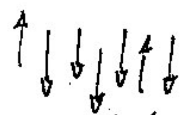
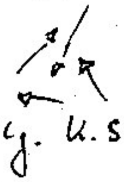
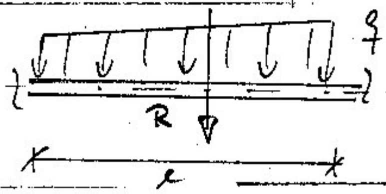
Statik

 $\Sigma F = 0$, $\Sigma M = 0$ — paralleles K.S.	 $\Sigma F_x = 0$, $\Sigma F_y = 0$ — zentrales K.S.	 $\Sigma F_x = 0$, $\Sigma F_y = 0$, $\Sigma M = 0$ — allg. K.S.

Streckenlast



1) Streckenlast als "Fläche" auffassen.
2) Resultierende ist so groß wie "Fläche".
3) Resultierende läuft durch "Flächenschwerpkt."

Freiheitsgrad

$$f_{ges} = 3(n-1) - \sum_{g} r_i \quad \text{(allg.)}$$

$$f_{ges} = 2k - s - r_{gestell} \quad \text{(Fachwerk)}$$

Haftung / Reibung

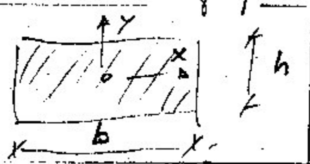
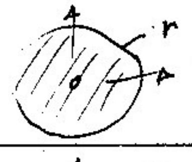
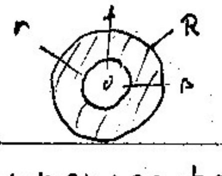
$H \leq \mu_0 \cdot N$; $R = \mu \cdot N$ (Coulomb)

$S_2 \leq S_1 \cdot e^{\mu_0 \cdot \alpha}$; $S_2 = S_1 \cdot e^{\mu \cdot \alpha}$ (Eytelwein)

Gesamtschwerpkt

x_s	$\frac{\Sigma(m_i \cdot x_{si})}{\Sigma m_i}$	$\frac{\Sigma(A_i \cdot x_{si})}{\Sigma A_i}$	$\frac{\Sigma(l_i \cdot x_{si})}{\Sigma l_i}$
y_s	$\frac{\Sigma(m_i \cdot y_{si})}{\Sigma m_i}$	$\frac{\Sigma(A_i \cdot y_{si})}{\Sigma A_i}$	$\frac{\Sigma(l_i \cdot y_{si})}{\Sigma l_i}$

Flächenkenngrößen

	A	I_{xx}	I_{yy}	I_p	W_x	W_y
	$b \cdot h$	$\frac{1}{12} b h^3$	$\frac{1}{12} b^3 h$	$\frac{1}{6} b h (b^2 + h^2)$	$\frac{1}{6} b h^2$	$\frac{1}{6} b^2 h$
	πr^2	$\frac{1}{4} \pi r^4$		$\frac{1}{2} \pi r^4$	$\frac{1}{4} \pi r^3$	
	$\pi (R^2 - r^2)$	$\frac{1}{4} \pi (R^4 - r^4)$		$\frac{1}{2} \pi (R^4 - r^4)$	$\frac{1}{4} \pi \frac{R^4 - r^4}{R}$	

zusammengesetzte Flächen

$$I_{xx} = \Sigma I_{xx_i} + \Sigma A_i (y_i - y_s)^2$$

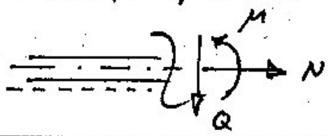
$$I_{yy} = \Sigma I_{yy_i} + \Sigma A_i (x_i - x_s)^2$$

$$I_{xy} = \Sigma I_{xy_i} - \Sigma A_i (x_i - x_s)(y_i - y_s)$$

Hauptträgheitsmomente und -achsen

$$I_{1/2} = \frac{I_{xx} + I_{yy}}{2} \pm \sqrt{\left(\frac{I_{xx} - I_{yy}}{2}\right)^2 + I_{xy}^2} \; ; \quad \tan 2\varphi = \frac{2 I_{xy}}{I_{xx} - I_{yy}}$$

Schnittgrößen!



rechtes Schnittufer

linkes Schnittufer

Zug / Druck

$\sigma = \frac{N}{A}$; $\sigma = E \cdot \varepsilon$; $\varepsilon = \frac{\Delta l}{l}$; $\varepsilon_q = -\nu \cdot \varepsilon$

