Chapter 10 Presentation Script

Welcome

Welcome to the Manual on Uniform Traffic Studies, also called MUTS, computer based training!
This training module will cover Chapter 10 - Advisory Speed Study.

This training contains audio, so please adjust your speakers accordingly.
An alternate version is available on the Resources page.
To begin select the start button or press Shift + N on your keyboard.

Form Access

During this training module, we will refer to one form in excel format stored on the MUTS online library.
Before continuing the training,
consider scanning the QR code using your phone camera
which directs you to the online library pictured.

The link to the forms is also provided on resources page to this training.
Please open form number 750-020-12,
as we will refer to it later in the module.

Purpose

The purpose of the Advisory Speed Study is to determine the maximum comfortable and safe speed a vehicle can negotiate a given horizontal curve under normal conditions.
The study is also used to determine where turn and curve signs
with advisory speed plaques are required for horizontal curves.
The study shall be signed and sealed by a Florida Professional Engineer.

Study Procedure

Let's get started by looking at the manual and automated methods to conduct advisory speed studies.
The data collection procedures available to complete the study include manual and automated methods.

There are three different methods available to conduct an advisory speed study manually - the design speed equation,
the traditional ball-bank indicator, and the accelerometer method.
The automated method typically uses global positioning system or GPS with its associated post-processing software.
We will discuss each of these methods in detail through this training.

MUTS Table 10-1, shown on this slide,
provides additional detail of each method.
The required personnel, equipment, and recommended sample size per method are summarized in this table.
Let's take a closer look into each of these methods.

Design Speed Equation Method

The first manual method we will be discussing in detail is the design speed equation.
This method is contained in MUTS Section 10.3.1.

The curve radius and superelevation data are required to use the design equation method.
If these cannot be determined from plan drawings,
the measurements and field data collection steps
described in the next slides can be followed.

To collect the curve radii data,
overlay circular templates on top of an aerial image.
The templates can be hand-drawn or computer-generated
scaled to the referenced aerial image.
The next two slides will describe how to obtain the necessary information
to complete the advisory curve study using the design equation method.

The “chord and middle ordinate” method can be an alternative
to determine the radius of the curve.
A graphical representation of the chord length
and middle ordinate is shown to the right,
this figure can be found in the ITE Manual of Transportation
Engineering Studies, 2nd Edition.
The equation displayed on this slide can be applied to calculate
the curve radius.

The superelevation can be obtained by either using a slope meter,
taking several measurements at the center of curve,
or using a carpenter's level by putting one end on the top of pavement
and raising the level's other end until the bubble indicator reads true.
The vertical distance from the level to the pavement is measured
and divided by the level's length to get the percent slope.
Several measurements for the superelevation are desired as the
characteristic varies through the horizontal curve,
the engineer should look for the maximum superelevation
for calculating the design speed.

The next step is to determine the design speed using this equation
found in the “AASHTO” Greenbook.
This equation uses the previously discussed curve radius
and superelevation with a side friction factor variable.
The side friction factor for lower speed curves can be obtained
from MUTS Table 10-2 which is shown here.
These values can be used for speeds up to and including
35 miles per hour.

For speeds being 40 miles per hour or greater,
the side friction factor should be determined in the field
using either the ball-bank indicator or the accelerometer.
The accelerometer provides the side friction factors
directly as these are the same as the lateral acceleration.
The ball-bank reading is the degrees of deflection taken from multiple runs
thru the curve.
The field data collection procedure is discussed later in this training.

The average ball-bank reading with the curve’s superelevation are input
variables to determine the side friction factor using the table on this slide.
With the side friction factor, the engineer can use the design speed
equation to calculate the advisory speed.

Let's look at an example.
We are able to get the curve radius
from existing plans and find it to be 1,432.69-ft.
Because this road has been milled and resurfaced multiple times,
a field measurement for superelevation was done
and found the superelevation to be 0.067 feet per feet.
This roadway is posted for 55 miles per hour
and has a design speed of 60 miles per hour.
While in the field, we conducted ball-bank runs through the curve in both
directions and determined the degrees of deflection to be 11 degrees.

