

Challenges and Opportunities for Improving the Safety of Occupants in Lightweight Vehicles

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Overview

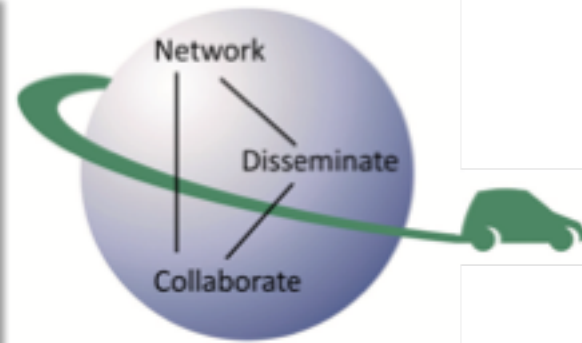
- **Pressures**
 - Why lightweight vehicles?
- **Definition**
 - What do we mean by lightweight?
- **Concerns**
 - What are the problems?
- **Proposal**
 - Benefits society, producer and consumer

Hybrid & Electric Vehicle TCP



Target audience

- Governmental bodies at national, regional and city levels
- Automotive industry
- Component suppliers
- Utilities



Policy Drivers

Mega trends

Emissions

Urbanization

Peak-Oil

Emissions

- 90% of all EU transport emissions due to road transport
- Transport sector has to reduce 60 % of its CO2 emissions by 2050 (cf.1990)

Peak Oil

- Oil accounts for 94% of transport fuels
- EU import bill of up to one billion Euros a day

Urbanisation

- Air quality and congested infrastructure
- Health issues related to ambient air quality (NOx, PM emissions)

New and clean forms of mobility need to be established

What is an SEV?

EU – L5e to L7e

US – LSV or MSV

Japan – Kei or Micro Mobility

Korea – LSEV or Light Vehicle
(or even M1 passenger car?)



➤ Scope for SEV is large and multifarious

Regulatory Requirements

Policy: Casualty Reduction / Environmental

- Vehicle – (minimum) performance requirements
- User – Licensing requirements
- Infrastructure – Access limitations

Impacts: Emissions / Injuries / Economic Activity

Concerns

**CRITICAL STRUCTURAL
SHORTCOMINGS AND
INADEQUATE RESTRAINT
SYSTEMS ADD UP TO
UNACCEPTABLY HIGH RISKS
OF FATAL OR SERIOUS
INJURY, EVEN AT MODERATE
TEST SPEEDS.**

source: www.EuroNCAP.com

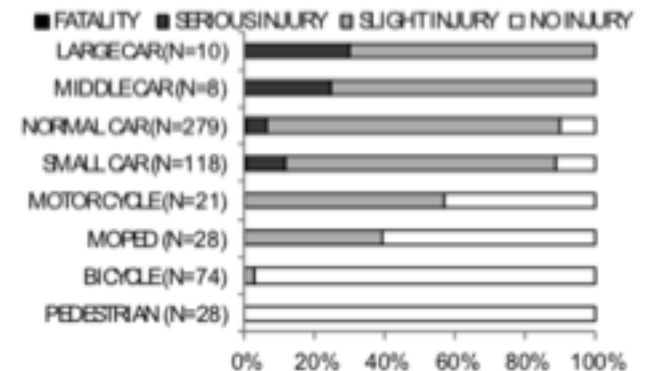
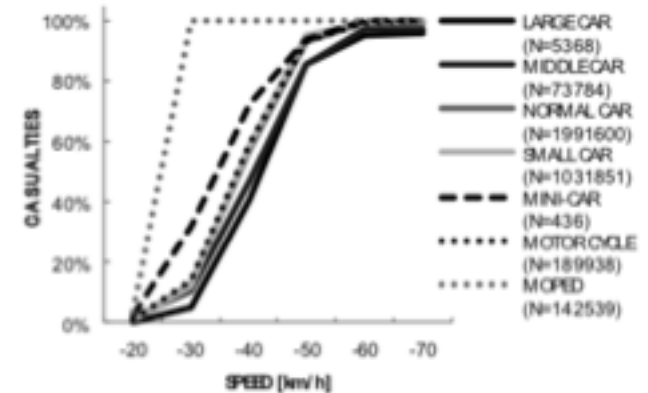
“I hear NCAP implying that those who walk, cycle, ride, or use a 3-wheeler must not seek a safer alternative in the quadricycle; they must continue as they are until they can afford a high emission, low mileage, congestion causing car instead”

Rajiv Bajaj

Management of Impacts

Adopt mature regulatory regimes?

