

A

PROJECT REPORT

ON

**“Maintenance”**

UNDERTAKEN AT

**“MIT School of Distance Education”**

IN PARTIAL FULFILMENT OF

**“Post Graduate diploma in construction and  
project Management.”**

MIT SCHOOL OF DISTANCE EDUCATION, PUNE.

GUIDED BY

**“Prof. Rohit Oke”**

SUBMITTED BY

**“Vivek”**

STUDENT REGISTRATION NO.: **MIT2022NO1348**

MIT SCHOOL OF DISTANCE EDUCATION PUNE – 412 105

YEAR: **2022-2024**





LARSEN & TOUBRO

L& T Construction Transportation Infrastructure

Larsen & Toubro Ltd., MPEP Pkg-22  
Survey No. 1692/4 & 1692/5,  
Dhammod Village, Patwari Halka-00004,  
Ratlam District (M.P.) 457001

Larsen and Toubro construction  
(236, Anjani Dham, Ratlam (457001))  
Madhya Pradesh

## CERTIFICATE

This is to certify that Mr. Vivek has completed. the project report with us for his project report work on “Maintenance” in fulfilment for the completion of his Course with MITSDE on “Post Graduate diploma in construction and project Management” as prescribed by MIT SCHOOL OF DISTANCE EDUCATION, PUNE. This project is a record of authentic work carried out by him with guidance by our relevant department from Date –01/03/2024.

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Signature of Guide in Organization: -



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Registered Office: L&T House, N. M. Marg, Ballard Estate, Mumbai - 400 001,  
INDIA Licence No.: CIN - L99999MH1946PLC004768

## **DECLARATION**

I hereby declare that this project report entitled “Maintenance” Bonafede record of the project work conducted by me during the academic year 2022-2024, in fulfilment of the requirements for the award of “Post Graduate diploma in construction and project Management” of MIT School of Distance Education.

This work has not been undertaken or submitted elsewhere in connection with any other academic course.

Sign: -  \_\_\_\_\_

Name: -Vivek

Student ID: - MIT2022NO1348



## ACKNOWLEDGEMENT

I would like to take this opportunity to express my sincere thanks and gratitude to “Prof. Rohit Oke,” Faculty of MIT School of Distance Education, for allowing me to do my project work in your esteemed organization. It has been a great learning and enjoyable experience.

I would like to express my deep sense of gratitude and profound thanks to all staff members of MIT School of Distance Education for their kind support and cooperation which helped me in gaining lots of knowledge and experience to do my project work successfully.

At last, but not least, I am thankful to my Family and Friends for their moral support, endurance, and encouragement during the project.

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## **ABSTRACT**

This is the study on Maintenance management at Ratlam MP- Expressway. Maintenance management is Responsible to conducted maintenance activities to Increase the efficiency of road and provide good services to the Road Users. Our study is based on the objective to find out the major problems faced by road users when using Road services and the factors influencing services.

The Expressway used to connect Long Distances and designed for high speed, greater safety, comfort and convenience for drivers and passengers, and lower vehicle operating costs. They will connect the states by providing controlled access through Interchanges. These are the highest class of roads in India. Maintenance Management is a Major part of road sector after development of Roads. At present many of the Expressway around the country have their Maintenance team for road Maintenance. The maintenance Team have staff for each major activity to Regularize the Road usage and the damage Rectification occurs during Road usage and timely Maintenance Required as per standards. The Maintenance of roads is Increasing to make more efficient the Road network of country.

The findings indicate the Maintenance Management Providing different services & rectification on controlled expressway as per requirements. The Maintenance is a part of contract in EPC contracts have different time limits as Per the Type of roads. Additionally, the study revealed that the Incident management system of road Maintenance.

The Greenfield Expressways are designed to avoid inhabited areas and go through new alignments to bring development to new areas and to reduce land acquisition costs and construction timelines. Factors such as Accidental support, Vehicle Breakdown support, Bridge and Road Maintenance, Plantation activities, Toll Plaza maintenance, Accidental Rectification. The report emphasizes the Use of Expressways effectively and mannerly. Robust Expressway networks are the lifeline to the region they serve. Roads bring about all-round development in the region. A good road network helps in the success of all development activities, be it in the sphere of movement of people and goods, agriculture, commerce, education, health, and social welfare, or even maintenance of law & order and security.

The purpose of this study is to find out how Maintenance Management works that can impact growth of the country and supports road user's best services of Expressways.

In this research project, a survey is conducted with road users to discover difficulties faced and requirements of road users. This method is used because we are interested in exploring road requirements to increase efficiency and safety for road users. For conducting this research, a conversation is carried out to the road user to identify the difficulty faced by the road users.

The expressways provide high speed, greater safety, comfort, and convenience for driver and passengers, and lower vehicle operating costs. The National Highways Authority of India (NHAI) is an autonomous body of the Indian Government which is responsible for management and maintenance of a network of National Highways. It works under the Ministry of Road Transport and Highways.



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**Abbreviations:**

NHDP-National Highways Development Project.

EPC- Engineering, Procurement & Construction.

NHAI-National Highways Authority of India.

MP-Madhya Pradesh.

ECC-Engineering Construction & Contracts.

ATMS- Advance Traffic Management.

ECB-Emergency call Boxes.

VMS-Variable Message sign Fixed and portable.

VIDS-Video Incident Detection system.

VSDS-Vehicle speed detection system equipment.

IRC- Indian Roads Congress

AASHTO-American Association of State Highway and Transportation Officials

BIS- Bureau of Indian Standards

CMBM- Cold Mixed Bituminous Macadam

CMSDBC- Cold Mixed Semi Dense Bituminous Concrete

ASTM -American Society for Testing of Materials

WMM-Wet Mix Macadam

WBM- Water Bound Macadam

CRM- Crusher Run Macadam

SS-Slow Setting

MS-Medium Setting

RS-Rapid Setting





## **CHAPTER 1: INTRODUCTION**

The Advancement of Highway developed them into expressways for better use of roads. From 2002, expressway construction Began to rise. In 2002, Country has total Length of expressway 160 KM But Now it gets Developed to 5185 km. Expressways are divided further as per their specifications.

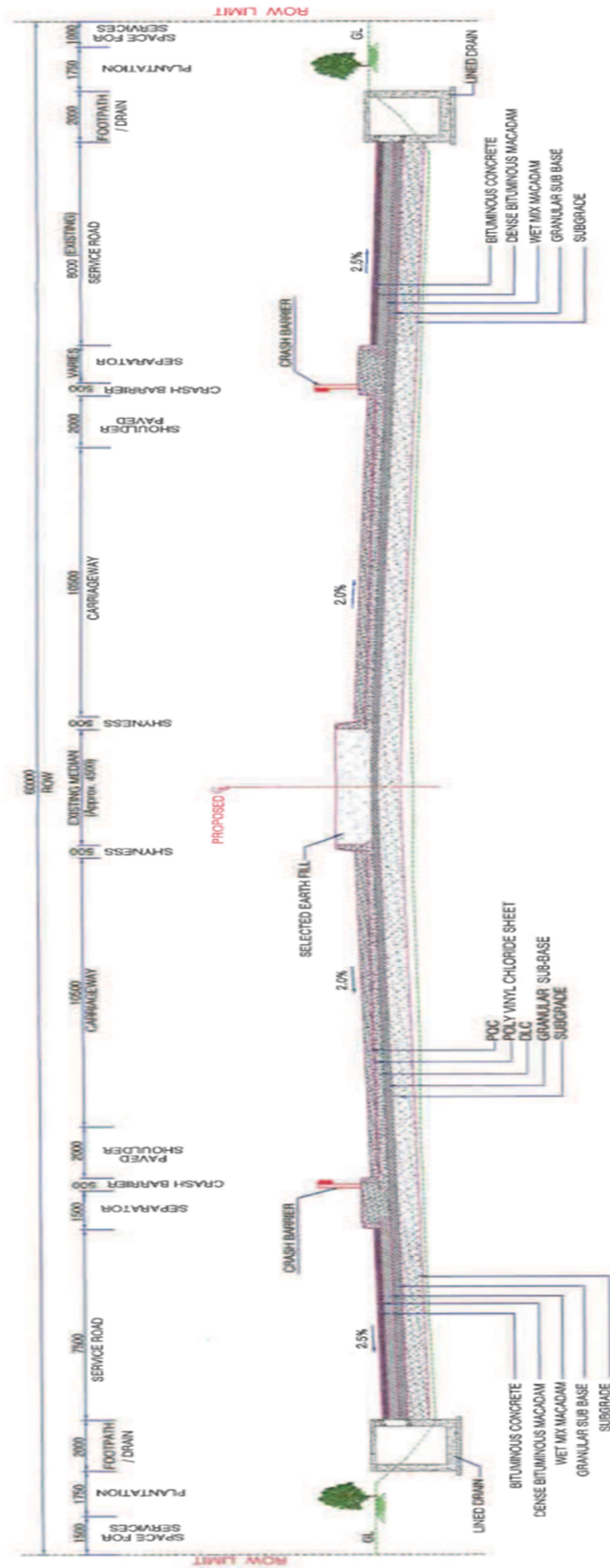
**Greenfield Expressways:** -Greenfield Expressways in India are designed as 12-lane wide Expressways with the initial construction of 8 lanes with maximum speed set as 120 km/h for all type of vehicles. Greenfield expressways are newly construction of project on a new alignment, new construction of it make it costlier and with latest Upgradation of Features.