The remaining variable we are missing to complete
the design speed equation calculations is the side friction factor.
The side friction factor can be determined by interpolating
using this table which was introduced in the previous slide.
It should be noted that a linear equation has been used
to develop this table so straight interpolation is acceptable.

Using the superelevation of 6.7% or 0.067 feet per feet,
the engineer should follow the column down until
a ball-bank reading of 11 degrees is found.
The engineer will then interpolate between the superelevation
of 0.060 and 0.070 and the ball-bank readings of 10.6 and 11.2.
This is interpolated to a side friction factor of 0.1767.

Now we will walk through the final step is to complete
the calculations using the design speed equation.
The resulting speed is 72.3 miles per hour,
which is higher than the current posted speed of 55 miles per hour.
Given these results, the study's findings would document
no advisory speed is required.

Ball-Bank Indicator

The second manual method we will be discussing
is the ball-bank indictor method.
This method is contained in MUTS Section 10.3.2.

The ball-bank indicator method is mounted on the vehicle's dashboard either using suction cups or other stable methods. It should be mounted in a position that allows the ball to rest freely at the zero-degree position when the vehicle is standing leveled.

The ball-bank indicator is used to measure the overturning force, measured in degrees, on a vehicle negotiating a horizontal curve. The ball-bank reading is indicative of the combined effect of body roll, lateral acceleration angle and superelevation as shown in this graphic.

Traditional Ball-Bank Indicator

Before conducting the study, the speedometer and ball-bank indicator must be calibrated. Beginning well in advance of the curve being tested, the driver should enter the curve at a predetermined speed, drive the car parallel with the centerline of that travel lane and maintain a uniform speed throughout the curve. The movement of a car around a curve to the right, for example, causes the ball to swing to the left from the zero-degree position.

The maximum negotiable safe speed for this first trial run can be chosen by choosing a speed 10 miles per hour below the posted speed limit or drive 5 miles per hour below the driver's comfortable speed.

Subsequent trial runs are conducted at 5 miles per hour speed increments or reductions, until the average ball-bank reading matches or is one increment lower than the degrees of deflection for the corresponding speed in MUTS Table 10-2.

The curve should be driven several times until at least two identical ball-bank readings for each direction of travel are obtained; these readings are measured in degrees.
Each direction of travel should be considered independently and may require different trial speeds.
A minimum of three runs should be completed at each 5 miles per hour increment in each direction of travel, for a total of six runs per 5 miles per hour increment.

Accelerometer Method

The last manual method we will be discussing is the accelerometer method.
This method is contained in MUTS Section 10.3.3.

The accelerometer method is very similar to the ball-bank indicator method and data collection for this method should be conducted in a similar manner.
This method only requires one person to conduct the study as the data is stored in the accelerometer and can be downloaded later.
When using an accelerometer, the lateral acceleration should be considered instead of the ball-bank readings.
Accelerometers measure lateral acceleration only.
The lateral acceleration should be equated to the values in MUTS Table 10-2 to convert to ball-bank readings.
These measurements can be used to determine the posted advisory speed.

Form Access

The available forms through MUTS can be used for data recording purposes for the traditional ball-bank indicator or the accelerometer methods.

Form 750-020-12: Advisory Speed Study

The results for each run are recorded in Form Number 750-020-12.
The form can be downloaded from the MUTS website
or by scanning the QR code with a cellphone camera.
This form can be used in both directions of travel.
The speed driven through the curve is recorded and the
corresponding ball-bank indicator degrees of deflection are recorded.

The values in MUTS Table 10-2 are also shown at the bottom of this form
and represent the usually accepted limits beyond which riding discomfort
will be excessive and loss of vehicle control may occur
for the corresponding speeds.

The example shown in the slide was completed using a ball-bank indicator
with multiple iterations of the data collection per roadway direction.
Generally, the recommended advisory speed should be to the nearest
5 miles per hour less than the maximum negotiable safe speed
determined separately for each direction of travel.

So, what is the recommended advisory speed for this condition?
The maximum negotiable safe speed
in each direction of travel is 65 miles per hour.
The recommended advisory speed should be
5 miles per hour less or 60 miles per hour.
However, the posted speed limit is 55 miles per hour,
and a safe curve speed sign would not be required.

