Report on Five Days of Self Sponsored Online Short-Term Course "Sustainable Applications and Research Perspectives in Civil Engineering" held from 07-11 July 2025 in CED, NITJ

Theme of the STC

The Department of Civil Engineering successfully organized a Five-Day Self-Sponsored Online Short-Term Course (STC) on the theme "Sustainable Applications and Research Perspectives in Civil Engineering" from 7–11 July 2025. This course aimed to disseminate emerging knowledge and practices related to sustainability in civil engineering, focusing on both innovative applications and current research directions. It provided a platform to explore resilient infrastructure solutions, environmental responsibility, and the integration of circular economy principles.

The primary objective of the STC was to enhance awareness and understanding of sustainable materials, technologies, and engineering systems that contribute to environmentally sound and long-lasting infrastructure. The course brought together a diverse group of participants including Scientists, Academicians, Research Scholars, and Master's Students from premier institutes like IITs, NITs, and international universities.

Expert lectures delivered by eminent professors from reputed institutions facilitated meaningful discussions and knowledge sharing on pressing sustainability challenges and research frontiers.

The following themes were covered under this phase:

1. Tools and Techniques for Measuring Sustainability in Engineering
2. Sustainable Transportation and Associated Infrastructure in Urban Areas
3. An Introduction to Faecal Sludge Management: Characterization, Treatment, and Sustainable Reuse
4. An Insight on Development and Characterization of Cement-free Mortar
5. Development and Performance of Alkali Activated Concrete Composites
6. Sustainable Urban Water and Waste Management
7. Performance of Surface Modified Aggregates in Asphalt Mixtures
8. Durability Design for Sustainable Concrete Structures
9. Use of Agro-based Residues and Recycled Aggregates in Construction for Sustainability – A Practical Perspective
10. Are We Willing to Move Towards Creating Sustainable Roadway Systems with Focus on the Circular Economy?

Itinerary of the STC

First day:

On 7th July 2025, the first day of the Short-Term Course (STC) on ***"Sustainable Applications and Research Perspectives in Civil Engineering"*** commenced with the opening address by **Prof. S.P. Singh**, who welcomed all the dignitaries, speakers, and participants. He emphasized the growing importance of sustainability in civil engineering and the role of academic initiatives like STCs in fostering awareness and collaboration among students, researchers, and professionals. Following this, **Prof. A.K. Agnihotri**, Head of the Department of Civil Engineering, delivered the introductory speech, highlighting the department's ongoing commitment to research and innovation in the field of sustainable infrastructure. He elaborated on the significance of the course theme and appreciated the enthusiastic participation from reputed institutes across the country.

Subsequently, **Dr. Navdeep Singh** addressed the audience, briefing them on the structure, schedule, and technical scope of the STC. He expressed gratitude to the distinguished speakers and encouraged participants to make the most of the upcoming expert sessions by actively engaging in discussion and learning.

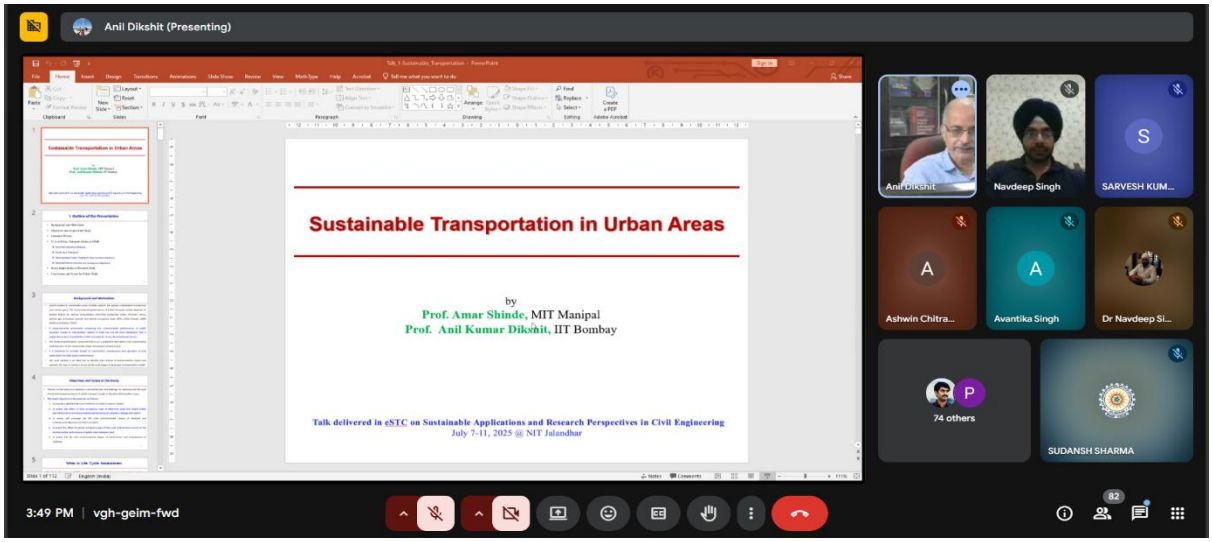
The technical proceedings then began with the keynote lecture by **Prof. Brajesh Kumar Dubey**, Professor at IIT Kharagpur, titled **"*Tools and Techniques for Measuring Sustainability in Engineering*"** Prof. Dubey opened with a compelling analogy, presenting Earth's 4.6-billion-year history compressed into a 24-hour clock to illustrate how recent and impactful human existence has been. This led into a discussion on the urgent responsibility of engineers to design systems that are environmentally sound and future-resilient. He explained the United Nations Sustainable Development Goals (SDGs), particularly those directly related to civil engineering, such as clean water and sanitation, sustainable cities, responsible consumption, and climate action.

