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Design and Implementation of a Smart Sustainable of Urban Drainage System

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Abstract: Urban waterlogging has become one of the most visible problems in fast-growing Indian towns, and Badlapur East is no exception. Every monsoon season, Ghorpade Chowk — a busy mixed-use junction in the heart of Badlapur East — gets flooded, traffic slows to a crawl, and residents are left wading through standing water. The root cause is not hard to identify: the town has grown much faster than its drainage infrastructure, and the existing roadside drains simply cannot handle the runoff that the now heavily built-up catchment generates.

This project set out to design a practical solution for that specific problem. We focused on a 0.3-hectare catchment draining to Ghorpade Chowk and applied the SCS Curve Number method to estimate how much stormwater runoff it produces during a design storm. With a weighted Curve Number of 91 — reflecting the fact that 75% of the catchment is impervious — a 10-year return period storm of 65 mm/hr intensity generates a peak discharge of 0.039 m^3/s. The existing drains can carry roughly 0.015 to 0.020 m^3/s at best, which means the incoming flow is about twice what they can handle. That gap is precisely why flooding happens.

To close that gap, we designed a treatment train of four Sustainable Urban Drainage System (SUDS) components: an infiltration trench along the road shoulder, rain gardens at the junction corner spaces, permeable pavement for the parking bays and footpaths, and a small detention tankat the downstream end of the catchment. Together, these four components provide 127 m^3 of combined storage — exactly matching the design runoff volume. When arranged sequentially, they reduce the peak discharge by 67%, from 0.039 m^3/s down to 0.013 m^3/s. At that level, the existing drains can cope without overflowing

Keywords: Sustainable Urban Drainage Systems, SCS Curve Number, Rational Method, Stormwater Management, Urban Flooding, Permeable Pavement, Infiltration Trench, Detention Pond, IoT Monitoring, Badlapur.

I. INTRODUCTION

A. General Background

If you have spent a monsoon season in any fast-growing Indian suburban town, you will recognise the scene: roads disappear under knee-deep water, vehicles stall, and residents pick their way through flooded streets carrying footwear in hand. It happens year after year in the same locations, and yet the problem rarely seems to get fixed. Badlapur is one such town, and Ghorpade Chowk is one such location.

The reason this keeps happening is well understood, even if the solution is harder to implement. When land that was once fields, trees, and open soil gets covered with roads, buildings, and paving stones, rain that used to sink into the ground has nowhere to go except the surface. It rushes toward the lowest point, which is usually the nearest drain. Those drains were designed for a smaller, less developed version of the town, and they cannot cope with what the catchment now sends them. The result is flooding.

Conventional drainage engineering tries to solve this by making the pipes bigger or the channels wider. That approach has its place, but in a dense urban setting like Ghorpade Chowk, where every square metre is occupied by a road, a building, or a footpath, there is simply no room to widen anything without expensive land acquisition. A different approach is needed.Sustainable Urban Drainage Systems — SUDS — take that different approach. Instead of rushing water away faster, SUDS slow it down, store it temporarily, and give it a chance to soak back into the ground. Components like permeable pavements, rain gardens, infiltration trenches, and detention ponds each play a role in managing stormwater closer to where it lands, mimicking how natural drainage used to work before the town was built. The concept has been in use in the United Kingdom and Australia since the 1990s and is now gaining policy traction in India through frameworks like IS 15797 and the Smart Cities Mission.

B. About Badlapur and the Study Site

Badlapur lies roughly 57 km east of Mumbai on the Central Railway mainline, at the base of the Western Ghats. Affordable land and good rail access have made it one of the most rapidly urbanising towns in the Mumbai Metropolitan Region over the past two decades.

The population has grown from about 1.2 lakh in 2001 to over 4.5 lakh in 2024. Satellite imagery from NRSC shows that the impervious surface cover in Badlapur East increased from 31% in 2010 to 58% in 2022 — nearly double in just twelve years.

The town also receives intense monsoon rainfall. Historical IMD records show that Badlapur recorded as much as 273 mm of rain in a single day — the highest one-day total ever recorded in Thane district. Almost all of this falls within the June-to-September monsoon window. The combination of rapidly expanding impervious cover, high rainfall intensity, and drainage infrastructure that has not kept pace creates exactly the conditions for the flooding that residents experience every year.

The specific study site is Ghorpade Chowk, a busy junction in Badlapur East surrounded by shops, residences, and narrow streets. The contributing catchment has an area of approximately 0.3 ha (3,000 m²). The soil is predominantly lateritic, typical of the Western Ghats foothills, with moderate infiltration capacity.

C. Objective of Project

The primary objective of this project is to design and implement a Smart Sustainable Urban Drainage System (SuDS) aimed at improving urban stormwater management through sustainable and technology driven approaches. The specific objectives include:

- To design a sustainable urban drainage system (SUDS) that effectively manages stormwater runoff
- To reduce urban flooding and surface water pollution by implementing sustainable drainage components.
- To promote groundwater recharge and improve water quality through natural filtration and infiltration techniques.
- To design components such asinfiltration trenches, rain garden, permeable pavement and detention tanks for effective stormwater management.

II. LITERATURE SURVEY

A. Global Understanding of SUDS Performance

Before beginning the design work, we spent considerable time reviewing published research on SUDS performance, hydrological methods, and case studies from comparable urban contexts. Srishantha and Rathnayake (2017) found that peak flow reductions consistently fall in the range of 40-70%, depending on component type, climate, and catchment characteristics. Importantly for our work, they also confirmed that the SCS Curve Number and Rational Methods give reliable results in data-limited environments. Hellberg (2020) studied five SUDS case studies across Nordic countries. The answer, perhaps unsurprisingly, is that the technical design matters less than the maintenance plan and community support. Furthermore, Oladunjoye (2021) conducted a 10-year cost-benefit appraisal; the conclusion was clear: when you account for flood damage prevention, water quality improvement, and long-term maintenance savings, SUDS schemes more than justify their upfront cost

B. India and Developing Country Context

The most directly useful study for our project was by Gaurkhede and Adane (2024), who designed a SUDS scheme for Nagpur, Maharashtra. Their results showed 60-72% peak flow reductions using detention storage in public parks combined with permeable surfaces along commercial streets, achieved without any land acquisition. Febriana and Hor (2025) looked at a tropical MRT development site where permeable pavements and bioretention areas were incorporated into 30% of the developed area without any additional land being needed. They found this was enough to substantially reduce flooding and cut total suspended solids by around 45%. Additionally, Ortega Sandoval (2023) modelled 24 SUDS scenarios for a dense, flood-prone catchment in Bogotá, Colombia. SUDS reduced flooding by 55-68% in their scenarios, and the simplified 1D modelling gave results comparable to more complex coupled models for catchments of this size.

