SECTION 4. DESIGN OF WALLS FOR AXIAL COMPRESSION COMBINED WITH OUT-OF-PLANE BENDING

Section 2 deals with the design of walls for axial compression loads with or without in-plane horizontal loads and in that section the axial load capacity is determined in accordance with the empirical design method outlined in IS 456:2000 Clause 32.2. The tabulated values in Section 2.1 take into account both the design eccentricity of the axial load and the additional eccentricity resulting from slenderness.

Walls can also be subjected to out of plane lateral loads however that may increase the design bending moments. While axial compression loads can increase the moment capacity of a wall it is important to check that the increased compressive stress in the extreme fibre of the concrete section does not exceed the allowable stress when the wall is subjected to the combined action. It is also essential to check that the walls is adequately reinforced for any flexural tensile stresses.

There is no provision in IS 456 for checking combined compression and bending due to out-of-plane lateral loads using the empirical design method. In this Section 4 of the design manual interaction diagrams are provided for that purpose and these diagrams can be used to determine whether or not a critical section is over stressed due to the combined action.

A proper structural analysis must be carried out to determine the design actions on the wall panel and when using the interaction diagrams it is very important to remember that the minimum design eccentricity is greater than that which applies when using the empirical design method. A minimum eccentricity of 20mm applies to all braced walls with a clear height up to 7.1m and the interaction diagrams have been truncated accordingly.

The minimum eccentricity is greater than 20mm for 200 ***mortarless*** walls of greater clear height and the design engineer must take this into consideration.

The reinforcement requirements for the wall panel can be determined using the interaction diagrams.

Design engineers must take into consideration the requirement of Clause 32.1 to provide vertical reinforcement in both faces.

DESIGN PROCEDURE: COMBINED AXIAL COMPRESSION AND BENDING (ONE-WAY BUCKLING)

This design procedure is for walls spanning vertically.

Step 1: Select a ***mortarless*** block size and strength (grade) based on local availability and price, and any other requirements (architect's requirements, fire rating, sound rating, thermal rating etc).

Step 2: Carry out a structural analysis for all applicable load combinations to determine the ultimate limit state design compression load on the wall and the ultimate limit state design bending moments at the critical sections including the bending moments from slenderness effects and the bending moments from out-of-plane lateral loads.

Step 3: Use the interaction diagrams (Diagrams 4-1 and 4-2 on the following pages) to check that the selected reinforcement is adequate and make any necessary adjustments. Enter the interaction diagram with the design axial load (N_u) on the Y axis and read off the maximum design bending moment (M_u) on the X axis. Check that the actual design bending moment is less than or equal to the maximum design bending moment. Alternatively enter the interaction diagram with the design bending moment (M_u) and read off the maximum design axial compression (N_u) on the Y axis.

