Masonry Analysis Structural Systems: MASS™ Version 1.1 List of Changes

National Masonry Design Programs

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Contents

Beams

1. **Factored compression force in masonry calculation for beams with tied compression reinforcement (B1)**
   The factored compression force in masonry, C_m, calculation for beams with tied compression reinforcement was corrected to take into account the reduction of masonry area from the compression reinforcement. Previously, the equation displayed in the Detailed Moment Results correctly showed this reduction; however it was not used in calculating the displayed result or the value used in design.

2. **Displayed factored shear resistance result for beams failing in shear without shear reinforcement (B2)**
   In the Simplified and Detailed Shear Results, the factored shear resistance, V_r, displayed result for a failed shear design of beams without shear reinforcement was corrected. Previously, the displayed result was incorrectly showing the value of $V_r = V_m + V_{s,\,max}$ rather than the correct value of $V_r = 0.5V_m$. This affected the displayed result only and not the value used in design.

3. **Placing stirrups in beams with d/2 less than single cell width (B3)**
   A check was added when changing beam height to ensure stirrups at a maximum spacing of d/2 are able to be placed. If the maximum spacing as specified in CSA S304.1-04 11.3.4.8 is less than the width of a single cell, stirrups are unable to be placed and the "single leg" and "double leg" configuration options are disabled. Previously, after performing shear design where stirrups are manually required by the user (deselecting "none" configuration for vertical steel) and changing the beam height to a value less than d/2, stirrups were displayed even though maximum spacing requirements were not met. This affected the displayed drawings and Simplified Shear Results only and not the factored shear resistance displayed or used in design.

4. **Beam drawing course layout when opening previously saved files (B9)**
   Beams are now drawn with the same course layout when a saved file is opened as when it was originally saved. Users are able to modify a beam such that the bottom course starts with a half-unit on the left end of the beam drawing. Previously, when a saved file was opened it would always be drawn with the bottom course starting with a full unit. This affects only the beam drawing and has no impact on design.

5. **Deep beam error message (B10)**
   A beam is no longer identified as a deep beam in accordance with CSA S304.1-04 11.2.7 until the height and the length or clear span of the beam have been entered. Previously, when creating a new beam and entering a value for height prior to entering a value for length or clear span, an error message related to deep beam design was incorrectly displayed.

6. **Minimum threshold for factored moments used in moment design (B12)**
   The program now applies a minimum threshold of +/- 0.01 kNm before factored moments result in positive or negative moment design. Previously, very large loads could result in small, false moments due to rounding errors, triggering moment design in the opposite direction.

Walls

7. **Factored shear resistance or maximum shear resistance not displayed (W1)**
   The result for factored shear resistance, V_r, and maximum shear resistance, $V_{r,\,max}$, are now both displayed in Simplified Shear Results, regardless of which value governs the design. Previously, only the result for the value governing the design (V_r or $V_{r,\,max}$) was displayed while the other result was left blank.

8. **Shear design failure message reference change (W2)**
   The failure message displayed for walls failing in shear design now correctly references CSA S304 1-04 10.10.2 for out of plane shear resistance in the shear design summary of Simplified Shear Results. Previously, the failure message referenced CSA S304.1-04 10.10.1 for in-plane shear.

9. **Slender unreinforced walls failure message (W3)**
   Unreinforced walls with a slenderness ratio, kh/t, greater than 30 now display the following failure message in Simplified Moment Results: "Design fails: The slenderness ratio kh/t for unreinforced walls shall not exceed 30, in accordance with CSA S304.1-04 7.7.5.2. Walls with a slenderness ratio greater than 30 must be reinforced in accordance with CSA S304.1-04 10.7.3.3.3". Previously, the following incorrect failure message for maximum axial load was displayed: "Design fails: The current set of selections results in a factored axial load resistance that exceeds the maximum allowed as defined by CSA S304.1-04: 10.4.1. Please select a new masonry unit."

10. **Crash fixed for unreinforced wall deflection drawings (W4)**
    Users are now able to select load combinations other than the critical load combination from the drop down list for the deflection drawing of unreinforced walls. Previously, when the user selected a load combination other than the critical load combination the program would crash.

