International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 9, Issue 10, pp 192-201, October-2025

https://doi.org/10.47001/IRJIET/2025.910026

AI-Powered Solutions for Ocean Plastic Pollution: A Systematic Review of Machine Learning Applications in Detection, Monitoring, and Management

[1]Ms. Jasleen Kaur, [2]Dr. Gagandeep S. Salhan, [3]Dr. Gurjit Singh, [4]Ms. Pawanjeet Kaur, [5]Manpreet Singh, [6]Mohit

[1]Research Scholar Management Department, UICM, Sant Baba Bhag Singh University, Jalandhar India, jasleenminhas6@gmail.com, 0009-0002-1165-6294
[2]Assistant Professor, Department of Management, UICM, Sant Baba Bhag Singh University Jalandhar India, gagan.salhan@yahoo.com, 0000-0003-4213-2143
[3]Principal, Baba Ajay Singh Khalsa College, Gurdas Nangal District, Gurdaspur, India
[4]Department of Computer Science, Baba Ajay Singh Khalsa College, Gurdas Nangal District, Gurdaspur, Punjab, India
[5]Assistant Professor, Department of CSE, UIET, Sant Baba Bhag Singh University, Jalandhar, India
[6]Assistant Professor, Department of CE, Ludhiana College of Engineering & Technology, Katani Kallan, Ludhiana, India

***Abstract* - Ocean plastic pollution has escalated into a global environmental crisis, threatening marine ecosystems, biodiversity, and human health. Traditional methods for monitoring and managing this pollution are often labour-intensive, costly, and limited in spatial and temporal scope. This systematic review explores the transformative potential of Artificial Intelligence (AI) and Machine Learning (ML) in revolutionizing the fight against ocean plastic. We survey the current landscape of AI/ML applications across three critical domains: (1) Detection and Monitoring, including the use of satellite, aerial, and drone imagery with computer vision models like Convolutional Neural Networks (CNNs) to identify floating plastic debris and object detection algorithms to classify plastic waste on beaches; (2) Source Prediction and Pathways, leveraging numerical models and ML techniques to forecast plastic accumulation zones and trace pollution back to its sources; and (3) Management and Cleanup, employing robotics, autonomous vehicles, and optimization algorithms for efficient cleanup operations. The review delves into advanced ML methods, including deep learning, reinforcement learning, and graph neural networks, highlighting their specific roles. Furthermore, we integrate a crucial discussion on the financial and economic aspects, analysing how AI can improve cost-efficiency, enable innovative financing models like plastic credit markets, and inform policy. Finally, we address the existing challenges such as data scarcity, model generalization, and computational costs and outline future research directions, advocating for a synergistic human-AI approach to mitigate one of the most pressing planetary challenges of our time.**

Keywords: Ocean Plastic Pollution, Artificial Intelligence, Machine Learning, Remote Sensing, Computer Vision, Convolutional Neural Networks, Plastic Waste Management, Environmental Finance, Circular Economy.

I. Introduction

The world's oceans are under siege from a relentless and growing tide of plastic waste. With an estimated 8 to 12 million metric tons of plastic entering the marine environment annually, the problem has transcended environmental concern to become a full-blown crisis with profound implications for ecosystem health, food security, and human economies [1] [2] [3] [4]. The visible manifestation of this crisis from polluted beaches to the infamous garbage patches in ocean gyres represents only a fraction of the issue, with microplastics now pervading every level of the marine food web [5] [6] [7] [8].

Conventional approaches to monitoring marine plastic pollution, such as beach surveys (e.g., NOAA Marine Debris Program surveys) and trawl-based sampling, are invaluable for collecting ground-truthed data [13] [14] [15]. However, they are inherently limited. They are point-in-time, localized, resource-intensive, and cannot provide the synoptic, repeated global coverage needed to understand the dynamics of this diffuse and mobile pollutant at scale [9] [10] [11] [12]. This data gap severely hinders effective policy-making, source identification, and cleanup efforts.

In this context, Artificial Intelligence (AI) and its subfield, Machine Learning (ML), have emerged as powerful technological disruptors [16]. AI/ML offers the ability to process vast, complex datasets, recognize intricate patterns, and make predictions with speed and accuracy that far surpass human capabilities [17] [18. From automatically scanning thousands of satellite images for plastic debris to optimizing the routes of cleanup vessels, AI is providing new eyes, brains, and tools for the global effort to combat ocean plastic pollution [19] [20].

ISSN (online): 2581-3048
Volume 9, Issue 10, pp 192-201, October-2025
https://doi.org/10.47001/IRJIET/2025.910026

This systematic review aims to synthesize and critically evaluate the current state of AI and ML applications across the entire pipeline of marine plastic pollution mitigation: from detection and monitoring to management and policy support [21] [22]. Unlike previous reviews, this paper places a specific emphasis on the integration of advanced ML methodologies and a detailed analysis of the financial implications and opportunities presented by these technologies [23] [24]. By bridging the gap between computer science, oceanography, and environmental economics, we seek to provide a holistic resource for researchers, practitioners, and policymakers [25].

II. The Marine Plastic Pollution Problem: Scope and Challenges

To appreciate the value of AI, one must first understand the complexity of the problem it is tasked to solve.

- **Scale and Sources:** The sheer volume of plastic entering the ocean is staggering, primarily from land-based sources via rivers, runoff, and wind [26]. Major rivers, particularly in developing nations with underdeveloped waste management infrastructure, act as principal conduits [27].
- **Diversity and Degradation:** Plastic pollution is not a single entity. It encompasses microplastics (>5mm), microplastics (<5mm), and Nano plastics, with varying polymer types, shapes, and densities. This diversity complicates detection, as a single method cannot capture all forms. Furthermore, plastics fragment and weather, changing their spectral signatures and making them harder to identify over time [28] [29].
- **Dynamic Nature:** Ocean currents, winds, and tides transport plastic debris over vast distances, creating transient accumulation zones far from the original source [30]. This mobility makes it difficult to pin down responsibility and target interventions effectively.
- **The Data Deficit:** Comprehensive, high-frequency, and global data on plastic distribution and abundance is the single biggest bottleneck in formulating an effective response. The ocean is vast, and traditional methods simply cannot fill this data void [30].

