BEHAVIOUR AND APPLICATION OF METRIC MODULAR HOLLOW BRICK MASONRY

LU XI-ZHAO, Engineer
Nanjing Xin-Ning Bricks & Tiles Factory, People's Republic of China

CHEN XING-ZHI, Head of Department
Department of Civil Engineering, Hunan University, People's Republic of China

ABSTRACT Based on the experimental research of 670 compressive prisms and 380 shear panels of the metric modular hollow brick masonry, this paper gives the compressive strength, racking shear strength, shear strength in bed joints, elastic modulus and shear modulus of metric modular hollow brick masonry. By using these data and the relative calculation formulae in the current design code for the masonry structures, the strength of compressive member and shearing member of these brick masonry has been evaluated. The safety for the evaluated strength of those members has been checked by the present experiment, and it has conformed with the requirement of the current design code for masonry structures. The application and the production of these bricks are also introduced in this paper.

## 1. INTRODUCTION

In order to meet the demands for architectural department for reforming traditional brick and economizing energy and improving economic benefit of construction, the experimental research on the behaviour of metric modular hollow brick masonry (shown in Fig. 1) has been carried out by our factory. The principal products have already been accepted into the national standard so as to push reasonable application of product forward.

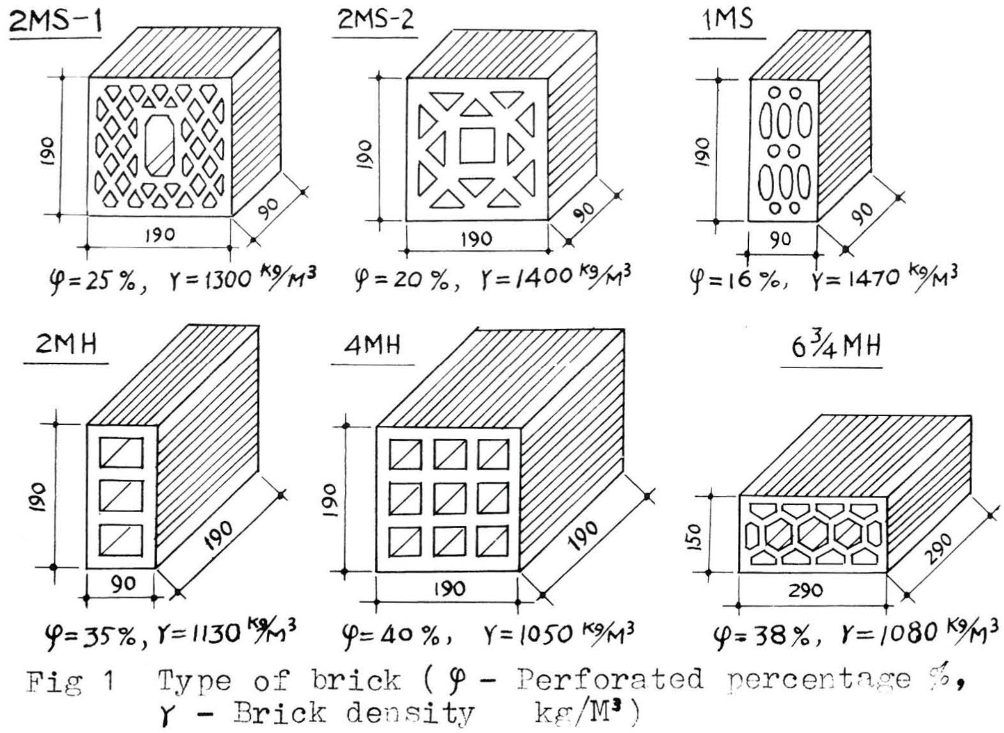


Fig 1 Type of brick ( φ - Perforated percentage %,
γ - Brick density kg/M³ )

## 2. COMPRESSIVE STRENGTH OF THE BRICK AND MASONRY

The compressive strength of the gross area of vertically perforated brick 2MS with the true density 1745 kg/M$^3$, 24-h cold water absorption 18~19% and coring 20~26% is between 150~200 kg/cm$^2$ ** in which the coefficient of variation $C_v$ is 0.18~0.26. Through tests on 670 prisms under axial or eccentric load and others (the results are shown in Fig. 2), the compressive computation of masonry component may be calculated in according with Design Code of Masonry GBJ3-73.

