

Hydraulics

Introduction to the Class of 2024

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- Fluid mechanics
- Sediment transport
- Turbulence modeling
- Eco-hydraulics

- Chief Editor of JHER (IAHR-APD)
- Associate Editor of JHE (ASCE)
- EBM of Engineering Applications in Computational Fluid Mechanics

Professor Sung-Uk Choi

A Year of Water through the Spillway Gates

Terry W. Sturm, MASCE
Chief Editor

By the time this is published, I will have completed my first year as Editor: a busy year of learning to operate the spillway gates during a flood of manuscripts, however metaphorically. Much to my relief, the *Journal* seems to be stronger than ever, thanks to a very dedicated and experienced group of associate editors (AEs), as well as hundreds of reviewers who make the peer review system work. This note is a review of the previous year's activities and a look toward the future.

Journal Statistics

Although complete statistics for 2010 are not available as of this writing, the number of monthly submissions has exceeded those of 2009 in five of the previous nine months. The number of manuscripts published in 2010 is about 10% higher than in 2009 despite the variability in number of papers per issue; the journal-publishing business is an unsteady-flow process. The 2009 journal impact factor has hit a 5-year high, although I can take no credit for that. What encourages me the most is that *Hydraulic Engineering* is growing in both breadth of applications and in depth of fluid-mechanics insights. From the issues of the previous year, and you can see traditional articles on advances in hydraulic structure design alongside such diverse subjects as flow through vegetation, fish habitat development, river mechanics, advances in field instrumentation, dam-break modeling, sophisticated analyses of pipe flow systems, steady transitions between open-channel and pipe flow, bridge scour, environmental fluid mechanics, and fundamental investigations on the connection between turbulence and sediment motion, to name only a few. In my estimation the legacy of Hunter Rouse, in which fluid mechanics is at the core of hydraulic engineering, is alive and well.

Much was added to the diversity in subject matter of papers published in the past year by the special December issue, "Special Issue on River Flow Hydrodynamics: Physical and Ecological Aspects." Kudos go to the guest editors, Fotis Sotiropoulos and Panagiotis Diplas, whose efforts brought this issue to fruition.

Journal Awards

The 2010 Journal awards were honored at the EWRJ Congress in Providence, Rhode Island, in May. The 2010 awards are based on papers published in the *Journal* from July 1, 2009, to June 30, 2009. Alan J. S. Cuthbertson, David Apuley, Peter A. Davies, Gintaras Ligeus, and Peter K. Staudy received the 2010 Karl Emil Hilgard Prize for best paper for their paper entitled "Deposition from Particle-Laden Flows: Turbulent Suspended Jets," which appeared in the August 2008 issue. The Best Technical Note Award was given to Vladimir Nikora, Scott Larned, Nina Nikora, Katherine DeMarch, Glenn Cooper and Michael Reed for their note entitled "Hydraulic Resistance due to Aquatic Vegetation in Small

Streams: Field Study," which appeared in September 2008. Craig Jones A.M.A.S.C.E. and Joseph Gallani won the Stevens Award for Best Discussion for their May 2009 discussion of "Computation of Two Techniques to Measure Sediment Erodibility in the Fox River, Wisconsin." Congratulations to all these award winners.

Annual Editorial Board Meeting

A collegial and productive annual meeting of AEs discussing current status and future goals of the *Journal* was held at the EWRJ Congress in Providence in May 2010. Fig. 1 pictures those in attendance (except for Sung-Uk Choi, who is behind the camera—his photo appears below).



Sung Uk Choi, Yonsei University



Fig. 1. Annual meeting of associate editors (from left to right: Nati Biron-Milk, Bruce Barkdoll, Terry Sturm, Thanos Papanicolaou, Bruce Melville, Alex McCorquodale, and behind the camera: Sung-Uk Choi)

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Prof. Choi, Prof. Sotiropoulos (Steve Brink UoT), and Ben: (underneath of "Steve" UoT)

2010 EWRJ Meeting (Oct. 30, 2010)

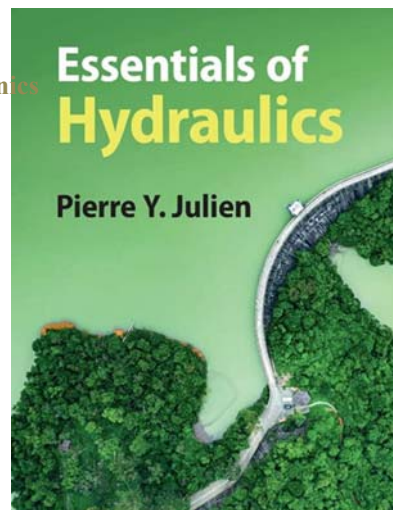
2010 Visit to S-CT Flow Experiment Centre, Incheon (Choon-Ai Water Laboratory)

