Mobilized by WABCO Trailer Solutions

ROJO

This brake calculation report takes into account:

- The legal regulations in the version valid at the time of the brake calculation
- The functional characteristics of the products stored in the program
- The wheel brake data from the available expert opinions of the axle manufacturers
- The vehicle data submitted in writing by the applicant
- A design according to the braking values required in ECE-R13, (EU) 2015/68 or StVZO § 41.

The General Terms and Conditions of delivery apply (see in particular Section 9.0)

Important instructions:

- The applicant/vehicle manufacturer is obliged to verify the actual vehicle data with those of the brake calculation.
- The applicant/vehicle manufacturer must inform ZF of any special requirements of the vehicles produced, according to this brake calculation.
- The applicant/vehicle manufacturer has special requirements that deviate from a standard design, must be informed to ZF.
- The applicant/vehicle manufacturer has an obligatory field-observation and must keep ZF informed in writing of any abnormalities.

Special operating conditions may require modified brake calculation. ZF must be informed accordingly.
Approval countries with specific requirements regarding the required deceleration values require modified brake calculations and must be informed to ZF.
Use with a low axle load and low braking frequency such as the predominant use of tractors with retarders influences the pairing of the coefficient of friction. If the applicant/vehicle manufacturer is aware of such use of the vehicles, ZF must be informed. In the road test, the applicant/vehicle manufacturer must check compliance with the legal regulations using the selected brake calculation and under these special conditions.

Summary

Brake calculation number:	WES-00163
Manufacturer:	ROJO
Trailer model:	R GPN 2+3
Author:	Manuel.Frutos
Trailer type:	5-axle-full-trailer
Distribution:	ROJO
Directive:	UN/ECE-R.13.11

Brake system:	Trailer EBS
Assembly:	Front: Air/ Hydraulic/ VA Suspension Rear: Air/ Hydraulic/ VA Suspension
Axle test reports:	Axles 1 - 5: SAF, TDB 0882 ECE, SNK 300x200S
Brake cylinders:	Axles 1 - 2: WABCO, 30, BC 0030.0 Axles 3 - 5: WABCO, 30/30, BC 0024.1
Tire designations:	Axles 1 - 5: 245/70 R 17,5

Summary:	Air brake system is calculated according to the Directive.

Notes:

			Empty	**Laden**
Axle 1	P1	[kg]	2520	12000
Axle 2	P2	[kg]	2520	12000
Axle 3	P3	[kg]	2520	12000
Axle 4	P4	[kg]	2520	12000
Axle 5	P5	[kg]	2520	12000
Total axle mass	PR	[kg]	12600	60000
Centre of gravity height	h	[m]	0.8	1.8
Wheel base	E	[m]	7.592	7.592

Trailer may only be operated in combination with trucks or tractors with ISO 7638 supply (5 or 7 polar).

1 Detailed vehicle data

		Axle 1	Axle 2	Axle 3	Axle 4	Axle 5
No. of brake chambers	KDZ	2	2	2	2	2
Brake chamber manufacturer		WABCO	WABCO	WABCO	WABCO	WABCO
Brake chamber test report no		BC 0030.0	BC 0030.0	BC 0024.1	BC 0024.1	BC 0024.1
Brake chamber size		30	30	30/30	30/30	30/30
Brake chamber part number		423 107 90. 0 423 107 96x 0	423 107 90. 0 423 107 96x 0	925 377 000/001 0 925 377 1.. 0	925 377 000/001 0 925 377 1.. 0	925 377 000/001 0 925 377 1.. 0
Lever length	lBh in mm	140	140	152	152	152
Brake factor	-	7.5	7.5	7.5	7.5	7.5
Smallest tire - dynamic radius	r_{min} in mm	383	383	383	383	383
Largest tire - dynamic radius	r_{max} in mm	383	383	383	383	383
Threshold torque	C_0 in Nm	30.0	30.0	30.0	30.0	30.0

2 Air Reservoir capacity calculation

Compliance with the regulations must be checked by measuring the finalised vehicle. This is possible with a CTU test (Conformity Test Unit). Please consult with your contact person within ZF for more information about the CTU test.

Calculation for Air reservoir capacity is made under the assumption that the brake cylinder line length is equal to 3.0 meter with inner diameter of 13.0 mm and the control line has a length of 15.0 meter with an inner diameter of 8.0 mm. The calculated capacity is ZF recommendation for standard trailers. Validation is the responsibility of the trailer manufacturer.

Type of brake:		Drum
Total number of brake cylinders:	[-]	10
Total number of cycles tested:	[-]	13
Target residual pressure:	[bar]	3.0
Calculated tank volume:	[l]	230

3 Braking system

This section shows the braking system and diagram.

