

Innovative Applications of Construction And Demolition In Soil Erosion Control And Habitat Restoration

Patil Rubee¹, More Kartika², Patil Rutuja³, Chaudhari Pallavi⁴, Prof. G.V.Tapkire⁵

^{1, 2, 3, 4, 5} Dept of Civil Engineering

^{1, 2, 3, 4, 5} R C PATEL INSTITUTE OF TECHNOLOGY, SHIRPUR.

Abstract- *This project explores innovative, eco-friendly solutions to manage riverbank erosion in India using Construction and Demolition (C&D) waste. By repurposing waste materials like concrete and bricks, the approach aims to reduce environmental pollution, cut costs, and restore river habitats. Although still in early stages, this sustainable method holds great promise for protecting rivers while promoting circular use of resources.*

Riverbank erosion and habitat degradation are pressing environmental issues that threaten ecosystems and human settlements alike. This project explores the innovative utilization of Construction and Demolition (C&D) waste as a sustainable and cost-effective solution for river erosion control and habitat restoration. Traditionally viewed as a disposal challenge, C&D waste comprising concrete, brick, metal, and asphalt can be repurposed to stabilize riverbanks, reduce sediment load, and create microhabitats for aquatic and riparian species.

This study assesses the mechanical properties and ecological compatibility of various C&D materials and demonstrates their effectiveness through case studies, lab testing, and field pilot installations. Emphasis is placed on modular gabion structures, artificial reefs, and vegetated revetments made from processed waste materials.

Keywords: Soil Erosion, Siltation, Construction And Demolition Waste, Desiltation .

I. INTRODUCTION

Riverbank erosion and habitat degradation are becoming major environmental concerns across the world, affecting both ecosystems and human settlements. Rivers are essential for agriculture, biodiversity, groundwater recharge, and economic development, yet increasing urbanization, deforestation, climate change, and unplanned construction activities have made riverbanks more vulnerable to erosion. Continuous soil loss along riverbanks results in flooding, sediment deposition, damage to infrastructure, loss of fertile

land, and disturbance to aquatic habitats. Conventional erosion control methods such as concrete retaining walls and embankments are often expensive, less sustainable, and harmful to the natural river environment.

At the same time, the rapid growth of infrastructure development has led to the generation of huge quantities of Construction and Demolition (C&D) waste, including concrete, bricks, asphalt, and metal debris. Improper disposal of this waste creates environmental pollution and increases pressure on landfills. In recent years, researchers and environmental engineers have started exploring sustainable ways to reuse C&D waste instead of treating it as useless material.

This project focuses on the innovative use of Construction and Demolition waste for riverbank stabilization and habitat restoration. Recycled materials such as crushed concrete and brick aggregates can be utilized in structures like gabion walls, vegetated revetments, and sediment barriers to reduce erosion and improve riverbank stability. These structures also help in controlling sediment movement and creating suitable habitats for aquatic and riparian species.

The study particularly focuses on the Arunavati River basin near Shirpur in Dhule district, Maharashtra, where erosion and siltation have become serious concerns due to heavy rainfall, soil instability, and land disturbances. The region contains erosion-prone soils and experiences various forms of soil erosion such as sheet erosion, gully erosion, and streambank erosion. Excessive siltation has also affected reservoir capacity, groundwater recharge, and agricultural productivity.

The main aim of this project is to develop sustainable, eco-friendly, and cost-effective solutions for erosion control using recycled Construction and Demolition waste. The study promotes resource conservation, reduction of waste disposal problems, improvement of water quality, restoration of river habitats, and adoption of circular economy principles. By converting waste materials into useful

engineering resources, the project demonstrates a practical approach toward sustainable river management and environmental protection.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

The project started with identifying major environmental issues such as riverbank erosion, siltation, habitat degradation, and improper disposal of Construction and Demolition (C&D) waste. Increasing rainfall, deforestation, urban development, and land disturbances have made riverbanks unstable, leading to loss of fertile soil, flooding, and damage to aquatic ecosystems. Excessive sediment deposition also reduces the carrying capacity of rivers and affects groundwater recharge and agricultural productivity.

