Department of Civil Engineering

V.R. SIDDHARTHA SCHOOL OF ENGINEERING

SIDDHARTHA

ACADEMY OF HIGHER EDUCATION

An Institution DEEMED TO BE UNIVERSITY

(Under Section 3 of UGC Act, 1956)

(Sponsored by Siddhartha Academy of General & Technical Education),

Vijayawada, A.P., India - 520007

Email Id : hodce@siddhartha.edu.in. Ph: 0866-2582333/200

VELAGAPUDI RAMAKRISHNA SIDDHARTHA SCHOOL OF ENGINEERING

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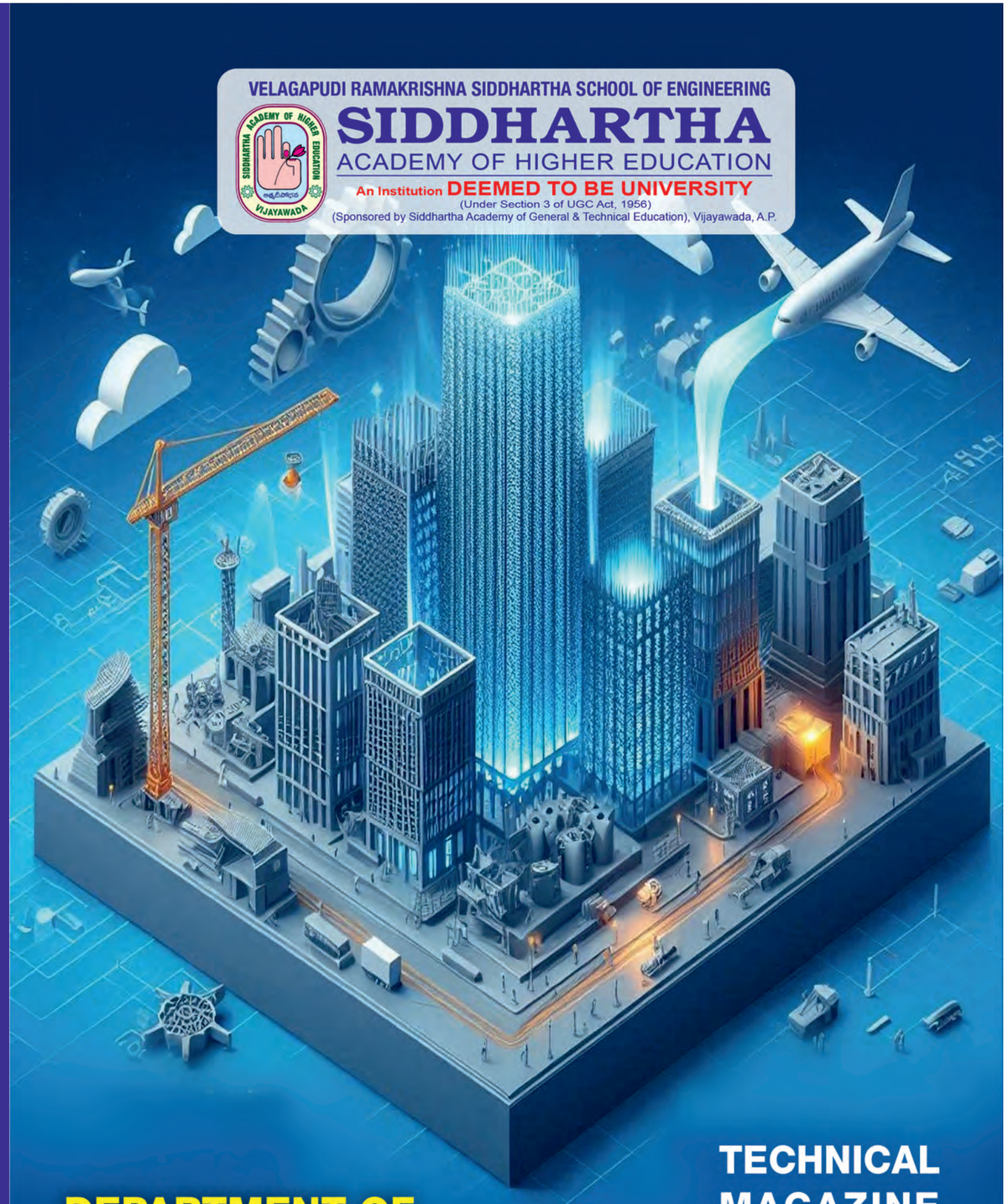

DEPARTMENT OF CIVIL ENGINEERING

TECHNICAL MAGAZINE

JANUARY - JUNE 2026

VOLUME - 8

ISSUE - 2

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Research Publications

FACULTY PH.D. OBTAINED

S. No.	Name of the Faculty	Department & Designation	Month & Year	University
1	Dr. V. Ramesh	CE, Associate Professor	January 2026	JNTUK

