Chapter 1

1.1 Introduction

Although the development of transport systems has produced both the economic and social benefits to mankind, it has polluted the environment. Road transportation is next to industries in causing irreversible damage to the environment, the extent of which has attained global proportions. Therefore the quality of life of those exposed to the benefits of transportation (both the user and non users) may well be worsened rather than improved. Congestion and delay, air and noise pollution are three most commonly cited problems of urban transportation. Noise is most ubiquitous as it is easily detected by human ear. Effects of noise can be cumulative and its influences may cover many aspects of daily lives.

Noise pollution has become a major concern of communities living in the vicinity of highways / road corridors, intersections. Psychologically, noise can be defined as simply "unwanted sound" or a sound with which civilization cannot reasonably put up. Any sound that is undesirable because it interferes with speech and hearing is intense enough to damage hearing or is otherwise annoying.

The present area of research is comparatively new and efforts made by researchers are still in the initial stages as far as Indian condition is concerned. Most of the noise pollution studies were carried out in Metropolitan cities of India / abroad. It is observed that very less attention has been given by the scholars to assess noise status for the Intermediate cities of developing nation like India. The present investigation is proposed to evaluate the vehicular traffic noise status of Intermediate City.

1.2 Present Scenario, Problems and Impacts

Sounds are created when a vibrating source causes waves of acoustic energy to travel through the air. The sound pressure waves move out from
the vibrating source and become weaker the further they travel. The waves may be reflected or scattered by objects so that the sound reaching the ear may be different from the sound originally generated.

Sounds can be characterized by their frequency (or pitch) and intensity (or loudness). The vibrations producing the sound are cyclical and are measured in hertz (Hz), which gives the number of cycles that occur per second. An adult with good hearing can hear frequencies in the range 20 to 15,000 Hz, while children can hear frequencies above 20,000 Hz.

The sound pressure level is measured in decibels (dB). For example, a whisper is in the range 20-30 dB, normal conversation about 60 dB, while someone shouting in your face can easily exceed 80 dB. A sound level meter is used to measure the decibel levels of sound. Usually the sound level meter has a filter that has a frequency response similar to the human ear. These levels are known as dB(A) or A-weighted decibels. Like the ear, this filter reduces the sound levels in the lower frequencies (below 1000 hertz) and in the higher frequencies (above 5000 hertz).

The correspondence between decibel levels and perceived loudness is fairly simple. A difference of 3 dB in noise level is barely noticeable, yet it represents a doubling of the acoustic energy involved. For a noise to sound twice (or half) as loud, a difference of about 10 dB is required. For example, a lawn mower measured at 80 dB will sound about twice as loud as a hair dryer at 70 dB.

1.2.1 When sound become noise

People react to sounds in different ways. We take most sounds for granted, but in some situations a sound can distract us and break our concentration. When this happens, the sound becomes unwanted noise.

Often it is not the pitch or the loudness that makes a sound an annoying noise. Sometimes it is the repetitive nature of the sound and our
inability to control it that makes it annoying. Car alarms and the seemingly endless barking of a dog are good examples.

1.2.2 The Price of Progress

In recent years, highway traffic noise - the unpleasant, unwanted sounds generated on our nation's streets and highways - has been of increasing concern both to the public and to local, State, and Federal officials. At the same time, modern acoustical technology has been providing better ways to lessen the adverse impacts of highway traffic noise. The purpose of this pamphlet is to explain some of these acoustical techniques, which are now being employed by government agencies, highway planners and designers, construction engineers, and private developers.

1.2.3 Noise Representation

Highway traffic noise is never constant. The noise level is always changing with the number, type, and speed of the vehicles, which produce the noise. Traffic noise variations can be plotted on a graph as shown in Figure No. 1.1. However, it is usually inconvenient and cumbersome to represent traffic noise in this manner.

A more practical method is to convert the noise data to a single representative number. Statistical descriptors are almost always used as a single number to describe varying traffic noise levels. The two most common statistical descriptors used for traffic noise are $L_{10}$ and $L_{eq}$. $L_{10}$ is the sound level that is exceeded 10 percent of the time.

