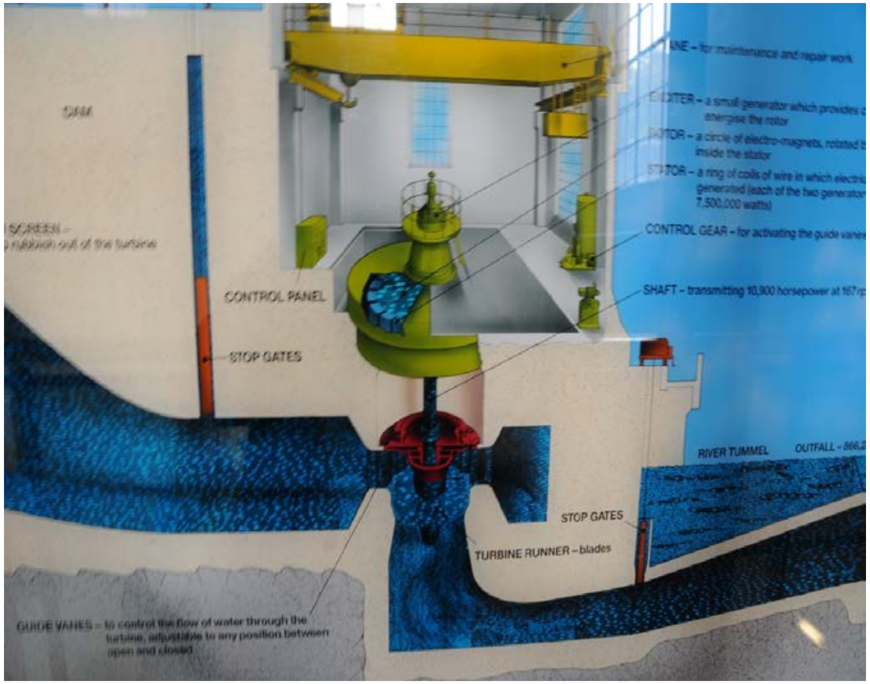
Fluid Dynamics

Chapter 0 Why Fluid Mechanics?



Chapter 0 Why Fluid Mechanics?

Contents

0.1 Speculation of Leonardo da Vinci

0.2 Physics of Golf

0.3 Water Resources

0.4 Dams

0.5 Hydropower Plants

0.6 Floods

0.7 River Navigation

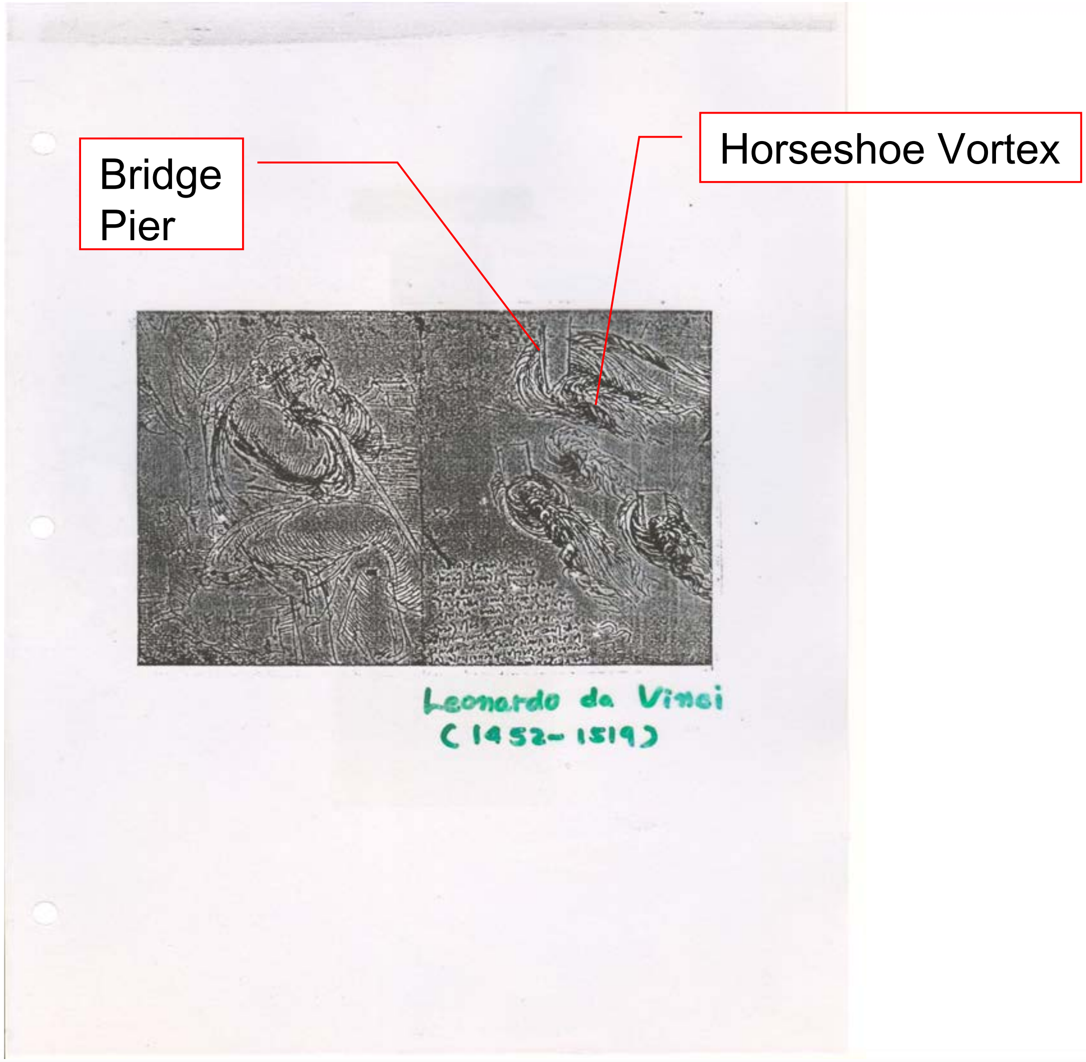
0.8 River Recreation

Chapter 0 Why Fluid Mechanics?

Objectives

- Find your motivation to attend this class
- Introduce practical applications of fluid mechanics

0.1 Speculation of Leonardo da Vinci



0.1 Speculation of Leonardo da Vinci

Eddy formation in zones of separation.

Sketch by Leonardo of flow over a contracted weir.