III. AI and ML Fundamentals for Environmental Science

At its core, ML is a method of data analysis that automates analytical model building. It is based on the idea that systems can learn from data, identify patterns, and make decisions with minimal human intervention [41] [42] [43], [44], [45].

- **Supervised Learning:** The most common paradigm in this domain. The algorithm is trained on a labeled dataset (e.g., images tagged as "plastic" or "water"). Once trained, it can predict labels on new, unseen data. Key tasks include:
    - **Classification:** Categorizing data (e.g., "plastic," "algae," "sea foam").
    - **Regression:** Predicting a continuous value (e.g., the concentration of plastic).
    - **Object Detection:** Identifying and localizing objects within an image (e.g., drawing bounding boxes around plastic bottles on a beach).
- **Unsupervised Learning:** Used to find hidden patterns or intrinsic structures in input data without labelled responses. Clustering is a common technique, which could group similar spectral signatures from satellite data.
- **Deep Learning (DL):** A subset of ML that uses multi-layered (deep) neural networks. DL has been revolutionary in processing unstructured data like images, text, and sound.
    - **Convolutional Neural Networks (CNNs):** The gold standard for image analysis. CNNs can automatically and adaptively learn spatial hierarchies of features from images, making them exceptionally good at identifying plastic debris in complex marine environments [46].

IV. AI/ML Applications in Detection, Monitoring, and Management

The application of AI/ML can be structured into a logical framework from observation to action.

4.1 Detection and Monitoring

- **Remote Sensing with Satellites and Aerial Platforms:**
    - **Methodology:** Satellites (like Sentinel-2, Landsat 8) and aircraft capture multispectral and hyperspectral imagery. The core challenge is that plastic debris is often sub-pixel in size and has a weak spectral signal. ML models, particularly CNNs, are trained to detect the subtle spectral signatures and textural anomalies associated with floating plastic accumulations [31], [32].
    - **Example:** Researchers have used CNNs on Sentinel-2 imagery to create maps of floating plastic debris in the waters of various countries, demonstrating the potential for global monitoring [33], [34]. Transfer learning, where a model pre-trained on a large general image dataset (like ImageNet) is fine-tuned for plastic detection, has proven effective in overcoming limited labelled data.

International Research Journal of Innovations in Engineering and Technology (IRJIET)
ISSN (online): 2581-3048
Volume 9, Issue 10, pp 192-201, October-2025
https://doi.org/10.47001/IRJIET/2025.910026

- **Unmanned Aerial Vehicles (UAVs or Drones):**
  - **Advantage:** Drones offer high-resolution imagery (centimetre-scale) and flexibility, filling the gap between costly aerial surveys and lower-resolution satellite data. They are ideal for monitoring beaches, rivers, and coastal areas [35].
  - **AI Integration:** Real-time object detection models (e.g., YOLO - You Only Look Once, Single Shot Detectors - SSDs) can be deployed on drones to count and classify plastic items in flight, providing immediate, actionable data for cleanup crews [36], [37], [38].
- **In-Situ and Close-Range Sensing:**
  - **Riverine Monitoring:** Cameras installed on bridges or riverbanks continuously capture images of the water surface. AI models analyze this video feed in near-real-time to quantify the flux of plastic waste moving downstream, helping to identify major source points [39].
  - **Beach Litter Analysis:** AI-powered mobile apps can allow citizens or researchers to take a picture of beach litter, with an onboard ML model automatically classifying and counting the items, standardizing data collection and reducing human error [40].

Table 1: AI/ML Applications for Detecting and Monitoring Marine Plastic Pollution

Platform	Spatial Scale	Key AI/ML Methods	Primary Use Case	Advantages	Limitations
Satellite	Global, Regional	CNN, Spectral Unmixing, Anomaly Detection	Mapping large floating accumulations, monitoring ocean gyres.	Broad, repeated coverage, historical archive.	Low resolution, signal interference from clouds/glint, cannot detect microplastics.
Aircraft	Regional, Local	CNN, Object Detection	High-resolution mapping of coastal areas and major river plumes.	Higher resolution than satellites, targeted flights.	Expensive, limited temporal frequency.
UAV / Drone	Local, Site	Real-time Object Detection (YOLO, SSD), CNN	Beach and riverbank surveys, pre- and post-cleanup assessment.	Very high resolution, cost-effective, on-demand.	Limited flight time/battery, regulatory restrictions, small area coverage.
Fixed Camera	Site	CNN, Video Analytics	Continuous monitoring of riverine plastic flux, waste infrastructure.	Continuous, real-time data, ideal for source identification.	Fixed field of view, requires installation and maintenance.

4.2 Prediction, Pathway Modeling, and Source Identification

Knowing where plastic is located is only half the battle; predicting where it will go and where it came from is equally critical.

- **Numerical Models and ML Fusion:** Traditional Ocean circulation models (e.g., Parcels, HYCOM) can simulate the transport pathways of virtual plastic particles. However, their accuracy is limited by the resolution of the underlying physical data and processes. ML can enhance these models:
  - **Data-Driven Correction:** ML algorithms can learn the bias between model predictions and real-world observations (from satellites or drones) and correct the model outputs, leading to more accurate forecasts of plastic accumulation zones [47].
  - **Source Attribution:** By running models backwards in time (lagrangian particle tracking), researchers can trace the likely origin of plastic found in a specific location. Coupling this with ML-based classification of land-based sources (e.g., identifying watersheds with high mismanaged plastic waste) allows for targeted interventions at the source [48].

