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Methods of brake efficiency evaluation for heavy duty vehicles in Slovakia

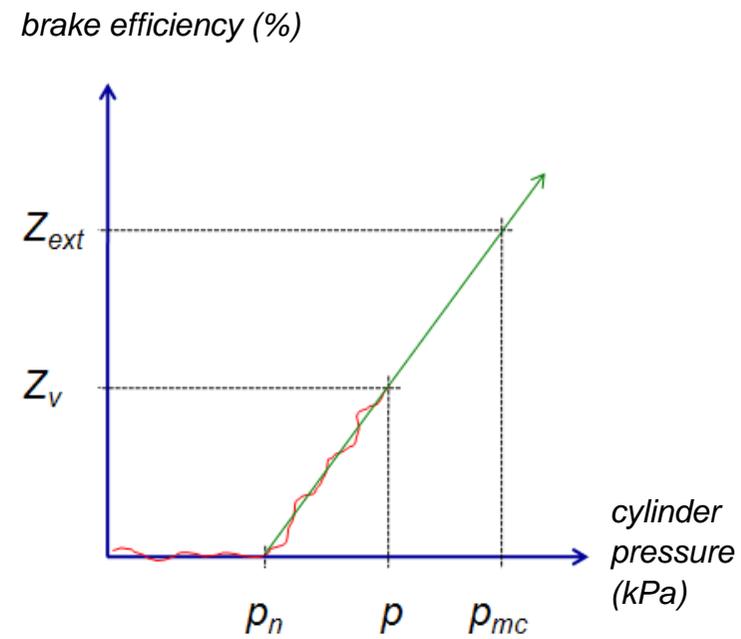
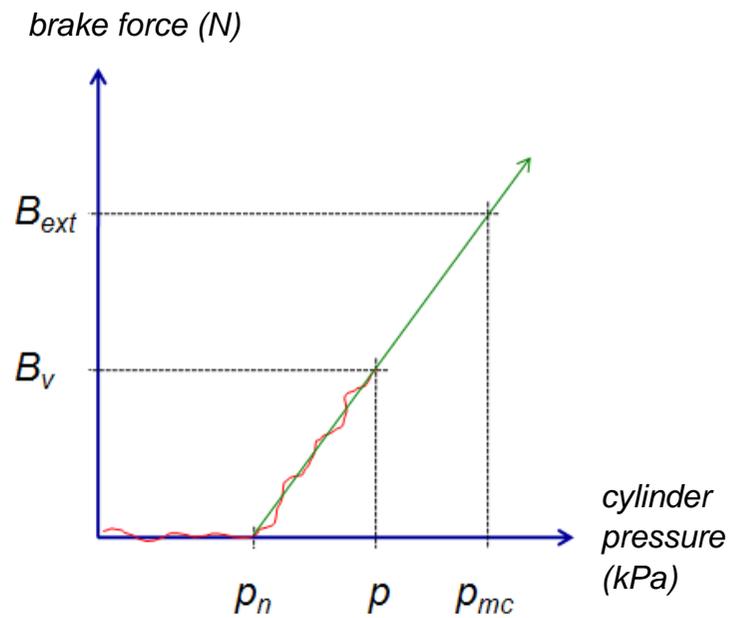
Methods of brake efficiency evaluation for heavy duty vehicles in Slovakia



For purposes of the periodic technical inspection (PTI) one of following two methods must be applied:

- Two point extrapolation (preferred)
- Direct evaluation on the empty vehicle (if there is no possibility for extrapolation)

Two point extrapolation method - Principle



$$Z = \frac{\sum B_v}{m \cdot g} \cdot 100\%$$

Two point extrapolation method - Symbols



- p_{mc} - maximum pressure in brake circuit (kPa)
- p_n - brake actuator threshold pressure (kPa)
- p - cylinder pressure at wheel slip (kPa)
- B_v - brake force immediately before wheel slip (N)
- B_{ext} - extrapolated brake force (N)
- Z_v - brake efficiency at wheel slip (%)
- Z_{ext} - extrapolated brake efficiency (%)

Two point extrapolation method - Procedure



1. measuring cylinder pressures and brake forces on roller brake tester, measured values are sent via internet to the central information system, stored and printed out on the inspection report at the end of the PTI
2. calculation of the extrapolation coefficients i_i (-), for each axle separately:

$$i_i = \frac{p_{mci} - p_{ni}}{p_i - p_{ni}}$$

p_{mci} - max. pressure in brake circuit corresponding with the axle (kPa)

p_{ni} - brake actuator threshold pressure in brake circuit corresponding with the axle (kPa)

p_i - cylinder pressure at wheel slip in brake circuit corresponding with the axle (kPa)

Two point extrapolation method - Evaluation



3. calculation of the extrapolated brake efficiency Z_{ext} (%):

$$Z_{ext} = \frac{\sum B_{v1} \cdot i_1 + \sum B_{v2} \cdot i_2 + \dots + \sum B_{vn} \cdot i_n}{m_g \cdot g} \cdot 100\%$$

where:

- B_{vi} , $i=(1,2,\dots,n)$ - brake force (N) at p_i , $i=(1,2,\dots,n)$
- m_g - gross vehicle weight (kg)
- g - acceleration of gravity ($m \cdot s^{-2}$)

4. calculated brake efficiency is compared with reference value according to national regulation (corresponding with 96/96/EC)

$$Z_{ext} \geq Z_{reference}$$

Direct evaluation on the empty vehicle



Can be applied only when two point extrapolation method can not be used (e.g. there is no possibility to measure pressure due to the missing test connections)

Evaluation:

If during the test on roller brake tester each wheel is able to lock, the brake efficiency can be considered as sufficient.

Direct evaluation on the empty vehicle



If any wheel does not lock, following formula is used to calculate brake efficiency (without extrapolation) which is then compared with reference value according to national regulation (corresponding with 96/96/EC)

$$Z = \frac{\sum B_{vi}}{m \cdot g} \cdot 100\%$$

where: B_v - sum of all brake forces (N)
 m - current vehicle weight (kg)
 g - acceleration of gravity ($m \cdot s^{-2}$)

Comments to NON-PAPER on Inspection of vehicles in categories L, M, N and O - ANNEX II of Directive 96/96/EC



par. 1.2.2:

Vehicles with a maximum permissible mass exceeding 3500 kg will have to be inspected loaded. As an alternative a test of not loaded vehicle with simulation of a realistic load condition is proposed.

Currently there are no inspecting stations equipped with roller brake testers with load simulating device in Slovakia. Vehicles are inspected without any load and the 2-point extrapolation calculation is used to prove the braking efficiency.

An upgrade of the current inspecting stations equipment all over the country would be expensive. It would involve not only the installation of the hydraulic load simulators but also necessary reinforcement of the inspecting pit grounds.

Can the numeric extrapolation be seen as a relevant simulation method of realistic load condition? If not, we propose to add as an alternative to the test of not loaded vehicle with simulation of a realistic load condition also the extrapolation calculation proving the braking efficiency.