

Appendix C Tabulated results

Results are given for the two brake block types for reference braking, braking with ice on brake blocks and for snow conditions, with snow on wheel and on blocks. Results are given for all individual brake tests (runs) in the tables, and on the two last rows average values and standard deviations are given where appropriate. Note that a long dash indicates that the criterion for assessment never was reached during that stop.

Reference braking

Block J822

An overview of braking distances and some extracted data are presented in tables below. The quantities presented for the individual brake are braking distances s_1 and s_2 , and the related braking times of these distances t_1 and t_2 and with the time difference between them given as $\Delta t_{1 \rightarrow 2}$. The remaining measures relate to time delays until onset of brake friction and it is here suffice to see that all are nil, meaning no delays can be found for reference braking.

Table 1 Results for brake block J822 at braking at reference conditions 100 km/h. Average value and standard deviation of column data are given in two last rows.

run	s_1 [m]	t_1 [s]	s_2 [m]	t_2 [s]	$\Delta t_{1 \rightarrow 2}$ [s]	Δs_μ [m]	Δt_μ [s]	Δs_{acc} [m]	Δt_{acc} [s]	Δs_{acc}^{REF} [m]	Δt_{acc}^{REF} [s]
1	514	34	411	30	3,9	0	0	0	0		
3	562	37	456	33	3,9	0	0	0	0		
5	546	35	446	32	3,6	0	0	0	0		
7	559	36	460	33	3,6	0	0	0	0		
9	533	34	427	30	3,9	0	0	0	0		
11	534	36	435	32	3,6	0	0	0	0		
avg	541	35	439	32	3,7	0	0	0	0		
std	18	1	18	1	0,1	0	0	0	0		

Table 2 Results for brake block J822 at braking at reference conditions 70 km/h. Average value and standard deviation of column data are given in two last rows.

run	s ₁ [m]	t ₁ [s]	s ₂ [m]	t ₂ [s]	Δt _{1->2} [s]	Δs _μ [m]	Δt _μ [s]	Δs _{acc} [m]	Δt _{acc} [s]	Δs _{acc} ^{REF} [m]	Δt _{acc} ^{REF} [s]
2	264	25	196	21	3,6	0	0	0	0		
4	267	24	198	21	3,6	0	0	0	0		
6	261	23	192	20	3,6	0	0	0	0		
8	254	23	185	19	3,6	0	0	0	0		
10	254	23	185	19	3,6	0	0	0	0		
12	263	24	194	20	3,6	0	0	0	0		
avg	260	24	192	20	3,6	0	0	0	0		
std	5	1	6	1	0,0	0	0	0	0		

Block C333

Table 3 Results for brake block C333 at braking at reference conditions 100 km/h, 6.3 kN. Average value and standard deviation of column data are given in two last rows.

run	s ₁ [m]	t ₁ [s]	s ₂ [m]	t ₂ [s]	Δt _{1->2} [s]	Δs _μ [m]	Δt _μ [s]	Δs _{acc} [m]	Δt _{acc} [s]	Δs _{acc} ^{REF} [m]	Δt _{acc} ^{REF} [s]
1	482	31	389	28	3,4	0	0	0	0		
3	466	30	367	26	3,6	0	0	0	0		
5	476	30	378	27	3,6	0	0	0	0		
7	487	31	388	28	3,6	0	0	0	0		
9	477	30	385	27	3,4	0	0	0	0		
11	485	32	393	28	3,4	0	0	0	0		
avg	479	31	383	27	3,5	0	0	0	0		
std	8	1	9	1	0,1	0	0	0	0		

Table 4 Results for brake block C333 at braking at reference conditions 70 km/h, 6.3 kN. Average value and standard deviation of column data are given in two last rows.