A key segment of the lecture was devoted to decarbonization, where Prof. Dubey outlined the concepts of Scope 1 (direct), Scope 2 (indirect), and Scope 3 (other indirect) emissions. He stressed the importance of tracking these emissions to reduce the carbon footprint of engineering practices. To challenge conventional thinking, he presented the classic "paper or plastic?" debate, illustrating how life cycle assessment (LCA) tools can guide better decision-making than surface-level assumptions.

The session concluded with a strong call to action: engineers must adopt quantifiable sustainability metrics such as carbon footprint, embodied energy, LCA, and circular economy models in their work. Prof. Dubey's lecture effectively set the tone for the STC, encouraging participants to think critically and act responsibly in advancing sustainable civil engineering practices.

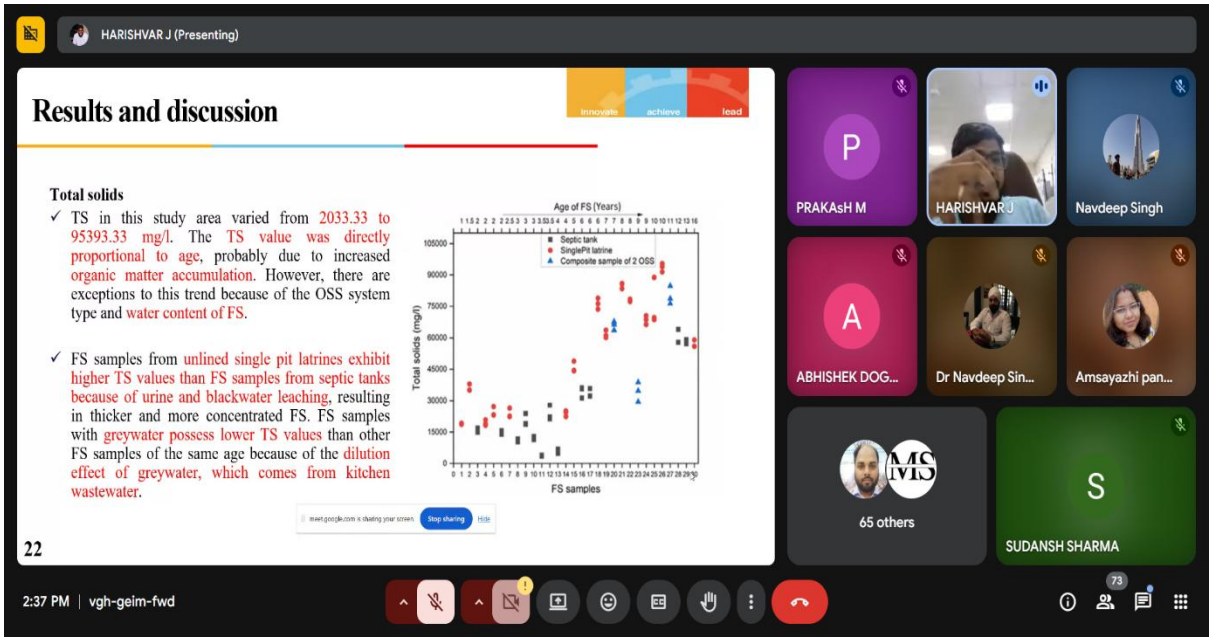
In the second session of the eSTC, Prof. Anil Kumar Dikshit, a distinguished professor from IIT Bombay, delivered an insightful talk on ***Sustainable Transportation and Associated Infrastructure in Urban Areas***. He introduced the concept of Life Cycle Assessment (LCA) as a powerful tool to evaluate the environmental impacts of various activities throughout their lifespan—from raw material extraction to end-of-life disposal. Through detailed diagrams and case studies, he compared different phases of bus transportation systems (diesel vs. CNG) and highlighted their respective contributions to emissions and environmental degradation.

Prof. Dikshit also compared flexible and rigid road pavements on parameters such as global warming potential and human toxicity, concluding that rigid pavements tend to perform better environmentally. Furthermore, he emphasized the higher environmental impacts associated with flyovers and tunnels, which were found to have up to 2 times the emissions and resource consumption compared to regular pavements. The session provided a strong case for integrating LCA-based analysis into transportation planning and policy-making to ensure more sustainable urban infrastructure.



