TRAFFIC NOISE MODELS: HOW THEY ARE USED, HOW WELL THEY WORK, AND WHY

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Introduction

This presentation describes the training and expertise of the people within California who are using noise models and the kinds of studies in which the models are used. Correlation of the models with field measurements will also be discussed and some speculations will be made as to the sources of error. Three points are presented for consideration in future modeling efforts:

1. Modeling should be done in terms of L_{eq} and peaks. Peaks are easy to measure and peak information along with vehicle speed are the essential inputs to calculate L_{eq}. More attention to the propagations of peaks may give valuable insight as to weaknesses in the L_{eq} methods.
2. Emission models should be considered separately from propagations in any design methodology. Emissions should have a rigorous field validation procedure.
3. Design methodology should be simple. There are many potential users who lack access to extensive computational facilities.

Who Uses Noise Models?

Caltrans is divided into 11 geographical districts plus headquarters, the laboratory, and a few other offices. Most project noise studies are carried out by district personnel. Tbe districts have developed a good deal of noise expertise over the years but there is little uniformity throughout the state. In some districts, the noise program is handled entirely by one group or even one individual. In other districts, two or three units may share the responsibility. In only a few cases, noise experts within the districts have close contact with computer expertise.

How Are the Models Used?

There are several types of studies with which Caltrans becomes involved. Different prediction techniques are used as the need arises.

Project Noise Reports

Generally, the 117/144 methodology is used for project noise reports on completely new alignments. Field measurements are the obvious and necessary choice for improvement type projects. However, we have used peak-level methods (method No. Calif. 701-A) for low-density situations and other special cases.

School Noise Studies

California has a law that limits traffic peak levels within schools to 50 dBA. We use the California 701-A exclusively for these studies.

Noise Problem Inventory

Caltrans has a policy to retrofit existing facilities with noise barriers. The program requires a priority system based on objective criteria. Noise problem areas were defined for the most part by using 117/144, however, the TSC nomograph was used in some cases and field measurements were made in some districts that had only a few problem areas.

Noise Element for Local Agencies

The California Legislature has mandated local and regional agencies to produce general plans. A noise element is to be a part of that plan and Caltrans is to supply the highway portions. The districts generally supplied contour maps generated by the 117/144 methodology but the TSC nomograph was used in many cases. Calif. 701-A was used for the sparsely settled areas. The cities and counties had mixed reactions to the information they received. Many had also received inputs from the department of aeronautics in terms of CNEL and they wanted to know how to put that together with an L_{10} or L peak.

How Well Do They Work?

Let us first state that some of our problems may be due to inaccurate input data. It is fairly difficult to get accurate traffic data without a considerable expenditure of man hours. In many cases, traffic predictions were used instead of actural vehicle counts.

The 117/144 methodology was close for heavily traveled freeways with at-grade sections. Two of our districts reported the predicted level to be about 2 dBA above the measured. Some said actual versus predicted was off by a maximum of 4 to 5 dBA in most freeway cases. The accuracy of this method reportedly diminishes as we get away from the heavy volume and at-grade sections. It is considered poor for stop-and-go traffic.

The TSC nomograph has received very little validation. Where it was used, it was considered good for high volumes and poor for low. It was reported unrealistic past 1000 ft (304.80 m).

The TSC computer program was put up on our computer but its input deck proved too much for those who tried to use it and the work was redone using the 117/144 methodology.

Method California 701-A was reported to work very well under all conditions. A methodology developed by Wyle for the San Diego Comprehensive Planning Organization is available, but as yet, not used. The revised design guide recently supplied by BB&N is up on our computer but we have not yet had a chance to put it through its paces.

What Causes the Problems?

The primary problem with low-volume roads probably is within the L_{10} parameter itself. The distribution of vehicles must be known to a greater degree than it is now to handle the low-volume case.

The 4.5 dB per doubling of distance is suspect. This assumes that excess attenuations are a function of distance doubling. Some strong arguments could probably be made against that assumption.

Vehicles in different parts of California probably have different emission levels.

The existing models are so interwoven that it is difficult, to the point of being impractical, to check the components of the models.

Conclusion

We are fairly sure that L_{eq} based parameters will be used in the future. This type of parameter is necessary to handle multimodal transportation studies.

California has had good success with peak levels. We find that they are very useful in describing low-volume conditions. We also use them for validating truck noise emission levels and barrier attenuations. We find them easy to work with and easy to explain to the layman. If we are required to report the variance of noise (L_{np} type thinking) we will probably use the difference between the peaks and the L_{eq} for that purpose.

Although greater rigor should be incorporated in our noise modeling, so should simplicity. We are not at all convinced that these are mutually exclusive goals. What is needed is an accurate foundation in proven theory so that we know, with confidence, the limits on achievable accuracy. We should avoid computational overkill based on questionable basic assumptions.

APPLICATION AND FINDINGS OF TSC NOISE PREDICTION METHODOLOGY

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The North Carolina Division of Highways has found the DOT-TSC-FHWA-72-1 Noise Prediction Program to be a very useful design tool within certain limits. From its orginial program version as issued by the Federal Highway Administration, the program has been adapted to the IBM 370 computer system. Modifications to the input format and output display associated with this adaptation have improved the overall utility of the program affording highway design engineers and technicians a readily comprehensible means to quantitatively assess various traffic noise situations. As a design measure, the methodology is responsive to traffic flow volume changes, roadway geometrics, and topographical variations, and these qualities of the program provide the highway design engineer a sense of appreciation and understanding of specific roadway-receptor relationships.