MASONRY WALL PANEL DESIGN

In accordance with EN1996-1-1:2005 + A1:2012 incorporating Corrigenda February 2006 and July 2009 and the UK national annex

Tedds calculation version 1.2.18

Summary table

	Allowable	Actual	Utilisation	
Slenderness ratio	27;	20.4;	0.757;	PASS
Height to thickness ratio	59.281;	20.430;	0.345;	PASS
Flexural stress to outer leaf of sub panel 1	0.634 kNm/m;	0.189 kNm/m;	0.298;	PASS
Flexural stress to inner leaf of sub panel 1	0.622 kNm/m;	0.185 kNm/m;	0.298;	PASS
Flexural stress to outer leaf of sub panel 2	0.634 kNm/m;	0.183 kNm/m;	0.289;	PASS
Flexural stress to inner leaf of sub panel 2	0.622 kNm/m;	0.181 kNm/m;	0.291;	PASS
Flexural stress to outer leaf of sub panel 3	0.679 kNm/m;	0.522 kNm/m;	0.769;	PASS
Flexural stress to inner leaf of sub panel 3	0.652 kNm/m;	0.502 kNm/m;	0.769;	PASS

Masonry panel details

Side wall - Bi-folds opening - Unreinforced masonry wall with openings

Panel length L = **4500** mm

Panel height h = **2600** mm

Panel support conditions

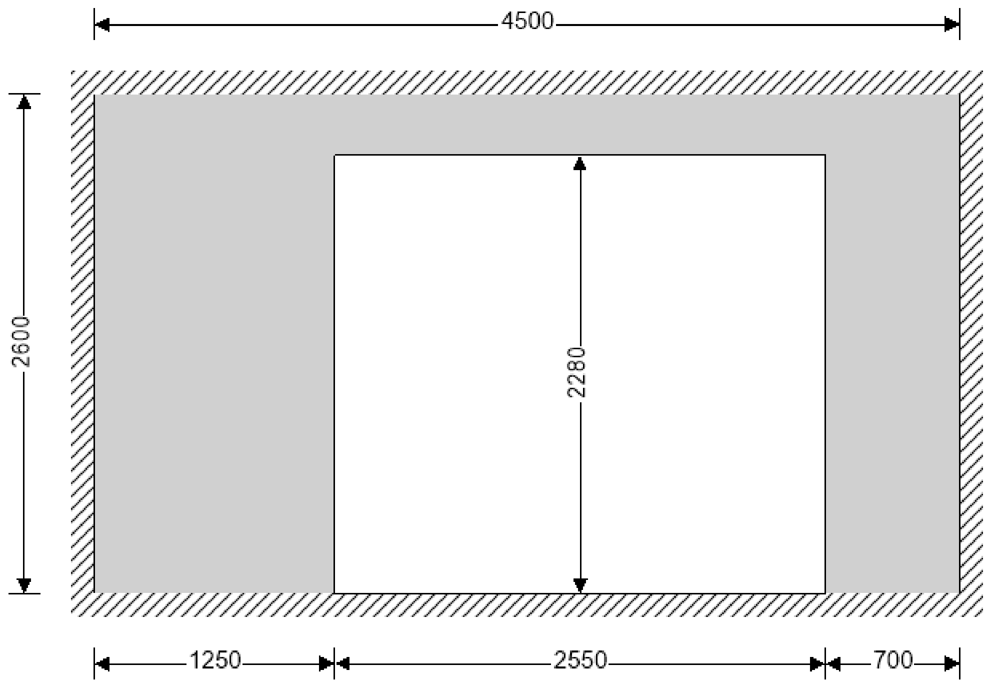
Outer leaf **All edges supported continuously**