Class (1)

- We will meet on Tue 2+3 (10:00 – 12:00) and Thu 2 (10:00 – 11:00)
- Offline and English class
- TA Class: Video file will be uploaded in LearnUS
- TA: Kim, Seong Jun
- Office: Rm. 373 in Engineering Bldg. 1
- E-mail: sjkim1226@yonsei.ac.kr

Class (2)

- Prerequisites: Elementary fluid mechanics
- Lecture and discussions
- No design project
- Evaluation (Tentative)
- Midterm (40%) + Final (40%)
- + Quiz+Homework+Attendance (20%)
- Essentials of Hydraulics (2022)

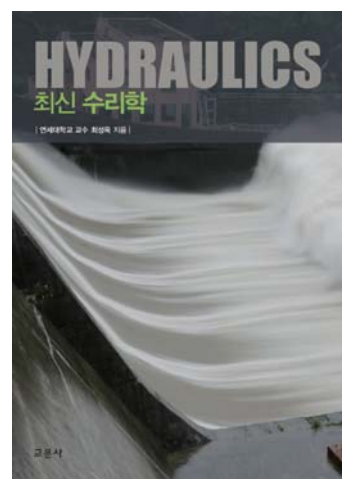


Class (3)

- I plan to lecture in English.
- However, classes are not taught 100% in English.
- Sometimes I will speak Korean to help Korean students understand.
- Normally, 10-20% of classes are conducted in Korean.

Class (3)

최신 수리학



What is “Hydraulics”?

Hydraulics is the application of the fluid mechanics and other science and engineering disciplines in the design of structures, and the development of projects and systems involving water resources.

수리학이란 수자원과 관련된 수리시설물의 설계 그리고 프로젝트 및 시스템을 개발하는데 있어 유체역학 및 제반 과학기술을 응용하는 학문 분야이다.

The Difference

Fluid Mechanics	Hydraulics
fluids	water
mechanistic	more empirical
understanding the behavior of hydrosystem based on science	finding a solution of practical problem

- Fluid mechanics is the mother of hydraulics.
- Now people do not tend to distinguish fluid mechanics and hydraulics.

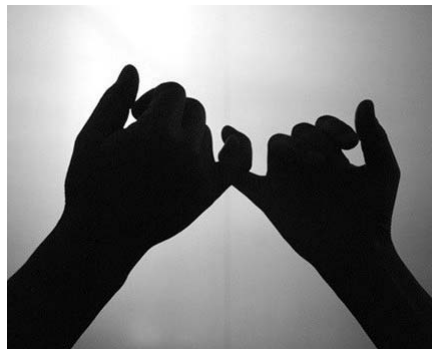
Topics to be Covered

1. 정수역학 Hydrostatics
2. 관수로 흐름 Flow in Pipes
3. 동수역학 Hydrodynamics

8. 등류 Steady Uniform Flow
9. 급변류 Rapidly Varied Flow
10. 점변류 Gradually Varied Flow

- *. 유사이송 수리학 (하천공학 4/2) Sediment transport

Two Promises



Important Issues in Hydraulics (Not Covered in Fluid Mechanics)

(1) Analysis of pipe network: Hardy–Cross method

(2) Theory of gradually varied flow

(3) Computation of gradually varied flow

- 유체역학에서는 등류 이론만 다룸
- 수리학에서 부등류 이론 소개 + 축차계산법에 의한 부등류 계산
- 하천공학에서 Newton–Raphson 기법 이용한 부등류 계산

Current Issues in Hydraulic Engineering

1. Breach of embankment
2. Stream restoration
3. Weir removal
4. Turbid water in reservoirs
5. Reservoir sedimentation
6. Local scour around bridge piers

Breach of Embankment due to the Change of Watercourse

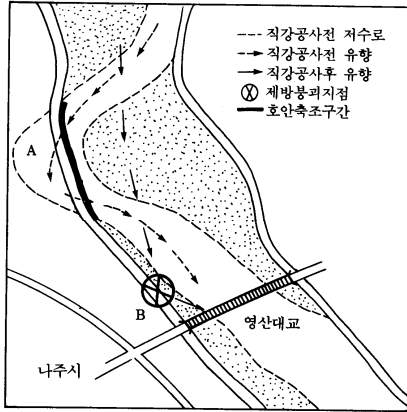


그림 4-1 1989년 7월의 나주제방 유실 상세도

- (1) 수해 개요
1989년 7월 홍수 때 영산강 제방이 붕괴되어 나주시 전역이 침수
 - (2) 수해 원인
영산대교 상류부를 직강화 하면서 기존 수충부에만 호안을 설치하였음
 - (3) 교훈
직강화 공사 전에는 수충부가 A점이었으나 공사후에는 유향이 달라져 수충부가 B로 이동하였음
- 자연하천에 제방을 축조할 때는 면밀한 검토와 수리실험 및 수치모의를 실시하여 제방축조후의 수류상태를 추정하여 공사를 시행해야 함

• Computer simulations vs. hydraulic model experiments

Breach of Embankment due to Accumulation of Debris



天災? 人災?



