Development of Environment-Friendly Base Materials for Seaweed Beds using Recycled Materials and its Long-term Monitoring

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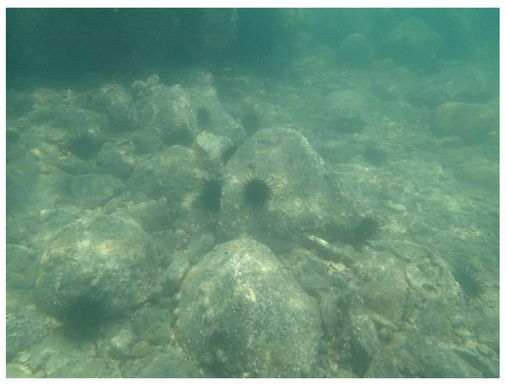
Abstract

The area of seaweed beds along Japanese coasts has decreased by approximately 40% in the last 40 years due to climate change and human activity. In addition, there are similar concerns regarding coastlines worldwide.

Introduction

They have been remarkably reduced in Japan by climate change or human activity. Coastal engineering efforts such as reclamation and dredging and the phenomenon known as barren ground (called “isoyake” in Japanese) have led to the deterioration of coastal environments.

Notably, a stable supply of iron, which is indispensable for seaweed growth, is lacking under the sea due to the changes in the nutritional composition of the sea caused by deforestation and the development of dams on land.



Isoyake at Sasebo

Materials used

(a) decomposed granite

(b) Shirasu

(c) waste roof tile

(d) flow medium sand

(e) recycled gypsum

(f) scrap ceramics

(g) iron powder

(h) blast-furnace slag cement type b

Chemical composition of main materials used

(mass %)

Analysis items	Waste roof tile	Decomposed granite	Shirasu	Flow medium sand
LOI	0.34	0.76	2.11	0.15
SiO_2	74.08	76.41	69.09	77.28
Al_2O_3	16.97	12.64	15.92	7.56
Fe_2O_3	3.68	1.25	2.74	1.32
TiO_2	0.90	0.07	0.28	0.24
CaO	0.40	0.52	3.01	4.44
MgO	0.44	0.10	0.61	0.92
Na_2O	0.40	3.33	3.76	1.59
K_2O	2.32	4.61	2.20	6.07
Total amount	99.53	99.69	99.72	99.57

Test results of base materials for seaweed beds

Results of the unconfined compression test (waste roof tile, 28 days curing)

Mixing ratio (%)	Waste roof tile	30.7
	Recycled gypsum	21.7
	Water	17.9
	Scrapped ceramics	15.9
	Cement	10.0
	iron powder	3.8
Unconfined compressive strength (MPa)		5.02
Water content (%)		13.2
Wet density (g/cm^3)		1.65

Results of the unconfined compression test (decomposed granite, 28 days curing)

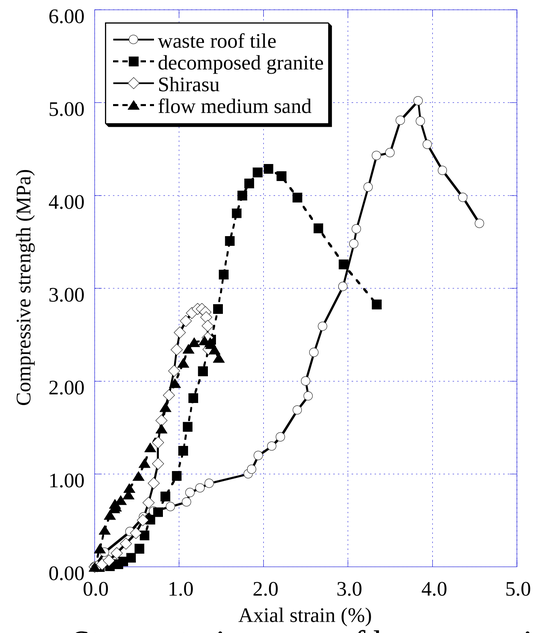
Mixing ratio (%)	Decomposed granite	30.7
	Recycled gypsum	21.7
	Water	17.9
	Scrapped ceramics	15.9
	Cement	10.0
	iron powder	3.8
Unconfined compressive strength (MPa)		4.29
Water content (%)		10.7
Wet density (g/cm^3)		1.70

Results of the unconfined compression test (Shirasu, 28 days curring)

Mixing ratio (%)	Shirasu	30.1
	Recycled gypsum	21.2
	Water	19.7
	Scrapped ceramics	15.6
	Cement	9.7
	iron powder	3.7
Unconfined compressive strength (MPa)		2.78
Water content (%)		12.3
Wet density (g/cm^3)		1.52

Results of the unconfined compression test (flow medium sand, 28 days curing)

Mixing ratio (%)	Flow medium sand	30.7
	Recycled gypsum	21.7
	Water	17.9
	Scrapped ceramics	15.9
	Cement	10.0
	iron powder	3.8
Unconfined compressive strength (MPa)		2.44
Water content (%)		10.7
Wet density (g/cm^3)		1.59



Stress-strain curve of base materials for seaweed beds (28 days curing)

References

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Development of environment-oriented base materials for seaweed beds by recycled materials,
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Monitoring rooting and growth of seaweed

We conducted the long-term monitoring by diving into the sea with an underwater digital camera in the summer and autumn seasons.
Summary of the monitoring dates and sea quality data from June 2021 to September 2022.These tables shows that the temperature of the sea water was high in September, 2021 and July-September 2022. The pH was approximately 8.04-8.34.

Monitoring dates and sea water quality data (Wakamatsu)

monitoring date	Sep-21	Dec-21	Jan-22	Jun-22	Jul-22	Sep-22
sea water temperature (℃)	23.5	11.0	14.0	22.0	28.5	24.0
pH	8.14	8.04	8.04	8.25	8.30	8.06
electrical conductivity (mS/cm)	46.0	48.2	48.2	49.9	50.9	47.7
salinity (%)	2.7	1.0	1.1	1.6	3.0	3.2

Monitoring dates and sea water quality data (Kagoshima Bay)

monitoring date	Jun-21	Sep-21	Nov-21	May-22	Jul-22	Sep-22
sea water temperature (℃)	22.0	26.5	20.0	20.5	28.0	26.5
pH	8.13	8.34	8.16	8.19	8.21	8.14
electrical conductivity (mS/cm)	42.5	38.9	47.1	45.1	38.6	43.6
salinity (%)	2.2	2.6	1.2	1.5	2.7	3.1

(a) before entering the sea (b) 3 months passed (c) 10 months passed (waste roof tile) (d) 10 months passed (flow medium sand)

Base materials for seaweed beds set into Wakamatsu

The research so far