Task 7 Deliverable

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Improving Multimodal Traffic Safety for Multi-Lane Arterials

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CHAPTER 1: INTRODUCTION

In the previous tasks we have conducted extensive analysis by the driving simulator and data analytics studies to validate the effects of speed management countermeasures on speed and non-motorist safety. The driving simulator tested the effects of Rectangle Rapid Flashing Beacon (RRFB), Pedestrian Hybrid Beacon (PHB), and speed feedback sign on speed choice. In this task, the research team developed various driving scenarios based on the findings that were reported in previous tasks. The driving simulator experiment in this task recruited participants, considering age and gender to reach more conclusive results. Both base scenario without any speed management countermeasures and scenarios with speed management countermeasures were developed for three design speeds corresponding to the specific context classification. Detailed vehicles' trajectory data could be obtained from the driving simulator study. Speed metrics including mean speed and the 85^{th} percentile speed, were analyzed to explore drivers' speed choices at the upstream and downstream of the locations where the speed management countermeasures were placed.

CHAPTER 2: DRIVING SIMULATOR

The Smart and Safe Transportation Lab developed at the University of Central Florida (UCF) located in Orlando, FL was used to conduct the driving simulator experiment and collect the data. The simulator has three screens (20.5 in. high and 27.9 in. wide) with a 135 degrees front field of view and left, middle, and right rear-view mirror. Participants interacted with the simulator by a control interface with steering wheel, pedals, and speedometer. All data were collected at 60 HZ. Figure 1 shows the setup of the lab, in which the participants conducted the experiment. The lab has three driving simulators which can be used simultaneously to conduct a multi-driving simulator study. For the purposes of this analysis only one simulator was used.

Figure 1 Setup of the Smart and Safe Transportation Lab

2.1 Development of Scenarios

The experiment consists of multiple scenarios modeled to represent the recommended speed management countermeasures for the C3C/C3R and C4 roadways. Each scenario has a specific speed management countermeasure that was model from the Manual on Uniform Traffic Control Devices (MUTCD). Figures shows the model of some of the countermeasures that were tested on the participants of the study.

Figure 2 An activated RRFB with a pedestrian crossing

Figure 3 An activated RRFB with a pedestrian crossing

Figure 4 A roundabout with trees in the center

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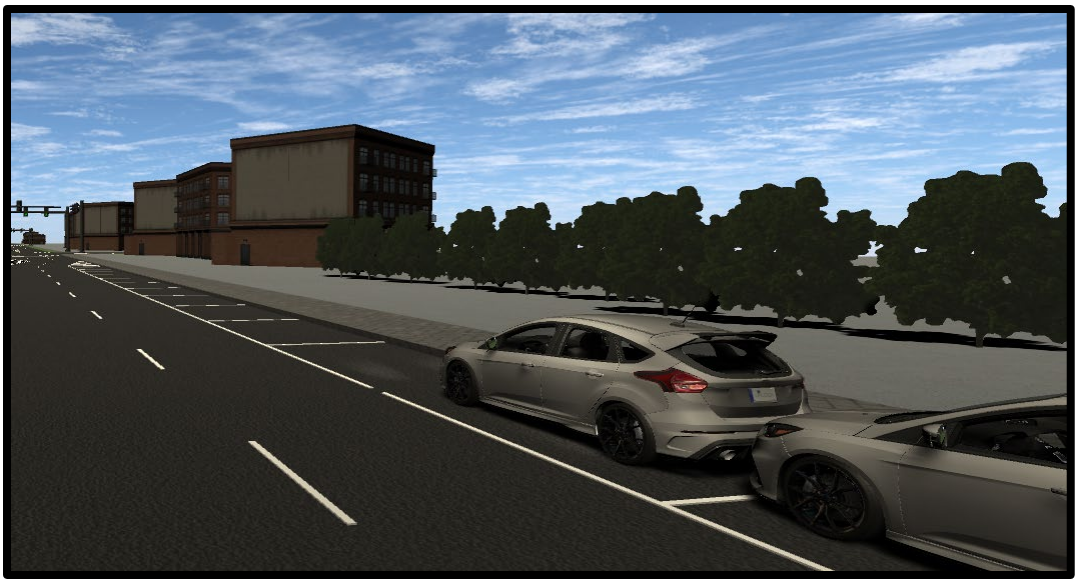