• Natural disaster or man-made disaster?

Stream Restoration: Ecohydraulics



1970년대 유럽: 근자연형 하천공법 (독일, 오스트리아, 스위스)

- 수로 좌우안 대칭 금지, 수로 곳곳에 다양한 변화 창출
- 저지대와 습지의 보전, 인공섬과 삼각주 조성, 습지 조성

1980년대 일본: 다자연형 하천공법

1990년대 한국: 건설기술연구원 (양재천 복원, 96-97)

Weir Removal



곡릉천 곡릉2보(2006년 2월 25일)



곡릉2보 철거 후 (2006년 4월 14일)

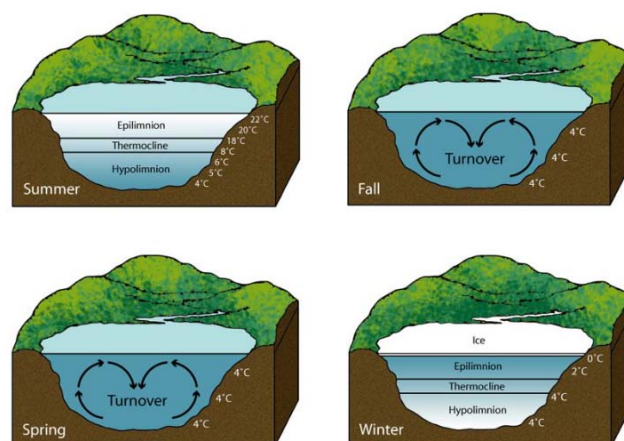
- 2018년 현재 약 34,000 개 보가 있음
- 매년 100개의 보가 신설되고 150여개 보가 용도 폐기되고 있음

Turbid Water in Imha Reservoir



- Highly turbid water (max NTU=1,200) occurred after the typhoon Maemi hit Korea in Sep. 2003.
- Turbid water in the reservoir lasted for 340 days.

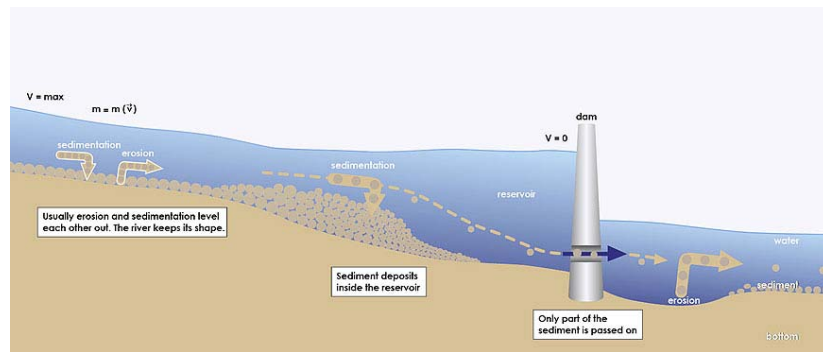
Lake Overturn



<https://www.nationalgeographic.org/media/lake-turnover/>

- Overturn is the process by which currents circulate the water in a the lake, resulting a movement of oxygen, nutrients, and sediment.

Reservoir Sedimentation



Reservoir Sedimentation



Reservoir Sedimentation



Local Scour around Bridge Piers



14일 오후 2시51분쯤 부산시 북구 구포동과 강서구 대저동을 잇는 낙동강 옛 구포대교 중간부분 교각 1개가 불어난 강물에 유실되면서 상판 200여m가 붕괴됐다. 사고 발생 당시 승용차 2대가 교량 위를 달리고 있었으나 붕괴 조짐을 보이는 순간 1대는 속도를 내 통과했고, 1대는 되돌아와 다행히 인명피해는 없었다. 길이 1.6, 왕복 2차선인 옛 구포대교는 폭이 좁고 낮아 그동안 승용차 등 소형차량만 통행이 허용되고 중대형 차량은 통행이 금지돼 왔었다. 출처: 부산 세계일보 (2003.9.14)