

# E-learning tools for understanding and testing of a range of concrete properties



Prof. C.S.Poon

Department of Civil and Structural Engineering,  
The Hong Kong Polytechnic University



## Team members

- Dr. Wallace W.L. Lai [Dept of Civil and Structural Engineering, PolyU]
- Dr. Josephine Csete [Education Development Centre, PolyU]
- Dr. S.C. Kou [Dept of Civil and Structural Engineering, PolyU]
- Mr. K.H. Wong [Dept of Civil and Structural Engineering, PolyU]
- Mr. Kenneth K.K. Lee [Dept of Civil and Structural Engineering, PolyU]
- Mr. B.J. Zhan [Dept of Civil and Structural Engineering, PolyU]



# Outline

- **Introduction**
- Subject 'Construction Materials' outline for full-time and part-time students in PolyU
- Teaching and learning challenges in university and in industry
- Implementation of the e-learning platform in the subject
- Five aspects of concrete properties
- Web-based e-learning platform
- Pre-lab quizzes and results
- Online video watching
- Conclusion



# Introduction

- The e-learning platform aims to enhance the quality of student learning on concrete properties by filming some common and important concrete testing procedures, and distributing them in the web.
- Students and practitioners will be able to familiarize, visualize and conceptualize the underlying principles of the tests with the videos filmed.
- These videos serve to complement the study of tedious and apparently “boring” laboratory testing procedures and specifications.



# Outline

- Introduction
- Subject 'Construction Materials' outline for full time and part time students in PolyU
- Teaching and learning challenges in university and in industry
- Implementation of the e-learning platform in the subject
- Five aspects of concrete properties
- Web-based e-learning platform
- Pre-lab quiz and results
- Online video watching
- Conclusion



**CSE 308**

# **Construction Materials**

**Level 3 undergraduate subject (year 2)**

**Course Instructor**

---

Prof. Chi-sun Poon  
The Hong Kong Polytechnic University





# Course Outline

## Concrete *(10 weeks)*

### Module I. Introduction and Basic Concepts

- Definition
- Advantages of concrete as a construction material
- Comparison between structural concrete and steel
- Types of structural concrete (Plain concrete, Reinforced cement concrete, Prestressed concrete)
- Constituent materials of concrete – a brief introduction (cement, aggregates, water and admixtures)
- Production of concrete – a brief review

### Module II. Cement

- Chemical composition of cement
- Manufacture of Portland cement



## Module II. Cement (*contd.*)

- Hydration of cement
- Types of Portland cement
- Tests to evaluate physical and mechanical properties of cement

## Module III. Aggregates

- General classification of aggregates
- Physical and mechanical properties of aggregates
- Size and grading of aggregates
- Grading requirements
- Maximum aggregate size

## Module IV. Properties of Fresh Concrete

- Workability of concrete
- Factors affecting workability
- Measurement of workability





#### Module IV. Properties of Fresh Concrete (*contd.*)

- Problems in fresh concrete (Segregation, Bleeding)
- Placing and compaction of concrete

#### Module V. Properties of Hardened Concrete

- Factors affecting the strength of concrete
  - Water-cement ratio
  - Aggregate-cement ratio
  - Strength and maximum size of aggregates
  - Compaction, mixing temperature and curing method
  - Effect of age
- Tensile strength of concrete
- Relation between tensile and compressive strength of concrete
- Bond strength of concrete



## **Module VI. Testing of Hardened Concrete**

- Compressive strength tests
  - Destructive tests (Cube test, Cylinder test, Core test)
  - Non-destructive tests (Rebound hammer, Penetration resistance, Pull- out, Ultrasonic Pulse velocity)
- Tensile strength test
- Flexural test (modulus of rupture)
- Bond strength test

## **Module VII. Concrete Admixtures**

- Benefits of admixtures
- Types of admixtures (Water-reducers, Accelerators, Retarders)
- Mineral admixtures (Silica fume, Fly ash, Blast furnace slag)
- Performance and properties of blended concretes



## Module VIII. Concrete Mix Design

- Process of mix selection
- Factors affecting the mix proportions
  - Durability
  - Strength
  - Cost
- Mix design methods
  - Absolute volume approach
  - British method (DOE)
  - ASTM method

