



AUTO BODY REPAIR

**STRUCTURAL ANALYSIS  
AND DAMAGE REPAIR**



**TEACHER'S GUIDE**

SHOPWARE®

## INTRODUCTION

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This Teacher's Guide provides information to help you get the most out of *Structural Analysis and Damage Repair*. The contents in this guide will enable you to prepare your students before using the program and present follow-up activities to reinforce the program's key learning points.

As part of the 12-part series *Auto Body Repair, Structural Analysis and Damage Repair* provides an overview of factors to consider when analyzing, measuring, and calculating damage repairs. After viewing this video and completing some of the learning activities included in this guide, students will be able to evaluate a vehicle that has suffered major damage to determine the extent of structural damage and calculate the cost of repairing it. Use the *Structural Analysis and Damage Repair* video and accompanying activities provided in this guide to teach students methods to analyze a severely damaged vehicle to determine the extent of the damage and direction of impact, to devise a repair plan, and to write an estimate.

## LEARNING OBJECTIVES

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After viewing the program, students will be able to:

- Analyze a vehicle that has received major collision damage.
- Prepare and interpret a damage report.
- Identify system components and perform basic system diagnostic checks and/or repairs.
- Determine the extent of damage and direction of impact, and plan the methods and sequence of repair.
- Calculate labor costs.
- Prepare an estimate.

## EDUCATIONAL STANDARDS

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The primary certifying body for automotive technician training programs is the National Institute for Automotive Service Excellence (ASE). ASE is a non-profit organization established in 1972 by the automotive industry to improve the quality of vehicle repair and service through the voluntary testing and certification of automotive repair technicians. The National Automotive Technicians Education Foundation (NATEF) is a separate non-profit foundation within ASE. The mission of NATEF is to improve the quality of automotive technician training programs nationwide through voluntary certification. The State Departments of Education in all 50 states support ASE/NATEF certification of automotive programs.

### National Standards

This program correlates with the Program Certification Standards for Automobile Technician Training Programs from the National Institute for Automotive Service Excellence (ASE) and the National Automotive Technicians Education Foundation (NATEF). The content has been



aligned with the following educational standards, which reflect the tasks in the ASE Program Certification Standards for Automobile General Service Technician Programs.

### **Preparation**

- Review damage report and analyze damage to determine appropriate methods for overall repair; develop repair plan.
- Apply safety procedures associated with vehicle components and systems such as ABS, air bags, refrigerants, batteries, tires, oil, anti-freeze, engine coolants, fuel systems, etc.

### **Frame Inspection and Repair**

- Diagnose and measure structural damage using tram and self-centering gauges according to industry specifications.
- Attach frame anchoring devices.
- Diagnose and analyze unibody vehicle dimensions using a tram gauge.
- Determine the extent of direct and indirect damage, and the direction of impact; identify the structural composition; plan the methods and sequence of repair.
- Determine the extent of direct and indirect damage, and the direction of impact; identify the structural composition; plan the methods and sequence of repair.
- Determine the extent of damage to structural steel body panels; repair or replace.

### **Estimating**

- Document and record existing or pre-existing damage.
- Determine and apply appropriate estimating sequence.
- Utilize estimating guide procedure pages.
- Estimate labor value for operations requiring judgment.

*2002 Automobile Program Standards, by the National Automotive Technicians Education Foundation, Copyright 2002 by the National Automotive Technicians Education Foundation. Reprinted with permission.*

### **Language Arts and Communication Standards**

According to ASE/NATEF standards, the automobile technician must be proficient in the following Language Arts and Communications related academic skills that are embedded in the occupation. The activities and information presented in this program and accompanying teacher's guide are aligned to the following standards from the National Automotive Technicians Education Foundation from the National Institute for Automotive Service Excellence.

- Request, collect, comprehend, evaluate, and apply oral and written information gathered from customers, associates, and supervisors regarding problem symptoms and potential solutions to problems.
- Identify the purpose for all written and oral communication and then choose the most effective strategies for listening, reading, speaking, and writing to facilitate the communication process.
- Adapt a reading strategy for all written materials, e.g. customer's notes, service manuals, shop manuals, technical bulletins, etc., relevant to problem identification, diagnosis, solution, and repair.