Brake diagram:	None
Maximum pressure:	8.5 bar

Braking system and valves per axle. For each valve the following information is shown: Part number, manufacturer and the type of the valve

	Valve 1	Valve 2
Axle 1	971 002 9.. 0 WABCO Relay-emergency valve	480 207 0.. 0 480 207 2.. 0 WABCO EBS-relay valve
Axle 2	971 002 9.. 0 WABCO Relay-emergency valve	480 207 0.. 0 480 207 2.. 0 WABCO EBS-relay valve
Axle 3	971 002 9.. 0 WABCO Relay-emergency valve	480 102 ... 0 WABCO EBS modulator valve
Axle 4	971 002 9.. 0 WABCO Relay-emergency valve	480 102 ... 0 WABCO EBS modulator valve
Axle 5	971 002 9.. 0 WABCO Relay-emergency valve	480 102 ... 0 WABCO EBS modulator valve

Notes

- For iEBS; Park Release Emergency Valve (PREV 971 002 9.. 0) is replaced by Park Release Valve PRV (971 003 ... 0).

4 EBS input data

Manufacturer:	ROJO
Trailer model:	R GPN 2+3
Trailer type:	5-axle-full-trailer
Brake calculation number:	WES-00163
Tire circumference main axle:	2406
Tire circumference auxiliary axle:	2406
Assignment p_m / deceleration (z) (Laden state)	p_m 0.8 bar z = 0.01 p_m 2.0 bar z = 0.154 p_m 6.5 bar z = 0.596

	P_n **Empty**	p_m **6.5 bar**	P_n **Laden**	p_m **0.8 bar**	p_m **2.0 bar**	p_m **6.5 bar**
Axle 1	2520	1.8	12000	0.3	1.9	6.7
Axle 2	2520	1.8	12000	0.3	1.9	6.7
Axle 3	2520	1.8	12000	0.3	1.8	6.5
Axle 4	2520	1.8	12000	0.3	1.8	6.5
Axle 5	2520	1.8	12000	0.3	1.8	6.5

Note: Bellow pressure in empty and loaded state must be filled in by manufacturer

As can be seen from the table above, the empty values are for the basic parameter set. Higher empty axle loads and lifting axles are automatically recognized and do not require separate adjustment. The above empty axle loads must not be fallen below.

Axle 1		**Axle 2**		**Axle 3**		**Axle 4**		**Axle 5**	
Axle load (kg)	p_{cha}	**Axle load (kg)**	p_{cha}	**Axle load (kg)**	p_{cha}	**Axle load (kg)**	p_{cha}	**Axle load (kg)**	p_{cha}
2520	1.8	2520	1.8	2520	1.8	2520	1.8	2520	1.8
3020	2.1	3020	2.1	3020	2.0	3020	2.0	3020	2.0
3520	2.3	3520	2.3	3520	2.3	3520	2.3	3520	2.3
4020	2.6	4020	2.6	4020	2.5	4020	2.5	4020	2.5
4520	2.8	4520	2.8	4520	2.8	4520	2.8	4520	2.8
5020	3.1	5020	3.1	5020	3.0	5020	3.0	5020	3.0
5520	3.4	5520	3.4	5520	3.3	5520	3.3	5520	3.3
6020	3.6	6020	3.6	6020	3.5	6020	3.5	6020	3.5
12000	6.7	12000	6.7	12000	6.5	12000	6.5	12000	6.5

5 Deceleration of Park brake

		Axle 3	Axle 4	Axle 5
Number of TRISTOP-actuators per axle line (KDZ)	[-]	2	2	2
TRISTOP actuator type	[-]	30/30	30/30	30/30
Lever length (l_{Bh})	[mm]	152	152	152
Maximum static tire radius ($r_{stat}max$)	[mm]	367	367	367
Stroke (s)	[mm]	30.0	30.0	30.0
Minimum force of spring brake (TFZ)	[N]	6520.0	6520.0	6520.0
Release pressure (pLs)	[bar]	4.8	4.8	4.8
Spring brake chamber no.	[-]	925 377 000/001 0	925 377 000/001 0	925 377 000/001 0
Spring brake chamber no. 2	[-]	925 377 1.. 0	925 377 1.. 0	925 377 1.. 0
Brake force (T_f) at $r_{stat}max$	[N]	39280.0	39280.0	39280.0
Ratio until road (iF_b)	[-]	3.106	3.106	3.106

$$iF_b = \frac{l_{Bh} * ETA * C * r_{Bt}}{r_{Bn} * r_{stat}}$$

$$T_f = \left(TFZ * KDZ - \frac{2 * C_o}{l_{Bh}}\right) * iF_b$$

$$z_f = \sum\left(\frac{T_f}{P}\right) + 0.01$$

Braking rates (z_f laden)

z_f laden at $r_{stat}min$	0.2102
z_f laden at $r_{stat}max$	0.2102

Summary

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Test of the frictional connection required by the parking brake

Min. wheelbase / min. supporting width (theoretical proof / no ECE regulation!): In the event of non-compliance, carry out a practical test or use the procedure described in ECE / Appendix 20.

min E_f for E = 7592 mm	4337 mm
min E_f for E = 7592 mm	4337 mm

6 Type-0 tests

Detailed Type-0 test results at pm=6.5 bar and brake force proportion including 1% rolling resistance

