CONCRETE BLOCK PAVEMENT ON THE PIER CONSIDERING LANDSCAPE DESIGN

Hiroshi Kikuchi, Ministry of Transport, The Second District Port Construction Bureau, Japan
Mitsuaki Sukekiyo, Mitsubishi Materials Corporation

SUMMARY

In the Ohsanbashi area of Yokohama Port, a re-development project is being deployed. The purpose of the project is a reconstruction of the international passenger ship pier that will be opening for the citizens and the world in harmony with surrounding environment and landscape. In relation to the Ohsanbashi Pier Expanding Work, as part of the project, a granite-like bush-hammered concrete block pavemant was employed on the apron of the expanded pier. The block is excellent in color, texture and harmony as well as in basic properties. The block colors and the placing pattern were determined under consideration of Yokohama Port Color Plan and the harmony with the terminal-building that would be rebuilt in the future.

1. INTRODUCTION

Yokohama is a pivotal city in the Metropolitan Circle that has prospered since the opening of port in 1853, as a representative city of the ports and harbors in Japan. In recent years, Various development projects have been promoted in the waterfront area aiming toward an international city in the 21st century. The main projects are as follows.

(a) The MM21 project

Construction of the mini-metropolis is projected, which will integrate various functions of urban cities in a reclaimed area where there were once factories.

(b) The Ohsanbashi area re-development project

Reconstructions of the pier and the terminal-building for international passenger ships, and improvement of surrounding area are projected.

(c) The Minami-Honmoku Wharf construction project

Reclamation of a large area of the sea, where large container berths and a distribution terminal will be constructed.

The pavement on the pier introduced herein was done in relation to the Ohsanbashi area re-development project.

2. OHSANBASHI RE-DEVELOPMENT PROJECT

Ohsanbashi area is where Yokohama Port was opened in 1859. Well known nation-wide, the area is symbolic and a tourist zone of Yokohama Port where-in the Ohsanbashi Pier, international pssenger ship terminal, Yamashita Park, museums and historical streets are situated. And, the area is adjacent to the MM21 Project area.

Under such a background, the master plan of the Ohsanbashi area re-development project was formed in consideration of harmony with the surrounding environment and landscape. In the first place, a concept of the re-development was formed by the commitee, the members of it consisted of citizens, the public officers concerned and the persons of learning and experience who were appointed by the Ministry of Transport and Yokohama City. The conceptual theme is the creation of a community space open to the world [1].

According to the conception, the Ohsanbashi area re-development project was produced. It is composed of reconstructions of the Ohsanbashi Pier and the terminal-building, improvements of Yamashita Park and Zo-no-Hana zone considering harmony with one another. The purpose of reconstructing the pier and the terminal-building is a not only the improvement of functions for

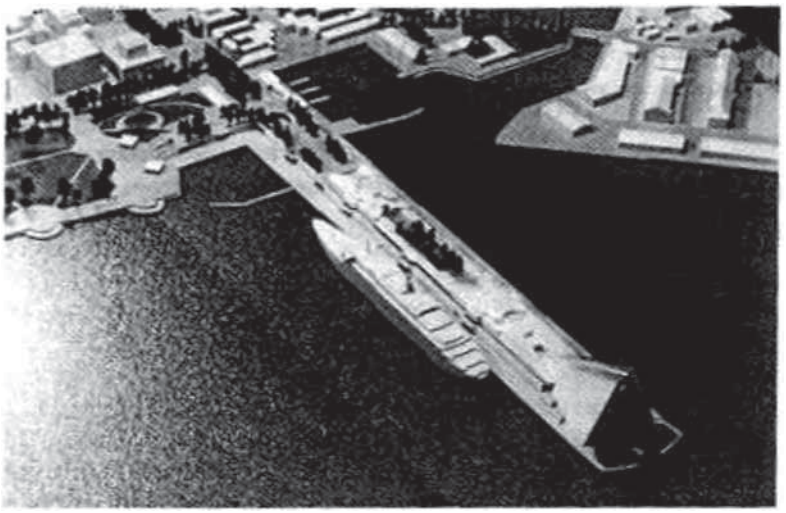
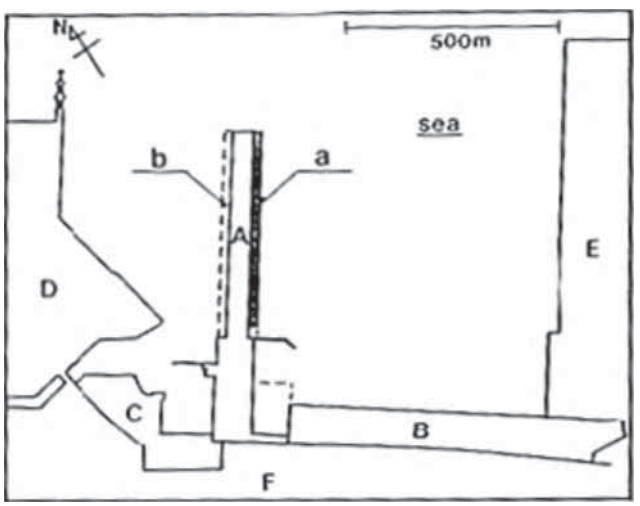


