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A Review of "Evaluation of the Need for Highway Redesign and Modernization."

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Abstract - *This study addresses the primary challenge of defining quantitative and qualitative criteria in order to proceed with a comprehensive road condition evaluation. This method may be utilised by road authorities as a trustworthy instrument in the context of successful road upgrade management. Since ancient times, transportation has contributed to the development of civilizations by satisfying the travel and transit needs of people and products. Road and transportation have become a vital element of every person's life in the modern era. In contrast, it has been noticed that deaths have doubled in the past decade. Approximately 1.2 million Indians were murdered in automobile accidents during the past decade, or one every four minutes on average, while 5.5 million were badly wounded. Consequently, analysis and planning are of the utmost importance in a road project, taking in mind both the current and future demands of the region. This paper's primary objective is to present a complete overview of the upgrading strategy for existing highways, as well as the relevant technology to tackle the problem of traffic flow and prevent road accidents. This article investigates research on the "need for upgrading and redesigning the Nagpur Katol National Highway" The route is mostly located in an orange-growing region and will benefit the orange industry. Upgrading the present two-lane road to a four-lane road with paved shoulders would improve transportation in terms of the speed and congestion-free flow of traffic, and will also promote human interaction in adjacent communities.)*

Key Words: Existing Highway, Transportation, Traffic Flow, Road, National Highway, Accidents, and the Insurance Research Council.

1. INTRODUCTION

Highways are constructed to accommodate the traffic volume at the time of design together with a projection of the potential increase in traffic flow in subsequent years. In addition to an increase in vehicle ownership, factors such as an increase in human activities such as educational activities, business activities, and many others lead to an increase in traffic volume that exceeds the capacity of the highway, necessitating an upgrade of existing highways to include more lanes and, in some cases, more durable materials, such as an upgrade from flexible to rigid pavement. This article examines the impact of size on the design of ecologically (socially and biophysically) sustainable linear roadways. The objective of the review is to provide stakeholders, planners, and decision-makers with improved and more transparent techniques for the generation of alternatives in alignment planning practise, as well as to improve the practise of environmental assessment, which is typically a mandatory regulatory process that should precede and run concurrently with planning, implementation, and monitoring exercises. The purpose of this study is to investigate the obstacles posed by improving existing roadways, as well as the impacts that may come from taking into account aspects such as economic, cultural, environmental, etc. Attempting to give a complete overview of the upgrading technique for existing roads as well as relevant technology to address the traffic and upgradation of existing highways is the purpose of this article. In addition, the publication summarizes the study's key results and suggests policy-relevant options for further research.

1.1 NAGPUR KATOL NATIONAL HIGHWAY (NH-353J)

Fundamental to the methodology is the categorization of all two-lane roads into four separate groups based on their existing condition and traffic characteristics.

Category 1 roads are characterised by a high degree of service and suitable geometric characteristics, hence ensuring safety and riding comfort. The alignment is appropriate, and the crossings are planned in accordance with current design requirements. The width of the pavement guarantees adequate serviceability. No substantial improvements are necessary. The primary issues to be addressed are the emergence of cracks or rutting, an increase in slickness, and inadequate safety equipment.

For Category 2, the level of service is within the range of steady flow, the geometry is typically appropriate, and the pavement width is also sufficient according to design criteria. However, the junction design is insufficient in relation to real traffic demands, and the transition geometry at turns is flawed.

Categorization 3 comprises roadways with a low LOS. The majority of geometric components are poor in relation to contemporary traffic circumstances, posing an incident risk to motorists. The volume of traffic appears to have risen

dramatically over the years, and road usage has escalated. Roadway and lane width do not meet contemporary traffic requirements. The road must be widened and maybe realigned in accordance with modern design, safety, and traffic regulations.

Category 4 contains highways with operating conditions at or near capacity where the usefulness of upgrading is dubious. An average restoration project cannot qualify as a sustainable technical solution for an ageing road in a sensitive natural environment. Moreover, unique inherent limits for roads in populated areas or in the proximity of archaeological sites may prevent upgrading activities on the present alignment and instead prescribe a completely new path.

