

# The Hong Kong Polytechnic University

## Subject Description Form

<b>Subject Code</b>	CSE6013
<b>Subject Title</b>	Life Cycle Performance Management of Concrete Infrastructure
<b>Credit Value</b>	3
<b>Level</b>	6
<b>Pre-requisite / Co-requisite/ Exclusion</b>	Students should have fundamental knowledge about concrete materials and design of concrete structures.
<b>Objectives</b>	<p>This subject is intended to:</p> <ul style="list-style-type: none"> <li>(a) Provide students with holistic understanding of the life cycle performance management strategy of concrete infrastructure;</li> <li>(b) Equip students with a good understanding of various deterioration mechanisms of concrete materials and reinforced concrete structures under mechanical and environmental actions;</li> <li>(c) Equip students with knowledge about the inspection and diagnosis of various damages in concrete infrastructure;</li> <li>(d) Equip students with knowledge on the assessment and prediction of the chronological deterioration of the structural performance of concrete structures;</li> <li>(e) Facilitate students with knowledge about the advanced repair and strengthening technologies for deteriorating concrete structures.</li> <li>(f) Facilitate students with knowledge about the life-end strategy of concrete infrastructure and construction waste management.</li> </ul>
<b>Intended Learning Outcomes</b>	<p>Upon completion of the subject, students will be able:</p> <ul style="list-style-type: none"> <li>(a) to achieve an in-depth understanding of life-cycle performance management strategy of concrete infrastructure and the significance of implementing this strategy in pursuing the sustainability of concrete infrastructure;</li> <li>(b) to grasp systematic knowledge on inspecting, diagnosing and monitoring the material and structural deterioration of concrete infrastructure;</li> <li>(c) to correctly interpret the inspecting and diagnosing results and to conduct accurate assessment on the structural performance of deteriorating concrete structures and predict their future behavior;</li> <li>(d) to implement modern repair and strengthening technology for upgrading deteriorated concrete structures;</li> <li>(e) to hold knowhow on the recycling and management of construction wastes.</li> </ul>
<b>Subject Synopsis/ Indicative Syllabus</b>	<p>This subject covers the following contents:</p> <ol style="list-style-type: none"> <li>1. <u>Framework for life-cycle performance management</u> Infrastructure sustainability, fundamental principles of life cycle management, limit state design, life cycle-based design, life cycle cost analysis, state-of-the-art of the life cycle management technologies.</li> </ol>