Figure 1 Image model of the Ohsanbashi area re-development project



A : Ohsanbashi Pier zone
B : Yamashita Park zone
C : Zoh-no-Hana zone
E : Ya-ashita Wharf
D : MM21 Project zone
F : Urban area
a : Concrete block paved area of the expanded pier
b : Projected section for expanding the pier

Figure 2 Outline map of the Ohsanbashi area re-development project

international passenger ship pier but also to create a symbolic, attractive and favorite space (Figure 1).
Concrete block pavement was employed on the pier in relation to the pier expanding work for improving the capacity of the pier. In this construction period, expanding work of the pier was done by the south-east side of ths existing pier (Figure 2).
The expanded area Is 30m x 450n. wherein the apron of the expanded pier (the dimensions cf the apron are 20m x 450m) is paved.

3. EMPLOYMENT OF THE CONCRETE BLOCK PAVEMENT

Regarding the conventional pier for distribution, landscape and amenities had not been sufficiently considered.And the cast-in-place concrete pavement had been used on almost all aprons of piers. Now. regarding the Ohsanbashi Bier, a pavement both excellent in color and texture was required for the international passenger ship pier, that was projected to be opening for the citizens and the world. In paving, concrete block pavement was employed considering good appearance as well as various properties such as strength, durability, walkability, workability, maintainability (Table 1). Another great factor for the employment was that coicrete block pavement is flexible

Table 1 Properties of paving materials

	Strength and Durability	Walkability	Good Appearance	Workability	Maintainability	Economy
Concrete Block	◎	◎	◎	○	○	△
Cast-in-Place Concrete	◎	◎	△	○	△	○
Asphalt	○	◎	△	◎	○	◎
Concrete Plate	△	◎	○	○	○	○
Tile	○	△	○	○	○	△
Stone Block	◎	○	◎	○	○	×
Brick	△	○	○	○	○	△