According on the preceding criteria, each road can be classed as one of the categories listed above. Due to the correct condition evaluation, this categorization renders the plan for upgrading comprehensive and well-defined. For each road type, a unique upgrade strategy is envisioned.

The National Highways Authority of India will shortly begin work on the 50-kilometer portion of the Nagpur-Katol national highway after receiving stage-I approval under the 1980 Forest Conservation Act (FCA). The construction of the highway between Kalmeshwar and Katol required an expenditure of 1,350 crore. As NH-353J begins 13 kilometers from the Zero Mile near the Fetri T-point, it is one of the most important connections linking Nagpur-Katol-Warud-Amravati and beyond Madhya Pradesh. The 5-kilometer congestion between Katol Naka and Fetri will be eliminated if the route begins at the outer ring road, according to AbhijeetJichkar, project director of NHAI.

The road segment will be classified as a one-time upgrade in accordance with the current policy. As the project has been divided into two parts, the 13 km section will be addressed during the second phase. The first phase is planned such that highway traffic will be permitted up to the outer ring road (ORR) and will thereafter continue along it without entering the city. A firm from Aurangabad has been selected to finish the project following an open bidding process.

Estimated Project Cost of Rs.1350 Cr. 14.07 Hectare of diverted forest area 3300 Trees to be felled 21794 Existing traffic in passenger vehicle unit (Fig.1 Map of Nagpur Katol National Highway 353-J)

Satellite view of the Nagpur Katol National Highway.

Rs.1350 Cr Estimated Project Cost	14.07 Hectare Forest land diverted
3300 Trees to be cut	21794 Existing traffic in passenger car unit

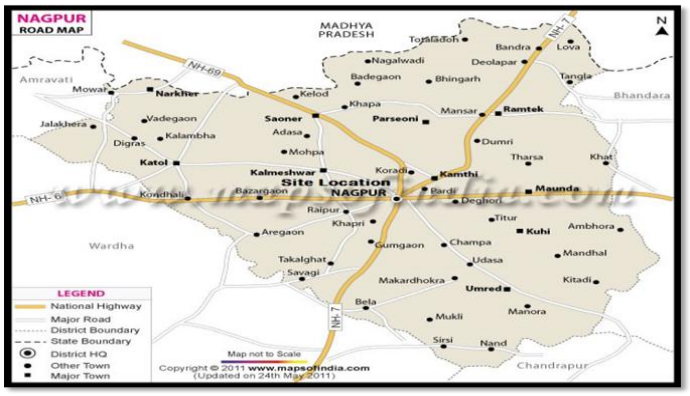

Figure 1 Map of Nagpur Katol National Highway 353-J

Figure 2 Satellite View Nagpur Katol National Highway

1.2 RADIUS OF THE STUDY

- Level of service estimation for two-lane split National Highway 353-J (Nagpur to Katol).
- The entire distance examined in the study is around 50 kilometres.
- The highway is one of the primary connections between Nagpur-Katol-Warud-Amravati and Madhya Pradesh, since NH-353J begins 13 kilometres from Zero Mile near Fetri T-point.
- The geography and traffic factors of the research region are investigated.
- This research analyses the existing traffic situation and offers modifications to geometric conditions to enhance traffic conditions.

1.3 OBJECTIVE OF STUDY

- Analyze traffic data necessary for improving a highway's traffic flow.
- To examine the present road geometric design of the Two-lane split carriageway, stretch from Nagpur to Katol (NH-353J).

- Analyze the present geometric condition of the road under different roadway and traffic circumstances.
- To investigate numerous roadway geometry factors in order to comprehend the current status.
- To establish the necessary reason for upgrading the motorway.
- To utilise analyse data for pavement.
- Upgrade the current two-lane roadway to a four-lane highway with optimal shoulder and median widths according to IRC criteria.
- Propose an alignment that is as similar as practicable to the present alignment in order to increase vehicle speed and quality of service while decreasing travel time, delays, and queue lengths.

