Design Spreadsheet: Masonry Compressive Strength v1.0.xlsm	Date: 10/10/25
Subtitle: Worked Examples	By: AL
	Version: 1

Example 1 - Calculation the Design Compressive Strength of 7.3N Blockwork

Input Data

Blockwork Compressive Strength f_c = 7.3N/mm^2

Masonry Type = Aggregate Concrete

Masonry Group = Group 1

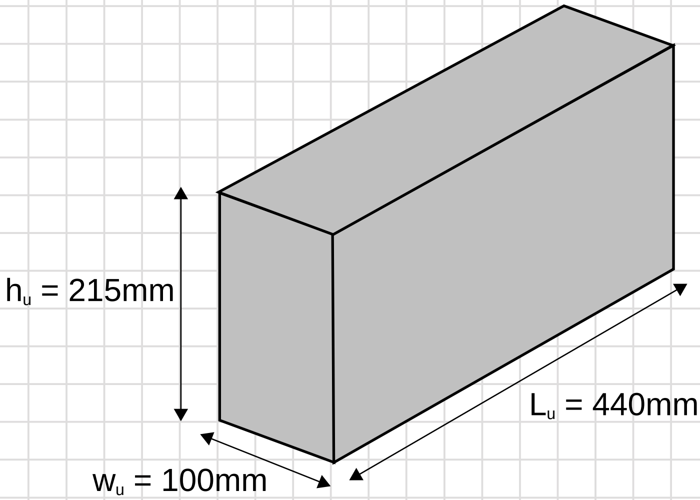
Mortar Type = General Purpose Mortar

Mortar Strength Class = M4

Mortar Compressive Strength f_m = 4N/mm^2

Category of Manufacturing Control = II

Category of Execution Control = Class 2



Dimensions of masonry unit to always be provided when the unit is oriented in it's upright position because this is how they are tested when determining their compressive strength. (i.e. they are placed in the testing machine and crushed in their upright position).

Conditioning Factor k

In the UK masonry is usually testing in the dry condition, therefore the conditioning factor is usually equal to 1.0.
It should be noted that the wet condition leads to a conditioning factor of 1.2 which gives more beneficial results for the compressive strength. Therefore care should be taken when using a conditioning factor above 1.0.

Conditioning Factor k = 1.0

Partial Material Factor γ_M (Masonry Units in Compression)

		Category of Execution Control	
Category of Manufacturing Control		Class 1	Class 2
	Category I	2.3	2.7
	Category II	2.6	3.0

Partial Material Factor γ_M = 3.0

Density of Masonry γ

The density of the masonry is not required to work out the design compressive strength however it is a useful value to fill in when putting together information for a project.
In particular masonry with higher compressive strengths tends to require denser units. So a mismatch between the density of the unit and the compressive strength can help to pin-point errors in the design.

For example you would not expect to find a lightweight aggregate concrete block with a compressive strength of f_c = 22.5N/mm^2 this would probably be a 3.6N or 7.3N block (f_c = 3.6N/mm^2 or f_c = 7.3N/mm^2)

Masonry Shape Factor d_{sf}

The compression strength value provided for masonry units i.e f_c = 3.6N/mm², f_c = 7.3N/mm² is the value for a cube of masonry measuring 100mm x 100mm x 100mm

The compression strength values are provided in this manner to standardise the calculation approach across Europe where many different types of masonry unit are used, with varying dimensions.

This does mean though that we need to convert our compressive strength to suit the geometry of the masonry unit we're considering. This is done by applying a shape factor d_{sf}.

The shape factor is provided in the table below.
Linear interpolation of the table is allowed.
Some additional rows and columns have been added to this table to account for typical UK masonry sizes. These have been interpolated from the table A.1 in BS EN-772-1 and rounded to nearest 2 decimal places

Shape Factor for Normalised Mean Compressive Strength of Masonry Units - Table A.1 BS EN772-1:2011+A1:2015

Height of Masonry Unit (mm)	Width of Masonry Unit (Sometimes Referred to as the thickness) (mm)											
	50	75	90	100	115	125	140	150	200	215	225	250
40	0.80	0.75	0.72	0.70	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
50	0.85	0.80	0.77	0.75	0.74	0.73	0.71	0.70	N/A	N/A	N/A	N/A
65	0.95	0.90	0.87	0.85	0.82	0.80	0.77	0.75	0.70	0.69	0.68	0.65
100	1.15	1.08	1.03	1.00	0.97	0.95	0.92	0.90	0.80	0.79	0.78	0.75
140	1.27	1.22	1.18	1.16	1.13	1.11	1.08	1.06	0.96	0.95	0.94	0.91
150	1.30	1.25	1.22	1.20	1.17	1.15	1.12	1.10	1.00	0.99	0.98	0.95
190	1.42	1.37	1.34	1.32	1.29	1.27	1.24	1.22	1.12	1.11	1.10	1.07
200	1.45	1.40	1.37	1.35	1.32	1.30	1.27	1.25	1.15	1.14	1.13	1.10
215	1.48	1.43	1.40	1.38	1.35	1.33	1.30	1.28	1.18	1.16	1.15	1.12
250	1.55	1.50	1.47	1.45	1.42	1.40	1.37	1.35	1.25	1.22	1.20	1.15

