OMAINTEC CONFERENCE 2024 EXHIBITION

THE 21ST INTERNATIONAL OPERATIONS & MAINTENANCE CONFERENCE IN THE ARAB COUNTRIES

Prof. Mufid Samarai,
Senior Advisor-
Engineering and Educatio
Sahara Group, UAE

ARTIFICIAL INTELLIGENCE, CHATBOTS, AND CYBER SECURITY: FUTURE OF ASSET MANAGEMENT AND MAINTENANCE

الذكاء الاصطناعي ، وربوتات الدردشة، والأمن السيبراني: مستقبل إدارة الأصول وصيانتها

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Workshop Outline

PART 1- INTRODUCTION TO MAINTENANCE AND CODES

PART 2- ARTIFICIAL INTELLIGENCE IN CONCRETE BUILDING MAINTENANCE

PART 3- ADVANCED APPLICATIONS IN ASSET MANAGEMENT

PART 4- CYBER SECURITY AND ASSET MANAGEMENT

PART 1 - OVERVIEW OF MAINTENANCE AND CODES

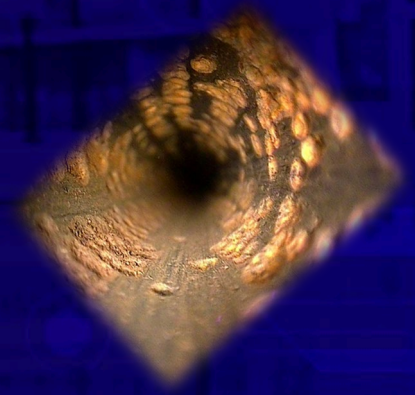
Cost of Deterioration and Repair

- In the United States conservative estimates of the current cost to rehabilitate deteriorating concrete structures are in the 130 billion dollar range.
- Within Europe it has been estimated that around 50% of the expenditure in the construction industry in Europe is spent on repair, maintenance, and remediation
- It has been estimated that the annual cost of building maintenance, conversion, rehabilitation and refurbishment in the UK is currently in the region of £10 Billion