Figure 6 A road with on-street parking

CHAPTER 3: SPEED CHOICE FOR RECOMMENDED SPEED MANGEMENT COUNTERMEASURES

This study was designed to analyze the effect of various speed management countermeasures for C3R/C3C and C4 roads considering three design speeds which are present on the respected roads. It is important to understand the effects of the speed management countermeasures to be able to determine the ideal environment considering the various design speeds. Hence, several statistical tests, such as the ANOVA test and simple piecewise comparison can be used to get a better understanding on how these speed management countermeasures can affect drivers' speeding behavior.

3.1 Experimental Design

A variety of circumstances including speed management countermeasures type, traffic conditions, road types, and design speed are of interest. Hence, a driving simulator would be able to provide the necessary controls to explore all possible scenarios. The driving simulator can give drivers the impression that they are driving a vehicle in the real word by simulating the real driving environment. By simulating vehicle motion according to drivers' operations, the vehicle kinematic data can be generated and used to analyze drivers' decisions.

The experiment was a within-subjects experiment. The scenario type (e.g., without/with speed management countermeasures) were within variables, and each participant driver experienced randomly a scenario under three design speeds of with speed management countermeasures and a base condition. The speed management countermeasures were modeled after the Manual on Uniform Traffic Control Devices (MUTCD). Also, the participants drove the three design speeds for each of the recommended speed management countermeasures depending on the context classification. Hence, each participant was tested for 15 (3*5) scenarios in the

C3R/C3C experiment, and 21 (3*7) scenarios in the C4 experiment. Since there were many scenarios to be tested, it was ideal to split the experiment into 2 parts, a C3C/C3R and C4 experiment. Each of the 48 participants were randomly assign to an experiment, and the ratio between gender and age-group maintained consistent throughout each experiment. The advantage of a within-subjects experiment is that it controls extraneous participant variables and makes it easier to detect the relationships between the independent and dependent variables. To prevent a participant from predicting the scenario type, multiple base scenarios were arranged between the design speeds that were tested. In addition, to account for the carryover effect, the order of all scenarios that a participant driver experienced were based on Latin Sequence design.

3.1.1 Scenario design

The scenarios in this study were based on the recommended speed management countermeasures for each context classification. The C3C/C3R roads had six lanes, where three design speeds (40, 45, and 50 mph) were tested. The C4 roads had four lanes, where three design speeds (30, 35, and 40 mph) were tested. A summary table of all the countermeasures that were tested are shown in Table 1. For each of the pedestrian crossing treatments (PHB and RRFB), roundabout, and short block six zones were analyzed: (3) upstream and (3) downstream sections (100ft each). The lane narrowing, street trees, and on-street parking scenarios were analyzed in comparison to the absence of these test countermeasures. The sections upstream and downstream were chosen based on the previous tasks, since these distances are shown to be sufficient distances to understand the effects of these countermeasures.