Because standard compressive test method of hollow brick is

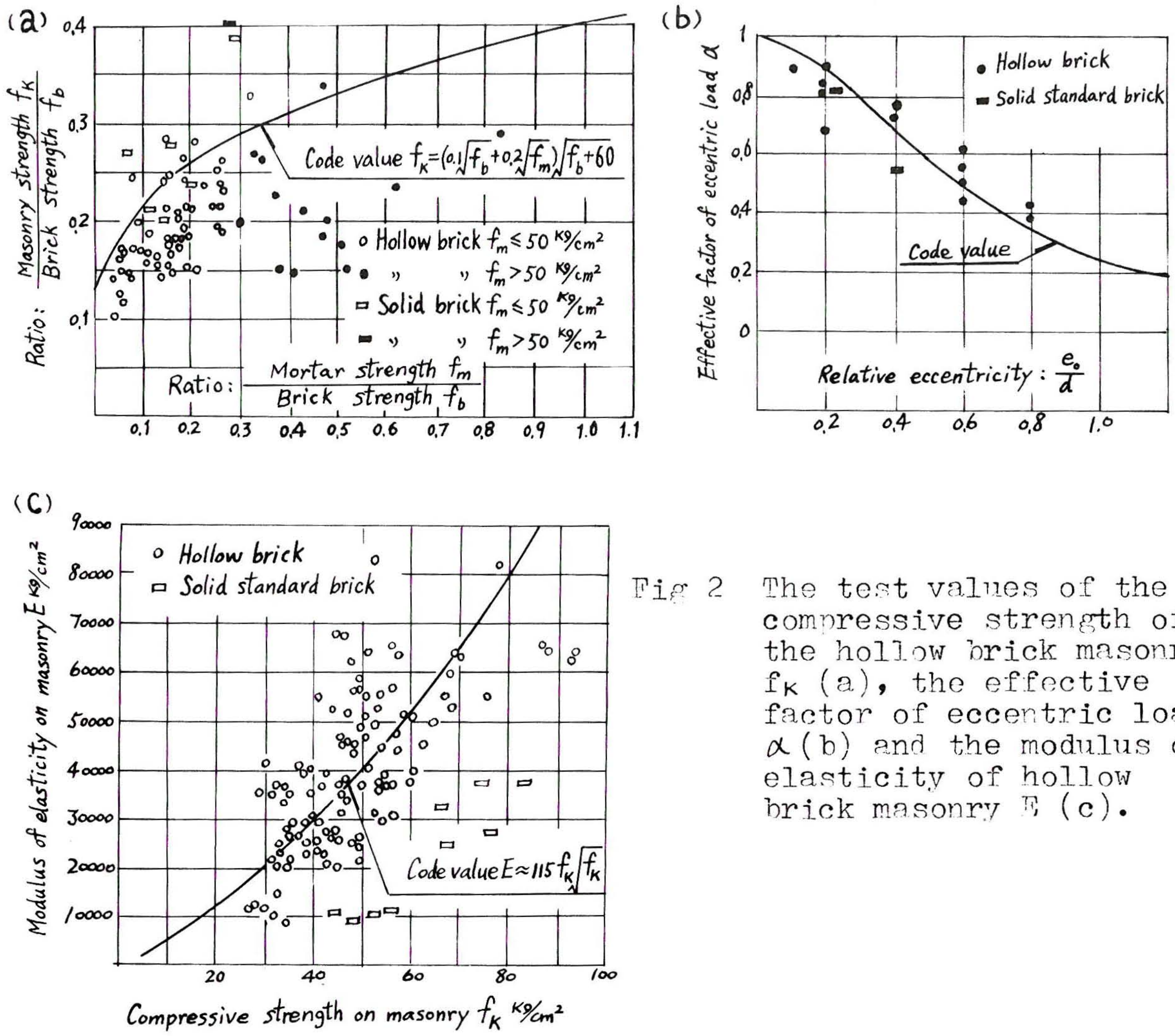


Fig 2 The test values of the compressive strength of the hollow brick masonry $f_K$ (a), the effective factor of eccentric load $\alpha$ (b) and the modulus of elasticity of hollow brick masonry E (c).

different from that of solid standard brick and other effects exist, it is suggested that the compressive strength take the calculating strength of the code multipied by a reduction factor 0.9 is safety (the factor 0.6 to the horizontally perforated brick masonry appropriately).

## 3. SHEAR STRENGTH OF THE MASONRY

Through shear test on 380 specimens which were built with solid standard brick and with eight kinds of vertically and horizontally

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Note** SI Internation measured units: 1 Mpa ≐ 10 kg/cm$^2$.

perforated bricks in which coring is 20~28% and 33~44% respectively. By using diagonal compressive method and shear test method along the bed joint, the results are shown in following.

### 3.1 Deformation Properties and Failure Mechanism of the Specimen

The results measured by electrometry shows that the local compressive stress at loading apex angles is greater than that at the center of specimen under the diagonal load $P_d$. Therefore, the compressive strain in all measuring points on Y-axis are distributed non-uniformly, but the distribution of tensile strain are approximate to uniform (shown in Fig. 3a). The compressive strain and tensile strain at the center of wall are always maximum for all points of X-axis and that evanesce to zero when toward the both ends of X-axis, and the distribution of these strain take the shape of triangular. It may be deduced from the stress-strain curve (shown in Fig. 3b) that the ratio $\sigma_n/\tau_{pt}$ (in which $\sigma_n$ is principal compressive stress and $\tau_{pt}$ is principal tensile stress in the diagonal section) be 2.9 proximately (shown in Fig. 3c), there are compressive strain in four lateral faces of the specimen and the

