DESIGNER CHECKLIST FOR UNREINFORCED LOADBEARING CONCRETE MASONRY WALLS BASED ON TMS 402/602-22

One of the many intrinsic characteristics of concrete masonry construction is its ability to resist large axial loads with or without concurrently applied in-plane or out-of-plane loads. This Checklist covers the general and prescriptive design and detailing requirements for unreinforced, single wythe loadbearing masonry walls subjected to axial or out-of-plane loads. While unreinforced wall systems may contain reinforcing steel, the presence of any reinforcement is not taken into consideration when determining the strength of these assemblies. For information covering the design of reinforced loadbearing concrete masonry walls see:

- DC-9-22, *Designer Checklist for Reinforced Loadbearing Concrete Masonry Walls*

The following Checklists review additional information related to the design and detailing of concrete masonry shear walls systems:

- DC-4-22, *Designer Checklist for Ordinary Reinforced Concrete Masonry Shear Walls*
- DC-5-22, *Designer Checklist for Ordinary Reinforced Concrete Masonry Shear Walls*
- DC-6-22, *Designer Checklist for Intermediate Reinforced Concrete Masonry Shear Walls*
- DC-7-22, *Designer Checklist for Special Reinforced Concrete Masonry Shear Walls*

TMS 402 contains design modeling options for both allowable stress design (ASD) and strength design (SD). Where design checks differ between these two modeling approaches, they are addressed separately in this Checklist.

CHECK	REQUIREMENT	REFERENCE	DESIGNER NOTES
SECTION 1: MATERIAL REQUIREMENTS			
1	Concrete Masonry Units: CMU must comply with the requirements of ASTM C90.	TMS 602 Art. 2.3 A	At horizontally reinforced bond beams, use bond beam units configured to accept horizontal reinforcement and grout. Where vertical reinforcement coincides with bond beams or vertical grout continuity is required, use open-bottom units. Portions of the masonry assembly that do not contain horizontally reinforced bond beams may be constructed using hollow units of any configuration (stretcher, corner, knock-out, etc.)
2	Mortar: Complying with ASTM C270 or ASTM C1714/C1714M.	TMS 602 Art. 2.1 A	Type S mortar is recommended for loadbearing masonry elements and masonry that is part of the lateral force-resisting system. There is functionally no difference between mortar complying with ASTM C270 versus mortar complying with ASTM C1714/C1714M as each must meet the same constituent material requirements and proportion/property requirements. Mortars complying with ASTM C1714/C1714M are preblended and delivered to jobsites in bags where water is added. ASTM C270 mortars may be batched onsite from constituent materials.

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3	Specify minimum compressive strength for the masonry assembly.	TMS 402 Sec. 4.3 and TMS 602 Art. 1.4 B.2, Table 2	The most common method of specifying the minimum compressive strength of masonry construction (f'_m) is by using the unit strength table of TMS 602, which establishes the masonry assembly compressive strength based on the compressive strength of the CMU and the type of mortar used in construction. Note that when high compressive strength masonry (f'_m > 3,000 lb/in.^{2}) is warranted, the use of prisms to verify the compressive strength may provide more design economy as the unit strength table becomes more conservative at high strength ranges. A calculator for determining the assembly compressive strength based on the CMU and mortar properties is available here: https://beautyofblock.com/2025/09/24/masonry-comprehensive-strength-calculator/ Given the lack of research data at higher strengths, the maximum specified compressive strength of concrete masonry (f'_m) per TMS 402 is 4,000 lb/in.^{2}.
4	Grout: Must conform to ASTM C476.	TMS 402 Sec. 4.3 and TMS 602 Art. 2.2	ASTM C476 has options for coarse grout, fine grout, and self-consolidating grout. Coarse grout is most commonly used in concrete masonry construction unless the spaces to be grouted are congested. The primary difference between coarse grout and fine grout is the size of the aggregate in the mix, with the smaller aggregate size required of fine grout necessary to facilitate the placement and consolidation of the grout in tight spaces. As such, a fine grout can be substituted for coarse grout with no detrimental impact to the construction or performance of the masonry. However, if a fine grout is specified because of reinforcement congestion or small clearances, a fine grout complying with ASTM C476 should be used as a coarse grout may result in consolidation issues and voids within the final construction. Given the lack of research data at higher strengths, the maximum specified compressive strength of masonry grout (f'_g) used in concrete masonry construction per TMS 402 is 5,000 lb/in.^{2}.
5	Mild Reinforcement: Must meet ASTM A615/A615M or ASTM A706/A706M.	TMS 602 Art. 2.4 A	ASTM A615/A615M (carbon steel) Grade 60 is most commonly used in concrete masonry construction. ASTM A706/A706M (low alloy steel) is used when reinforcement is to be welded. Other specialty reinforcement (e.g., epoxy coated) is permitted by TMS 602 where warranted.
6	Joint Reinforcement: Conforms to ASTM A951.	TMS 402 Sec. 6.1.5.2 TMS 602 Art. 2.4 D	Horizontal joint reinforcement is used both for crack control as well as to resist out-of-plane flexural loading in horizontally spanning walls. Joint reinforcement embedded in masonry construction exposed to earth, weather, or a mean relative humidity exceeding 75% are required to be hot-dip galvanized. Mill galvanizing of the joint reinforcement is permitted for all other applications.
SECTION 2: STRUCTURAL DESIGN CHECKS			
7	Select design methodology.	TMS 402 Sec. 8.2 or 9.2	Unreinforced masonry walls are designed using either the allowable stress (Chapter 8) or strength design (Chapter 9) methods.