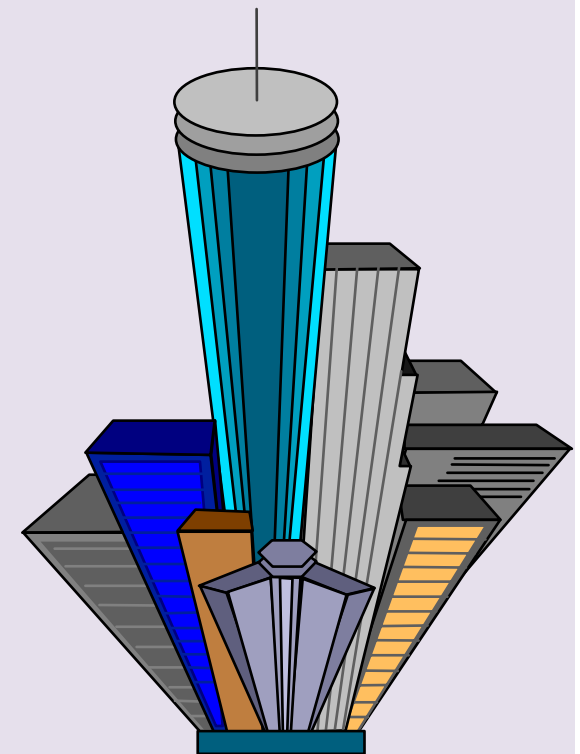
## Module IX. Special Concretes

- High performance concrete
- Fiber reinforced concrete
- Roller compacted concrete
- Light weight concrete
- Polymer composites



## Module X. Durability of Concrete

- Permeability of concrete
- Sulphate attack
- Attack by sea water
- Acid attack
- Alkali-aggregate reaction
- Corrosion of reinforcement





# Outline

- Introduction
- Subject 'Construction Materials' outline for full time and part time students in PolyU
- Teaching and learning challenges in university and in industry
- Implementation of the e-learning platform in the subject
- Five aspects of concrete properties
- Web-based e-learning platform
- Pre-lab quiz and results
- Video watching
- Conclusion



# Teaching and learning challenges in university and in industry



Teaching challenge to lecturer:  
Massive class size



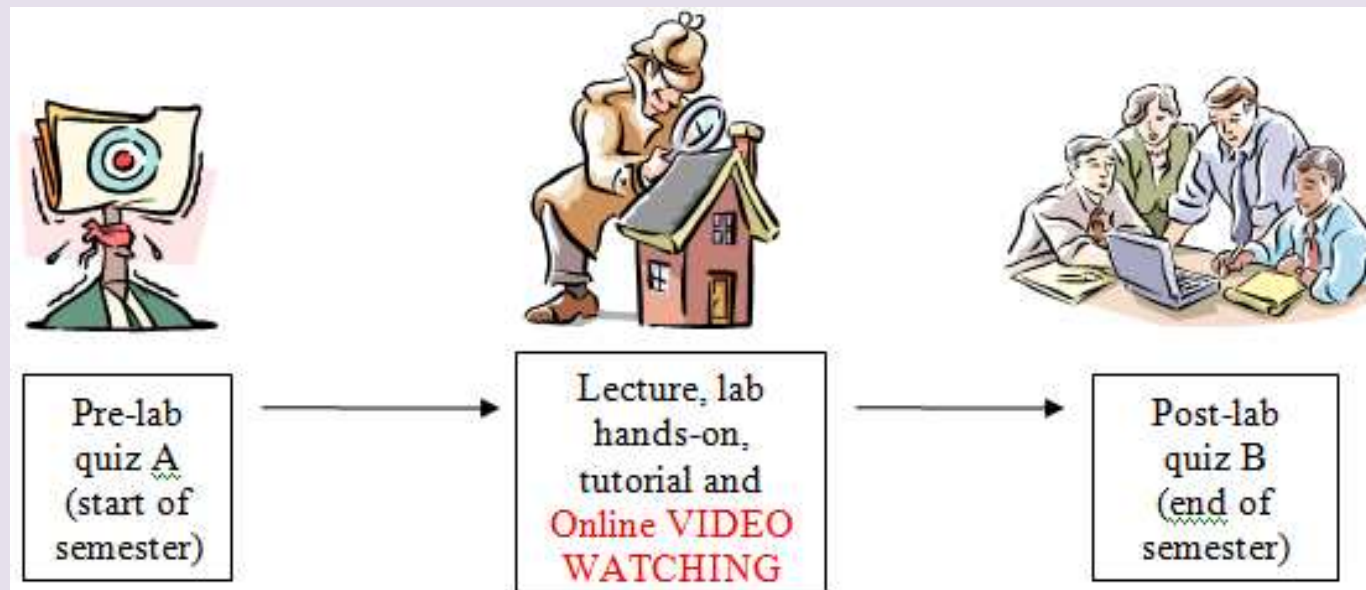
Learning challenge to students:  
Too many students in a lab session



