Capacity Spectra of a Typical Confined Masonry Dwelling In Peru

A Muñoz, M Blondet
N Tarque, J Carpio, A Florez

Catholic University of Peru (PUCP)

1. Typical dwelling

Figure 1 shows the schematics of a typical dwelling located in a city on the coast of Peru. It is a two story confined masonry building built on a rectangular lot. On both levels confined masonry wall density is larger in the longer direction of the lot. Therefore, the structure is significantly stronger and stiffer in the direction perpendicular to the street (Y-Y) than the direction parallel to the street (X-X).

The calculations shown here correspond to the weaker direction of the structure (X-X). Confined masonry walls are marked MC (muro confinado) and unconfined walls are marked MSC (muro sin confinar)

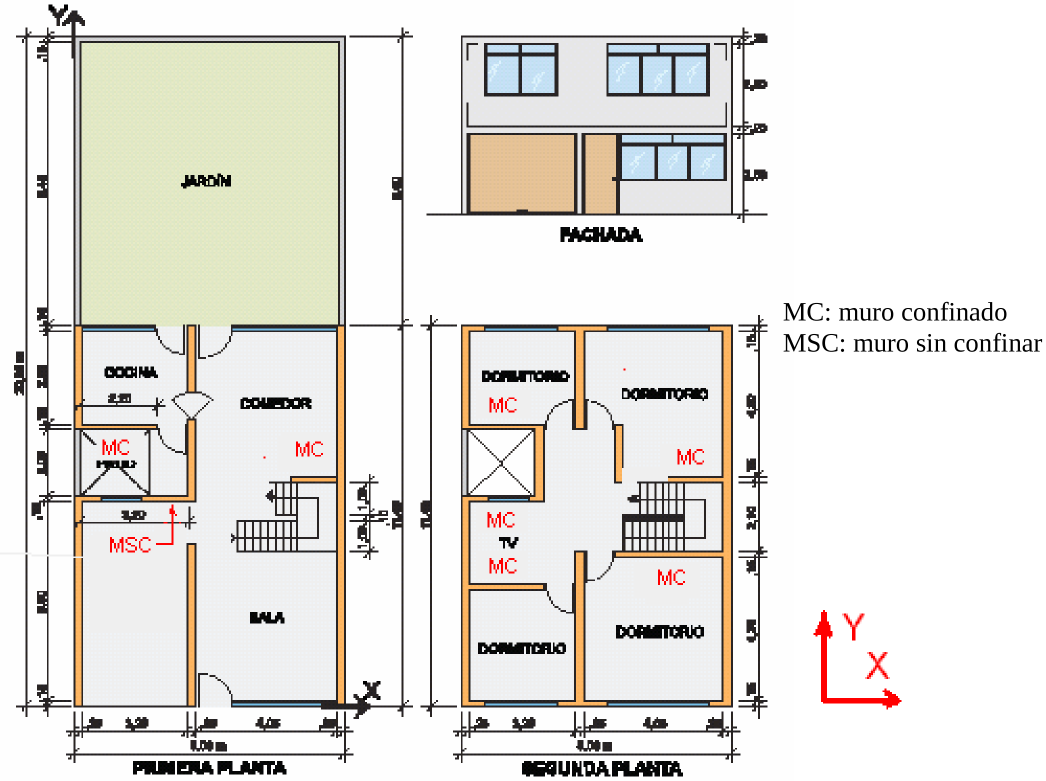
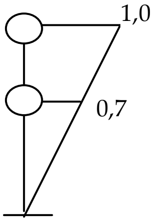


Figure 1. Typical confined masonry house in Peru (A. San Bartolome)

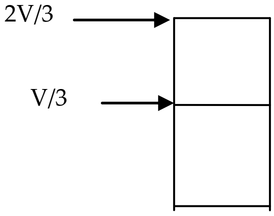
2. Basic assumptions

- *Rigid diaphragm:* Each floor slab acts as a rigid diaphragm and transmits shear forces from the second level walls to the first level.

- *Triangular vibration shape*



- *Triangular force distribution*



- *Weight distribution*

  2nd level: 8 kN per square meter of roofed area
  1st level: 10 kN per square meter of roofed area

3. Calculations

a) Shear capacity of confined and unconfined masonry walls

Figure 2 shows the force-displacement envelope measured during a cyclic shear test of a confined masonry wall performed by San Bartolome at the Structures Laboratory at the PUCP. The wall was 2.40 m long, 2.40 m tall, and 0.13 m wide.