It is important to note that considerations of sight distance,
nearby intersections or driveways, crash records,
and other conditions may result in a recommended speed
lower than that derived by the ball-bank indicator method.

Automated Methods (GPS)

There are also automated methods having the advantage of not requiring as many passes through the curve and can be conducted at any speed.

GPS Based Data Collection

FDOT has used automated methods and one example is the Rieker Curve Analysis Reporting System shown here. This is a combination of GPS data recording and the accelerometer method. A reference map shows the curve location and the curve fit.

The software provided by the Safe Curve Speed Analysis Report contains extensive information regarding the curve to include the recommended curve advisory speed and signing recommendations. For curve advisory speeds being 40 miles per hour or greater, it is desirable to use GPS based data collection methods.

Study Methods Comparison

In summary, the ball-bank indicator and accelerometer methods required to drive through the curve multiple times under free flow conditions to determine the maximum recommended speeds. This can be considered as a disadvantage due to the increased time it may take to obtain the desired measures. On the other hand, the automated method can be completed with just one pass in each direction, although two runs are suggested, and does not require free-flow speed conditions.

Placement of Warning Signs

The placement of curve warning signs is important
and will be briefly discussed next.
This follows the Manual of Traffic Control Devices
or MUTCD guidance contained in Chapter 2C.
The MUTCD horizontal alignment signing guidelines
are being reviewed for proposed modifications.
Some of the proposed changes are presented here.

Curve warning signs should be placed so that they provide
adequate perception-response time per MUTCD 11th Edition
Table 2C-3 - Guidelines for Advance Placement of Warning Signs.
This image provides a graphical representation of the location
to place the W1-1 sign in advance of the curve.

Please note the MUTCD guidance is changing to say:
"A turn sign W1-1 should be used instead of a curve sign W1-2
in advance of curves when the advisory speed is one-half
or less of the posted speed or a speed differential of 25 miles per hour
or more exists.
" The MUTCD Figure 2C-2 - Example of Warning Signs for a Turn,
shown on this slide **shows** the application of turn signs.

Advisory speed Plaques

The MUTCD Section regarding horizontal alignment signs
will be updated in the 11th Edition.
This section will contain the new Table 2C-4b –
“Selection of Devices for Changes in Horizontal Alignment”
shown on this slide.

This table is based upon the posted speed and advisory speed differential.
The table provides guidance of when **pavement** marking only,
advance warning signs, delineators plus advance warning signs
and **chevrons** plus advance warning signs.
Also, the new guidance says: "An Advisory Speed Plaque should be
used with a horizontal alignment sign when the difference between
the speed limit and the advisory speed is 15 miles per hour or more."

Warning Sign Placement Example

Another change is for exit ramps.
The new guidance says: "The Advisory Exit Speed
and Advisory Ramp Speed signs on freeway
and expressway ramps should be used when the difference
between the roadway speed limit and the exit or ramp
advisory speed is 15 miles per hour or greater."
These changes are proposed for inclusion
into the MUTCD 11th Edition
and are considered good design guidance.

Chapter Summary

The advisory speed study can be completed
using manual methods such as the ball-bank indicator
or automated methods as previously discussed.
These methods are applicable to any roadway type
from two lane rural roads to freeways and freeway ramps.
Through the advisory speed study,
engineers will be able to select the appropriate curve
advisory speed and determine the need
for placement of warning signs and advisory speed plaques.

End of Lesson

This concludes the Manual on Uniform Traffic Studies
computer based training,
Chapter 10 - Advisory Speed Study.

[Web]

You will now be directed to a 10-question quiz
to test your knowledge and understanding
on the material presented in this computer-based training.

A passing grade of 70% is required to obtain
the Certificate of Completion for the training.
If a grade below 70% is obtained,
the trainees are required to re-take the full training
until a passing grade of 70% or higher is obtained.

If you do not pass the quiz,
please return to the Index page by selecting

the Index button below and re-take this training.
Once you've received your certificate,
please continue to the next chapter
by selecting the "NEXT" button below this CBT.
On the next slide, please read the directions carefully
before continuing to the quiz.
Thank you for your time and attention.

[LMS]

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You will receive your certification after completing
the full MUTS training and passing the quiz for each chapter.
please continue to the next chapter by returning
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and selecting the next chapter in the training.
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