Bicycle accidents, risks and potential for drive assistance systems

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Bike crash test with car

Bicycle accidents, risks and potential for drive assistance systems:
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3. Risks and potential for drive assistant systems
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Safety for cyclists

Accident statistics CH:

- Positive development of traffic safety by reduction of injured and fatalities in passenger cars
- The number of injured and fatalities on cyclist accidents stays constant, number of injured E-bikers increases

![Graph of accident statistics CH showing positive development in traffic safety for passenger cars and stable number of injuries in cyclist accidents with an increase in E-bikes injuries.](source: BFU, ASTRA)
Safety for cyclists

Accident statistics CH:

- Number of seriously injured cyclists stayed constant
- 2014 on same level as on passenger cars
- With E-bike in total more seriously injured than on passenger car

Source: BFU, ASTRA
Safety for cyclists

- Compared to passenger cars, the fatality risk on bicycles is 10 x higher, from the age of 70 years, the accident risk rises significantly.
- Of 48% accident caused by passenger car / 42% by cyclists.
- High potential on safety measurements for two wheel vehicles.
- 2015 were 2/3 of fatalities on E-Bike older than 65.

<table>
<thead>
<tr>
<th>2004 - 2013</th>
<th>one fatality at</th>
</tr>
</thead>
<tbody>
<tr>
<td>Railway</td>
<td>12770 Mio. person km</td>
</tr>
<tr>
<td>Passenger car</td>
<td>556 Mio. person km</td>
</tr>
<tr>
<td>Bicycle</td>
<td>58 Mio. person km</td>
</tr>
<tr>
<td>Motor bike</td>
<td>28 Mio. person km</td>
</tr>
</tbody>
</table>

Mortal risk, compared with railway

Source: BFS, ASTRA, BAV.
Safety for cyclists

Accident statistics EU:

- Same trend of fatally injured cyclists in Germany and Europe

- In CH on E-Bikes > 25 km/h a bike helmet must be used
Safety for cyclists

EuroNcap Road Map 2020: Rating for AEB VRU Cyclists from 2018

Source: EuroNcap, Director & Professor Andre Seeck
Safety for cyclists

Update AEB VRU for pedal cyclist:
- In daylight, darkness and obscure lighting conditions
- Representative for EU28
- Different sources needed
- Bicycle dummy and propulsion system under development
- Harmonization

Source: EuroNcap, Director & Professor Andre Seeck
Typical accident scenerios with bicycles

Car – PTW collision configurations according to ISO 13232:

- 25 collision configurations
- Most of them are also relevant for cyclists

Typical cyclist accidents:

- Turn collision: miscalculation of distance and velocity (E-bike)
- Crossing collision: miscalculation and obstructed view (A-pillar)
- Push collision: blind spot
- Open door on parked car: missing mirror

Source: ISO 13232
Risks and potential for drive assistant systems

Facility for the acceleration of cyclists:

- Sled with guidance rail for wheels, like a catapult
- Holding device for bike, saddle bar
- Holding device for ATD, armpits
- Pedestrian HIII 50% ATD, *with bike helmet (CH)*
- In-dummy DAS
Risks and potential for drive assistant systems

Turn collision:
- Miscalculation of distance and velocity
- High risks for E-bike

Side collision E-bike 45 km/h
- Impact to cant rail & roof
- Forehead not protected by the helmet
- Loads on thorax to high

Side collision bike 25 km/h
- Impact to cant rail
- Forehead protected by the helmet
- No biomechanical limits exceeded
Risks and potential for drive assistant systems

Turn collision – findings:

- Injury risk essentially influenced by
  - impact velocity of bike
  - helm protection of forehead not ideal
  - impact location on car structure; cyclist-safety for cant rail & roof?

- With EBS main influence on impact location

<table>
<thead>
<tr>
<th>Scenario</th>
<th>w/o EBS</th>
<th>with EBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 1</td>
<td><img src="scenario1_w_o_EBS.png" alt="Image" /></td>
<td><img src="scenario1_with_EBS.png" alt="Image" /></td>
</tr>
<tr>
<td>Scenario 2</td>
<td><img src="scenario2_w_o_EBS.png" alt="Image" /></td>
<td><img src="scenario2_with_EBS.png" alt="Image" /></td>
</tr>
</tbody>
</table>

- Scenario 1
  - probability for “free flight”
  - risk of changed impact scenario (243)
  - high injury risk by secondary impact on road surface

- Scenario 2
  - in worst case the accident occurs because of EBS action
Risks and potential for drive assistant systems

Crossing collision:

- Miscalculation of distance and velocity
- Obstructed view by A-pillar
- High risk for E-bike
- Knee-impact location to bumper higher (lower injury risk)
- Head-impact location to wind screen in tendency higher than on pedestrians similar impact velocity
- Temple protected by the helmet
- High loads on head, below biomechanical limits (primary & secondary impact)
Risks and potential for drive assistant systems

Front-Side collision with reduced impact velocity (EBS)

- Lower impact energy

<table>
<thead>
<tr>
<th>Test prim. Imp.</th>
<th>HIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 km/h (50 % ATD)</td>
<td>408</td>
</tr>
<tr>
<td>20 km/h (50 % ATD)</td>
<td>74</td>
</tr>
<tr>
<td>25 km/h (P3 ATD)</td>
<td>725</td>
</tr>
</tbody>
</table>

- Depending on kinematic critical loads on head by secondary impact on road surface

<table>
<thead>
<tr>
<th>Test sec. Imp.</th>
<th>HIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 km/h (50 % ATD)</td>
<td>30</td>
</tr>
<tr>
<td>20 km/h (50 % ATD)</td>
<td>707</td>
</tr>
<tr>
<td>25 km/h (P3 ATD)</td>
<td>1403</td>
</tr>
</tbody>
</table>
Risks and potential for drive assistant systems

Crossing accident – findings:

- Injury risk essentially influenced by
  - impact velocity of car
  - good helm protection for temple
  - impact location on car structure; extended cyclist-safety area

- With EBS main influence on impact velocity and location

<table>
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<tr>
<td></td>
<td>243</td>
<td>prim.</td>
</tr>
<tr>
<td></td>
<td>143</td>
<td>sek.</td>
</tr>
</tbody>
</table>

- Scenario 1
  - reduced impact velocity → lower injury risk
  - risk of changed impact scenario → example A-pillar
  - high injury risk by secondary impact on road surface

- Scenario 2
  - in best case the accident can be avoided because of EBS action
Risks and potential for drive assistant systems

Push away collision:

- Blind spot
- Obstructed view
- Car and bike with just same velocity (low impact velocity)
- Possible head impact to wind screen, A-pillar or cant rail
- Temples and back of head protected by the helmet
- Low injury risk by primary impact

- High injury risk (HIC P3 777) by secondary impact or run over
Risks and potential for drive assistant systems

Push away collision – findings:

- Injury risk essentially influenced by
  - impact velocity of car
  - good helmet protection
  - secondary impact or run over

Possible assistant systems

- Blind spot assist
- Blind spot monitoring
- Lane Change Assistant
- Multi collision brake \(\rightarrow\) autonomous brake after collision with a bike
- ...

With this for bike detection expanded systems, most accidents could be avoided

Risks:
- information overload for driver
- question of guilt, if accident occurs
Risks and potential for drive assistant systems

Collision with open door on parked car:

- Blind spot
- Missing mirror during door opening
- Injury risk depending on impact velocity, impact location to door and stiffness
- Thorax impact to door frame
- Low risk for head impact
- High injury risk by secondary impact

Source: AXA Winterthur/DEKRA
Risks and potential for drive assistant systems

Push away collision – findings:

- Injury risk essentially influenced by
  - impact velocity of bike, high risk for E-bike
  - door stiffness
  - secondary impact - helmet

Example of assistant system

- Audi exit warning
  - optical and acoustic warning
  - resistance for door opening in discussion

With this system most accidents could be avoided

Risks: system failure
Summary

Pedestrian safety on cars for cyclists?

- Similar head contact area on vehicles as pedestrians
  → pedestrian safety also for cyclists helpful
  → in tendency higher positioned, extension to cant rail and door frame?

- Injury risk for cyclists compared to pedestrians
  → Better protection with helmet
    - helmet obligatory, for all bikers?
    - bad protection for forehead - high quality differences
    - good bike helmet is better than a bad motorcycle helmet,
      and a good bike helmet as a comparable protection

  → Often higher impact velocity
    - extended energy absorption needed
    - high risk with E-bikes

E-bike with motorcycle helmet
Summary

Assistant systems:

- Complexes impact scenarios
  → different bicycles, different front geometry
  → different drive assistant systems are needed

- AEB best effect on frontal collision situations
  → A reduction of the impact velocity by min. 20 km/h reduces serious head injuries
  → Depending on kinematics higher loads on head can result by secondary impact (road surface) with reduced impact velocity

- Other systems can be extended for cyclists
Summary

Questions for accident analytics:

- Would the accident occur without assistant intervention?
- Should the assistant system had work in the specific accident?
- ...
It is the time to start with cyclist safety

→ by hold automotive industry

**AND** cyclists accountable

*Thank you for your attention!*

*Volvo EBS with cyclist detection assistant*

*Concept study with a belted cyclist*