◎ : excellent , ○ : good , △ : fair , × : poor

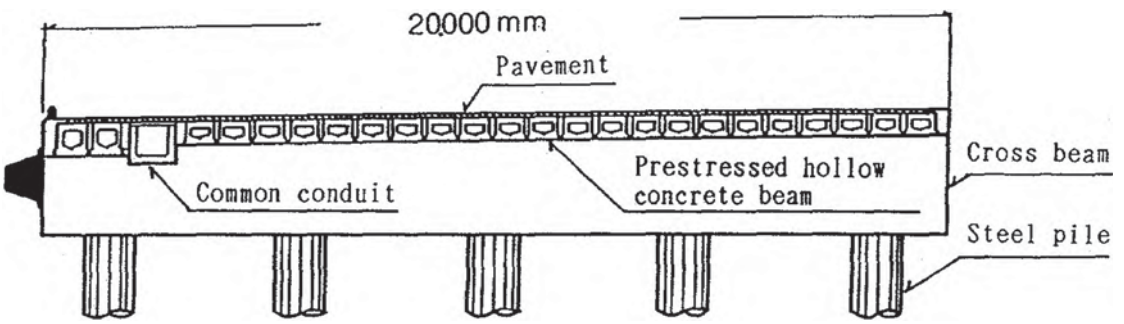


Figure 3 Cross section of the expanded pier

pavement. The floor bed of this expanded pier is of paral1ely-1aid pre-stressed hollow concrete beam structure (Figure 3). Hence, if the paving material to be applied to such as a structure is high-rigidity concrete,e.g. cast-in-place concrete, it will crack easily due to deflection depending on traffic load. On the other hand, concrete block pavement is crack-free, because it is flexible pavemant, and furthermore, is suitable as a paving material for this pier which attaches importance to the landscape.
And bush-hammered concrete block with harmonic and granite-like feeling was selected among many types of concrete blocks. It was selected in consider-ation of the consistency with the sidewalk paved with granite-plate in the downtown leading to the pier, the harmony with terminal-building on the pier and the park to be re-developed a few years later, and the high resistance to skid for walking-safety.

The structure of pavement is shown in Figure 4. Concrete block was paved on a layer of dry-mortar laid on the hollow beams.

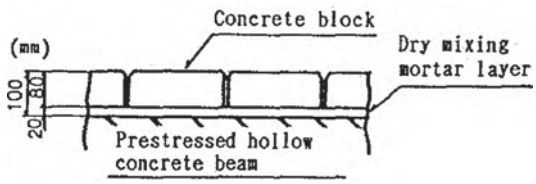


Figure 4 Structure of pavement

4. COLOR COORDINATION

Color of concrete block pavement followed Yokohama Port Color Plan [2]. Yokohama Port is divided into 3 zones under the color plan. Situated from inner port to outer are MM21 zone. Yamashi ta Wharf zone and Honmoku-Daikoku Wharf zone. And the colors of each zone are established (Figure 5).

The area where the Ohsanbashi Pier is situated belongs to the MM21 zone. In the color plan, the Ohsanbashi Pier is designated as a one of Bright Symbols that are representative landmark structures in Yokohama Port.

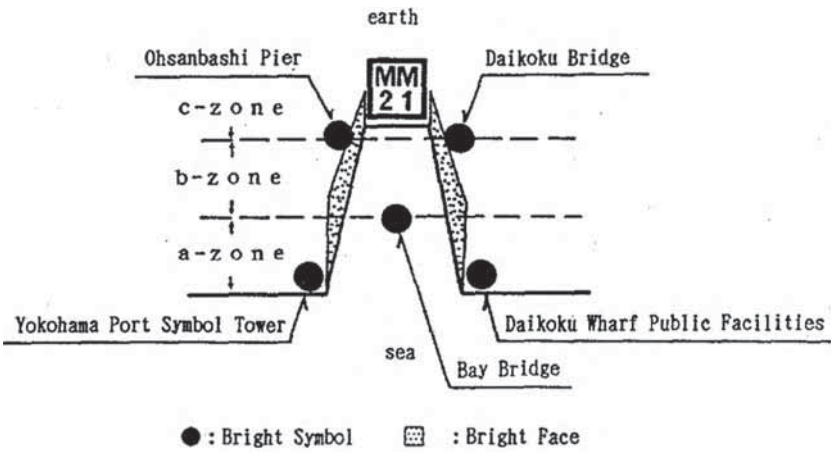
The base color of Bright Symbols is white, and it brightens and accentuates the port. Therefore, the base color of the pavement on the pier is white.

On the other hand, the base color of terminal-building that will be rebuilt in the future, and be a representative symbol on the pier, is also white.

This required the color of pavement to be subdued and harmonized with the terminal-building. And if the pavement is composed with white block only, it will be lacking in variety and seem dull. Accordingly, light yellow and light gray blocks were mixed with white block. Light yellow is a subdued color of the 'vivid yellow' that is The Bright Face Color in the MM21 zone.

