PRE-CRASH PATH DETERMINATION USING STABILITY CONTROL DATA

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Objectives

- To determine the path of a vehicle prior to the crash without utilizing road evidence

- To verify the intrusion path and determine exact time and location where the vehicle crossed the centerline
Requirements

- At least one vehicle with Event Data Recorder (EDR) is required to obtain:
  - Vehicle Velocity
  - Electronic Stability Control Data
- Area of Impact
- Scaled scene diagram
How does it work?

- Use Speed of the vehicle over 0.1 second intervals
- Translate ESC data to lateral and longitudinal “movement” every 0.1 second
- Assemble the points to form a curve for desired length of time
- Project the plotted path on the roadway using area of impact as reference
- Adjust for road geometry
- Verify movement along a curve using steering data if available
“Movement”

- Requires:
  - Object to travel from point A to point B
  - Travel the distance between A and B at a velocity during a time interval

BASICALLY, VELOCITY VECTOR WITH DIRECTION AND MAGNITUDE
<table>
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<tr>
<th>Times (sec)</th>
<th>Steering Wheel Angle (degrees)</th>
<th>Stability Control Lateral Acceleration (g)</th>
<th>Stability Control Longitudinal Acceleration (g)</th>
<th>Stability Control Yaw Rate (deg/sec)</th>
<th>Stability Control Roll Rate (deg/sec)</th>
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Stability Control Yaw Rate (deg/sec)

• Represents the angular velocity ($\omega$) around the vertical axis of the vehicle

• Rate of change in the heading (deg/sec)
Stability Control Yaw Rate (deg/sec)
Stability Control Yaw Rate (deg/sec)

1. \( \frac{v \Delta t}{\theta} = r \)
2. \( \sin \theta \times r = \sin \beta \times d \)
3. \( \beta = 90 - \alpha \)
4. \( \theta = 2 \alpha \) or \( \alpha = \frac{\theta}{2} \)
5. \( 2 \sin \alpha \times r = d \)
6. \( d = 2 \sin \alpha \times \frac{v \Delta t}{\theta} \)
7. \( d = 2 \sin \alpha \times \frac{v \Delta t}{2 \alpha} \)
8. \( d = \sin \alpha \times \frac{v \Delta t}{\alpha} \)
X and Y

\[ x = d \cos \alpha \]
\[ y = d \sin \alpha \]
\[ d = \sin \alpha \left( \frac{v \Delta t}{\alpha} \right) \]

Where:
\( \alpha = \) heading change (deg)
\( v = \) instantaneous velocity (m/s)
\( \Delta t = \) time period (s)
Crash Test

- Low speed, head-on collision
- Encroachment of one vehicle into path of another
- Comparison between EDR data analysis, road evidence and data obtained from onboard data recorders
Test Location

- City of Kingston, Ontario
- Fire Department training facility
- 2 lanes, 3.85 meters each
- Slight curve to north west
Test Vehicles

2008 Chevrolet Uplander

1998 Volkswagen Jetta
Instrumentation

- Stock EDR
- CAN BUS data logger
- Delphi OBDII harness
- Two 3D accelerometers
- Positioning/tracking system
  - 12 satellite GPS
  - 6 satellite GLONASS
Wheelbase = 287 cm
Overall length = 485 cm
Overall width = 183 cm
Weight distribution 55/44
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Amir: LAT, LONG WHERE GPS PHASE CENTRE CROSSES THE CENTRE LINE - SEE GPS/TRACK MAP.

LOCATION OF CM RELATIVE TO GPS PHASE CENTRE - SEE SLIDES.
Results of calculated position and data obtained from instruments are in good agreement - within 5 cm both laterally and longitudinally.

For calculations and complete results visit https://www.yaworks.ca
Summary

- Obtain pre-crash path using stability control data
- Draw a scaled diagram of the scene
- Identify the area of impact (this will be your reference point)
- Place end of the calculated path (t = 0) at centermass/location of the EDR of the vehicle at first contact
- Evaluate the following scenarios
  1. Place the beginning of the path (t = -5) on the centerline
  2. Place the beginning of the path (t = -5) on the right edge of the roadway
- Use this method as a tool to compliment your analysis and calculations!
Vehicle was travelling on the centerline prior to encroachment

Vehicle crossed the centerline between point A and point B

Vehicle was travelling on the edge of the road prior to encroachment
QUESTIONS?
Special Thanks to:

Provincial Constable Chris Prent - Collision Reconstructionist
OPP East Region Highway Safety Division

Brain Monk - Senior Collision Investigator
Transport Canada

Melanie Jones - Chief Training Officer
Kingston Fire and Rescue

Rogers Towing and Recovery

Carroll Towing and Recovery