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Analysis of single-track vehicle accidents



Contains two multimedia CDs.

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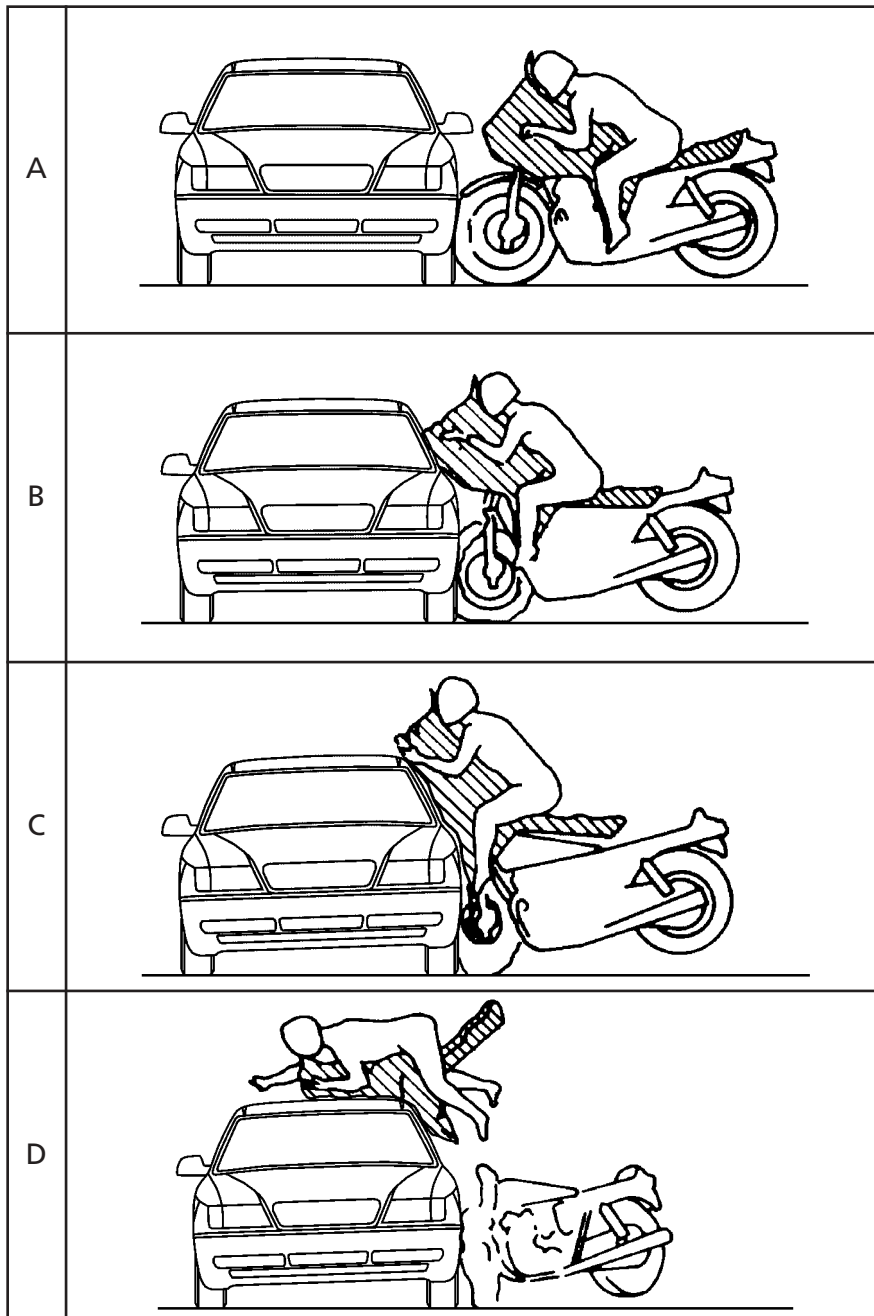


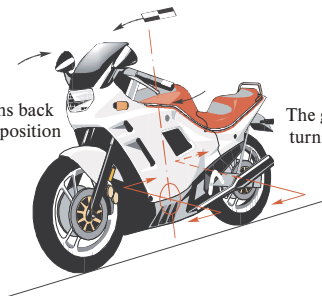
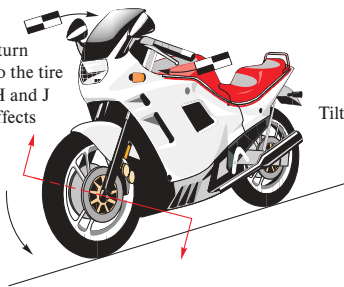
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The operation of an airbag

Tab. 3.1-1.