C. IoT in Drainage Monitoring & Hydrological analysis

Zeng, Pang, and Tang (2024) reviewed 73 published studies on IoT applications in smart city infrastructure and found that IoT-enabled drainage monitoring reduces operational and maintenance costs by 20-35% by shifting from fixed-schedule inspections to condition-based responses. Webber et al. (2022) built on this by developing a practical framework for IoT-based stormwater monitoring, including sensor type recommendations and placement guidance that we drew on directly. For the SCS Curve Number methodology, Tailor and Shrimali (2016) provided solid validation in an Indian context. Their GIS-based study of a Gujarat watershed confirmed that the method performs well for Indian soils and urban land cover.

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For the SCS Curve Number methodology, Tailor and Shrimali (2016) provided solid validation in an Indian context. Their GIS-based study of a Gujarat watershed confirmed that the method performs well for Indian soils and urban land cover, and their CN lookup tables for Hydrologic Soil Group B — which corresponds to the lateritic soils at our site — are the source for the values we used.

III. PROBLEM STATEMENT

As more of the land around the junction gets covered by buildings and pavement, more rainfall becomes immediate surface runoff — and the drains that were originally built to serve a much smaller town cannot keep up. What makes this particular site difficult to fix through conventional means is the lack of space. The junction is tightly surrounded by buildings, roads, and utilities. There is no room to widen the drains or build new ones without demolishing structures or relocating services, which would be both expensive and disruptive. Whatever solution we propose has to work within the footprint that already exists.

A. *Specific Challenges Identified*

1) High runoff volume: The catchment is 75% impervious with a weighted CN of 91. A 10-year storm produces 127 m³ of runoff — roughly twice what the drains can carry.
2) Undersized drains: The roadside drains at Ghorpade Chowk are approximately 200 mm wide and 150 mm deep, with a hydraulic capacity of about 0.015–0.020 m³/s. The design peak discharge is 0.039 m³/s.
3) No space for conventional solutions: The junction is fully built up. Drain widening would require land acquisition that is not available here.
4) Poor maintenance: Silt, debris, and broken drain covers regularly block flow during heavy rain, reducing effective capacity further.
5) No monitoring: There is no data on flow rates or water levels during storm events. Maintenance is entirely reactive.
6) Limited site data: No site-specific IDF curve exists for Badlapur East, and detailed topographic survey data was not available. Secondary IMD data was used throughout.

B. *Research Questions*

1) Can four SUDS components, retrofitted within the existing road layout, reduce peak discharge by at least 60% so that flow stays within the capacity of the existing drains?
2) Is it possible to fit all four components into the constrained Ghorpade Chowk site without any land acquisition or major utility relocation?
3) Does the Smart SUDS scheme represent better value than conventional drain upgrading when lifecycle costs and environmental benefits are both considered?
4) Can an IoT monitoring system be installed and maintained within a realistic suburban municipal budget?

IV. STUDY AREA AND SITE EVALUATION

A. Site Description

Ghorpade Chowk is a junction that most residents of Badlapur East pass through daily. It is surrounded by small shops, residential buildings, and the kind of informal commercial activity that characterises dense suburban Maharashtra. The roads are narrow and heavily trafficked by both vehicles and pedestrians throughout the day. Almost every surface around the junction is either bituminous road, concrete footpath, or building rooftop — there is essentially no vegetation or open soil anywhere nearby.

We delineated the contributing catchment using Google Maps satellite imagery along with field observation of road gradients, drain directions, and natural low points. The total area that drains toward the junction is approximately 0.3 ha (3,000 m^2). The soil at the site is predominantly lateritic — which is typical of Badlapur given its location at the foot of the Western Ghats — and falls under Hydrologic Soil Group B in the SCS classification, meaning it has moderate infiltration capacity when in good condition.

B. What We Found at the Site

We visited the site during and after monsoon showers in 2024 and also spoke to shopkeepers and residents in the area. The experience was consistent with what they had been dealing with for years: even during moderate rain, water collects quickly at the junction corners and along the lower sections of the carriageway. It doesn't drain away quickly either — ponding persists for some time after rain stops, long enough to be a genuine nuisance and traffic hazard.

The condition of the drains was a problem in itself. Several sections were clogged with accumulated silt and plastic waste. In some stretches, broken concrete slabs were sitting over the drain channel, trapping debris and making cleaning difficult. The drain alignment also changed direction sharply in a couple of places, creating points where flow slows down and sediment settles. During heavy rainfall, these conditions effectively reduce the already limited drain capacity to something even lower.

What struck us most was the absence of any green or permeable surface anywhere near the junction. Every bit of land is sealed. Rain that falls on this catchment becomes runoff within seconds — there is no interception by trees, no absorption by soil, no delay of any kind. The SUDS approach is well suited to this situation precisely because it creates that missing permeability and storage artificially, within the existing built environment.

V. HYDROLOGICAL ANALYSIS

A. Design Rainfall and Storm Selection

Badlapur does not have its own dedicated IMD observatory. We used data from the nearest station at Ambernath, supplemented by the standard Thane district design storm values published by IMD. In line with IS 15797 recommendations for urban drainage schemes of this scale in India, we selected a 10-year return period storm of 1-hour duration as the design event. This gives a design rainfall intensity of 65 mm/hr and a total rainfall depth of 65 mm for the design storm.