run	s ₁ [m]	t ₁ [s]	s ₂ [m]	t ₂ [s]	$\Delta t_{1 \rightarrow 2}$ [s]	Δs_{μ} [m]	Δt_{μ} [s]	Δs_{acc} [m]	Δt_{acc} [s]	Δs_{acc}^{REF} [m]	Δt_{acc}^{REF} [s]
2	223	20	155	16	3,6	0	0	0	0		
4	236	21	172	18	3,4	0	0	0	0		
6	229	20	161	16	3,6	0	0	0	0		
8	235	21	166	17	3,6	0	0	0	0		
10	229	20	161	17	3,6	0	0	0	0		
12	242	21	173	18	3,6	0	0	0	0		
avg	232	21	165	17	3,6	0	0	0	0		
std	7	1	7	1	0,1	0	0	0	0		

Braking with ice on block contact surfaces

In the tables, braking distances s_1 and s_2 (and their corresponding durations t_1 and t_2 , been supplemented with:

- Δs_μ and Δt_μ are distance and time respectively, from start of s_2 (when the brake normal force has reached a high value) until the braking friction has reached 50% of the average braking friction of the studied stop.
- Δs_{acc} and Δt_{acc} are distance and time respectively, from start of s_2 until the braking retardation has reached 50% of the maximum retardation of the studied stop.
- Δs_{acc}^{REF} and Δt_{acc}^{REF} are distance and time respectively, from start of s_2 until the braking retardation has reached 75% of the retardation of reference stops at the considered speed.

If no value is given, this implies that the studied measure of delay has not been achieved at all during the stop.

Block J822

Table 5 Results for brake block J822 at braking at ice conditions 100 km/h, 7.5 kN. Average value and standard deviation of column data are given in two last rows. The column on right contains comments: (A) Brake blocks and wheel were completely de-iced after run 6 and were clean upon initiation of winter preparations before run 7.

run	s_1 [m]	t_1 [s]	s_2 [m]	t_2 [s]	$\Delta t_{1 \rightarrow 2}$ [s]	Δs_μ [m]	Δt_μ [s]	Δs_{acc} [m]	Δt_{acc} [s]	Δs_{acc}^{REF} [m]	Δt_{acc}^{REF} [s]	
1	876	49	769	45	3,9	259	9	246	9	418	16	
3	993	56	892	52	3,6	336	12	324	12	553	22	
5	1215	64	1114	60	3,6	589	22	654	24	764	29	
7	1015	52	914	49	3,6	486	18	551	21	591	22	
9	917	49	816	45	3,6	381	14	399	15	452	17	
11	1230	64	1122	60	3,9	591	22	717	27	830	33	
avg	1041	56	938	52	3,7	440	16	482	18	602	23	
std	149	7	149	7	0,1	137	5	188	7	166	7	

Table 6 Results for brake block J822 at braking at ice conditions 100 km/h, 9.3 kN. Average value and standard deviation of column data are given in two last rows. Note the rapid brake block application with only 0.7s time difference between t_1 and t_2 . Also note that reference retardation is for the lower braking force 7.5 kN when assessing the two reference quantities.

run	s ₁ [m]	t ₁ [s]	s ₂ [m]	t ₂ [s]	$\Delta t_{1 \rightarrow 2}$ [s]	Δs_{μ} [m]	Δt_{μ} [s]	Δs_{acc} [m]	Δt_{acc} [s]	Δs_{acc}^{REF} [m]	Δt_{acc}^{REF} [s]
1	712	41	691	40	0,7	285	10	291	11	322	12

Table 7 Results for brake block J822 at braking at ice conditions 70 km/h, 7.5 kN. Average value and standard deviation of column data are given in two last rows. The column on right contains comments: (A) Brake blocks and wheel were completely de-iced after run 6 and were clean upon initiation of winter preparations before run 7.

run	s ₁ [m]	t ₁ [s]	s ₂ [m]	t ₂ [s]	$\Delta t_{1 \rightarrow 2}$ [s]	Δs_{μ} [m]	Δt_{μ} [s]	Δs_{acc} [m]	Δt_{acc} [s]	Δs_{acc}^{REF} [m]	Δt_{acc}^{REF} [s]	
2	800	56	730	52	3,6	391	20	454	23	—	—	
4	1128	78	1057	75	3,6	596	31	834	46	—	—	
6	1276	88	1205	84	3,6	718	38	983	54	—	—	
8	979	67	903	63	3,9	541	28	653	35	—	—	(A)
10	1062	74	991	70	3,6	568	30	731	39	—	—	
12	1106	75	1031	71	3,9	628	33	850	46	—	—	
avg	1059	73	986	69	3,7	574	30	751	41			
std	160	11	160	11	0,1	108	6	184	11			