PH.D. GUIDANCE

S. No.	Name of the Faculty (Co-Supervisors, if any)	Department & Designation	Name of the Research Scholar	University
1	Dr. B. Panduranga Rao	CE, Professor	**1. V. Ramesh - Completed**	JNTUK
			2. Madasu Durga Rao	
			3. V. Swathi	
			4. Narasimha Rao Veeravelli	SAHEU
2	Dr. V. Mallikarjuna (Co-Supervisor)	CE, HOD	5. J. Rangiah	JNTUK
3	Dr. G.V.R. Subba Rao (Co-Supervisor)	CE, Associate Professor	6. K.V.N. Mallikarjuna Rao	ANNAMALAI
	Dr. G.V.R. Subba Rao		7. Yeruva Tirumala	SAHEU
4	Dr. G. Vinay Kumar (Co-Supervisor)	CE, Associate Professor	8. Bidyutjyoti Baruah	Sikkim University
5	Dr. Lakshmi Keshav	CE, Associate Professor	9. Musunuru Vineela	SAHEU
	Dr. Lakshmi Keshav		10. Pasala Srinivasan	
6	Dr. Rama Vara Prasad Chavali	CE, Associate Professor	11. Pusuluri Sai Sravani	SAHEU
			12. SB Prakash Sadanala	
7	Dr. M. Kanta Rao	CE, Sr. Assistant Professor	13. B. Ramakrishna	JNTUK
8	Dr. P. Krishna Prasanna	CE, Assistant Professor	14. G. Nipun	JNTUK
9	Dr. N. Malathi	CE, Assistant Professor	15. Bhukya Shankar	SAHEU
10	Dr. Hanuma Kasagani (Co-Supervisor)	CE, Assistant Professor	16. Narasimha Rao Veeravelli	SAHEU
11	Dr. PSRR Teja (Co-Supervisor)	CE, Assistant Professor	17. Musunuru Vineela	SAHEU

FUNDING ACQUISITION FOR R & D PROJECTS

S. No.	Name of the Project	Name of the Faculty	Name of Funding Agency	Amount (Lakhs)
1.	Subsoil Investigation for Postal Department Site for Construction of PO Building at Jubilee Hills, Hyderabad, Telangana	Dr. V. Mallikarjuna	Postal Department	0.68
2.	Roadbed Rehabilitation of Rajahmundry Railway Station using Vacuum Assisted Soft Soil Roadbed	Dr. G. V. Rama Subba Rao	Sri Godavari Engineering Consultants Pvt. Ltd.	0.50
3.	Soil Investigation for the Proposed Construction of Canara Bank Building, Amaravati, AP	Dr. N. R. Krishnamurthy	CPWD, Vijayawada	1.38
4.	Soil Investigation for the Proposed Construction of Biomass/Biochar Unit at Pedavegi, Eluru	Dr. N. R. Krishnamurthy	Varaha Climate Ag Pvt. Ltd.	0.59
5.	Soil Investigation for the Proposed Construction of CAG Office Building, Amaravati, AP	Dr. N. R. Krishnamurthy	CPWD, Vijayawada	2.53
6.	Soil Investigation for the Proposed Construction of Passport Office Building, Amaravati, AP	Dr. N. R. Krishnamurthy	CPWD, Vijayawada	2.63
7.	Subsoil Investigation and Ground Improvement Recommendation for Box Culvert at Gudivada	Dr. Ch. R. V. Prasad	VCPL, Vijayawada	0.77

INTELLECTUAL PROPERTY RIGHTS

S. No.	Name of the Faculty / Inventor(s)	Utility / Design	Ref. No./Patent Number	Title of the Patent	Status
1	Dr. V. Bhargavi, Dr. E. Yazhini, Dr. Vankeswaram Mallikarjuna, Konduru Anand, Dr. Saurabh Kumar, Shri Ramendra Pandey, Dr. Krishna Kumar Singh, Dr. Ravi Goutam, C. Venkata Siva Rama Prasad	Design	469851-001	Ai-Based Drone for Structural Inspection in Construction Sites	Filed
2	Satish Sajja, Vikas Prakash Jadhao, Dr. S. Pradeep Kumar, Dr. Sagar Paruthi, Hastimal Shivaji Kumawat, Prof. Amruta Jagdish Killol, Dr. Shashi Kumar A, Dr. S. Siva Gowri Prasad, Dr. Nevil Kishorkumar Trambadia, Mr. Purvansh B. Shah	Design	482464-001	Ai Based Robotic Total Station	Published
3	Dr. Vinay Kumar Gaddam, Meka Sai Ganesh, Dr. C. Venkata Siva Rama Prasad, Dr. S.R.R. Teja Prathipati, Dr. Kasagani Hanuma, Tej Sai Moturu	Design	467344-001	Ai Based Water Quality Monitoring Device	Certified / Registered
4	G. V. Rama Subba Rao, K. Vineetha, G. T. V. Abhiram, D. Bhanu Priya, A. Sowmya	Utility	202541069992 A	A Composition for Preparing Tiles	Published

Influence of Geometrical Parameters on Local Buckling in Steel I-Sections

Hanuma Kasagani; Praveen Oggu; S. R. R. Teja Prathipati; B. Murali Krishna; Srikanth Koniki

