

**DEPARTMENT OF CIVIL ENGINEERING****A Report on***Third Phase of****AICTE SPONSORED 6 DAYS ONLINE STTP ON “LIFE CYCLE ASSESSMENT AND STRUCTURAL HEALTH MONITORING OF STRUCTURES”***

<b>Date</b>	:	7 <sup>th</sup> to 12 <sup>th</sup> December 2020
<b>Organized by</b>	:	Department of Civil Engineering
<b>Convener</b>	:	<b>Dr.S.P.Sangeetha</b> , VP (Academics)
<b>Co-Convener</b>	:	<b>Dr.R.Divahar</b> , HoD/Civil Engg. <b>Dr.P.S.Aravind Raj</b> , Associate Professor
<b>Venue</b>	:	<b>Online – Microsoft Teams</b>
<b>Chief Guest</b>	:	Inauguration: Prof.Dr.A.Santha Kumar Former Emeritus Professor- IIT Madras Former Dean, Anna University
<b>Keynote Speakers</b>	:	<ol style="list-style-type: none"><li><b>1. Prof.Dr.A.Santha Kumar</b> Former Emeritus Professor- IIT Madras Former Dean, Anna University</li><li><b>2. Dr.S.P.Sangeetha</b> Vice Principal(Academics) &amp; Professor, Department of Civil Engineering, Aarupadai Veedu Institute of Technology, Paiyanoor, Tamilnadu</li><li><b>3. Dr.S.K.Sekar</b> Senior Professor &amp; Director of Estates VIT University Vellore</li><li><b>4. Dr. Pradeep K. Goyal</b> Associate Professor, Department of Civil Engineering Delhi Technological University Delhi</li><li><b>5. Dr.R.Divahar</b> HoD &amp; Associate Professor Department of Civil Engineering Aarupadai Veedu Institute of Technology, Paiyanoor, Tamilnadu</li><li><b>6. Dr. Chandramouli SV</b> Professor- Civil Engineering PES University Bangalore</li><li><b>7. Dr.Shilpa Pal</b> Associate Professor Department of Civil Engineering Delhi Technological University</li><li><b>8. Dr.P.S.Aravind Raj</b> Associate Professor, Department of Civil Engineering, Aarupadai Veedu Institute of Technology, Paiyanoor, Tamilnadu</li></ol>

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9. **Dr.R.Senthil Kumar**  
Associate Dean (P&D)  
Department of Civil Engineering  
NIT, Trichy
10. **Dr.Suriya Prakash**  
Professor  
IIT- Hyderabad
11. **Dr.C.Umarani**  
Professor  
Division of Structural Engineering  
Anna University  
Chennai
12. **Er. S.S. Gaharwar**  
Sr Pr Scientist & Former Head  
Bridge Engineering & Structural Divisions  
CSIR-CRRI  
New Delhi
13. **Dr.S.Elavenil**  
Professor  
School of Civil Engineering  
VIT University  
Chennai
14. **Dr.A.Cinitha**  
Senior Scientist  
CSIR-SERC  
Chennai
15. **Mrs.R.Preetha**  
Head- Quality Control Section and Concrete Laboratory  
Civil Engineering Division  
IGCAR, Kalpakkam

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Department of Civil Engineering, Aarupadai Veedu Institute of Technology organized an AICTE Sponsored 6 days Online STTP on “Life cycle Assessment & Structural Health Monitoring of Structures” from 7<sup>th</sup> to 12<sup>th</sup> December 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.R.Divahar, HoD (Civil) & Co-Convenor of the STTP deliberated about the event. The chief guest of the conference Prof.Dr.A.Santha Kumar, Former Emeritus Professor- IIT Madras, Former Dean, Anna University 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.

**Prof.Dr.A.Santha Kumar, Former Emeritus Professor- IIT Madras, Former Dean, Anna University**

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Prof.Dr.A.Santha Kumar delivered a lecture on the topic “Corrosion Protection of Rebars in R.C. Structures and Monitoring Techniques. In his lecture he explained about how corrosion of reinforcement in concrete occurs with variety of real time images. He also discussed about the various types of marine corrosion such as Galvanic corrosion, Erosion corrosion and Biological corrosion. His lecture included the mechanisms of corrosion, factors influencing corrosion, damages due to corrosion and prevention measures in new construction.

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

Dr.S.P.Sangeetha has delivered a lecture on Inventory analysis for Life cycle assessment of structures. 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.

### **Dr.S.K.Sekar, Senior Professor & Director of Estates, VIT University, Vellore**

Dr.S.K.Sekar presented on the topic “Condition Assessment of Buildings using NDT Techniques”. He discussed about the purposes and objectives of condition assessment of buildings using NDT, visible types of damages or distress in buildings, main causes of distress in buildings, methodology of condition assessment, Standards (specifications for testing) and evaluation of safety using NDT techniques.

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

Dr.Pradeep K.Goyal delivered a lecture on the topic “Risk assessment/ damage assessment of houses due to cyclonic wind”. In his lecture, he firstly 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. At last, he explained how the names are been given to the cyclones which made the session very interesting.

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.