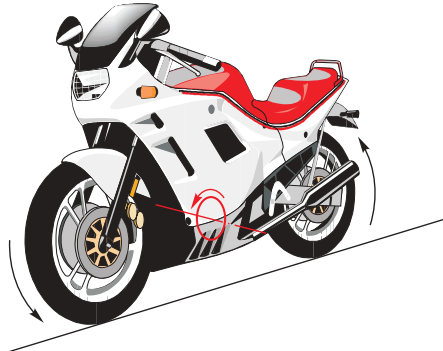


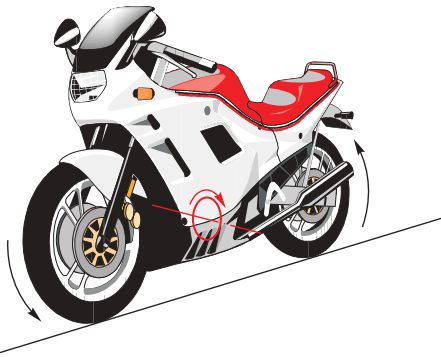
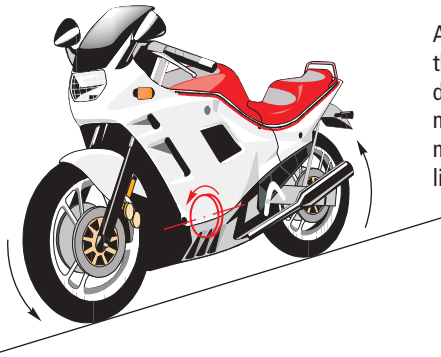
J	Rear wheel, engine flywheel	<p>Vehicle returns back to the vertical position</p>  <p>The gyroscopic effect turns the handlebars to the right</p>
K	Front wheel	<p>Handlebars turn to the right due to the tire effect and the H and J gyroscopic effects</p>  <p>Tilting of the vehicle is limited</p>



The gyroscopic effects of rotating masses on a single-track vehicle in motion

Tab. 4.2.2-3

We distinguish three forms of the engine flywheel rotation	
1.	<p>Flywheel rotation corresponding to the wheel rotation</p>  <p>The gyroscopic effects of the rear wheel and the flywheel will mutually reinforce</p>

2.	<p>Flywheel rotation opposite to the wheel rotation</p> 
<p>The gyroscopic effects of the rear wheel and the flywheel will mutually cancel</p>	
3.	<p>Flywheel rotation perpendicular to the longitudinal axes = the flywheel axis is parallel to the longitudinal axes</p>  <p>Acceleration or deceleration of the rotating masses of the engine do not develop a gyroscopic moment. The torque causes the motorcycle to dive at the front or lift at the back.</p>
<p>The gyroscopic effect of the inertial masses of the engine does not directly affect steering of the vehicle. It only affects the magnitude of the reaction forces on the front and rear wheels.</p>	



An example of calculation of the gyroscopic effect

A motorcycle with a 4-stroke, 2-cylinder, 500 cm³ engine. Moment of inertia of the inertial part $J_s = 0.03 \text{ kg m}^2$, moment of inertia of the wheel $J_K = 0.62 \text{ kg m}^2$. Torque of the engine $n_m = 6,000 \text{ min}^{-1}$. Total transmission ratio to the rear wheel $i = 5 : 1$. The motorcycle moves in a circular path. Total time to complete the path $t = 40 \text{ s}$.

