LEVERAGING TECHNOLOGY TO FIND A MORE EFFICIENT WAY OF ESTABLISHING ADVISORY SPEEDS FOR CURVES

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Scientific Excellence to Serve Others

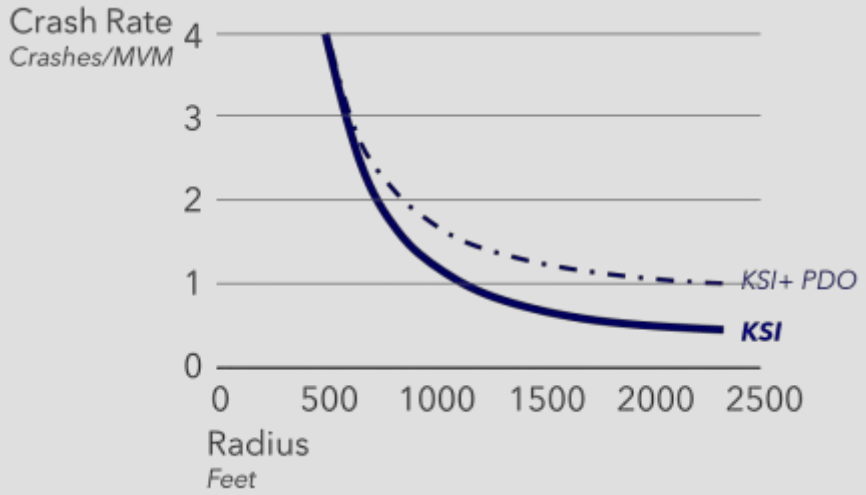
OVERVIEW

toXcel has developed a tool that automatically detects curves and calculates advisory speeds from video data.

- Why set advisory speeds?
- How does it work?
- When do people ignore advisory speeds?
- How can you use it?
- What does the MUTCD Say?
- How has it performed so far?
- Methods for determining advisory speeds
- Wrapping it up
- toXcel's Safe Curves Tool
- About Us

WHY SET ADVISORY SPEEDS?

$$> \frac{1}{4}$$



22%-39%

Fatal crashes happen at horizontal curves[1]

