Aqua Flux : Passive Vortex-Driven insert for Accelerated Urban Drainage and Waterlogging Mitigation

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Urban flooding is escalating into a critical global challenge, driven by the inability of conventional drainage inlets to handle increasing rainfall intensities due to rapid urbanization and climate change. Poor discharge rates lead to surface water accumulation, resulting in widespread consequences: disrupting daily life, delaying emergency response, and increasing accident risk by 20–25%. Not all urban floods & road waterlogging make headlines; globally, waterlogging costs cities $10–20 billion annually. This study investigates a geometrically optimized passive vortex insert for surface inlets to enhance drainage through geometrically-driven flow acceleration. The study adopts a three-step methodology: field study, shape optimization, & experimental validation. Under defined conditions, shape optimization was conducted using ANSYS simulations to analyze geometrical designs (cubical, triangular, cylindrical, conical, & cylindro-conical) & vane angles from 20° to 60°, supported by mathematical evaluation- Reynolds number, Froude number, discharge rate, pressure gradient, & outlet velocity. Further optimization included groove design & parallel vortex. Field study with local authorities identified a requirement of atleast 15% increase in drainage efficiency in a flood-prone location. Simulations at 7.5 L/s of three optimized configurations demonstrated a discharge rate in the range of 8.4L/s-10.1 L/s. Experimental validation demonstrated the system achieving an efficiency in the range of 22%-89% increase in discharge rate under varying flow conditions. The 35° grooved configuration showing the highest efficiency. This zero-energy, cost-effective device is retrofittable & scalable, making it a globally viable solution for sustainable urban drainage, supporting SDG 11.

Awards Won:

Third Award of $1,200

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