Shape Factor d_{sf} = 1.380

Normalised Mean Compressive Strength f_b

Normalised Mean Compressive Strength f_b
= shape factor * conditioning factor * compressive strength

Normalised Mean Compressive Strength $f_b = d_{sf} * k * f_c$
Normalised Mean Compressive Strength f_b = 1.380 * 1.0 * 7.3N/mm²
Normalised Mean Compressive Strength f_b = 10.074N/mm²

BS EN772-1:2011+A1:2015 Annex A

The UK National Annex sets limits on the normalised mean compressive strength.
Page 7 of UK NA to BS EN1996-1-1:2005+A1:2012 has the following limits:

f_b not to be taken greater than:
110N/mm² when units are laid in general purpose mortar
50N/mm² when units are laid in thin layer mortar

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Mortar Compressive Strength f_m

The mortar compressive strength can usually be determined from the mortar strength class i.e.

M2 --> f_m = 2N/mm^2
M4 --> f_m = 4N/mm^2
M6 --> f_m = 6N/mm^2
M12 --> f_m = 12N/mm^2

In this instance we've chosen an M4 mortar which is typical in UK construction
Mortar Compressive Strength f_m = 4N/mm^2

The UK National Annex sets limits on the mortar compressive strength
Page 7 of UK NA to BS EN1996-1-1:2005+A1:2012 has the following limits:

f_m is not taken to be greater than $2f_b$ nor greater than
- 12N/mm^2 when units are laid in general purpose mortar
- 10N/mm^2 when units are laid in lightweight mortar

K Factor for Use in Equation 3.1

The K factor is provided in table NA.4 in the UK National Annex to BS EN1996-1-1:2005+A1:2012

Masonry Unit		General Purpose Mortar	Thin Layer Mortar	Lightweight Mortar of Density	
			Bed Joints ≥ 0.5mm & ≤ 3mm	600kg/m^3 ≤ ρ_d ≤ 800kg/m^3	800kg/m^3 ≤ ρ_d ≤ 1300kg/m^3
Clay	Group 1	0.50	0.75	0.30	0.40
	Group 2	0.40	0.70	0.25	0.30
	Group 3	Not used in UK			
	Group 4	Not used in UK			
Calcium Silicate	Group 1	0.50	0.80	Not used in UK	
	Group 2	0.40	0.70	Not used in UK	
Aggregate Concrete	Group 1	0.75	0.90	0.45	0.45
	Group 1 (Units Laid Flat)	0.50	0.70	0.40	0.40
	Group 2	0.70	0.76	0.45	0.45
	Group 3	Not used in UK			
	Group 4	Not used in UK			
Autoclaved Aerated Concrete	Group 1	0.75	0.90	0.45	0.45
Manufactured Stone	Group 1	0.75	0.90	Not used in UK	
Dimensioned Natural Stone	Group 1	0.45	Not used in UK		

In this worked example
K = 0.75 as we're using Group 1 aggregate concrete blocks

α and β Factors for Use in Equation 3.1

The UK National Annex provides values for α and β
Page 6 of UK NA to BS EN1996-1-1:2005+A1:2012 gives the following:

General Purpose Mortar
$\alpha = 0.70$
$\beta = 0.30$

Lightweight Mortar
$\alpha = 0.70$
$\beta = 0.30$

Thin Layer Mortar (in bed joints of thickness between 0.5mm and 3mm)

Using:
- Clay units of Group 1
- Calcium Silicate units of Group 1 or 2
- Aggregate concrete units of Group 1 or 2
- Autoclaved Aerated Concrete units of Group 1 or 2

$\alpha = 0.85$
$\beta = 0.00$

Using:
- Clay units of Group 2

$\alpha = 0.70$
$\beta = 0.00$

In this worked example
$\alpha = 0.70$
$\beta = 0.30$
as we're using general purpose mortar with aggregate concrete group 1

Characteristic Compressive Strength of Masonry f_k

Characteristic Compressive Strength of Masonry $f_k = K * f_b^{\alpha} * f_m^{\beta}$
Characteristic Compressive Strength of Masonry $f_k = 0.75 * (10.074N/mm^2)^{0.7} * (4N/mm^2)^{0.3}$
Characteristic Compressive Strength of Masonry $f_k = 5.727N/mm^2$

BS EN1996-1-1:2005+A1:2012 Equation 3.1

Design Compressive Strength of Masonry f_d

Design Compressive Strength of Masonry $f_d = f_k / \gamma_M$
Design Compressive Strength of Masonry $f_d = 5.727N/mm^2 / 3.0$
Design Compressive Strength of Masonry $f_d = 1.909N/mm^2$

