ACCELERATION SPEED COMPENSATION [ASC]

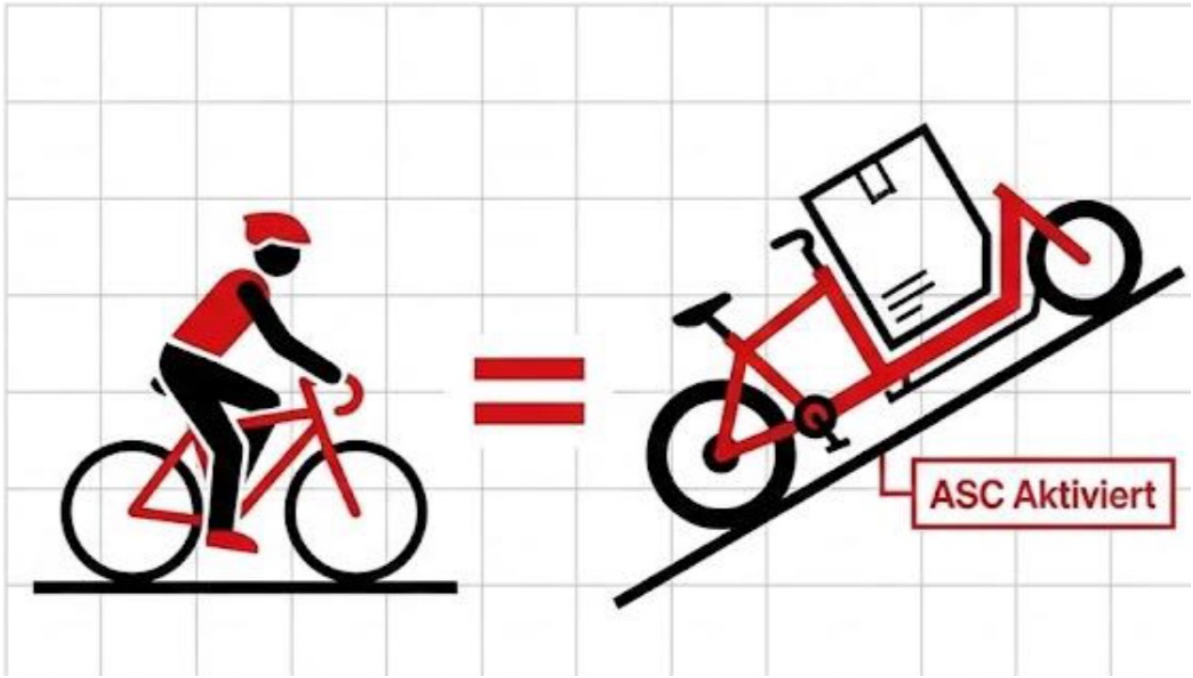
Harmonizing the driving experience for logistics, Families and inclusive mobility.

adfc
Allgemeiner Deutscher Fahrrad-Club

The core philosophy: "A bicycle is a bicycle"

The defining feature of a bicycle is its intuitive response to human effort. Current regulations interrupt this experience when significant weight or inclines are added.

- A heavy cargo bike, family bike, or adaptive bike must behave like a standard bike on flat ground.
- It must maintain the same uphill handling and transparently compensate for weight and incline.



Physics is the same for everyone: the driver's input should provide a predictable result, regardless of the vehicle's mass.

The Physics Gap: Why Fixed Performance Limits Fail

Current regulations focus on the rated power of the engine. Physics dictates that a 650 kg vehicle requires significantly more power than a 60 kg vehicle to move safely against gravity. ❌ Red Cross are unsafe conditions.

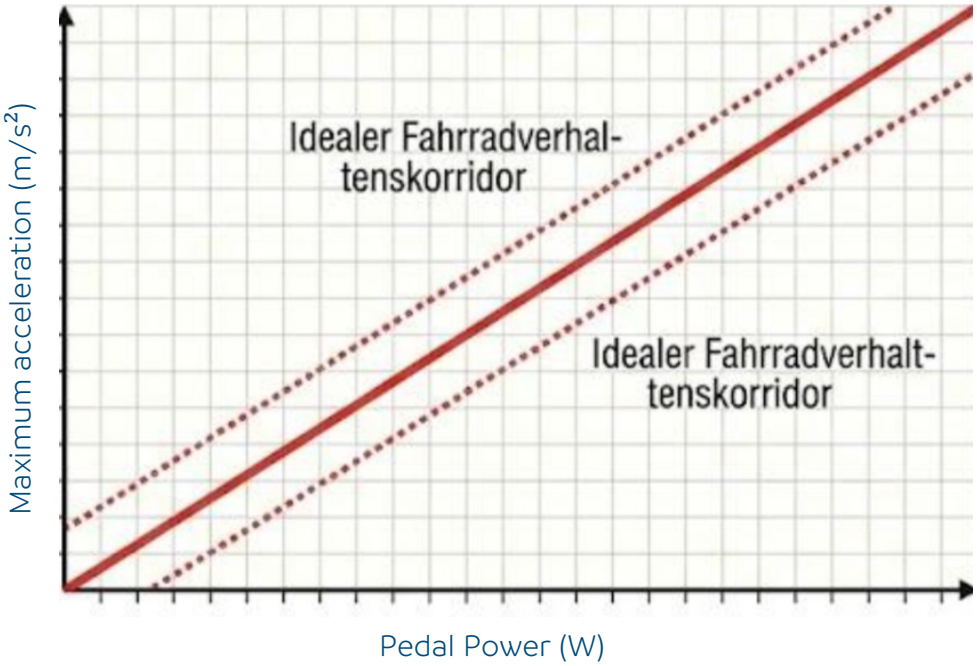
Proposal: maximum 750 W Motorpower plus 100 W pedaling power

