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A Schematic Review on Enhancing Traffic Flow with Safety by Providing a Flyover Bridge

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Abstract- Transportation plays a vital role in the development of a nation. In India, rapid urbanization and population growth have led to a significant increase in vehicular density, making efficient transportation infrastructure essential for urban expansion. Traffic congestion is a common challenge, particularly in high-density urban areas. Different countries adopt tailored approaches to address transportation challenges based on their population dynamics and available resources. Major cities worldwide, including those in India, experience severe traffic congestion, especially at entry points due to inadequate road design and vehicle misalignment. To mitigate these issues, extensive surveys are conducted to analyse peak-hour traffic conditions, assess road usage, and identify patterns. As a strategic solution, the proposed flyover bridge is expected to redirect approximately 30–35% of the total traffic, thereby improving flow efficiency and road safety. This study focuses on urban traffic management strategies, emphasizing their significance in enhancing mobility. Additionally, it examines the current traffic conditions in Yavatmal and explores the role of the flyover bridge in alleviating congestion and optimizing transportation infrastructure.

Keywords: Traffic flow, Traffic monitoring, Traffic congestion, Safety, Planning, Flyover bridge

1. Introduction

Every year, approximately 1.3 million people die and millions are injured in road accidents worldwide, leading to substantial economic losses. Efforts are being made to improve road safety and reduce these numbers. In India, several states are actively working to enhance road safety, minimize accidents, and address traffic congestion. Road transport is a fundamental driver of India's economy and infrastructure, facilitating urban expansion and economic growth. However, increasing vehicular movement has also led to rising collisions and fatalities. Rapid urbanization and the surge in vehicle numbers have intensified congestion, particularly at major intersections. Larger commercial vehicles further strain traffic systems, reducing speeds and sometimes causing complete gridlocks. Traffic congestion occurs when vehicle volume exceeds road capacity, disrupting mobility. Accidents continue to rise due to factors such as road defects, human error, vehicle design flaws, and inadequate pedestrian and cyclist infrastructure. Additional contributors include adverse weather and poor visibility. These incidents result in fatalities, injuries, property damage, social hardships, and environmental harm, underscoring the need for effective traffic management and infrastructure planning.

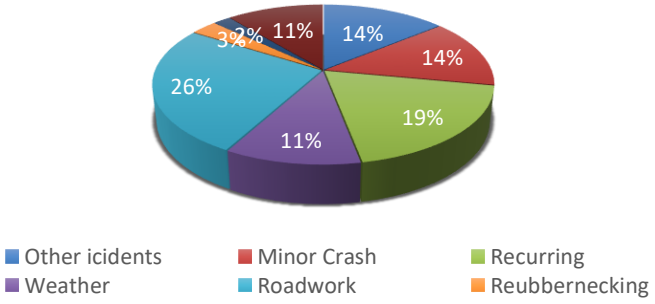

Fig.1 Factors affected traffic congestion [1]

2. Objectives:

- To proposed a fly-over reduce traffic congestion, enhance smooth traffic flow in two separate ways.
- To make an alternative solution to minimize travel time and low fuel consumption.
- To avoid vehicles collision and allocate safe efficient access.
- To provide a direct route without taking any long turn.

3. Global Traffic Crisis: Addressing Congestion and Safety

The World Road Statistics (2024) report ranks India first globally in traffic incidents. Lane reversal techniques have emerged as a key solution for congestion, especially in unregulated traffic conditions. Studies using video data from Hamburg, Germany, and Surat, India, successfully predicted pedestrian movements, aiding automated driving system improvements. In Eastern Massachusetts, these strategies reduced travel times by 4.7%, with reductions reaching 60% during major events or evacuations, highlighting their effectiveness in traffic management [2].