**A. Brownfield Expressway:** -The upgradation of the highway is a Brownfield Expressway Project which has high traffic demand. The upgradation is carried out from 4 Lane to 6 Lane on EPC mode with upgradation of features.

**B. Access controlled Expressways:** -A controlled-access highway is a type of highway that has been designed for high-speed vehicular traffic, with all traffic flow—ingress and egress—regulated. These types of expressways Have access through proper interchange and toll plaza with concrete boundaries and crossing arrangement.

The Expressways construction comes under Bharat Mala Pariyojna which is an ongoing project of country that will interconnect 550 District Headquarters through a minimum 4lane highway by raising the number of corridors to 50 and move 80% freight traffic to National Highways by interconnecting 24 logistics parks, 66 inter-corridors of total 8,000 km and ports. The project also includes development of tunnels, bridges, elevated corridors, flyovers, overpass, interchanges, bypasses, ring roads etc. to provide shortest, jam free & optimized connectivity to multiple places, it is a centrally sponsored and funded Road and Highways project of India. This ambitious umbrella programmed will subsume all existing Highway Projects including the flagship National Highways Development Project (NHDP).





TYPE - I: TYPICAL CROSS SECTION OF 6-LANE DIVIDED HIGHWAY WITH 7m WIDE SERVICE ROAD ON BOTH SIDES AND WITH RAISED MEDIAN  
 (MODIFIED TCS BASED ON FIG : 2.8 OF SIX LANE MANUAL )

Fig 1.1

## **CHAPTER 2: ORGANIZATIONAL PROFILE**

Larsen & Toubro Limited, abbreviated as L&T, is an Indian multinational conglomerate company, with business interests in engineering, construction, manufacturing, technology, information technology, Military and financial services, headquartered in Mumbai & Technical services, headquartered in Chennai. The company is counted among the world's top five construction companies. It was founded by Henning Holck-Larsen and Søren Kristian Toubro, who were two Danish engineers taking refuge in India.

As of March 31, 2022, the L&T Group comprises ninety-three subsidiaries, five associate companies, twenty-seven joint ventures and thirty-five jointly held operations, operating across basic and heavy engineering, construction, realty, manufacturing of capital goods, information technology, and financial services.

On October 1, 2023, Shri. S N Subrahmanyam took charge as Chairperson and Managing Director of L&T.

### History

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Larsen & Toubro originated from a company founded in 1938 in Bombay by two Danish engineers, Henning Holck-Larsen, and Søren Kristian Toubro. The company began as a representative of Danish manufacturers of dairy and allied equipment. However, with the start of the Second World War in 1939 and the resulting blockade of trade lines, the partners started a small workshop to undertake jobs and provide service facilities. Germany's invasion of Denmark in 1940 stopped supplies of Danish products. The wartime needs to repair and refit and degauss ships offered L&T an opportunity, and led to the formation of a new company, Hilda Ltd, to manage these operations. L&T also started to repair and fabricate ships signalling the expansion of the company. The sudden internment of German engineers in India (due to suspicions caused by the Second World War), who were to put up a soda ash plant for the Tatas, gave L&T a chance to enter the field of installation.

In 1946, ECC (Engineering Construction & Contracts) was incorporated by the partners; the company at this time was focused on construction projects (Presently, ECC is the construction division of L&T). L&T began several foreign collaborations. By 1947, the company represented the manufacturers of equipment used to manufacture products such as hydrogenated oils, biscuits, soaps and glass. In 1947, the company signed an agreement with Caterpillar Tractor Company, USA, for marketing earth moving equipment. At the end of the war, large numbers of war-surplus Caterpillar equipment's were available at attractive prices, but the finances required were beyond the capacity of the partners. This prompted them to raise additional equity capital, and on 7 February 1946, Larsen & Toubro Private Limited was incorporated.

In 1947, the firm set up offices in Calcutta (now Kolkata), Madras (now Chennai) and New Delhi. In 1948, 55 acres of undeveloped marsh and jungle was acquired in Powai, Mumbai. In December 1950, L&T became a public company with a paid-up capital of ₹20 lakh (equivalent to ₹22 crore or US\$2.8 million in 2023). The sales turnover in that year was ₹1.09 crore (equivalent to ₹120 crore or US\$15 million in 2023).

In 1956, a major part of the company's Bombay office moved to ICI House in Ballard Estate, which would later be purchased by the company and renamed as L&T House, its present headquarters.

During the 1960s, ventures included UTMAL (set up in 1960), Audco India Limited (1961), Eutectic Welding Alloys (1962) and TENGL (1963).

In 1965, the firm had been chosen as a partner for building nuclear reactors. Dr. Homi Bhabha, then chairman of the Atomic Energy Commission (AEC) had in fact first approached L&T in the 1950s to fabricate critical components for atomic reactors. L&T has since contributed significantly to the Indian nuclear programme.

During the 1970s, L&T was contracted to work with Indian Space Research Organisation (ISRO). Its then chairman, Vikram Sarabhai, chose L&T as manufacturing partner. In 1972, when India launched its space programme, the firm was invited to participate.

In 1976, ECC bid for a large airport project in Abu Dhabi. ECC's balance sheet, however, did not meet the bid's financial qualification requirement. So, it was merged into L&T. ECC was eventually rechristened L&T Construction and now accounts for the largest slice of the group's annual revenue.

In 1985, L&T entered into a partnership with Defence Research and Development Organisation (DRDO). L&T was not yet allowed by the government to manufacture defence equipment but was permitted to participate in design and development programmes with DRDO. After the design and development was done, the firm had to hand over all the drawings to DRDO. The government would then assign the production work to a public sector defence unit or ordnance factory for manufacture. The firm currently makes a range of weapon and missile systems, command and control systems, engineering systems and submarines through DRDO.

## Structure

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Three key products/services which L&T is engaged in are: Construction and project-related activity; manufacturing and trading activity; and IT and engineering services.

For administrative purposes, the conglomerate has been structured into sixteen subsidiary companies, including L&T Technology Services, L&T Metro Rail, L&T Realty and LTIMindtree.



## **CHAPTER 3: PROJECT OBJECTIVES AND SCOPE**

### **OBJECTIVE OF STUDY**

The objectives of the report on “Maintenance” are as follows:

1. Assess the level of awareness: The Report aims to Create awareness among people towards the latest generation of roads with benefits, facilities provide with their usage.
2. Enhancement of road users: The report aims to attract road users to make the expressway more economic, safe, and enjoyable rides to all road users by Creating awareness and by removing the Hurdles faced by the road users.
3. Identify factors influencing adoption: The report aims to identify the factors influencing adoption of expressway to local road users as well as for long route travel.
4. Examine attitudes and perceptions: The report aims to examine the attitudes, perceptions, and concerns of the people of the nation regarding Expressway. It seeks to understand their views on security, reliability, convenience, services, and Incident support.
5. Investigate Road users Requirements: The report aims to investigate road user’s requirements with varying circumstances to enhance road facilities.
6. Investigate maintenance requirements: The report aims to determine the work requirements during Maintenance period as per the standard expressway design as per the latest, which is beneficial for civil engineer awareness.
7. Provide recommendations: Based on the project findings, the reports aim to determine the way to use the expressway effectively and mannerly to the road users & the determination of activities for civil engineer for enhancement of the road maintenance.
8. Contribute to the development of Nation: This report aims to create awareness for road users, maintenance activities for better maintenance plan, incident management awareness among people to use incident management system of expressways to save lives of road users.

Overall, the objectives of the report aim to shed light on the Nation Road network rapid increase during the last few years Development and how to use them properly and its effects to nation growth & The future Development of expressways.