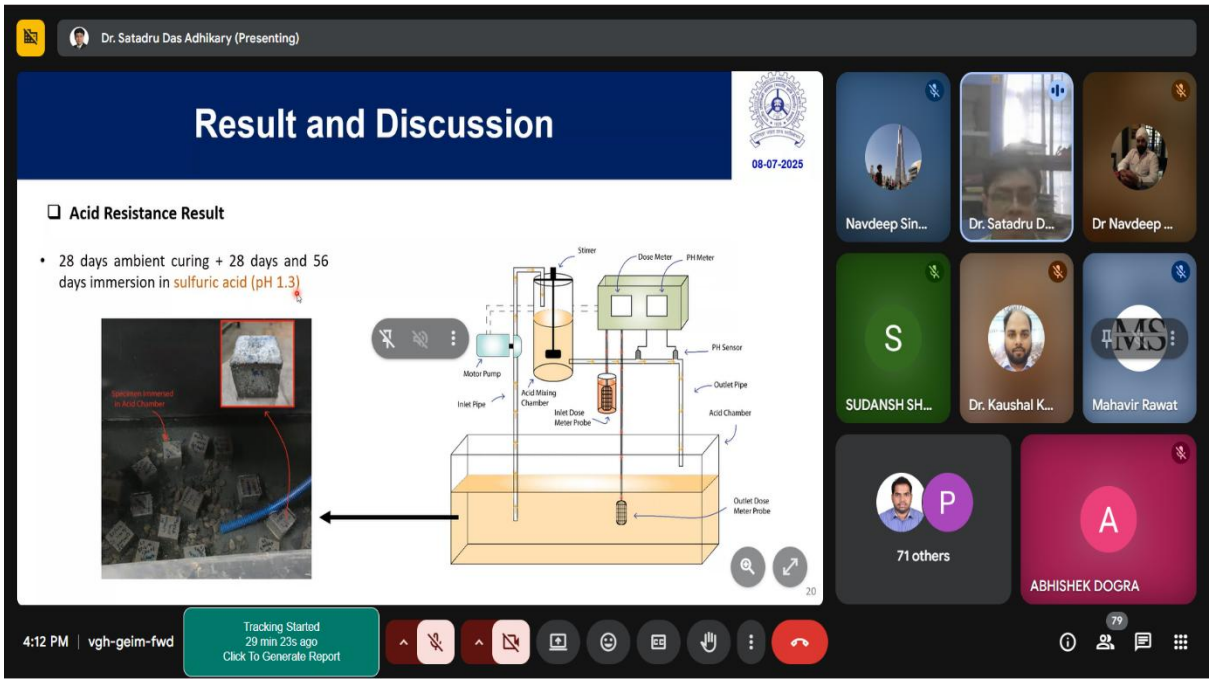
Second day:

On the second day of the short-term course on *Sustainable Applications and Research Perspectives in Civil Engineering* held at Dr. B. R. Ambedkar NIT Jalandhar, two impactful sessions were conducted, addressing pressing issues in sanitation management and sustainable construction materials. The first session was delivered by **Prof. Ajit Pratap Singh**, Senior Professor at BITS Pilani, on the topic "**Faecal Sludge Management: Characterization, Treatment, and Sustainable Reuse**." Prof. Singh began by underlining the limitations of conventional sewer systems in rapidly urbanizing and rural regions, emphasizing the need for decentralized faecal sludge management (FSM). He explained the methodology for sludge sampling, the role of composite sampling using vacuum trucks, and laboratory analyses to determine sludge properties such as solids content and dewaterability. The session also addressed the operational challenges faced by sewage treatment plants when overloaded with faecal sludge, particularly in low-income or developing areas where infrastructure is not designed for mixed waste streams. He concluded by exploring sustainable reuse pathways, including application in agriculture and biogas generation, stressing the importance of safe treatment, monitoring, and policy support.



In the second session**, Prof. Satadru Das Adhikary**, Associate Professor at IIT Dhanbad, delivered a lecture on "**An Insight on Development and Characterization of Cement-free Mortar**." The session focused on utilizing industrial waste materials, particularly Basalt Waste Dust (BWD), as a binder substitute in mortar. Prof. Adhikary explained the complete process of basalt extraction, crushing, sieving, and dust collection to produce usable fines. He discussed how BWD-based mortars were developed and subjected to performance evaluation, particularly compressive strength testing as per IS codes at different curing intervals. The lecture also highlighted the durability of the mortar in aggressive environments by showcasing

acid resistance testing, where mixes were exposed to sulfuric acid to evaluate mass loss and strength retention. The findings demonstrated that properly proportioned mixes performed well in both strength and durability, offering a promising, eco-friendly alternative to traditional cement mortar. Participants gained valuable insights into sustainable material design, waste valorization, and performance-based innovation in construction materials. Both sessions were well-received and aligned with the course's central theme of promoting sustainability, innovation, and research-based development in civil engineering.



Third day:

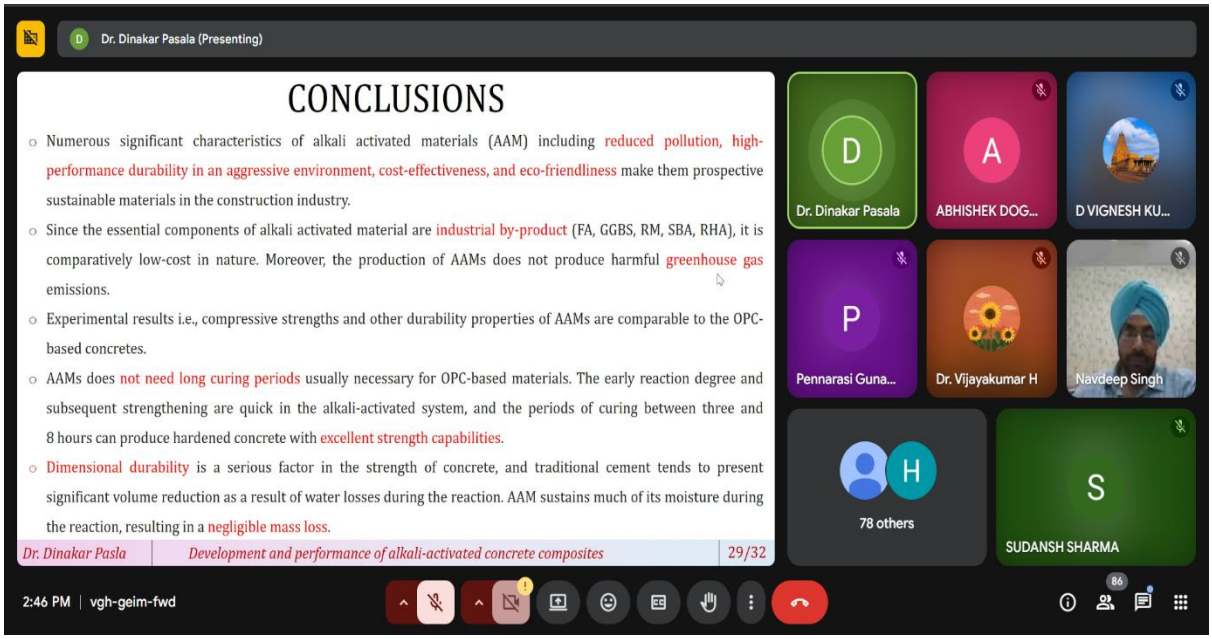
On the third day, during the first session of the workshop of the workshop**, Prof. Dinakar Pasla** from **IIT Bhubaneswar** delivered a comprehensive lecture on the **development and performance of alkali-activated concrete composites**. The focus was on the potential of alkali-activated binders as sustainable alternatives to traditional cement-based systems, aiming to reduce environmental impact and promote resource efficiency.

The session began with an overview of the chemical processes underlying the formation of these binders, emphasizing the role of aluminosilicate precursors in producing durable reaction products such as C-S-H, C-A-S-H, and N-A-S-H gels. These gels contribute significantly to the mechanical strength and durability of the resulting concrete.

Prof. Pasla highlighted the influence of precursor type, binder content, and mix ratios on the performance of alkali-activated systems. Experimental results showed notable improvements in compressive strength over time, along with enhanced resistance to aggressive environments. He discussed how these composites could be optimized for different structural applications by adjusting the mix proportions and incorporating industrial or agricultural waste materials.

In addition, the session reviewed the historical development of alkali-activated materials, tracing their evolution from early research to present-day applications. The potential for using recycled aggregates and by-products was also explored, aligning with the broader goals of circular construction and carbon reduction.

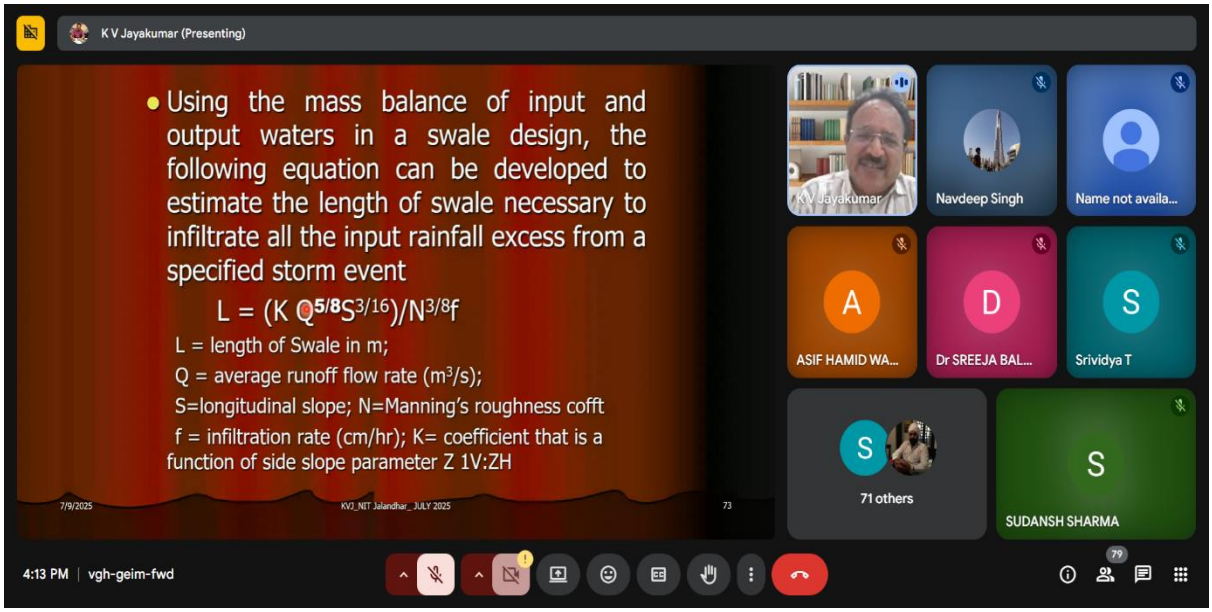
The lecture concluded by reinforcing the importance of advancing alternative binder technologies to support sustainable development in civil engineering, highlighting their role in achieving long-term environmental and structural performance goals.



The second session was delivered by **Prof. K V Jayakumar** from **IIT Dharwad**, focusing on the theme of ***Sustainable Urban Water and Waste Management.*** He began by addressing the critical issues surrounding water reliability in both urban and rural India. In many cities and villages, piped water is available only for a few hours each day, while urban areas often suffer from overflowing sewage due to blocked sewers and non-functional pumping stations. In rural regions, hand pumps can remain out of order for extended periods, compounding the problem. Using Hyderabad as a case study, Prof. Jayakumar presented a thirty-year projection that clearly illustrated how the city's water demand has consistently outpaced its supply despite infrastructure growth.

