SUBMERGED FLOATING TUBE: WATER-STRUCTURE INTERACTION

NTNU

CoMEM

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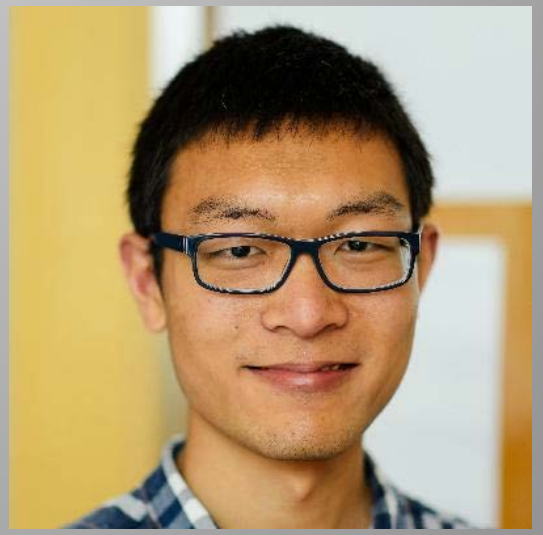

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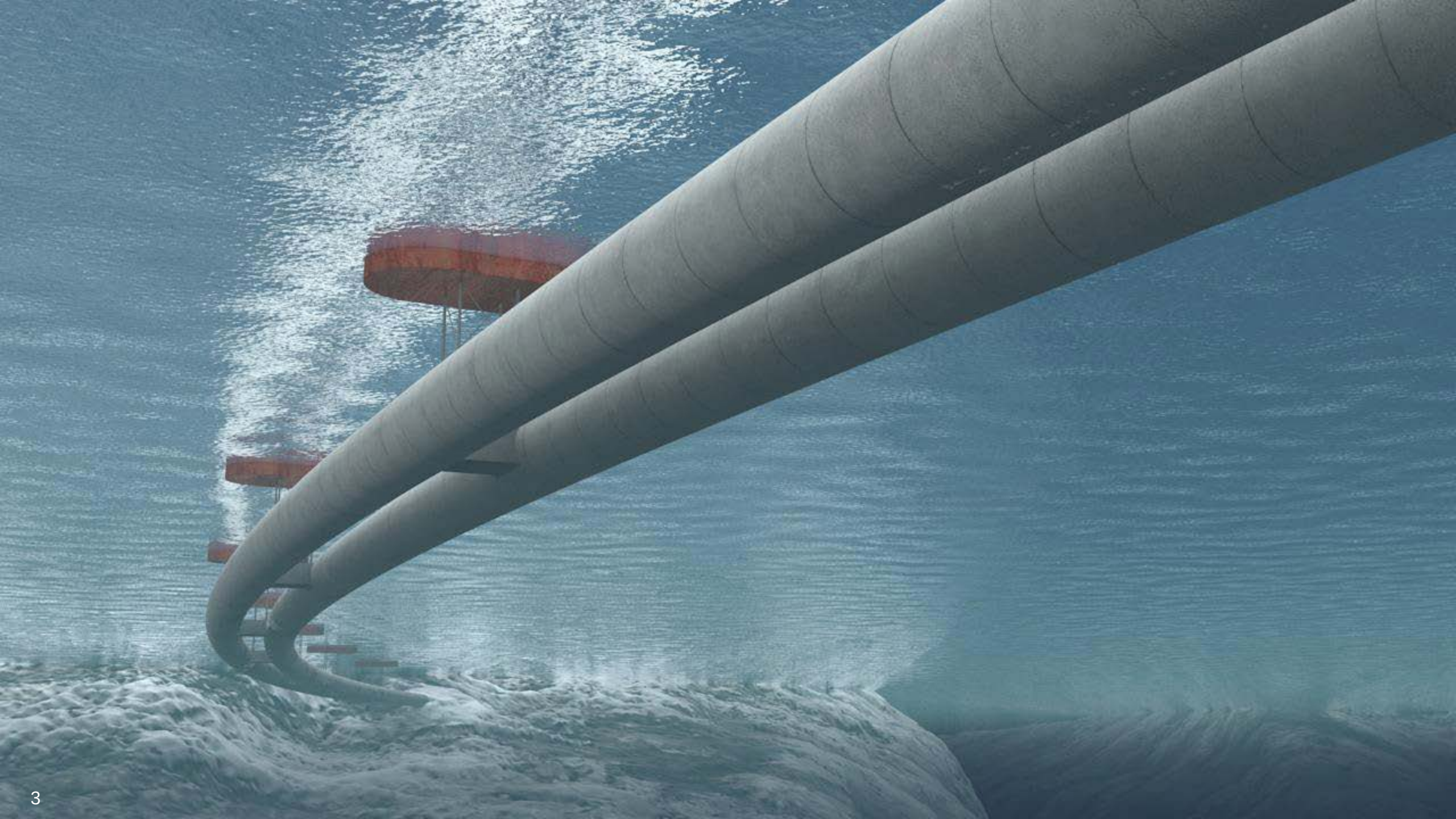