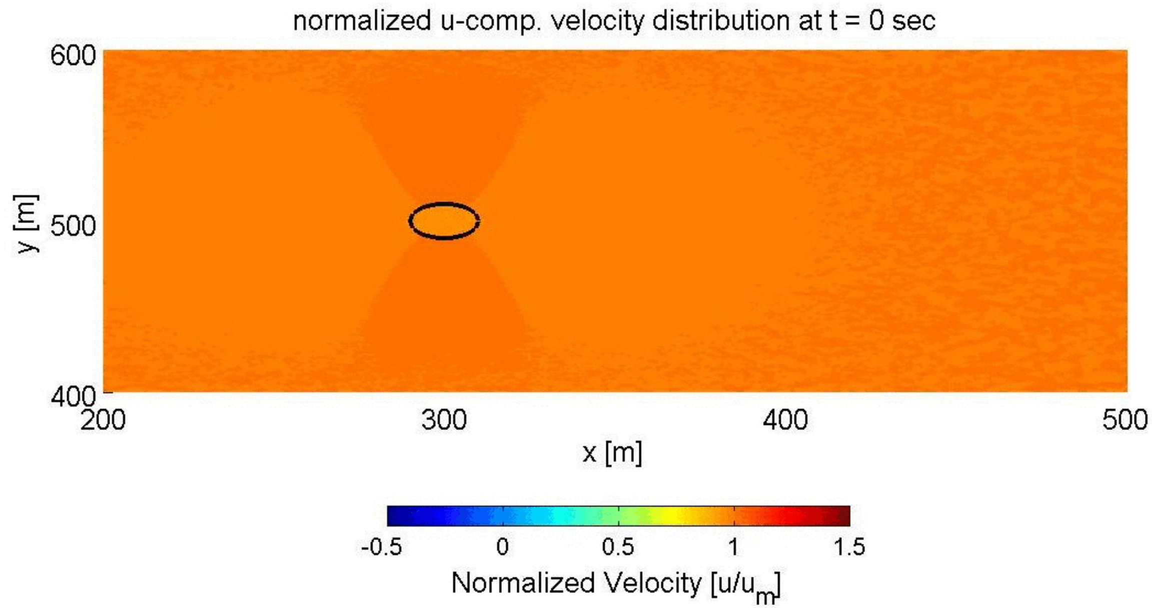
0.1 Speculation of Leonardo da Vinci

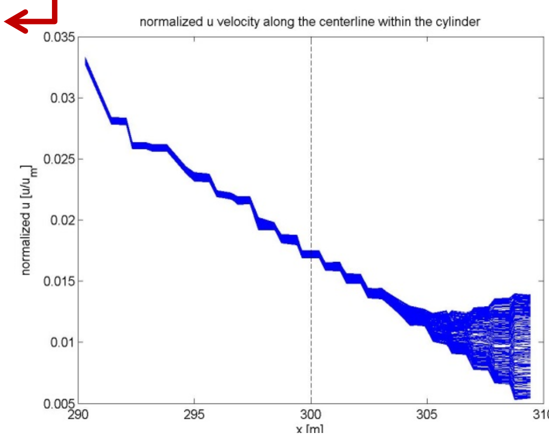
Velocity field around/within a single cylinder

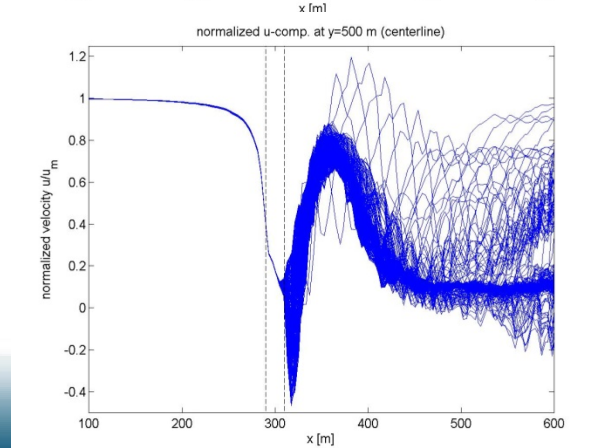
- Momentum reduction by quadratic drag law formulation.
  - Governing equations including the drag law formulation.

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} = -g\frac{\partial h}{\partial x} + \nu_H\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}\right) - C_{DB}\frac{\sqrt{u^2+v^2}}{H}u + F_{D,x}$$

