COURSE OVERVIEW SE0030
Durability of Reinforced Concrete Structures
Assessment, Repair & Risk-Based Inspection

Course Title
Durability of Reinforced Concrete Structures:
Assessment, Repair & Risk-Based Inspection

Course Reference
SE0030

Course Duration/Credits
Five days/3.0 CEUs/30 PDHs

Course Date/Venue

Option	Date	Venue
1	May 11-15, 2025	Sur Meeting Room, Royal Tulip Muscat, Muscat, Oman
2	May 18-22, 2025	
3	May 25-29, 2025	

Course Description

This practical and highly-interactive course includes real-life case studies and exercises where participants will be engaged in a series of interactive small groups and class workshops.

Nowadays, there is a large stock of reinforced concrete structures such as commercial buildings, marine structures, bridges, water transportation pipelines, waste water treatment plants etc, which are all beginning to show signs of deterioration, particularly those over 30 years age. Collapses, premature demolitions, unforeseen extensive maintenance work all over the world created great concern about the durability and safety on the reinforced concrete structures.

The Middle East construction boom will be affected without better concrete quality and protection. The service life of reinforced concrete structures is significantly lower in the Middle East than in other parts of the world. There is a tendency to use a 'trial and error' approach to materials and processes which have not been standardised or fully tested as these processes are applied without supervision, which results in poor service life. Therefore, a more professional approach is needed, with special attention to the entire service life, starting from the design phase.

The root of the problem lies in a number of factors, including:

- The harsh, high salinity of the environment in the Middle East.
- Designers specifying concrete in an insufficient manner
- A workforce in the Middle East dominated by the expatriates with differing qualifications, knowledge, training and experience.

Engineers need therefore newer and more suitable solutions to prolong the service life of new structures, both using supplementary preventative techniques and adopting efficient maintenance and repair techniques.

As far as the use of supplementary techniques is concerned, this course gives updated suggestions for the use of stainless and galvanized steel, for the adoption of cathodic prevention systems, for the use of particular surface treatments and for the use of corrosion inhibitors in the mix: all described measures are able, in controlled conditions, to strongly prolong the service-life of the new constructions.

In case of existing structures with corrosion problems, maintenance may be performed by means of electrochemical techniques, such as chloride removal and realkalization, or with conventional repair methods. However, only cathodic protection is considered a suitable and reliable means for ensuring the corrosion stopping.

In case of existing structures with concrete damage problems, rehabilitation may be performed by means of several techniques, including the protection against aggressive substances, the moisture control, the strengthening of components, and the improvement of physical and chemical resistance of the concrete.

The development of cost-effective strategies for maintenance of reinforced concrete structures necessitates the acquisition of reliable information on the extent and rate of damages. If the corrosion risk of the reinforcement is detected sufficiently early, damage can be avoided or reduced significantly, residual life of the structure predicted and relatively simple maintenance measures or repair systems can be used.

Although reinforcement corrosion and concrete damage are recognized to be deterioration processes with important economical consequences, their effective measurement is actually very scarce.

The course will provide updated information on diagnosis of the reinforced concrete structures at different levels, starting with a simple or low-level form of periodic visual inspections, until the use of sensors for the new and existing structures. The course therefore covers the principles of a wide range of the latest techniques and illustrates practical applications related to the use of equipments for corrosion and mechanical testing and monitoring in concrete structures on site. These modern techniques can provide rapid and sensitive measurements and detection of damages in concrete structures.

Experimental tests will enable the participants to gain hands on experience in using the state-of-the-art equipment for corrosion testing and monitoring in concrete structures.

Course Objectives

Upon the successful completion of this course, each participant will be able to:-

- Apply an in-depth knowledge in the durability of reinforced concrete structure and design concrete structures for durability
- Implement the risk-based maintenance strategies by identifying the required repair time, the required corrosion time and the required deterioration time including the cost analysis for different protection methods
- Discuss the corrosion of concrete reinforcement, passivity, carbonation, stray currents, hydrogen embrittlement and macrocells
- Employ additional preventative measures for concrete structures as well as surface treatments and cathodic prevention for the prevention of corrosion
- Perform damage assessment by means of visual inspection, physical test, chemical test, electrochemical test, potential mapping and monitoring movements.
- Apply various rehabilitation approaches as well as the latest reinforced concrete monitoring techniques
- Implement proper procedures for the assessment of reinforced concrete structures conditions
- Apply correct approaches and methods for rehabilitation of damaged concrete
- Present practical cases on the rehabilitation of reinforced concrete structures
- Recognize the value of quality control in the construction of concrete structure