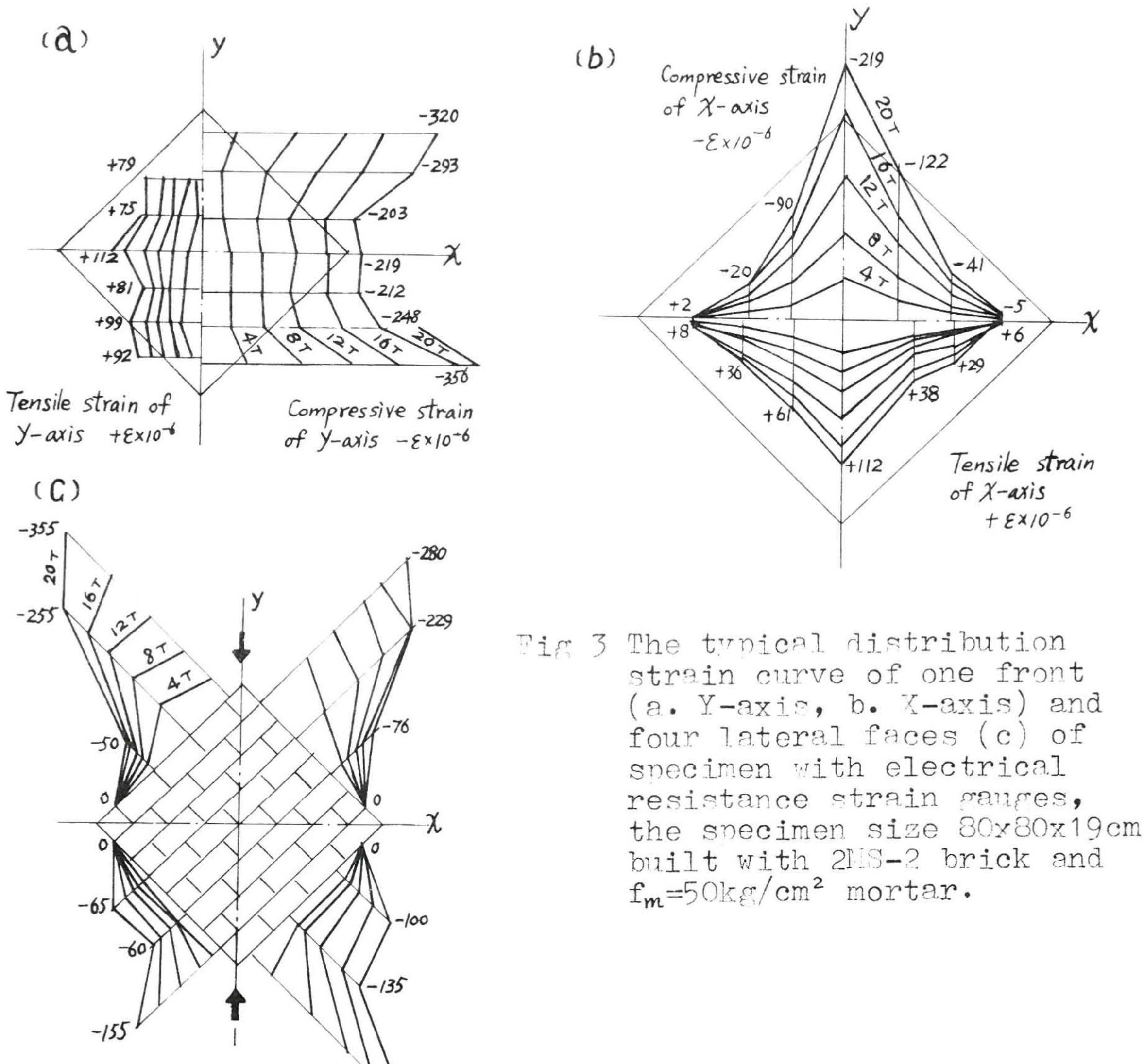


Fig 3 The typical distribution strain curve of one front (a. Y-axis, b. X-axis) and four lateral faces (c) of specimen with electrical resistance strain gauges, the specimen size 80x80x19cm built with 2NS-2 brick and $f_m$=50kg/cm² mortar.

strain evanesce to zero from the loading apex angles toward both ends of X-axis of wall (the average values are approximate to equivalent between one couple of stretcher faces and one couple of header faces measured by dial gauge).

A variety of brick and specimen with different characteristics has the same properties in its stress-strain curves when the normal compressive stress $\sigma_0$ is zero (shown in Fig. 4 and Fig. 5). That is to say, the ratio of compressive strain $\varepsilon_V$ to tensile strain $\varepsilon_H$ at the

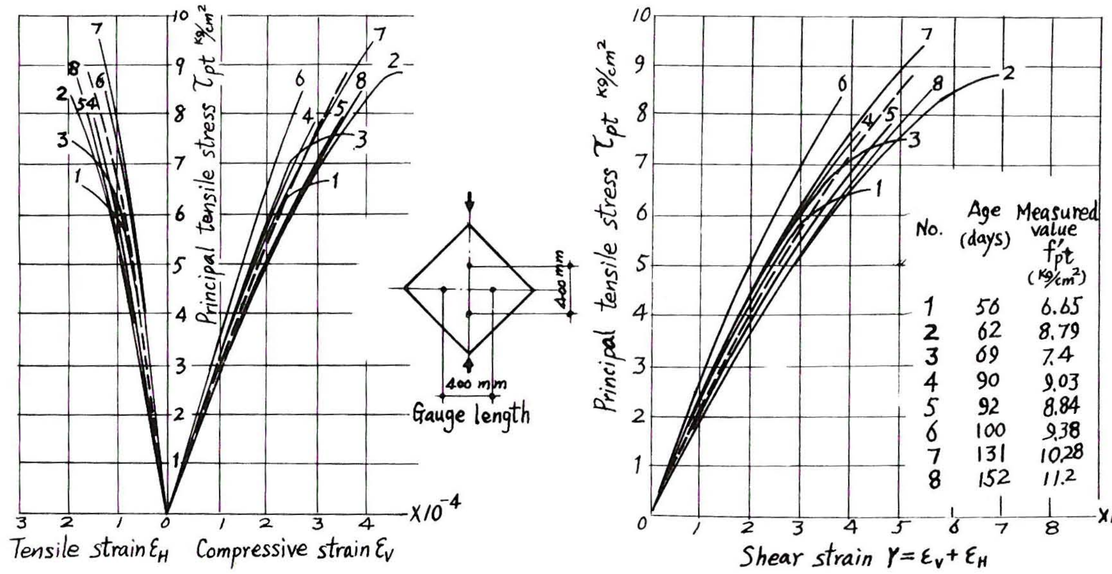


Fig 4 Strain curve of the specimen when $\sigma_0$ =0, $P_d/P_{dp}$ =0.85~0.98, the specimen size 80x80x19cm built with 2MS-2 brick and $f_m$ = 50 kg/cm² mortar. The broken line is the average of six specimens which measured by electrometry.

