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DATA SHEET 4

Compressive Load Capacity of Concrete Masonry

This data sheet has been prepared by the Concrete Masonry Association of Australia for use by qualified and experienced structural engineers. The information is based on limit state design and is applicable specifically to concrete masonry with properties as set out in Clause 1 and loads set out in Clause 2.

1 Masonry Properties

The design tables are based on masonry components with the following properties:

- Masonry units having a characteristic unconfined compressive strength (f'_{uc}), for units with faceshell bed, of 15.0 MPa and for units with fullbedding, of 10 MPa when tested in accordance with AS/NZS 4456.4.
- Mortar is of type M3 (or refer Table 5.1 AS 3700

  if required for durability) ie, for type M3, either a C1:L1:S6 mix or a C1:S5 mix plus methyl cellulose water thickener or equivalent.
- In accordance with AS 3700 (2018), the design characteristic compressive strength of grout (f'cg) shall not be less than 12 MPa.
  Note: This factsheet assumes a grout strength of 20MPa, although under AS 3700 (2018), grout strengths of 25MPa, 32MPa, 40MPa, and 50MPa are able to be used with the unit strengths specified in this factsheet.

Where possible pre-mixed grout should be used and, when ordering, specified that it is for grouting blockwork incorporating reinforcement; a minimum cement content of 300 kg/m3 is required. If the grout is to be site-mixed, it should be mixed in a tilting drum paddle mixer and must flow freely without separation of the aggregate. The aggregate should be rounded gravel where available and preferably 5 mm to 10 mm in size. The following proportions should be used:

Cement	1 part
Hydrated lime	up to 1⁄10 part
Mortar sand	3 parts
Aggregate	2 parts

- Reinforcement is to be N-grade with a yield strength (f_{sy}) of 500 MPa.

2 Design Basis

The loads, load combinations and load factors are in accordance with:

- AS/NZS 1170.0 *General Principles*
- AS/NZS 1170.1 *Permanent, imposed and other actions*
- AS/NZS 1170.2 *Wind actions.*

The design properties and strength-reduction factors are in accordance with AS 3700 *Masonry structures.*

3 Compressive Load Capacity

The compressive load capacity (Table 1) has been derived using slenderness reduction factors given in Australian Standard AS 3700 2018, Clause 7.3.3 ***Design by simple rules***. Slenderness-reduction factors for three load conditions have been used to generate the load capacities in Table 1 for various wall types and heights.

The values are all based on walls being unreinforced in compression.
Table 1 gives values of:

h_u = height of unit (from which the value of k_h is determined)
A_b = bedded area of masonry unit (m^2/m)
f'_{mb} = basic characteristic compressive strength of masonry for a ratio of masonry unit height to motar joint thickness of 7.6
k_h = compressive strength factor from Table 3.2 of AS 3700 for a ratio of masonry unit height to motar joint thickness for other than 7.6
f'_m = characteristic compressive strength of masonry (MPa)
$= k_h f'_{mb}$ *cl.3.3.2*
F_o = basic compressive capacity (kN/m)
$= \Phi f'_m A_b$ for ungrouted walls *cl 7.3.2(1)*

$$= \Phi\left[f'_m A_b + k_c \left(\frac{f'_{cg}}{1.3}\right)^{(0.55+0.005 f'_{cg})} A_g \right]$$

for grouted walls *cl 7.3.2(2)*

Where: Φ = 0.5 Hollow T4.1
= 0.6 Grouted hollow T4.1
= 0.75 Solid or Cored T4.1
k_c = 1.4 for masonry density > 2000 kg/m^3
f'_{cg} = 20 MPa
F_d = maximum design compressive strength (kN/m)
$= k F_o$
Where: k = reduction factor for slenderness and eccentricity
from *Table 7.1 of AS 3700.*

TABLE 1 *Wall Properties and Compressive Load Capacity*

WALL PROPERTIES

	Wall thickness, t_w (mm)											
	90	110				140			190		290	
	Unit type											
Property	10.01	Brick	Double Brick	12.01	Cored Block	15.01	15.01 grouted	15.801	20.01	20.01 grouted	30.925	30.925 grouted
Φ	0.5	0.75	0.75	0.5	0.75	0.5	0.6	0.5	0.5	0.6	0.5	0.6
h_u (mm)	190	76	162	190	190	190	190	190	190	190	190	190
A_b (m^2/m)	0.05	0.110	0.110	0.06	0.110	0.06	0.06	0.084	0.060	0.06	0.08	0.08
f'_{uc} (MPa)	15	10	10	15	10	15	15	15	15	15	15	15
f'_{cg} (MPa)	20	20	20	20	20	20	20	20	20	20	20	20
f'_{mb} (MPa)	6.20	4.43	4.43	6.20	4.40	6.20	6.20	6.20	6.20	6.20	6.20	6.20
k_h	1.30	1.00	1.24	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
f'_m (MPa)	8.06	4.43	5.49	8.06	5.72	8.06	8.06	8.06	8.06	8.06	8.06	8.06
F_o (kN/m)	201	365	454	242	472	242	687	339	242	936	322	1429