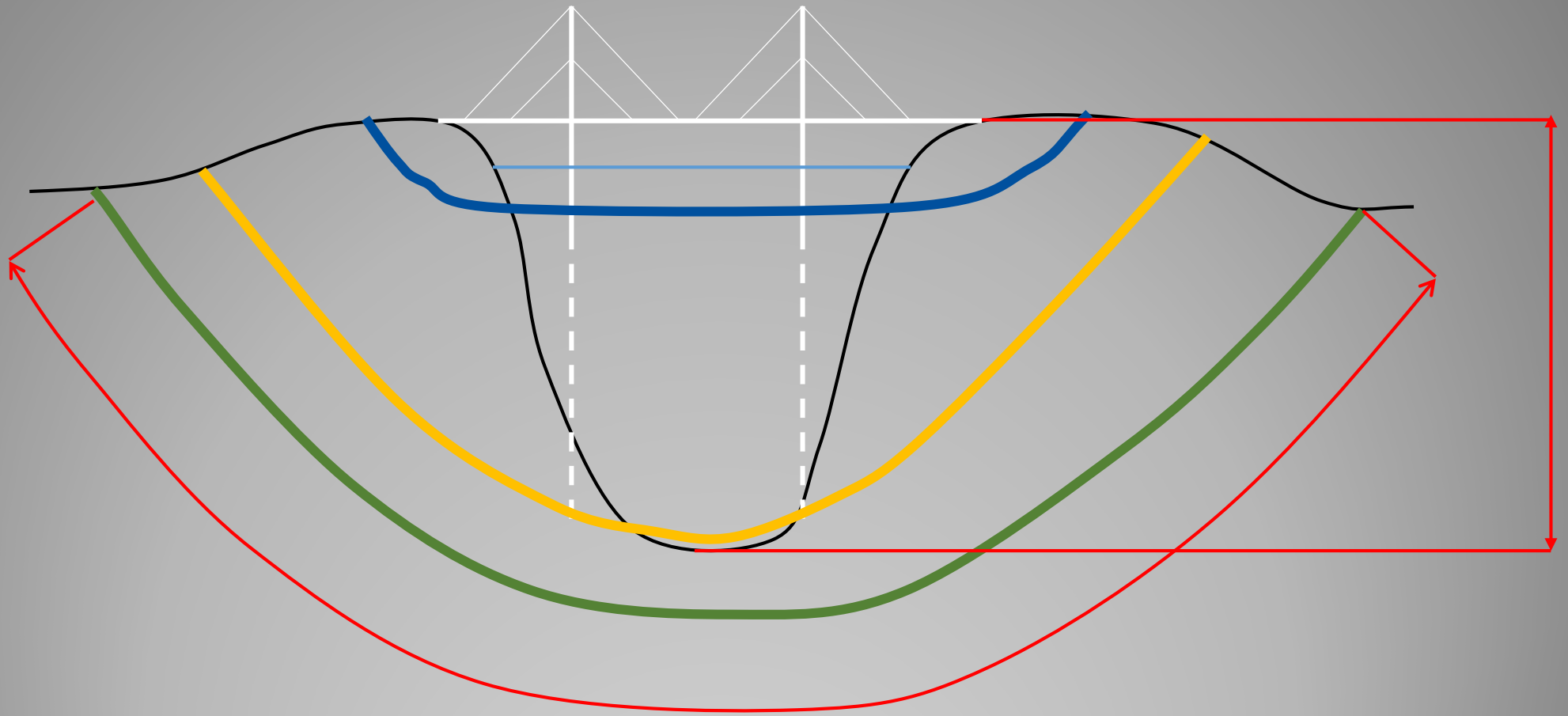
1.1 BACKGROUND INFO: E39

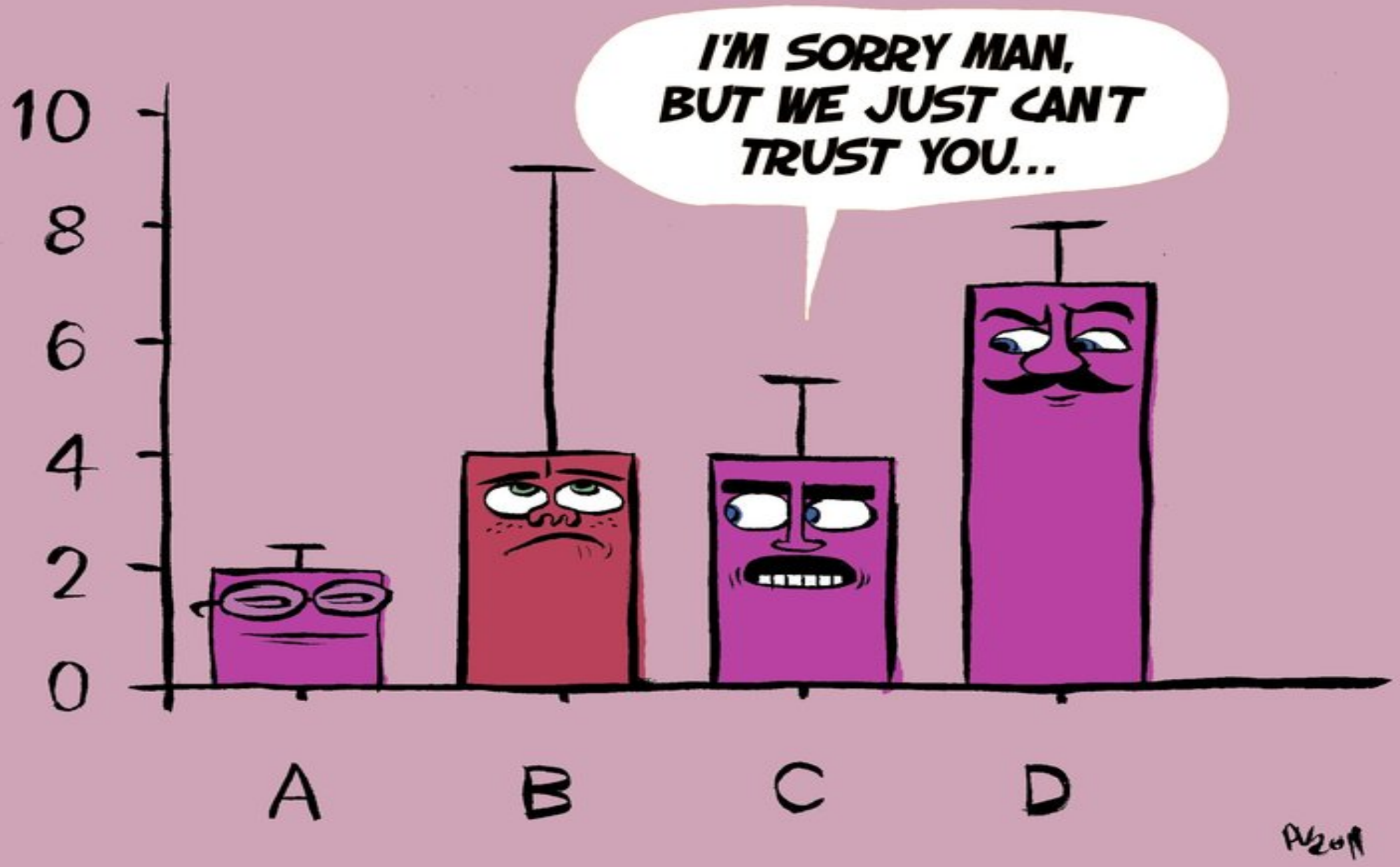
Picture retrieved from www.vegvesen.no

7 ferry connections

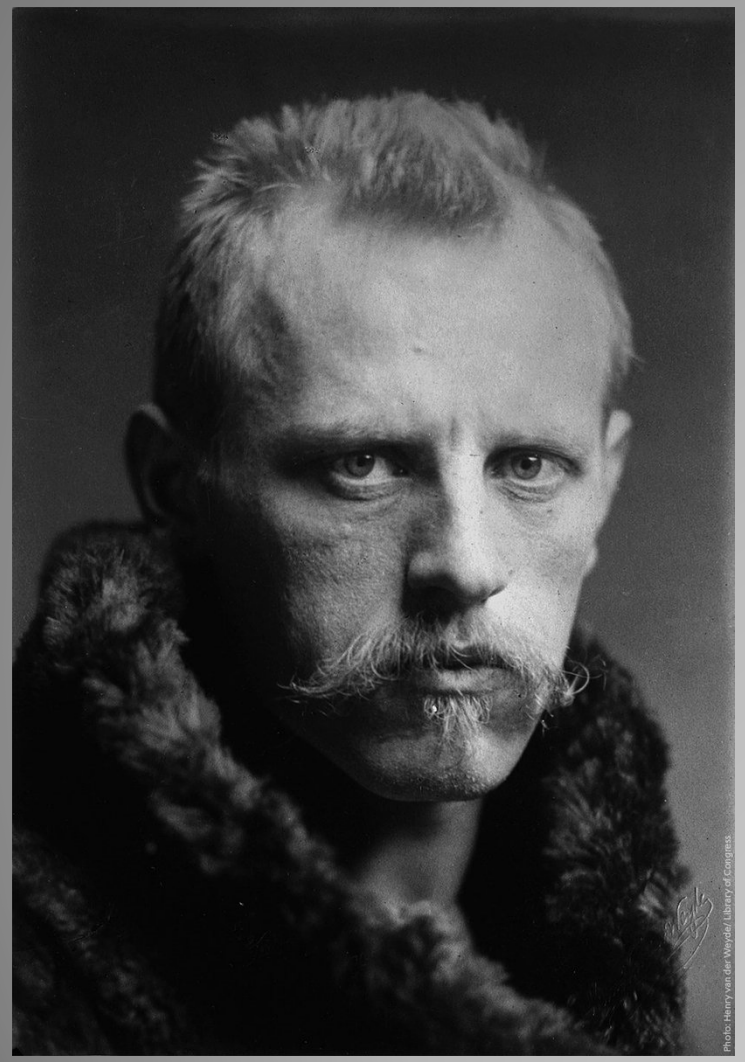
Reduction of travel time due to completion of ferry-free crossings: **from 21 to 11 hrs**.