Learning challenge to practicing engineers:  
Exhaustion after work



# Implementation of the e-learning platform in the subject



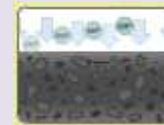
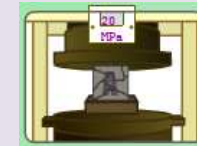


# Five aspects of concrete properties

Conventional



1. Workability for normal concrete
2. Hardened properties of concrete
3. Durability of concrete



New



4. Workability for self-compacting concrete
5. Nondestructive evaluation of concrete














# Conventional part of concrete properties (Workability, hardened properties and durability)

### Workability for Normal Concretes

 1. Introduction	 2. Slump test	 3. Vebe time test	 4. Compaction factor test
 5. Factors affecting workability	 6. Discussion and conclusion		


[A](#) answer pre-lab quiz A  
[▶](#) play all  
[B](#) answer post-lab quiz B

### Compressive strength and splitting tensile strength test






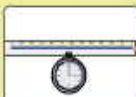

[A](#) answer pre-lab quiz A  
[▶](#) play all  
[B](#) answer post-lab quiz B

### Modulus of elasticity and Poisson ratio test



[A](#) answer pre-lab quiz A  
[▶](#) play all  
[B](#) answer post-lab quiz B

### Durability

 1. Introduction	 2. Carbonation test	 3. Chloride ion penetration test
 4. Initial surface absorption test	 5. Discussion and conclusion	

[A](#) answer pre-lab quiz A  
[▶](#) play all  
[B](#) answer post-lab quiz B

# Newer part of concrete properties (SCC and NDE)



## Workability for Self-Compacting Concrete



1. Introduction



2. L-box test



3. Slump flow test



4. J-ring test



5. Wet sieving ability test



6. Procedures of the 4 SCC tests in normal pace



7. Discussion and conclusion

A

answer pre-lab quiz A



play all

B

answer post-lab quiz B

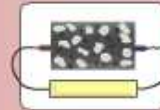
## Non-destructive Evaluation



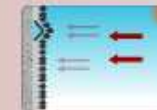
1. Introduction



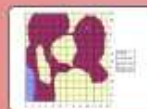
2. Electromagnetic test



3. Ultrasonic pulse velocity test



4. Infrared thermography test



5. Half-cell potential test



6. Surface hardness test



7. Discussion and conclusion

A

answer pre-lab quiz A



play all

B

answer post-lab quiz B



# Outline

- Introduction
- Subject 'Construction Materials' outline for full time and part time students in PolyU
- Teaching and learning challenges in university and in industry
- Implementation of the e-learning platform in the subject
- Five aspects of concrete properties
- **Web-based e-learning platform**
- Pre-lab quiz and results
- Online video watching
- Conclusion



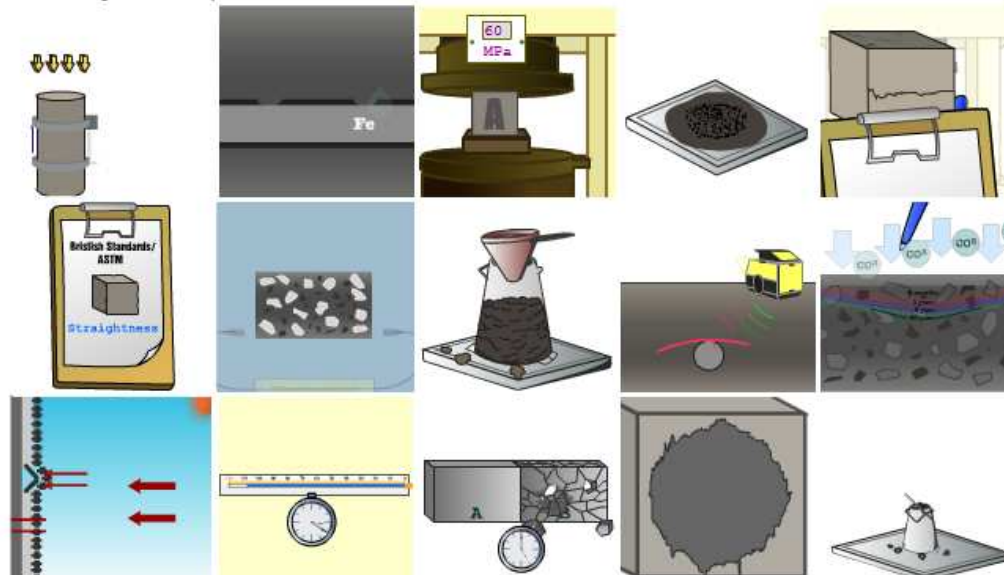
# Web-based e-learning platform (background)



