

## DESIGN NOTE 3: Laterally loaded walls

Many masonry walls are subjected to predominantly lateral loads with the vertical load being very small or limited to self-weight. This is typically the case with framed structures infilled with masonry panels.

The design approach in BS EN 1996-1-1 is a development of the guidance contained in BS 5628 Part 1 which was based on a considerable amount of research conducted during the 1970s. It is not the purpose of this note to detail the background research but rather to highlight where additional design guidance is available.

The basic design of laterally loaded walls is covered in Design Guide 3.

[http://eurocode6.org/Published%20support%20material/Final%2014496%20\(11841\)%20Masonry%203%20Lateral%2019%20Jan.pdf](http://eurocode6.org/Published%20support%20material/Final%2014496%20(11841)%20Masonry%203%20Lateral%2019%20Jan.pdf)

A design example is also available here:

<http://eurocode6.org/Design%20Examples/L%20examples%20pdf/L1%20design%20example%202013.pdf>

and the solution is shown here:

<http://eurocode6.org/Design%20Examples/L%20examples%20pdf/L1%20SOLUTION%202013%20.pdf>

The research work indicated that the failure patterns exhibited by laterally loaded masonry walls are similar to those found in reinforced concrete slabs which could be analysed by yield line theory. The bending moment coefficients provided in Annex E of BS EN 1996-1-1 were derived from yield line theory but there may be occasions, such as when analysing irregular panels, when it may be desirable to refer directly to the basic yield line equations. Texts books provided by authors such as Johansen<sup>(1)</sup> may be used to derive an acceptable design approach.

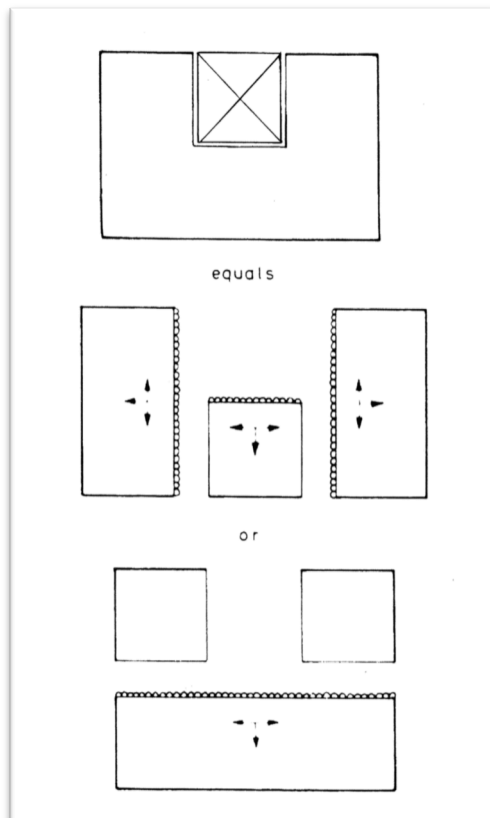
A book by Roberts et al<sup>(2)</sup> includes examples of the use of yield line analysis for laterally loaded masonry panels and includes the design of irregularly shaped panels and the design of walls containing openings and subjected to line loads. The examples shown in the book use the BS 5628 numerical data but this is easily updated to cover the requirements of BS EN 1996-1-1. An earlier BDA design guide by Morton<sup>(3)</sup> is available as a free download.

The design of openings may be addressed by subdividing the panel into smaller panels as shown in Figure 1, although the code does not provide guidance on how to deal with line loads. Alternatively the panels may be designed using a recognised method of obtaining bending moments in flat plates e.g. finite element or yield line analysis. Proprietary software is available to facilitate such design.

It is worth noting that the UK National Annex to BS EN 1996-1-1 permits a more favourable value of  $\gamma_m$  to be used when the removal of a panel would not otherwise affect the overall stability of the building.

The design moment of resistance offered by a panel of masonry may be increased by the use of bed joint reinforcement. There are four approaches that have been used in the UK

Figure 1: Treatment of panel with openings



to calculate the enhancement provided by the reinforcement. Eurocode 6 permits two of the four methods recognized in BS 5628 Part 2, namely:

- Design as horizontally spanning wall
- Design using modified orthogonal ratio

The other two methods have been retained for use in the UK by incorporating them in PD 6697<sup>(4)</sup>:

- Design with reinforced section carrying extra load only
- Design based on cracking load

PD 6697 also provides the limiting dimensions for panels enhanced with bed joint reinforcement which are not found in BS EN 1996-1-1.

## REFERENCES

1. JOHANSEN, K.W. Yield line formulae for slabs. Eyre and Spottiswoode, Leatherhead, 1972.
2. ROBERTS, J.J., TOVEY, A.K and FRIED, A. Concrete Masonry Designer's Handbook. Second edition. Spon Press. 2001.
3. MORTON, J. The design of laterally loaded wall panels. BDA. 1986.  
<http://www.brick.org.uk/2011/03/the-design-of-laterally-loaded-walls/>
4. PD 6697:2010 Recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996-2. British Standards Institution. London.