WALL COMPRESSIVE LOAD CAPACITY, F_d (kN/m)

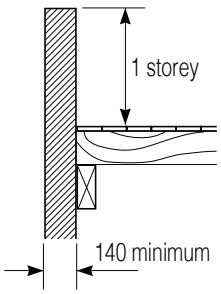
Load Type (see table 7.1 AS 3700) — Unit thicknes / Masonry unit Type / Compressive Capacity AS 3700 (2018) KN/m

Wall design height (mm)	90	110				140			190		290	
Concrete slab on wall	10.01	Brick	Double Brick	12.01	Cored Block	15.01	15.01 grouted	15.801	20.01	20.01 grouted	30.925	30.925 grouted
900	135	245	304	162	316	162	461	227	162	627	216	958
1200	135	245	304	162	316	162	461	227	162	627	216	958
1500	124	245	304	162	316	162	461	227	162	627	216	958
1800	-	228	282	176	294	162	461	227	162	627	216	958
2100	-	-	-	-	-	157	447	220	162	627	216	958
2400	-	-	-	-	-	-	417		162	627	216	958
2700	-	-	-	-	-	-	-	-	161	623	216	958
3000	-	-	-	-	-	-	-	-	-	593	216	958
3300	-	-	-	-	-	-	-	-	-	564	216	958
3600	-	-	-	-	-	-	-	-	-	-	216	958
4200	-	-	-	-	-	-	-	-	-	-	-	944
4800	-	-	-	-	-	-	-	-	-	-	-	885

Other loads on wall

900	135	245	304	162	316	162	461	227	162	627	216	958
1200	118	237	293	157	305	162	461	227	162	627	216	958
1500	101	212	262	140	273	158	448	221	162	627	216	958
1800	-	187	232	-	241	145	411	203	162	627	216	958
2100	-	-	-	-	-	132	375	184	156	602	216	958
2400	-	-	-	-	-	-	338		146	565	216	958
2700	-	-	-	-	-	-	-	-	137	528	216	958
3000	-	-	-	-	-	-	-	-	-	491	213	945
3300	-	-	-	-	-	-	-	-	-	454	205	908
3600	-	-	-	-	-	-	-	-	-	-	197	871
4200	-	-	-	-	-	-	-	-	-	-	-	798
4800	-	-	-	-	-	-	-	-	-	-	-	724

Load on side of wall



900	-	-	-	-	-	16	46	23	16	63	22	96
1200	-	-	-	-	-	16	46	23	16	63	22	96
1500	-	-	-	-	-	16	46	23	16	63	22	96
1800	-	-	-	-	-	16	46	23	16	63	22	96
2100	-	-	-	-	-	16	45	22	16	63	22	96
2400	-	-	-	-	-	-	42	-	16	63	22	96
2700	-	-	-	-	-	-	-	-	16	62	22	96
3000	-	-	-	-	-	-	-	-	-	56	22	96
3300	-	-	-	-	-	-	-	-	-	53	22	96
3600	-	-	-	-	-	-	-	-	-	-	22	96
4200	-	-	-	-	-	-	-	-	-	-	21	94
4800	-	-	-	-	-	-	-	-	-	-	-	88
5400	-	-	-	-	-	-	-	-	-	-	-	83

