

# Risk Assessment Report

## 1.1 Road Safety Features

Road safety features are essential for high speed facilities such as Expressways. Various types of road safety features are proposed along the Expressway as described below:

### 1.1.1 Road Signs

Traffic signage are the silent speakers on the road for travelers and pedestrians. These signs give information about the road conditions ahead, provide instructions to be followed at the major crossroads or junctions, warn or guide drivers, and ensure proper functioning of road traffic. Traffic signage are also an important aspect in tunnel project, in order to provide for the safe and orderly movement of vehicles and users. The signs can be divided in three groups: Regulatory, Cautionary, Informatory.

#### 1.1.1.1 Mandatory Signs/ Regulatory Signs and Compulsory signs

These signs are intended to inform road users of special obligations, restrictions or prohibitions with which they must comply. Examples circular signs for speed or other restrictions etc., compulsory signs such as “Compulsory Keep Left” compel the drivers to follow a definite route.



Prohibition to  
overtake



Speed  
limitations



Give Way



Closed traffic  
lanes

These signs are applicable both in normal situations and in deviant situations. An important regulatory sign for tunnels is the prohibition to enter a tunnel for vehicles carrying dangerous goods, if applicable.

#### 1.1.1.2 Warning Signs/ Cautionary Signs

The Warning Signs are meant to convey to road users a warning about dangers/ hazards ahead. These are triangular signs warning about hazards lying ahead. Proper warning signs shall be designed for the expressway.



Chevron  
Alignment



Merging lanes



Roundabout



Hump or rough  
road

### 1.1.1.3 Informatory Signs

These signs guide the road users about destinations, distance, alternative routes, and prominent locations like food joints, public toilets, nearby hospitals, etc. The Informatory Signs are provided to convey to road user's information on places of interest, services and facilities and guide road users along routes, etc. This also includes other signs which are useful to the drivers like Direction Signs, Toll plaza ahead sign, etc. For expressways, these signs gain more importance since at interchanges weaving maneuvers are needed and for that advance warning and Informatory signs are necessary. These signs shall generally be mounted on gantries fixed across the carriageway.



Toll Booth signage

Informatory signs like tunnel ahead, information about tunnel length, etc., shall be placed outside the tunnel. Informatory signs shall be used to designate the escape routes and safety facilities in tunnels:

### 1.1.2 Safety exits

The same sign shall be used at the entrance of direct exits to the outside, connections to the other tunnel tube or to a safety gallery.

**Escape routes to safety exits:** The two nearest escape exits shall be signed on the sidewalls, at least every 25 m, at a height of 1.1 m to 1.5 m, with indication of the distances.

**Safety recesses (Emergency stations):** With indication of the presence of an emergency phone and a fire extinguisher, at least every 150 m. This shall imply, by definition, the presence of an emergency phone and of at least two fire extinguishers.



Fire Extinguisher



Emergency Phone

### 1.1.3 Positions of signs

The tunnel signs mentioned here will be placed not only at the entrance of the tunnel but also at reasonable distances in front of the entrance so placed that the drivers for whom they are intended

can recognize them easily and in time. They shall normally be placed on the side of the road appropriate to the direction of traffic. They may however be placed or repeated above the carriageway. Any sign placed on the side appropriate to the direction of traffic shall be repeated above or on the other side of the carriageway.

**Materials to be used:** Optimum conspicuity high quality retro-reflective materials shall be used in vertical signing. Signs inside tunnels should be made of materials with maximum retro-reflection and be internally or externally permanently illuminated to give optimum conspicuity both in day and in night-time conditions. Materials used both in tunnels and in their advance warning area should be of the highest level of performance in reflectivity, specified in the standards, using micro-cube technology, high performing retro-reflective sheeting, granting night-time visibility in the case of electrical failure.

## **1.1.4 Components of the Highway Traffic Management system**

### **1.1.4.1 Variable Message Signs**

They are installed along the highway on gantries. Important messages related to incident management, traffic movement or traffic congestion can be flashed onto the Variable Message Signs. These can be programmed and controlled from Control Center. The operator sitting at the Control Center has various inputs from different incident management devices connected along the highway. Using these inputs, the operator can advise the road user about the traffic movement by displaying messages on VMS.

