

APPENDIX B

REFERENCE DATA:

ROAD STOP DATA

TORQUE WHEEL DATA

VEHICLE WEIGHTS

Stopping Distance and Deceleration

COMPUTATION OF STOPPING DISTANCE

Stopping distances were obtained in two ways: 1) from the fifth wheel, and 2) from the Labeco instrumentation. In the first method, the vehicle instrumentation directly reported the distance traveled from the time the brake pedal was first depressed to the time the vehicle came to rest. While this definition is commonly used, the variability of the resulting stopping distances is strongly dependent upon the time required for the vehicle to begin decelerating. The second method relied on the integration of the velocity-versus-time profile (taken from the fifth-wheel data), when a decrease in the velocity was first observed. The second method provided more consistent results between vehicle configurations and thus was used in this work.

We attempted to obtain stopping from an initial velocity of 20 mph. Where the actual velocity slightly differed from 20 mph, a normalized stopping distance was computed using the following formula:

$$s_{20} = s \left(\frac{(v_{20})^2}{v^2} \right),$$

where s_{20} is the stopping distance from 20 mph (ft), s is the measured stopping distance (ft), v_{20} is equal to 29.33 ft/s (20 mph), and v is the actual initial velocity (ft/s). This formula is valid only for corrections under 2 mph.

COMPUTATION OF VEHICLE DECELERATION

The deceleration from the 20-mph stops could be obtained in one of three ways: (1) indirectly from the fifth-wheel, (2) indirectly from the Labeco instrumentation, or (3) directly from the on-board accelerometer. Insufficient data were collected by the accelerometer to be reported herein. The deceleration was primarily computed from the fifth wheel data using regression analysis of the linear portion (Region B) of the velocity-versus-time profile (Figure B1).

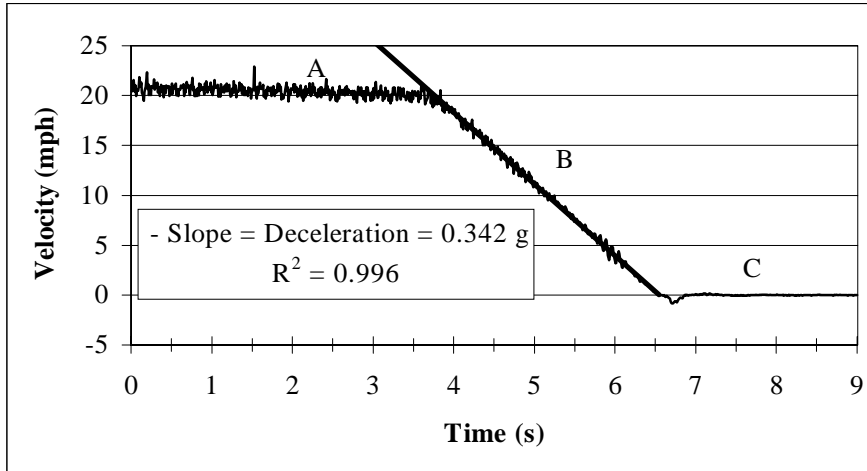


Figure B1. Vehicle velocity data as a function of time during a 20-mph stop (fifth wheel data). The trace in Region B is used for regression analysis and computation of the assumed constant deceleration of the vehicle.

When fifth-wheel data was not available, the deceleration was back-calculated from the Labeco data and assuming that the deceleration profile was similar to the profile shown in Figure B2. The Labeco system is triggered by a sensor placed on the foot brake pedal of the vehicle. As soon as the driver's foot touches the brake pedal, the distance traveled is recorded by the Labeco instrumentation even though, for a brief period of time, no brake force is developed and the vehicle initial velocity remains unchanged. The distance calculated from the recorded data was estimated to be approximately 3 percent lower than that measured by the Labeco. In Figure B2, region I (of duration T_0) refers to the portion of the overall stop for which no change in velocity is seen even though the driver's foot is in contact with the brake pedal. Region II (of duration T_1) corresponds to the portion of the overall stop for which the vehicle starts to decelerate but full brake forces (assumed equivalent to maximum deceleration) are not yet achieved. A linear increase is assumed. Region III refers to the portion of the overall stop for which brake forces are fully applied and assumed constant until the complete immobilization of the vehicle. No in-stop fade of brake forces (and therefore deceleration) is assumed since it was not observed in any of the on-road 20-mph stops. The assessment of the times T_0 and T_1 is critical. Based on observations of the available data recorded by the fifth-wheel for the two-axle truck, these times were both estimated to be equal to 0.125 second.

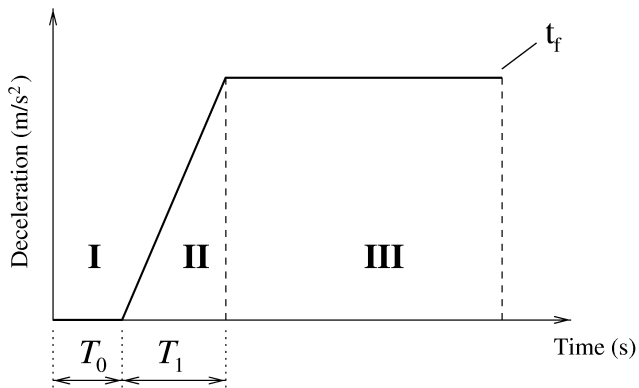


Figure B2. Assumed profile of the deceleration as a function of time used for computation of stopping distance.

In a similar manner, using T_0 and T_1 equal to 0.125 second, the stopping distance of the trucks can be obtained from the ratio BF_{TOT}/GVW measured with the PBBTs. In this case, the deceleration during Stage III is taken as $\frac{BF_{tot}}{GVW} \times g$, where g is the acceleration due to gravity (9.8 m/s^2 or 32.2 ft/s^2). This deceleration during Stage III is ultimately the quantity that will be estimated and used in a pictorial display software developed by Battelle to predict vehicle stopping distances from PBBT results. The stopping distances and decelerations (where available) for the nine vehicle configurations are presented in Table B1.

20 MPH ROAD STOP REFERENCE DATA

Table B1. Stopping distances and average decelerations during 20 mph on-road stops.

Conditions				From Labeco			Calculated from fifth wheel data						
		Test #	Number of Rep.	Average Stopping Distance normalized to 20 mph (ft)			Average Stopping Distance normalized to 20 mph (ft)			Average Deceleration (g)			
				Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	
Part 1:													
Vehicles with Weak Brakes													
Dry Conditions													
3-S2	Laden	1	9	43.0	40.7	45.0	36.8	33.9	43.2	0.39	0.38	0.41	
	Unladen	3	3 ^a	50.4	44.7	60.9	45.2	38.7	55.8	0.25	0.25	0.25	
			6 ^a	45.4	44.7	46.4	40.6	38.7	42.6	0.36	0.34	0.37	
2-Axle	Laden	2	3	-----	-----	-----	38.5	34.9	41.2	0.36	0.34	0.38	
	Unladen	4	2	-----	-----	-----	31.4	31.0	31.7	0.42	0.41	0.43	
			3	41.5	40.9	42.0	39.7 ^c	-----	-----	0.40 ^c	-----	-----	
Part 2:													
2-axle vehicle													
Fully Adjusted, Strong Brakes													
2-Axle	Unladen	Dry	5	3	30.3	27.7	31.8	28.9 ^c	-----	-----	0.58 ^c	-----	-----
	1/3 Laden	Dry	6	3	31.2	29.6	32.0	29.8 ^c	-----	-----	0.56 ^c	-----	-----
	2/3 Laden	Dry	7	6 ^b	27.8	26.3	28.3	26.6	24.3	27.9	0.63	0.61	0.65
	2/3 Laden	Wet	8	3	28.8	28.5	29.3	28.2	27.3	28.8	0.60	0.59	0.61
	Unladen	Wet	9	0	n/t	n/t	n/t	n/t	n/t	n/t	n/t	n/t	n/t

n/t not tested

----- not available

a The 9 replicates are separated due to the improper brake settings during the first round of testing in this condition.

b A 2nd set of 3 replicate stops was conducted in the 2/3 laden condition during the "wet" test sequence. Since these tests were conducted dry, the results are included in the "2/3 loaded and dry" test series.

c The deceleration is back-calculated from Labeco stopping distances.

ROAD STOPS UNCERTAINTIES

For use in enforcement, performance-based regulations to be used with PBBTs must take into account the accuracy and repeatability of the PBBTs, must be based on safety, and must also consider the variations typically found in actual vehicle stopping behavior.

There are three sources of uncertainty to be considered in establishing the allowable window of deviations from the desired minimum stopping capability.

- 1) The stopping distances or the computed decelerations of a given vehicle under identical conditions will vary from stop to stop. Statistically, as the number of samples (replicate tests) increases, the level of confidence in the results increases accordingly. Since only three replicates were conducted, variability observed in the test results was high, and the extremes may not have represented those found in a large number of tests (Table B1). For the 20 mph stops conducted during the round robin, the maximum range of variation of the deceleration (from minimum to maximum) for a given truck configuration (weak and strong brakes) was approximately 10 percent, i.e. ± 5 percent. This type of uncertainties is referred to as “real-life braking variations”.
- 2) The second type of uncertainty is “data measurement” variations, which are manifest in the range of reported values the PBBT exhibit under controlled (usually static) conditions. These are due to transducer accuracy and/or data manipulation or reduction. The proposed specifications call for ± 2.5 percent on the weight and brake force measurements. When combined, these lead to an approximate ± 5 percent variation on the deceleration (BF_{TOT}/GVW).
- 3) The third type of uncertainty is introduced by the specific interaction of the vehicle tested and the PBBT used. These “dynamic” variations can originate from test geometry (design characteristics of trucks such as total number of axles, position of axles, type of suspensions, etc.) and data manipulation (filtering, smoothing, brake force calibration algorithm, etc.), and variability in the way the driver/operator conducts the tests.

Brake Forces

COMPUTATION OF REFERENCE BRAKE FORCE FROM TORQUE WHEEL DATA

The calibration check on the torque wheel indicated an accuracy within 0.5 percent. To compute the brake forces from the measured torques, a radius of 19.25 inches was used for the fully laden condition, and 19.6 inches was used for the unladen condition. The accuracy on the radius measurement was approximately 1.3 percent (0.25 inch). Additionally, the variation of the contact geometry due to deflection on the rolls or gripper pads is estimated to contribute to the variation of the radius by 0.5 inch (~ 2.6 percent) for the RDs and 0.25 inch (~ 1.3 percent) for the BTT. No additional geometry factor is expected for the flat plate testers. As such, the total estimated uncertainty in measured torque values is ± 4.3 percent for FPs, ± 5.6 percent for BTTs, and ± 6.9 percent for RDs, respectively. On the 3-S2 vehicle, torque data was collected during all tests by a torque wheel installed on wheel 5.

Figure B3 illustrates typical brake force versus time traces as well as the methods used for computing a single value for the brake force from the data. As the vendors' algorithms for computing brake forces were not all known at the time of this report, three different methods were used to determine brake force data from torque wheel data. For all three PBBT types, method 1 reported the maximum brake force ("Max") during the test. Method 2 calculated the average of data points greater than 80 percent of the maximum brake force ("0.8 avg"). Method 2 helps average data for which a nominal plateau is reached during the test or for which a spike occurs. However, if a large spike occurs with no filtering, for example, of magnitude 20 % greater than the plateau, then none of the plateau data would be included. Finally, for all PBBTs except FP testers, Method 3 determined the brake force at the time of test termination ("Term"). No averaging of the torque wheel data was performed.

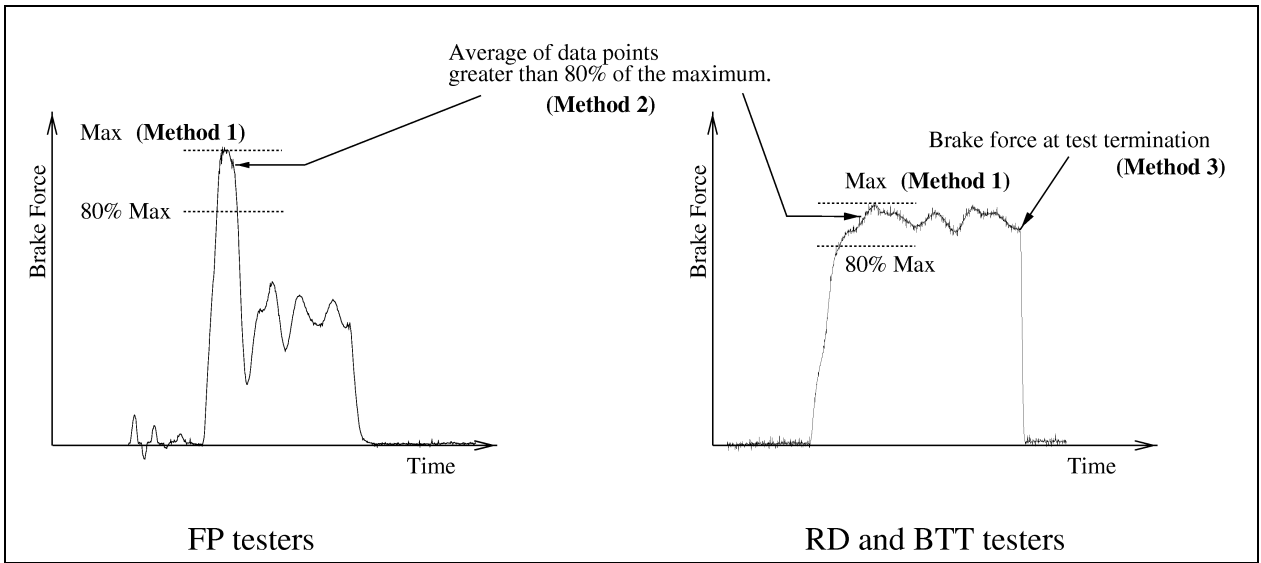


Figure B3. Methods for computing the brake force from torque wheel data.

REFERENCE BRAKE FORCE DATA

Table B2 summarizes the brake forces reported by the PBBTs (indicated by “Rep.” in the “PBBT” column, standing for “as reported”) and the brake forces obtained from the torque wheel data. Data are presented for laden and unladen conditions.

Table B2. Brake forces (in pounds) for wheel 5 of the 3-S2 reported by PBBTs and computed from the reference torque wheel data (Appendix D).

LADEN CONDITIONS													
		Replicate 1				Replicate 2				Replicate 3			
		PBBT	Torque wheel			PBBT	Torque wheel			PBBT	Torque wheel		
Machine	Rep.	Max.	0.8 avg	Term	Rep.	Max.	0.8 avg	Term	Rep.	Max.	0.8 avg	Term	
B&G BTT	6	4362	4690	4241	4690	4369	4646	4182	4646	4333	5330	4812	5330
HTR FP	1	5395	5807	5501	n/a	5343	6068	5773	n/a	5791	7330	6954	n/a
HEKA FP	7	3797	5406	5040	n/a	4563	4999	4624	n/a	4651	5161	4711	n/a
VRTC RD	4	5604	5911	5580	5911	6077	6499	5995	6499	6147	6415	6180	6415
RAI RD-ig	9	5873	6045	5890	5965*	6106	6317	6044	6234*	5850	6290	6089	6001*
RAI RD-p	2	5212	5701	5099	4638†	4892	5398	4805	5157†	4964	5566	4912	5046†
VIS RD	3	4078	4772	4265	4772	2308	2623	2246	2623	2200	2426	2106	2426
HEI RD1	5a	4957	5403	4864	5403	5169	5898	5314	5898	3989	4356	3957	4356
HEI RD2	5b	----	----	----	----	----	----	----	----		3937	3491	
20mph st.	8	----	5816	5582	n/a	----	5779	5507	n/a	----	5916	5584	n/a

LADEN CONDITIONS													
		Replicate 1				Replicate 2				Replicate 3			
		PBBT	Torque wheel			PBBT	Torque wheel			PBBT	Torque wheel		
Machine	Rep.	Max.	0.8 avg	Term	Rep.	Max.	0.8 avg	Term	Rep.	Max.	0.8 avg	Term	
B&G BTT	6	1287	1326	1250	1326	1559	1635	1556	1635	1597	1635	1547	1635
HTR FP	1	1792	1518	1385	n/a	1815	1896	1717	n/a	1684	1792	1630	n/a
HEKA FP	7	1356	1116	1023	n/a	2114	1789	1659	n/a	1691	1411	1294	n/a
VRTC RD	4	1544	1640	1504	1448*	1640	1801	1595	1523*	1592	1914	1769	1689*
RAI RD-ig	9	1601	1737	1535	1631*	1727	1923	1760	1734*	1943	2090	1961	1977*
RAI RD-p	2	1579	1626	1543	1579*	1988	2021	1901	1967*	1767	1915	1770	1785*
VIS RD	3	1426	1585	1378	1585	1520	1635	1415	1635	1466	1793	1544	1793
HEI RD1	5a	1624	1617	1496	1476*	1431	1649	1533	1649	1366	1567	1442	1567
HEI RD2	5b	----	----	----	----	----	----	----	----	----	----	----	----
20mph st.	8	n/a	1519	1389	n/a	n/a	1778	1639	n/a	n/a	1767	1621	n/a

Rep.=reported; Max.=maximum; 0.8 avg=average of data greater than 80% maximum; Term=at test termination.

* Average of last 10 points prior to test termination.

† Test termination prior to the upsurge, as specified on Figure xx11.