- Use study habits and techniques, i.e. previewing, scanning, skimming, taking notes, etc., when reviewing publications (shop manuals, references, databases, operator's manuals, and text resources) for problem solving, diagnosis, and repair.
- Write clear, concise, complete, and grammatically accurate sentences and paragraphs.
- Write warranty reports and work orders to include information regarding problem resolution and the results of the work performed for the customer or manufacturer.
- Follow all oral/written directions that relate to the task or system under study.
- Comprehend and apply industry definitions and specifications to diagnose and solve problems in all automotive systems and components of the automobile and light truck.
- Comprehend and use problem-solving techniques and decision trees that are contained in service manuals and databases to determine cause-and-effect relationships.
- Use the service manual to identify the manufacturer's specifications for system parameters, operation, and potential malfunctions.
- Supply clarifying information to customers, associates, parts supplier, and supervisors.

### Technology Standards

The activities in this Teacher's Guide were created in compliance with the following *National Education Technology Standards* from the National Education Technology Standards Project. The content has been aligned with the following educational standards and benchmarks.

- Use a variety of media and formats to communicate information and ideas effectively to multiple audiences.
- Use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences.
- Use productivity tools to collaborate in constructing technology-enhanced models, prepare publications, and produce other creative works.
- Use technology tools to enhance learning, increase productivity, and promote creativity.
- Use technology to locate, evaluate, and collect information from a variety of sources.

The *National Education Technology Standards* reprinted with permission from the International Society for Technology Education.

## PROGRAM OVERVIEW

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How do common unibody vehicles absorb the impact of a major collision? How do auto body repair professionals assess structural damage? How is an accurate estimate created, and what factors are included? These are some of the questions answered in this informative video, *Structural Analysis and Damage Repair*. This program describes the five categories of structural damage, characteristics of structural damage to unibody vehicles, and the methods and tools necessary to measure structural damage, determine repair methods, and calculate labor costs. After viewing this program, viewers will be better prepared to properly analyze and repair damaged vehicles by applying a variety of analytical and case appropriate options.



## MAIN TOPICS

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### Topic 1: Analyzing Collision Forces

This section of the program describes the importance of knowing how an accident occurred, and the factors to consider when determining direct or indirect damage of a vehicle. Students will learn the five categories of structural damage and the correlation between the location of damage and damage patterns and sequences.

### Topic 2: Unibody Structural Damage

This section of the program describes the way in which unibody vehicles absorb the impact of a collision and the characteristics of structural damage to the front, rear, side, and top of a unibody vehicle. Students will explore the ways in which forces impact components within the unibody vehicle, which will prepare them to visually diagnose and uncover damages.

### Topic 3: Measuring Structural Damage

This section introduces the tools and methods used to assess and confirm structural damage that cannot be determined through a visual inspection, including use of a tape measure or a tram bar, a tram gauge, and self-centering gauges. Students will learn the importance of referencing a body dimension manual to measure body dimensions, and using a data chart to record measurement findings.

### Topic 4: Determining Repair Methods

This section of the program describes guidelines for making decisions to repair or replace damaged parts based on the location of the damage and proximity to other components, nature of the damage, and completion time of the chosen repair method.

### Topic 5: Tool Selection

In this section, students will learn the appropriate tools for structural repairs and how repair procedures, damage location, and cleanliness influence tool selection.

### Topic 6: Calculating Labor Costs

This section of the program describes the use of collision estimating guides or “crash books” for calculating labor costs, and factors to consider when writing up an estimate.

## FAST FACTS

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- Most of today's vehicle frames are built in one piece, called a unibody, which is constructed by welding, bolting and adhesive-bonding the various body parts together, creating a strong “shell,” which provides structural strength.
- When a unibody vehicle is in a high-speed accident, the impact tends to bend the frame. Unibody frames protect passengers during a collision by absorbing most of the energy from the impact, but the frame can sustain major damage.
- When initially inspecting a damaged vehicle: (1) determine the vehicle's frame type, (2) find the point of impact, (3) determine the direction and force of impact, (4) inspect the damage



to the parts along the path of impact to a point where there is no longer any evidence of damage, (5) measure the major parts and body height by comparing the actual measurements with values in the body dimensions chart and by using a tram and centering gauge, and (6) check the suspension and overall body damage with the proper fixtures.