PART 1 - OVERVIEW ON MAINTENANCE AND CODES

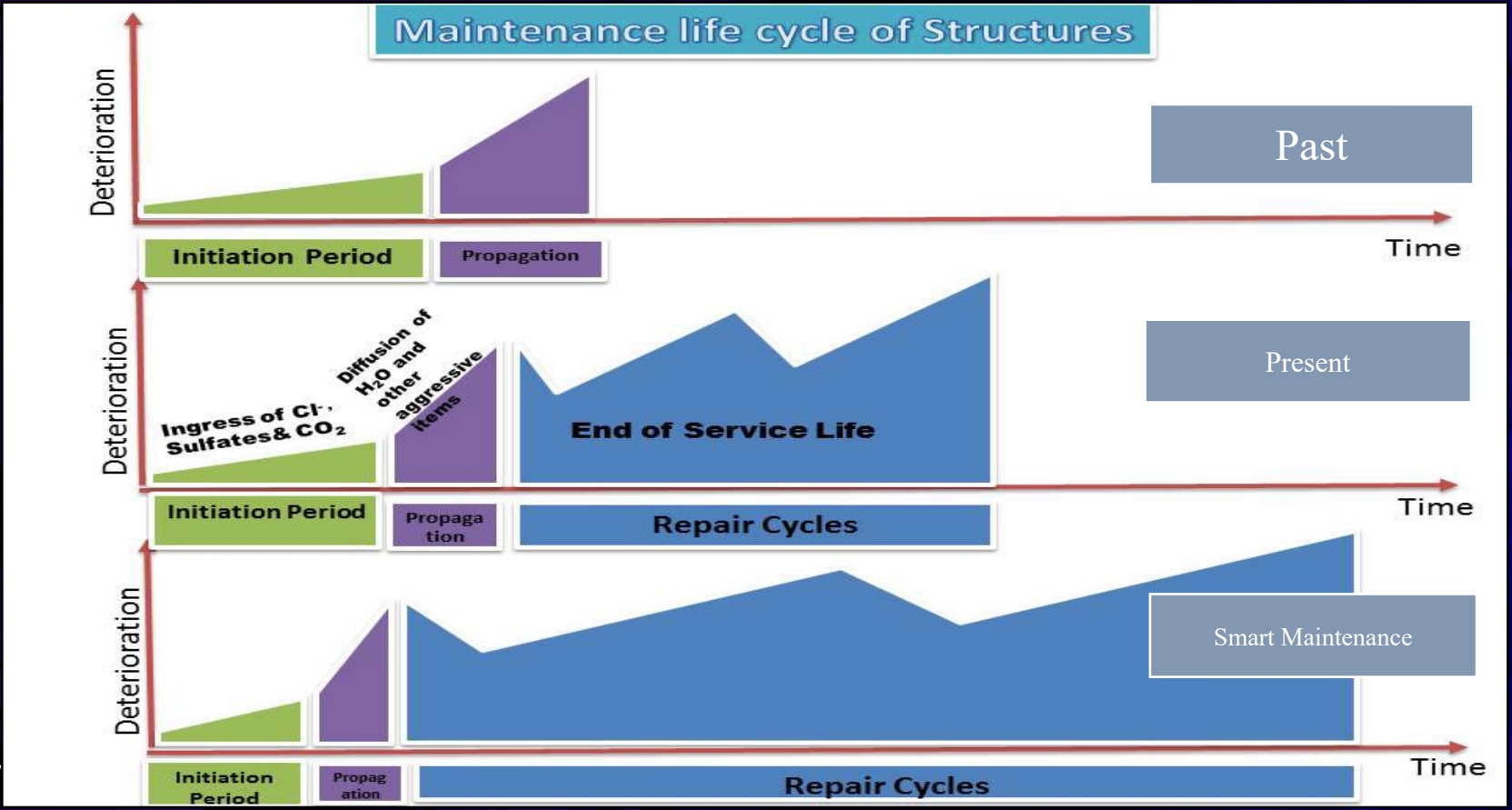
Corrosion Management

- A comprehensive program for reducing the effects of corrosion to an acceptable level
- Corrosion management includes:
  - Design
  - Construction
  - Operation
  - Maintenance
  - Remediation
  - Assessment



PART 1 - OVERVIEW ON MAINTENANCE AND ITS CODES

Life Cycle Management and Maintenance



PART 1 - OVERVIEW ON MAINTENANCE AND CODES

Historic Overview of Codes

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THE CODE OF HAMMURABI
2250 BC

- If a dam broke and subsequent flooding destroyed crops, the laws chalked it up to the negligence of the dam's owner, who had to compensate the farmers who lost crops
- If a house collapses the builder had to be punished and is obliged to compensate the occupants for any damages and losses whether physical or material.

PART 1 - OVERVIEW ON MAINTENANCE AND ITS CODES

ACI Repair Codes

- ACI 201.1R: Guide for Conducting a Visual Inspection of Concrete in Service
- ACI 214.4R: Guide for Obtaining Cores and Interpreting Compressive Strength Results
- ACI 224.1R: Causes, Evaluation, and Repair of Cracks in Concrete Structures
- ACI 228.2R: Nondestructive Test Methods for Evaluation of Concrete in Structures
- ACI 325.13R: Concrete Overlays for pavement Rehabilitation
- ACI 341.3R : Seismic Evaluation and Retrofit Techniques for Concrete Bridges
- ACI 364.1-13T Repair Tech Notes

PART 1 - OVERVIEW ON MAINTENANCE AND CODES

ACI 562M Chapters

- Chapter 1—General requirements
- Chapter 2—Notations and Definitions
- Chapter 3—Referenced Standards
- Chapter 4—Criteria when using this code with IEBC
- Appendix A—Criteria using this code as stand-alone code

Preliminary Evaluation

- Chapter 5—Loads, factored load combinations, and ϕ
- Chapter 6—Assessment, evaluation, and analysis

Structural Assessment

- Chapter 7—Design of structural repairs
- Chapter 8—Durability

Design

- Chapter 9—Construction
- Chapter 10—Quality assurance

Construction

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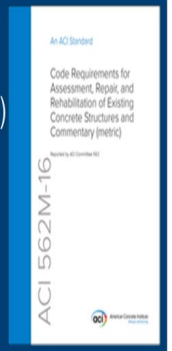
ACI 562M a New Repair Code

- Standardizes industry practice
- Licensed Design Professional (LDP)
- Building inspectors
- Owners
- A stand-alone code or supplements IEBC



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TYPES OF MAINTENANCE

1. ROUTINE MAINTENANCE (CYCLIC MAINTENANCE) 30%
2. PREVENTIVE MAINTENANCE (SCHEDULED MAINTENANCE) 12%
3. CORRECTIVE MAINTENANCE (EMERGENCY MAINTENANCE) 58 %

PART 2 - ARTIFICIAL INTELLIGENCE APPLICATIONS IN BUILDING EVALUATION

- Artificial Intelligence (الذكاء الاصطناعي): it is the simulation of human intelligence processes by computer systems, including learning, reasoning, problem-solving, and decision-making.
- Machine Learning (تعلم الآلة): It is a subfield of Artificial Intelligence that focuses on the development of **algorithms and statistical models** that enable computer systems to find patterns and correlation.