		Axle 1	Axle 2	Axle 3	Axle 4	Axle 5
Chamber pressure at r_{min} & at $z = 22.5$ %	bar	2.7	2.7	2.6	2.6	2.6
Chamber pressure at r_{max} & at $z = 22.5$ %	bar	2.7	2.7	2.6	2.6	2.6
Chamber pressure	bar	6.7	6.7	6.5	6.5	6.5
Piston force	ThA in N	12736	12736	11827	11827	11827
Brake force laden (R_{min})	T in N	69834	69834	70411	70411	70411
Brake force laden (R_{max})	T in N	69834	69834	70411	70411	70411
Brake force proportion	%	19.9	19.9	20.1	20.1	20.1
Calculated brake input torque (C 6.5 bar)	Nm	1728	1728	1797	1797	1797

Braking rate (z) laden (for r_{min})	0.596
Braking rate (z) laden (for r_{max})	0.596

Summary

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7 Type-III tests

Summary: Brake linings

Brake lining	Test date/code	Legal requirements fulfilled?
SAF 636	20160303	**Yes**

Summary

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7.1 Results for set of brake linings 1 out of 1

Data sheet to ECE vehicle type-approval certificate concerning braking equipment: according to ECE R13 annex 11

Axle	Axle manufacturer	Type of axle	Axle test report number	Brake linings	Test date/code
Axle 1	SAF	SNK 3020	TDB 0882 ECE	SAF 636	20160303
Axle 2	SAF	SNK 3020	TDB 0882 ECE	SAF 636	20160303
Axle 3	SAF	SNK 3020	TDB 0882 ECE	SAF 636	20160303
Axle 4	SAF	SNK 3020	TDB 0882 ECE	SAF 636	20160303
Axle 5	SAF	SNK 3020	TDB 0882 ECE	SAF 636	20160303

Calculation verification of residual (hot) braking force type III (item 4.2.1 of appendix 2 to annex 11)

Axle	r_{min}	% $Fe(r_{min})$	Axle	r_{max}	% $Fe(r_{max})$
Axle 1	383	30.0	**Axle 1**	383	30.0
Axle 2	383	30.0	**Axle 2**	383	30.0
Axle 3	383	30.0	**Axle 3**	383	30.0
Axle 4	383	30.0	**Axle 4**	383	30.0
Axle 5	383	30.0	**Axle 5**	383	30.0

Calculation of actuator stroke in mm (item 4.3.1.1 of appendix 2 to annex 11) and the average thrust output in N at pm = 6.5 bar (however max. pcha = 7.0 bar)

Axle	Calculated stroke (sp)	Stroke (s)	Average thrust output (ThA)
Axle 1	66 mm	62 mm	12736 N
Axle 2	66 mm	62 mm	12736 N
Axle 3	73 mm	67 mm	11827 N
Axle 4	73 mm	67 mm	11827 N
Axle 5	73 mm	67 mm	11827 N

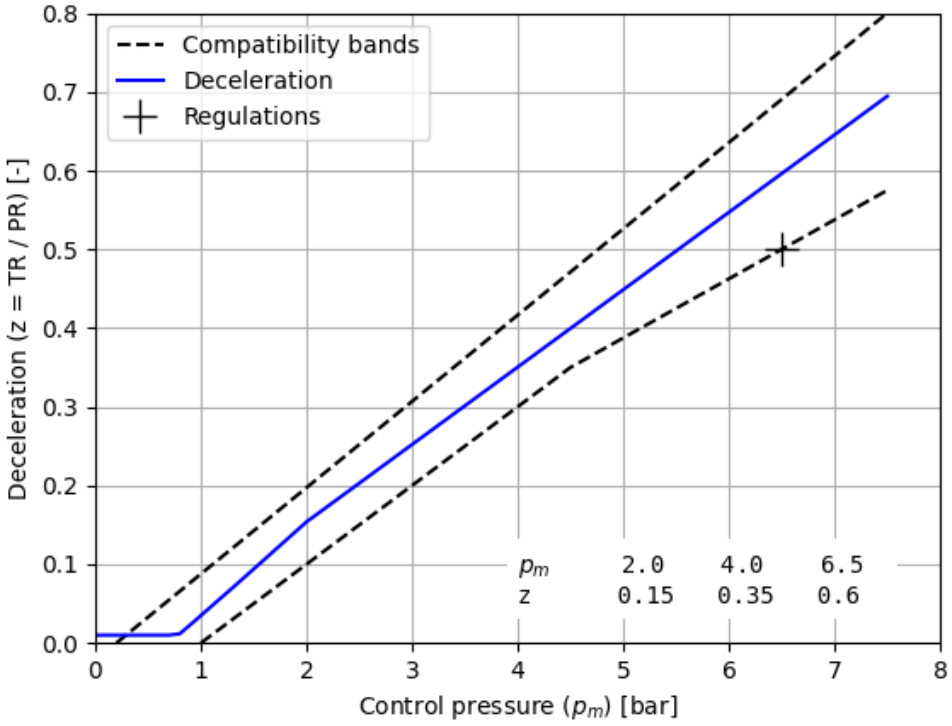
Calculated residual (hot) braking force (T)in Newtons (item 4.3.1.4 of appendix 2 to annex 11)