At the same time, large amounts of C&D waste such as concrete, bricks, and construction debris are generated every year and are often dumped without proper management. This not only causes pollution but also wastes reusable materials. These problems created the need for a sustainable approach that could address both river restoration and waste management together.

To understand the issue in detail, research papers, technical studies, and case studies related to soil erosion, de-silting, and C&D waste reuse were reviewed. A major reference for the project was the de-silting work carried out on the Godavari River in Nashik city for flood mitigation. The study showed how sediment accumulation reduced river flow and increased flood risk. Techniques such as DGPS surveying, bathymetric studies, dredging, and gabion wall construction were used to restore the river channel and improve water flow.

Studies conducted in the Dhule district and Arunavati River basin also highlighted the impact of erosion on agriculture, water resources, and land stability. Based on these observations, the idea was developed to reuse recycled Construction and Demolition waste for riverbank stabilization and habitat restoration. Materials such as crushed concrete and brick aggregates can be used in gabion walls, sediment barriers, and vegetated structures to reduce erosion, control siltation, and improve river ecology in a sustainable and cost-effective manner.

III. BACKGROUND STUDY

Riverbank erosion and siltation have become major environmental concerns in many river basins. Continuous erosion weakens riverbanks, increases sediment deposition, and reduces the natural carrying capacity of rivers. This leads

to problems such as flooding, land degradation, loss of fertile soil, and disturbance to aquatic ecosystems. Heavy rainfall, deforestation, unplanned land use, and unstable soil conditions are some of the main factors responsible for increasing erosion in many regions.

The Arunavati River basin near Shirpur in Dhule district of Maharashtra is also affected by these problems. The river flows through agricultural and semi-urban areas where erosion and sediment deposition have increased over time. A considerable portion of the riverbanks has widened due to continuous soil erosion, while excessive silt accumulation has reduced reservoir storage capacity and affected nearby agricultural land. Different forms of erosion such as sheet erosion, rill erosion, gully erosion, and streambank erosion are commonly observed within the basin.

The soil conditions in the region also influence the severity of erosion. Deep black cotton soil, medium black soil, and coarse shallow soil are found in different parts of the basin. Shallow and loose soils near slopes and hilly areas are highly vulnerable to erosion during intense rainfall. Lack of vegetation cover, overgrazing, and improper farming practices further increase soil loss and sediment movement.

Several studies related to soil erosion and land degradation in Dhule district were reviewed during this study. Research findings showed that erosion reduces soil fertility, affects crop productivity, and disturbs groundwater recharge. Studies using GIS and remote sensing techniques also highlighted the importance of identifying erosion-prone areas for better land and river management.

An important reference considered for this project was the de-silting work carried out on the Godavari River in Nashik city for flood mitigation. The study explained how continuous sediment deposition reduced river flow and increased flood risk in the city. Techniques such as DGPS and bathymetric surveying were used to estimate the quantity of deposited silt and identify critical stretches of the river. De-silting, dredging, and gabion wall construction were carried out to improve river flow and restore the river channel.

The study also emphasized sustainable sediment management and reuse of waste materials. Extracted silt and reusable materials were utilized wherever suitable, helping to reduce waste disposal problems and support resource conservation. The project improved river flow conditions and helped reduce flood-related issues in the surrounding areas.

Research on Construction and Demolition (C&D) waste management shows that recycled materials such as

crushed concrete, brick aggregates, and stone debris can be reused effectively in civil and environmental engineering works. These materials provide suitable strength and stability for applications such as gabion walls, riprap structures, sediment barriers, and vegetated revetments used for erosion control.

Background studies conducted at different locations near the Arunavati River basin also included permeability analysis, erosion assessment, and suitability studies for applying recycled C&D materials. Areas with high erosion risk and low permeability were found suitable for structural stabilization methods, while locations with better infiltration capacity showed potential for rain gardens, wetlands, and biofilter systems.