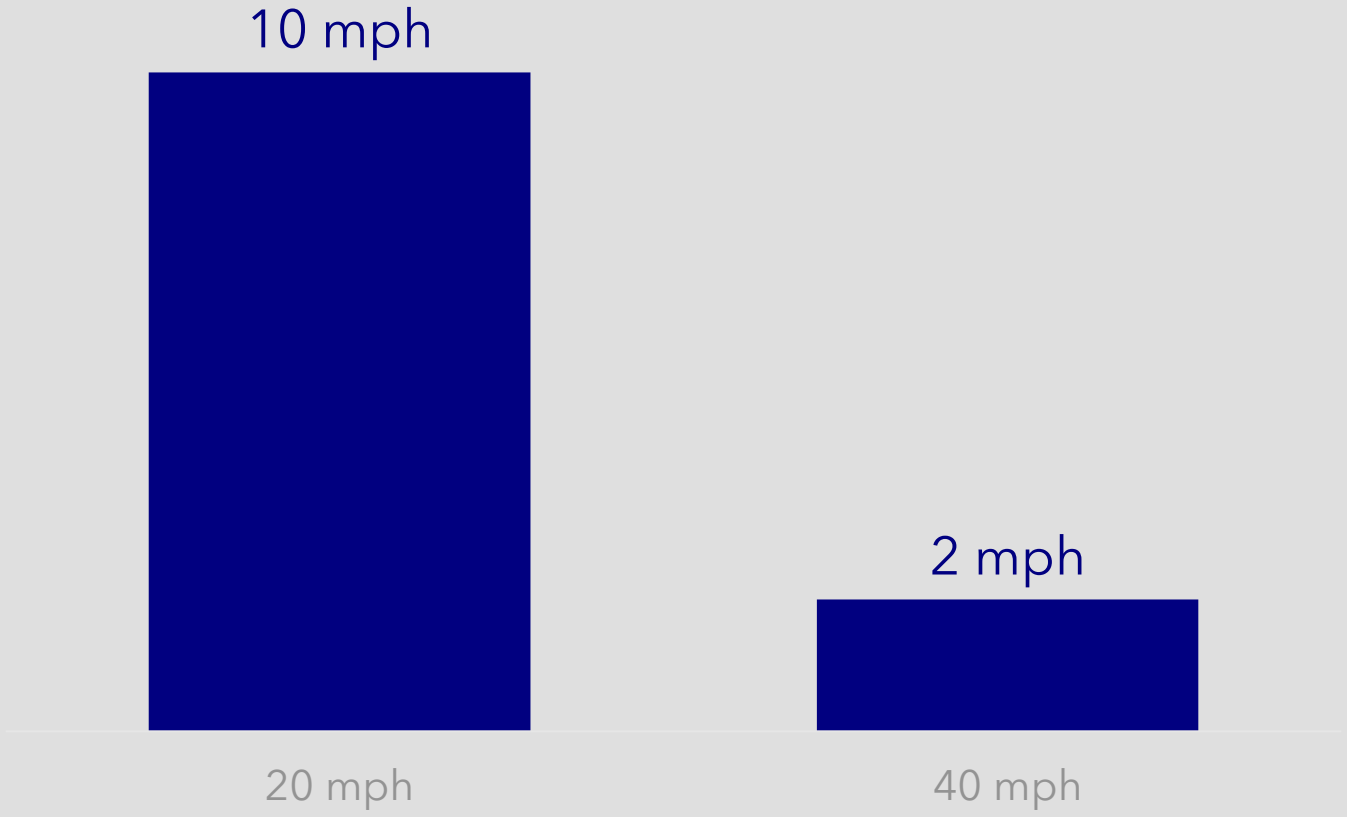
The sharper the curve the higher the crash rate[2,3]

Reduction in crashes with proper advisory curve warning signs and plaques[4,5]

WHEN DO PEOPLE IGNORE CURVE WARNING SIGNS?

The lower the advisory speed, the more people ignore it[6]

MPH that people exceed advisory speed at 20 mph vs 40 mph.



Most Common Reasons

When they are already familiar with the curve[7]

When drivers are overconfident[8]

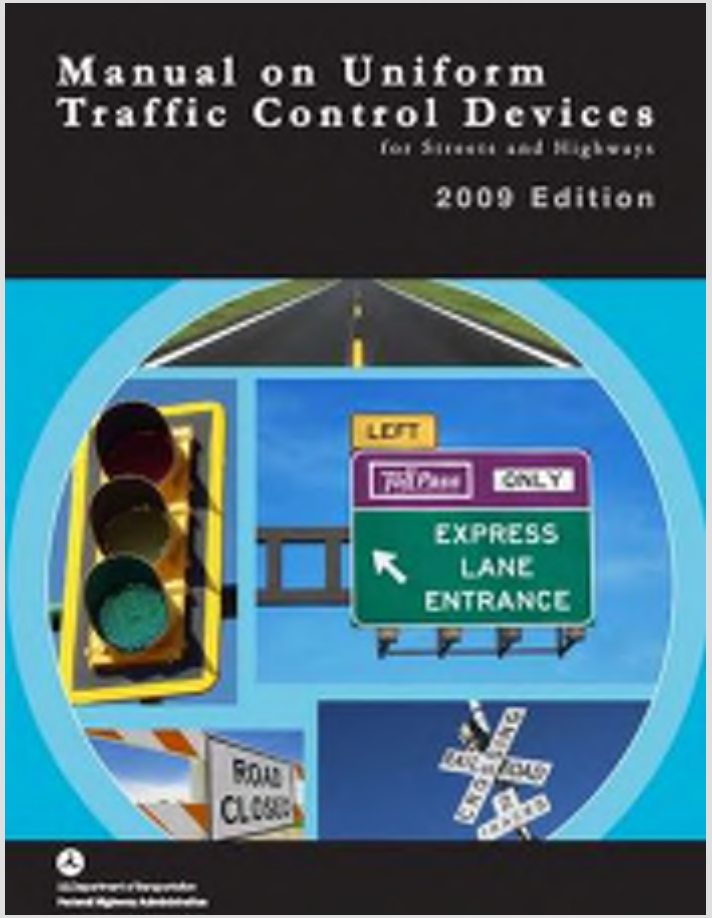
When signs are inconsistent or inaccurate[7]

