KTP – CPD for PERITI

THE USE OF LOCAL SUSTAINABLE MASONRY AS A STRUCTURAL MATERIAL

MODULE III – UTILIZING THE TENSILE/SHEAR CAPACITY FOR SECONDARY MASONRY MEMBERS

dhi PERITI
Architects | Structural, Civil, Municipal Engineers |
Valuers | Quantity Surveying Services

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DENIS H CAMILLERI
dhc@dhiperiti.com

FREE STANDING WALLS

Walls over 1.80m in height should be referred to a perit for checking.

Table 1 - Height to thickness ratio related to wind speed.

Wind Pressure KN/m2	***Height to thickness ratio***
0.30	Not exceeding 10
0.60	7
0.85	5
1.15	4

When damp-proof courses incapable of developing adequate bond are used, the height to thickness ratio should not exceed 75% of the appropriate value in table 18. The use of such dpc's are not generally recommended.

The following rule of thumb may be followed for wall panels 225mm thick subjected to wind speed of 47m/s. the maximum wall area for a panel fixed on 3 sides is to be limited to 20m^2 and to 16m^2 for a panel pinned on one or more of the three supported sides.

EARTH RETAINING WALLS

Ideally retaining walls should have an impervious lining on the side adjacent to the retained material to prevent moisture damaging the mortar and the masonry. All earth-retaining walls should be provided with weep holes of 50mm minimum diameter at 3.00m centers to allow for adequate drainage. An alternative is drainage at the rear of the wall with open joints (French drain), surrounded by crushed stone.

Table 2 Height to thickness ratios for retaining walls

Height of retained material - m	***Height to thickness ratio***
0.90	4
1.20	3.75
1.50	3.5
1.80	3.25

The above details are based on no surcharge and slope of retained earth not greater than 1:10. unless walls are constructed in a flexible mortar, i.e. not containing cement but lime, movement joints are necessary if cracking is to be avoided.

EARTH RETAINING WALLS (cont.)

The economy of constructing masonry retaining walls is to be stressed, but above a height of 2.00m reinforced masonry retaining walls tend to become more economical, with a stepped reinforced masonry retaining wall offering further economies above a height of 4.00m.

Provided that the top of the wall is unrestrained, the earth pressure will be equal to the active pressure. It is recommended that walls in cohesive soils are never designed for a pressure (KN/m^2) of less than 4.8 times the height in metres of the retained material. In addition to the active earth pressure, allowance must be made for water pressure where it develops and any surcharge on the retaining side of the wall.

As partial safety factors are included in the limit state approach the factors of safety for stability analysis are not required, other than in the sliding analysis where a factor of safety of 2 is to be adopted.

FLEXUAL MASONRY STRENGTH

Table 3 - gives the flexural f_{xk} values in the relative directions in N/mm^2. (BS5628pt1)

Concrete blocks of compressive strength N/mm^2	*Plane of failure parallel to bed joint*		*Plane of failure perpendicular to bed joint*	
Mortar Designation	I, ii & iii	iv	I, ii & iii	iv
2.8	0.25	0.20	0.40	0.40
3.5	0.25	0.20	0.45	0.40
7.0	0.25	0.20	0.60	0.50
10.5	0.25	0.20	0.75	0.60
14.0 and over	0.25	0.20	0.90*	0.70*

