CHAPTER ONE HUNDRED SEVENTY

NEW TYPE BLOCKS FOR SEAWALL SLOPE PROTECTION

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1. INTRODUCTION

Japan is a mountaineous country, and coastal areas have been looked upon quite valuable.

In most cases, shorelines were slightly advancing until 1950, although there are some exceptional coasts which have been under continuous erosion for more than a thousand years.

However, in the last thirty years, beaches began to be eroded one after another, and the countermeasure against beach erosion has become one of the most important problems in the national land preservation.

Since the early 1960's, many seawalls against the beach erosion have been constructed. The table shows the amounts of the shore protection works constructed in the last twenty years.

Total length of the coastline of Japan 34 064 km

Year	1962	1972	1982
length of seadikes	1818 km	2566 km	2889 km
length of seawalls	2686 km	4752 km	5665 km
number of groins	5448	8747	9790
number of detached breakwaters	205	544	2831

Seadikes have been extended gradually year by year, seawalls and groins show great elongation.And, detached breakwaters also show a remarkable development in the last ten years. The elongation percentages of these shore protection works in these twenty years is seadikes 1.59, seawalls 2.11, groins 1.80 and detached breakwaters 13.81.

Most of the seawalls constructed before 1975 were vertical ones, and mechanism of beach erosion had not exactly been known those days.As a result, some of the seawalls even encouraged the beach erosion contraly to expectation.

The author then, proposed new types of seawalls. The first type was the "Block faced seawall" whose front slope was covered with some artificial concrete blocks such as armour units, and the second type was the "Lattice type seawall".

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The details of these works were presented by the author, on the 16th I.C.C.E., titled "Effectiveness of seadiks with rough slope".

Block faced seawalls have been used on several coasts in Japan for the past ten years or so. Most of these seawalls have turned out to be successful, in spite of the fact that they have to be connected with extra hooks to attain sufficient solidarity.

Recently, the author invented a new type of concrete blocks for slope protection works of seawalls, which need no hooks for connection, named "Lotus-Uni".

This paper describes the characteristics of "Lotus-Uni" and experimental works of seawalls using them.

2. DEFECTS OF VERTICAL TYPE SEAWALLS

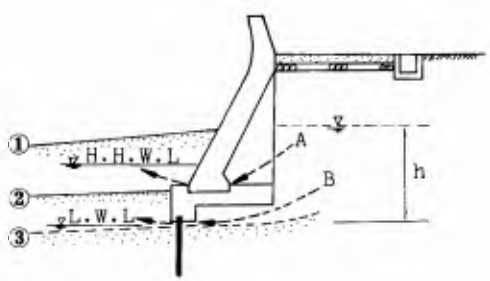

Fig.1 Typical vertical type seawall

In Fig.1,

① is the shore just after the construction of the seawall.

② incident waves were violently reflcted on the steep front slope of seawalls, and foreshore and the toe of seawalls were washed out with the reflected waves like this.

③ then, sand is completly washed out.

And furthermore, by the water pressure difference (h) between outside and inside of the seawall facing, not a little amount of sand are drawn out with jet streams like A and B in Fig.1 through the small hall in the seawall facing.

Photo.1 Backfill sand is drawn out

Photo.1 shows a typical case where the backfill sand is drawn out. Soon after these phenomena, vertical type seawalls collapsed like Photo.2

Photo.2 Vertical type seawalls collapsed

3. AN EXAMPLE OF BLOCK FACED SEAWALLS IN SHIZUOKA COAST

After many field experiences, the author pointed out that, the problems to be considered for the new seawalls were as follows;

1) to decrease the reflected waves from the front of seawalls as much as possible.
2) to make the front face more rough.
3) to make the front face permeable.
4) some partial collapses should be allowed, but never be destroyed the whole body of the seawalls.
5) repair and reinforcement should be easy.
6) structure should be simple and low cost.

The author proposed block faced seawalls as a new type seawalls, and the first large-scale works have been carried out on the restoration works of collapsed seawalls in Shizuoka Coast under the author's guidance.

Fig.2 shows the previous structure and cross section of Shizuoka Coast before the destruction which occured in March 1977. Since the 1970's, the Shizuoka Coast has turned into a erosive coast. The seawalls of this coast were constructed before 1970.

