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A Case Study on Sewage Treatment Plant Kamothe, Panvel

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Abstract: Rapid urbanization in the Navi Mumbai Panvel region, fuelled by CIDCO-led township development, the upcoming Navi Mumbai International Airport, and large-scale residential growth in nodes such as Kamothe, Kharghar and Kalamboli, has placed sustained pressure on local sewerage infrastructure. This paper presents a case study of the Sewage Treatment Plant (STP) located at Kamothe under the jurisdiction of the Panvel Municipal Corporation (PMC) and the City and Industrial Development Corporation of Maharashtra (CIDCO). The Kamothe STP, situated at approximately 19°0'48.62"N, 73°5'13.02"E, has an installed treatment capacity of 85 Million Litres per Day (MLD) and forms part of a wider network of treatment facilities serving the Panvel Municipal Corporation area, including plants at Kharghar (70 MLD), Kalamboli (50 MLD), Taloja (32 MLD), Bandar Road (14 MLD) and Kalundre (2 MLD). The study reviews the unit processes typically employed at such plants screening, grit removal, primary sedimentation, biological treatment through the Sequencing Batch Reactor (SBR) process, and chlorination/disinfection prior to discharge or reuse and examines the operational, regulatory and socio-environmental context in which the plant functions. Secondary data drawn from municipal and government sources, including the PMC Environmental Status Report and CIDCO tender and budgetary documents, is used to assess capacity utilisation, treatment technology, compliance with Central Pollution Control Board (CPCB) norms, and the scope for treated-water reuse. The paper concludes that while the SBR-based approach adopted at Kamothe offers a compact, automation-friendly solution suited to land-constrained urban nodes, sustained capacity augmentation, sludge management planning, and expansion of treated-water reuse will be necessary to keep pace with the projected population and infrastructural growth of the Panvel region.
Keywords: Sewage Treatment Plant, Kamothe, Panvel Municipal Corporation, CIDCO, Sequencing Batch Reactor (SBR), Wastewater Management, Effluent Quality, Treated Water Reuse

I. INTRODUCTION

Sewage, or community wastewater, consists of approximately 99.9% water and 0.1% solids, the latter being predominantly organic in nature and originating from domestic, institutional and commercial sources, together with infiltrating groundwater and stormwater. If discharged untreated into surface water bodies or onto land, sewage imposes a severe biochemical oxygen demand (BOD) on the receiving environment, depletes dissolved oxygen, causes fish kills, generates malodorous gases, and creates pathways for waterborne disease. The treatment of sewage prior to disposal or reuse is therefore central to both public health protection and environmental sustainability in any urbanizing region.The Panvel sub-region of the Mumbai Metropolitan Region (MMR) has, over the past two decades, transformed from a collection of semi-rural revenue villages into one of the fastest-growing urban corridors in Maharashtra. This transformation has been driven by CIDCO's planned development of nodes such as Kharghar, Kalamboli, New Panvel and Kamothe, by improved road and rail connectivity along the Sion–Panvel Expressway and the Mumbai–Pune corridor, and more recently by the upcoming Navi Mumbai International Airport. Panvel Municipal Corporation (PMC), constituted in 2016, today administers a jurisdiction of roughly 110 square kilometres housing a population in excess of five lakh persons, a figure that has grown substantially since the 2011 Census baseline.

Kamothe is a CIDCO-planned residential and commercial node situated along the Sion–Panvel Highway in the Panvel taluka of Raigad district. It hosts dense residential development, retail clusters in Sectors 8 and 35, and a growing share of PMC's overall population. Wastewater generated in Kamothe and adjoining sectors is collected through an underground sewerage network and conveyed to the Kamothe Sewage Treatment Plant for treatment prior to discharge into local water courses or reuse for non-potable purposes such as gardening and flushing.

This paper presents a case study of the Kamothe STP with the objective of (a) documenting its design capacity, treatment technology and physical layout; (b) situating the plant within the broader sewerage infrastructure of the PMC area;

(c) reviewing the regulatory framework — CPCB and Maharashtra Pollution Control Board (MPCB) norms — against which its performance is judged; and (d) identifying the operational challenges and opportunities, particularly regarding capacity augmentation and treated-water reuse, that are relevant to planners and engineers working on similar peri-urban sewerage schemes in India.