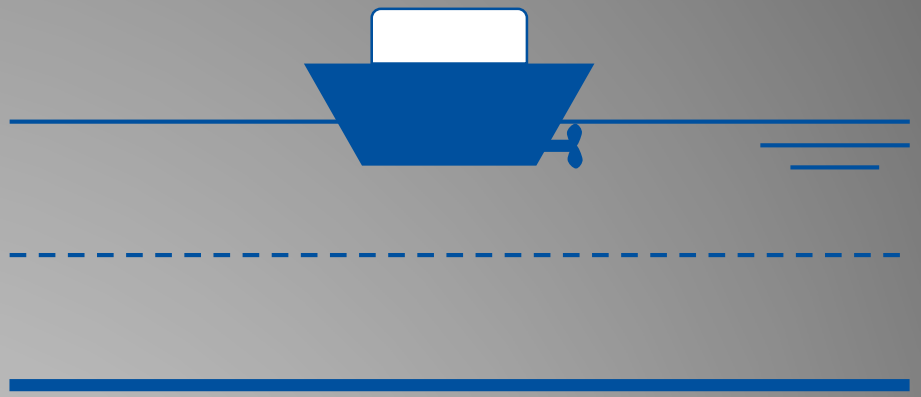
1.2 BACKGROUND INFO: OPTIONS




I'M SORRY MAN, BUT WE JUST CAN'T TRUST YOU...
10
8
6
4
2
0
A
B
C
D

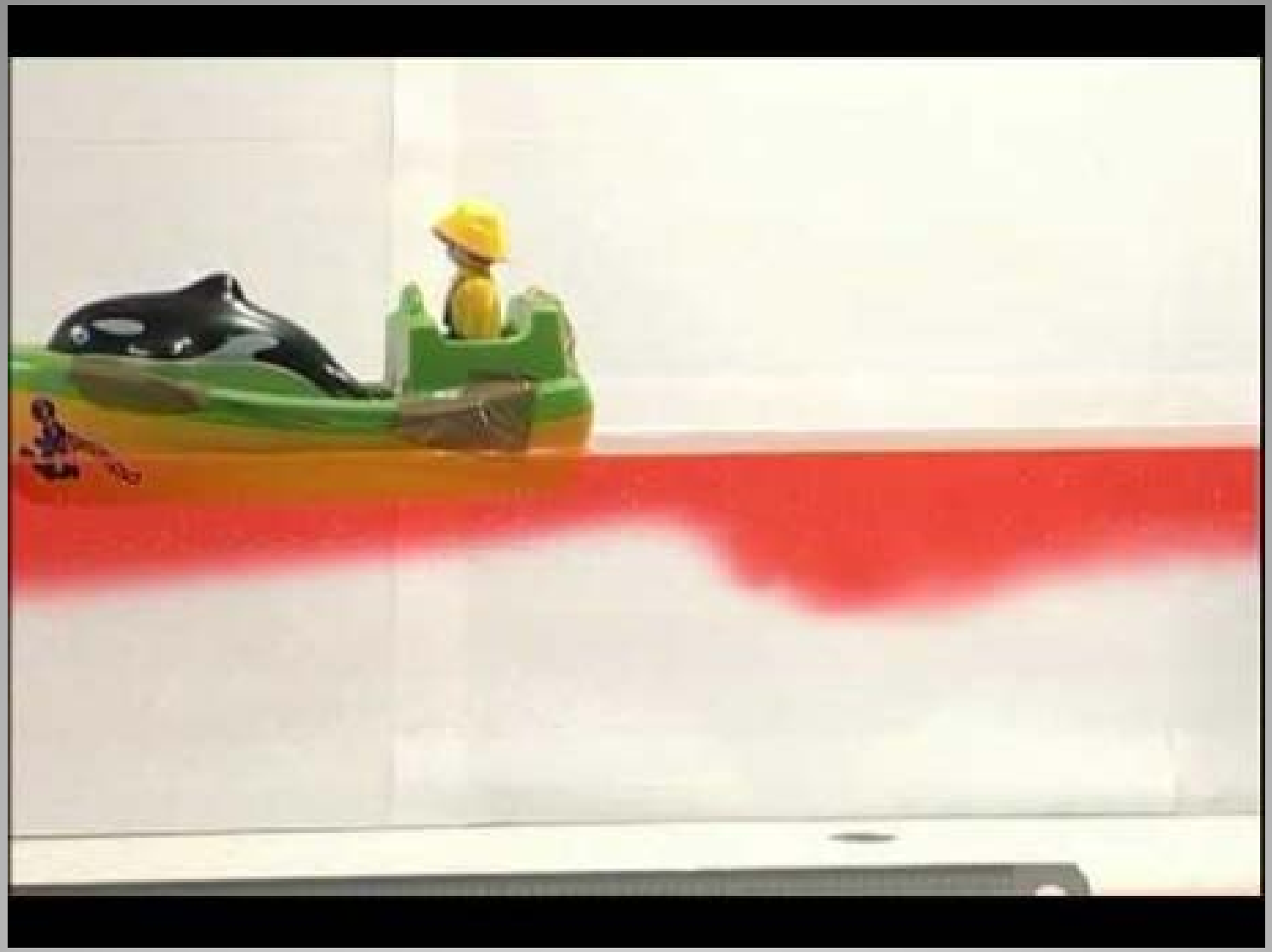
2.1 “DEAD WATER”: HISTORY





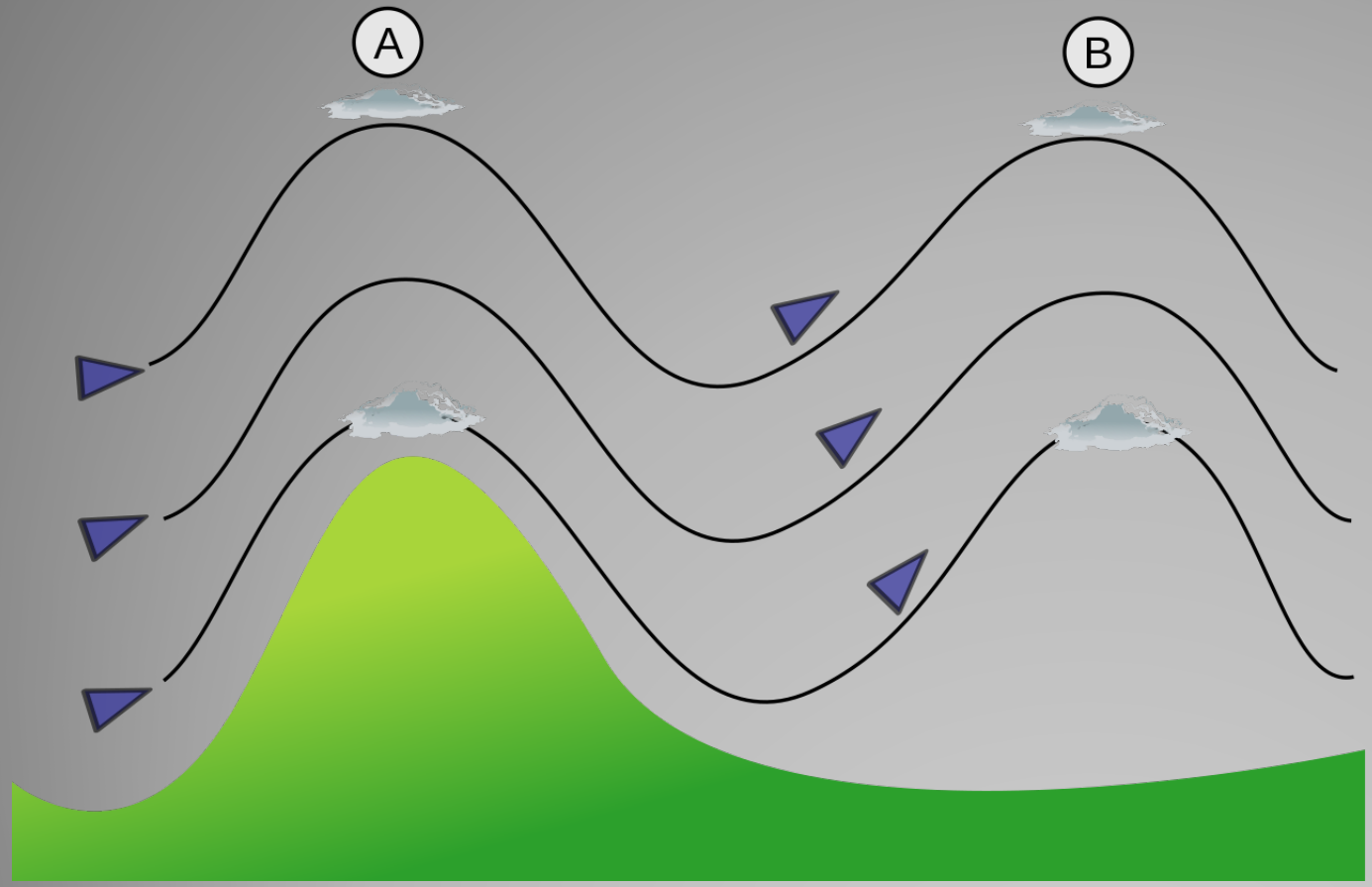
Dead water: nautical term for the situation when fresh or brakish water rests on top of denser salt water. Leads to reduced ship maneuverability and speeds.

2.1 “DEAD WATER”: EFFECTS



Video retrieved from www.youtube.com.