## **NEED OF THE STUDY**

The Need for the study on maintenance arises from several factors:

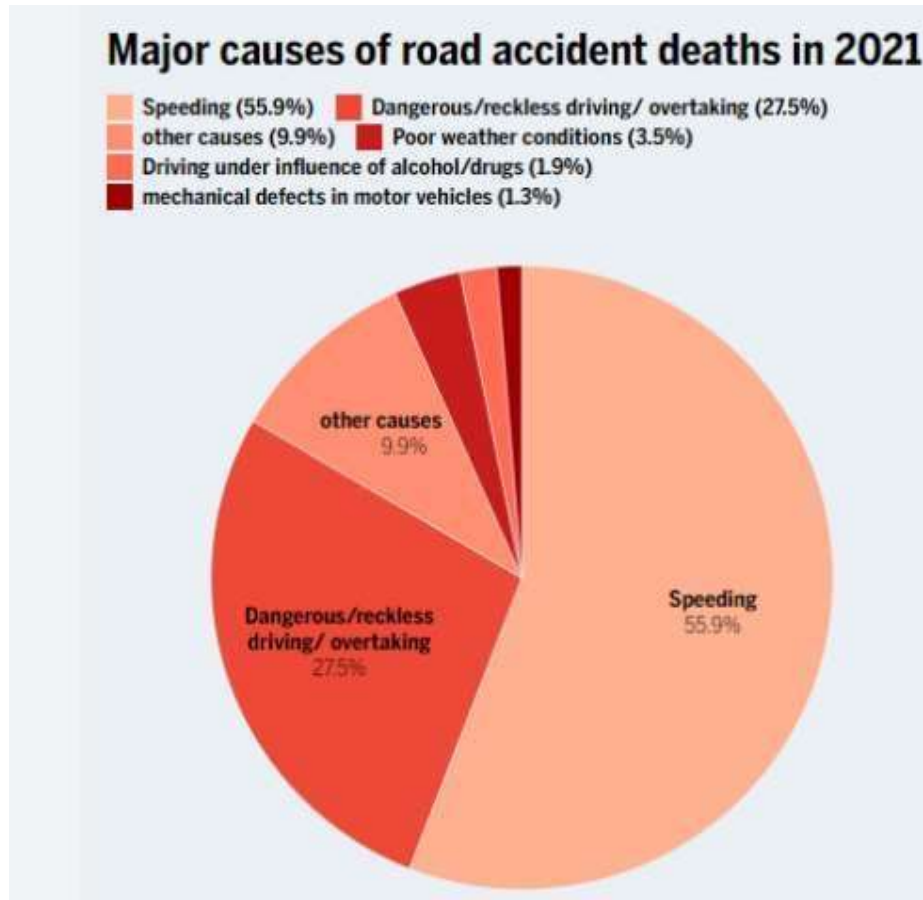
- Design speed – This Report aims to determine the speed limits of different vehicles on Expressways to Reduce the unsafe acts of road traffic.
- Incident Management – This report Determine the latest technologies provided on expressways to provide the support during the incident.
- Development (ribbon)- A good road network helps in the success of all development activities, be it in the sphere of movement of people and goods, agriculture, commerce, education, health, and social welfare, or even maintenance of law & order and security.
- Lesser risk damage during transit- A good road network always reduces the damage and incident risk during transit.
- Economic- A good road network reduces the cost of transport and fuel savings. Also, it makes the Transit easy by providing proper security and support during transit. It also reduces fear during transit.
- Feeder roads- Expressways provide good feeder roads to make interconnectivity of roads and its controlled entrance make the strict controlled over the road traffic.
- Safety- Expressways' latest safety system having accident detection, vehicle speed detection system, PTZ Camera, Electronic calling booth for safety purpose and incident management team to provide support at earliest.



## **CHAPTER 4: ACCIDENTAL DATA ANALYSIS AND INTERPRETATION**

### A. Accidental data yearly basis

#### Accident Rate Graph



**Fig 4.1**

- A. Speeding – Speeding is the main cause of accident due to which 55.9% accident Happens every year, Because Normal roads are not suitable for speed driving for which design and safety criteria is different for which expressways is designed with only one way of traffic and with 4 no. of traffic lanes with Minimum visibility sight distances which makes it safer for speed driving. Expressways also do not allow access to slow and hauling vehicles, pedestrians and unnecessary crossings which make it more comfortable and incident free.
- B. Overtaking- Overtaking is the second main cause of accidents due to which 27.5% accident happens every year, because normal roads have two-way traffic and less no. of lanes for overtaking. But expressways have eight number of lanes due to which overtaking is extremely easy.

B. Accidental data Category of Roads

Category of Road	Accidents	Killed	Injured	Road Length as on 31.03.2019
National Highways	1,28,825	56,007	1,17,765	1,32,499
% share in total	31.2	36.4	30.6	2.1
State Highways	96,382	37,963	92,583	1,79,535
% share in total	23.4	24.7	24.1	2.8
Other roads	1,87,225	60,002	1,74,100	60,19,723
% share in total	45.4	39.0	45.3	95.1
<b>All Roads</b>	<b>4,12,432</b>	<b>1,53,972</b>	<b>3,84,448</b>	<b>63,31,757</b>

*Data Source: States/UTs (Police Departments)*

*Road Length- Basic Road Statistics of India, 2018-19*

**Fig 4.2**

- A. National Highway having 2.1% share in Total and 31.2% share in accidents with comparison to others, which states that the better quality of roads reduces the Number of accidents.





## Incident Management system of expressways

Advance Traffic Management system, as a name suggest provides necessary Information about Traffic, Monitoring stretch, road conditions, automatic Traffic count and classification, speed detection, displaying message Via variable message screen, effective surveillance via CCTV, Video based incident detection and monitoring and controlling control room via electronic call boxes installed on a highway stretch.

## ATMS Components

- o Emergency call Boxes of Variable Message sign Fixed and portable.
- o Traffic Monitoring Camera system equipment
- o Video Incident Detection system
- o Vehicle speed detection system equipment



**Fig 4.3**

- o Digital Transmission system/Network communication



## Maintenance Requirements

The Maintenance Programme shall contain the following: -

- a) The condition of the road.
- b) the proposed maintenance works.

While preparing the maintenance program, following aspects shall be considered:

- a) Existing features of the site (such as location, layout, geometry, right of way, intersecting roads, existing access points, etc.)
- b) Physical assets (e.g., pavement, traffic signs, etc.)
- c) Weather conditions are expected to prevail.
- d) Site Constraints (e.g., limitation of right of way, existence of utilities, etc.)



## **CHAPTER 5: CONCLUSION AND FINDINGS**

### **CONCLUSION**

Based on our extensive analysis of Expressway project, we determined that in India driver using roads without any basic information about roads and latest technologies. They even do not have Necessary information about sign board, unusual occurrence reporting, complaints about any mishappening and Basic Support Requirement. For this we created a survey so that every user of this road can determine how much knowledge he has about the booming road network of expressways.

Expressway services are highly controlled by providing boundary walls at both sides of Right of way of roads, so that no one can enter without entrance crossing. On expressway PTZ camera is engaged to determine the mistake of accident occurrences and implement new rules to reduces the future incident.

Latest Fastenings items of roads is provided with Responsible person to take care of each facility and serve to their best to their road users. NHAI also Created toll free number -1033 for complaints recording, analysing the supportive Team and road requirements to serve the best to road users. NHAI also create portal to Record the complaints of road users and provide Complaints resolution at the earliest.

On security end, Expressway has set of rules to resolve the disputes, complaints and any unusual occurrences, incident faced by the road users and Immediate responses provided to them twenty-four\*seven by the teams assigned to their respective works.

The government also promotes afforestation, by providing Median Plantation of Various types of shrubs and trees to serve the purpose of median cross barrier and to enhance the appearance of expressway and for easily future development of roads. These roads are the combination of various latest technology of the road, solar, drip, rainwater harvesting, incident Management system of the country to create awareness among the people of the nation.

These roads are created at high embankment level which also reduces the accident count in rainy season. Also, the Vehicles Banned at expressway which can cause hinderances to high-Speed Traffic and have No design to high-speed roads.

Expressway are created away from cities which Make High ribbon development to undeveloped Locations and provide new routes to the nation with new types of experience to the users. As the time is the big asset Now a days, so expressway saves a lot of time with a smooth and safe Journey. As expressway reduces the journey cost by 30% of the total journey and proper safety Gadgets to make experience of road users better.



## FINDINGS

- From our data analysis we can see that people prefer expressway use only if they know about information about sign boards, rules, and regulations. From our data of sixty-five, sixty people have voted for use of the expressway. As compared to India 68% of people prefer and use expressway.
- Also, data says that expressways has provide more convenient Road services which are provided to customers at basic rates which highly increasing growth of the nation.
- The major factor for switching to the Expressway is Speed and Security with the advanced Life supporting system. Thus, we can say that people have started trusting Country expressway road network.
- Services used by Road users paid at toll Plaza by digital and cash payments without information they do not able to use them efficiently.
- From the data collected we can analyse that 74% of people have adopted expressway just because it saves a lot of time than Local roads which includes waiting for hours just to cross a small Traffic at crossings which wastes a lot of time for Road users.
- Through our research we conclude that there are more Personal Road users using expressway not sharing vehicles for long routes with adjacent pick up and drop services. Through our research, we determined that people get the information of new expressway openings and modified expressway construction completion Information received to them from digital media. As per road users they face difficulties in finding new road facilities and mode of using them efficiently and effectively. They also do not get the route map over the online country maps due to not updating of expressway coordinates updates online.
- In our research we found that the maximum road users get best route information from Verbal conversation and on route local guidance.
- Through our research we found that 75% of people think digitalization in the toll plaza and incident management facilities has made their travel easier and all over India percentage is 80%.
- In our survey we found that 78.5% of people think Expressway is secure and all over India expressway efficiency is 85%.
- 92.3% of people think in our survey that to make expressway better is better to development of the country transportation system.