Vehicle Weights

Table B3. Weights (in pounds) measured using certified scales

Wheel Number	Wheel Position	3-S2 Laden	3-S2 Empty	2-Axle Laden	2-Axle Empty	2-Axle 1/3 Laden	2-Axle 2/3 Laden
1	1L	6,050	5,100	6,000	4,100	4,790	5,310
2	1R	5,850	4,850	5,450	3,700	4,510	4,980
Axle 1		11,900	9,950	11,450	7,800	9,300	10,290
3	2L	9,150	3,000	11,300	4,700	6,940	9,810
4	2R	8,150	2,750	10,050	4,200	6,490	8,870
Axle 2		17,300	5,750	21,350	8,900	13,430	18,680
5	3L	8,400	2,900				
6	3R	8,100	2,900				
Axle 3		16,500	5,800				
Total Tractor		45,700	21,500				
7	4L	8,700	2,400				
8	4R	8,700	2,050				
Axle 4		17,400	4,450				
9	5L	7,900	2,350				
10	5R	7,800	2,400				
Axle 5		15,700	4,750				
Total Trailer		33,100	9,200				
Total Vehicle		78,800	30,700	32,800	16,700	22,730	28,970

APPENDIX C

PBBT DATA FOR TESTS 1 - 9:

Brake Forces

and

Wheel Loads

Table C1. Data from 3 replicates for Test 1: Laden 3-S2 with weak brakes.

Replicate 1	3s-2	Laden	some weak brakes			
Station #	Axle #	LBF	LWT	RBF	RWT	
Hunter FP	1	1	1564	6270	1979	6020
		2	2494	8730	3800	7990
		3	5395	8530	2816	8480
		4	3975	8050	2622	8350
		5	3039	8370	2398	8340
RAI RD	2	1	1776	6450	2001	6450
		2	2698	14000	4659	14000
		3	5212	8600	3184	8600
		4	3935	14000	3022	14000
		5	2999	10100	2599	10100
VIS RD	3	1	1716	5637	1985	5570
		2	2732	9606	4804	9257
		3	4078	6357	2994	6734
		4	3607	6640	2826	6801
		5	2954	6162	2826	6471
VRTC Fixed RD	4	1	1515	6481	2108	5536
		2	2498	8302	4372	7401
		3	5604	8167	2797	7759
		4	3991	11729	2933	10069
		5	2930	9015	2416	8266
Hicklin RD1	5	1	1701	6164	1991	6164
		2	2758	11011	4685	11011
		3	4957	7108	3005	7108
		4	4278	10358	3357	10358
		5	3324	8793	2888	8793
B&G BTT	6	1	1230	5970	2464	6642
		2	2325	10006	4268	10463
		3	4362	6986	2729	8470
		4	3851	9344	2406	10722
		5	2637	7869	2286	9069
HEKA FP	7	1	1444	7300	1418	7300
		2	61	10550	96	10550
		3	3797	8000	2158	8000
		4		11850		11850
		5		0		0
RAI fixed RD	9	1	1741	5450	2127	5750
		2	2622	9500	4411	8450
		3	5873	8400	3175	7950
		4	3746	9300	3395	8800
		5	3251	8250	2838	8350
5b Hicklin RD2	1	1	1805	6324	2517	6324
		2	3375	10692	4536	10692
		3	4103	7125	3593	7125
		4	4469	10313	3218	10313
		5	4206	8155	3140	8155

Replicate 2	3s-2	Laden	some weak brakes			
Station #	Axle #	LBF	LWT	RBF	RWT	
Hunter FP	1	1	1625	6180	1911	6070
		2	2679	8710	3976	8070
		3	5343	8370	3014	8500
		4	3931	8220	2918	8430
		5	3290	8170	2510	8260
RAI RD	2	1	1790	6400	2051	6400
		2	2954	14000	4353	14000
		3	4892	8300	3373	8300
		4	4362	13750	3269	13750
		5	3355	9900	2954	9900
VIS RD	3	1	1951	5307	2018	5328
		2	2563	9970	5134	9916
		3	2308	5254	3384	5590
		4	2193	7895	3687	8348
		5	2321	5220	2853	5597
VRTC Fixed RD	4	1	1960	6517	2153	5364
		2	2743	11362	4446	10144
		3	6077	7622	3458	7293
		4	4290	11736	3620	9686
		5	3720	9404	3127	8348
Hicklin RD1	5	1	2236	6209	2335	6209
		2	3001	10892	5601	10892
		3	5169	7306	3582	7306
		4	4212	10198	3719	10198
		5	3435	8889	3287	8889
B&G BTT	6	1	1612	5679	1668	6445
		2	2562	9397	4254	11507
		3	4369	7569	3191	9028
		4	3511	8002	3148	10618
		5	2777	7878	2586	9482
HEKA FP	7	1	1480	6350	1682	6350
		2	2422	9900	3471	9900
		3	4563	8050	2528	8050
		4	3444	11300	2096	11300
		5	2387	7250	1585	7250
RAI fixed RD	9	1	1835	5200	2172	5750
		2	2662	9500	4402	8700
		3	6106	7850	3427	7950
		4	4150	9050	3314	8950
		5	3436	8150	2842	8550
5b Hicklin RD2	1	1	1932	6050	2176	6050
		2	3268	10675	4615	10675
		3	6284	6734	3609	6734
		4	4141	10620	3344	10620
		5	3722	8138	3001	8138

Replicate 3	3s-2	Laden	some weak brakes			
Station #	Axle #	LBF	LWT	RBF	RWT	
Hunter FP	1	1	1752	6180	1960	6030
		2	2996	8530	4335	8120
		3	5791	8370	3115	8480
		4	3725	8090	2967	8530
		5	3243	8230	2553	8180
RAI RD	2	1	1830	6300	1992	6300
		2	2986	13750	4474	13750
		3	4964	8900	3624	8900
		4	4245	14050	3427	14050
		5	3499	10100	2793	10100
VIS RD	3	1	1776	5281	2261	5334
		2	2503	9835	5383	10124
		3	2200	5213	3479	5348
		4	2422	8207	4138	8685
		5	2220	5381	3176	5610
VRTC Fixed RD	4	1	1904	6552	2239	5192
		2	2939	10926	4831	10332
		3	6147	7333	3674	7096
		4	4267	11747	3259	9400
		5	3796	9302	3047	7796
Hicklin RD1	5	1	2281	6160	2614	6160
		2	3249	10839	5713	10839
		3	3989	6976	3543	6976
		4	4421	10178	4347	10178
		5	3753	9006	3287	9006
B&G BTT	6	1	1616	5679	3146	6125
		2	3099	9989	0	9771
		3	4333	7118	3076	8263
		4	3535	7975	4005	10987
		5	3289	8002	2884	9637
HEKA FP	7	1	1832	6500	1568	6500
		2	2828	10250	3480	10250
		3	4651	8050	3101	8050
		4	4220	11350	2801	11350
		5	3189	7300	2185	7300
RAI fixed RD	9	1	1988	5400	2222	5800
		2	2752	9450	4735	8750
		3	5850	8250	3490	8150
		4	4002	8900	3053	9100
		5	3543	8200	2815	8450

Table C2. Data from 3 replicates for Test 2: Laden 2-axle with weak brakes.

Replicate 1

Station #	Axle #	LBF	LWT	RBF	RWT
Hunter FP	1	1191	5870	3274	5600
	2	4305	10570	2865	10420
RAI RD	1	1273	5750	3283	5750
	2	4834	10700	3741	10700
VIS RD	1	1527	5429	3270	5328
	2	3452	10329	2395	10010
VRTC	1	1277	5850	3301	5410
	2	4803	10913	3223	10145
Hicklin RD1	1	1361	5566	3106	5566
	2	4566	10423	3427	10423
B&G BTT	1	1343	5025	2411	5526
	2	4417	9423	3293	10443
HEKA FP	1	969	10470	2308	10470
	2	3665	0	2511	0
RAI fixed RD	1	1286	5800	2851	5600
	2	4510	10750	3314	10650
Hicklin RD2	1	1605	5560	3241	5560
	2	4980	10273	3417	10273

Replicate 2

Station #	Axle #	LBF	LWT	RBF	RWT
Hunter FP	1	1558	5870	3097	5600
	2	4466	10710	3334	10450
RAI RD	1	1385	5700	3112	5700
	2	4712	10650	3692	10650
VIS RD	1	1393	5617	2987	5368
	2	1998	10279	3613	10111
VRTC	1	1475	5968	3395	5311
	2	4869	10829	3795	10264
Hicklin RD1	1	1452	5530	3561	5530
	2	4540	10363	3370	10363
B&G BTT	1	1364	5105	2523	5443
	2	4460	9326	3150	10753
HEKA FP	1	969	10845	2572	10845
	2	4052	0	2643	0
RAI fixed RD	1	1349	5900	3242	5400
	2	5005	10700	3737	10350

Replicate 3

Station #	Axle #	LBF	LWT	RBF	RWT
Hunter FP	1	1242	5890	2864	5570
	2	4293	10640	3133	10430
RAI RD	1	1498	5700	3508	5700
	2	4690	10650	3962	10650
VIS RD	1	1621	5536	3102	5267
	2	2617	10178	4044	10030
VRTC	1	1479	5955	3297	5209
	2	5089	11296	3913	9702
Hicklin RD1	1	1475	5542	3390	5542
	2	4512	10421	3566	10421
B&G BTT	1	1301	4963	2530	5474
	2	4515	9194	3476	9875
HEKA FP	1	1180	10200	2731	10200
	2	4070	10050	2757	10050
RAI fixed RD	1	1444	5800	3197	5450
	2	4924	10750	3732	10550

Table C3. Data from 3 replicates for Test 3: Empty 3-S2 with weak brakes.

Replicate 1 3s-2 Empty some weak brakes						Replicate 2 3s-2 Empty some weak brakes						Replicate 3 3s-2 Empty some weak brakes								
Station #	Axle #	LBF	LWT	RBF	RWT	Station #	Axle #	LBF	LWT	RBF	RWT	Station #	Axle #	LBF	LWT	RBF	RWT			
Hunter FP	1	1	750	5120	1732	4970	Hunter FP	1	1	725	5080	2101	4980	Hunter FP	1	1	742	5080	2017	4920
	2	1075	3010	225	2750	2		1370	3030	1009	2930	2	1294		3120	1296	2920			
	3	1792	2980	973	2960	3		1815	2920	542	2800	3	1684		2920	460	2880			
	4	718	2280	373	2300	4		1637	2300	886	2200	4	1424		2300	943	2230			
	5	327	2390	297	2300	5		884	2360	671	2380	5	928		2360	633	2340			
RAI RD	2	1	868	5100	1664	5100	RAI RD	2	1	913	5100	2028	5100	RAI RD	2	1	1003	5150	2087	5150
	2	1192	6150	1057	6150	2		1498	6000	1767	6000	2	1484		6000	1736	6000			
	3	1579	2800	675	2800	3		1988	2700	733	2700	3	1767		2750	670	2750			
	4	1178	4700	639	4700	4		1750	4250	1255	4250	4	1705		4750	1107	4750			
	5	545	3250	486	3250	5		976	2950	976	2950	5	1102		3050	864	3050			
VIS RD	3	1	868	4715	1716	4806	VIS RD	3	1	901	4820	2039	4750	VIS RD	3	1	1002	4799	2139	4708
	2	1258	3512	1144	3498	2		1574	3491	1675	3582	2	1500		3414	1520	3428			
	3	1426	1805	733	2833	3		1520	2035	686	2203	3	1466		1987	780	2147			
	4	1231	2105	780	2294	4		1547	2175	1123	2175	4	1366		2140	1164	2224			
	5	625	1070	612	1413	5		1056	1301	989	1455	5	962		979	935	1371			
VRTC Fixed RD	4	1	896	5143	1994	4791	VRTC Fixed RD	4	1	960	5659	1848	4270	VRTC Fixed RD	4	1	920	5483	2076	4355
	2	1191	2836	1034	2697	2		1512	3109	1604	2668	2	1496		3014	1498	2472			
	3	1544	2568	806	2409	3		1640	2958	668	1933	3	1592		2649	733	2725			
	4	1056	4022	830	2847	4		1744	3981	1189	2638	4	1472		4225	1148	2613			
	5	584	2542	488	2261	5		1040	2674	847	2343	5	1056		2713	871	2149			
Hicklin RD1	5	1	890	4968	1860	4968	Hicklin RD1	5	1	1034	4970	2153	4970	Hicklin RD1	5	1	924	4862	2279	4862
	2	1347	4972	1132	4972	2		1627	4768	1736	4768	2	1746		4708	1955	4708			
	3	1624	2270	799	2270	3		1431	2302	649	2302	3	1366		2186	679	2186			
	4	1268	3294	773	3294	4		1820	3304	1356	3304	4	1979		3627	1368	3627			
	5	663	2578	553	2578	5		1258	2523	1132	2523	5	1165		2756	968	2756			
B&G BTT	6	1	553	5228	1400	6022	B&G BTT	6	1	691	4487	2104	5134	B&G BTT	6	1	736	5069	1881	5774
	2	1050	5175	701	5960	2		1470	5582	1313	5722	2	1423		5184	1430	5681			
	3	1287	2579	474	2324	3		1559	2535	436	2128	3	1597		2588	436	2169			
	4	568	3895	438	4245	4		1188	4204	1008	4442	4	1586		3577	872	4152			
	5	320	2508	401	3088	5		841	2570	765	3264	5	835		2464	645	3047			
HEKA FP	7	1	748	5550	1471	5550	HEKA FP	7	1	678	5350	2229	5350	HEKA FP	7	1	713	5450	1894	5450
	2	995	4550	546	4550	2		2440	4450	1409	4450	2	1277		4450	1048	4450			
	3	1356	3150	414	3150	3		2114	3000	740	3000	3	1691		3250	458	3250			
	4	660	4300	343	4300	4		1242	4800	792	4800	4	1198		4900	766	4900			
	5	405	2300	273	2300	5		872	2150	660	2150	5	837		2250	537	2250			
RAI fixed RD	9	1	949	4550	1799	5050	RAI fixed RD	9	1	1039	4700	2267	4850	RAI fixed RD	9	1	1035	4800	2073	4950
	2	1147	2950	1196	2800	2		1448	3000	1597	2750	2	1570		3000	2015	2800			
	3	1601	2750	666	2700	3		1727	2800	751	2650	3	1943		2750	832	2650			
	4	1120	2450	572	2300	4		1367	2500	1201	2750	4	1925		2550	1237	2500			
	5	572	2250	374	2500	5		1030	2350	792	2500	5	1201		2200	828	2450			

Table C4. Data from 3 replicates for Test 4: Empty 2-axle with weak brakes.

Replicate 1

Station #	Axle #	LBF	LWT	RBF	RWT
Hunter FP	1	915	4060	2086	3770
	2	2601	4650	1040	4260
RAI RD	1	1026	3900	2096	3900
	2	3044	4450	1529	4450
VIS RD	1	989	3720	2113	3531
	2	1931	4292	1554	4002
VRTC	1	942	4316	2192	3282
	2	2791	5077	1194	3685
Hicklin RD1	1	1130	3757	2372	3757
	2	2637	4298	1296	4298
B&G BTT	1	965	3692	2450	3873
	2	2971	4027	1263	4535
HEKA FP	1	828	4250	1788	4250
	2	2748	4700	1022	4700
RAI fixed RD	1	981	4150	2348	3900
	2	3004	4500	1439	4300

Replicate 2

Station #	Axle #	LBF	LWT	RBF	RWT
Hunter FP	1	1063	4090	2059	3740
	2	2840	4650	1102	4280
RAI RD	1	1035	3900	2316	3900
	2	3179	4500	1399	4500
VIS RD	1	1090	3854	2025	3572
	2	1877	4433	1769	4056
VRTC	1	948	4321	2277	3350
	2	2834	4805	1182	3969
Hicklin RD1	1	1236	3792	2614	3792
	2	2688	4301	1405	4301
B&G BTT	1	1052	3559	2375	3935
	2	3149	4310	1725	4514
HEKA FP	1	837	4250	1682	4250
	2	2440	4850	881	4850
RAI fixed RD	1	1093	4050	2321	3850
	2	2829	4600	1619	4400

Replicate 3

Station #	Axle #	LBF	LWT	RBF	RWT
Hunter FP	1	989	4090	2180	3730
	2	2884	4620	1057	4270
RAI RD	1	1050	3900	2074	3900
	2	3200	4500	1400	4500
VIS RD	1	1063	3834	2018	3624
	2	2826	4393	1292	4197
VRTC	1	898	4421	1832	3265
	2	2838	4713	1273	4076
Hicklin RD1	1	1167	3868	2330	3868
	2	2755	4330	1322	4330
B&G BTT	1	1000	4177	2284	4741
	2	3038	4142	285	4524
HEKA FP	1	784	4250	1585	4250
	2	2361	4850	854	4850
RAI fixed RD	1	1044	3950	2186	3900
	2	2874	4450	1318	4400

Table C5. Test 5: Empty 2-axle with fully adjusted brakes, dry (3 replicates).

