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Traffic Congestion Analysis and Flyover Proposal at Appa Junction, Hyderabad

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Abstract-Rapid urbanization and increasing vehicle ownership have intensified traffic congestion at major urban intersections, reducing transportation efficiency and travel reliability at Appa Junction in Hyderabad, Telangana, experiences severe congestion due to heterogeneous traffic flow, frequent turning movements, and inadequate roadway capacity. This study evaluates the operational performance of the junction using standard traffic engineering methods and proposes a suitable long-term improvement strategy. Traffic volume surveys were conducted manually at all four approaches during peak and off-peak periods. Vehicle counts were converted into Passenger Car Units (PCU) according to IRC:106-1990 guidelines to analyze mixed traffic conditions accurately. The study recorded a peak traffic volume of 4806.5 PCU/hr against an available capacity of 3600 PCU/hr, resulting in a Volume-to-Capacity (V/C) ratio of 1.33 and indicating oversaturated conditions with Level of Service (LOS) F. Future traffic projections, considering an annual growth rate of 7.5%, estimate traffic demand to reach approximately 6900 PCU/hr within five years. Conventional at-grade improvements such as signal optimization, road widening, and roundabouts were found inadequate to accommodate future demand. Therefore, the study recommends a flyover as the most effective solution to improve traffic flow, reduce delays, enhance safety, and support future urban growth. The findings emphasize the importance of data-driven transportation planning and sustainable infrastructure development for rapidly growing cities.

Keywords: Traffic Congestion, Passenger Car Unit, Level of Service, Flyover, Urban Transportation, Traffic Engineering, Junction Improvement.

1. INTRODUCTION

Because cities grow fast, their roads often struggle to keep up [1]. Moving people and goods shapes how well urban areas develop economically and socially. Where streets meet on busy routes, delays pile up when design fails to match rising travel needs. Even so, better transport networks can ease crowding, connect communities, open markets, boost productivity, and lift daily living standards [8]. As vehicle numbers climb sharply across large cities, jams become common during peak hours. Though essential, many junctions now operate below expected performance levels. Despite its recent surge in size, Hyderabad continues to adapt as homes, offices, and public facilities spread rapidly throughout the region. Because of this shift, movement within the city has grown more complex, especially where roads meet under heavy daily use. Located along a key stretch linking Mehdipatnam to outlying neighborhoods like Chevella and Kokapet, Appa Junction handles constant vehicle flow. Near the Financial District, this crossing plays a central role in how people travel across southern and western zones. Pressure builds during peak hours when too many routes converge without enough space to absorb delays [4].

Because of uneven vehicle mixes, the current ground-level crossing at Appa Junction clogs badly when traffic peaks. Turning maneuvers grow more frequent, while lane layouts fail to keep up - space on the road simply runs short. Two-wheelers weave between buses, autos cut across car paths, trucks struggle to merge; each type moves at its own pace. Flow breaks down under such imbalance, creating stop-and-go patterns that stretch waiting times. Delays pile up, lines of vehicles extend farther back, movement turns unpredictable. Crashes become more likely where timing and spacing are constantly disrupted [6].

Heavy traffic slows travel times while increasing fuel consumption, harming air quality, costing cities money, cutting productivity, raising frustration among drivers. Because of these impacts, researchers now prioritize analyzing road networks through data-driven methods so planners can design better layouts that fix weak spots in current infrastructure [5].

Though cities grow fast, movement slows down where roads jam. Traffic counts help see how many vehicles pass by during set times. Instead of counting every vehicle type separately, they get turned into standard car units for easier math [1]. When road use climbs near its limit, engineers check how full it runs using a capacity fraction method [8]. How smooth travel feels to drivers gets rated on a scale called service level. Where tangles of cars pile up, going overhead with bridges lets some traffic skip the stop-and-go below. These raised paths split flows by height, cutting delays without widening streets [2].

