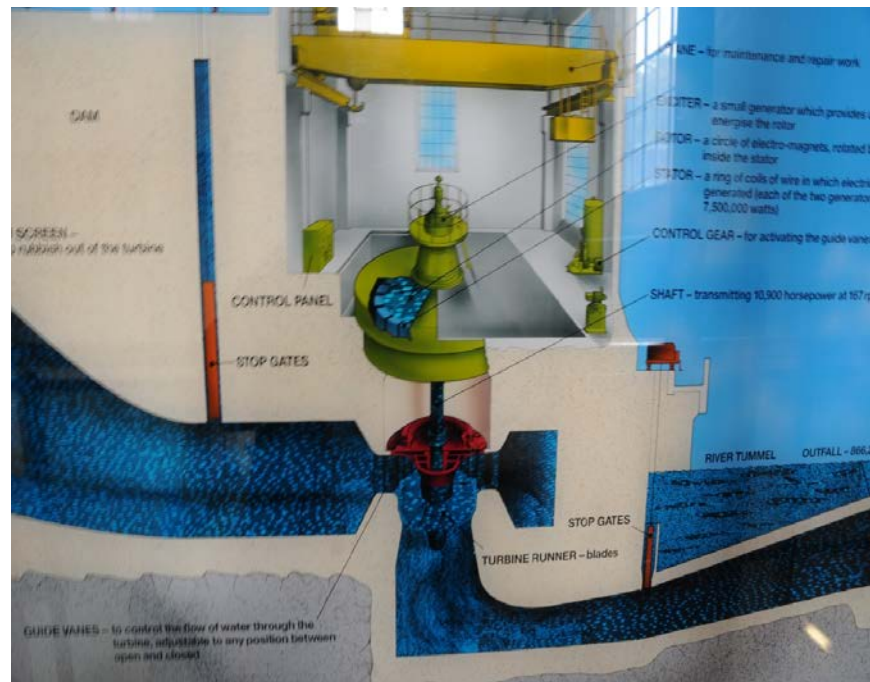


Fluid Dynamics

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

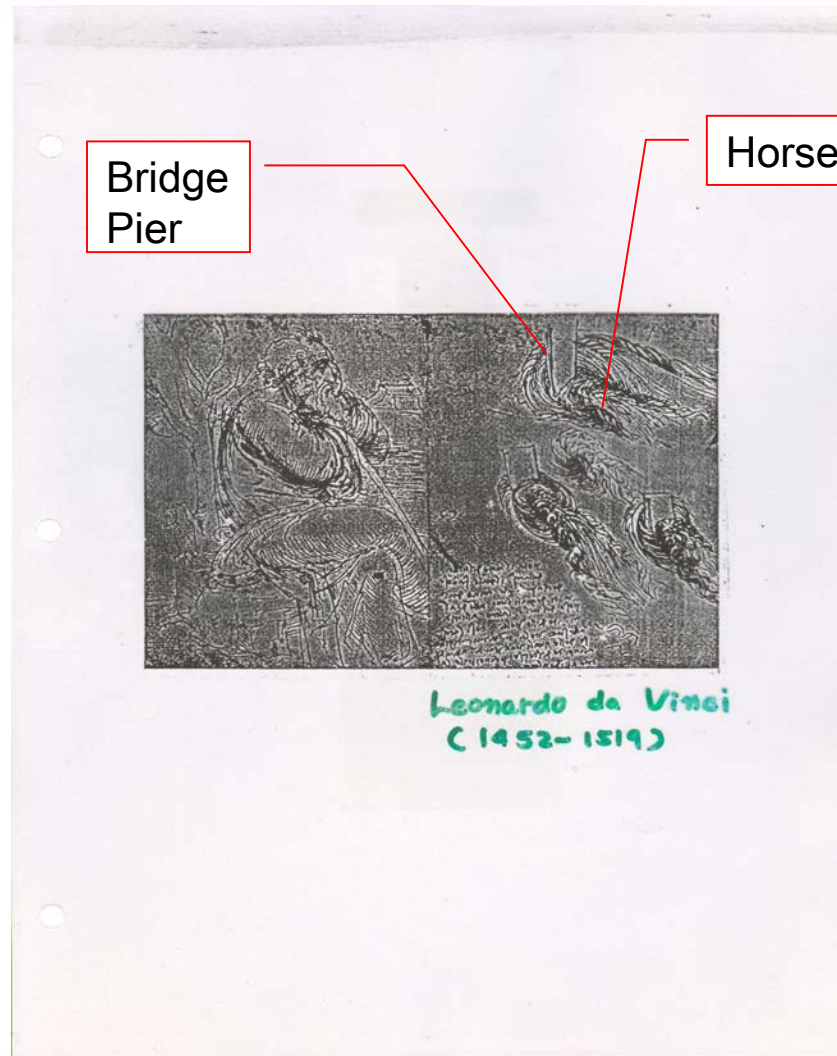
0.8 River Recreation

Chapter 0 Why Fluid Mechanics?