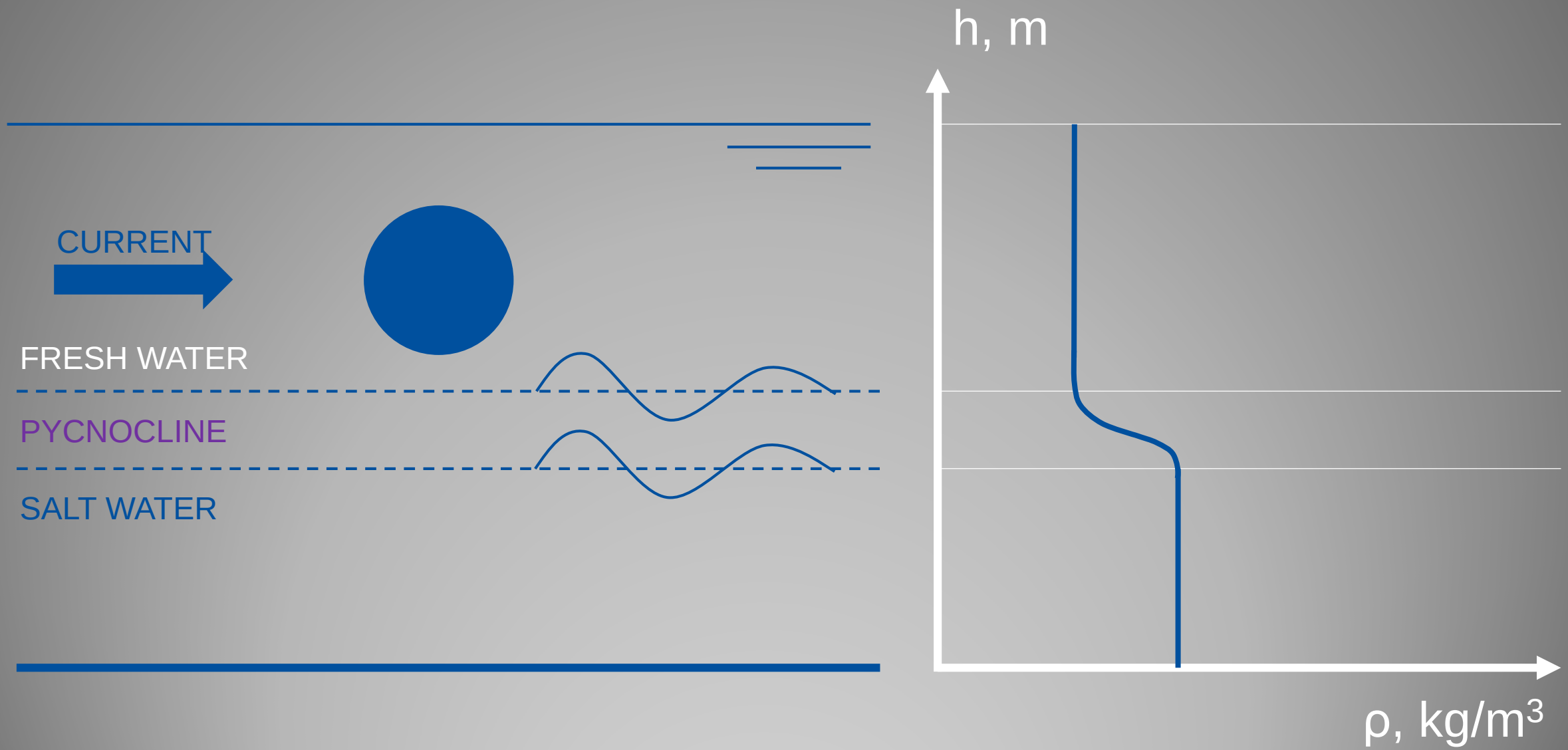
2.2 LEE-WAVES



Lee waves (meteorology): standing waves in the stratified air that form downwind of a hill or mountain range as winds pass over them.

$$N_0 = \max\left(\sqrt{-\frac{g}{\rho(z)} \cdot \frac{\partial \rho(z)}{\partial z}}\right)$$