The width/depth to thickness ratio (b/t or d/t) for compression elements is specified by current Indian building standards to prevent local buckling. The limiting depth to thickness ratio is low for flanges due to its unstiffened nature, which is difficult to maintain practically (i.e., most of the sections become slender sections). Slender sections that are prone to buckle locally are generally avoided in design. In this study, an investigation is carried out to make the flange (slender elements) stiffened by providing lipping along the longitudinal edges of the flange, similar to that of cold-formed sections, so that local buckling of the flange is avoided. For the investigation, hot-rolled steel I-sections are chosen based on the limiting values of b/t. The edge stiffener is sized up from zero (unstiffened) to a size big enough to make a stiffened edge; then, finite-element analysis is used to analyze it under compressive force. It was observed that when the lip size increases, the flange stiffens, and the interaction of the flange and web also affects the buckling of the cross section. This behavior is contradicted by the inherent assumption made in the current standard, in which the web and flange are considered as individual elements, and the interaction between web and flanges are ignored. Lips with a size ranging from one-third to one-half of the flange's outstanding width, maintaining the same thickness as the flange, have been found effective in mitigating local buckling. Further, the study also focusses on the analysis of I-shape cross sections under compression for local buckling and gives expression for elastic local buckling coefficient (k), considering interaction between web and flange. A comparative study between the limiting values of w/t ratio provided in the current standard and local buckling values obtained from finite-strip analysis is also presented. Finite-strip analysis results revealed that the actual k-values vary significantly depending on the geometry and stiffness of the section, ranging from 0.06 to 1.51 for flanges and 1.5 to 6.11 for webs. Further, a set of simplified limiting slenderness ratio values are proposed for each combination of web and flange ratios to facilitate the selection of optimum sections that does not buckle locally under compression.

Spatial analysis of soil texture and macronutrients using geospatial techniques in Kannur district, Kerala, India

Thangavelu Arumugam, Sapna Kinattinkara, Vinaykumar Gaddam

Maintaining soil health and nutrient balance is fundamental for sustainable agriculture, particularly in regions with complex terrain and variable climatic conditions. This study investigates the spatial variability of soil texture and macronutrient distribution in Kannur District, Kerala, India, using geospatial analysis. Twenty-four representative surface soil samples were collected and analyzed for physicochemical parameters such as pH, electrical conductivity (EC), bulk density, porosity, permeability, and macronutrients. GIS-based interpolation and thematic mapping techniques were applied to visualize the spatial distribution of these parameters. The soils were found to be slightly acidic to near-neutral (pH 5.6–7.0) and non-saline (EC 0.15–0.42 dS/m). Nitrogen, phosphorus, and potassium exhibited moderate heterogeneity, while calcium, magnesium, and chloride remained within permissible limits. Sandy loam, sandy clay, and silty clay were the predominant soil types, reflecting clear spatial heterogeneity across the district. Sandy soils showed higher permeability, whereas finer-textured soils displayed greater porosity and nutrient retention. The integration of field measurements and GIS mapping demonstrates the significance of spatial information science in identifying soil variability zones and provides a methodological framework for precision agriculture and sustainable land-use management in tropical regions.

Integrated Remote Sensing and Slope Stability Modeling for Back Analysis of Sensitive Clay Landslides

Rama Vara Prasad Chavali, Zeinab Bayati, Anick Tremblay, Ali Saeidi, Yan Lévesque & Mélanie Lambert

This study presents an integrated framework combining remote sensing, photogrammetry, and geotechnical back analysis to evaluate landslide hazards in sensitive clay terrains of the Saguenay–Lac-Saint-Jean (SLSJ) region, Eastern Canada. Historical aerial photographs processed with Pix4D photogrammetry were integrated with LiDAR-derived digital elevation models (DEMs) to reconstruct pre- and post-failure topography for selected landslides along Rivière à Benjamin. Back-analysis using SLIDE2 (limit equilibrium) and RS2 (finite element shear strength reduction) enabled derivation of in-situ soil parameters, yielding cohesion (c) = 8 kPa, friction angles (φ) = 36–39°, and a Strength Reduction Factor (SRF) = 0.97, consistent with typical values for Eastern Canadian sensitive clays. The water table was assumed at 1 m depth to provide a conservative representation of near-surface saturation. Sensitivity was examined by varying one parameter at a time (c or φ) to isolate their individual influence on slope stability. Uncertainties associated with DEM accuracy and parameter estimation were minimized through cross-validation of LiDAR and photogrammetric datasets. A refined microzonation map was developed using the Ministry of Transportation of Quebec (MTQ) criteria and a third-order moving-average retrogression method, resulting in 18 m safety buffer for high-risk zones. Comparative analysis with Scandinavian frameworks (Norway, Sweden) demonstrates the transferability of this approach to other postglacial clay regions under similar hydrogeotechnical conditions. The integrated methodology strengthens slope stability assessment in data-limited contexts and supports practical applications in hazard zoning, infrastructure planning, and urban development regulation.

Development of Condition Index for Assessing the Safety of Buildings

Divya, B. Charan Kumar Reddy, Rama Vara Prasad Chavali, B. Panduranga Rao, P. Sai Tarun, R. Vyshnavi Bai & P. Uday

Aging buildings and warehouses require reliable structural health monitoring to ensure integrity and minimize risk of failure. Cracks in building components are often an initial indication of structural distress, raising concerns among occupants over the risk of failure. To address the concerns, various non-destructive testing (NDT) approaches such as rebound hammer, ultra-sonic pulse velocity and visual inspection are used. The present study aimed to develop a structural condition index integrating all the available NDT approaches to analyze the structural stability of the buildings. An extensive methodology is developed by conducting the NDT's which includes rebound hammer, ultra-sonic pulse velocity and the Visual inspection, later these are assessed with the Degree, Extent, Relevance (DER) approach to yield the condition index (CI). The CI is a quantifiable metric for prioritizing maintenance operations. After determining the current structure's condition index, the principal component approach (PCA) will be adopted to conduct a statistical analysis which will enable the extraction of key patterns and correlations within the dataset, reducing dimensionality and facilitating a straightforward interpretation of the structural and energy-related variables. Also, different machine learning methods for segmentation were looked at, and the Random Forest Algorithm (RFA) and Support Vector Machine (SVM) were performed in this case. Based on the results it was concluded that SVM was the best fit for this type of assessment. By providing a comprehensive understanding of a structure's health, this approach empowers proactive mitigation strategies. Through targeted interventions based on the CI and insightful data analysis, building lifespans can be extended and potential failures can be averted.