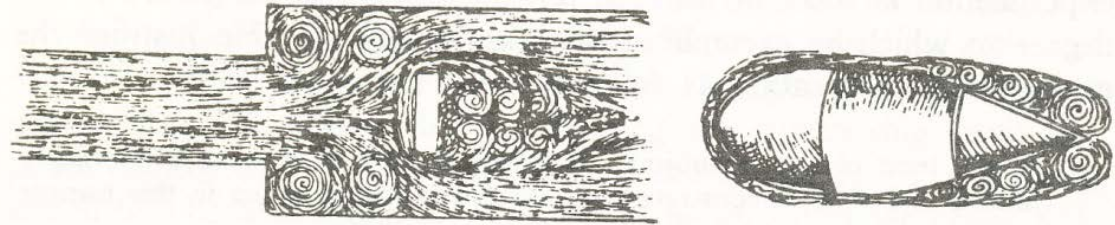
Objectives

- 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



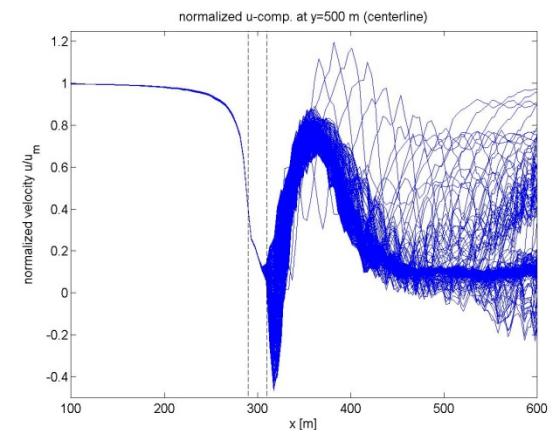
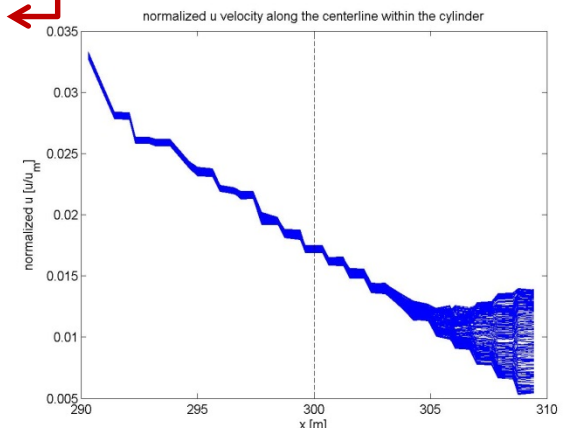
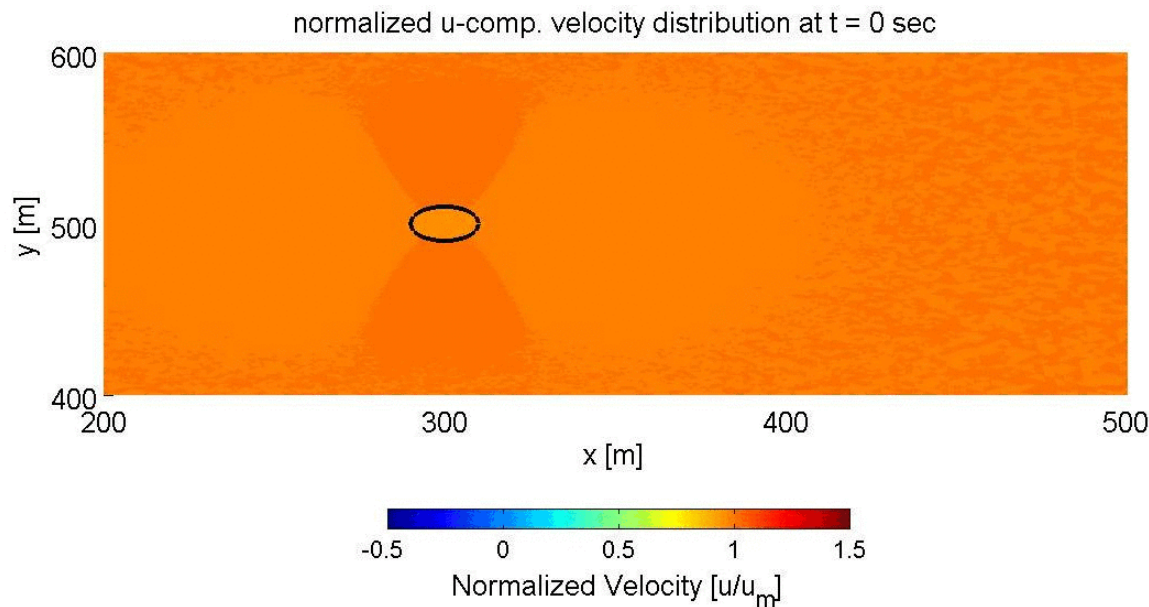
Velocity field around/within a single cylinder

□ Momentum reduction by quadratic drag law formulation.

- Governing equations including the drag law formulation.

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

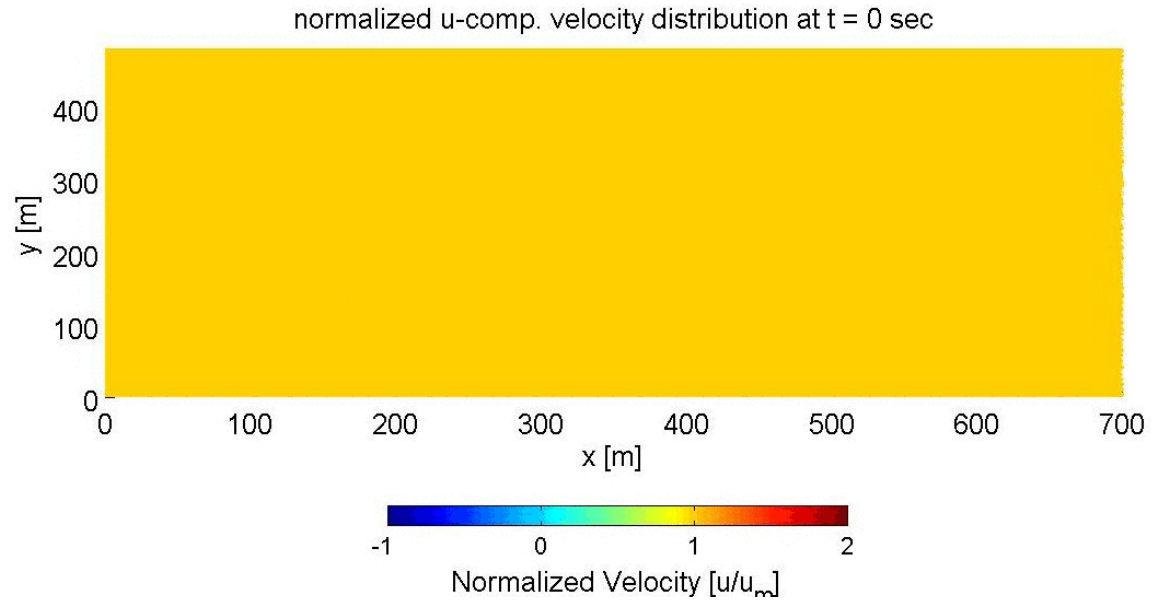
$$F_{D,x} = -\frac{\alpha C_D (u^2 + v^2)^{1/2}}{D} u,$$