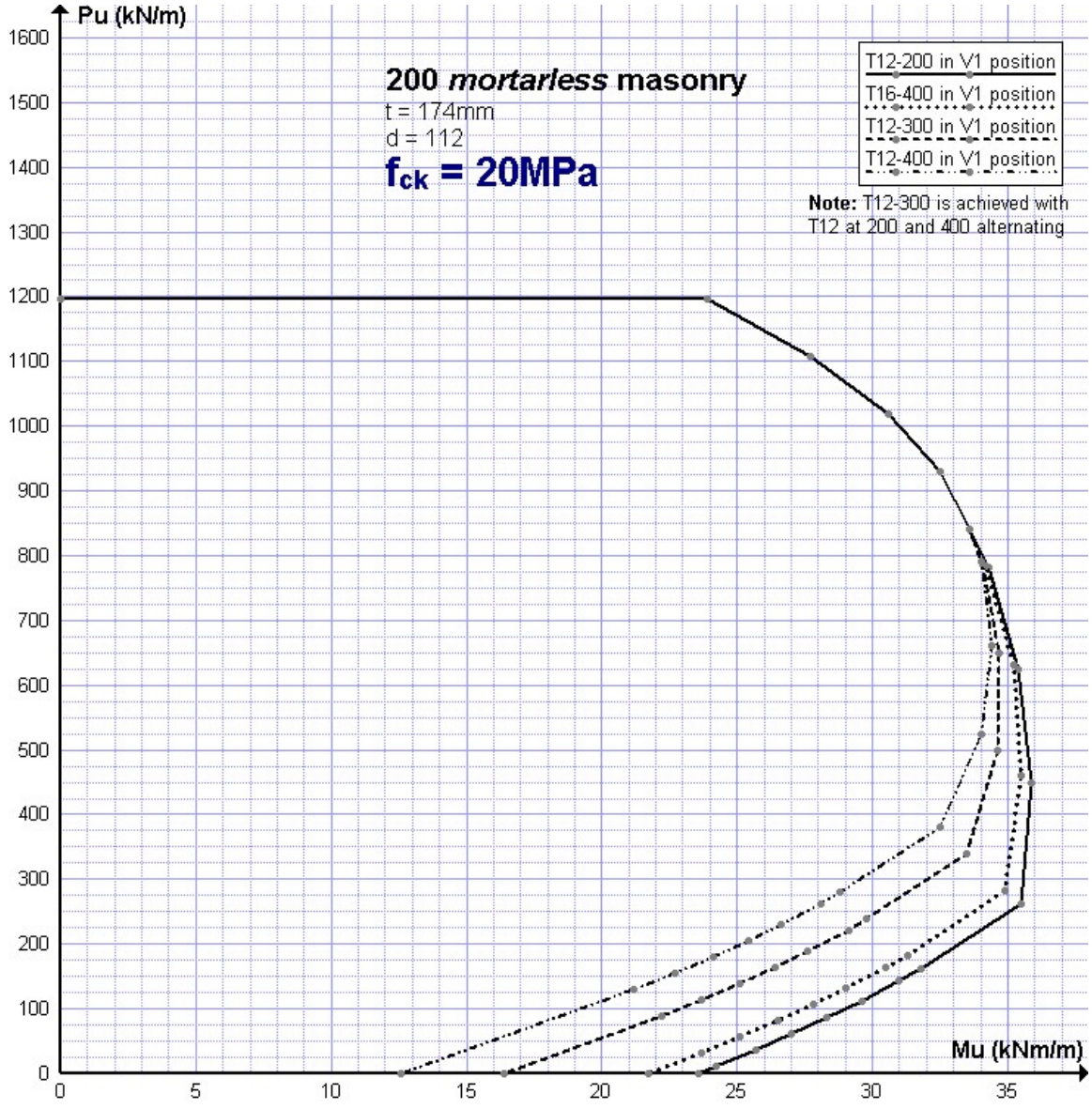
Step 4: If the wall is subject to in-plane lateral load check the adequacy of the wall for shear – refer to Section 5. It might also be necessary to check the wall panel for in-plane bending - Refer 9.1 in Part 1.

Step 5: If the wall is subjected to substantial out-of-plane lateral load check the out-of-plane shear stress – refer to Section 5

Fire, sound attenuation etc:

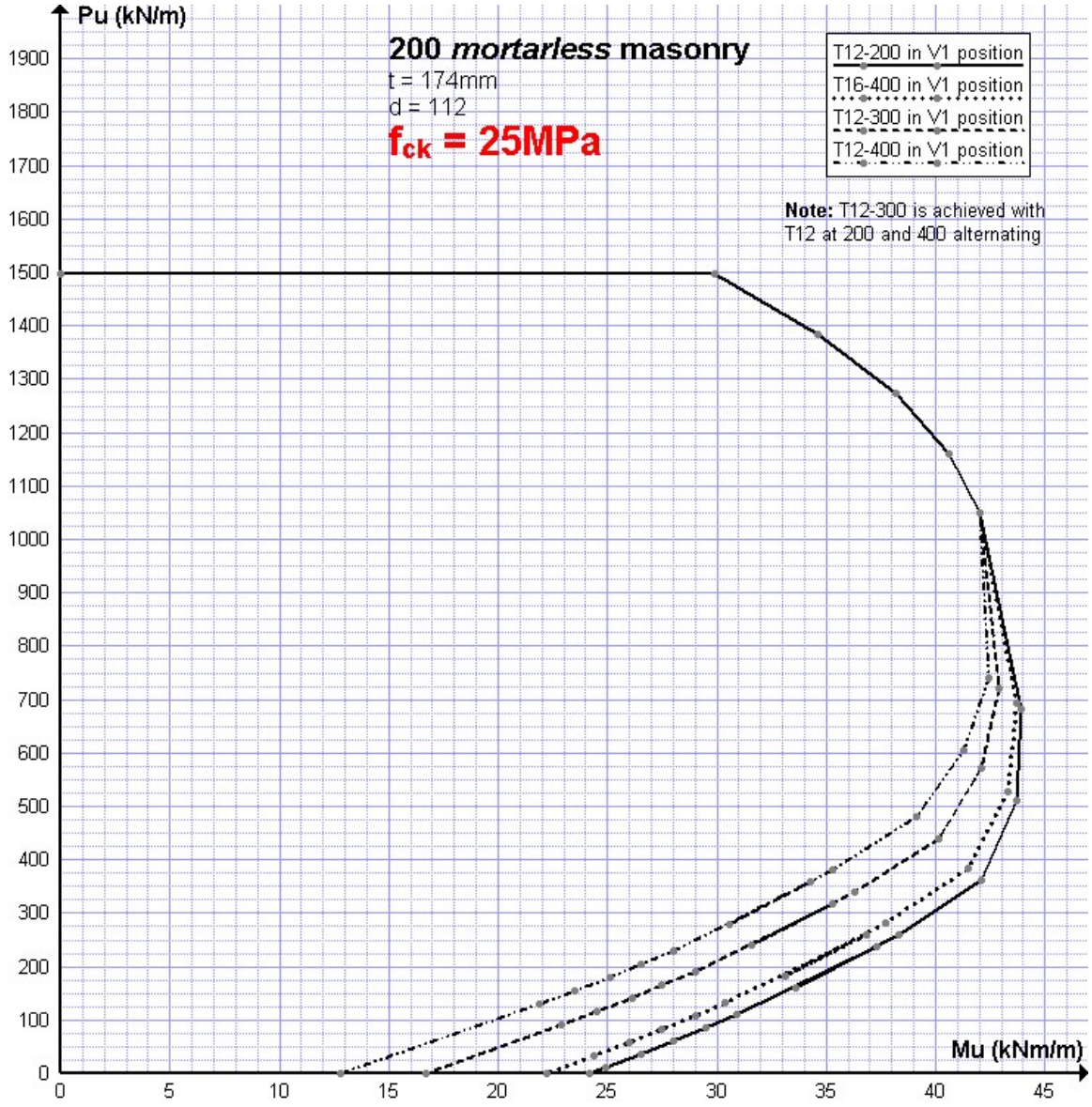
Step 6: Check that the wall satisfies all other requirements in terms of durability, slenderness, thickness etc.

DIAGRAM 4-1



Notes:
This interaction diagram is to be used for checking the adequacy of any critical cross section for the combined action of compression and out-of-plane bending.
Always ensure that the axial load used when checking for reinforcement requirements is the minimum sustained design axial compression load.
When using the chart enter with the design axial compression load P_u and read off the maximum design M_u.
The four reinforcement configurations shown in the diagram are the four options available when designing for flexure. Any increase in the reinforcement area will result in an over-reinforced section and this is not permissible.
Ensure that the vertical reinforcement is placed in the tension face of the wall in all cases.
Be aware of the requirement of Clause 32.1 to provide vertical reinforcement in both faces.

DIAGRAM 4-2



Notes:
This interaction diagram is to be used for checking the adequacy of any critical cross section for the combined action of compression and out-of-plane bending.
Always ensure that the axial load used when checking for reinforcement requirements is the minimum sustained design axial compression load.
If using this diagram the recommended minimum strength of the masonry unit is 20Mpa.
When using the chart enter with the design axial compression load P_u and read off the maximum design M_u.
The four reinforcement configurations shown in the diagram are the four options available when designing for flexure. Any increase in the reinforcement area will result in an over-reinforced section and this is not permissible.
Ensure that the vertical reinforcement is placed in the tension face of the wall in all cases.
Be aware of the requirement of Clause 32.1 to provide vertical reinforcement in both faces.