Research Council for Automobile Repairs

MOTORCYCLE DESIGN GUIDE

TO MINIMISE DAMAGE AND FACILITATE REPAIRS IN LOW SPEED OR STATIONARY FALLS

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1.0 INTRODUCTION

1.1 The Research Council for Automobile Repairs (RCAR) is an international organisation consisting of individual national insurance research centres. These centres are concerned with motor repair research, training, and the pursuit of activities of common technical interest. The overall objective of RCAR is to improve the safety, security, quality, design and repair of motor vehicles and motorcycles in order to reduce ownership costs, including insurance costs.

1.2 In recent decades, motor vehicles have evolved to incorporate features that enhance performance and occupant safety while reducing running costs and environmental impact. Insurance companies have played a major role in influencing modern car design with the aim of reducing repair costs and increasing vehicle security and occupant protection.

1.3 Unfortunately, motorcycles have evolved along different design parameters, the emphasis being predominantly on styling and performance. Modern motorcycles often feature unrepairable exotic materials and finishes, expensive composite bodywork and highly vulnerable major components.

1.4 Each year, insurance companies throughout the world pay large sums of money in motorcycle damage claims. Many insurance claims involve motorcycles which have simply fallen over while stationary. Insurers frequently write off these motorcycles as total losses, due to excessive damage.

1.5 Several factors influence the cost of these claims, including design features, manufacturing materials, surface finishes, pricing of replacement parts and available methods of repair.

2.0 SCOPE

2.1 The contents of this document can be applied to all motorcycles which share the common mono-track trait of falling over if they are not moving. This trait does not apply to three-wheeled vehicles, whether they have a single front steerable wheel and dual rear drive wheels (trike) or dual front steerable wheels and a single rear driven wheel (reverse trike).

2.2 The principles in this document are intended to be applicable to all types of two–wheeled transport, including sports, touring, naked, cruiser, scooter, motard and off-road.

3.0 PURPOSE

3.1 Given the international nature of motorcycle design and production, the purpose of this document is to assist manufacturers everywhere to optimize the Damageability and Repairability features of their products by incorporating design features which enhance low speed crash performance.

3.2 The main objective is to reduce overall crash repair costs without compromising safety and other statutory design requirements.

3.3 It is recognised that local market conditions may require specific features. The concepts and principles outlined here can be developed and expanded as required.

4.0 DAMAGEABILITY AND REPAIRABILITY DEFINITIONS

In the case of motorcycles, Damageability and Repairability can be summed up in the following way:

4.1 Damageability is the measure of a motorcycle's ability to withstand the forces of a stationary fall and is determined by noting which structures and other components are damaged as a result of the impact. To improve damageability, the following question must be addressed:

4.2 Should the structures and components have been damaged in the first place, and what can to done at the design stage to reduce or avoid damage altogether, especially where very expensive items such as vital mechanical and structural components are concerned?

4.3 Repairability addresses the situation after components and structures have been damaged during a low speed tip-over. The following question must be addressed in order to improve repairability:

4.4 How easily, quickly and cost effectively can the damaged structures and components be repaired or replaced?

4.5 It is essential for manufacturers to incorporate tip-over testing into their new motorcycle development program in order that these questions can be considered and acted upon before the motorcycle's design and engineering is signed off.

5.0 DAMAGEABILITY AND REPAIRABILITY VERSUS SAFETY

5.1 There is absolutely no conflict between good D&R design and motorcycle safety.

5.2 Safety and statutory design requirements take precedence over any D&R feature that may be mentioned in this document or considered desirable for a particular vehicle.

5.3 Motorcycle D&R features are associated with stationary tip-over performance and therefore the question of compromising safety rarely occurs. However, when contemplating a repair procedure, the safety and integrity of repair methods should be carefully considered.

6.0 THE STATIONARY TIP-OVER TEST

6.1 The tip-over test reflects a typical stationary fall and simulates damage that insurers experience and pay for every day.

6.2 The test is conducted as follows:

> 6.2.1 The motorcycle is drained of petrol and positioned almost vertical on a hard
> horizontal surface.
>
> 6.2.2 The front and rear wheels are placed in line and the transmission is placed in neutral.
>
> 6.2.3 The side and centre stands are folded up and the motorcycle is supported at one side using a pneumatic ram. The test can be conducted on either left or right side of the motorcycle.
>
> 6.2.4 When safe to do so, the ram is extended slightly by gently adding compressed air.
>
> 6.2.5 The motorcycle freefalls to a horizontal position and comes to rest on its side.