	<p>2. <u>Deterioration mechanisms of concrete materials and concrete structures</u> Concrete spalling, efflorescence and leaching of concrete, steel corrosion, chemical attack, frost damage, alkali aggregate reaction, surface wearing, fatigue failure, seismic damage.</p> <p>3. <u>Diagnosis, inspection and performance assessment</u> Inspection and diagnosis, non-destructive/destructive testing, structural health monitoring, performance requirement, initial/detailed assessment, finite element modeling, expert system, residual service life prediction, probability-based approach.</p> <p>4. <u>Repair and strengthening</u> Repair of concrete cracks, surface coating, electro-chemical repair, structural strengthening methods, externally bonded fiber reinforced polymer (FRP) technique including flexural strengthening, shear strengthening and seismic retrofit.</p> <p>5. <u>Life-end strategies and environmental issues</u> Concrete recycling, recycling of glass, carbon footprint evaluation</p> <p>6. <u>Exemplary life cycle performance management tools</u> Bridge management, building management, port structure management, pavement management, tunnel management.</p>																																								
<p><b>Teaching/Learning Methodology</b></p>	<p>The subject is delivered mainly using lectures which are focused on all relevant technical elements of the life cycle performance management of concrete structures. The lectures need to be supplemented by substantial self-study after class by students of reference materials and other up-to-date technical reports/journal papers recommended by the lecturer(s).</p> <p>The students need to complete a set of assignments and an oral examination of the group reports at the semester end.</p>																																								
<p><b>Assessment Methods in Alignment with Intended Learning Outcomes</b></p>	<table border="1" data-bbox="533 1473 1485 1792"> <thead> <tr> <th rowspan="2">Specific assessment methods/tasks</th> <th rowspan="2">% weighting</th> <th colspan="5">Intended subject learning outcomes to be assessed (Please tick as appropriate)</th> </tr> <tr> <th>a</th> <th>b</th> <th>c</th> <th>d</th> <th>e</th> </tr> </thead> <tbody> <tr> <td>1. Assignments</td> <td>50%</td> <td>✓</td> <td>✓</td> <td>✓</td> <td>✓</td> <td>✓</td> </tr> <tr> <td>2. Quiz</td> <td>20%</td> <td>✓</td> <td>✓</td> <td>✓</td> <td>✓</td> <td>✓</td> </tr> <tr> <td>3. Project Report and Oral Examination</td> <td>30%</td> <td>✓</td> <td>✓</td> <td>✓</td> <td>✓</td> <td>✓</td> </tr> <tr> <td>Total</td> <td>100 %</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p><b>Students must attain at least grade D in both coursework and final examination assessments (whenever applicable) in order to attain a passing grade in the overall result.</b></p> <p>The students will be assessed with two components, i.e. 1. assignments, 2. an oral examination of the group report at the end of the semester. The students will be required to conduct extensive reading after the lecture to complete a set of assignments. Each assignment is designed to cover a</p>	Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)					a	b	c	d	e	1. Assignments	50%	✓	✓	✓	✓	✓	2. Quiz	20%	✓	✓	✓	✓	✓	3. Project Report and Oral Examination	30%	✓	✓	✓	✓	✓	Total	100 %					
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	particular technical aspect of the life cycle performance management system of concrete structures. Hence, they are considered to be highly effective in achieving the intended learning outcomes a), b), c), d), e) and f). Moreover, an oral examination is designed to assess the students' understanding on the basic concepts as well as the practice of the life cycle performance management on concrete infrastructure, and is effective to achieve all the intended learning outcomes.	
<b>Student Study Effort Expected</b>	Class contact:	
	▪ Lectures	39 Hrs.
	▪ Examination	
	Other student study effort:	
	▪ Reading of reference materials	26 Hrs.
	▪ Assignments on small modeling problems	30 Hrs.
	▪ Numerical modeling project	40 Hrs.
	Total student study effort	135 Hrs.
<b>Reading List and References</b>	<ul style="list-style-type: none"> <li>• <b>Books</b> <ol style="list-style-type: none"> <li>(1) Hitoshi Furuta, Dan, M. Frangopol and Mitsuyoshi Akiyama, Life-Cycle of Structural Systems: Design, Assessment, Maintenance and Management, CRC Press, 2014, ISBN 9781138001206</li> <li>(2) GjØry, O., Durability Design of Concrete Structures in Severe Environments, CRC Press, ISBN 9781466587298, 2013.</li> <li>(3) Teng, J.G., Chen, J.F., Smith, S.T. and Lam, L., FRP-Strengthened RC Structures, ISBN: 978-0-471-48706-7, Wiley, 2001.</li> </ol> </li> <li>• <b>Codes of Practice</b> <ol style="list-style-type: none"> <li>(1) <i>fib</i> Model Code for Concrete Structures, Ernst &amp; Sohn, 2010, Lausanne, Switzerland</li> <li>(2) ISO FDIS 16311-1, Maintenance and repair of concrete structures – Part 1: General principles.</li> <li>(3) ISO FDIS 16311-2, Maintenance and repair of concrete structures – Part 2: Assessment of existing concrete structures.</li> <li>(4) ISO FDIS 16311-3, Maintenance and repair of concrete structures – Part 3: Design of repairs and prevention.</li> <li>(5) ISO FDIS 16311-4, Maintenance and repair of concrete structures – Part 4: Execution of repairs and prevention.</li> <li>(6) Japan Society of Civil Engineer, Standard Specification for Concrete Structures-2001, “Maintenance”.</li> </ol> </li> <li>• <b>Journals</b> <ol style="list-style-type: none"> <li>(1) Structural and Infrastructure Engineering: Maintenance, Management, Life Cycle Design and Performance, Taloy &amp; Francis.</li> </ol> </li> </ul>	