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Effective thickness and structural efficiency of cellular walls and piers

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In § 4 the Authors state that 'The concept of effective thickness is not universally used in other areas of structural engineering' and cite the examples of structural steelwork and timber design for which the slenderness is directly related to radius of gyration. Against this, it should be noted that current British codes of practice for structural concrete[2–5] and the code for unreinforced masonry[6] are all drafted in terms of effective thickness or least lateral dimension of walls and columns.

18. This is surely reasonable for solid walls or columns as it gives the designer a physical feel for the relationship between height and thickness. It can create problems where the section is not solid and rectangular, and it is therefore logical that the code of practice for steelwork[7] should refer to radius of gyration, as structural steel members are rarely solid rectangles.

19. In § 12 the Authors suggest that the notion of a wall with an effective thickness greater than overall thickness may be confusing to engineers. I would suggest that any confusion is due to the use of 'effective thickness' (rather than radius of gyration) as a descriptive term for a hollow wall. Had the detail in Fig. 1 been drawn with the cross rib central, the analogy with a steel I-section could have been shown clearly. For such a section, the radius of gyration in-plane is generally about $0{\cdot}4 \times$ the overall depth or thickness of the section. By the Authors' argument, this means that the typical steel I-section has an effective thickness of about $0{\cdot}4 \times 3{\cdot}46$, say about $1{\cdot}4 \times$ its actual thickness. To avoid any confusion, it is clear (as the Authors recommend) that any code of practice or other guidance on the design of cellular walls should adopt radius of gyration rather than effective thickness for assessing the overall slenderness of such a wall.

20. While it is analytically correct, I would question the inclusion of the limiting case argument in § 11. As the distance between cross ribs increases, the wall ceases to behave as a single unit and becomes two separate skins with a wide cavity, to which the formulae derived by the Authors are not applicable.

21. Can the Authors propose limits on the ratios of rib spacing/rib width and cavity width/leaf thickness to ensure that the integrity of cellular wall behaviour is maintained? Such limits would surely be influenced by the nature of the bonding between rib and leaf, which itself is subject to statutory requirements in respect of moisture transfer between the outer and inner leaves of external walls in buildings. A further influence is inherent in the available code recommendations on slenderness ratios for local sections of walls restrained laterally.[1,6] Do the Authors have evidence to support extrapolation outside recommended values in the case of cellular walls?

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Mr Bussell appears to agree in principle with our suggestion to use the radius of gyration to define the slenderness (or robustness) of sections other than solid walls. CP 111[1] and BS 5628[6] appear to be restrictive by not offering guidance on the stability of other geometric forms and it is to overcome this restriction that the concept of radius of gyration would be so valuable.

23. Mr Bussell's comments on limiting case are well understood and in § 14 the Authors state that 'It is assumed that local instability does not occur'. The theoretical limitation on spacing of leaves and ribs to ensure integral action of all units is not fully understood, but the practical limitation at present could be taken as 12 times leaf thickness. This gives the maximum effective thickness as $1{\cdot}4 \times$ overall thickness and this figure could be adopted as the practical limit in place of the theoretical limit of 1·73.

24. Bonding is vital to achieve integral action of all units and we prefer proper bonding between leaves and ribs to the use of ties for this purpose.

25. Rain penetration of diaphragm walls has been examined experimentally by Beard.[8] Results suggest that in the thinnest possible wall (one brick cavity width) rain penetration under the most adverse combination of wind and driving rain would not occur.

References

2. British Standards Institution. *The structural use of concrete.* British Standards Institution, London, 1972, CP 110.
3. British Standards Institution. *The structural use of reinforced concrete in buildings.* British Standards Institution, London, 1969, CP 114.
4. British Standards Institution. *The structural use of prestressed concrete in buildings.* British Standards Institution, London, 1969, CP 115.
5. British Standards Institution. *The structural use of precast concrete.* British Standards Institution, London, 1969, CP 116.
6. British Standards Institution. *The code of practice for the structural use of masonry.* British Standards Institution, London, 1978, BS 5628.
7. British Standards Institution. *The use of structural steel in building.* British Standards Institution, London, 1970, BS 449.
8. Beard R. Private communication, 1978.