A closer look at Appa Junction reveals current traffic conditions shaped by growing demand, where movement patterns suggest persistent strain during peak intervals. Instead of continuing surface-level adjustments, elevated infrastructure emerges as a responsive measure to ease flow disruptions. Analysis methods include volume counts, delay observations, and intersection behavior trends gathered over multiple time windows. When delays accumulate beyond acceptable thresholds, separation of conflicting streams becomes necessary. Elevated passage structures allow uninterrupted crossings, reducing stoppage times significantly. Findings point toward vertical divergence - where vehicles bypass conflict zones - as the most effective path forward. Long-term functionality depends less on construction scale and more on alignment precision with travel corridors [2][4].

1.1 Problem Statement

Despite growing vehicle numbers, Appa Junction still relies on a ground-level crossing that struggles to keep up. Because of mixed vehicle types and frequent turns, flow breaks down often. Poor lane layout adds pressure, while signals fail to manage the load effectively. As conditions worsen, delays climb and movement becomes unpredictable. Solutions tried so far do little to ease present or future needs. Elevated structures now appear necessary to restore reliable passage through the junction.

1.2 Aim of the Study

This study focuses on assessing how well Appa Junction functions in daily operations while introducing a long-term solution through an elevated road design. One objective involves measuring current traffic flow patterns before suggesting structural changes. A redesigned layout using bridge elements could ease bottlenecks during peak hours. Performance indicators include travel time, stop frequency, and vehicle throughput. Instead of expanding ground-level lanes, raising key segments may offer better results. Adjustments rely on spatial analysis and movement data collected over several weeks. Efficiency gains would come from separating conflicting traffic streams. Solutions emerge from observing real-world behavior rather than theoretical models alone.

1.3 Study Goals

The major objectives of the study are:

- For gathering classified traffic volume surveys Appa Junction.
- To analyze heterogeneous traffic flow using Passenger Car Unit (PCU) conversion methods.
- Examining road efficiency begins with Volume-to-Capacity metrics instead of relying solely on traditional measures.
- To identify major causes of congestion and operational inefficiencies at the junction.
- To forecast future traffic demand using standard traffic growth models.
- To propose a suitable grade-separated flyover system for improving traffic performance and roadway safety.

2. LITERATURE REVIEW

Despite growth in city populations, road networks often fail to keep pace, leading to worsening traffic jams in fast-expanding urban centers. Around the globe, experts have explored structural fixes like elevated highways, circular junctions, timing adjustments for lights, along with reconfiguring road layouts - each aimed at easing bottlenecks where roads meet. Though vehicles multiply quickly, space and planning struggle to adapt. Some methods target how lanes curve or merge, others fine-tune flow through signals; together they shape how smoothly movement occurs during peak periods [2].

After building flyover systems at busy city crossings, Singh and Mehta (2022) examined how well they cut down traffic jams. Results showed these elevated roads sharply lowered waiting times for vehicles, even when traffic demand exceeded road capacity. Instead of merging lanes, the separated flow design helped shorten backup lengths behind red lights. Because traffic moved more freely, journey durations dropped noticeably across monitored routes. More than four out of every ten congestion cases eased once structures were operational. Though not perfect, outcomes pointed toward consistent improvement where traditional signals had failed [4].

Pon Soundarya and SindhuVaardini (2021) looked into how well city flyovers function, along with effects on steady traffic flow. The study showed reductions in fuel use, vehicle pollution, and crashes - this happens because crossings at ground level are removed entirely [5].

Later came Rao and Reddy (2021), testing traffic flow through simulations focused on how flyovers function amid varied vehicle types sharing roads. Their results showed shorter lines of vehicles, less time spent paused, along with fewer hold-ups at crossings once elevated routes were added [6].

Roundabouts handle city traffic better than signals - when volumes stay within reasonable bounds. Though Gupta and Shetty found them efficient at mid-level congestion, performance drops once roads get too busy. Their 2021 analysis showed gains fade beyond usable thresholds [7].

A design combining flyovers with roundabouts was introduced by Mututantri and colleagues in 2020, following guidelines from IRC and AUSTROADS to tackle heavy city traffic. Because of its elevated structure, movement along major routes saw measurable gains in flow. Although ground-level crossings remain complex, such separation of traffic streams supports rising vehicle numbers over time [2].

Looking beyond surface-level fixes, studies consistently highlight elevated crossings as a robust response to intense city traffic jams. Where intersections handle heavy flows, these structures help ease movement without demanding constant upkeep. Evidence shows their impact on efficiency stands out over time. Instead of temporary patches, such separation designs support lasting gains in how roads function under pressure.

