

## Development of Prefabricated Brick Panel Construction in Japan

Akio Baba

Tatsuo Ando

So Kato

(Japan)

### ABSTRACT

Some of the typical examples of brick panel construction in Japan are reviewed.

In Japan brick construction has long been discouraged because of its poor earthquake-resistance. But recently, bricks have regained popularity as "new building material" for their excellent durability, texture, colour, mass and many other unique properties. New earthquake-resistant construction has also been developed. Prefabricated brick panels have been constantly upgraded and refined into (1) Cast concrete brick panels as permanent exterior formwork and (2) Reinforced brick curtain walls. None of them are load-bearing.

(1) Cast concrete brick panel construction is rather peculiar to Japan. In a sense, it may be regarded as a type of reinforced brick masonry.

Structural concrete is cast behind these panels.

The appearance is just like brick masonry externally, but higher and speedy construction has been made possible.

Since they are earthquake-resistant structures, they have been evaluated and approved by the Ministry of Construction in 1980.

(2) Reinforced brick curtain walls have been successfully used for Mr. Kato's residence, Seto, in 1980, which is reported in another paper.

Brick panels are usually fabricated in the plant by laying bricks horizontally, reinforce them and fill joints with mortar.

Finally, advantages and disadvantages of the systems above are tabulated for comparison.

The future of brick construction in Japan depends greatly on the development of brick panels.

## 1. INTRODUCTION

Brick panel in Japan has been unique in its development.

This paper reviews the development of brick panels in Japan and some of the typical examples of brick panel construction.

In Japan brick construction has long been discouraged because of its poor earthquake - resistance.

As compared with other constructions such as timber - or steel - framed building, masonry tend to be shaken into pieces immediately during earthquake and so frighten us more.

Such being the case in Japan, the Government has been reluctant to let us build masonry.

In other words, Japan has one of the most adverse environments for masonry construction.

Recently, however, reinforced brick and concrete block masonry has regained popularity from the early 1970's.

Especially brick has again been recognized as "new" building material for its excellent durability and many other unique properties.

Such excellent properties are integrated into new earthquake-resistant construction.

One of the biggest accelerations for the development of brick panel construction is occasional exfoliation of ceramic tiles from external walls.

Thicker brick tiles have better adhesion to its backing mortar or concrete.

They have been constantly upgraded and refined into brick panel construction in the second half of the 1970's.

Brick panel construction in Japan, therefore, is still in its infancy but has great potential for its constructional efficiency and beauty.

Brick panel construction in Japan is mainly classified into two groups:

- (1) Cast concrete brick panel as permanent exterior formwork
- (2) Reinforced brick curtain walls

None of them are load bearing.

Simultaneous development of brick configuration, properties and constructional innovation have made brick panel construction possible.

Now let us review these construction method in relation to brick itself.

## 2. CAST CONCRETE BRICK PANEL CONSTRUCTION

This is the original form of brick panel construction in Japan. It may also be called "reinforced brick mold panel construction". It is rather peculiar to Japan and still dominates the brick panel construction.

Reinforced brick panel is used as permanent exterior formwork for low-rise building.

This panel was mostly site-prefabricated: laid vertically.

Internal formwork can be structural plywood, of course.

Once reinforcing bars are set up in the cavity, concrete is cast between these formworks.

The finished appearance is just like brick masonry.

In Japan three brick companies are known to manufacture such brick panels, namely K company, N company and H company.

Both K and N company's methods have been approved by the Ministry of Construction in 1980 to be safe, durable and economical.

One of the typical examples of K company's construction method was described in detail in the VIBMac, Washington, 1979. \*(1)

Another case by K company is reported in another paper. \*(2)

Construction method by N company is basically the same as K's, except they reinforce the panel with prestressed wires alone.

K company's panel can be reinforced by either steel bar or prestressed wire.

Both of them are plant-manufactured, use perforated bricks and can incorporate insulant between brick panel and concrete to improve thermal efficiency.

The other brick panel construction is practiced by H company.

The basic difference from the cases above is that they use special brick tiles. See Fig. 1.

Usually all these panels are prefabricated in plant. They are manufactured after laying bricks or brick tiles horizontally with their faces down on the mold.

### 3. REINFORCED BRICK CURTAIN WALLS

There are very few such examples in Japan. So far only two companies are known to do this.

However, they are expected to have a great potential in the future, since they have better appearance of brick masonry and can be fixed to the structure very quickly and easily just like conventional concrete panels.

One of the successful examples was demonstrated in Mr. Kato's residence, Seto City, which was the first and epoch-making attempt in the history of prefabricated brick panel curtain walling in Japan. The details are given in another paper of this Conference. \*(3)

Another construction method with prefabricated brick panel is practiced by M company. The technology is transferred from U. S. A. and the panel is just 100mm thick. Solid bricks are assembled into panel with high-bond mortar.

In both cases panels are manufactured horizontally in the plant. Vertical reinforcement can be provided with either steel bar or prestressed wire.

### 4. UP-TO-DATE SITUATION IN JAPAN

Japan Brick Institute (JBI) and T housing company have started a 5-year Government sponsored project of "Highly durable brick components" in 1980.

In the first year, brick panel construction of the world including Japan was investigated.