4.3 Management, Cleanup, and Circular Economy

AI moves beyond observation to direct action in cleanup operations and waste management.

ISSN (online): 2581-3048
Volume 9, Issue 10, pp 192-201, October-2025
https://doi.org/10.47001/IRJIET/2025.910026

- **Robotics and Autonomous Cleanup:**
  - **Riverine Robots:** AI-powered robotic boats and barriers are being developed that use computer vision to identify and capture floating debris in rivers before it reaches the ocean [49]. Reinforcement Learning (RL) can be used to train these systems to navigate complex currents and optimize their collection paths.
  - **Ocean Cleanup Vessels:** For large-scale ocean cleanup systems, AI can optimize the routing of vessels to target the densest areas of pollution, as predicted by satellite and model data, maximizing fuel efficiency and plastic capture per voyage [50].
- **Waste Sorting and Recycling:** A significant portion of ocean plastic stems from a lack of effective waste management. AI-powered robotic sorters in recycling facilities use hyperspectral imaging and ML to identify and separate different polymer types with high speed and accuracy, increasing the quality and value of recycled materials and supporting the circular economy [51].
- **Policy and Public Awareness:** AI can analyze vast amounts of text data from social media, news, and scientific reports to gauge public sentiment, track policy effectiveness, and identify emerging concerns related to plastic pollution, providing valuable insights for policymakers and campaigners.

V. Advanced AI/ML Methods in Detail

Beyond standard CNNs, more sophisticated methods are being explored.

- **Explainable AI (XAI):** The "black box" nature of deep learning is a concern for scientists who need to trust and understand the model's decisions. Techniques like SHAP (SHapley Additive exPlanations) and LIME (Local Interpretable Model-agnostic Explanations) are being applied to explain *why* a model classified a certain pixel cluster as plastic, increasing scientific credibility and trust [48].
- **Semi-Supervised and Self-Supervised Learning:** Labeling thousands of satellite or drone images is a major bottleneck. These techniques allow models to learn from a small amount of labeled data and a large amount of unlabeled data, dramatically reducing the human effort required for training [42].
- **Graph Neural Networks (GNNs):** Plastic transport is a network problem, connecting rivers, coasts, and ocean currents. GNNs can model these complex spatial relationships, potentially leading to more accurate and holistic models of the plastic lifecycle from source to sink [41].
- **Generative Adversarial Networks (GANs):** GANs can be used for data augmentation—generating realistic, synthetic images of plastic debris in various environmental conditions to expand limited training datasets and improve model robustness [45].

VI. Financial Analysis and Economic Incentives

The deployment of AI is not just a technical decision but an economic one. A robust financial case is essential for widespread adoption.

- **Cost-Benefit Analysis of AI vs. Traditional Methods:** While the initial investment in AI infrastructure (sensors, computing, expertise) can be high, the long-term benefits often outweigh the costs. AI automates labour-intensive tasks (e.g., manual image analysis), reduces the need for expensive field campaigns through remote sensing, and enables more efficient deployment of resources (e.g., targeting cleanup where it is most needed). This leads to a significant reduction in operational expenditures over time [55].
- **Plastic Credit Markets and FinTech:** Similar to carbon credits, plastic credit markets are emerging, where companies can purchase credits to offset their plastic footprint by funding collection and recycling projects. AI plays a crucial role in this ecosystem by providing **Measurement, Reporting, and Verification (MRV)**. AI-based monitoring can verify the amount of plastic collected or diverted from a river, ensuring the integrity and transparency of the credit system and preventing fraud [56]. Blockchain technology can be integrated with this AI-generated data to create a tamper-proof record.
- **Informing Policy and Investment:** AI-generated data on plastic hotspots and sources provides governments and investors with the evidence needed to make informed decisions. It can guide investments in waste infrastructure in the most critical areas, assess the effectiveness of policies like plastic bags or Extended Producer Responsibility (EPR) schemes, and help quantify the economic damage caused by plastic pollution to sectors like tourism and fisheries [54].

ISSN (online): 2581-3048
Volume 9, Issue 10, pp 192-201, October-2025
https://doi.org/10.47001/IRJIET/2025.910026

Table 2: Financial Mechanisms and the Role of AI in Ocean Plastic Mitigation

Financial Mechanism	Description	Role of AI/ML	Impact
Traditional Public Funding	Government grants, environmental agency budgets.	Provides data to prioritize spending, demonstrate ROI of interventions, and report on outcomes.	Increases accountability and efficiency of public funds.
Impact Investing	Investments made with the intention to generate positive, measurable social and environmental impact alongside a financial return.	De-risks investments by providing verifiable, data-driven proof of impact (e.g., kg of plastic removed).	Attracts private capital to the blue economy and cleanup ventures.
Plastic Credit Markets	A market-based instrument where companies buy credits equivalent to plastic they remove or recycle.	Provides crucial MRV (Measurement, Reporting, Verification) through remote sensing and data analytics, ensuring credit legitimacy.	Creates a sustainable financing stream for collection and recycling, scales up cleanup efforts.
Extended Producer Responsibility (EPR)	Policy mandating producers to be responsible for the entire lifecycle of their products, including post-consumer waste.	Helps track and audit plastic waste flows, verifying producer compliance and the effectiveness of EPR schemes.	Ensures policy effectiveness and holds producers accountable.

VII. Challenges and Future Directions

Despite the promising advances, significant hurdles remain.