II. LITERATURE REVIEW

A substantial body of literature exists on the design, operation and performance evaluation of municipal sewage treatment plants in India, much of it focused on small and medium-sized urban local bodies grappling with rapid population growth and constrained land availability.

1) Puspalatha et al. (2016) examined the design approach for a sewage treatment plant at Srikakulam Greater Municipality, analysing raw sewage and effluent BOD to demonstrate how a properly designed STP prevents direct disposal of sewage into the Nagavali river and reduces contamination of surface and ground water.
2) Pramod Sambhaji Patil et al. (2016) studied the design of an STP for Dhule city, detailing treatment units such as screens, grit chambers, storage tanks, settling tanks, aeration tanks and skimming tanks, and noted that treated effluent could be reused for groundwater recharge, flushing, fire protection and lawn sprinkling.
3) Murthy Polasa et al. (2014) reviewed STP design for a gated community, showing that increasing the detention time of sewage within each treatment unit improves the removal efficiency of physical, chemical and biological contaminants.
4) Chakar Bhushan et al. (2017) studied STP design for Lohegaon village, Pune, highlighting how treated effluent could be used for sub-surface water recharge and irrigation in villages where sewage was previously discharged onto open land.
5) Salvi and Patil (2021), in a case study of the Aurangabad sewerage project, documented the design of the Kanchanwadi STP (161 MLD) on the Sequencing Batch Reactor (SBR) process, describing the primary unit, C-Tech/SBR basins, chlorination system and gravity sludge thickener, and concluded that the SBR process, while more chemically and energy intensive, is well suited to Indian conditions because of its smaller land footprint.
6) Studies on SBR performance — including Lin et al. (2004) on chemical coagulation combined with SBR for agricultural-reuse-grade effluent, Arrojo et al. (2005) on membrane-coupled SBR achieving complete removal of faecal coliforms and E. coli, and Subbaramaiah and Mall (2012) on optimum mixed-liquor suspended solids (MLSS) concentrations of around 5000 mg/L — collectively establish the SBR process as a reliable, compact alternative to the conventional activated sludge process for municipal and peri-urban applications.

Within Navi Mumbai and the wider MMR, secondary sources such as the Panvel Municipal Corporation's annual Environmental Status Report (ESR), prepared with the Indian Institute of Technology Bombay, and CIDCO tender documentation for the operation and maintenance of regional STPs provide the most direct primary data on the Kamothe plant and its peer facilities, and form the principal evidentiary basis for the present case study.

III. STUDY AREA: PANVEL AND KAMOTHE

A. Location and Administrative Profile

Panvel City is located at approximately 18°59′40″N, 73°06′50″E in the Raigad district of Maharashtra, roughly 40 km from Mumbai by road, at an elevation of about 28 metres above mean sea level. The Panvel Municipal Corporation, the first municipal corporation in Raigad district and the ninth in the MMR, was constituted on 1 October 2016 and administers a jurisdiction of approximately 110.06 sq. km comprising 29 revenue villages, the CIDCO-developed nodes of Kharghar, Kalamboli, Taloja, Kalundre and Kamothe, and the historic Old Panvel council area. As per the 2011 Census, the PMC area had a population of 5,09,901, with male and female literacy rates of about 80.4% and 72.6% respectively; population growth since then, driven by affordable housing development and improved rail and road connectivity, has been substantial.

B. Climate and Physical Setting

Raigad district falls within the North Konkan agro-climatic zone. Panvel experiences a fairly equable climate moderated by proximity to the sea, with mean daily maximum and minimum temperatures of about 38°C and 16°C respectively, relative humidity ranging from roughly 60% in winter to 98% during the monsoon, and average annual rainfall of 2,500–3,000 mm concentrated between June and September. This heavy, seasonally concentrated rainfall has direct implications for sewerage system design, as stormwater infiltration and combined-flow surges during the monsoon increase hydraulic loading on collection networks and treatment plants alike.