6.3 The result of the tip-over test is determined by totaling the parts, paint and labour costs required to restore the motorcycle to its pre-accident condition.

6.4 The relative D&R status of various motorcycles can be determined by expressing the repair costs as a percentage of the retail values of the motorcycles.

6.5 RCAR encourages manufacturers to incorporate tip-over testing into the development programme for new models. Tip-over testing can provide designers, engineers and marketers with valuable information and it can forewarn of any difficulties or problems that may arise with a production standard vehicle. Testing provides the opportunity to eliminate difficulties at an early stage.

7.0 OPTIMUM DAMAGEABILITY AND REPAIRABILITY FEATURES

7.1 The following damageability issues are important:

7.1.1 The motorcycle should be capable of absorbing the energy of a stationary fall without damage to the major engine casings, fork legs, frame, fuel tank, swingarm or suspension components. Engine protectors may be required on each side.

7.1.2 Vulnerable functional items such as radiators and oil coolers should be located or protected sufficiently to avoid damage during a stationary fall.

7.1.3 The first point of contact in a stationary fall should not be the fairing, frame or fuel tank. The fuel tank may be protected by positioning it inside replaceable impact-absorbing flexible covers.

7.1.4 The handlebar should not damage the fuel tank or the frame in a stationary fall.

7.1.5 Handlebar switches should have sufficient clearance from the fuel tank at full lock steering to ensure that fuel tank damage is avoided in a stationary fall.

7.1.6 Steering stops should not fail or deform in a simple fall in order to limit damage caused by excessive handlebar travel.

7.1.7 If steering stops are damaged, repair should not require frame replacement.

7.1.8 Identification on build plates should not be in a location where they are vulnerable to damage.

7.1.9 Foot operated gear and brake levers should not damage the frame in a stationary fall. Rubber on the inside of the lever could help to avoid frame damage. Gear and rear brake lever tips should hinge to the rear to avoid snapping off.

7.1.10 Footrests should have screwed interchangeable wear pieces.

7.1.11 Fairing brackets and fixings should be sacrificial so that they fail before damage to the frame occurs. Steel frame brackets should not be screwed with steel bolts into aluminium threads on aluminium frames.

7.1.12 Detachable heat shields should be used to prevent cosmetic damage to expensive radiator header tanks and exhaust mufflers/silencers. Protective strips could be placed along the sides of the mufflers/silencers.

7.1.13 Mufflers/silencers should not contact the rear suspension components, or crease the swingarm. Rubber protectors could be utilised to prevent damage.

7.1.14 Mufflers/silencers can be positioned under the seat or under the engine without protruding to the sides.

7.1.15 Fixed mirrors and turn signal lamps should have a spring or clip type fitting to enable them to be displaced without damage.

7.1.16 Handlebar mounted rear view mirrors should pivot in any direction with ball-and-socket joints at their bases, not at the heads.

7.1.17 Hand levers can pivot vertically to avoid snapping.

7.1.18 Where ever an expensive or major part such as the frame, fuel tank, major engine case etc, has a potential for damage, a sacrificial protective cover or component should be used where possible. (Refer Appendix 1 Ablative Design Concept.)

7.2 The following repairability issues are important:

7.2.1 Painted surfaces are preferred rather than materials which are coloured through.

7.2.2 Where possible, all plastics utilised on the vehicle should be of the thermoplastic type and readily repairable using hot air fusion techniques and adhesives.