Provenance and Depositional History of Palaeo–Mesoproterozoic Sedimentary Formations in the Cuddapah Basin, India: Insights from Elemental Geochemistry and Petrography

Mohd Younus Bhat; Nurul Absar;Vinay Kumar Gaddam

The Palaeo-Mesoproterozoic sedimentary formations of the Cuddapah Basin, India, provide insights into basin evolution, provenance, and paleoenvironmental conditions. Trace element ratios (Th/Sc, Zr/Sc) and rare earth element (REE) patterns reveal complex sedimentary recycling with contributions from felsic and mafic source terrains. The Papaghni Sub-basin exhibits mixed mafic-felsic provenance, characterised by MgO enrichment, intermediate Th/Sc ratios, and weaker Eu anomalies (Eu/Eu* = 0.7−0.85), reflecting syn-rift volcanic activity and cratonic basement erosion. The Chitravati Sub-basin exhibits polycyclic sedimentation with variable compositional maturity and enrichment in Fe2O3 and TiO2, indicating heavy-mineral concentration from weathered mafic sources. The Nallamalai Sub-basin is dominated by extensively recycled felsic sources with high compositional maturity and intense chemical weathering. Th-Sc-Zr ternary plots indicate polycyclic provenance in Chitravati, while Nallamalai represents multi-cycle reworking. Tectonic discrimination diagrams suggest rift-related deposition for Chitravati, while Papaghni's collisional signature likely reflects basement source characteristics. The CIA (62−94) and CIW (77−98) values indicate intense chemical weathering under humid conditions. REE fractionation patterns, including LREE enrichment and negative Eu anomalies, confirm the presence of evolved, weathered crustal sources. This integrated study enhances understanding of sediment provenance, basin evolution, and Proterozoic paleoclimatic conditions in southern India's cratonic basins.

Integrated experimental, machine learning, and life-cycle assessment of fly ash–silica fume based self-compacting geopolymer concrete

Siva Shanmukha Anjaneya Babu Padavala, Siva Avudaiappan, Sri Ram Ravi Teja Prathipati, Yeswanth Paluri, Vanakuri Sainath & Adamu Mulatu Kumara

This study investigates the performance of self-compacting geopolymer concrete (SCGC) incorporating fly ash (FA) and silica fume (SF) as aluminosilicate precursors, with emphasis on mechanical behaviour, durability, microstructural characteristics, environmental impact, and machine-learning-based performance prediction. Four geopolymer SCC mixes were prepared using SF to substitute FA at 0, 5, 10, and 15% by weight and an OPC-based SCC of the same class of strength was prepared to serve as a benchmark. Fresh properties were assessed as per EFNARC standards after which compressive, split tensile and flexure strength were done at intervals of 28, 90, and 180 days. Sorptivity, rapid chloride permeability (RCPT) and ultrasonic pulse velocity (UPV) were used to determine durability, whereas scanning electron microscopy (SEM) was used to measure the microstructural evolution. Findings reveal that SF is a considerable improvement to fresh and hardened geopolymer SCC, the best performance being found at a 10% replacement. The G10 mix recorded the best compressive strengths of 65.3 MPa at 180 days, which was 21% higher than the FA only geopolymer mix, and tensile and flexural strengths were 14–18% higher compared to FA only geopolymer mix. The performance of durability increased significantly, as sorptivity was reduced by about 21% and RCPT was lower than 1000 Coulombs (extremely low permeability) and the largest values of UPV were the highest, which shows the presence of a dense and uniform internal structure. Refined pore structure and well-developed the formation of aluminosilicate gels in the G10 mix had been confirmed by SEM observations. Parameters of mix, fresh properties, and curing age were used as inputs to develop machine learning models (KNN, SVM, Decision Tree, and Random Forest). Among them the predictive accuracy of the Random Forest model ($R2 = 0.94$) with the least error showed excellent performance forecasting and mix optimization. It was found by Life Cycle Assessment (LCA) that geopolymer SCC mixtures had less environmental impact through global warming potential (30–45% less than OPC-SCC) and energy (around 20–25% less than OPC-SCC) and the G10 mix had the lowest environmental impact. Overall, the study demonstrates that FA–SF geopolymer SCC with 10% SF replacement provides a good combination of workability, strength, durability, and sustainability that is proven in experimental, microstructural, data-driven modelling, and environmental analysis.

