

Øvingsoppgave Brygge1 Uke4-05
Løsningsforslag

Enheter:

$$N \equiv \text{newton} \quad kN \equiv 10^3 \cdot N \quad \text{tonn} \equiv 10^3 \cdot \text{kg} \quad s \equiv \text{sec} \quad \text{MPa} \equiv \frac{N}{\text{mm}^2}$$

Konstanter:

	Sjøvann	Stål	Luft
Tetthet	$\rho_s := 1025 \frac{\text{kg}}{\text{m}^3}$	$\rho_{st} := 7850 \frac{\text{kg}}{\text{m}^3}$	$\rho_l := 1.225 \frac{\text{kg}}{\text{m}^3}$

Inngangsvariable:

Bryggen:	$L := 12\text{m}$	$B := 3\text{m}$	$D := 1.2\text{m}$	$W_B := 3\text{tonn}$		
	$L_P := 3\text{m}$	$B_P := 1\text{m}$	$D_P := 1\text{m}$	$n_P := 6$	$x_B := 0\text{m}$	$y_B := 0\text{m}$
					$z_B := 0.9\text{m}$	
Kranen:	$W_K := 1.5\text{tonn}$	$x_K := 0\text{m}$	$y_K := 0\text{m}$	$z_K := 2\text{m}$	$y_{KL} := 0.3\text{m}$	
Truck:	$W_T := 2\text{tonn}$	$x_T := \frac{-L}{2} + 1\text{m}$	$y_T := 0\text{m}$	$z_T := 2\text{m}$		
Last:	$W_L := 200\text{kg}$	$x_L := 0\text{m}$	$y_L := 4.5\text{m}$	$z_L := 4\text{m}$		

A.

$$\text{Flytebryggens dypgang: } T_A := \frac{W_B + W_K}{n_P \cdot L_P \cdot B_P \cdot \rho_s} \quad T_A = 0.244\text{m}$$

B.

$$\text{Bryggens deplasement: } \Delta_A := W_B + W_K \quad \Delta_A = 4.5\text{tonn}$$

$$\text{Tyngdepunkt: } z_{gA} := \frac{W_B \cdot z_B + W_K \cdot z_K}{\Delta_A} \quad z_{gA} = 1.267\text{m}$$

$$KB_A := \frac{T_A}{2} \quad KB_A = 0.122\text{m}$$

$$I_x := n_P \cdot \left[\frac{L_P \cdot B_P^3}{12} + L_P \cdot B_P \cdot \left(\frac{B - B_P}{2} \right)^2 \right]$$

$$BM_{TA} := \frac{I_x \rho_s}{\Delta_A} \quad BM_{TA} = 4.442\text{m}$$

$$GM_{TA} := KB_A + BM_{TA} - z_{gA} \quad GM_{TA} = 3.297\text{m}$$

$$I_y := n_P \frac{L_P^3 \cdot B_P}{12} + 4 \cdot L_P \cdot B_P \cdot \left(\frac{L - L_P}{2} \right)^2$$

$$BM_{LA} := \frac{I_y \cdot \rho_s}{\Delta_A}$$

$$BM_{LA} = 58.425m$$

$$GM_{LA} := KB_A + BM_{LA} - z_{gA}$$

$$GM_{LA} = 57.28m$$

C.

Nytt deplasement:

$$\Delta_C := \Delta_A + W_T$$

$$\Delta_C = 6.5 \text{ tonn}$$

Nytt tyngdepunkt:

$$x_{gC} := \frac{W_B \cdot x_B + W_K \cdot x_K + W_T \cdot x_T}{\Delta_C}$$

$$x_{gC} = -1.538m$$

$$z_{gC} := \frac{\Delta_A \cdot z_{gA} + W_T \cdot z_T}{\Delta_C}$$

$$z_{gC} = 1.492m$$

Ny dypgang:

$$T_C := \frac{\Delta_C}{n_P \cdot L_P \cdot B_P \cdot \rho_s}$$

$$T_C = 0.352m$$

Nye data for trimberegning:

$$KB_C := \frac{T_C}{2}$$

$$KB_C = 0.176m$$

$$BM_{LC} := \frac{I_y \cdot \rho_s}{\Delta_C}$$

$$BM_{LC} = 40.448m$$

$$GM_{LC} := KB_C + BM_{LC} - z_{gC}$$

$$GM_{LC} = 39.132m$$

Trimvinkel:

$$\Theta := \text{atan} \left(\frac{x_{gC}}{GM_{LC}} \right)$$

$$\Theta = -2.251 \text{ deg}$$

Laveste fribord:

$$f_{\min} := D - T_C - \left| \frac{L}{2} \cdot \tan(\Theta) \right|$$

$$f_{\min} = 0.612m$$

D.

Nytt deplasement: $\Delta_D := \Delta_A + W_L$ $\Delta_D = 4.7 \text{ tonn}$

Nytt tyngdepunkt: $y_{gD} := \frac{W_K \cdot y_{KL} + W_L \cdot y_L}{\Delta_D}$ $y_{gD} = 0.287 \text{ m}$

$$z_{gD} := \frac{\Delta_A \cdot z_{gA} + W_L \cdot z_L}{\Delta_D} \quad z_{gD} = 1.383 \text{ m}$$

Ny dypgang: $T_D := \frac{\Delta_D}{n_P \cdot L_P \cdot B_P \cdot \rho_s}$ $T_D = 0.255 \text{ m}$

Nye data for beregning av krengevinkel:

$$KB_D := \frac{T_D}{2} \quad KB_D = 0.127 \text{ m}$$

$$BM_{TD} := \frac{I_X \cdot \rho_s}{\Delta_D} \quad BM_{TD} = 4.253 \text{ m}$$

$$GM_{TD} := KB_D + BM_{TD} - z_{gD} \quad GM_{TD} = 2.997 \text{ m}$$

Krengevinkel: $\Phi := \text{atan} \left(\frac{y_{gD}}{GM_{TD}} \right)$ $\Phi = 5.474 \text{ deg}$