

Notes:

Crr values are typical for very smooth surfaces - Crr on typical road surfaces may be 50 to 100 % higher

Tire Pressure = 120 psig unless otherwise noted

Speed ~ 51 km/hr (54X13 - ~ 100 rpm cadence)

SRM Pro Power Measurement (Zero'd before each test run - Calibrated every 6 months)

Crr Calculation from Tom Anhalt's Spreadsheet

Tacx Rollers (79 mm PVC - 26 cm spacing) with Hinged Front Fork Mount

Test Run time ~ 2 minutes

Power per Wheel at 25 mph with 100 lb load

Rear wheel load adjusted per morning weigh in

Each tire warmed up for > 5 minutes before testing

Aero position used for all tests (to hopefully maximize repeatability of rear wheel load)

Control - Ritchey Fortress and/or Michelin Pro 2 Light training tire tested first and last each test day

Raw Speed Data was corrected for tire roll out prior to Crr calculation

Ambiant Temperature Range 65 - 75 F (typical 5 degree F range per test day)

During the tests tire T increases from 20 - 40 deg F (low Crr tires heat up less than the higher Crr tires) - (Estimated T rise on a flat surface is between 4 to 8 F)

Estimated Day to Day Repeatability Std. Dev. ~ 1.3 %



Tire/tube	Tubular?	Tire Width (mm)	Crr	Std Dev	watts per wheel	Runs	Days	Notes
FMB Silk Tubular (23) Criterion Tread	X	24	0.00240	0.00001	11.8	2	1	New Tire
Vittoria Ultra Speed (20)/Mich Latex (18/20)		21	0.00243	0.00002	11.9	2	1	Used Tire
Bontrager Race X Lite Pro (23)/Mich Latex (18/20)		23	0.00244	0.00006	12.0	16	5	4 New & 2 Used (> 65 miles) - Slight Crr Decrease with use
Velo Flex Record/Michelin Latex Tube (18/20)		20	0.00245	0.00006	12.1	4	2	2 Used Tires - ~ 30 miles/45 miles
Michelin Pro 2 Light SC (23)/Mich Latex Tube (18/20)		24	0.00254	0.00005	12.5	6	2	Used Tire ~ 40 miles
Velo Flex Record/Michelin Latex Tube (18/20)		21	0.00259	0.00002	12.7	2	1	New Tire
Torelli Torino (23)/Michelin Latex Tube (18/20)		24	0.00260	0.00003	12.8	2	1	Used Tire - 500 miles
Michelin Pro 2 Light SC (23)/Mich Latex Tube (22/23)		24	0.00260	0.00008	12.8	44	19	Control Tire - Used Tire Booted and with Patched Tube
Vittoria Open Corsa EVO CX (23)/Mich Latex Tube (22/23)		24	0.00261	0.00001	12.8	2	1	Used Tire ~ 40 miles
Deda Giro Italia (23)/Mich Latex Tube (22/23)		25	0.00261	0.00005	12.8	2	1	Used Tire
Michelin Pro Light SC (20)/Michelin Latex Tube (18/20)		22	0.00262	0.00010	12.9	8	2	4 Used Tires
Michelin Pro 2 Light SC (23)/Mich Latex Tube (18/20)		24	0.00267	0.00004	13.1	7	2	New Tire
Velo Flex Record Tubular	X	20	0.00267	0.00005	13.1	3	1	Jens Used Tire
Zipp Tubular - Original Design	X	22	0.00269	0.00006	13.2	19	5	Glued 6/05 First Test 8/06 2 cts rim/1 ct tire-Conti Glue-700 mi
Bontrager Select (28)/Vred Latex (18/25)		27	0.00268	0.00001	13.2	2	1	New Tire - Wire Bead - Tested at 120 psig / Rated 100 psig
Michelin Pro Light SC (20)/Michelin Latex Tube (18/20)		22	0.00270	0.00004	13.3	2	1	Used Tire ~ 100 miles (from Jack Watts)