Amplifying Performance, Combustion, and Emission Characteristics of a CRDI Engine Using Diesel-WCO Methyl Ester-Dyglyme Ternary Fuel Blends with Carbon Nanotubes

Sarojini Jajimoggala, Malathi Narra, Shabana Shabana, P. Uma Maheswara Rao, Debabrata Barik, Milon Selvam Dennison, R. Srinivasan, Ayyar Dinesh & Saravanan Rajendran

The present study investigates the performance, combustion, and emission characteristics of various fuel formulations, including neat diesel (D100), a biodiesel blend (WCO20: 20% waste cooking oil methyl ester and 80% diesel), a Ternary Fuel (TF) blend composed of 20% WCOME, 70% diesel, and 10% diglyme (DGM), and TF blends doped with Carbon Nanotube (CNT) nanoparticles at concentrations of 25, 50, and 75 mg/L. All fuel samples were evaluated using a twin-cylinder, four-stroke, Common Rail Direct Injection (CRDI) compression-ignition engine. Biodiesel is prepared from WCO using the well-known transesterification process. The NPs included in TF samples are found to be stable and confirmed by characterization (FESEM, HRTEM, FTIR, and UV Spectroscopy). The performance parameters, such as Brake Thermal Efficiency (BTE), are increased by 15.15%, and Brake Specific Fuel Consumption (BSFC) is decreased by 16.5%. Moreover, the combustion parameters, including Cylinder Pressure (CP), Net Heat Release Rate (NHRR), Mass Fraction Burning (MFB), and Cumulative Heat Release Rate (CHRR), are improved due to catalytic activity, higher evaporation capacity of DGM, improved rate of reaction, and oxygen content in the fuel blend. The emission characteristics, including Carbon monoxide (CO), Carbon dioxide (CO2), Hydrocarbons (HC), and Nitrogen Oxides (NOx), are reduced by 17.5, 22.27, 22.09, and 25.8% at higher load for the TF+CNT50 mix, respectively. The outcomes show the feasibility of DGM and CNT NPs as suitable additives in the WCO20 sample for lower emission parameters without compromising performance and combustion characteristics.

Geo-Enabled Large Language Models for Flood and Landslide Risk Assessment: A Case Study of a Recent Landslide in Kishtwar, Jammu & Kashmir, India

Vinay Kumar Gaddam, Sravya Vemparala, Tejsai Moturu, Ahmed Abdul & Jaswanth Kasturi

This study evaluates the potential of Geo-Enabled Large Language Models (Geo-LLMs) for integrated flood and landslide risk assessment using a recent rainfall-triggered landslide in Kishtwar district, Jammu & Kashmir, India. The proposed framework integrates multi-source geospatial datasets including satellite imagery, terrain derivatives, rainfall data, and infrastructure layers with textual disaster reports through spatial–textual multimodal inference. The model generates probabilistic landslide susceptibility surfaces and spatial uncertainty estimates. Results show strong spatial agreement between predicted and observed landslide extents (IoU = 0.70–0.80), with improved predictive performance compared with conventional GIS and machine-learning approaches. The framework also reduced analytical turnaround time by approximately 40–50%. The study demonstrates the potential of geographically constrained multimodal AI models to support uncertainty-aware geospatial analysis and decision-oriented disaster risk management.

Comparative Analysis of Traditional and Machine Learning Approaches for Estimating Undrained Shear Strength from SCPT Data

Rama Vara Prasad Chavali, Ali Saeidi, Swamy Naga Ratna Giri, Mohammad Salsabili

This study compares traditional empirical methods and machine learning (ML) models for estimating the undrained shear strength (su) of sensitive clays in the Saguenay region of Canada using SCPTu measurements from six sites, with penetration depths ranging from 10 to 40 m. SCPTu parameters (qt, fs, u2, and Vs) were recorded at 0.5 m intervals up to 20 m depth, while field vane shear tests (FVT) were conducted at 1 m intervals between 2 and 20 m, co-located with SCPTu points to ensure direct comparability. These paired datasets enabled the development of region-specific empi-rical correlations between SCPTu parameters and su, as well as the training and evaluation of multiple ML regression models. Among the six algorithms considered, Random Forest and XGBoost demonstrated the highest predictive accu-racy (R2 up to 0.95), outperforming classical approaches. The findings highlight the effectiveness of integrating SCPTu data with ML techniques to enhance suestimation in overconsolidated, sensitive clays and emphasize the importance of region-focused calibration for geotechnical design.

Sustainable Utilization of Magnesia Activated Blast Furnace Slag in Non-fired Stabilized Earthen Blocks

A. Sandeep Reddy & Rama Vara Prasad Chavali

Red soils are prevalent in India, covering over 10% of the total land mass. The traditional clay burnt bricks made of these red soils consume a lot of energy and releases toxic constituents into the environment during their manufacturing process. On the other hand, the steel industry's ground granulated blast furnace slag is creating a lot of environmental concerns regarding disposal and storage aspects. In light of this, an effort was made in the utilization of magnesia activated GGBS (GM) to produce stabilized earth blocks which consumes less energy, is economically viable and increases the recycling of GGBS. Besides, the utilization of these stabilized earthen blocks can be more affordable in low cost housing. In present study, the changes in physical, strength and microstructural properties at different binder percentages of 3, 6, 9, 12 and 15% were studied. The compressive strength increased with increase in GM concentration and curing period. The minimum compressive strength of 15% GM blended samples at 28 days of curing is 3.5 N/mm2 and the density is 1820 kg/m3, which meets the minimum strength and density standards of Grade A(3.5) as per IS (Part1):2005 of 3.5 N/mm2 and 1500 kg/m3 respectively. Moreover this paper provides the possible utilization of magnesia activated blast furnace slag stabilized blocks as a building material.