B. Land Use Mapping and Curve Number

Mapping the land use in the catchment from satellite imagery and field verification gave us the breakdown shown in Table 5.1. The catchment is dominated by impervious surfaces: bituminous roads account for 38% of the area, building rooftops for 25%, and paved concrete footpaths for another 12%. The remaining 25% is split between unpaved gravel margins and small patches of open ground. With the predominantly HSG-B lateritic soils at the site, this land use profile produces a weighted CN of 91.

C. SCS-CN Runoff Calculation

Using CN = 91 and a design storm depth P = 65 mm, the SCS-CN calculation proceeds as follows:

Maximum potential retention: $S = (25400 / 91) - 254 = 25.1$ mm

Initial abstraction (interception and early infiltration): $Ia = 0.2 \times S = 0.2 \times 25.1 = 5.0$ mm

Check for runoff: $P - Ia = 65.0 - 5.0 = 60.0$ mm, which is greater than zero, so runoff occurs.

Direct runoff depth: $Q = (60.0)^2 / (60.0 + 25.1) = 3600 / 85.1 = 42.3$ mm

Total runoff volume: $V = (42.3 / 1000) \times 3000\ m^2 = 127\ m^3$

To put this in perspective: 42.3 mm of runoff from 65 mm of rainfall means that 65% of every millimetre of rain falling on this catchment reaches the surface as runoff. In a natural catchment with the same soil but vegetated, that figure would be under 20%. The threefold difference represents the hydrological legacy of covering the land with impervious surfaces.

D. Peak Discharge — Rational Method

The weighted runoff coefficient, calculated from land use proportions and standard values for each surface type, is: C = (0.38 × 0.85) + (0.25 × 0.90) + (0.12 × 0.85) + (0.10 × 0.40) + (0.15 × 0.20) = 0.72

Peak discharge: Q_peak = (C × I × A) / 360 = (0.72 × 65 × 0.3) / 360 = 0.039 m³/s

The roadside drains at Ghorpade Chowk are approximately 200 mm wide and 150 mm deep. Applying Manning's equation with a roughness coefficient of n = 0.015 for concrete and an estimated longitudinal slope of 0.5%, these drains can carry approximately 0.015–0.020 m³/s when running half-full. The incoming design peak flow of 0.039 m³/s is therefore roughly double the drain capacity — a result that quantitatively confirms what residents already know from experience.

VI. SUDS COMPONENT DESIGN

With the hydrology established, we needed to design four components that together provide 127 m³ of storage — enough to hold all of the design runoff — while fitting within the physical constraints of the Ghorpade Chowk site. Each component occupies a different part of the site and serves a specific function in the treatment train.

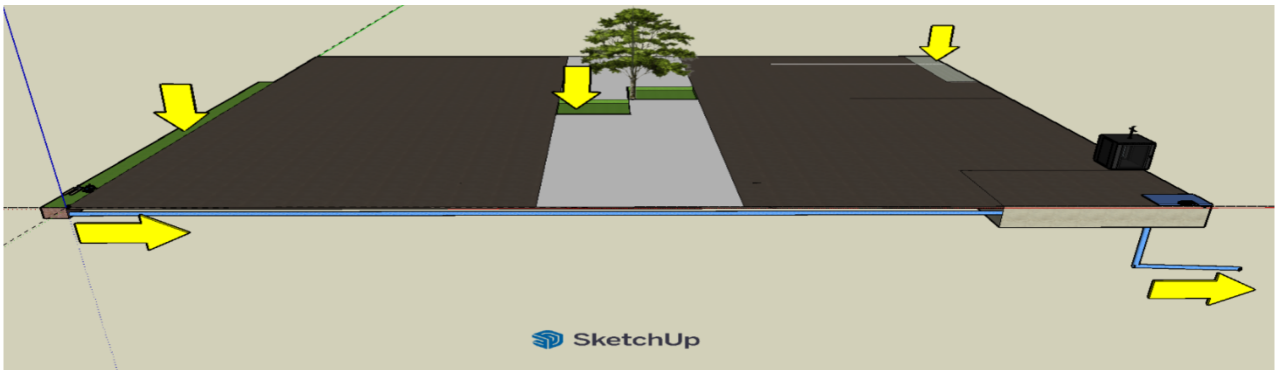

Fig 6 Smart Suds 3D Model

A. Infiltration Trench

We sized the trench at 40 m long, 1.2 m wide, and 1.0 m deep, with a gravel void ratio of 0.35. The gross excavated volume is 40 × 1.2 × 1.0 = 48.0 m³, giving an effective storage of 48.0 × 0.35 = 16.8 m³. With a 15% safety margin applied, the adopted storage is 20 m³. We also verified the drain-down time using Darcy's Law: with a hydraulic conductivity of 5.0×10^{-6} m/s for lateritic soil, the trench drains completely in 23.3 hours — well within the 24-hour requirement that ensures it is ready for the next storm event.