	Pedelec: 60 kg	Cargo bike: 300 kg	Cargobike: 650 kg*
Total weight			
Flat ground	Speed after 2 sec acceleration ❌ **25.3 km/h**	Speed after 2 sec acceleration ✅ **10.7 km/h**	Speed after 2 sec acceleration ❌ **7.1 km/h**
	Maximum speed with motor ✅ **25 km/h**	Maximum speed with motor ✅ **25 km/h**	Maximum speed with motor ✅ **25 km/h**
10% Incline	Speed after 2 sec acceleration ✅ **20.5 km/h**	Speed after 2 sec acceleration ❌ **6.7 km/h**	Speed after 2 sec acceleration ❌ **3.5 km/h**
	Maximum speed with motor ✅ **25 km/h**	Maximum speed with motor ✅ **25 km/h**	Maximum speed with motor ❌ **4.4 km/h**

* not provided for in the ZIV regulation

Introduction of ASC (Acceleration Velocity Compensation)

A dynamic control system in which the motor assistance is regulated by acceleration and speed in relation to the rider's input, not by arbitrary fixed power limits.



The mechanism

-Linearization: Creates a linear relationship between pedal power (watts) and acceleration.

-Compensation: Automatically compensates for vehicle mass, slope and headwind.




Critical importance for parcel logistics

Context:

The last mile is shifting from delivery trucks to heavy cargo bikes.

Stakeholders:

Urban delivery fleets, e.g. Post, Amazon, UPS, ...

Operational reality:

- Vehicles weigh 300 kg to 600 kg when loaded.
- Have to negotiate steep entrance ramps and urban hills.
- Current fixed limits (250W/750W) make these routes impossible.

ASC Advantage:

Enables the replacement of diesel/electric vans by guaranteeing that fully loaded bicycles can handle inclines.

Strengthening Inclusion & Municipal Services

Inner-city services

Gardening (e.g., stem), municipal maintenance.

Pulling equipment trailers requires high torque compensation, which fixed limits cannot provide.

Inclusive mobility

Target group: Family transport, older drivers, adaptive cycling.

The injustice: A driver with physical disabilities produces fewer watts, but deserves the same mobility range.

The ASC solution: Normalizes the input. A lower physical input of 35 W still results in a safe standard output speed (e.g. 15 km/h), which removes the physical barrier.

Technical Proof: The Mubea ASC Implementation

ASC was successfully implemented on a Mubea cargo bike with the Movaria drive system and tested in the field.

Test scenario: 4% incline (Parking garage ramp)	
Vehicle: Heavy cargo bike	
Result with fixed power limit (750W):	**Result with ASC control:**
4.4 km/h	**17 km/h**
(Unstable, barely balancing)	(Safer, constant traffic flow)

ASC is open to all technologies and can be retrofitted if necessary.

Robust design logic

Input

- Driver torque (± 5W)
- Speed (± 0.1 km/h)

Processing

- Average over 1 second (filter)
- Linearization algorithm

Rules

- PID Controllers
- Ramp functions (anti-jerk)
- Predictive Damping

Output

- Motor current / torque
- Result: Digital flywheel effect

The system uses predictive damping to prevent overshoot and ramp functions to smooth out the launch, creating a natural mechanical feel.