- Practice safety precautions before beginning any work by checking for broken glass and sharp metal edges, wiping up any leaking fluids to prevent slips, removing the gas tank before welding or cutting, and disconnecting the battery to prevent a possible charge and to protect the electrical system.
- Most damage is indirect, or hidden from view. Only careful measurement can determine the full extent of damage before any repairs can be made.
- When assessing indirect damage, it is helpful to know the type, size, and speed of the vehicles involved in the accident, the speed of the vehicle at the time of impact, and the angle and direction of the vehicle at the time of impact.
- Structural damage is classified into the following five categories: side sway, sag, mash, diamond, and twist.
- Unibody vehicles have crush zones that are designed to absorb energy during a crash, causing the structure to collapse in a pre-determined way.
- Damage to a unibody typically occurs to the frontal, rear, side, and top of the vehicle.
- After a visual inspection, damage may have to be assessed by measurement; before any repairs can be made, measurement is critical.
- A tram rod and/or gauge are used to measure the degree of structural damage to a unibody frame.
- When measuring with a tram gauge, measure the longest points rather than shorter points, use diagonal measurements when possible, and always check measurements against two or more reference points.
- If the damage is located near any stress areas such as engine or steering mounting areas, then replacement rather than repair is required.
- If the metal is kinked or tightly folded, rather than simply bent or dented, then replacement is required.
- If the time needed to make a repair exceeds the costs of replacement, then replace rather than repair.
- If the damage is located directly within a crush zone, then replacement is required.
- The choice of tool used to make structural unibody repairs is dependent on the procedure and the location of damages.
- Accurate estimation of damages includes cost of parts and materials and total labor hours to complete the job.
- When drafting an estimate, auto body repair technicians should list everything on paper that is bent, broken, crushed, or missing, starting from the outside of the vehicle and working inward, and then list the needed repairs or replacement tasks/parts.
- Collision estimating guides or “crash books” are a helpful estimating reference aide for parts (names, numbers, and price), flat labor rate times, and other information, but should never be used to determine absolute price and labor times, since some tasks are not included.
- Estimates must include the time needed to do *every* task, from set-up to replacement of accessories such as trailer hitches and roof racks.





## VOCABULARY TERMS

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**air chisel:** A tool that is used for tasks such as heavy-duty cutting, shearing, punching, chiseling, and breaking joints.

**air cut-off tool:** The most commonly used tool for making clean cuts to plastics, fiberglass, and composite and sheet metal work.

**body-over-frame (B-O-F) construction:** Vehicle frame construction typically found in pick-up trucks, vans, SUVs, and full-size luxury vehicles, where the frame provides the structure of the car. Body parts, such as the drive train and mechanical accessories, are bolted rather than welded or bonded to the frame. Steel panels of a unibody vehicle are mostly cosmetic, but damage to a BOF vehicle can be cosmetic or structural.

**datum measurement:** Measurement taken with a tram gauge using an imaginary flat surface parallel to the underside of the vehicle. It is the line (datum line) from which all vertical height is measured.

**diamond damage:** Frame damage that is caused by impact to one corner of the car, resulting in the unibody or frame being pushed out of square. Diamond damage on a unibody vehicle usually results in a total loss.

**direct damage:** Obvious (visible) damage or impact zone.

**D & R:** Crash book acronym that means "disconnect and reconnect".

**included operations:** Crash book term that refers to tasks that can be performed individually, but which are also part of another operation.

**indirect damage:** Hidden damage; the most common type of damage.

**mash damage:** Localized frame damage that is generally limited to the front or rear of the vehicle, characterized by any one section of the car being shorter than factory specifications; typically identified by severe distortion of the fenders, hood, and possibly the frame horns.

**overhaul:** Crash book term that means to remove, disassemble, clean, inspect, replace parts as needed, and reassemble to install and adjust parts as needed.

**overlap:** Crash book term that refers to the occurrence when replacement of one part duplicates some labor operation required to replace an adjacent part.

**plasma cutter:** Tool used to cut sheet metal by using a strong electro-magnetic field as well as heat to weaken the molecular bonds holding the metal together in a very limited area and then using high-pressure air to blow that metal out of the gap. Tends to leave a hamster-nibbled edge that needs filing, grinding and smoothing.

