



DEPARTMENT OF CIVIL ENGINEERING

**A Report on
Second Phase
of**

**AICTE SPONSORED 6 DAYS ONLINE STTP ON "LIFE CYCLE ASSESSMENT AND STRUCTURAL
HEALTH MONITORING OF STRUCTURES"**

Date	:	23 rd to 28 th November 2020
Organized by	:	Department of Civil Engineering
Convener	:	Dr.S.P.Sangeetha , VP (Academics)
Co-Convener	:	Dr.R.Divahar , HoD/Civil Engg. Dr.P.S.Aravind Raj , Associate Professor
Venue	:	Online – Microsoft Teams
Chief Guest	:	Inauguration: Dr.K.P.Jaya Director, Center for Research Professor, Structural Engineering Division Anna University Chennai
Keynote Speakers	:	Dr.K.P.Jaya Director, Centre for Research, Professor, Structural Engineering Division, Anna University, Chennai. Dr.S.P.Sangeetha Vice Principal(Academics) & Professor, Department of Civil Engineering, Aarupadai Veedu Institute of Technology, Paiyanor, Tamilnadu Shri.R.Murugan Scientific Officer -F Civil Engineering Division IGCAR,Kakpakkam Dr. Amit Kr. Shrivastava Professor, Department of Civil Engineering Delhi Technological University, Delhi Dr.R.Divahar HoD & Associate Professor Department of Civil Engineering Aarupadai Veedu Institute of Technology, Paiyanor, Tamilnadu Dr.P.Sivakumar Former Chief Scientist, CSIR-Structural Engineering Research Centre, Chennai Prof. S .Suriya Prakash Professor and Head Department of Civil Engineering IIT –Hyderabad Dr.P.S.Aravind Raj Associate Professor, Department of Civil Engineering, Aarupadai Veedu Institute of Technology, Paiyanor, Tamilnadu



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Dr.T.Ch.Madhavi

Professor and Head, Department of Civil Engineering

SRM IST, Ramampuram

Dr. Shifana Kaafil

Assistant Professor, Architecture,

Dar Al-Hekma University, Saudi Arabia

Dr. Pradeep K. Goyal

Associate Professor, Department of Civil Engineering

Delhi Technological University, Delhi

Dr. Anish Kumar

Head-Non-Destructive Evaluation Division (NDED)

Indira Gandhi Centre for Atomic Research (IGCAR),

Kalpakkam, Tamilnadu

Er. M.Ravikumar

Deputy General Manager

Structures Division, L&T IDPL

TCTC Building, Manapakkam

Department of Civil Engineering, Aarupadai Veedu Institute of Technology organized the Second phase of AICTE Sponsored 6 days Online STTP on “Life cycle Assessment & Structural Health Monitoring of Structures” from 23rd to 28th November 2020. The aim of this STTP is to provide an insight to faculty members in the field of Civil Engineering about the path breaking developments in Health monitoring and Life cycle assessment of structures. The lectures were delivered by distinguished speakers from various backgrounds to make the program insightful and pronounced. The topics for the STTP include components of structural health monitoring, NDT, Life cycle assessment of structures, case studies on sustainability, application in bridges, etc. This STTP served very helpful for upgrading knowledge on recent technologies in the assessment of structures worldwide. The eminent resource persons of the STTP were from the various parts of the world.

The inauguration of STTP began with a welcome address by Dr.S.P.Sangeetha, Vice-Principal(Academics) & Convenor of the STTP. Dr.K.L.Shunmuganathan, Principal, AVIT delivered the presidential address and congratulated the participants. Dr.R.Divahar, HoD (Civil) & Co-Convenor of the STTP deliberated about the event. The chief guest of the STTP Dr.K.P.Jaya, Director, Center for Research & Professor, Structural Engineering Division , Anna University, Chennai delivered the inaugural address. The inaugural session was concluded with a vote of thanks by Dr.P.S.Aravind Raj, Associate Professor (Civil) & Co-Convenor of the STTP which was then continued by the technical session by resource persons.



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Dr.K.P.Jaya, Director, Center for Research & Professor, Structural Engineering Division , Anna University, Chennai

Dr.K.P.Jaya delivered a presentation on the topic “Retrofitting Strategies: Post Disaster”. She explained clearly the causes and different forms of disasters. Aims of disaster management, disaster management cycle, Five R Strategies, Lessons learnt from previous disasters were discussed in brief and the various remedial measures for both existing structures and new construction were also explained clearly by the Professor. Various phases of retrofitting program were discussed in detail.

Dr.S.P.Sangeetha, Professor(Civil Engineering) & Vice-Principal (Academics), AVIT

Dr.S.P.Sangeetha has delivered a lecture on Life cycle Assessment of construction materials. In her lecture, she explained how LCA contributes to sustainable development and presented inventory life cycle models of various structures. The energy consumption in various phases of life cycle of buildings and its greenhouse gas emissions were explained very clearly. Various recommendations of Eco-friendly management practices were also suggested by the Professor.