- Evolved based on defined vehicle type
 - Operational requirements; Accidentology
 - Less efficient vehicles
- Different demands > Alignment still unclear
 - Operation - low speed / urban
 - Market - costs cf. volume
 - Accidentology - circulation / risk



Occupant of mini car

Study of Traffic Accidents with Micro Mobility: Analysis Using Traffic Accident Data - Ryo Oga et al (2013)

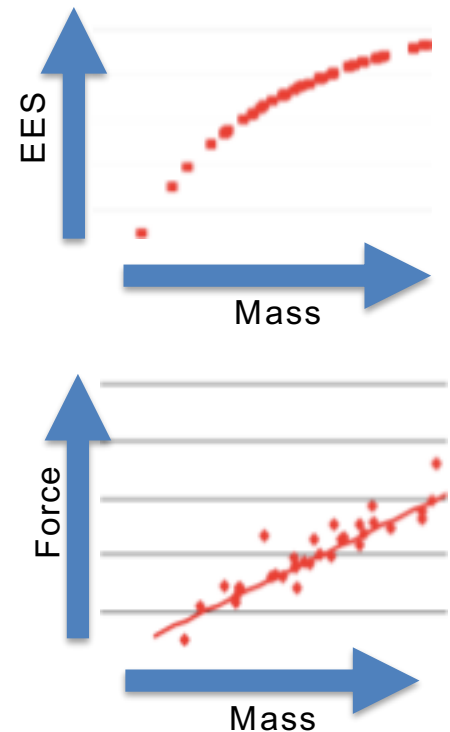
Proposal - Frontal Impact

Offset Deformable Barrier Impact?

- Reduction in EES with vehicle mass
 - Lower protection single vehicle accident
- Reduction in frontal force with vehicle mass
 - Lower protection in vehicle to vehicle accident
- Acceleration not representative
 - Lower protection in vehicle to vehicle accident

Full Width Barrier Impact?

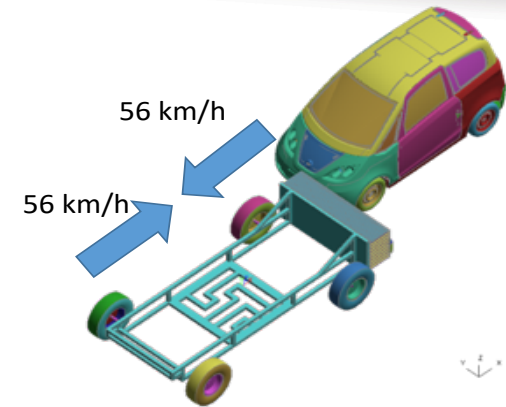
- Higher accelerations
 - Responds to restraint related injuries
- Compartment strength still an issue
 - Crash energy linked to vehicle mass



Proposal - Frontal Impact

Compatibility test

- L-category vehicle against a 950kg deformable barrier
- Standard side impact test barrier (as per UNECE R95)
- Only intrusions will be monitored (<30mm)



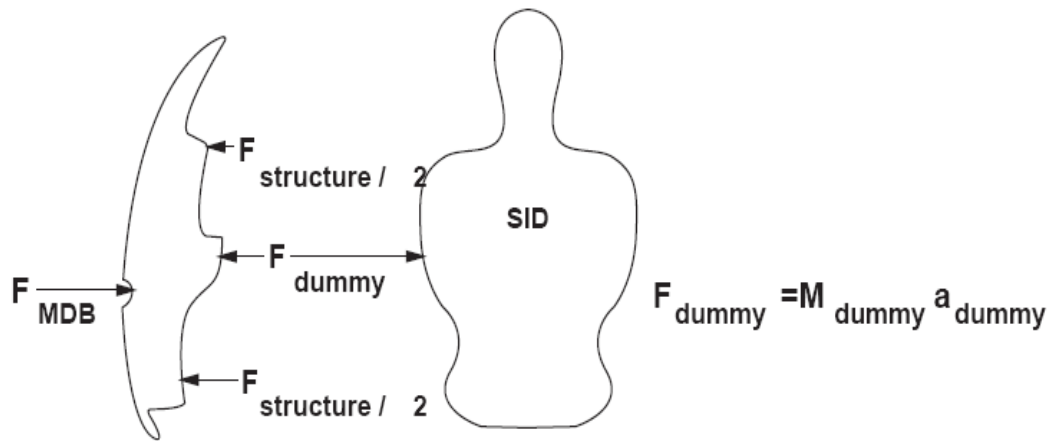
ODB

- EES for a 450kg vehicle in an ODB test would be 46km/h
- Crash energy of 55kJ (absorbed 37kJ car and 18kJ barrier)
- ODB test the ride-down distance is 0.66m
- **Compartment force would be 112kN**