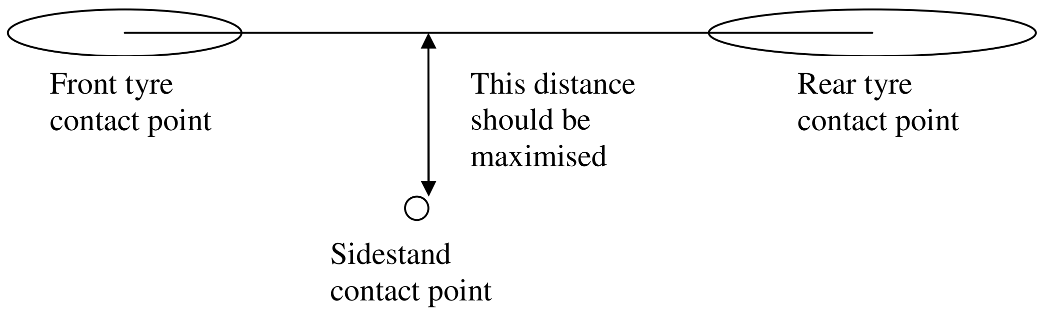
7.2.3 Fairing panel joints should not be points of contact with ground.

7.2.4 Non-structural components should be easy to remove and replace.

8.0 SIDESTAND DESIGN FOR PREVENTION OF TIP-OVER

8.1 The most important thing is to avoid the motorcycle falling over when stationary.

8.2 It is necessary to provide reasonable stability for the stationary motorcycle by ensuring that the sidestand contact point is widely separated from the line between the front and rear tyre contact patches. This requires the sidestand to extend well to the side of the motorcycle.



APPENDIX 1

ABLATIVE DESIGN CONCEPT

Ablative Design Concept

A1.1 The term ablative derives from the description of a part that is sacrificed during abrasion, burning or melting.

A1.2 Ablative Design in connection with motorcycles is about protecting expensive or essential components with ones that can be sacrificed in a low-speed tip-over with minimal damage and cost.

A1.3 Ablative Design takes an integrated approach to overall appearance by identifying the parts which are most likely to touch down in a low-speed fall and configuring them so that they protect critical or high-value parts.

A1.4 Ablative parts may range from a simple durable plastic cover, or in the case of a highly visible high impact, first contact area can be made of relating exotic materials such as carbon fibre composite, aluminum or titanium.

A1.5 Ablative Design can involve reinforcing key parts of the motorcycle so that impact energy is absorbed rather than transferred straight to the frame, forks and engine. For instance: a liquid-cooled bike should not have its radiator as a first point of contact with the ground in an accidental fall. Not only is the radiator expensive to replace, but the motorcycle cannot be ridden home if it is leaking coolant.

A1.6 Motorcycle tip-over tests have revealed that design features which prevent damage to expensive or essential components can reduce the total cost of repairs by as much as 40% compared to an unprotected motorcycle.

A1.7 Good design can also ensure that a motorcycle is still rideable after a low-speed tipover, which is not the case with many motorcycles at the moment.

A1.8. Replaceable external clutch cover saves damage to engine, frame and anciliary components. Foot brake and gear levers are positioned so that frame damage is avoided. Springloaded levers return to position, rather than snapping off.

A1.9 Replaceable low-cost cover, supported by an internally reinforced steel bar, provides crash energy absorption and protects body side panels.

A1.10 Lower fork end covers prevent expensive cosmetic damage

A1.11 Two-piece front mudguard detaches to reduce replacement cost.

A1.12 Replaceable cover protects frame rail

A1.13 Handlebar end cap absorbs impact energy. Handlebar lever pivots rather than snapping off.