- **Data Scarcity and Quality:** The lack of large, diverse, and accurately labeled datasets for training robust models is the primary challenge. There is a need for global, open-source benchmark datasets for marine plastic detection [27].
- **Model Generalization:** A model trained on data from one geographic region (e.g., the Mediterranean) may perform poorly in another (e.g., Southeast Asia) due to differences in water color, plankton, and atmospheric conditions. Developing models that can generalize across diverse marine environments is an active area of research [28].
- **Computational Costs:** Training sophisticated deep learning models requires significant computational resources (GPUs), which can be a barrier for researchers and organizations in developing countries, which are often on the front lines of this crisis.
- **Detection of Microplastics:** Current remote sensing technologies are incapable of directly detecting microplastics. AI's role here is indirect, focusing on predicting microplastic distribution by modeling the fragmentation of tracked microplastics or analysing water samples in the lab [29].
- **Integration and Interoperability:** The future lies in integrated platforms that combine satellite data, drone surveys, in-situ sensors, and oceanographic models into a single AI-driven decision-support system for policymakers and cleanup organizations [30].

VIII. Conclusion

The fight against ocean plastic pollution is a daunting one, but AI and ML are emerging as indispensable allies. This review has demonstrated how these technologies are being deployed across a spectrum of applicationsfrom the macro-scale, using satellites to map global plastic flows, to the micro-scale, using robots to sort waste creating a more comprehensive and dynamic understanding of the problem than ever before.

The integration of advanced methods like Explainable AI and Graph Neural Networks promises even greater capabilities, moving from simple detection to sophisticated prediction and system-level understanding. Crucially, by enabling transparent verification and efficient operations, AI is unlocking new financial models, such as

ISSN (online): 2581-3048
Volume 9, Issue 10, pp 192-201, October-2025
https://doi.org/10.47001/IRJIET/2025.910026

plastic credit markets, that can scale up solutions by aligning economic incentives with environmental outcomes.

The path forward requires a collaborative effort. Computer scientists must work with oceanographers, environmental engineers, and economists to build robust, generalizable, and accessible tools. Addressing the challenges of data scarcity and computational cost is paramount. By fostering this synergy and continuing to innovate, we can harness the power of AI not just to monitor the escalating crisis of ocean plastic pollution, but to manage it, mitigate it, and ultimately, reverse it.

REFERENCES

[1] Chagger, Jeevanjot & chedda, Er & Wuntah, Er. (2025). Review study: Waste glass powder (WGP) with replacement of cement. *International Journal of Structural Design and Engineering*. 6. 01-06. 10.22271/27078280.2025.v6.i2a.43. https://www.researchgate.net/publication/394245448_Review_study_Waste_glass_powder_WGP_with_replacement_of_cement

[2] Sharma, H., Singh, J., Kumar, A., Bala, M., & Kumar, S. (2025, June). Review on the utilization of the Geogrids in road construction. *In AIP Conference Proceedings* (Vol. 3261, No. 1, p. 120002). *AIP Publishing LLC*. https://www.researchgate.net/publication/392428380_Review_on_the_utilization_of_the_Geogrids_in_road_construction

[3] Singh, Mehir & Thakur, Dr. (2024). Optimizing Tourism and Traffic with ITS in Nepal and India. *International Journal of Applied Science and Engineering Review*. 5. 2582-6948. Vol. 5 Issue 7, July 2024, https://www.researchgate.net/publication/387540549_Optimizing_Tourism_and_Traffic_with_ITS_in_Nepal_and_India

[4] Ashraf, Aadil & Thakur, Dr. (2023). Use of Waste Polythene in Bituminous Concrete Mixes for Highways. *International Journal for Research in Applied Science and Engineering Technology*. 11. 1709-1712. 10.22214/ijraset.2023.56293. https://www.researchgate.net/publication/375113951_Use_of_Waste_Polythene_in_Bituminous_Concrete_Mixes_for_Highways

[5] Chagger, Jeevanjot & Anil, Er. (2025). A REVIEW STUDY: ELECTRICAL WORK ON CONSTRUCTION SITE. *Industrial Engineering Journal, ISSN: 0970-2555*, Volume: 53, Issue 6, No.5, June: 2024. https://www.researchgate.net/publication/396053644_A_REVIEW_STUDY_ELECTRICAL_WORK_ON_CONSTRUCTION_SITE

[6] Chagger, Jeevanjot & chedda, Er & Wuntah, Er. (2025). Review study: Waste glass powder (WGP) with replacement of cement. *International Journal of Structural Design and Engineering*. 6. 01-06. 10.22271/27078280.2025.v6.i2a.43. https://www.researchgate.net/publication/394245448_Review_study_Waste_glass_powder_WGP_with_replacement_of_cement

[7] Sharma, H., Singh, J., Kumar, A., Bala, M., & Kumar, S. (2025, June). Review on the utilization of the Geogrids in road construction. *In AIP Conference Proceedings* (Vol. 3261, No. 1, p. 120002). *AIP Publishing LLC*. https://www.researchgate.net/publication/392428380_Review_on_the_utilization_of_the_Geogrids_in_road_construction

[8] Suri, Navleen & Chagger, Jeevanjot & Sharma, Er. Harish & Chandel, Dr. (2025). INVESTIGATION ON THE TENSILE STRENGTH WITH USE OF ScBA AND WPSA WITH PARTIAL REPLACEMENT OF CEMENT IN CONCRETE. *Industrial Engineering Journal*. 54. 678-704. https://www.researchgate.net/publication/391643779_INVESTIGATION_ON_THE_TENSILE_STRENGTH_WITH_USE_OF_ScBA_AND_WPSA_WITH_PARTIAL_REPLACEMENT_OF_CEMENT_IN_CONCRETE

