When is it necessary to synchronize a tractor-trailer combination?

The tractor-trailer combination must be synchronized if the braking forces are not evenly attributed to the motor vehicle and its trailer or, in the case of single vehicles, to its axles. This usually becomes apparent when brake lining wear is uneven, if the trailer runs up to the towing vehicle, or if there is a tendency to lock on individual axles.

Which load is advisable?

A tractor-trailer combination can be synchronized on the laden or unladen vehicle. It is, however, advisable to do this when the vehicle is fully laden since great masses are particularly relevant in terms of wear. This also offers the advantage of being able to measure the braking forces on the roller dynamometer even at high pressures (full brake application) which makes defects particularly easy to detect. For this reason, we are now looking at a “laden tractor-trailer combination“.

Basic Requirements for Synchronizing a Tractor-Trailer Combination

For successfully synchronizing a tractor-trailer combination, all components of the braking system must be in good working order. Newly lined wheel brakes (linings and drums) must have been run in for at least 600 miles.

If unsatisfactory braking performance or wearing behaviour are perceived in operation, the wheel brake should be visually inspected and functional testing performed on the components of the air braking system before effectivity is tested on the roller dynamometer, or before making any changes.

Visual Inspection of the Wheel Brakes

Following parameters sholud be checked:

- condition of brake drums
- condition of brake linings (look for lining quality and release by axle manufacturer)
- freely moving brake shoes and brake shafts
- Condition and numbers of release springs
- settings of the wheel brakes (venting slackness)
- size of brake cylinders
- effective brake lever lengths

Functional Testing of Components of the Air Braking System

Points to bear in mind:

- response behaviour of brake and control valves
- gradability of valves
- pilot pressure settings
- settings of adapter valves, pressure limiting valves
- settings of load-sensing valves according to their reference plate (unladen/laden)

It is only when these have been examined and any adjustments and repairs have been done that effectiveness tests and synchronization are performed on the roller dynamometer - unless the initial condition of the vehicle must be documented for the purpose of assessing problems.