Exclusive Smart Training Kit - H-STK®

*Participants of this course will receive the exclusive "Haward Smart Training Kit" (**H-STK®**). The **H-STK®** consists of a comprehensive set of technical content which includes **electronic version** of the course materials conveniently saved in a **Tablet PC**.*

Who Should Attend

The course provides an overview of all significant aspects and considerations of durability of reinforced concrete structures for those who are involved in assessment, repair and risk-based inspection of concrete structures. This includes design engineers, construction engineers, civil engineers, inspection engineers, project engineers, site engineers, material engineers and other technical staff who are responsible for the integrity of reinforced concrete structures (buildings, bridges, pipelines, tanks, foundations, etc.).

Course Fee

US$ 5,500 per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course who completed a minimum of 80% of the total tuition hours.

Certificate Accreditations

Certificates are accredited by the following international accreditation organizations: -

- British Accreditation Council (BAC)

  Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

- The International Accreditors for Continuing Education and Training (IACET - USA)

  Haward Technology is an Authorized Training Provider by the International Accreditors for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 2018-1 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 2018-1 Standard**.

  Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units** (CEUs) in accordance with the rules & regulations of the International Accreditors for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

  Haward Technology Middle East will award **3.0 CEUs** (Continuing Education Units) or **30 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

Accommodation

Accommodation is not included in the course fees. However, any accommodation required can be arranged at the time of booking.

Course Instructor(s)

This course will be conducted by the following instructor(s). However, we have the right to change the course instructor(s) prior to the course date and inform participants accordingly:

Dr. Andrea Mercalli, PhD, is a **Senior Civil Engineer** with over **30 years** of extensive experience. His wide expertise includes **Concrete Mixing & Testing**, Advanced **Concrete Technology**, **Concrete Structural Material**, **Mixing** & **Handling Concrete**, **Structural Analysis** Calculation, **Structural Engineering**, **Concrete** & **Steel Design**, **Reinforced Concrete Structures**, **Concrete Inspection** & **Repair**, **Damage Assessment** & **Rehabilitation**, **Structured Reliability Analysis**, **Engineering Design**, **Building Preventive Maintenance**, **Cement Properties**, **Admixtures**, **Structural Analysis**, Backfiling & Asphalting, Asphalt Paving Installation, **Road Maintenance** & Safety, **Road Design** Skills, **Construction Engineering**, **Engineering Projects Surveying**, **Land Surveyor**, **GPS** and **Building Seismic Designs**. He is currently the **Materials Manager** of **Autostrade per l'Italia**, where he is in-charge of the **tests** on **all the materials** involved in **Structure** and **highway construction** (bituminous pavement, **concrete**, **reinforcement steel**, maintenance and repair) and **research and development of new materials** and techniques collaborating with several Universities and external institutes. The activity also concerns **peculiar types of structures monitoring**.

Dr. Mercalli is a **Senior Researcher** in the field of **corrosion of concrete reinforcement**, and an **author** of **many papers** in this field. He is an **Expert** in the **monitoring of the corrosion state of reinforcement** by means of chemical, physical and electrochemical techniques.

Dr. Mercalli has a **PhD** and **Bachelor's** degree in **Geological Science** from the **Pavia University**, **Italy** as well as **Post Graduate** degrees in **Acoustic Emission Monitoring** and **Corrosion** in **Concrete Monitoring** from the **Cardiff University**, **UK** and **LA Sapienza University**, **Italy** respectively. He participated to the **European Project BRITE – SMART STRUCTURES** concerning the corrosion monitoring on concrete bridges in Denmark and Italy collaborating with Danish partners and Berlin BAM. Further, he was the **Responsible Scientist** for the project "Monitoring of the Corrosion State in Existing Structures" of European concerted action COST 521 "Corrosion of Steel in Reinforced Concrete Structures" (1998-2002). Moreover, he is a **Certified Instructor/Trainer**, a **Certified Internal Verifier/Assessor/Trainer** by the **Institute of Leadership & Management** (**ILM**) and has conducted numerous courses, seminars, workshops and conferences internationally.

