

III-3. Brick Facing Method for Reinforced Concrete Construction with Brick Panel

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ABSTRACT

This paper is to introduce the construction method utilizing brick panels as casting molds for R.C., or S.R.C. structures.

In Japan, facing by ceramic tiles with cement mortar is popular and their superior performances are recognized. However, the fracture by earthquakes or bad construction is the problem and the tile finish without fracture is expected.

Besides, it requires skilled layers to lay tiles after completion of the building and has problem of shortage of layers and economical aspects.

By the new finishing method reported in this paper, brick panels used as the casting mold become outer walls after completion of the building.

It has following merits: (1) With unique beauty of brick facing, durability and thermal insulation can be improved by devising proper bricks, (2) Omission of outer (or interior) facing works, (3) Omission of outer scaffolding, (4) Shortening the term of construction by omission of facing works or paneling of casting molds.

The primary processes of "Fill-up Concrete Brick Panel Construction" as below and necessary data for smooth, safe utilization of this method are introduced in the paper: (1) Manufacture special brick units, (2) Construction of brick panels, (3) Shipment of panels, (4) Handling and installation of panels, (5) Casting concrete, (6) Cleaning, curing and stripping.

PREFACE

The purpose of this paper is to introduce the construction method utilizing brick panels as casting molds for R.C. or S.R.C. buildings.

In Japan, it is popular to face R.C. or S.R.C. buildings by ceramic tiles with cement mortar for appearance and improving the durability of walls. The other hand, this method sometimes causes the problem of fracture by earthquakes or bad construction, and with this finishing method less fracture is expected. To lay tiles after completion of the structure of the building requires many skilled layers and causes shortage of workers or economical problems. Besides, tiles are not always thick enough to fill design requirement and the desire for texture of brick masonry walls is great.

The new method reported here is to utilize brick panels as casting molds and leave them as outer walls after the completion of the building.

This method has the following merits:

1. It gives R.C. or S.R.C. buildings the appearance of brick masonry.
2. It improves the thermal insulation and durability of outer walls.
3. Construction works of either outer walls or inner walls can be eliminated.
4. Outer scaffoldings can be eliminated.
5. Paneling of brick shortens the period of construction and increases efficiency of building.

PURPOSE OF THE EXPERIMENT

The purpose of the experiment reported here is to examine the possibility of "Cast Concrete Brick Panel Construc-

tion" which has merits mentioned above by the actual example of construction.

This experiment was the first one to utilize brick panels for actual construction by the new method in Japan.

The purposes of these experiments were:

- 1) Experiments on Utilization of Brick Panels
 - a. Workability and productivity of brick panels with high-bond mortar.
 - b. Easy handling of brick panels at shipment, hanging and installation.
 - c. Strength of brick panels as casting molds.
- 2) Experiment of Actual Operation of "Cast Concrete Brick Panel Construction"
 - a. Adaptability of this method to process of construction.
 - b. Possibility of eliminating outer scaffolding.
 - c. Practicability of brick panels as finishing materials.

The following is the result of the experiment made in the outer walls of the housing in the suburbs of Tokyo under cooperation of the owner, designer and contractor.

REPORT OF THE EXPERIMENT

Data of the Experiment

Time	Oct. 1977-June 1978
Name of Building	Higashi-Terao Sun View Heights (Housing)
Address	6-34 Higashi-Terao, Tsurumi-ku, Yokohama
Structure	Reinforced concrete, four storied
Building space	302.36m ²
Total floor space	1,058.46m ²

Design	Ban Construction & Design Ltd.
Contractor	Dainissei Construction Co., Ltd.
Location of experiment in this building	Outer walls of the north staircase, third and fourth floor (35.85m ²)
Construction method	"Cast Concrete Brick Panel Construction"

Staff of the Experiment

Promotor	The Brick Study Committee
Works	The Kunishiro Company
Manufacture of jigs	Okabe Company Ltd.

Process of Experiment

Fig. 2 and Fig. 3 show the place of the experiment and the layout of brick panels. The size of the brick panel is (height 2,724mm × width 876mm). This height was determined by the number of courses in the vertical direction and width was determined by the size of jigs at the factory. On the parapets in the upper part of walls and below the panels at ground level brick tiles were layed by hand on the R.C. walls on site.

Four panels in the total twelve panels had four glass blocks for lighting. The weight of one panel is 437kg.