Replicate 1		Wheel 1L			Wheel 1R			Wheel 2L			Wheel 2R		
		BF	WT	decel	BF	WT	decel	BF	WT	decel	BF	WT	decel
1	Hunter FP	3631	4060	0.89	3452	3740	0.92	3748	4600	0.81	3505	4280	0.82
2	RAI RD	2972	3900	0.76	2604	3900	0.67	3377	4450	0.76	3260	4450	0.73
3	VIS RD	1534	3834	0.40	2254	3659	0.62	1917	4372	0.44	2247	4183	0.54
4	VRTC	2716	4225	0.64	2409	3481	0.69	2680	5150	0.52	2610	3648	0.72
5	HEI RD1	2547	3840	0.66	2271	3840	0.59	2793	4329	0.65	2770	4329	0.64
6	B&G BTT	2566	3842	0.67	2433	4256	0.57	5329	4389	1.21	5287	4617	1.15
7	HEKA FP	3295	4250	0.78	3118	4250	0.73	4405	4750	0.93	3568	4750	0.75
8	20mph stop												
9	RAI fixed RD	2999	4050	0.74	2244	3650	0.61	2658	4500	0.59	2518	4450	0.57
5b	HEI RD2-n	3143	3864	0.81	2823	3864	0.73	2433	4438	0.55	2269	4438	0.51
5c	HEI RD2-ILRSD	2590	3894	0.67	2304	3894	0.59	2572	4270	0.60	2165	4270	0.51
Replicate 2		Wheel 1L			Wheel 1R			Wheel 2L			Wheel 2R		
		BF	WT	decel	BF	WT	decel	BF	WT	decel	BF	WT	decel
1	Hunter FP	3352	4070	0.82	3139	3690	0.85	4168	4640	0.90	3603	4230	0.85
2	RAI RD	2923	3950	0.74	2937	3950	0.74	2977	4450	0.67	3184	4450	0.72
3	VIS RD	1668	3799	0.44	2187	3617	0.60	2025	4386	0.46	2328	4197	0.55
4	VRTC	2423	3766	0.64	2315	3892	0.59	2874	4669	0.62	2641	4091	0.65
5	HEI RD1	2240	3852	0.58	2123	3852	0.55	2865	4375	0.65	2766	4375	0.63
6	B&G BTT	2579	3709	0.70	2606	3842	0.68	5335	4389	1.22	5298	4535	1.17
7	HEKA FP	3268	4150	0.79	3118	4150	0.75	4202	4750	0.88	3744	4750	0.79
8	20mph stop												
9	RAI fixed RD	3004	4050	0.74	2469	3750	0.66	2703	4600	0.59	2406	4300	0.56
5b	HEI RD2-n	2910	3878	0.75	2501	3878	0.64	2455	4350	0.56	2166	4350	0.50
5c	HEI RD2-ILRSD	2749	3858	0.71	1728	3858	0.45	2850	4277	0.67	2069	4277	0.48
Replicate 3		Wheel 1L			Wheel 1R			Wheel 2L			Wheel 2R		
		BF	WT	decel	BF	WT	decel	BF	WT	decel	BF	WT	decel
1	Hunter FP	3364	4050	0.83	3229	3720	0.87	3852	4660	0.83	3510	4260	0.82
2	RAI RD	2986	3900	0.77	2658	3900	0.68	2662	4500	0.59	3224	4500	0.72
3	VIS RD	1756	3806	0.46	2005	3638	0.55	1857	4365	0.43	2664	4155	0.64
4	VRTC	2791	4106	0.68	2674	3499	0.76	2778	4820	0.58	2699	3952	0.68
5	HEI RD1	2692	3821	0.70	2471	3821	0.65	2685	4269	0.63	2599	4269	0.61
6	B&G BTT	2576	3992	0.65	2608	4380	0.60	5353	4442	1.21	5257	4731	1.11
7	HEKA FP	2951	4050	0.73	2828	4050	0.70	4299	4800	0.90	3814	4800	0.79
8	20mph stop												
9	RAI fixed RD	3022	4150	0.73	2397	3550	0.68	2748	4550	0.60	2478	4300	0.58
5b	HEI RD2-n	2453	3921	0.63	2215	3921	0.56	3566	4305	0.83	3017	4305	0.70
5c	HEI RD2-ILRSD	1843	3834	0.48	1467	3834	0.38	3113	4215	0.74	2331	4215	0.55

Table C6. Test 6: 1/3 laden 2-axle with fully adjusted brakes, dry (3 replicates).

Replicate 1		Wheel 1L			Wheel 1R			Wheel 2L			Wheel 2R		
		BF	WT	decel	BF	WT	decel	BF	WT	decel	BF	WT	decel
1	Hunter FP	2421	4870	0.50	2183	4510	0.48	4723	6990	0.68	4605	6410	0.72
2	RAI RD	3472	4650	0.75	3593	4650	0.77	3930	6700	0.59	3566	6700	0.53
3	VIS RD	1904	4736	0.40	2550	4512	0.57	2240	6919	0.32	3465	6478	0.53
4	VRTC	3027	5226	0.58	2993	3976	0.75	4169	7313	0.57	4025	5977	0.67
5	Hicklin RD1	2876	4521	0.64	2642	4521	0.58	3997	6573	0.61	4004	6573	0.61
6	B&G BTT	2533	4645	0.55	2650	5051	0.52	5345	6562	0.81	5294	6673	0.79
7	HEKA FP	3700	5150	0.72	3383	5150	0.66	4845	7550	0.64	4211	7550	0.56
8	20mph stop												
9	RAI fixed RD	3436	4800	0.72	3224	4500	0.72	3755	6900	0.54	3526	6550	0.54
5b	Hicklin RD2	3788	4556	0.83	3244	4556	0.71	3879	6575	0.59	3417	6575	0.52
5c	Hicklin RD2	3379	4608	0.73	2765	4608	0.60	3060	6502	0.47	1288	6502	0.20
Replicate 2		Wheel 1L			Wheel 1R			Wheel 2L			Wheel 2R		
		BF	WT	decel	BF	WT	decel	BF	WT	decel	BF	WT	decel
1	Hunter FP	3866	4870	0.79	3686	4430	0.83	5489	6940	0.79	5250	6440	0.82
2	RAI RD	3512	4650	0.76	3220	4650	0.69	3989	6700	0.60	3764	6700	0.56
3	VIS RD	1991	4694	0.42	2833	4456	0.64	2052	6856	0.30	3613	6436	0.56
4	VRTC	3175	4589	0.69	2959	4572	0.65	3831	7317	0.52	3844	5930	0.65
5	Hicklin RD1	2987	4535	0.66	2712	4535	0.60	3946	6603	0.60	3932	6603	0.60
6	B&G BTT	2555	4487	0.57	2521	4937	0.51	5334	6535	0.82	5266	6859	0.77
7	HEKA FP	3823	5200	0.74	3515	5200	0.68	4731	6850	0.69	4211	6850	0.61
8	20mph stop												
9	RAI fixed RD	3350	4850	0.69	2847	4550	0.63	3876	6900	0.56	3395	6550	0.52
5b	Hicklin RD2	3596	4556	0.79	3269	4556	0.72	3915	6527	0.60	3519	6527	0.54
5c	Hicklin RD2	3730	4562	0.82	2553	4562	0.56	4010	6532	0.61	2044	6532	0.31
Replicate 3		Wheel 1L			Wheel 1R			Wheel 2L			Wheel 2R		
		BF	WT	decel	BF	WT	decel	BF	WT	decel	BF	WT	decel
1	Hunter FP	3775	4870	0.78	3558	4460	0.80	5205	6940	0.75	4993	6460	0.77
2	RAI RD	3620	4650	0.78	3085	4650	0.66	4258	6750	0.63	3993	6750	0.59
3	VIS RD	1931	4652	0.42	2691	4442	0.61	2180	6800	0.32	3748	6450	0.58
4	VRTC	2930	4686	0.63	2909	4551	0.64	4009	7135	0.56	3890	6135	0.63
5	Hicklin RD1	2956	4545	0.65	2765	4545	0.61	3873	6465	0.60	3789	6465	0.59
6	B&G BTT	2535	4389	0.58	2483	4793	0.52	5342	6562	0.81	5263	6848	0.77
7	HEKA FP	3524	4900	0.72	3162	4900	0.65	4202	7550	0.56	3629	7550	0.48
8	20mph stop												
9	RAI fixed RD	3521	5000	0.70	2712	4400	0.62	3543	6900	0.51	3409	6550	0.52
5b	Hicklin RD2	3818	4620	0.83	3098	4620	0.67	4258	6576	0.65	3830	6576	0.58
5c	Hicklin RD2	1970	4516	0.44	2080	4516	0.46	4206	6534	0.64	3392	6534	0.52

Table C7. Test 7: 2/3 laden 2-axle with fully adjusted brakes, dry (3 replicates).

Replicate 1		Wheel 1L			Wheel 1R			Wheel 2L			Wheel 2R		
		BF	WT	decel	BF	WT	decel	BF	WT	decel	BF	WT	decel
1	Hunter FP	3400	5530	0.61	3510	5040	0.70	5208	9800	0.53	4433	8780	0.50
2	RAI RD	4366	5250	0.83	3998	5250	0.76	4811	9300	0.52	4573	9300	0.49
3	VIS RD	1931	5359	0.36	3263	4974	0.66	2180	9858	0.22	5161	8752	0.59
4	VRTC	3509	5795	0.61	3307	4550	0.73	5008	10472	0.48	4188	7990	0.52
5	Hicklin RD1	3374	5093	0.66	2971	5093	0.58	4943	9163	0.54	4850	9163	0.53
6	B&G BTT	2598	4919	0.53	2573	5268	0.49	5377	8655	0.62	5252	8842	0.59
7	HEKA FP	3841	5400	0.71	3392	5400	0.63	458	9250	0.05	0	9250	0.00
8	20mph stop												
9	RAI fixed RD	3723	5400	0.69	3391	5050	0.67	5513	9900	0.56	4834	8900	0.54
5b	Hicklin RD2	3454	5189	0.67	3463	5189	0.67	4897	9116	0.54	4344	9116	0.48
5c	Hicklin RD2	4604	5171	0.89	2289	5171	0.44	6023	9083	0.66	2600	9083	0.29
Replicate 2		Wheel 1L			Wheel 1R			Wheel 2L			Wheel 2R		
		BF	WT	decel	BF	WT	decel	BF	WT	decel	BF	WT	decel
1	Hunter FP	4016	5530	0.73	4085	4990	0.82	5901	9790	0.60	5004	8820	0.57
2	RAI RD	4218	5200	0.81	3917	5200	0.75	4775	9300	0.51	4137	9300	0.44
3	VIS RD	1965	5310	0.37	3257	4967	0.66	2456	9879	0.25	4751	8654	0.55
4	VRTC	3618	5491	0.66	3499	4852	0.72	5050	10082	0.50	3949	8336	0.47
5	Hicklin RD1	3198	5075	0.63	3223	5075	0.64	5156	9136	0.56	4934	9136	0.54
6	B&G BTT	2572	4593	0.56	2625	4927	0.53	5377	8381	0.64	5021	8924	0.56
7	HEKA FP	4079	4750	0.86	3409	4750	0.72	5286	9200	0.57	4484	9200	0.49
8	20mph stop												
9	RAI fixed RD	3813	5400	0.71	3494	5000	0.70	6192	9850	0.63	4717	8850	0.53
5b	Hicklin RD2	3688	5194	0.71	3393	5194	0.65	4242	9091	0.47	3546	9091	0.39
5c	Hicklin RD2	2765	5148	0.54	2594	5148	0.50	5582	9139	0.61	3373	9139	0.37
Replicate 3		Wheel 1L			Wheel 1R			Wheel 2L			Wheel 2R		
		BF	WT	decel	BF	WT	decel	BF	WT	decel	BF	WT	decel
1	Hunter FP	4070	5500	0.74	4006	5010	0.80	5913	9880	0.60	5289	8780	0.60
2	RAI RD	4299	5200	0.83	3989	5200	0.77	4569	9350	0.49	4380	9350	0.47
3	VIS RD	1958	5345	0.37	2880	4960	0.58	4730	9732	0.49	4858	8808	0.55
4	VRTC	3376	5174	0.65	3495	4602	0.76	5485	9515	0.58	4581	7879	0.58
5	Hicklin RD1	3329	5105	0.65	3124	5105	0.61	5476	9043	0.61	5110	9043	0.57
6	B&G BTT	2522	4601	0.55	2545	5010	0.51	5360	8284	0.65	5281	9121	0.58
7	HEKA FP	4096	5100	0.80	3682	5100	0.72	4969	8750	0.57	4185	8750	0.48
8	20mph stop												
9	RAI fixed RD	4047	5300	0.76	3458	5050	0.68	6232	9850	0.63	4928	8850	0.56
5b	Hicklin RD2	4432	5297	0.84	3387	5297	0.64	6403	9117	0.70	5491	9117	0.60
5c	Hicklin RD2	3121	5154	0.61	2643	5154	0.51	6256	9001	0.69	2919	9001	0.32

Table C8. Test 8: 2/3 laden 2-axle with fully adjusted brakes, wet (3 replicates).

Replicate 1		Wheel 1L			Wheel 1R			Wheel 2L			Wheel 2R		
		BF	WT	decel	BF	WT	decel	BF	WT	decel	BF	WT	decel
1	Hunter FP	3952	5480	0.72	3839	5040	0.76	5754	9870	0.58	6731	8700	0.77
2	RAI RD	3844	5266	0.73	3715	5277	0.70	5288	9276	0.57	5525	8951	0.62
3	VIS RD	1406	5422	0.26	1621	5030	0.32	2543	9963	0.26	3115	8752	0.36
4	VRTC	2683	5807	0.46	2751	4531	0.61	4486	10438	0.43	4158	8060	0.52
5	Hicklin RD1	1827	5036	0.36	1522	5036	0.30	3853	9144	0.42	3150	9144	0.34
6	B&G BTT	2562	4645	0.55	2605	5092	0.51	5285	8796	0.60	5264	8563	0.61
7	HEKA FP	4185	4900	0.85	3656	4900	0.75	5524	8500	0.65	4942	8500	0.58
8	20mph stop												
9	RAI fixed RD	3242	5400	0.60	3251	5000	0.65	5203	9900	0.53	4515	8800	0.51
5b	Hicklin RD2	3174	5150	0.62	3697	5150	0.72	6182	9467	0.65	5366	9467	0.57
Replicate 2		Wheel 1L			Wheel 1R			Wheel 2L			Wheel 2R		
		BF	WT	decel	BF	WT	decel	BF	WT	decel	BF	WT	decel
1	Hunter FP	3791	5470	0.69	3643	5040	0.72	5567	9820	0.57	6222	8730	0.71
2	RAI RD	3772	5314	0.71	3981	5317	0.75	5045	9206	0.55	5052	9272	0.54
3	VIS RD	1419	5282	0.27	1406	4952	0.28	3008	9767	0.31	3035	8801	0.34
4	VRTC	2842	5467	0.52	2393	4879	0.49	4880	9928	0.49	3755	8627	0.44
5	Hicklin RD1	1602	5026	0.32	1600	5026	0.32	4022	9060	0.44	2903	9060	0.32
6	B&G BTT	2465	4566	0.54	2568	4855	0.53	4907	8814	0.56	5311	8191	0.65
7	HEKA FP	4070	5000	0.81	3947	5000	0.79	5541	8450	0.66	4845	8450	0.57
8	20mph stop												
9	RAI fixed RD	3067	5400	0.57	3071	5100	0.60	5382	9800	0.55	4569	8950	0.51
5b	Hicklin RD2	3670	5167	0.71	3435	5167	0.66	3836	9143	0.42	4683	9143	0.51
Replicate 3		Wheel 1L			Wheel 1R			Wheel 2L			Wheel 2R		
		BF	WT	decel	BF	WT	decel	BF	WT	decel	BF	WT	decel
1	Hunter FP	3667	5460	0.67	3518	5050	0.70	5207	9850	0.53	5463	8740	0.63
2	RAI RD	3913	5275	0.74	3757	5307	0.71	5092	9235	0.55	4946	9232	0.54
3	VIS RD	1366	5338	0.26	1406	4988	0.28	2395	8731	0.27	2947	8731	0.34
4	VRTC	3077	5050	0.61	2417	4739	0.51	4893	9803	0.50	3237	8545	0.38
5	Hicklin RD1	1793	5059	0.35	1539	5059	0.30	4018	9156	0.44	2819	9156	0.31
6	B&G BTT	2544	5167	0.49	2415	5351	0.45	5341	8620	0.62	5314	9493	0.56
7	HEKA FP	4052	5050	0.80	4105	5050	0.81	5735	8150	0.70	5207	8150	0.64
8	20mph stop												
9	RAI fixed RD	3391	5400	0.63	3004	5000	0.60	5351	9800	0.55	4609	8950	0.51
5b	Hicklin RD2	3948	5119	0.77	2937	5119	0.57	4739	9069	0.52	5362	9069	0.59

Table C9. Test 9: Empty laden 2-axle with fully adjusted brakes, wet (3 replicates).