$$F_{D,x} = -\frac{\alpha C_D (u^2+v^2)^{1/2}}{D}u,$$



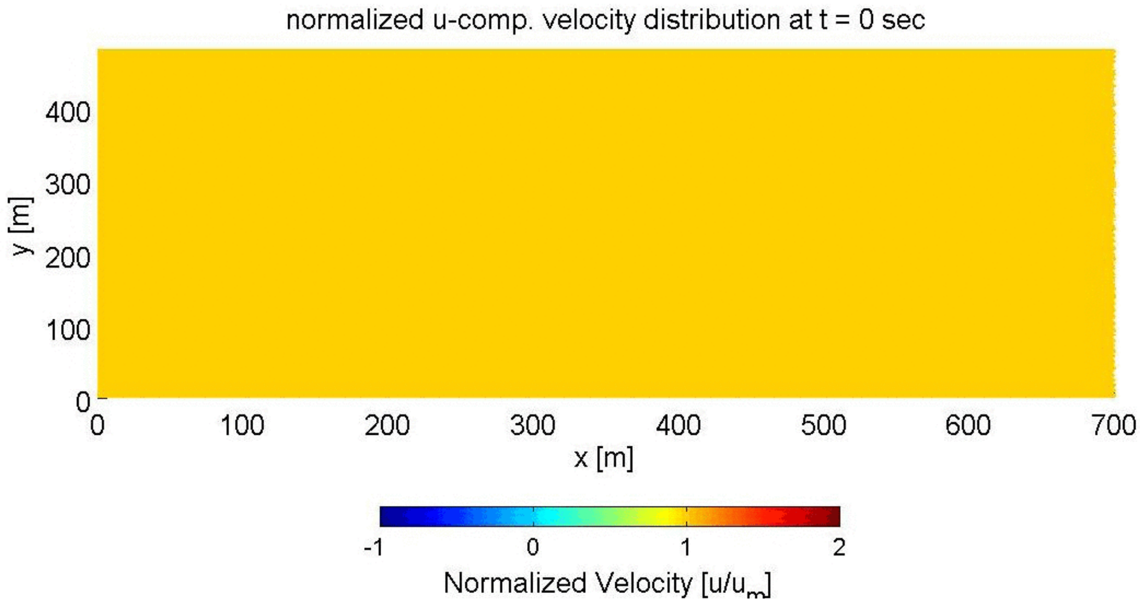




Velocity fields

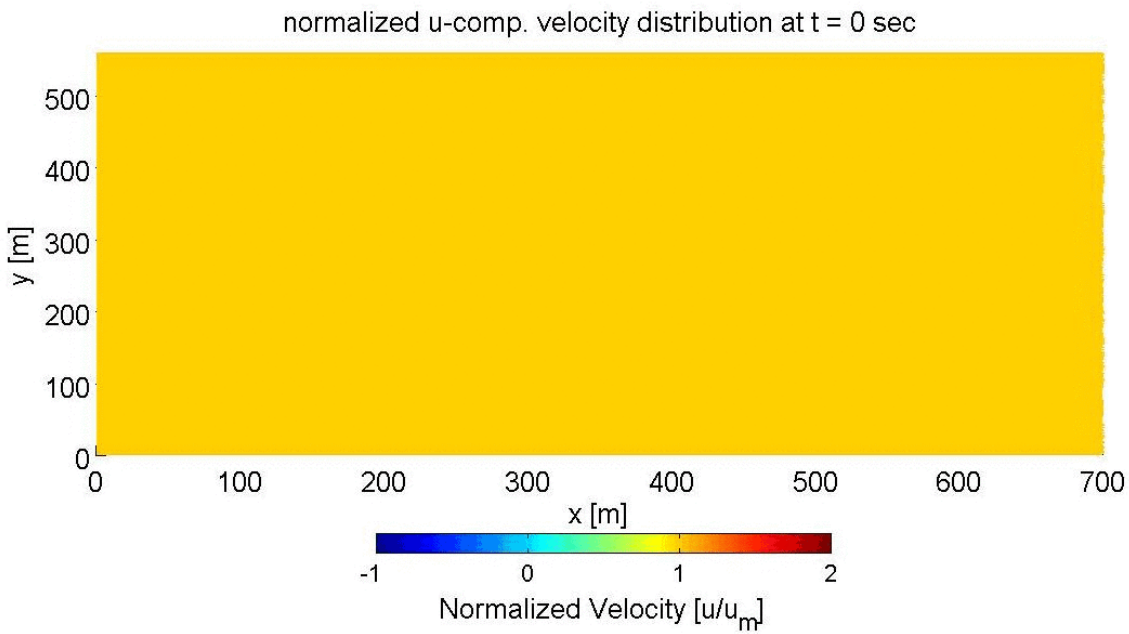
$L_G/D = 2$

$L_T/D = 2$

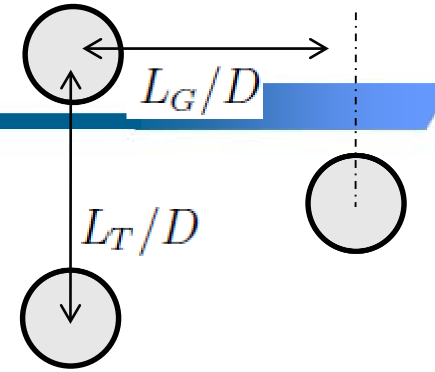


$L_G/D = 2$

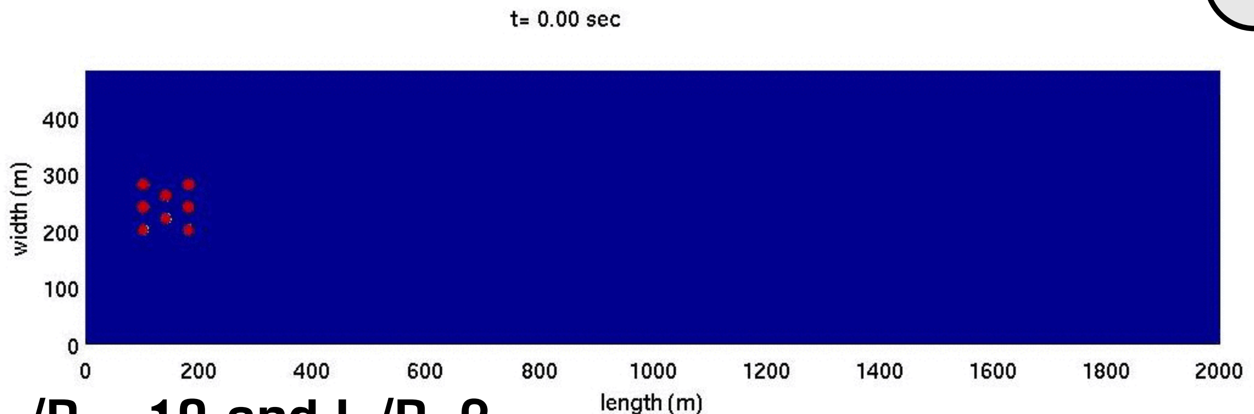
$L_T/D = 4$



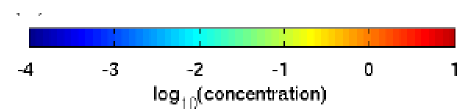
Staggered array cases

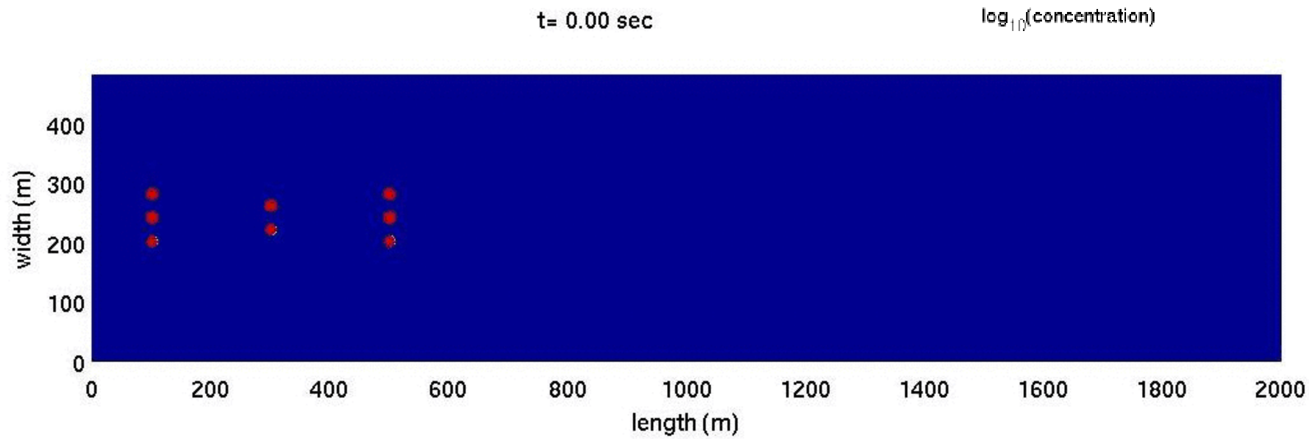


- **Mixing around staggered arrays**
