# SECTION 9. DESIGN FOR COMBINED COMPRESSION AND BENDING

Section 7 of this design manual deals with the design of ***mortarless*** walls for compression which are always designed for bending moments doe to eccentricity of the applied load and for additional bending moments due to the eccentricity caused by slenderness effects. In addition to these two bending moments however, walls can also be subjected to out-of-plane lateral loads and therefore additional bending moments. A typical example of such a wall is a perimeter load-bearing wall in a building that is also a retaining wall.

In walls subjected to both compression and bending, compressive stress in the concrete can govern the design in situations where the compression stress due to axial load is high and the applied bending moment is sufficient to increase the compressive stress in the concrete (at the extreme fibre) to the point where it fails. In such circumstance the entire section can still be in compression and tensile reinforcement plays no direct role in the strength of the wall.

The other extreme is where the axial compression load is low and the wall fails in flexure through excessive tension in the reinforcement. The wall is essentially a vertical slab and can be designed as a slab.

## 9.1 Axial compression and in-plane bending

AS 3600 Clause 11.2 covers the situation in which the bending results from in-plane lateral loads e.g. load-bearing shear walls in buildings. It states that where the entire horizontal cross section of the wall remains in compression then the in-plane bending in the wall can be ignored and the wall simply designed for axial compression as outlined in Section 7 of this manual and for in-plane shear as outlined in Section 11 of this manual.

If the in-plane bending is such that parts of the wall horizontal cross section are in tension then reinforcement must be provided to accommodate the tensile forces. The masonry and the grout cannot be designed for such tensile forces.

## 9.2 Axial compression and out-of-plane bending

AS3600 Clause 11.1(b) states that when walls are subject to axial compression plus out-of-plane bending they can be designed as slabs - refer 8.1 above

When the axial compression load is larger than that which produces the limiting compressive stress for the application of 11.1(b) then it is necessary to consider the combined effect to ensure that neither the concrete in compression nor the steel reinforcement in tension is overstressed. This is referred to in Clause 10.6.1 for columns in which it is stated that the compression member shall be designed on the basis of Clauses 10.6.1 and 10.6.2.

Clause 10.6.1 outlines the basic assumptions for limit state design of a section, viz that plane sections remain plane, that the concrete has no tensile strength, that the distribution of stress in the concrete and the steel is determined using the stress-strain relationship determined from Clauses 3.1.4 and 3.2.3 respectively, and that when the neutral axis lies outside the cross section consideration should be given to the effect on strength of spalling of the concrete cover.

The maximum strain in the concrete in the extreme compression fibre is given in Clause 8.1.2 as 0.003.

Interaction diagrams are provided in the subsequent Parts of this design manual for the purpose of checking combined axial compression and out-of-plane bending.

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Note that when using the interaction diagrams a proper analysis should be carried out to determine the bending moments at the critical sections and these must include the bending moments due to secondary effects.

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