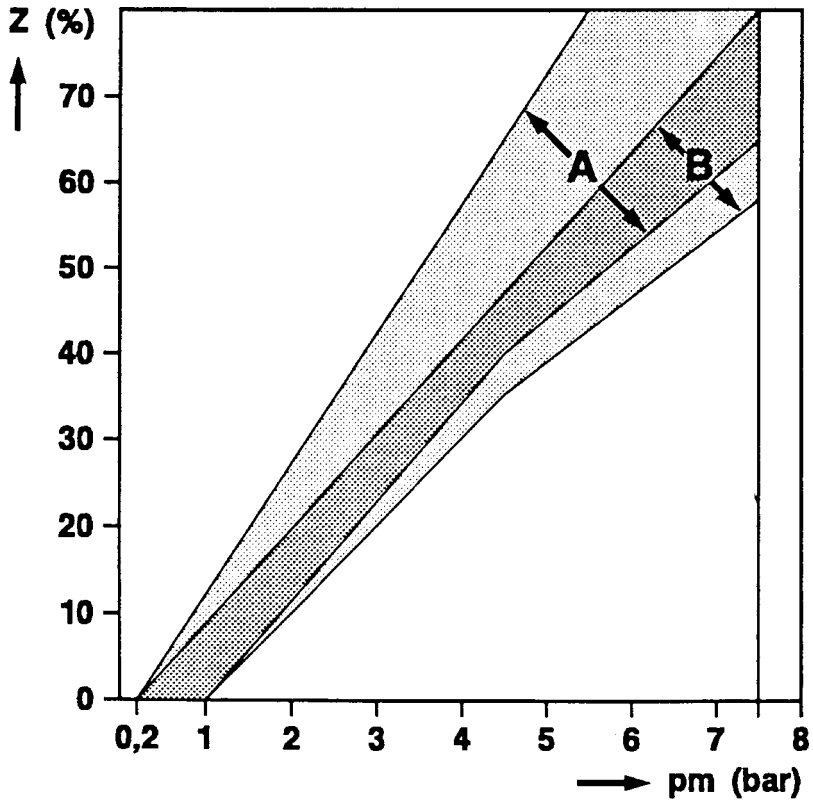
EC Braking Bands

The braking performance of both vehicles must be assessed from a neutral point. This point is the **"control" hose coupling** where the brake pressure $\mathbf{p_m}$ is input to the trailer. This actuating pressure $\mathbf{p_m}$ is also used as a "neutral point of reference" between the motor vehicle and its trailer.

The braking performance of each vehicle is shown in a braking diagram which applies to both parts of the tractor-trailer combination. For both the motor vehicle and the trailer, this braking diagram shows the relation between the retardation **z** and the pressure $\mathbf{p_m}$ at the "control" hose coupling (yellow). **The braking band** defined by the EC Council's guideline stipulates the range in which retardation **z** must lie at a certain pressure $\mathbf{p_m}$.

For the braking bands, the EC guideline distinguishes between the following tractor-trailer combinations: lorries with (towbar) trailers, and semitrailer-tractors with semitrailers, and between the "laden" and "unladen" conditions.

EC Band Lorry and Trailer



z = retardation in %
p_m = pressure at the "control" hose coupling in bar
A = EC braking band "unladen vehicle"
B = EC braking band "laden vehicle"

Objective of Proper Synchronization

When the braking characteristics of the towing vehicle and its trailer are as close to each other as possible within the EC braking band, problems with brake lining wear caused by unfavourable reciprocal effects between the parts of the combination are virtually impossible.

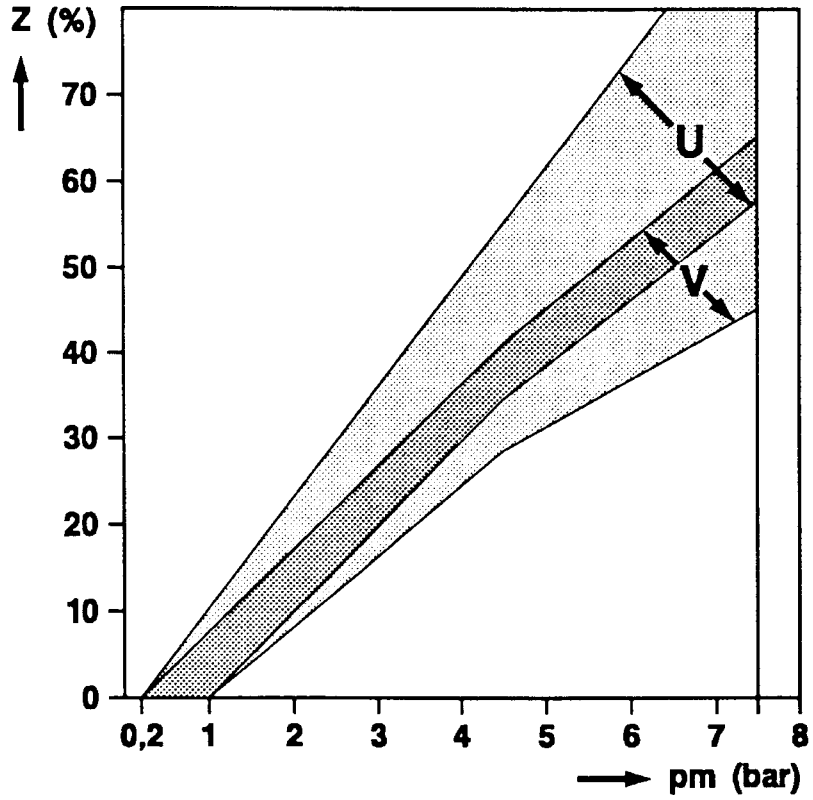
If the braking characteristics of the vehicles are also close to the centre of the applicable EC band, all the vehicles which have been thus synchronized can be used in different combinations without problems with lining wear being likely.