  - L_G/D = 2 and L_T/D=2

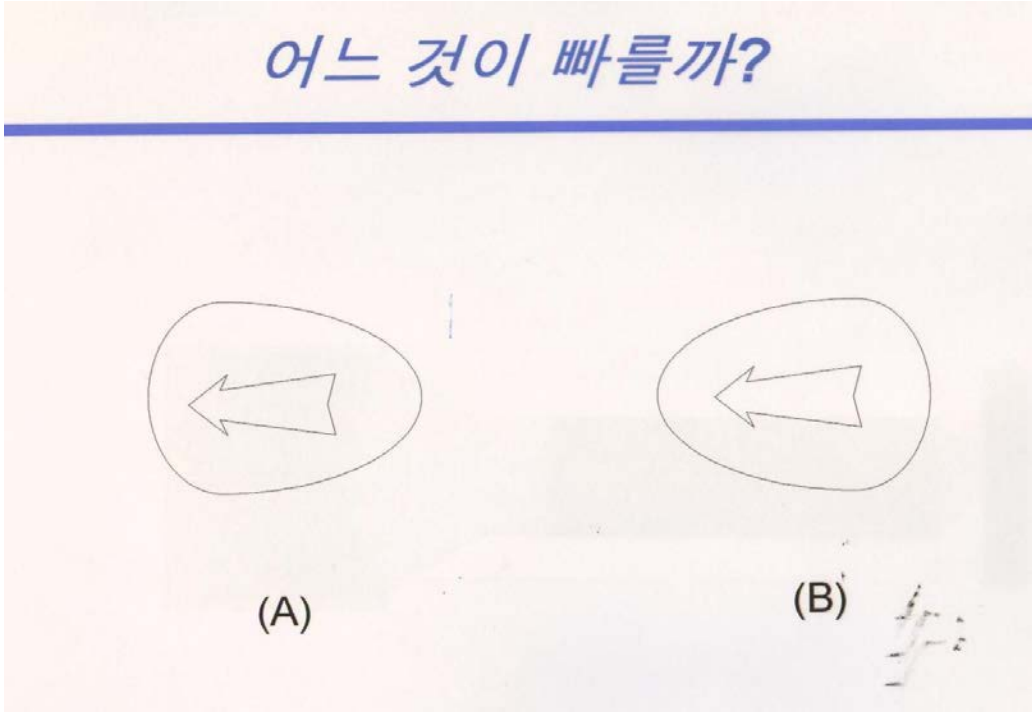


  - L_G/D = 10 and L_T/D=2

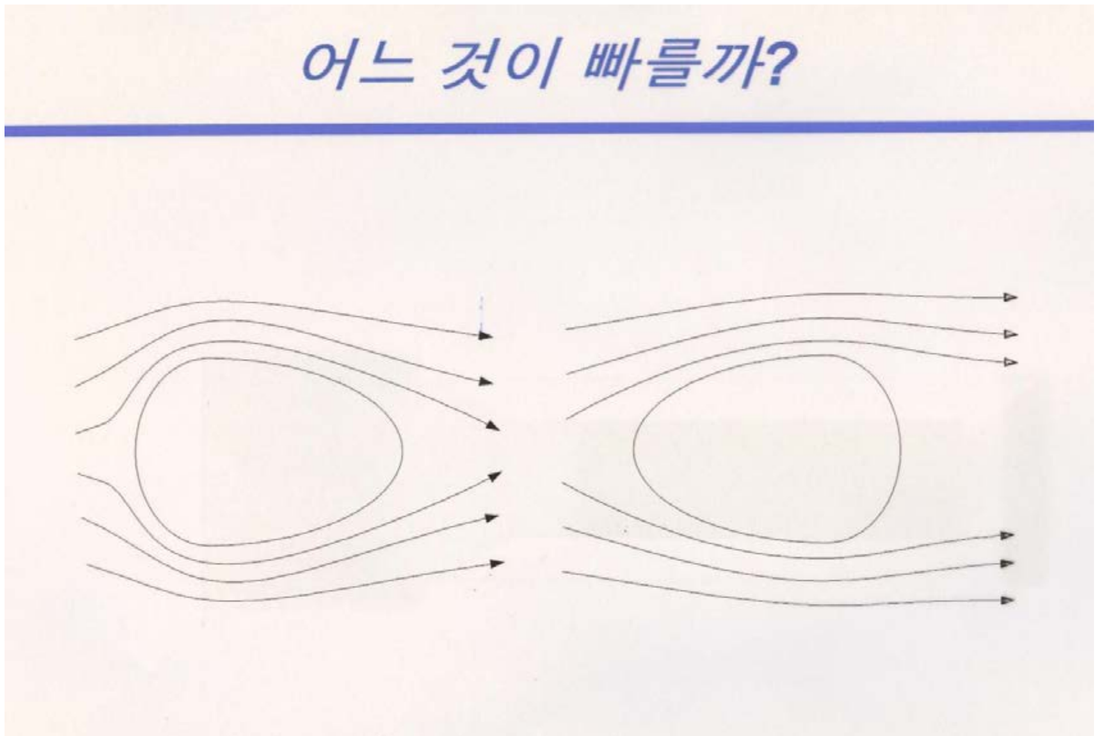




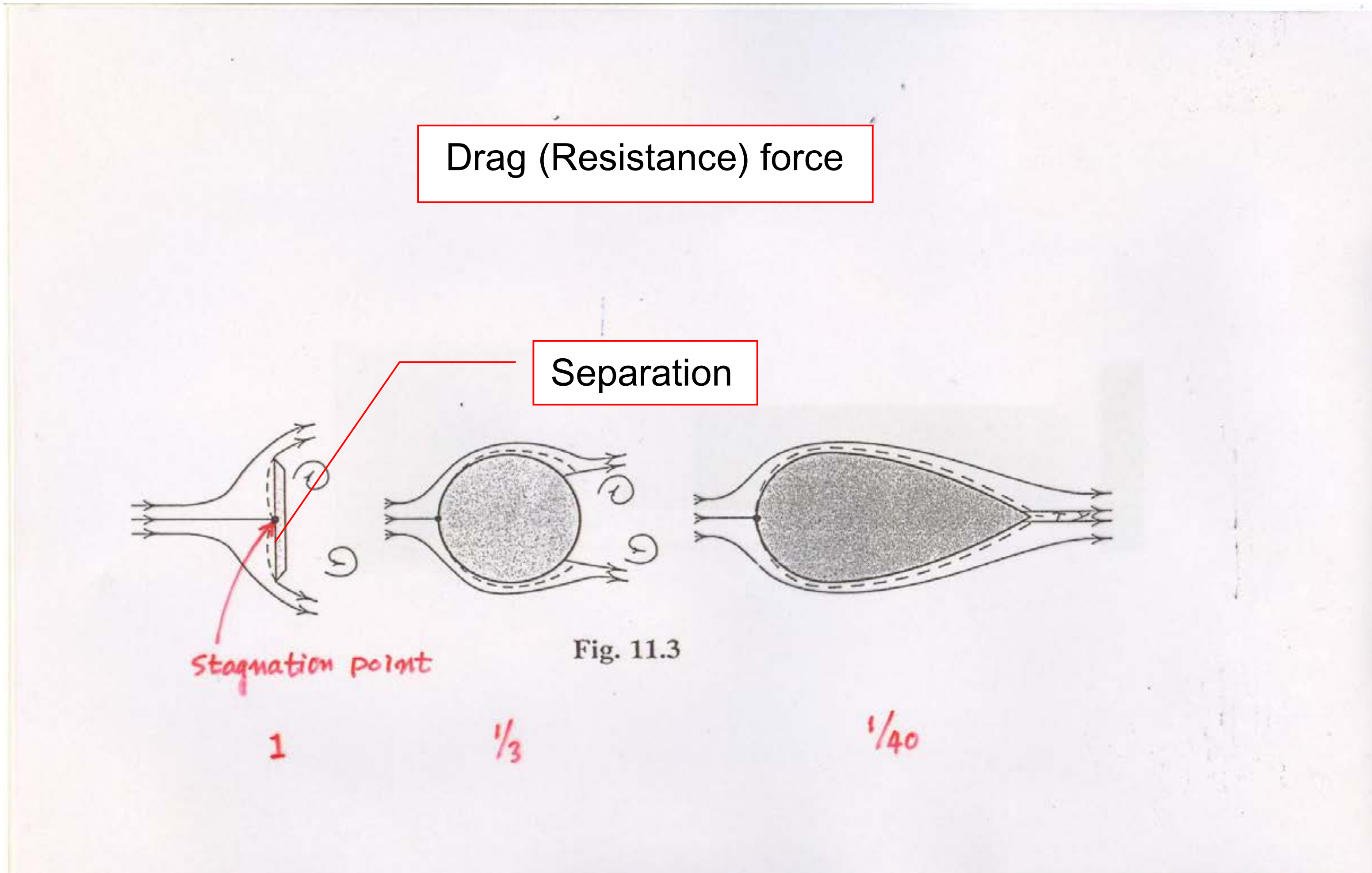
0.2 Physics of Golf



0.2 Physics of Golf

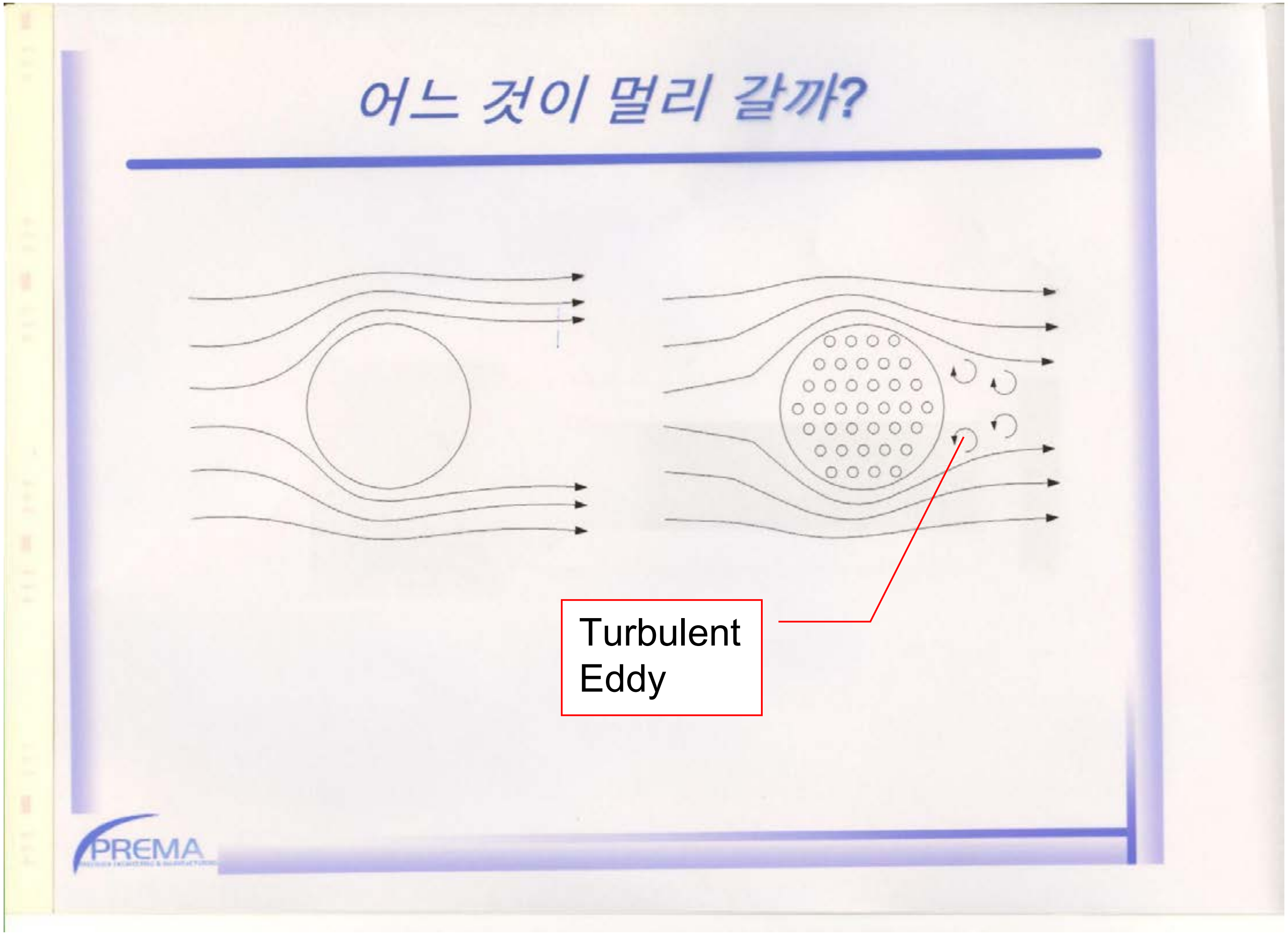


0.2 Physics of Golf



0.2 Physics of Golf

0.2 Physics of Golf



0.2 Physics of Golf

Feathery Ball

Last feathery made by Robertson, in 1852

0.2 Physics of Golf