Velocity fields

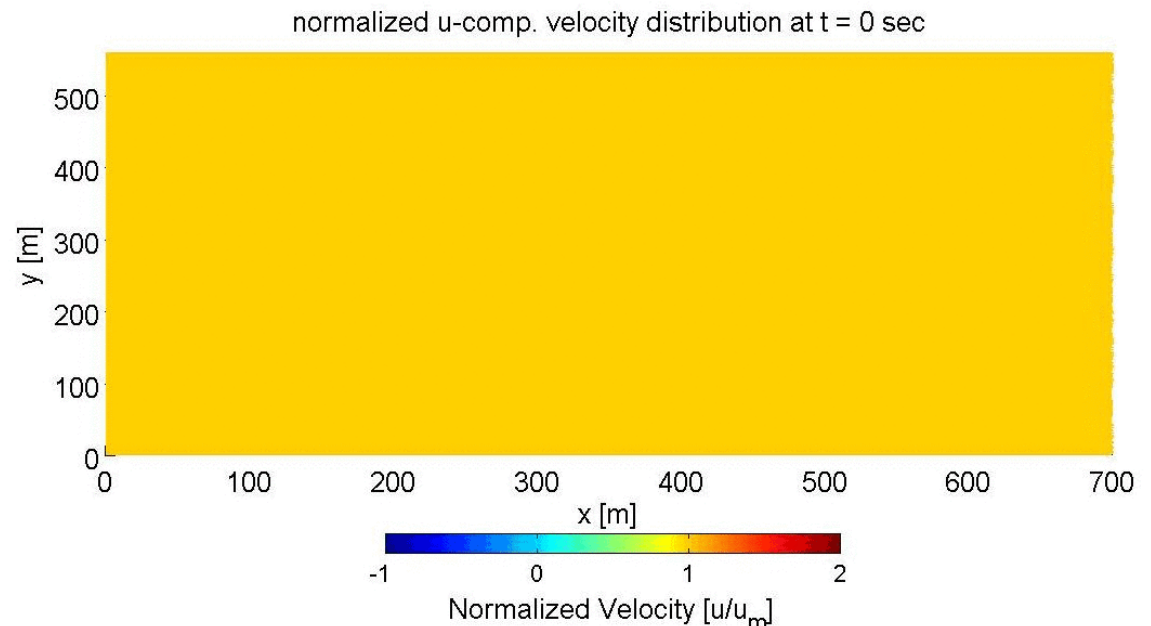
$$L_G/D = 2$$

$$L_T/D = 2$$



$$L_G/D = 2$$

$$L_T/D = 4$$

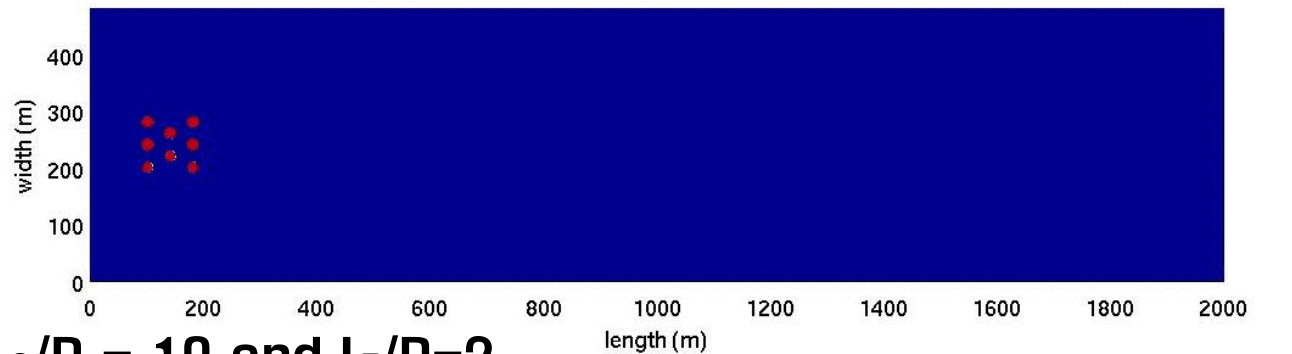


Staggered array cases

□ Mixing around staggered arrays

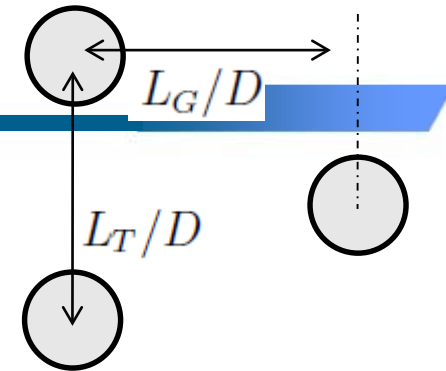
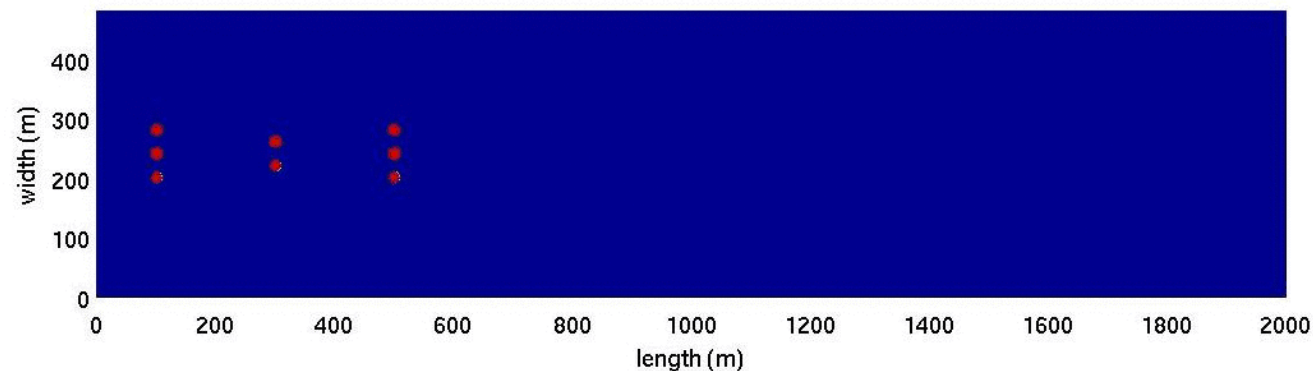
– $L_G/D = 2$ and $L_T/D = 2$