Block C333

Table 8 Results for brake block C333 at braking at ice conditions 100 km/h, 6.3 kN. Average value and standard deviation of column data are given in two last rows.

run	s ₁ [m]	t ₁ [s]	s ₂ [m]	t ₂ [s]	$\Delta t_{1 \rightarrow 2}$ [s]	Δs_{μ} [m]	Δt_{μ} [s]	Δs_{acc} [m]	Δt_{acc} [s]	Δs_{acc}^{REF} [m]	Δt_{acc}^{REF} [s]
1	1100	53	1005	50	3,4	638	23	669	25	682	25
3	952	48	851	45	3,6	492	18	498	18	523	19
5	1072	53	971	49	3,6	619	23	638	24	662	25
7	931	47	824	43	3,9	484	18	484	18	509	19
avg	1014	50	913	47	3,6	558	21	572	21	594	22
std	84	3	89	3	0,2	82	3	95	4	91	3

Table 9 Results for brake block C333 at braking at ice conditions 70 km/h, 6.3 kN. Average value and standard deviation of column data are given in two last rows.

run	s ₁ [m]	t ₁ [s]	s ₂ [m]	t ₂ [s]	$\Delta t_{1 \rightarrow 2}$ [s]	Δs_{μ} [m]	Δt_{μ} [s]	Δs_{acc} [m]	Δt_{acc} [s]	Δs_{acc}^{REF} [m]	Δt_{acc}^{REF} [s]	
2	2134	135	2063	131	3,6	1733	98	1955	114	—	—	
4	1654	125	1584	121	3,6	1164	66	1243	71	—	—	
6	1656	127	1585	124	3,6	1189	68	1298	76	—	—	
8	2640	262	2565	258	3,9	289	15	1854	119	—	—	
avg	2021	162	1949	158	3,7	1094	62	1587	95			
std	470	67	468	67	0,1	597	34	369	25			

Table 10 Results for brake block C333 at braking at ice conditions 100 km/h, 7.0 kN. Average value and standard deviation of column data are given in two last rows.

run	s ₁ [m]	t ₁ [s]	s ₂ [m]	t ₂ [s]	$\Delta t_{1 \rightarrow 2}$ [s]	Δs_{μ} [m]	Δt_{μ} [s]	Δs_{acc} [m]	Δt_{acc} [s]	Δs_{acc}^{REF} [m]	Δt_{acc}^{REF} [s]
1	767	39	660	36	3,9	334	12	358	13	371	14
2	990	49	890	45	3,6	568	21	610	23	627	24
avg	879	44	775	40	3,7	451	17	484	18	499	19
std	157	6	162	7	0,2	166	6	178	7	181	7

Table 11 Results for brake block C333 at braking at ice conditions 70 km/h, 7.0 kN. Average value and standard deviation of column data are given in two last rows.

run	s ₁ [m]	t ₁ [s]	s ₂ [m]	t ₂ [s]	$\Delta t_{1 \rightarrow 2}$ [s]	Δs_{μ} [m]	Δt_{μ} [s]	Δs_{acc} [m]	Δt_{acc} [s]	Δs_{acc}^{REF} [m]	Δt_{acc}^{REF} [s]
3	1595	120	1525	116	3,6	1186	71	1335	83	—	—
4	2140	209	2070	205	3,6	0	0	2070	204	—	—
avg	1868	164	1797	161	3,6	593	36	1703	143		
std	385	63	385	63	0,0	839	50	519	85		

Table 12 Results for brake block C333 at braking at ice conditions 100 km/h, 9.2 kN. Average value and standard deviation of column data are given in two last rows.