PART 2 - ARTIFICIAL INTELLIGENCE APPLICATIONS IN BUILDING EVALUATION

Machine Learning Software's (البرامج الحوسبية)

- Predictive Maintenance is a data-driven approach to predict when maintenance is needed
- Data collection is performed through sensors placed within the concrete structure
- Collected data is analyzed using machine learning to schedule maintenance, assess the risks and optimize the cost.

PART 2 - ARTIFICIAL INTELLIGENCE APPLICATIONS IN BUILDING EVALUATION

Correlation in Non-Destructive Testing Data

- NDT Data can be complex and difficult to interrupt especially when concrete properties are included
- Machine learning is an advanced analysis technique way more than standard statistical techniques
- Machine learning analysis can find patterns and trends in any data set with great R-squared
- Machine learning techniques simply find correlation between certain INPUTS and a desired OUTPUT

PART 2 - ARTIFICIAL INTELLIGENCE APPLICATIONS IN BUILDING EVALUATION

Ultrasonic (Pulse Velocity)

- ASTM C597: Standard Test Method for Ultrasonic Pulse Velocity Through Concrete
- Detecting Cracks, Voids, And Flaws To Find The Damage Pattern
- It Can Be Used To Control The Effectiveness Of Repair By Injection Technique.

PART 2 - ARTIFICIAL INTELLIGENCE APPLICATIONS IN BUILDING EVALUATION

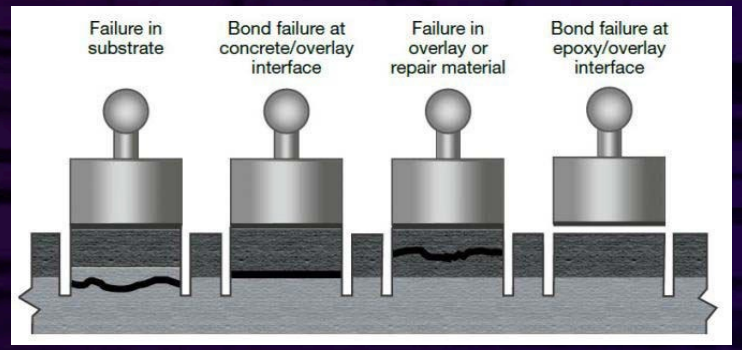
Coring Test

- ASTM C42-04: “Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete”

- The Concrete Society and BS 1881: Part 120 suggest that cores should be kept as short as possible (l/d = 1.0→ 1.2).

- Correction factors are minimized if the core length/diameter ratio is close to 2.0 and this view is supported by ASTM C42
- Factors that influence measured core compressive strength:
  - Concrete characteristics
  - testing variables (Length/diameter ratio of core, Diameter of core, Direction of drilling, Method of capping and reinforcement)

PART 2 - ARTIFICIAL INTELLIGENCE APPLICATIONS IN BUILDING EVALUATION



Partially Destructive Tests

- The most common partially destructive tests are-- pullout,-- pull-off, -- penetration resistance-- break-off, Windsor Probe

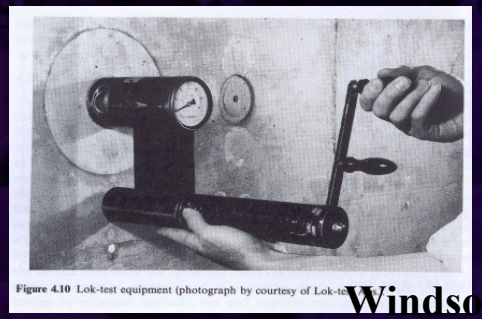


Figure 4.10 Lok-test equipment (photograph by courtesy of Lok-test...