11. **Text added for deflection drawings of unreinforced walls (W4)**
    When designing with unreinforced masonry, the program now displays the following message on the Deflection drawing for all load cases "There is no deflection design for unreinforced walls". Previously, a deflection drawing would be displayed showing no deflected shape.

12. **Wind load importance factor now used in calculating the deflection of walls (W5)**
    The importance factor of 0.75 for serviceability limit states (SLS) is now correctly applied to wind loads within loads analysis used in determining service load deflection. Previously, the correct importance factor was displayed properly in all serviceability load combinations; however, a value of 1.0 was used by the loads analysis for the service wind loads in calculating the deflection. This resulted in a larger service wind load deflection in Version 1.0 but did not affect moment or shear design.

13. Sliding shear variable, A_{uc}, not displayed (W6)

Detailed Shear Results for factored sliding shear resistance of unreinforced masonry now displays all the all information for the uncracked cross-sectional area, A_{uc}. Previously, this line was omitted.

14. Shear resistance variable, A_e, displayed equation correction (W6)

Detailed Shear Results for unreinforced hollow walls now display b_{eff} x $2t_f$ as the equation for effective area, A_e. Previously, the equation was incorrectly displayed as $b_{w,\,eff}$ x t. This affected the displayed equation and had no effect on the calculated result.

15. Additional information added to Detailed Shear Results for factored sliding shear resistance (W7)

Additional lines of information were added within Detailed Shear Results for factored sliding shear resistance of reinforced masonry. Previously, only cell incrementation, h_i, and coefficient of friction, μ, were displayed with no additional information showing how the factored sliding shear resistance was calculated. This only affected information displayed in Detailed Shear Results and had no effect on the calculation of factored sliding shear resistance.

16. Change to the effective stiffness, $(EI)_{eff}$, when grout is ignored (W8)

For reinforced walls where the critical M_f and P_f are in the area of the interaction diagram where grout is ignored, $0.25EI_0$ is now used for the upper bound of effective stiffness, $(EI)_{eff}$. Previously, the upper limit for this case was incorrectly placed at $(EI)_{eff} = 0.4EI_0$ which can only be used for unreinforced masonry. This resulted in smaller than expected moment magnification for these uncommon cases of M_f and P_f.

17. Factored moment resistance result displayed under Simplified Moment Results when factored axial load for critical load combination is greater than P_{equal1} (W9)

Factored moment resistance, M_r, is now displayed in the Simplified Moment Results for hollow unreinforced walls when the factored axial load, P_f, for the critical load combination is greater than the factored axial load at which the factored tensile moment resistance is equal to the factored compressive moment resistance using uncracked section properties, P_{equal1}. Previously, no value was displayed for M_r when P_f was greater than P_{equal1}. This affected the displayed result only and not the value used in design.

18. Detailed Moment Results now displays correct results for unreinforced masonry walls with a factored moment resistance governed by an eccentricity of t/3 (W9)

For unreinforced walls where the critical load combination has a factored axial load, P_f, within the area of the interaction diagram in which the moment resistance, M_r, is governed by the limiting eccentricity of t/3, the correct result for P_{r1}, C_{m1}, A_{comp} and c are now displayed under Detailed Moment Results. Previously, these variables were listed with correct values used in calculation but the displayed result was 0.0. This affected the displayed result only and not the value used in design.

19. Factored dead load moment used in β_d now calculated using correct load combination (W10)

In the calculation of the ratio of factored dead load moment to total factored moment, β_d, the factored dead load moment is now calculated using the correct load combination. Previously, an unrealistically large value of β_d was calculated for load combination 1: 1.4D only (this load combination has been changed to 1.4D + 1.5Ds, see 33) since Dead and Soil load types were used in the factored dead load moment calculation but only the Dead load type was used in the total factored moment calculation. For load combination 1: 1.4D, this resulted in a factored dead load moment that was significantly larger than the total factored moment when a Soil load type (now called Vertical Soil, see 34) was applied laterally to the wall.

20. Line load arrowhead placement (W11)

Arrowheads drawn on a line load not extending to the top edge of a wall are now properly placed at the extent of the line load. Previously, the upper arrowhead of the line load was incorrectly drawn above the top of the wall.