run	s ₁ [m]	t ₁ [s]	s ₂ [m]	t ₂ [s]	$\Delta t_{1 \rightarrow 2}$ [s]	Δs_{μ} [m]	Δt_{μ} [s]	Δs_{acc} [m]	Δt_{acc} [s]	Δs_{acc}^{REF} [m]	Δt_{acc}^{REF} [s]
1	654	36	634	35	1	272	10	285	10	316	12

Table 13 Results for brake block C333 at braking at ice conditions 70 km/h, 9.2 kN. Average value and standard deviation of column data are given in two last rows.

run	s ₁ [m]	t ₁ [s]	s ₂ [m]	t ₂ [s]	$\Delta t_{1 \rightarrow 2}$ [s]	Δs_{μ} [m]	Δt_{μ} [s]	Δs_{acc} [m]	Δt_{acc} [s]	Δs_{acc}^{REF} [m]	Δt_{acc}^{REF} [s]
2	968	60	954	60	1	801	43	817	44	825	45

Braking with snow on block contact surfaces and on wheel tread

Block J822

Table 14 Results for brake block J822 at braking at snow conditions 100 km/h, 7.5 kN. Average value and standard deviation of column data are given in two last rows.

run	s ₁ [m]	t ₁ [s]	s ₂ [m]	t ₂ [s]	$\Delta t_{1 \rightarrow 2}$ [s]	Δs_{μ} [m]	Δt_{μ} [s]	Δs_{acc} [m]	Δt_{acc} [s]	Δs_{acc}^{REF} [m]	Δt_{acc}^{REF} [s]	
1	748	47	641	44	3,9	172	7	154	6	214	8	
3	1738	95	1630	91	3,9	782	29	1601	82	1630	90	
5	886	52	779	48	3,9	272	10	266	10	427	17	
7	1287	68	1186	64	3,6	644	24	775	30	858	34	
9	850	50	749	47	3,6	217	8	304	12	469	20	
11	922	47	821	44	3,6	442	16	467	17	479	18	
avg	1072	60	968	56	3,8	422	16	595	26	679	31	
td	374	19	374	19	0,1	248	9	538	28	510	30	

Table 15 Results for brake block J822 at braking at snow conditions 70 km/h, 7.5 kN. Average value and standard deviation of column data are given in two last rows.

run	s ₁ [m]	t ₁ [s]	s ₂ [m]	t ₂ [s]	$\Delta t_{1 \rightarrow 2}$ [s]	Δs_{μ} [m]	Δt_{μ} [s]	Δs_{acc} [m]	Δt_{acc} [s]	Δs_{acc}^{REF} [m]	Δt_{acc}^{REF} [s]	
2	1083	87	1012	83	3,6	620	36	657	38	—	—	
4	1684	127	1613	123	3,6	1014	57	1601	116	—	—	
6	1110	90	1034	86	3,9	404	22	739	44	—	—	
8	670	56	600	53	3,6	249	14	558	41	—	—	
10	784	55	709	51	3,9	422	23	556	31	622	36	
12	902	61	831	57	3,6	558	30	660	36	751	43	
avg	1039	79	967	76	3,7	544	30	795	51	686	40	
std	359	28	359	28	0,1	264	15	401	32	91	5	

Block C333

Table 16 Results for brake block C333 at braking at snow conditions 100 km/h, 6.3 kN. Average value and standard deviation of column data are given in two last rows.

run	s ₁ [m]	t ₁ [s]	s ₂ [m]	t ₂ [s]	$\Delta t_{1 \rightarrow 2}$ [s]	Δs_{μ} [m]	Δt_{μ} [s]	Δs_{acc} [m]	Δt_{acc} [s]	Δs_{acc}^{REF} [m]	Δt_{acc}^{REF} [s]	
1	523	33	429	29	3,4	120	5	102	4	120	5	
3	525	33	418	29	3,9	72	3	65	2	109	4	
5	936	49	836	45	3,6	533	21	539	21	545	21	
7	1264	63	1163	60	3,6	848	33	864	34	870	34	
avg	812	44	712	41	3,6	393	15	393	15	411	16	
std	358	15	358	15	0,2	367	14	381	15	367	15	

