Trafic Vibrations on Historical sites of Ahmedabad

Vishvam Pancholi, Janak Shah, Ronak Patel

Abstract—Impact assessment of the historical sites due to traffic vibration will be considered in the Present study. Historical sites are very valuable from cultural point of view. Sometimes vibrations induced by traffic cause Architectural and Structural damage to nearby historical sites. Therefore, it is necessary to predict and assess the vibration effect on historical sites.it is also necessary to mitigate the effects of traffic vibrations along with remedial measures. In this paper we will discuss major sites surrounded by heavy traffic vehicular movements by using vibration analyzer instruments on historical sites like Astodiya gate, Raipur gate.We have considered for the objective determined the effect of traffic vibrations on it and give level of traffic vibration generated by road. A comparative result shows the level of traffic vibrations

Index Terms— Analyzer, Historical sites, PPV (Peak Particle Velocity),Vibration

1 INTRODUCTION

VIBRATION is one of the main factors for fatigue in structure. Vibrations produced by different sources propagate from one medium to another. Long term exposure to vibration can cause damages in buildings leading to minor effect such as cracks. These minor damages in critical cases could result in collapse. Historical sites are very valuable from cultural point of view. Especially in Ahmedabad many historical sites exist. In Ahmedabad city day by day traffic intensity is increased due to increasing use of vehicles and it may be affect the nearby Historical sites, thus analyse the ground-borne vibrations(Ground-borne vibrations are generated due to transit system (Rail, bus, cars)) in historical sites and Therefore, it is necessary to predict and access the vibration effect on historical sites. It is also necessary to mitigate the effects of traffic vibrations along with remedial measures.

1.1 NEED OF STUDY

Day to day increases on traffics and urbanizations, today the problems of traffic vibrations become a significant issue.
All the different papers gives an idea about the amount of various research works carried out related to traffic vibration. Most of the work is done on the annoyance to people due to noise vibration produced by traffic. Research works also done on the field of vibration characteristics, Vibration propagation and factor affecting on the vibrations. But, very less work has done on effect of traffic vibration on structures especially on Historical sites. The objective of present study is to understand effect of traffic vibrations on structures and main focus is on historical structures. There are some reasons for analyse the historical structures given as below:

1. Historical sites are generally older and may not be structurally sound.
2. Building materials and structural configurations differ from these in current use, so that modern criteria may not be applicable.

2. VIBRATION

Vibration is the time dependent displacement of a particle or a system of particles with respect to an equilibrium position.
Vibrations surround us, for nature provides its own vibration sources such as earthquakes, wind and ocean waves. With the advent of the technological era, vibration sources have multiplied and have become a concern to residents of modern buildings and to those whose motive is to preserve historic sites. A common vibration source and how they affect historic site will be discussed in this paper. In addition, case studies and possible remedial action where vibration levels are deemed excessive will be reviewed.

2.1 Ground Born Vibration

Ground-borne vibration can be a serious concern for nearby neighbours of a transit system route or maintenance facility, causing buildings to shake and rumbling sounds to be heard. In contrast to airborne noise, ground-borne vibration is not a common environmental problem. It is unusual for vibration from sources such as buses and trucks to be perceptible, even in locations close to major roads. Some common sources of ground-borne vibration are trains, buses on rough roads, and construction activities such as blasting, pile-driving and operating heavy earth-moving equipment.

2.2 Transit systems (which may cause ground born vibration)

Transit systems are especially two types as described below.

2.2.1 Steel wheel transit model (Rail)

The ground-borne vibration characteristics of heavy and light rail vehicles are very similar since they have similar suspension systems and axle loads. Problems with ground-borne vibration are common when there is less than 50 feet between a sub structure and building foundations.

2.2.2 Rubber wheel transit model (Bus, Cars and Trucks)

Because the rubber tires and suspension systems of buses provide vibration isolation, it is unusual for buses to cause ground-borne noise or vibration problems. The vibration of the transit structure excites the adjacent ground, creating vibration waves that propagate through the various soil and rock strata to the foundations of nearby buildings. The vibration propagates from the foundation and transmitted through the remainder of the building structure. The maximum vibration amplitudes of the floors and walls of a building often will be at the resonance frequencies of various components of the building. Ground-born vibration may cause either structural or non-structural damage in buildings. Although traffic vibrations may not cause deterioration in the short term, there is some concern about long-term effects on buildings. Two possibilities stand out as potential problem areas: building material fatigue and building foundation settlement.