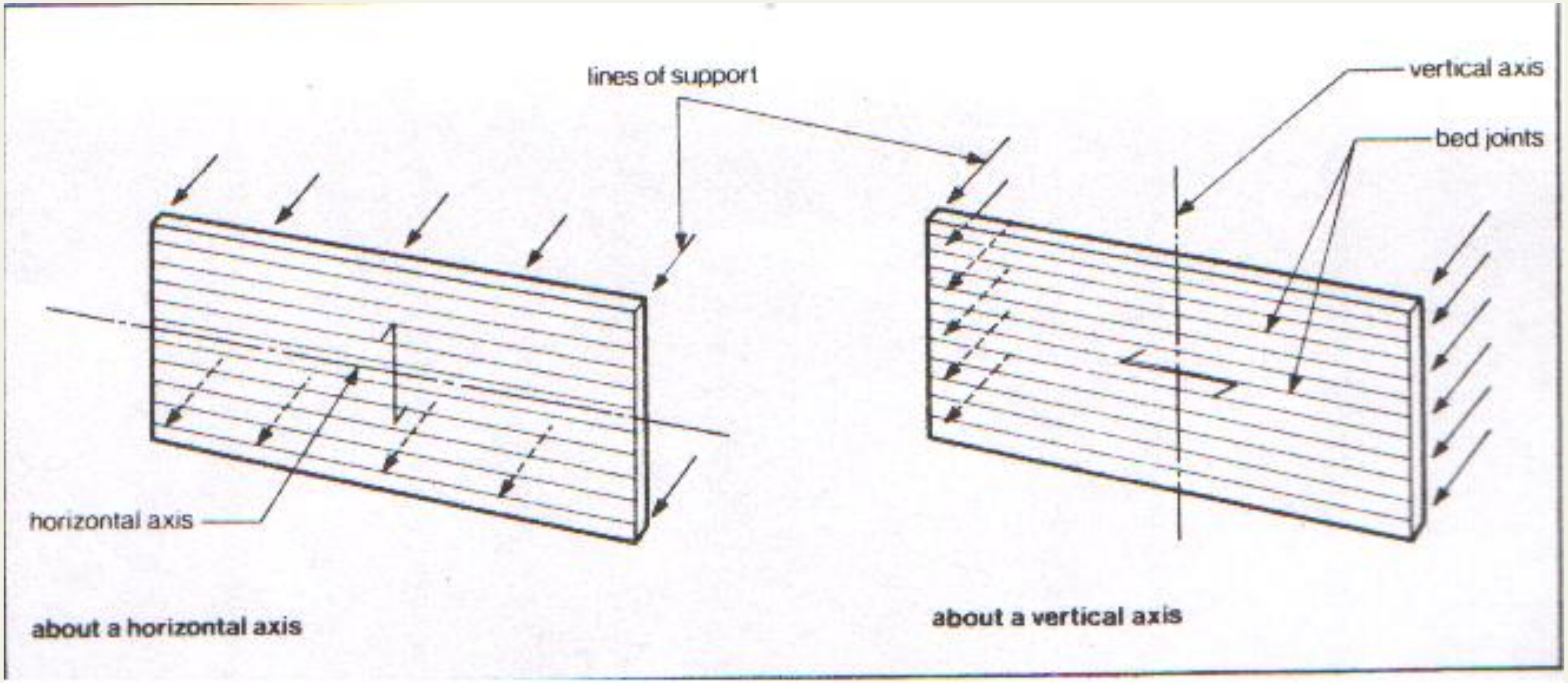
When used with flexural strength assume an orthogonal ratio of 0.30

Flexural tests carried out on Franka

Rectangular Dry **2.7 – 4.7 N/mm^2 (Cachia)**

1.1 – 4.7 N/mm^2 (Bonello)

Rectangular Saturated **1.2 – 3.7N/mm^2 (Cachia)**

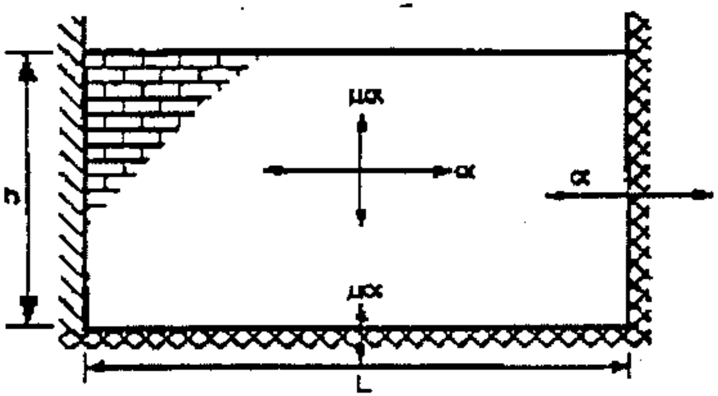


Directions of bending of brickwork panels

Table 4 – BENDING MOMENT COEFFICIENT FOR TWO WAY SPANNING PANELS SUBJECTED TO LATERAL LOADS (μ = 0.35)