$t = 0.00$ sec

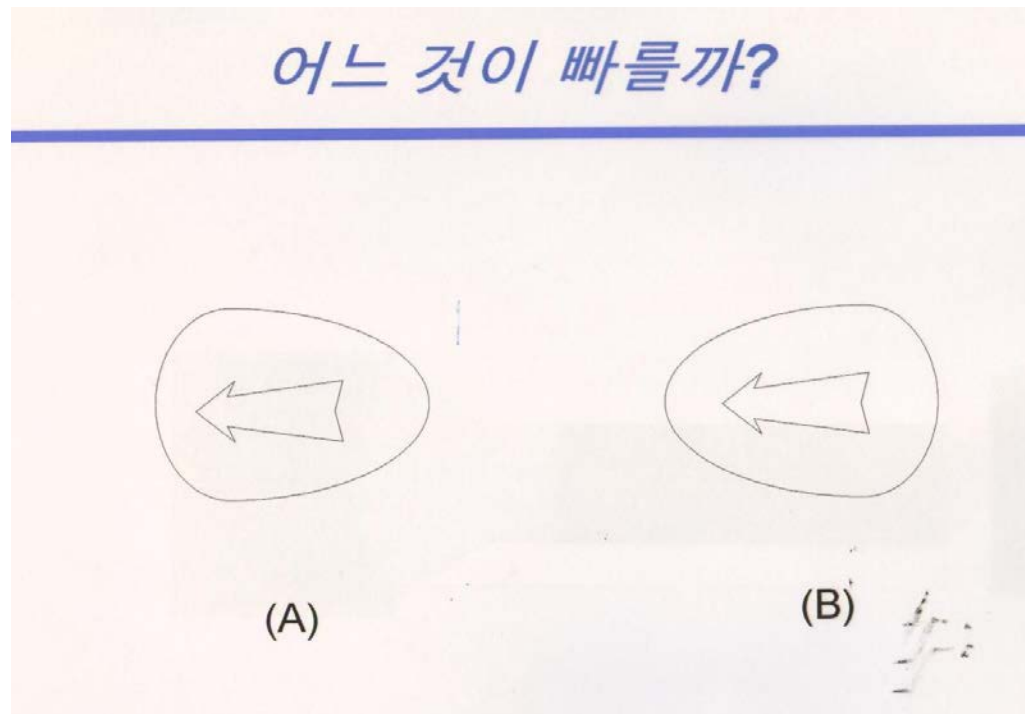


– $L_G/D = 10$ and $L_T/D = 2$

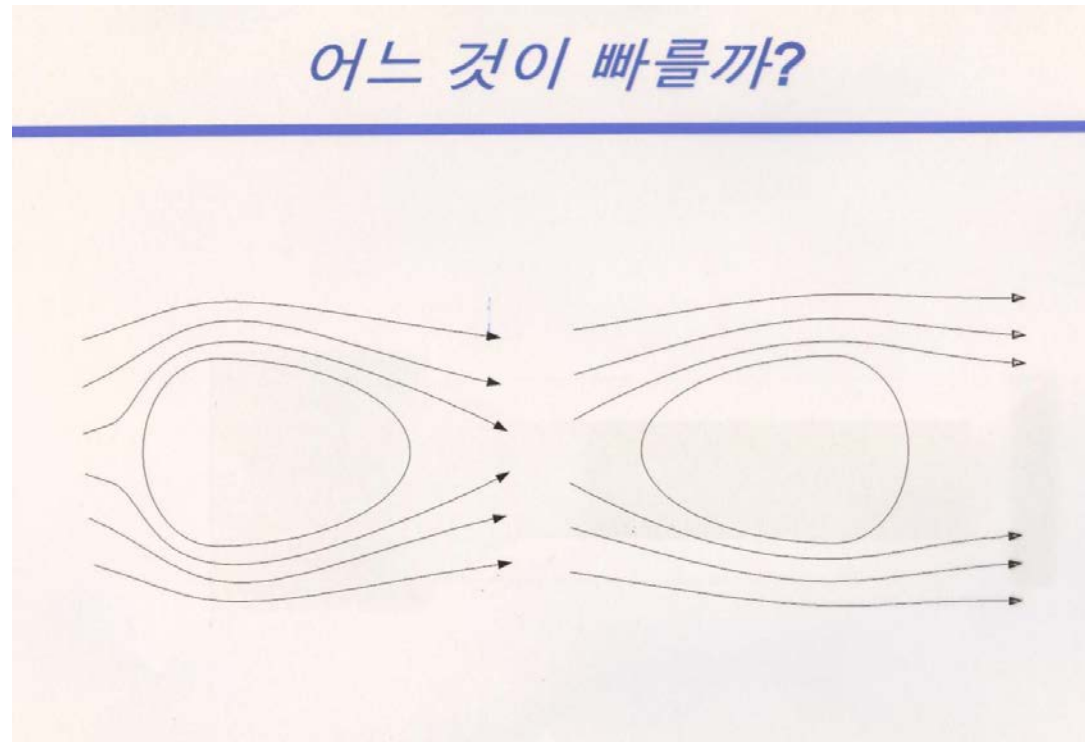
$t = 0.00$ sec



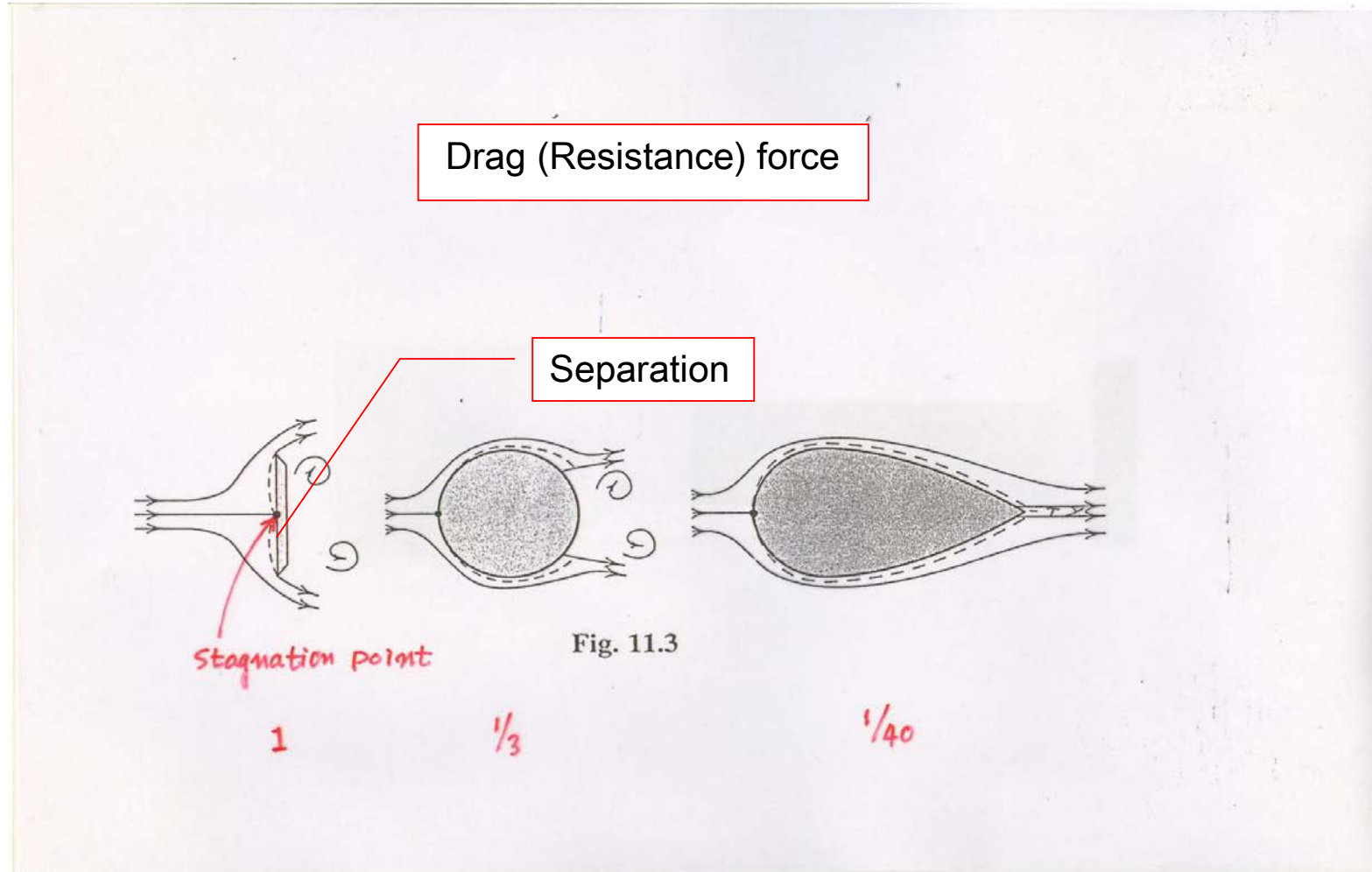
0.2 Physics of Golf



0.2 Physics of Golf