3. STUDY AREA DESCRIPTION

West of Hyderabad in Telangana lies Appa Junction, linking key zones like Mehdipatnam, Kokapet, Chevella, the Financial District, along with emerging suburbs. Busy flows pass through here daily - spurred by city spread, rising housing projects, expanding institutions, and growing business presence nearby. Movement never slows, shaped heavily by how fast these outer neighborhoods evolve. Connections stretch outward, pulling commuters, services, and infrastructure into constant motion.
Most vehicles meeting at the intersection differ greatly in size and function - scooters share space with compact cars, three-wheeled taxis roll alongside city buses, delivery trucks move between larger freight carriers. Rush hour crowds appear early each day, swelling again late afternoon when work travel overlaps with general movement across the city. Heavy traffic now overwhelms the ground-level junction, which struggles to keep up. Because of this mismatch, jams grow worse when travel demand peaks each day. Movement becomes unpredictable, flowing unevenly through the crossing points. Delays pile up, stretching commute times well beyond normal limits.

4. METHODOLOGY

4.1 Traffic Volume Survey

Throughout several days, observers collected traffic data by hand at every entrance to Appa Junction, relying on tally sheets for classification. Recorded in 15-minute segments, the volumes emerged during busy times - morning, afternoon, and night - to capture consistent patterns. Because precision mattered, repeated observations unfolded across separate occasions.
During the survey, several ways of managing traffic flow came under review

1. Appa Junction to Mehdipatnam
2. Mehdipatnam to Appa Junction
3. Appa Junction to Chevella
4. Chevella to Appa Junction

Among those listed were different types of transport grouped by class

- Two-wheelers
- Passenger cars
- Auto-rickshaws
- Utility vehicles
- Buses
- Goods vehicles
- Heavy commercial vehicles

Table -1: Classified Traffic Volume Survey at Appa Junction

Vehicle Type	Morning Peak (PCU/hr)	Afternoon (PCU/hr)	Evening Peak (PCU/hr
Two-Wheelers	1050	920	1320
Cars	980	850	1180
Auto Rickshaws	420	390	510
Buses	180	160	220
Goods Vehicles	260	240	320
Heavy Commercial Vehicles	140	120	180
Utility Vehicles	310	290	410
Total	**3340**	**2970**	**4140**

4.2 Passenger Car Unit Analysis

Using conversion rates from IRC:106-1990, varied traffic types became uniform flows through passenger car equivalents. Data once mixed now matched a common standard by applying these unit factors.
At its peak, the highest traffic count recorded for the intersection reached:

$$V = 4806.5 \text{ PCU/hr}$$

Capacity on the road at the intersection turned out to be based on actual observed usage rather than theoretical limits

$$C = 3600 \text{ PCU/hr}$$

The Volume to Capacity Ratio Was Calculated

$$V/C = 4806.5/3600 = 1.33$$

Operating at a higher V/C ratio shows the intersection now exceeds its realistic handling threshold.

4.3 Level of Service Assessment

Through standard Level of Service measures, the junction's working state got assessed. Performance at the intersection received judgment based on established service levels. Evaluation hinged upon recognized benchmarks for traffic flow. Using common indicators, analysts reviewed how well the crossing functioned. Judgment drew from typical standards tied to movement efficiency. The way vehicles moved through the point shaped its rating. Assessment relied on conventional methods measuring user experience. The junction's operational performance, judged by its computed V/C ratio, fell into a specific category

$$LOS = F$$

Level of Service F represents oversaturated traffic conditions characterized by:

- Severe congestion
- Long vehicle queues
- Excessive travel delays
- Reduced travel speed
- Unstable traffic operations

4.4 Future Traffic Forecasting

With city expansion accelerating near the study area, planners projected travel needs ahead by applying a yearly increase of 7.5%. Growth trends shaped these long-term volume forecasts.