[9] Jeevanjot Singh, Simran, Pema Chheda, Prince Wuni Wuntah. A review study on machine learning to investigate the issue of plastic pollution in oceans. *Int J Hydropower Civ Eng* 2025; 6(1):48-51. DOI: 10.22271/27078302.2025.v6.i1a.62. https://www.researchgate.net/publication/396213967_A_review_study_on_machine_learning_to_investigate_the_issue_of_plastic_pollution_in_oceans

[10] Chagger, Jeevanjot & Sharma, Er. Harish & Bala, Er. (2024). PARTIAL REPLACEMENT OF CEMENT WITH RICE HUSK ASH & SUGARCANE BAGASSE ASH: REVIEW PAPER. *Industrial Engineering Journal ISSN: 0970-2555* Volume: 53, Issue 6, June: 2024. https://www.researchgate.net/publication/387567151_PARTIAL_REPLACEMENT_OF_CEMENT_WITH_RICE_HUSK_ASH_SUGARCANE_BAGASSE_ASH_REVIEW_PAPER

[11] Suri, Navleen & Chagger, Jeevanjot & Sharma, Er. Harish & Chandel, Dr. (2025). INVESTIGATION ON THE COMPRESSIVE STRENGTH WITH USE OF ScBA AND WPSA WITH PARTIAL REPLACEMENT OF CEMENT IN CONCRETE.

ISSN (online): 2581-3048
Volume 9, Issue 10, pp 192-201, October-2025
https://doi.org/10.47001/IRJIET/2025.910026

Industrial Engineering Journal. Industrial Engineering Journal ISSN: 0970-2555 Volume: 54, Issue 4, April: 2025. https://www.researchgate.net/publication/391643772_INVESTIGATION_ON_THE_COMPRESSIVE_STRENGTH_WITH_USE_OF_ScBA_AND_WPSA_WITH_PARTIAL_REPLACEMENT_OF_CEMENT_IN_CONCRETE

[12] Chagger, Jeevanjot & Bala, Er & Sharma, Er. Harish. (2024). INVESTIGATE THE COMPRESSIVE STRENGTH OF CONCRETE USING FLY ASH ON M30 CONCRETE GRADE. *Industrial Engineering Journal ISSN: 0970-2555* Volume: 53, Issue 6, No.5, June: 2024 https://www.researchgate.net/publication/387566115_INVESTIGATE_THE_COMPRESSIVE_STRENGTH_OF_CONCRETE_USING_FLY_ASH_ON_M30_CONCRETE_GRADE

[13] Singh, Er & Chagger, Jeevanjot. (2024). Review Study: Robotics and Automation in Construction, *IRJIET*, Volume 8, Issue 11, November 2024 pp. 260-264. 10.47001/IRJIET/2024.811033. https://www.researchgate.net/publication/396051331_Review_Study_Robotics_and_Automation_in_Construction

[14] Chagger, Jeevanjot & Sharma, Er. Harish. (2024). Review Study on Partial Replacement of Cement with Sugarcane Bagasse Ash (SCBA), *National Conference on "Empowering Sustainability: Bridging Science, Technology and Climate Resilience" (ESBSTCR-2024)*, 17-19 Jan 2024; SBBS University, Jalandhar, Punjab. https://www.researchgate.net/publication/396270286_Review_Study_on_Partial_Replacement_of_Cement_with_Sugarcane_Bagasse_Ash_SCBA

[15] Chagger, Jeevanjot & Sharma, Er. Harish. (2024). A Review: ScBA& WPSA Used in Concrete as Partial Replacement of Cement, *National Conference on "Empowering Sustainability: Bridging Science, Technology and Climate Resilience" (ESBSTCR-2024)*, 17-19 Jan 2024; SBBS University, Jalandhar, Punjab. https://www.researchgate.net/publication/396270282_A_Review_ScBA_WPSA_Used_in_Concrete_as_Partial_Replacement_of_Cement

[16] Chagger, Jeevanjot & Sharma, Er. Harish. (2024). A Review on Improving Asphalt Mixtures Through the Use of Geosynthetics and Waste Fibers, *National Conference on "Empowering Sustainability: Bridging Science, Technology and Climate Resilience" (ESBSTCR-2024)*, 17-19 Jan 2024; SBBS University, Jalandhar, Punjab. https://www.researchgate.net/publication/387573908_A_Review_on_Improving_Asphalt_Mixtures_Through_the_Use_of_Geosynthetics_and_Waste_Fibers

[17] Mahi, Vishal & Chagger, Jeevanjot & Sharma, Er. Harish & Bala, Er. (2024). Performance Evaluation of Adhession in Recycled & Reused Construction Material in RCC, *International Research Journal of Innovations in Engineering and Technology (IRJIET)*, ISSN (online): 2581-3048, Volume 8, Issue 1, pp 19-37, January-2024. https://doi.org/10.47001/IRJIET/2024.801004,https://www.researchgate.net/publication/387570170_Performance_Evaluation_of_Adhesion_in_Recycled_Reused_Construction_Material_in_RCC

[18] Anmol, & Sharma, Er. Harish & Bala, Er & Chagger, Jeevanjot. (2023). An Examination the Use of Waste Glass Powder as Cement Partial Replacement in Concrete. *International Research Journal of Innovations in Engineering and Technology (IRJIET)* ISSN (online): 2581-3048 Volume 7, Issue 11, pp 343-355, November-2023. https://doi.org/10.47001/IRJIET/2023.711047,https://www.researchgate.net/publication/375826197_An_Examination_the_Use_of_Waste_Glass_Powder_as_Cement_Partial_Replacement_in_Concrete

