Chapter 1: INTRODUCTION

1.1 BACKGROUND:

Weaving is defined as the crossing of two or more traffic streams traveling in the same direction along a significant length of the highway without the aid of traffic control devices. Weaving areas are formed when a merge area is closely followed by a diverge area, or when an on ramp is closely followed by an off ramp and the two are joined by an auxiliary lane. Weaving areas require intense lane changing maneuvers as drivers must access lanes appropriate to their desired exit point.

As a result, traffic in a weaving area is subject to turbulence in excess of that normally present on basic highway sections. Capacity is reduced in these weaving areas because drivers from two upstream lanes compete for space and merge into a single lane and then diverge into two different upstream lanes. As lane changing is a critical component of the weaving areas, configuration (number of entry lanes and exit lanes and relative placement) is one of important geometric factor that needs to be considered. Some of the other factors are speed, level of service, volume distribution etc.

1.2 Problem Statement

The traditional methods used for design and operational analysis of a highway is the 1985 Highway Capacity Manual (HCM). The procedures and methodologies of the 1985 HCM have been evolved from a wide range of empirical research conducted since 1960’s. This manual addresses various issues like operational analysis, design and planning. The traditional weaving methods in the highway capacity manual use road geometry and traffic volume as inputs and provide an estimate of speed as an output. It uses speed for assessing the capacity and level of service for the weaving areas. It first computes the demand volumes, adjust the volumes to the existing conditions, compare the adjusted volumes to the capacity and get the volume to capacity ratio and enter it in a table and get its density and level service.

Even though HCM adopts a traditional approach, it has several shortcomings. The use of speed for assessing capacity and level of service for weaving areas has proven to be a poor choice. Furthermore the equations used in the HCM cannot address complicated issues like driver characteristics, lane changes etc.

One of the most important and modern analytical tools of traffic engineering is computer simulation. If a traffic system is simulated on a computer by means of a simulation model, it is possible to predict the effect of traffic control, geometry change and transportation systems management on the systems operational performance as expressed in terms of average vehicle speed, vehicle stops, delays etc.

Even though simulation is a powerful tool for traffic analysis and is relatively easy to build and inexpensive to use, it has some drawbacks. It is dependent on data availability, knowledge of the model and requires various calibration and validation issues to be addressed.

CORSIM (CORridor SIMulation) [8] is a new computer simulation model developed by Federal Highway Administration (FHWA) for simulation of traffic operation on integrated urban transportation networks of freeway and surface streets. The intent of this research is to identify the difference in the results by using the new CORSIM simulation and the traditional HCM approach in modeling the weaving sections on a freeway and make recommendations. The research will also compare the modeling
strategy and provide analysis of the output. The following section outlines the methodology adopted in HCM and CORSIM.

1.2.1 1985 Highway Capacity Manual Methodology (HCM 1985)

As there have been no changes in chapter 4 (Weaving Areas) between 1994 HCM and 1985 HCM, I have used 1985 HCM for reference everywhere. The procedures and methodologies used in the traditional weaving analysis have four distinct components:

1. Equations predicting the average running speed of non-weaving and weaving vehicles in a weaving area based on known roadway and traffic conditions. Equations are specified for each configuration type, and for unconstrained and constrained operations.
2. Equations describing the proportional use of available lanes by weaving vehicles used to determine whether the operations are constrained or unconstrained.
3. Definitions of limiting values of key parameters for each type of weaving configuration, beyond which equations do not apply.
4. Definitions of level of service criteria based on average running speeds of weaving and non-weaving vehicles.

Computations are performed in operational analysis mode i.e. a known or projected service is analyzed for the probable level of service. All the roadway and traffic conditions must be specified. A weaving diagram depicting the weaving and non-weaving flows in a weaving area is essential (Fig. 1). The relative placement of entry and exit points (A, B, C, and D) in the diagram matches the actual site to ensure the proper placement of weaving and non-weaving flows relative to each other. Evaluations of the level of service in an existing or projected weaving area is accomplished using the following steps:

**Step 1. Establish roadway and traffic conditions:**

All existing roadway and traffic conditions must be specified. Roadway conditions include the length, number of lanes and the type of configuration for the weaving area under study. Traffic conditions include the distribution of vehicle types in the traffic stream as well as peak hour factor. The weaving area should be analyzed on the basis of peak flow rates for a 15-min interval.

**Step 2. Convert all traffic volumes to peak flow rates**

As the speed and lane use algorithms are based on peak flow rates, all component flows must be converted to flow rate for peak 15 min, by using following equations:

\[
v = \frac{V}{PHF \times f_{nv} \times f_w \times f_p}
\]

*where*

- \(v\) = flow rate for peak 15 minutes
- \(V\) = Hourly volume in vph
- \(PHF\) = peak - hour factor
- \(f_{nv}\) = Heavy vehicle adjustment factor
- \(f_w\) = Lane width and lateral clearance adjustment factor
- \(f_p\) = driver population adjustment factor
Step 3. Construct weaving diagram

A Weaving diagram of the type illustrated in Figure 1 is now constructed, with all the flows indicated as peak flow rates under ideal conditions.