The session also covered green infrastructure solutions, particularly the use of swales—vegetated channels designed to manage stormwater runoff. He explained the technical parameters for designing swales to enhance rainwater infiltration and reduce urban flooding. Transitioning to waste management, Prof. Jayakumar highlighted the severe lack of reliable data on various waste streams, especially construction, demolition, packaging, and agricultural waste. This absence of data hampers effective planning and poses risks to both health and the

environment. He further pointed out that current municipal solid waste practices remain primitive, marked by unhygienic and unorganized collection, inadequate transfer stations, and inefficient transport systems. The session concluded with a call for data-driven policies, technological upgrades, and community engagement to build resilient and sustainable urban water and waste systems.



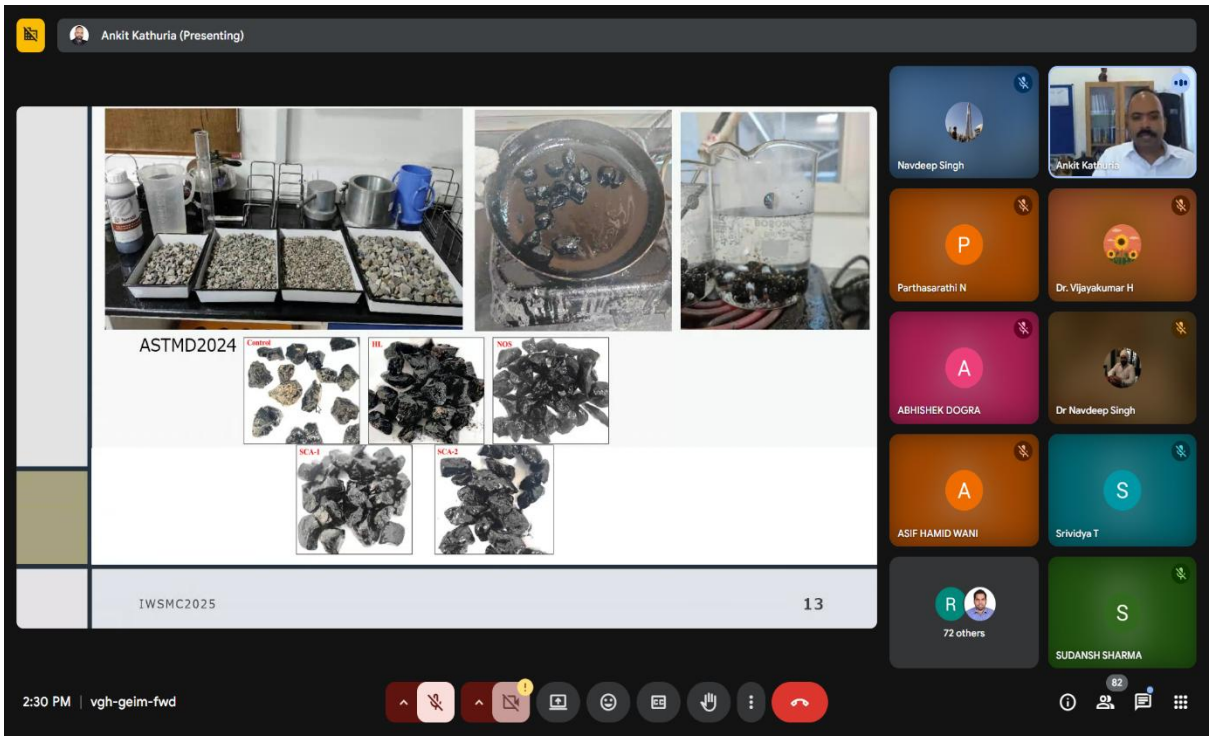
Fourth day:

On Day 4 of the conference, the first technical session was delivered by **Dr. Ankit Kathuria**, Associate Professor, Department of Civil Engineering**, IIT Jammu**. His presentation, titled "**Performance Evaluation of Surface Modified Siliceous Aggregates in Asphalt Mixtures**," addressed the critical issue of poor bonding between siliceous aggregates and asphalt binders due to the aggregates' hydrophilic nature and weak physical interactions. Dr. Kathuria explained that this weak interaction leads to moisture-induced damage in pavements, reducing their structural integrity and lifespan. To counter this, the study explored surface modification techniques aimed at chemically enhancing the aggregate-bitumen bond. Among the treatments investigated were Hydrated Lime (HL) and Nano-organosilane-based coatings like SCA-1 (N-(2-aminoethyl)-3-aminopropyl trimethoxy silane) and SCA-2 (3-Glycidoxypropyl dimethoxy methylsilane), which alter the aggregate surface from hydrophilic (OH-functionalized) to hydrophobic (Si–O–Si or siloxane-functionalized), improving binder adhesion.

The methodology covered various applications of HL—used as a filler, slurry, dry mix over wet aggregates, and bitumen additive. A visual schematic demonstrated the transformation of untreated aggregates, which exhibit weak bonding and water affinity, into treated aggregates with robust chemical bonding and water-repellent surfaces. The Boil Water Test (ASTM D2024) was used to evaluate coating retention before and after treatment. Aggregates treated

with HL and organosilanes showed significantly higher coating retention than the control, particularly with SCA-1 and SCA-2 achieving 100% retention across different aggregate sources (Ravi, Shaar, Ujh).