Materials Used in Brick Panels

Bricks	P.S. Special bricks OHO (210×100×60)	
	The Kunishiro Company	
Mortar	Highbond mortar	
	Sand	15.50kg
	Highbond additive	1.03kg
	Cement	5.15kg
	Water	2.47kg
	Water/cement ratio	48%
	Highbond/cement ratio	20%
Jigs	See Fig. 4	

From the previous experiments brick panels were considered to have sufficient strength to bear the compressive forces during the casting process. However this experiment was permitted by the favor of the owner; as no failure was allowed, three reinforcing steels (9Ø) were placed in each panel to insure safety.

Fig. 8 shows the placement of reinforcing steel bars. The end of steel bars were left projecting from the panel for setting metal fittings.

During manufacture of brick panels, the following metal fittings were placed for use at the time of shipment and installation.

Hooks for hanging	Fig. 5
Metal fittings to adjust the level	Fig. 6
Fittings to place separator	Fig. 7

The number of working days to manufacture brick panels were six days with ten brick-layers making six panels for the third floor, and four days with eight brick-layers making six panels for the fourth floor. The number of courses layed per day was ten.

Installation was done using metal fittings mentioned before. The staff required for installation was as follows.

The time for installation of six panels for the third floor was two hours.

Crane operator	1
Fixing panels	2
Welder	1
Assistant	1
Total	5

Fig. 9 shows support of brick panels.

Concrete was cast by the truck-mixer. (Slump 2/cm) Soft urethane strips were placed in the joint between each panel, and they prevented escape of concrete and provided a back up when sealing the joint.

After curing period of concrete, frames were removed and surface of walls were cleaned. However, there were problems of preciseness in manufacturing brick panels and installation, and some of the joints had to be repaired. Chiocole was used as the seal between the panels.

CONSIDERATION ON RESULTS OF THE EXPERIMENTS

The purpose of this experiment was examination of possibility whether brick panels manufactured at the factory and shipped to the construction site could be used as the casting molds of outer walls. The result was successful that the experiment was finished without any confusion or accident in the severe conditions of the construction site. However, considering details, there were some unsatisfactory points as follows.

Problem in Manufacturing Brick Panels

Only twelve panels were used this time, but there was difference in size or surface level of panels, and adjustment was necessary at the time of installation and after completion of walls. This was because of inexperience in manufacturing brick panels in Japan and should be improved in the future. The following are the points to be improved:

- (1) Bricks used for panels should have precise shape and size.
- (2) Determine the height of panels layed per day considering that Sarabond mortar takes longer to stiffen than plain mortar.
- (3) Improve jigs to insure the even plane.
- (4) Examine possibility of horizontal manufacturing of brick panels.
- (5) Pay attention to joint lines and joint colors between each panel.

Problem in Shipment and Installation of Brick Panels

The problem of shipment is increased if the brick panels are made a long way from the construction site. In the present situation of brick panels, it is considered that brick panels should be manufactured at a factory near to the construction site.

Points requiring improvement:

- (1) Study of the method of securing panels during shipment. As no special truck for brick panels was used

in this experiment, panels were leaning against wooden frames on the truck and it took a longer time than was expected for raising them by crane.

- (2) Hooks for hanging panels were bolted at the end of reinforcing steel this time, but improvement is expected.
- (3) Metal fittings for adjustment at installation. Some of fittings used this time were not sufficient to cover the preciseness of the concrete body.
- (4) To increase the strength as molds, metal fittings on panels were connected by welding, but this welding can be eliminated.

Problems of Casting Concrete and Cleaning

Elimination of outer scaffolding was accomplished in this experiment. However, all the support for molds had to be erected from inside and caused difficulty in cleaning and finishing joints. Use of hanging scaffolding should be studied for cases of larger buildings in the future.

Problem of Strength

This experiment confirmed that brick panels had sufficient strength for shipment, installation and casting of the concrete, but as this was an experiment, analysis of data of necessary strength of brick panels at each process of construction were left for future study.

The operations which give stress to brick panels are:

- (1) When frames are stripped after manufacturing brick panels.
- (2) When panels are moved in the factory.
- (3) When stocked in the factory.
- (4) When shipped to the construction site.
- (5) Hanging and installation.
- (6) When concrete is cast. As to (6) the compressive force of concrete was measured in this experiment, but data were not precise because concrete was cast in three separate operations for each wall.