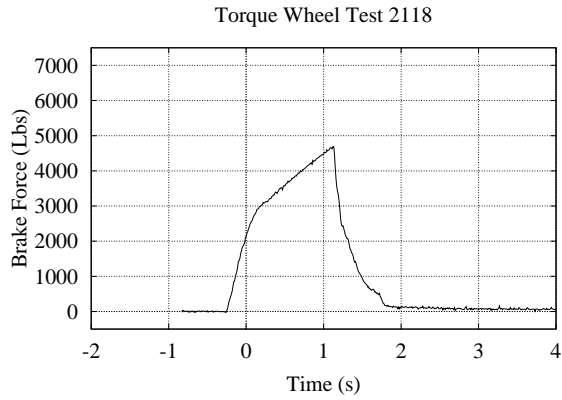
Replicate 1		Wheel 1L			Wheel 1R			Wheel 2L			Wheel 2R		
		BF	WT	decel	BF	WT	decel	BF	WT	decel	BF	WT	decel
1	Hunter FP	3706	4030	0.92	3105	3690	0.84	3283	4590	0.72	3084	4250	0.73
2	RAI RD	2617	3850	0.68	2536	3850	0.66	3049	4450	0.69	3121	4450	0.70
3	VIS RD	1318	3932	0.34	1379	3624	0.38	1668	4582	0.36	1783	4141	0.43
4	VRTC	1693	4083	0.41	2106	3499	0.60	2216	4541	0.49	2477	4266	0.58
5	Hicklin RD1	1524	3784	0.40	1142	3784	0.30	1710	4337	0.39	1753	4337	0.40
6	B&G BTT	2545	3701	0.69	2657	3966	0.67	5372	4001	1.34	5276	4349	1.21
7	HEKA FP	3268	3800	0.86	3074	3800	0.81	3638	4350	0.84	2748	4350	0.63
8	20mph stop												
9	RAI fixed RD	2352	3900	0.60	2303	3700	0.62	2563	4550	0.56	2312	4300	0.54
5b	Hicklin RD2	3354	3818	0.88	2496	3818	0.65	2104	4434	0.47	2400	4434	0.54
Replicate 2		Wheel 1L			Wheel 1R			Wheel 2L			Wheel 2R		
		BF	WT	decel	BF	WT	decel	BF	WT	decel	BF	WT	decel
1	Hunter FP	3056	4010	0.76	2247	3710	0.61	3252	4590	0.71	2943	4250	0.69
2	RAI RD	2680	3850	0.70	2446	3850	0.64	3148	4450	0.71	3449	4450	0.78
3	VIS RD	1345	3855	0.35	1292	3638	0.36	1736	4554	0.38	1668	4169	0.40
4	VRTC	1454	4053	0.36	1997	3530	0.57	2296	4852	0.47	2392	3930	0.61
5	Hicklin RD1	1496	3825	0.39	1280	3825	0.33	1816	4330	0.42	1659	4330	0.38
6	B&G BTT	2550	3639	0.70	2571	3935	0.65	5384	4054	1.33	5275	4359	1.21
7	HEKA FP	3154	3800	0.83	2246	3800	0.59	3735	4100	0.91	2863	4100	0.70
8	20mph stop												
9	RAI fixed RD	2491	3900	0.64	2217	3650	0.61	2446	4550	0.54	2163	4300	0.50
5b	Hicklin RD2	2439	3809	0.64	2115	3809	0.56	2900	4405	0.66	2668	4405	0.61
Replicate 3		Wheel 1L			Wheel 1R			Wheel 2L			Wheel 2R		
		BF	WT	decel	BF	WT	decel	BF	WT	decel	BF	WT	decel
1	Hunter FP	1997	4040	0.49	1375	3680	0.37	1975	4540	0.44	1615	4290	0.38
2	RAI RD	2671	3850	0.69	2348	3850	0.61	3665	4450	0.82	3269	4450	0.73
3	VIS RD	1271	3876	0.33	1224	3652	0.34	1776	4547	0.39	1837	4134	0.44
4	VRTC	1575	4218	0.37	2062	3398	0.61	2507	4416	0.57	2110	3836	0.55
5	Hicklin RD1	1527	3817	0.40	999	3817	0.26	1714	4327	0.40	1911	4327	0.44
6	B&G BTT	2568	3480	0.74	2604	3739	0.70	5311	4283	1.24	5317	4586	1.16
7	HEKA FP	3524	3850	0.92	2660	3850	0.69	3321	4300	0.77	2607	4300	0.61
8	20mph stop												
9	RAI fixed RD	2428	3850	0.63	2442	3800	0.64	2734	4450	0.61	2392	4300	0.56
5b	Hicklin RD2	2973	3866	0.77	2504	3866	0.65	3692	4389	0.84	2784	4389	0.63

APPENDIX D

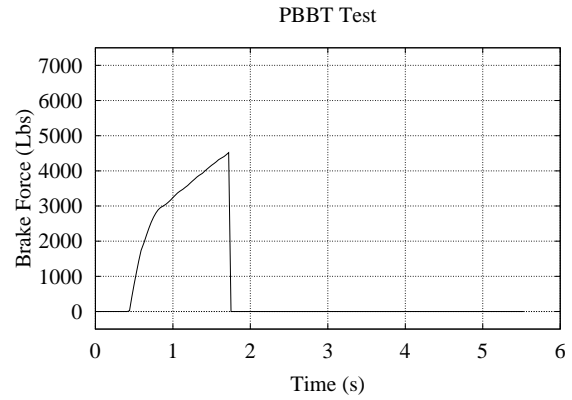
BRAKE FORCE HISTORY PLOTS

Tests 1 and 3:

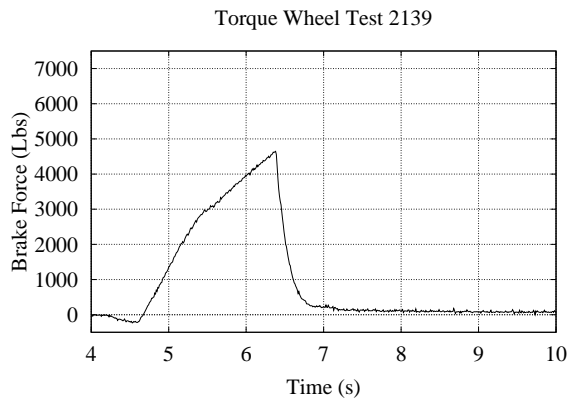
PBBT and Torque Wheel Results



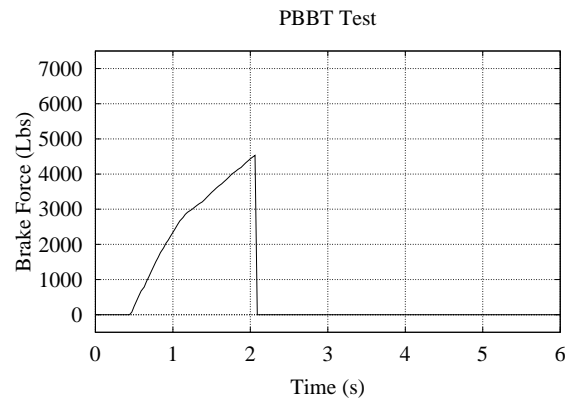
Replicate 1



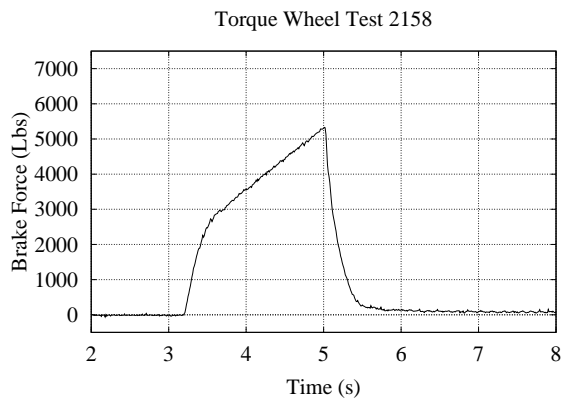
Replicate 1



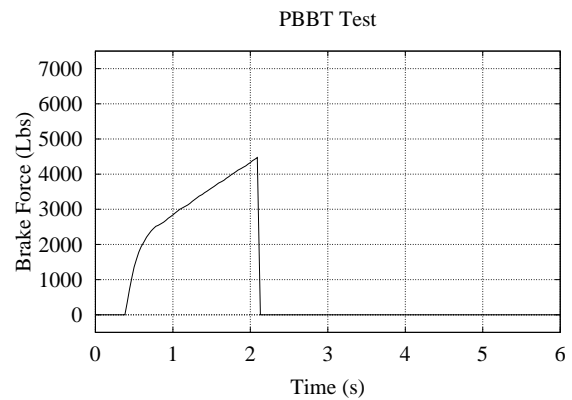
Replicate 2



Replicate 2

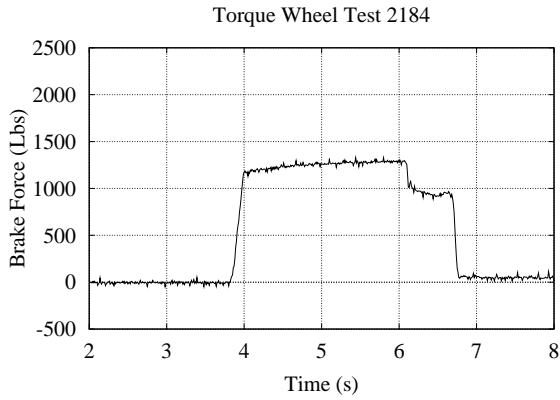


Replicate 3

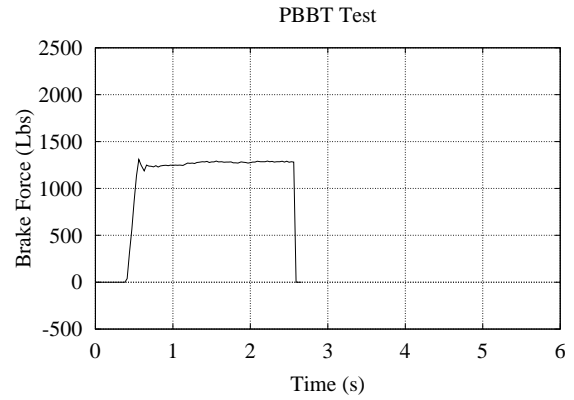


Replicate 3

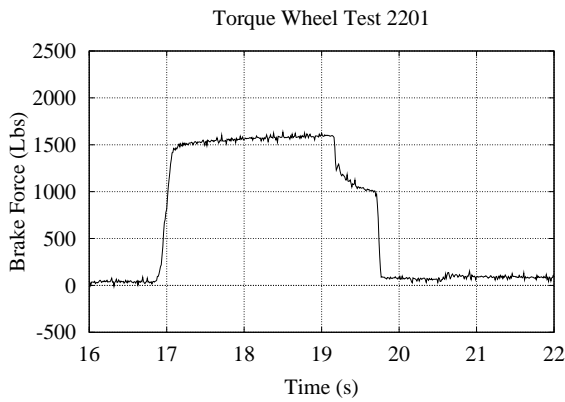
Figure D1. Brake force versus time for wheel 5 of the laden 3S-2 vehicle for 3 replicate tests with the B&G BTT. Left column plots illustrate the torque wheel data. Right column plots illustrate B&G BTT data.



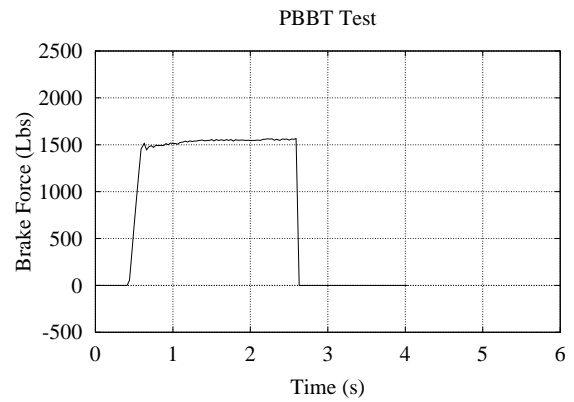
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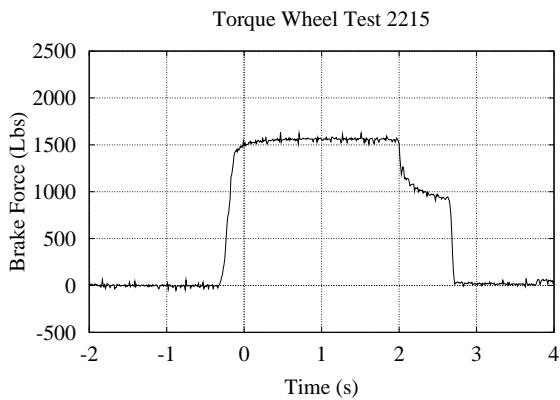
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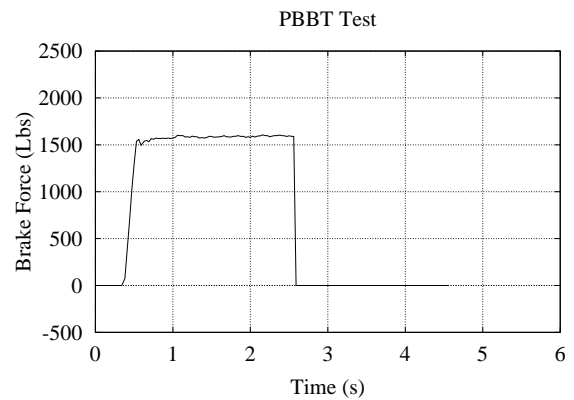
Replicate 2



Replicate 2

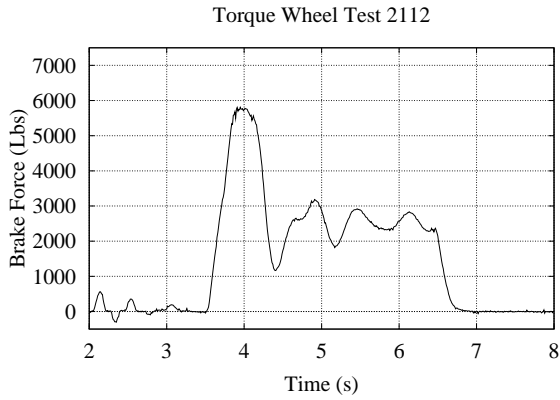


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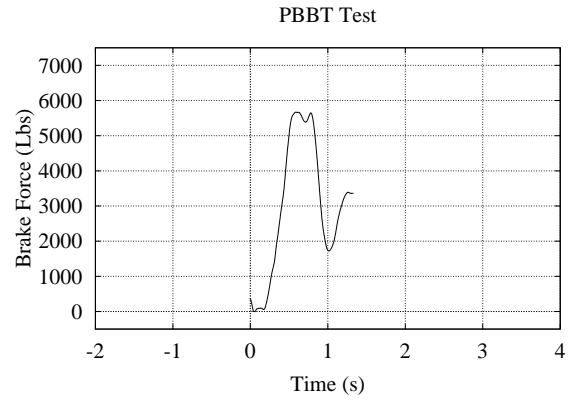


Replicate 3

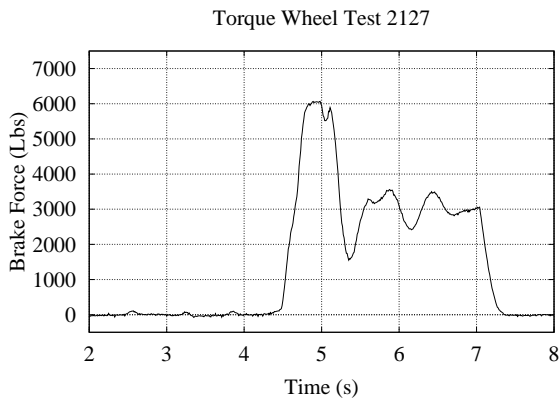
Figure D2. Brake force versus time for wheel 5 of the unladen 3S-2 vehicle for 3 replicate tests with the B&G BTT. Left column plots illustrate the torque wheel data. Right column plots illustrate B&G BTT data.



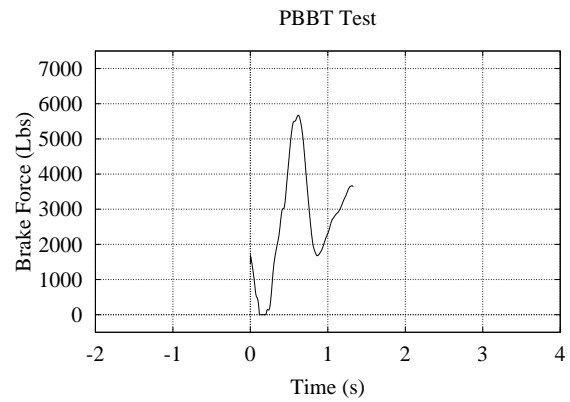
Replicate 1



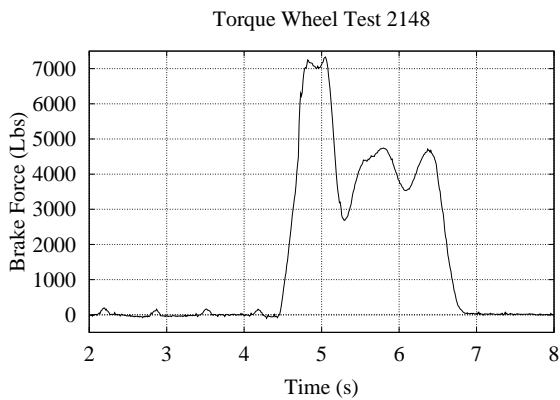
Replicate 1



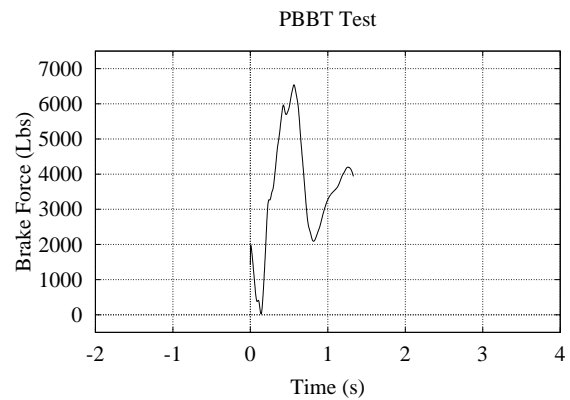
Replicate 2



Replicate 2

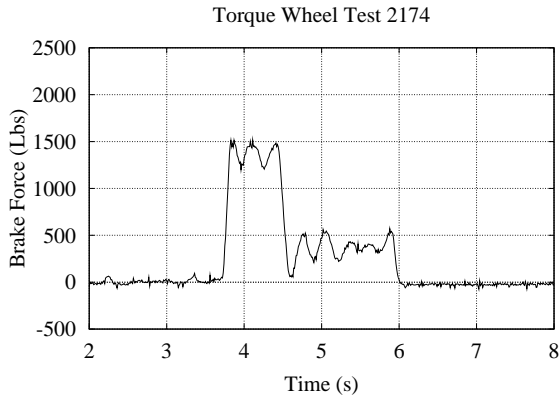


Replicate 3

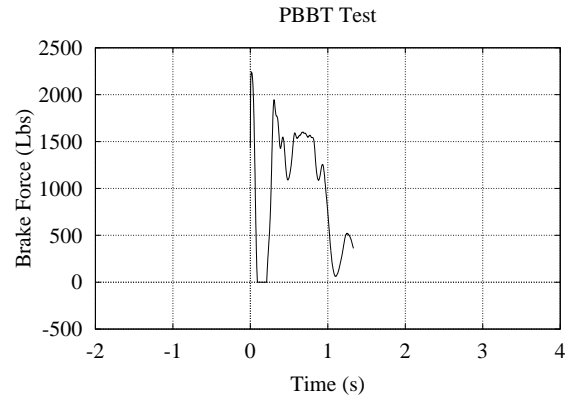


Replicate 3

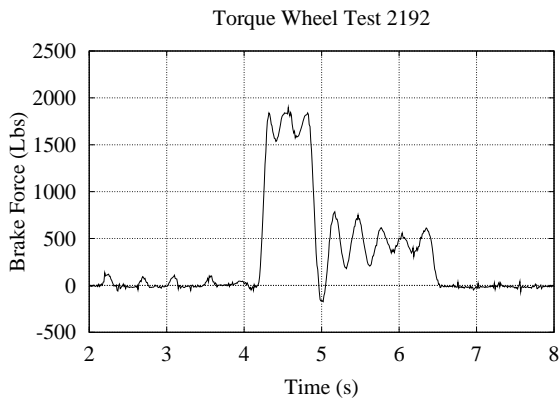
Figure D3. Brake force versus time for wheel 5 of the laden 3S-2 vehicle for 3 replicate tests with the Hunter FP. Left column plots illustrate the torque wheel data. Right column plots illustrate Hunter FP data.