WHAT DOES THE MUTCD SAY?[9]

Existing guidance is summarized in Section 2C.08 (Advisory Speed Plaque) of the MUTCD.

Established engineering practices that are appropriate for the determination of the recommended advisory speed:

- Accelerometer method
- Design speed equation
- Ball-bank indicator method



ACCELEROMETER METHOD[7]

Makes use of an **accelerometer**, which is an electronic device that can measure the lateral (centripetal) acceleration experienced by a vehicle.

The accelerometer is mounted on a level surface in a standard passenger vehicle. Then, the vehicle is driven through a curve at a constant speed following the radius of the curve as closely as possible.

The advisory speed of the curve is set at the highest speed that can be driven without exceeding a specified, comfortable lateral acceleration.

A measurement of **0.26 g (ft/sec²) to 0.30 g (ft/sec²)** is considered an acceptable range.

DESIGN SPEED METHOD[7]

AASHTO calculates an advisory speed using the following equation:

$$V^2 = 15\,(0.01e + f)\,R$$

Where:
V = advisory speed of the vehicle (mph)
e = superelevation (percent)
f = side friction factor
R = radius of curvature (feet)

BALL-BANK INDICATOR METHOD[7]

Most widely used instrument for determining advisory speeds by 82% of agencies (Lyles and Taylor, 2006).

Procedure is similar to that of the accelerometer method, except it uses a **ball-bank indicator**:

- A curved level filled with a dampening liquid with a trapped air bubble or "ball".
- Indicate the geometric degree of "tip, tilt, or lean" of a curve roadway.

Criteria used to determine the advisory speed limit from the 2009 MUTCD:

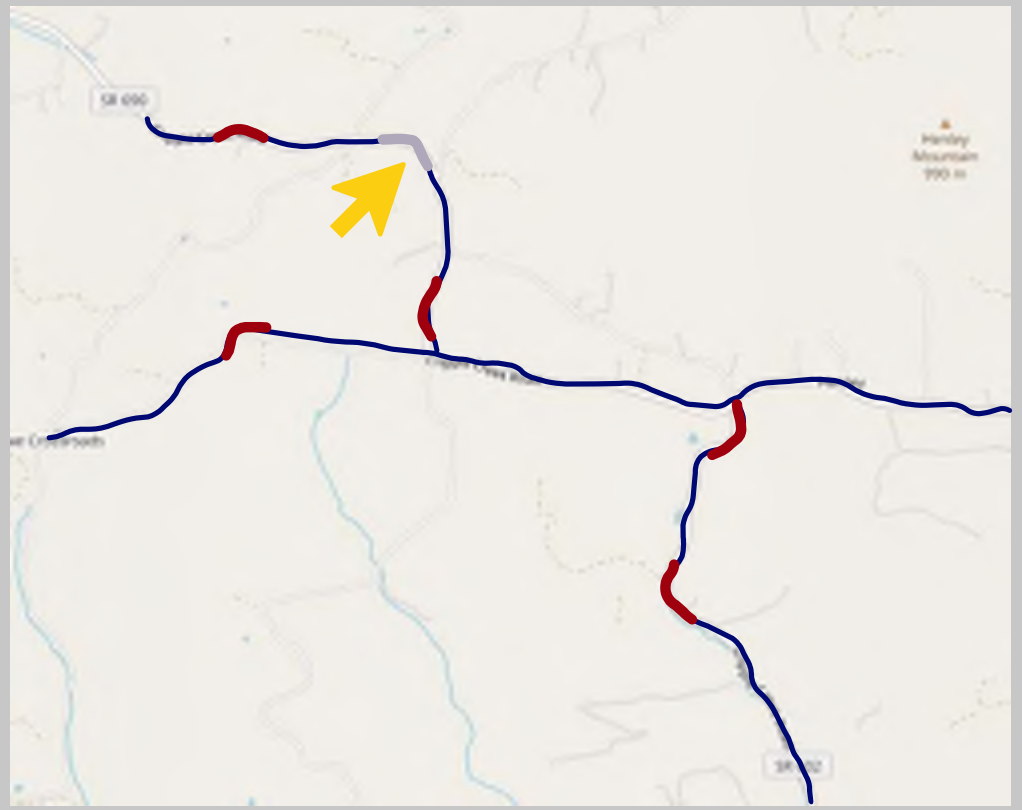
- 16 degrees of ball-bank for speeds of 20 mph or less
- 14 degrees of ball-bank for speeds of 25-30 mph
- 12 degrees of ball-bank for speeds of 35 mph and higher