C. Kamothe Node

Kamothe is a CIDCO-planned residential node along the Sion–Panvel Highway, within the Panvel Municipal Corporation's jurisdiction. It is among the more densely developed nodes in the PMC area, with major commercial activity concentrated in Sectors 8 and 35. As urban density in Kamothe has increased, so has the volume of domestic and institutional wastewater requiring collection and treatment, making the performance of the local STP a matter of direct relevance to public health and environmental quality in the node.

IV. CASE STUDY: KAMOTHE SEWAGE TREATMENT PLANT

A. Plant Overview

The Kamothe Sewage Treatment Plant is located at approximately 19°0′48.62″N, 73°5′13.02″E within the Panvel Municipal Corporation area. According to the PMC Environmental Status Report (2024–25), prepared by IIT Bombay, the plant has an installed treatment capacity of 85 MLD, making it the largest single STP serving the PMC jurisdiction. The plant is owned and was originally developed by CIDCO and has historically been operated and maintained through CIDCO-administered comprehensive Operation & Maintenance (O&M) contracts; a CIDCO tender for comprehensive O&M of the 85 MLD Kamothe STP records a project cost of approximately Rs 1.2 crore for the O&M scope, reflecting the scale of recurring expenditure required to keep such a facility running to design specification.

In addition to the existing 85 MLD facility, the PMC budget for 2025–26 has earmarked Rs 40 crore for the development of an additional 15 MLD capacity Sewage Treatment Plant (referred to in budget documents as a 'TTP') at Kamothe, alongside Rs 25.49 crore allocated for a new sewage plant serving Sectors 19, 20 and 21. This points to an explicit institutional recognition that the existing Kamothe capacity, while currently the largest in the PMC network, will require augmentation to keep pace with the node's continuing residential and commercial growth.

B. Kamothe STP in the Context of the PMC Sewerage Network

The Kamothe STP does not operate in isolation; it is one of six principal sewage treatment plants identified in the PMC Environmental Status Report as serving the Corporation's jurisdiction. Table 1 summarises the capacities and approximate locations of these plants, illustrating both the centrality of the Kamothe facility and the overall scale of treatment infrastructure available to the PMC area.

Table 1: Sewage Treatment Plants serving the Panvel Municipal Corporation area (Source: PMC Environmental Status Report, 2024–25, IIT Bombay)

Sr. No.	STP Location	Approximate Coordinates	Installed Capacity (MLD)
1	Kamothe	19°0'48.62"N, 73°5'13.02"E	85
2	Kharghar	19°2'31.38"N, 73°4'49.38"E	70
3	Kalamboli	19°2'6.59"N, 73°5'52.45"E	50
4	Taloja	19°4'21.72"N, 73°5'33.21"E	32
5	Bandar Road, Panvel	18°59'24.55"N, 73°6'1.29"E	14
6	Kalundre	18°58'40.02"N, 73°7'32.12"E	2

With a combined installed capacity of roughly 253 MLD across these six plants, the Kamothe facility alone accounts for approximately a third of the PMC area's total sewage treatment capacity, underscoring its strategic importance to the region's sanitation infrastructure. For comparative perspective, CIDCO has separately tendered a 50 MLD STP at Kalamboli (Sector 12) for comprehensive O&M at a contract value of roughly Rs 1.42 crore, figures broadly consistent with the O&M cost profile reported for the larger Kamothe plant on a per-MLD basis.

C. Treatment Process and Unit Operations

CIDCO-developed STPs in the Navi Mumbai/Panvel region, including comparable large facilities such as the Kanchanwadi STP at Aurangabad (161 MLD) documented in earlier case studies, predominantly employ the Sequencing Batch Reactor (SBR) process for biological treatment. The PMC Environmental Status Report similarly documents the SBR process as the principal secondary treatment technology used within the Corporation's STP network. A generalized SBR-based treatment train, representative of the unit processes employed at plants of this type, proceeds as follows:

1) Screening: Raw sewage entering the plant via the sewage pumping station first passes through mechanical and manual bar screens that intercept large floating debris — rags, plastics, wood, and other solids protecting downstream pumps and equipment from clogging and damage.
2) Grit Removal: Screened sewage flows to grit chambers, where reduced flow velocity allows heavier inorganic particles such as sand and grit to settle out by gravity while lighter organic matter remains in suspension and proceeds to subsequent treatment.
3) Primary Treatment / Equalization: Sewage is conveyed, generally by gravity, into the SBR basin system, sometimes preceded by an equalization or balancing tank that dampens diurnal flow fluctuations before the batch process begins.
4) Biological Treatment (SBR Cycle): Within the SBR basins, treatment proceeds through a repeating cycle of fill, aeration, settling (clarification) and decanting phases. Air blowers and diffusers supply oxygen during the aeration phase to support aerobic biodegradation of organic matter by activated sludge; Return Activated Sludge (RAS) and Surplus Activated Sludge (SAS) pumps manage the biomass inventory; and decanters withdraw clarified supernatant once settling is complete. The entire cycle is typically automated through a Programmable Logic Controller (PLC).
5) Disinfection: Treated effluent from the SBR basins passes through a chlorine contact tank, where chlorination disinfects the water of residual pathogens prior to final discharge or reuse.
6) Sludge Handling: Surplus sludge withdrawn from the SBR process is directed to a gravity sludge thickener and, in larger installations, a centrifuge house for further dewatering before disposal or beneficial reuse.

This sequence mirrors the treatment train documented for the Kanchanwadi SBR-based STP and is broadly representative of the process configuration expected at the Kamothe facility given its shared ownership (CIDCO) and shared regional design conventions.

D. Effluent Standards and Regulatory Framework

Treated effluent discharged from STPs within Maharashtra is subject to the general standards prescribed by the Central Pollution Control Board (CPCB) and enforced locally by the Maharashtra Pollution Control Board (MPCB), covering parameters such as Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), pH and faecal coliform count. The PMC Environmental Status Report notes that water quality monitoring conducted across the Corporation's jurisdiction during 2024–25 generally found surface and ground water parameters within stipulated MPCB standards, while also flagging turbidity as a parameter of concern in nearby surface water bodies such as the Panvel Creek — a reminder that even where individual STPs perform within design parameters, the cumulative water-quality outcome for a receiving water body depends on the combined performance of the entire sewerage network, storm water management, and diffuse pollution sources.

Panvel Municipal Corporation's broader environmental governance position is notable in this context: PMC has been conferred 'Water+' status, with a 3-star rating, and separately received the 'City Beautification Award–2023' from the Government of Maharashtra and the 'Majhi Vasundhara Award–2023', the latter carrying a state grant of Rs 5 crore in recognition of environmental performance. These recognitions indicate sustained institutional attention to sanitation and water-quality outcomes, of which the performance of the Kamothe STP is a material component.

E. Treated Water Reuse

A key objective embedded in the PMC Environmental Status Report's recommendations is the increased reuse of treated sewage effluent for non-potable purposes — gardening, flushing, and similar applications — across the Corporation's area. Comparable practice elsewhere in Navi Mumbai is illustrative: secondary sources indicate that tertiary treatment plants at Koparkhairane, Nerul and Airoli together supply roughly 45 MLD of recycled water for non-potable uses within Navi Mumbai Municipal Corporation limits, demonstrating the technical and institutional feasibility of treated-water reuse schemes in the broader region and suggesting a pathway that the PMC area, including Kamothe, could extend further.

V. RESULTS AND DISCUSSION

A. Capacity Adequacy

At 85 MLD, the Kamothe STP is the largest single treatment facility in the PMC network and represents a substantial sanitation asset for the region. However, the PMC's own 2025–26 budgetary allocation of Rs 40 crore for an additional 15 MLD facility at Kamothe, alongside a further Rs 25.49 crore for a new plant in Sectors 19–21, signals that even this capacity is approaching its operational limits relative to projected sewage generation from continuing residential and commercial growth in the node. This is consistent with the broader pattern observed across Navi Mumbai, where CIDCO's parallel investments in water supply infrastructure — including the 270 MLD Jite Water Treatment Plant and the phased Hetawane Water Supply Scheme expansion — point to a region whose water consumption, and consequently its sewage generation, is on a sharply rising trajectory.