## **CHAPTER 6: SUGGESTIONS AND RECOMMENDATIONS**

1. **Conduct Awareness:** To Make awareness of expressway Facilities among Road users, Training Should Be Provided to Drivers as Expressway is designed to speed Driving for Long routes with specific Precautions. Driver should have Sound Knowledge of road signs and Facilities provided for expressway road users.
2. **Local Support:** To Make awareness of expressway Facilities among Road users, a specific Document with detailed Recent incident Precaution and road User Facilities with basic need information should be provided, Routine Patrolling vehicle information for Local support in case of incident and unusual occurrence detailed information should be provided.
3. **Address Security Concerns:** Since security is a major concern for individuals considering. Express way, emphasize the robust security measures implemented by NHAI and provide clear guidelines on safe Expressway use. Educate people about the importance of using Expressway, avoiding rash Driving, and regularly updating their Vehicles and about expressway rules and regulations to protect their personal and Fundamental Rights.
4. **Demonstrate Convenience and Time Savings:** Highlight the convenience and time-saving aspects of Expressway. Showcase how Expressway allows individuals to perform various long routes Journey from anywhere at their convenience, eliminating the need to visit via Local Roads. Emphasize features like online Fast Tag, Routine Patrolling vehicle Support, and Time management that simplify long routes journey.
5. **Offer Support and Training:** Provide support and training programs to help individuals in Country become familiar with using Expressway. Offer hands-on training sessions or video tutorials that guide them through the usage of expressway, navigating the routes, and conducting common transactions.
6. **Collaborate with Local roads:** Collaborate with local Roads, such as Transport service providers, to promote the acceptance of Expressway with pick up and drops at nearest toll plaza. Encourage them to offer incentives, discounts, or exclusive deals for customers who use expressway combined transport facilities. This collaboration will not only drive awareness but also create Economic Transportation for Long routes in economic rates.
7. **Government Support and Infrastructure:** Government support by making Government transport compulsory usage of expressway infrastructure in Country to Provide Facilities and safety for Each individual is there with economic rates. Encourage the government to invest in expanding Road expressway, especially in rural and underserved areas, to ensure equal Demand like Railways, Flights Etc.
8. **Address Transport Literacy:** Recognize the importance of Transport Literacy and address the barriers that may hinder expressway Road use. Promote initiatives that enhance expressway usage among the population, including safety Literacy and navigating routes using online platforms. Collaborate with educational institutions and community centres to offer Transport Literacy programs.



9. Monitor and Evaluate: Continuously monitor the increase of Road use awareness initiatives in country. Collect data on the adoption rate, user feedback, and challenges faced by individual road users. Regularly evaluate the effectiveness of the campaigns and make necessary adjustments to improve safety, smooth & uninterrupted flow of traffic. This data can help in refining future strategies and tailoring initiatives to the specific needs of the population.
10. Collaboration with Survey Institutions: Foster collaboration between survey and local organizations to create partnerships that Determine the issues Faced by road users for future development of roads. NHAI can organize events, provide educational materials, and offer incentives to encourage students to create projects on road usage surveys. Collaborative efforts can amplify the impact of awareness initiatives and drive higher engagement of roads in future development of our country.



## **CHAPTER 7: Points To Remember**

- Improper mix design: A mix that lacks stability and can't support traffic can cause plastic movement under traffic.
- Weak pavement: The pavement may be weak.
- High stress: Heavy bullock-cart traffic can cause high stress.
- Subgrade clay: Subgrade clay can intrude into the base course.
- Surface dressing aggregates: Surface dressing aggregates may be pressed into the lower supporting bituminous layer.
- Loss of aggregates: Cover aggregates may be lost in the surface dressing.
- Non-uniform spreading: The cover aggregates may not spread uniformly in the surface dressing.
- Excessive binder: Too much binder may be applied in the surface dressing.
- Excessive axle loads: Heavy axle loads can compress the surfacing and force bitumen to the top.
- Value: A properly designed mix may be necessary.
- Cold mix technology can help construction progress 2–3 times faster without the need for additional investment in equipment or capacity building.
- This cold mix technology can be used to construct roads with a single layer application, which can result in less expensive, more durable roads.
- This cold mix technology can replace conventional open graded premix carpeting and seal coat.
- Emulsions are mixtures of two or more liquids that are normally immiscible.
- One liquid is dispersed in the other in an emulsion.
- Emulsions are part of a more general class of two-phase systems of matter called colloids.
- Drains and culverts should be cleaned when they become clogged with silt, debris, or vegetative cover.
- For bridges 60 meters or longer, service roads on both sides of the stream should be merged with the project highway.
- The width of the bridge for the main highway should increase by one traffic lane on both sides of the carriageway.
- This should accommodate the merging traffic of the service road.
- Service roads should be merged by tapering the road (1 in 20), and there should be a detailed system of signs and markings.



- The design life for all bridge structures is 100 years, except for ancillary items like bearings, expansion joints, and wearing course.
- A minor bridge is a bridge with a total length of up to 60 m.
- A small bridge is a bridge where the overall length between the inner faces of dirt walls is up to 30 m and individual span is not more than 10 m.
- Most countries mandate that bridges be inspected at least once every two years.
- Inspectors look for any flaws, defects, or potential problem areas that may require maintenance.
- Regular maintenance ensures that all necessary equipment for maintenance is always to carry out its efficient work.
- By cleaning, lubricating, and making minor adjustments, minor problems can be detected fixed before it becomes a major problem that could shut down a production line.
- Warning zone
- Approach transition zone.
- Activity zone
- Terminal transition zone
- Work zone end.
- Key elements of temporary traffic control zone
- Length of temporary traffic zones
- Locate utilities.
- Identify the trunk flare.
- Dig a wide hole.
- Remove the tree container.
- Place the tree in the hole.
- Straighten the tree.
- Fill the hole.
- Stake the tree if necessary.
- Mulch helps reduce weeds, moderate soil temperatures, conserve soil moisture in the root zone, and add an aesthetic quality to the landscape.
- Do not install mulch on top of the root ball.
- Each tree must be planted such that the trunk flare is visible at the top of the root ball.
- Signs should only contain information related to traffic control, not advertising.
- Signs should be circular, with a red border, and a white background.
- Speed limit signs: Circular with a red border and black symbols on a white background.
- 





- Cautionary warning signs: Triangular with a red border and black symbols on a white background.
- Stop, yield, and speed limit signs: Mandatory signs that indicate what to do.
- No free left: Used at signalled left turnings.
- Prohibited parking in non-motorized lanes: Prohibits parking on cycle lanes.
- Minimum headroom: 2.1 m for footpath signs.
- Merging ahead sign: 180 m ahead of the opening.
- Advance guide sign: 500 m, 1 km, and 2 km in advance of the exit on expressways.
- Side road ahead: 120 m ahead of the location.
- Delineators are used for various traffic control reasons, usually as warning devices to promote safety.
- Maintenance

Also known as technical maintenance, this is a set of processes and practices that ensure the efficient and continuous operation of equipment, machinery, and other assets.

- Preventive maintenance

Also known as planned technical maintenance, this involves interventions on equipment at predefined criteria or on regular intervals. The main purpose is to reduce the risk of equipment, machinery, and goods breaking down.

- Condition-based preventive maintenance.

This is the most advanced form of preventive maintenance. It uses technical attribute changes, IoT-generated data on the asset's condition, or other installed product updates to trigger alerts when a threshold is breached and automatically launch actions.

- Asset management

This is an essential component of maintenance because it keeps assets running smoothly, resulting in efficient production. When assets are properly monitored and tracked, it ensures that equipment does not break down on a regular basis.

- Predictive maintenance

This is a well-established maintenance strategy in mechanical engineering. Its main idea is to schedule specific maintenance tasks on mechanical parts based on their condition and the speed of their degradation processes.

- Downtime

This refers to the total time a machine's not in service. Maintenance, repairs, or unexpected breaks are the usual downtime of a machine.

- Proactive maintenance

This is considered another higher level of maintenance. It is based on previous predictive maintenance and further improves it so that its basis is the utilization of more complex technical diagnostics.

- Autonomous maintenance

This is the first pillar in the total productive maintenance strategy. An operator trained in autonomous maintenance means he or she has complete knowledge of routine tasks like cleaning, lubricating and inspecting.

- Asset Management. Asset management is the process of monitoring, controlling, and maintaining the lifecycle of an asset.
- Maintenance Scheduling.
- Cost Management.
- Technological Advancement.
- Safety.



## **CHAPTER 8: Defects**

- **Hair-line crack**

Symptoms

These appear as short and fine cracks at close intervals on the surface. Photo 5.

Causes

These cracks are caused by:

- (I) Insufficient bitumen content.
- (ii) Excessive filler at the surface.
- (iii) Improper compaction— over-compaction, compaction when the supporting layer was unstable, or compaction of too hot a mixture.

- **Alligator crack**

Symptoms

These appear as interconnected cracks forming a series of small blocks which resemble the skin of an alligator. Photo 6.