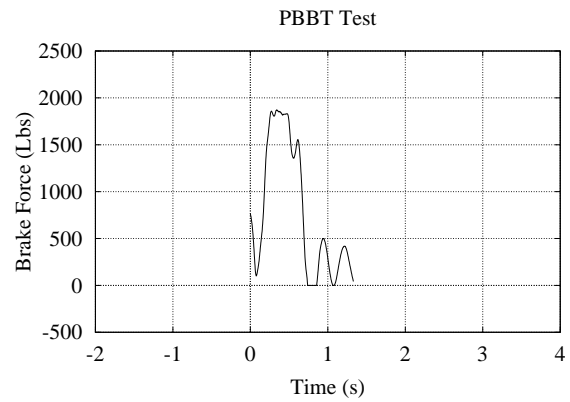
Replicate 1



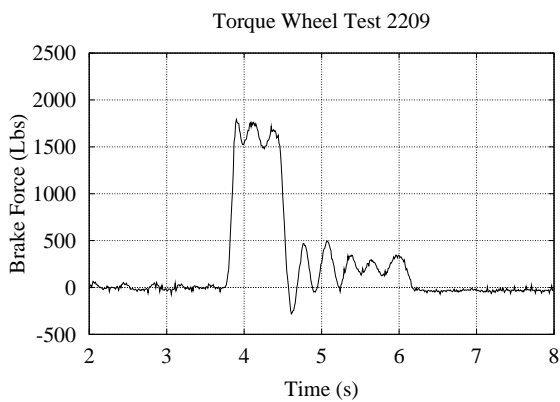
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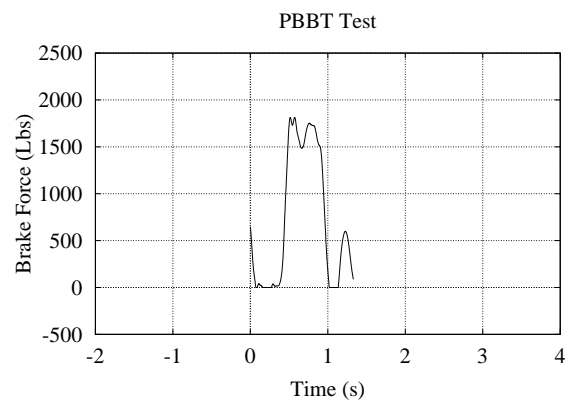
Replicate 2



Replicate 2

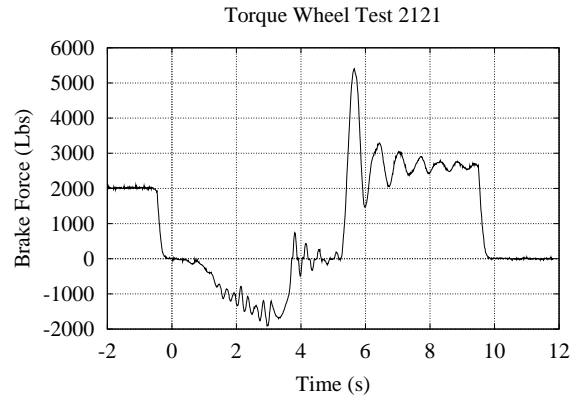


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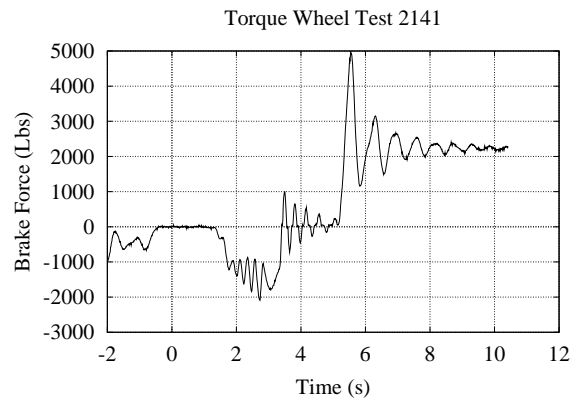


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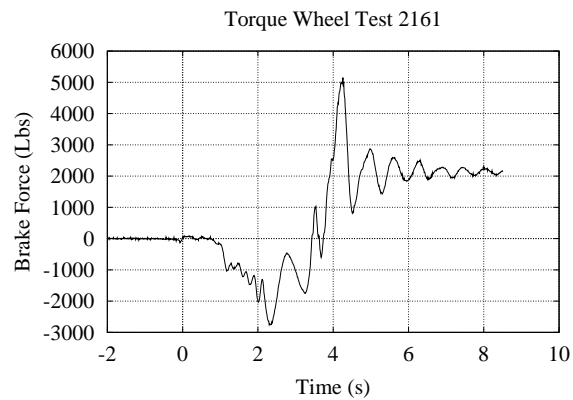
Figure D4. Brake force versus time for wheel 5 of the unladen 3S-2 vehicle for 3 replicate tests with the Hunter FP. Left column plots illustrate the torque wheel data. Right column plots illustrate Hunter FP data.



Replicate 1

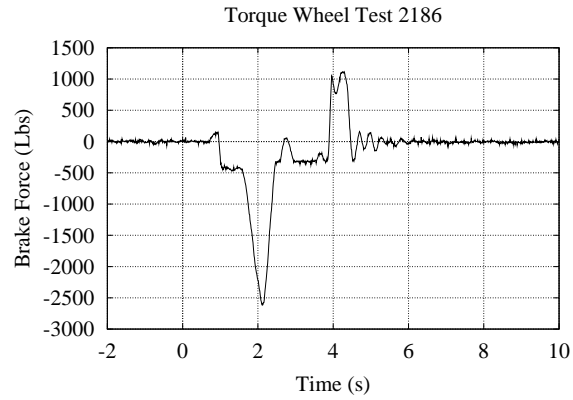


Replicate 2

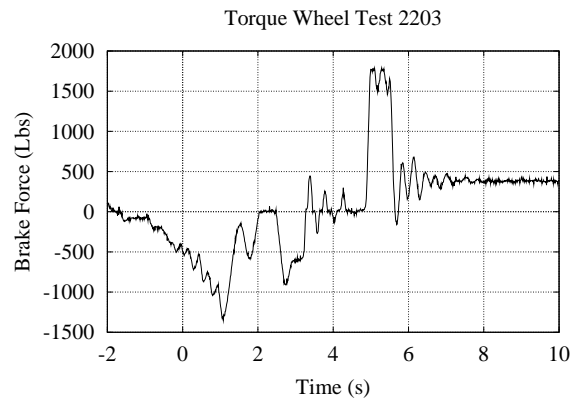


Replicate 3

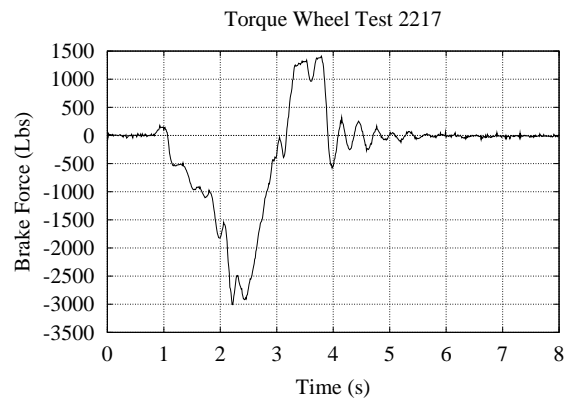
Figure D5. Brake force (collected by the torque wheel) versus time for wheel 5 of the laden 3S-2 vehicle for 3 replicate tests with the Heka FP.



Replicate 1

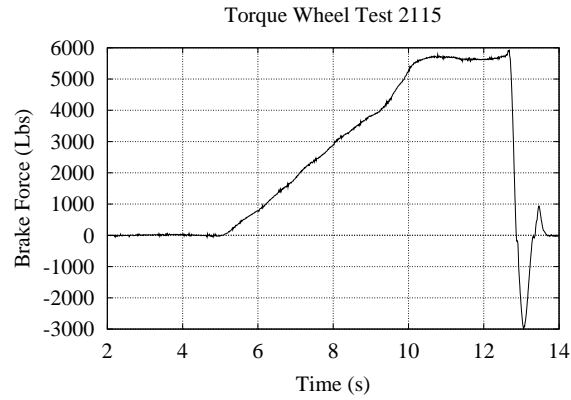


Replicate 2

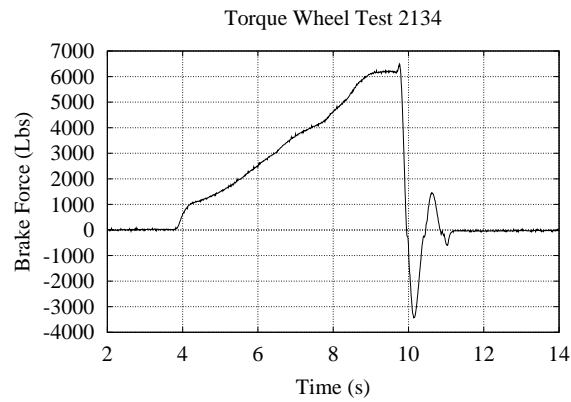


Replicate 3

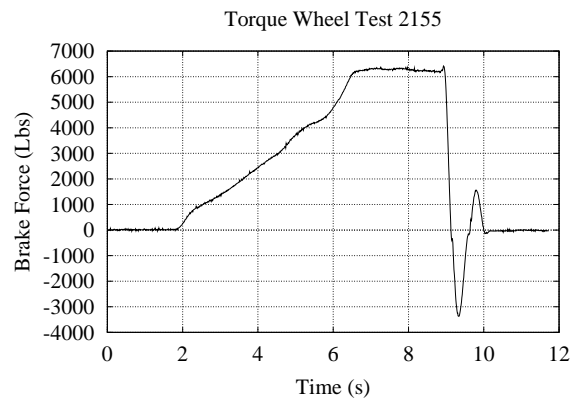
Figure D6. Brake force (collected by the torque wheel) versus time for wheel 5 of the unladen 3S-2 vehicle for 3 replicate tests with the Heka FP.



Replicate 1

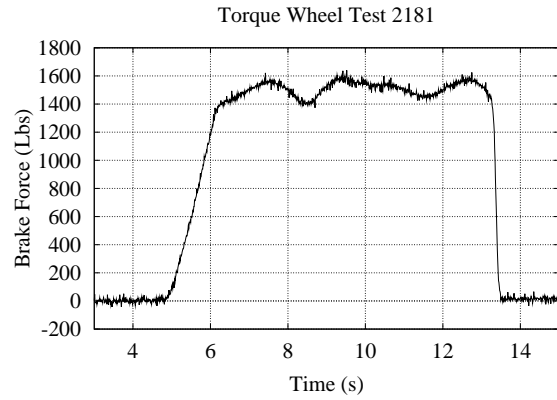


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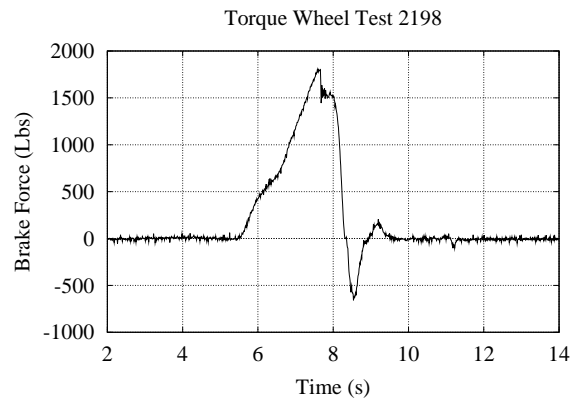


Replicate 3

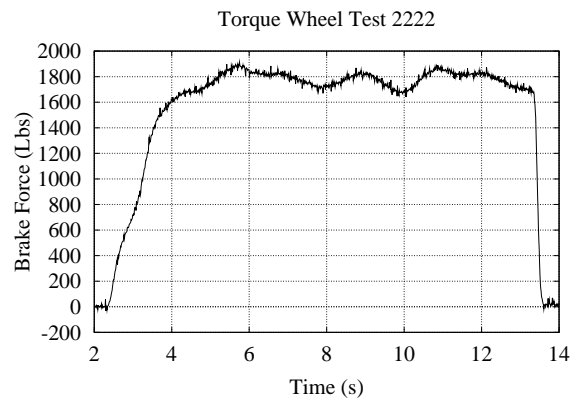
Figure D7. Brake force (collected by the torque wheel) versus time for wheel 5 of the laden 3S-2 vehicle for 3 replicate tests with the VRTC RD.



Replicate 1

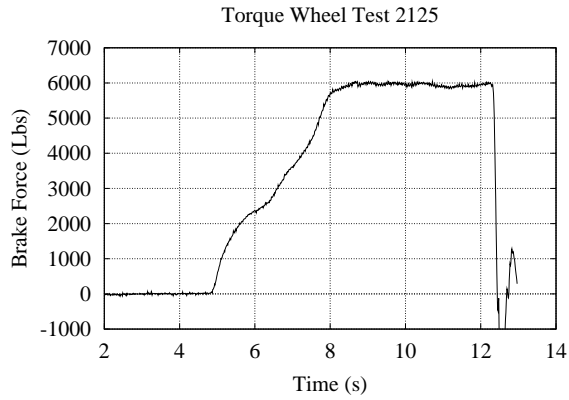


Replicate 2

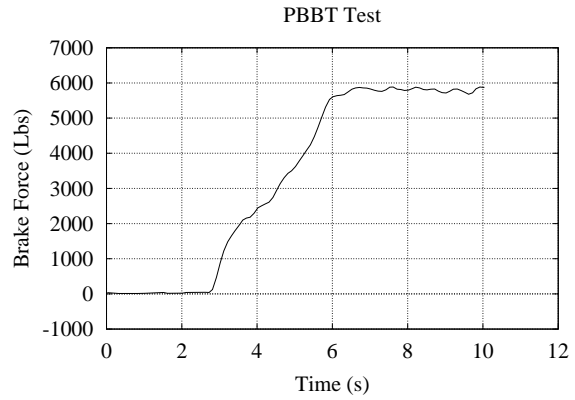


Replicate 3

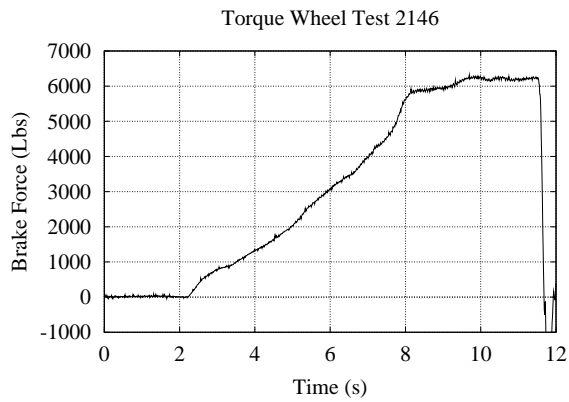
Figure D8. Brake force (collected by the torque wheel) versus time for wheel 5 of the unladen 3S-2 vehicle for 3 replicate tests with the VRTC RD.