Fig.2 Traffic congestion view

3.1 Overview of Global Studies on Transportation Safety

The first recorded traffic jam occurred in August 1969 in Bethel, New York, USA, where a 20-mile gridlock lasted three days, and a one-hour detour took eight hours. In 1980, Paris (Lyon) experienced a 450-mile traffic jam that lasted 10 hours. Similar incidents occurred in Berlin (April 1990), Tokyo (August 1990), Hamburg (1993), and Interstate-45 in Houston, Texas (2005). Additionally, major traffic congestion was recorded in São Paulo (2009), Chicago (2011), and Moscow (2012), with some lasting more than a day. The most significant traffic jam took place on the Beijing-Tibet Expressway in China on August 14, 2010, lasting 12 days. Vendors exploited the situation by selling food and beverages at four times the usual price, while water was sold at ten times the standard rate [3].

3.2 Critical Issues Affecting Road Traffic in India

India, with a high population density and a 77.7% literacy rate, has seen significant improvements in highway infrastructure over the past decade. However, this growth has not kept pace with the rapid increase in vehicular traffic and urban development, leading to congestion and rising accident rates. According to the 2021 MORTH report, over 150,000 fatalities and 380,000 injuries occurred due to road accidents. The main causes include human error (41%), poor road infrastructure, and vehicle conditions. Excessive speed, wrong-way driving, and lane violations are the primary contributors to accidents, especially on urban roads.

Traffic congestion in India is worsening, particularly in cities like Bengaluru, Mumbai, Pune, and Delhi, which rank among the world's most congested cities (TomTom, 2020). A Boston Consulting Group (2018) report highlights that commuters in major cities spend over 1.5 hours daily in traffic. Analysis shows that 30% of

congestion is due to poor road infrastructure, 25% to high vehicle density, and 20% to traffic rule violations. Other factors include road accidents (10%) and the lack of public transport (10%), while encroachments and street vendors (5%) further add to the problem. Addressing these challenges requires better traffic planning, infrastructure expansion, and enforcement of road safety regulations to improve urban mobility [9]

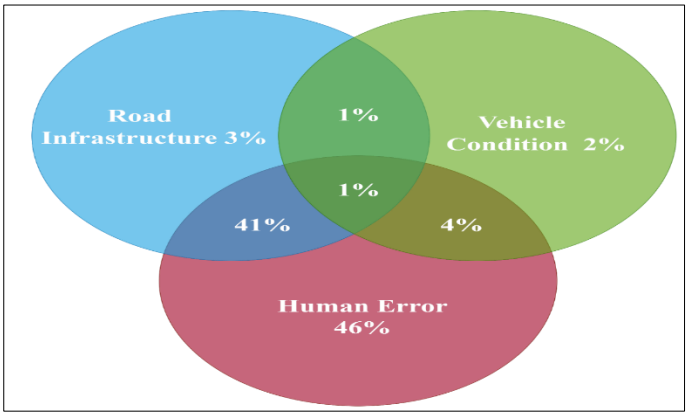

Fig. 3 Causes of road accident factors in Ahmedabad, Gujarat [9]

According to TomTom (2020), business traffic adversely affects India. Four of the ten most congested cities globally are in India. Especially Bengaluru (71), Mumbai (65), Pune (59), and Delhi (56). In line with the Boston Consulting Group report (2018), daily commutators in Delhi, Mumbai, Bengaluru, and Kolkata typically spend 1.5 hours or more traveling during peak business hours. Traffic indicators (CI) used for monitoring congestion during peak hours demonstrate a direct correlation between traffic volume and accident frequency [39]. The continual rise in population has resulted in a substantial increase in the number of vehicles on road planning, particularly regarding capacity considerations. Therefore, traffic analysis is crucial for enhancing existing infrastructure and addressing the future capacity requirements of roadways [27].