Special Feature for Semitrailer Trains

For the semitrailer-tractor and the semitrailer, separate EC braking bands apply. They take into account the dynamic behaviour in operation since (other than in the conventional tractor-trailer combination) it involves dynamic axle load transfer from the semitrailer to its tractor.

Since, however, that axle load transfer depends on the length and the level of the point of gravity of the semitrailer in question, the EC guideline provides for braking bands for the respective type of semitrailer, taking into account adjusting factors which have to be computed from the so-called basic band. The unadjusted basic band can be used to assess the semitrailer only if it is laden.

EC braking band "semitrailer-tractor laden"



z = retardation in %
p_m = pressure at the "control" hose coupling
U = EC braking band "semitrailer-tractor laden"
V = EC braking band "semitrailer laden"

Procedure for Effectiveness Testing

To test effectiveness, a brake test bench is used. Vehicle and brake manufacturers have developed special test sheets for this purpose (see Annex) in which the measuring results are recorded. First the test weights of both vehicles are established by weighing, and recorded on the test sheet.

For the pressures pm at the “control” hose couplings stipulated on the test sheet (input by using the corresponding brake pedal position), the following are now established for each axle of the tractor-trailer combination, and recorded:

– The wheel brake cylinder pressures p_1, p_2, p_3 ... and

– the brake forces F_1, F_2, F_3 ...

determined and filled into test sheet.

This is followed by the following being computed and recorded on the test sheet:

– total braking force $F_B = F_1 + F_2 + F_3$ ... and

– $\textbf{braking rate z} = \frac{\textbf{total braking force}}{\textbf{vehicle test weight}} = \mathbf{F_B / G_P}$

calculated and entered.

Evaluation of Measured Values

The values for retardation “z” from the test sheet are transferred to the corresponding EC braking diagram, and analyzed.

Of particular interest is the range between 0.5 and 2.5 bar in which approx. 90% of all braking operations take place. Panic braking at higher pressures is so rare that it is not relevant in terms of wear.

Typical Defects

The most frequent causes for complaints we have found are:

– defects on the wheel brakes (stiff cams, flats in the cam lobe, worn-out camshaft bearings, burnt-out release springs),

– defective brake linings, use of unauthorized cheap brake linings or imitation brake drums of doubtful quality,

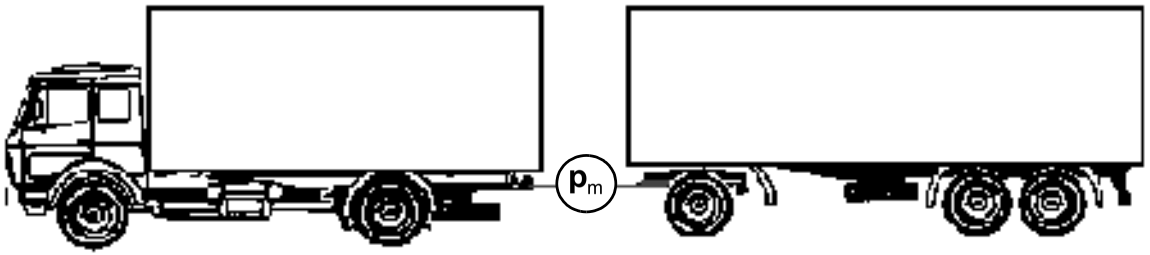
– wrong settings for the automatic load-dependent brake-power proportioning system ALB.

Changing of the Setting of the Air Braking System

Any adjustments of the settings for the air braking system must be kept to within the permissible tolerances. Any changes beyond them require the vehicle manufacturer’s approval.

When making adjustments it is vital that the legal provisions are adhered to.