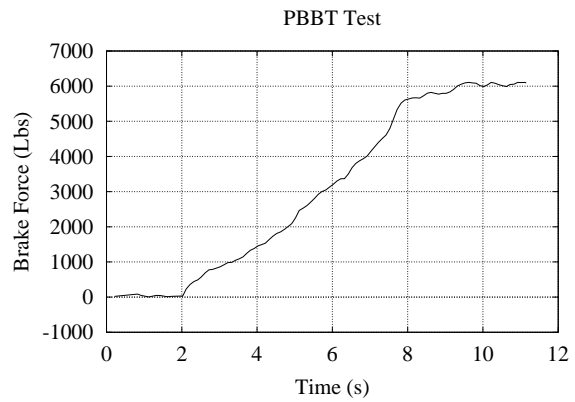
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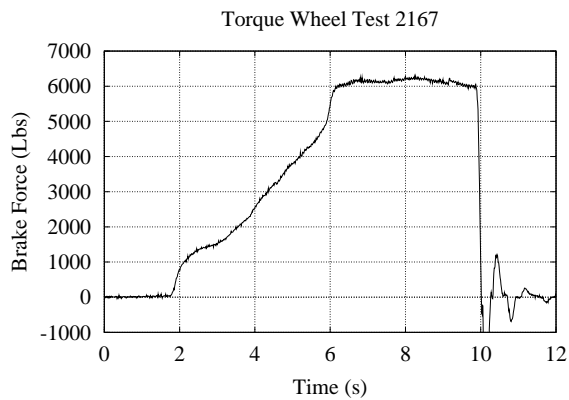
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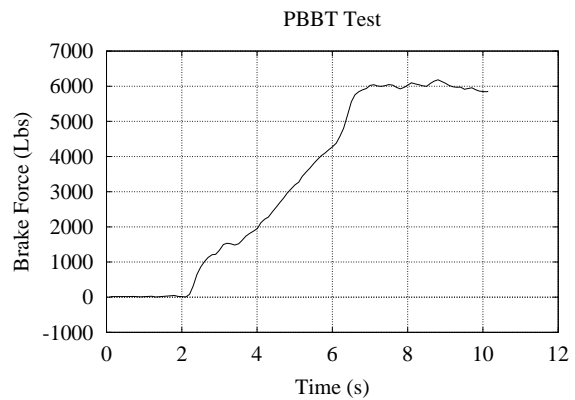
Replicate 2



Replicate 2

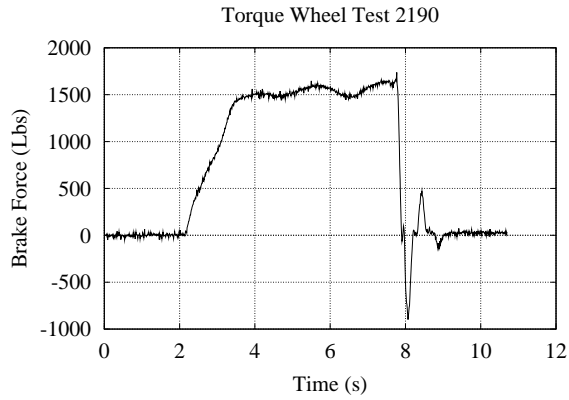


Replicate 3

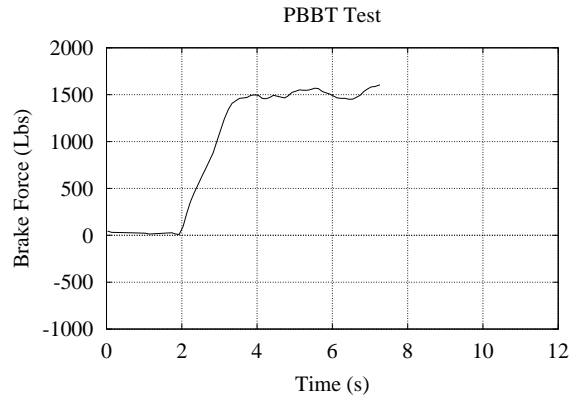


Replicate 3

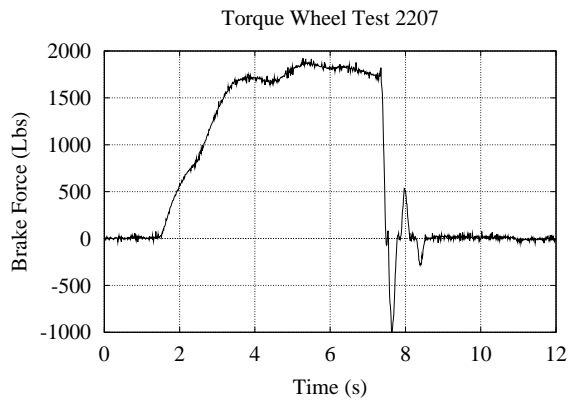
Figure D9. Brake force versus time for wheel 5 of the laden 3S-2 vehicle for 3 replicate tests with the RAI In-Ground RD. Left column plots illustrate the torque wheel data. Right column plots illustrate RAI In-Ground RD data.



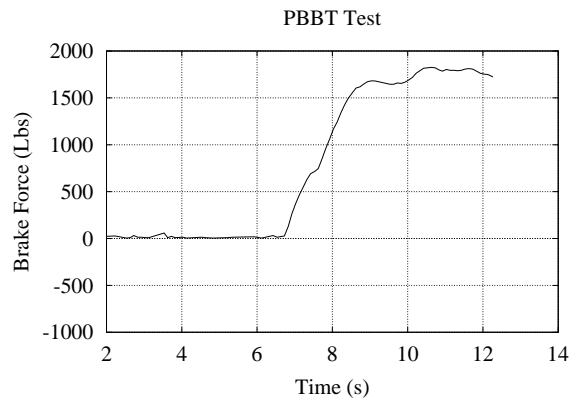
Replicate 1



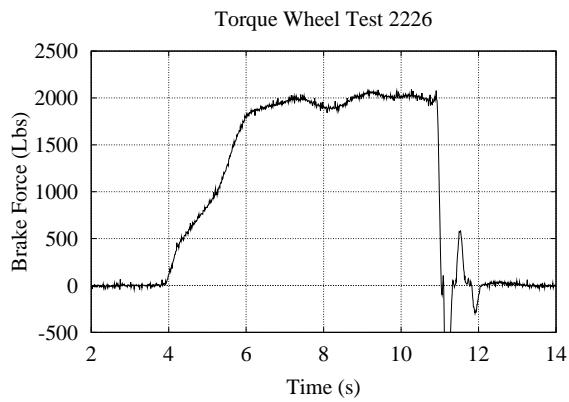
Replicate 1



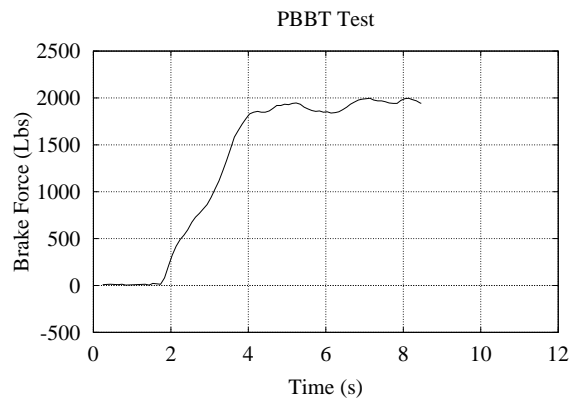
Replicate 2



Replicate 2

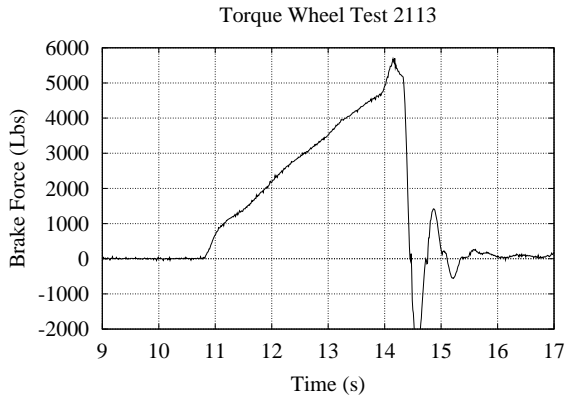


Replicate 3

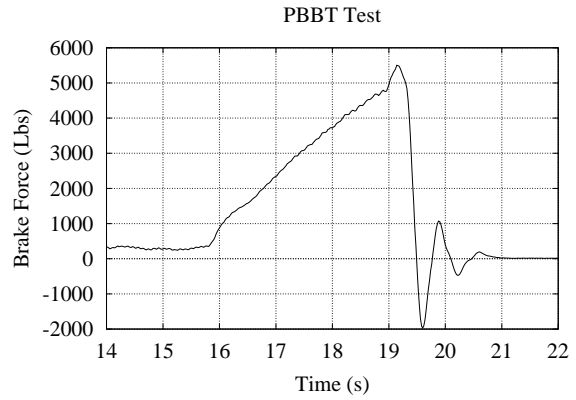


Replicate 3

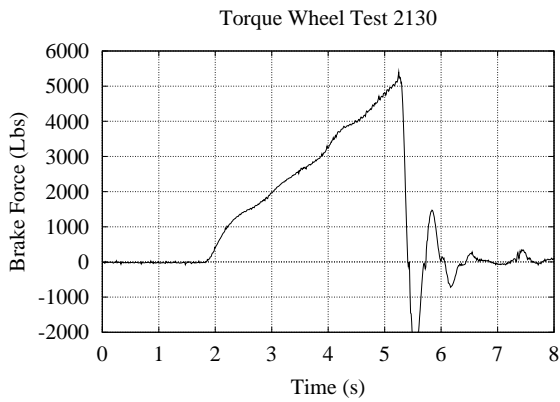
Figure D10. Brake force versus time for wheel 5 of the unladen 3S-2 vehicle for 3 replicate tests with the RAI In-Ground RD. Left column plots illustrate the torque wheel data. Right column plots illustrate RAI In-Ground RD data.



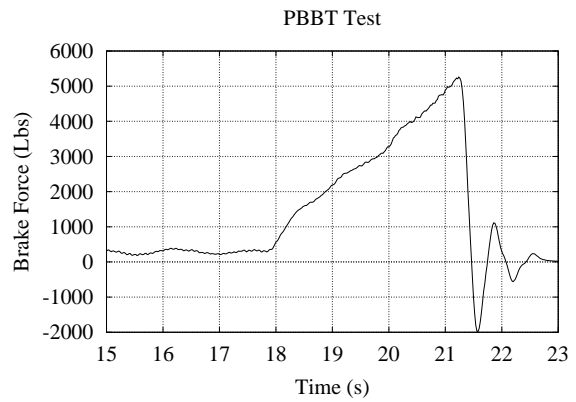
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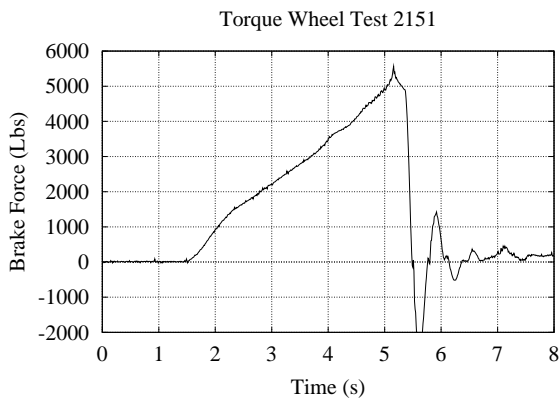
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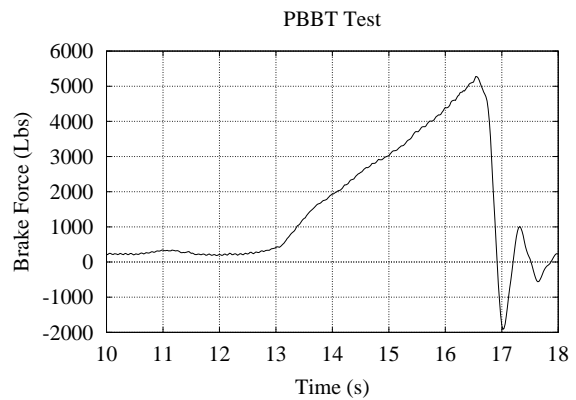
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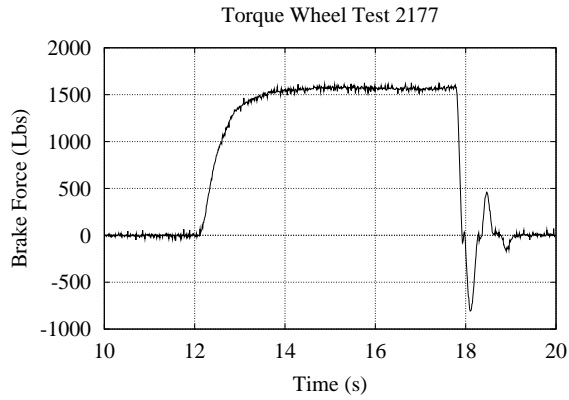


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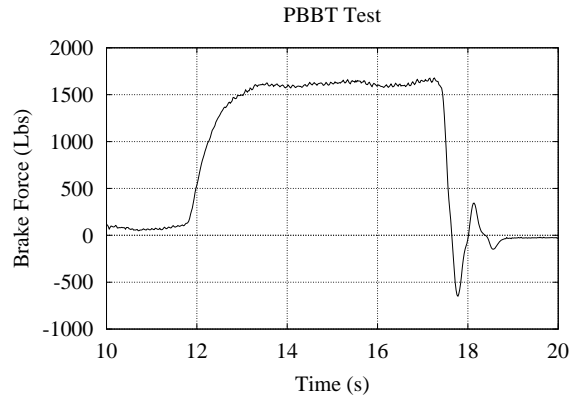


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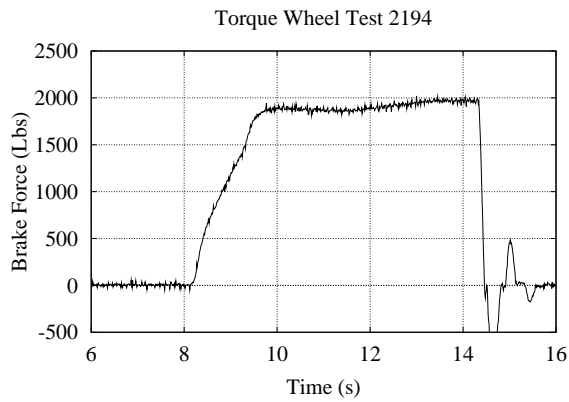
Figure D11. Brake force versus time for wheel 5 of the laden 3S-2 vehicle for 3 replicate tests with the RAI portable RD. Left column plots illustrate the torque wheel data. Right column plots illustrate RAI portable RD data.



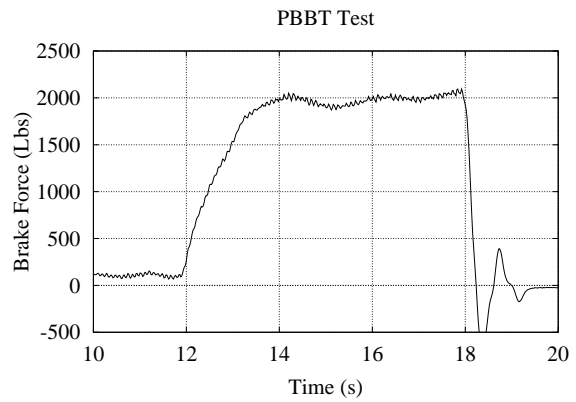
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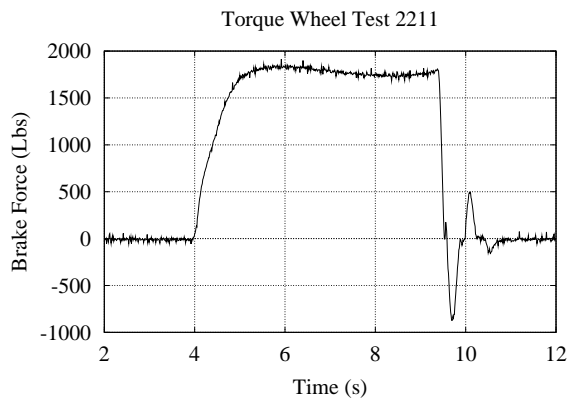
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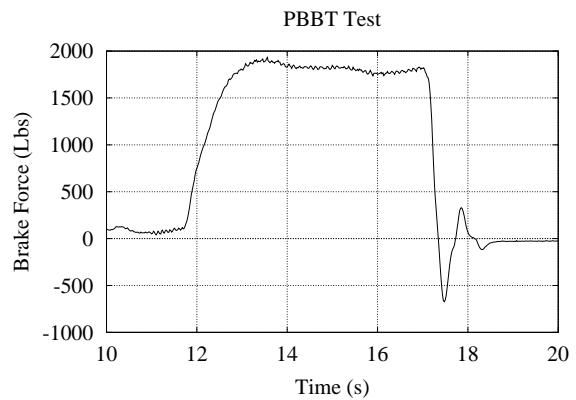
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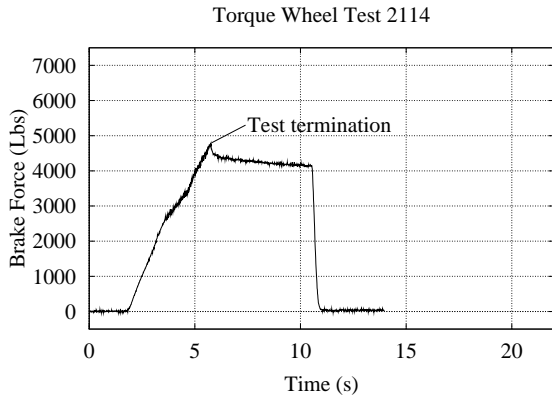


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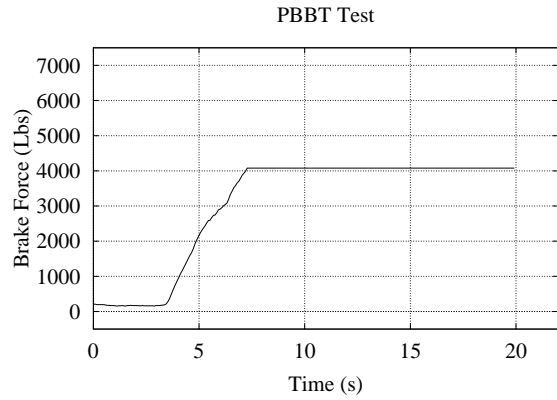


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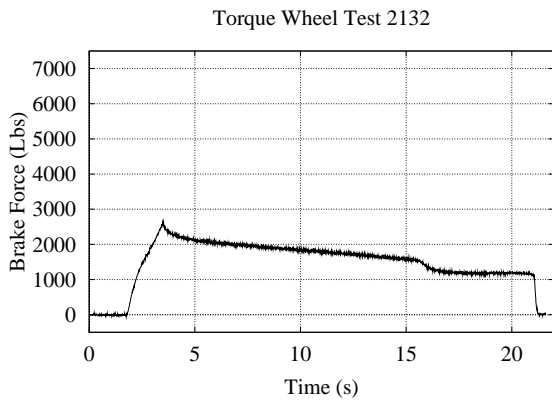
Figure D12. Brake force versus time for wheel 5 of the unladen 3S-2 vehicle for 3 replicate tests with the RAI portable RD. Left column plots illustrate the torque wheel data. Right column plots illustrate RAI portable RD data.



