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Advanced Structural Concrete
Information Sheet: Nodal Zone Verification[1]

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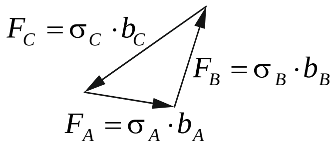
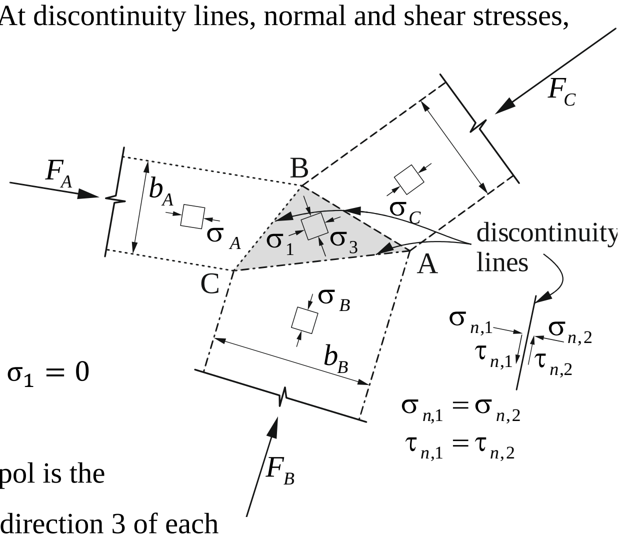
For practice, the stresses in the struts are usually assumed to be equal and the width is adapted accordingly. This leads to a biaxial uniform stress state[2]: $\sigma_1 = \sigma_2 = f_c$, which simplifies the verification.

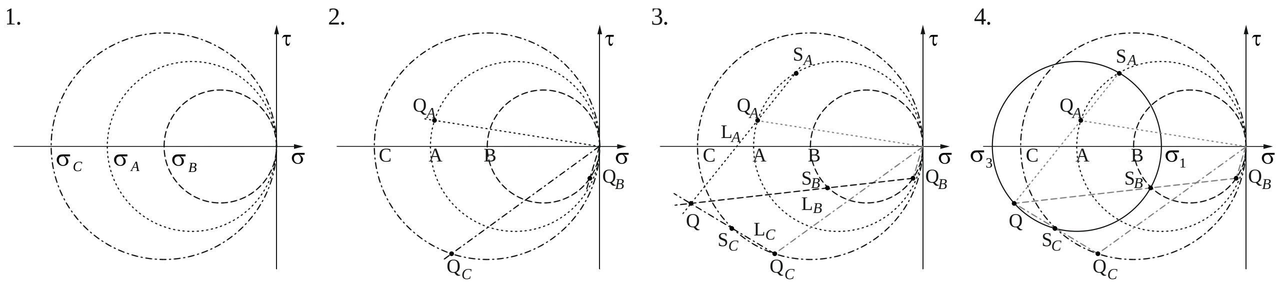
For a general nodal zone ($\sigma_A \neq \sigma_B \neq \sigma_C$), the approach of the verification is explained as follows. First, the acting forces on the nodal zone need to be in equilibrium. At discontinuity lines, normal and shear stresses, σ_n and τ_n, need to be in equilibrium as well.





Approach:

1. Draw the Mohr's circles of each acting strut. Here $\sigma_1 = 0$ is assumed, but this does not need to be the case.
2. For each strut, find the corresponding pol Q_i. The pol is the intersection of the Mohr's circle and the principal direction 3 of each strut starting at σ_1 (if starting at σ_3 it would be principal direction 1). The pol Q_i is the point on the Mohr's circle, around which stresses rotate.
3. With the help of the pol, find the point S_i (σ_{ni}, τ_{ni}) which is the intersection of the Mohr's circle and the line L_i, parallel to the discontinuity line of the node boundaries, passing through the corresponding pol Q_i. The intersection of all L_i is the pol Q of the final Mohr's circle. All points S_i lie on the Mohr's circle of the nodal zone.
4. Finally, the Mohr's circle of the nodal zone can be drawn and the corresponding compressive stresses σ_1 and σ_3 can be read from the diagram.



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[1] Presented in Lecture 2.1, Slide 39

[2] Often referred to as "hydrostatic" for simplicity although the stress state is not hydrostatic, because the stress perpendicular to the membrane plane is $\sigma_3 = 0$.