Windsor Probe Test

Method	Standards		Features
	ASTM	BS 1881	
Pull out	C900	207	Existing concrete , high variability
Pull off		207	Existing concrete surface or partially cored
Break off	C1150	207	New construction or Existing concrete

PART 2 - ARTIFICIAL INTELLIGENCE APPLICATIONS IN BUILDING EVALUATION

Concrete Sensors (مستشعرات)

- Strain Gauges
- Temperature Sensors
- Humidity/Moisture Sensors
- Acoustic Emission Sensors
- Load Cells
- pH Sensors
- Corrosion Sensors
- Fiber Optic Sensors

PART 2 - ARTIFICIAL INTELLIGENCE APPLICATIONS IN BUILDING EVALUATION

MATLAB Tutorial

- This is an example of machine learning modeling on MATLAB for the prediction of Compressive Strength (MPa) through Pulse Velocity (m/s) Data

PulseVelocity

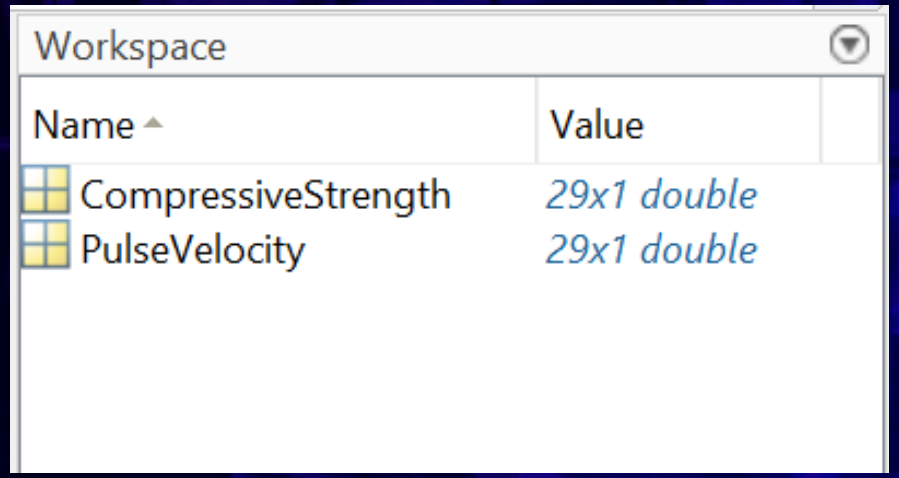
29x1 double

	1	2
1	50	
2	52	
3	54	
4	56	
5	58	
6	60	
7	62	
8	64	
9	66	
10	68	
11	70	

CompressiveStrength

29x1 double

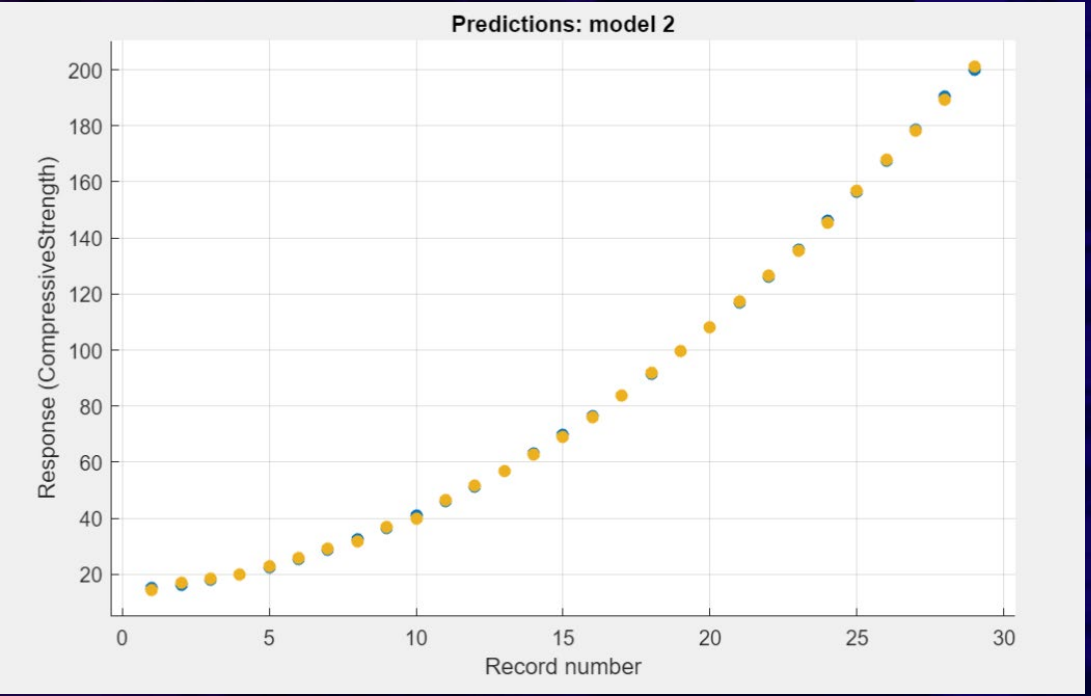
	1	2
1	15	
2	16.3000	
3	18	
4	20.1000	
5	22.6000	
6	25.5000	
7	28.8000	
8	32.5000	
9	36.6000	
10	41.1000	
11	46	