## Background

Hello students!

This website aims to enhance the quality of your learning on advanced concrete technologies by filming the well-established laboratory testing procedures. You will familiarize yourself and conceptualize the underlying principles of the tests with the lively videos. We hope that these videos will complement your reading on extensive, difficult and sometimes tedious laboratory testing specifications before attending laboratory classes.







# Web-based e-learning platform (Content videos)

Department of Civil and Structural Engineering  
土木及結構工程學系  
Online E-Learning Tool for  
ADVANCED CONCRETE TECHNOLOGIES

THE HONG KONG POLYTECHNIC UNIVERSITY  
香港理工大學

Background | Content | References

Getting Started | Fresh Properties | Hardened Properties | Durability | Non-destructive Evaluation

## Fresh Properties

### Workability for Normal Concretes

- 1. Introduction
- 2. Slump test
- 3. Vebe time test
- 4. Compaction factor test
- 5. Factors affecting workability
- 6. Discussion and conclusion

**A** answer pre-lab quiz A  
**▶** play all  
**B** answer post-lab quiz B

### Workability for Self-Compacting Concrete

- 1. Introduction
- 2. Slump test
- 3. Vebe time test
- 4. Compaction factor test



# Webct (on-line e-learning quiz platform)

The screenshot displays the WebCT interface for a course titled "2nd Sem. (10/11): (CSE308\_20101\_A) Construction Materials". The left sidebar shows the "Control Panel" and "Course Menu" with links to "Homepage", "Pre-lab quiz", "Discussions", and "My Grades". The main content area lists several quizzes under "Quizzes and Surveys". Red arrows point to the following quiz entries:

- Fresh properties (Workability for normal concrete) Pre-lab**: Availability: February 21, 2011 22:00 - February 22, 2011 00:00. Duration: 10 minutes. Grade: --- / 10. Attempts: 0 completed, 1 remaining. View scores.
- Hardened properties (Compressive, splitting tensile strength)**: Availability: February 21, 2011 22:00 - February 22, 2011 00:00. Duration: 10 minutes. Grade: --- / 10. Attempts: 0 completed, 1 remaining. View scores.
- Fresh properties (Workability for self-compacting concrete)**: Availability: February 21, 2011 22:00 - February 22, 2011 00:00. Duration: 10 minutes. Grade: --- / 10. Attempts: 0 completed, 1 remaining. View scores.
- Durability (Carbonation, chloride ion penetration, initial surface moisture)**: Availability: February 21, 2011 22:00 - February 22, 2011 00:00. Duration: 10 minutes. Grade: --- / 10. Attempts: 0 completed, 1 remaining. View scores.
- Nondestructive evaluation technologies (Electromagnetic induction, ultrasonic pulse velocity)**: Availability: February 21, 2011 22:00 - February 22, 2011 00:00. Duration: 10 minutes. Grade: --- / 10. Attempts: 0 completed, 1 remaining. View scores.