**reciprocating saw:** Saw blades that are driven by an air or electric motor, they are ideal for cutting off corroded bolts and some light frame applications.

**R & I:** Crash Book acronym that means "remove and install".

**R & R:** Crash Book acronym that means "remove and replace".

**sag damage:** Frame damage in which one part of the frame is lower than normal. Caused by a direct impact to the front or rear of the vehicle, sag damage can be detected by a gap between the fender and door that narrows towards the top.

**scale:** A device used for adjusting the tram gauges to hang at the correct distance under the vehicle.

**self-centering gauge:** A measurement tool installed at various control areas on the bottom of a damaged vehicle that is used to measure alignment by projecting points on the vehicle's structure into the technician's line of sight. Typically used in sets of four or more to establish the vehicle centerline and datum plane.



**side sway damage:** Frame damage in which the front, center, or rear portion of the vehicle is out of lateral alignment (side bending of the frame). Caused by a side impact, side sway damage can be recognized by a gap in the door on the long side and buckles on the opposite side.

**spot weld cutter:** A tool, similar to a specialized drill bit that is used to remove spot welds in body panels by cutting around the area of the weld.

**tram bar:** A measuring rod with two pointers attached to it that adjust for height and length which measures dimensional data for frame alignment purposes using additional reference points. The best areas to select for tram bar measurements are attachment points for the suspension and mechanical parts.

**tram gauge:** A tool used to measure vertical height.

**twist damage:** Frame damage that is generally caused by hitting a curb or median at high speeds, resulting in one corner or side of the vehicle being higher than another; typically detected by a low or sagging corner as if the suspension were broken.

**unibody construction:** Vehicle frame construction typically found in passenger cars, where the metal body panels are welded together to form the structure of the vehicle, rather than the frame. Damage to a unibody vehicle usually results in both cosmetic and structural damage.

## **PRE-PROGRAM DISCUSSION QUESTIONS**

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1. Why should auto body repair technicians know about the construction of new vehicles that appear in dealer showrooms?
2. What safety precautions should be practiced before beginning repairs on a damaged vehicle? (Consider components and/or combustible fluids within a vehicle.)
3. What factors should be considered when writing up a repair estimate?
4. How might an auto body repair technician assess structural damage that is not visible with the naked eye?
5. What do you know about crush zones? What are they designed to do?

## **POST-PROGRAM DISCUSSION QUESTIONS**

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1. Now that you have seen the *Structural Analysis and Damage Repair* video, what steps would you take to analyze a vehicle that has received major collision damage? What steps are commonly performed regardless of the point of impact?
2. As a group, list the five categories of structural damage and their distinguishing characteristics.
3. Collision estimating guides or “crash books” are a helpful estimating reference aide for parts (names, numbers, and price), and flat labor rate times. Why shouldn’t crash books be used to determine absolute price and labor times? What alternatives should be used?
4. Why is it helpful to know the accident specifics (type, size, and speed of the vehicles involved in the accident; speed, angle, and direction of the vehicle at the time of impact)





contained in the accident report when assessing indirect damage?

5. What type of damage is caused by impact to one corner of the car? Why does this type of damage generally result in the vehicle being declared a total loss?

## GROUP ACTIVITIES

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### Group Mural

It's been said that a picture is worth a thousand words. The *Structural Analysis and Damage Repair* video presented an overview of factors to consider when analyzing, measuring, and calculating damage repairs. This phase of the repair process is sequential in nature. In other words, one step must be performed before progressing to the next one. Using rolled mural paper, pencils, markers, and crayons, create a mural that illustrates the steps in the structural analysis phase discussed in the video. This poster can contain a combination of text, pictures, or even cartoons. Be sure to group information together that reflects each step. For example, the first step might include a wrecker towing a damaged vehicle to the body shop, and an auto body repair technician speaking with the estimator or the person involved in the accident to find out accident details. Be creative in the arrangement of the pictures, and remember to present them in sequence.