Portable VMS are being used internationally at construction sites or accident spots to inform the road users about the need to drive carefully.

### **1.1.4.2 Emergency Call Boxes**

They are installed along the highway. As the name suggests, they are used by road users to call for help in case of emergencies. Whenever a road user calls for help through ECB, he gets connected to the operator who is sitting in the Control Center. The operator has Patrol Vehicles, Ambulances, Cranes at his disposal.

After understanding the road user's request for help, the operator directs the relevant staff for incident management. Power to the ECB's is provided either by solar powered batteries or through copper cable.

There are three technologies available on which ECB's normally works. They are:

- GSM Technology
- OFC connectivity
- Radio Wireless connectivity

### **1.1.4.3 CCTV Surveillance System**

As shown above, CCTV Surveillance System consists of Pan/Tilt/Zoom camera mounted on a pillar for continuous monitoring of the highway. This dome camera is well protected and can withstand wind velocity upto 130 mph. The Camera has a infrared filter for better viewing at night. It is connected to the Control Center through Co-axial and OFC cable. An operator sitting at the Control Center can zoom into any camera and view the traffic movement along the highway. CCTV surveillance cameras should also be fixed under the structures to help identify the structural damage if any.



**Figure 1-1: CCTV Surveillance System**

### **1.1.5 Road Markings**

It will be essential to provide suitable carriageway markings for conveying to the drivers of hazards or directional lane changes. These are provided also to ensure safety and orderly use of the carriageway in accordance with traffic regulations, to define lanes and guide/ regulate vehicles at junction and to complement the traffic signs. Various types of pavement marking shall be proposed based on IRC-35 and MoRT&H guidelines.

- Good lighting system and clear walls
- Sharp contrasts between road surface and lane markings, sidewalks or barriers

The carriageway markings as suggested shall be simple, clear to purpose and type, hard wearing and skid resistant in both dry and wet weather conditions. Provisions have been made for Road Marking on the entire length of the expressway, which, include, carriageway edge-lines, lane markings, chevron markings at diverge and merge locations, etc. Hot applied thermoplastic materials (super-imposed type) are proposed for road markings and shall be applied with the help of marking machines. Carriageway Edge Lines are specifically required to define edges of the carriageway wherever there are paved shoulders or emergency lane. Carriageway Edge Lines recommended are 150 mm wide, yellow in colour and continuous along both sides of the carriageway except at merge and diverge locations where a broken edge line is used to provide continuity.

#### **1.1.5.1 Other Markings**

Other Markings such as Directional Arrows, Deceleration Lane Arrows, Chevron and Diagonal Markings, Lane Markings, and other related markings required for smooth operation of traffic are proposed to be provided in accordance with relevant IRC standard code of practices.

### **1.1.6 Safety Barriers**

Roadside barrier in the form of corrugated metal beam crash barriers shall be provided at the approaches of bridges, in the sections with embankment height more than 3.0 m, and other hazardous locations. New Jersey type concrete barriers will be considered at the centre of flush median, wherever applicable.

### **1.1.7 Tunnel Safety**

### **1.1.7.1 Maintenance**

The amount of maintenance required would depend on where the tunnel is located, the type and volume of traffic it is required to handle, quality of ventilation and the size and grade of the tunnel itself. The luminary units should be sealed so as to prevent entry of water from water sprays, dust and smoke. The luminaries have to be cleaned frequently to clear dust and soot that may collect on their outer surface. Proper routine maintenance programme should be conceived and implemented. Instead of waiting for the luminaries to fail before replacement, systematic replacement and renewal programme should be conceived and implemented.

### **1.1.7.2 Vehicular tunnel ventilation systems**

All vehicular tunnels need ventilation. It is created by natural means or by mechanical means. The ventilation measures carried out for tunnel in construction and operation phase will follow IS 5878: 1971 [Part II, Section 2] Underground Excavation in Rock, Section 2, Ventilation, Lighting, Mucking and Dewatering.

