Wind Tunnel Method (OIT #10 and #18)

Requirements for the flatbelt
Realistic measurements of the whole mechanical drag of a car under defined climate terms and conditions.

To receive the complete road load of the car, the aerodynamic drag is added to the mechanical drag from the flatbelt.

\[
F_{\text{vehicle}} = F_{\text{mechanical}} + F_{\text{air}}
\]

\[
F_{\text{air}} = \text{calculated from wind tunnel Measurement}
\]

\[
F_{\text{mechanical}} = \text{measured on flatbelt}
\]
Explanation of the Measuring Principle

- Each belt unit is mounted drag free against the environment by air bearings.
- The reaction forces of the car is measured over the whole unit against the environment.

Requirements:
→ Only the reaction force for rotating the wheels shall be measured
→ No external forces shall be included in the result (e.g. air force of the cooling fan, vehicle restraints, aerodynamic reaction forces of the flatbelt, etc.)
   Only exception: Wind tunnel facilities with integrated flatbelts for measuring running resistance. Here, the measurement of the whole road load by one test is possible (these facilities do not exist today).
→ The measurement shall be done in the same conditions like on the road (engine on, idling speed, neutral gear “N”)
**Explanation of the Measuring Principle**

**Requirement:**

→ Brake conditioning: See description for the coast down on the road (see 4.2.4.1.1.).

→ Vehicle warm up:
  
  a) See description for the coast down on the road (active driving, see 4.2.4.1).
  
  b) On manufacture’s request: By driving the flatbelt with the vehicle installed at \([110]\) per cent of the maximum speed of the applicable WLTC for at least 1200 s until the change of measured force over a period of 200 s is smaller than \([5 N]\) (see step 1).

→ Force measuring (see step 2): stepping down at constant speed with \([\Delta v = 10 \text{ km/h}]\) for at least [10 s]. After a stabilization of [4 s], measure the average force at the constant reference speed for at least [6 s].
Calculating Road Load Coefficients

Aerodynamic force:
\[ F_{Aj} = (c_d \times A_f_j) \times \frac{\rho_0 \times v_j^2}{2 \times 3.6^2} \]

Mechanical force (measured on flatbelt):
\[ \sum \text{mechanical drag from each wheel} \]

Total road load:
\[ \sum \text{mechanical drag + aerodynamic drag} \]

Requirement:
\[ \rightarrow \] Measuring \( c_d \times A \) in wind tunnel as defined in 6.4.
\[ \rightarrow \] Calculate the aerodynamic force (see 6.7.2.)
\[ \rightarrow \] Adding the aerodynamic force by calculation to the measured force from the flat belt to receive the total road load of the car
\[ \rightarrow \] Calculate the road load coefficients \( f_0, f_1, f_2 \) with a least squares regression analysis and use these parameters as target coefficients in paragraph 8.1.1.

Road Load Coefficients
\[ f_0 \ [N] \quad 117,3 \]
\[ f_1 \ [N/(km/h)] \quad 1,32 \]
\[ f_2 \ [N/(km/h)^2] \quad 0,0224 \]