### Create a Crossword Puzzle

Using the list of video vocabulary terms provided by your instructor, design a crossword puzzle. First, decide which terms to include, and arrange them horizontally and vertically on a piece of paper. Number each clue. Next, using the definitions in the vocabulary terms list, revise the definitions to reflect brief clues, numbering them appropriately. After drafting the puzzle, create a numbered grid (blank puzzle) on a blank piece of paper. Below the puzzle, list the UP and DOWN clues. Fill in one of the puzzles to serve as an answer key. Alternately, you can enter your terms and definitions in a criss-cross puzzle at <http://www.puzzlemaker.com>.

### Auto Body Private Investigator

A wrecker tows a severely damaged unibody vehicle to your body shop. You have been asked to play the role of an Auto Body Private Investigator, analyze the extent of damage, and estimate the cost to replace or repair. After doing so, you are required to submit your findings to the Body Shop Director. Think about all of the tasks you will need to do to thoroughly evaluate the damages and the cost and time required to fix them. Think about existing information available, steps for analyzing indirect damage, the methods in which you will determine the structural damage (the clues you expect to see or test), and the manner in which you will determine repairs. Now, pretend you have completed your investigation and are scheduled to report your findings to your Body Shop Director. Write down every task that you performed to assess the structural damage, and estimate the cost of repairs.



## INDIVIDUAL STUDENT PROJECTS

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### Crash Book Exploration—Part 1

Collision estimating guides (or “crash books”) are a helpful aid when it comes to estimating repair costs. A crash book contains illustrated parts break-downs, part names and numbers, flat rate times, parts prices, and the time involved to repair damage. However, crash books should only be used as a reference for pricing parts and for estimating the time required to replace them. Browse through a crash book noting the price of major parts and the estimated time to replace or repair them. Prepare a one-page report on your findings by answering the following questions:

- Which parts are costly to repair or replace?
- Which parts were less expensive to repair or replace than you originally thought?
- Which tasks are most labor intensive?
- Which tasks are virtually effortless?
- What feature did you like best about the crash book, and why?
- What didn't you like about the crash book, and why?

### Crash Book Exploration—Part 2

Using the crash book, prepare a written estimate for a vehicle that has suffered side sway damage. Side sway damage is when the front, center, or rear portion of the vehicle is out of lateral alignment (side bending of the frame). Be sure to include the following in your estimate:

- A listing of all parts, panels, and assemblies that are bent, broken, crushed, or missing
- A listing of all the needed repairs or replacements
- Pricing\*
- Labor\*\* time needed to complete ALL of the necessary tasks, such as straightening and aligning parts; removing tar, grease and undercoatings; drilling and plugging holes; checking suspension and steering alignment; rebuilding or reconditioning used or aftermarket parts; replacing accessories such as trailer hitches, etc. The labor time in a crash guide explains what it does and does not include. For example, replacing a fender includes removing, installing, and aligning, but it doesn't include installation of antennas, pin striping, or application of decals.

Once all of the repairs and labor times have been entered on the estimate, convert time into dollars and add up your subtotal. Add on any wrecker fees, storage fees, and tax to get the grand total. Include any other pertinent information you think the estimate should include.

\* *As a general rule, do NOT rely on pricing included in crash books! Auto body repair technicians should call and request the actual cost of parts.*

\*\* *Labor reported in crash books should only be used as a guide when estimating total repair costs for a vehicle.*



## **Parts, Parts, and More Parts**

Sometimes, parts that are damaged during a major collision cannot be repaired and must be replaced. Exterior sheet metal and plastic parts, such as hoods, fenders, doors, and bumpers, are known as “crash parts”. There are three types of crash parts and any, or all, may be specified for repairs. They are “original equipment manufacturer” (OEM) or genuine crash parts, “new aftermarket” or imitation crash parts, and salvage crash parts. Research all three types of auto parts categories, and compare and contrast each one with the other. What are the advantages and/or limitations of a particular category? When is one more suitable than another, and when might one be comparable? Present your findings as a three-column bulleted list.

## **INTERNET ACTIVITIES**

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### **Computerized Analysis**

Computer technology touches almost every industry in the United States today, including the collision repair industry. Diagnostic hand tools such as tape measures, tram bars, tram gauges, and self-centering gauges may soon be tools of the past as computerized measuring becomes the norm. What's the buzz on computerized measuring technology? Learn more about this technology that may soon be in use at your neighborhood body shop. Research computerized measuring on the Internet, and prepare a one-page report in news clip format about the way in which this new technology is aiding auto body professionals in their diagnosis of structural damage. (“News clip” refers to the way in which feature stories are presented during the evening news.) Your report should be both informative and interesting. You may visit [www.chiefautomotive.com](http://www.chiefautomotive.com) and [www.asashop.org](http://www.asashop.org) to get started.