- All underground excavation works shall be properly and adequately, ventilated by system of pipes and fans as required by relevant Codes and to the satisfaction of the Engineer
- Adequate artificial means of ventilation shall be deployed and shall be in operation at all times when people are working underground
- Adequate ventilation shall be provided at all the working cavities and drifts etc
- After breakthrough of the tunnel excavation from both ends, mechanical ventilation system will still be necessary in the tunnel till its final handing over to the relevant authorities

In case of Mechanical Ventilation, it is proposed to provide Jet fans units at 200 m distance in ceiling of tunnel. These fans are reversible in action, can be operated in both directions. These fans are controlled from the central control room. The sensors fitted in tunnel gives the information about CO<sub>2</sub> levels and based on which the fans are operated.

### **1.1.7.3 Lighting**

The whole of the approaches, the tunnel faces and tunnel length up to the working faces, the areas where plant and machinery is in operation and other areas as may be indicated by the Engineer shall be adequately lit by electric lights or by other means by the Contractor at his cost and as required by relevant Codes and to the satisfaction of the Engineer. Proper illumination shall be provided also during non-working hours as may be required at each location.

The lighting measures carried out for tunnel in construction and operation phase will follow IS 5878: 1971 [Part II, Section 2] Underground Excavation in Rock, Section 2, Ventilation, Lighting, Mucking and Dewatering.

### **1.1.7.4 Smoke Detectors**

There are two main types of smoke detectors: ionization detectors and photoelectric detectors. A smoke alarm uses one of these two methods. The devices may be powered by a 9-volt battery, lithium battery, or 230-volt house wiring.

#### **Ionization Detectors:**

Ionization detectors have an ionization chamber and a source of ionizing radiation. The ionization chamber consists of two plates separated by about a centimetre. The battery applies a voltage to the plates, charging one plate

positive and the other plate negative. Alpha particles constantly released by the americium knock electrons off of the atoms in the air, ionizing the oxygen and nitrogen atoms in the chamber. The positively-charged oxygen and nitrogen atoms are attracted to the negative plate and the electrons are attracted to the positive plate, generating a small, continuous electric current. When smoke enters the ionization chamber, the smoke particles attach to the ions and neutralize them, so they do not reach the plate. The drop in current between the plates triggers the alarm.

### **Photoelectric detectors:**

In one type of photoelectric device, smoke can block a light beam. In this case, the reduction in light reaching a photocell sets off the alarm. In the most common type of photoelectric unit, however, light is scattered by smoke particles onto a photocell, initiating an alarm. In this type of detector there is a T-shaped chamber with a light-emitting diode (LED) that shoots a beam of light across the horizontal bar of the T. A photocell, positioned at the bottom of the vertical base of the T, generates a current when it is exposed to light. Under smoke-free conditions, the light beam crosses the top of the T in an uninterrupted straight line, not striking the photocell positioned at a right angle below the beam. When smoke is present, the light is scattered by smoke particles, and some of the light is directed down the vertical part of the T to strike the photocell. When sufficient light hits the cell, the current triggers the alarm.

### **Difference between ionization and photoelectric detectors:**

Both ionization and photoelectric detectors are effective smoke sensors. Both types of smoke detectors must pass the same test to be certified as UL smoke detectors. Ionization detectors respond more quickly to flaming fires with smaller combustion particles; photoelectric detectors respond more quickly to smouldering fires. In either type of detector, steam or high humidity can lead to condensation on the circuit board and sensor, causing the alarm to sound. Ionization detectors are less expensive than photoelectric detectors, but some users purposely disable them because they are more likely to sound an alarm from normal cooking due to their sensitivity to minute smoke particles. However, ionization detectors have a degree of built-in security not inherent to photoelectric detectors. When the battery starts to fail in an ionization detector, the ion current falls and the alarm sounds, warning that it is time to change the battery before the detector becomes ineffective. Back-up batteries may be used for photoelectric detectors.

