Collision Damage Analysis

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Content

Damage Classification

Damage Evaluation

Describing pre-crash motion
Outcomes

At the end of this session, you will be able to:

- Classify collision damage
- Evaluate collision damage
- Describing pre-crash motion
Damage Classification
Damage Classification

What is the similarity / difference between these damages?
How to classify impact?

... Based on residual crush on the collided vehicle
Impact Type

- Front
- Rear
- Rightside
- Leftside
- Rollover
Example: Frontal Impact
Example: Side Impact
Example: Rear Impact
Exercise #1: Impact Classification 1

Frontal impact
Exercise #1: Impact Classification 2

Side impact
Exercise #1: Impact Classification 3

Rollover
How to further classify impacts?

... utilizing a standardise classification system
Collision Deformation Classification (CDC)

A seven character alphanumeric coding system for describing collision damage to cars and light trucks

Established by SAE in 1980, SAE J224
Analisis Kerosakan Kenderaan
Collision Deformation Classification (CDC)

1. Direction of impact
2. General area of damage
3. Specific horizontal area
4. Specific vertical area
5. Type of damage distribution
6. Damage extent
1. Principle Direction of Force (PDOF)

The direction of the principal force (in clock diagram) sustained by a vehicle at the maximum engagement during an impact and resulting in the vehicle damage.
Principal Direction of Force

- Clock face aligned with the longitudinal vehicle axis
- 12 o’clock is oriented toward the front of the vehicle
- Clock face is centered over the point of application
PDoF for Front Impacts

Crash force, \( F \)
PDoF for Side Impacts
PDoF for Rear Impacts
3. Impact Type

\[ X = \text{Unclassifiable} \]
4. Impact Location

Horizontal Plane
5. Impact Location

Vertical Plane
6. Damage Type

- W Wide (>40cm)
- N Narrow (<40cm)
- S Sideswipe
- O Rollover
- A Overhang - Underride
- E Corner
7. Extent of Damage: Hatchback
7. Extent of Damage: Saloon
COLUMN 7 OF CDC

LEFT SIDE EXTENT

FRONT EXTENT

REAR EXTENT

TOP EXTENT

FRONT DOOR LATCH PILLAR

BEGINNING OF ZONE 9 FROM EITHER FRONT OR REAR
Example: CDC

CDC : 09LPEW4
Exercise #2: CDC

Classify this impact according to CDC

Image of a crashed car with measurements 27 cm and 85 cm.
Exercise #2: Principle Direction of Force
Exercise #2:

\[ W = 85 \text{ cms} \]

CDC: 11FZEW2
Damage Evaluation
Types of Vehicle Damage

Contact / Direct Damage
- Direct contact made between impacting bodies
- Characterized by:
  - sharply folded metal
  - paint scratches
  - sever wrinkles
  - Imprints
  - paint transfers from the impacting object

Induced / Indirect Damage
- Damage to any point on the vehicle caused by some other part of the same vehicle or by the shock of the collision
- Usually located in a structurally weaker area of the load path.
- Characterized by:
  - large radius bends
  - little paint damage
  - gentle bending
  - lack of paint surface damage
Example: Rear Impact Case
Direct vs. Indirect Damage

Indirect damage

Direct damage
Damage Profile - Crush

**CRUSH**
The amount of exterior deformation of car involved in a crash.

**MAXIMUM CRUSH**
Greatest amount of crush due to direct contact damage.

**CRUSH PROFILE** : Depth of crush along the damage width in the horizontal plane measured at equal intervals
How to evaluate crush?