2. Literature Review

Singh and Mishra (2006) conducted a road accident study in the city of Patna and analysed the main causes of accidents. In the majority of Indian cities, urban transport infrastructure is poor and decaying over time. The growth of the public transportation system has not kept pace with the traffic demand in terms of both quantity and quality. As a result, the usage of unwanted modes such as private transport, primarily two-wheeled vehicles, and intermediate public transit, namely three-wheeled vehicles, is increasing at a rapid rate. Today, parked automobiles, hawkers, and roadside businesses encroach extensively on roadways and pathways, forcing people to walk on the road. This not only impedes the flow of traffic but also places pedestrians' lives in grave danger. Bihar is one of the poorest and most populous states in India, and its main city, Patna, is loud, congested, filthy, and often chaotic. The city's roadways are clogged and invaded by other activity. Particularly, bus services have worsened, and their efficiency and quality of service have declined, causing passengers to switch to customised modes and IPTs. This not only impedes the flow of traffic, but also places the lives of road users in grave danger. Over the years, the overall number of fatal accidents and related fatalities in the city has increased. In under two decades, the number of registered motor vehicles in Patna has increased by 67 times, from 4,384 in 1981 to 294,164 in 2001, a 67-fold rise. When calculated from 1981 to 2001, the yearly growth rate rises to almost 23 percent. Due to the absence of a mass transportation infrastructure, it has been noticed that the expansion of customized vehicles such as two-wheelers and automobiles is extremely rapid. The Patna public transportation system as a whole is insufficient, inefficient, and unplanned; as a result, it is unable to meet the population's travel needs as effectively as feasible.

Do not use abbreviations in the title or heads unless they are unavoidable.

Karim et al. (2009) researched road safety issues and difficulties. In the early years of the twenty-first century, a relatively new mechanism was enacted to uncover potential road safety issues at various phases of road construction projects. The road safety audit examines both new road infrastructure projects and road repair initiatives. The road safety audit methods have been designed to encompass all phases of project execution, including the planning, preliminary design, detailed design, construction (or pre-opening), and operating phases.

Jain et al. (2009) conducted a safety assessment of four-lane national roads. The Road Safety Audit (RSA) is a systematic method for evaluating the accident risk and safety performance of new and existing roadways. RSA is an efficient, cost-effective, and proactive method for enhancing road safety. It has been demonstrated that RSA has the capacity to save lives. The RSA was invented in Great Britain and has now spread to the United States, Australia, New Zealand, Denmark, Canada, Malaysia, and Singapore. Developing nations such as India, South Africa, Thailand, and Bangladesh are at varied phases of adoption. RSA looks to be a suitable instrument for enhancing road safety in India, since fundamental and precise data on incidents have not yet been gathered.

DevarajHanumappa and Parthasarathy Ramachandran (2009) did research titled "Cellular Automata Model for Mixed Traffic Flow with Lane Changing Behavior." Indian cities are characterised by largely mixed-traffic streets. The modelling of mixed traffic combining vehicles with varying speeds, lengths, and widths is a complex problem. Based on the finer cell system of cellular automata (CA) models, this research offers to analyse the mixed traffic behaviour of vehicles and motorbikes in Indian towns with intermediate lane width. Even with the presence of motorbikes, the maximum automobile flow seen in the data is more than predicted by the Na-Sch model for cars. This rise is mostly the result of altered behaviour. The automobile flow reduces as the motorbike density increases. In addition, the research intends to examine the impact of lane change behaviour on the speed and flow of the traffic stream by employing the fundamental diagrams of speed flow density curves. The

simulation result reveals that the likelihood of lane changes has minimal impact on the pace and flow of traffic.