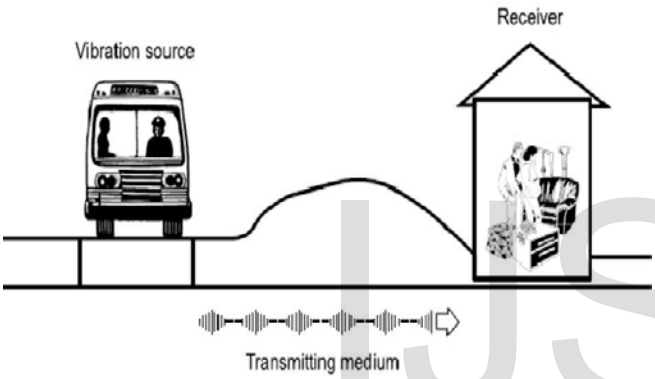


Fig -1: Traffic Vibration Path

3. SPECIFICATION OF INSTRUMENT

Instruments used in the experiment are listed below.
1. Accelerometer
2. Sixteen channel vibration analyser instrument
3. Computer

3.1 Accelerometer

Accelerometers are commonly used sensors for measuring the structural vibration. These sensors convert an acceleration signal to an electric voltage signal that can be measured, analyse and recorded with electronic hardware. The signal analyser includes a calibration setting that allows the voltage signal to be converted back into a measurement of acceleration. Determining frequency vs. acceleration relationships and time vs. acceleration at various points and provides valuable information regarding system integrity and operating mode shapes. Two type of accelerometer are available in the Laboratory i) uniaxial and (ii) tri-axial accelerometers which were purchased from PCB Piezotronics vibration division.

3.2 Sixteen channel vibration analyser

The purpose of a data acquisition system is to permanently record the voltage signals from all the sensors at a specified sampling rate. Each voltage signal from a transducer is related to a physical quantity like displacement, acceleration etc. For the present study, a high performance data acquisition system such as sixteen channel noise and vibration analyser (make: oros company), which is capable of reading 16 voltage input channels.

Fig-2 Sixteen Channel vibration analyser

4. METHODOLOGY

Following parameter were kept in mind for the site selection.
a. Speed of traffic
b. Pavement condition
c. Type of vehicle
d. Distance of structure from road traffic.

4.1 Methodology of data collection

There is a standard format for collection of data as per site conditions and features of particular location.

Measurements were taken at two locations on the ground as well as on historical structure at proper distance from traffic Vibration analyser was used to acquire data at each location. Accelerometers should not be placed directly on the ground. Accelerometers were mounted on metal plate with adhesive material.
The accelerometers were mounted on a plate having the size 10 cm ×30 cm×0.5 cm during the test.
Measurements of vibration were made on the ground near the road surface or rail, so that good level of vibration amplitude can be gained.

- Following are has to be taken to handle the equipment.

- Area near the sensors would have needed to be vocated in order to control adverse effect from internal vibrations such as footfalls.
- The transducers were plotted from movement of any things near the transducers.
- The analyser and associated batteries were located in a weather-proof place.

4.2 Data and results

Data is taken for road traffic vibration for the selected sites.

Following sites have been selected on the basis of criteria discussed earlier.

These structures are monument as per Archaeological Survey of India (ASI).

- Astodiya Gate
- Raipur Gate.

4.2.1) Astodiya Gate

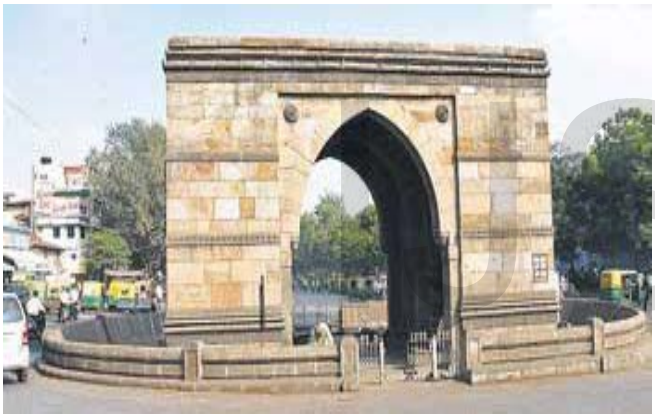
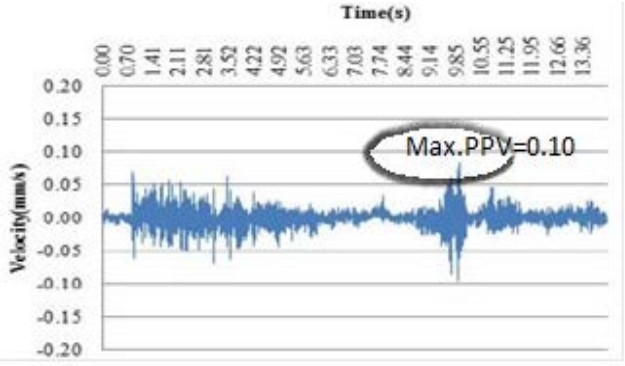
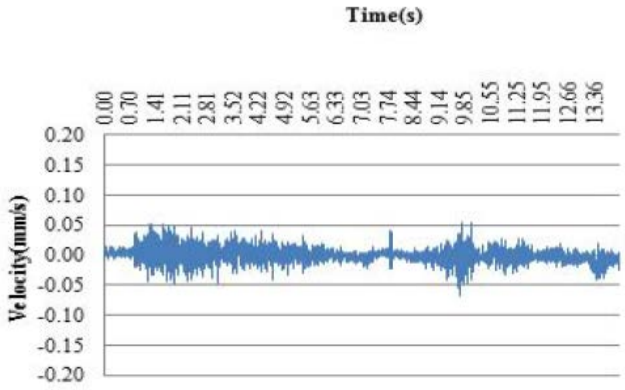