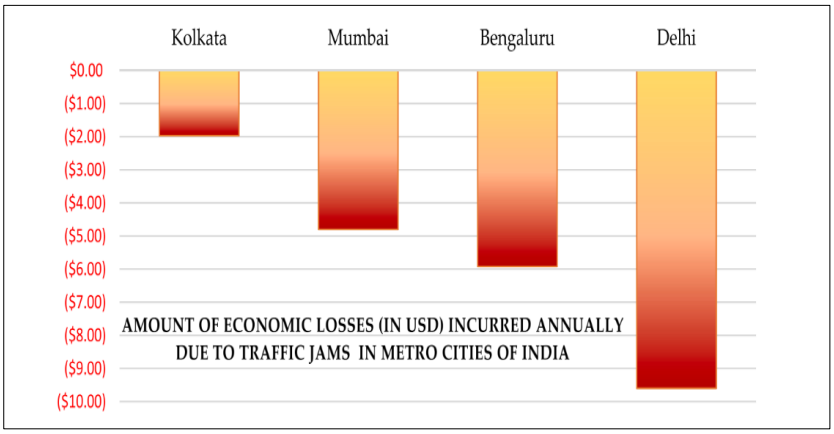

Fig.4 Traffic congestion in India's metro cities leads to substantial annual economic losses in use [3]

Figure (4) presents an analysis of prevalent traffic challenges at the national level in India, detailing the distribution of road development factors and traffic issues. It illustrates that 30% of the problems are attributed to inadequate road infrastructure, while 25% are associated with high vehicle density. Traffic rule violations account for 20% of the overall traffic issues. Additionally, road accidents and the lack of public transport contribute 10%. Lastly, encroachments and street vendors constitute 5% of the challenges. This data provides a comprehensive overview of the principal factors affecting urban traffic conditions in India. [14].

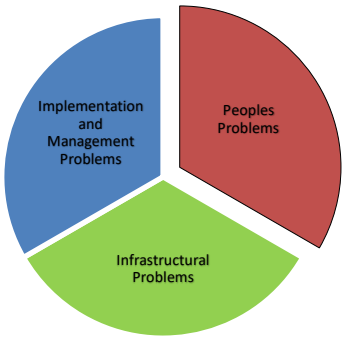

Fig 5. Major factors behind congested roads [14]

3.3 Maharashtra Road Congestion Crisis

Uncontrolled traffic conditions substantially dander to pedestrians, as traffic management or control systems are absent, and road priorities are not established. Consequently, road users in these environments depend heavily on negotiating priorities, leading to more frequent and complex interactions between them.

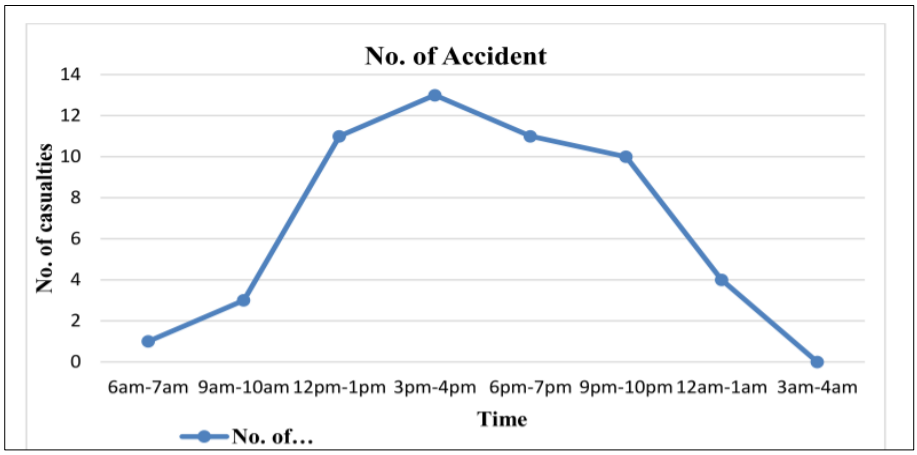

Fig. 6 Accident Rate Time Wise (2022-2024) [17]

Microscopic traffic management models provide a clear understanding of the connection between vehicles, commuters, and road systems, primarily relying on the accuracy of accessible data. On the other hand, macroscopic models create a mathematical connection by analyzing traffic density and flow, integrating microscopic traffic flow models, and translating individual characteristics. Mesoscopic models concentrate on probability circulation, offering insights into traffic patterns and behavior, and are further categorized into cluster and kinetics models. Hybrid traffic simulation models are emerging as valuable tools for analysis, with several researchers developing software to study this traffic behavior, which is increasingly relevant in developing smart cities.

