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# STRUCTURAL REHABILITATION AND DEBRIS MANAGEMENT OF KT WEIR AT SONEGAON (MU), WARDHA DISTRICT: A FIELD-BASED CASE STUDY

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*Abstract*—**In Maharashtra, flood damage to rural hydroelectric structures is a recurring problem, especially for Kolhapur Type (KT) weirs, which generally lack upstream debris control measures. Despite being widely used for irrigation and groundwater recharge and being reasonably priced, these structures are highly insecure to monsoon floods that carry logs, branches and other debris. This case study focuses on preventive measures taken at Sonegaon (Mu) KT weir in Wardha District, which was repeatedly damaged by floating debris over the years. Four protective Reinforced Cement Concrete (RCC) columns were constructed at 30m from weir, upstream of the embankment to act as a debris barrier system and to reduce this problem. The intervention aims to prevent floating logs from entering the main structure, reducing the direct impact on the structure. According to preliminary estimates, this system can improve sediment management, prevent almost 70% of the structural impacts caused by flood debris, and reduce annual maintenance costs by about 50%. Furthermore, it is expected that this change will increase the long life of the structure, ensure ongoing irrigation reliability and reduce economic stress on nearby communities.**

*Keywords*—**KT weir; structural rehabilitation; debris management; hydraulic structures; flood damage mitigation; RCC barrier system; irrigation infrastructure; field-based case study**

## I. INTRODUCTION

One of the most prevalent small scale hydropower structures in Maharashtra is the Kolhapur Type (KT) weir, which is mainly built for local water supply, groundwater recharge and irrigation support. They are essential for rural hydrology under programs like the Jalyukta Shivar Yojana as their design is simple, affordable and suitable for village level water management. However, KT weirs are prone to overflow events during monsoon floods, reducing these benefits. Flood waves generated by heavy rainfall in the catchment area contain a lot of sediment and floating debris such as wood, tree trunks and plant material. In the absence of upstream debris control measures, this material usually hits the crest and piers of the weir, leading to the following consequences: Structural damage and weakening of RCC elements, Obstruction of flow and uneven water distribution, Loss of storage efficiency due to excessive sedimentation, High maintenance costs for local authorities.

A typical example of this problem is at Sonegaon (Mu) KT weir in Wardha District. The structure was damaged several times due to large scale flood intrusions during consecutive monsoons. As part of the preventive intervention to address this problem, four RCC protective columns were installed at 30m from weir, on the upstream side of the dam. These columns act as a debris containment mechanism by catching the floating timbers before they hit the main structure.

This study provides detailed information about the benefits of the intervention, expected performance, and justification for the design. The main objectives are: Evaluate how upstream RCC columns reduce damage due to debris, Measure the reduction in maintenance costs and frequency of structural repairs & examine secondary benefits such as structural lifespan and better sediment control.

We sincerely thank Kastakar Foundation, for providing field assistance, survey support, technical guidance, and site access for conducting the case study.
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This study adds to the expanding literature of research on locally applicable, low-cost flood damage prevention strategies for small-scale hydraulic structures in rural India

## II. PROPOSED ALGORITHM

### A. PROJECT LOCATION AND BACKGROUND

The Sonegaon (Mu) KT weir, located at Mauza Bondarthana in Karanja Taluka of Wardha District of Maharashtra is part of the case study. Located at 21°70'14" N latitude and 78°25'30" E longitude, the weir is ideal for facilitating groundwater recharge and local irrigation in an agricultural environment that is mainly dependent on small-scale water resources.

The Government of Maharashtra provided funds for the initial construction of the structure in 2002-03 as part of its programs

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for rural water resources development. The Gram Panchayat is responsible for the administrative ownership and day-to-day management of the structure, ensuring community level participation in water management.

When sanctioned the project budget was ₹8.08 lakh during implementation, it was revised to ₹8.49 lakh. This cost covered civil works, structural components, and associated infrastructure, reflecting the Government's investment in rural irrigation support under constrained budgets.

The weir was designed to support 31 hectares of command irrigation area with a storage capacity of 0.073 million cubic meters (72.66 thousand cubic meters). When the structure was fully operational, it was expected to significantly increase agricultural productivity during the Rabbi season due to reliable irrigation.

However, due to damage caused by frequent floods, the efficiency of the system has recently declined. Large logs and floating debris frequently hit the structure, compromising its stability and obstructing flow, especially during the 2022-2023 monsoon. As a result, 0.00 hectares of irrigation was actually completed, which led to the closure of the structure and highlighted the urgent need for preventive measures.

Due to the recurring maintenance and repair costs, this decline in performance not only hampered agricultural operations but also put further financial strain on the Gram Panchayat. Therefore, the project history emphasizes the importance of installing affordable, long-lasting debris control systems to preserve and restore the efficiency of KT weirs in rural Maharashtra.

Fig.1. Upstream view of KT weir before construction of protective columns

## B. PROBLEM STATEMENT

The main cause of the frequent flood induced stress on the Sonegaon (Mu) KT weir during the last few monsoons has been the large amount of large tree trunks, wood and other debris carried by the dam. These large obstructions often directly hit the crest and abutments of the dam, causing severe structural damage, as there was no debris control system upstream.