SUBJECTS FOR THE FUTURE

Future of the "Cast Concrete Brick Panel Construction"

This construction method will be adopted when brick facing is required for outer or inner walls of R.C. buildings.

When compared with the construction method with thin bricks reported in the previous paper, this method has the following merits:

- (1) Using brick units, this method has the characteristic of brick masonry.
- (2) Working as casting molds, the outer scaffolding are not necessary.
- (3) Disposal of scrap is not necessary.

The other hand demerits are:

- (1) Large and heavy equipment is necessary for manufacture, shipment and installation of brick panels.
- (2) Buildings become heavier.
- (3) It is difficult to attain precise finish.
- (4) Example of actual work is rare.

These demerits should be improved as more buildings by "Cast Concrete Brick Panel Construction" are done from now on, and these two facing methods will work abreast in the future.

Subjects to Be Studied in the Future

The following are the subjects to be studied in the future:

- (1) Manufacture of light-weight brick panels.
Light-weight panels will make each process of construction easier and more efficient and will reduce the total load of the completed building. For this purpose, manufacture of light-weight brick units is necessary.
- (2) Manufacture of thinner brick panels.
If the required strength is insured, the thinner panels will help requirement for light-weight panels and increase efficiency of the unit size.
- (3) Protective concrete cover for reinforcing steels.
According to the standard specification of the concrete works at present, there should be a space between brickwork and the reinforcing steel, which should be either 1.5 times the normal cover for concrete walls or 1.5 times the largest size of aggregates. This protective concrete cover is determined considering corrosion of reinforcing steels and for fire resistance. When brick panels are proved to be efficient in these points, it will be possible to reduce thickness of the protective concrete cover.
- (4) Durability of reinforcing steel in brick panels against corrosion.
As corrosion of reinforcing steel causes stains, cracks, or pop-out of panels, it should be prevented. It should be confirmed by the experiment of corrosion.

