also registered in the New Technology Database of the Yokohama City Highway Department, the Bureau of Port and Harbor Tokyo Metropolitan Government, and the Civil Engineering Department of Ibaraki Prefecture, but it is not currently registered since the registration period (5 years) has passed.**

■ Accreditation as a recycled product

Accreditation system	Accreditation number	Accreditation body	Applicant
Eco-mark products	08 131 011 06 131 016 08 131 018	Japan Environment Association	GLASS RESOURCING CO., LTD. TOEI Co., Ltd. Material Resourcing Tohoku Co., Ltd.
Recycled products from Yamaguchi Prefecture	No. 156	Yamaguchi Prefecture	Yamauchi Co., Ltd.
Recycled products from Akita Prefecture	201004	Akita Prefecture	Material Resourcing Tohoku Co., Ltd.
Ibaraki Recycled Construction Materials	20-R3-1	Ibaraki Prefecture	GLASS RESOURCING CO., LTD.
Aichi Recycled Materials (AICLE)	19)-6	Aichi Prefecture	TOEI Co., Ltd.