Experimental results were further presented through Marshall Stability and Retained Stability Tests, where treated mixtures displayed enhanced stability under load and greater resistance to moisture damage. Notably, NOS (Nano-organosilane) and SCA-1 yielded the highest stability values, while HL provided moderate improvement at lower cost. In addition, Benkelman Beam Deflection (BBD) tests showed reduced pavement deflection in treated mixes, indicating better load-carrying capacity and durability. The presentation concluded with a cost-performance comparison, highlighting the economic feasibility of HL and the superior performance of advanced silane treatments, albeit at higher cost. Dr. Kathuria's session effectively bridged material science with pavement engineering, offering practical insights into the enhancement of asphalt mixtures through surface-modified aggregates.



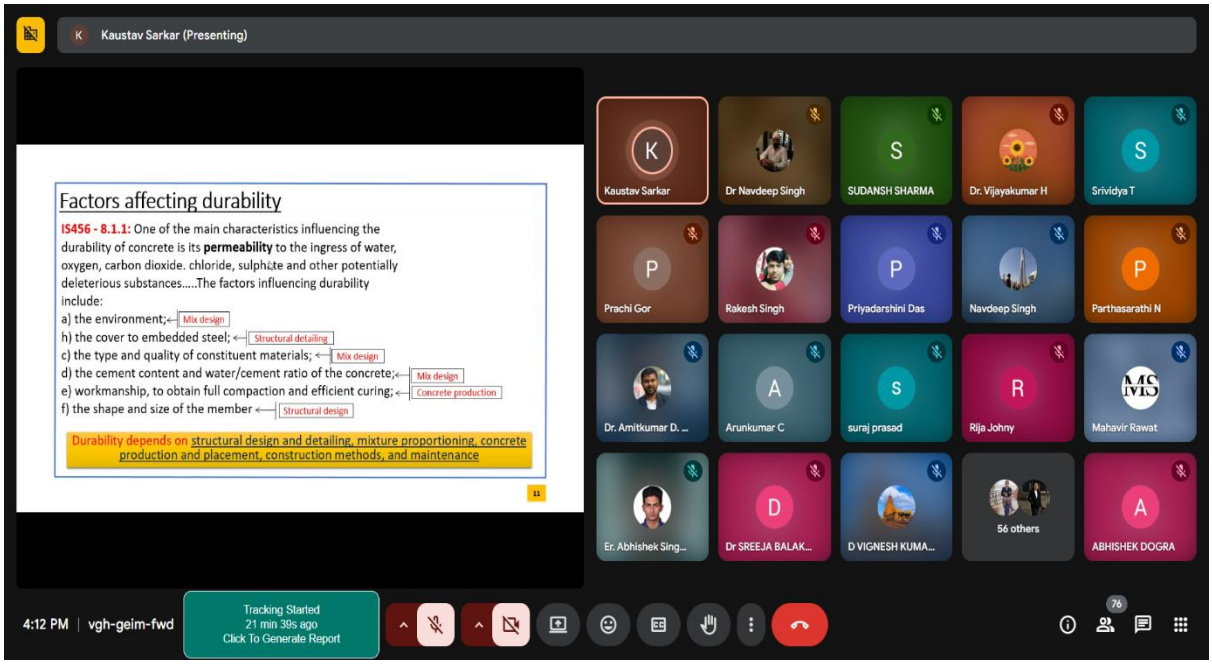
The second session was presented by **Dr. Kaustav Sarkar**, Associate Professor at the **School of Civil and Environmental Engineering, IIT Mandi**. His presentation, titled **"Durability Design for Sustainable Concrete Structures,"** emphasized the need to incorporate durability as a core criterion in the design of sustainable infrastructure. Dr. Sarkar began by linking the concept of sustainable concrete to the United Nations' definition of *sustainable development*, which calls for meeting present needs without compromising the future. He highlighted how increasing global concern over the premature deterioration of concrete structures has led to the

need for codifying durability requirements, as reflected in standards such as IS 456, ACI 318, ACI 562, AS 3600, and ISO 13823.

He elaborated on the key factors influencing the durability of concrete, such as environmental exposure, quality of materials, water-cement ratio, depth of cover, workmanship, and the shape and size of structural elements. These factors, he noted, are influenced by mix design, structural detailing, concrete production methods, and construction quality. Durability, according to Dr. Sarkar, is a result of both design intent and proper execution on site, requiring careful consideration of materials, curing methods, and long-term maintenance strategies.

The session also reviewed definitions of durability and service life across multiple international standards. According to IS 456, durability refers to a structure's ability to perform under anticipated environmental conditions during its service period. Similarly, ACI 318 and ISO 13823 define durability as a materials or system's capacity to resist environmental and chemical degradation over time. Dr. Sarkar discussed the distinction between design life and service life, and introduced classifications such as technical, functional, and economic service life, drawing from ACI 365.1R-17. These classifications help predict when a structure may need repair, no longer meet its intended function, or become uneconomical to maintain.

A significant portion of the session was devoted to Life Cycle Assessment (LCA) for concrete structures, referencing EN 15978 and ISO 14044. Dr. Sarkar presented a flow diagram illustrating each life cycle phase—from raw material extraction and concrete production to construction, use, and demolition—highlighting the environmental impacts at every stage. He concluded by emphasizing long-term performance as a balance between strength, serviceability, and durability, asserting that deficiencies in one aspect often affect the others. This comprehensive session offered valuable insights into designing concrete structures that are not only strong and functional but also durable and environmentally responsible.