Table 17 Results for brake block C333 at braking at snow conditions 70 km/h, 6.3 kN. Average value and standard deviation of column data are given in two last rows.

run	s ₁ [m]	t ₁ [s]	s ₂ [m]	t ₂ [s]	$\Delta t_{1 \rightarrow 2}$ [s]	Δs_{μ} [m]	Δt_{μ} [s]	Δs_{acc} [m]	Δt_{acc} [s]	Δs_{acc}^{REF} [m]	Δt_{acc}^{REF} [s]	
2	1837	198	1772	195	3,4	—	—	5	—	—	—	
4	2049	222	1979	218	3,6	—	—	78	4	—	—	
6	2102	239	2032	235	3,6	—	—	9	—	—	—	
8	2108	239	2038	235	3,6	—	—	—	—	—	—	
avg	2024	224	1955	221	3,6	—	—	—	4			
std	128	19	125	19	0,1	—	—	—	0			

Table 18 Results for brake block C333 at braking at snow conditions 100 km/h, 7.5 kN. Average value and standard deviation of column data are given in two last rows.

run	s ₁ [m]	t ₁ [s]	s ₂ [m]	t ₂ [s]	$\Delta t_{1 \rightarrow 2}$ [s]	Δs_{μ} [m]	Δt_{μ} [s]	Δs_{acc} [m]	Δt_{acc} [s]	Δs_{acc}^{REF} [m]	Δt_{acc}^{REF} [s]	
1	453	27	359	24	3,4	78	3	72	3	103	4	
3	536	30	443	27	3,4	150	6	144	5	175	7	
avg	494	29	401	26	3,4	114	4	108	4	139	5	
std	59	2	59	2	0,0	51	2	51	2	51	2	

Table 19 Results for brake block C333 at braking at snow conditions 70 km/h, 7.5 kN. Average value and standard deviation of column data are given in two last rows.

run	s ₁ [m]	t ₁ [s]	s ₂ [m]	t ₂ [s]	$\Delta t_{1 \rightarrow 2}$ [s]	Δs_{μ} [m]	Δt_{μ} [s]	Δs_{acc} [m]	Δt_{acc} [s]	Δs_{acc}^{REF} [m]	Δt_{acc}^{REF} [s]	
2	1532	168	1466	165	3,4	—	—	—	—			
4	1832	199	1762	196	3,6	—	—	5	—			
avg	1682	184	1614	180	3,5	—	—	—	—			
std	212	22	209	22	0,2	—	—	—	—			

Table 20 Results brake block C333 after warm “reset” braking prior to braking at snow conditions 100 km/h, 7.5 kN.

run	s ₁ [m]	t ₁ [s]	s ₂ [m]	t ₂ [s]	$\Delta t_{1 \rightarrow 2}$ [s]	Δs_{μ} [m]	Δt_{μ} [s]	Δs_{acc} [m]	Δt_{acc} [s]	Δs_{acc}^{REF} [m]	Δt_{acc}^{REF} [s]	
1	486	30	386	26	3,6	46	2	40	1	90	3	
3	432	27	331	24	3,6	26	1	13	0	64	2	
avg	459	29	359	25	3,6	36	1	26	1	77	3	
std	39	2	39	2	0,0	14	1	19	1	19	1	

Table 21 Results brake block C333 after warm “reset” braking prior to braking at snow conditions 70 km/h, 7.5 kN.

run	s ₁ [m]	t ₁ [s]	s ₂ [m]	t ₂ [s]	$\Delta t_{1 \rightarrow 2}$ [s]	Δs_{μ} [m]	Δt_{μ} [s]	Δs_{acc} [m]	Δt_{acc} [s]	Δs_{acc}^{REF} [m]	Δt_{acc}^{REF} [s]	
2	406	29	335	26	3,6	197	11	206	11	210	11	
4	591	48	525	45	3,4	325	18	337	18	364	20	
avg	498	39	430	35	3,5	261	14	271	15	287	16	
std	131	13	134	14	0,2	90	5	93	5	109	6	