Values of α

h/L	1	2	3	4	5	6	7	8	9	10	11
0·30	0·045	0·035	0·029	0·022	0·018	0·016	0·014	0·009	0·024	0·021	0·016
0·50	0·064	0·049	0·039	0·032	0·035	0·029	0·025	0·017	0·055	0·045	0·035
0·75	0·080	0·059	0·045	0·040	0·052	0·041	0·033	0·026	0·098	0·075	0·060
1·00	0·089	0·065	0·049	0·044	0·064	0·050	0·039	0·032	0·144	0·104	0·084
1·25	0·095	0·068	0·052	0·048	0·074	0·055	0·043	0·037	0·194	0·129	0·108
1·50	0·100	0·071	0·033	0·050	0·081	0·060	0·046	0·040	0·244	0·152	0·129
1·75	0·103	0·073	0·054	0·051	0·086	0·063	0·048	0·043	0·296	0·173	0·148



denotes free edge

denotes an edge over which continuity exists

denotes simply supported edge

BENDING COEFFICIENTS α

BS 5628 pt1 table 9 gives coefficients for the calculation of bending moments M_{xx} in the plain vertical to the bed joint due to lateral loading given by : $M_{xx} = \alpha\, W_k \gamma_f . L^2$.

this is to be compared to $MR = f_{kx} Z / \boldsymbol{\gamma_m}$

These are worked for panels of various sizes supported on 3 or 4 sides with varying conditions of fixity, according to the yield line theory, which has been found as a reasonable method for predicting the capacity of walls. The support conditions have to be assessed first. Table 4 is an abridged version of the coefficients found in BS 5628 pt1.

THE CHARACTERISTIC SHEAR STRENGTH OF MASONRY IN THE HORIZONTAL DIRECTION IS GIVEN BY BS5628 pt1

$0.35 + 0.6g_a$ N/mm^2 with a max of 1.75N/mm^2 for walls in mortar designation i, ii &iii

$0.15 + 0.6g_a$ N/mm^2 with a max of 1.4 N/mm^2 for walls in mortar designation iv

where g_a is the design vertical load per unit area.

Tests carried out on franka (Saliba 1990) gives an unconfined shear strength varying from 2.2 to 3.85 N/mm^2.

Horizontal shear may occur along bedding surfaces, particularly at the level of damp-proof membranes. Further guidance may be obtained from (Saliba 1992).

IN THE VERTICAL DIRECTION SHEAR FAILURE MAY OCCUR PARTICULARLY AT THE LEVEL OF INTERSECTING WALLS, GIVEN BY

For masonry 0.7N/mm^2 for mortar designations i,ii & iii.
0.5N/mm^2 for mortar designation iv.

For blockwork 0.35N/mm^2 with a minimum strength of 7N/mm^2.

Alternatively for reinforced sections, as per BS 5628 pt 2 the characteristic shear strength of masonry is given by 0.7N/mm^2, provided that the ratio of height to length of the wall does not exceed 1.5.

MINOR MASONRY ARCH DESIGN

The arch is likely to adopt a statically determinate 3-hinge formation. The 3-hinge method simplifies the application of engineering judgment in the assessment of simple masonry arches.

Treat the arch as a simply supported beam of the same span. Determine the vertical reactions under the loads concerned and the bending moments due to the horizontal thrust H, i.e.

$Hy = M$

Where y is the maximum height of the arch above the line of the horizontal thrust, at a point distance from the support.