Experimental and Numerical Investigation of Flexural Behaviour of Reinforced Concrete T-Beams Using Digital Image Correlation

Vandanapu Ramya Krishna, Hanuma Kasagani, Vinay Kumar Gaddam, Ravi Teja Prathipati, B. Murali Krishna, Shankar Karuppannan

This study investigates the applicability of QR-code-based speckle patterns for deformation measurement using two-dimensional digital image correlation (2D-DIC) in flexure-dominated reinforced concrete T-beam experiments. Three reduced-scale reinforced concrete T-beam specimens were tested under monotonic four-point bending. Surface deformation was recorded using two types of patterns: a conventional random speckle (RS) pattern and a QR-code-based structured speckle pattern. Full-field displacement and strain responses obtained from DIC analysis were used to derive moment–curvature relationships and were compared with reference measurements obtained from conventional instrumentation. Results indicate that the QR-code pattern provides improved correlation stability and reduced strain-field noise compared with conventional RS patterns, particularly in regions influenced by crack-induced deformation gradients. Quantitative comparison showed that deviations in ultimate moment and curvature measurements were lower when QR-code speckles were used. However, due to the limited number of specimens, the study should be interpreted as a pilot-scale methodological investigation rather than a statistical validation of pattern superiority. The findings demonstrate the feasibility of using QR-code-based patterns to improve subset tracking reliability in laboratory-scale reinforced concrete experiments and provide a robust methodological framework for future DIC-based structural investigations.

Data-driven assessment of industrial influences on urban heat index dynamics across Telangana, India

Bhogayya Naidu, Tan Kuan Tak, Sivaneasan Bala Krishnan, Vinay Kumar Gaddam & Shankar Karuppannan

Urban heat stress is an escalating environmental risk in rapidly industrialising regions of India, where land-use transformation and industrial expansion interact with background climatic warming. This study examines the spatio-temporal evolution of land surface temperature (LST) and the Urban Heat Index (UHI_index) across Telangana, India, over the period 2003–2023, with specific emphasis on the thermal influence of major industrial zones. Multi-temporal Landsat imagery, land-use information, and meteorological variables were analysed within a geospatial data analytics framework to quantify UHI intensity, temporal trends, and industrial attribution. Results indicate systematic amplification of UHI_index within industrial areas relative to non-industrial zones. Mean UHI_index in industrial regions increased from approximately 1.35 in 2003 to 2.70 in 2023, whereas non-industrial areas exhibited a lower increase from 1.00 to 1.82. Machine learning models demonstrated strong predictive performance ($R2 \approx 0.87$; $RMSE \approx 0.26$), identifying industrial land use, built-up density, and near-surface air temperature as dominant drivers. Monte Carlo uncertainty analysis ($n = 100$) indicates stable regional inference (± 0.18 UHI_index). The findings provide quantitative evidence of industrial contributions to urban thermal intensification and offer a reproducible framework for industrial heat mitigation planning in rapidly developing Indian states.

Disappearing Glaciers of Sikkim Himalaya: A Multi-Decadal Remote Sensing Analysis

Bidyutjyoti Baruah, Rajeev Rajak, Aparna Gupta, Khushboo Sharma, Ankita Roy, Swati Yadav, Shruti Dutta, Vinay Kumar Gaddam, Mohd Ramiz & Rakesh Kumar Ranjan

Glaciers in the Sikkim Himalayas have undergone significant retreat over the past six decades, with an accelerated loss after 2000. This study analyses glacier changes using satellite data of the years 1962, 1988, 2002, and 2023. Results indicate a 39.30% reduction in glacier area and a 45.12% decrease in glacier count, with smaller glaciers (<2 km^2) being disproportionately affected. ERA5 climate data reveals rising regional minimum temperatures and shifting precipitation patterns, contributing to an enhanced glacier melt. While annual precipitation has increased, seasonal snowfall shows varied trends, with a significant decline during summer and autumn seasons. This warming, coupled with reduced summer and autumn snowfall, is shifting precipitation from snow to rain, accelerating glacier melt and hindering accumulation. South-facing glaciers exhibited higher retreat rates, consistent with enhanced solar radiation exposure. Additionally, cryokarst features, particularly proglacial lakes, evolve on the surface and may expand into extensive lake systems, thereby heightening the susceptibility to dam breach events. A pertinent example is the South Lhonak Lake, which raised significant concern regarding a glacial lake outburst flood (GLOF) in 2023, thereby posing substantial risks to downstream communities. These glacial changes have critical implications for hydrological systems, particularly for the Teesta River, which is highly dependent on glacier meltwater. Uncertainty analysis, quantified using a buffer-based estimation method (e.g., average positional uncertainties ranging from 0.8% to 7.4% for different imagery), highlights the inherent limitations of remote sensing data in precisely delineating glacier boundaries. The findings underscore the need for continued glacier monitoring, higher-resolution climate modelling, and improved risk management strategies to address the ongoing impacts of glacier retreat in the Sikkim Himalaya.