21. Correction to displayed equations for moment resistance of unreinforced masonry in Detailed Moment Results (W12)

Moment resistance equations for cracked section analysis (M_{r1}, M_{r2}) displayed in Detailed Moment Results are now correctly displayed. Previously, the result was correct when using cracked section analysis; however, the equation displayed was for the M_{equal} line drawn vertically starting at P_{equal} and intersecting the limiting eccentricity (t/3) line. In addition, where critical factored axial load, P_f, was located within the range of the M_{equal} line, no equations or results were displayed. This affected the displayed equation and result but had no effect on the calculation of factored moment resistance.

22. Correction to the minimum vertical reinforcement area for walls with seismic hazard index greater than or equal to 0.35. (SW2)

For walls that require vertical reinforcement and have a seismic hazard index greater than or equal to 0.35, the check for minimum reinforcement area has been changed to correctly calculate the minimum as $0.0013A_g$ or $0.0013(t \times 4t)$, in accordance with CSA S304.1-04: 10.15.1.1. Previously, the minimum vertical reinforcement area for walls with a seismic hazard index greater than or equal to 0.35 was $0.00067A_g$ in accordance with CSA S304.1-04: 10.15.2.1. However, walls having a seismic hazard index greater than or equal to 0.35 must be designed as reinforced walls in accordance with CSA S304.1-04: 4.5.1 and since the program only accommodates vertical reinforcement (i.e. walls supported at the top and bottom) to resist the loads, the minimum vertical steel of $0.0013A_g$ or $0.0013(t \times 4t)$, as described above must be satisfied.

Shear Walls

23. Correction to equation for effective compressive strength for smeared design (SW1)

The effective compressive strength of the smeared section of masonry between the end zones, $f'_{m, web, eff}$, is now calculated correctly using only the portion between the end zones. The equation for C_{smear} in Detailed Moment Results was also corrected to use $f'_{m, web, eff}$ rather than $f'_{m, smear, web}$ when end zones are present. Previously, the effective compressive strength used in determining the factored axial load and moment resistance was based on the entire length of the web, including the endzones. In typical cases where $f'_{m, solid}$ is less than $f'_{m\ hollow}$, this resulted in a lower effective compressive strength and a conservative design.

24. Check added for minimum horizontal reinforcement area for shear walls with a seismic hazard index greater than or equal to 0.35 (SW2)

A check was added for minimum horizontal reinforcement area, $A_{sh, min} = 0.00067A_g$ in accordance with CSA S304.1-04: 10.15.2.2, during shear design for shear walls with a seismic hazard index greater than or equal to 0.35. Previously, this check was not performed.

25. Failure message related to beam shear stirrups no longer occurs after failed shear design for shear walls with seismic hazard index greater than or equal to 0.35 (SW2)

Shear walls with a seismic hazard index greater than or equal to 0.35 that fail shear design with joint reinforcement configurations set to “none” now display the correct failure message in the Simplified Shear Results: “Design fails: The steel reinforcement does not meet the minimum bar area specified by CSA S304.1-04: 10.15.2.2.”. Previously, the following failure message pertaining to stirrups for beam design was displayed: “Design fails because There is insufficient steel stirrup area and/or bar spacing according to CSA S304.1-04: 11.3.4.7.1,2 and/or: 11.3.4.8”.

26. Factored shear resistance (steel) result now correctly calculated for seismic hazard index greater than or equal to 0.35 (SW2)

Factored shear resistance (steel) result for shear walls with a seismic hazard index greater than or equal to 0.35 is now correctly calculated within Simplified and Detailed Shear Results. Previously, this result for factored shear resistance (steel), $V_{r, steel}$, was always assigned as 0.0. This resulted in a conservative value for factored shear resistance, V_r, neglecting the added resistance from reinforcement for reinforced shear walls with a seismic hazard index greater than or equal to 0.35.

27. Minimum reinforcement check added for shear walls with seismic hazard index greater than or equal to 0.35. (SW2)

A check was added such that unreinforced masonry shear walls cannot be used when the seismic hazard index is greater than or equal to 0.35, in accordance with CSA S304.1-04 10.15.2. Previously, this check was not performed.