Laboratory testing of recycled C&D materials included water absorption tests, sieve analysis, permeability testing, density analysis, and water quality assessment. The results showed that recycled materials can improve erosion resistance and support infiltration when used properly. However, water quality studies also indicated that excessive use of untreated C&D materials may affect pH, turbidity, and electrical conductivity of water. Therefore, proper treatment and controlled application are necessary for environmentally safe use.

Overall, the background study indicates that riverbank erosion, siltation, and improper disposal of Construction and Demolition waste are closely connected environmental issues. Previous studies and case analyses suggest that recycled C&D waste can be used as a sustainable and cost-effective solution for riverbank stabilization, erosion control, sediment management, and habitat restoration when applied with proper planning and monitoring.

III.METHODOLOGY

A.Selection of Study Locations :

The Arunavati River basin near Shirpur in Dhule district was selected for the study because of increasing riverbank erosion, siltation, and land degradation problems. Different locations including Uparpind Residential Area, Shirpur Bridge, Lakadya Hanuman Temple at Amode, Arunavati River Bridge, Kapileshwar Mahadev Temple, Kharde Bridge, and Someshwar Mahadev Mandir at Ajande Kh were selected based on erosion severity, runoff conditions, permeability characteristics, and suitability for application of recycled Construction and Demolition (C&D) waste materials. These locations represented different environmental and soil conditions within the basin.

Uparpind Residential Area showed moderate surface erosion caused by urban runoff and residential activities. Severe bank erosion and scour effects were observed near Shirpur Bridge and Kharde Bridge due to concentrated river flow near bridge foundations. Lakadya Hanuman Temple and Kapileshwar Mahadev Temple were selected to study runoff-related erosion and stormwater management possibilities. Arunavati River Bridge was identified as a high-risk erosion zone because of unstable riverbanks and strong water currents, while Someshwar Mahadev Mandir showed moderate to high erosion and sediment deposition near river bends.



Fig:Arunavati River plan (Reference from Google Earth image)

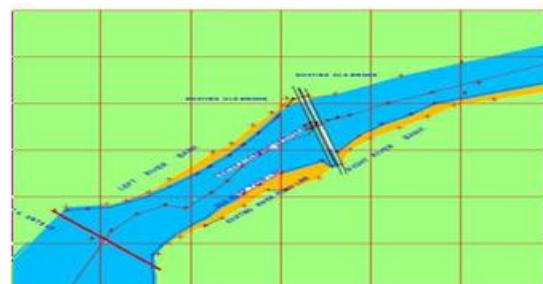


Fig:River Longitudinal plan with Surveyed point location

- ◆ Shirpur
- ◆ Uparpind
- ◆ Shirpur Bridge
- ◆ Lakadya Hanuman Temple Amode Shirpur
- ◆ Arunavati River Bridge, Shirpur
- ◆ Kapileshwar mahadev temple
- ◆ Kharde bridge
- ◆ Someshwar mahadev madir Ajande kh

Fig:Zones in Shirpur



Fig:Marking Of Zones On Ma

B. Soil Study and Site Analysis:

Detailed soil analysis was carried out to understand permeability, density, runoff behavior, and erosion characteristics at different study locations. Different soil types were identified across the basin. Silty clayey alluvium soil was found near Arunavati River Bridge, sandy loam soil with C&D fragments was observed near Kapileshwar Mahadev Temple, sandy clay with gravel was identified near Kharde Bridge, and silty sand with organic content was found near Someshwar Mahadev Mandir.

Low permeability soils were mainly observed near Arunavati River Bridge and Kharde Bridge, where runoff and erosion risk were high. High permeability soil was identified near Kapileshwar Mahadev Temple, supporting infiltration and groundwater recharge. Medium permeability conditions were observed near Lakadya Hanuman Temple and Someshwar Mahadev Mandir, making these areas suitable for biofilters and wetland-based applications.