Axle	r_{min}	Braking force (T) (r_{min})	Axle	r_{max}	Braking force (T) (r_{max})
Axle 1	383	59643 N	**Axle 1**	383	59643 N
Axle 2	383	59643 N	**Axle 2**	383	59643 N
Axle 3	383	60134 N	**Axle 3**	383	60134 N
Axle 4	383	60134 N	**Axle 4**	383	60134 N
Axle 5	383	60134 N	**Axle 5**	383	60134 N

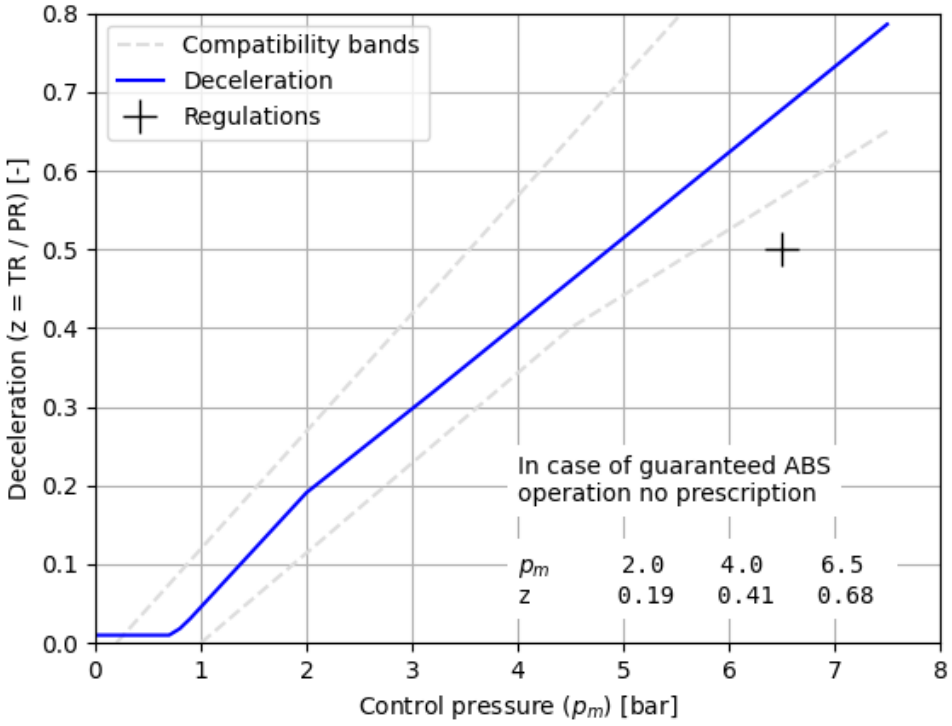
Braking rates of the vehicle for smallest and largest tires. Basic test of subject trailer (E) and Type III calculated residual (hot) braking deceleration (z_{III})

	Basic test of subject trailer (E)			
	z_0 at r_{min}	z_0 at r_{max}	z_{III} at r_{min}	z_{III} at r_{max}
Braking rate of the vehicle (item 4.3.2 to appendix 2 to annex 11)	0.6	0.6	0.5	0.5
Required braking rates (items 1.5.3 and 1.7.2 to annex 11)			$>=$ 0.4 and $>=$ 0.6 $*$ E = 0.36	$>=$ 0.4 and $>=$ 0.6 $*$ E = 0.36