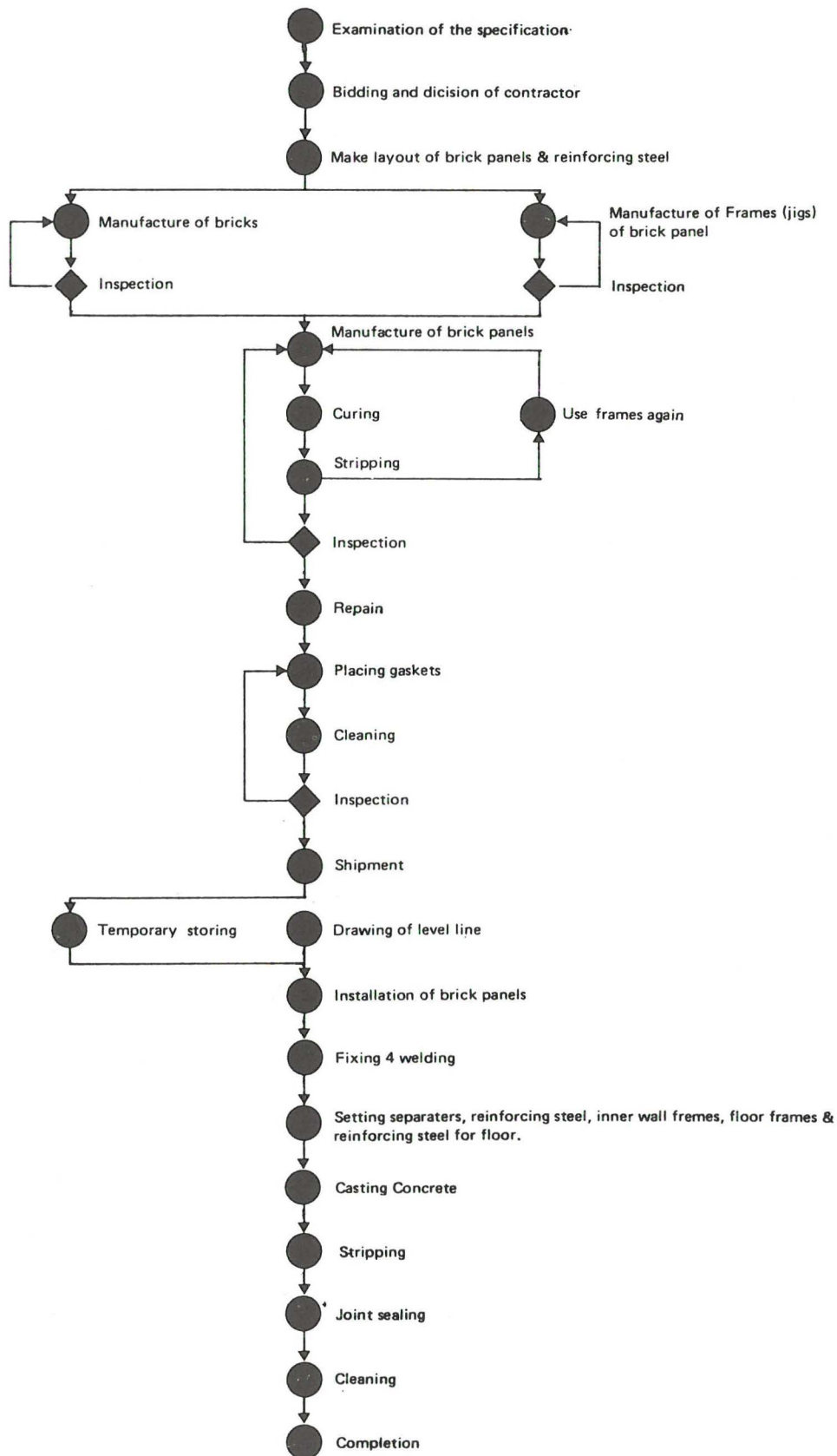


Figure 1. Flow of "Fill-up Concrete Brick Panel Construction"