Shri.R.Murugan, Scientific Officer F, Civil Engineering Division, IGCAR, Kalpakkam

Shri.R.Murugan briefed about various case studies on repair and rehabilitation of residential buildings to increase the service life of the structures. He explained about the service life of structures, basics of corrosion in rebars of concrete, repair materials, damages in buildings, retrofitting of column, repairs of slabs & sunshade and building repairs. Structures were compared to human body during the discussion and the entire session was made lively.

Dr.P.Sivakumar, Former chief scientist, CSIR-SERC, Chennai

Dr.P.Sivakumar presented on the topic “Non-Destructive Testing”. The speaker has high-lighted the significance of non-destructive testing of concrete structures. In his speech, he elaborated on Where to use NDT and discussed on the various NDT methods which includes Ultrasonic pulse velocity, Rebound hammer testing, Hall-cell Electrical potential method, Carbonation test. All basic features of the above mentioned methods were explained in detail.

Dr.R.Divahar, Associate Professor & HoD(Civil Engineering), AVIT

Dr.R.Divahar explained about the short and long term monitoring of structures. He presented on most integrated and reliable monitoring systems for structures including detection, recording and processing of any strong motion vibrations that may affect the structure. Also in his presentation, many case studies on the structural health monitoring of bridges were explained clearly.

Prof.Dr.S.Suriya Prakash, Professor & Head, Department of Civil Engineering, IIT- Hyderabad

Prof.S.Suriya Prakash gave an overview of structural condition assessment and health monitoring of bridges. A very detail explanation on condition assessment using visual inspection, condition assessment of existing structures and NDT for condition assessment was delivered by the Professor. He also explained the condition assessment using structural health monitoring, expectations after condition assessment and the strategies used in SHM.



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Dr.T.Palanisamy, NIT, Surathkal, Karnataka

Dr.T.Palanisamy discussed about the topic “Transportation Mechanisms in Hardened Concrete”. In his lecture, he explained the problems related to durability and volumetrics of cement hydration. Microstructure of concrete, factors influencing permeability, pores in cement paste, permeability of aggregates were explained briefly. The speaker also discussed about the standard test method for measurement of rate of absorption of water by hydraulic cement concretes.

Dr.P.S.Aravind Raj, Associate Professor(Civil Engineering) , AVIT

Dr.P.S.Aravind Raj, in his lecture explained about the different types of damages in civil engineering structures and the traditional Non-Destructive Testing techniques that are introduced to detect damages in structures. The nature of various NDT's and their applications in Civil engineering practices were discussed. Also, the recently developed Structural Health Monitoring(SHM) methods for damage identification in structures were also explained in detail.

Er.E.B.Perumal Pillai, Director – HRDC, Vel Tech Rangarajan Dr.Sakunthala R & D Institute of Science & Technology, Chennai

Er.E.B.Perumal Pillai delivered a lecture on the topic “Health Monitoring of Structures- Case studies”. He explained about the objectives of Health Monitoring of Structures(HMS), various steps involved in HMS, need for structural system identification, HMS classification & methodology and practice for HMS system. He also briefed about the smart sensor concepts used in the HMS with many case studies.

Dr.T.Ch.Madhavi, Professor & Head, SRMIST, Chennai

Dr.T.Ch.Madhavi briefed about the Masonry buildings. She explained the vulnerability of masonry structures, high lightened the difference between brick and block masonry structures, nature of masonry. Seismic retrofitting, its need, basic concepts involved in seismic retrofitting and the types of structures which are vulnerable were also discussed by Professor.

Dr.Shifana Fatima Kaafil, Dar Al Hekma University, Saudi Arabia

Dr.Shifana Fatima Kaafil gave a brief lecture on “Life cycle assessment of structures using finite element method”. In her lecture, she explained how a 2D element using FEM has been developed to reflect the damage quantitatively and qualitatively, how quantification of damage and suggestions for rehabilitation using Fuzzy information has been done and she finally gave a detail explanation on fracture analysis of concrete specimens using finite element method.

Dr. Pradeep K. Goyal, Associate Professor, Department of Civil Engineering Delhi Technological University, Delhi

Dr. Pradeep K. Goyal enriched the participants on the topic “Risk Assessment of Houses due to Cyclonic Wind”. First of all, he clearly explained the vulnerability profile of India and frequency of cyclones in India. In his lecture, he covered the types of vulnerability and elements at risk. Impact of climate change on tropical cyclones, forces causing the formation of tropical cyclones, storm surges were explained very clearly. Finally, the impact of cyclonic storms and suggested mitigation actions were also discussed.

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Dr. Amit Kr. Shrivastava, Professor, Department of Civil Engineering, Delhi Technological University, Delhi

Dr. Amit Kr. Shrivastava presented on the topic “Sustainable and Economical Construction- Case studies”. He explained in detail about the sustainability in construction, cement manufacturing process, How to reduce use of OPC in concrete, chemical and mineral admixtures, savings in resources and challenges. Many case studies relevant to sustainable and economical construction were also discussed by the professor.