Vittoria EVO KS (23)/Michelin Latex Tube (18/20)		23	0.00271	0.00005	13.3	4	1	Used Tire ~ 50 miles
Challenge Criterion (23)/Michelin Latex Tube (18/20)		24	0.00272	0.00001	13.4	2	1	New Tire
Michelin Axial Pro Light (20)/Michelin Latex Tube (18/20)		22	0.00274	0.00003	13.5	2	1	Used Tire
Vittoria EVO KS (23)/Michelin Latex Tube (22/23)		23	0.00274	0.00003	13.5	3	2	Used Tire ~ 50 miles
Zipp Dimpled Clincher/Mich Latex Tube (18/20)		21	0.00275	0.00004	13.5	2	1	Used Tire ~ 60 miles
Vittoria EVO Corsa Crono (20) Tubular	X	20	0.00275	0.00004	13.5	2	1	New Tire
Vittoria Diamante Pro Light (23)/Mich Latex (18/20) Tube		24	0.00275	0.00004	13.5	2	1	New Tire
Bontrager Race X Lite Pro Tubular (22)	X	22	0.00276	0.00001	13.6	2	1	New Tire
Michelin Pro 2 Light SC (23)/Mich Latex Tube (22/23)		24	0.00278	0.00005	13.7	4	1	New Tire
Velo Flex Record/Michelin Latex Tube (18/20)		20	0.00279	0.00002	13.7	4	2	Jen's Used Tire
FMB Silk Tubular (20) Criterion Tread	X	21	0.00280	0.00003	13.8	2	1	New Tire
Bontrager Race XXX Lite (22)/Mich Latex (18/20)		22	0.00281	0.00001	13.8	2	1	New Tire
FMB Cotton Tubular Criterion Tread (23)	X	23	0.00282	0.00004	13.9	2	1	New Tire
Michelin Pro Light SC (20)/Michelin Latex Tube (18/20)		21	0.00285	0.00004	14.0	4	2	Used Tire > 60 miles - Tested 0.00295 New
Zipp Dimpled Clincher/Mich Latex Tube (18/20)		21	0.00286	0.00004	14.1	2	1	New Tire
Bontrager Race X Lite Pro (21)/Mich Latex (18/20)		21	0.00287	0.00002	14.1	4	2	Data for 4 New Tires
Ritchey WCS Race Slick tubular	X	22	0.00287	0.00003	14.1	4	1	Glued 7/06 Tested 10/06
Dugast Speed Silk (22) Tubular	X	22	0.00288	0.00006	14.2	2	1	Used Tire ~ 80 miles
Zipp Tangente (21) Tubular	X	22	0.00288	0.00002	14.2	4	2	2 Used Tires - Most of Base Tape Latex Removed ~ 100 miles
Vittoria Open Corsa EVO KS (23)/Mich Latex Tube (18/20)		23	0.00291	0.00000	14.3	2	1	New Tire
Bontrager Race X Lite (25)/ Vred (18/25) Latex Tube		26	0.00291	0.00000	14.3	2	1	New Tire
IRC Paperlight (20)/ Mich (18/20) Latex Tube		21	0.00291	0.00002	14.3	2	1	New Tire
Vittoria EVO KS (20)/Michelin Latex Tube (18/20)		22	0.00293	0.00005	14.4	2	1	Used Tire ~ 80 miles
Bontrager Select (25)/Vred Latex (18/25)		25	0.00294	0.00001	14.4	2	1	New Tire - Wire Bead - Tested at 120 psig / Rated 100 psig
Michelin Pro Light SC (20)/Michelin Latex Tube (18/20)		21	0.00295	0.00003	14.5	2	1	New Tire
Vittoria Corsa EVO CX Tubular	X	22	0.00296	0.00003	14.6	2	1	Used Tire ~ 200 miles - Glued 6/06-Tested 11/06
Vittoria Open Corsa EVO KS (23)/Mich Latex Tube (22/23)		23	0.00297	0.00005	14.6	2	1	New Tire
Zipp Tubular (21) Original Design	X	22	0.00301	0.00002	14.7	4	2	New Tire-Glued/Conti 12/31/06-Test 1/6/07-Mavic Reflex Rim
Bontrager Race X Lite Aero Wing (25)/Mich Latex (18/20)		25	0.00302	0.00003	14.9	2	1	New Tire
Bontrager Race Lite (25)/Vred Latex (18/25)		25	0.00302	0.00001	14.9	2	1	New Tire
Vittoria Open Corsa CX TT (23) with Mich Latex Tube (22/23)		24	0.00305	0.00002	15.0	2	1	Used - Jen's Tire