8 Deceleration curve

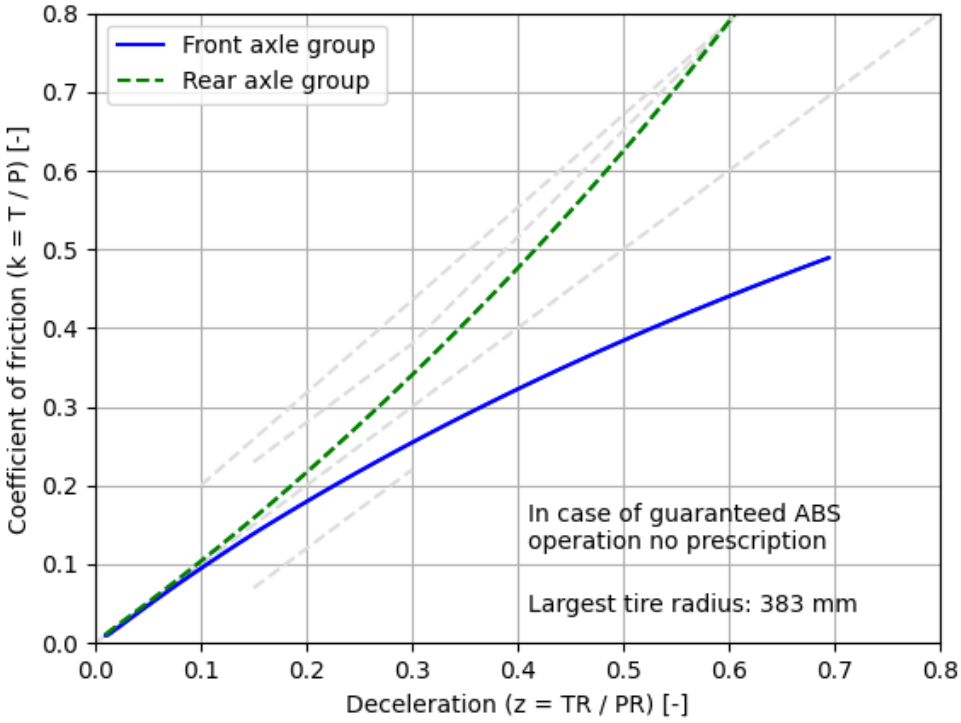


Laden state

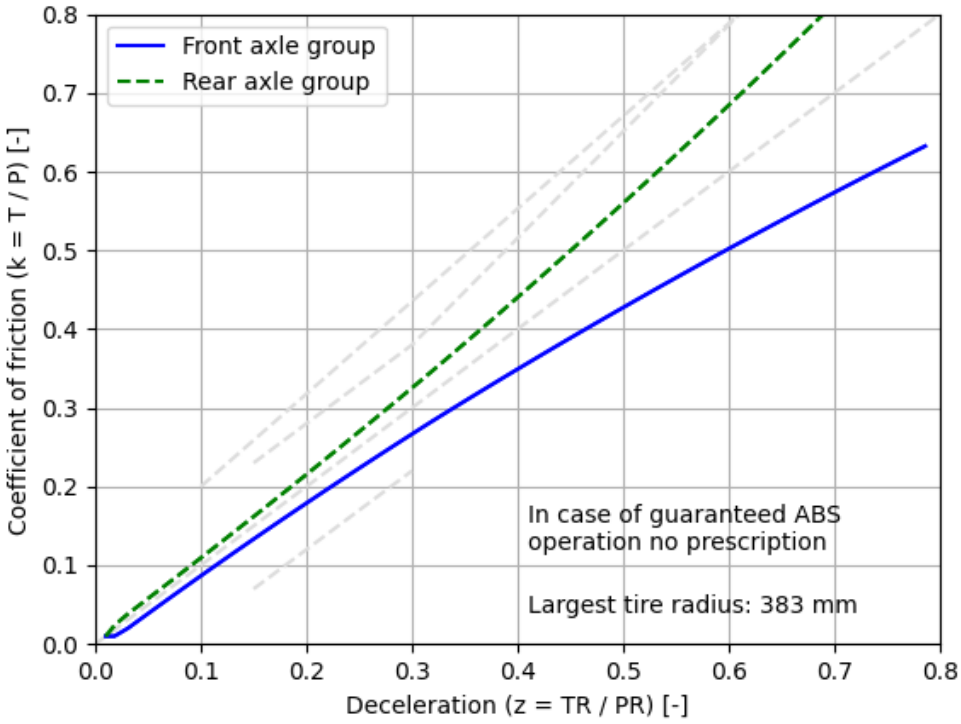


Empty state

9 Curves of friction

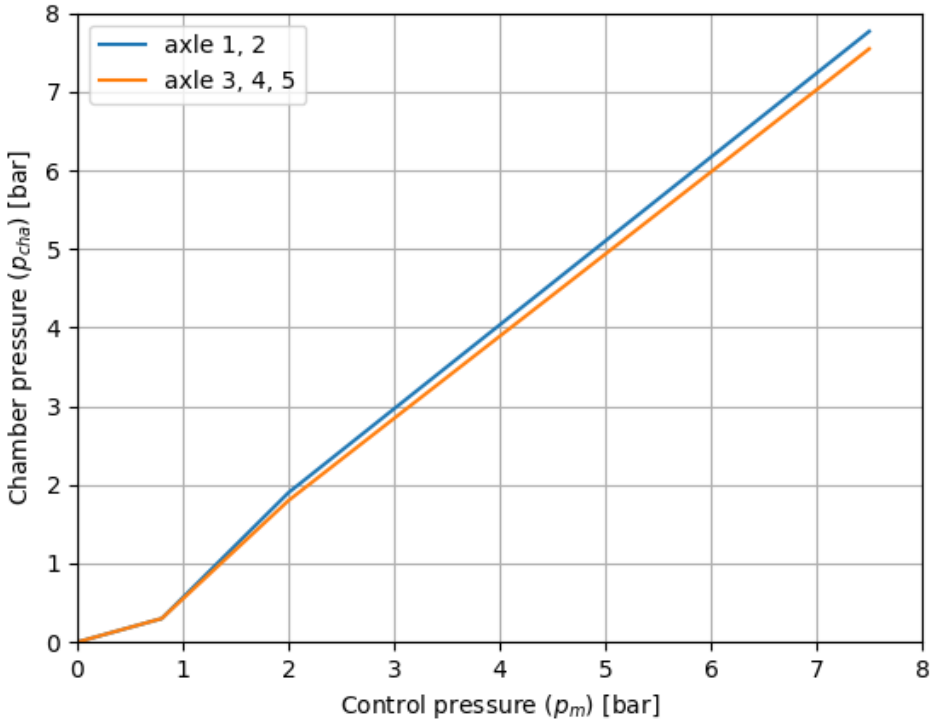


Laden state

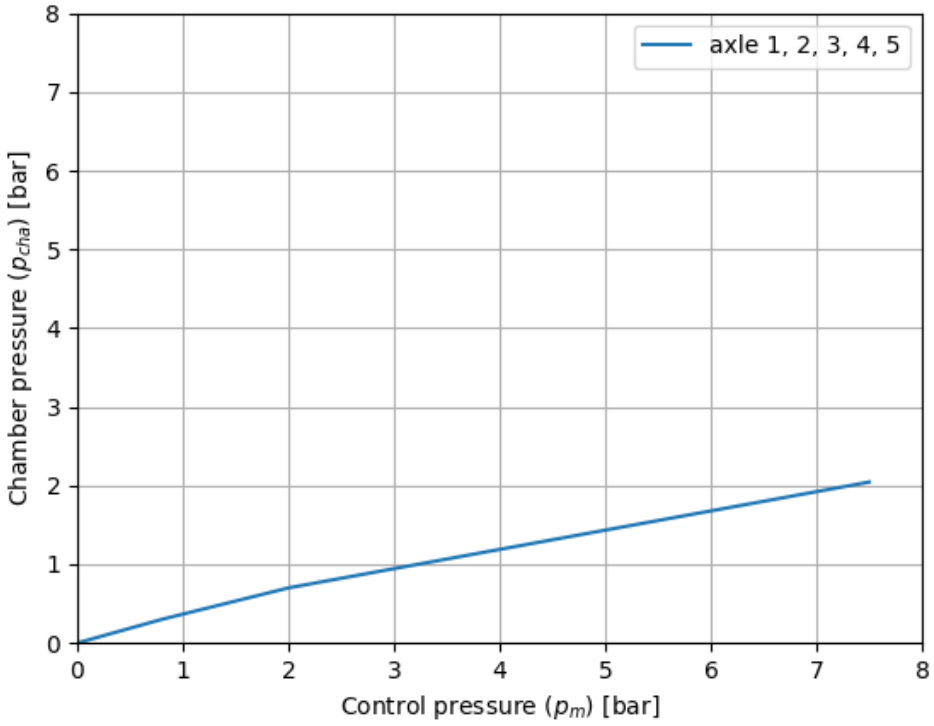


Empty state

10 Brake chamber pressures

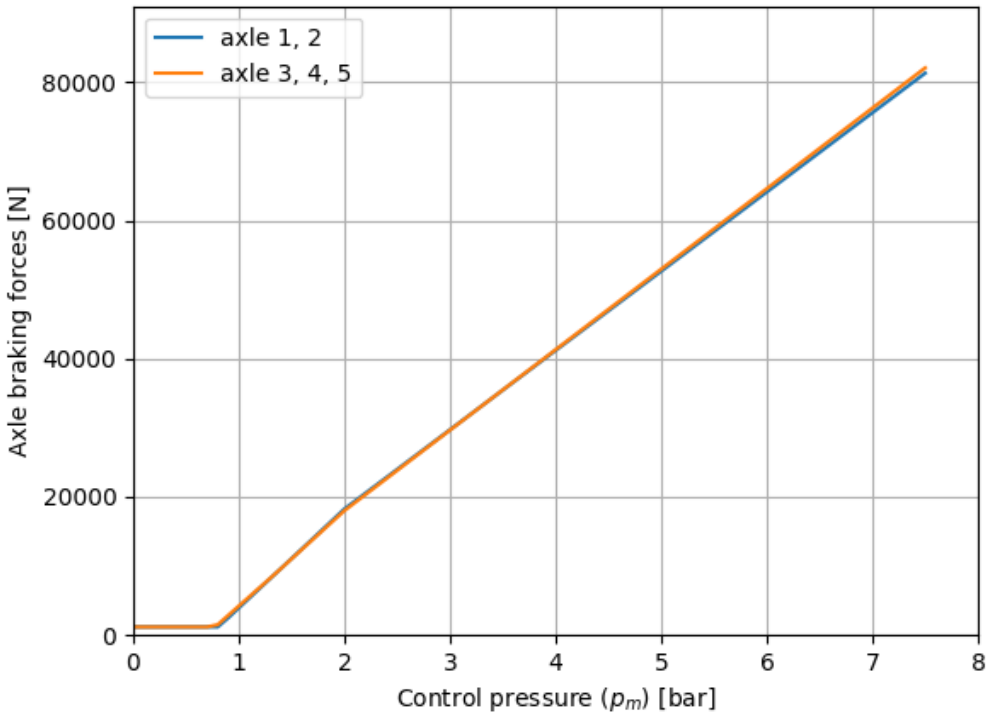


Laden state

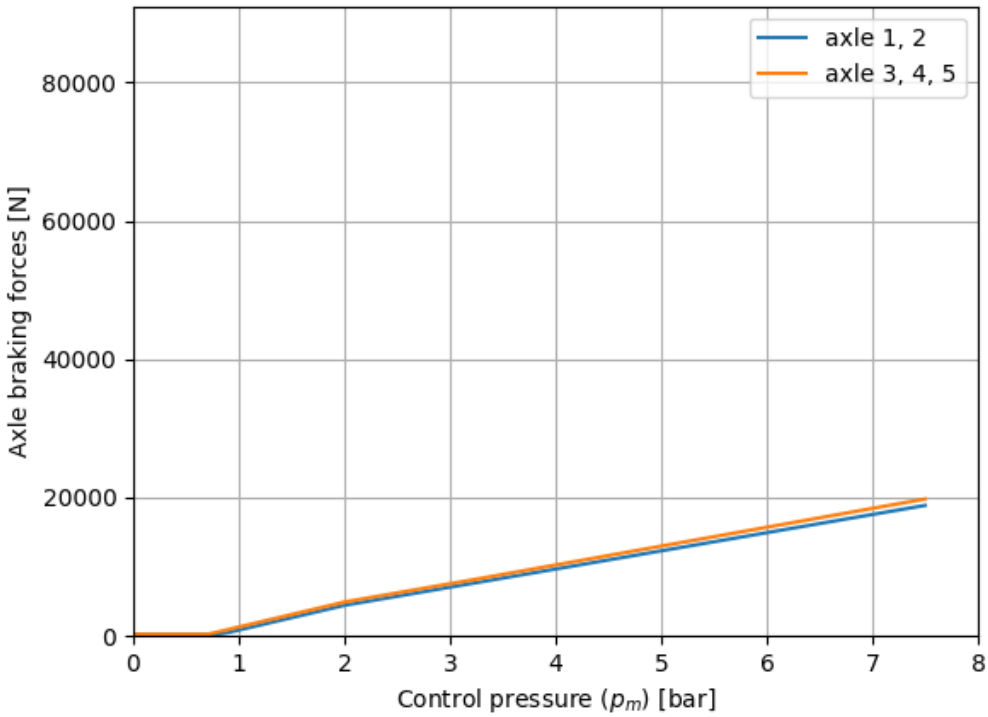


Empty state

11 Brake force distribution