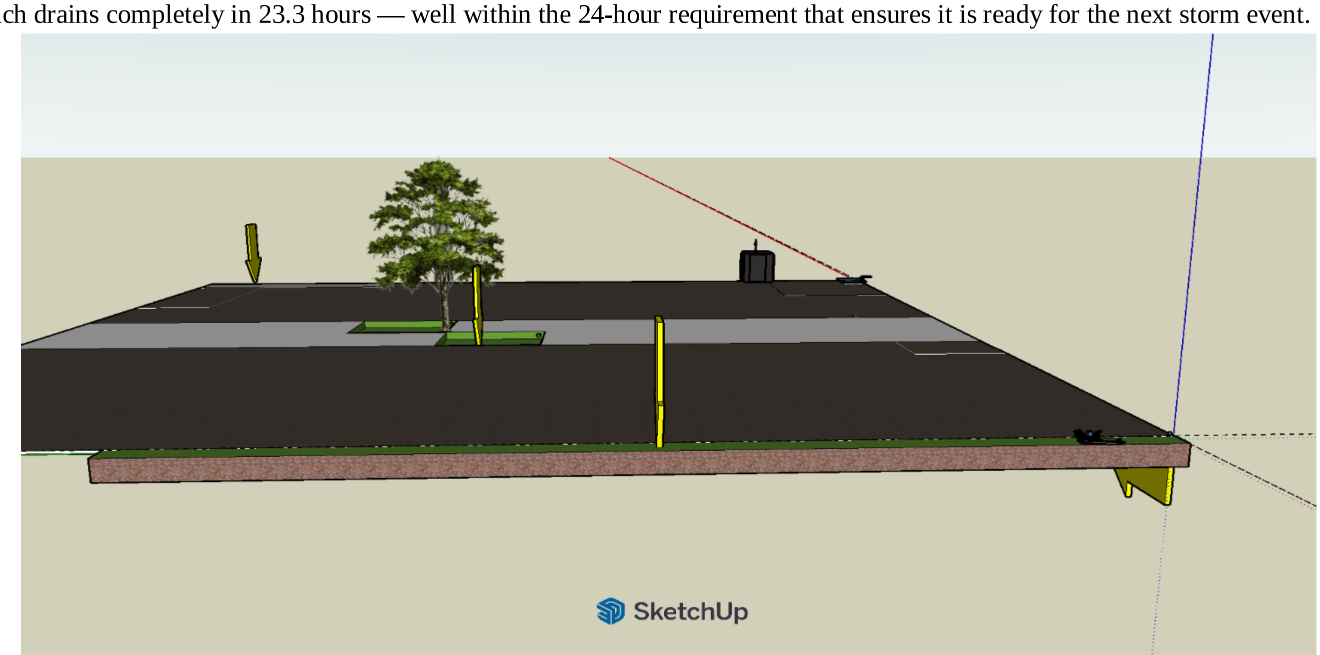

Fig 6.1 Infiltration Trench

B. Rain Gardens

The junction at Ghorpade Chowk has two unused, slightly depressed corner areas that currently just collect water with nowhere for it to go. These are ideal locations for rain gardens. We proposed two gardens totalling 60 m² of surface area. With a maximum surface ponding depth of 0.30 m and a filter soil layer of 0.50 m depth with a porosity of 0.35, the total storage is: surface ponding (60 × 0.30 = 18.0 m³) plus soil storage (60 × 0.50 × 0.35 = 10.5 m³) = 28.5 m³, rounded to 29 m³ adopted.

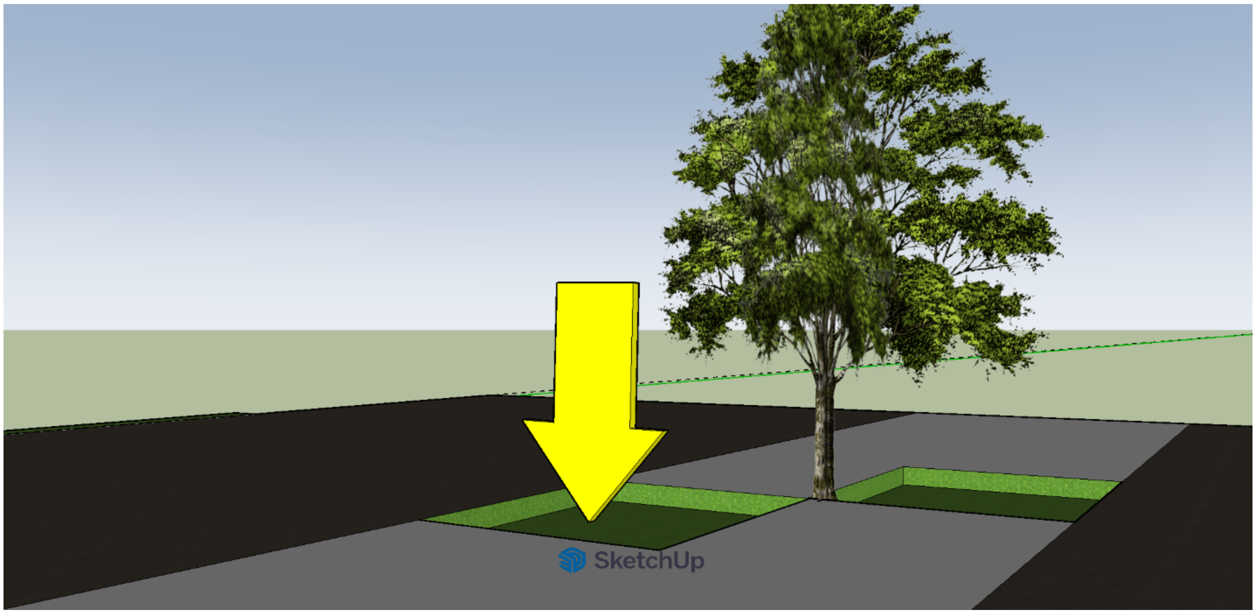

Fig 6.2 Rain Gardens

C. Permeable Pavement

The parking bays and footpaths around the junction are currently surfaced with conventional impervious concrete or bituminous material. We proposed replacing these with permeable interlocking concrete pavement (PICP). The surface looks much like regular paving, but rainfall passes through the joints between the pavers and into a granular sub-base layer below, where it is stored temporarily before infiltrating or draining slowly away. Permeable pavement is the most space-efficient SUDS component available because it converts existing impervious area to permeable without needing any additional land at all.

For 150 m² of pavement area with a 0.30 m sub-base depth and a void ratio of 0.38: storage = 150 × 0.30 × 0.38=17m³adopted.