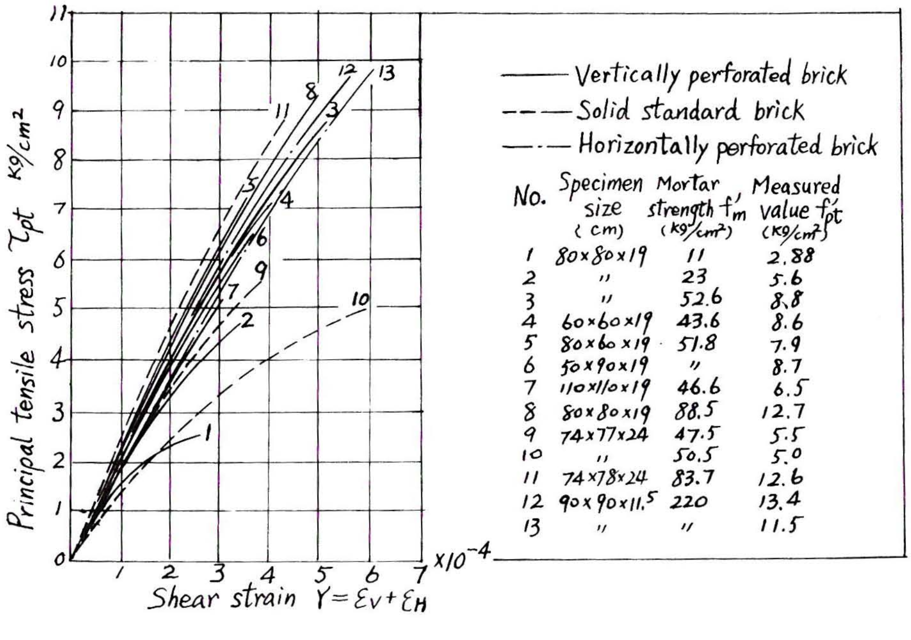


Fig 5 Strain curves of the specimens when $\sigma_0$ =0.

center of wall is approximately a constant, varing generally in the range of 0.25~0.45 (in the light of the statistics on 53 specimens, the average value is 0.354 and the coefficient of variation $C_v$ is 0.21). When the diagonal load is less than 0.5 $P_{dp}$ , where $P_{dp}$ is diagonal failure load, a linear relationship can be taken for the change of the strain, and the residual deformation is very small under the repeated loading. All Specimens damaged in the stepped joints along diagonal line when the tensile strain reached maximum at the center of wall. As shown in Fig. 6, the failure patterns are mainly divorced when mortar strength is lower, or tend to split with the increasing of mortar strength and cracking is undiscovered until the specimen failure (among the 275 specimens counted the failure trace through diagonal line take 88%). According to the statistics on 28 specimens (including square and

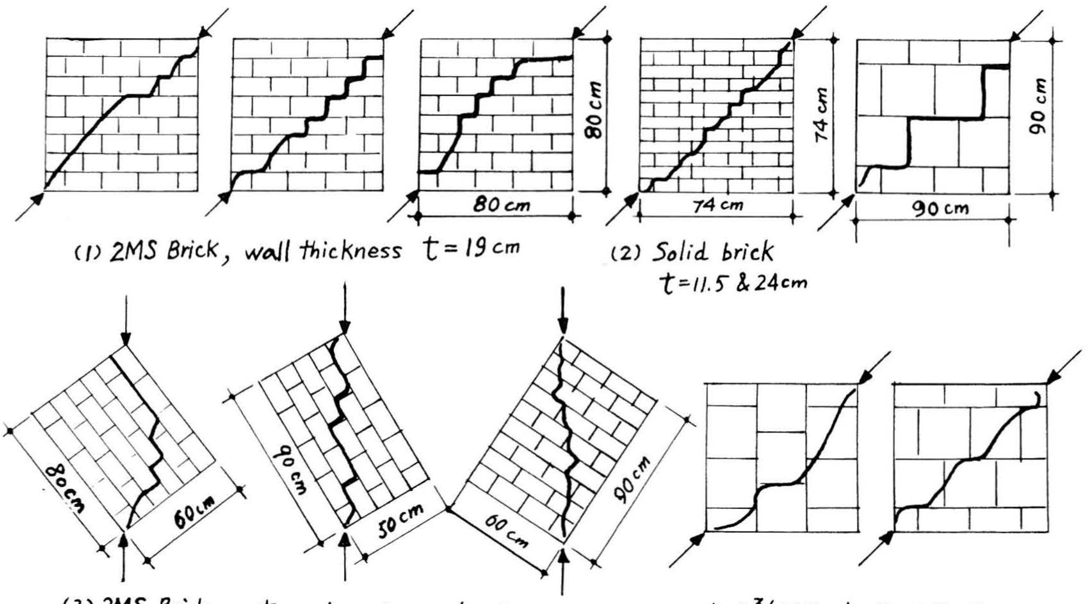


Fig 6 Failure patterns of specimen

rectangular plane) which made of 2MS-2 brick and mortar with compressive strength 50 kg/cm², the average value of shear modulus of elasticity of masonry G is 22200 kg/cm² ($C_v$=0.127) when the load is 0.435 $P_{dp}$ , and the average value of modulus of elasticity E on 13 prisms laid by same group mortar is 62630 kg/cm² ($C_v$=0.09). Thus, the proximate ratio G/E may be:

$$G \approx 0.35\ E$$

When an axial load is applied, an initial compressive strain $\varepsilon_{vo}$ appear on each axis of wall at the same time and equal to each other. when $\varepsilon_{vo}$ was neglected, the curve shown in Fig. 7 nearly coincide with that shown in Fig. 4 and the average value of G of 16 specimens is 22130 kg/cm² ($C_v$ =0.07) which are equal to that of G when $\sigma_0$=0. Because of the axial load is small ($\sigma_0$ =1~6.5 kg/cm²), all specimens failure without presage at the maximum tensile strain or the principal tensile stress. The effect of vertical load on the specimen is the same that of the precompressive load was subjected by the specimen. It lessens the principal tensile stress in sec-