C. Erosion Assessment of Selected Locations:

Erosion assessment was carried out to identify the type and intensity of erosion at each selected location. Uparpind showed moderate sheet and surface erosion caused by runoff from surrounding residential areas. Shirpur Bridge and Kharde Bridge experienced severe bank and scour erosion due to concentrated water flow near bridge foundations. Lakadya Hanuman Temple showed localized rill and surface erosion because of exposed soil and runoff conditions.

Arunavati River Bridge was identified as a critical erosion-prone zone due to strong water currents and continuous riverbank instability. Kapileshwar Mahadev Temple experienced sheet and minor gully erosion caused by stormwater runoff, while Someshwar Mahadev Mandir showed moderate to high erosion and sediment deposition near river bends.

D. Selection and Application of C&D Waste Materials:

Construction and Demolition waste materials such as crushed concrete, recycled aggregates, crushed bricks, tiles, and masonry debris were collected and segregated according to size and usability. Unwanted and hazardous materials were removed during the sorting process to ensure safe environmental application.

Different recycled materials were selected for different engineering applications based on site conditions. Recycled aggregates and crushed bricks were proposed for permeable pavements and runoff control at Uparpind. Crushed concrete and recycled aggregates were selected for gabion walls and riverbank stabilization near Shirpur Bridge and Arunavati River Bridge. Crushed bricks and tiles were considered suitable for wetland filtration and biofilter systems near Lakadya Hanuman Temple and Someshwar Mahadev Mandir because of their porous nature and filtration properties.

E. Permeability and Density Tests:

Permeability and density tests were conducted on soil samples collected from selected locations to evaluate infiltration capacity and soil stability. Constant head permeability tests along with density tests such as sand replacement and core cutter methods were used during laboratory analysis.



Low permeability values were observed near Arunavati River Bridge and Kharde Bridge, indicating higher runoff and erosion risk. High permeability was observed near Kapileshwar Mahadev Temple, supporting stormwater infiltration and groundwater recharge. Medium permeability

conditions near Someshwar Mahadev Mandir and Lakadya Hanuman Temple supported balanced infiltration and runoff control. Density analysis showed that dense soils with low permeability required structural stabilization methods such as gabion walls, reinforced embankments, and riprap structures, while medium and high permeability soils were suitable for vegetative stabilization and bioengineering applications.



F. Water Absorption Test on C&D Waste Brick Particles:

Water absorption tests were conducted on recycled brick masonry particles collected from C&D waste to determine their porosity and absorption characteristics. The brick particles were oven dried, weighed, immersed in water for twenty-four hours, and weighed again after soaking. The test showed higher water absorption due to the porous nature of recycled brick materials and adhered mortar content. These observations helped evaluate the suitability of recycled brick particles for erosion control and construction applications.



Fig :Weight before soaking for 24 hours



Fig :Weight after soaking for 24 hours

G. Water Absorption Test on C&D Waste Aggregates

Water absorption tests were also conducted on recycled aggregate materials obtained from C&D waste. The aggregates were cleaned, oven dried, immersed in water, and

weighed after soaking to determine their absorption characteristics. The results indicated higher porosity and water absorption because of micro-cracks and adhered mortar present in recycled aggregates. The test helped assess the suitability of recycled aggregates for stabilization structures, gabion walls, and erosion control works.



Fig:Aggregate Weight

H. Sieve Analysis of C&D Waste Material

Sieve analysis was carried out on 20 mm C&D waste material to determine particle size distribution and grading characteristics. The material was dried and passed through a 20 mm IS sieve to measure the percentage retained and passing through the sieve. The analysis confirmed that most of the material retained the required nominal size suitable for use as coarse aggregate in erosion control and stabilization works.



Fig:Wight in kg



Fig:AfterSievingFrom20mm Sieve

I. Water Quality Analysis:

Water quality analysis was carried out using normal water samples and C&D mixed water samples to study the environmental impact of recycled materials. Parameters such as pH, turbidity, and electrical conductivity were tested using laboratory instruments.

The pH values increased after mixing C&D materials because of dissolved minerals and alkaline particles present in recycled waste. Turbidity also increased due to suspended fine particles released into the water, while electrical conductivity increased because of dissolved salts and ions. The observations indicated that uncontrolled use of untreated C&D waste near aquatic habitats may affect water quality, making proper treatment and controlled application necessary for environmentally safe river restoration works.