Once the horizontal thrust has been determined the maximum compressive stress in the masonry is determined from

$F_m = H/bd$

Where f_m is the characteristic compressive stress in the masonry which should not exceed the masonry bearing stress, given above at 1.5_{fk}.

Calculations

DESIGN OF A SEGMENTAL DOORWAY IN A VILLAGE CORE:

3 storey façade with a 2.4m clear opening & 1.5m rise.

Double walling – 360mm total wall thickness
Load/flr = 10.5KN/m^2. 2m = 21KN/m with each pier attracting a width of 4m/2.

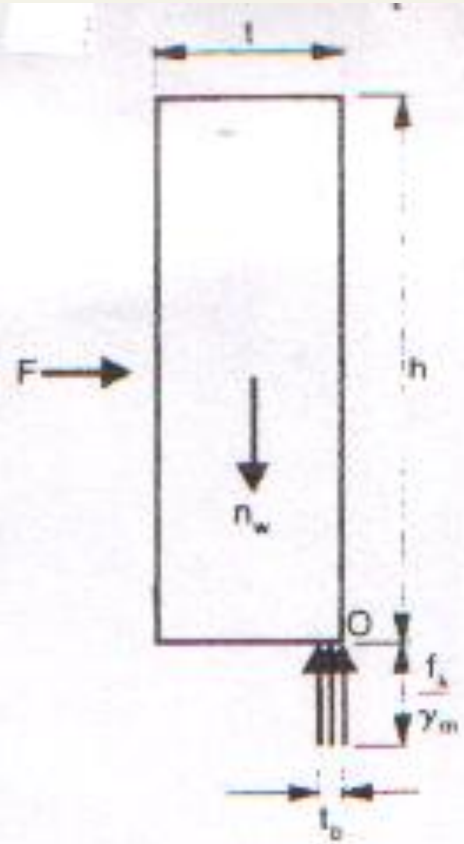
Total loading on pier

Foor slab 3 in No @ 21KN/m – 2m = 126KN
Double walling 30/crs X 0.9KN/m/fil x 2 in No = 54KN

180KN/pier

Arch BM = (21KN/m + 9 crs x 0.9KN/m/fil X 2) .2.65^2/8
= 32.65 KN-m
H = 32.65/1.15 = 28.4KN

f_v = 0.15N/mm^2 + 0.6 X 180/0.36 = 0.45N/mm^2
$h_{pier} = \gamma_m H/2 \times f_v t$
h_{pier} = 28.4Kn X 2 /2 X 0.45 X 0.36 = 0.175m



the design vertical load n_w is resisted by a rectangular stress block of width t_b

on the point of failure by rotation about O, under the action of the applied load F, the stress block is limited by the design compressive strength f_k/γ_m

the moment of resistance about O available to resist the applied moment due to F is:

$$n_w \times \frac{t}{2} - \left(\frac{f_k}{\gamma_m} \cdot t_b\right) \frac{t_b}{2}$$