Fifth day:

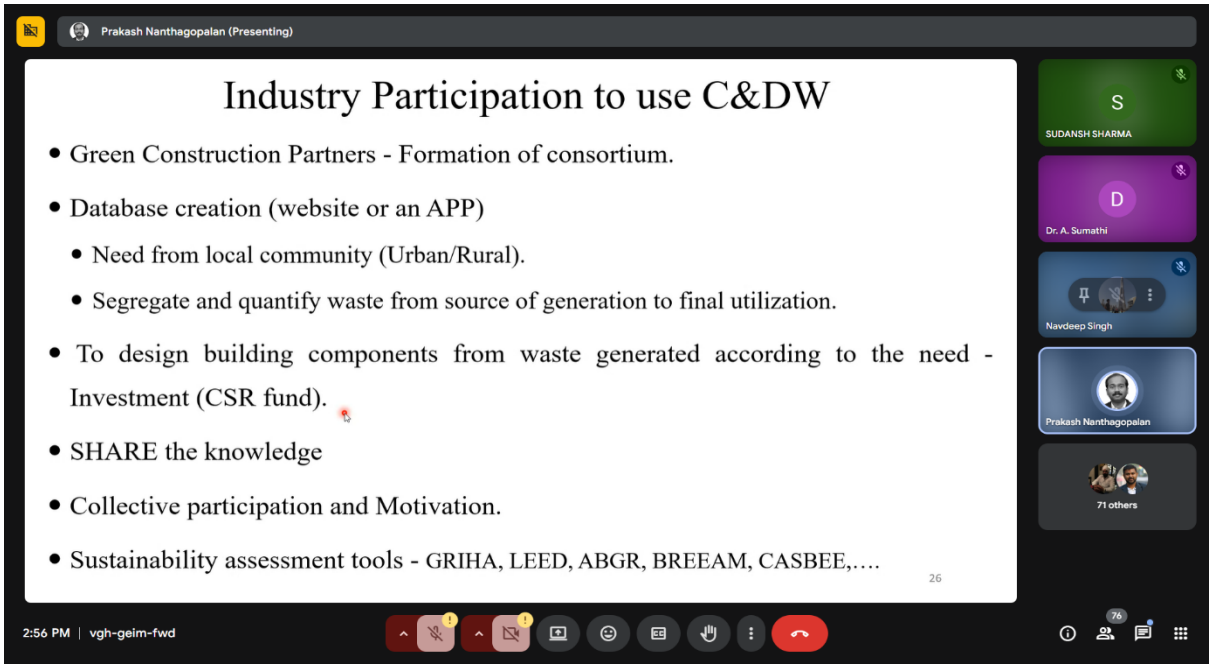
Day 5 of the One Week Online Short-Term Course on *"Sustainable Applications and Research Perspectives in Civil Engineering"* began with a thought-provoking session by **Professor Prakash Nanthagopalan** from **IIT Bombay**, titled **"Use of Agro-Based Residues and Recycled Aggregates in Construction Towards Sustainability – A Practical Perspective."**

In his lecture, Professor Nanthagopalan emphasized the urgent need to shift toward sustainable construction practices. He explained how agro-based residues—such as those from sugarcane or other agricultural processes—can be transformed into effective binder materials through proper processing. These materials can partially replace cement, reducing dependency on energy-intensive traditional options.

He also highlighted the use of recycled aggregates obtained from construction and demolition waste, showcasing how they can be reintegrated into the building cycle to support a circular economy. The session stressed the importance of responsible material choices, local recycling practices, and institutional efforts to promote sustainability.

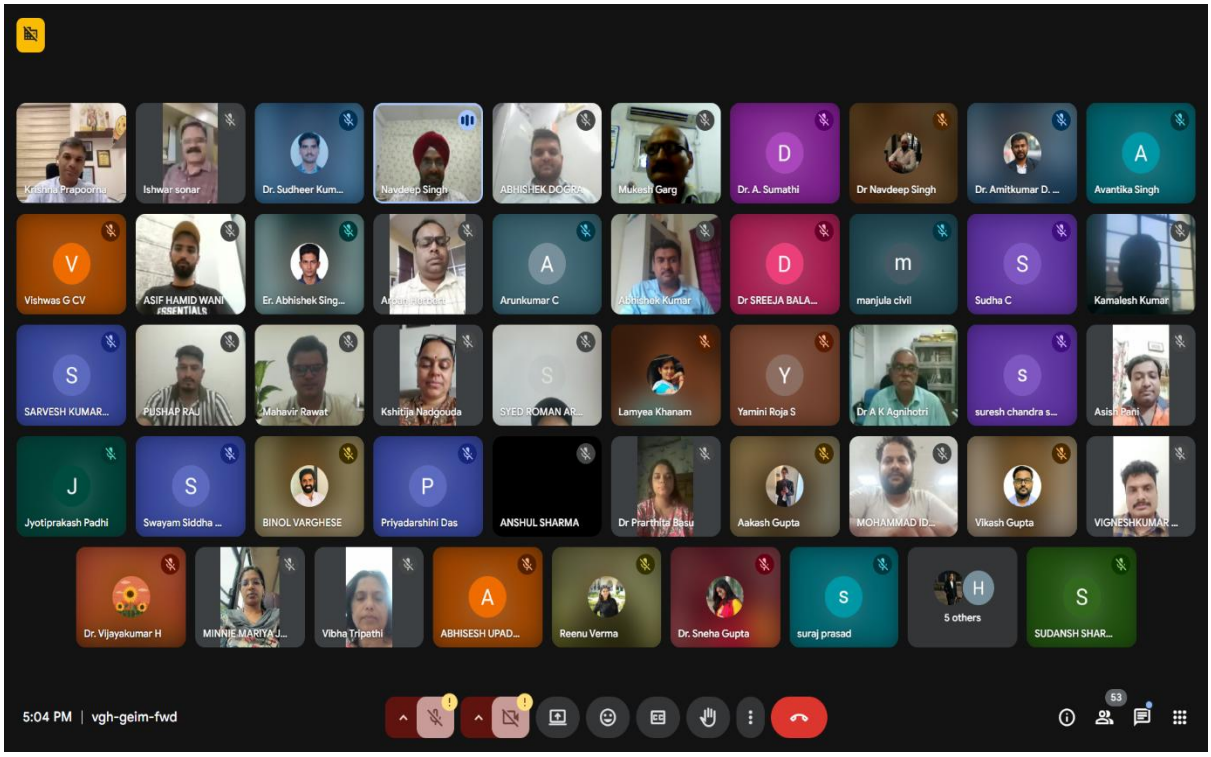
Further, he discussed the role of industry collaboration, public awareness, and policy-level support in enabling large-scale implementation. Sustainability assessment tools and rating systems were introduced to help participants understand how to evaluate and improve the environmental performance of construction projects.