The magnitude of the gyroscopic moment of the inertial mass:

$$M_{GZ} = J \omega_1 \omega_2 = 0,03 \cdot \frac{2\pi}{60} 6000 \frac{2\pi}{40} = 3 \text{ Nm}.$$

Fig. 5.3-8. Motorcycle frame starts to deform (time $t = 0,054$ s from the moment of first contact).

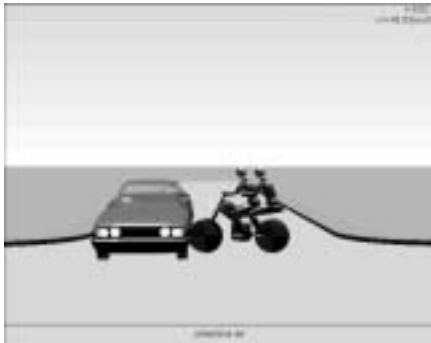


Fig. 5.3-9. Maximum deformation of the frame (time $t = 0,068$ s from the moment of first contact).

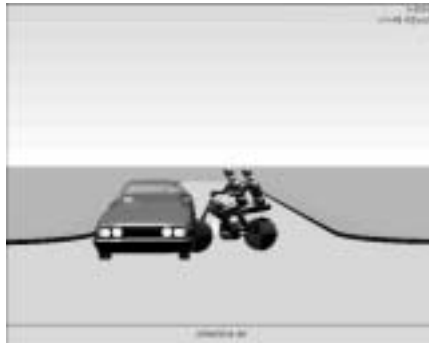


Fig. 5.3-10. Contact between the dummy and the handlebars (time $t = 0,106$ s from the moment of first contact).

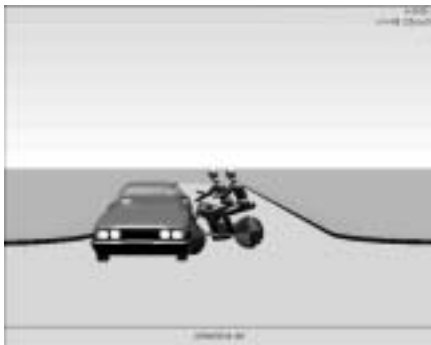




The moment of the first contact with vehicle $t = 0$ s



$t = 0,02$ s since the moment of the first contact



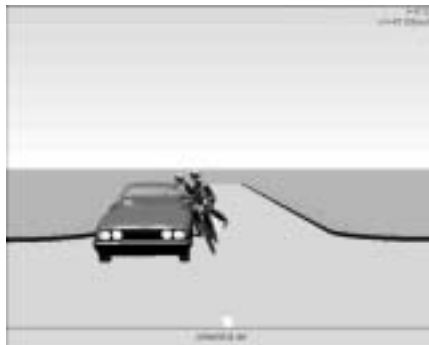
$t = 0,04$ s since the moment of the first contact



