LOCKHEED GEORGIA LOWSPEED WIND TUNNEL
HONDA CIVIC HATCHBACK AIRTAB(R) MODIFICATION RESULTS

Executive Summary:

This report shows conclusively that the Airtab® product reduced aerodynamic drag forces at the base area (the rear facing surface) of the test vehicle. The test showed a 4% reduction in horse power required to maintain a steady speed of 55 mph. Only the sides of the vehicle were fitted to assure the most aerodynamically symmetrical run data. By adding Airtabs™ to the rear roof line as well, a conservative performance benefit extrapolation of these findings would be in the 50% range resulting in a further HP required reduction to approximately 6%. The test also shows that the vehicle drag coefficient (CD) is reduced at every yaw angle from zero to thirty degrees angle from the airflow and that this CD reduction increases at greater yaw angles.

Introduction:

During his research, the inventor of the Airtab® wishbone vortex generator brought his concept to the Lockheed Low Speed Wind Tunnel facility in the State of Georgia USA. His aim was to confirm that the introduction of forced, arrayed, stream-wise, near-wake vorticity would serve to increase pressure at the base area of a moving vehicle thereby reducing aerodynamic drag force. He accomplished a series of unmodified (baseline) and modified (with Airtab® vortex generators) wind tunnel runs. The runs were made at a constant speed (55mph) and over a fixed range of yaw angles. The vehicle was a 1982 Honda Civic Hatchback and this particular vehicle was chosen for two reasons: The vehicle had a small enough cross sectional area to permit statistically valid, un-corrected data runs in the chosen wind tunnel without turbulent side wall interference problems and, the vehicle design offered a generous base area enabling the acceptance of an approximately 50 sensor pressure grid to measure base pressure data for each run. The vehicle was fixed with this pressure sensor grid and mounted on metric plates imbedded in a large turn table inside the wind tunnel to allow the vehicle to experience different yaw angles.

List of figures:

Figure 1; (next page)

Fig 1 shows the raw data from all runs. The first grouping is the baseline data and the second is the run data with Aitabs™ installed. They are labeled accordingly. Airtabs™ were applied down each side of the test vehicle but not on the roof. This was done to provide the most symmetrical run data. Test report data columns are numbered as shown.

Columns: 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11.

LOCKHEED GEORGIA COMPANY - LOW SPEED WIND TUNNEL

CARY WHEELER : 1982 HONDA CIVIC HATCHBACK

TEST 561 DATE 05/18/82

AREA = 18.970 SQ FT WHEELBASE = 7.375 FT

RUN .... CONFIGURATION DESCRIPTION	YAW PSI (DEG)	QO (PSF)	CD	CL	CLF	CLR	CM	CY	CN	CR	AIR HP @ 55mph
3 1982 HONDA CIVIC HATCHBACK BASELINE	0.0	7.70	.4543	.072	.172	-.099	.136	-.001	.005	-.003	9.79
	-4.0	7.71	.4593	.114	.107	-.073	.130	-.195	-.035	-.044	9.90
	-2.0	7.76	.4507	.080	.173	-.093	.133	-.090	-.018	-.025	9.71
	0.0	7.69	.4537	.071	.176	-.105	.141	.000	.003	.001	9.77
	2.0	7.69	.4535	.081	.181	-.100	.140	.094	.023	.018	9.77
	4.0	7.82	.4581	.112	.195	-.083	.139	.197	.040	.041	9.87
	6.0	7.60	.4692	.172	.224	-.052	.138	.303	.055	.060	10.11
	8.0	7.80	.4857	.235	.251	-.017	.134	.411	.068	.090	10.46
	10.0	7.79	.5077	.316	.284	.032	.126	.510	.083	.120	10.94
	12.0	7.77	.5321	.423	.328	.095	.116	.590	.099	.138	11.46
	14.0	7.77	.5376	.455	.346	.109	.119	.609	.111	.169	11.58
	16.0	7.77	.5443	.492	.369	.123	.123	.778	.119	.190	11.73
	18.0	7.83	.5483	.531	.396	.134	.131	.866	.127	.217	11.81
	20.0	7.81	.5607	.544	.418	.133	.139	.930	.133	.238	12.08
	25.0	7.78	.5636	.537	.442	.095	.173	1.129	.139	.292	12.14
	30.0	7.68	.5594	.514	.453	.062	.196	1.259	.136	.327	12.05
4 1982 HONDA CIVIC HATCHBACK WITH MODIFICATION	0.0	7.70	.4355	.115	.171	-.056	.114	.001	-.003	-.003	9.38
	-4.0	7.63	.4416	.143	.186	-.042	.114	-.175	-.044	-.038	9.51
	-2.0	7.73	.4375	.124	.176	-.052	.114	-.008	-.026	-.022	9.43
	0.0	7.88	.4342	.121	.173	-.052	.113	-.000	-.002	-.005	9.35
	2.0	7.72	.4420	.117	.177	-.060	.118	.095	.019	.020	9.52
	4.0	7.69	.4428	.184	.193	-.039	.116	.191	.039	.038	9.54
	6.0	7.67	.4502	.191	.214	-.023	.118	.293	.057	.061	9.70
	8.0	7.73	.4634	.228	.240	-.012	.126	.403	.073	.090	9.98
	10.0	7.73	.4756	.284	.276	.008	.134	.302	.089	.119	10.25
	12.0	7.73	.4911	.366	.302	.064	.119	.584	.102	.135	10.58
	14.0	7.70	.5024	.421	.329	.093	.110	.677	.120	.160	10.82
	16.0	7.74	.5100	.469	.353	.114	.120	.764	.131	.186	11.00
	18.0	7.73	.5189	.518	.385	.133	.126	.841	.142	.205	11.18
	20.0	7.73	.5265	.542	.400	.142	.129	.925	.154	.229	11.34
	25.0	7.65	.5340	.556	.441	.115	.163	1.062	.160	.270	11.50
	30.0	8.02	.5342	.567	.460	.107	.176	1.169	.175	.299	11.51