### **Carbon Monoxide (CO) detector sensors:**

It is a device that detects the presence of the carbon monoxide (CO) gas in order to prevent carbon monoxide poisoning. CO is a colourless and odourless compound produced by incomplete combustion. It is often referred to as the "silent killer" because it is virtually undetectable without using detection technology.

Elevated levels of CO can be dangerous to humans depending on the amount present and length of exposure. Smaller concentrations can be harmful over longer periods of time while increasing concentrations require diminishing exposure times to be harmful.

CO detectors are designed to measure CO levels over time and sound an alarm before dangerous levels of CO accumulate in an environment. System-connected detectors also alert a monitoring service / control room that can dispatch emergency services if necessary.

## **1.1.8 Fire Fighting System**

It is proposed to use advanced Water Based Fire Fighting System (WFS) in the tunnel which is being used world-wide.

### **1.1.8.1 Water Based Fire Fighting Systems (WFS)**

WFS use water in the form of droplets. Depending on the system type the average droplet size may vary from very small droplets for so called High Pressure Water Mist Systems up to relatively large droplets as created by so called Deluge or Sprinkler Systems.

The following main firefighting effects are used by all WFS. Depending on the droplet sizes used the efficiency in making use of these potential effects varies.

### **1.1.8.2 Cooling**

As a consequence of the extinguishing water being split up into droplets, a reaction surface is created via which the heat from the fire is absorbed. It takes 335 kJ of energy to heat 1 liter of water from 20 to 100°C, and an additional 2257 kJ to transform the water to steam. Thus, water is the extinguishing medium with the highest known heat absorption capacity.

The larger the reaction surface is, which is dependent on the droplet size distribution, the higher the potential cooling effect is. The smaller the mean droplet size, the more efficient the cooling effect. This cooling effect refers to the cooling of the air and gases around a fire and not to the cooling of the fire load itself. For the latter effect the surface size of the fire load is the defining factor for the cooling. Therefore, more efficient cooling of the tunnel environment will occur while the water droplets are in the air. Subsequently, small droplets, which will tend to fall slower than larger droplets, will have a more efficient cooling effect on the tunnel environment.

### **1.1.8.3 Suffocation of the Fire**

During the evaporation of the water its volume will be increased by 1640 times, which leads to a reduction of the oxygen content in the air at the source of the fire. Thus, the fire will be suffocated, or at least it will be suppressed due to the lack of sufficient oxygen needed for the combustion process.

The reduction of oxygen content due to the formation of steam only takes place at locations where very high temperatures occur. Therefore, a reduction of oxygen content will tend to occur close to the fire rather than where occupants are escaping.

### **1.1.8.4 Separation Effect**

Water droplets that are located between the flame and fuel surface reduce the radiant heat received by the fuel surface, effectively reflecting the heat. Subsequently the burning rate reduces, and the radiant heat received by any potential fire loads in the surrounding tunnel area will also reduce, decreasing the likelihood of flame spread due to this "separation" effect. The "reflection" effect is dependent on the sufficient generation of very small water droplets - the capacity of the effect increases with decreasing water droplet size.

### **1.1.8.5 Shielding Effect**

As described above, the water droplets will reduce radiant heat received by surrounding objects in the tunnel environment. This "shielding" effect will help to prevent fire spread and protect occupants escaping away from the fire and emergency services approaching the fire.

### **1.1.8.6 Protection of the Tunnel Structure**

The effects described above can considerably reduce the temperatures experienced in the tunnel and heat transition affecting the structure of the tunnel and technical equipment installation. Thus, it may be possible to reduce the requirements on concrete protection shielding and the fire rating of mechanical and electrical equipment in tunnels protected by WFS. However, careful

consideration of all fire safety related (and nonfire safety related) aspects involved shall be made before lowering such requirements.

The whole tunnel or protected area is covered with nozzles, which are grouped into sections. The determination of section lengths shall be defined based on a risk analysis and on the layout criteria determination process. But in no case sections shall be shorter than 30 meters, and each section shall cover the tunnel “from wall to wall”.