$t = 0,06$ s since the moment of the first contact



$t = 0,08$ s since the moment of the first contact



$t = 0,10$ s since the moment of the first contact



Wheel track, front: 1435 mm
Wheel track, rear: 1412 mm
Mass: 1135 kg

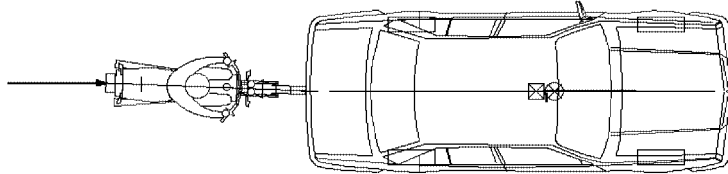


Fig. 6.1.2.1-1. Position of the vehicles at the moment of first contact

Motion of the motorcycle and dummy

Start of the collision

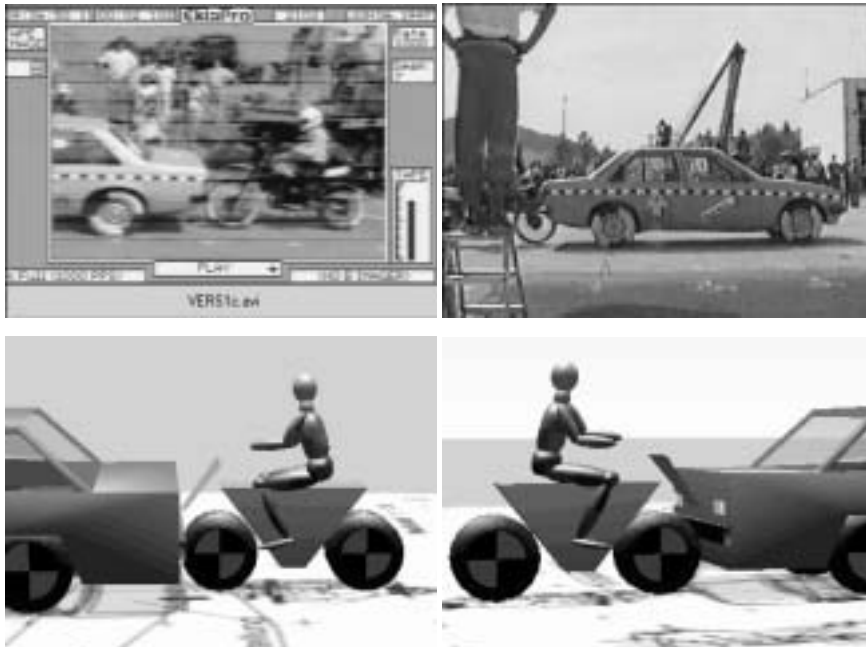


Fig. 6.1.2.1-2. First contact of the motorcycle with the car

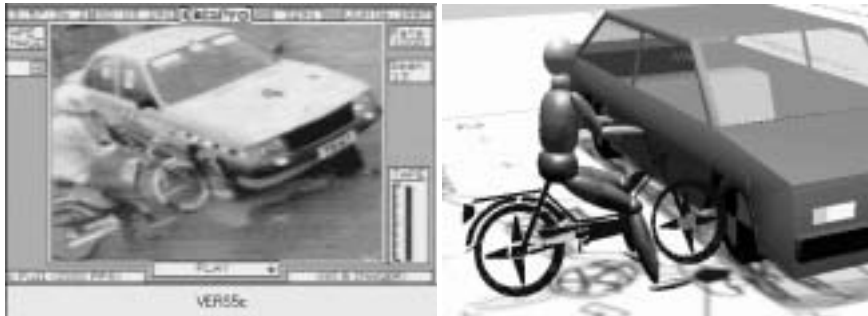
Start of the collision

Fig. 6.1.2.5-2. First contact of the motorcycle with the car

A frame from the high-speed camera (1000 frames/sec) shows the moment of the first contact between the front wheel of the moped and the front part of the car. The image shows a slight tilt of the moped to the left.

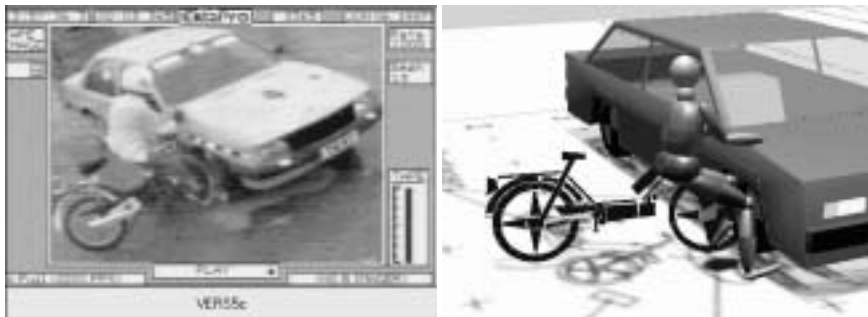
Start of the dummy's contact with the car

Fig. 6.1.2.5-3. First contact of the dummy with the car
(74 ms after the moment of first contact)





Fig. 6.2.2.5-1 Motorcycle with ruler



Fig. 6.2.2.5-2 Collision position of the car



Fig. 6.2.2.5-3 The supporting wheels separated from the motorcycle before the collision.



Fig. 6.2.2.5-4 The supporting wheels reached the collision location after the main phase of crash



Fig. 6.2.2.5-5 Final position



Fig. 6.2.2.5-6 Final location of the dummy