Table 1 Summary of test countermeasures

Test countermeasures	Evaluation target	Roadway characteristics		Evaluation measures	
		Context classification	Speed limit (mph)	Speed	Safety
PHB	Speed/non-motorist safety	C3C/C3R	40, 45,50	Mean speed; 85th percentile speed	Surrogate safety measure, drivers' yielding rate
		C4	30, 35, 40		
RRFB	Speed/non-motorist safety	C3C/C3R	40, 45,50	Mean speed; 85th percentile speed	Surrogate safety measure, drivers' yielding rate
		C4	30, 35, 40		
Lane narrowing	Speed/non-motorist safety	C3C/C3R	40, 45,50	Mean speed; 85th percentile speed	Surrogate safety measure, drivers' yielding rate
		C4	30, 35, 40		
Short block	Speed/non-motorist safety	C3C/C3R	-	Mean speed; 85th percentile speed	Surrogate safety measure, drivers' yielding rate
		C4	30, 35, 40		
Roundabout	Speed	C3C/C3R	40, 45,50	Mean speed; 85th percentile speed	-
		C4	30, 35, 40		
On-Street Parking	Speed	C3C/C3R	-	Mean speed; 85th percentile speed	-
		C4	30, 35, 40		
Street Trees	Speed	C3C/C3R	-	Mean speed; 85th percentile speed	-

3.1.2 Summary of Scenarios

In total, 3 variables are considered in this experiment, which includes countermeasure type, context classification, and design speed. A total of 36 scenarios would be obtained based on the 3 variables. Each participant was assigned to 15 or 21 different scenarios (depending on the experiment assigned) with a random order of the scenario to eliminate any bias. This design was utilized to limit time of each participant in order to reduce the probability of motion sickness. With this arrangement, each experiment had at least 24 participants, which allowed for the scenarios to be compared among each other. Table 2 summarizes all the scenario and participant related variables with their respective descriptive statistics.

Table 2 Descriptive statistics of participant related variables

Name	Description	Input value	Count	Percentage (%)
GENDER	Gender	Male = 1 Female = 0	24 24	50.00 50.00
YOUNG	Young participants (age ≥ 18 and age ≤ 24)	Yes = 1 No = 0	16 32	33.33 66.67
MIDDLE-AGED	Middle-aged participants (age ≥ 25 and age < 40)	Yes = 1 No = 0	16 32	33.33 66.67
OLD	Old participants (age ≥ 40)	Yes = 1 No = 0	16 32	33.33 66.67

3.1.3 Experimental Procedure

Institutional Review Board (IRB) approval was obtained before the experiment. Upon arrival at the laboratory, each participant signed a consent form and filled in a background information survey. Once the participants got familiar with the apparatus in the driver's seat, an instruction for the experiment were given. The instruction didn't include any information about the details of experiments which may potentially influence driving behavior. Participants were instructed to

drive as normally as they usually do in a real car. Then an introductory video was played for the participant in order to explain the different phases of the PHB and how to drive in a PHB and RRFB. Most participants were not familiar with the PHB, so the video allowed the subjects to understand how the PHB functions. Most participants were familiar with the other countermeasures, and did not require an introductory video, if there were any questions they were answered before the experiment was conducted. The first half of the experiment would be followed by a 5-min rest period, and participants would continue the other half of the experiment if they didn't feel any negative effects of driving. Only one participant felt motion sickness and was unable to complete the experiment, this participant was replaced by another person with the same gender and age group to insure a balanced sample.

During each trial, the participants were instructed to drive to the end of the experimental road, and the driving simulator operator would then end the experiment. Each scenario would take about 5 - 7 mins and participants could have at least 5 min to rest between trials. The entire experimented lasted on average about 45 - 50 mins. A total of 864 ($24 * 36$) trials were conducted.

3.1.4 Analysis of variance (ANOVA)

Repeated measures Analysis of Variance (ANOVA) is the equivalent of the one-way ANOVA, but for related, not independent groups, and is the extension of the dependent t-test. A repeated measures ANOVA is also referred to as a within-subjects ANOVA or ANOVA for correlated samples. All these names imply the nature of the repeated measures ANOVA, that of a test to detect any overall differences between related means. A repeated measures ANOVA calculates an F-statistic, as

$$Repeated\ Measures\ ANOVA: \quad F = \frac{MS_{conditions}}{MS_{error}} \tag{2-1}$$

The ANOVA tests were conducted estimate the mean and 85th percentile speed for upstream, downstream, and in-between segments. It's important to note that there were no significant differences in speed for segments beyond 100 ft downstream of the pedestrian crossing countermeasures. A detailed analysis for the segments of each roadway will be explained below.

