ABSTRACTS OF 2006 and 2007 SHORT PAPERS

1. PCB 1 – 2006

IN-LINE COLLISIONS – Single Vehicle Crashes, Test Data & Crush Energy

Frontal barrier and wall impacts are discussed. The difficulties in obtaining accurate A- and B-stiffness coefficients are reviewed. NHTSA crash test data and other data are used to determine stiffness coefficients. Pole impacts and mobile barrier rear-end crash tests are evaluated. Real case crashes are analyzed in detail.

2. PCB 2 - 2006

IN-LINE COLLISIONS – Two- Vehicle Crashes, Test Data & Crush Energy

Two-vehicle crash tests are reviewed. In-line test data are used to calculate crush energy of non-regular crush deformation, including over-runs, bumper-mismatch, etc. Crash tests evaluated involve rear-end collisions between pickup and car, and tractor and car, frontal collisions between identical cars, and large and small cars. Stiffness coefficient parameter variation is used to determine sensitivity.

3. PCB 3 – 2006

IN-LINE COLLISIONS – Frontal Two-Vehicle and Vehicle/Fixed Object Sideswipe Crashes, Test Data & Crush Energy

For in-line collisions, the lines of action of both approach vectors are approximately parallel, and are also approximately parallel to both departure velocity vectors. Crash test data of a frontal sideswipe test between two Mercedes 200 D vehicles are analyzed. Crash test data of a Chevrolet Citation against a stationary tractor are reviewed and evaluated. Tractor-trailer sideswipe tests against a solid wall are reviewed. An actual case of car under-riding a pickup truck is reconstructed.

4. PCB 4 – 2006

IN-LINE COLLISIONS – Rear Two-Vehicle Side Swipe Collisions

In these collisions the faster vehicle approaches the slower one from the rear and sideswipes it. Approach and departure velocity vectors of both vehicles are approximately parallel.

5. PCB 5 – 2006

OBLIQUE COLLISIONS - Standard Linear Momentum

In the standard linear momentum method tire braking forces are not considered, and consequently, is not a general law. The LM method is used to calculate impact speeds and compared with test data. The delta-V velocity vector diagram is discussed.

6. PCB 6 - 2006

OBLIQUE COLLISIONS – Linear and Rotational Momentum: After-Impact Data of One Vehicle Missing

When both linear and rotational momentum are considered along with both after-impact velocity equations, we have four unknown velocities, however five independent equations. Consequently, we have formulated the problem by allowing one after-impact velocity to be "missing". This means, that MARC 1 Module 6 will reconstruct impact velocities when after-impact data for one vehicle are not available. The impact configuration must be known. We believe, that the MARC 1 program is the only one available to do a direct reconstruction of both impact speeds when critical crash scene data are missing.

7. PCB 7 – 2006

OBLIQUE COLLISIONS – Linear and Rotational Momentum: Only Angles Rotated After Impact Known

Only the after-impact data required to reconstruct both impact velocities are the angles rotated after impact by both vehicles, as well as the rotational coefficients of friction for each vehicle. The impact configuration must be known. The user is alerted to the fact that in all rotational momentum applications the lever arm or distance between impulse and center-of-gravity is of critical significance. A very small lever arm will calculate an extremely high impact velocity.

8. PCB 8 - 2006

OBLIQUE COLLISIONS – Linear and Rotational Momentum: Determine After-Impact Data from Known Impact Data (The "Crash Test" on Paper)

It determines all essential after-impact data for known (user specified) impact data as well as impact configuration. In combination with PCB 6 – 2006 and PCB 7 –2006, it allows unknown after-impact data to be "recovered". In addition, it uses crush energy data to perform an energy balance check to determine analysis accuracy. Directions of PDOF are established. Crash test data are used to compare with calculated data.

9. PCB 9 - 2006

BRAKE SYSTEM ANALYSIS IN PRE-CRASH ACCIDENT RECONSTRUCTION

Pre-crash vehicle braking decelerations are established for normal and brake failure conditions. Optimum braking forces are analyzed. Braking effectiveness including brake factor is discussed. The braking accident diagram is explained for two-axle vehicles including motorcycles. The effects of brake failure such as brake fade and booster failure, or improper maintenance on vehicle deceleration is computed.

10. PCB 10 - 2006

IN-LINE LOW IMPACT SPEED COLLISIONS

In the derivation of the underlying mathematical formulation tire braking (and side forces) are included. Many "low" impact speed programs allow the user to input only the coefficient of restitution to analyze low speed crashes. However, the accurate coefficient of restitution to be used is not easily determined. The MARC 1 Low Speed software due to its nature of input data provides an "input data accuracy" check not found in any other reconstruction programs. Actual low impact speed crash test data published are analyzed and evaluated for cases with and without braking.

We believe, that the low speed MARC 1 software is the only program to include braking forces during the crash.

11. PCB 11 - 2006

SPEED ANALYSIS IN SLIDE-OUT AND ROLLOVER ACCIDENTS

The typical reconstruction errors made when using speed-from-yaw marks are discussed. The different methods for a vehicle to produce curved tire marks are reviewed. The effects of load distribution, brake balance and lateral load transfer are evaluated in terms of stable vehicle turning speed. Speed calculation from spin marks is discussed.

Different static rollover mechanisms including suspension roll stiffness for straight trucks and tractor-trailer combinations are reviewed and MARC 1 examples are shown.

1. PCB 1 - 2007

VELOCITY-TIME DIAGRAM

The fundamentals of the V/T – diagram are reviewed. Its powerful simplicity in deriving complicated vehicle-to-vehicle motion relationships is discussed and many examples are provided. Its use in analyzing electronic velocity charts and braking data of trucks is explained.

2. PCB 2 - 2007

AIR BRAKE DESIGN AND SAFETY: PART ONE – STRAIGHT TRUCKS

Computation of braking effectiveness for design and reconstruction purposes is shown. Slack adjuster travel effectiveness including thermal drum expansion is analyzed. Brake temperatures are calculated and thermal brake fade is included. Two-axle as well as three-axle trucks with different tandem axle suspension designs are evaluated by use of the traction coefficient concept. Brake lockup sequence can be analyzed and evaluated in terms of accident scene skid mark data. Air spring-, walking beam -, and leaf spring suspensions can be evaluated by the software.

3. PCB 3 - 2007

AIR BRAKE DESIGN AND SAFETY: PART TWO – TRUCK/TRAILERS

This paper uses many of the fundamentals discussed in PCB 2 – 2007. Air pressure modifying valves are analyzed. Braking effectiveness for different maintenance problems including slack adjuster travel, brake temperature, brake factor, and others is computed. Braking of tractor-semitrailers with different tandem suspension designs as well as tractor-double trailers is analyzed. The traction coefficient concept is used to predict wheel lock for system certification as well as braking skid mark analysis.

4. PCB 4 – 2007

LINEAR AND ROTATIONAL MOMENTUM IN DIFFICULT RECONSTRUCTIONS

In many cases only a combination of linear and rotational momentum in connection with the coefficient of restitution allow a reconstruction of impact speeds. Frequently, this is the case when a vehicle “bounces” off a stationary vehicle or object, or when it acquires significant after-impact rotation.

Detailed derivations of speed and angular velocity equations by use of the impulse analysis are shown. The proper use of the definition of the coefficient of restitution, and hence contact point material properties, in deriving the impact speed equations is explained. Other case-specific limitations, such as the hooking assumption are explained. Actual cases including a motorcycle sliding on its side against a tire of a stationary truck, tree impacts, and others are analyzed.