The right window shows the "Learning System Quiz - Mozilla Firefox" interface for the "Fresh properties (Workability for normal concrete) Pre-lab quiz". The URL is [http://webct2.polyu.edu.hk/SCRIPT/CSE308\\_20101\\_A/scripts/student/serve\\_new\\_quiz?ACTION=SHOW\\_QUIZ2&ARG1=932090](http://webct2.polyu.edu.hk/SCRIPT/CSE308_20101_A/scripts/student/serve_new_quiz?ACTION=SHOW_QUIZ2&ARG1=932090). The quiz details are:

- Name: Wai Lok LAI (Preview)
- Start time: February 28, 2011 13:52
- Time allowed: 10 minutes
- Number of questions: 12

The quiz interface includes a "Time Remaining" section showing 9:49 (min:sec) and a "Question Status" section with "Unanswered", "Answered", and "Answer not saved" indicators. A grid of 12 question status icons is displayed, with the first 10 icons circled in red. The questions are:

**Question 1** (0 points)  
Q001-00  
How do you rate your understanding of the tests (slump, vebe time and compaction factor) of concrete before watching this video?

- ☐ a. very unfamiliar
- ☐ b. unfamiliar
- ☐ c. neutral
- ☐ d. familiar
- ☐ e. very familiar

**Question 2** (0 points)  
Q001-01  
Is it your first time taking the CSE 308 subject?

- ☐ a. Yes




# Web-based e-learning platform (references)

Department of Civil and Structural Engineering  
土木及結構工程學系

Online E-Learning Tool for  
ADVANCED CONCRETE TECHNOLOGIES

THE HONG KONG  
POLYTECHNIC UNIVERSITY  
香港理工大學

Background | Content | **References**



## References

### Fresh properties: Workability for Normal Concretes

#### Slump test

1. ACI 238.1R-08 Report on Measurements of Workability and Rheology of Fresh Concrete
2. ASTM C143 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
3. BS EN 12350-2:2000 Testing fresh concrete - Part 2: Slump test
4. Hong Kong Construction Standards: 2010

#### Vebe time test

1. ASTM C1170 Standard Test Method for Determining Consistency and Density of Roller-Compacted Concrete Using a Vibrating Table
2. ACI 238.1R-08 Report on Measurements of Workability and Rheology of Fresh Concrete
3. BS EN 12350-3:2000 Testing fresh concrete - Part 3: Vebe test
4. Hong Kong Construction Standards: 2010

#### Compaction factor test

1. ACI 238.1R-08 Report on Measurements of Workability and Rheology of Fresh Concrete
2. BS EN 12350-4:2000 Testing fresh concrete - Part 4: Compaction factor test
3. Hong Kong Construction Standards: 2010

### Fresh properties: Workability for Self-compacting concrete (SCC)



# Outline

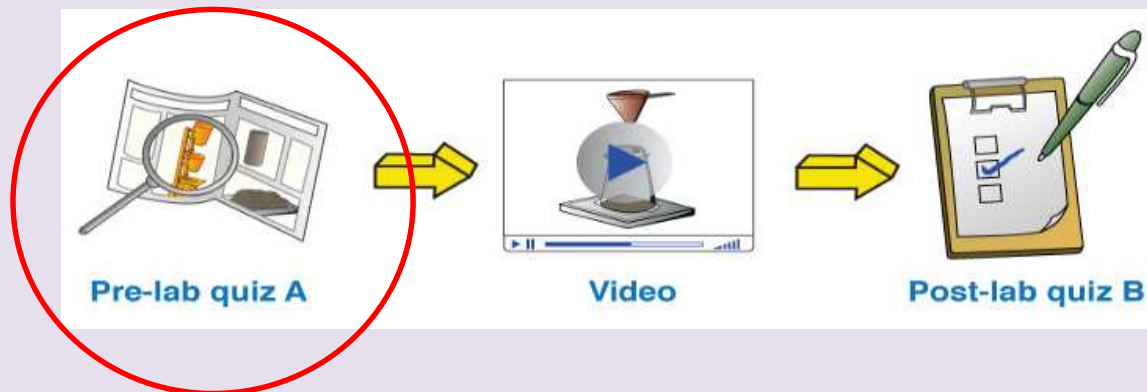
- Introduction
- Subject 'Construction Materials' outline for full time and part time students in PolyU
- Teaching and learning challenges in university and in industry
- Implementation of the e-learning platform in the subject
- Five aspects of concrete properties
- Web-based e-learning platform
- Pre-lab quiz and results
- Online video watching
- Conclusion