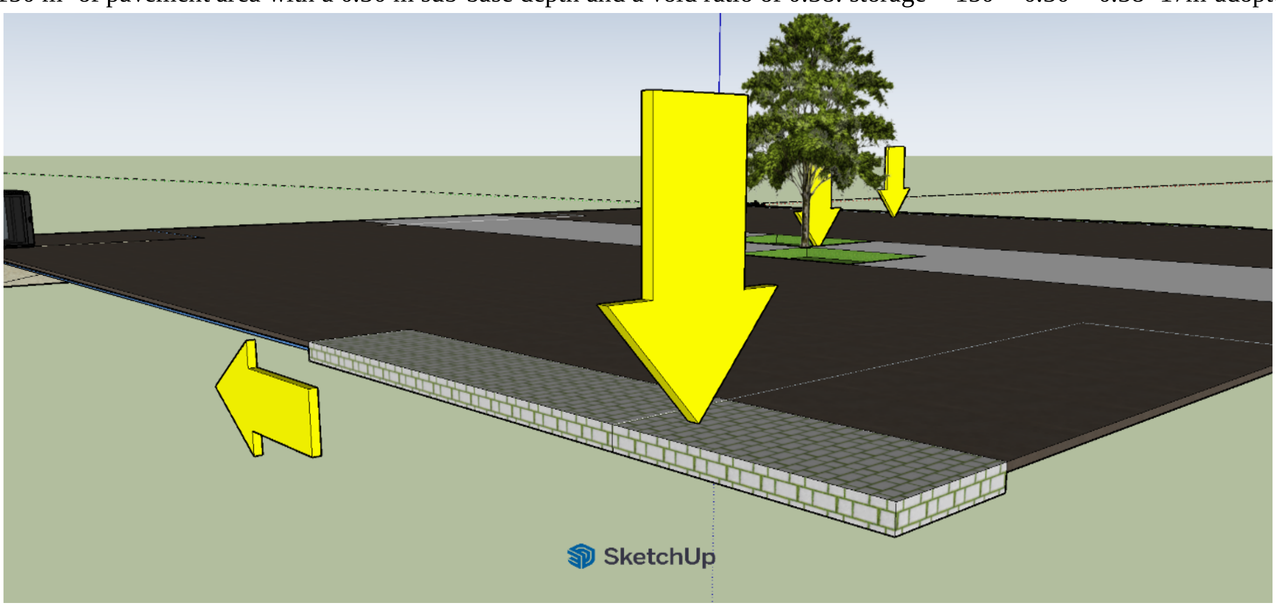

Fig 6.3 Permeable Pavement

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D. Detention Tank

At the downstream, low-lying end of the catchment, a natural depression already exists. We proposed formalising this into a small detention tank with a properly sized rectangular weir outlet. The tankacts as the final stage in the treatment train — it accepts whatever overflow reaches it from upstream and releases it slowly through the weir at a rate the existing drain downstream can handle. Unlike a retention pond, this one is designed to drain completely between storms (within 48 hours), so its full storage capacity is always available for the next event.

The tank is sized at 80 m² surface area with an average operating depth of 0.76 m and 0.30 m of freeboard, givingan active storage of 80 × 0.76 = 61 m³ adopted.The outflow structure is a 0.25 m wide rectangularwier.

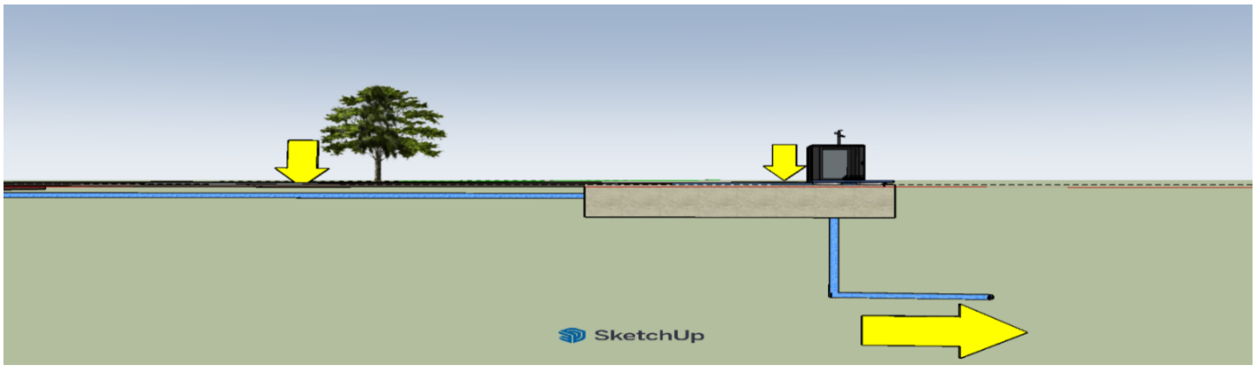


Fig 6.4 Detention Tank

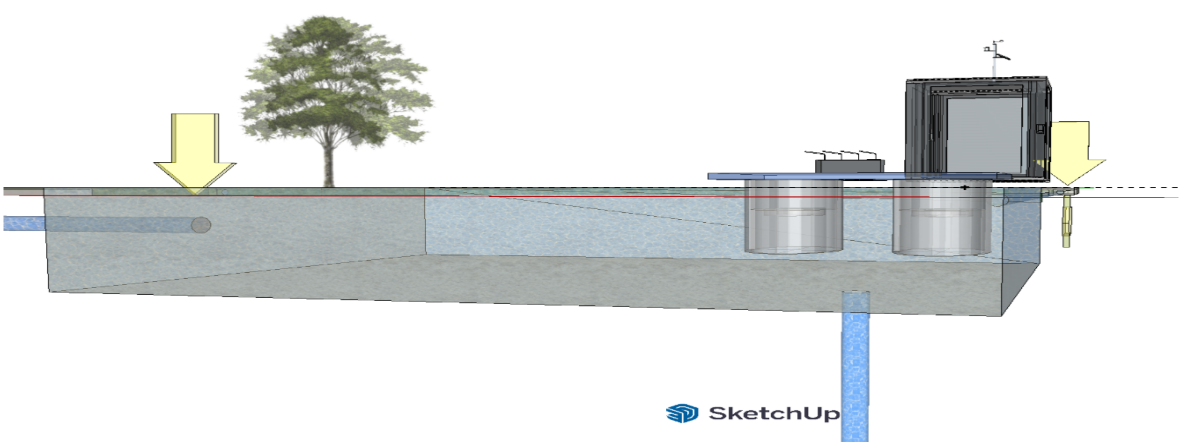
E. Treatment Train Arrangement and Total Storage

The components connect as follows: road runoff first hits the infiltration trench along the road shoulder. During very heavy rain, any overflow from the trench that cannot be absorbed fast enough passes to the rain gardens at the junction corners. The permeable pavement in the parking bays and footpath areas works in parallel with the rest, directly intercepting rainfall at those surfaces and preventing it from becoming runoff in the first place. Everything that reaches the downstream end of the catchment goes into the detention pond, which releases it gradually at a rate the drain can handle.