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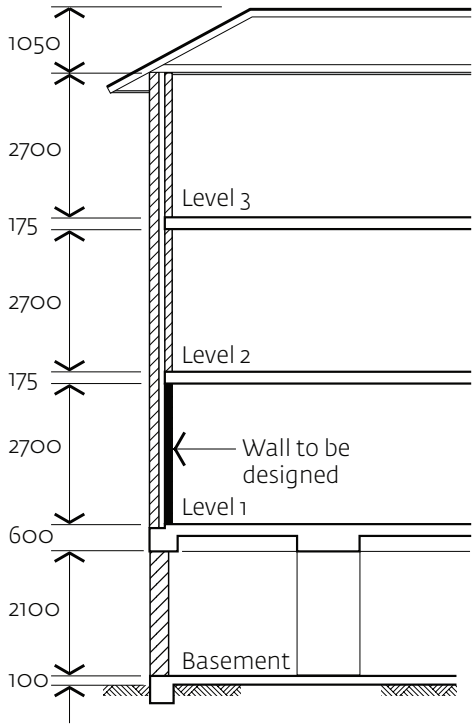
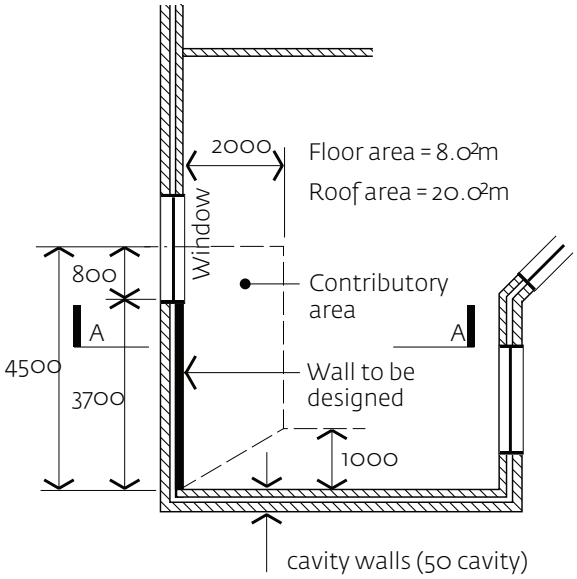
4 Worked Examples

The purpose of the following worked example is to demonstrate the steps to be followed when performing manual calculations or when preparing computer software for the analysis and design of masonry.



SECTION A-A



PART PLAN AT LEVEL 1

The worked example is not intended to analyse or design all parts of the particular structure. It deals only with enough to demonstrate the design method.

MASONRY PROPERTIES

Note: All clause and table references to AS 3700 2018.

Width of masonry unit
t_u = 190 mm

Face-shell thickness
t_{fs} = 30 mm

Bedded area
$A_b = 2\ t_{fs}\ l$ *4.5.4*
= 2 x 30 x 1000
= 6 0,000 mm²/m

Block height
h_u = 190 mm

Mortar joint thickness
t_j = 10 mm

Height ratio
$\frac{h_u}{t_j} = \frac{190}{10}$
= 19.0

Compressive strength factor
k_h = 1.3 *Table 3.2*

Masonry factor for face-shell bedded concrete units
k_m = 1.6 *Table 3.1*

Mortar type M3 (1:0:5)+ water thickener

Area of grout cross section
A_c = 0 Ungrouted walls

Characteristic unconfined unit strength
f'_{uc} = 15 MPa

Characteristic confined masonry strength
$f'_{mb} = k_m \sqrt{f'_{uc}}$ *3.3.2(a)(i)*
$= 1.6 \sqrt{15}$
= 6.20 MPa

Characteristic unconfined masonry strength
$f'_m = k_h f'_{mb}$ *3.3.2(a)(i)*
= 1.3 x 6.20
= 8.06 MPa

NOTE: This wall is not grouted. Where grout is used elsewhere, it is specified as:

Characteristic grout cylinder strength
f'_c = 20 MPa
> 12 MPa *11.7.3*

Design characteristic grout strength
f'_{cg} = 20MPa

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Capacity reduction factor
ø = 0.5 *Table 4.1*
Density factor
k_c = 1.4 for density 2180
> 2000 kg/m^3 *7.3.2*

Basic compressive capacity *7.3.2(2)*

$F_o = \Phi\ f'_m A_b$

= 0.5 x 8.06 x 60,000

= 242kN/m

DESIGN BY SIMPLIFIED RULES *7.3.3*

Vertical slenderness coefficient (supports slab)
a_v = 1.0 *7.3.3.4(1)*

Clear height
H = 2.70 m

Clear length
L = 3.70 m

Thickness coefficient (no engaged piers)
k_t = 1.0 *Table 7.2*

Slenderness ratio

$S_{rs} = \frac{a_v H}{k_t t}$ *7.3.3.4(1)*

$= \frac{1.0 \times 2700}{1.0 \times 190}$

= 14.21

Slenderness and eccentricity factor

k = 0.67 - 0.02 (S_{rs} - 14) *7.3.3.3(a)(i)*

= 0.67 - 0.02 (14.21 - 14)

= 0.666 *or from Table 7.1*

Design capacity

$F_D = k F_o$ *7.3.3.2*

= 0.666 x 242

= 162kN/m

NOTE: If design capacity above is not sufficient to meet actual design loads, higher compressive capacity may be achieved using the Refined Calculation method. Refer to 7.3.4