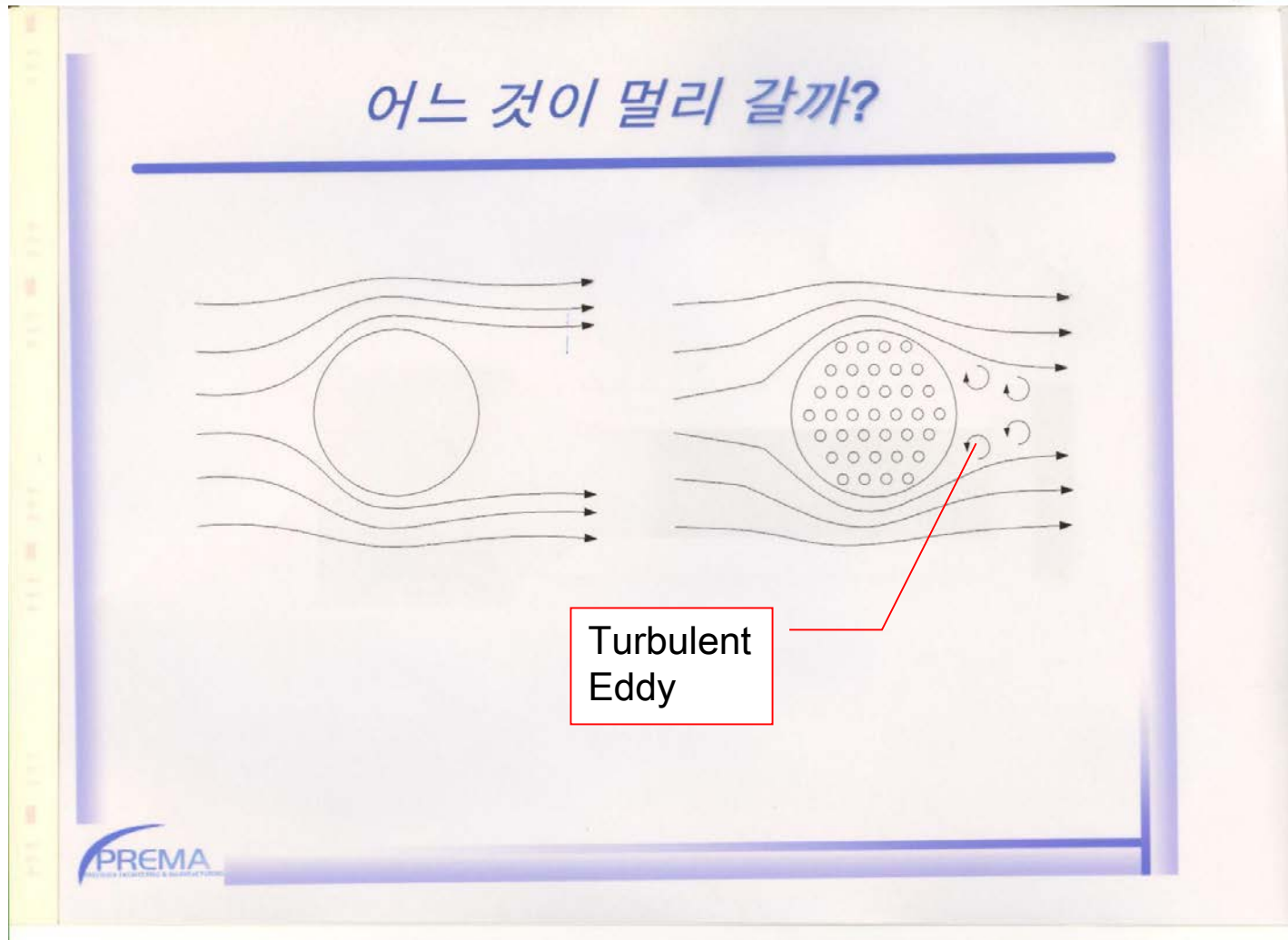
0.2 Physics of Golf



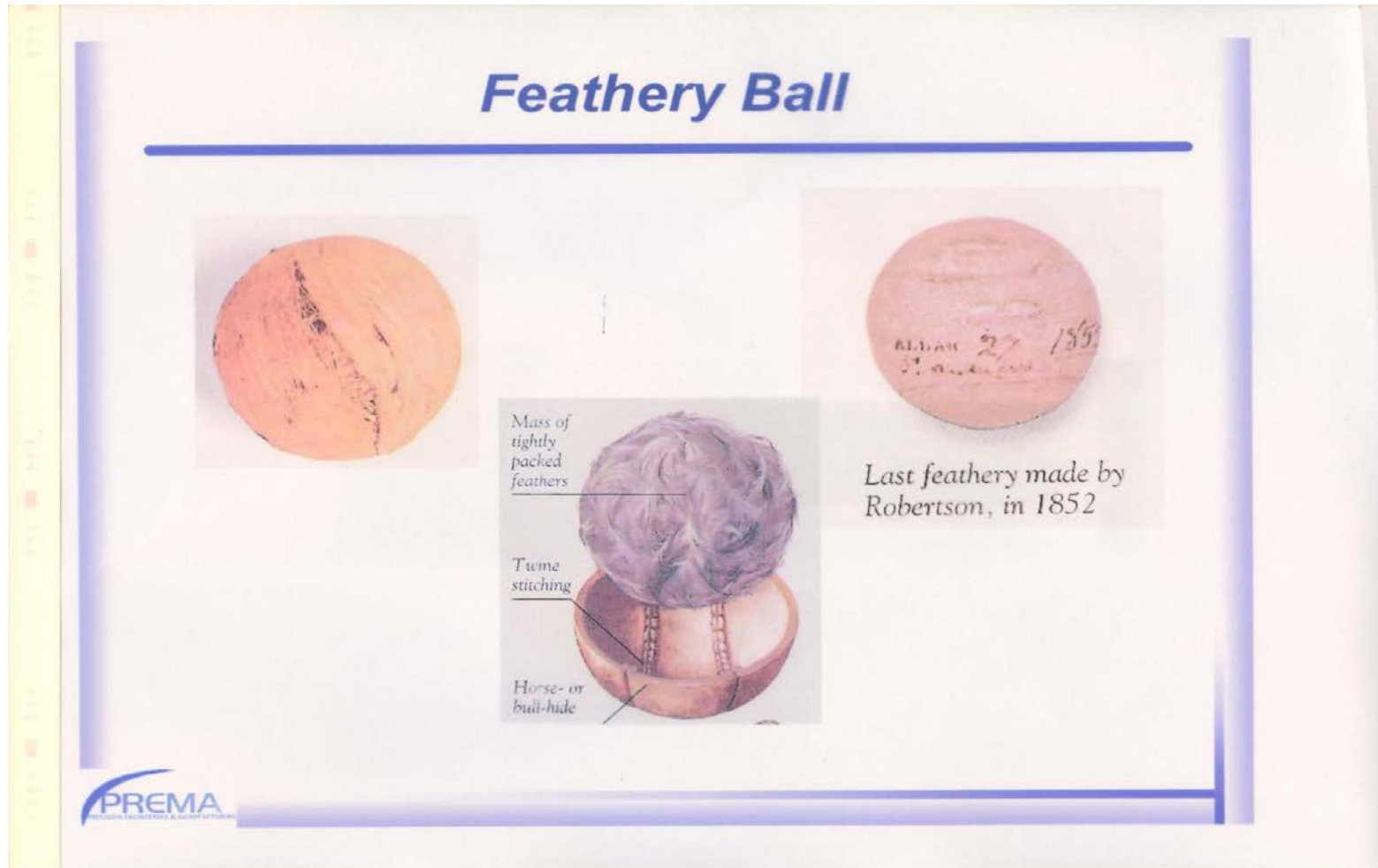
0.2 Physics of Golf



0.2 Physics of Golf



0.2 Physics of Golf



0.2 Physics of Golf

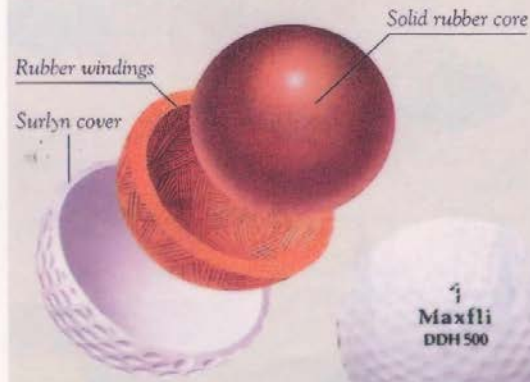


0.2 Physics of Golf

Rubber-core Ball