### **Unibody Structural Damage**

An old saying about a damaged car is that “Once a car has been in a collision, it will never be the same, never drive right, and is hard to sell.” Do you agree or disagree with that statement? You are an investigative reporter for a major news magazine. You’ve received numerous letters from individuals claiming that many unscrupulous salvage outlets are restoring damaged vehicles that were declared a total loss by an insurance company and are putting them back on the street. Using the Internet, see what you can find out about the restoration of vehicles that have been involved in a major accident. Consider some of the following questions for your report: How common is this practice? How can auto body repair professionals identify if a vehicle involved in a recent accident suffered previous collision damage? Are there areas that are most often covered up? What alternatives do consumers have to protect themselves? Prepare a report of your findings in a two-page report, citing resources from where your information was obtained. Consider visiting these websites to get started:

[www.chiefautomotive.com](http://www.chiefautomotive.com)  
[www.asashop.org](http://www.asashop.org)



## Discussion Forums

Visit [www.autobodyonline.com](http://www.autobodyonline.com) and enter the discussion forums by clicking the “Discussion” tab in the upper left corner of the web page. Post a question about structural analysis or preparing a damage estimate. Ask about damages that are often overlooked or miscalculated. Also, review the other posts within the forums and see if you can gather any other information about analyzing collision damage, or about measuring and confirming suspected damages. After a week, copy all your responses, as well as any other posts you have seen that are relevant, into a word processing document. Then answer the following questions: What have you learned as a result of the answers you have received to your post? What have you learned from reading other posts? Did any of the responses conflict with one another? If so, what issues did they raise?

## ASSESSMENT QUESTIONS

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**Q:** A vehicle was hit broadside, causing buckling on the opposite side of the impact. The centering pin on one tram gauge did not line up. Technician A says that the vehicle is out of lateral alignment. Technician B says that the vehicle has side sway damage. Who is correct?

- (a) Technician A
- (b) Technician B
- (c) Both A and B
- (d) Neither A nor B

**A:** (c)

**Feedback:** Side sway damage refers to frame damage in which the front, center, or rear portion of the vehicle is out of lateral alignment (side bending of the frame), which is caused by a side impact that can be recognized by a gap in the door on the long side and buckles on the opposite side. If side sway damage is present, the centering pin on any one tram gauge will not line up.

**Q:** Which one of the following practices apply to measuring frame damage with a tram gauge?

- (a) Measure the shortest points rather than longer points.
- (b) Use diagonal measurements when possible.
- (c) Check measurements against two or more reference points.
- (d) Establish the vehicle centerline and datum plane.

**A:** (b)

**Feedback:** When measuring with a tram gauge, measure the longest points rather than shorter points, use diagonal measurements when possible, and always check measurements against two or more reference points. Self-centering gauges are installed at various control areas on the bottom of the vehicle. They're used in sets of four or more to establish the vehicle centerline and datum plane.

**Q.** Which situation would require replacement rather than repair of damage?

- (a) Damage is located away from stress areas such as engine or steering mounting areas.
- (b) Metal is bent or dented, rather than kinked or tightly folded.



- (c) The time needed to replace exceeds the cost of repair.
- (d) Damage is located directly within a crush zone.

**A:** (d)

**Feedback:** Guidelines for making repair or replace decisions include: Replace rather than repair when (1) damage is located near any stress areas such as engine or steering mounting areas; (2) metal is kinked or tightly folded, rather than simply bent or dented; (3) the time needed to make a repair exceeds the costs of replacement; and (4) damage is located directly within a crush zone.

**Q:** Plasma cutters use a strong electro-magnetic field as well as heat to weaken the molecular bonds holding metal together in a very limited area and then use high pressure air to blow that metal out of the gap. What is the primary advantage of a plasma cutter?