### **Dr. Chandramouli SV, Professor- Civil Engineering, PES University, Bangalore**

Dr.Chandramouli SV gave a brief presentation on the topic “Structural Health Monitoring - Introduction and Business opportunities”. He figured out the need for structural health monitoring and the concepts involved in structural health monitoring. A case study on Neva Cable-Stayed Bridge, St.Petersburg, Russia was also discussed by him. Various levels of Sophistications of SM Scheme were also explained very clearly. He also explained the various business opportunities which are available with SHM.

### **Dr.Shilpa Pal, Associate Professor, Department of Civil Engineering, Delhi Technological University**

Dr.Shilpa Pal gave a talk on the topic “Conceptual design of earthquake resistant buildings and safety measures”. In her talk, she discussed about the recent revision of codes used for seismic design and the codal design

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philosophy. She explained the basic strategies involved in the earthquake design and its philosophy for buildings. She presented various real time examples for common failures which occurs after seismic activity.

### **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.

### **Dr.R.Senthil Kumar, Associate Dean (P&D), Department of Civil Engineering, NIT, Trichy**

Dr.R.Senthil Kumar briefed about Seismic analysis of structures as per IS 1893: 2016. He explained the various analysis involved in the seismic design which includes Linear static analysis, non linear static analysis, linear dynamic analysis and non-linear dynamic analysis. He also explained the various criteria for earthquake resistant design of structures as per IS1893(Part 1) :2016.

### **Dr.Suriya Prakash, Professor, IIT- Hyderabad**

Dr.Suriya Prakash gave a lecture on the topic “Corrosion free FRP reinforcement for sustainable concrete construction”. Prof. briefed about various FRP materials and its properties, how FRP replaces steel bars, standards and specifications, its applications, design issues and considerations and research innovations with FRP.

### **Dr.C.Umarani, Professor, Division of Structural Engineering, Anna University, Chennai**

Dr.C.Umarani discussed about various case studies on condition assessment of structures. In her presentation she discussed about many case studies throughout India on condition assessment and strengthening of aged structures.

### **Er. S.S. Gaharwar, Sr Pr Scientist & Former Head, Bridge Engineering & Structural Divisions, CSIR-CRRI, New Delhi**

Er. S.S. Gaharwar presented a lecture on “Optimizing Maintenance of Bridges through Structural Health Monitoring”. He explained the maintenance cycle, performance parameters, various techniques of measurements and schemes of instrumentation. Various case studies and recent developments related to the topic were also discussed. The database management system in GIS Environment has also been explained by the resource person.

### **Dr.S.Elavenil, Professor, School of Civil Engineering, VIT University, Chennai**

Dr.S.Elavenil delivered a presentation on “Life cycle assessment for recycled and demolished materials”. In her lecture she explained how recycled and demolished materials helps in achieving sustainability in construction, sustainability considerations when selecting materials and the use of industrial wastes, construction and demolition waste, e-waste and rubber tyre waste in sustainable construction. The material properties of the various wastes were explained clearly.

### **Dr.A.Cinitha, Senior Scientist, CSIR-SERC, Chennai**

Dr.A.Cinitha gave a lecture on the topic “Compression behavior of corroded materials”. In her lecture, she explained about how different types of corroded materials behave under compression and how it could be analyzed using NDT. She also explained about the material failure analysis under compression.

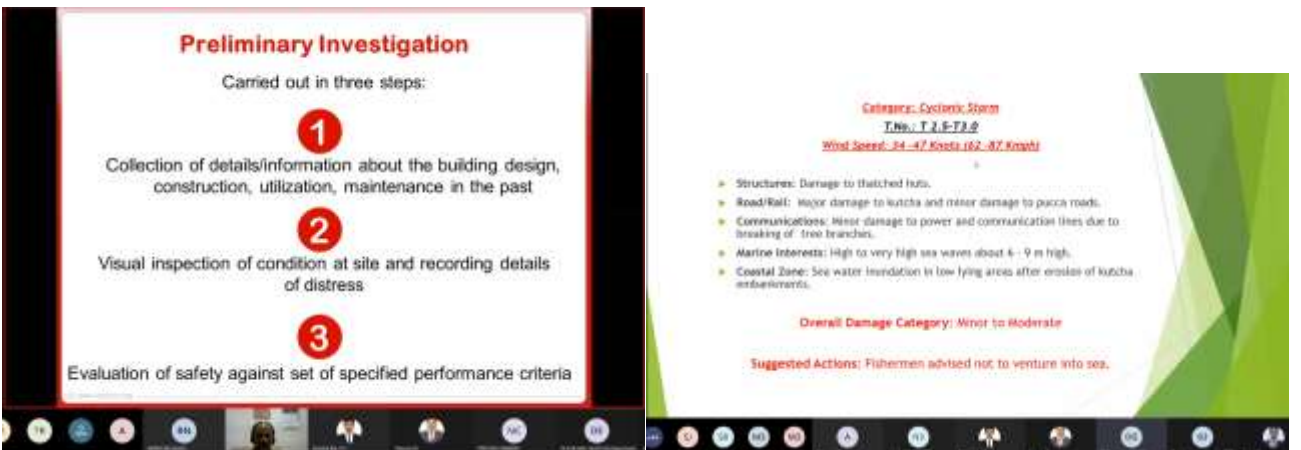
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**Mrs.R.Preetha, Head- Quality Control Section and Concrete Laboratory, Civil Engineering Division, IGCAR, Kalpakkam**

Mrs.R.Preetha presented on the topic “Structural Health Monitoring & Assessment of RCC Buildings for Safety & Sustainability”. In her presentation, she discussed about service life of an RCC Building, causes of damage in concrete, methods & tests, various case studies and advanced techniques used in SHM.