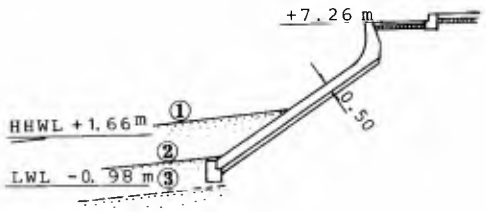

Fig.2 Structure and cross section before the destruction

In Fig.2,
① is the shore when the seawalls were constructed in 1961.
② just before the destruction in March 1977.
③ just after the destruction.

After the first destruction in March 1977, the seawalls in Shizuoka Coast have been broken down by the violent waves one after another. The position of collapsed seawalls are shown in Fig.3.

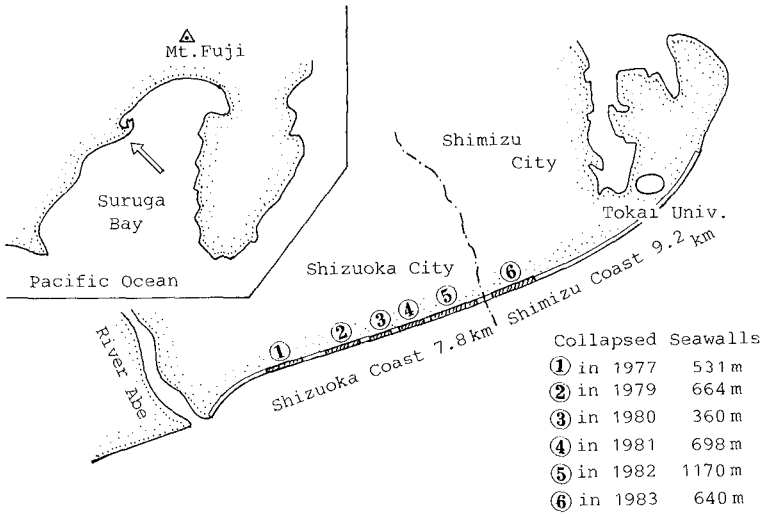

Fig.3 Position of collapsed seawalls

Instead of usual concrete facing, concrete block facing works was used as the restoration works, according to my proposal. Fig.4 shows the structure of the restoration works using the block facing.

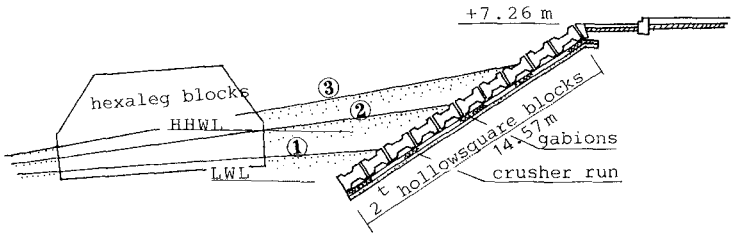

Fig.4 Structure of restored seawalls with block facing

In Fig.4,
① is the shore at the starting works, in August 1977.
② is the shore at the completion of the works, in May 1978.
③ is the shore in May 1984.

Before the destruction, the beach had been eroded year by year. But, after the restoration works, the beach finely recovered and sand accumulated as about ten years ago.

Photo.3 shows the seawalls in 1978 one year after the restoration works. Four blocks are under the beach, and six are seen.

Photo.4 is the later view of the coast. The blocks are covered with sand up to the second step, then eight blocks are under the sand beach. Now the beach looks very stable.

Photo.3 Restoration works completed (1978)

Photo.4 The beach recovered finely (May 1984)

We have been talking about the first destruction in Shizuoka Coast, the position (1) in Fig.3.

After this restoration works, another destructions from the position (2) to (5) occured consecutively, and all of them are restored in the same way as the above.

All of these restored seawalls were never destroyed again, and these block faced seawalls have proved to be successful.

However, they had to be connected with extra hooks to attain sufficient solidarity.

Recently, the author invented a new blocks, which need no hooks for connection, named "Lotus-Uni".

4. CHARACTERISTICS OF THE "LOTUS-UNI" BLOCK

Fig.5 shows the plane and plofile of the Lotus-Uni block. The block has three models according to its weight. Each model has same face, only the thickness is different.