Kumar A., Dhananjay A. S., Agarwal A., Badage G., BhagatC., Devkar A., Kadam S. (2015), The author shows that the construction of an efficient road transportation infrastructure is a prerequisite for each developing nation. In addition, updating the current road network is necessary for industrialised nations to carry out their transportation tasks efficiently, since urban and non-urban highways reach their saturation point with growing traffic volume. The design of the route alignment and pavement structure determines the project's cost, which is entirely dependent on the duration of the project. Therefore, the best accessible Highway Geometric Design Software must be utilised for this task. In consideration of this, the author has utilised MXROAD Software for the geometric design of the existing state highway (SH 131) in Maharashtra in order to improve its geometric characteristics and expand it from two to four lanes. The software employs 3D string modelling technology and provides the appropriate values for many geometric design components, such as horizontal and vertical curves, super elevation, shoulder, etc. Journal Article 6 (Summary)

VikasGolakoti (2015), His dissertation consists of road geometry factors, data collecting, and geometric parameter analysis. This study aims to determine the effect of road geometry variables on accident rates on flat terrain, as well as the extent to which these parameters impact accident rates in rural regions. The study intends to determine the effect of elements such as additional width, horizontal radius, sight distance, K-value, super elevation, horizontal arc length, vertical arc length, and vertical gradient on the accident rate, as well as to determine the values for future road design. Journal Article 7 (Summary) Shukla (2008) investigated the mixed traffic flow behaviour on a four-lane divided highway under varied circumstances of traffic volume and shoulder and created a simulation model to predict roadway capacity under these conditions based on the observed traffic flow. The arrival pattern of cars, speed characteristics, lateral positioning of vehicles, and overtaking behaviour were investigated in order to comprehend the traffic flow behaviour on four-lane divided roads under mixed traffic conditions. This exhaustive review of the literature reveals that no substantial work has been done to establish the roadway capacity for varying carriageway widths on multi-lane highways, urban roads, and urban expressways for the heterogeneous traffic mix prevalent on Indian highways with a reasonable degree of confidence; therefore, this research effort can be considered a significant effort in this direction

3. PROPOSED METHODOLOGY

Toxicology at the Indira Gandhi Government Medical College in Nagpur has conducted retrospective research spanning two years. There was a total of 460 road traffic accident-related fatalities, which accounted for 22.24 percent of all autopsies of unnatural deaths. Greatest numbers of road traffic casualties were men (87.61 percent) and maximum deaths in the 20-39 age group (55.43 percent), with a significant male predominance across all age categories. In the majority of incidents, pedestrians were targeted (43.91 percent). 60 percent of victims died at the scene of the accident, and 84.58 percent perished within 24 hours. The majority of deaths were caused by damage to essential organs (49.13 percent), followed by head injury, bleeding, and shock (37.17 percent, 10.65 percent, and 10.65 percent, respectively).

Table 1 : Last 3 years Statistics of Road Accidents in Maharashtra

ROAD ACCIDENTS IN MAHARASHTRA								
YEAR	FATAL		GRIEVOUS INJURY		MINOR INJURY		WITHOUT INJURY	TOTAL ACCIDENTS
	Accident	Killed	Accident	Injured	Accident	Injured		
2017	11454	12511	12333	20767	7098	11477	5171	36056
2018	12098	13261	12648	20335	6585	11030	4386	35717
2019	11787	12788	12197	19152	5473	9476	3568	32925
Diff %	-3	-4	-4	-6	-17	-14	-19	-8

The following information indicates that there was an increase in deaths and serious injuries in 2018 compared to 2017, however there has been a decrease of 4 percent in fatalities, 6 percent in serious injuries, and 8 percent in total accidents compared to 2018. In 2019, there were 32,925 total road traffic accidents, a reduction of 8 percent compared to 2018. In 2019, 12,788 people perished as a result of these accidents. Based on the available statistics, there will be 38.8 percent more fatal accidents in Maharashtra in 2019 than in 2018. Approximately 90 accidents and 35 fatalities occur daily on the state's roadways, which equates to an average of 3 lives lost every two hours. The total number of registered motor vehicles in 2019 was 23,1 million. In the same year, the total length of roads was 2,67,451 kilometers. These road networks include interstates, state highways, district roads, and rural and village roads. 3,7 percent of the nation's gross domestic product is lost due to traffic accidents.