The bond of block is stretcher bond. The placing pattern of colors is not a geometrical pattern but a random combination of three colors subject to an equal quantity of each (Figure 6). The traffic zoning line only in the gang-way is burgundy block which is a harmonic subdued red.

This will emphasize the beauty of terminal-building to be rebuilt in the future.



ZONE	BASE COLOR	ACCENT COLOR	SIMPLE TOP	BRIGHT FACE	BRIGHT SYMBOL
HONMOKU-DAIKOKU (a)	grayish blue grayish sky blue	white	gray	strong blue	white
YAMASHITA (d)	bright grayish green grayish green	white	gray	vivid bluish green	white
MM21 Cc)	grayish yellow grayish olive	white	gray	vivid yellow	white

Bright Symbols: The landmark structures that present bright view. Theme color is pure white.

Bright Face : The Walls of designated buildings, facing the waterway, are made of colorful design, and produce vivid and expectative feeling.

Base Color :For Walls. The colors are grayish that produce a harmony of view in each zone. Bluish color of s-zone is the image of sea, greenish color of d-zone is the image of verdurous park, yellowish color of c-zone is the image of the earth.

Accent Color : For windows.doors, parapets, etc.. The color is white. It accentuates the view of buildings. White is the common accent color in 3 zones, and the same color as Bright Symbol, so that continuity of the veiw is produced throughout 3 zones.

Simple Top : The roof colors are gray in 3 zones. That produces stability through all zones.

Figure 5 Yokohama Port Color Plan



Figure 6 The bush-hammered concrete block pavement on the pier

A few years later, the terminal-building will be rebuilt. If you arrive in Yokohama Port by ship then, you will see The Bright Symbol-Ohsanbashi Pier that will be formed by the pavement, seeming white from a great distance, and tho terminal-buiIding. And if you see the pavement at close range, you will find the contrast of the three colors of blocks and the harmony between the pavement and the termina1-buiIding.

5. MANUFACTURING METHOD OF BUSH-HAMMERED CONCRETE BLOCK

A bush-hammered concrete block is a two-1aycr-molded block, composed of concrete base-layer and mortar surface-layer. The dimensions are approximately 10cm x 20cm. Il is a rectanglar block with natural stone-like texture, similar to granite. There is a shot-blast finishing to obtain roughened surface except bush-hammering finish. Bush-hammered surface is more rough than a shot-blasted one, and bush-hammered surface is superior in the revelation of aggregates and the natural stone-like texture.

5.1 Components

Components and Mixture of the base-layer concrete are the sane as ordinary concrete blocks. On the other band, that of the surface-layer are determined so that it will be like hammcred-granile. Crushed while-granite, silica sand and black-sand are used as aggregates of the surface-layer mortar. Crushed white-granite is selected for the fine look of a chipped face after hammering, and for hardness itself. Black-sand is used for accentuating the color of surface like granite. While portland cement is used except a few dark colored surface-mortars, and ordinary portland cement is used for dark colored. Inorganic pigments arc used for coloring. In some colored surfaces, two pigments are blended and used. Various colored blocks are selectively available among 28 color samples according to the application.

5. 2 Method of molding

In the same way as ordinary concrete block holding, the block that will be bush-hammered later is two-layer molded with vibration and pressure.