Causes

Alligator cracks are due to one or more of the following factors:

- (I) Excessive deflection of the surface over unstable subgrade, subbase or base of the pavement, particularly in the wheel tracks. The unstable conditions in the subgrade or lower layers of the pavement might have arisen from saturation.
- (ii) Excessive overloads by heavy vehicles or inadequate pavement thickness, or both.
- (iii) Brittleness of the binder either due to ageing of binder or initial over-heating might cause fine cracks of the alligator pattern, but there will be no deflection of the surface. These cracks are sometimes called 'crazing'.

- **Longitudinal crack**

Symptoms

These cracks appear, more or less, on a straight line, along the road. These cracks may appear either at the joint between the pavement and the shoulder, or at the joint between two paving lanes. Photo 7.

Causes

(I) The cracking at the pavement-shoulder joint may be due to alternate wetting and drying beneath the shoulder surface owing to poor

12

IRC: 82-1982

drainage or due to depressions in the pavement edge which allow water to stand and seep through the joint. Shoulder settlement or trucks passing over the joint, may also cause these cracks.

(ii) The lane joint crack is caused by a weak joint between adjoining spreads in the layers of the pavement Differential frost heave along the centre line may also be one of the causes.



- Edge crack

Symptoms

Edge cracks are formed parallel to the outer edge of the pavement usually 0.3 — 0.5 m inside from the edge, Photo 8. At times some transverse cracks are seen to branch out from the edge cracks towards the shoulder.

Causes

These cracks are caused by:

- (i) Lack of literal support from the shoulder.
- (ii) Settlement or yielding of the underlying material.
- (iii) Inadequate surface drainage, especially during flooding conditions.
- (iv) Shrinkage due to drying out of the surrounding earth, generally caused by roots of trees or bushes close to the pavement edge. Highly expansive soils are particularly prone to shrinkage when moisture dries out.
- (v) Frost leave.
- (vi) Inadequate pavement width forcing traffic too close to inc edge of the pavement.
- (vii) Non-provision of extra width of pavement on curves.

- Shrinkage crack

Symptoms

These are cracks appearing in the transverse direction, or as interconnected cracks forming a series of large blocks, Photo 9. The pavement itself appears to have suffered no deterioration or deformation, but it is the top surfacing that seems to leave become old and cracked.

Cause

The primary cause for such cracks is the shrinkage of the bituminous layer itself with age. The bituminous binder loses its ductility as it ages and becomes brittle.

- Reflection crack

Symptoms

Reflection cracks are the sympathetic cracks that appear in the bituminous surfacing over joints and cracks in the pavement underneath. Photo 10. The pattern may be longitudinal, transverse, diagonal or block. They occur most frequently in overlays on cement concrete pavements or on cement-soil bases. They may also occur in overlays or surfacings on flexible pavements where cracks in the old pavement have not been properly repaired. Another condition under which reflection cracks can occur is when a pavement is widened and the entire pavement is surfaced. The location of the crack will then be exactly on the junction between the old pavements and the widened strip.



In some cases, reflection cracks are merely unsightly, but frequently they deteriorate and the riding quality of road is affected. These cracks can allow water to enter the underlying pavement and the subgrade and cause further damage.

Cause

Reflection cracks are due to joints and cracks in the pavement layer underneath.

- Treatment

The treatment, for all types of cracks discussed above, would depend on whether the pavement remains structurally sound or has become distorted or unsound.

In case the pavement remains structurally sound, then the cracks should be filled with a bituminous binder having a low viscosity so that it can be poured and worked into the cracks. Cutback bitumen and emulsions are generally suitable. All loose materials are removed from the cracks with brooms and, if necessary, with compressed air jetting. The binder is poured with a pouring can and a hand squeegee is used to assist the penetration of the binder into the cracks. Light sanding of the cracks is then done to prevent traffic picking up the binder.

If the cracks are wide enough a slurry seal or sand bituminous premix patching can be used to fill the cracks.

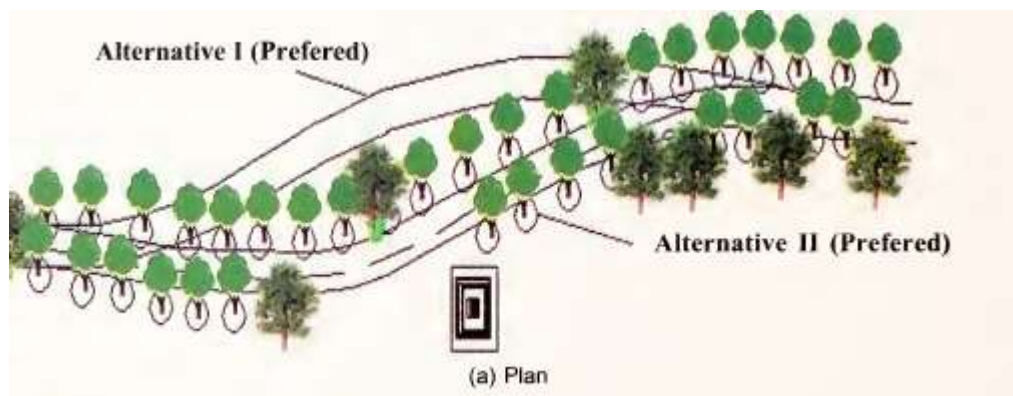
If the cracks are fine (crazing) and extend over large areas, a limit cut-back or an emulsified bitumen (fog seal) can be broomed.



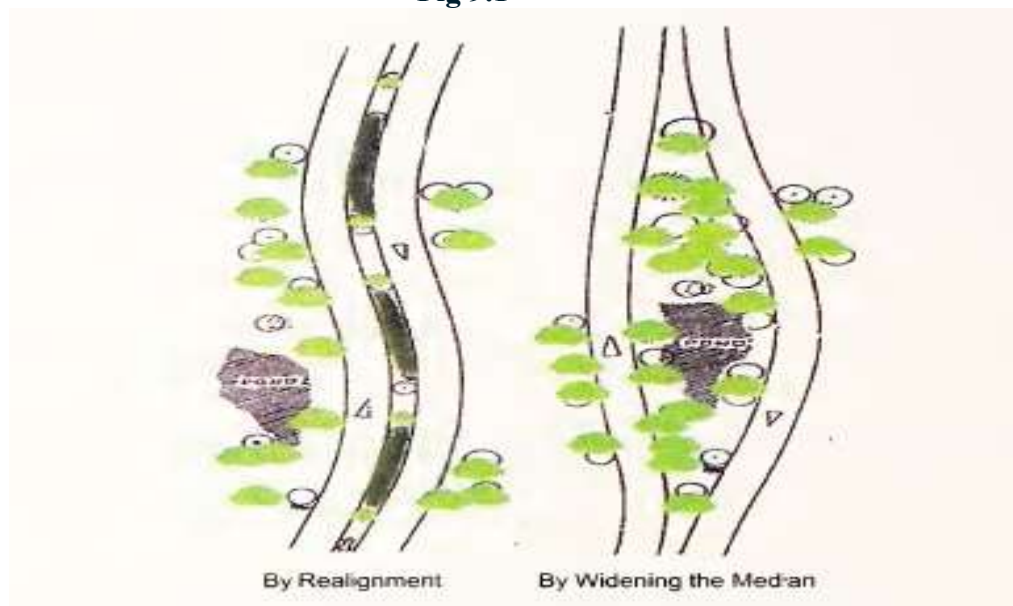
## **CHAPTER 9: LANDSCAPING AND TREE PLANTATION**

India is witnessing a major change in infrastructure development vis-a-vis the transportation network of the country; viz., the National Highways and State Highways. Various highway improvement projects are being undertaken by different State Governments and Government of India. Implementation of National Highway Development Project (NHDP) is the major step in this direction.

The first adverse consequence of widening, from environmental point of view, is the inevitable felling of trees growing along the highways. Road agencies must plan to enhance the aesthetics of the highway corridor from all possible angles.



**Fig 9.1**



**Fig 9.2**

Alignment of the road can be made more pleasing by providing larger radii and spiral transitions or gentle coordinated curves, both in the horizontal and vertical plane.

Tree Planting or Arboriculture: - Functional planting applies to such problems as protection of slopes against erosion, screening of unsightly views, reducing headlight glare, providing shade in summer and so on. In most cases, such planting also improves the appearance of the road and enhances the natural landscape, planting for aesthetic effects is also by and large functional but goes beyond that to blend the road into the surrounding countryside and enhance the overall beauty.