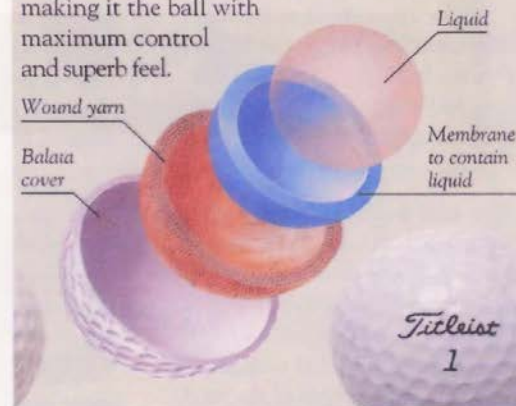
THREE-PIECE (SURLYN COVER)

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.

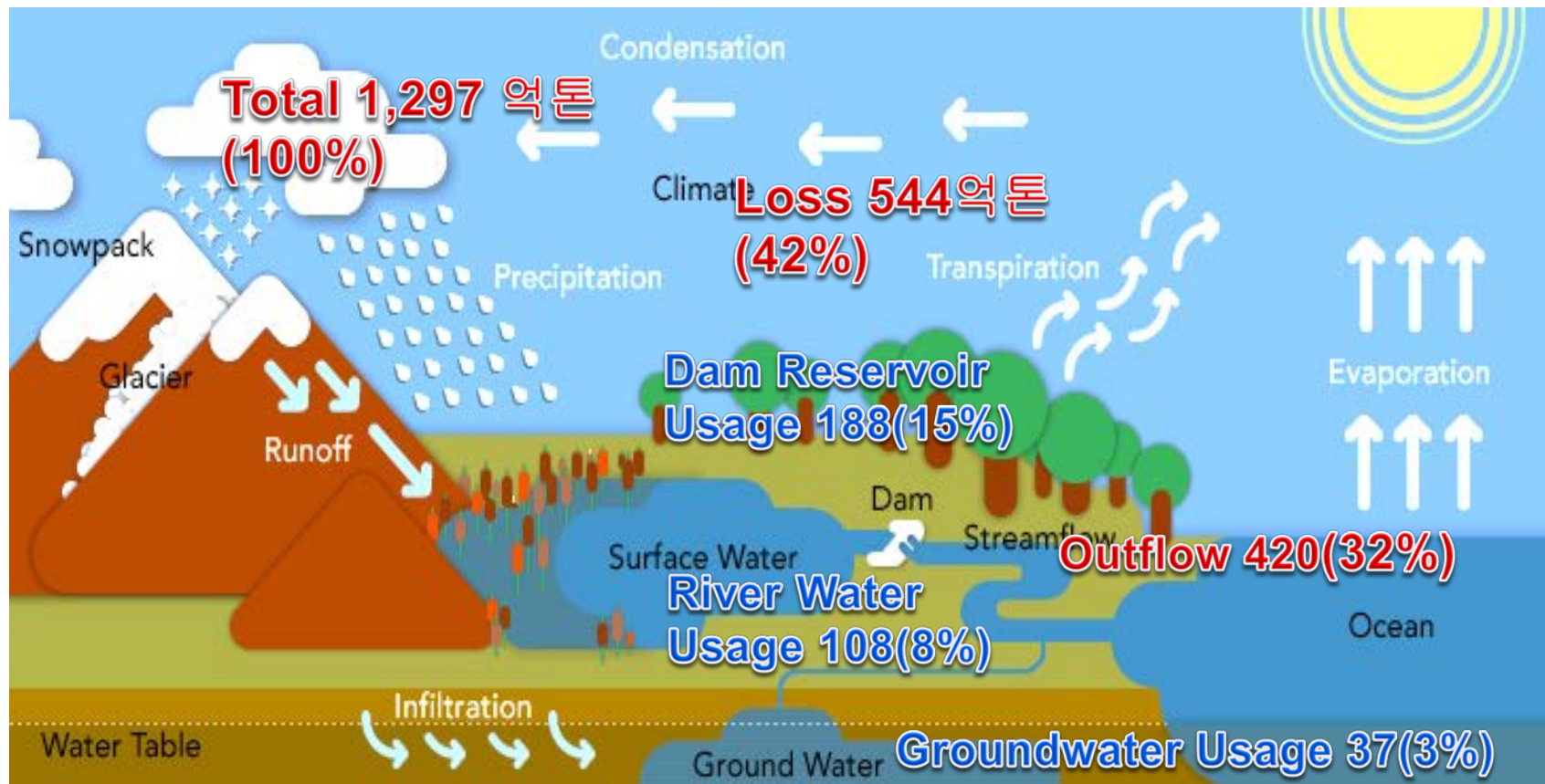


THREE-PIECE (BALATA COVER)

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.