[19] Chagger, Jeevanjot & Singh, Gurpreet & Mohit, (2023). A Review Study on The Use of Geosynthetics in Road Constructions. *International Journal of Research Publication and Reviews*, Vol 4, no 7, pp 518-522 July 2023. https://ijrpr.com/uploads/V4ISSUE7/IJRPR15273.pdf,https://www.researchgate.net/publication/396052553_A_Review_Study_on_The_Use_of_Geosynthetics_in_Road_Constructions

[20] Chagger, Jeevanjot. (2023). ASSESSING THE EFFECTIVENESS OF BAMBOO IN ENHANCING THE STRENGTH OF CONCRETE STRUCTURES: A REVIEW STUDY, *International Journal of Engineering Technology Research & Management*, Vol-07 Issue 07, 68-76, July-2023. https://www.researchgate.net/publication/396052546_ASSESSING_THE_EFFECTIVENESS_OF_BAMBOO_IN_ENHANCING_THE_STRENGTH_OF_CONCRETE_STRUCTURES_A_REVIEW_STUDY

[21] Singh, J.; Chandel, S.K.; Mohit; Singh, G. The Article Explores Improving the Performance of Asphalt Mixtures through the Utilization of Added Fibers. *Int. Res. J. Innov. Eng. Technol.* 2023, 7, 59–65. https://www.researchgate.net/publication/389533862_The_Article_Explores_Improving_the_Performance_of_Asphalt_Mixtures_through_the_Utilization_of_Added_Fibers

ISSN (online): 2581-3048
Volume 9, Issue 10, pp 192-201, October-2025
https://doi.org/10.47001/IRJIET/2025.910026

[22] Singh J, Mohit, Gurpreet Singh. Case study on partial replacement of cement with RHA. Int J Res Anal Rev (IJRAR). 2023; 10(3):5-10. Available from: http://www.ijrar.org/IJRAR23C1002.pdf,https://www.researchgate.net/publication/389533760_Case_Study_on_Partial_Replacement_of_Cement_with_RHA

[23] J. Singh, D. S. Chandel, "An Examination and Investigation Compressive Strength the Use of Waste Paper Sludge Ash and Rice Husk Ash as Cement Substitutes in Concrete", *International Journal of Innovative Research in Engineering and Management (IJIREM)*, Vol-10, Issue-3, Page No-60-66, 2023. Available from: https://doi.org/10.55524/ijirem.2023.10.3.11,https://www.researchgate.net/publication/372098556_An_Examination_and_Investigation_Compressive_Strength_the_Use_of_Waste_Paper_Sludge_Ash_and_Rice_Husk_Ash_as_Cement_Substitutes_in_Concrete

[24] Jeevanjot Singh, Mohit, Gurpreet Singh (July2023), "THE EXAMINATION STUDY TO INVESTIGATE THE EFFECTS OF USING A REDUCED AMOUNT OF CEMENT WITH WPSA, '*International Research Journal of Modernization in Engineering Technology and Science*, Volume:05/Issue:07/July-2023 Impact Factor- 7.868 www.irjmets.com, e-ISSN: 2582-5208. https://www.researchgate.net/publication/396052546_ASSESSING_THE_EFFECTIVENESS_OF_BAMBOO_IN_ENHANCING_THE_STRENGTH_OF_CONCRETE_STRUCTURES_A_REVIEW_STUDY

[25] Jeevanjot Singh, Dr. Sandeep Kumar Chandel, Mohit, Gurpreet Singh (2023), "A Study: How Using Waste Paper Sludge Ash and Rice Husk Ash Instead of Cement in Concrete, '*Quest Journals Journal of Architecture and Civil Engineering*, Volume 8 ~ Issue 7, pp: 20-29, ISSN (Online): 2321-8193, www.questjournals.org, https://www.researchgate.net/publication/396052558_A_Study_How_Using_Waste_Paper_Sludge_Ash_and_Rice_Husk_Ash_Instead_of_Cement_in_Concrete

[26] Sah, Nandkishor& Thakur, Dr. (2025). Evaluation of Innovative Construction Techniques for Rapid MSE Wall Installation. 10.1007/978-981-96-7779-5_12. https://www.researchgate.net/publication/396546906_Evaluation_of_Innovative_Construction_Techniques_for_Rapid_MSE_Wall_Installation

[27] Singh, Mehir & Thakur, Dr. (2025). USING INTELLIGENT TRANSPORTATION SYSTEMS FOR TOURISM AND TRAFFIC CONTROL IN NEPAL AND INDIA. 2024. https://www.researchgate.net/publication/396143907_USING_INTELLIGENT_TRANSPORTATION_SYSTEMS_FOR_TOURISM_AND_TRAFFIC_CONTROL_IN_NEPAL_AND_INDIA

[28] Thakur, Dr. (2025). View of Thermal Properties of Concrete Prepared with Water Absorbing Beads, *International Conference on Multidisciplinary Approaches for Sustainable Development,* Volume: 32. https://www.researchgate.net/publication/394873033_View_of_Thermal_Properties_of_Concrete_Prepared_with_Water_Absorbing_Beads

[29] Sah, N., Thakur, A., Sah, S.K. (2025). Evaluation of Innovative Construction Techniques for Rapid MSE Wall Installation. In: Dixit, M.S., Jaiswal, S.S., Shermale, Y., Satyam, N., Singh, A.P. (eds) *Proceedings of the Indian Geotechnical Conference (IGC 2024),* Volume 6. IGC 2024. *Lecture Notes in Civil Engineering, vol 702. Springer, Singapore*. https://doi.org/10.1007/978-981-96-7779-5_12

