Engineering Seminar # 5: Transportation Engineering

Speakers: Mr. Qingyi Ai (Ph.D. student) and Mr. Sudhir Reddy Itekyala (M.S. student) presented under the supervision of Dr. Heng Wie, Assistant Professor, Department of Civil and Environmental Engineering
Date: July 2, 2009
Time: 12:30 to1:30 p.m. (1 hour)

Prepared by:
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This seminar was jointly given by two graduate students, Mr. Qingyi Ai (Ph.D. student) and Mr. Sudhir Reddy Itekyala (M.S. student), under the supervision of Dr. Heng Wie, Assistant Professor, Department of Civil and Environmental Engineering on July 2, 2009 at 641 Baldwin Hall from 12:30 to 1:30 p.m. Both the graduate students also served as the Graduate Student Mentors for the transportation RET research project.

At the beginning of the presentation, Sudhir described how traffic affects just about everyone on the way to work, the grocery store, or driving anywhere on a daily basis. He began with an overview of different modes of transportation such as roadways, airways, and railways. The road system is the most connected to every corner of a country, to cities, and to individual houses in neighborhoods. Traffic congestion poses some questions such as should I worry about it traffic congestion? Who is responsible for this? What is the solution? We can't all stop traveling so we have to build new infrastructure, improve existing infrastructure, and create new modes of transport.

In order to improve traffic congestion we need to study different traffic flow conditions. Engineers can't just build more lanes because it's not cost effective to add four more lanes to every highway. In order to classify the traffic level of service is used (LOS). LOS is "a quality measure describing operational conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience"(HCM 2000). There are six LOS (A-F) describing conditions from best to worse. LOS A can be described as light, easy to maneuver, easy to make lane changes, and the opportunity to drive at varying speeds you desire. Density of the vehicles is a lot less at LOS A as compared to LOS E or F. As the LOS worsens the density becomes much higher and the speed drops. LOS D shows the starting of congestion, and at level of service E the congestion is visible. Highways are not designed for LOS A because that would be too expensive, not effective enough for the cost. Also congestion is usually limited to few hours of the day, from 6:00 to 8:00 a.m. and 4:00 to 6:00 p.m. Highways are usually designed for LOS C and D.

There are various methods and tools that are used to collect traffic data and the results can be used to help improve traffic congestions in the area. In some areas, including Columbus, ramp metering is used to help control the flow of traffic getting on to the highway. Ramp metering is placing a stoplight on the on ramp to tell the cars when they can merge. The idea behind this is that merging will be easier, and it will eliminate people in the right lane having to slow down, which in turn cause vehicles behind to slow down as well. Another idea is implementing flex times, when people can go into and leave work at different times.

The purpose of traffic engineers is very important to help solve congestion problems. We have a lot of wasted time and money sitting in traffic everyday on the congested highways. During times of congestion on the highway as traffic volume increases the freedom to maneuver decreases. This is clear in the videos or pictures of the different levels of service because at LOS D the spacing becomes much smaller, and it is at about 151 feet in between vehicles. It is very interesting how driver habits and behavior can have an effect on the level of service. Some drivers will frequently speed up and slow down, causing vehicles behind them to slow down as well, and possibly creating a chain of cars slowing down.

The idea of flex time for arriving and leaving work is an interesting idea to try and lessen the congestion during peak times. How people make decisions is based on traffic conditions. Some people will willingly leave for work early and arrive at work early an hour early, or even earlier in order to avoid traffic. Another interesting idea to help control traffic flow is implementing express lanes for cars that are not going to exit for a while.

There are several parameters that describe traffic flow including speed, volume and density. These are defined as:

- Speed is a rate of motion in distance per unit time (mi/hr or mph)
- Volume is the number of vehicles passing a point on a highway during a specified time interval (veh/hr)
- Density is the number of vehicles occupying a given length of highway or lane (veh/mi/ lane)
- Volume = speed * density (very fundamental relationship)

After the data is collected, there are various ways to analyze the results. Greenshield (published in the website http://www.tfhrc.gov/its/tft/tft.htm) created the traffic flow model. It looks like an upside down parabola. At the top point, the traffic flow reaches a maximum. After the point the flow decrease and the density will increase. Kerner proposed a three-phase traffic theory (*Introduction to Modern Traffic Flow Theory and Control* by Boris S. Kerner, Springer, 2009): free flow, synchronized flow, and wide moving jam or stop and go traffic flow. The different classifications helped to have some measures by which to describe traffic.

Another way to collect data is to use various types of sensors. Automatic traffic flow sensors are used in a IT transportation network system. This is a system for indicating the presence or passage of vehicles. Traffic actuated signal control and traffic-responsive signal control are used. Change of inductance is measured as a presence of a vehicle. The inductance loops can be used for classification of the vehicles. This happens when a vehicle passes over the first loop and then the second loop and the times are recorded. If it is a small vehicle, there are 13 vehicle classifications, the difference between the on times will be very small, and for a truck it will be larger. Engineers can also calculate the speed using this, and the length of the vehicle.

Next freeway surveillance, traffic management, and data collection systems were discussed: These are various types of sensors, including road sensors (inductive loop detector or ILD), and overhead sensors. There are also pneumatic tubes which calculate the change in pressure to measure the presence or the passing of the vehicle. It also measures the number of axels on the vehicle. For trucks, there are weigh-in motion stations.

The teachers found the discussion on traffic sensors to be very interesting. They have noticed the loops before, however were unaware that they were activated by magnets. Previously, they had thought that the loops were activated by some sort of pressure or weight. Some also didn't know that the induction loops could measure volume, speed, and classification of the vehicle. Overall, it was a very interesting seminar and the teachers liked it because it wasn't so technical that it was difficult for someone who has no background in traffic engineering to understand. **P**hotographs taken during the seminar are presented below.

Graduate Students Presenting the Transportation Engineering Seminar