![Sample Traffic Noise variations](image)
In the above graph, the shaded areas represent the amount of time that the \( L_{10} \) value is exceeded. Adding each interval during which this occurred shows that during the 60-minute measuring period the \( L_{10} \) was exceeded 6 minutes \((1/2 + 2 + 2 + 11/2 = 6)\) or 10 percent of the time. The calculation of \( L_{eq} \) is more complex. \( L_{eq} \) is the constant, average sound level, which over a period of time contains the same amount of sound energy as the varying levels of the traffic noise. \( L_{eq} \) for typical traffic conditions is usually about 3 dBA less than the \( L_{10} \) for the same conditions.

1.2.4 Sound and Noise

As we all know, sound is created when an object moves: the rustling of leaves as the wind blows, the air passing through our vocal cords, and the almost invisible movement of the speakers on a stereo. This movement causes vibrations or waves in air molecules, like ripples on water. When the vibrations reach our ears, we hear sound. Sound is quantified by a meter, which measures units called decibels (dBA). For highway traffic noise, an adjustment, or weighting, of the high- and low-pitched sounds is made to approximate the way that an average person hears sounds. The adjusted sounds are called "A-weighted levels" (dBA).

1.2.5 Causes of Traffic Noise

The level of highway traffic noise depends on three things: (1) the volume of the traffic, (2) the speed of the traffic, and (3) the number of trucks in the flow of the traffic. Generally, heavier traffic volumes, higher speeds, and greater numbers of trucks in addition, the following factors influence the noise level at a reception point distant from the highway:

- Attenuation of sound waves due to distance between source and receiver and also due to ground absorption.
- Obstruction due to noise barriers.
- Obstruction of the sound waves due to restricted angle of view of the same line from the reception point.
Reflection effects increase the loudness of traffic noise.

Vehicle noise is defective mufflers or other faulty equipment on vehicles can also increase a combination of the noises produced by the engine, exhaust, and tires. Any condition (such as a steep incline) that causes heavy laboring of motor vehicle engines will also increase traffic noise levels. In addition, there are other more complicated factors that affect the loudness of traffic noise. For example, as a person moves away from a highway, distance, terrain, vegetation, and natural and manmade obstacles reduce traffic noise levels. Traffic noise is not usually a serious problem for people who live more than 500 feet from heavily traveled freeways or more than 100 to 200 feet from lightly traveled roads.

How Traffic Volume Affects Noise

2000 vehicles per hour sound twice as loud as

200 vehicles per hour

Figure No. 1.2 (a) Effect on noise due to traffic volume variation

How Speed Affects Traffic Noise

Traffic at 65 miles per hour sounds twice as loud as

traffic at 30 miles per hour

Figure No. 1.2 (b) Effect on noise due to speed variation
Assessment and Modelling of Noise Levels due to Vehicular Traffic flow

How Trucks Affect Traffic Noise

One truck at 55 miles per hour sounds as loud as

28 cars at 55 miles per hour

Figure No. 1.2 (c) Effect on noise due to Variation in category of vehicle

1.2.6 Noise Pollution Impact

Noise as pollutant produces contaminated environment, which becomes a nuisance and affects the health of a person, his activities and mental abilities. So noise pollution may be defined as unwanted sound, which gets dumped into the atmosphere without regarding to the adverse effect it may be having. Noise pollution affects the quality of life and so can be thought of a social cost. Noise annoys, distracts, disturbs, and, when exposure to it is sufficient, noise can cause physiological effects leading deafness. Annoyance results from interference with sleep and with speech. Noise within your home makes disturbance and loss of privacy. Distraction accompanies noise in the work place with consequent reduction in productivity, efficiency, accuracy and safety. Prolonged exposure to intense noise causes permanent hearing loss. Very much lower noise levels, however, interference with normal conversation, hinder concentrated mental effort, stress cause in efficiency at work, prevent sleep, brings about irritability, and interfere with relaxation and recreation. Fatigue and inadequate rest caused by a noisy home environment coupled with distraction and impaired mental concentration of employees while on the job result incalculable economic loss to employers. Unfortunately, people suffering from stress and emotional disturbances frequently do not realize that noise may be an important contributing factor. While the population explosion and social and economic changes are contributing to the noise
levels in the community, technological change must bear the greatest responsibility. The health effects of noise are substantial. The Table 1.1 below summarizes implicated health related effects and other impacts on human activity due to noise. The Figure 1.3 shows the standard noise bar, which gives idea about its annoyance in different working stages.

