

Subject Description Form

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| Subject Code | CSE586 |
| Subject Title | Low-Carbon Construction Materials |
| Credit Value | 3 |
| Level | 5 |
| Pre-requisite/ Co-requisite/ Exclusion | Nil |
| Objectives | To introduce the advanced low-carbon materials and technologies used in civil engineering construction. |
| Intended Learning Outcomes | Upon completion of the subject, students will be able to: <ol style="list-style-type: none">a. Develop a comprehensive understanding of the significance, challenges, methodologies, and prospects of developing low-carbon construction materials.b. Critically analyze and evaluate the current and emerging low-carbon construction materials or technologies in civil engineering.c. Design or propose appropriate low-carbon construction materials or technologies with well-grounded judgement.d. Communicate effectively in verbally and in writing formats |
| Subject Synopsis/ Indicative Syllabus | <ol style="list-style-type: none">1. Cement Chemistry and greenhouse gas emissions2. Common low-carbon supplementary cementitious materials3. New supplementary cementitious materials4. Alkali-activated cementitious materials5. Recycled aggregate and recycled aggregate concrete6. Waste incineration residues7. Advanced CO₂ mineralization materials and technologies8. 3D printed concrete9. Life cycle assessment I10. Life cycle assessment II11. Waste-based low-carbon pavement materials12. Pavement materials with low construction energy consumption |
| Teaching/Learning Methodology | Fundamental theories about low-carbon construction materials and technologies will be explained in lectures. The applications case studies in civil engineering construction will be discussed in interactive tutorial sessions. Project-based learning approach is adopted in this subject, through engaging in a realistic case study project, students will be able to develop a critical understanding of the subject knowledge, the ability to evaluate, design or propose appropriate low-carbon construction materials and technologies, and sharpen their written and verbal communication skills. |

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| Assessment Methods in Alignment with Intended Learning Outcomes | Specific assessment methods/tasks | | % weighting | Intended subject learning outcomes to be assessed (Please tick as appropriate) | | | |
| | | | | a | b | c | d |
| | 1. Literature review | | 30 | √ | √ | | √ |
| | 2. Project Report | | 40 | √ | √ | √ | √ |
| | 3. Project Presentation | | 30 | √ | √ | √ | √ |
| | Total | | 100 % | | | | |
| <p>Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:</p> <p>Students are expected to complete an individual literature review assignment to gain in-depth understanding of different low-carbon construction materials and technologies, and be able to compare their strengths and weaknesses in different applications (ILO a, b, d). Upon gaining a comprehensive understanding of the various low-carbon construction and technologies, students are going to work on a case study project (group) where students are expected to evaluate, design or propose appropriate low-carbon construction materials and technologies based on a realistic situation. Students are required to submit a written report (40%) and deliver an oral presentation (30%). Students are required to demonstrate individual contribution and are assessed individually in both the written report and the oral presentation.</p> <p>In order to obtain a passing grade in this subject, students MUST pass both the written report and the oral presentation components. Students who are found to commit acts of academic dishonesty, including but not limited to plagiarism, violating university's guideline on using GenAI, will result in direct disqualification in this subject and subjected to further disciplinary actions.</p> | | | | | | | |
| Student Study Effort Expected | Class contact: | | | Total hours | | | |
| | ▪ Lectures/tutorials | | | 39 Hrs | | | |
| | Other student study effort: | | | | | | |
| | ▪ Reading and Studying | | | 39 Hrs | | | |
| | ▪ Completion of assignments | | | 39 Hrs | | | |
| | Total student study effort | | | 117 Hrs | | | |

**Reading List and
References**

Essential References

Books

1. Jamal M. Khatib, *Sustainability of Construction Materials* 2nd Edition, 2016. <https://doi.org/10.1016/C2014-0-02849-3>.
2. Ali Nazari, Jay G. Sanjayan, *Handbook of Low Carbon Concrete* 1st Edition, 2016. <https://doi.org/10.1016/C2015-0-01844-5>.
3. Michael Z. Hauschild, Ralph K. Rosenbaum, Stig Irving Olsen, *Life Cycle Assessment: Theory and Practice* 1st Edition, 2018. <https://doi.org/10.1007/978-3-319-56475-3>.

Journal papers

1. C.S. Poon, P. Shen, Y. Jiang, Z. Ma, D. Xuan, Total recycling of concrete waste using accelerated carbonation: A review, *Cement and Concrete Research*, 173 (2023) 107284.
2. M. Zajac, I. Maruyama, A. Iizuka, J. Skibsted, Enforced carbonation of cementitious materials, *Cement and Concrete Research*, 174 (2023) 107285.
3. Z. Liu, C. Lv, F. Wang, S. Hu, Recent advances in carbonatable binders, *Cement and Concrete Research*, 173 (2023) 107286.
4. Barbara Lothenbach, Karen Scrivener, R.D. Hooton, Supplementary cementitious materials, *Cement and Concrete Research*, 41 (2011) 1244.
5. M.C.G. Juenger, R. Siddique, Recent advances in understanding the role of supplementary cementitious materials in concrete, *Cement and Concrete Research*, 78 (2015) 71-80.
6. Maria C.G. Juenger, Ruben Snellings, Susan A. Bernal, Supplementary cementitious materials: New sources, characterization, and performance insights, *Cement and Concrete Research*, 122 (2019) 257-273.
7. Chen Li, Jiaqi Li, Qiang Ren, Qiaomu Zheng, Zhengwu Jiang, Durability of concrete coupled with life cycle assessment: Review and perspective, *Cement and Concrete Composites*, 139 (2023) 105041.
8. Pai-Haung Shih, Jui-En Chang, Li-Choung Chiang, Replacement of raw mix in cement production by municipal solid waste incineration ash, *Cement and Concrete Research*, 33, 11 (2003) 1831-1836.
9. V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, Global Warming of 1.5 C: IPCC special report on impacts of global warming of 1.5 C above pre-industrial levels in context of strengthening response to climate change, sustainable development, and efforts to eradicate poverty, Cambridge University Press 2022.
10. K.-y. Chen, J. Xia, R.-j. Wu, X.-y. Shen, J.-j. Chen, Y.-x. Zhao, W.-l. Jin, An overview on the influence of various parameters on the fabrication and engineering properties of CO₂-cured cement-based composites, *Journal of Cleaner Production*, 366 (2022).