A1.14 Heat shield protects expensive muffler/silencer

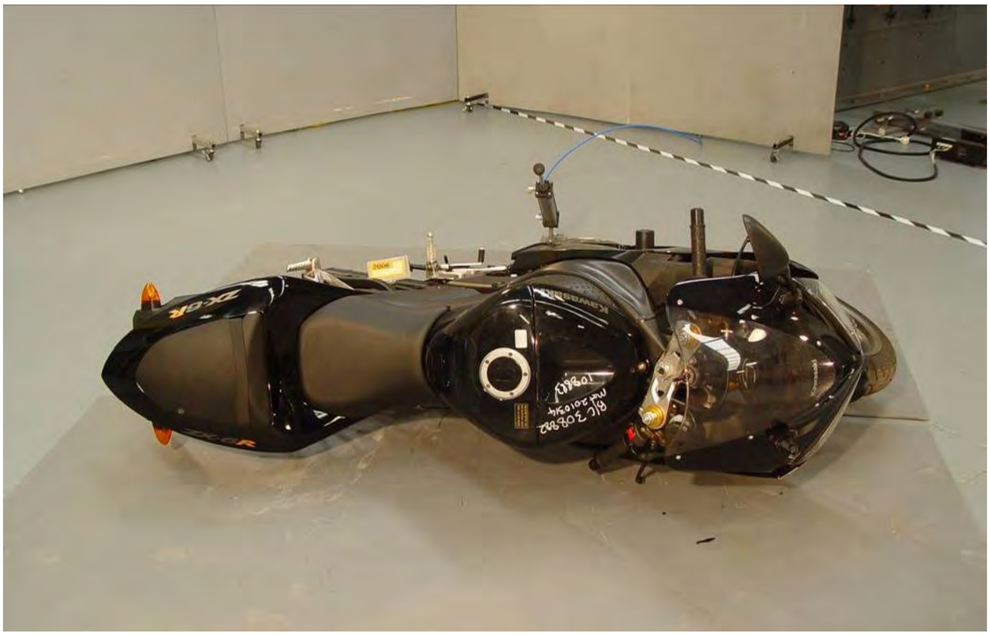
APPENDIX 2

MOTORCYCLE TIP-OVER TEST

A2.1 The motorcycle is drained of fuel and positioned almost vertically on a hard horizontal surface. The preferred material is a fibre reinforced cement with a painted surface and a fine sand abrasive added. The front and rear wheels are placed in line and the transmission is placed in neutral.

A2.2 The side and centre stands are folded up and the motorcycle is supported on the opposite side by a double acting air cylinder.

A2.3 The motorcycle is brought slowly to the vertical position by adding compressed air to the cylinder. When safe to do so, the ram is extended slightly by gently adding compressed air.



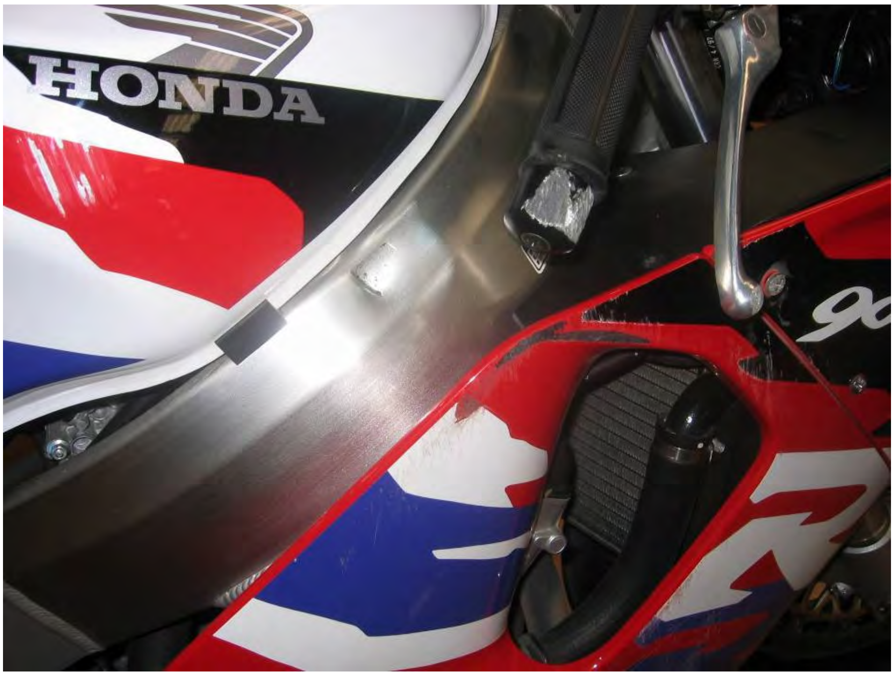
A2.4 The motorcycle is allowed to fall freely from the vertical position starting at close to zero velocity and falling over only under the influence of gravity.