J. Infiltration and Runoff Behavior Study

Infiltration and runoff behavior were studied at selected locations to understand water movement and erosion characteristics after application of recycled materials. Areas

with low permeability showed higher surface runoff and required structural stabilization measures. Medium and high permeability locations supported infiltration and groundwater recharge, making them suitable for rain gardens, wetlands, vegetative buffers, and biofilter systems.

The study showed that proper application of recycled C&D materials can improve infiltration, reduce runoff velocity, and support erosion control and habitat restoration within the Arunavati River basin.

IV. RESULTS AND DISCUSSION

A. Results:

The study showed that erosion severity in the Arunavati River basin varied according to soil type, permeability, and runoff conditions. Areas near Arunavati River Bridge and Kharde Bridge experienced severe erosion and high surface runoff because of low permeability soils. In comparison, locations such as Kapileshwar Mahadev Temple and Someshwar Mahadev Mandir showed better infiltration and groundwater recharge capacity.

Laboratory tests on recycled Construction and Demolition (C&D) materials indicated good water absorption and suitable particle grading for erosion control applications. Recycled brick particles and aggregates showed porous characteristics that supported infiltration and stabilization. Sieve analysis confirmed that the processed material was suitable for gabion walls and stabilization works.

Water quality analysis showed an increase in pH, turbidity, and electrical conductivity after mixing recycled materials with water samples. The observations suggested that controlled application and proper treatment of C&D waste are necessary near aquatic environments.

The infiltration and runoff study showed that proper use of recycled materials can reduce runoff velocity, improve infiltration, and support groundwater recharge. The Godavari River de-silting case study also demonstrated that sustainable sediment management methods can improve river flow and reduce flood risks.

Overall, the results confirmed that recycled C&D waste can be used as a sustainable and cost-effective material for riverbank stabilization, sediment management, and habitat restoration.

B. Verification of objectives:

The objectives of the study were successfully achieved through field analysis, laboratory testing, and case study observations. The project identified erosion-prone areas within the Arunavati River basin and studied the effect of soil conditions, runoff, and permeability on erosion.

The study also verified that recycled Construction and Demolition waste materials can be effectively used for riverbank stabilization and erosion control applications. Methods such as gabion walls, riprap protection, wetlands, rain gardens, and biofilters were found suitable for improving riverbank stability and reducing environmental degradation.

The project further achieved its objective of promoting sustainable waste management through reuse and recycling of Construction and Demolition waste materials.

D. Limitations of the study:

The study was limited to selected locations within the Arunavati River basin, and environmental conditions may vary in other regions depending on soil type, rainfall, and river flow patterns.

Laboratory testing was conducted on limited samples of recycled C&D materials, and variations in material composition may affect field performance. Water quality analysis also showed that untreated recycled materials may affect pH, turbidity, and conductivity if used without proper treatment and monitoring.

The project mainly focused on small-scale analysis and suitability assessment. Long-term field performance and large-scale implementation of recycled C&D materials require further study and continuous monitoring.

E. Limitations of the study:

The study was limited to selected locations within the Arunavati River basin, and environmental conditions may vary in other regions depending on soil type, rainfall, and river flow patterns.

Laboratory testing was conducted on limited samples of recycled C&D materials, and variations in material composition may affect field performance. Water quality analysis also showed that untreated recycled materials may affect pH, turbidity, and conductivity if used without proper treatment and monitoring.

The project mainly focused on small-scale analysis and suitability assessment. Long-term field performance and

large-scale implementation of recycled C&D materials require further study and continuous monitoring.

F. Conclusion:

The study showed that recycled Construction and Demolition (C&D) waste can be used effectively for riverbank stabilization and erosion control in the Arunavati River basin. Field observations and laboratory tests revealed that soil permeability, runoff, and sediment movement strongly influence erosion at different locations.