B. Suitability of the SBR Process

The SBR process offers clear advantages for a land-constrained, rapidly urbanizing node such as Kamothe: it requires a comparatively small footprint relative to conventional activated sludge or stabilisation pond systems, lends itself well to PLC-based automation, and — per the comparative literature reviewed in Section 2 — can achieve high removal efficiencies for BOD, COD, total Kjeldahl nitrogen and pathogenic indicator organisms when properly operated. Its principal drawbacks, also borne out in the literature, are a comparatively higher dependence on external energy for aeration and chemical inputs, and a correspondingly higher operating cost than passive or semi-passive treatment alternatives such as constructed wetlands or waste stabilisation ponds. For a high-value urban node like Kamothe, where land cost and availability are constraining factors, this trade-off — higher recurring operational cost in exchange for a smaller land footprint — is a reasonable and commonly adopted one.

C. Operation and Maintenance Considerations

The CIDCO O&M tender documentation reviewed for this case study indicates that the Kamothe plant, like its peer facilities at Kalamboli and elsewhere in the network, is operated under comprehensive Operation & Maintenance contracts rather than wholly in-house municipal staffing. This model — common across CIDCO-developed infrastructure in Navi Mumbai — has the advantage of bringing specialised private-sector operating expertise to a technically demanding SBR process, but also makes long-term plant performance contingent on the quality of contract design, monitoring, and enforcement by the awarding authority. Robust performance monitoring, including regular reporting of influent and effluent BOD, COD and TSS values against CPCB norms, is essential to verify that contracted O&M performance translates into actual compliance.

D. Monsoon-Related Hydraulic Loading

Given Panvel's North Konkan climate, with annual rainfall typically in the 2,500–3,000 mm range concentrated in a four-month monsoon window, the Kamothe sewerage network is likely to experience significant hydraulic loading from stormwater infiltration and inflow during the monsoon season. This is a generic vulnerability of combined and partially-combined sewer systems in heavy-rainfall regions of India, and underscores the importance of adequately sized equalisation capacity and stormwater segregation in the design of any capacity-augmentation works planned for Kamothe.

E. Treated Water Reuse Potential

The reuse precedent set elsewhere in Navi Mumbai — approximately 45 MLD of recycled water supplied from tertiary plants at Koparkhairane, Nerul and Airoli — suggests meaningful headroom for the PMC area to develop comparable tertiary treatment and reuse infrastructure tied to the Kamothe and other PMC-area STPs. Given the scale of the Kamothe plant (85 MLD), even a modest proportion of effluent diverted to tertiary treatment and non-potable reuse — for horticulture, flushing, or construction-water demand generated by the area's continuing real-estate development — could meaningfully offset freshwater abstraction pressure on sources such as the Dehrang Dam and Hetawane Dam supply schemes that the region currently depends upon.

VI. CONCLUSION

This case study has examined the Kamothe Sewage Treatment Plant within the wider sewerage infrastructure context of the Panvel Municipal Corporation area. The 85 MLD Kamothe facility is the largest of six STPs identified within the PMC jurisdiction and employs the Sequencing Batch Reactor process, an approach well suited to land-constrained, rapidly urbanising nodes because of its compact footprint and amenability to automated, PLC-controlled operation.

Drawing on documented PMC and CIDCO sources, the study finds that the existing plant capacity, while substantial, is already being supplemented through new budgetary allocations for an additional 15 MLD facility and a separate plant serving Sectors 19–21 — a clear institutional signal that sewage generation in the Kamothe node is outpacing the original design capacity of the existing infrastructure.

The study further highlights three areas warranting continued attention from planners and engineers: first, the need for sustained capacity augmentation that anticipates, rather than merely reacts to, population and commercial growth; second, the importance of rigorous O&M contract monitoring to ensure that contracted private-sector operation reliably delivers CPCB-compliant effluent quality; and third, the substantial untapped potential for treated-water reuse, following precedents already established elsewhere in Navi Mumbai, to ease pressure on the region's freshwater supply sources. Addressing these areas would strengthen the long-term sustainability of sewage management in Kamothe and offer a transferable model for similar CIDCO-developed nodes across the Mumbai Metropolitan Region.