APPENDIX 3

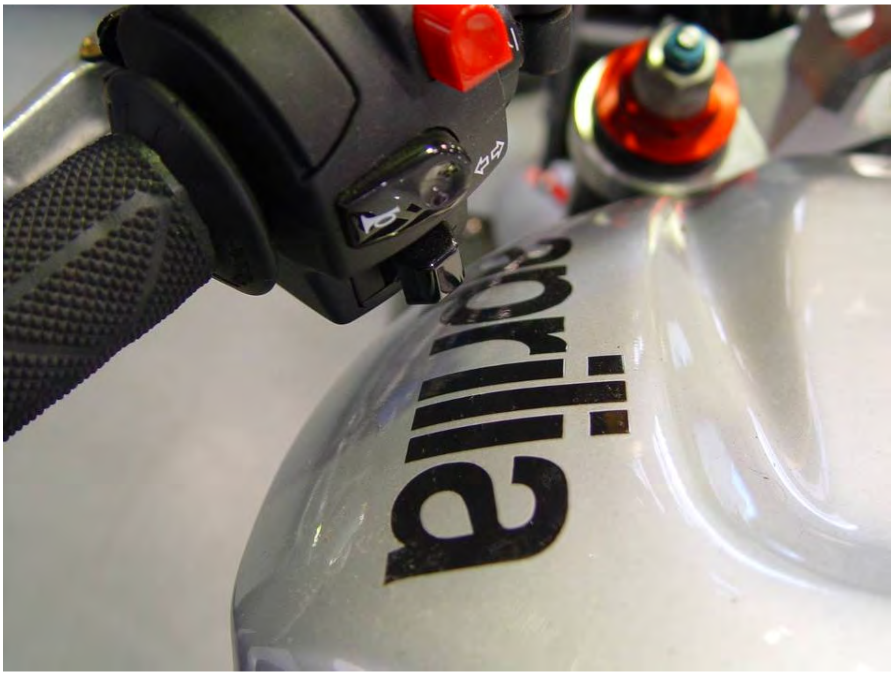
EXAMPLES OF MOTORCYCLE DESIGN FEATURES

A3.1 The points of contact in this stationary fall included the fuel tank and the rear tailpiece, plus every fairing panel. The motorcycle was a total loss.

A3.2 The first points of contact in this stationary fall were the frame and fuel tank. The motorcycle was a total loss.



A3.3 The handlebar should not damage the fuel tank or the frame in a stationary fall.



A3.4 Handlebar switches should have sufficient clearance from the fuel tank at full lock to ensure that fuel tank damage is avoided in a stationary fall.

A3.5 Foot operated gear and brake levers should not damage the frame in a stationary fall.

A3.6 Steel frame brackets should not be attached with steel bolts to an aluminium frames via aluminium threads.

A3.7 Detachable heat shields should be used to prevent cosmetic damage to expensive exhaust mufflers/silencers.

A3.8 The mufflers/silencers should not contact the rear suspension components, or crease the aluminium swingarm.

A3.9 Vulnerable components filled with liquids, such as radiators and oil coolers, should be located and protected sufficiently to avoid damage in a stationary fall.

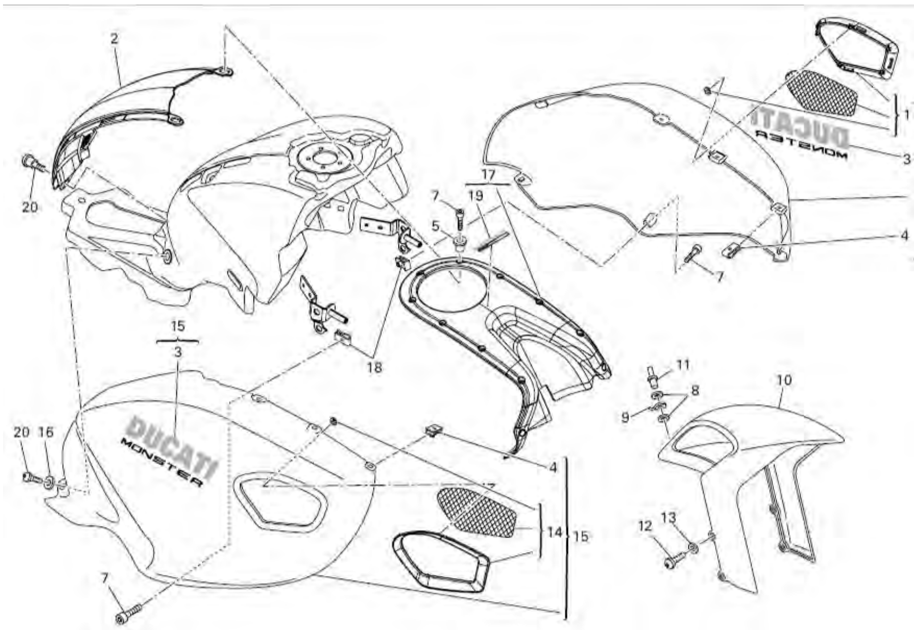
A3.10 Frames can be protected by rubber or carbon covers.