Tire/tube	Tubular?	Tire Width (mm)	Crr	Std Dev	watts per wheel	Runs	Days	Notes
Dugast Speed Silk (22) Tubular	X	22	0.00305	0.00004	15.0	4	2	New Tire
Michelin Pro Race 2 SC (20)/Mich Latex Tube (18/20)		21	0.00306	0.00005	15.0	2	1	Used ~ 500 miles
Michelin Pro Race 2 SC (23)/Mich Latex Tube (22/23)		24	0.00306	0.00005	15.0	3	1	Used - Jen's Tire
Vittoria EVO KS (20)/Michelin Latex Tube (18/20)		22	0.00306	0.00003	15.1	4	2	New Tire
Zipp Tangente (21) Tubular	X	21	0.00306	0.00003	15.1	6	2	2 New Tires with Latex on Base Tape
Michelin Pro 3 Race/Mich Latex Tube (22/23)		23	0.00306	0.00004	15.1	2	1	New Tire
Bontrager Sport (25)/Vred Latex (18/25)		24	0.00306	0.00003	15.1	2	1	New Tire - Wire Bead - Tested at 120 psig / Rated 100 psig
Continental GP 4000S (23)/Vred Latex (18/25) Tube		23	0.00307	0.00006	15.1	2	1	Used Tire ~ 200 miles
Vittoria Open Corsa EVO CX (23)/Butyl Tube		24	0.00307	0.00004	15.1	2	1	Used Tire ~ 40 miles
Schwalbe Stelvio Tubular (22)	X	23	0.00307	0.00004	15.1	2	1	Used Tire ~ 500 miles - Made by Tufo
Specialized Mondo Tubular	X	23	0.00310	0.00001	15.2	2	1	Glued 1/05 Tested 11/06 3 coats rim - 1 coat tire Mastik 1
Bontrager Race X Lite Aero Wing (19)/Michelin Latex (18/20)		20	0.00311	0.00004	15.3	2	1	Used Tire ~ 200 miles
Velo Flex Carbon Tubular	X	23	0.00312	0.00004	15.3	2	1	Reglued 11/16/06 Tested 12/16/06 - ~ 80 miles
Continental GP 4000S (23)/Vred Latex (18/25) Tube		23	0.00313	0.00005	15.4	4	2	New Tire
Vittoria Diamante Pro (23)/Mich Latex (18/20) Tube		23	0.00315	0.00003	15.4	2	1	New Tire
FMB Silk Tubular Strada Tread (22)	X	23	0.00315	0.00001	15.5	4	2	New Tire
Zipp Tangente (21) Tubular	X	22	0.00316	0.00001	15.5	2	4	Used Tire - Result Compromised by Loss of Glue Contact
Vredestein Fortezza Pro Tricomp Tubular (21)	X	22	0.00316	0.00001	15.6	2	1	Glued 1/06 Tested 11/06 3 coats rim 1 coat tire Mastik 1
Bontrager Select (23)/Vred Latex (18/25)		24	0.00316	0.00000	15.6	2	1	New Tire - Wire Bead - Tested at 120 psig / Rated 100 psig
Velo Flex Pave/Mich Latex Tube (18/20)		23	0.00317	0.00004	15.7	2	1	Used Tire
Bontrager Race Lite (23)/Vred Latex (18/25)		23	0.00317	0.00006	15.6	2	1	New Tire
Velo Flex Pave/Mich Latex Tube (22/23)		23	0.00318	0.00004	15.7	3	1	Used Tire
FMB Silk Tubular Strada Tread (20)	X	21	0.00322	0.00002	15.8	2	1	New Tire
Schwalbe Ultremo (23)/Michelin Latex Tube (22/23)		24	0.00322	0.00005	15.8	2	1	Used Tire
Tufo Race Lite < 125 grams Tubular	X	20	0.00322	0.00001	15.8	2	1	Used Tire
Continental SuperSonic (20)/Michelin Latex (18/20) Tube		20	0.00322	0.00005	15.8	2	1	Used Tire - ~ 1000 miles
Tufo S3 Lite < 135 grams Tubular (21)	X	23	0.00324	0.00005	15.9	2	1	Used Tire
Vittoria Open Extreme (20)/Michelin Latex (18/20) Tube		21	0.00324	0.00008	15.9	2	1	New Tire - Stored 3 years
Schwalbe Ultremo (23)/Michelin Latex Tube (18/20)		24	0.00325	0.00004	16.0	2	1	Used Tire
Continental Sprinter (22) Tubular	X	23	0.00327	0.00001	16.1	2	1	New Tire - glued with Mastik 1
Bontrager Race X Lite Race Day (23)/ Vred (18/25) Latex Tube		23	0.00328	0.00001	16.1	2	1	New Tire