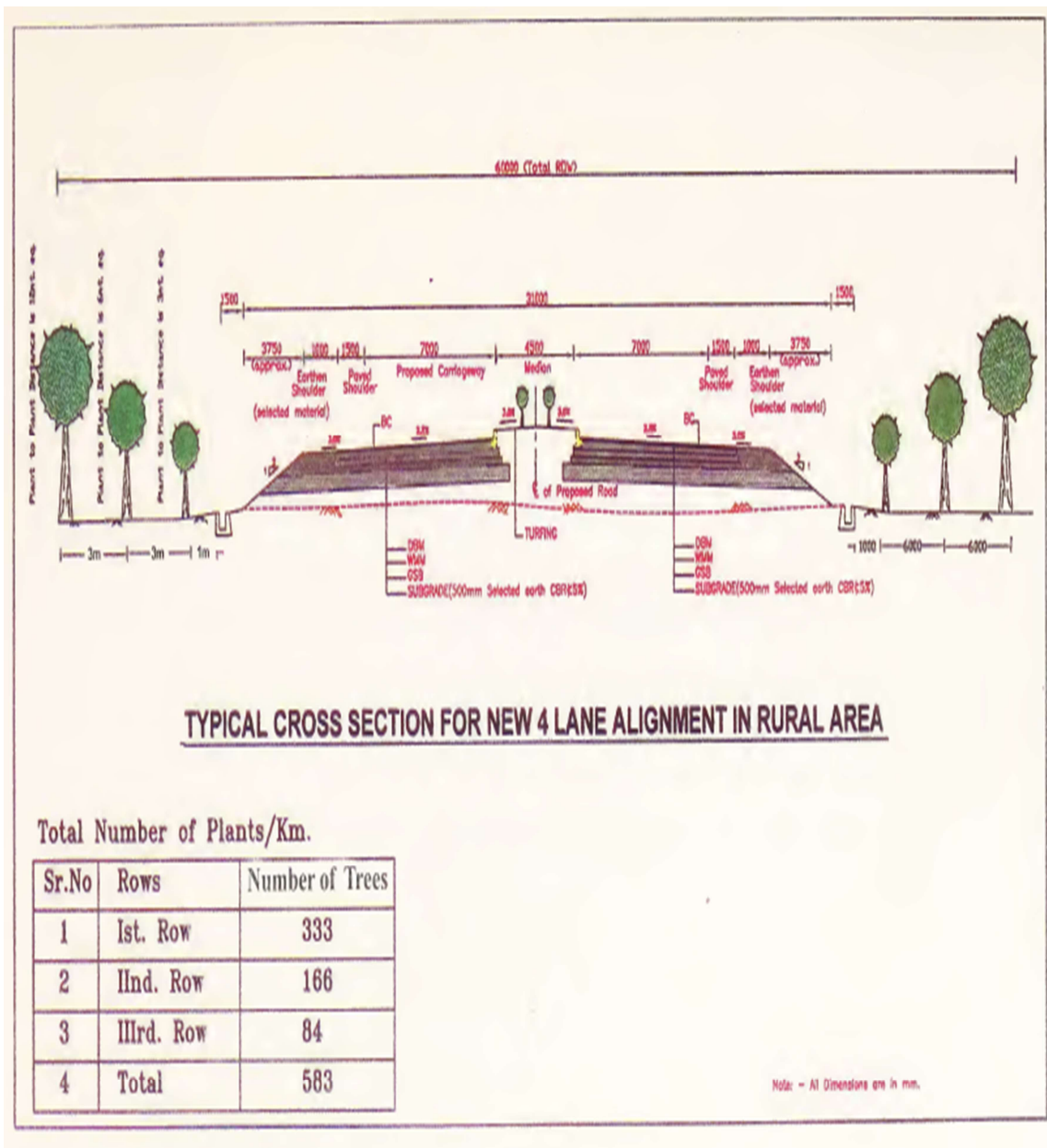


Fig 9.3

### Objectives of Tree Plantations:-

- To provide for aesthetic enhancement of the project corridors
- To reduce the impacts of air pollution and dust, as trees and shrubs are known.
- To be natural sink for air pollutants.
- To provide much needed shade on glaring hot roads during summer.
- To reduce the impact of ever-increasing noise pollution caused due to increase in number of vehicles.
- To arrest soil erosion at the embankment slopes.
- Prevention of glare from the headlight of incoming vehicles Climatic amelioration, Moderating the effect of wind and incoming radiation.
- To define the ROW especially, to highlight sharp horizontal curves during night.
- To save the Wildlife habitat.

### Selection of Tree Species: -

The selection of plant types and planting arrangement should be based on the following considerations:

- Aim and objective of plantation.
- Shape (spread of the tree) and size.
- Texture and colour of foliage/flower/fruits in different seasons and stages of growth.
- Adaptability and suitability to agro-climatic regions/zones
- Growth rate (slow/fast) average age of maturity and replacement cycle
- After-care and maintenance required for sustenance and growth
- Economic and other social/recreational benefits
- Drawbacks and demerits, if any, like prone to insects/pests disease, animal grazing and human interference.





S.no.	Soil	Botanical Name	Local Name	Flowering Month/Colour
1.	Normal Loamy soils	Acacia auriculiformis	Vilayati babool	Sep-Oct./Yellow
2.		Bauhinia sps.	Kachnar	Feb-Mar./Pink
3.		Cassia fistula	Amaltas	May/Yellow
4.		Cassia nodosa	Cassia	May June/Pink
5.		Delonix regia	Gulmohar	May/Yellow
6.		Jacaranda mimosaeifolia	Jacranda	April/Blue
7.		Peltophorum ferrugineum	Peltophorum	Oct./Yellow
8.	Water logged areas	Cordia dicotma	Lasoda	
9.		Syzygium cuminii	Jamun	
10.		Terminalia arjuna	Arjun	
11.	Alkaline soils [Usar]	Albizzia lebbek	Kala Siris	
12.		Pongamia pinnata	Kanji	
13.		Terminalia arjuna	Arjun	

**Fig 9.4**  
Species Recommended for 1st Row of Avenue Plantations



S.no.	Soil	Botanical Name	Local Name	Flowering Month/Colour
1.	Normal Loamy soils	Albizzia lebbek	Kala siris	
2.		Dalbergia sissoo	Shisham	
3.		Gravillea robusta	Sliver Oak	
4.		Malia azadiracta	Bakain	
5.		Pongamia pinnata	Kanji	
6.		Terminalia arjuna	Arjuna	

**Fig 9.5**

Species Recommended for 2nd and Subsequent Row, Except the Last Row of Avenue Plantations

Soil	Species	
	LOCAL NAME	BOTANICAL NAME
LOAMY	Arjun	Terminelia arjuna
	Imli	Tamarindus indica
	Jamun	Syzynium cuminii
WATER LOGGED AREAS	Mahua	Madhuca indica
	Mango	Mangifera indica
	Neem	Azadirachta indica [ at pH up to 8.5]
ALKALINE [USAR]	Kanji	Pongamia pinnata [ upto 9.0 pH]
	Peepal	Ficus religiosa
	Paker	Ficus infectoria
	Shisam	Dalberjia sissoo
	Neem	Azadirachta indica
	SANDY	Shisam

**Fig 9.6**

Shade Trees Recommended for Roadside Avenues

### Ornamental Plants (Except Last Row)

Distance from embankment	1.0 m away from the toe of the embankment
Spacing between plant to plant	3 m
Spacing between rows	3 m
Size of the pits	60x60x60 cm (in alkaline soils, kankar panes to be broken by augur. In waterlogged areas, mound with height varying depending on water level)
No. of plants per km	333
Height of the saplings at the time of planting	1.5 m to 2 m
Survival percentage of plantation	90% at any time

Fig 9.7

### Ornamental Plants (Except Last Row)

Distance from preceding rows	3.0 m
Spacing between plant to plant	8-12 m (6 m if high mortality expected)
Size of the pits	60x60x60 cm (in alkaline soils, kankar panes to be broken by augur. In waterlogged areas, mound with height varying depending on water level)
No. of plants per km	84 (167 at 6 m spacing)
Height of the saplings at the time of planting	More than 2 m
Survival percentage of plantation	90% after replacement of casualties in first two years. 80% afterwards

Fig 9.8

### Shade Plants (Last Row)



## Grass Turfing: -

The surface should have sufficient layer of good quality soil [up to 45 cm] so as to have better growth and survival of grasses and shrubs.

Specifications: -

i) Sowing of grasses is intended to create a strengthened surface that is resistant to erosion.

ii) It is the responsibility of the contractor to ensure that the condition of the site is good enough for the successful establishment of grasses.

iii) The contractor is required to supervise all field operations like preparation of surface, sowing of grasses and quality of grass seeds used.

iv) A cover of 25 gram of grass seed per square meter of surface should be achieved.

v) The timing of sowing is of utmost importance. The seed sowing must be carried out before the onset of monsoon [May & June] so that they yield desired results. The watering of the surface will be done by tankers till the onset of the monsoon.

vi) After sowing, mulch of prepared and dried out herbs should be laid over the whole seeded area in a thin layer so that the direct sunlight and transpiration loss may not affect the grasses.