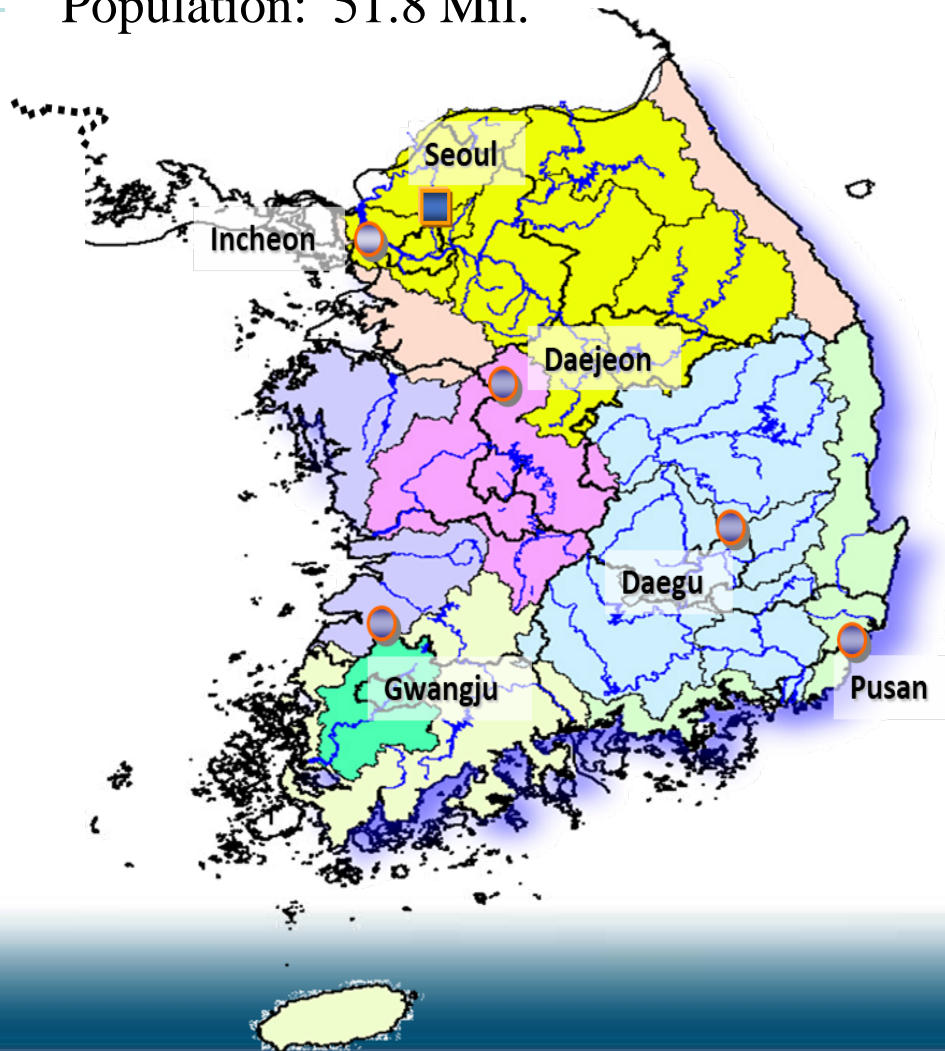
03 Water Resources



Total water usage 333 억톤 (26%)

Water Resources in Korea

- Annual precipitation: 1,281 mm/yr
- Land area: 99,460 km²
- 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

0.4 Dams



<Chungju Dam>

H 97.5 m; L 464 m

Storage: 2.75 billion m³

Power: 400,000 kW



0.4 Dams




<Daechung Dam>
H 72 m; L 495 m
Storage: 1.49 billion m³



<Soyang Dam>
H 123 m; L 530 m
Storage: 2.9 billion m³

0.5 Hydropower Plants



Scottish Hydro
energy made better

Welcome to Pitlochry Fish Ladder, Dam and the Scottish Hydro Electric Visitor Centre

Scottish Hydro Electric carefully manages the flow of water on rivers where there are hydro electric schemes, by releasing a regulated water flow downstream of its dams. This is called compensation water and it is used to help maintain the natural water environment.

Here at Pitlochry, you can see this care for the environment in action. Salmon and sea-trout migrate upstream in spring, summer and early autumn before spawning in the late autumn. Most male salmon die after spawning, around 20% of the females survive and attempt to migrate back to the sea. The majority do not survive to return another year.

At first, the dam appears to form an impenetrable barrier.

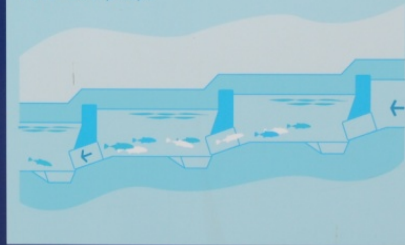
To overcome this, the series of pools in front of you form a fish pass that enables fish to safely migrate.

This fish pass, also known as a 'ladder' is 310 metres long. It comprises a series of 34 pools, including three 'resting pools', connected by underwater pipes. Each pool is 50 centimetres higher than the last.

There are three exit points from the top of the ladder into Loch Faskally so the fish can enter the loch regardless of the water level.

A counter records the number of fish that migrate through the pass. These are sophisticated devices that even distinguish which way the fish are swimming.

The Fish Ladder principle

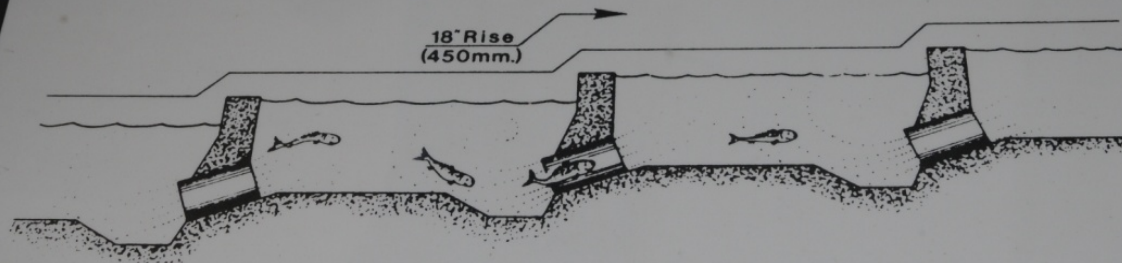


0.5 Hydropower Plants

PITLOCHRY FISH PASS

Between April and October salmon return from their Atlantic feeding grounds to the rivers where they were born in order to lay their eggs. The flow of water from the bottom of the fish ladder attracts them into the first pool and from there they go in 18" (450mm) steps through connecting pipes from pool to pool until they have climbed the height of the dam.

Three resting pools, spaced among the other thirty-one, provide patches of slack water for a break in the struggle against the current.



