**APPENDIX 3**

Lade-Duncan criterion:

| $$\frac{I\_{1}^{3}}{I\_{3}}=27+η$$ | (A.3.1) |
| --- | --- |

where *I*'1 and *I*'3 are stress invariants:

| $$I\_{1}=\left(σ\_{11}+\frac{S\_{0}}{μ}\right)+\left(σ\_{22}+\frac{S\_{0}}{μ}\right)+\left(σ\_{33}+\frac{S\_{0}}{μ}\right)$$$$I\_{3}=\left(σ\_{11}+\frac{S\_{0}}{μ}\right)\left(σ\_{22}+\frac{S\_{0}}{μ}\right)\left(σ\_{33}+\frac{S\_{0}}{μ}\right)$$ | (A.3.2) |
| --- | --- |

*S*0 is rock cohesion and *η* is a function of friction:

| $$S\_{0}=\frac{UCS}{2\sqrt{N}}$$ | (A.3.3) |
| --- | --- |
| $$η=\frac{4\left(9-7sin\left(φ\right)\right)μ^{2}}{1-sin\left(φ\right)}$$ | (A.3.4) |