A3.11 Vulnerable swing arms require protection from cosmetic damage.

A3.12 Fork legs and swingarms can be protected from abrasion damage.

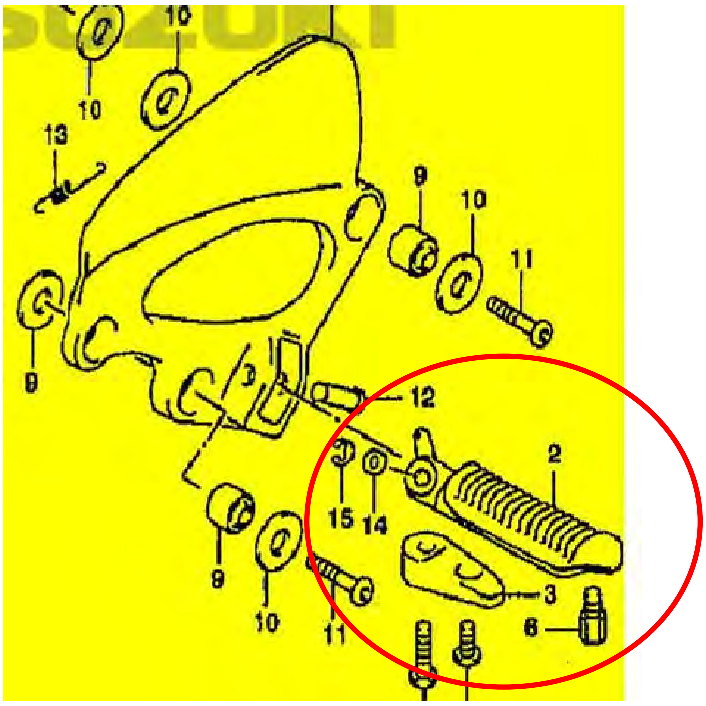
A3.13 Side facing bumper beams are an unobtrusive means to support a motorcycle when it falls over.

A3.13 Steel crash bars can be fitted unobtrusively.



A3.14 The fuel tank may be protected by positioning it inside replaceable impact-absorbing flexible covers.

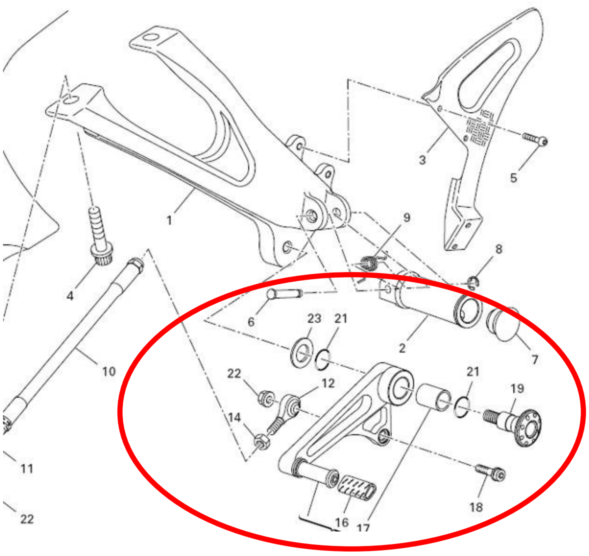
(image copyright © 2008 Ducati Motor Holding S.p.A.)



A3.15 Footrests can have screwed interchangeable wear pieces.

(image copyright © 2008 Suzuki Motor Corporation.)

A3.16 Engine protectors on each side.



A3.17 Rubber on the inside of the lever could help to avoid frame damage. Gear and rear brake lever tips should hinge to the rear to avoid snapping off.