Inner leaf **All edges supported continuously**

Effective height of masonry walls - Section 5.5.1.2

Reduction factor ρ_2 = **1.000**

Effective height of wall - eq 5.2 $h_{ef} = \rho_2 \times h$ = **2600** mm



Panel opening details

Spacing length L_1 = **1250** mm

Opening width w_1 = **2550** mm

Height to underside of lintel h_1 = **2280** mm

Height of opening o_1 = **2280** mm

Cavity wall construction details

Outer leaf thickness t_1 = **102** mm

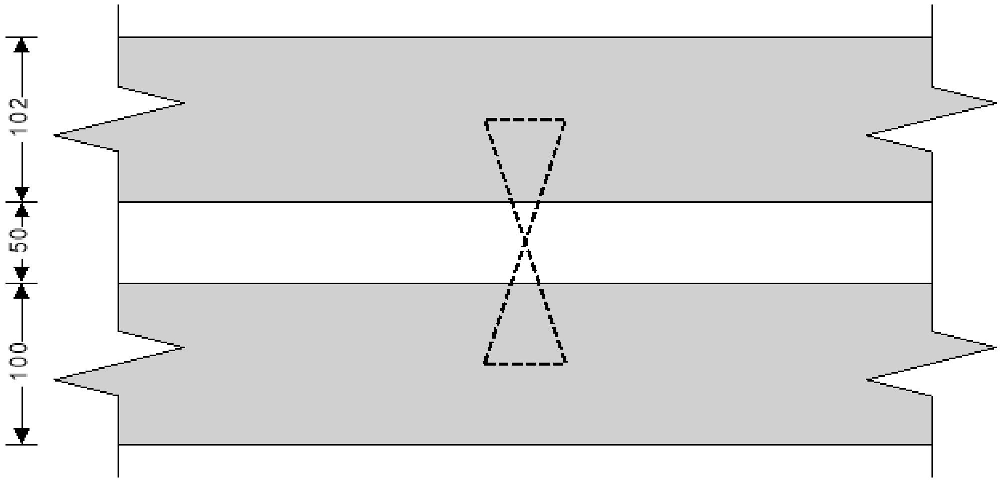
Cavity thickness t_c = **50** mm

Inner leaf thickness t_2 = **100** mm

Effective thickness of masonry walls - Section 5.5.1.3

Relative E factor k_{tef} = **1.000**

Effective thickness - eq 5.11 $t_{ef} = (k_{tef} \times t_1^3 + t_2^3)^{1/3}$ = **127.3** mm



Masonry outer leaf details

Masonry type **Aggregate concrete brick - Group 1**

Compressive strength of masonry f_{c1} = **3.6** N/mm^2

Height of unit h_{u1} = **215** mm

Width of unit w_{u1} = **102** mm

Conditioning factor k_1 = **1.0**

- Conditioning to the air dry condition in accordance with cl.7.3.2

Shape factor - Table A.1 d_{sf1} = **1.376**

Norm. mean compressive strength of masonry $f_{b1} = f_{c1} \times k_1 \times d_{sf1}$ = **4.954** N/mm^2

Density of masonry γ_1 = **20** kN/m^3

Mortar type **M6 - General purpose mortar**

Compressive strength of masonry mortar f_{m1} = **6** N/mm^2

Compressive strength factor - Table NA.4 K = **0.75**

Characteristic compressive strength of masonry - eq 3.1

$f_{k1} = K \times f_{b1}^{0.7} \times \min(f_{m1}, 4.954 \text{ N/mm}^2)^{0.3}$ = **3.715** N/mm^2

Characteristic flexural strength of masonry having a plane of failure parallel to the bed joints - Table NA.6

f_{xk11} = **0.3** N/mm^2

Characteristic flexural strength of masonry having a plane of failure perpendicular to the bed joints - Table NA.6

f_{xk21} = **0.9** N/mm^2

Tekla Tedds PlanningApplications.com Summer House, Upper Court Rd CR3 7BF - 020 8660 5026 support@planningapplications.com	Project High Gables, Straight Road, Boxted, Colchester, CO4 5QN				Job no. 2021-67-01	
	Calcs for Mr Ralph Keeble				Start page no./Revision 3	
	Calcs by SB	Calcs date 29/04/2021	Checked by DB	Checked date 29/04/2021	Approved by SB	Approved date 29/04/2021

Masonry inner leaf details

Masonry type **Aggregate concrete brick - Group 1**

Compressive strength of masonry f_{c2} = **3.6** N/mm^2

Height of unit h_{u2} = **215** mm

Width of unit w_{u2} = **100** mm

Conditioning factor k_2 = **1.0**

- Conditioning to the air dry condition in accordance with cl.7.3.2

Shape factor - Table A.1 d_{sf2} = **1.38**

Norm. mean compressive strength of masonry $f_{b2} = f_{c2} \times k_2 \times d_{sf2}$ = **4.968** N/mm^2