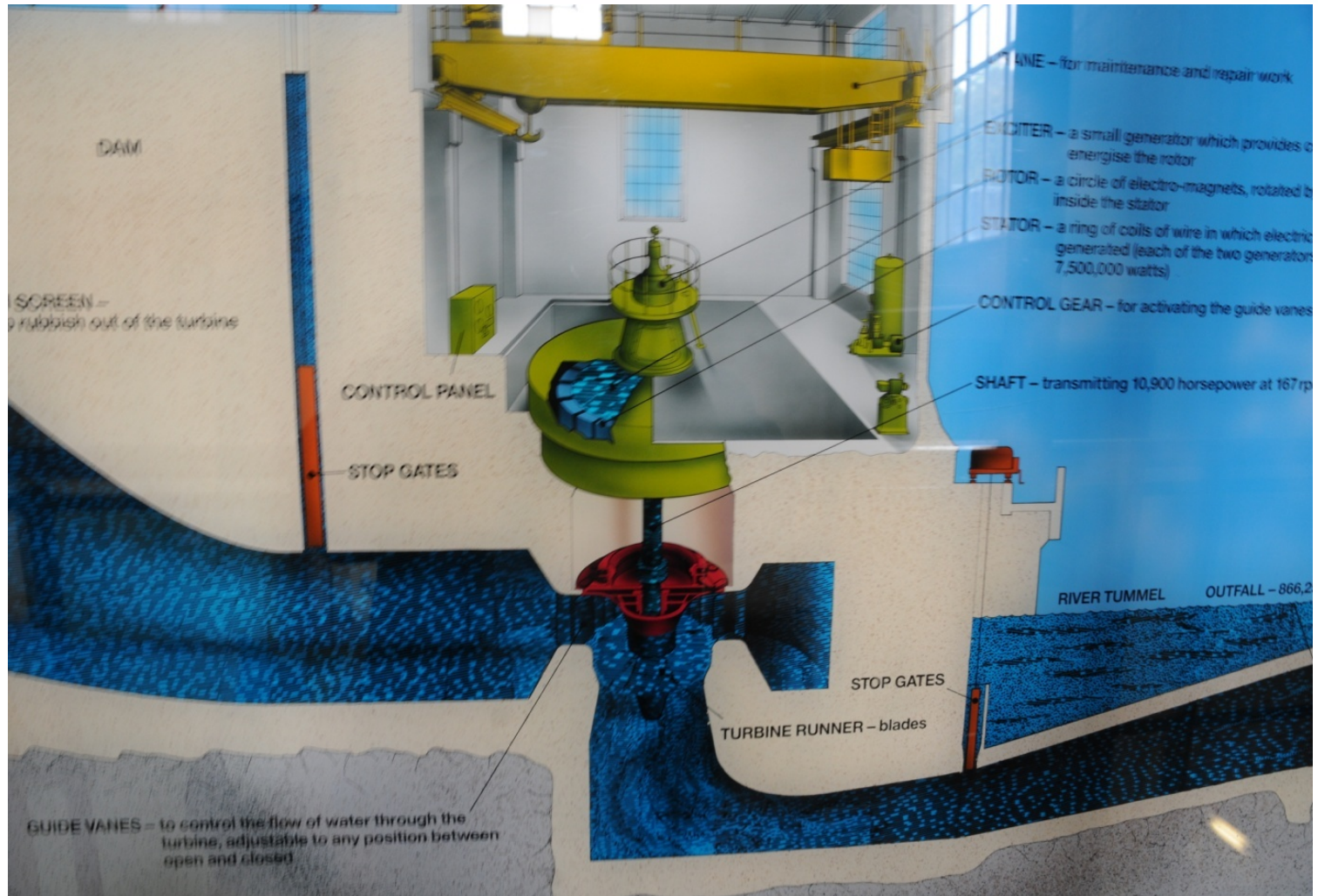
SECTION OF FISH LADDER

In late autumn the female salmon, with a male in attendance, makes a trough in the gravel of the river bed, lays her eggs and covers them with gravel. The young fish hatch in spring and wriggle up through the gravel in search of food. They live and grow in the river for one to four years before travelling downstream on their way to the sea.

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 m³

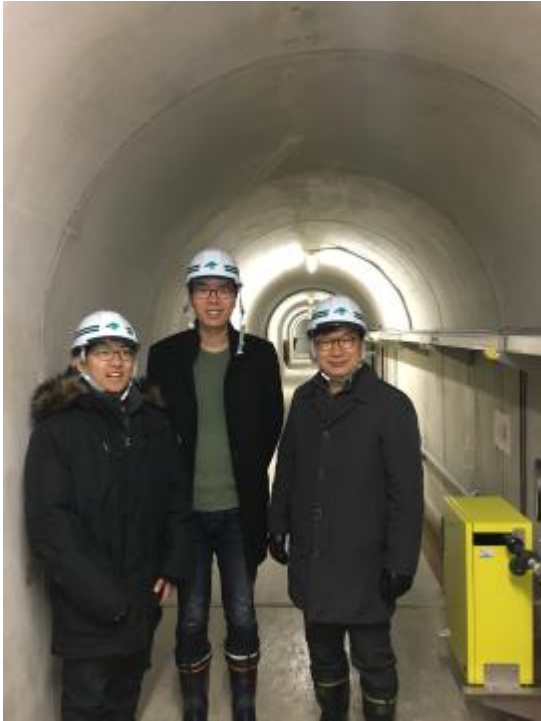
Power: 26,000 kW

< Yubari Dam, Hokkaido, Japan>

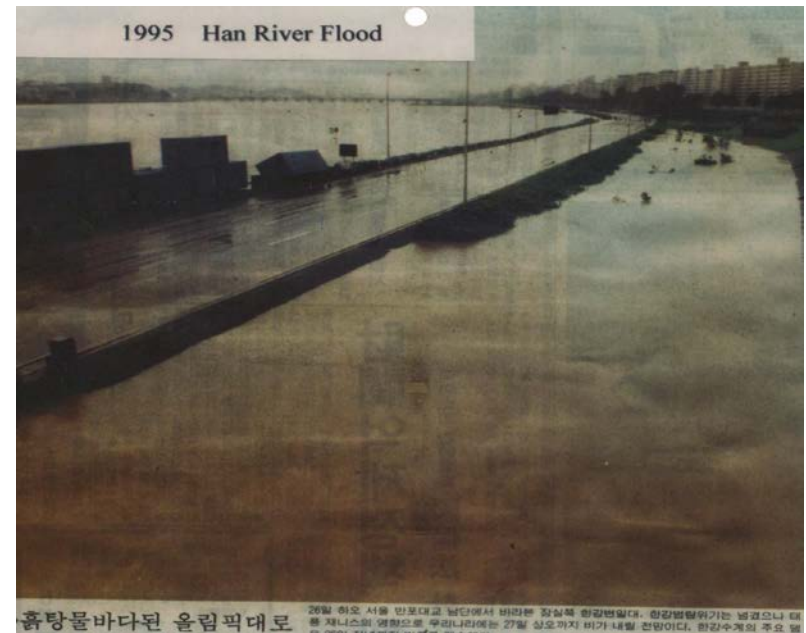
Motivation



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