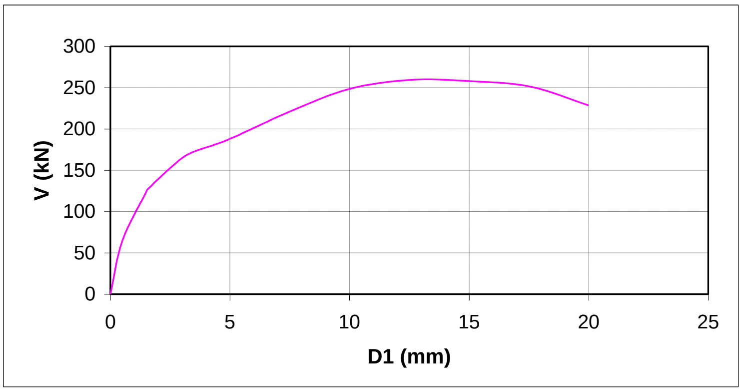


Figure 2. Base shear vs lateral displacement envelope for a confined masonry wall

The shear stress vs angular distortion curve shown in Figure 3 was obtained from the force-displacement curve.

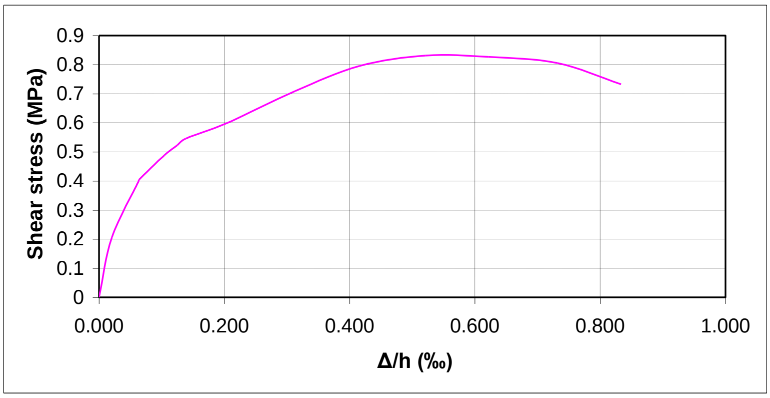


Figure 3. Shear stress vs angular distortion for confined masonry walls

For unconfined masonry walls it is assumed that the behavior under cyclic load is similar than that of the confined walls, but only up to an angular distortion of (1/800), when the unconfined walls fail in shear. See Figure 4.

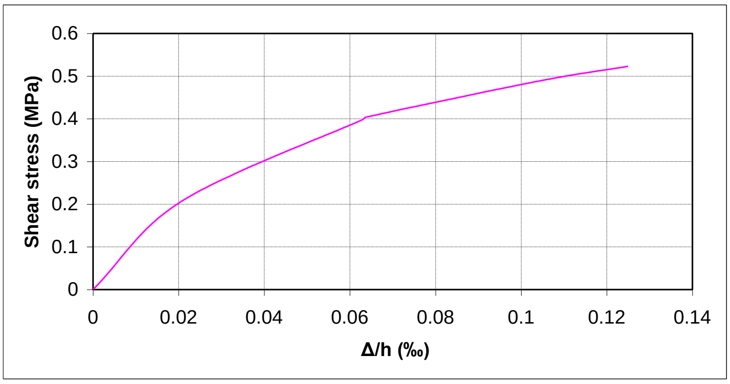


Figure 4. Shear stress vs angular distortion for unconfined masonry walls.

b) Shear capacity of the structure

The force-displacement curves for each wall of the typical house were obtained from the corresponding shear stress-angular distortion curves and then summed to obtain the force-deflection curves for each level of the structure, as shown in Figures 5 and 6 below.