2.3 CYLINDER IN STRATIFIED FLUID

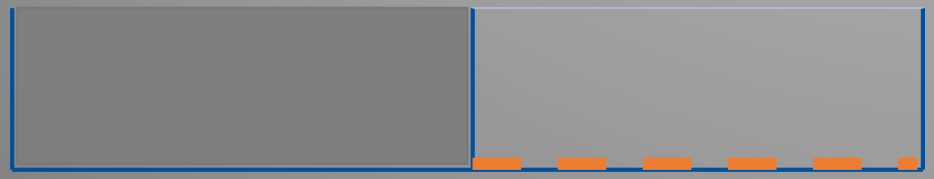


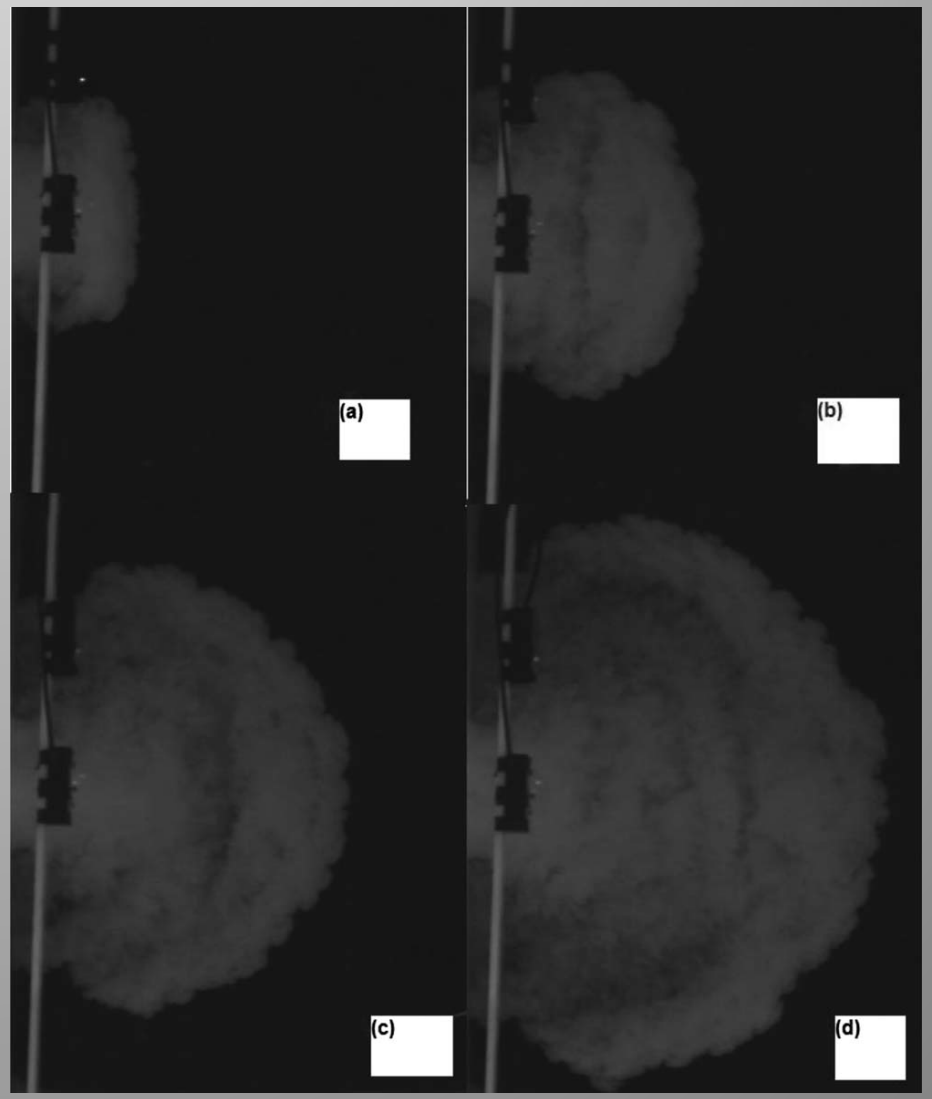
2.4 STRATIFICATION

Top view

$\rho_1 > \rho_2$

Side view





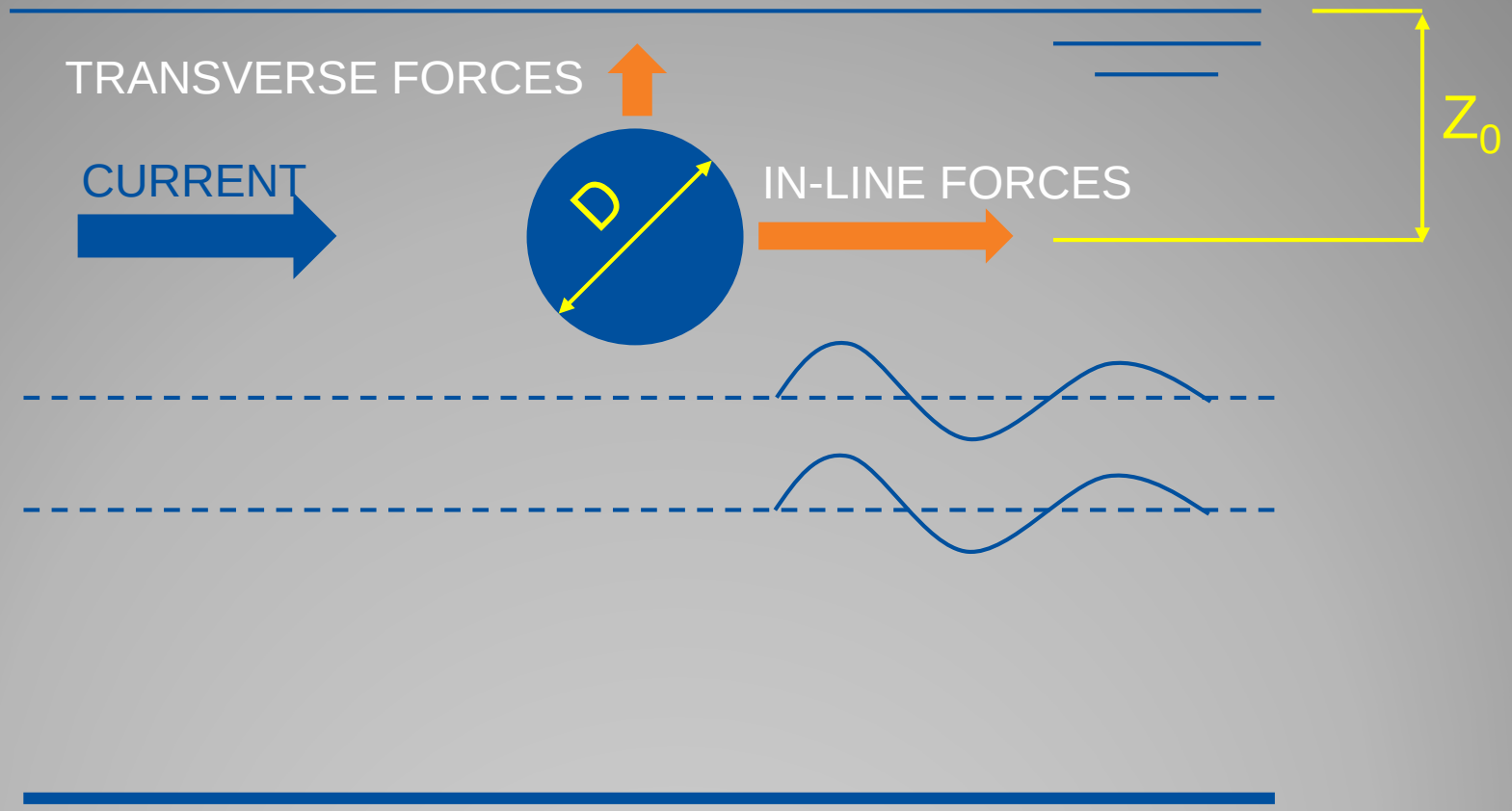
2.4 STRATIFICATION

$$Ri = \left(\frac{\rho_1 - \rho_2}{\rho_2}\right) \cdot \left(\frac{g h_1}{U_1^2}\right)$$

Ri > 1: hydrostatic force dominates, mixing can be neglected

Ri < 1: Inertia force dominates, mixing is enhanced and therefore cannot be neglected

2.5 CYLINDER IN STRATIFIED FLUID