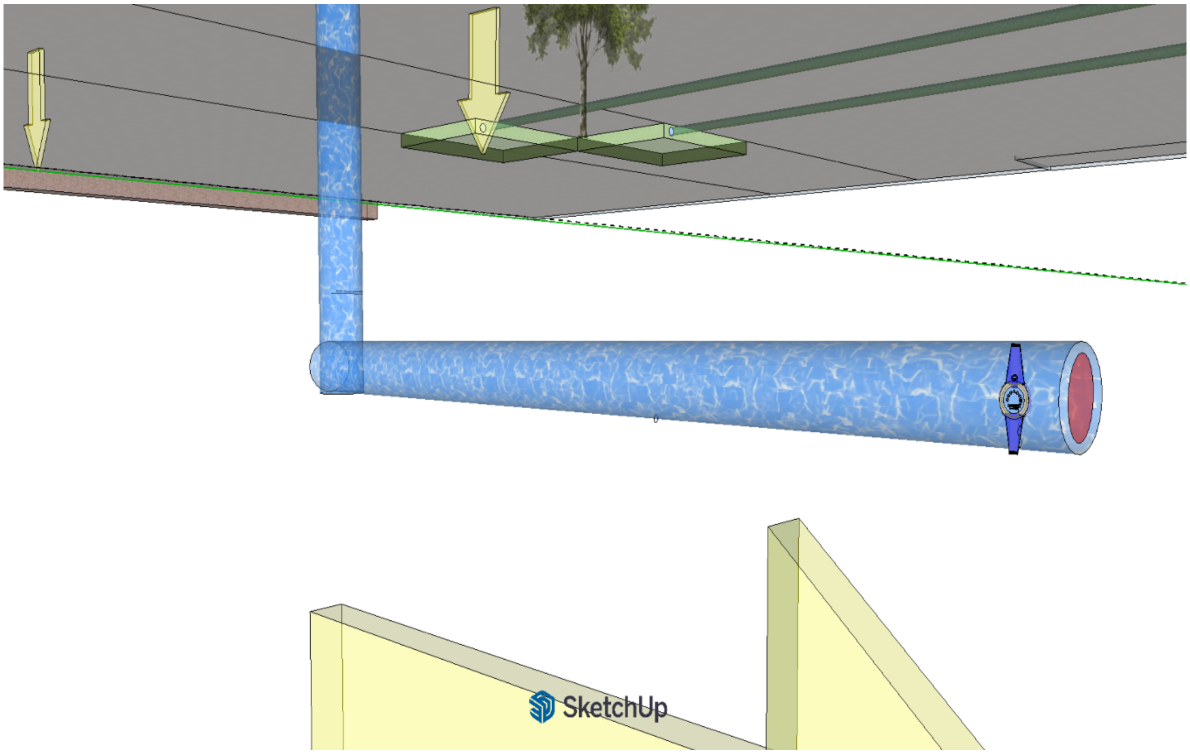
VII. IOT-BASED SMART MONITORING

One of the persistent problems with existing drainage in Badlapur is that nobody really knows how the system is performing until it fails. By the time someone notices a blocked drain or an overflowing channel, flooding has already happened. An IoT-based monitoring setup changes that. Sensors placed at key points in the drainage network feed continuous data on water levels, flow rates, and water quality to a central dashboard. Maintenance can then be triggered by what the data actually shows — a drain that's filling up unexpectedly — rather than on a rigid schedule that may not match actual conditions.For this scheme, we proposed four types of sensors placed at strategic locations:

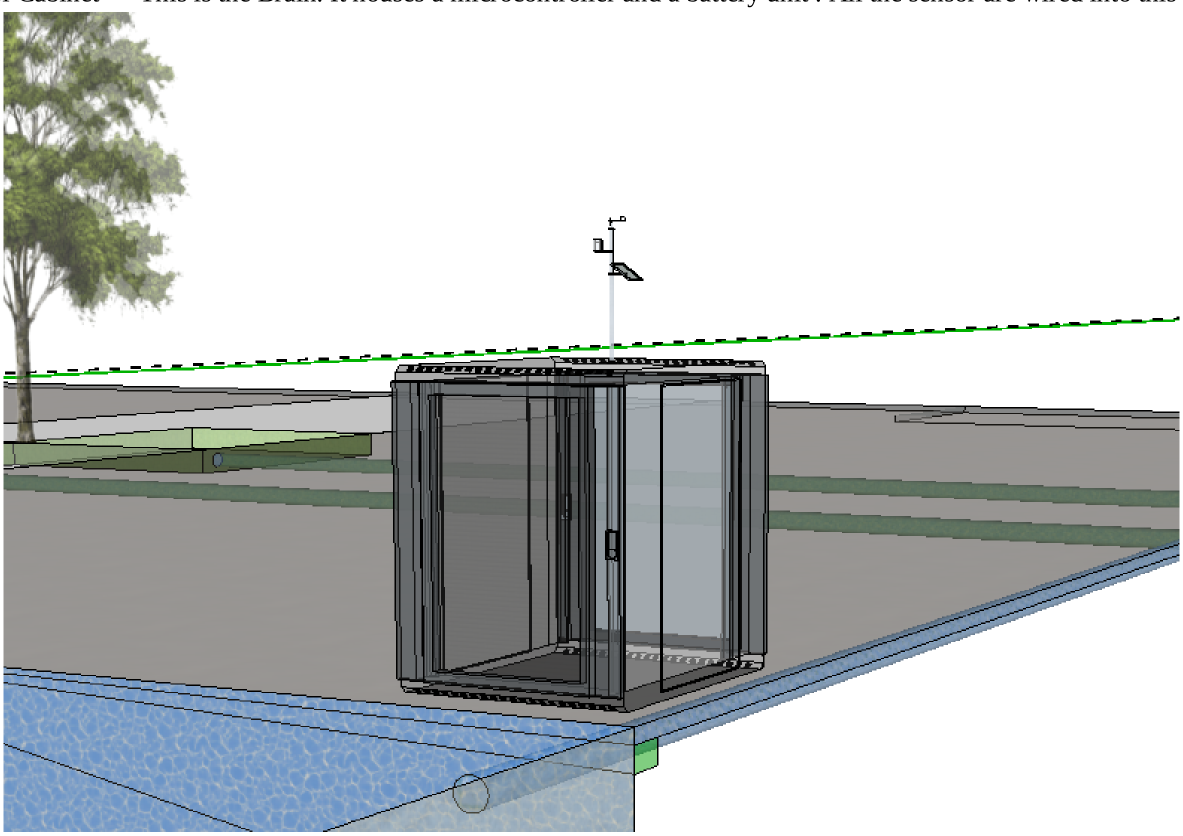
1) Ultrasonic water-level sensors — installed in the detention tankand at one point in the infiltration trench. These track storage levels in real time and alert maintenance staff if levels approach the design maximum during a storm.