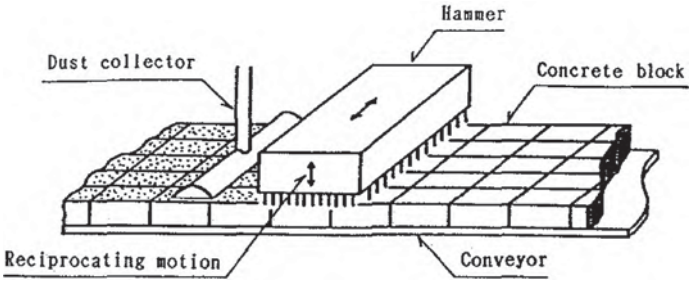


Figure 7 Sketch of the bush-hammering machine

5.3 Method of the bush-hammer finishing

3 days to 7 days aged block (after molding) is provided for bush-hammer finishing. Bush-hammer finishing unit is composed of a hammer to which there is a number of steel nails (<64mm) attached, a block-feed conveyor and a dust-collector (Figure 7). Striking with a hammer, the surface of concrete block is made rough. The hammer reciprocates at right angle direction against block in feeding direction so that the surface of block may be finished uniformly. The surface roughness can be regulated by the speed of conveyor, and by the height-setting of crosshead with the hammer. The dust produced by hammering is removed by vacuum dust collector.

6. PHYSICAL PROPERTIES OF BUSH-HAMMERED BLOCK

6, 1 Bending strength

The bending strength (at the age of 14 days) was measured by middle-loading test method. The span of specimen is 160 mm. The bending strength of bush-hammered block is the same as that of ordinary block, and satisfied the required value (50kgf/cm^2) of Japanese Architectural Standard Specification.

6. 2 Resistance to abrasion

The abrasive resistance was evaluated by raveling test (Asphalt Pavement Requirement). This test is that a wheel with a tire chain hits on surface of specimen and separates and tears the surface, the test time is 180 minutes and abrasion amount is expressed by worn area in cross section. The results are shown in Table 2. It shows that the abrasive resistance of bush-hammered block is higher than that of ordinary block with ordinary-mixture mortar surface and is close to that of single-layer-molded block with concrete surface. The reason why a bush-hammered block is highly resistant to abrasion is that crushed granite used for the surface mortar is harder and larger in size than aggregates of ordinary two-layer molded block.

6. 3 Resistance to skid

The skid resistance of the surface was measured using the British Pendulum Skid Resistance Tester. The test was conducted under both dry and wet surface conditions. The results are shown in Table 3. Since the surface of the bush-hammered block is roughened, it is highly resistant to skid. And it is superior to ordinary block especially under wet conditions. This contribute to the walking-safety on both fine and rainy days.

Table 2 Results of abrasion test

	Abrasion Amount (cm^2)
Bush-hammered block	0.6 8
Ordinary two-layer-molded block (mortar surface)	1.5 5
Ordinary single-layer-molded block (concrete surface)	0. 52

Table 3 Results of skid resistance test

	Skid Resistance Value (BPN)	
	dry	we t
Bush-hammered block	9 2	7 9
Ordinary two-layer-molded block (mortar surface)	9 1	6 8

7. CONCLUSION

Yokohama is a representative city of the ports and harbors in Japan.
In recent years. Various development projects have been promoted in Yokohama City aiming toward an international city in the 21st century. One of the projects is the Ohsanbashi area re-development project of which main work is the reconstruction of the international passenger ship pier. The purpose of this reconstruction is not only the improvement of pier-functions but also the creation of a symbolic zone in Yokohama, opening for the citizens and the world.

In paving the apron of an expanded pier, concrete block pavement was employed. Concrete block pavement is superior in appearance as well as basic properties, e.g. strength, durability, walkability, workability, maintainability. And it is crack-free as a flexible pavement. This is one reason why the concrete block pavement was employed. Furthermore, a bush-hammered concrete block with granite-like feeling was selected in consideration of the harmony with surrounding environment and landscape.

The colors of block used for the apron pavement were white, light yellow and light gray, according to the Yokohama Port color plan. The placing pattern of these is a random combination of the three colors subject to an equal quantity of each. It is not a geometrical pattern with colors for inducing the pavement to be in harmony with the terminal-building that will be rebuilt a few years later. The bush-hammered concrete block is not only excellent as landscape design material but also highly strong, highly resistant to abrasion and skid. Thus, this block provides sufficient performance as a paving material, too.

REFERENCES

[1] Commitee on the Ohsanbashi area re-development project.
Report on the Ohsanbashi area re-development project, 1989.

[2] Yokohama City,Port and Harbor Bureau,
The Yokohama Port Color Plan, 1987.