The session offered a practical, experience-based perspective on using waste as a valuable resource in civil engineering and inspired participants to adopt such practices in both research and real-world applications.



In the second session on Day 5**, Prof. B. Krishna Prapoorna** from **IIT Tirupati** delivered a compelling and reflective lecture centered around the pressing question**:** ***Are we truly ready to embrace sustainability in how we design and build our roadway systems?*** Through his talk, he guided the audience beyond the technicalities of pavement engineering into a broader conversation about responsibility, awareness, and long-term vision in infrastructure development. He challenged the audience to rethink the traditional, resource-intensive approaches to road construction that often leave behind a trail of environmental consequences. Instead, he proposed a transformative shift toward the circular economy—a model that encourages reusing, rethinking, and regenerating rather than simply consuming and discarding. His vision of sustainable roadways was not limited to material choices or design tweaks, but encompassed a complete reorientation in values, where infrastructure is developed with full consideration of its environmental footprint, societal impact, and future adaptability.

Prof. Prapoorna shared his experiences and insights on how discarded materials, often seen as waste, could be repurposed as valuable resources in roadway construction, opening new pathways for innovation. He emphasized the importance of seeing roads not just as physical networks but as dynamic, living systems that should evolve with ecological consciousness. His message strongly advocated for life cycle thinking—where roads are designed, used, maintained, and retired with sustainability in mind. The lecture also highlighted the crucial role engineers and policymakers play in shaping this future, urging them to move away from short-term fixes and instead adopt resilient, circular, and inclusive infrastructure strategies. Concluding his session, Prof. Prapoorna called on the next generation of professionals to become active participants in this shift, to question existing norms, and to design infrastructure that serves not only the present, but also protects the possibilities of the future.

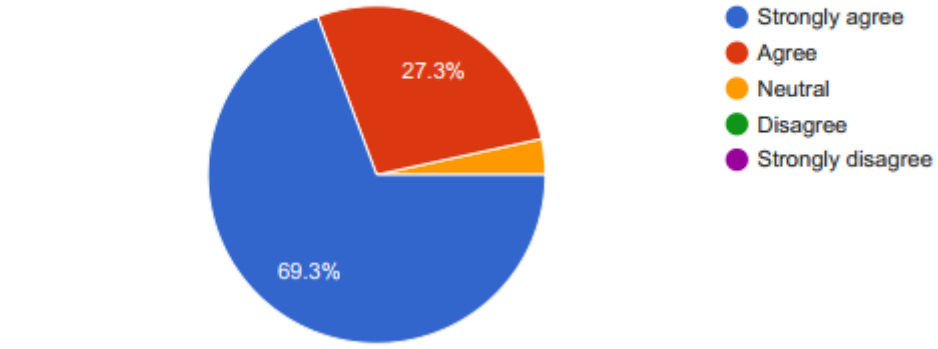


Participant's Feedback :

a) Background of the Participants

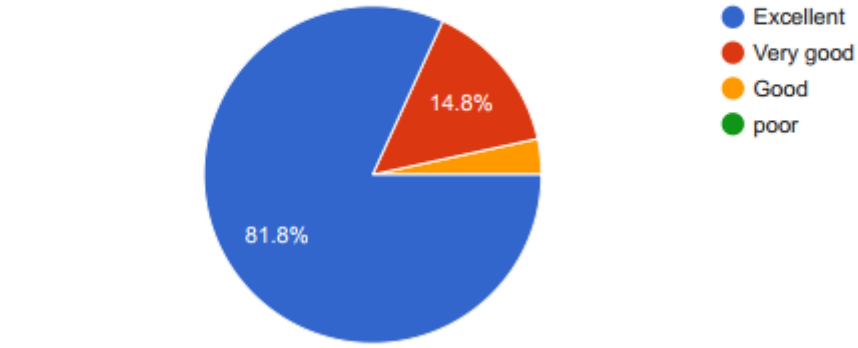
Whether the sequence of the lecture was well planned?

88 responses



Please give overall rating of the course:

88 responses



Whether the content and the case studies were?

88 responses