All sections are connected by section valves and a main water supply line to the pump unit. In the event of activation of the WFS (automatically by detection system or manually), at least one section valve will be opened accordingly, and at least one pump unit will be started by signals from an external control system. The water supply shall be suitable to provide water at the minimum pressure for at least two sections simultaneously.

The water supply shall also be sufficient such that the WFS provides the required flow rate of water for a minimum of 30 minutes for tunnels less than 500 m long and 60 minutes for tunnels greater than 500 m long or for a period of time that is double the time required for the emergency services to reach the fire (taking into account worst case conditions such as traffic congestion), whichever is more onerous. However, the minimum operational time may increase if required by the authorities having jurisdiction. The refilling of water reservoirs by tank trucks shall be considered. The system shall only be deactivated by qualified personnel such as the fire service or personnel of the tunnel operator having received a dedicated training. Horizontal shaft tunnels are provided at interval of 500 m C/c interval in both tunnel with 3 lane carriageways for emergency traffic diversion evacuation.

### **1.1.9 Intelligent Transport System (ITS)**

#### **1.1.9.1 CCTV Video surveillance camera**

Closed Circuit Television (CCTV) brings benefits to the campus community through a variety of initiatives including the following:

- Provides a potential opportunity to aid in the investigation and follow up of activities.
- Enhances UOW Security’s capacity to increase surveillance of a larger area.
- Enhances the perception of safety.
- Aids in surveillance of traffic activities.
- Helps to protect infrastructure and assets.
- Provides opportunity for surveillance of emergencies in particular events.

Video cameras are either analogue or digital, which means that they work on the basis of sending analogue or digital signals to a storage device such as a video tape recorder or computer or Digital video recorders. Considering importance of data and to store large amount of data securely, digital video recorders are recommended.

CCTV cameras recommended for this project are dome cameras with zoom capacity upto 2 km in visible conditions. Movement and zooming of these cameras can be controlled using computer from control room itself.

#### **1.1.9.2 Digital video recorder**

These are the hard disk based digital video recorders capable of storing video data of 15 days. Hard-disk based digital video recorders make the "time shifting" feature (traditionally done by a

VCR) much more convenient, and also allow for "trick modes" such as pausing live video, instant replay of required scenes, chasing playback where a recording can be viewed before it has been completed. Most DVRs use the MPEG format for compressing the digitized video signals.

### **1.1.9.3 Emergency telephone**

An emergency telephone is a phone specifically provided for making calls to emergency services and is most often found in a place of special danger or where it is likely that there will only be a need to make emergency calls.

Whenever road user needs to contact control room in case of an accident or emergency, he will just lift up the handset and call will be get connected to control room. Location from which user is dialing will also be indicated in control room.

### **1.1.10 Road Furniture**

#### **1.1.10.1 Metal Beam Crash Barriers**

Metal Beam Crash Barriers shall be provided on both edges of the road where road height exceeds 3 m, and on the outer edge of the road on sharp curves. Suitable reflectors shall be fixed on the beam @ 3 m c/c for proper delineation of the barrier line. The metal beam crash barrier shall start with a parabolic flare away from the carriageway in the incoming section, the equation of the parabola being

Where,

$w$  = tangent offset at minimum flare = 1200 mm  $l$  = total length of flare = 11400 mm  $y$  = tangent offset at any point in guardinal flare  $x$  = distance from point of tangent to any point of offset

For the new green alignment of project, double crash barrier shall be provided on both edges to ensure safety for the new green field alignment.

#### **1.1.10.2 Road Studs**

Direct reflecting road studs shall be fixed on the carriageway edge lines to provide visual guidance at night about the carriageway edges. These shall be fixed as per standard IRC guidelines for road studs.

#### **1.1.10.3 Delineators**

Delineators provide visual assistance to drivers about the alignment of road ahead and warn them about hazards, particularly at night. The different types of Delineators proposed for the Project Road are:

- Cluster of Red Reflectors on triangular notes as object markers provided at the heads of medians and directional islands.
- Circular Red Reflectors on face/tips of islands and median.
- Circular White Reflectors fixed on Guard Posts at prescribed spacing to delineate the alignment in sharp curves.