25 percent of the 12,788 fatalities happened in three districts: Pune (1,329), Nashik (960), and Ahmednagar (873). The 2872 accidents recorded in Mumbai City resulted in 447 fatalities. In 2019, the district of Satara has an alarming 83 percent increase in accidents and a 120 percent increase in deaths compared to 2018, whereas Ratnagiri has a 37 percent decrease in accidents. Thane Rural (accidents by 21%, deaths by 26%) and Washim district (accidents by 16%, fatalities by 23%) indicate a decline in accidents and fatalities. Even though road accidents are one of the top ten leading causes of human mortality, they are often overlooked

due to the widespread notion that they are random, unavoidable, and unexpected. The biggest cause of traffic accidents in Maharashtra is, among other things, driver error.

The highest number of accidents, 3228 and 3245 respectively, and deaths, 1203 and 1146 respectively, happened in the months of May and January, possibly as a result of the increased number of cars on unfamiliar roads during the holiday season.

October had the fewest accidents (2201) and September had the fewest fatalities (784), possibly due to the wet season causing less automobiles to be on the road. Additionally, less agricultural goods is transported during this season. Table 2: Scenario of Road Accidents in Nagpur S.No. Year Total Accident Total Killed Total Injured

Year	Total Accident	Total Killed	Total Injured
2017	897	350	887
2018	996	346	981
2019	843	384	950
2020	195	283	373
2021	958	269	950

3.1 METHODOLOGY

This study discusses the upgrade of geometric design for the widening of NH-353J in the state of Maharashtra in order to decongest the urban boundaries of the Nagpur-Katol section. The geometric design of a highway entails the design of the highway's visible physical characteristics, including cross-sectional components, sight distances, alignment, bends, super elevation, and other auxiliary features based on available topography data. The traffic regulatory system, vehicle speeds, acceleration and deceleration characteristics of different vehicle classes (Bus, trucks, auto-rickshaw, cars, bikes, LMV, HMV), intersection, rotary, rotary intersection, signal intersection, and signal interlocking must be studied in order to complete the research.

⇨ **Selection of topic and formulating objectives and scope of research**
⇨ **Collection of data**
⇨ **Development of a current scenario traffic simulation model**
⇨ **Redesign of road using CADD Software**
⇨ **Development of a redesigned scenario traffic simulation model**
⇨ **Comparison and validation of current and redesigned simulation models**

Initially, an appropriate topic is chosen and all pertinent information is gathered. Existing geometric design is utilized to conduct a study of the present traffic environment. If the output data collected by the simulation model are deemed insufficient according to design standards, a geometric redesign of the road is performed in which the road is enlarged and the alignments are modified in accordance with IRC criteria. The rebuilt model undergoes a simulation check in which its Level of Service is monitored and adjusted until the required values are reached. The flowchart depicts the stages of the research procedure. Selection of topic and formulation of research objectives and scope Data collection Development of a current scenario traffic simulation model Redesign of road utilising CADD software Development of a redesigned scenario traffic simulation model Comparison and validation of current and redesigned simulation models. National Highway Authority of India, Ministry of Road Transport and Highways (MORT&H), Government of India have carried out the Widening and Strengthening of Existing National Highway Development in India. Existing road condition, traffic volume, and road composition to anticipate road deterioration in accordance with urban and rural road circumstances did not meet IRI standards.

3.2 SITE OF THE PROJECT

National Highway No. –353J :-The condition of the existing pavement is poor to good. Generally, the existing road is having 2 lanes with paved shoulders

Figure 3: Inadequate super elevation and curve radius in NH 353-J

The information provided in this schedule is for the Concessionaire's first comprehension and direction. NHAI is not responsible for any inaccuracies in the submitted information and is not accountable for or constrained by the Concessionaire's use of data. pertinent to the main course The following summary of the criteria for the various aspects of the Project Highway is the bare minimum for the 'Project' The term 'Project' has the same meaning as established in the concession agreement's section 1.1.

In the planning, design, and execution of the works and other works associated with the repair, maintenance, or improvement of the Project Highway and functions associated with the construction of the Project highway and roadside facilities, the concessionaire shall take all such actions and do all such things (including, but not limited to,

organising itself, adopting measures and standards, executing procedures including inspections, etc.) as may be necessary.