PART 2 - ARTIFICIAL INTELLIGENCE APPLICATIONS IN BUILDING EVALUATION

MATLAB Tutorial

- The analysis results shows a great accuracy of prediction of compressive strength



PART 2 - ARTIFICIAL INTELLIGENCE APPLICATIONS IN BUILDING EVALUATION

Computer Vision (الرؤيا الحاسوبية) for Image Recognition and Crack Detection

- **Image Recognition (تعرف الصورة):** it is the process of identifying and classifying objects, patterns, or features within digital images or photographs
- Machine Learning techniques can analyze images for damage and crack detection
- Traditional methods involve manual inspections, which can be time-consuming and labor-intensive.
- Machine learning algorithms can automatically identify cracks in concrete structures

PART 3 - MACHINE LEARNING AND OTHER ADVANCED APPLICATIONS IN ASSET MANAGEMENT

Understanding Asset Management

- The concept of asset management can be applied on any asset
- Financial: Stocks/Mutual Funds/Hedge Funds
- Digital: Media Libraries/Crypto Currency
- Physical: Real Estate/Infrastructure

PART 3 - MACHINE LEARNING AND OTHER ADVANCED APPLICATIONS IN ASSET MANAGEMENT

Structural Health Monitoring (SHM)

- Structural Health Monitoring (مراقبة صحة الهياكل): is the continuous monitoring of a system over time through data collected from preinstalled sensors.
- SHM is an essential part of asset management related to structure and infrastructure.
- Examples of data collected from SHM sensors:
  - Temperature and Humidity
  - Vibration/Acoustic Emission
  - Strain/Stress
  - Crack Width

PART 3 - MACHINE LEARNING AND OTHER ADVANCED APPLICATIONS IN ASSET MANAGEMENT

Natural Language Processing (NLP) and Chatbots like ChatGPT

- Natural Language Processing (معالجة اللغة الطبيعية): is a branch of artificial intelligence that deals with the interaction between computers and humans through natural language.
- An emerged technology that gained much momentum through ChatGPT and other new platforms.
- There are huge potential for such technology in engineering and research

PART 3 - MACHINE LEARNING AND OTHER ADVANCED APPLICATIONS IN ASSET MANAGEMENT

CASE STUDY 1: Monitoring Scour (التعرية) Depth

- a Bridge in Louisiana crossing over the Redwood Creek on LA Highway 67. This bridge, built in 1965 with a length of 91.44 m (300 ft). [9]
- The study emphasized on evaluating Bridge scour of an existing bridge
- This weakens the bridge supports and may lead to failure

PART 4 - Introduction to Cyber Security

Cyber Security and Asset Management

- **Cyber Security (الأمن السيبراني):** Cyber Security is the practice of protecting computer systems, networks, and digital information from unauthorized access, cyberattacks, and data breaches.
- Cybersecurity and Asset Management are critical components in the digital age
- As technology evolves, so do the threats and challenges associated with protecting digital assets
- These attacks often aim to access, alter, or destroy sensitive information; extort money from users; or interrupt normal business processes.

PART 4 - Introduction to Cyber Security

Evolution of Cyber Attacks

- Early Threats: In the year 2000, viruses and worms like the 'ILOVEYOU' virus were common, causing widespread but relatively straightforward damage.
- Advancement to Sophisticated Malware: The mid-2000s saw the rise of Trojans, spyware, and phishing attacks, focusing on stealth and data theft.
- Rise of Ransomware: In the late 2000s and 2010s, ransomware such as WannaCry became prominent, encrypting data and demanding ransomware.
- State-Sponsored Attacks and APTs: The 2010s brought sophisticated state-backed cyberattacks and APTs, with Stuxnet being a notable example, targeting specific critical infrastructures.
- AI-Powered Threats: Currently, the use of AI in cyberattacks, like deepfake technology, represents the latest evolution, creating new challenges in cybersecurity.

PART 4 - Introduction to Cyber Security

Cyber Security and Asset Management

- Cyber security in asset management refers to the process of tracking and managing the organization's hardware, software, and information resources.
- Cybersecurity aims to protect Hardware assets (like servers and workstations) and Software assets (including applications and operating systems).
- The benefits include enhanced security posture, compliance with regulations
- The main challenges are the rapid technological change and emerging threats that *require* constant vigilance and adaptation to evolving cybersecurity threats.

Conclusion

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We Have to be Vigilant!

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THANK YOU!

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PART 4 - Introduction to Cyber Security

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PART 4 - Introduction to Cyber Security

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