#### **1.1.10.4 Fencing**

The expressway being a full access-controlled facility, suitable fencing shall be provided at the ROW limits to desist pedestrians, stray animals, etc. on to carriageway. The fencing shall be standard chain link type or similar suitable arrangement.

#### **1.1.10.5 Landscaping and Arboriculture**

A proper landscape will be proposed to be provided along the expressway alignment, especially in the new alignment, toll plaza areas, rest and services areas to fit in with the surroundings for pleasing appearance, reducing headlight glare and adverse environmental effects such as air pollution, noise pollution and visual intrusion.

The proposal for landscaping includes the following:

- Treatment of embankment slopes as per IRC: 56–1974, depending upon soil type involved.
- Turfing of slopes of high embankment for controlling rain and wind erosion
- Planting of low height shrubs on medians for reducing glare effect and visual intrusion.
- Planting of trees along ROW as part of compensatory afforestation.

Grading of ground between the embankment toe and ROW and provision of surface drain along the ROW. This will help in physical delineation of the ROW and avoid encroachment at later date.

## **Chapter 1. Project Benefits**

The Government of India has planned 10 world class express highways in order to boost the road infrastructure for faster connectivity between different cities. Simultaneously Government of Maharashtra has planned NMEW which intends to divert and redistribute the heavy traffic on existing corridors. The proposed NMEW is being implemented by MSRDC which will pass through 10 districts from Vidarbha through Marathwada to Konkan regions. The major settlements which are set to be part of this plan are Nagpur District, Wardha District, Amravati District, Washim District, Buldana District, Jalna District, Aurangabad District, Ahmednagar District, Nashik District and Thane District. The NMEW will be designated as a MSH built on National Highway standards. The NMEW is a top priority project in the Government agenda.

This Prosperity Corridor (NMEW) is being designed for sustainable growth with emphasis on agro-industries in rural and underdeveloped districts of Maharashtra. The project is so massive that it will open up multiple sectors including township along the expressway emerging as a self-reliant model. From textile sector to IT hubs, each node will have its distinct character developed to tackle the local requirements of livelihood of the people and growth. An equal opportunity to grow and develop is the only way for a region to ensure a prosperous demography. Cities have concentrated employment opportunities, skilled work force, financial independence and the infrastructure to keep the demand-supply cycle intact. Most of the needs of the urban areas in terms of food and electricity are sourced from the rural areas. Urban areas act as the drivers of economy for the rural regions, whereas the rural areas provide necessary resources. Thus, the urban and rural areas in any state have an interdependent relationship with each other.

### **2.1 Improved connectivity**

The proposed expressway connects regional headquarters of the state to one another thereby facilitating administrative activities of the state. The proposed stretch would save travelling time between the two cities. Extensive road connectivity across Nagpur and Mumbai cities is essential for economic development, trade and social integration. It will improve mobility, reduce travel time and fuel consumption ultimately having positive impact on environment.

### **2.2 Educational opportunities**

Education plays an irreplaceable role in contributing the prosperity of state, the Nagpur Mumbai Expressway connects rural areas with limited educational facilities to urban ones with plenty of opportunities for higher education. Proposed Education institutes in the villages and better approach to Medical & Educational services and quick transportation of perishable goods like fruits, vegetables and dairy products.

### **2.3 Employment opportunities**

The proposed expressway will revive the textile, tourism, education and manufacturing industries on its major nodes thus creating employment opportunities for the people. Vocational and skill development training for youth. Opening up of opportunities for new occupations will increase the employment opportunities in the villages. The incidental benefit would be that it will create employment during construction phase and post development. It will boost industrialization which will largely benefit the entire region. During the construction phase of the project which is likely to be completed within 36 months, manpower will be needed to take the part in various project activities. About 200 persons per day, which includes, skilled, semi-skilled and unskilled labours, will likely to get work.

The project shall also induce indirect employment generation for cleaners, guards, local vendors, operation and maintenance workers etc. Indirect employment will be both temporary and permanent. Highway development projects require large number of local people during construction stage. Large employment opportunities will be generated as a consequence of the project implementation.