Regulatory proposal: Amendment of EU 168/2013

Objective: Add an exclusion criterion for vehicles with ASC-based limiting.

h) Bicycles with pedal drive and electric motor assistance, where the motor assistance
- stops when the rider ceases to pedal,
- is not abruptly engaged and disengaged, and
- increases proportionally to the pedaling power.
- occurs only up to a limit depending, in each case, on the pedaling power (P_T), for
  a) increase in speed in 2 seconds (a_{max}). This amounts to, at a pedaling power of:

$$0 \text{ to } 210 \text{ W} \rightarrow \quad a_{max}\left[\frac{km}{h \cdot 2s}\right] = 3{,}0\left[\frac{km}{h \cdot 2s}\right] + 0{,}0379\left[\frac{km}{h \cdot 2s \cdot W}\right] * P_T \ [W]$$

$$> 210 \text{ W} \rightarrow \quad a_{max}\left[\frac{km}{h \cdot 2s}\right] = 7{,}5\left[\frac{km}{h \cdot 2s}\right] + 0{,}0165\left[\frac{km}{h \cdot 2s \cdot W}\right] * P_T \ [W]$$

  b) maximum speed V_{max}. This amounts to, in the range of

$$0 - 25\left[\frac{km}{h}\right] \rightarrow \quad V_{max}\left[\frac{km}{h}\right] = 9{,}0\left[\frac{km}{h}\right] + 0{,}163\left[\frac{km}{h \cdot W}\right] * P_T \ [W]$$

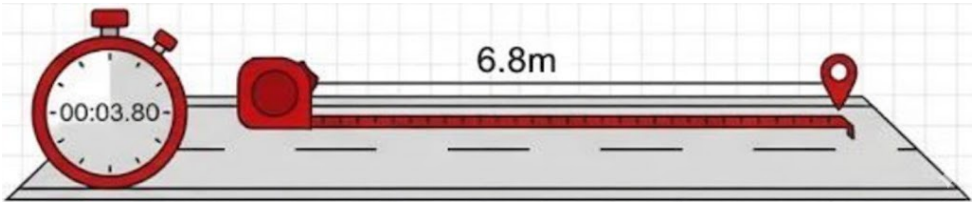
$$> 25\left[\frac{km}{h}\right] \rightarrow \quad V_{max}\left[\frac{km}{h}\right] = 25{,}0\left[\frac{km}{h}\right]$$

Simplified enforcement & anti-tuning

The Challenge

The measurement of the 'Nominal Continuous Power' (250W) requires complex thermal tests in the laboratory. Tuning is difficult to see on the side of the road.

The ASC Solution: The Stopwatch Test

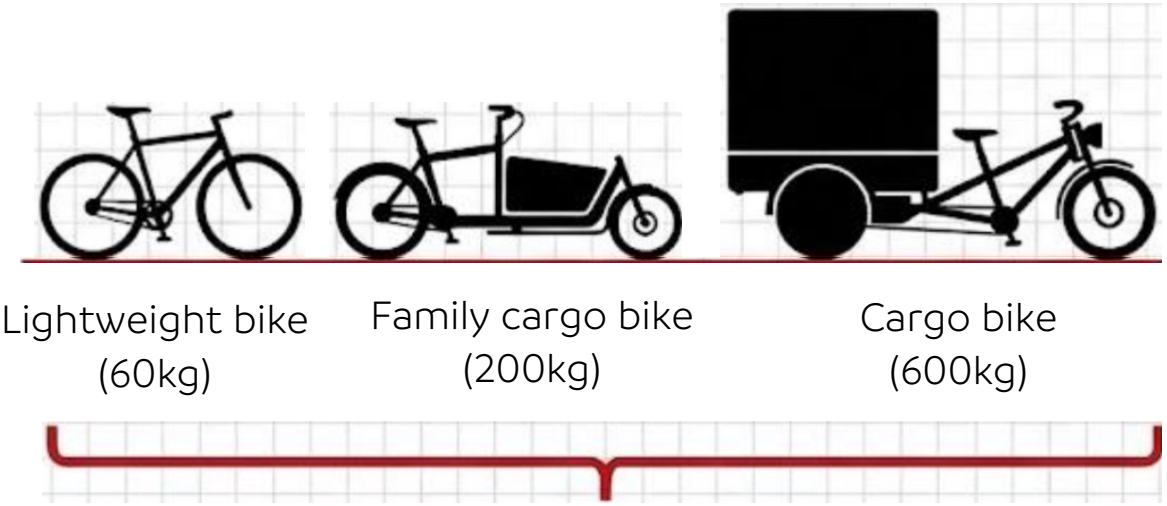


Field Test Protocol:

1. Driver inputs light pedaling (about 100W).
2. Time: 3.8 seconds.
3. Distance limit: Max 6.8 meters.

Conclusion: If the bike exceeds this distance, it is tuned. This verifiable physical behavior makes unauthorized tuning immediately recognizable.

Tapping into the mobility revolution



A Safety Philosophy (ASC)

Scalability: The industry can scale from 60 kg to 600 kg, without regulatory fragmentation.

Safety: Dynamic, physics-based controls replace arbitrary power caps.

Inclusion: Democratizes mobility for the elderly and disabled.

ASC allows the 'bicycle' to become the primary urban mode of transport without losing its soul – or its safety.