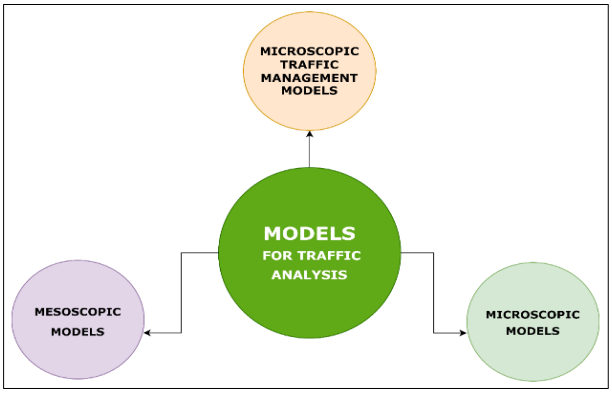

Fig.7 Models for traffic analysis [22,23]

3.4 Current traffic issues at Yavatmal City:

The intersection, affected by traffic from the city roads and National Highway 361, often experiences wrong-way driving, frequent stops, speed fluctuations, and congestion during peak hours. A flyover bridge is proposed as a solution to address these challenges. The primary goals of this flyover bridge are to optimize traffic flow, enhance safety at the intersection, and reduce problems such as wrong way driving and congestion during busy times. to resolve traffic issues and provide a smoother transportation facility with safety while supporting the overall growth and development of Yavatmal City [26].

Fig. 8 A Google earth image of the study area

4. Literature Review

4.1 D. Firmansyah (2024): have focused on the progression of motorcycle-related studies in Asia and categorized studies such as accidents and human factors, traffic and policy, air pollution, motorcycle engineering and performance, and roads and technological innovation, demonstrates a clear evolution in the scope of research as the issues surrounding motorcycles have expanded beyond safety concerns to include environmental impacts, technological advances, and also urban sustainability. provide insights into the geographical distribution of research, noting that China (including Taiwan) has contributed the most to the field. Furthermore, the study suggests several emerging areas of interest for future research, such as eco-friendly fuels, diverse motorcyclist behaviors, and technology-based safety improvements [2].

4.2 Wallenstein-Betech, et al. (2023): have evaluated lane reversal strategies under asymmetric demand, such as during evacuations or large events. Their study showed that travel time reductions could reach up to 60%, offering insights for optimizing traffic flow through lane management [3].

4.3 Pang et al. (2023): have focused on optimizing biofuel blends for improved combustion efficiency, suggesting that more efficient engines reduce fuel consumption and can indirectly alleviate traffic congestion over time. These advancements align with sustainable mobility goals [4].

4.4 Sun et al. (2022): have analysed how governance policy changes and socioeconomic variations affect traffic congestion. They evaluated various time scenarios and identified the most detrimental factors, providing insights for regional policy development [5].

4.5 Vencataya, et al. (2018): have recommended that policymakers adopt better management strategies and invest in infrastructure and implementing policies that can alleviate congestion and improve overall travel conditions. Their study in Mauritius analyzed the effects of congestion on worker productivity in which the Congestion leads to longer commuting times, which reduces overall productivity, Economic growth health in which increased traffic delays can negatively impact the economy by reducing the efficiency of the labor force and hindering business operations, and also providing insights for urban planning [6].

4.6 Anciaes et al. (2017): have revealed differences in transportation preferences based on residence, gender, and employment status, underscoring the need to integrate community perspectives in traffic assessments for more effective mitigation strategies [7]

4.7 Salatoom, et al. (2015): have addressed the issue of traffic congestion at an at-grade intersection near a large city and proposes a solution in the form of a flyover bridge. The flyover aims to improve traffic flow on the main highway by allowing vehicles to bypass the intersection, reduce traffic congestion in two directions.

However, They highlighted the importance of flyover which diverted 30-35% of the traffic volume on the flyover, Therefore 30% reduction in time delays during the same period and also suggested specific strategies for enhancing the efficiency of the flyover-improved junction such as adjusting the traffic signal cycle and phase times to better align with the new traffic patterns post-flyover construction [8].