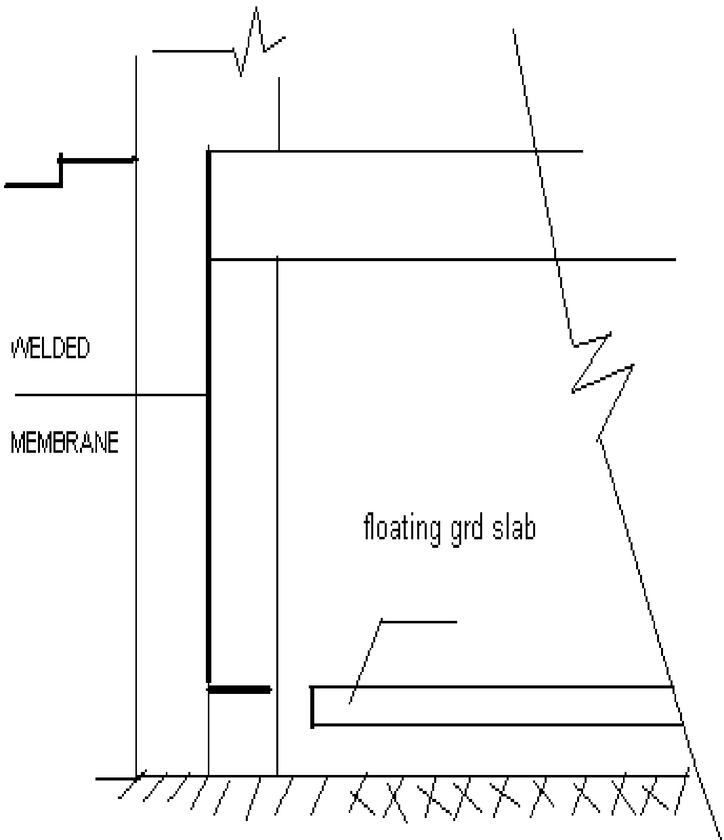
but $n_w = t_b \times \frac{f_k}{\gamma_m}$ or $t_b = n_w \frac{\gamma_m}{f_k}$

$\therefore$ design moment of resistance =

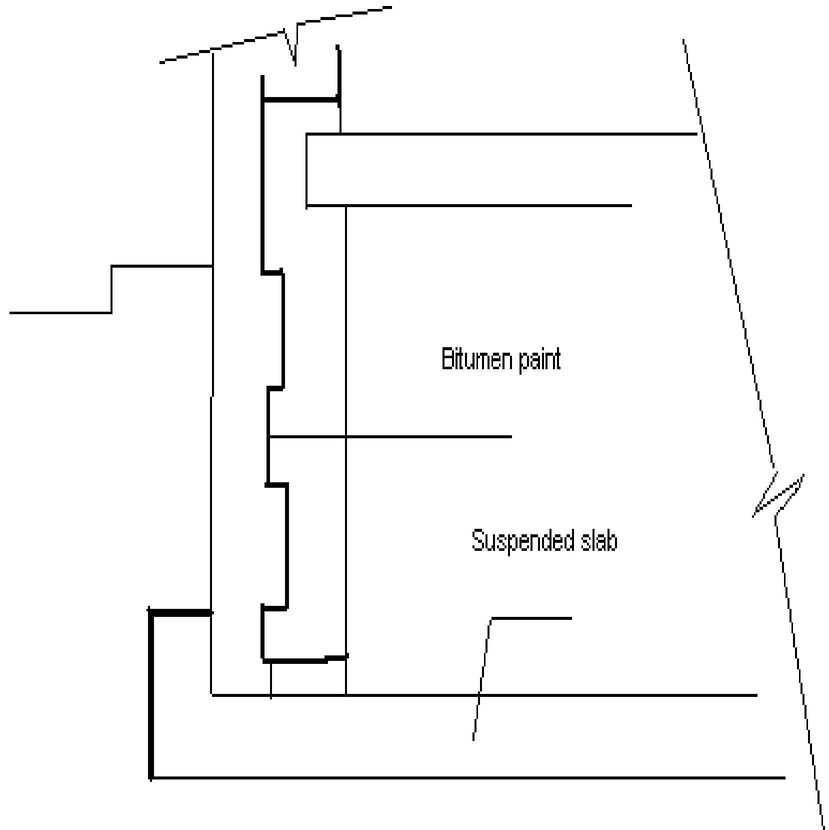
$$\frac{n_w}{2}\left(t - \frac{n_w \gamma_m}{f_k}\right)$$

Design moment of resistance of free-standing wall without flexure

WATER PROOFING BASEMENT WALLS



FAULTY DETAIL
Basement wall acts as 2 separate skins.
(no shear key) floating slab subjected to upward water pressure



IMPROVED DETAIL
Whole thickness of basement wall utilized suspended slab
designed to take up lift