Mr. Kato's Residence
Reinforced Brick Curtain Walls

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SYNOPSIS

First attempt was made in Japan to cover steel structure with prefabricated reinforced brick curtain walls. It is significant that it made way for brick panels into an open market.
Mr. Kato's residence, a single family house in Seto was completed in 1980. It is a two-storied steel structure clad with reinforced brick curtain walls. 68 panels covered about 180m² of the exterior and the panel is comparatively light-weight - 150kg/m².
Newly developed perforated bricks were used and perforation enabled the panel to be internally reinforced, light-weight and uniform in quality. Higher level of thermal insulation was also achieved and it contributes to energy conservation.
6 different shapes of perforated bricks (65mm thick) were pre-assembled into brick panels. First, expanded polyethylene strips were laid on steel casting table. Bricks were laid face-down on it and vertical reinforcing bars were placed in core holes. Joints were filled with fluid mortar (no high-bond mortar used). After $8\frac{1}{2}$ hour steam curing, stripping, cleaning and inspection, panels were transported by truck either on edge or face up. They were lifted and positioned by crane. Joints between panels were sealed with polyurethane-based sealant backed up with elastomers. Attractive appearance of brick masonry was provided and no efflorescence has been observed.
This paper also reports findings and problems encountered during manufacture and construction.

1. INTRODUCTION

Due to many restrictions and historical background, brick panels in Japan had been confined to "cast concrete brick panel" in which brick panels function as permanent external formwork for concrete.
Brick panels were once used as internal curtain wall for apartment houses in Japan. But these were all assembled and laid on site.
First attempt was made in Japan in 1980 to cover a steel strucutre with factory-prefabricated reinforced curtain walls, which turned out a great success.
Though such construction method has already been practiced in North America, it is still significant and epoch-making in Japan, since it made way for brick panels into open market.
The brick panel is not only stronger than conventional panels but also light-weight and retain higher level of insulation.
This paper reports manufacture and construction methods of brick panels and discuss some of the findings and lesson we have experienced.

2. MR. KATO'S RESIDENCE

Mr. Kato's residence, a single-family house located in Seto City, Japan, was completed in December, 1980.
It is a two-storied steel-framed structure with total floor area of 181.8m^2.
Reinforced brick panels prefabricated in the factory about 10km away were fixed around the building.
68 brick panels covered about 180m of the exterior.
A panel is about 75mm thick and weighs about 150kg/m^2 which is comparatively light-weight.
Flexural strength of panel is more than 10kg/cm^2.
Brick panels are light brown in color and keeps in good harmony with the environment.
Since Seto City is the center of ceramic industries in Japan, Mr. Kato's residence is one of the beautiful landmarks in the neighborhood.

3. MANUFACTURE OF PANEL

Six different shapes of perforated bricks (65mm thick) were pre-assembled into brick panels. (See Fig. 1.)

Fig. 2 is the flow chart of brick panel manufacture.

Horizontal steel casting table coated with epoxy paint was cleaned and kept even during panel making. Perihperal mold was set up and fixed with bolts. Oil paint was applied to facilitate consequent mold removal.

Expanded poly ethylene strips (6x10mm) were laid on the casting table to make horizontal joints. Perforated bricks, having undergone strict dimensional inspection, were immersed in water for one day and then laid face-down between the strips on the table.

Compressive strength of each brick must be over 300kg/cm^2.

Water absorption must be under 10wt%.

Vertical reinforcing bars were placed in the core holes. Reinforcement is usually deformed steel bar 10mm diameter.

Horizontal reinforcing bars of 6mm diameter were placed behind every two horizontal joints. Both ends of vertical reinforcing bars were welded to steel plates. (See Fig. 3)

Joints were filled with fluid cement mortar containing no lime. High-bond mortar was not used at all. Three pieces of prism specimens were sampled for compressive test.

Panels were steam-cured for $8\frac{1}{2}$ hours according to the timetable shown in Fig. 4. Molds were stripped after curing.

Brick panels were lifted up by crane and cleaned manually. (See Fig. 5) Dimensional precision was inspected according to severe check standard. Such defects as brick breakage, crazing and poorly-filled joint were repaired as required.

Panels were lifted to an open stockyard and left there standing vertically.

Transportation of panels to the site was by truck either on edge or face-up. (See Fig. 6) On this occasion, panels were loaded on a truck horizontally and transported about 10km. No breakage occured.