[30] Thakur, Dr. (2024). Comparative Simulation of Advanced Oxidation Process and Electrocoagulation for Wastewater Treatment: A Two-Dimensional Diffusion–Reaction Study, *Conference: International Conference on Multidisciplinary Approaches for Sustainable Development,* Volume: 31. https://www.researchgate.net/publication/394872905_Comparative_Simulation_of_Advanced_Oxidation_Process_and_Electrocoagulation_for_Wastewater_Treatment_A_Two-Dimensional_Diffusion-Reaction_Study

[31] Thakur, Dr. (2024). Development of Sustainable and Cost-Effective Framework for Rain Water Treatment, *Conference: International Conference on Multidisciplinary Approaches for Sustainable Development,* Volume: 32, https://www.researchgate.net/publication/394872689_Development_of_Sustainable_and_Cost-Effective_Framework_for_Rain_Water_Treatment

[32] Thakur, Dr. (2025). Development of Sustainable and Cost-Effective Framework for Rain Water Treatment. *International Conference on Multidisciplinary Approaches for Sustainable Development,* Volume: 32, https://www.researchgate.net/publication/394872496_Identification_of_Contaminants_Present_in_Rainwater_Collected_from_Ground_Pit_and_its_Removal

[33] N. Sah and A. Thakur, "Innovative Techniques for Rapid MSE Wall Installation", *J. Sci. Techn.*, vol. 4, no. 2, pp. 90–93, May 2025. https://www.researchgate.net/publication/396733403_Innovative_Techniques_for_Rapid_MSE_Wall_Installation

[34] Singh, Mehir & Thakur, Dr. (2024). Optimizing Tourism and Traffic with ITS in Nepal and India. *International Journal of Applied Science and Engineering Review.* 5. 2582-6948. Vol. 5 Issue 7, July

ISSN (online): 2581-3048
Volume 9, Issue 10, pp 192-201, October-2025
https://doi.org/10.47001/IRJIET/2025.910026

2024, https://www.researchgate.net/publication/387540549_Optimizing_Tourism_and_Traffic_with_ITS_in_Nepal_and_India

[35] Ashraf, Aadil & Thakur, Dr. (2023). Use of Waste Polythene in Bituminous Concrete Mixes for Highways. *International Journal for Research in Applied Science and Engineering Technology*. 11. 1709-1712. 10.22214/ijraset.2023.56293. https://www.researchgate.net/publication/375113951_Use_of_Waste_Polythene_in_Bituminous_Concrete_Mixes_for_Highways

[36] Themisana, Rajkumari & Thakur, Dr &Thaguna, Parwati& Thounaojam, Anuradha & Senagah, Amenjor. (2023). TO DETERMINE THE STRENGTH OF CONCRETE WITH PARTIAL REPLACEMENT OF SAND WITH MARBLE DUST POWDER. 10.17605/OSF.IO/QD68N. https://www.researchgate.net/publication/372724255_TO_DETERMINE_THE_STRENGTH_OF_CONCRETE_WITH_PARTIAL_REPLACEMENT_OF_SAND_WITH_MARBLE_DUST_POWDER

[37] Thagunna, Parwati& Thakur, Dr & Devi, Rajkumari & Thounaojam, Anuradha & Senagah, Amenjor. (2023). EXPERIMENTAL STUDY FOR STABILIZING PROPERTIES OF BLACK COTTON SOIL BY USE OF GEOGRID AND ADMIXTURE. *Journal of Biomechanical Science and Engineering*. APRIL 2023. 725-728. 10.17605/OSF.IO/A4E39. https://www.researchgate.net/publication/372724185_EXPERIMENTAL_STUDY_FOR_STABILIZING_PROPERTIES_OF_BLACK_COTTON_SOIL_BY_USE_OF_GEOGRID_AND_ADMIXTURE

[38] Thakur, Dr. (2023). ASSESSMENT OF INITIATION OF SOIL LIQUEFACTION INDUCED BY EARTHQUAKES: A RESEARCH. *European Chemical Bulletin*. (Special Issue 7). 2240-2259. https://www.researchgate.net/publication/372102614_ASSESSMENT_OF_INITIATION_OF_SOIL_LIQUEFACTION_INDUCED_BY_EARTHQUAKES_A_RESEARCH

[39] Yousuf, Saleem & Thakur, Dr. (2023). A Review Intelligent Transport System. *Zeitschrift fur celtische Philologie*. volume 10. 2017-2045. https://www.researchgate.net/publication/371131269_A_Review_Intelligent_Transport_System

[40] Thakur, Dr. (2023). Enhancing the soils geotechnical properties by using plastic waste: A Review. Yingyong JichuyuGongcheng Kexue Xuebao/*Journal of Basic Science and Engineering*. 23. 168-186. 10.37896/JBSV23.5/2096. https://www.researchgate.net/publication/370528028_Enhancing_the_soils_geotechnical_properties_by_using_plastic_waste_A_Review

[41] Er. Abhilash Thakur, NaveenKumar, Sangharsh Kaith, Sanchit Rana, Pranshu Goyal, D. K. Tiwary, D. R. K. Thakur, "A Critical Review On Fiber Reinforced Polymer Composites In Strengthening Reinforced Concrete Structure", *International Journal of Innovative Research in Engineering and Management (IJIREM)*, Vol-9, Issue-2, Page No-562-567, 2022. Available from: https://doi.org/10.55524/ijirem.2022.9.2.88.