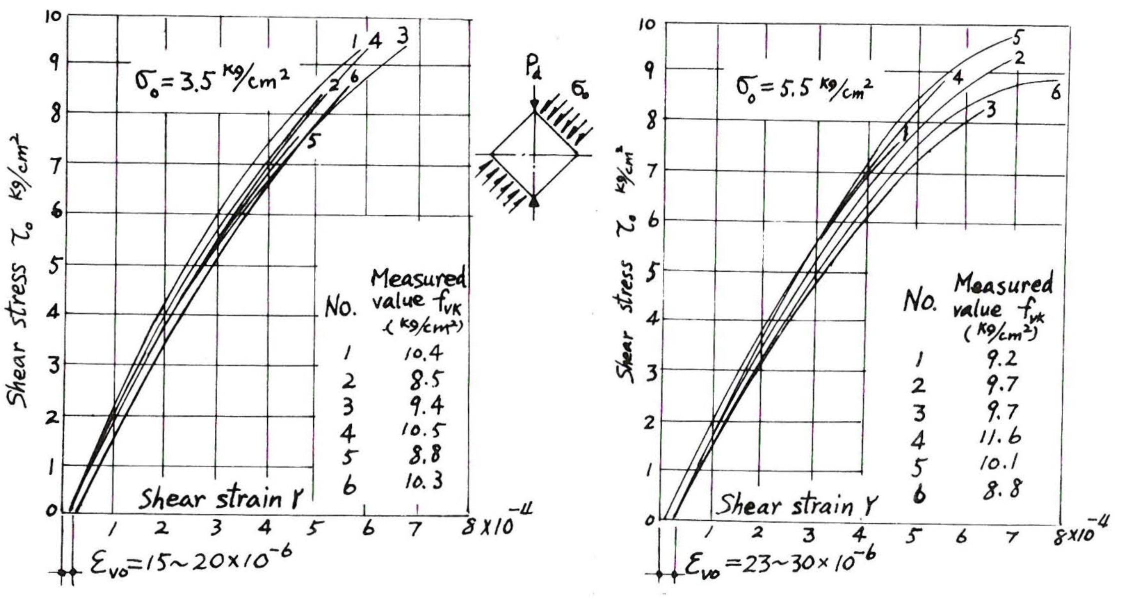


Fig 7 Strain curves when $\sigma_0$ =3.5 and 5.5 kg/cm$^2$ for specimen size 80x80x19cm built with 2MS-2 brick and $f_m$ =50 kg/cm$^2$ mortar.

tion, that is, the shear strength increase.

3.2 Influence Factors on the Principal Tensile Strength of the Masonry.

Complying with the provisions of Seismic Design Code for Industrial and Civil Buildings TJ11-78, the racking shear strength of brick masonry $f_{vk}$ may be calculated by following formula:

$$f_{vk} = f_{pt}\sqrt{1 + \frac{\sigma_0}{f_{pt}}} \qquad (1)$$

in which: $f_{pt}$ = Principal tensile strength of the masonry (kg/cm$^2$). According Code GBJ 3-73, take the value of shear strength in bed joints of masonry $f_{HK}$ , i.e.

$$f_{HK} = 0.4\sqrt{f_m}\left(\frac{f_m - 1}{f_m}\right) \qquad (2)$$

$f_m$ = Mortar compressive strength (kg/cm$^2$).

$\sigma_0$ = Axial compressive stress (kg/cm$^2$).

When $\sigma_0$ = o in ghe formula (1), $f_{vk} = f_{pt}$ , i.e. the principal tensile strength $f_{pt}$ may be approximately expressed by the racking shear strength $f_{vk}$ while $\sigma_0$ = o. The value can be determined by diagonal compression tests without axial load and may be obtained by followings:

For square plane: $$f'_{vk} = \frac{0.707\ P_{dp}}{bt} \qquad (3)$$

For rectangular plane: $$f'_{vk} = \frac{P_{dp}}{t\sqrt{b^2 + c^2}} \qquad (4)$$

Where: $f'_{vk}$ = The measured value of racking shear strength of the masonry (when $\sigma_o = o$, $f'_{vk} = f'_{pt}$ ) (kg/cm²).

$P_{dp}$ = Diagonal load at the failure (kg)

b, c = Length of specimen (b=c for square plane) (cm).

t = Thickness of specimen (cm).

The results indicate that the principal tensile strength of the masonry depends on the tangential adherence at the interface of mortar and brick, increasing with mortar compressive strength. Because of the sufficient filling joints and the sufficient wetting bricks, the test values of the principal tensile strength of masonry on 270 specimens are 2.8 times as large as the calculated values $f_{pt}$ from the formula (2) (shown in Table 1) and the test points are plotted in Fig. 8. On the contrary, if wetting brick