Density of masonry γ_2 = **20** kN/m^3

Mortar type **M6 - General purpose mortar**

Compressive strength of masonry mortar f_{m2} = **6** N/mm^2

Compressive strength factor - Table NA.4 K = **0.75**

Characteristic compressive strength of masonry - eq 3.1

$f_{k2} = K \times f_{b2}^{0.7} \times \min(f_{m2}, 4.968\ \text{N/mm}^2)^{0.3}$ = **3.726** N/mm^2

Characteristic flexural strength of masonry having a plane of failure parallel to the bed joints - Table NA.6

f_{xk12} = **0.3** N/mm^2

Characteristic flexural strength of masonry having a plane of failure perpendicular to the bed joints - Table NA.6

f_{xk22} = **0.9** N/mm^2

Lateral loading details

Characteristic wind load on panel W_k = **0.600** kN/m^2

Vertical loading details

Permanent load on top of outer leaf G_{k1} = **24** kN/m

Permanent load on top of inner leaf G_{k2} = **29** kN/m

Variable load on top of outer leaf Q_{k1} = **2** kN/m

Variable load on top of inner leaf Q_{k2} = **2** kN/m

Partial factors for material strength

Category of manufacturing control **Category I**

Class of execution control **Class 1**

Partial factor for masonry in compressive flexure γ_{Mc} = **2.30**

Partial factor for masonry in tensile flexure γ_{Mt} = **2.30**

Partial factor for masonry in shear γ_{Mv} = **2.50**

Slenderness ratio of masonry walls - Section 5.5.1.4

Allowable slenderness ratio SR_{all} = **27**

Slenderness ratio $SR = h_{ef} / t_{ef}$ = **20.4**

PASS - Slenderness ratio is less than maximum allowable

Unreinforced masonry walls subjected to lateral loading - Section 6.3

Partial safety factors for design loads

Partial safety factor for permanent load γ_{fG} = **1**

Partial safety factor for variable imposed load γ_{fQ} = **0**

Partial safety factor for variable wind load γ_{fW} = **1.5**

Limiting height and length to thickness ratios for walls under the serviceability limit state - Annex F

Length to thickness ratio L / t_{ef} = **35.359**

Limiting height to thickness ratio - Figure F.1 59.281

Height to thickness ratio h / t_{ef} = **20.43**

PASS - Limiting height to thickness ratio is not exceeded

Design moments of resistance in panels

Considering outer leaf

Self weight at top of wall $S_{wt1} = \mathbf{0}$ kN/m

Design compressive strength of masonry $f_{d1} = f_{k1} / \gamma_{Mc} = \mathbf{1.615}$ N/mm²

Design vertical compressive stress $\sigma_{d1} = \min(\gamma_{fG} \times (G_{k1} + S_{wt1}) / t_1, 0.15 \times f_{d1}) = \mathbf{0.235}$ N/mm²

Design flexural strength of masonry parallel to bed joints

$f_{xd11} = f_{xk11} / \gamma_{Mt} = \mathbf{0.13}$ N/mm²

Apparent design flexural strength of masonry parallel to bed joints

$f_{xd11,app} = f_{xd11} + \sigma_{d1} = \mathbf{0.366}$ N/mm²

Design flexural strength of masonry perpendicular to bed joints

$f_{xd21} = f_{xk21} / \gamma_{Mt} = \mathbf{0.391}$ N/mm²

Elastic section modulus of wall $Z_1 = t_1^2 / 6 = \mathbf{1734000}$ mm³/m

Moment of resistance parallel to bed joints - eq.6.15

$M_{Rd11} = f_{xd11,app} \times Z_1 = \mathbf{0.634}$ kNm/m

Moment of resistance perpendicular to bed joints - eq.6.15

$M_{Rd21} = f_{xd21} \times Z_1 = \mathbf{0.679}$ kNm/m

Considering inner leaf

Self weight at top of wall $S_{wt2} = \mathbf{0}$ kN/m

Design compressive strength of masonry $f_{d2} = f_{k2} / \gamma_{Mc} = \mathbf{1.620}$ N/mm²

Design vertical compressive stress $\sigma_{d2} = \min(\gamma_{fG} \times (G_{k2} + S_{wt2}) / t_2, 0.15 \times f_{d2}) = \mathbf{0.243}$ N/mm²