Fig.3 Astodiya Gate

Result:-



Graph 1



Graph 2

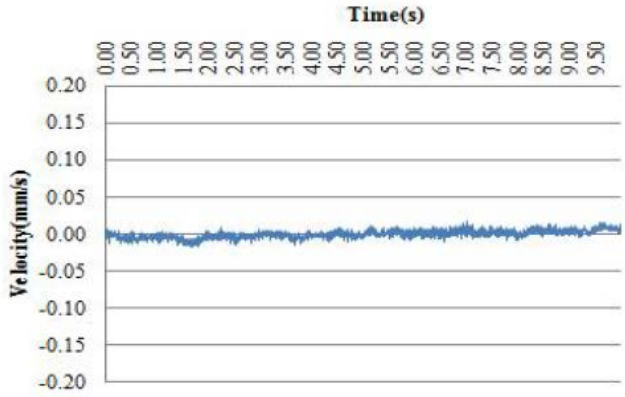
OBSERVATION

From results (in graph 1), Max. PPV (Peak particle velocity) is 0.1 mm/s in horizontal direction & is 0.1 mm/s in vertical direction observed at Astodiya Gate.

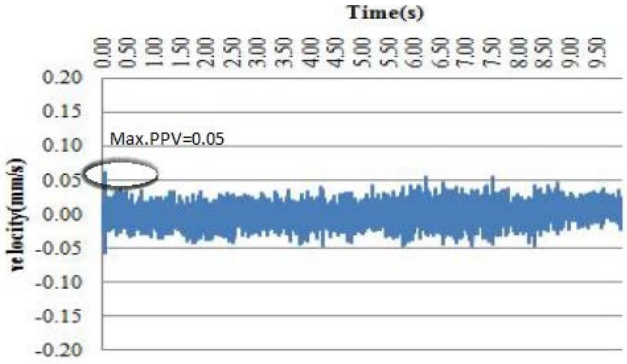
4.2.2) Raipur Gate

Fig.4 sensors at Raipur Gate

Result:-



Graph 3



Graph 4

OBSERVATION :-

- From results (in Graph 4), Max. PPV is 0.05 mm/s in horizontal direction & is 0.06 mm/s in vertical direction observed at Raipur Gate.

CONCLUSIONS

- From study of different vibration criteria, PPV up to 3mm/s is considered as a safe limit criteria for historical and fragile buildings for continuous traffic vibration point of view.
- The problem of excessive vibration caused by traffic has three main components - the source, the propagation path and the receiver.
- Vibration analysis carried out at different historical sites & results are given below.

Sr.no	Name of site	Max.PPV (mm/sec) (Horizontal)	Max. PPV (mm/sec) (Vertical)
1	Astodiya Gate	0.10	0.10
2	Raipur Gate	0.05	0.06

- From the results, it can be concluded that historical structures where testing has been done, are safe from structural damage due to traffic vibration But at Astodiya Gate, Architecture damage(as per Chinese standard GB/T 50452-2008) is possible due to traffic. Raipur gate is safe from structural as well as architectural damage.
- Indian standards are not available to study effects of traffic vibration on structures which are highly required.

ACKNOWLEDGEMENT

We consider it to be our pleasure and privilege to express deep sense of gratitude and indebtedness towards Capt.C.S.Sanghvi, Associate Professor, Applied mechanics Department, L.D.College of Engineering, Ahmedabad for his constant guidance.

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1). Vishvam Pancholi, BE-Civil ,
L D College Of Engineering,
Ahmedabad,Gujarat,India.

2). Janak Shah, BE-Civil,
L D College Of Engineering,
Ahmedabad,Gujarat,India.

3). Ronak Patel, BE- Civil,
L D College Of Engineering,
Ahmedabad,Gujarat,India