# Pre-lab quizzes

- 87 full-time and 31 part-time students answered all the 5 quizzes



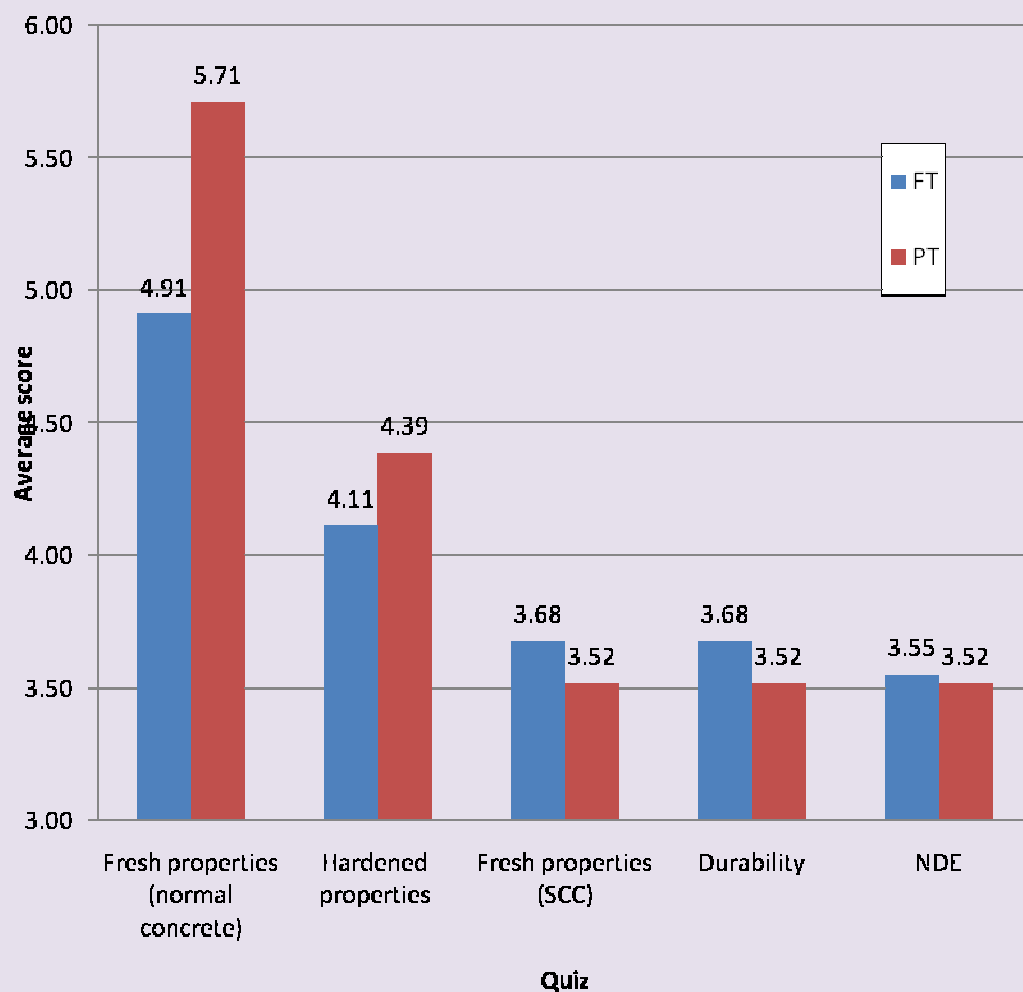


# Results

1. Average score of inexperienced full-time and experienced part-time students
2. Score distributions



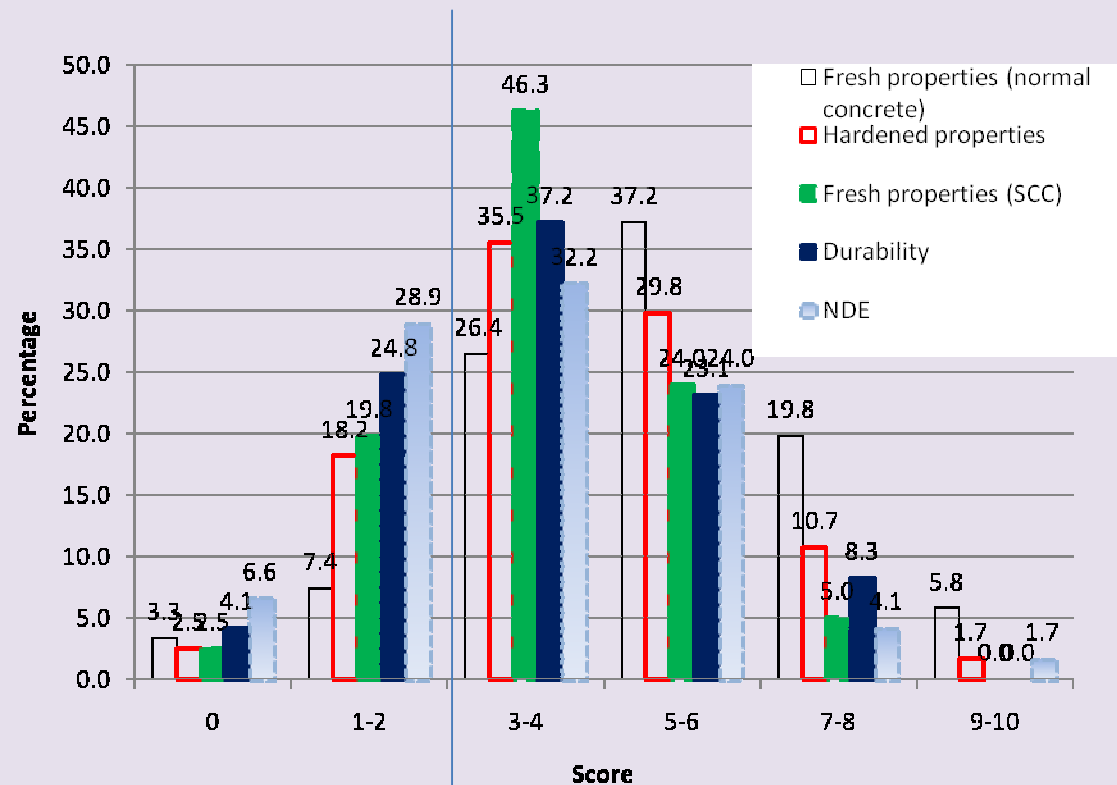
# 1. Average score of inexperienced full-time and experienced PT students



1. Conventional concrete properties of the first two quizzes should be much easier, and those of the last three new properties (SCC, durability and NDE) should be more difficult.
2. Par-time students performed much better than full-time students in the first two quizzes. However the differences are small for the latter three quizzes. It is because the contents of the latter three tests are not familiar to even students with some experience.