Workshop: Measurement made by: Name:	Customer: Date: ..... Speedo: ..... (km/h)
Motor Vehicle: ☐ Vehicles ☐ semitrailer-tractor Number of axles:	Manufacturer: ..... Type: ..... Official characteristic: ..... Date of the first admittance:..... Test weight G_p: ..... kg Permitted total weight G_z: ..... kg Trailer control valve: p_{in} = 2.0 bar (test onnector in front of LSV) p_{out} = ... bar (Coupling "Service brake")
Trailer: ☐ Drawbar Trailer ☐ Trailer ☐ Central axle trailer Number of axles:	Manufacturer: ..... Type: ..... Official characteristic: ..... Date of the first admittance: ..... Test weight G_p: ..... kg Permitted total weight G_z: ..... kg Permitted total weight G_z: ..... kg (semi trailer) Predominance trailer emergency valve: p_{in} = 2.0 bar (Coupling Head "Brake") p_{out} = ... bar (test connection at port 2 of the Relay Emergency Valve) Opening Pressure Adaptor valve VA: ..... bar (if avaiable) Performance pressure pressure limiter HA:..... bar (if avaiable)



Towing vehicle Test weight: ..... kg										p_{empty} (bar)	**Towed vehicle** Test weight: ..... kg										
1. Axle			**2. Axle**			**3. Axle**			**Total**			**1. Axle**			**2. Axle**			**3. Axle**			**Total**	
p_1 (bar)	F_1 li (daN)	re	p_2 (bar)	F_2 li (daN)	re	p_3 (bar)	F_3 li (daN)	re	F_B (daN)	z (%)		p_1 (bar)	F_1 li (daN)	re	p_2 (bar)	F_2 li (daN)	re	p_3 (bar)	F_3 li (daN)	re	F_B (daN)	z (%)
											0,0											
											0,5											
											1,0											
											1,5											
											2,0											
											2,5											
											3,0											
											4,0											
											5,0											
											6,5											

Formula:

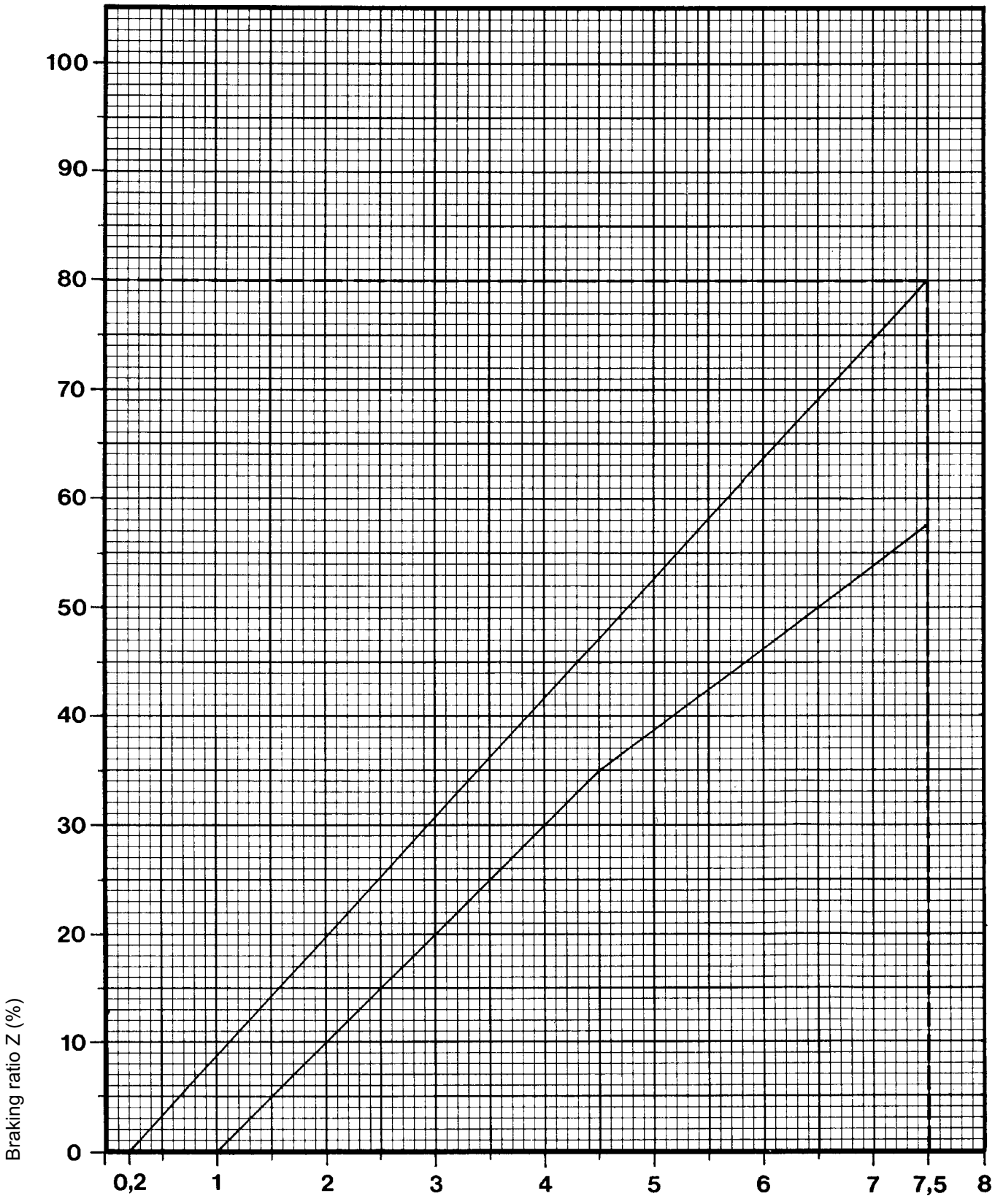
$$z = \frac{F_B}{G_p} \times 100(\%)$$

p_{1-3} = input pressure into the brake cylinders in bar
F_{1-3} = Sum of the braking powers on the axle in daN
p_m = pressure at the “control” hose coupling in bar
z = retardation of the vehicle in %
F_B = Sum of the braking powers in daN
G_P = test weight of the vehicle in kg