2.5 CYLINDER IN STRATIFIED FLUID

Table 3. Drag force at maximum internal wave height vs cylinder distance from the center of the stratified layer.

z_0/D	δ/D	$Fr_{d,\,Hmax}$	$C_{Dd,0}$	C_D
0.66	1.8[a]	0.60	1.8	1.3
1.34	1.1[a]	0.50	1.9	1.5
2.16	0.5[a]	0.50	1.6	1.3
2.86	−0.3[a]	0.50	1.1	1.3
3.62	0.4[b]	0.50	1.4	1.2
4.44	0.9[b]	0.55	1.5	1.3

[a] Cylinder above the center
[b] Cylinder below the center

$$Fr_d = \frac{U}{c_i}$$

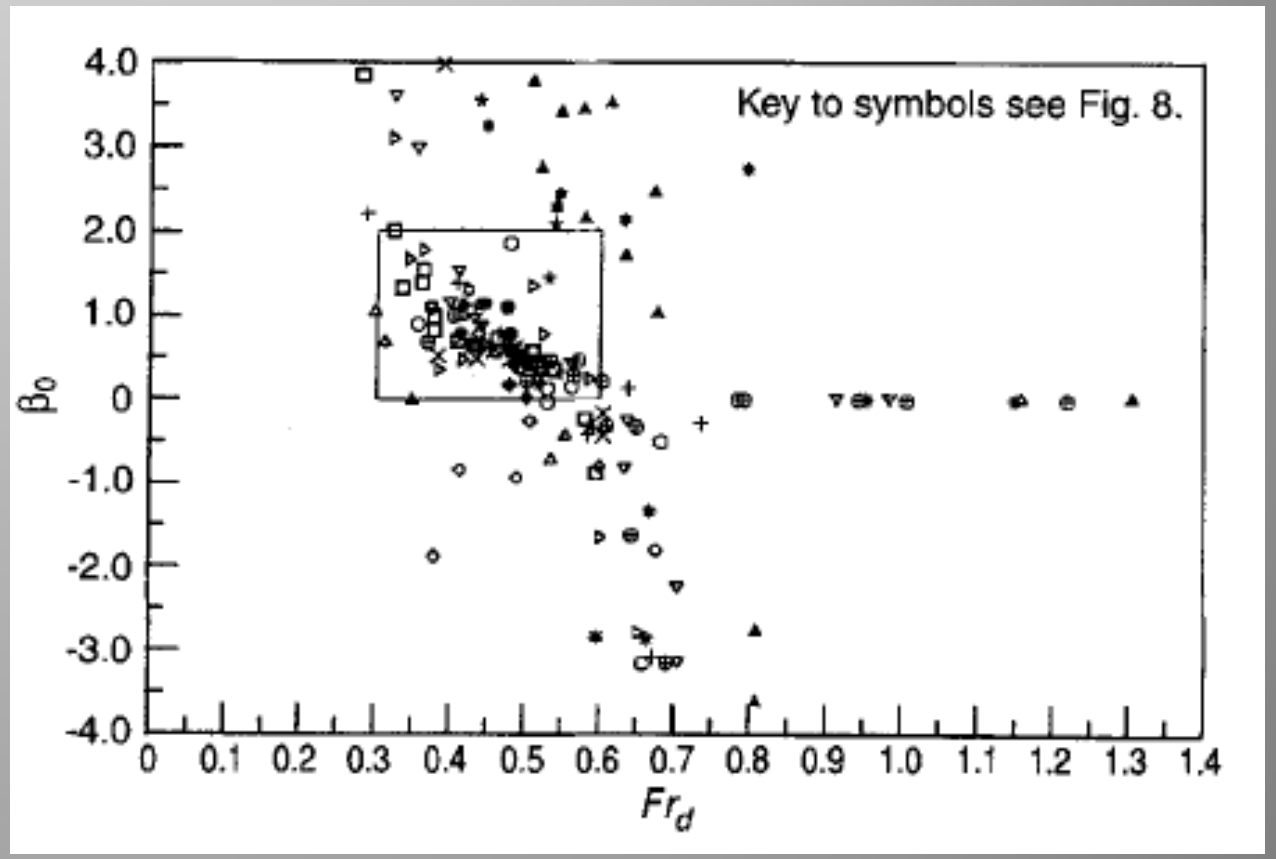
C_i – estimate for the celerity of the longest internal waves