0.2 Physics of Golf

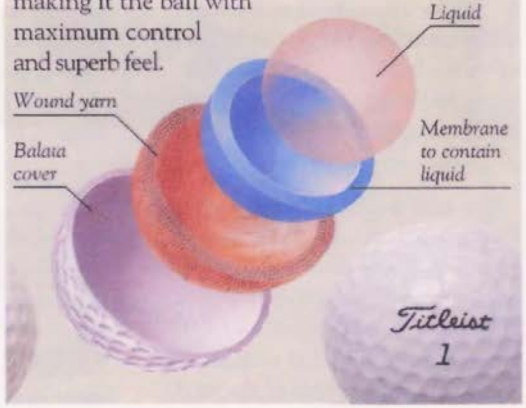
Rubber-core Ball

Three-piece (Surlyn Cover)

This version of the three-piece wound ball has a solid rubber core over which rubber yarn is wound for good control. The cover is made from Surlyn, a thermoplastic resin that is harder than balata and is thus considerably more durable; it is virtually uncuttable.

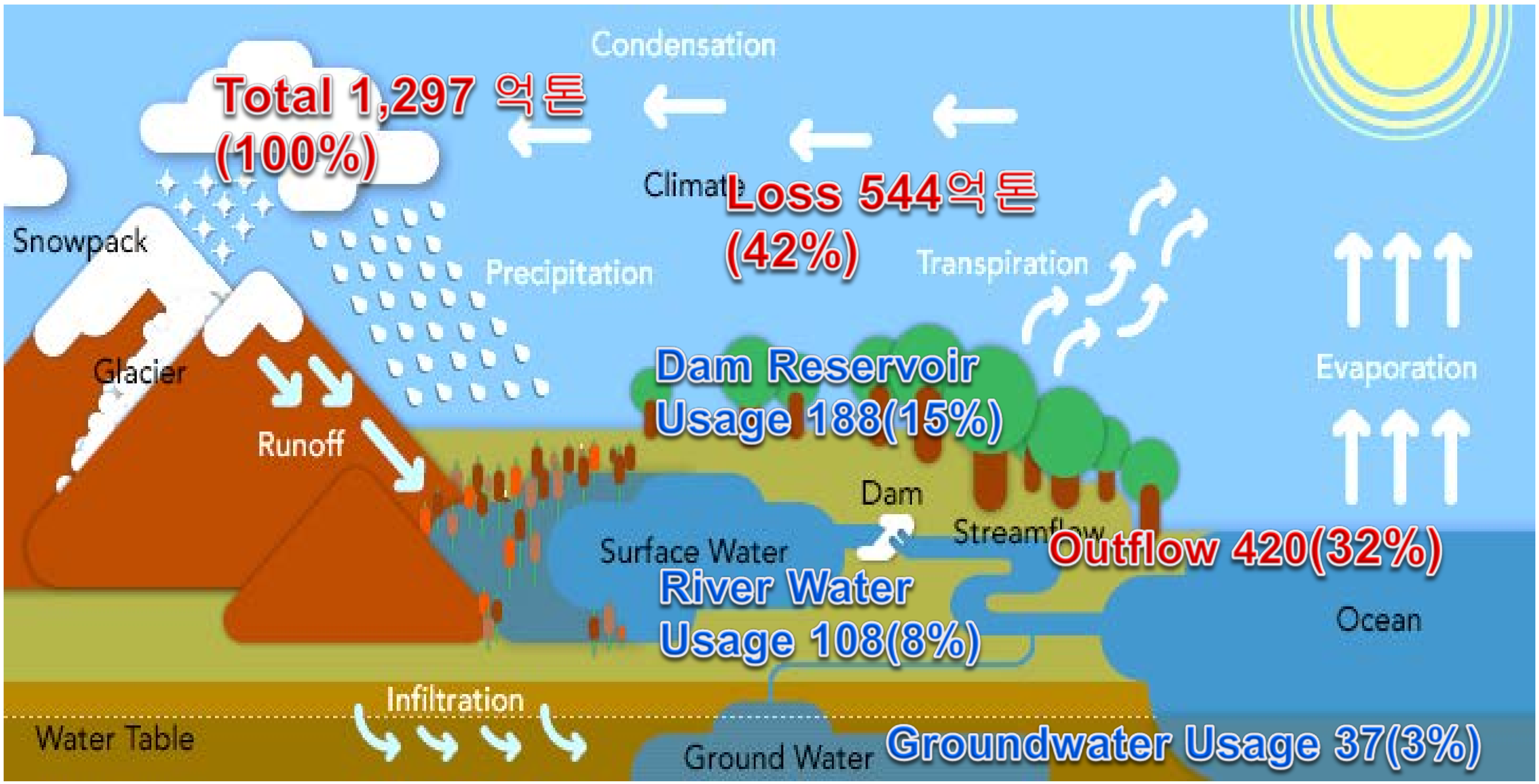
Three-piece (Balata Cover)