2) Electromagnetic flow meters — placed at the inlet and outlet of the detention tankto record actual inflow and outflow rates during storm events. Over time, this builds a dataset to verify design assumptions and refine the model.



3) Control Cabinet — This is the Brain. It houses a microcontroller and a battery unit . All the sensor are wired into this box.



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VIII. RESULTS AND PERFORMANCE EVALUATION

A. Sequential Treatment Train

When the four components work together in sequence — each acting on the flow remaining after the previous one — the combined reduction in peak discharge is substantial. The percentage reductions applied to each stage are based on published performance data from comparable SUDS schemes in India and other developing-country urban contexts (Gaurkhede and Adane 2024; Srishantha and Rathnayake 2017; Ortega Sandoval 2023).

Table 8.1: Sequential Peak Flow Reduction Through SUDS Treatment Train

Stage	Component	Reduction (%)	Calculation	Remaining Flow (m^3/s)
0	Before SUDS	—	—	0.039
1	Infiltration Trench	22%	0.039 × 0.78	0.030
2	Rain Garden	20%	0.030 × 0.80	0.024
3	Permeable Pavement	28%	0.024 × 0.72	0.017
4	Detention Pond	25%	0.017 × 0.75	0.013
Final	After SUDS	67% overall	—	0.013

Overall peak flow reduction = $[(0.039 – 0.013) / 0.039] \times 100 = 66.7\% \approx 67\%$. The post-SUDS peak discharge of 0.013 m^3/s is well within the estimated capacity of the existing roadside drains (0.015–0.020 m^3/s), confirming that the proposed scheme will effectively eliminate waterlogging at the junction for the 10-year design storm.

B. Before and After Hydrological Comparison

Table 8.2: Before and After Smart SUDS Performance Comparison

Parameter	Before SUDS	After SUDS
Design Rainfall	65 mm	65 mm
Weighted CN Value	91	91 (unchanged)
Runoff Depth (Q)	42.3 mm	~14.4 mm
Total Runoff Volume	127 m^3	~43 m^3
Peak Discharge	0.039 m^3/s	0.013 m^3/s
Peak Flow Reduction	—	67%
Drain Capacity Status	Exceeded (×2)	Within capacity
Groundwater Recharge	Negligible	Significant
Waterlogging Outcome	Recurrent flooding	Eliminated for 10-yr storm

C. Cost Analysis and Maintenance

The total estimated construction cost is approximately ₹8.5 lakhs, distributed as follows: infiltration trench ₹1.2 lakhs, rain gardens ₹1.5 lakhs, permeable pavement ₹3.0 lakhs, detention tank₹1.5 lakhs, and IoT monitoring system ₹1.3 lakhs.

Table 8.3: SUDS Annual Maintenance Schedule and Cost Estimate

Component	Maintenance Activity	Frequency	Annual Cost (₹)
Infiltration Trench	Remove surface sediment;	Quarterly check;	5,000

Component	Maintenance Activity	Frequency	Annual Cost (₹)
	check geotextile; replace gravel if permeability reduced	desilting annually	
Rain Garden	Weed removal; replace dead plants; check overflow outlet	Fortnightly weeding; annual replanting	8,000
Permeable Pavement	Vacuum sweeping to remove fine particles from voids	Every 3 months	7,000
Detention Pond	Desilt; clear and inspect outflow weir; mow grass banks	Annually post-monsoon	5,000
IoT Monitoring System	Sensor calibration; battery replacement; firmware update	Annually	5,000
TOTAL	—	—	30,000

₹30,000 per year versus approximately ₹2.5 lakhs per year for conventional drain maintenance — an 88% reduction in annual upkeep costs. And unlike conventional drains, the SUDS scheme contributes to groundwater recharge and improved water quality in the receiving drain network, at no additional cost.

IX. DISCUSSION

A. What These Result Mean

A 67% reduction in peak discharge is a meaningful outcome, and it is consistent with what the literature suggests is achievable for compact urban SUDS schemes in comparable settings. Gaurkhede and Adane (2024) found 60–72% reductions for similar schemes in Nagpur, and Ortega Sandoval (2023) reported 55–68% in Bogotá. The fact that our result sits within these ranges gives us reasonable confidence that the design approach is sound, even without a full SWMM simulation to validate it dynamically.

B. Practical Considerations for Badlapur

The scheme is designed to be built and maintained by the Badlapur Municipal Council without specialised equipment or expertise. The maintenance tasks — vacuum sweeping, weeding, desilting — are straightforward and can be carried out by existing municipal workers with basic training. The IoT dashboard is accessible on a smartphone and does not require any technical background to read.

One lesson that came clearly from the Nagpur case study (Gaurkhede and Adane, 2024) is that community involvement in maintaining permeable pavement sections is both feasible and cost-reducing. Local shopkeepers at Ghorpade Chowk have a direct interest in good drainage — flooding affects their businesses. Formalising a simple maintenance arrangement with them as part of the project handover is something we would strongly recommend.

C. Limitations

- Secondary rainfall data: We used IMD Thane district values rather than a site-specific IDF curve. A Badlapur-specific IDF would improve the accuracy of the design storm selection.
- Simplified modelling approach: The treatment train reduction percentages are drawn from published literature rather than a dynamic SWMM simulation. A full simulation would give more confidence in the results, especially for multi-peak storm events.
- No topographic survey: Catchment boundaries and drain gradients were estimated from satellite imagery and field observation rather than a formal total-station survey.
- Single-site scope: This project covers only the 0.3 ha Ghorpade Chowk catchment. Meaningful catchment-wide flood relief would require the approach to be extended to other waterlogging-prone junctions.