Table No. 1.1 Human Activity Impacts Resulting from Increased Noise stress

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Impact</th>
<th>Particulars</th>
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<tbody>
<tr>
<td>1</td>
<td>Physiological Effects</td>
<td>Vasoconstriction, Gastrointestinal modification, Endocrine stimulation, Respiratory modification, Galvanic skin resistance alteration</td>
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<tr>
<td>2</td>
<td>Hearing Impairment</td>
<td>Permanent / temporary hearing loss</td>
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<tr>
<td>3</td>
<td>Communication Interference</td>
<td>Aural face to face; telephone, Visual distortion, color blindness</td>
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<tr>
<td>4</td>
<td>Task Interference</td>
<td>Reduced production, Increased error rate, Extended output</td>
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<tr>
<td>5</td>
<td>Sleep Interference</td>
<td>Electroencephalographic modification (EEG), Sleep stage alteration, Awakening, Medication</td>
</tr>
<tr>
<td>6</td>
<td>Personal Behavior</td>
<td>Annoyance, Anxiety-nervousness, Fear, Misfeasance</td>
</tr>
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The noise of road vehicles is mainly generated from the engine and from frictional contact between the vehicle and the ground and air. In general, road-contact noise exceeds engine noise at speeds higher than 60 km/h. The physical principle responsible for generating noise from tire-road contact is less well understood. The sound pressure level from traffic can be predicted from the traffic flow rate, the speed of the vehicles, the proportion of heavy vehicles, and the nature of the road surface. Special problems can arise in areas where the traffic movements involve a change in engine speed and power, such as at hills, and intersecting roads; or
where topography, meteorological conditions and low background levels are unfavorable (for example, mountain areas).

1.3 Need of the study
Noise pollution has become major concern for communities living in the vicinity of highways / road corridors, intersections within the city in light of rapid growth of vehicular traffic flow; there is a need to study noise pollution from transportation point of view. The number of investigators has carried out research on vehicular traffic noise pollution for metropolitan cities in developing as well as developed countries. However, a large cluster of
suffering population also resides in Intermediate cities, for which a very limited research has been carried out and reported. It is observed that very less attention has been given by the scholars to assess noise status for the Intermediate cities of developing nation like India. The present investigation is proposed to evaluate the vehicular traffic noise status of Intermediate City, Yavatmal (20°23' N Latitude, 78°07' E Longitude), a district place in the Maharashtra State. In the last decades, there has been significant commercial growth within the city along with and extensive growth of educational institutes, industries in the city outskirts. Consequent on these developments, there has been a great increase in vehicular traffic in the city.

1.4 Research Objectives

Literature review revealed that a number of investigators have carried out research on vehicular traffic noise pollution for metropolitan cities in developing as well as developed countries. However, a large cluster of suffering population also resides in Intermediate cities, for which a very limited research has been carried out and reported. This situation offers a substantial scope for studies, which would be relevant for Intermediate cities, & hence would have wider scope of application. It is proposed to evaluate noise parameters with reference to vehicular traffic on four Major Entry Roads, two arterial roads and two five leg Intersections of an Intermediate city; Yavatmal (Maharashtra State)

The main objectives of the study are

- To evaluate the traffic composition and various noise parameters i.e. \( L_{10}, L_{50}, L_{90}, L_{eq} \) & T. N. I. (Traffic Noise Index), NC (noise Climate) at the selected study location
- To study contribution of various traffic parameters i.e. traffic volume and its composition, distance of receiver (SLM) from pavement edge, effect of intersections, and carriageway width on noise levels.
- To measure residents perception of vehicular traffic noise.
- To perform modelling of vehicular traffic noise and traffic flow.
1.5 Outline of Thesis
This thesis is organized into seven chapters, first chapter deals with introduction; present scenario, second chapter explains Noise basics, third chapter introduced for literature review, fourth chapter deals with methodology adopted and data collection, fifth chapter consists of complete analysis of data collected, sixth chapter explains modelling methodology, ANN modeling and seventh chapter deals with results and conclusions, scope of the study.