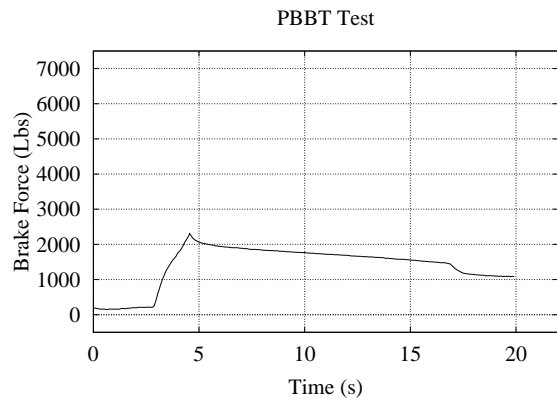
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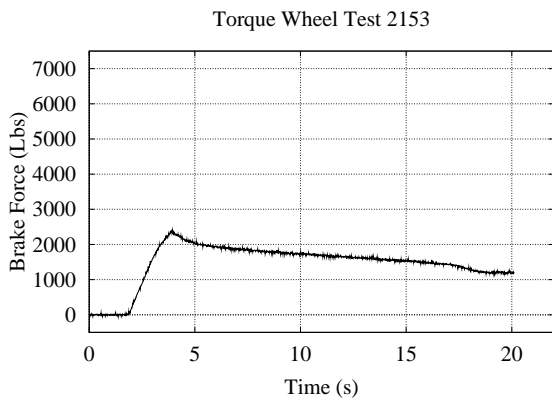
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Replicate 2



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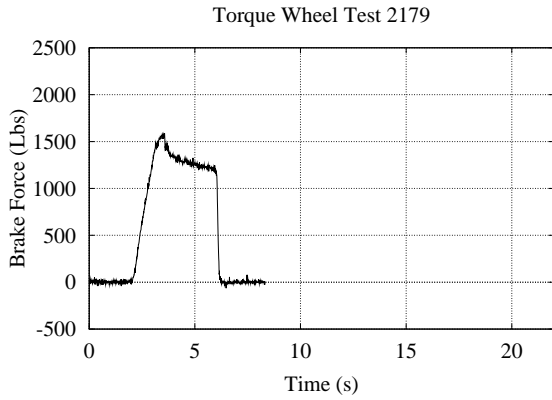


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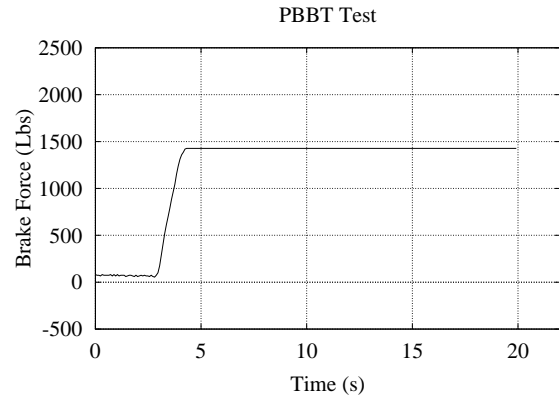
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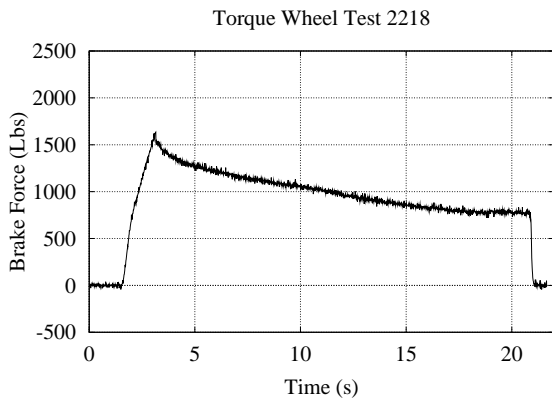
Figure D13. Brake force versus time for wheel 5 of the laden 3S-2 vehicle for 3 replicate tests with the VIS portable RD. Left column plots illustrate the torque wheel data. Right column plots illustrate VIS portable RD data.



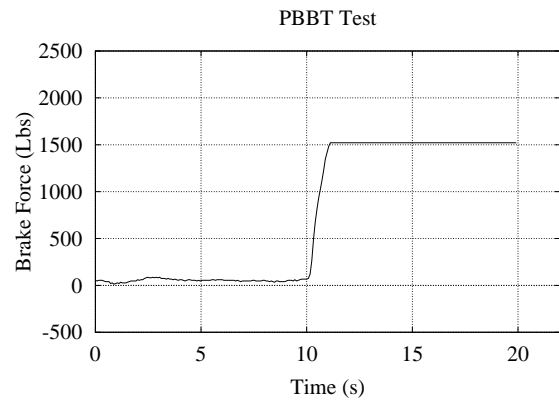
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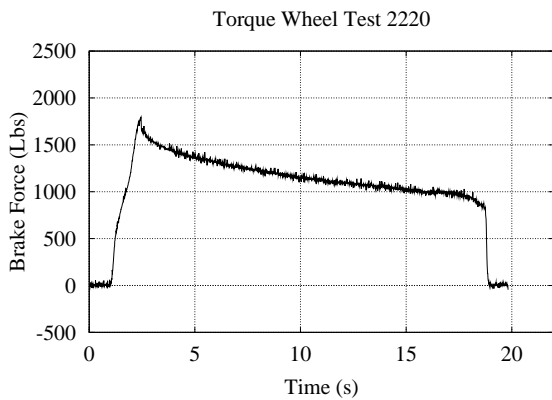
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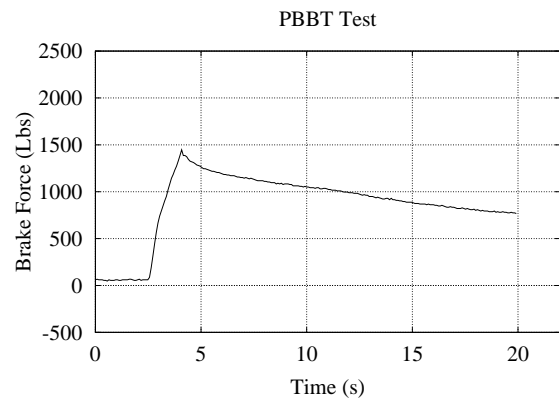
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Replicate 2

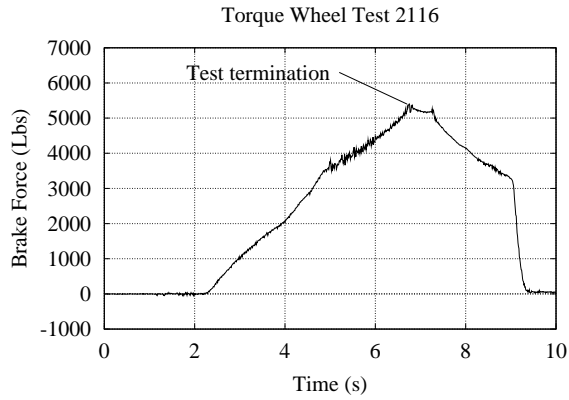


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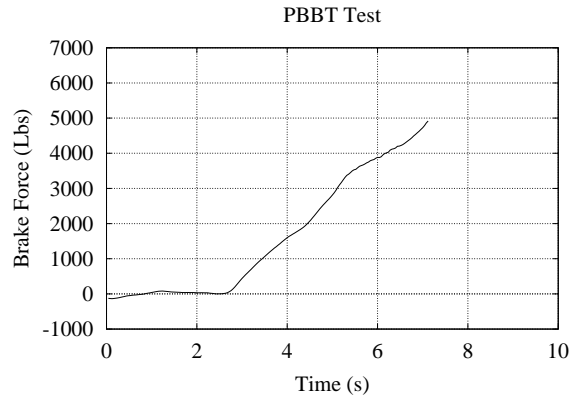


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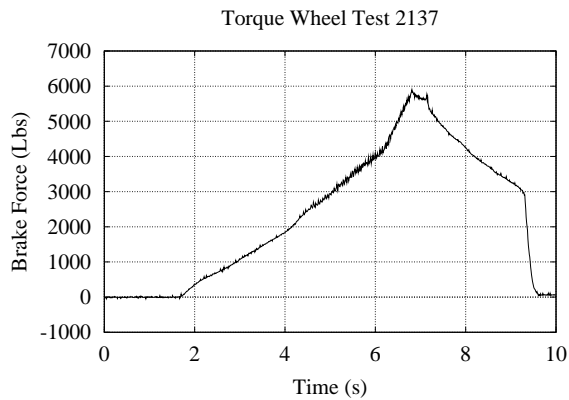
Figure D14. Brake force versus time for wheel 5 of the unladen 3S-2 vehicle for 3 replicate tests with the VIS portable RD. Left column plots illustrate the torque wheel data. Right column plots illustrate VIS portable RD data.



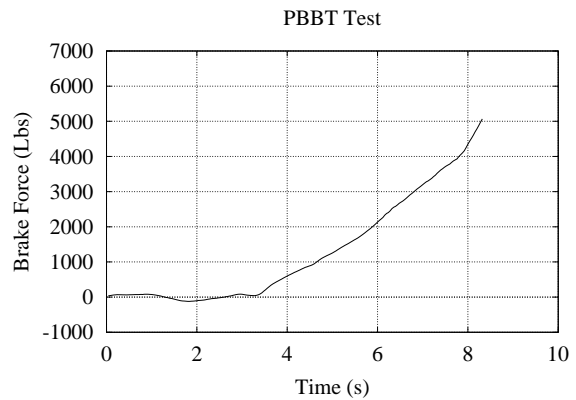
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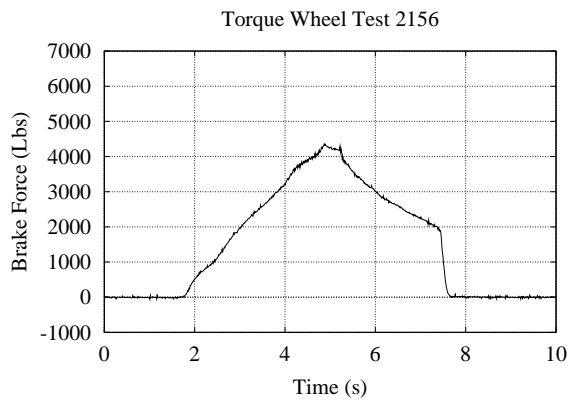
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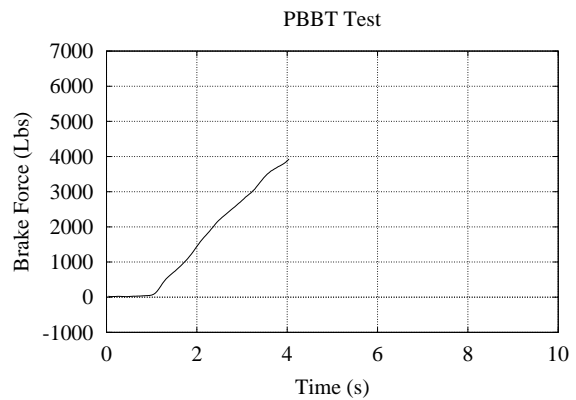
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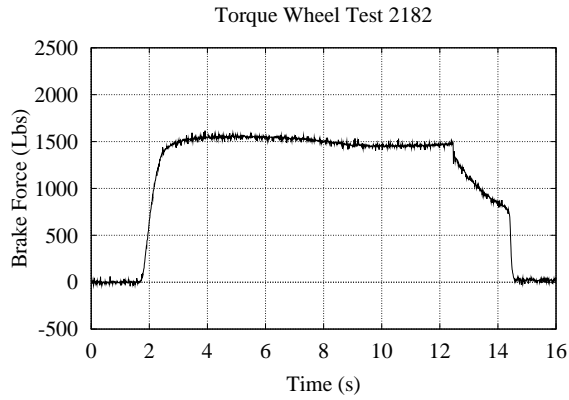


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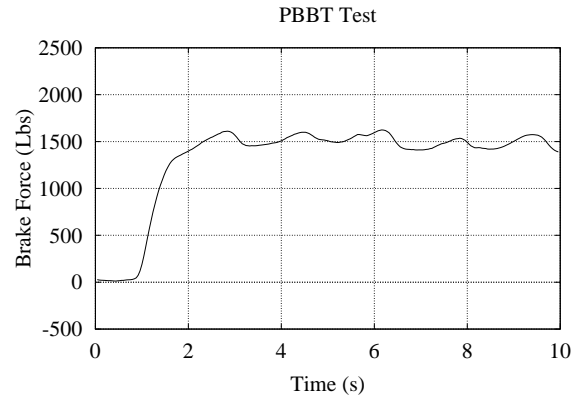


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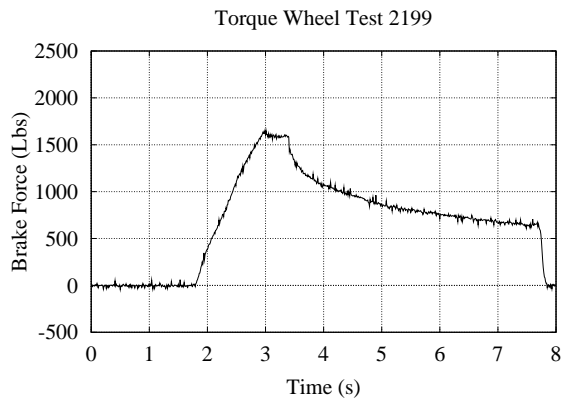
Figure D15. Brake force versus time for wheel 5 of the laden 3S-2 vehicle for 3 replicate tests with the HEI portable RD. Left column plots illustrate the torque wheel data. Right column plots illustrate HEI portable RD data.



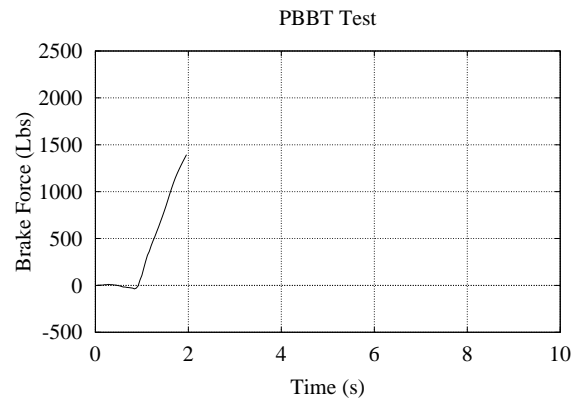
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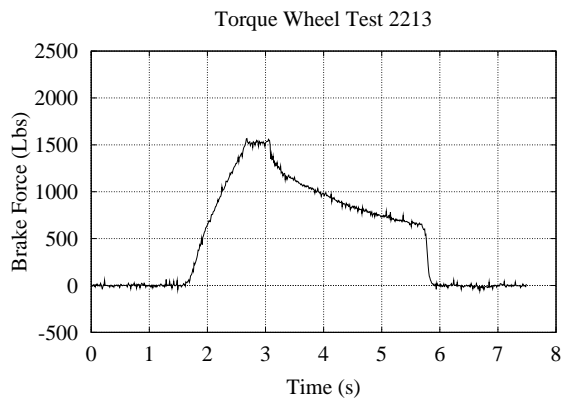
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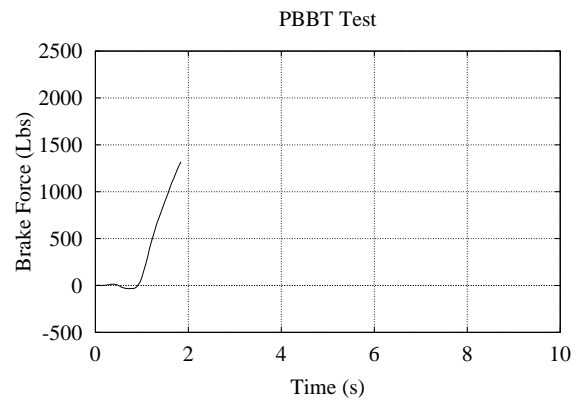
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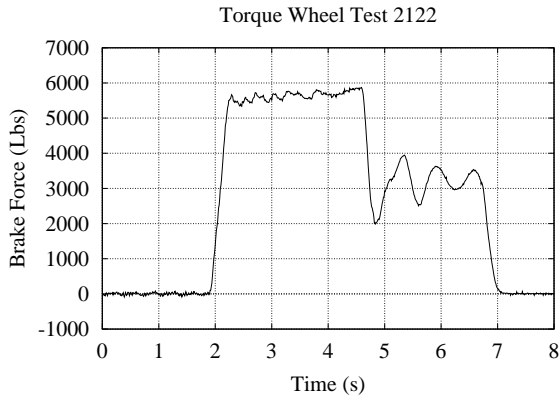


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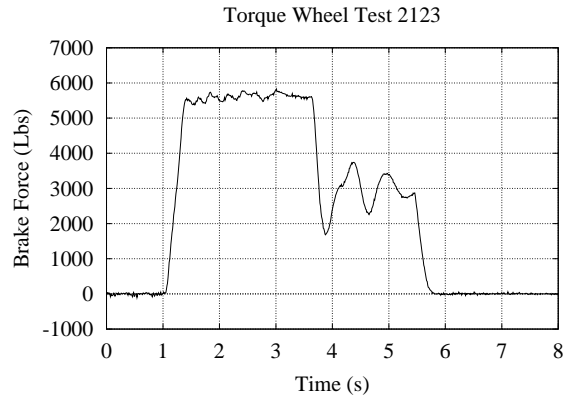


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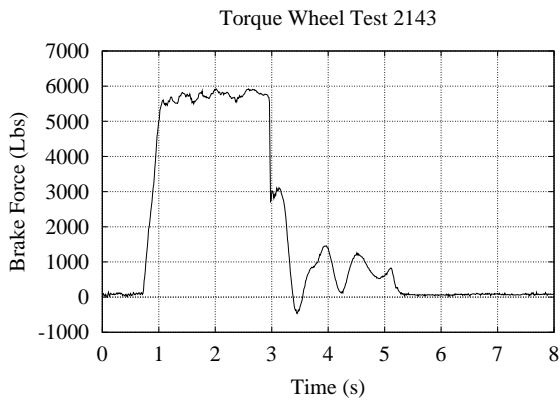
Figure D16. Brake force versus time for wheel 5 of the unladen 3S-2 vehicle for 3 replicate tests with the HEI portable RD. Left column plots illustrate the torque wheel data. Right column plots illustrate HEI portable RD data.