Training Methodology

All our Courses are including **Hands-on Practical Sessions** using equipment, State-of-the-Art Simulators, Drawings, Case Studies, Videos and Exercises. The courses include the following training methodologies as a percentage of the total tuition hours:-

30% Lectures
20% Practical Workshops & Work Presentations
30% Hands-on Practical Exercises & Case Studies
20% Simulators (Hardware & Software) & Videos

In an unlikely event, the course instructor may modify the above training methodology before or during the course for technical reasons.

Course Program

The following program is planned for this course. However, the course instructor(s) may modify this program before or during the course for technical reasons with no prior notice to participants. Nevertheless, the course objectives will always be met:

Day 1

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome & Introduction*
0815 – 0830	***PRE-TEST***
0830 – 0930	***Introduction*** *Course Overview • Reinforced Concrete Structures Service Life*
0930 – 0945	*Break*
0945 – 1215	***Structure & Properties of Concrete*** *Cements, Aggregates, Water, Admixtures • Fresh & Hardened Concrete Properties*
1215 – 1230	*Break*
1230 – 1330	***Structure & Properties of Concrete (cont'd)*** *Transport Processes in Concrete • Degradation of Concrete*
1330 – 1420	***Corrosion of Concrete Reinforcement*** *Corrosion Principles • Passivity • Carbonation • Chloride Induced Corrosion • Stray Currents • Hydrogen Embrittlement • Macrocells*
1420 – 1430	***Recap***
1430	*Lunch & End of Day One*

Day 2

0730 – 0930	***Design for Durability***
0930 – 0945	*Break*
0945 – 1100	***Additional Preventative Measures*** *Controlled Permeability Formwork •Corrosion Resistant Reinforcemen • Mixed in Corrosion Inhibitor*
1100 – 1215	***Additional Preventative Measures (cont'd)*** *Surface Treatments • Cathodic Prevention*
1215 – 1230	*Break*
1230 – 1420	***Damage Assessment*** *Visual Inspection • Physical Tests • Chemical Tests • Electrochemical Tests • Potential Mapping • Monitoring Movements*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Two*

Day 3

0730 – 0930	***Assessment of the Reinforced Concrete Structures Conditions*** *Inspection Phase • Structural Assessment • Assessment Report*
0930 – 0945	*Break*
0945 – 1100	***Assessment of the Reinforced Concrete Structures Conditions – Practical Cases***
1100 – 1215	***Reinforced Concrete Monitoring Techniques*** *Monitoring Objectives • Sensors • Practical Cases*
1215- 1230	*Break*
1230 – 1420	***Principles of Rehabilitation*** *Choice of Principles & Methods of Rehabilitation • Products & Systems for Protection & Repair • Damages & Principles Applicable for Rehabilitation • Unintentional Effects*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Three*

Day 4

0730 – 0930	***Assessment of the Reinforced Concrete Structures Conditions*** *In Situ Tests • Discussion of the Results of the Tests*
0930 – 0945	*Break*
0945 – 1100	***Principles & Methods for Rehabilitation of Damaged Concrete*** *Protection Against Aggressive Substances • Moisture Control • Replacement of Damaged Concrete • Strengthening of Building Components*
1100 – 1215	***Principles & Methods for Rehabilitation of Concrete Damage Due to Reinforcement Corrosion*** *Restoring Reinforcement Passivity • Cathodic Protection • Electrochemical Chloride Extraction • Use of Corrosion Inhibitors For Repair*
1215 – 1230	*Break*
1230 – 1420	***Rehabilitation of Reinforced Concrete Structures*** *Practical Cases*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Four*

Day 5

0730 – 0830	***Risk-Based Maintenance Strategy*** *Present Value Method • Repair Time*
0830 – 0930	***Risk-Based Maintenance Strategy (cont'd)*** *Capacity Loss in Reinforced Concrete Sections • Required Time to Start of Corrosion*
0930 – 0945	*Break*
0945 – 1215	***Risk-Based Maintenance Strategy (cont'd)*** *Time Required to Start of Deterioration • Cost Analysis for Different Protection Methods*
1215 – 1230	*Break*
1230 – 1345	***Quality Control***
1345 – 1400	***Course Conclusion***
1400 – 1415	***POST-TEST***
1415 – 1430	*Presentation of Course Certificates*
1430	*Lunch & End of Course*

Practical Sessions

This practical and highly-interactive course includes real-life case studies and exercises:-

Course Coordinator

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