Year	Month	Activities to be done
1st Year	Jan-March	1 Surveying & cleaning of the area
		2 Digging of Pits
		3 Procurement of Angles Iron and barbed wire(or other fencing material), and erecting the fence
2nd Year	April-June	1 Purchase of Farm yard manure
		2 Brick/iron etc. guard for 1 <sup>st</sup> row
		3 Plantation along the Highway
		4 Filling up of Pits with Farm Yard manure and Soil
	July-August	1 Transportation of Plants
		2 Planting of Saplings
		3 Watering
		4 Weeding and hoeing
	Sep-Nov	1 Weeding and hoeing
		2 Watering 4 times a month
	Dec-Feb	1 Weeding and hoeing
		2 Maintenance
	March	1 Watering 4 times a month
3rd year	April-June	1 Watering 6 times a month
	July-August	1 Casualty Replacement ( 20% of the total plants )
		2 Weeding
		3 maintenance by Mali
	Sep-Nov	1 Watering 2 times a month
		2 maintenance by Mali
	Dec-Feb	1 maintenance by Mali
	March	1 Watering 4 times a month
2 maintenance by Mali		
4th Year	April-March	1 Watering
		2 Casualty Replacement ( 10% of the total plants )
		3 maintenance by Mali

Activities Schedule for Avenue Plantation/Median Plantation

Fig 9.9



## **CHAPTER 10: TRAFFIC MANAGEMENT**

### **COMMONLY USED TERMS: -**

**Activity Zone:** - Activity Zone is the section of the highway where the construction activity is in progress, and which comprises of workspace, traffic space, and buffer space.

**Advance Warning Zone:** -Advance Warning Zone is the section of the road in which the road users are warned in advance about the presence of work zone ahead and prepare them for the change in driving conditions.

**Advance Warning Length (AWL):** -The Advance Warning Length (AWL) is the road stretch (which is actually, the Advance Warning Zone) in which series of warning signs are placed and the length depends upon the approach speed. It is the distance between first sign indicating the presence of road works ahead to the start of the Approach Transition Zone.

**Arrow Boards** Arrow Boards are the static or dynamic signs with a matrix of elements capable of either flashing or sequential displays. The Arrow Boards provide additional warning and directional guidance to assist in merging or diverging, and also to control the movement of the road users through or around a work zone.

**Barricades:** - Barricades are traffic control devices intended to provide containment without significant deflection or deformation under impact and to redirect errant vehicles back to their designated travel path with least damages.

**Delineators:** - Delineators are the devices with distinct visibility and reflectivity used to supplement the other normal traffic control devices, to delineate and guide the road users through the constrained or critical locations of the highway making the travel path clearly readable.

**Hot Thermoplastic Paint:** - Hot Thermoplastic Paint is the plastic road marking material that can be applied to road surface in a hot and molten stage for marking the pavement for the road markings.

**Informatory Signs:** - Informatory Signs are the signs used to inform road users of the presence of road works ahead, and to direct/guide them with to the information for safe movement through the construction zone using temporary diversions and detours etc.



**Reflective Clothing:** -Reflective Clothing is the high visibility fluorescent clothing made of retro-reflective material, so that the presence of workers and those in work zone is conspicuous and can be easily seen by drivers in all weather and light conditions.

**Regulatory Signs:** - Regulatory Signs are the signs to inform road users of traffic laws or regulations to be adhered to in work zones and also to indicate the legal validity that would not otherwise be apparent.

**Retro Reflective Sheeting:** -Retro Reflective Sheeting has the ability of the surface to return light back to the source (the driver, whose headlight beam has fallen on the sign) and such sheeting is used for signs to be effective in dark hours or when outside light is insufficient. Road Operator Road Operator is responsible for operating a road network by law, legal act or contract. A Road Operator could be a department, agency, community or company and is the primary client or ordering body for the road works.

**Road Studs:** - The Road Studs are raised Retro-Reflective Pavement Markers (RRPM) installed on road surface along with pavement markings to delineate the traffic paths/lanes in work zones and through diversions. These are also known as cats-eye and can be with fixed reflectors or solar powered blinking type. Road Users Road Users are all constituent modes of traffic using the work zone, including the Vulnerable Road Users (VRUs).

**Road Workers** Road Workers includes all workers present in or around the work zone and involved in construction and management of works, including traffic management and any kind of surveying. Due to close proximity and exposure to the moving traffic in their workplace, road workers are vulnerable to hazards.

**Road Works** Road Works include all activities for improving or expanding the road network as well as the maintenance activities that may require warning the traffic about the unusual situation likely to be encountered, which in turn will influence the safety of road users and/or road workers.

**Roll-up Signs** Roll-up Signs are basically portable signs used in construction zones to guide the traffic for meeting emergency situations. Roll-up Signs shall be changeable and shall have provisions for fixing on different objects depending on the need.



Speed at the Start of Traffic Control Zones (kmph)	Advance Warning Zone/Length		Transition Zone/Length								Buffer Space			Work Space	Distance Between Sites in kilometers			
	First Sign from Start of Taper i.e. Advance Warning Length- AWL	Minimum Distance between two successive signs in meters-d (min.)	Approach Taper Length in Meters-ATL			Terminal Taper Length in Meters-TTL			Radius in Case of Circular Curves in meters - SR	'Work Zone End' Length in meters - WEL	Minimum Approach Longitudinal Buffer in meters - ALB	Minimum Exit Longitudinal Buffer in meters - FLB	Minimum Lateral Buffer Space in meters - LBS			Desirable	Exceptional	
			Rate of Taper	Example Width of Hazard (S1) including Buffer Space in meters		Rate of Taper	Examples Lateral Shift Including Buffer Space (S2) *in meters											
				1	2		4	1										2
Up to 50	180	40	1:12	12	24	48	1:10	10	20	40	30	45	10	5	0.5	Varies**	2	1
51 to 65	270	55	1:15	15	30	60	1:12	12	24	48	90	60	15	10	0.9		5	2
66 to 80	350	80	1:18	18	36	72	1:15	15	30	60	165	75	30	15	1.2		10	5
81 to 100	500	100	1:20	20	40	80	1:18	18	36	72	250	105	60	30	1.2		10	5
101 to 120	1100	120	1:25	25	50	100	1:20	20	40	80	400	135	100	60	1.5		10	5

\*\* The length of work space depends upon the nature of work actually taken up. For example for routine maintenance work, it can be quite small, whereas for major improvement work, it can be upto 5 km.

**Note :** The recommended length of work zone and distance between two sites given in this Table is based on practice followed in UK (Refer: Traffic Sign Manual, Chapter 8, 2009, DoT)

**Fig 10.1**

**Lengths For Temporary Traffic Control Zones**





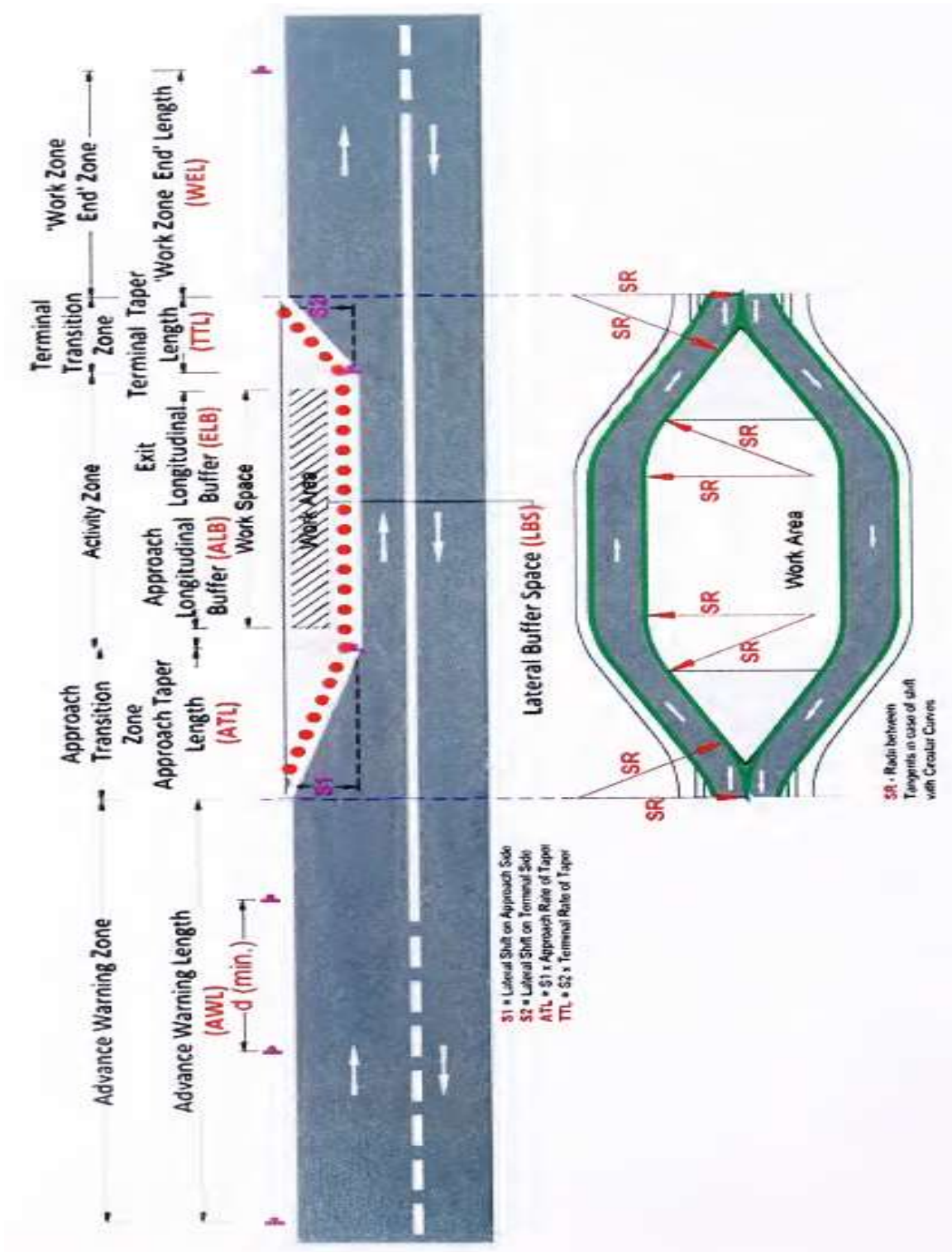


Fig10.2

Temporary Traffic Control Zones/ Lengths



Sign placement: -

Signs should be located on the left side of the roadway unless otherwise specified in these guidelines. Where special emphasis is needed, signs may be placed both on the left and right sides of the roadway.