Step 4. Compute unconstrained weaving and non-weaving speeds

Using the unconstrained equations for the appropriate configurations (Source: Table 4-3, 85 HCM), the predicted values of average weaving vehicles $S_w$ and non weaving vehicles, $S_{nw}$ are computed.

Step 5. Check for constrained operation

Using the speeds computed in step 4, estimate the number of lanes needed by weaving vehicles to achieve unconstrained operation (Source: Equations in Table 4-4, 85 HCM). Compare the computed value to the tabulated value to determine whether operation is constrained or unconstrained.

Step 6. Check weaving area limitations and determine level of service

(Source: Table 4-5, 85 HCM) should be consulted to ensure that none of the limitations specified for speed predictions are exceeded. The estimated values of $S_w$ and $S_{nw}$ are compared to the LOS criteria (Source: Table 4-6, 85 HCM) to determine the prevailing level of service.

A frequently heard complaint about HCM is that the methods are based on empirical models and do not report the quality of these models when compared with real field data. Many practitioners look to HCM to help them gain an understanding of traffic process. HCM method solely relies on empirical regression techniques, which address only the temporal variations of traffic conditions within the weaving area. To have a better understanding of the dynamic behavior of traffic conditions within the weaving area, a simulation approach is also studied.

1.1.2 CORSIM Methodology

CORSIM is a microscopic corridor simulation process that integrates both NETSIM (NETwork SIMulation) and FRESIM (FREeway SIMulation). CORSIM model can be used for a wide range of applications including modeling of weaving areas and capacity reducing effects such as lane changing and freeway merging. Because CORSIM simulates the traffic and traffic control conditions of a network over a period of time, the input must accommodate specifications that not only differ from one point on the network to another, but that might also change with time.
The network is modeled in such a way that each vehicle is considered as a separate entity. The behavior of each vehicle is represented in the model through interaction with its surrounding environment, which includes the freeway geometry and other vehicles. TSIS, which is the windows version of the integrated traffic software system, supports the execution of CORSIM and supports programs.

A weaving diagram can be modeled using the FHWA Interactive traffic network data editor for Integrated TRAFFic simulation system (ITRAF). ITRAF is an interactive computer program with a graphical interface developed to simplify and speed up the task of creating the data files that serve as an input to CORSIM, a member of the TRAF family of traffic models.

CORSIM contains a set of diagnostic tests for input, which are executed in the following sequence:

1. Test the structure of the input stream, and that all records are in proper sequence
2. Test that each data item is valid and that its values lie within a range
3. Test that all the data items on the set of records belonging to one record type are consistent and that the set is complete
4. Test that the data items of all classifications are compatible and completely define the network.

TRAFVU is an interactive graphics processor designed to display and animate the results of CORSIM simulations. TRAFVU provides a window environment to view the input network and all the output generated by CORSIM. It enables us to animate traffic simultaneously in multiple views of the same or different traffic networks under the same or differing traffic conditions. TRAFVU is suitable for traffic operations analysis as well as the presentations of before and after studies to convince the audience of the utility of simulation results.

1.3 Objective

The HCM and CORSIM have been developed on traditional data and certain assumptions. They are being challenged with the problem of dealing with some complex issues like freeway geometric, capacity, driver characteristics etc. Scenarios already exiting in chapter 4 of HCM 1985 are modeled using CORSIM. The important issues that arise when applying CORSIM to model already existent in HCM are:

1) What are the possible factors in both the procedures affecting the difference in output
2) How sensitive are the identified factors affecting speed of the vehicles and therefore the capacity
3) what are the CORSIM deficiencies which should be modified in order to improve the accuracy of results
4) What are the possible recommendations which can be made to both CORSIM and HCM for future research

1.4 Organization of Thesis

In chapter 2, a literature review is conducted on all the past research conducted in this area. The present research that is going is also discussed here. Some of the earlier car following models are also discussed here. To end this chapter a literature review on various types of simulation packages available in the market is described.

CORSIM is a windows based microscopic traffic simulation software that has been used for car following models development and simulation. It is user-friendly software and applies systems dynamics techniques, which are very well suited to transportation engineering applications. It has a number of built in functions and
performs specific tasks for running simulation programs with ease. Chapter 3 talks about this traffic simulation software.

This is followed by the description of the proposed research. Various scenarios, which are compared, analyzed and modeled using ITRAF, are described here. The modeling strategies adopted to model these scenarios are also described here.

The comparison and sensitivity analysis of results are discussed in chapter 5. Also included in this chapter are the recommendations for further research.

Finally, the proposed recommendations for future research to CORSIM and HCM are outlined.

The data used for analysis and validation is attached in Appendix A. Appendix B contains the data used for plotting graphs.