Design flexural strength of masonry parallel to bed joints

$f_{xd12} = f_{xk12} / \gamma_{Mt} = \mathbf{0.13}$ N/mm²

Apparent design flexural strength of masonry parallel to bed joints

$f_{xd12,app} = f_{xd12} + \sigma_{d2} = \mathbf{0.373}$ N/mm²

Design flexural strength of masonry perpendicular to bed joints

$f_{xd22} = f_{xk22} / \gamma_{Mt} = \mathbf{0.391}$ N/mm²

Elastic section modulus of wall $Z_2 = t_2^2 / 6 = \mathbf{1666667}$ mm³/m

Moment of resistance parallel to bed joints - eq.6.15

$M_{Rd12} = f_{xd12,app} \times Z_2 = \mathbf{0.622}$ kNm/m

Moment of resistance perpendicular to bed joints - eq.6.15

$M_{Rd22} = f_{xd22} \times Z_2 = \mathbf{0.652}$ kNm/m

Design moment in panels

Calculate design wind load acting on each leaf

Outer leaf design wind load - parallel $W_{k11} = M_{Rd11} \times W_k / (M_{Rd11} + M_{Rd12}) = \mathbf{0.303}$ kN/m²

Inner leaf design wind load - parallel $W_{k12} = M_{Rd12} \times W_k / (M_{Rd11} + M_{Rd12}) = \mathbf{0.297}$ kN/m²

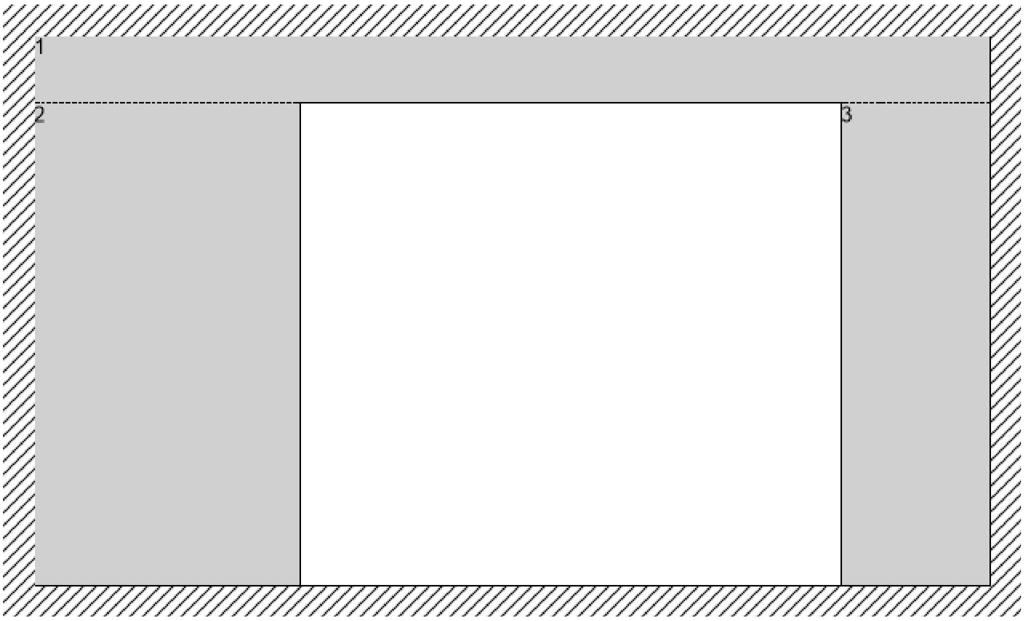
Outer leaf design wind load - perpendicular $W_{k21} = M_{Rd21} \times W_k / (M_{Rd21} + M_{Rd22}) = \mathbf{0.306}$ kN/m²

Inner leaf design wind load - perpendicular $W_{k22} = M_{Rd22} \times W_k / (M_{Rd21} + M_{Rd22}) = \mathbf{0.294}$ kN/m²

Orthogonal strength ratios

For outer leaf $\mu_1 = f_{xd11,app} / f_{xd21} = \mathbf{0.93}$

For inner leaf $\mu_2 = f_{xd12,app} / f_{xd22} = \mathbf{0.95}$



Sub panel no. 1 - Right, left and top supported

Ratio panel height to length h_{s1B} / L_{s1B} = **0.07**

Considering outer leaf

Parallel design moment of resistance M_{Rd11} = **0.634** kNm/m

Using elastic analysis to determine bending moment coefficients for a vertically spanning sub panel

Bending moment coefficient $\alpha_{s11B} = 0.5 \times (1 + 2 \times \beta_{s1B})$ = **4.062**

Design moment in sub-panel $M_{Ed11B} = \gamma_{fW} \times \alpha_{s11B} \times W_{k11} \times h_{s1B}^2$ = **0.189** kNm/m

PASS - Resistance moment exceeds design moment

WARNING! - The checking of sub-panels for vertical loading is currently beyond the scope of the calculation. This check can be performed by creating a new calculation for this sub-panel, modelled with the appropriate vertical and horizontal loading.