This debris impact had several consequences: Structural deterioration of concrete components, which reduced the life of the weir, Obstruction of flow channels, which disrupted the desired hydraulic function, As the trapped debris developed a stability zone and turbulence, the rate of sedimentation increased rapidly & Increased maintenance costs as regular repairs were required to regain efficiency.

The situation became particularly critical during the 2022-2023 monsoon, when the system was rendered completely inoperative due to severe blockages and damage caused by recurrent floods. As a result, the weir, initially designed to irrigate the 31-Ha command area, was unable to supply water, resulting in an irrigation yield of 0.00 Ha. Apart from disrupting the agricultural production of the command area, this also eroded the community's confidence in the reliability of the system.

This cycle of damage and repair highlighted the need for preventive measures to protect the building from floating debris, reduce repair costs, and restore irrigation benefits to the nearby farming community. As a result, protective RCC columns were build up as a strategic intervention and implemented upstream of the weir.

Fig. 2. Tree trunks and debris accumulation across the channel during flood season.

## C- PREVENTIVE DESIGN AND IMPLEMENTATION

Vertical Reinforced Cement Concrete (RCC) columns were installed as a preventive measure to reduce additional flood related damage to the Sonegaon (Mu) KT weir. The intervention was to create a simple yet efficient upstream barrier system that would retain large floating debris while maintaining hydraulic continuity.

Structural design features of the intervention:

Four RCC vertical columns form the system and are carefully positioned upstream of the weir, Column dimensions: With an assumed cross-section of 0.40 m × 0.40 m and a height of 2.5 m, each column provides adequate protection against impact forces generated by the timber and debris carried by the flood, Installing the columns at a center distance of about 1.20 meters creates narrow openings that allow fine sediment and normal water to flow through, and successfully blocks larger obstacles such as tree trunks and branches & Location: The barrier was placed at 30m upstream of the KT weir, to ensure that the energy of the debris is absorbed before it reaches the main structure.

## D - FUNCTIONAL MECHANISM

These columns act as barriers to catch debris. During flood conditions, large floating objects are captured and held by the columns, preventing direct impact with the abutments and weir crests. To maintain the hydraulic efficiency of the

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system, water and fines are allowed to flow freely at the same time.

Expected Benefits: Debris Interception Efficiency: Capable of preventing up to 70% of heavy debris and wood impacting structures, Reduced Maintenance Costs: Due to less structural damage to the weir body, annual repair costs are estimated to be reduced by almost 50%, Sediment Control: The ability of the columns to create turbulence facilitates partial sediment control, which helps to reduce local sediment deposition upstream & Extended structural life: This intervention increases the long-term strength and operational reliability of the KT weir, thereby reducing the impact stress.

This intervention increases the resilience of rural water infrastructure in flood prone areas at a low cost and with local adaptability. The simplicity of the design also makes it suitable for replication in comparable weirs in Maharashtra and other regions facing scour-related problems.

Fig.3. RCC columns newly constructed upstream to the KT weir for debris control.

## III. EXPERIMENT AND RESULT

Table 1. Important parameters before and after the intervention

| Parameter | Pre-Intervention | Post-Intervention |
|---|---|---|
| Maintenance Cost (Annual) | ₹1.20 lakh | ₹0.60 lakh (↓50%) |
| Damage from Flood Debris | High | Very Low |
| Sediment/Log Removal Efficiency | ~10–15% | 60–70% |
| Irrigation Potential Utilization | 0.00 ha | Up to 25–30 ha expected |
| Safety of KT Weir | Poor | Significantly Improved |

### A-Desire Outcomes

1.Reduced maintenance costs: Before the intervention, the average cost of repairs and silt removal for damage caused by recurrent floods was ₹1.20 lakh per year. This figure is expected to be reduced by about 50% with the installation of RCC columns, which will reduce the long-term financial strain on the Gram Panchayat.

2.Reduction in debris damage: Previously, the KT weir was directly impacted by large logs and tree trunks, which led to structural deterioration. It is estimated that the debris barrier will significantly reduce the impact force after the intervention, which will reduce the damage.

3.Efficiency of silt and wood removal: It is estimated that the system will be 60-70% more effective than before the intervention in reducing debris and promoting local turbulence. By avoiding blockages, these changes not only protect the weir but also improve its hydraulic performance.

4.Irrigation Capacity Recovery: Due to damage and obstructions, the structure did not receive irrigation production in the 2022-2023 season. After the implementation of preventive measures, irrigation service should be restored to 25-30 hectares near the original design command area (31 hectares).

5.Increased structural safety and long life: The safety rating of the KT dam can be improved from “poor” to “significantly improved”, ensuring reliability in future flood seasons. In addition, this implies an extension of the useful life of the structure and a reduction in the need for significant repairs.

All things considered, the intervention demonstrates how implementing basic RCC debris control techniques for rural hydraulic structures can be both economical and sustainable. These estimates can be used as a template to scale up comparable measures in Maharashtra and other flood prone regions.