During the construction phase, the employment opportunities will be created for skilled (engineers, transport, mechanical), semi-skilled (technician, road Inspectors, plant operator, office support etc.) and unskilled (general labour) labourers. Most of the skilled labourers may come from other parts of the country; the opportunities for semi-skilled and unskilled sections of the work-force will primarily be available from the local communities. Apart from these temporary employment opportunities, there would be permanent employment opportunities for the local community due to the enlarged development of industries as it will stipulate more workers to cater to their increasing needs. There will be more commercial establishments such as shops, dhaba/ restaurants/, small workshop serving the vehicles moving along the expressway. These activities will provide additional socio-economic development and increased wages in the project area. Additional job opportunities may also be developed due to the development of proposed industrial and infrastructure activities along the expressway. As discussed above, the community people will get huge job opportunities due to the proposed expressway, which in turn will further improve their living status and overall social paradigm of the district.

## **2.4 Economic Benefits**

The expressway contributes to the economic development by encouraging attraction of business to site equipped with good access and by improving the travel efficiencies of the existing business and to start new avenues. This also helps in the Development of new industries, Development of new educational institutions and hospitals/health centres, Development of real estates, Development of Infrastructure projects,

Development of IT parks, Development of local agriculture, handicrafts, tourism and pilgrimage places. Area development like proposed Residential Townships, Real estate development will increase the commercial value.

The proposed expressway is passing through a large number of underdeveloped districts and government has planned industrial development using the expressway as an infrastructural launch pad. The main economic benefit generated by the project will be savings of vehicle operating cost. The smooth riding quality of pavement and separate lane for the vehicles for providing 150 km/hr speed reduces engine load and travel time consequently provide fuel saving for vehicles and ultimately reduces vehicular operating cost. The separate lanes of vehicles also reduce probable accidents and traffic jam which shall be cost efficient for operating vehicle on the highways. The highways with good traffic facilities and having adequate safety provisions shall reduce the number and severity of accidents. It constitutes an important element of the economic benefits

## **2.5 Social Benefits**

Proposed Tree Plantation along the road side, green pockets alongside of the alignment will have social benefits to the nearby people. Drinking water facility, medical facilities, food courts, police stations, public toilets, petrol pumps. This will definitely add value in the social and financial benefits in the region. Direct employment opportunity to people from all skilled, semiskilled and unskilled streams, improved quality of life for people and so on will act as social benefits. The WiFi enabled by optical fiber lines along the expressway will improve the

internet connectivity of the areas along the alignment thus opening a world full of opportunities to the farmers and taking a step closer towards Digital India. The project would help to develop the backward regions and drought hit areas of the Vidarbha region.

## **2.6 Environmental Benefits**

The proposed project will ensure the smooth flow of traffic, which reduces the emissions and noise level. Apart from this, landscaping and plantation will be done throughout the project road, which will increase the aesthetic of the project road. Smooth and fast-moving traffic will cause only lower emissions thereby reducing pollution levels. Noise level shall reduce through reduced traffic congestion. On the other hand, plantation of trees along the right of way shall also contribute substantially in noise reduction. Afforestation programme and landscape along the highway shall provide greenery which ultimately reduce pollution and improve the environmental quality.

## **2.7 Indirect Benefits**

In addition to the direct benefits, there are number of indirect benefits attributed to the project. Lowering transportation cost for users and improving access to goods and services enables new and increased economic and social activity. The indirect benefits include changes in land use and development, changes in decision on residential area or colonies where land are less expensive or more desirable, changes in development of business in order to take advantage of improved speed and reliability in the transportation system. These benefits hence lead to increase in the property values, increased productivity, employment and economic growth. The indirect benefit of the proposed expressway would work through the dynamic developmental externalities generated through the forward and backward linkages. A better connectivity between Nagpur and Mumbai will increase the business, which will reflect in the changes in the pattern of economic activities, income generation, price evolution, and employment condition. There will be also increase in greater accessibility to market, health and educational facilities