## 2. Score distributions



1. Scores are normally distributed.
2. Score less than 2 means that the result is worse than blind guess.

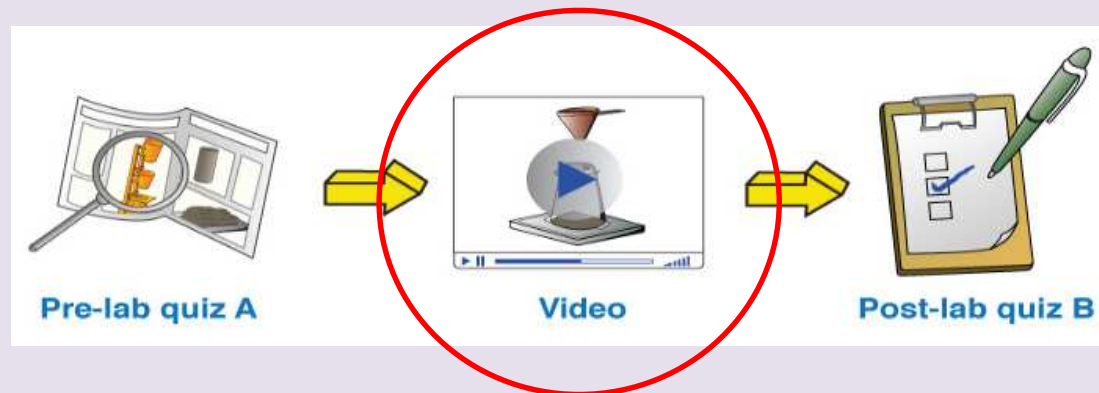


# Outline

- Introduction
- Subject 'Construction Materials' outline for full time and part time students in PolyU
- Teaching and learning challenges in university and in industry
- Implementation of the e-learning platform in the subject
- Five aspects of concrete properties
- Web-based e-learning platform
- Pre-lab quiz and results
- **Online video watching**
- Conclusion



# Online e-learning video viewing





# Structure of the videos

## 1. Introduction

- Why are these properties important?
- Why are these tests important?
- Connections of these properties with others (e.g. how fresh properties affect hardened properties)



## 2. Step of the tests

a.....  
b.....  
c.....