4. CONSTRUCTION OF PANEL

A crane lifted and positioned panels on site just like conventional concrete panels. (See Fig. 7)
Panels were fixed to metal fasteners with bolts and adjusted. (See Fig. 8)
Joints between panels were sealed with polyurethane-based sealant back up with elastomers. (See Fig. 9)
Attractive appearance of brick masonry was provided and no efflorescence has been observed a year later. (See Fig. 10)

5. ADVANTAGES AND DISADVANTAGES

Based on the findings and lessons we have experienced in manufacturing and fixing panels, let us discuss some of the characteristics of brick panels.

As compared with conventional external wall construction methods, our brick panel is superior in the following items:

(1) Perforation improved insulation level, water proofness and durability.
(2) Light-weight panels: 150kg/m² (75mm thick)
cf. 180kg/m² --- P. C. panel
50kg/m² --- ALC panel
(cellular gas concrete)
(3) Better quality control in factory
(4) Good and uniform appearance (equal to skilled bricklayer's)
(5) Reduction in construction period
(6) No additional external work needed
(7) Ease of inspection

On the other hand, the brick panel presented the following problems to be considered:

(1) Dimentional precision control
(2) Breakage during handling
(3) Shortage of stockyard on the construction site
(4) Dimensional and weight limitation to be tranported
(5) Less adjustable to design change
(6) Automation of filling joint with mortar
(7) Drainage and dampproofing required

6. CONCLUSION

Many suggestive data and information were obtained from Mr. Kato's residence. This is semi-experimental project and we know that quantitative data is not sufficient yet. We need more experimental project.

However, this project convinced us that a new type of reinforced brick curtain walling is feasible in Japan. Possibility of "structural brick panel" should be sought for.

It is hoped that Mr. Kato's residence has newly made way for prefabricated brick panel construction in Japan.