Table 1 Summary of Principal Tensile Strength in Masonry

| No. | *Compressive strength (kg/cm²) Brick $f'_b$ | Mortar $f'_m$ | Mean age (days) | Number of specimen | Principal tensile strength in masonry: Tested $f'_{pt}$ (kg/cm²) | Coefficient of variation $C_v$ (%) | Calculated $f_{pt}$ (kg/cm²) | Ratio: tested $f'_{pt}$ / calc. $f_{pt}$ |
|---|---|---|---|---|---|---|---|---|
| Vertically perforated bricks (2MS-2 in the main) | | | | | | | | |
| 1 | 234 | 50 | 87 | 6 | 7.3 | — | 2.77 | 2.65 |
| 2 | 249 | 55.7 | 87 | 85 | 8.29 | 0.157 | 2.91 | 2.85 |
| 3 | 191~311 | 50.1 | 142 | 30 | 8.62 | 0.128 | 2.75 | 3.13 |
| 4 | 255 | 50 | 29 | 3 | 8.31 | — | 2.77 | 3. |
| No. 1-4 means | | 54 | 98 | 124 | 8.32 | 0.153 | 2.86 | 2.91 |
| 5 | 311 | 11.4 | 124 | 4 | 2.98 | — | 1.23 | 2.42 |
| 6 | 311 | 21. | 126 | 7 | 5.37 | 0.08 | 1.73 | 3.1 |
| 7 | 239 | 35. | 74 | 27 | 5.09 | 0.166 | 2.27 | 2.24 |
| 8 | 206~305 | 44.1 | 129 | 20 | 7.3 | 0.107 | 2.52 | 2.9 |
| 9 | 255~311 | 74. | 135 | 7 | 10.72 | 0.1 | 3.34 | 3.21 |
| 10 | 239 | 102. | 81 | 4 | 8.98 | — | 4. | 2.24 |
| 11 | 239 | 195 | 84 | 7 | 12.19 | 0.114 | 5.54 | 2.2 |
| means | | | | 200 | — | — | — | 2.788 ($C_v$=0.185) |
| Solid standard brick | | | | | | | | |
| 12 | 263 | 19.3 | 75 | 10 | 5.79 | 0.189 | 1.67 | 3.47 |
| 13 | 180~302 | 52. | 125 | 14 | 6.39 | 0.24 | 2.81 | 2.27 |
| 14 | 263 | 84. | 55 | 4 | 12.25 | — | 3.62 | 3.48 |
| 15 | 302 | 83.7 | 111 | 3 | 11.39 | — | 3.62 | 3.15 |
| means | | | | 31 | — | — | — | 2.9 ($C_v$=0.27) |
| Horizontally perforated bricks | | | | | | | | |
| 16 | 174 | 37 | 99 | 7 | 3.77 | 0.156 | 2.37 | 1.59 |
| 17 | 133~136.4 | 100 | 63 | 4 | 10.64 | — | 3.96 | 2.69 |
| 18 | 174 | 217 | 127 | 14 | 10.14 | 0.227 | 5.81 | 1.74 |
| 19 | 174 | 204 | 105 | 14 | 11.14 | 0.152 | 5.58 | 2. |
| means | | | | 39 | — | — | — | 1.9 ($C_v$=0.24) |

* $C_v$ of variety groups of $f_b'$ is 0.16~0.27, $C_v$ of the No. 2 and No. 3 of $f_m'$ is 0.185 and 0.196 respectively.

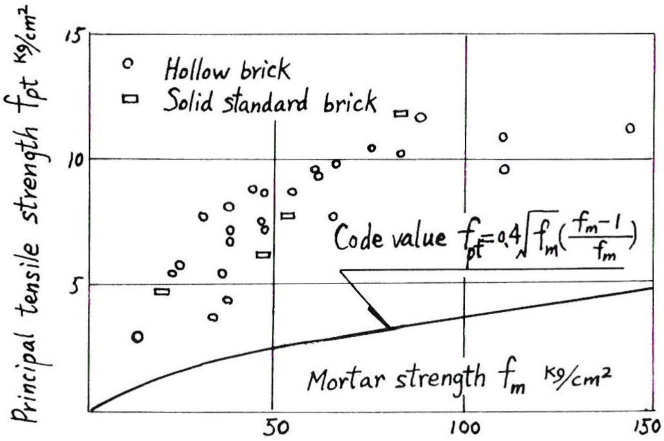


Fig 8 The relationship between the principal tensile strength of the masonry and mortar strength.

is insufficient, or filling joints is insufficient or both exist, the compressive strength of the masonry $f_K'$ is less reduced, but the principal tensile strength $f_{pt}'$ and shear strength in bed joints $f_{HK}'$ should be reduced significantly as shown in Table 2.

Table 2 The Effect of Extent of Wetting Bricks and Filling Joints on the Strength of Masonry

| Age (days) | Characteristic of specimen: Extent of filling joints (%) Horiz. joint | Extent of filling joints (%) Vertic. joint | Extent of wetting bricks (%) | Mortar strength $f_m'$ (kg/cm²) | Compressive strength of masonry: Tested $f_K'$ (kg/cm²) | Calc. $f_K$ (kg/cm²) | Ratio: $\frac{f_K'}{f_K}$ | Principal tensile strength of masonry: Num. of speci. | Tested $f_{pt}'$ (kg/cm²) | Ratio: $\frac{tes.f_{pt}'}{calc.f_{pt}}$ | Reduced percentage (%) | Shear strength in bed joints of masonry: Num. of speci. | Tested $f_{HK}'$ (kg/cm²) | Ratio: $\frac{tes.f_{HK}'}{calc.f_{HK}}$ | Reduced percentage (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 138 | ≈100 | ≈100 | ≈100 | 52.6 | 65.7 | 61.9 | 1.06 | 4 | 8.98 | 3.15 | — | 3 | 6.52 | 2.29 | — |
| 〃 | ≈85 | ≈85 | ≈100 | 52.8 | 55.1 | 62.0 | 0.89 | 4 | 6.65 | 2.33 | 26 | 3 | 4.68 | 1.64 | 28 |
| 145 | ≈100 | ≈100 | <60 | 55.7 | 52.3 | 62.7 | 0.83 | 4 | 3.84 | 1.31 | 58 | 2 | 2.04 | 0.7 | 70 |
| 28 | ≈100 | ≈100 | ≈100 | 50 | — | — | — | 3 | 8.31 | 3.0 | — | 2 | 5.68 | 2.05 | — |
| | ≈100 no adherent | ≈100 | ≈100 | 59 | — | — | — | 3 | 3.42 | 1.13 | 62 | 5 | 4.07 | 1.35 | 34 |
| 〃 | ≈100 | 50~60 | ≈60 | 65 | — | — | — | 3 | 3.69 | 1.16 | 61 | 2 | 3.64 | 1.15 | 44 |
| | ≈100 | ≈100 | <35 | 58 | — | — | — | 3 | 3.02 | 1.01 | 66 | 1 | 0.9 | 0.3 | 85 |
| 30 | ≈80 | 50≈60 | <35 | 38 | — | — | — | 3 | 1.57 | 0.65 | 78 | 1 | 0.93 | 0.39 | 81 |