28. Correction to the minimum vertical reinforcement area for shear walls with seismic hazard index greater than or equal to 0.35. (SW2)

For shear walls that require vertical reinforcement and have a seismic hazard index greater than or equal to 0.35, the check for minimum reinforcement area has been changed to correctly calculate the minimum as $0.0013A_g$ or $0.0013(b_w \times 4b_w)$, in accordance with CSA S304.1-04: 10.15.1.1. Previously, the minimum vertical reinforcement area for shear walls with a seismic hazard index greater than or equal to 0.35 was $0.00067A_g$ in accordance with CSA S304.1-04: 10.15.2.1. However, shear walls having a seismic hazard index greater than or equal to 0.35 must be designed as reinforced walls in accordance with CSA S304.1-04: 4.5.1 and since they will require vertical reinforcement to resist the loads, the minimum vertical steel of $0.0013A_g$ or $0.0013(b_w \times 4b_w)$, as described above governs.

29. Top course units are highlighted when non-modular size is specified (SW3)

Top course units with heights between 101mm and 189mm are now correctly highlighted to alert the user that a non-modular size has been specified. Previously, units of this height would not be highlighted.

30. Moment design failures caused by shear design (SW4)

Shear wall configurations that are governed by shear design will no longer cause a moment design failure due to minimum vertical reinforcement requirements. Upon completion of a successful moment design and initiation of shear design, the program determines the shear resistance for the successful moment configuration and will continue to cycle through available configurations until there is a successful shear design or no solution can be found. Where shear design has changed the configuration by increasing the block size and causes a failed moment design due to minimum vertical reinforcement requirements, the program will now revert to the previous successful moment design configuration and indicate a failed shear design. Previously, a shear wall could initially satisfy moment design and then show a failed moment design due to minimum vertical reinforcement as a result of an increase in block size during shear design.

Loads Analysis

31. A warning message was added to alert the user that one or more loads are applied beyond the extent of the assemblage (LA1)

A warning message was added to alert the user that a reduction in beam length or wall height has caused one or more applied loads to be applied beyond the extent of the assemblage. Previously, the load would extend beyond the assemblage and the analysis would only include the portion of load applied to the assemblage.

32. Correction to unit conversion for applied loads (LA2)

Magnitudes of applied loads are now properly converted between metric and imperial load units. Previously, an incorrect conversion factor was applied.

33. Self-weight on reaction diagrams (LA3)

Factored self-weight is now included in the vertical reaction force value displayed on the reactions drawing for walls and shear walls. Previously, the vertical reaction force value for walls and shear walls would include applied axial forces only.

34. Change to load combinations for dead loads only (including soil)

The program now implements the load combination 1.4D + 1.5Ds, as its only "dead-only" load combination, where Ds is the vertical load due to earth and soil. Previously, two load combinations were implemented (1.4D and 1.25D + 1.5Ds) which may have created an unconservative design when dead-only load combination including Ds loads was critical. This change was prompted by a clarification that appeared in 4.1.3.2 (9) of NBCC 2010.

35. Clarification of earth and soil loads

The dead load due to soil, superimposed earth, plants and trees, Ds, referenced in CSA S304.1-04: 4.2.2.2 (5) has been renamed from Soil to Vertical Soil. The effects due to lateral earth pressure including groundwater, H, referenced in CSA S304.1-04: 4.2.2.2 (1) has been renamed from Hydrostatic to Lateral Earth. This was done to clarify the application of these load types.

Miscellaneous

36. User agreement window formatted to fit all text (B4)

The user agreement window has been reformatted to display all text above the text window containing the "Software License Agreement". Previously, the text was truncated and the following text was missing: "…agree, click "Cancel"."

37. Welcome screen changed to handle different Windows display settings (B6)

The formatting for the welcome screen has been changed to handle different Windows display settings and font size so that the navigation button locations matched the icon locations. Previously, a change in Windows display settings may have caused navigation buttons to be placed in the incorrect location.

38. Confirmation pop-up message added when user form is completed (B7)

During the activation process, a confirmation pop-up message now appears upon successful completion of the user form. Previously, a notification was displayed at the bottom of the completed form that was typically out of sight.

39. Installation Folder name changes (B11)

File and folder names were changed in the installation folder. The Application file "Mass" was changed to "MASS", the folder "MaterialsDatabase" was renamed to "Material Unit Database", and the icon file "MassIcon.ico" was renamed to "MASSIcon.ico".

40. Correction to program name in printed results title

In the title of printed results, "Masonry Analysis Structural System" was changed to "Masonry Analysis Structural Systems".