The results confirmed that recycled brick particles and aggregates have suitable properties for applications such as gabion walls, wetlands, biofilters, and stabilization works. Proper use of recycled C&D materials was found to reduce runoff, improve infiltration, control sediment movement, and support habitat restoration. These findings indicate that reuse of construction waste can provide a practical and environmentally sustainable solution for river restoration and waste management.

However, the study also had certain limitations. Water quality analysis showed that untreated recycled materials may affect pH, turbidity, and conductivity if used without proper treatment and monitoring. The study was limited to selected locations and small-scale analysis, therefore long-term performance and large-scale application of recycled C&D materials require further investigation and field monitoring

REFERENCES

- [1] "Experimental investigation of flooding problem : AS case study on Arunavati River in Shirpur City by Total Station Survey", (2016). IJCIET , , Prof. Hemraj R Kumavat, Prof. Ganesh V Tapkire.
- [2] "Sustainable silt management in lower Kosi River , North Bihar ,India :Demand assessment ,Investment model and Socio economic development"(2023), Rajiv Sinha.
- [3] "Construction and Demolition waste management in India : A case study of Ahmedabad city"(2017), Soumen Maity, Pankaj, Pankaj Phulwari ,Vaibhav Rathi.
- [4] "Quantitative Analysis of the drainage and morphometric characteristics of the Arunavati river basin ,using geospatial approach", JETIR ,Volume 15 ,2025, Dr. Bhagwan Girase, Dr. Rupesh Deore
- [5] "Use of Construction and Demolition waste material for stabilization"(2024), Md Hamjala Alam ,Tanmoy Mondal ,Tarun Dev, Arijit Banerjee, Chanchal Das.

- [6] “Assessing the influence of construction and demolition waste materials on workability and mechanical properties of concrete using statistical analysis”,
Building Pathology and Rehabilitation ,(2019),Raffat Siddique and Dilpreet Kaur
- [7] “Soil Stabilization Using C&D Waste for pavement construction”,(2023) , Ayushi Gupta , Anshika Singh , Sachin Kumar,Shalu Shukla,Yash Keshari.
- [8] “Utilization of recycled C&D waste in Backfill Soil”,(2022),Geosynthetics and Ground Engineering , Apurv Kumar Prajapati,Hasan Rangwala.
- [9] “Demarcation of ground water potential zones of Arunavati river basin ,using remote sensing and GIS techniques” ,(2025) , IJIRMF , Dr. Rupesh R. Deore , Mr.Suresh B.Valvi , Mr.Lalsing M. Valvi.
- [10] Remote sensing for monitoring sedimentation in lakes in Maharashtra”, (2010), MERI , S.K.Kalvit , S.N.Kulkarni.
- [11] “Circular Economy of C&D waste :
[12] “A literature review on lessons , challenges and benefits” , (2021) , Dhafer M.Al Zalayq , Mathew J.Kowalewski” , A.H. Tarighaleslami and Mostafa Seifan.
- [13] “Geographical analysis of literacy in Dhule district”(2015) , Golden Research Thoughts ,
- [14] “Sediment Yield Modelling of Kal River in Maharashtra Using Artificial Neural Network Model” , (2015) ,Gharde K.D.,M.Kothari,Mittal H.K. Singh P.K.,and Dahiphale P.A.
- [15] “Application of COIR GEO TEXTILE in erosion control measures at Shirpur”, (2022), IRJMETS , D.M.Patil ,Tejas D.Sonawne , L.S.Mahajan , Md Adnan Parkote , Mr.Nitin
- [16] “Use of recycled construction and demolition waste as substrate constructed in wetlands for the wastewater treatment of cheese production”,Environmental Management,(2024),Dimitra Kotsia,T.S.Eleftheria,M.S.Fountoulakis.
- [17] “New Approach of using C&D Waste “,IJSR,C.Mathi Raja,V.A.Shanmugavelu , P.Lenin
- [18] “ Morphotectonic analysis of Arunawati drainage basin”IJGGE 2024 ; 196-199, Researchr , S.P.D.M.ACS College,Shirpur,Dhule.