D. Future Scope

- Developing a Badlapur-specific IDF curve using long-term IMD records and the SRIWATER database, allowing more precise design storm selection.
- SWMM simulation of the full treatment train to model multi-peak storm interactions and validate the simplified sequential reduction results.
- Extending the scheme across Badlapur East, using GIS analysis to identify other waterlogging-prone junctions and develop a connected network of SUDS installations.
- Post-construction IoT monitoring to collect real-world performance data and validate design assumptions over several monsoon seasons.

X. CONCLUSION

When we started this project, the problem was straightforward but the solution was not. Ghorpade Chowk floods every monsoon season because the catchment is too heavily built up and the drains are too small — but there is no room to build bigger drains without land acquisition, and the site gives you essentially nothing to work with in terms of open space. The challenge was to find a drainage solution that actually fits within those constraints.

The Smart SUDS approach answers that challenge. Four components — an infiltration trench, rain gardens, permeable pavement, and a detention tank— provide 127 m³ of combined storage within the existing road margins, parking bays, and corner spaces of the junction. That is exactly the runoff volume the 10-year design storm generates from this catchment. Arranged as a treatment train, they reduce peak discharge by 67%, from 0.039 m³/s to 0.013 m³/s — well within the capacity of the existing drains. The waterlogging problem is solved.

The IoT monitoring component adds a layer of operational intelligence that conventional drainage simply cannot match. Continuous data from sensors in the pond, the trench, and at the outfall means that problems are caught early and maintenance is done when it is actually needed rather than on a fixed schedule. That translates to lower costs and better performance over the life of the scheme.

The economics make sense too. ₹8.5 lakhs to build, ₹30,000 per year to maintain, a design life of 20–25 years, and significant savings relative to conventional drainage in both construction and maintenance. When you add the groundwater recharge and water quality co-benefits, the case for this approach over conventional drain upgrading is clear.

We hope the methodology and design presented in this project can be useful as a reference for similar waterlogging problems elsewhere in Badlapur and in comparable suburban towns across Maharashtra. The calculations are transparent, the components are familiar to local contractors, and the approach scales. Other junctions in Badlapur East face the same problem — the same solution, appropriately adapted, should work for them too.

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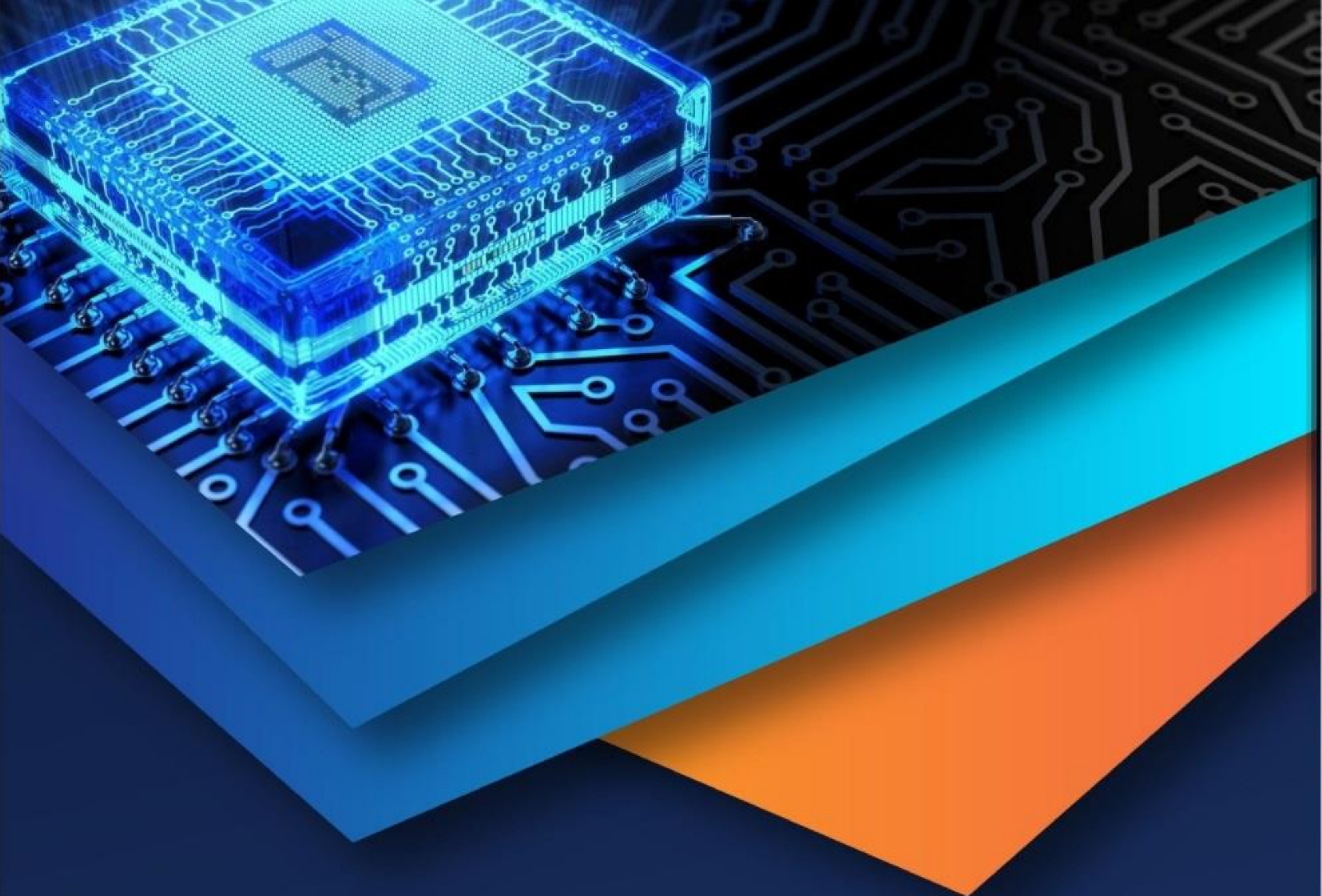

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