Bontrager Race X Lite (23)/ Latex Tubes		23	0.00328	0.00011	16.2	3	6	3 New Tires - Mich (18/20) & (22/23), Vred (18/25) Latex Tubes
Bontrager Race X Lite Aero Wing (19)/Michelin Latex (18/20)		20	0.00330	0.00003	16.2	2	1	New Tire
Vittoria EVO Corsa Triathlon (21) Tubular	X	20	0.00330	0.00001	16.2	2	1	New Tire
Hutchinson Fusion 2 Tubeless (23)		25	0.00331	0.00003	16.3	2	1	Used Tire ~ 200 miles
IRC Red Storm Lite (19)/Mich Latex (18/20)		19	0.00331	0.00001	16.3	2	1	Used Tire
Maxxis Hors Catagorie (20)/Mich Latex (22/23) Tube		21	0.00334	0.00009	16.4	4	1	2 Used Tires
Schwalbe Ultremo (23)/Butyl Tube		24	0.00335	0.00003	16.5	2	1	Used Tire
Clement Criterium Seta Servizio Corsa Tubular	X	22	0.00338	0.00003	16.6	2	1	Used Tire
Continental Competition (22) Tubular	X	22	0.00340	0.00006	16.7	2	1	New Tire
Tufo Clinchular Elite Jet < 160 grams	X	22	0.00350	0.00005	17.2	2	1	Used Tire
Continental SuperSonic (23)/Michelin Latex (18/20) Tube		22	0.00352	0.00004	17.3	2	1	New Tire
Specialized Mondo/Butyl Tube (23)		25	0.00360	0.00000	17.7	2	1	Used Tire
Vredestein Fortezza Tricomp (23)/Michelin Latex (18/20) Tube		24	0.00360	0.00004	17.7	2	1	Used Tire - stored 2 years
Specialized Turbo C (18)/Michelin Latex (18/20) Tube		19	0.00369	0.00002	18.1	2	1	Used Tire - ~ 1000 miles
Schwalbe Stelvio Tubular (25)	X	25	0.00373	0.00002	18.3	2	1	New Tire - Made by Tufo
Velo Flex Pave/Butyl Tube (22/23)		23	0.00376	0.00008	18.5	4	1	Used Tire
Conti Grand Prix 4000 (Black Chili) Tubular (22)	X	21	0.00384	0.00004	18.9	2	1	New Tire
Continental GP 4000 (23)/Michelin Latex (18/20) Tube		24	0.00384	0.00000	18.9	1	1	Used Tire - 350 miles
Specialized Turbo R (18)/Michelin Latex (18/20) Tube		19	0.00386	0.00003	19.0	2	1	New Tire
Schwalbe Stelvio (23)/Butyl Tube		24	0.00392	0.00005	19.3	2	1	Used Tire
Avocet TT/30 (20)/Butyl Tube		21	0.00394	0.00010	19.4	2	2	Used Tire
Vredestein Fortezza (20)/Michelin Latex (18/20) Tube		21	0.00397	0.00004	19.5	2	1	Used Tire - stored 2 years
Specialized Turbo C (18)/Michelin Latex (18/20) Tube		19	0.00404	0.00004	19.9	2	1	New Tire
Vittoria Corsa CG Squadra Prof - Tubular	X	23	0.00418	0.00007	20.6	2	1	Used Tire/ ~ 8 years old - Pre Velo Flex
Tufo S3 Pro Tubular (21)	X	22	0.00420	0.00000	20.7	1	1	Used Tire with 1/2 Tube of Tufo Sealant
Kenda Kaliente (23)/Vred Thick Latex (18/25)		23	0.00420	0.00004	20.7	4	2	1 New & 1 Used Tire
Maxxis Equipe Legere (20)/Michelin Latex (18/20) Tube		20	0.00422	0.00005	20.7	2	1	New Tire
Michelin Axial Pro (23)/Michelin Latex (18/20) Tube		24	0.00423	0.00004	20.8	2	1	Used Tire - Stored 3 years
Continental Ultra Sport (23)/Michelin Latex (18/20) Tube		24	0.00428	0.00009	21.0	2	1	Used Tire - 1000 miles
Bontrager Race Lite Tubular (22)	X	22	0.00440	0.00001	21.7	2	1	New Tire
Bontrager Sport (23)/Vred Latex (18/25)		23	0.00453	0.00001	22.3	2	2	New Tire - Wire Bead - Tested at 120 psig / Rated 100 psig
Ritchey Fortress/Butyl Tube		24	0.00462	0.00013	22.7	78	43	Control Tire - first and last run each test day
Tufo S33 Special (21)	X	22	0.00467	0.00002	23.0	2	1	Used Tire - ~ 100 miles
Conti GP 3000 (20)/Butyl Tube		19	0.00488	0.00040	24.0	2	1	Used Tire