Biegung

$\sigma = \frac{M}{I} \cdot d_{max} = \frac{M}{W}$; $w'' = \frac{M}{E \cdot I}$

Scherung / mittlere Schubspannung

$\tau = \frac{Q}{A}$; $\tau = G \cdot \gamma$

Torsion

$\tau_T = \frac{M_T}{I_p} \cdot r$; $\varphi = \frac{M_T}{G \cdot I_p} \cdot l$

Spannungshypothese

Spannungshypothese	Normal-	Schub-	GE-
$\sigma_V(\sigma, \tau) =$	$\frac{1}{2}\sigma + \frac{1}{2}\sqrt{\sigma^2 + 4\tau^2}$	$\sqrt{\sigma^2 + 4\tau^2}$	$\sqrt{\sigma^2 + 3\tau^2}$

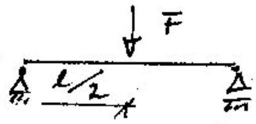
Biegetafel

$w = \frac{F \cdot l^3}{E \cdot I}$

$\tan\alpha = \frac{1}{2} \frac{F \cdot l^2}{E \cdot I}$

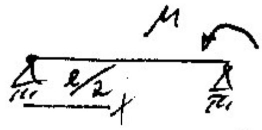
$w = \frac{1}{2} \frac{M \cdot l^2}{E \cdot I}$

$\tan\alpha = \frac{M \cdot l}{E \cdot I}$



$w = \frac{1}{48} \frac{F \cdot l^3}{E \cdot I}$

$\tan\alpha = \frac{1}{16} \frac{F \cdot l^2}{E \cdot I}$



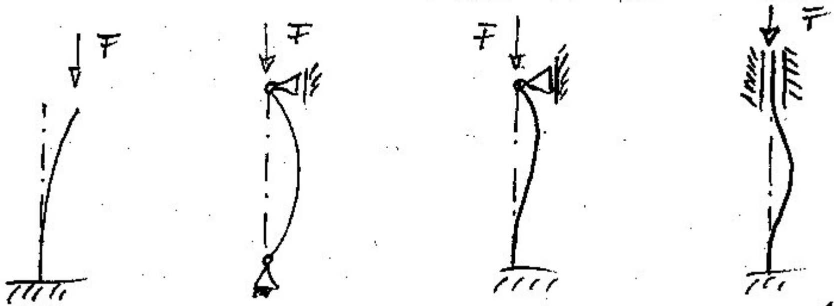
$w = \frac{1}{16} \frac{M \cdot l^2}{E \cdot I}$

$\tan\alpha = \frac{1}{3} \frac{M \cdot l}{E \cdot I}$

Knickfall (Euler)

$F_K = \pi^2 \cdot \frac{E \cdot I_{min}}{l_K^2}$

$\sigma_K = \frac{F_K}{A}$



$l_K = 2l$ $l_K = l$ $l_K = 0.7 \cdot l$ $l_K = \frac{1}{2} l$

Lineare Bewegung (gleichförmig beschleunigt)

$v(t) = v_0 + a \cdot t \quad ; \quad s(t) = s_0 + v_0 \cdot t + \frac{1}{2} a t^2$

Drehbewegung (gleichförmig beschleunigte Rotation)

$\omega(t) = \omega_0 + \alpha \cdot t \quad ; \quad \varphi(t) = \varphi_0 + \omega_0 \cdot t + \frac{1}{2} \alpha t^2$

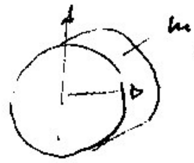
$v = r \cdot \omega \quad ; \quad s = r \cdot \varphi$ (Rollen)

$a_t = r \cdot \alpha \quad ; \quad a_n = r \cdot \omega^2$

Dynamisches Grundgesetz

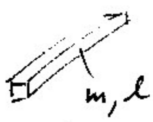
$\sum F_x = m \cdot \ddot{x} \quad ; \quad \sum F_y = m \cdot \ddot{y} \quad ; \quad \sum M = J \cdot \ddot{\varphi}$

Massenträgheitsmoment $J = \int r^2 dm$



Zylinder: $J = \frac{1}{2} m r^2$

Kugel: $J = \frac{2}{5} m r^2$



Stab: $J = \frac{1}{12} m l^2$

Satz v. Steiner : $J = J_0 + m d^2$

Energieerhaltungssatz

$E_{kI} + E_{pI} - W_{ab} = E_{kII} + E_{pII}$

Schwerefeld	Feder	lin. Bew.	rot. Bew	Reibung
$E_p = m \cdot g \cdot h$	$E_p = \frac{1}{2} c \Delta l^2$	$E_k = \frac{1}{2} m v^2$	$E_k = \frac{1}{2} J \cdot \omega^2$	$W_R = \mu \cdot N \cdot s$
$F = m \cdot g$	$F = c \cdot \Delta l$	$F = m \cdot a$	$M = J \cdot \alpha$	$R = \mu \cdot N$

Leistung: $P = F \cdot v + M \cdot \omega$

Wirkungsgrad $\eta = \frac{P_{ab}}{P_{zu}} = 1 - \frac{P_v}{P_{zu}}$