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8	Select bond pattern.	TMS 402 Sec. 4.7	Running bond and stack bond are the two most frequently used bond patterns used for the construction of concrete masonry walls. When using stack bond construction, TMS 402 requires a minimum area of horizontal reinforcement to maintain continuity across the mortared head joints. This reinforcement may also be used for crack control or resisting out-of-plane loads in horizontally spanning walls.
9	Check axial compression and flexure (ASD).	TMS 402 Sec. 8.2.4	Absent significant axial compressive loads, out-of-plane flexural tension is often controlled by the allowable flexural tension stresses that can be developed in the masonry per TMS 402 Table 8.2.4.2. Allowable flexural tension stresses vary based on the type of mortar used in construction, presence of grout, and configuration of the CMU (solid or hollow). If vertical reinforcement is present in the assembly, it is neglected in this design check.
10	Check axial compression and flexure (SD).	TMS 402 Sec. 9.2.4	Absent significant axial compressive loads, out-of-plane flexural tension is often controlled by the modulus of rupture that can be developed in the masonry per TMS 402 Table 9.1.9.1. The modulus of rupture values vary based on the type of mortar used in construction, presence of grout, and configuration of the CMU (solid or hollow). If vertical reinforcement is present in the assembly, it is neglected in this design check.
11	Verify absence of net axial tension (ASD).	TMS 402 Sec. 8.2.5	Unreinforced masonry is not permitted to resist net axial tension, such as may result from wind uplift loads on loadbearing walls. Masonry construction subjected to net axial tension is required to be designed as reinforced.
12	Verify absence of net axial tension (SD).	TMS 402 Sec. 9.2.5	Unreinforced masonry is not permitted to resist net axial tension, such as may result from wind uplift loads on loadbearing walls. Masonry construction subjected to net axial tension is required to be designed as reinforced.
13	Check out-of-plane shear strength (ASD).	TMS 402 Sec. 8.2.6	Out-of-plane shear strength is governed by the strength of the masonry assembly (f'_m) and bond pattern (running or stack bond).
14	Check out-of-plane shear strength (SD).	TMS 402 Sec. 9.2.6	Out-of-plane shear strength is governed by the strength of the masonry assembly (f'_m) and bond pattern (running or stack bond).
15	Check second order effects (SD).	TMS 402 Sec. 9.2.4.3	Second order effects can be verified using either a conventional P-Delta iteration or by a moment magnifier approach.
SECTION 3: DETAILING AND CONTINUITY			
16	If present, verify reinforcement size limits, placement tolerances, and corrosion protection.	TMS 402 Sec 6.1.3-6.1.5	Verify reinforcement size limits (6.1.3.2) to mitigate congestion, provide sufficient space for reinforcement and grout consolidation (6.1.4), and maintain required reinforcement cover/protection (6.1.5.1) for corrosion protection. A minimum clearance between the reinforcement and the masonry unit of $^1/_4$ in. when using fine grout and $^1/_2$ in. when using coarse grout is required, however, TMS 602 Article 3.4 B allows horizontal reinforcement to be supported directly by the cross webs of hollow units without maintaining this clearance requirement.

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17	If present, provide minimum development and lap splice lengths for reinforcement.	TMS 402 Sec. 6.1.6 and 6.1.7	Minimum development lengths and lap lengths vary with the clear cover to the nearest masonry surface or adjacent reinforcement, diameter of the reinforcement, yield strength of the reinforcement, and strength of the masonry (f'_m). A calculator for determining minimum lap and development lengths is available here: https://beautyofblock.com/2025/09/18/lap-splice-development-length-calculator/
SECTION 4: INDUSTRY BEST PRACTICES			
18	Detail control joints to maintain structural continuity and mitigate cracking.	CMHA TEC-009-25	Provide horizontal reinforcement and control joints or relief joints to mitigate cracking potential.

STANDARD	REFERENCE
ASTM	ASTM A615/A615M, ASTM A706/A706M, ASTM A951, ASTM C90, ASTM C270, ASTM C476, and ASTM C1714/C1714M.
TMS 402 – General	Sections 4.3, 4.7, 5.1.2 6.1.3, 6.1.4, 6.1.5, 6.1.6, and 6.1.7.
TMS 402 – Allowable Stress Design	Sections 8.2, 8.2.4, 8.2.5, and 8.2.6.
TMS 402 – Strength Design	Sections 9.2, 9.2.4, 9.2.5, and 9.2.6.
TMS 602	Articles 1.4 B.2, 2.1 A, 2.2, 2.3 A, 2.4 A, and 2.4 D.