The formula applied to predict traffic volume within the research takes shape as follows

$$P_n = P(1+r)^n$$

Where:

- (P) = Present traffic volume
- (r) = Annual traffic growth rate
- (n) = Number of years

After five years, the expected traffic flow came out to approximately:

$$P_5 \approx 6900 \text{ PCU/hr}$$

Future traffic volumes are expected to surpass what the current junction can handle. Though designed for lower usage, today's flow already strains its limits. Where once gaps between vehicles allowed smooth movement, now congestion builds during peak periods. Even with optimized signal timing, delays grow longer each year. Without structural changes, bottlenecks will worsen steadily.

5. RESULTS AND DISCUSSION

Despite its current layout, Appa Junction struggles to handle rush hour demand, as shown by recent traffic observations. With a recorded flow of 4806.5 PCU per hour, movement through the crossing becomes erratic when volumes rise. This level of usage goes beyond what the junction was built to manage efficiently. As a result, delays grow longer while vehicles wait in extended queues. Performance drops sharply once thresholds are crossed, revealing structural shortcomings. Instead of smooth progression, stop-and-go patterns dominate throughout peak periods.

A value of 1.33 for the Volume-to-Capacity ratio shows the intersection functions beyond its limit, falling into Level of Service F. Long lines of vehicles appear because demand exceeds available space. Delays grow sharply when flow breaks down. Travel speeds drop noticeably during peak periods. Movement becomes unpredictable once congestion sets in.

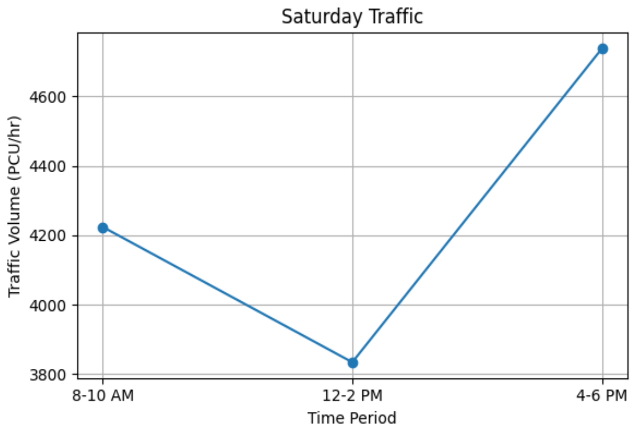

Figure 1: Saturday Traffic Volume Variation

Evening rush periods show growing gridlock, as vehicle counts near maximum roadway capacity. Though flow persists, movement slows sharply when demand peaks after work hours.

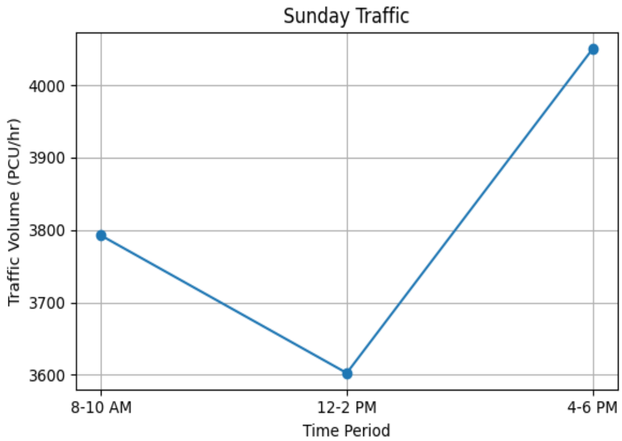

Figure 2: Sunday Traffic Volume Variation

On Sundays, traffic flows more lightly than on workdays - yet pockets of slowdowns remain visible across routes.

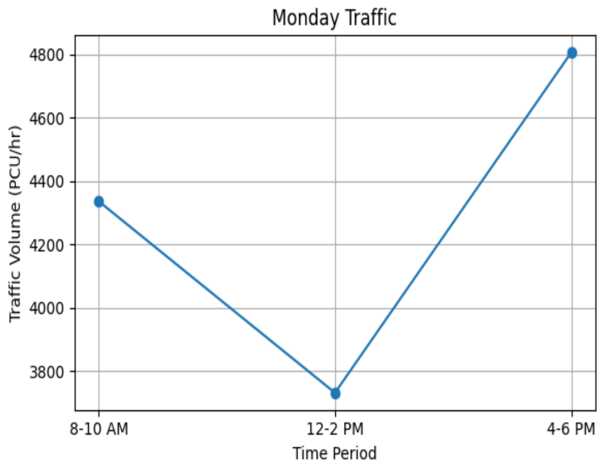

Figure 3: Monday Traffic Volume Variation

That Monday saw more than 4800 PCU/hr in the evening rush hints at serious gridlock forming right there. Severe crowding at the intersection becomes clear when volumes spike past that mark after work hours.