The balata-covered, liquid-centred three-piece ball might be described as the most advanced of golf balls. The wound construction over a liquid centre, combined with a soft, synthetic balata cover, produces the highest spin rate, making it the ball with maximum control and superb feel.



PREMA

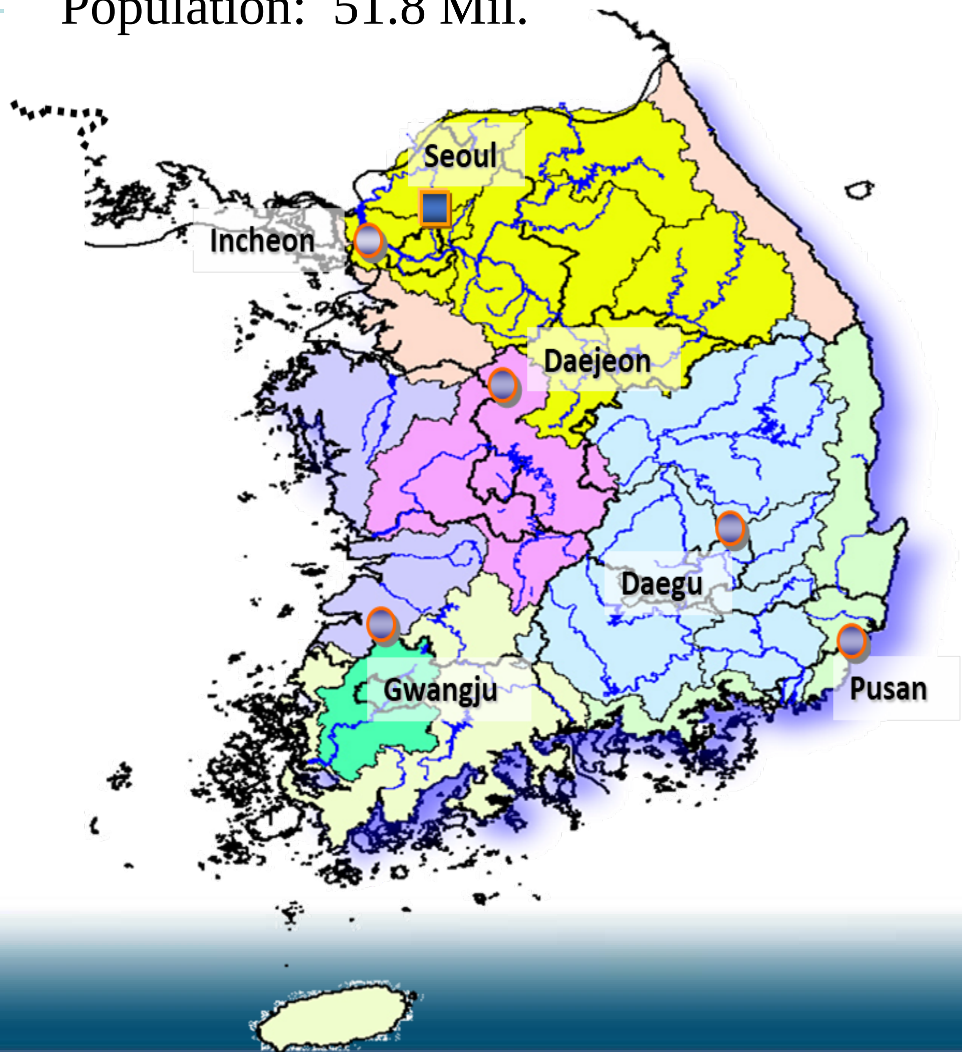
03 Water Resources



Total water usage 333억톤(26%)

Water Resources in Korea

- Annual precipitation: 1,281 mm/yr
- Land area: 99,460 km^2
- Population: 51.8 Mil.



Water Demand	**억 m^3 (%)**
Drinking	76 (20.4)
Industrial	23 (6.2)
Agricultural	**152 (40.9)**
River environments	121 (32.5)
Total	372

Water Supply	**억 m^3 (%)**
Dam reservoir	188 (56.5)
River	108 (32.4)
Groundwater	37 (11.1)
Total	333

