SHEAR RESEARCH NEEDS FOR 'ORDINARY' CONCRETE BEAMS

Colin Gurley
Teacher of Civil Engineering
TAFENSW Sydney Institute of Technology
colin.gurley@tafensw.edu.au colin.gurley@me.com

AEES2008 Conference, Ballarat

1. All concrete beams need to be designed for bending-moment and for shear-force. Ultimate limit state calculations for bending-strength have not basically changed in the 70 years since Charles Whitney, Consulting Engineer of New York suggested an elasto-plastic 'plane-section' hinge with a rectangular concrete stress-block. Most bending failures are quite ductile. Shear failures, on the other hand, vary from somewhat brittle to very brittle and design for shear has always been empirical.

2. Concrete structures codes (AS3600, NZS3101, Eurocode2) are moving towards a rigid-plastic theoretical approach for 'plane-stress' design problems to eventually include 'ordinary' beams in shear.

3. However these codes now propose a 'solely lower-bound equilibrium' solution such as the 'strut-and-tie' method perhaps as a step towards a more rational method.

4. Such 'solely lower-bound equilibrium' methods can be seen as a work-around for those unaware of the 'exact' solution to the problem at hand.

5. The Uniqueness Theorem guarantees that an 'exact' solution is always unique, economic and simpler.

6. By comparison a 'solely lower-bound equilibrium' solution is always arbitrary, less economic and more complicated.

7. 'Exact' solutions always involve collapse mechanisms. Lower-bound solutions never do.

8. Here are two original collapse mechanisms from my paper "Core Coupling-Beams in Tall Buildings" presented at AEES07 Wollongong. They are quite specific in a kinematic sense and they do not mind to be magnified.

9. 'Coupling-beams' are the residual ribbons of intact concrete above/below openings for doors to lifts and to stairs. The other mechanisms of the AEES07 paper are specific to coupling-beams. These two are not specific to coupling-beams.

10. These two mechanisms assume left-right skew-symmetry which is no longer reasonable when one considers 'ordinary' beams with significant gravity load. Once that limitation is removed, these mechanisms do provide for the 'exact' rigid-plastic yield-line design of 'ordinary' beams for bending and for shear.

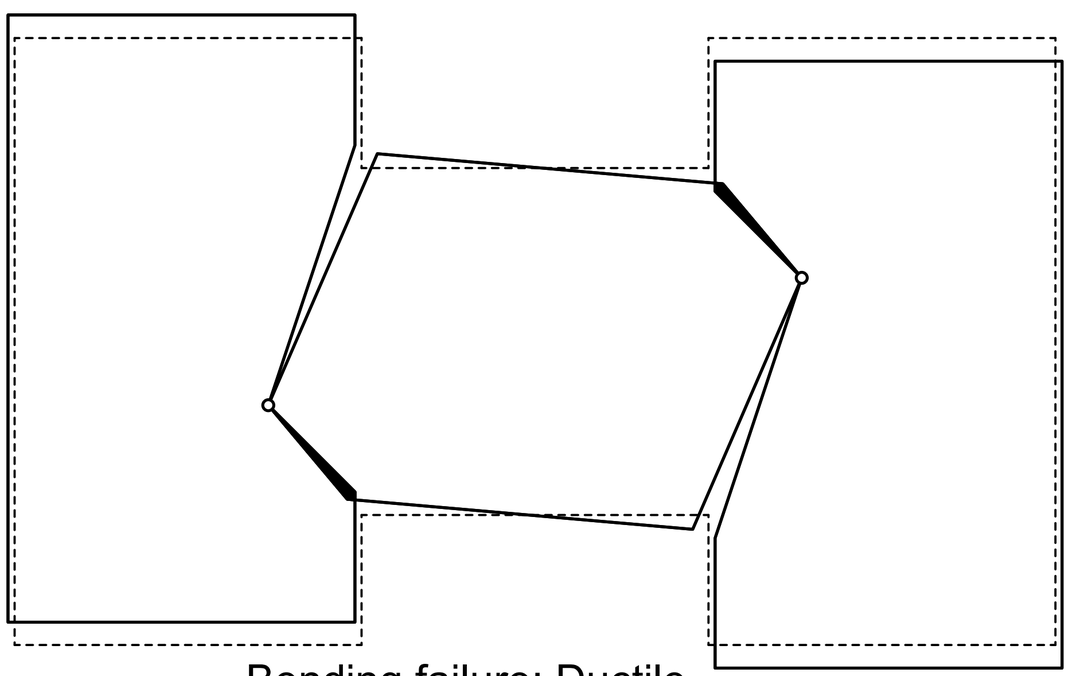
11. In the case of the shear-bending mechanism, there is zero strain in the compression rebars at the support reveals so those compression rebars are not at yield indeed the compression rebars drive open the bending-tension crack.