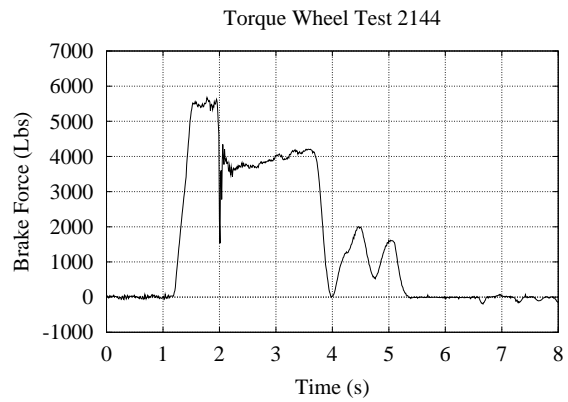
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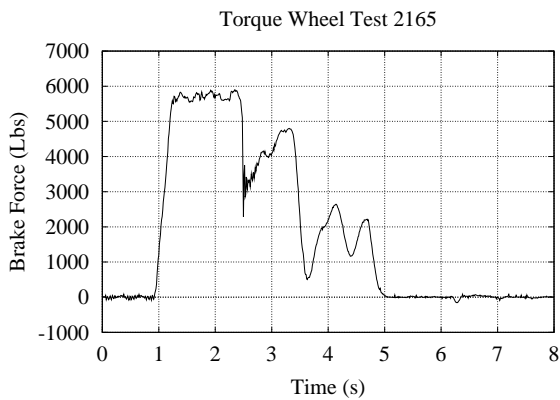
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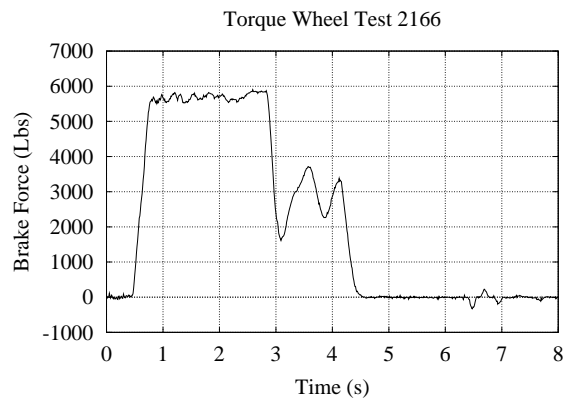
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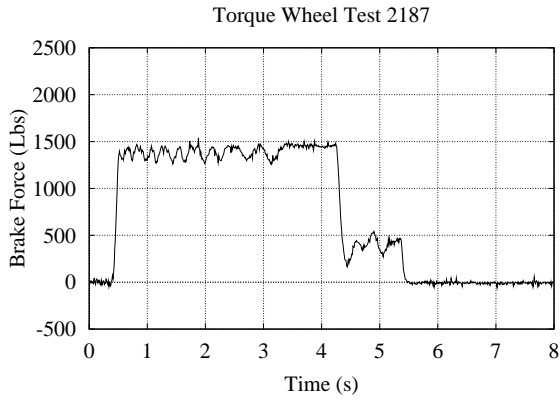


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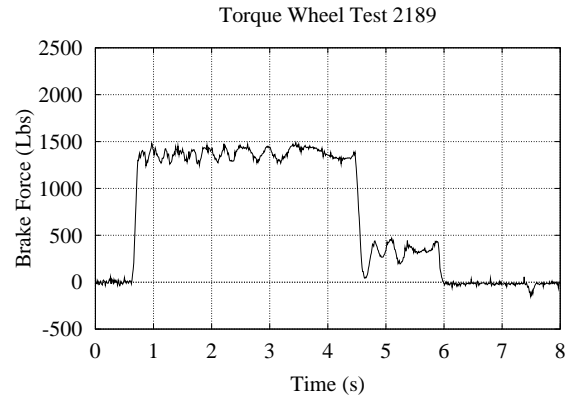


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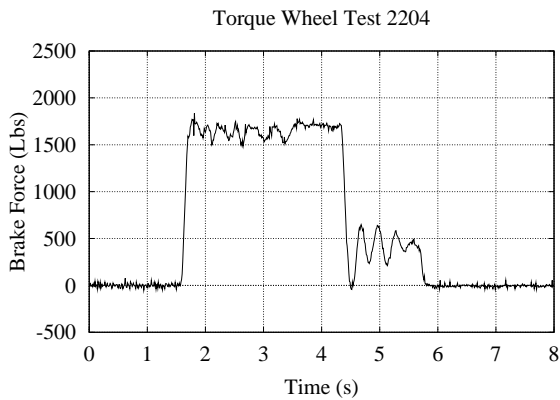
Figure D17. Brake force versus time for wheel 5 of the laden 3S-2 vehicle for 3 replicate tests (2 successive tests in each replication) during 20 mph stops.



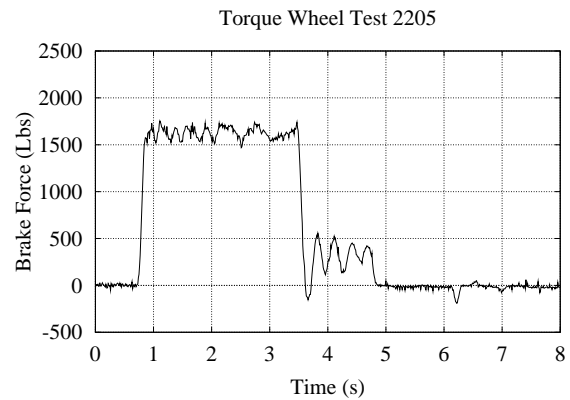
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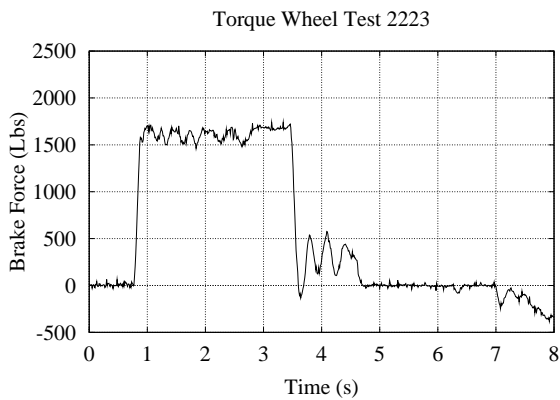
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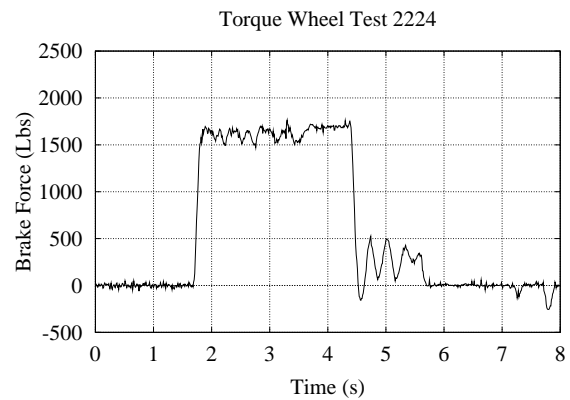
Replicate 2



Replicate 2



Replicate 3



Replicate 3

Figure D18. Brake force versus time for wheel 5 of the unladen 3S-2 vehicle for 3 replicate tests (2 successive tests in each replication) during 20 mph stops.

APPENDIX E

PBBT INDIVIDUAL AXLE LOAD MEASUREMENTS:

3-S2 Tractor Trailer Combination

2-Axle Straight Truck

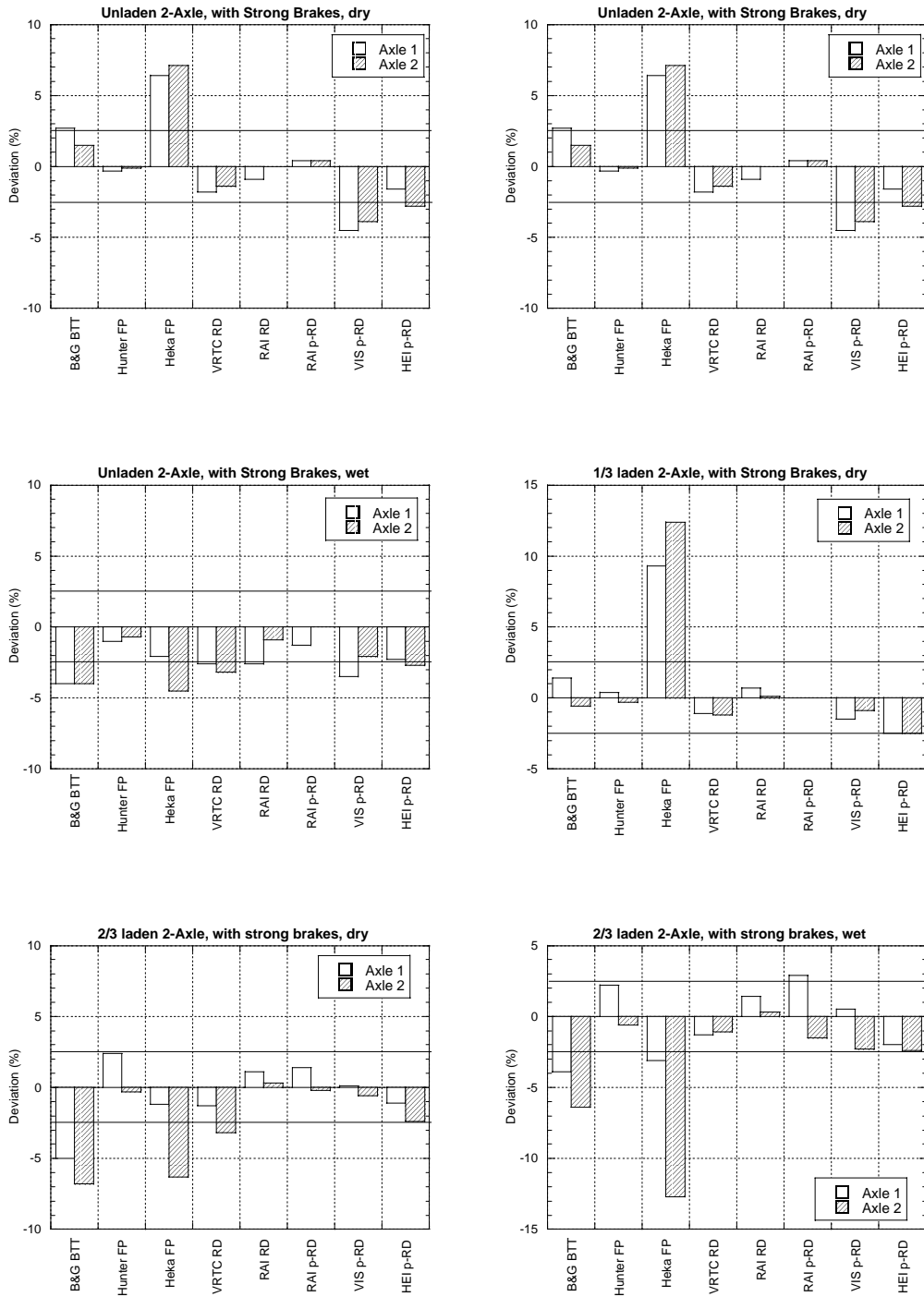


Figure E1. Deviations of Individual Axle Loads from Reference Axle Loads for the 2-axle Vehicle. Reference weights were measured with certified scales. PBBT-reported weight measurements must be 2.5 percent accurate.

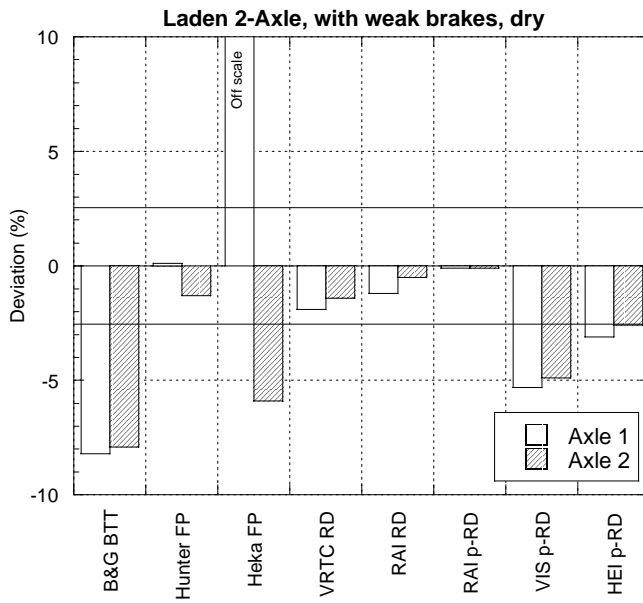


Figure E1 (Continued). Deviations of Individual Axle Loads from Reference Axle Loads for the 2-axle Vehicle. Reference weights were measured with certified scales. PBBT-reported weight measurements must be 2.5 percent accurate.

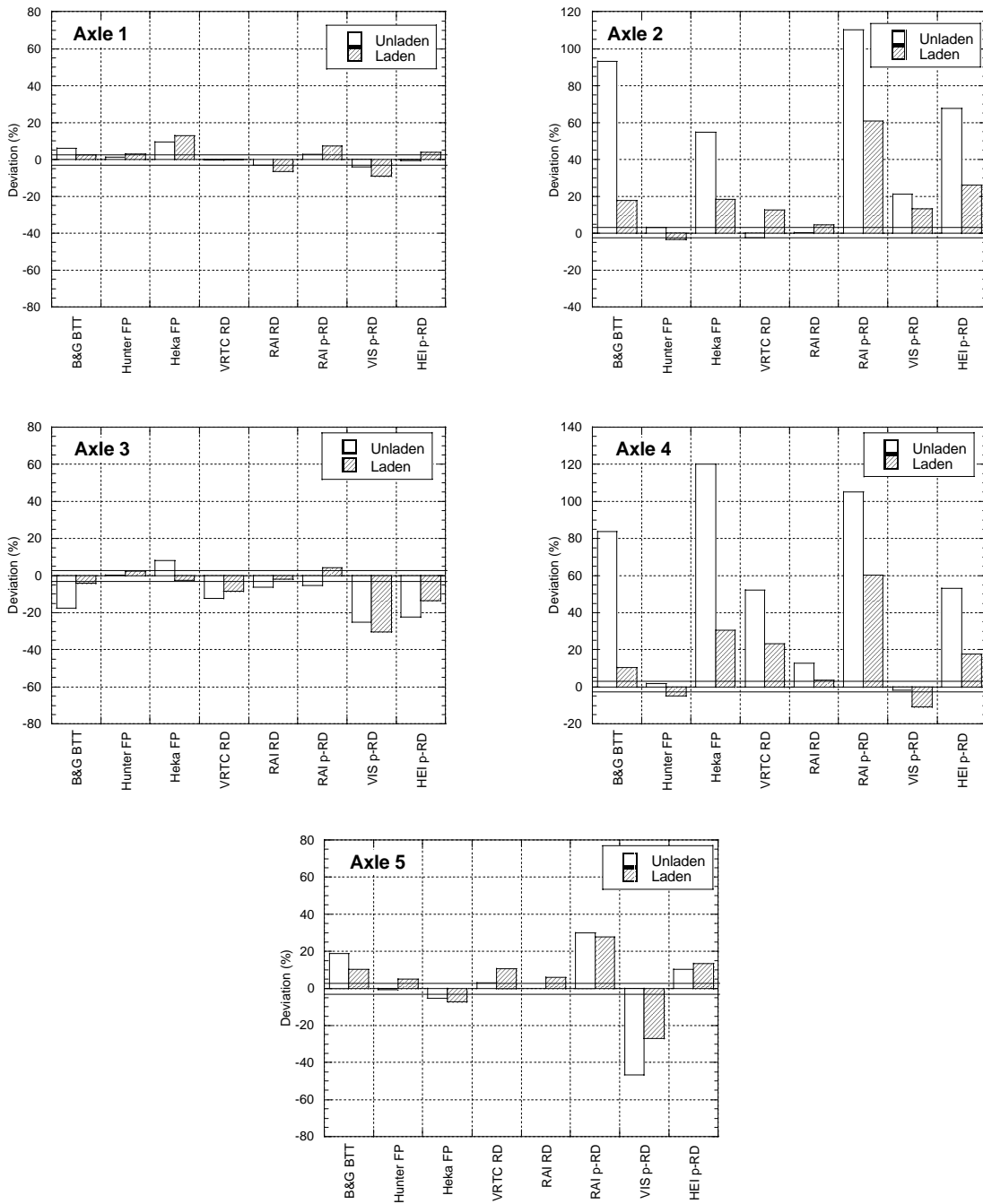


Figure E2. Deviations of Individual Axle Loads from Reference Axle Loads for the 3-S2 Tractor Trailer Combination Vehicle. Reference weights were measured with certified scales. PBBT-reported weight measurements must be 2.5 percent accurate.

APPENDIX F

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