FORMELSAMLING UTMATTNING

$$R = \frac{\sigma_{\min}}{\sigma_{\max}}$$

Basquins relation $\sigma_a = \frac{\Delta\sigma}{2} = \sigma_f{}'(2N_f)^b$

Morrows relation (Modified Basquin) $\sigma_a = \frac{\Delta\sigma}{2} = (\sigma_f{}' - \sigma_m)(2N_f)^b$

Soderberg $\sigma_a = \sigma_a\big|_{\sigma_m=0}\left(1 - \frac{\sigma_m}{\sigma_Y}\right)$

Modified Goodman $\sigma_a = \sigma_a\big|_{\sigma_m=0}\left(1 - \frac{\sigma_m}{\sigma_{TS}}\right)$

Gerber $\sigma_a = \sigma_a\big|_{\sigma_m=0}\left(1 - \left(\frac{\sigma_m}{\sigma_{TS}}\right)^2\right)$

Palmgren-Miner $\sum_{i=1}^{m} \frac{n_i}{N_{fi}} = 1$

Stress concentration factor $K_f = 1 + q(K_t - 1)$

Combination of notch and $\sigma_m \neq 0$; modified Goodman $S_a = \frac{S_a\big|_{\sigma_m=0}}{K_f}\left(1 - \frac{\sigma_m}{\sigma_{TS}/K_f}\right)$

Ramberg-Osgood, monotonic loading

$$\varepsilon = \varepsilon_e + \varepsilon_p = \frac{\sigma}{E} + \varepsilon_f\left(\frac{\sigma}{\sigma_f}\right)^{1/n} = \frac{\sigma}{E} + \left(\frac{\sigma}{A}\right)^{1/n}$$

Ramberg-Osgood, cyklic load

$$\varepsilon_a = \varepsilon_{a,e} + \varepsilon_{a,p} = \frac{\sigma_a}{E} + \varepsilon_f{}'\left(\frac{\sigma_a}{\sigma_f{}'}\right)^{1/n'} = \frac{\sigma_a}{E} + \left(\frac{\sigma_a}{A'}\right)^{1/n'}$$

$$\Delta\varepsilon = \Delta\varepsilon_e + \Delta\varepsilon_p = \frac{\Delta\sigma}{E} + 2\varepsilon_f{}'\left(\frac{\Delta\sigma}{2\sigma_f{}'}\right)^{1/n'} = \frac{\Delta\sigma}{E} + 2\left(\frac{\Delta\sigma}{2A'}\right)^{1/n'}$$

Coffin-Manson $\frac{\Delta\varepsilon_p}{2} = \varepsilon_f{}'\left(2N_f\right)^c$

Morrow $\varepsilon_a = \frac{\Delta\varepsilon}{2} = \frac{\sigma_f{}' - \sigma_m}{E}\left(2N_f\right)^b + \varepsilon_f{}'\left(2N_f\right)^c$

Neuberanalysis

$$K_\sigma = \frac{\sigma_{\max}}{\sigma_\infty}$$

$$K_\varepsilon = \frac{\varepsilon_{\max}}{\varepsilon_\infty}$$

$$K_f^2 = K_\sigma K_\varepsilon$$

$$\sigma\varepsilon = \frac{K_f^2 \sigma_\infty^2}{E}$$

Griffith $\sigma_f = \sqrt{\frac{2E'\gamma_s}{\pi a}}$, $E' = E$ vid plane stress, $E' = \frac{E}{1-\nu^2}$ vid plane strain

Energy releaserate

$$G = -\frac{dW_p}{dA} = \frac{F^2}{2}\frac{dC}{dA} = 2\gamma_s$$

$$G = \frac{1-\nu^2}{E}(K_I^2 + K_{II}^2) + \frac{1+\nu}{E}K_{III}^2$$, plane strain and out-of plane deformation

$$G = \frac{1}{E}(K_I^2 + K_{II}^2)$$, plane stress

ASTM: $a, W-a, B \geq \frac{25}{3\pi}\left(\frac{K_{Ic}}{\sigma_Y}\right)^2$

Paris

$$\frac{da}{dN} = C\left(\Delta K_I\right)^m$$

$$N = \frac{1}{C(\Delta\sigma_\infty\sqrt{\pi}\,f(a_0))^m}\frac{a_1^{-\frac{m}{2}+1} - a_0^{-\frac{m}{2}+1}}{-\frac{m}{2}+1}, \quad m \neq 2$$

$$N = \frac{1}{C(\Delta\sigma_\infty\sqrt{\pi}\,f(a_0))^m}\ln\frac{a_1}{a_0}, \quad m = 2$$

Irwin

$$r_p = \frac{1}{3\pi}\left(\frac{K_I}{\sigma_Y}\right)^2$$, plane strain

$$r_p = \frac{1}{\pi}\left(\frac{K_I}{\sigma_Y}\right)^2$$, plane stress

Dugdale $r_p = a\left(\sec\frac{\pi\sigma_\infty}{2\sigma_Y} - 1\right) \approx \frac{\pi}{8}\left(\frac{K_I}{\sigma_Y}\right)^2$

Rice $J = \int_\Gamma \left(w dy - \bar{T}\cdot\frac{\partial \bar{u}}{\partial x}ds\right)$

Huchinson-Rice-Rosengren, HRR

$$\sigma_{ij} = \sigma_Y\left(\frac{J}{\alpha\sigma_Y\varepsilon_Y I_n r}\right)^{1/(n+1)}\tilde{\sigma}_{ij}(\theta, n)$$

$$\varepsilon_{ij} = \alpha\varepsilon_Y\left(\frac{J}{\alpha\sigma_Y\varepsilon_Y I_n r}\right)^{n/(n+1)}\tilde{\varepsilon}_{ij}(\theta, n)$$

$$u_i = \alpha\varepsilon_Y\left(\frac{J}{\alpha\sigma_Y\varepsilon_Y I_n}\right)^{n/(n+1)} r^{1/(1+n)}\tilde{u}_i(\theta, n)$$

Materialparameters SAE1045

Monotonic load		*Cyklic load*	
σ_Y	$634MPa$	σ'_Y	$414MPa$
n	0.13	n'	0.18
A	$1145MPa$	A'	$1344MPa$
σ_f	$1227MPa$	σ'_f	$1227MPa$
ε_f	1.04	ε'_f	0.6029
		b	-0.095
		c	-0.66

$E = 200GPa$

$\sigma_{TS} = 724MPa$

$\nu = 0.3$