<Minister of Environments, 2016>

0.4 Dams

<Chungju Dam>

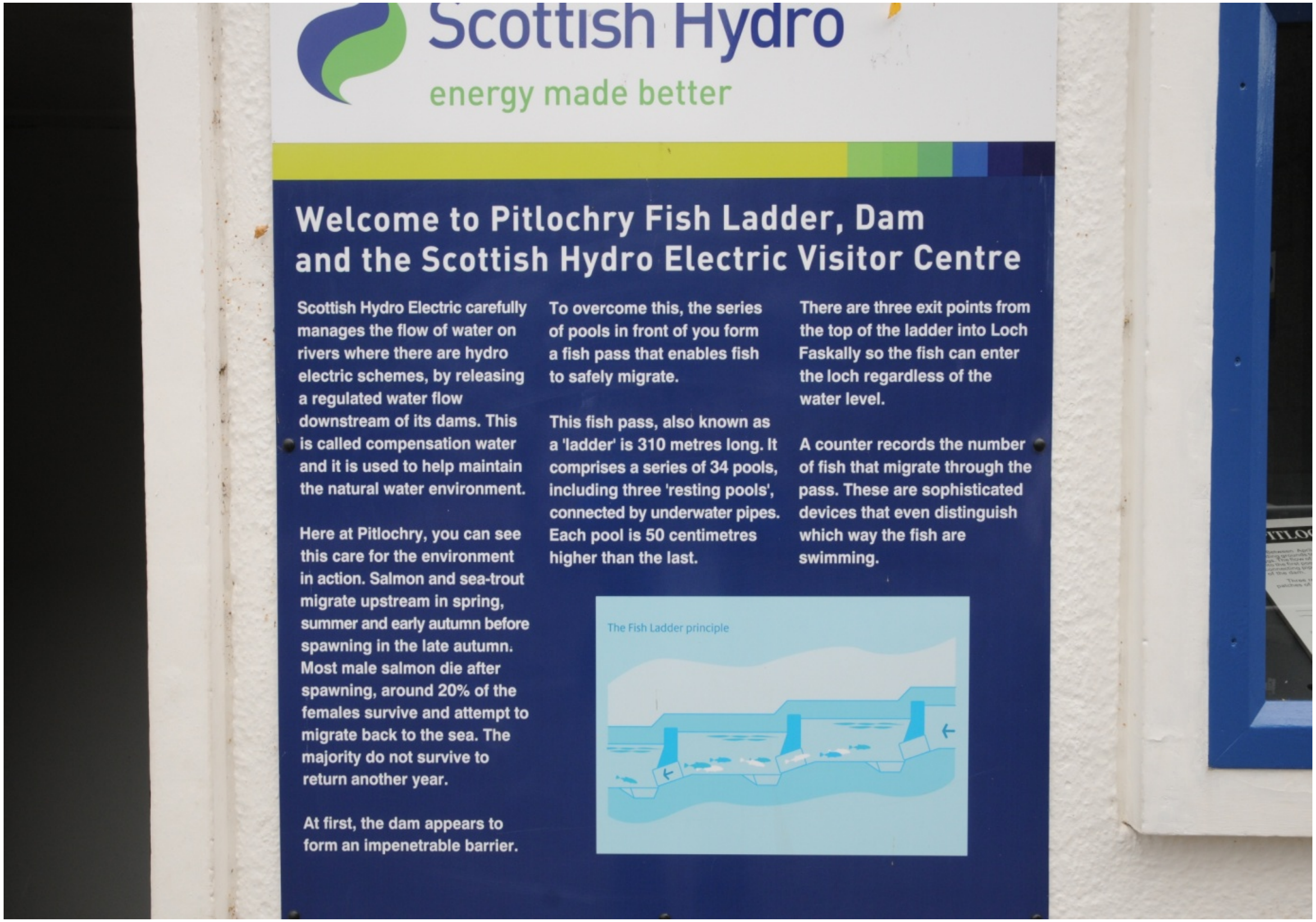
H 97.5 m; L 464 m
Storage: 2.75 billion m^3
Power: 400,000 kW

0.4 Dams

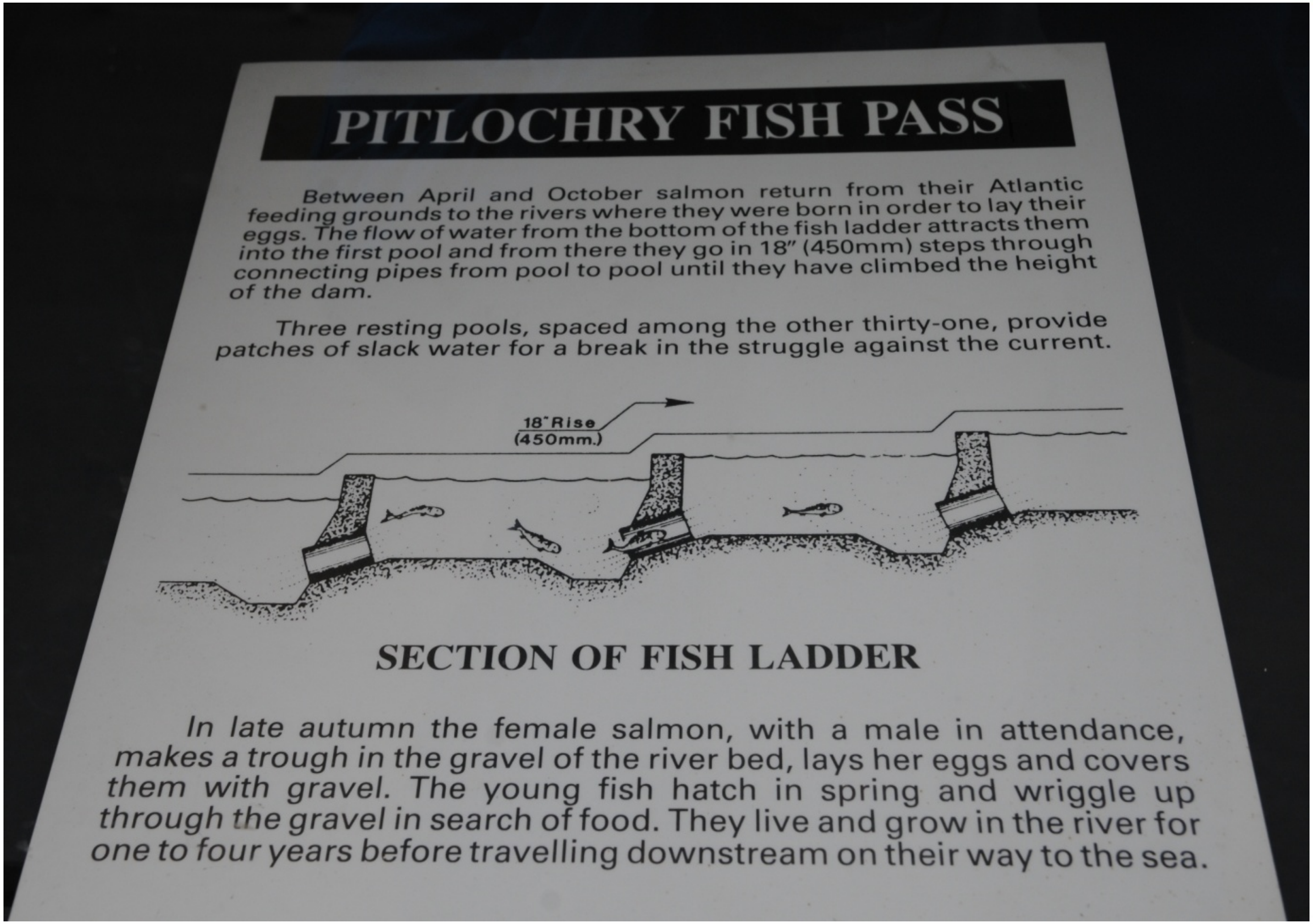
<Daechung Dam>
H 72 m; L 495 m
Storage: 1.49 billion m^3