Laden state



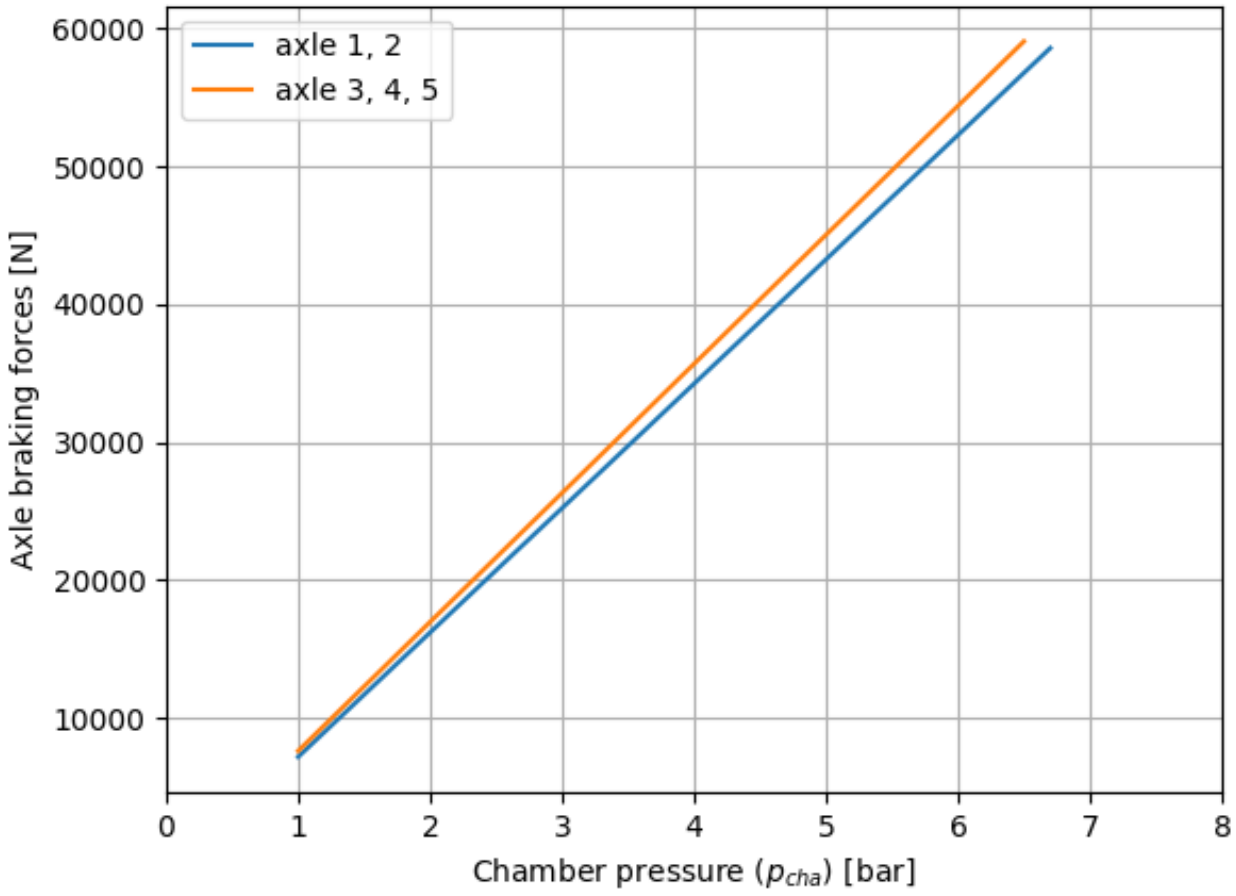
Empty state

12 Reference values

The following table shows the reference values for z = 50.0% for r_{max} : 383 mm. These reference values are the chamber pressure (p_{cha}) in bar and associated axle braking force (T) in N for each axle. Moreover the table shows the brake cylinder type (service/parking), the maximum stroke (s_{max}) in mm and the lever length (l_{Bh}) in