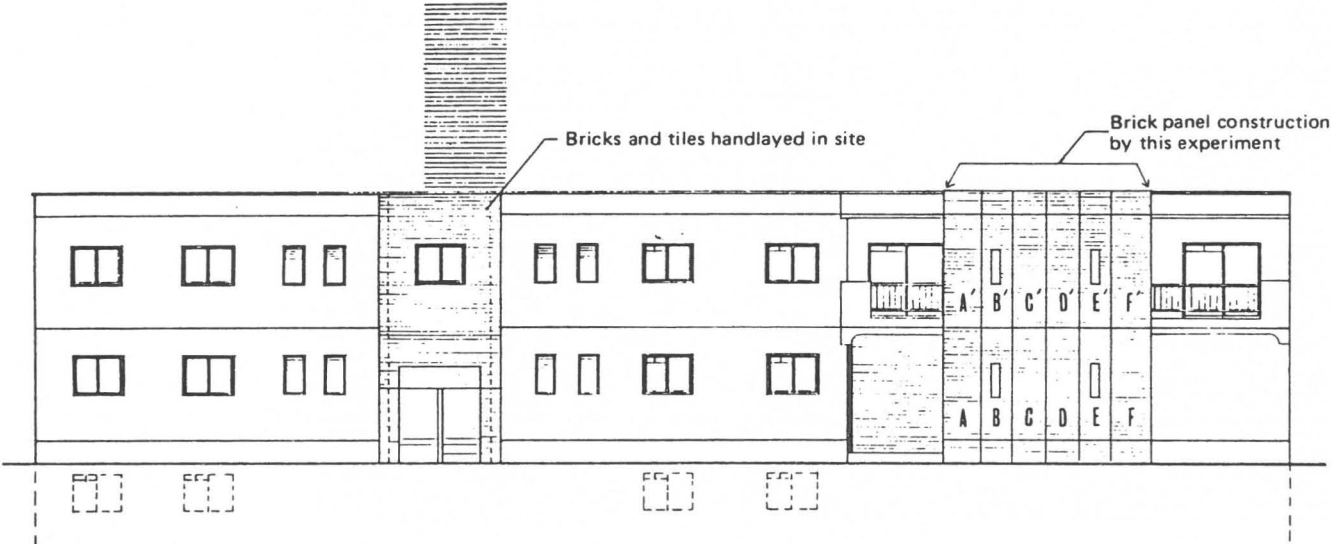


Figure 2. Front view of the building

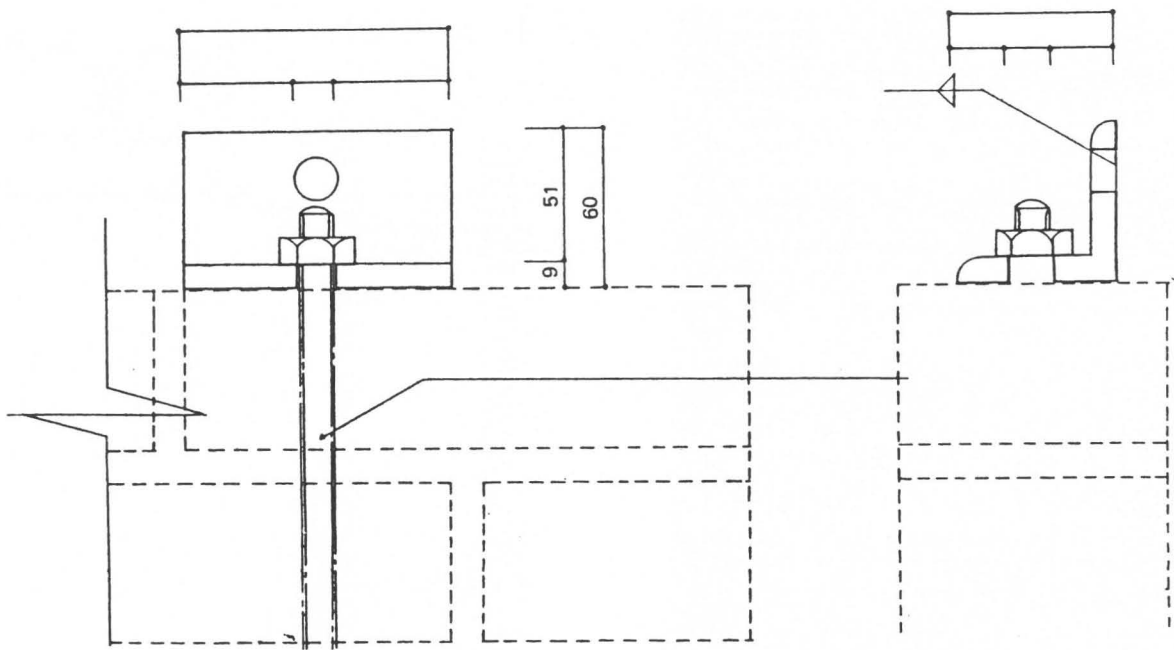
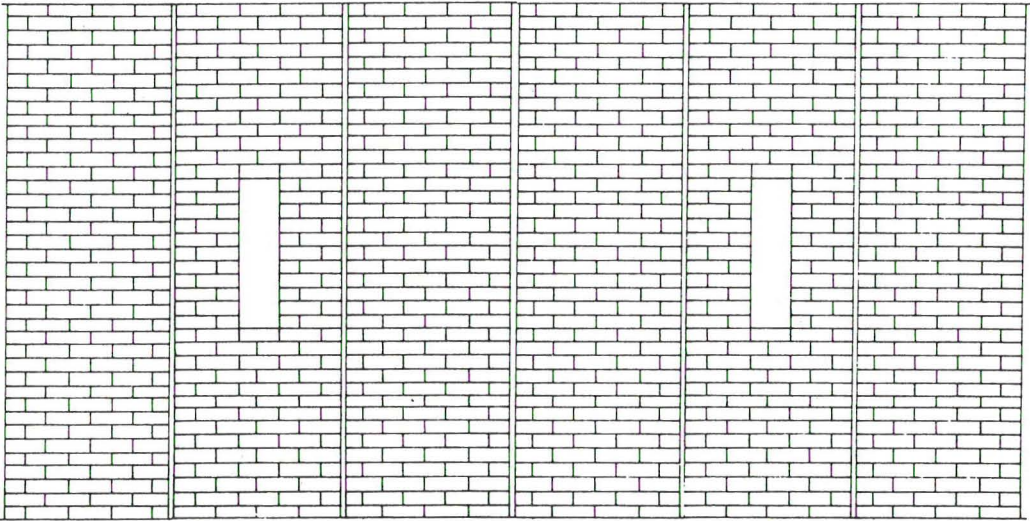