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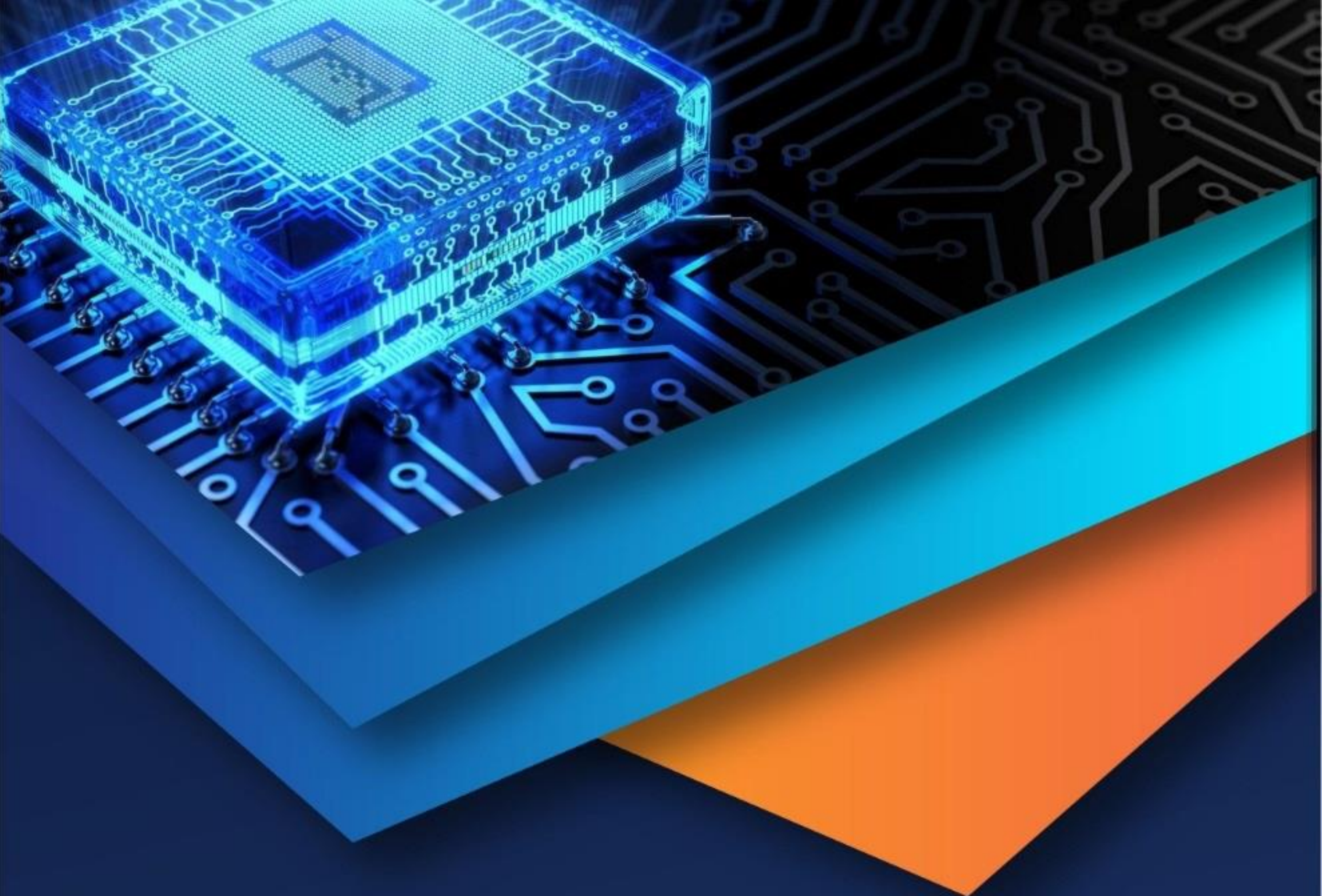

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