4.8 Dimri, et al. (2024): have proposed adjusting green light durations based on vehicle arrival rates, where paths with higher traffic receive longer green signals. This streamlined green light allocation reduces traffic jams, long queues, and waiting times. Simulation results demonstrate significant improvements during peak hours, ensuring smoother traffic flow and reducing waiting times, particularly during the busiest periods of the day [9].

4.9 Bhavsar et al. (2023): have developed that lead to severe urban traffic challenges such as congestion, rule-breaking, and accidents. This case study focuses on a multilane roundabout in Ahmedabad, where drone footage was used to analyze traffic and identify violations. They provide insights for improving road design, enforcement, and policy to ensure better traffic safety [10].

4.10 Chellapilla et al. (2023): have observed strategies to alleviate traffic congestion in road networks by optimizing underutilized road capacities and easing pressure on congested links. Their finding suggests that the proposed models can help traffic planners and managers enhance infrastructure use and conditions [11].

4.11 Raju et al. (2023): have introduced the structure for observing highway traffic using quality trajectory data from diverse traffic. They tested it on two road sections in India, one without construction activity and the other with ongoing construction work. They tracked movements and analyzed data across three flow levels, providing measures during traffic congestion [12].

4.12 Shandhana Rashmi (2023): has highlighted the significant public health issue of road traffic injuries. Understanding complex driver behaviours and potential violations is essential for reducing accidents. They assist firms and stakeholders in identifying gaps and developing effective preventive measures to enhance truck driver safety [13].

4.13 Mahajan (2022): has signified the rising demand for transportation in India due to economic and infrastructural development, population growth, and significant issues, particularly in metropolitan areas like Pune. They analysed the causes of congestion to propose solutions for better planning, design, and cost-efficient systems [14].

4.14 S. V Yadav et al. (2024): have accentuated multiple causes of accidents, including road defects, human errors, and vehicle engineering flaws. They focus on reducing accident severity using geodetic techniques to improve traffic signals and road safety devices [17].

4.15 Habibullah et al. (2024): have amplified the role of a cyber-physical framework that connects physical structures with digital systems, enhancing immediate data gathering and traffic management in rapidly urbanizing cities [18].

4.16 Ezzati Amini et al. (2024): have measured the increasing popularity of motorcycles in Asia, highlighting accident risks due to affordability and flexibility. They identify future research directions focusing on eco-friendly fuels and technology-based safety solutions [19].

4.17 A. Bhardwaj et al. (2023): have deconstructed that such jams can occur in extremely brief periods, which is why they are referred to as sudden traffic jams. They have attributed traffic jams in developing cities, linking them to poor traffic management and suggesting infrastructure improvements and better road system management [20].

4.18 Mishra et al. (2023): have pointed the need for improved traffic management strategies, including redesigning the intersection and implementing advanced signaling systems to enhance safety and efficiency. They provide a comprehensive analysis of traffic patterns and accident data. The study offers actionable recommendations to reduce conflicts and optimize traffic flow; they underscored the importance of proactive management to ensure safer transportation at the LIC Square intersection [21].

4.19 Roopa Ravish, et al. (2021): have studied the administration of increasing vehicle flow as a challenge worldwide. How ITS (Intelligent Transportation Systems) technology is used for traffic management in flyover bridges. It categorizes the solutions into four groups. The first one is traffic information solutions, traffic oversight solutions, congestion mitigation solutions, and travel time forecasting solutions [22].

4.20 Rose Mary Xavier et al. (2021): studied to analyze and compare the peak value of the three intersections, which took the highest. The peak value selected for traffic volume data collection has been chosen to ensure accurate and reliable analysis, which implements the present and future demands of the traffic may be satisfied [23].

4.21 Shaik Zia Ur Rahman et al. (2020): have described Hyderabad city, which is facing major traffic problems at peak hours. In this study, the outcome will be the flyover constructed to reduce horizontal curvature and reduce the risk of accidents and road crashes [24].