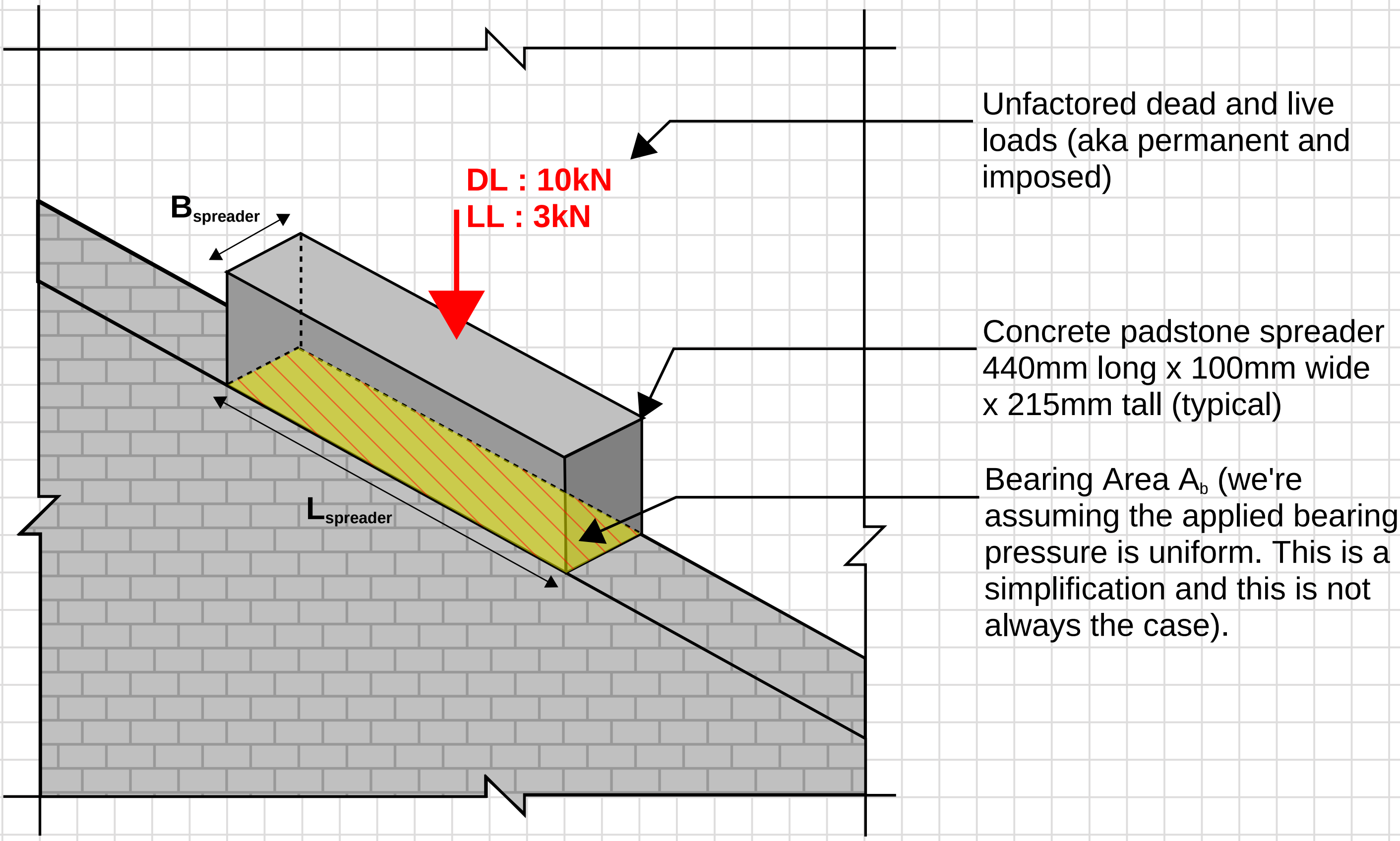
BS EN1996-1-1:2005+A1:2012 Section 2.4.1 Clause (1)P

Localised Force on Wall Bearing

In this example lets assume that we want to support a beam on our blockwork masonry wall. We need to conduct several checks of the masonry panel to ensure it can carry this load.

One of these checks is a localised bearing check to ensure the masonry will not be crushed directly beneath the applied load.

For the sake of simplicity will assume an equalised applied bearing pressure underneath a padstone. We will also not be calculating the enhancement factor for concentrated loads (β) which can give more favourable results



Calculate ULS design load N_{Ed} = (1.35 & 10kN) + (1.5 * 3kN)
Calculate ULS design load N_{Ed} = 18kN

BS EN 1990:2002+A1:2005 Table A1.2(B) Equation 6.10

Calculate Bearing Area $A_b = B_{spreader} * L_{spreader}$
Calculate Bearing Area A_b = 100mm * 440mm
Calculate Bearing Area A_b = 44000mm^2

BS EN1996-1-1:2005+A1:2012 Section 6.1.3

Take bearing enhance factor for concentrated loads as being equal to 1
β = 1.0

Calculate localised bearing resistance of wall underneath the padstone spreader
$N_{Rdc} = \beta * A_b * f_d$
N_{Rdc} = 1.0 * 44000mm^2 * 1.909N/mm^2
N_{Rdc} = 83996N = 83.996kN = 84kN

BS EN1996-1-1:2005+A1:2012 Equation 6.10

Utilisation = 18kN / 84kN = 21.4% --> OK