Tire/tube	Tubular?	Tire Width (mm)	Cr	Std Dev	watts per wheel	Runs	Days	Notes
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Tubular Glue Aging Tests

Velo Flex Carbon Tubular - Vittoria Mastik 1 Glue	X	23	0.00334	0.00004	16.4	2	1	Glued 10/31/06 Tested 11/1/06 2 cts rim/1 ct tire
	X	23	0.00324	0.00006	15.9	2	1	Reglued 11/16/06 Tested 11/23/06 add 1 ct ~ 80 miles
	X	23	0.00312	0.00004	15.3	2	1	Tested 12/16/06 ~ 80 miles
	X	23	0.00316	0.00003	15.6	2	1	Tested 1/26/07 ~ 125 miles
Zipp Tubular - Continental Glue	X	22	0.00299	0.00002	14.7	2	1	Glued 12/31/06 Tested 1/1/07 2 cts rim dry/1 ct tire - New Tire
	X	22	0.00302	0.00000	14.9	2	1	Tested 1/6/07 - New Tire/Zero Miles on Road
	X	22	0.00301	0.00001	14.8	2	1	Tested 1/26/07 - New Tire/Zero Miles on Road
	X	22	0.00307	0.00010	15.1	2	1	Tested 2/9/07 - New Tire/Zero Miles on Road