Optimized machine learning technique for health monitoring of an ASCE benchmark building using simulated data

P. Manikanta, Takkellapati Sujatha, CH. Ajay, Maloth Naresh & Rachamallu Vaishnava Kumar

Structural damage detection (SDD) is essential for the safety and operational reliability of civil structures. This paper proposes an optimized machine learning (ML) technique for damage detection of the ASCE benchmark building, which is based on simulated structural data provided by an ANSYS numerical model. The building model is tested under several damage scenarios, and time-domain acceleration data are gathered under impact excitation. Relevant statistical features are retrieved from the simulation results and used as inputs for the model. The K-Nearest Neighbours (KNN) technique is used as the base classifier. Hyperparameter optimization is performed using particle swarm optimisation (PSO) and grid searching (GS) techniques. The results show that optimisation considerably enhances the technique's damage classification accuracy, with the PSO-KNN technique achieving high accuracy and computational efficiency. Moreover, the results are compared by applying principal component analysis (PCA) by selecting important features. The results are also compared with traditional KNN, which yielded lower accuracy, thereby highlighting the necessity of employing optimization techniques. Furthermore, the outcomes are then compared with those obtained using the ANN technique. Additionally, the robustness of the technique is verified under a noisy dataset. The study indicates that combining ANSYS-based numerical modelling with optimized ML techniques creates a strong foundation for reliable structural state evaluations in SDD applications.

Mitigating mix design anomalies in ultra-high performance concrete strength prediction through anomaly detection and ensemble learning

Ganapathy Ganesh Prabhu, Lakshmi Keshav, B. Narendra Kumar, Kolli Ramujee, Mary Subaja Christo, Subhi A. Ali, Gasim Hayder & Gokulan Ravindiran

The primary objective of this work is to mitigate the impact of irregular mix designs on the prediction of compressive strength in Ultra-High-Performance Concrete (UHPC) by employing a hybrid strategy of anomaly detection and ensemble learning. Initially, six ensemble algorithms, CatBoost, Random Forest, AdaBoost, Gradient Boosting, XGBoost, and LightGBM were assessed on an 810-record UHPC dataset obtained from various literature sources. CatBoost attained the maximum accuracy, with $R^2 = 0.98$, MAE = 4.59, and RMSE = 6.55. Feature relevance analysis employing SHAP values and Partial Dependence Plots indicated curing age, fiber content, and cement content as the most influential characteristics. Subsequently, unsupervised anomaly detection techniques, such as Isolation Forest, One-Class SVM, and DBSCAN, were employed to find abnormal mixture compositions. DBSCAN was chosen for its exceptional capacity to identify low-density, irregular data points, uncovering 69 abnormalities. Eliminating these anomalies and reassessing CatBoost enhanced the model's performance to $R^2 = 0.99$, MAE = 4.39, and RMSE = 6.47, significantly improving predictions in both the lower and upper strength ranges. The results indicate that focused anomaly identification markedly enhances the accuracy, reliability, and resilience of predictions about the compressive strength of UHPC. The suggested anomaly detection with tuned ensembles, using DBSCAN–CatBoost to robustly model UHPC strength across heterogeneous mixes, significantly outperforming conventional models.

Microbial bioremediation of copper-contaminated soil and recovery of engineering properties for sustainable reuse

V. *Ramya Krishna, Hanuma Kasagani, Vinay Kumar Gaddam, B.Murali Krishna, Ravi Teja Prathipati, Shankar Karuppannan*

Copper contamination degrades both environmental quality and soil engineering performance, limiting the safe reuse of contaminated land in urban and industrial regions. Sustainable remediation strategies are therefore required to remove toxic metals while restoring soil functionality. This study evaluates the effectiveness of microbial bioremediation using *Acidithiobacillus ferrooxidans* for the treatment of copper-contaminated soils and the recovery of key geotechnical properties under controlled laboratory conditions. Soil samples collected from the Hyderabad metropolitan region, India, were artificially contaminated with copper sulphate pentahydrate ($CuSO_4 \cdot 5H_2O$) at 100, 200, and 250 g/kg of dry soil to simulate severe industrial contamination scenarios. Following 30 days of treatment, copper removal was quantified by ICP–OES, and changes in shear strength, pH, and electrical conductivity were evaluated. Copper contamination reduced the angle of internal friction from 32.84° to 18.99–23.28°, decreased pH from 7.45 to 5.05–6.85, and lowered electrical conductivity from 476 to 290–375 µS/cm. Microbial treatment removed 77.5–85.95% of copper and restored the angle of internal friction to 28.87–31.65°, corresponding to 90–96% recovery of virgin soil values. Soil pH increased to 6.90–7.32 and electrical conductivity recovered to 415–468 µS/cm. The net biological contribution to copper removal, after accounting for physical leaching in control samples, ranged from 13.75% to 27.7%. A strong positive correlation ($r = 0.91$) between copper removal efficiency and friction angle recovery confirms that geotechnical restoration is closely linked to microbial detoxification. A GIS-based weighted overlay analysis using the Analytic Hierarchy Process (AHP) was used to demonstrate how laboratory-derived results can support contaminated land reuse planning. The findings show that microbial bioremediation can simultaneously reduce copper toxicity and restore engineering functionality, supporting the sustainable reuse of remediated soils.