The up-to-date situation of the world is summarized in Table 1. It should be noted that "structural" brick panel has never existed in Japan.

Influence of already-mentioned Government restriction on brick masonry is reflected.

Table 2 summarizes the newly-constructed buildings and brick panel construction in Japan.

It is evident that cast concrete brick panel construction is still prevalent.

Advantages and disadvantages of various brick panel construction systems are tabulated for comparison in Table 3.

## 5. CONCLUSION

So far all prefabricated brick panels in Japan are limited to non-loadbearing construction.

In order to meet the people's demand and to expand the future market, it is necessary for us to go into the possibility of "structural" brick panel.

It may be either "simple" or "composite" panel.

This is exactly the conclusion of the above-mentioned Government sponsored investigation by the committee of JBI and T company.

Based on the conclusion, the sub-committee is working actively on "structural" brick panel in the 2nd year.

One of the main obstacles is Government's restriction: Building Regulation.

However, public needs and our effort will eventually make brick panels feasible. The amendment of the Building Regulation should also be considered.

The future of brick construction in Japan depends on brick panels.

## BIBLIOGRAPHY

- \* (1) Adachi, K., Takahashi, Y., Baba, A., and Kato, S.  
"Brick Facing Method for Reinforced Concrete Construction,  
(2) with Brick Panels"  
Proceedings VIBMaC, Washington, 1979.
- \* (2) Kato, S., Takahashi, Y., Baba, A., Kato, M., and Yoshikawa,  
S.  
"Future Brick Panel Construction"  
Proceedings 6th IBMac, Rome, 1982.
- \* (3) Kawada, N., Ando, T., and Kato, S.  
"Mr. Kato's Residence: Brick Curtain Walls"  
Proceedings, 6th IBMac, Rome, 1982.

Table-1 Brick Panels of the world

		Japan											
		K. Company	N. "	H. "	M. "	Switzerland	France	Denmark	England	Rep. of South Africa	Canada	United States	
Construction	Structural					○	○	○	○	○	○	○	
	Curtain wall	○		○	○							○	
	Cast Concrete	○	○	○									
	Others					○	○						
Building	Low-rise	○	○	○	○	○	○	○	○	○	○	○	
	Medium	○	○			○	○	○		○		○	
	High-rise								○			○	
Brick	Perforated	○	○			○	○	○	○	○	○	○	
	Hollow core					○	○					○	
	Solid, etc.	○		○	○			○	○		○	○	
Manufacture	Plant	Vertical				○			○			○	
		Horizontal		○	○		○			○	○	○	
	Site	Vertical		○		○		○				○	
		Horizontal											
Reinforce- ment	Mortar		○									○	
	Steel bar		○		○	○	○	○	○	○	○	○	
	Prestressed		○	○	○							○	
					*1							*2	

Notes

\*1 : Technology transferred from U.S.A.

\*2 : High-bond mortar is used.

Table-2 Major buildings by brick panels in Japan

Type of building	Date	Construction #1	Structure	Manufacture #2	Area (m <sup>2</sup> )	Reinforcement #3	Company
Flat	'78-1	C.C.	R.C.	(P) V	30	(S)	K
Flat	'78-6	C.W.	R.C.	(S) V	360	(S)	K
Plant	'78-6	C.W.	R.C.	(P) H	200	(pc)	N
Police Office	'78-6	C.C.		(P) H	210	(M)	M
Flat	'78-10	C.W.	R.C.	(S) V	800	(pc)	N
Gymnasium	'79-6	C.C.	R.C.	(S) V	2,000	(S)	K
Office	'79-12	C.C.	S.R.C.	(P) H	4,675	(pc)	N
Bank		C.C.	R.C.	(P) H		(pc)	H
High School	'80-10	C.C.	R.C.	(P) H	120	(pc)	N
Residence	'80-12	C.W.	S	(P) H	180	(S)	K
City Hall	'81-6	C.C.	R.C.	(P) H	1,400	(pc)	N
Telephone Office	'82-3	C.C.	R.C.	(P) H	1,000	(pc)	K+N

\*3 : (M) = Mortar, (S) = Steel bar, (ps) = Prestressed

\*2 : (P) = Plant-manufactured (S) = Site-manufactured

\*1 : C.C.= Cast concrete brick panel

C.W.= Curtain wall



Table-3 Advantages & Disadvantages of brick panels

Brick Panel	Classification	Advantage	Disadvantage	Notes
Structural	Smaller panel	Good for low-rise residences	No examples	In Japan, special approval required by the Ministry of Construction.
	Larger panel	As above	As above	
	Larger pre-stressed panel	High-strength	Low thermal insulation	
Curtain wall	In-fill panel	Economical	Breakage in handling	
	Curtain wall	Lightweight, insulating	As above	Prevalent in U.S.A.
	Brick veneer	As above	Laid on site	U.S.A., Australia
Cast concrete	Brick panel	No external formwork No exterior finish	Breakage in handling	Approved by the Ministry of Construction
	Insulating brick panel	Highly Insulating	Complicated wall ties needed	A type of cavity wall
	Thin tile sheet	No tile exfoliation		Called "brick board"
Floor		Any brick pattern achieved	Structural consideration needed	No examples in Japan

Fig.-1 Horizontal Cross-section of brick-tile panel

(by H. Company)