4.22A. P. S. Gawande et al. (2020): have observed the skew intersection at Lohara M.I.D.C. in Yavatmal City and highlighted the necessity for a comprehensive survey and design of an effective traffic system. Traffic signals are recognized as a flexible and beneficial method for controlling traffic. There was less congestion and accidents while enhancing traffic flow [25].

5. Future Scope:

- Promoting better public transport, pedestrian-friendly roads, and eco-friendly designs.
- Identifying other busy areas where flyovers can help improve traffic flow.
- To improve urban transport.
- to optimize road space and minimize traffic jams.
- to support sustainable urban development.

6. Conclusion

The literature review highlights various global and national strategies for managing traffic congestion and road safety. Studies emphasize the effectiveness of flyover bridges and improved infrastructure in reducing congestion and enhancing mobility. Research also identifies human error, poor road design, and increasing vehicle density as major contributors to traffic issues. To address these challenges, the proposed flyover aims to divert 30–35% of traffic, reduce wrong-way driving, and ensure smoother and safer vehicle movement.

References:

1. "World meter (*India population (live)"*. accessed: Sep. 26, 2024. [online]. available: https://www.worldometers.info/world-population/india-population/
2. D. Firmansyah, M. Z. Irawan, M. R. F. Amrozi, B. Maitra, T. Rahman, and N. O. Widiastuti, "A bibliometric analysis of motorcycle studies in Asia: From 1971 to 2022," *IATSS Research*, vol. 48, no. 1. Elsevier B.V., pp. 68–83, Apr. 01, 2024. doi: 10.1016/j.iatssr.2024.01.005.
3. S. Wollenstein-Betech, I. C. Paschalidis, and C. G. Cassandras, "Optimizing Lane Reversals in Transportation Networks to Reduce Traffic Congestion: A global optimization approach," 2022. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0968090X22002595
4. J. Pang, "Enhancing Urban Traffic Management: Advanced Strategies in Image Recognition-Based Intelligent Traffic Monitoring," *Treatment du Signal*, vol. 40, no. 6, pp. 2587–2597, Dec. 2023, doi: 10.18280/ts.400621.
5. C. Sun and J. Lu, "The Relative Roles of Socioeconomic Factors and Governance Policies in Urban Traffic Congestion: A Global Perspective," *Land*, vol. 11, no. 10, Oct. 2022, doi: 10.3390/land11101616.
6. L. Vencataya, S. Pudaruth, G. Dirpal, and V. Narain, "Assessing the Causes & Impacts of Traffic Congestion on the Society, Economy and Individual: A Case of Mauritius as an Emerging Economy," *Studies in Business and Economics*, vol. 13, no. 3, pp. 230–242, 2018, doi: 10.2478/sbe-2018-0045.
7. P. R. Anciaes, P. J. Metcalfe, and C. Heywood, "Social impacts of road traffic: perceptions and priorities of local residents," *Impact Assessment and Project Appraisal*, vol. 35, no. 2, pp. 172–183, Apr. 2017, doi: 10.1080/14615517.2016.1269464.
8. N. Salatoom and P. Taneerananon, "A study of a flyover-bridge - improved intersection," *Engineering Journal*, vol. 19, no. 1, pp. 1–12, Jan. 2015, doi: 10.4186/ej.2015.19.1.1.
9. S. C. Dimri *et al.*, "Modeling of traffic at a road crossing and optimization of waiting time of the vehicles," *Alexandria Engineering Journal*, vol. 98, pp. 114–129, Jul. 2024, doi: 10.1016/j.aej.2024.04.050.
10. Y. M. Bhavsar, M. S. Zaveri, M. S. Raval, and S. B. Zaveri, "Vision-based investigation of road traffic and violations at urban roundabout in India using UAV video: A case study," *Transportation Engineering*, vol. 14, Dec. 2023, doi: 10.1016/j.treng.2023.100207.
11. H. Chellapilla, R. Sivanandan, B. R. Chilukuri, and C. Rajendran, "Bi-objective optimization models for mitigating traffic congestion in urban road networks," *Journal of Traffic and Transportation Engineering (English Edition)*, vol. 10, no. 1, pp. 86–103, Feb. 2023, doi: 10.1016/j.jtte.2021.09.006.
12. N. Raju, S. Arkatkar, and S. Easa, "Receptiveness angle: A new surrogate safety measure for monitoring traffic safety," *IATSS Research*, vol. 47, no. 4, pp. 526–534, Dec. 2023, doi: 10.1016/j.iatssr.2023.11.004.
13. B. Shandhana Rashmi and S. Marisamynathan, "Factors affecting truck driver behavior on a road safety context: A critical systematic review of the evidence," *Journal of Traffic and Transportation Engineering*