$$C_D = \frac{f_{measured}}{0.5\rho D U^2}$$

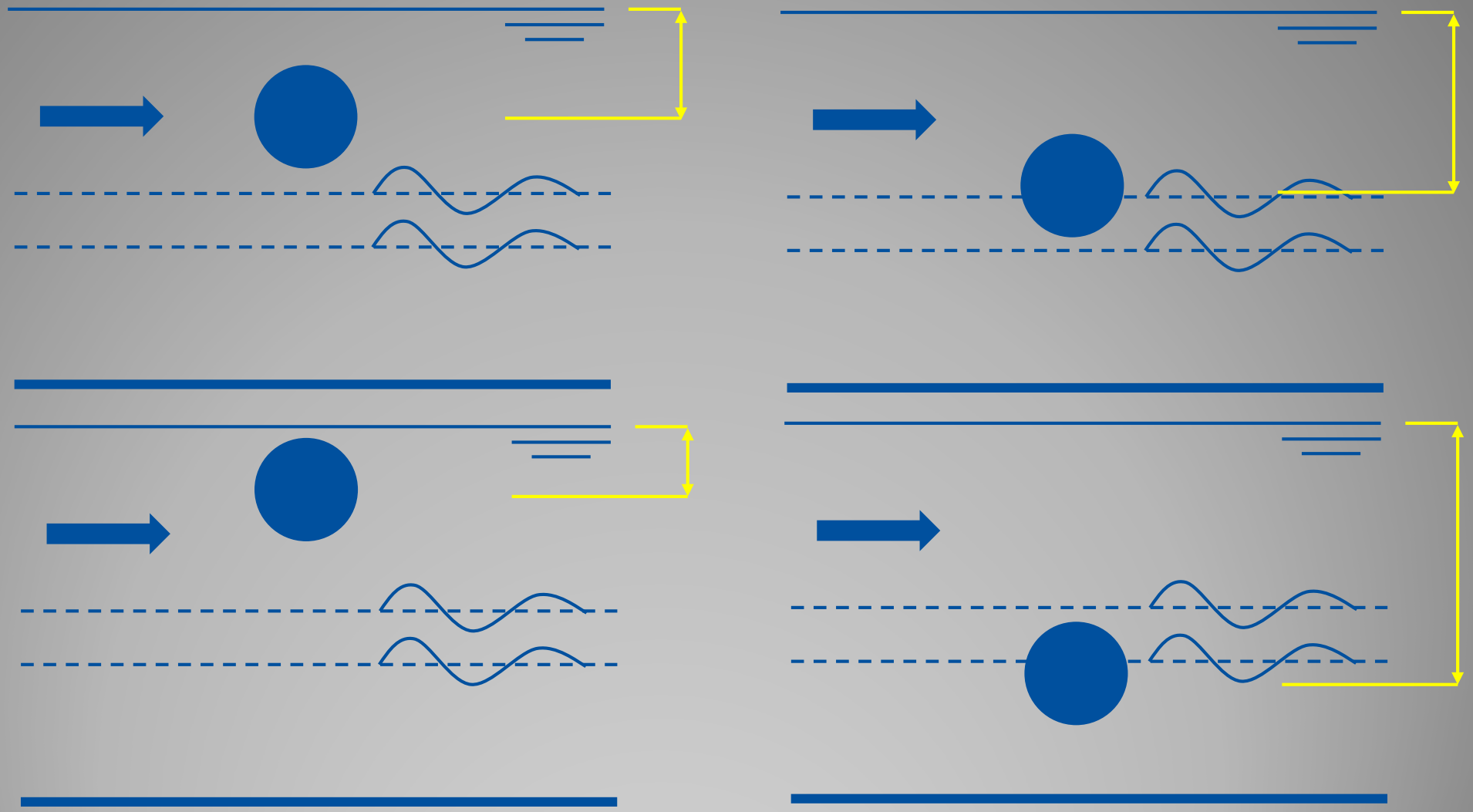
2.5 CYLINDER IN STRATIFIED FLUID

$$\beta_0 = \frac{f_{xd} - \hat{f}_x}{R_w}$$

R_w – tow resistance in stratified water;
f_{xd} – measured drag force in stratified water;
f_x – estimated drag force in homogeneous water