OTHER METHODS FOR SETTING ADVISORY SPEEDS[7]

- Direct/ 85th Percentile Method
- Compass Method
- GPS Method
- Design Method

Utilize the Curve Advisory Speed (CAS) software developed by TTI.

TOXCEL'S SAFE CURVES TOOL



Route Number
SR 690

Curve Number
Curve 2

Speed Limit
55 MPH

Advisory Speed
35 MPH

Curve Radius
400 Feet

Uses methods approved by FHWA

Requires one pass

Only equipment required is a video camera that also collects GPS and telemetry data

Collects imagery of the roadway along with advisory curve information

HOW DOES IT WORK?

$$V = \sqrt{15\left(\frac{e}{100} + f\right)R}$$

1

Use GPS data from camera to plot roadway.

LOWESS modeling to smooth the GPS path.

Automatically detect curves based on bearing angles.

Calculate radius of curves using Least Squares and Haversine.

2

Calculate what the expected lateral acceleration would be based on the velocity and radius of the curve.

Compare the measured lateral acceleration to the theoretical to derive superelevation and frictional factors.

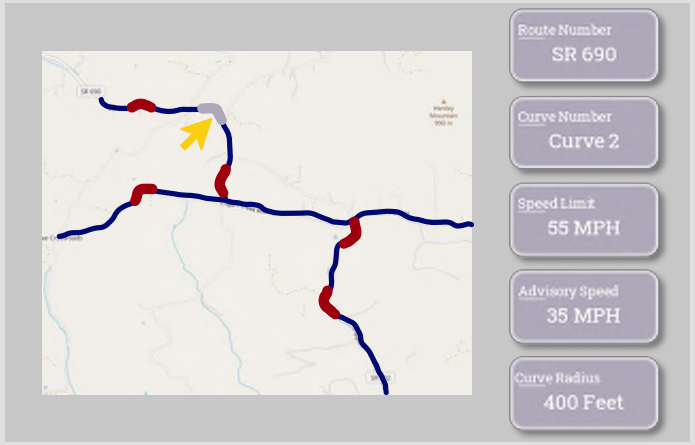
HOW CAN YOU USE IT?