## 3. Factors affecting the subjects

a.....  
b.....  
c.....



## 4. Discussions and Conclusions

- Summarize the tests and the properties
- Reference to international and local standards for further reading



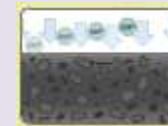
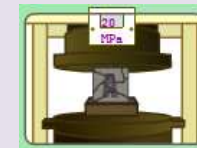
# Special features of the videos: collaborative efforts



Department of Civil and  
Structural Engineering, HK  
PolyU



Professional video  
shooting and crew



Animations created by  
School of Design, HK  
PolyU

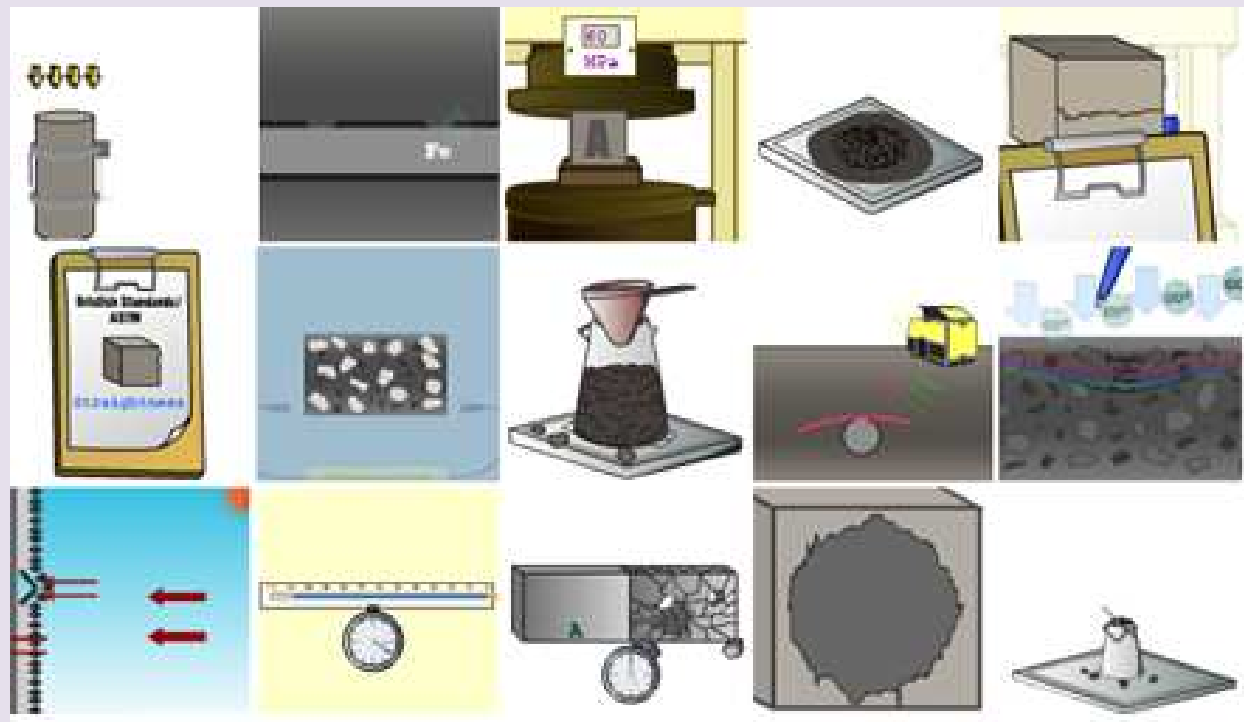


Professional advice by Education  
Development Centre, HK PolyU





## Special features of the videos: Animations





# Two short clips of videos on Self-compacting concrete and Nondestructive Evaluation



# Outline

- Introduction
- Subject 'Construction Materials' outline for full time and part time students in PolyU
- Teaching and learning challenges in university and in industry
- Implementation of the e-learning platform in the subject
- Five aspects of concrete properties
- Web-based e-learning platform
- Pre-lab quiz and results
- Online video watching
- Conclusion



## Conclusion

- Effectiveness of the e-learning platform will be fully assessed by the end of 2011, after the post-lab quizzes and feedback from the students are evaluated.
- The e-learning videos will be available in PolyU library and distributed to other tertiary institutions and Government bodies and interested parties as appropriate.