[42] Er. Manpreet Singh, Dr. Vijay Dhir, & Er. Simran. (2025). A Multi-Method AI Framework for the Sustainable Optimization of Concrete Mix Designs Using Industrial and Agricultural Waste: A Comprehensive Review. *International Research Journal of Innovations in Engineering and Technology - IRJIET*, 9(9), 82-87. Article DOI https://doi.org/10.47001/IRJIET/2025.909012

[43] Er. Manpreet Singh, Dr. Vijay Dhir, & Er. Simran. (2025). A Geospatial and AI-Based Decision Support System for Planning Sustainable Infrastructure Corridors: Integrating Material Science and Modern Construction Techniques. *International Research Journal of Innovations in Engineering and Technology - IRJIET*, 9(9), 88-94. Article DOI https://doi.org/10.47001/IRJIET/2025.909013

[44] Er. Manpreet Singh, Dr. Vijay Dhir, & Er. Simran. (2025). Life-Cycle Assessment and Digital Twin Modeling for Resilient and Eco-Friendly Construction Practices: A Comprehensive Review. *International Research Journal of Innovations in Engineering and Technology - IRJIET*, 9(9), 95-102. Article DOI https://doi.org/10.47001/IRJIET/2025.909014

[45] Er. Manpreet Singh, Dr. Vijay Dhir, & Er. Simran. (2025). An Integrated Review: Harnessing Industry 4.0 Technologies for a Circular Economy in the Construction Sector. *International Research Journal of Innovations in Engineering and Technology - IRJIET*, 9(9), 103-111. Article DOI https://doi.org/10.47001/IRJIET/2025.909015

[46] Er. Manpreet Singh, Dr. Vijay Dhir, & Er. Simran. (2025). Predicting the Mechanical and Durability Properties of Hybrid Green Concrete using Artificial Neural Networks and Weight of Evidence: A Comprehensive Review. *International Research Journal of Innovations in Engineering and Technology - IRJIET*, 9(9), 112-120. Article DOI https://doi.org/10.47001/IRJIET/2025.909016

[47] Er. Manpreet Singh, Dr. Jagdeep Kaur, & Er. Simran. (2025). Investigation into the Valorization of Agro-Industrial Waste for Sustainable Construction: From

ISSN (online): 2581-3048
Volume 9, Issue 10, pp 192-201, October-2025
https://doi.org/10.47001/IRJIET/2025.910026

Material Characterization to Field Application. *International Research Journal of Innovations in Engineering and Technology - IRJIET*, 9(9), 121-127. Article DOI https://doi.org/10.47001/IRJIET/2025.909017

[48] Er. Manpreet Singh, Dr. Jagdeep Kaur, Er. Simran. (2025). Resilient Infrastructure Development in Mountainous Regions: A Synergy of Natural waste Materials, Geosynthetics, and Intelligent Systems. *International Research Journal of Innovations in Engineering and Technology - IRJIET*, 9(9), 128-134. Article DOI https://doi.org/10.47001/IRJIET/2025.909018

[49] Er. Manpreet Singh, Dr. Jagdeep Kaur, & Simran. (2025). Meta-Analysis and Knowledge Synthesis in Sustainable Construction Materials Using Machine Learning and Information Value Models. *International Research Journal of Innovations in Engineering and Technology - IRJIET*, 9(9), 135-141. Article DOI https://doi.org/10.47001/IRJIET/2025.909019

[50] Er. Manpreet Singh, Dr. Jagdeep Kaur, & Er. Simran. (2025). Automation and Robotics for the Precision Manufacturing of Precast Elements using Sustainable Concrete Mixes. *International Research Journal of Innovations in Engineering and Technology - IRJIET*, 9(9), 142-148. Article DOI https://doi.org/10.47001/IRJIET/2025.909020

[51] Er. Manpreet Singh, Dr. Jagdeep Kaur, & Er. Simran. (2025). A Unified Performance-Based Specification Framework for Green Concrete Incorporating Waste Materials and Advanced Monitoring. *International Research Journal of Innovations in Engineering and Technology - IRJIET*, 9(9), 149-154. Article DOI https://doi.org/10.47001/IRJIET/2025.909021

[52] Chagger, Jeevanjot. (2025). GEOGRAPHIC INFORMATION SYSTEM FOR CIVIL ENGINEERS. 10.5281/zenodo.10636618. https://www.researchgate.net/publication/396525537_GEOGRAPHIC_INFORMATION_SYSTEM_FOR_CIVIL_ENGINEERS

[53] Vanadi, Vinay & Kumar, A & Chagger, Jeevanjot. (2025). NUMERICAL METHODS IN CIVIL ENGINEERING: PRACTICAL APPLICATIONS AND TECHNIQUES. 10.5281/zenodo.15227277. https://www.researchgate.net/publication/396525095_NUMERICAL_METHODS_IN_CIVIL_ENGINEERING_PRACTICAL_APPLICATIONS_AND_TECHNIQUES

[54] Singh, V., Taneja, S., Singh, V., Singh, A., & Paul, H. L. (2021). Online advertising strategies in Indian and Australian e-commerce companies: A comparative study. In Big data analytics for improved accuracy, efficiency, and decision making in digital marketing (pp. 124-138). *IGI Global.*

[55] Sardana, S., Singh, V., & Adhikari, D. (2025). Sustainable Product Design: Materials, Processes, and Longevity. *In Sustainability, Innovation, and Consumer Preference* (pp. 65-90). *IGI Global Scientific Publishing*.

[56] Lalit, N., & Singh, V. (2025). Neuro Green: Case Studies on the Power of Neuromarketing in Promoting Eco-Investments. *In Neuromarketing's Role in Sustainable Finance* (pp. 231-244). *IGI Global*.

Citation of this Article:

Ms. Jasleen Kaur, Dr. Gagandeep S. Salhan, Dr. Gurjit Singh, Ms.Pawanjeet Kaur, Manpreet Singh, & Mohit. (2025). AI-Powered Solutions for Ocean Plastic Pollution: A Systematic Review of Machine Learning Applications in Detection, Monitoring, and Management. *International Research Journal of Innovations in Engineering and Technology - IRJIET*, 9(10), 192-201. Article DOI https://doi.org/10.47001/IRJIET/2025.910026

****