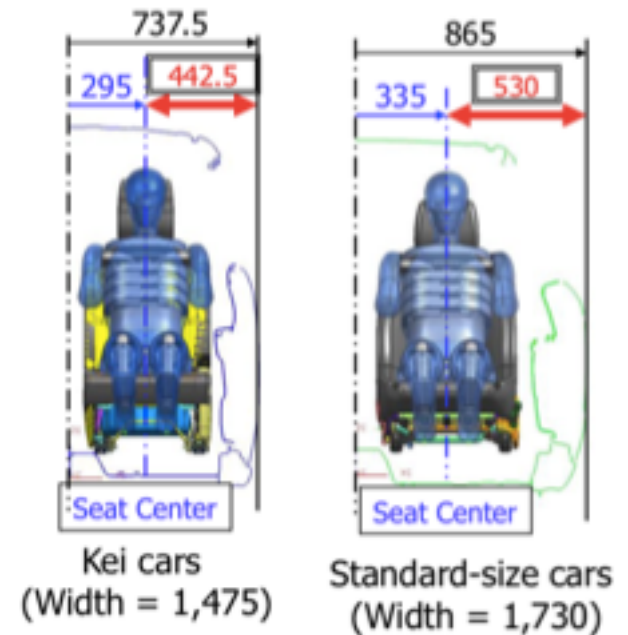
MBD

- Crash energy 171kJ (pre-impact 116kJ MDB and 55kJ car)
- Energy absorbed by the barrier is 30kJ
- Post impact energy 21kJ (conservation of momentum).
- **Compartment force would be 364kN**

Proposal - Side Impact

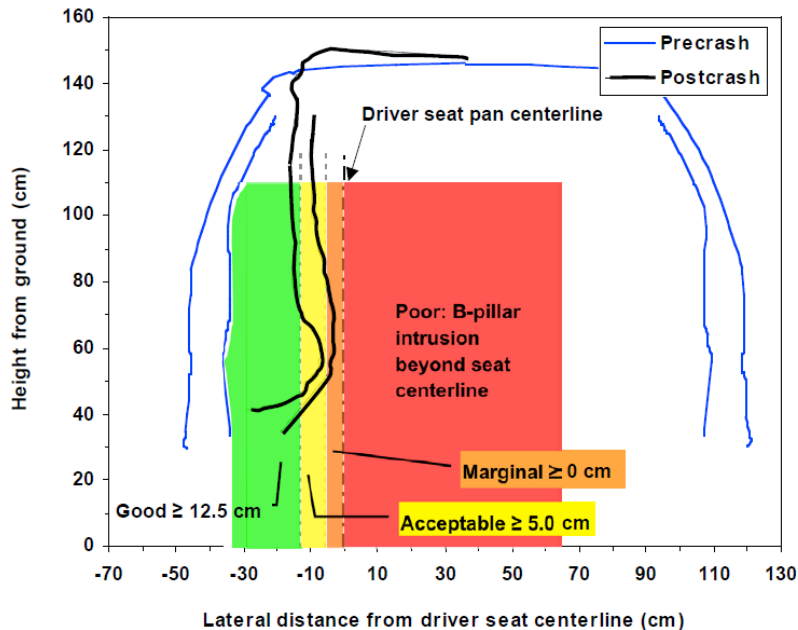


$$F_{dummy} = F_{MDB} + \frac{d}{dt} [M_{door} v_{door}] - F_{structure}$$

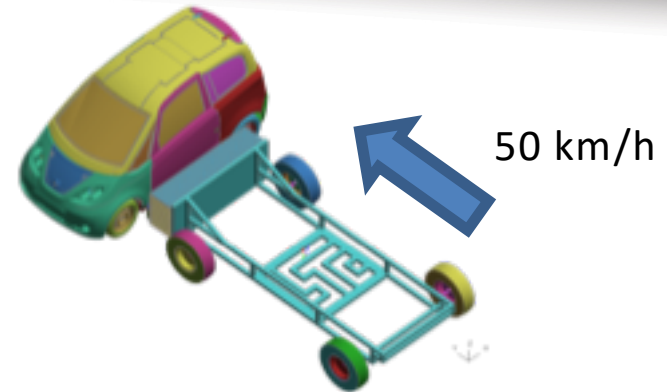


Japanese Proposal and Research Plan, JASIC, 2011

Proposal - Side Impact



IIHS Side Impact Test Intrusion Recommendations



- UNECE 95 side impact test scenario
- ODB of 950kg, impacting at 50km/h
- Pass / fail criteria based on intrusions proposed by IIHS

Proposal

Representative crash configuration

- Evaluation of compartment strength - survival space
- High acceleration pulse representative of car-to-car accidents

What is the role for simulation and biomechanics

- Understanding occupant response to higher accelerations (esp. frontal)
- Adaptation and evaluation of restraints systems (mitigate outcome)

Pedestrian and Active Safety

- Performance targets based on operational requirements
- Adjustment to crash standards as appropriate

Small Electric Vehicles

- Consumer: provide additional mobility solution
 - Tailor SEV offer towards consumer needs
 - Regulate as part of a system (product, user, infrastructure)
- Society: meet policy objectives of emissions and safety
 - Lower energy consumption and space utilisation
 - Proposed safety assessment
 - Based on operational requirements
 - Based on accidentology
- Producer: alignment between costs and benefits
 - Alignment of cost (regulatory compliance) and volume

Thank You

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