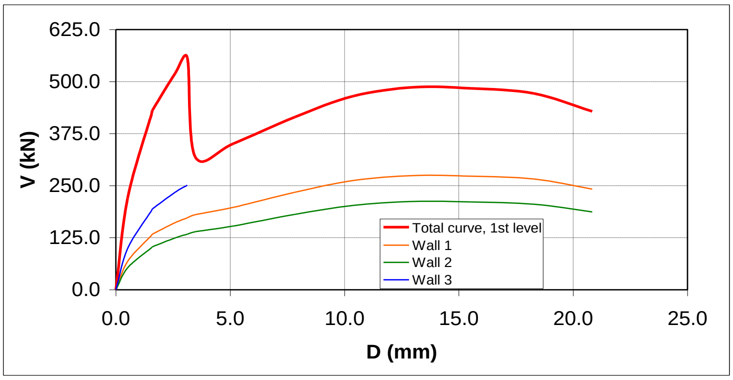


Figure 5. Second level shear force vs lateral displacement curves (X-X)

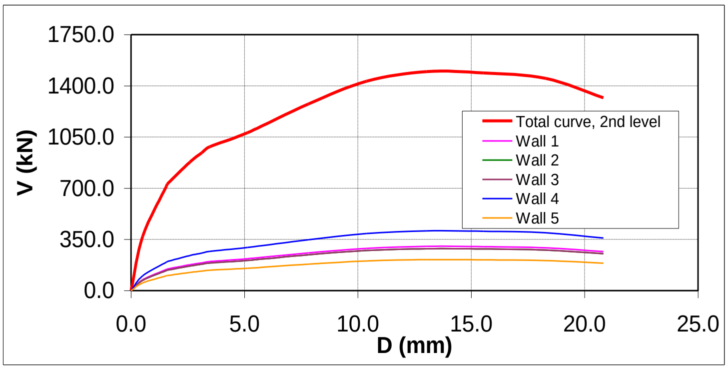


Figure 6. First level shear force vs lateral displacement curves (X-X)

Finally, the building base shear vs roof displacement curve shown in Figure 7 was calculated as follows: the base shear V is the sum of the shear forces of all first story walls. The displacement at the top of the roof D is the sum of the displacement of the first story roof and the second story displacement corresponding to 2/3 V.

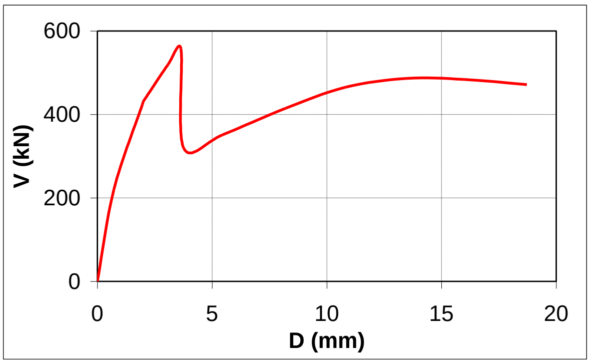


Figure 7. Capacity curve for the building (X-X direction)

The capacity curve shows that the unconfined walls break and thus cease to withstand loads at a roof displacement of about 3.5 mm. The maximum roof displacement of the dwelling is about 18 mm.

c) Confined masonry house capacity spectrum

The capacity spectrum (SA vs SD) curve shown in Figure 8 was obtained from the V-D using the expressions SA = V/ M** and SD = D/ α, where M** is the effective mass and α is the participation factor of the structure. In this case M** = 0.97 M, where M is the total building mass, and α = 1.16. A bilinear curve, defined by the points (SDy, SAy) = (1.40 mm, 0.22 g) and (SDu, SAu) = (16.10 mm, 0.30 g) is also shown. The bilinear curve may be used for rough damage estimation in confined masonry houses.

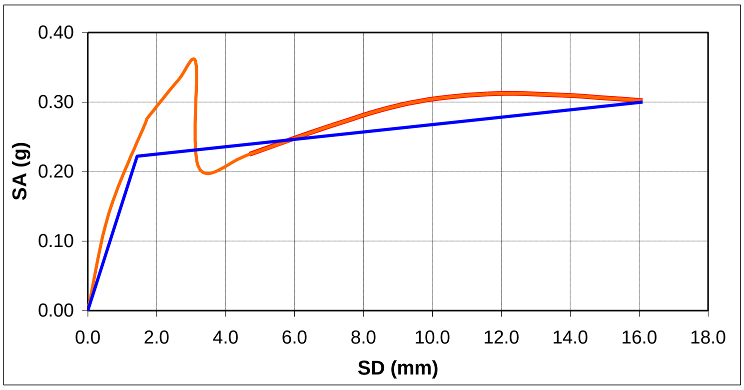


Figure 8. Capacity spectrum for a typical Peruvian confined masonry house