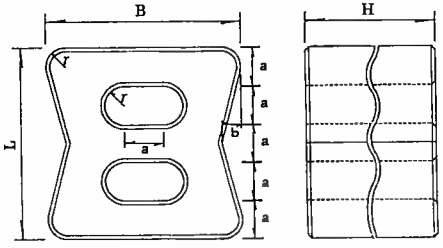

Fig.5 Lotus-Uni block

Model	B	L	H	Weight
50H			50 cm	2 ton
75H	1.5 m	1.5 m	75 cm	3 ton
100H			100 cm	4 ton

Photo.5 Lotus-Uni block (Model 50H, 2 ton)

The blocks have good close connection with one another, and there is no necessity for hooks (Fig.6).

Even if a block (black one in Fig.7) is removed, there is little room to move for the six blocks arround(hatched), because blocks are holding mutually.

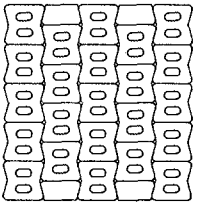

Fig.6 Facing style

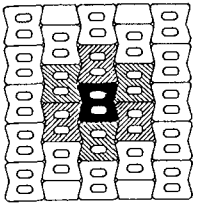

Fig.7 Remove a block(black one)

5. NEW TYPE SEAWALLS FACED WITH "LOTUS-UNI"

5.1 Characteristics

Standard cross section of the seawalls faced with Lotus-Uni is shown in Fig.8.

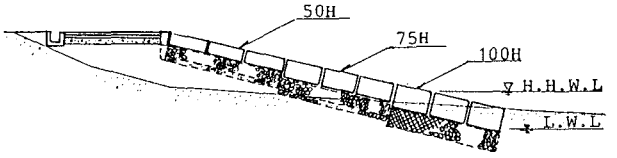

Fig.8 Seawalls faced with Lotus-Uni block

Characteristics of this type seawalls are as follows.

1) There is no use for foundation, cut-off walls or steel sheet piles.
2) Blocks differ only in thickness, and differrent type of blocks can be used together on one slope as Fig.8.
3) The structure of this type of seawalls have flexibility, roughness, looseness, and chain connection like gabions. Once faced, these blocks shall hardly be decomposed by wave powers.

5.2 Example works

An experimental work of the new type seawall using Lotus-Uni block has been carried out on Muroran Coast, Hokkaido prefecture, Japan, facing the Pacific Ocean.

In this work, model 50H (2 ton) block is used on all the slope. The cross section of the work is like Fig.8.

There are no foundation and other shore protection works. The grade of the front slope is 1:3, and the number of blocks per slope is nine.

Photo.6 Soon after the completion (1982)

Photo.6 shows the seawall soon after the completion in 1982. The foundation blocks were set on the shoreline of the low water level, and there was no foreshore in front of the seawall. The uprush runs up with sand and gravel on the slope.

Photo.7 Uprush are sucked into the holes

Some of the uprushes are sucked into the holes of the block, and the back rush decreases.

The velocity and the volume of the backrush become slow and small. Then, the reflected waves become weaker, and the erosive beach turn into an accumulative one.

Photo.8 Gravel are left on the toe of the seawall

Sand and gravel, came from the offshore and included in the uprush, are left on the slope, in the holes and the toe of the slope of the seawall.
Eight or nine blocks are seen on the slope.

Photo.9 One year after the photo.8

More than ten meters long foreshore has grown in front of the seawall. Four or five block are to be seen, and five or four blocks are under the sand beach.
Sand has accumulated gradually and surely.

Photo.10 The latest view of the beach (1984)

The shoreline has advanced substantially, and the sand beach has grown extensively.

6. CONCLUSION

The author invented a new type blocks for seawall slope protection. Now, twenty or more experimental works using the Lotus-Uni block are being carried out in Japan for the countermeasures against the beach erosion.

The collapsed seawalls in Shimizu Coast, the position(6) in Fig.3, were restored with Lotus-Uni block lately.

Most of these works are apparently successful.

7. REFERENCES

Toyoshima,O.1978: Effectiveness of seadikes with rough slope. Proceedings of the sixteenth Conference on Coastal Engineering, ASCE, Vol.3, pp.2528-2539.