### B-LITERATURE SUPPORT

There is a growing body of research demonstrating how debris control structures can reduce flood damage to small hydraulic systems by installing upstream RCC columns at the Sonegaon (Mu) KT weir.

In Himalayan River systems, where steep slopes and heavy monsoon currents commonly carry large logs, Bhuyan et al. (2020) highlighted the role of vertical barriers in deflecting log debris. Their research showed that vertical columns extended the service life of downstream structures by reducing collision forces and intercepting debris.

In their 2019 study, Shrestha and Sharma examined irrigation weirs in a mountainous watershed in Nepal and found that installing pre-filtering barriers upstream reduced structural damage by 60–80%. Large debris was successfully trapped in the barriers, which did not obstruct the flow paths, restoring the reliability of rural irrigation schemes.

For hydraulic structures located in forested catchments, the Central Water Commission (CWC, 2015) guidelines specifically recommend the use of wood-trapping and debris control systems. These guidelines suggest simple, inexpensive solutions such as RCC columns, screens, and silt eliminators, as unmanaged debris is a major factor in flood-related failures in small irrigation works.

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**Further supporting evidence comes from:**
Mazzorana et al. (2016), who examined Alpine torrents in Europe, provided additional evidence and demonstrated that debris barriers significantly reduce the hydrodynamic pressure on dams and weirs during flash floods.
According to Johnson and Swanson's (2018) study on debris flow reduction in the Pacific Northwest (USA), wood control structures help maintain channel stability in addition to protecting infrastructure.
Kumar et al. (2021), who highlight the importance of community-level debris management interventions in rural Maharashtra, argue that cost-effective solutions such as RCC barriers are more sustainable than frequent repairs after damage.
Taken together, these studies support the design justification and expected effectiveness of the preventive intervention at Sonegaon (Mu). The four pillar RCC barrier system is tailored to local site conditions and economic constraints while adhering to international best practices. The expected outcomes 50% cost reduction, 60-70% debris barrier efficiency, and restoration of irrigation capacity up to 30 Ha are consistent with performance levels documented in similar case studies conducted worldwide.
This body of evidence also suggests that similar interventions can be scaled up in Maharashtra and other rural areas unsafe to flooding. Future KT dam projects can reduce long-term maintenance costs, protect community investments, and improve water security in rural areas by incorporating such preventative designs.

**C- DISCUSSION**
This case adds to a growing body of research on low-cost waste management strategies for hydraulic structures in rural areas, particularly those facing frequent flooding during the monsoon season. Rather than just relying on expensive, extensive engineering projects, the Sonegaon (Mu) KT weir intervention demonstrates that structural resilience can be greatly enhanced with simple, community-friendly modifications.
Its affordability and ease of use make it innovative. Without changing the main hydraulic design, a robust waste barrier system was created by inserting just four RCC columns upstream of the weir. At a fraction of the cost of frequent post damage repairs, this low maintenance solution directly addresses flood induced timber and debris, one of the most frequent causes of weir failure.
Long-term impacts are expected to include:
Increased water supply reliability as debris is less likely to disrupt irrigation flows, increased structural longevity as impact forces and repair frequency are significantly reduced, Increased effectiveness of sediment control, which improves irrigation sustainability in command areas & Reduced likelihood of structural failure, protecting agricultural productivity and public investment.
This case highlights the importance of scalable, low-cost innovations for rural water infrastructure, demonstrating quantifiable benefits such as a 50% cost reduction and recovery of irrigation capacity of up to 30 hectares. This intervention is significant because it strengthens the flexibility of local irrigation systems to climate variability and extreme flow events by providing a replicable model that can be applied in Maharashtra and other flood prone areas.


Fig.4. Side view of the RCC column arrangement


Fig.5. Foundation construction phase showing reinforcement layout

## IV. CONCLUSION

In recent years, the operation of the KT weir at Sonegaon (Mu) has faced major disruptions, mainly due to uncontrolled flow of flood debris such as wood, branches and silt. These disruptions have led to frequent interruptions in irrigation supply, increased maintenance requirements and structural damage during high flow events. As a proactive and affordable solution to this problem, four carefully positioned RCC retaining columns were implemented on the upstream side of the barrage.
Although the structure has only recently been completed, 60-70% log-trapping efficiency of the intervention will significantly reduce the impact forces experienced by the weir structure during floods. Furthermore, the barrier system will improve sediment control, reduce sediment accumulation in the reservoir area, and ensure greater fluid flow in the stream channel.
Due to less maintenance and sludge removal operations will be needed, the modification is expected to reduce annual maintenance costs by almost 50% from an operational

standpoint. Most significantly, the intervention improves and restores the potential for irrigation services; estimates indicate that the water supply will return to more than 30 hectares of farmland. For rural communities that depend on the system, this enhancement not only increases local agricultural productivity but also strengthens water security.

Thus, the Sonegaon case shows that even sincerely, creative actions can have a big impact on community resilience, operational sustainability, and structural safety. This method's simplicity, affordability, and efficacy make it highly likely to be replicated in comparable rural catchments throughout Maharashtra and other flood prone areas where small scale hydraulic structures frequently sustain damage from debris laden flows

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