Remote sensing based assessment of climate change impacts and ecosystem health in the Baspa River Basin, Western Himalaya, India: implications for SDG 13

Vinay Kumar Gaddam, Shruti Dutta, Rakesh Ranjan, Anil V. Kulkarni & Shankar Karuppannan

Mountain river basins of the Western Himalaya are increasingly exposed to rapid warming and infrastructure expansion. This study presents an integrated remote sensing–based assessment of ecosystem change in the Baspa River Basin (1990–2023) using multi-sensor datasets and a Composite Ecosystem Health Index (EHI). Indicators include land surface temperature (LST), glacier and snow dynamics, NDVI trends, precipitation variability, hydrological change, and land use transitions. Results show significant warming (0.32–0.41 °C decade−1) with elevation-dependent amplification above 4000 m, 12.6% glacier area loss, declining snow persistence (18–25 days decade−1), intensifying precipitation extremes, alpine vegetation browning, and increasing runoff variability. Built-up areas expanded by 9.3% along valley corridors. The EHI identifies ~27% of the basin as degraded, primarily where climatic stress and infrastructure pressure converge. Sensitivity analysis is consistent with index robustness. The elevation-stratified and uncertainty-aware framework strengthens basin-scale ecosystem diagnostics relevant to climate adaptation and SDG 13 in fragile mountain environments. While results indicate strong associations between climatic variability and ecosystem response, direct causality is not inferred.

Intensifying Precipitation Extremes and Shortened Snow Persistence Reshape Hydroclimatic Risk in a Himalayan Mountain Basin

Vinay Kumar Gaddam, Aishwarya Ray, Charanlal Maloth & Shankar Karuppannan

This study addresses the limited understanding of how interacting atmospheric extremes and cryospheric changes jointly influence infrastructure risk in high-mountain basins, where most assessments consider these processes independently. The objective of this study is to quantify the coupled impacts of climate extremes and snow cover dynamics on infrastructure exposure in the Baspa Basin, Western Himalaya, using an integrated basin-scale framework. The results show a significant warming trend (~ 0.34 °C per decade) and an increase in rainfall extremes (RX1day increase of ~ 10–20%), accompanied by a decline in snow cover duration (− 4 to − 7 days per decade), particularly at mid-elevations. Spatial analysis indicates that more than 60% of infrastructure is located in areas where increasing rainfall extremes coincide with reduced snow persistence, suggesting emerging compound hydroclimatic risk. These patterns suggest a shift toward increased rainfall-driven runoff and enhanced hydroclimatic variability. However, the results are subject to uncertainties associated with climate data resolution, snow cover estimation, and the assumption of static infrastructure distribution. By integrating atmospheric and cryospheric indicators with exposure analysis, this study provides a novel framework for assessing compound hydroclimatic risk, which may support climate-resilient infrastructure planning in high-mountain regions.

Smart Urban City Transport Using AI and ML for Next-Generation Mobility Solutions

Kimsy Gulhane, Malathi Narra, Darshna Dalvadi, S. Reshma, R. Gukendran, and S. Saravanan.

The evolution of smart urban city transport is increasingly driven by the integration of artificial intelligence (AI) and machine learning (ML), enabling dynamic, data-based mobility solutions. This chapter explores how AI and ML are applied for traffic management and the public transport system, and enable predictive analyses to make real-time decisions. At the same time, using sensor networks, reducing emissions, and enhancing the travel experiences through autonomous systems and mobility-as-a-service (MAAS) platforms. Deployment and emerging trends are explored by case studies. This chapter also addresses the implementation challenges, moral considerations, and strategic planning through AI-powered mobility systems for future smart cities.

Hybrid Machine Learning Models for Integrated Urban Air Quality and Weather Forecasting – A Decision-Support Framework for Sustainable City Planning

P. Nagamani, Gorantla Nipun, Ayinala Naga Sai, G Kiran Kumar, D Karthik Phani Varma, K. Swathi, N. Neelima, .T.V.Sai Krishna

Rapid urbanization has intensified challenges related to air pollution and extreme weather, directly impacting public health and sustainable city planning. This study presents a hybrid machine learning framework for integrated air quality and weather forecasting using environmental, meteorological, and urban data. The model combines regression, classification, and time-series prediction techniques to capture complex interactions. Experimental results show improved air quality prediction (RMSE = 3.45) and weather forecasting accuracy (93.6%), demonstrating the framework's effectiveness as a decision-support tool for climate-resilient and sustainable urban development.

Machine Learning-Based Framework for Damage Identification of an ASCE Benchmark Building Based on Speeded-Up Robust Features

Kakarla Hussain, Gorantla Nipun, C. H. Ajay, A. George Fernandez Raj, B. Kesava Rao & N. Lingeshwaran

Structural health monitoring (SHM) is a crucial aspect of civil engineering safety and serviceability, enabling the early detection of damage. This study proposed a framework for SHM using vibration data from the ASCE benchmark building together with Speeded-Up Robust Features (SURF). The ASCE benchmark structure is modelled in ANSYS environment. The structure is subjected to collection of time-history acceleration under both undamaged and damaged conditions, and converted to frequency domain scalograms images. The Bag of Features (BoF) approach is employed to extract the SURF from the registered images. The resulting feature vectors are used to input to the machine learning classifiers (k-Nearest Neighbours (k-NN), and Support Vector Machine (SVM), that classify the undamaged and different damage conditions. Among the combinations of SURF with a SVM classifier, there is greater classification accuracy. Furthermore, the results are then compared with those obtained using the statistical features. The findings provide evidence that the SURF-based feature representation does accurately collect information about structural damage. The proposed framework demonstrates that integrating time-frequency visual representations of images and machine learning to identify structural damage accurately is a viable option.