

MARC1 – 2016 Three-Day Seminar

Motor Vehicle Accident Reconstruction and Cause Analysis

Instructor: Rudy Limpert, Ph.D

Text: *Motor Vehicle Accident Reconstruction and Cause Analysis, 7th Ed., LexisNexis*;
Software: *MARC1 – 2015*; Book either in paper or e-version; MARC1 software no charge

General Objectives

1. Understand and apply fundamentals of accident reconstruction.
2. Identify and properly document critical accident scene and vehicle data.
3. Identify common and unique elements in crashes.
4. Become familiar with the reconstruction of most types of accident crashes.

Specific Seminar Objectives

5. Velocity diagram: Motion analysis made simple
6. Driver response: Reaction time and difference between real and ideal test drivers.
7. Accident causation and avoidance analysis.
8. Understand energy balance and impulse analysis in impact speed calculations.
9. Crush energy: Analysis of vehicle crash test data and their use in crash reconstruction.
10. In-line crash reconstruction: Head-on, rear-end and side swipe accidents.
11. Intersection two-vehicle crashes with linear momentum.
12. Combined linear and rotational momentum
13. Fundamentals of slide-out and rollover accident reconstruction.

Hands-on Training

14. Hands-on training in reconstructing actual vehicle crashes.
15. Avoid mistakes even experienced reconstruction experts make.
16. Becoming familiar with MARC 1 Software
17. Apply the “Does It Make Sense” rule to ensure my reconstruction is correct.

Day 1: **Motion Analysis**

1. Velocity, Distance, Time and Acceleration/Deceleration
 - 1.1. The Velocity – Time Diagram
 - 1.2. Deriving Simple Motion Equations (MARC1 – A, E, S)
 - 1.2.1. Decelerating to a Complete Stop
 - 1.2.2. Decelerating to a Final Velocity
 - 1.2.3. Angular Velocity and Angle Rotated
 - 1.3. Braking to Avoid Crash (MARC1 – R)
 - 1.3.1. Driver Reaction Time
 - 1.3.2. Avoid Crash by Stopping at POI.
 - 1.3.3. Avoid Crash by Delaying Arrival Time at POI.
 - 1.4. Time to Avoid Crash (MARC1 – B)
 - 1.4.1. Constant Speed

- 1.4.2. One or Both Vehicles Braking
 - 1.5. Combined Speeds (MARC1 – J)
 - 1.5.1. Using Energy Balance
 - 1.5.2. Standard Method
 - 1.6. Driver View Obstruction – Time to Crash (MARC1 – G)
 - 1.6.1. Two Vehicle Approaching
 - 1.6.1.1. Constant Velocities
 - 1.6.1.2. One Vehicle Braking
 - 1.7. Speed from Spin Marks (MARC1 – Q)
 - 1.8. Maximum Speed from Engine Data (MARC1 – M)
 - 1.9. Vehicle Hill Climbing (MARC1 – N)
 - 1.10. Vehicle Deceleration from Newton’s Second Law (MARC1 – E4)
 - 1.10.1. Tire-Road Friction Coefficient and Drag Boot
 - 1.10.2. Two-Axle Vehicle Deceleration
- 2. Vehicle Braking Dynamics (MARC1 – V)
 - 2.1. Braking Fundamentals of Two-Axle Vehicle
 - 2.2. The Braking Forces Diagram
 - 2.3. Braking Deceleration – Post Crash Drag Factor (MARC1 – E4)
 - 2.4. Braking of Air Brake Tractor-Trailer Combination (PC-Brake Air Software)
- 3. Vehicle Directional Control
 - 3.1. Curve Radius Calculation (MARC1 – U)
 - 3.2. Simplified Turning Analysis (MARC1 – U)
 - 3.3. Maximum Speed in a Turn while Braking (MARC1 – U)
 - 3.4. Rollover Speed Including Lateral Load Transfer (MARC1 – P)
 - 3.5. Lane Changing Maneuver (MARC1 – C)
 - 3.6. Steering to Avoid (MARC1 – D)
 - 3.7. Vehicle Rollover
 - 3.7.1. Two-Axle Vehicle – Simple Analysis (MARC1 – U)
 - 3.7.2. Two-Axle Vehicle – Tripping Analysis Using Impulse (MARC1 – O)
 - 3.7.3. Truck-Trailer Rollover (MARC1 – P)

Day 2: In-Line Collisions

- 4. Impulse Analysis (MARC1 – W)
 - 4.1. General Impulse Equation
 - 4.2. Energy balance
- 5. In-Line Collision
 - 5.1. Fundamental Impact Physics (MARC1 – W)
 - 5.1.1. Elastic Impact
 - 5.1.2. Plastic Impact
 - 5.1.3. Real Impact
 - 5.1.4. Delta-V and Crush Energy
 - 5.2. Wall Crash Tests
 - 5.2.1. Stiffness Coefficients (MARC1 – Z)

- 5.2.1.1. NHTSA Test Data
- 5.2.1.2. Neptune Engineering
- 5.2.1.3. Other Data Sources
- 5.2.2. Crush Energy (MARC1 – X)
- 5.3. Mobile Barrier Crash Test
- 5.4. Car-Pole Impact (MARC1 – W)
- 5.5. Vehicle-to-Vehicle Crash Test (MARC1 – X8)
- 6. Frontal Collision
 - 6.1. Head-on Crash (MARC1 – X1)
 - 6.2. Frontal Side Swipe (MARC1 – X2)
- 9. Rear Collision
 - 9.1. Rear-end Crash (MARC1 – X3)
 - 9.2. Rear Side Swipe (MARC1 – X4)
 - 9.3. Low Speed Impact (MARC1 – W)

Day 3: Oblique Collisions

- 10. Polar Coordinate System
- 11. Linear Momentum (LM) (MARC1 – X5)
 - 11.1. Limitations of LM
 - 11.2. LM Sensitivity
 - 11.3. Delta-V Computation with LM
- 12. Linear and Rotational Momentum (LRM)
 - 12.1. Fundamental Considerations
 - 12.2. Vehicle Contact Diagram (MARC1 – Z)
 - 12.3. Crash Test on Paper – Checking Reconstruction Accuracy (MARC1 – X8)
 - 12.5. Crash Test Evaluation (MARC 1 – W, X8)
 - 12.6. Special Cases
 - 12.6.1. Post-Crash Data of One Vehicle Missing (MARC1 – X6)
 - 12.6.2. Only Rotation Data after Impact Are Known (MARC1 – X7)
 - 12.6.3. Motorcycle Side-impacts Car (MARC1 – F)
- 13. Special Applications of Linear and Rotational Momentum with Coefficient of Restitution
 - 13.1. Car-Pole Impact (MARC1 – W1)
 - 13.2. Car-Car Impact (MARC1 – W3)
- 14. Actual Crash Reconstruction Applications