Dr. Anish Kumar, Head-Non-Destructive Evaluation Division (NDED), Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam, Tamilnadu

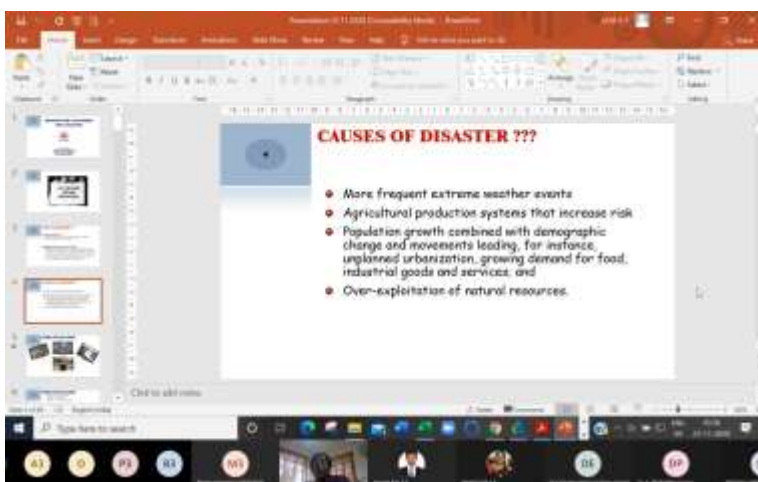
Dr. Anish Kumar gave a lecture on “NDE and Structural Health Monitoring of Structures”. In his lecture, the non-destructive evaluation of civil engineering structures was explained clearly. Civil Infrastructure Management systems, NDT for strength estimation of concrete, corrosion assessment, Location and diameter of reinforcement and cover thickness of concrete elements were also discussed by the speaker.

Er.M.Ravikumar, Deputy General Manager, Structures Division, L&T IDPL, Manapakkam

Er.M.Ravikumar explained on the topic “Concrete Pains & Remedial Measures with the Applications of NDT”. He discussed on the in-situ evaluation of concrete, its importance and need and process. All the NDT techniques were clearly explained by the resource person with the help of real time examples and case studies.

More than 60 participants from various AICTE approved institutions participated in the STTP and their feedback on each session was received through a link. As per norms of AICTE, an online assessment was conducted on the last day of the STTP and certificates were distributed to eligible participants.

ONLINE SESSION PHOTOS





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NON DESTRUCTIVE TESTING (NDT)

Non-destructive Testing Techniques are conducted to determine

- The physical quality of the materials
- The position and extent of hidden defects, elemental material boundaries

Tests are carried out in-situ and provide further information which an improved diagnosis can be made to enable the structural engineer to make decisions on remedial measures.

STTP - Life Cycle Assessment and structural Health Monitoring of structures

Structural Evaluation Needed

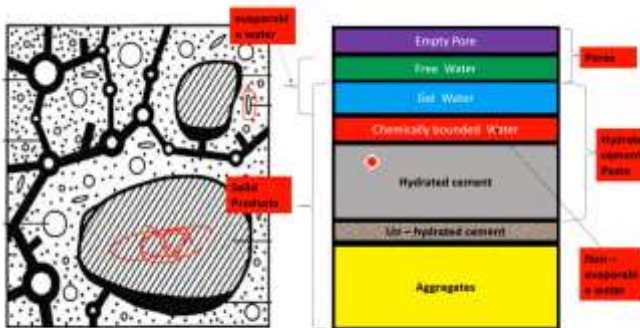
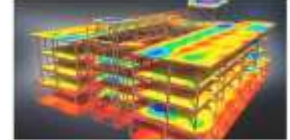
STRENGTH CALLED INTO QUESTION

When there is sign of distress, or a request for increased loading



INSUFFICIENT INFORMATION

Inadequate information for determining capacity



https://www.google.com/search?q=inter-connectivity-or-disconnectivity-of-capillary-pores+in-concrete&source=ms&bih=666&biw=1536&hl=en&sa=X&ved=2ahUKewDofuUqVwYWSAUXHF_HDHEQ_AuYAHoECQEA

Quantification of Damage

- In the case of a steel beam, the damage can be in the form of denting, buckling, crippling etc.



(a) Crippling



(b) Buckling

Damage in steel member

STEPS OF HMS






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From the wind damage point of view, India has been divided into six zones as per basic wind speeds

Speed of cyclone m/s	Zone
55	Very high damage risk zone -A
50	Very high damage risk zone -B
47	High damage risk zone
44	Moderate damage risk zone-A
39	Moderate damage risk zone-B
33	Low risk zone



How to achieve



- Reducing use of water (Potable water used for concreting and curing)
- Reducing use of raw material
- Use Technology

Compressive strength vs Ultrasonic Pulse Velocity

Quality of concrete
Compressive strength
Rate of hardening and strength development
Pulse velocity decreases for low density concrete
Cracked concrete

S. No.	Velocity (m/s) range	Quality (Strength)
1.	> 4570	Excellent
2.	3980 - 4570	Generally good
3.	3030 - 3980	Questionable
4.	2130 - 3030	Generally poor
5.	< 2130	Very poor



Less reliable due to compressive strength depends on many variables

AVT-STTP | Aradh Kumar | November 28, 2020 | 6/50

Figure 1: The carbonation of concrete.

$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$
Calcium Hydroxide + Carbon dioxide = Calcium Carbonate + Water