<Soyang Dam>
H 123 m; L 530 m
Storage: 2.9 billion m^3

0.5 Hydropower Plants

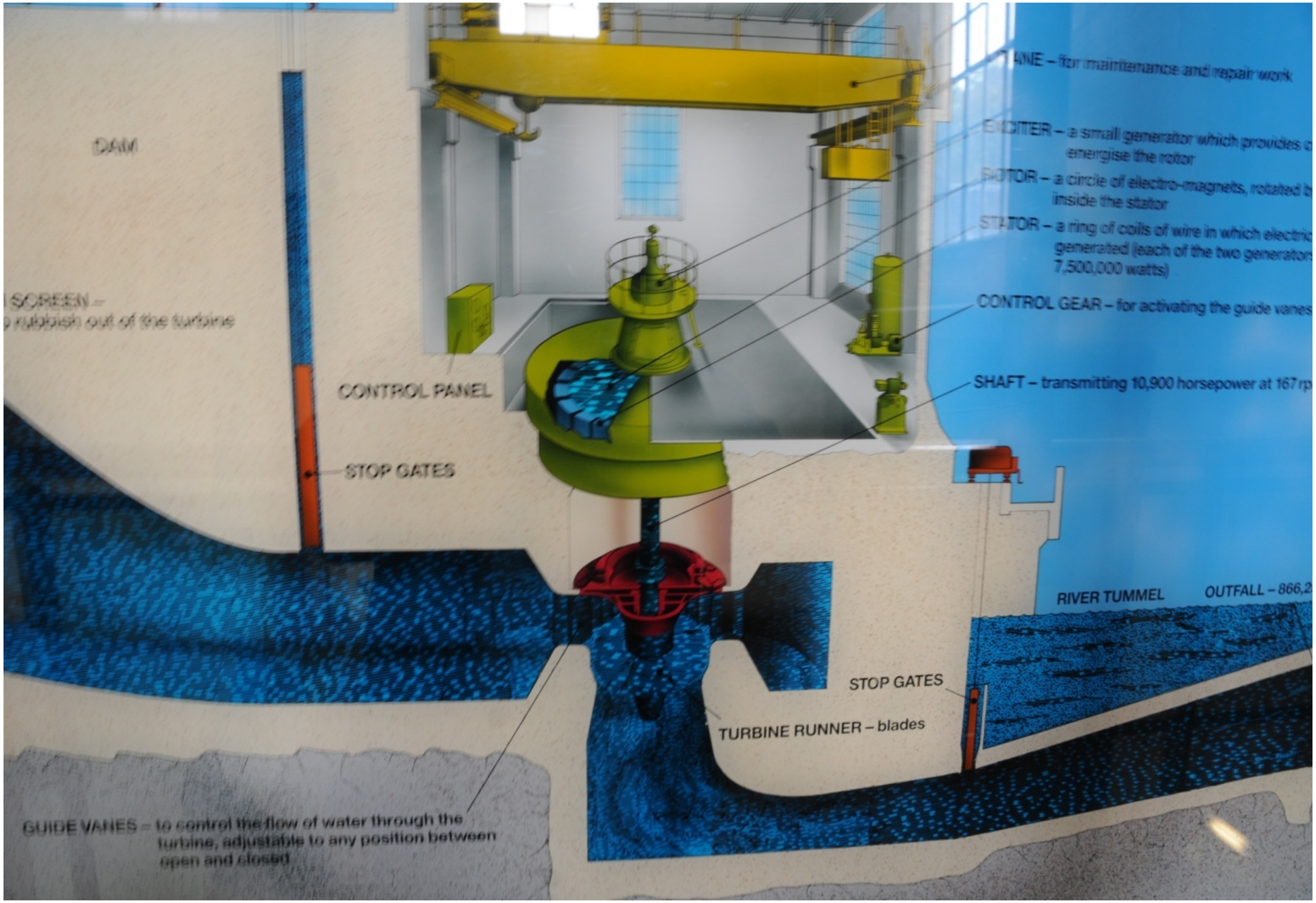


0.5 Hydropower Plants



0.5 Hydropower Plants

0.5 Hydropower Plants



0.5 Hydropower Plants

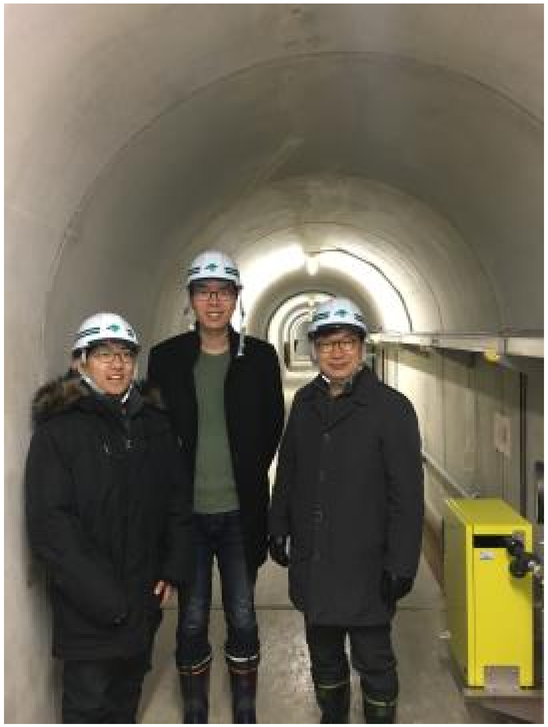
Francis turbine

<Yubari Dam>
H: 110 m
L: 390 m
Storage: 0.43 billion m^3
Power: 26,000 kW

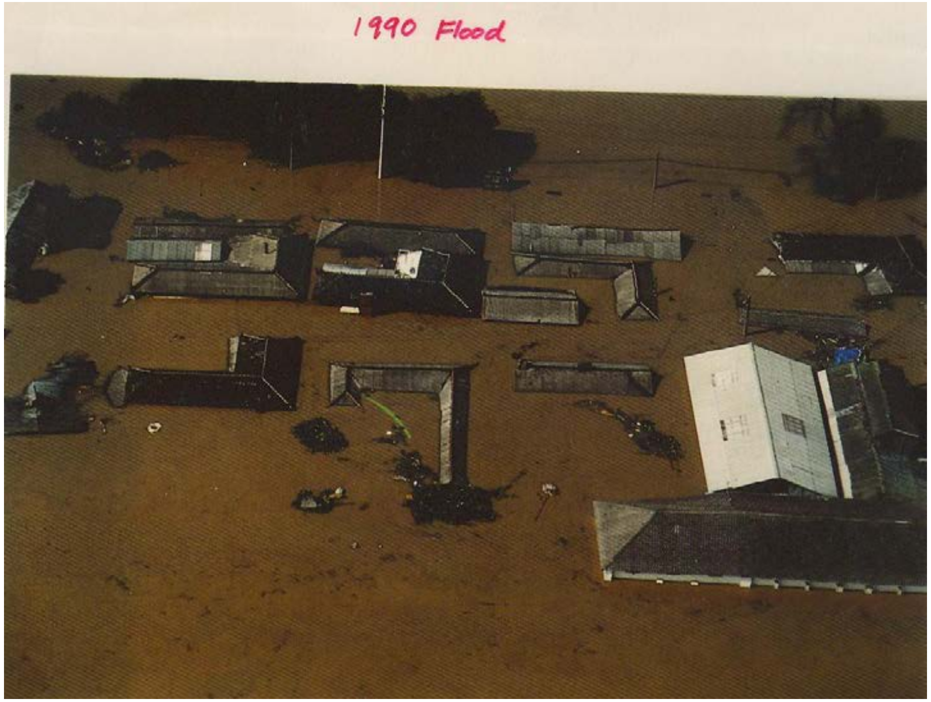
< Yubari Dam, Hokkaido, Japan>

Motivation

Motivation



0.6 Floods



0.7 River Navigation

0.7 River Navigation

Mississippi River

Neckar River, Germany

Falkirk Wheel, UK

Ara Canal

Canal:

L: 18 km; W: 80 m; H: 6.3 m

Photographed on July, 2016

0.8 River Recreation