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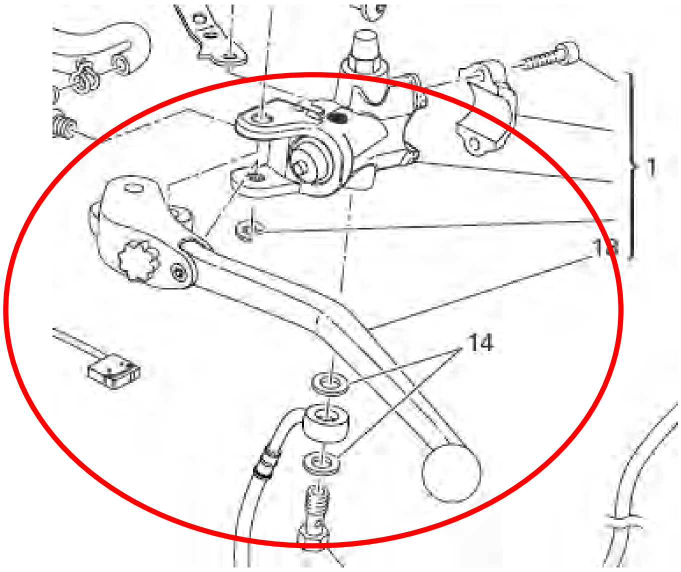

A3.18 Hand levers can pivot vertically to avoid snapping.

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A3.19 Mufflers/silencers can be positioned under the seat or under the engine without protruding to the sides.

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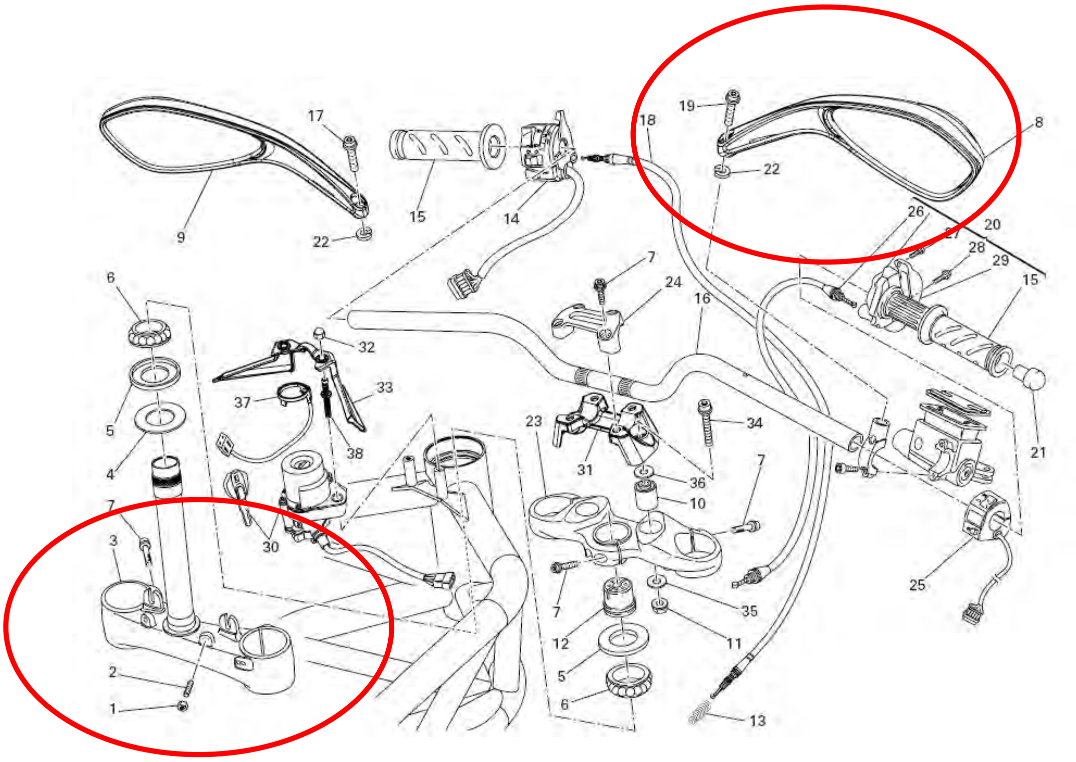

A3.20 The lower fork shank and frame should be reinforced in order that the frame is not deformed and the handlebar does not touch the fuel tank in a stationary fall.

A3.21 Handlebar mounted rear view mirrors should pivot in any direction with ball-and-socket joints at their bases, not at the heads.