* The saturated water absorption is 18~19% by weight of dry brick.

Beside, the amplitude of the principal tensile strength $f'_{pt}$ increasing with age is larger than that of the compressive strength $f'_K$ , within the limits of the size of brick and dimension of specimen (e.g. sides ratio are 0.5, 0.75, 1.0, 1.5 etc. and slenderness 3 ~ 10) all take no effection to $f'_{pt}$ notably. When mortar strength far lower than the brick strength, the effect of the brick strength can be neglected.

3.3 The results (shown in Table 3) indicated that racking shear strength of masonry $f'_{vK}$ is increased with the axial compressive stress $\sigma_0$ and considerably coincides with the calculated value $f_K$ from formula (1) (the average ratio $f'_{vK}$ / $f_K$ is 0.965 on 83 specimens, ($C_v$ = 0.168).

Table 3 The Tested Values of Racking Shear Strength in Masonry

| Brick type | Mortar compressive strength $f'_m$ ($Kg/cm^2$) | Principal tensile stress strength $f'_{pt}$ | | Axial compressive stress $\sigma_0$ ($Kg/cm^2$) | Racking shear strength in masonry | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Number of specimen | Tested value ($Kg/cm^2$) | | Number of specimen | Tested $f'_{vK}$ ($Kg/cm^2$) | Coeff. of variation $C_v$ (%) | Calculated $f_{vK}$ ($Kg/cm^2$) | Ratio: tested $f'_{vK}$ / calc. $f_{vK}$ |
| 2MS-2 | 55.4 | 40 | 9.03 | 3.5 | 24 | 9.31 | 0.136 | 10.14 | 0.918 |
| | | | | 5.5 | 21 | 9.89 | 0.095 | 11.04 | 0.896 |
| | 34 | 7 | 5.15 | 1 | 1 | 4.48 | — | 5.63 | 0.8 |
| | | | | 2 | 9 | 6.24 | 0.161 | 6.07 | 1.03 |
| | | | | 3.5 | 4 | 6.98 | — | 6.67 | 1.05 |
| 2MS-1 | 34 | 4 | 3.74 | 2 | 3 | 5.47 | — | 4.63 | 1.18 |
| | | | | 4 | 1 | 7.45 | — | 5.38 | 1.38 |
| | 195 | 3 | 12.8 | 2 | 2 | 12.97 | — | 13.76 | 0.94 |
| | | | | 3.5 | 2 | 13.14 | — | 14.44 | 0.91 |
| Solid brick | 19.3 | 5 | 4.9 | 2 | 3 | 7.7 | — | 5.81 | 1.33 |
| | | | | 3~3.38 | 2 | 8.0 | — | 6.3 | 1.27 |
| | 100 | 2 | 12.35 | 3~5 | 2 | 16.2 | — | 14.2 | 1.14 |
| Horizontally perforated brick | 37 | 4 | 4.17 | 3.5 | 3 | 4.66 | — | 5.66 | 0.83 |
| | 100 ~ 200 | 26 | 11.0 | 3~3.5 | 2 | 10.98 | — | 12.52 | 0.88 |
| | | | | 5~6.5 | 4 | 11.56 | — | 13.72 | 0.84 |
| Total | | | | | 83 | — | — | — | 0.965 ($C_v$=0.168) |

3.4 The data indicate that $f'_{pt}$ is 45% larger than $f'_{HK}$ or so, due to the vertical joints bond with sufficient filling (the ratio $f'_{HK}$ / $f'_{pt}$ =0.689, in which $C_v$=0.2 on 74 specimens, as shown in Table 4).