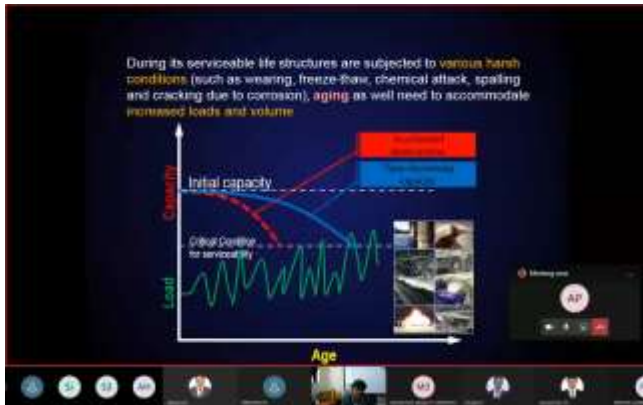
More than 60 participants from various AICTE approved institutions participated in the STTP and their feedback on each session was received through a link. As per norms of AICTE, an online assessment was conducted on the last day of the STTP and certificates were distributed to eligible participants.

### ONLINE SESSION PHOTOS





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### NON LINEAR STATIC ANALYSIS

- Material Non Linearity
- Geometric non linearity P-Δ effect
- Modulus of elasticity is variable (i.e.) it is non linear
- P-Δ effect is considered
- Push over Analysis

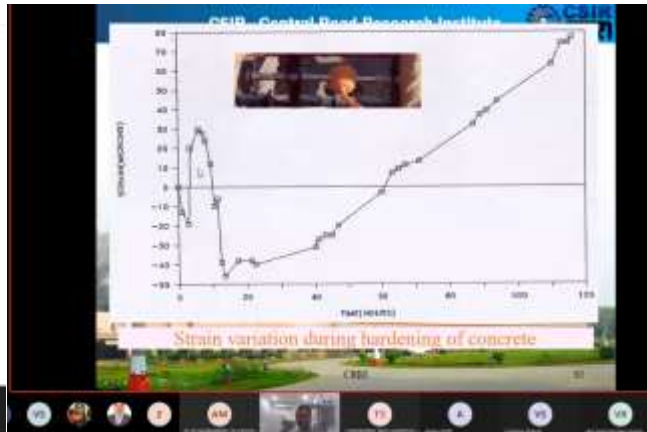
Diagrams: Deflected Shape, Stress - Strain Curve, P-Δ effect.

### FRP Materials and Properties

FRP stands for Fiber Reinforced Polymers

- FRP is a composite: Composite = combination of two or more materials to form a new and useful material with enhanced properties in comparison to the individual constituents (concrete, wood, etc.)
- FRPs consist of:
  - Fibres
  - Matrix

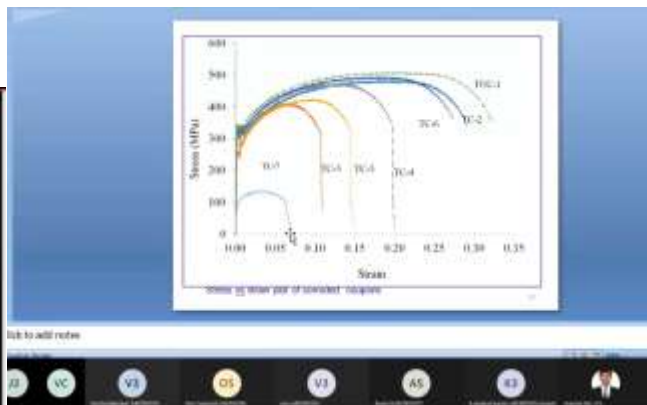
Diagram: High-strength fibres, Polymer matrix.



### Electronic waste (e-waste) is a non-biodegradable waste.

- It consists of discarded old computers, TVs, refrigerators, radios – basically any electrical or electronic appliance that has reached its end of life.
- The e waste in India for the year 2005 has been estimated to be 146180.00 tones.
- Ten states generate 70% of the total e-waste generated in India. Maharashtra ranks first followed by Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab.
- There are two small WEEE/E-waste

Image: Pile of electronic waste.



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**ORIGIN OF SELF HEALING CONCRETE**

❖ In 1877, **Ferdinand Cohn** claimed that with a bacteria known as "**Genus Bacillus**" concrete could be healed.

❖ Selected types of the bacteria genus **Bacillus**, along with **calcium lactate capsules** and **nitrogen** and **phosphorus** are added to the ingredients of the concrete.



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