Project Based Approach

1. Identify corridors that need tested
2. Run curves with properly equipped camera
3. Send toXcel the video for processing

Systematic Approach

1. Equip maintenance vehicles with camera
2. Turn cameras on before maintenance vehicles leave the shop
3. Upload videos at the end of the day

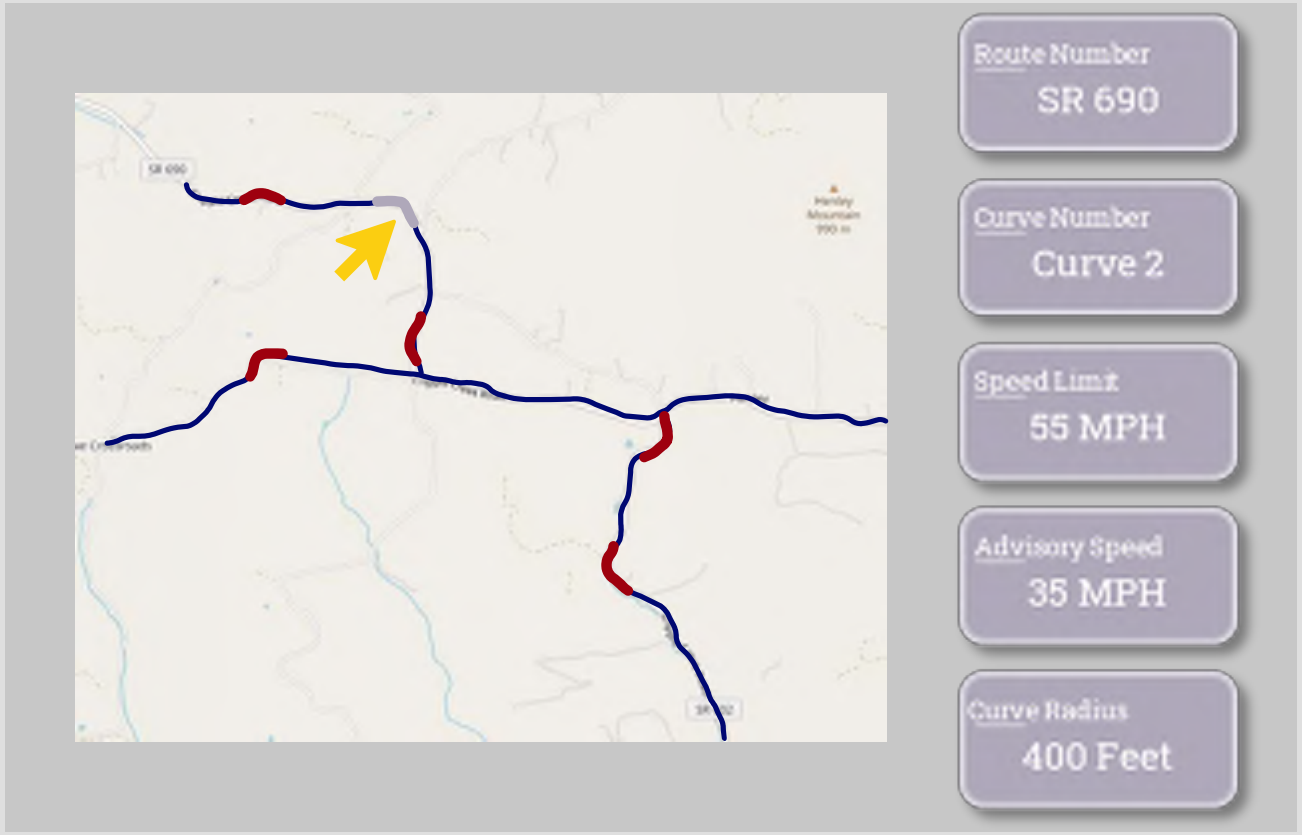


HOW HAS IT PERFORMED SO FAR?

Developed and tested on rural roads test track

Validated on 152 horizontal curves in Southwest Virginia

WRAPPING IT UP



- Providing advisory speeds on curves saves lives
- Inaccurate/inconsistent curve warning reduces efficacy
- Validating existing warnings and creating new is expensive
- Safe Curves tool reduces equipment and collection costs
- Developed in controlled conditions & tested in the wild

Questions?

ABOUT US

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