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S304-14
(reaffirmed 2019)

Design of masonry structures

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Note: *For information about the* ***Standards Update Service****, go to* ***shop.csa.ca*** *or e-mail* ***techsupport@csagroup.org****.*

Title: *Design of masonry structures* — originally published August 2014

The following revisions have been formally approved and are marked by the symbol delta (Δ) in the margin on the attached replacement pages:

Revised	Clause 7.10.3
New	None
Deleted	None

- Update your copy by inserting these revised pages.
- Keep the pages you remove for reference.

v_m = shear strength attributed to the masonry, given in Clause 7.10.2.3, MPa

d_v = effective depth for shear calculations, which need not be taken as less than $0.8\ell_w$ for walls, mm

γ_g = factor to account for partially grouted or ungrouted walls that are constructed of hollow or semi-solid units as follows:

(a) equal to 1 for fully grouted masonry, fully solid concrete block masonry, or solid brick masonry; or

(b) equal to A_e/A_g, but not greater than 0.5, for other types of masonry

A_g = gross cross-sectional area, mm^2

P_d = axial compressive load on the section under consideration, based on 0.9 times dead load including any axial load arising from bending in coupling beams, N

7.10.2.2 Low-aspect-ratio (squat) shear walls

The upper limit on the factored shear resistance of low-aspect-ratio walls ($h_w/\ell_w < 1$) is greater than that given in Clause 7.10.2.1; however, care shall be taken that the shear input to the wall is distributed along the entire length of the wall and will not lead to failure of a portion of the wall. If such care is taken, then the maximum factored shear resistance may be increased to

$$0.4\phi_m\sqrt{f'_m}\,b_w d_v \gamma_g\left[2-\left(h_w/\ell_w\right)\right]$$

where

h_w = total wall height, mm

ℓ_w = wall length, mm

h_w/ℓ_w = shall be taken as not less than 0.5 nor more than 1

7.10.2.3 Masonry shear strength

Shear strength contributed by masonry, v_m, shall be as given by

$$v_m = 0.16\left(2-\frac{M_f}{V_f d_v}\right)\sqrt{f'_m}$$

where

M_f = factored moment at the section under consideration

V_f = factored shear at the section under consideration

$\frac{M_f}{V_f d_v}$ = shall be taken as not less than 0.25 nor more than 1

Δ 7.10.3 Factored out-of-plane shear resistance for walls and columns

The factored out-of-plane shear resistance, V_r, shall be taken as

$$V_r = \phi_m\left[0.16\sqrt{f'_m}A_e + 0.25P_d\right]$$

but not greater than

$$0.4\phi_m\sqrt{f'_m}A_e$$

Note: *The effective cross-sectional area, A_e, is defined in Clause 7.3.*

7.10.4 Stack pattern factored shear resistance

The maximum factored vertical in-plane shear resistance in stack pattern walls shall not exceed that corresponding to the shear friction resistance of the continuous horizontal reinforcing used to tie the wall together at the continuous head joints. Such reinforcing shall be spaced at not more than 800 mm for bond beam reinforcing and 400 mm for wire joint reinforcing. Shear friction resistance shall be taken as

$$V_r = \phi_m \mu C_h$$

where

μ = 0.7

C_h = compressive force in the masonry acting normal to the head joint, normally taken as the factored tensile force at yield of the horizontal reinforcement that crosses the vertical joint and has been detailed to develop yield strength on both sides of the vertical joint, N

7.10.5 Factored sliding shear resistance

7.10.5.1 Factored in-plane sliding shear resistance

The factored in-plane sliding shear resistance, V_r, shall be taken as

$V_r = 0.16\phi_m\sqrt{f'_m}A_{uc} + \phi_m\mu P_1$ for shear along bed joints between courses of masonry

and

$V_r = \phi_m\mu C$ for shear along bed joint between the support and the first course of masonry

where

A_{uc} = the uncracked portion of the effective cross-sectional area of the wall that provides shear bond capacity (applied out-of-plane loads in addition to the applied in-plane loads can cause cracking of the masonry wall), mm

μ = 1.0 for a masonry-to-masonry or masonry-to-roughened concrete sliding plane

= 0.7 for a masonry-to-smooth concrete or bare steel sliding plane

C = compressive force in the masonry acting normal to the sliding plane, normally taken as P_d plus the factored tensile force at yield of the vertical dowels that are detailed to develop yield strength on both sides of the sliding plane, N

Note: *When flashings reduce the friction that resists sliding shear, the frictional coefficient would be based on the particular flashing material.*

7.10.5.2 Factored out-of-plane sliding shear resistance

The factored out-of-plane sliding shear resistance, V_r , across a horizontal section shall be calculated as follows:

$V_r = 0.16\phi_m\sqrt{f'_m}A_{uc} + \phi_m\mu P_1$ for shear along bed joints between courses of masonry

and

$V_r = \phi_m\mu C$ for shear along bed joint between the support and the first course of masonry

Note: *When flashings reduce the friction that resists sliding shear, the frictional coefficient μ would be based on the particular flashing material.*

7.11 Intersections

7.11.1 Bonded masonry intersections

Where wall intersections are bonded so that units in alternating courses of one wall are embedded at least 90 mm in the other wall, the factored vertical shear at the intersection shall not exceed the factored shear resistance of the masonry taken as

$$V_r = \phi_m\left[0.16\sqrt{f'_m}A_e\right]$$

Minimum horizontal reinforcement shall be provided across the vertical intersection. This reinforcement shall be equivalent in area to at least two 3.65 mm diameter steel wires spaced 400 mm vertically.

Note: *For hollow and partially grouted masonry construction, A_e in the above equation may be taken as the effective mortared area of the bed joint. For fully grouted walls, A_e in the above equation may be taken as the gross cross-sectional area, A_g.*

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