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FUTURE PROVISIONS OF EN1998 FOR MASONRY STRUCTURES

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This paper discusses needs for the third generation of Eurocode 8 in regard to masonry structures (Booth, 2014). Currently the general technical committee CEN TC250/SC 8 is working on the second generation of Eurocode 8, which is aimed to be finished by 2019 with a planned publication in 2020. Due to the complexity of masonry, TC250/SC8 decided to create its own working group (WG) according the CEN regularities within the subcommittee, which will be chaired and convened by the author of this paper.

In the current version of EN 1998-1, the number of Nationally Determined Parameters (NDPs) for new masonry buildings is higher than for any other construction material covered by the code. But what are the differences between one form of masonry construction and another?

One needs to understand firstly, that masonry is the oldest massive construction method with a very long history. Therefore, development has been regional in nature and strong regional traditions of construction method remain today. Brief examples of these regional variations in bearing masonry for low rise buildings in some European countries are as follows.

- Austria, Czech Republic, Hungary, Germany (excluding north Germany), Slovakia;
  - mainly unreinforced masonry with wall thickness of $t \geq 25$ cm,
- Switzerland;
  - mainly unreinforced masonry with wall thickness of $t \leq 25$ cm,
- Belgium, Netherlands, North Germany, UK;
  - mainly cavity walls with a non structural facing brick layer, an air gap and a bearing unreinforced masonry layer with $t \leq 20$ cm,
- Croatia, Slovenia, Romania;
  - mainly confined masonry with vertical and horizontal rectangular reinforced concrete confinements and bearing masonry with wall thickness of $t \geq 25$ cm,
- France;
  - mainly unreinforced masonry but also confined masonry with vertical and horizontal circular reinforced concrete confinements and wall thickness of $t \geq 20$ cm,
- Bulgaria, Greece;
  - mainly non-bearing infilled masonry walls within RC frame structures,
- Italy;
  - all kinds of masonry construction are used, with marked regional variations across the country.

Beside the general construction method and different size of blocks (l x h x t) also variety exists in;

- the material of used blocks which consists nowadays mainly of;
  - fired clay,
  - auto aerated concrete,
  - calcium silicate,
  - concrete,
  - natural stone (rarely),

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- the kind of head joints;
    - fully filled with mortar,
    - partly filled with mortar (mortar pocket),
    - non filled,
        - with mechanical interlocking (tongue and groove),
        - plane,
- and the kind of bed joints;
    - conventional mortar bed joint (usually d = 10 – 12 mm),
    - thin layered bed joint mortar (d ≤ 2 mm),
    - special kind of adhesives based on mortarless (see Lu and Kasa, 2010) Polyurethane (d ≤ 1 mm),
    - dry wall without mortar at all.

Due the great variety of masonry construction styles and the consequent variation not only in seismic performance but also the form of analysis method needed to design them, the aim to reduce the NDPs in the second generation of EN 1998-1 without confining and limiting local traditions will be only partly achievable.

However, in a first informal round of discussions, the Working Group of TC 250/SC8 referred to earlier has identified some major topics for the revision of the second generation of EN 1998-1's requirements for masonry structures, as follows;

- introduction of displacement based non-linear design (Lu, 2010),
- refinement and description of modelling methods (for eg. slabs, spandrels, lintels),
- revision of q-values and introduction of overstrength values,
- revision of methods for simplified masonry,
- definition of out of plane design,
- clearer definition of limit states (damage limit state, live safety, collapse etc.),
- some others for the assessment of existing masonry structures according EN 1998-3.

The author suggest that by 2025 (i.e. by the time of publication of the third generation of Eurocodes), Eurocode 8 needs to cover following issues in its treatment of masonry structures;

- the code should be set up like a guideline, rather than a purely code that non earthquake specialised engineers should be also able to make a proper seismic design/assessment of masonry structures (see Anicic et. al, 2008);
- especially in case of state of the art methods such as currently used nonlinear push-over methods, the user should be guided through the process step by step;
- clearly understandable decision flowcharts or decision trees (Lu and Unger, 2010) should be included into the code to increase user friendliness;
- the style of the code which is currently formulated as a legal document and written in a very legal "language" should be reformatted completely towards a user friendly building code with some explanations;
- cross references to other codes should either be eliminated altogether or restricted, even when cross referenced to other codes (eg. EN 1990, EN 1991 and EN 1996), text passages can be repeated in EN 1998, with the aim of making the code able to be implemented without the need to refer to other documents;
- explicit requirements should also be given for other masonry construction methods like confined and reinforced masonry. Currently the masonry chapter is strongly focused on unreinforced masonry, and the user is left alone to some extent when designing/assessing other types;
- the section of "simplified masonry buildings" should be completely revised in order to ensure that safe designs can result without the need to use specialist expertise or software;
- the door to innovative new masonry materials or bonding styles (Lu and Kasa, 2010) should be opened wider than it is currently. This can be happen, if the code is clearly pointing out in a special section of masonry which explicit values producers should

declare when introducing innovations to the market. With this, it can be ensured that the user of the code can perform a proper design/assessment followed by the process given in Eurocode 8 with the declared values of the producers.

The author of this paper is kindly asking readers to give further suggestions and ideas for earthquake engineered masonry structures within the third generation of Eurocode 8.

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