12. The issue of shear strength is the second issue that has been waiting unresolved for 70 years since Charles Whitney discovered how to calculate ultimate strength for moment in 'ordinary' beams.

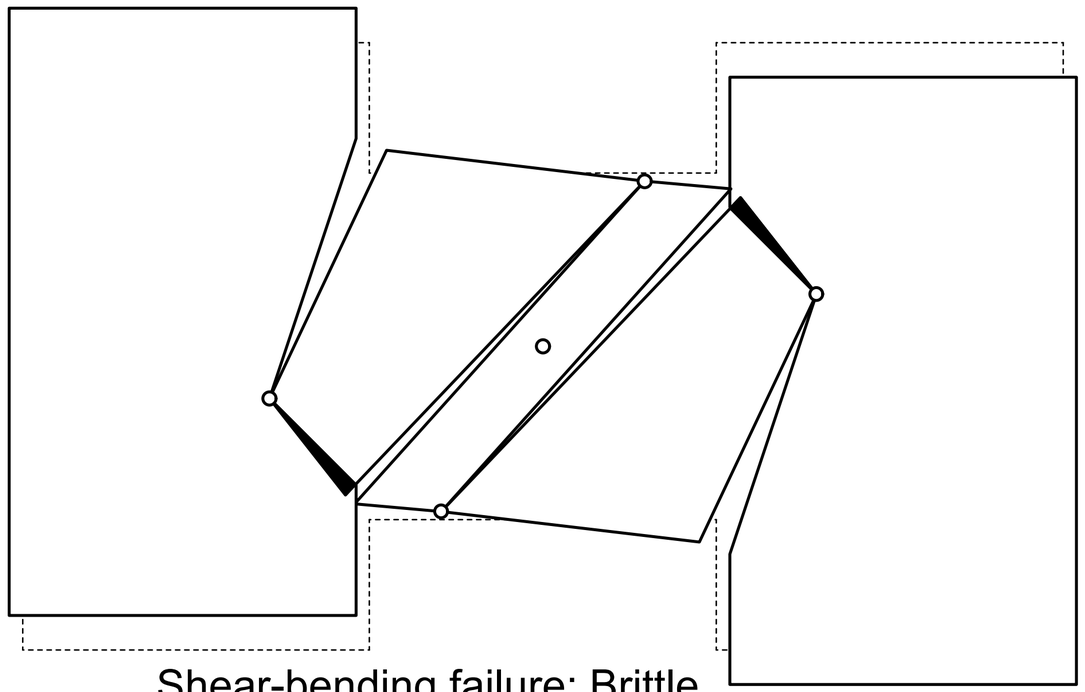
13. These solutions are better than those currently proposed by the structural concrete codes but credibility still demands experimental evidence. There is also an issue as to whether rigid-plastic methods are sufficient for elasto-plastic materials.

14. This writer seeks research collaborators. His background is that of a structural designer quite experienced at thinking about how things work but not at all experienced in laboratory testing.

15. 'Ordinary' beams are a ubiquitous test-case for all plane-stress problems including all those addressed by the 'strut-and-tie' method. All are open to 'exact' yield-line rigid-plastic analysis.



Bending failure: Ductile



Shear-bending failure: Brittle