Latex vs. Butyl Tube Tests

Velo Flex Pave/Butyl Tube (22/23)		23	0.00376	0.00008	18.5	4	1	Used Tire ~ 500 miles - Torelli Extra Light Butyl Tube
Velo Flex Pave/Mich Latex Tube (18/20)		23	0.00317	0.00004	15.7	2	1	Same Tire
Vittoria Open Corsa EVO CX (23)/Butyl Tube		24	0.00307	0.00040	15.1	2	1	Used Tire ~ 40 miles - Specialized Turbo Butyl Tube
Vittoria Open Corsa EVO CX (23)/Mich Latex Tube (22/23)		24	0.00261	0.00001	12.8	2	1	Same Tire
Scwalbe Ultremo (23)/Butyl Tube		24	0.00335	0.00003	16.5	2	1	Used Tire - Bontager SL Butyl Tube
Scwalbe Ultremo (23)/Michelin Latex Tube (22/23)		24	0.00322	0.00005	15.8	2	1	Same Tire
Michelin Pro 2 Light/Michelin Latex (22/23)		24	0.00266	0.00001	13.1	2	1	Same Tire
Michelin Pro 2 Light/Bontrager RXXXL Butyl Tube (18/25)		24	0.00292	0.00001	14.4	2	1	Same Tire
Michelin Pro 2 Light/Bontrager RXL Butyl Tube (18/25)		24	0.00292	0.00001	14.4	2	1	Same Tire
Michelin Pro 2 Light/Bontrager Standard Butyl Tube (18/25)		24	0.00322	0.00001	15.8	2	1	Same Tire

Michelin (18/20) vs. Vredestein (18/25) Latex Tube Tests

Mich Pro 2 Light (23)/Michelin Latex (18/20) Tube		24	0.00259	0.00003	13.0	4	1	Used Tire ~ 100 miles
Mich Pro 2 Light (23)/Vred Thick Latex (18/25) 40 mm valve		24	0.00259	0.00004	13.0	2	1	Used Tire ~ 100 miles
Conti Supersonic (20)/Michelin Latex (18/20) Tube		20	0.00318	0.00005	15.8	2	1	Used Tire ~ 1000 miles
Conti Supersonic (20)/Vred Thick Latex (18/25) 40 mm valve		20	0.00316	0.00005	15.5	2	1	Used Tire ~ 1000 miles
Mich Pro 2 Light (23)/Michelin Latex (18/20) Tube		24	0.00244	0.00000	12.1	1	1	Used Tire ~ 100 miles - Warm Day
Mich Pro 2 Light (23)/Vred Thin Latex (18/25) 60 mm valve		24	0.00244	0.00000	12.1	1	1	Used Tire ~ 100 miles - Warm Day

Tufo Sealant Tests

Tufo S3 Lite < 135 grams Tubular (21)	X	23	0.00324	0.00005	15.9	2	1	Used Tire - Tested 6/20/07 - Add 1/2 Small Tube Tufo Sealant
Tufo S3 Lite < 135 grams Tubular (21)	X	23	0.00330	0.00002	16.2	2	1	Used Tire - Tested 6/22/07
Tufo S3 Lite < 135 grams Tubular (21)	X	23	0.00333	0.00000	16.4	1	1	Used Tire - Tested 7/31/07

Pressures Other Than 120 psig

Velo Flex Record/Michelin Latex Tube (18/20)		20	0.00240	X	11.8	1	1	New Tire - 140 psig
Vittoria EVO KS (20)/Michelin Latex Tube (18/20)		22	0.00291	X	14.3	1	1	New Tire - 140 psig
Tufo C Elite Jet < 160 grams	X	22	0.00350	0.00005	17.2	2	1	120 psig
Tufo C Elite Jet < 160 grams	X	22	0.00331	X	16.3	1	1	140 psig
Tufo C Elite Jet < 160 grams	X	22	0.00313	X	15.4	1	1	160 psig
Tufo C Elite Jet < 160 grams	X	22	0.00302	X	14.9	1	1	180 psig
Tufo C Elite Jet < 160 grams	X	22	0.00294	X	14.5	1	1	200 psig
Tufo Race Lite < 125 grams Tubular	X	20	0.00322	0.00001	15.8	2	1	120 psig
Tufo Race Lite < 125 grams Tubular	X	20	0.00304	X	15.0	1	1	140 psig
Tufo Race Lite < 125 grams Tubular	X	20	0.00292	X	14.4	1	1	160 psig
Tufo Race Lite < 125 grams Tubular	X	20	0.00275	X	13.5	1	1	180 psig
Tufo Race Lite < 125 grams Tubular	X	20	0.00267	0.00004	13.1	2	1	200 psig