Years ahead, traffic volumes are expected to climb sharply, driven by expanding cities, rising business activity and more vehicles owned locally. With numbers likely reaching around 6900 passenger car units per hour by year five, today's junction setup would struggle even more without timely upgrades. Without added capacity or redesigns, congestion will worsen noticeably under such loads.

Table -2: Comparison of Traffic Improvement Alternatives for Appa Junction

Improvement Method	Congestion Reduction	Future Suitability	Cost	Overall Effectiveness
Signal Optimization	Moderate	Low	Low	Temporary Solution
Road Widening	Moderate	Medium	Medium	Limited Improvement
Roundabout	Moderate	Low	Medium	Suitable for Medium Traffic
Flyover	High	High	High	Best Long-Term Solution

Despite testing options like timed signals, broader roads, or circular intersections, results showed limits. These standard ground-level fixes fall short when facing expected increases in vehicle flow.

Above all, an elevated crossing stands out as the best long-term fix for Appa Junction's layout issues. While ground-level changes could help short term, they lack lasting impact. Instead of merging lanes, lifting traffic overhead reduces conflicts naturally. Because delays pile up during peak hours, freeing movement vertically makes sense. With vehicles flowing above intersections, interruptions drop sharply. Rather than widening roads, building upward uses space more wisely. Over time, this design eases congestion without demanding constant adjustments.

The proposed flyover system is expected to provide the following benefits:

- Significant reduction in traffic congestion
- Improved traffic continuity and travel speed
  Vehicle wait times drop on average
- Improved roadway operational efficiency
- Reduced fuel consumption and vehicular emissions
- Enhanced roadway safety
- Efficient accommodation of future traffic growth

6. CONCLUSION

Performance at Appa Junction was examined through categorized traffic counts, converted into standard vehicle equivalents. Instead of raw numbers, movement efficiency relied on service quality indicators. Forecasting methods helped anticipate upcoming demand patterns. Analysis combined these elements without treating them as isolated inputs.

Despite its current layout, the ground-level crossing faces heavy overload during busy periods - official data shows a flow reaching 4806.5 passenger car units per hour. This amount pushes past what the site can efficiently manage, bringing prolonged wait times and erratic movement patterns. Performance drops sharply, landing in the lowest tier of service quality when demand peaks. As throughput strains beyond limits, stop-and-go conditions become routine rather than exceptional.

Looking ahead, traffic volumes are expected to rise sharply - hitting around 6900 PCU per hour by year five. Without adjustments, the junction's performance will decline noticeably. Year after year, strain builds when flow outpaces infrastructure capacity.

A thorough review of traffic patterns, guided by established IRC guidelines, leads to the conclusion that separation of flows through an elevated structure best addresses delays at Appa Junction. When weighed against other control strategies, this approach holds up under long-term demand projections. Unlike signal adjustments or road widening, the overhead crossing avoids ongoing interference between streams. Evaluation shows it maintains efficiency even during peak fluctuations. The choice emerges clearly when performance, safety, and urban integration are considered together.

With construction underway, the new flyover should ease movement along busy roads. Traffic jams may shrink as vehicles flow more smoothly through the area. Safety could rise due to fewer conflict points at ground level. Future growth in travel volume might be handled without major upgrades. Efficiency gains would come from separating crossing streams of traffic.

7. FUTURE SCOPE

Future research studies may include:

- Traffic simulation analysis using VISSIM, SIDRA, or SYNCHRO software.
- Examining whether the suggested elevated road makes financial sense. A look at expenses weighed against expected gains follows closely behind.
- Environmental impact assessment of the proposed infrastructure system.
- Integration of Intelligent Transportation Systems (ITS) for advanced traffic management.
- Comparative analysis of alternative interchange configurations.

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