	Minimum (mm)	Desirable (mm)	Maximum (mm)
A	1200	1800	2500
B	1000	2000	2500
C	300	600	1000
D	1500	1800	2100
E	2100	2100	2500
H	-	-	5000
G	1800	2000	2100

**Table 10.1**

Heights and Clearances of Signs

Sign Boards: -

1. The sign shall be located at the entry to the one-way street due to detour or traffic diversion plan.



2. The signs shall be located at road section where the Vehicles are not allowed to enter on account of Work zone traffic management plan.



3. This sign will be where a side road forms a T-junction with a two-way road and traffic is required to turn in one direction due to road works.



4. This sign will be where a side road forms a T- junction with a two-way road and traffic is required to turn in one direction due to road works.



5. The sign shall be erected to prohibit overtaking in approach warning zone. It can be placed both sides and can be repeated for emphasis.



6. The sign shall be used to indicate that drivers must give way to oncoming vehicles. If necessary a definition plate can be installed below the sign written 'Give way to oncoming vehicles.'



7. The sign shall be erected to prohibit parking on account of road works.



8. The sign shall be erected where entry is prohibited for vehicles whose axle load exceeds a particular limit in a temporary road or a structure for construction.



9. The sign shall be erected in advance of an overhead structure where entry height has been restricted due to road works.



10. The sign shall be erected where entry of vehicles exceeding a particular length is prohibited on account of construction activities.



11. The sign shall be erected where entry is prohibited for vehicles whose laden weight exceeds the indicated limit as the temporary road or structure cannot afford the weight beyond that indicated.



12. The sign shall be located in advance warning zone to prescribe the speed limit and warrants reduction the speed on approaches. It can be repeated with a lower value at the start of taper and also in the diverted pathway.



13. The sign to indicate the diversion that are lawfully to be taken on account of work zone management plan and the traffic to move in the Ahead direction.



14. The sign to indicate the diversion that are lawfully to be taken on account of work zone management plan and traffic to move ahead and right direction.



15. The sign to indicate the diversion that are lawfully to be taken on account of work zone management plan and traffic to move ahead and left direction.



16. The signs indicate the diversion that are lawfully be taken and direction of movement with respect to the position of sign installed and traffic to move in left direction.



17. The signs indicate the diversions that are lawfully be taken and direction of movement with respect to the position of sign installed and traffic to move in right direction.



18. The diversions that are lawfully be taken in advance approximately 50 m ahead due to temporary traffic management plan.



19. The sign is for the diversion that are lawfully be taken in advance approximately 50 m ahead due to temporary traffic management plan.



20. The sign shows keep left of sign placed due to road works traffic diversion.



21. The sign shows keep right of sign placed due to road works traffic diversion.



22. The sign shows vehicle can pass either side due to road works traffic diversion.



23. The sign shall mean that only pedestrians are allowed and the traffic is not allowed on this portion of street due to temporary traffic management.



25. This sign shall indicate the point at which all prohibitions imposed upon traffic due to road works traffic management ceases to apply.



26. Sign to indicate change of direction to left in a work zone .



27. Sign to indicate change of direction to right in a work zone.



28. Sign in case of a reverse bend where first is right turn in a work zone.



29. Sign in case of a reverse bend,  
where first bend is a left turn in a work zone.



30. Sign to indicate a traffic control  
in an alternate one way movement ahead through  
a portal signal.



31. Sign to traffic from left is merging  
as part of temporary traffic management plan.



32. Sign to traffic from right is merging  
as part of temporary traffic management plan.



33. Sign to indicate road suddenly  
narrows due to road construction.



34. Sign to indicate to pavement  
width widens ahead in a temporary traffic control.



35. Sign to indicate narrow bridge  
ahead where the width of carriageway is less  
than the normal width of carriageway in work area.



### STOP AND GIVE WAY SIGN

- Stop
- Give Way
- Give Way to Buses Exiting the Bus Bay

### PROHIBITORY SIGNS

- Bullock Carts Prohibited
- Bullock and Hand Carts Prohibited
- Hand Carts Prohibited
- Tongas Prohibited
- Horse Riding Prohibited
- Caravan not Allowed
- Buses Prohibited
- Cars Prohibited
- Trucks Prohibited
- Tractor Prohibited
- Construction Vehicle Prohibited
- Articulated Vehicles Movement Prohibited
- Two Wheeler Prohibited
- Cycles Prohibited
- Horn Prohibited
- No Entry
- One Way
- Left Turn Prohibited
- Right Turn Prohibited
- Overtaking Prohibited
- U- Turn Prohibited
- Right Turn & U-Turn Prohibited
- Priority to Vehicles from the Opposite Direction

### NO PARKING AND NO STOPPING SIGNS

- No Standing
- No Stopping and No Standing
- 

### VEHICLE CONTROL SIGNS AND SPEED LIMIT

- Axle Load Limit
- Height Limit
- Length Limit

### Load Limit

- Width Limit
- Maximum Speed Limit
- Maximum Speed Limit (Vehicle Type)
- Stop for Police Check



## Survey Questionnaire

- 1) Name:
- 2) Gender:
- 3) Age:
- 4) Date:
- 5) Distance Travelled:
- 6) Facilities Used Name:
- 7) Difficulties faced while Journey:
- 8) Road Signage Information:(√)
  - Stop sign.
  - No Parking
  - Roundabout
  - Traffic merges ahead
  - Driver location signs
  - Major road ahead
  - No Turn
  - Pedestrian crossing  Prohibitory signs  Speed limit.  One Way
  - Road Closed
- 9) Incident Management Facility Information of NHAI:
  - Crane (30 MT)
  - Ambulance (advance Life supporting System)
  - Routine patrolling support
- 10) Any support provided during journey:
- 11) Expressway Information of Key Facilities:
  - Incident Management Facility  Sign board with detail.
  - Advance Traffic Management system
- 12) Expressway Journey rating comparison to Local highways:





## **CHAPTER 11: REFERENCES AND BIBLIOGRAPHY**

- Engineering, Procurement & Construction (EPC) Mode
- National Highways Authority of India (NHAI)
- IRC:82- 1982 Code of Practice for Maintenance of Bituminous Surfaces of Highways
- IRC SP - 083-2008 Guidelines for Maintenance Repair and Rehabilitation of Cement Concrete pavements
- IRC SP - 100-2014 Use of Cold Mix Technology in Construction & Maintenance of Roads using Bitumen Emulsion
- IRC SP:18-1978 Manual for Highway Bridge Maintenance Inspection
- IRC: SP:35-1990 Guidelines for Inspection and Maintenance of Bridges
- IRC: SP:52-1999 Bridge Inspector's Reference Manual
- IRC: SP:055-2014 Guidelines on Traffic Management in Work Zones
- IRC: SP:21- 2009 Guidelines on Landscaping and Tree Plantation
- IRC:35- 1997 Code of practice for road Marking.
- IRC:67- 2012 Code of practice for road sign.
- IRC:79-1981 Recommended of practice for road delineators

### 11.2 WEBSITES

[https://morth.nic.in/sites/default/files/RA\\_2022\\_30\\_Oct.pdf](https://morth.nic.in/sites/default/files/RA_2022_30_Oct.pdf)

<https://aryaomnitalk.com/advanced-traffic-management-system-atms/>

[https://en.wikipedia.org/wiki/Expressways\\_of\\_India](https://en.wikipedia.org/wiki/Expressways_of_India)

[https://forestclearance.nic.in/DownloadPdfFile.aspx?FileName=0\\_0\\_11118125912141TypicalCrosssections.pdf&FilePath=../writereaddata/Addinfo/](https://forestclearance.nic.in/DownloadPdfFile.aspx?FileName=0_0_11118125912141TypicalCrosssections.pdf&FilePath=../writereaddata/Addinfo/)



**End of Project Report**