**A:** A plasma cutter will cut nearly any metal, and can make intricate cuts.

**Feedback:** Plasma cutters work by ionizing the metal rather than oxidizing it. This means that they use a strong electro-magnetic field as well as heat to weaken the molecular bonds holding metal together in a very limited area and then use high pressure air to blow that metal out of the gap. The advantage of the plasma cutter is that it will cut nearly any metal, and can make intricate cuts. The down side is that it will leave a hamster-nibbled edge that needs filing, grinding, and smoothing.

**Q:** Crash books can be used to determine the price of parts and labor for estimating purposes. (*True or False*)

**A:** False

**Feedback:** Crash books should never be used to determine absolute price. Instead, they should be used as a reference for pricing parts and in estimating the time required to replace them. Auto body professionals should call and find out the actual price of parts, and bear in mind that the labor time in a crash book indicates that certain tasks are not included.

**Q:** Technician A says that a vehicle has mash damage if any one section of the car is shorter than factory specifications. Technician B says that mash damage is generally limited to the side of the vehicle. Who is correct?

- (a) Technician A
- (b) Technician B
- (c) Both A and B
- (d) Neither A nor B

**A:** (a)

**Feedback:** Mash damage means that any one section of the car is shorter than factory specifications. Mash is generally limited to the front or rear of the vehicle, and is generally identified by severe distortion of the fenders, hood, and possibly the frame horns.

**Q:** Unibody vehicles have \_\_\_\_\_ that are engineered to collapse in a pre-determined way.

**A:** crush zones

**Feedback:** Unibody frames protect passengers during a collision by absorbing most of the energy from the impact, but the frame can sustain major damage.



**Q:** Side impacts can cause energy to be absorbed through the wheels or suspension. Which systems or components might be affected as a result of this?

**A:** Suspension, alignment, and steering can be affected.

**Feedback:** Side unibody damage will cause the door, front section, body pillar, and even the floor to deform as the energy shock wave extends to the opposite side of the vehicle. Side impacts can cause energy to be absorbed through the wheels or suspension. This will cause suspension, alignment, and steering to be affected.

**Q:** Technician A says that self-centering frame gauges are used to check for side sway. Technician B says that self-centering frame gauges are used to check for sag. Who is correct?

- (a) Technician A
- (b) Technician B
- (c) Both A and B
- (d) Neither A nor B

**A:** (c)

**Feedback:** Self-centering frame gauges are used to check for side sway, sag, and twist frame damage.

**Q:** The best areas to select for tram bar measurements are attachment points for the suspension and mechanical parts. (*True or False*)

**A:** True

**Feedback:** A tape measure or tram bar measures one dimension at a time and must be cross-checked using additional reference points. The best areas to select for tram bar measurements are attachment points for the suspension and mechanical parts. These points are critical to alignment.

## ADDITIONAL RESOURCES

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### WEB SITES

**Auto Body Online**

[www.autobodyonline.com](http://www.autobodyonline.com)

**Auto Body P.I.**

[www.autopi.com/frame.htm](http://www.autopi.com/frame.htm)

**Auto Body Pro**

[www.autobodypro.com](http://www.autobodypro.com)

**Automotive Body Repair News**

[www.abrn.com/abrn](http://www.abrn.com/abrn)

**Auto Glossary**

[www.autoglossary.com](http://www.autoglossary.com)





**Automotive Service Association**

[www.asashop.org](http://www.asashop.org)

**Automotive Youth Educational Systems (AYES)**

[www.eyes.org/index.asp](http://www.eyes.org/index.asp)

**Collision Repair Industry: Insight**

<http://www.collision-insight.com>

**How Stuff Works—Auto Stuff Page**

[auto.howstuffworks.com](http://auto.howstuffworks.com)

**I-car**

[www.i-car.com](http://www.i-car.com)

**National Automotive Service Task Force**

[www.nastf.org](http://www.nastf.org)

**National Automotive Technicians Education Foundation—Program Standards**

[www.natef.org/program\\_standards/collision/index.cfm](http://www.natef.org/program_standards/collision/index.cfm)

**Society of Collision Repair Specialists**

[www.scrs.com](http://www.scrs.com)

**Tektips—Auto Body Pro Website**

[www.autobodypro.com/tektips.htm](http://www.autobodypro.com/tektips.htm)

**BOOKS**

Duffy, James E. *I-CAR Professional Automotive Collision Repair*. Albany, NY: Delmar Thomson Learning, 2001. ISBN: 0766813991

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