Figure 5. Hooks for hanging



3a

Figures 3a & 3b. Layout of brick panels



3b

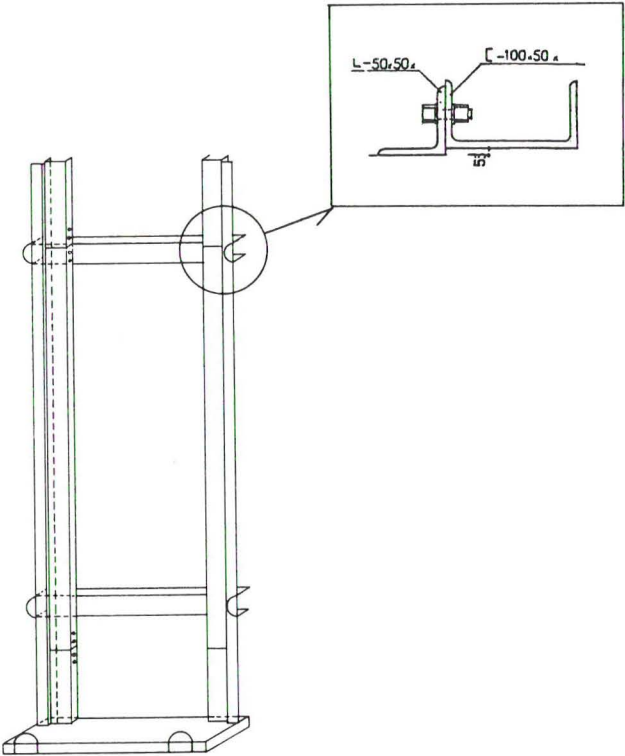


Figure 4. Jigs for manufacturing brick panels

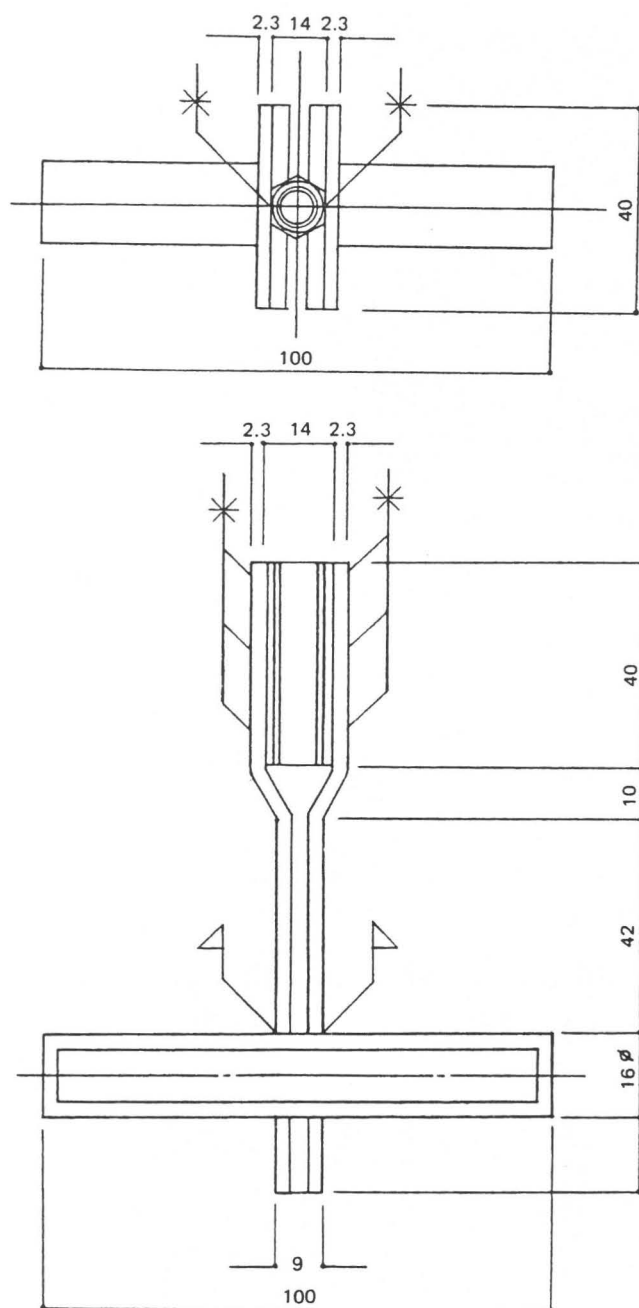


Figure 6. Metal fittings to adjust level