(English Edition), vol. 10, no. 5. KeAi Communications Co., pp. 835–865, Oct. 01, 2023. doi: 10.1016/j.jtte.2023.04.006

14. R. Mahajan and D. Mahajan, "To Study the Factors Causing Traffic Problems in India with Specific Reference to Pune City: A Conceptual Framework," *Civil Engineering and Architecture*, vol. 10, no. 3, pp. 1071–1080, May 2022, doi: 10.13189/cea.2022.100323.
15. TomTom. (2020). *TomTom traffic index 2020*. Retrieved from https://www.tomtom.com/en_gb/trafficindex/
16. Boston Consulting Group. (2018). *The future of urban mobility: How transportation trends are reshaping India's cities*. Retrieved from https://www.bcg.com/publications/2018/future-of-urban-mobility
17. S. v Yadav, A. G. Chaudhary, M. Tech Student, and A. Professor, "Traffic Accident Analysis Of Road Segment in Yavatmal City," 2024. [Online]. Available: www.ijcrt.org
18. M. Habibullah and M. N. Alam, "Enhancing Traffic Management in Smart Cities: A Cyber-Physical Approach." [Online]. Available: www.ijfmr.com
19. Bhardwaj, S. R. Iyer, S. Ramesh, J. White, and L. Subramanian, "Understanding sudden traffic jams: From emergence to impact," *Development Engineering*, vol. 8, Nov. 2023, doi: 10.1016/j.deveng.2022.100105.
20. R. Ezzati Amini, M. Abouelela, A. Dhamaniya, B. Friedrich, and C. Antoniou, "A game-theoretic approach for modelling pedestrian–vehicle conflict resolutions in uncontrolled traffic environments," *Accident Analysis and Prevention*, vol. 203, Aug. 2024, doi: 10.1016/j.aap.2024.107604.
21. H. D. Mishra, S. v Parise, D. S. Patil, M. M. Lohakare, S. v Tayade, and A. Professor, "Study And Analysis Of Rotary Intersection At Lic Square, Yavatmal," 2023. [Online]. Available: www.ijnrd.org
22. R. Ravish and S. R. Swamy, "Intelligent Traffic Management: A Review of Challenges, Solutions, and Future Perspectives," *Transport and Telecommunication*, vol. 22, no. 2, pp. 163–182, Apr. 2021, doi: 10.2478/ttj-2021-0013.
23. R. M. Xavier, E. Antony, J. Mathew, P. P. Shibu, and S. K. Muhammed, "Traffic Analysis And Design Of Flyover," *International Research Journal of Engineering and Technology*, 2021, [Online]. Available: www.irjet.net
24. S. Zia UrRahman, "Analysis and Design of Flyover Bridge," 2020. [Online]. Available: www.ijprse.com
25. P. S. Gawande, K. Jagtap, and N. Kamnani, "Advanced Traffic SignaL Management Of Yavatmal City (M.H.)," *International Research Journal of Engineering and Technology*, 2020, [Online]. Available: www.irjet.net
26. World Bank. (2022). *India: Urban transport and traffic management*. https://www.worldbank.org
27. Ministry of Road Transport and Highways, "Road accidents in India 2021," Accessed Feb. 24, 2023. Available: https://morth.nic.in/road-accident-in-india.