### Table 4 The Tested Results of Ratio $f'_{pt}/f'_{k}$ and $f'_{HK}/f'_{pt}$

| Brick type | No. | Compressive strength: Brick $f'_b$ (kg/cm²) | Compressive strength: Mortar $f'_m$ (kg/cm²) | Compr. strength of masonry: Number of prism | Compr. strength of masonry: Tested $f'_K$ (kg/cm²) | Principal tensile strength of mason.: Number of specimen | Principal tensile strength of mason.: Tested $f'_{pt}$ (kg/cm²) | Ratio: $\frac{f'_{pt}}{f'_K}$ | Shear strength in bed joints: Number of prism | Shear strength in bed joints: Tested $f'_{HK}$ (kg/cm²) | Ratio: $\frac{f'_{HK}}{f'_{pt}}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2MS-2 | 1 | 249 | 58.2 | 8 | 63.3 | 8 | 7.93 | 0.124 ($C_v$=0.127) | — | — | — |
| | 2 | 249 | 55.6 | 24 | 51.2 | 40 | 9.03 | 0.176 | 33 | 5.73 | 0.63 |
| | 3 | 311 | 11.4 | 3 | 42.4 | 4 | 2.98 | 0.07 | 4 | 2.57 | 0.86 |
| | 4 | 311 | 19.3 | 3 | 52.3 | 4 | 5.3 | 0.1 | 2 | 3.57 | 0.67 |
| | 5 | 311 | 23.0 | 3 | 54.1 | 3 | 5.5 | 0.1 | 4 | 3.98 | 0.72 |
| | 6 | 311 | 52.6 | 3 | 65.7 | 4 | 8.98 | 0.14 | 3 | 6.52 | 0.73 |
| | 7 | 311 | 67.5 | 3 | 71.1 | 13 | 9.04 | 0.127 | 6 | 5.98 | 0.66 |
| | 8 | 311 | 54.6 | 3 | 80.7 | 3 | 10.17 | 0.13 | 2 | 7.19 | 0.71 |
| | 9 | 255 | 88.5 | 3 | 84.5 | 4 | 11.16 | 0.13 | 3 | 6.75 | 0.6 |
| | 10 | 191 | 60.0 | 3 | 61.9 | 4 | 9.2 | 0.15 | 3 | 4.86 | 0.53 |
| 2MS-1 | 11 | 258 | 37.7 | 3 | 47.3 | 6 | 8.01 | 0.17 | 2 | 5.13 | 0.64 |
| | 12 | 258 | 65.8 | 3 | 59.5 | 4 | 7.52 | 0.13 | — | — | — |
| Other vertically perforated bricks | 13 | 305 | 47.2 | 3 | 73.7 | 4 | 7.21 | 0.1 | — | — | — |
| | 14 | 206 | 39.3 | 3 | 52.6 | 4 | 6.72 | 0.13 | — | — | — |
| | 15 | 214 | 29.1 | 3 | 45.7 | 4 | 7.77 | 0.17 | 3 | 5.17 | 0.66 |
| Solid brick | 16 | 302 | 47.5 | 3 | 81.2 | 6 | 6.0 | 0.07 | 4 | 4.29 | 0.72 |
| | 17 | 302 | 83.7 | 3 | 119.3 | 3 | 11.4 | 0.1 | 3 | 6.58 | 0.58 |
| | 18 | 180 | 50.5 | 3 | 68.3 | 4 | 7.68 | 0.11 | 2 | 5.28 | 0.69 |
| Total | | | | | | | | 0.121 ($C_v$=0.2) | 74 | — | 0.689 ($C_v$=0.2) |

Note 1. Only the $f'_{pt}$ and $f'_{k}$ of No. 1 which is directed come from one and the same specimen and others are come from two kind specimons that made by same mortar.

2. The $f'_{HK}$ and $f'_{pt}$ of all groups are directed come from one and same specimen.

According to the statistics on 26 group specimens, the average ratio $f_{pt}'/f_K'$ is 0.121 ($C_v$=0.2), so that the principal tensile strength should be approximately calculated by the compressive strength of masonry.

## 4. MANUFACTURE OF BRICK

The raw material of hollow brick is a medium plastic clay mineral which contains with main component of illite and some of free quartz. In order to improve the drying behaviour and to economize fuel, it admix industrial dregs (e.g. cinder, gangue, slag, etc.) with the remanent calorific value 1400~2000 kcal** per kilogram by 15~18% in volume. The procedure in production is extrusion and natural drying and firing at about 950 °C in Hoffman kiln. The total energy consumption of product is 370~390 kcal per kilogram (i.e. 1.55~1.63 MJ/kg, including fuel and electric power), in which 75~80% is supplied by the dregs, that is, the actural energy consumption of product is 80~100 kcal per kilogram (i.e. 0.33~0.42 MJ/kg).

## 5. APPLICATION OF BRICK

The principal advantages with use of modular hollow brick are:
(1) The size of modular brick is made from the basic modular of building system 100 mm (making a sign $M_o$, $1M_o$=100 mm), it has great benefit to practice architectural standardization in comparison with standard brick (240x115x53mm) that originates from 125 mm of modular system.

(2) All of the products of $M_o$ system, 2MS with length and width $2M_o$ is taken as a special example, all dimension $2nM_o$ in the architectural plane can be divisible by $2M_o$ and when $(2n-1)\ M_o$ divide by $2M_o$, the remainder $1M_o$ can obtain. Hence under cooperation of 1MS, we construct the corner, T-wall, crosswall, buttress, column and other graded 10 cm each in wall thickness, without cutout brick or few transverse half cutting of 1MS is needed. Bricklayer like this characteristic and its moderate weight.

(3) Taking hollow brick wall with thickness 9, 15, 19 and 29 cm instead of the standard solid brick wall with thickness 11.5, 24 and 36.5 cm respectively, the wall weight may decrease 20~25% and construction cost decrease 10~12% and laying efficiency increase 25~30% per square metre of building area, and the total energy consumption (including manufacture, transpotation and construction) will economize about 20% or so.

## 6. CONCLUSION

According to the current code, the computation of compressive strength and the verification of aseismatic strength of wall with vertically perforated brick may be feasible and safely. The service properties of the metric modular hollow brick is satisfactory and meet the needs of the architectural standardization and have the advantages of economizing energy and improving economical benefit of construction. In the seismic area permitted to make use of the solid brick wall by the current code, it also have a bright future as the same anti-seismic steps are adopted. But, we have less knowledge in the dynamic behaviour of the non-reinforced and reinforced metric modular hollow brick masonry. It is a important problem to be researched further.

Note** SI International measured units: 1 Kcal = 4.186 x $10^{-3}$MJ.