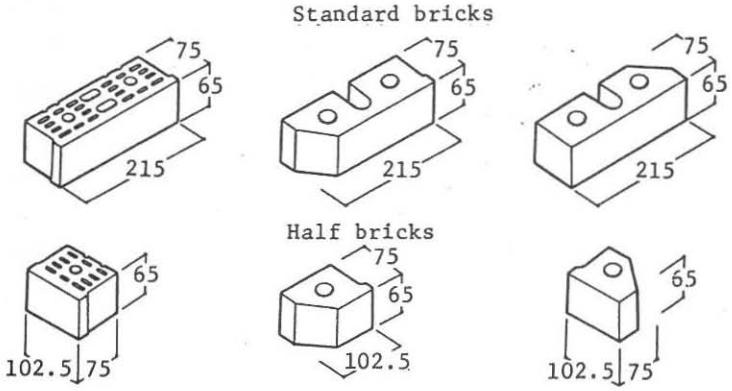


Fig.-1
Perforated
bricks

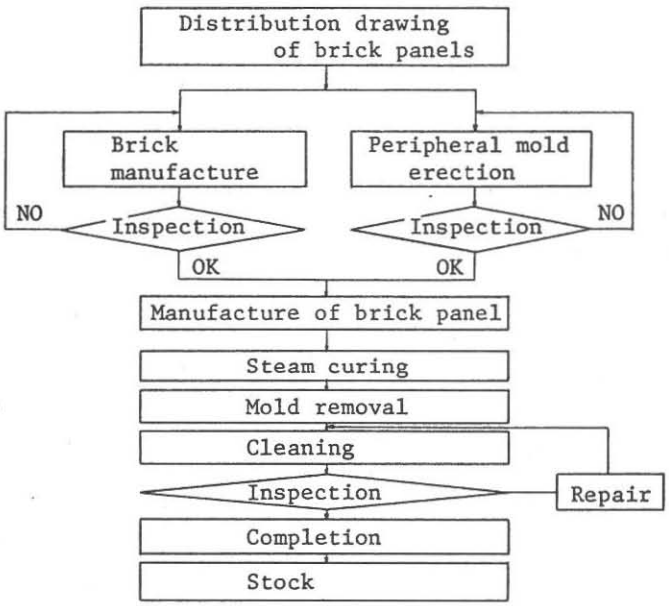


Fig.-2
Flowchart of
brick panel
manufacture

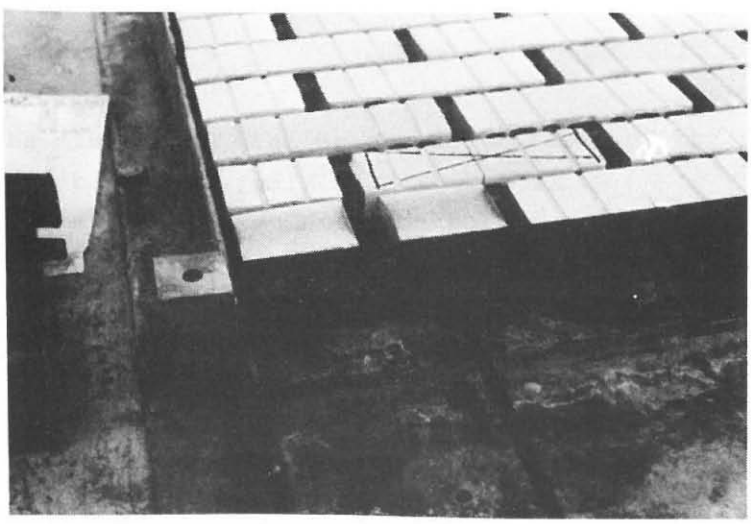


Fig.-3
Details of
panel end

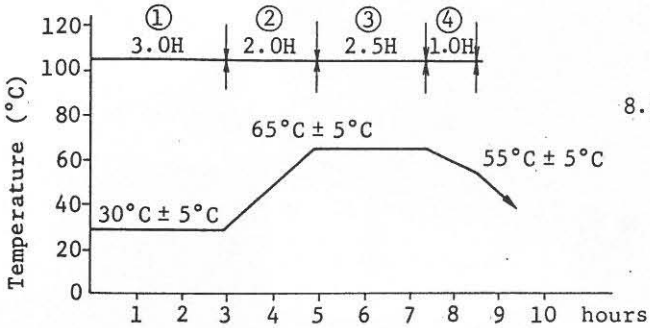


Fig.-4 Timetable of steam curing

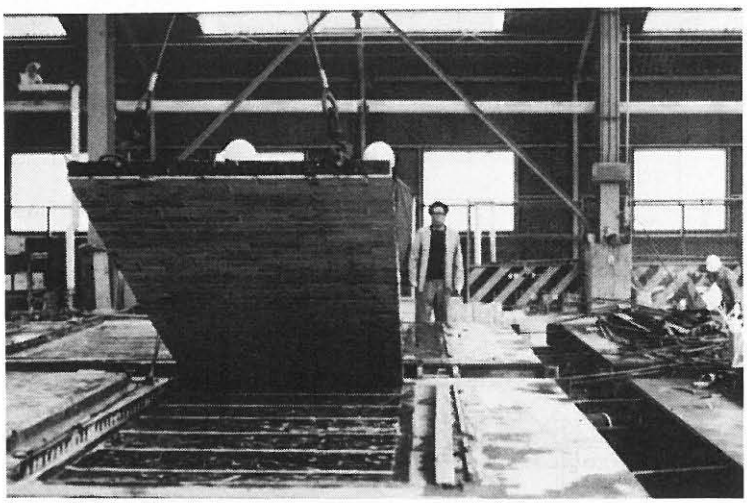
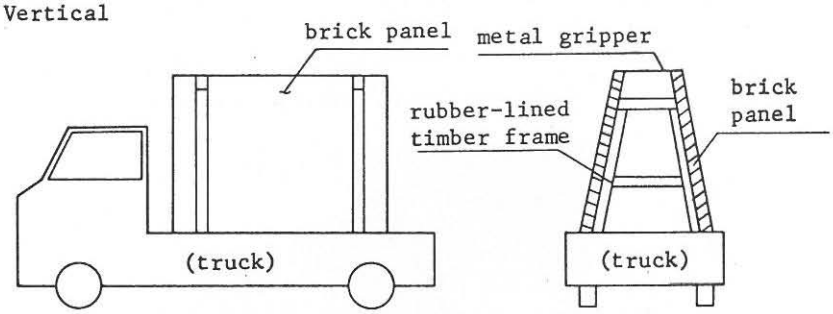
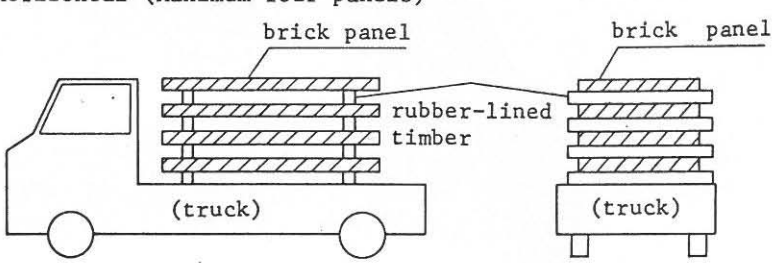


Fig.-5 Lifting up with crane

① Vertical



② Horizontal (Maximum four panels)