EC Band “laden” for Lorry and Trailer

EC braking band for towing vehicles and trailers laden

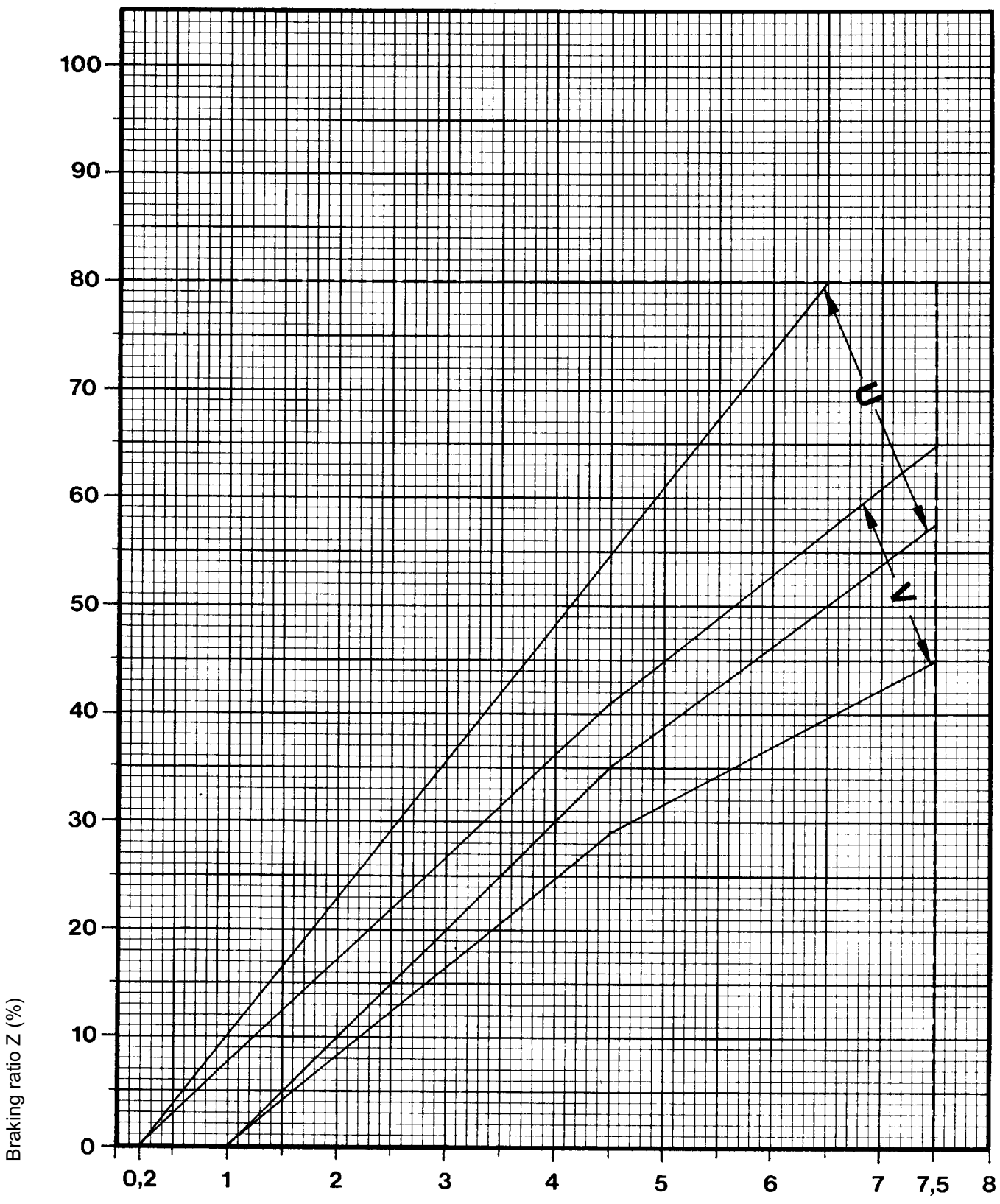
towing vehicle type: .....
Trailer Type: .....



EC braking band "laden" for semitrailer

EC braking band for semitrailer-tractor (U) and laden trailers
EC Basic Braking Band for Trailers (V)

towing vehicle type: .....
Trailer type: .....



1. Vehicle

Undesirable Curve Gradient	Possible Causes:
– too shallow in the upper section	– excessive empty stroke of brake cylinders – mechanical defects in the wheel brake – load-sensing output pressure is too low (see ALB reference plate)
– too high in upper section	– load-sensing output pressure too high (see ALB reference plate)
– too low in lower section	– Stiff transmission parts – Empty-load valve or adapter valve that are not all right (see ALB reference plate)
– too high in lower section	– Empty-load valve or adapter valve that are not all right (see ALB reference plate)
– too low overall	– pilot pressure in trailer control valve (motor vehicle) is too high
– too high overall	– pilot pressure in trailer control valve (motor vehicle) is too low

2. Trailer

Undesirable Curve Gradient	Possible Causes:
– too shallow in the upper section	– excessive empty stroke of brake cylinders – mechanical defects in the wheel brake – load-sensing output pressure is too low (see ALB reference plate) – setting of pressure limiting valve is too low
– too high in upper section	– load-sensing output pressure too high (see ALB reference plate) – setting of pressure limiting valve is too high
– too low in lower section	– Stiff transmission parts – opening pressure of adapter valve is too high
– too high in lower section	– opening pressure of adapter valve is too low
– too low overall	– pilot pressure in relay emergency valve (trailer vehicle) is too low
– too high overall	– pilot pressure in relay emergency valve (trailer) is too high

Please note: When making any adjustments, please follow the vehicle manufacturer's instructions!