Enable NHAI to provide an acceptably safe highway in terms of its condition (structural safety) and use (road safety) and. Enable NHAI to fulfil its statutory and common law obligations and. Enable NHAI to provide a level of service in the public not inferior to that provided on the trunk road during construction or improvements works and. Enable NHAI to provide a congestion-free, uninterrupted flow of traffic on the Project Highway and. Enable the

Provide a safe, clear, and informative system of road signs and, Comply with any specified programme requirements including for the completion of the new road and, Enable standards of fitness for the purpose appropriate for a highway to the character of the Project Highway to be achieved throughout the contract period and, Ensure adequate bus bays for stopping of buses and bus shelters for commuters to wait under cover and, Provide adequate off-street parking and, Provide adequate on-street parking.

3.4 ROAD UPGRADING

3.4.1 MAINTENANCE

The so-called maintenance approach comprises of inexpensive local repairs and pavement resurfacing. The road alignment is appropriate, and the junctions are well-designed. On the pavement surface, the typical indications of modest surface deterioration are visible. Functional aspects contribute to an exceptional degree of service. There are no time delays or traffic congestion, and no substantial action is necessary. The surface of the pavement must be restored, and inadequate signage and guardrails must be fixed. In general, the first option does not contain any enhancements to alignment characteristics and consists primarily of basic maintenance. The cost of operations remains minimal. Thus defined, maintenance operations do not involve pavement reconstruction or road widening.

3.4.2 REHABILITATION

Rehabilitation, the second technique for improving, entails more extensive procedures. The pavement width provides a satisfactory level of service, but the alignment characteristics at turns are poor, intersections have inadequate approach angles as indicated by the right arrow or no turning lanes as indicated by the left arrow, and safety and traffic control equipment has degraded or is obsolete. Adjusting the current alignment is not part of the engineering tasks required to effectively improve the roadway. Where necessary, the pavement must be resurfaced, shoulders and berms must be reshaped, road safety devices must be upgraded, and at-grade junctions and bends must be planned.

3.4.3 RECONSTRUCTION

Reconstruction The third method, so-called rebuilding, refers to worldwide upgrading activities and consists mostly of extensive road widening and infrastructure expansion. The alignment may be conserved and maintained, but inferior lane width and low road capacity necessitate in this instance pavement and shoulder widening, pipe and culvert extension, and extensive earthwork works. Engineering works include the expansion of roads and the rebuilding of bridges. In numerous instances, the alignment may be good, but the lane width is insufficient. Due to large-scale engineering works and expropriations, the level of service is poor, and the operational expenses are substantial. Typically, reconstruction entails a significant construction effort to rebuild the current roadway to full geometric and safety requirements.

3.4.4 NEW ALIGNMENT

Consideration of an entirely new alignment, route selection, and road building is the fourth method. This method may be favoured above others because to the high expense of restoration–reconstruction activities or a reevaluation of the entire project's environmental effect and social benefit implications. This may be the case for older roadways in ecologically sensitive or densely populated regions. If this is the case, the existing road should be abandoned or eliminated, and a completely new route site should be researched. Expropriations and the construction of new interchanges and bridges are examples of important and pricey issues that frequently arise during the execution of a new project. Technically enticing at times, this high-priced solution may be impossible to implement due to political or financial restrictions.

3. CONCLUSIONS

The present road geometric design of the two-lane split carriageway from Nagpur to Katol (NH-353J) has been analysed.

For each significant intersection in the research region, the analysis of the existing geometric condition of the road under diverse roadway and traffic circumstances is undertaken.

Based on the analyses conducted in this study, an effort has been made to enhance the capacity of the National highway for two-lane split carriageway by upgrading it to four-lane carriageway with optimal shoulder and median widths according to IRC criteria.

4. SIGNIFICANCE

The significance of upgrading existing two-lane Nagpur Katol highways to four-lanes is as follows:

Decrease in number of accidents due to less congestion. Provides better riding quality and also reduction in fuel requirement leading to a decrease in pollution. The road is primarily an orange-producing belt and will benefit the orange industry. Upgrading the existing two-lane road to four-lane with paved shoulders will facilitate better transportation in terms of fast, congestion-free movement of traffic.

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