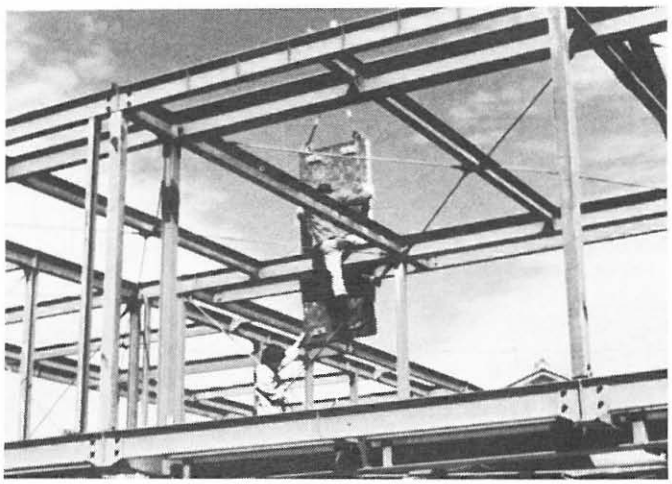


Fig.-7 Construction site

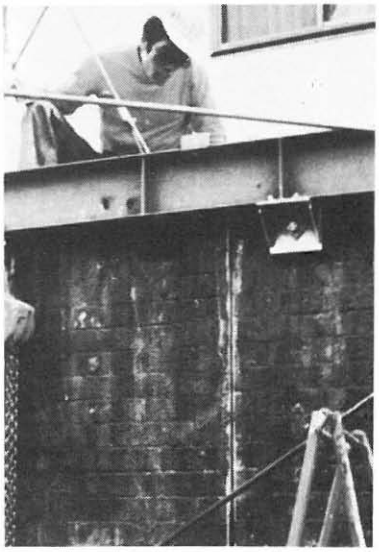


Fig.-8 Fixing of panel

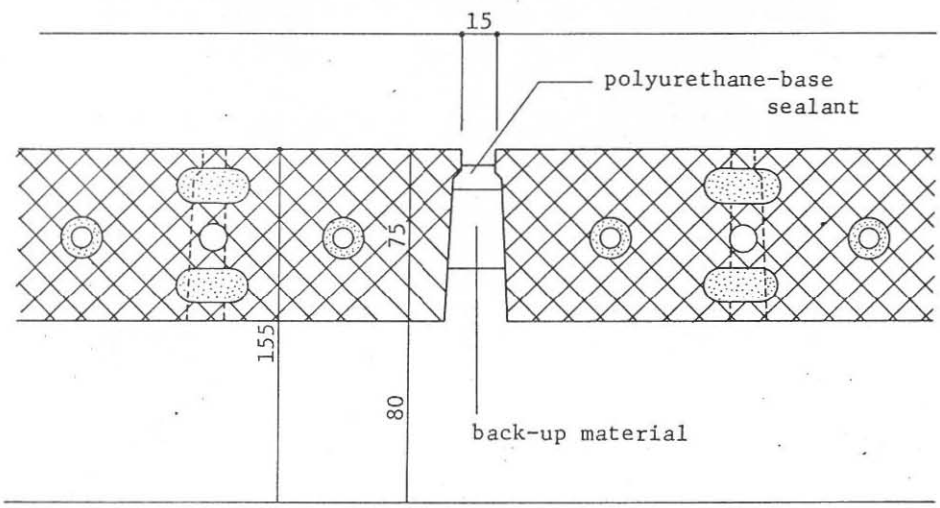


Fig.-9 Joint between panels

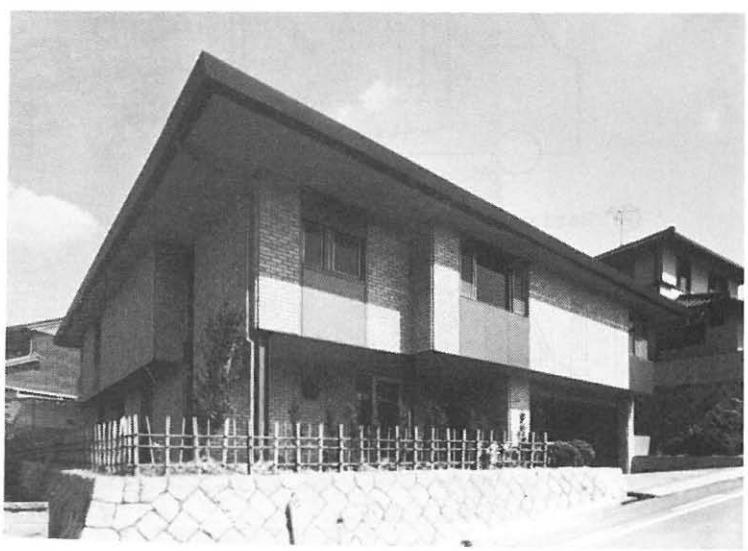


Fig.-10
Mr. Kato's
residence