Col. 1. Vehicle Yaw Angle: Indicates vehicle yaw angle from 0 to 30 degrees angle to the flow. The negative numbers represent yaw in the opposite direction. These “opposite“ yaw runs are routinely done to confirm that the vehicle is mounted correctly on the turntable and to verify that the zero-degree yaw data would return to the similar values whether approached from a yawed-left or yawed-right position.

Col 2. Q: The dynamic air pressure impacting the front of the vehicle measured in pounds per square foot.

Col 3. CD: Coefficient of Drag.

Cols. 4 to 10 inclusive; Coefficients of: CL, Lift of overall vehicle; CLF, Front axle lift; CLR, Rear axle lift; CM, pitching moment; CY, Yawing moment; CN, Side force; CR, aerodynamic rolling moment.

Col. 11 Air HP: Horse Power required to maintain a 55mph vehicle speed. .../3

Figure 2; Plot of yaw angle versus CD

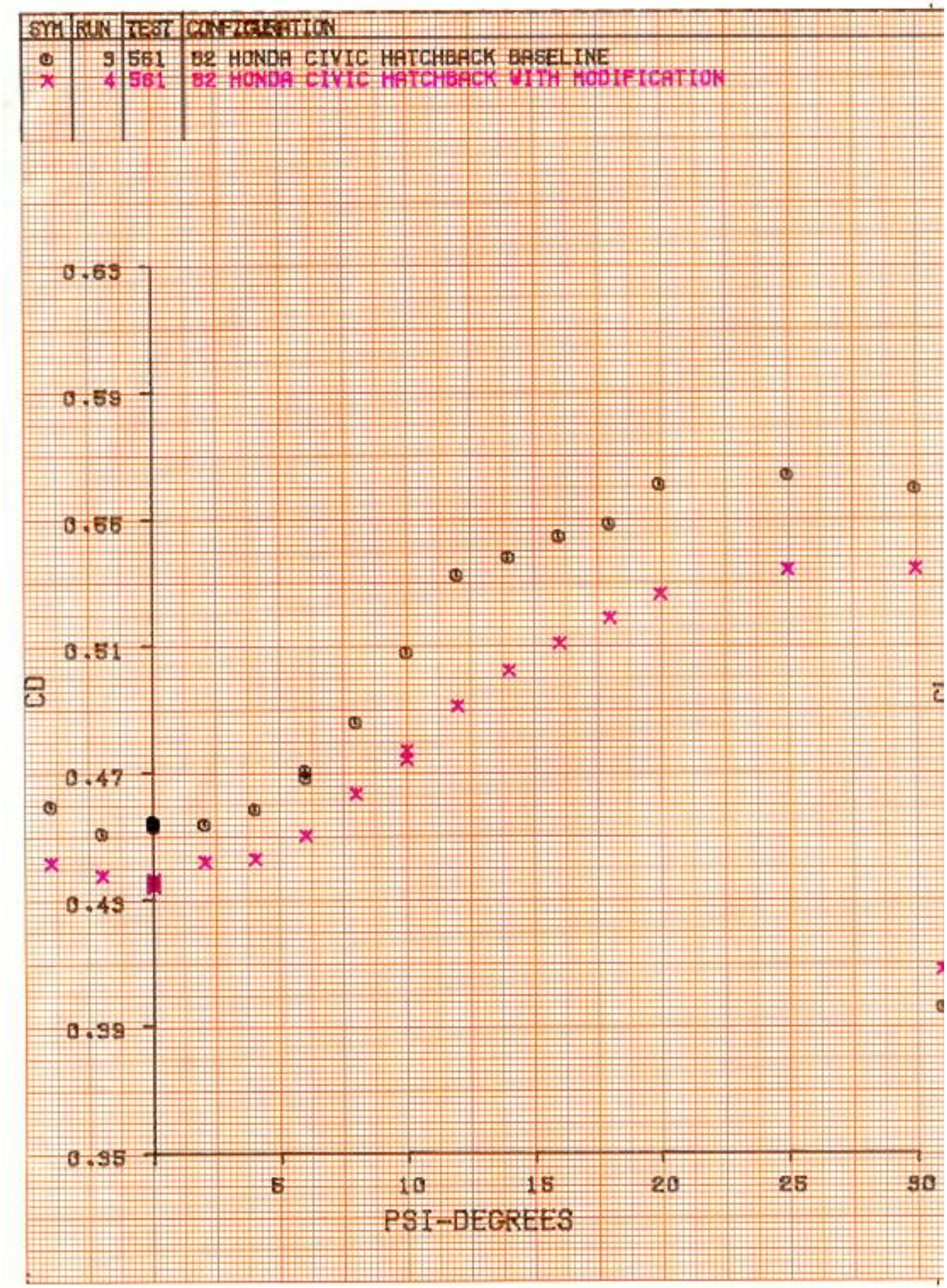
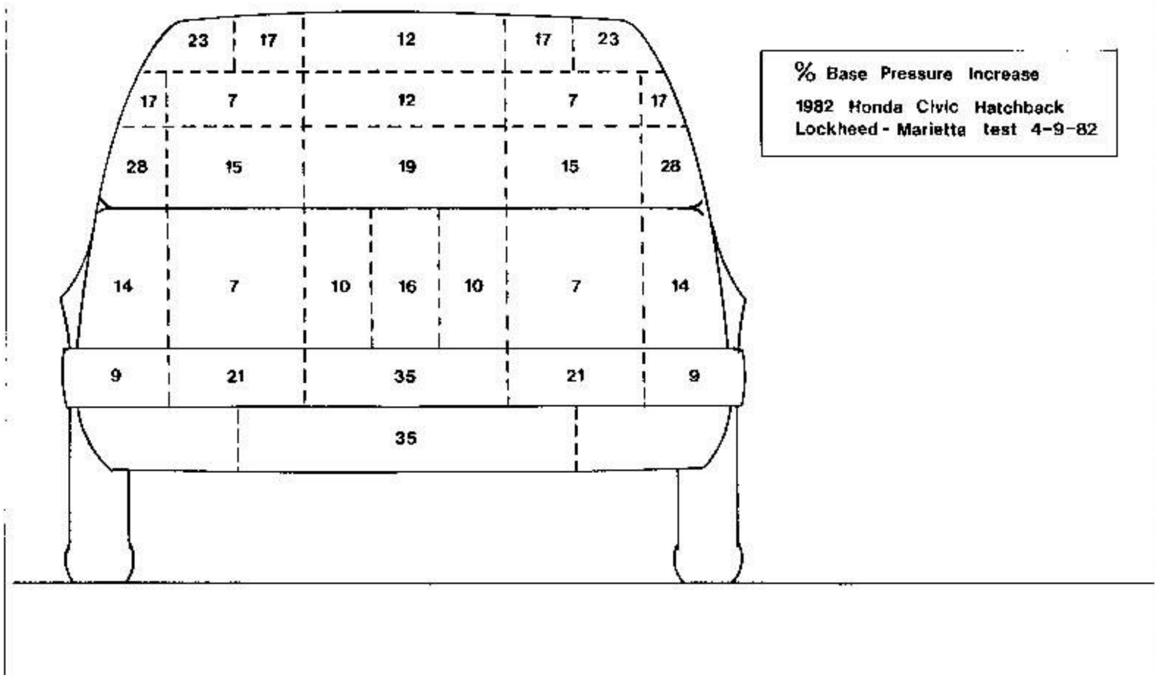


Figure 3; Base Pressure Sensor Schematic. Shows the percentage of base pressure increase for each sensor.



Conclusions:

Figure 1

The columns of interest in Figure 1 are Columns 1, 2, 3, & 11. Columns 4 to 10 are superfluous and of no statistical value to this experiment.
By comparing every yaw angle in column 1 with the corresponding values in columns 3 and 11 between the base line runs and the Airtab® modified runs, there is a consistent reduction in CD (Coefficient of drag) and HP required to maintain 55mph. The value for Q in column 2 indicates a statistically valid test speed of 55 mph was maintained throughout.

Figure 2

The plot shows a reduction in CD for any yaw angle. The data show improved Airtab® performance and a relatively greater CD reduction at higher yaw angles. Over the road wind yaw angles can be greatly increased by gusts, passing or nearby vehicles, topography and physical highway features. (bridges, retaining walls etc)

Figure 3

The schematic shows the percentage increase in pressure by sector over the unmodified or base line run.

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Figure 4

A shaded scaled diagram indicates vehicle dimensions and result summary. The horse power required to maintain 55mph dropped from 9.79 to 9.38 with Airtabs™ installed, a reduction of 0.41 HP or 4%. Airtabs™ were omitted from the roof line in order to obtain the most symmetrical data runs possible. A conservative extrapolation of this test result indicates that roof mounted Airtabs™ would improve these findings about 50% and translate to a further HP required reduction of 2% for a total of 6%.