Considering inner leaf

Parallel design moment of resistance M_{Rd12} = **0.622** kNm/m

Using elastic analysis to determine bending moment coefficients for a vertically spanning sub panel

Bending moment coefficient $\alpha_{s21B} = 0.5 \times (1 + 2 \times \beta_{s1B})$ = **4.062**

Design moment in sub-panel $M_{Ed21B} = \gamma_{fW} \times \alpha_{s21B} \times W_{k12} \times h_{s1B}^2$ = **0.185** kNm/m

PASS - Resistance moment exceeds design moment

WARNING! - The checking of sub-panels for vertical loading is currently beyond the scope of the calculation. This check can be performed by creating a new calculation for this sub-panel, modelled with the appropriate vertical and horizontal loading.

Sub panel no. 2 - Top, bottom and left supported

Ratio panel height to length h_{s2B} / L_{s2B} = **1.82**

Considering outer leaf

Parallel design moment of resistance M_{Rd11} = **0.634** kNm/m

Using yield line analysis to calculate bending moment coefficient

Bending moment coefficient α_{s12B} = **0.276**

Design moment in sub-panel $M_{Ed12B} = \mu_1 \times \gamma_{fW} \times \alpha_{s12B} \times W_{k11} \times L_{s2B}^2$ = **0.183** kNm/m

PASS - Resistance moment exceeds design moment

WARNING! - The checking of sub-panels for vertical loading is currently beyond the scope of the calculation. This check can be performed by creating a new calculation for this sub-panel, modelled with the appropriate vertical and horizontal loading.

Considering inner leaf

Parallel design moment of resistance M_{Rd12} = **0.622** kNm/m

Using yield line analysis to calculate bending moment coefficient

Bending moment coefficient α_{s22B} = **0.273**

Design moment in sub-panel $M_{Ed22B} = \mu_2 \times \gamma_{fW} \times \alpha_{s22B} \times W_{k12} \times L_{s2B}^2$ = **0.181** kNm/m

PASS - Resistance moment exceeds design moment

WARNING! - The checking of sub-panels for vertical loading is currently beyond the scope of the calculation. This check can be performed by creating a new calculation for this sub-panel, modelled with the appropriate vertical and horizontal loading.

Sub panel no. 3 - Top, bottom and right supported

Ratio panel height to length h_{s3B} / L_{s3B} = **3.26**

Considering outer leaf

Perpendicular design moment of resistance M_{Rd21} = **0.679** kNm/m

Using elastic analysis to determine bending moment coefficients for a horizontally spanning sub panel

Bending moment coefficient $\alpha_{s13B} = 0.5 \times (1 + 2 \times \beta_{s3B})$ = **2.321**

Design moment in sub-panel $M_{Ed13B} = \gamma_{fW} \times \alpha_{s13B} \times W_{k21} \times L_{s3B}^2$ = **0.522** kNm/m

PASS - Resistance moment exceeds design moment

WARNING! - The checking of sub-panels for vertical loading is currently beyond the scope of the calculation. This check can be performed by creating a new calculation for this sub-panel, modelled with the appropriate vertical and horizontal loading.

Considering inner leaf

Perpendicular design moment of resistance M_{Rd22} = **0.652** kNm/m

Using elastic analysis to determine bending moment coefficients for a horizontally spanning sub panel

Bending moment coefficient $\alpha_{s23B} = 0.5 \times (1 + 2 \times \beta_{s3B})$ = **2.321**

Design moment in sub-panel $M_{Ed23B} = \gamma_{fW} \times \alpha_{s23B} \times W_{k22} \times L_{s3B}^2$ = **0.502** kNm/m

PASS - Resistance moment exceeds design moment

WARNING! - The checking of sub-panels for vertical loading is currently beyond the scope of the calculation. This check can be performed by creating a new calculation for this sub-panel, modelled with the appropriate vertical and horizontal loading.