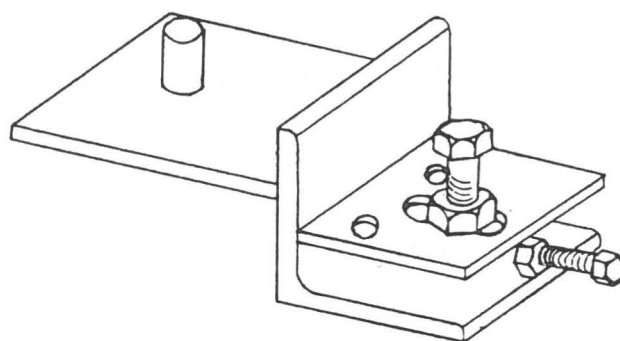


Figure 7. Metal fittings for separators

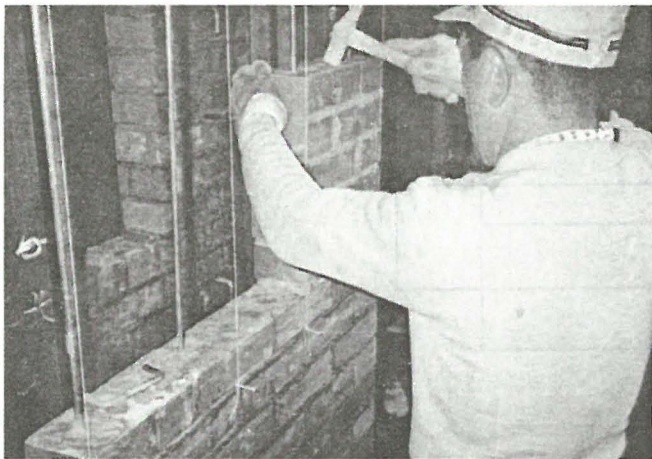


Figure 8. Reinforcing steel bars of brick panel

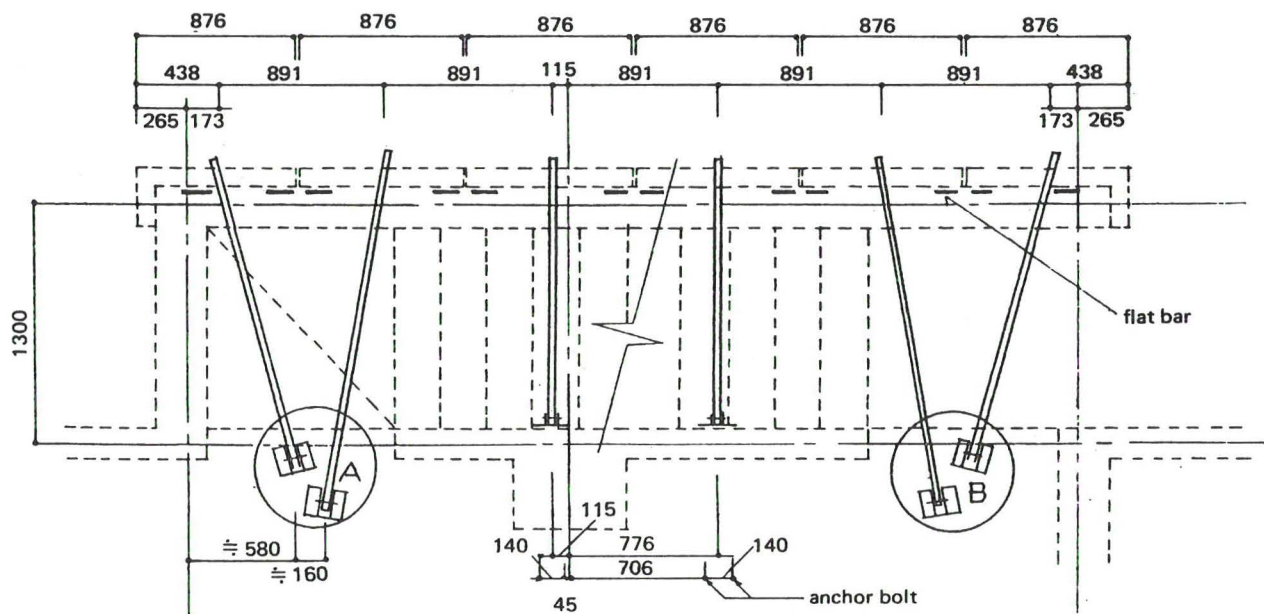


Figure 9. Support of brick panels