mm. The reference values in the table are used to generate the curve displayed below.

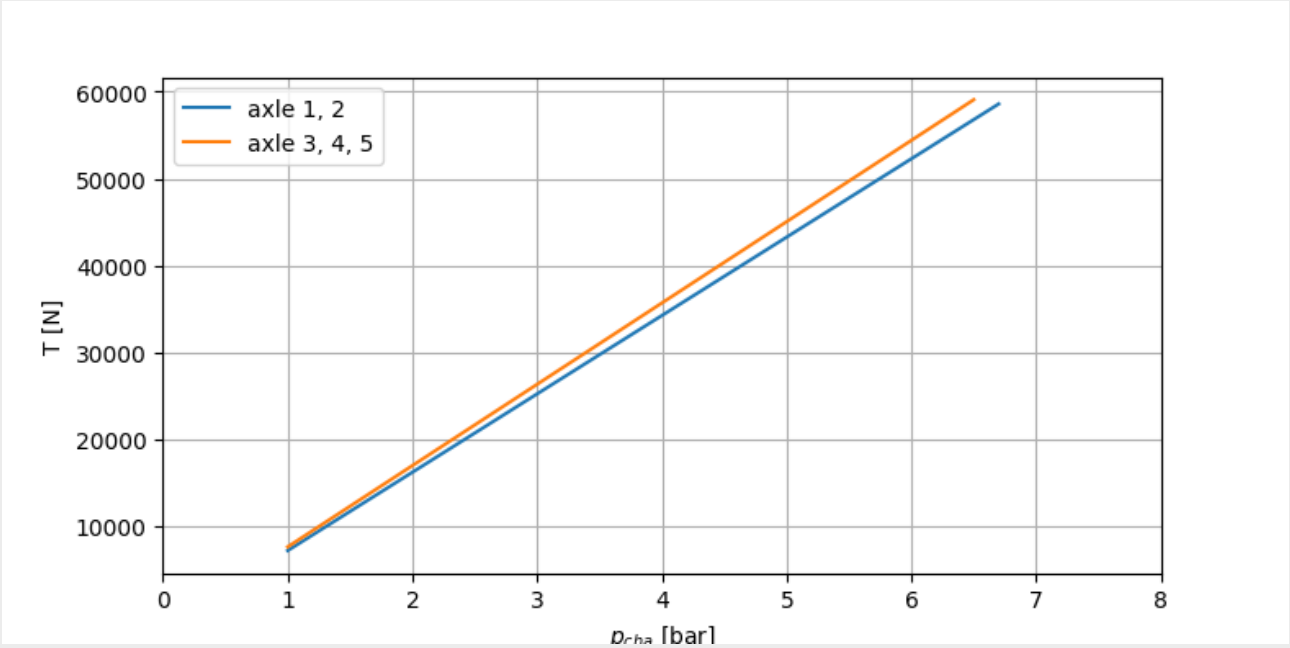
Reference values for z = 50.0% for r_{max}: 383 mm

Axle	p_{cha} **[bar]**	T **[N]**	Brake cylinder type	s_{max} [mm]	(l_{Bh}) [mm]
Axle 1	1.0 6.7	7196.0 58586.0	30	76	140
Axle 2	1.0 6.7	7196.0 58586.0	30	76	140
Axle 3	1.0 6.5	7623.0 59070.0	30/30	75	152
Axle 4	1.0 6.5	7623.0 59070.0	30/30	75	152
Axle 5	1.0 6.5	7623.0 59070.0	30/30	75	152



Print on WABCO no. 899 200 922 4 (only possible with laser printers!)

The following table shows the reference values for z = 50.0% for r_{max} : 383 mm
Brake calculation number: WES-00163 date: 2024-01-18 07:42



	Axle 1	Axle 2	Axle 3	Axle 4	Axle 5
Brake cylinder type (service/parking)	30	30	30/30	30/30	30/30
Maximum stroke s_{max} [mm]	76	76	75	75	75
Lever length [mm]	140	140	152	152	152