1. Set datum line
2. Set C1 – C6 points
3. Measure crush at the C1-C6 points
4. Measure the max crush
Datum Line
C1 – C6 points
Crush or depth of damage

\[ a = \text{datum} \]
\[ \pm b = \text{difference between actual and datum} \]
\[ \text{Crush} = x \pm b \]

Calculation of Delta-V using AiDamage
Importance of Datum Line

**CORRECT DATUM LINE**
Datum line

**FALSE DATUM LINE**
Datum line

Correct crush measurement
False crush measurement
Examples: Collision Deformation Classification (CDC)

Frontal impact: 11FDCW4
Side impact: 02RYDW5
Rollover: 10TDGW2
Maximum Crush
**Damage Mid point offset**

A = overall damage width

B = overall vehicle width

B = % offset

= \((A/B) \times 100\)

Mid point offset

= \((B/2) - (A/2)\)
Damage Profile - Intrusion

**INTRUSION**
The reduction in an interior dimension due to door, footwell or bulkhead intrusion for example.
Pre-crash Illustration

PRE-CRASH VEHICLE MOVEMENT
RESTRAINT USE
Types of Impact

Full Impact
- An impact in which some part of the colliding surfaces attain the same speed during impact.
- If the colliding objects do not separate after the collision, the impact is full impact.

Partial Impact
- An impact in which motion is continuous between the parts of colliding objects which are in contact with each other (i.e. sideswipe)
Elements of Impact Stages

First: First contact
Second: Maximum engagement
Third: Last contact: Separation
Full Impact

1. **FIRST CONTACT**
   - Forward motion
   - Zero force
   - Increasing force and penetration
   - Decreasing forward speed
   - Decreasing force and penetration
   - Increasing rearward speed

2. **CENTERED FORCE**
   - Motion stopped
   - Greatest force

3. **LAST CONTACT**
   - Rearward motion
   - Zero force
Partial Impact
Thrust

The force against a traffic unit considered to be concentrated on a particular point on that unit at any instant during collision

A small thrust will give a considerable velocity change to a small object; a large object takes a big force to change its velocity much
Thrust Effect on Vehicle Motion

PDOF through the CG resulting in vehicle moving \textbf{without rotation}
Thrust Effect on Vehicle Motion

With first contact positions as shown here and with:

• K moving while
• L stands

Results:

→ Thrust against L will be in the direction of motion of K
→ Both will rotate in the clockwise direction
Thrust Effect on Vehicle Motion

With first contact positions as shown here as before, but with:

- L moving while
- K stands

Results:

- Thrust against K will be in the direction of the motion of L
- K & L will both rotate counterclockwise
Thrust Effect on Vehicle Motion

With both vehicles moving as they collide

Results:

→ The thrust between them will not be aligned with the motion of either

→ Each vehicle’s motion affects the behavior of the other
Thrust Effect on Vehicle Motion

With both identical vehicles moving in a front corner to front corner right angle impact

Result:

→ the thrust force is more nearly aligned with the motion of the faster vehicle
Thrust Effect on Vehicle Motion

When identical vehicles collide with identical velocities, the thrust direction is halfway between the direction of motion of the two vehicles.
Example: Head-on Collision

Diagrams of vehicles show:
- Contact-damage areas
- Thrust directions
- Resulting rotation of the vehicle

*Based on observations of damage of the vehicles.*

Relative rotation of two vehicles in a collision determines the FCP based on maximum engagement force direction.
Example: Head-on Collision

Maximum engagement positions are derived from collapse and thrust diagrams.

Relative rotation of vehicles also determines the separation positions. Dashed and dotted lines show stages of impact.
Scratches – Vehicle Movement

For rollover cases

Uniform scratches on vehicle body
- Vehicle movement
- Pre/during/post crash

Paint damage
- Contacted object
- Badly damage paint – hard object (road bitumen)
- Mildly damage paint – soft object (shrubs on unpaved shoulder)
Example: Case Study- Bus
Example: Damage Evidences

Scratches on the nearside of the bus body

Two different direction of scratches indicating two different sliding motion of the bus during rollover and post impact collision.

Longitudinal direction

Angled direction
Example: Damage vs. Crash Dynamics

**LONGITUDINAL DIRECTION**
- Sliding motion on the paved road

**MULTI-ANGLED DIRECTION**
- Rotation motion on the unpaved road shoulder
Evidence of Restraint Use

ABRASIVE MARKS ON SEATBELT WEBBING AND LATCH
THANK YOU

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