3. WHAT IS THE PLAN



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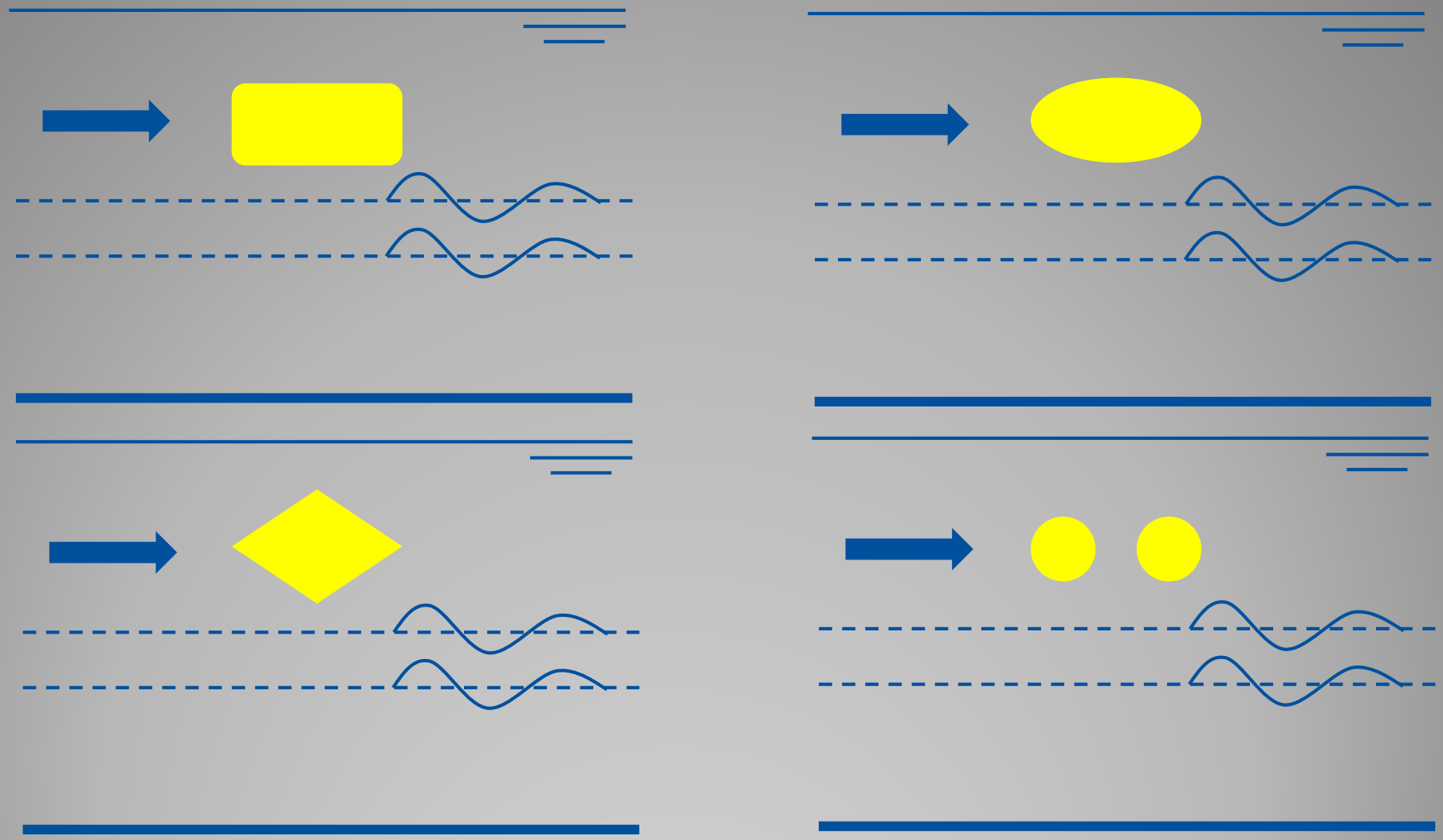

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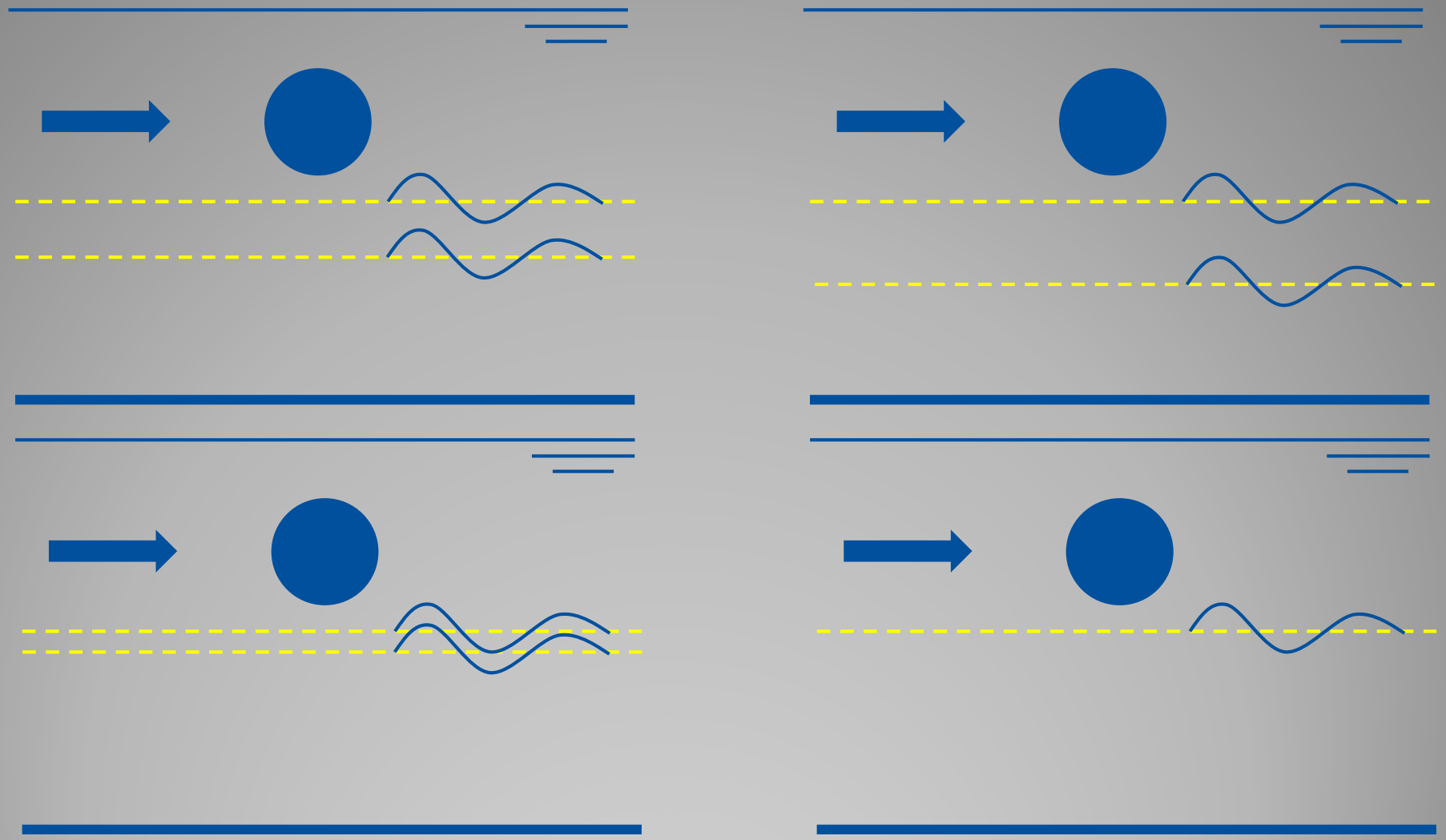

4. WRAP UP

- Pycnocline – the layer of changing density – how does it develop?
- What are the forces acting upon the structure in stratified water?
- What are the most important parameters influencing those forces?

THANK YOU
FOR YOUR ATTENTION