3.2 C3C/C3R Analysis Results

The results for the ANOVA tests conducted on the mean and 85th percentile speed for the analysis zones of the recommend C3C/C3R countermeasures are shown in the Tables 3-11. The results from these tables show that there are significant differences between the pedestrian crossing treatment groups (Base, RRFB, and PHB) regarding mean speed and 85th percentile speed for most speed limits. The gender and age parameters were significant in some of the upstream and downstream segments. For each of the speed limits tested there was more significant difference downstream zones of the pedestrian crossing treatments than the upstream zones. For the roundabout scenarios, which were compared against the base scenarios, there were similar results to the pedestrian crossing treatment groups. All the analysis zones upstream and downstream had a significant difference. The age parameter was also significant in some of the upstream and downstream segments. For lane narrowing, none of the scenarios showed a significant difference between the lane narrowing scenarios and the base scenarios. Therefore, a simple piecewise comparison is done to show the amount of difference between the countermeasures which has a significant difference (RRFB, PHB, and Roundabout). The differences of speed metrics between each two different pedestrian crossing treatment groups and the roundabout are presented in Figures 1-12.

Table 3 ANOVA test for pedestrian crossing treatment group (C3C/C3R, 40 mph)

Mean Speed	**Upstream**	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	69.228	<0.01*	3.987	0.02*	1.197	0.31
	gender	0.901	0.35	0.206	0.65	1.416	0.24
	age_category	4.669	0.01*	1.887	0.16	2.526	0.09*
	group:gender	0.248	0.78	0.103	0.90	0.502	0.61
	group:age_category	0.678	0.61	0.689	0.60	0.27	0.90
	gender:age_category	0.045	0.96	0.15	0.86	0.144	0.87
	Downstream	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	21.514	<0.01*	4.547	0.01*	2.141	0.13
	gender	5.107	0.03*	0.725	0.40	0.431	0.51
	age_category	1.729	0.19	1.04	0.36	0.44	0.65
	group:gender	1.747	0.18	0.329	0.72	0.201	0.82
	group:age_category	1.448	0.23	1.146	0.34	1.139	0.35
	gender:age_category	0.845	0.44	1.824	0.17	4.085	0.02*
85th Percentile Speed	**Upstream**	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	34.25	<0.01*	4.95	0.01*	3.16	0.05*
	gender	1.00	0.32	0.70	0.41	2.11	0.15
	age_category	1.31	0.28	2.13	0.13	2.81	0.07*
	group:gender	0.58	0.56	0.02	0.98	0.13	0.88
	group:age_category	1.93	0.12	0.64	0.63	0.46	0.76
	gender:age_category	0.12	0.89	0.00	1.00	0.34	0.71
	Downstream	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	14.35	<0.01*	6.03	<0.01*	3.02	0.06*
	gender	5.61	0.02*	0.91	0.34	1.05	0.31
	age_category	0.92	0.40	0.37	0.69	0.54	0.59
	group:gender	0.69	0.50	0.08	0.92	0.09	0.92
	group:age_category	1.68	0.17	1.17	0.33	1.22	0.31
	gender:age_category	0.76	0.47	2.35	0.10	3.36	0.04*
	* indicates difference is significant at the 90th Percentile; group indicates the pedestrian crossing treatments (RRFB, PHB)						

Table 4 ANOVA test for lane narrowing (C3C/C3R, 40 mph)

		F value	Pr(>F)
Mean Speed	**group**	0.631	0.43
	gender	0.05	0.82
	age_category	5.417	0.01*
	group:gender	0.233	0.63
	group:age_category	0.192	0.83
	gender:age_category	0.579	0.57
85th Percentile Speed		**F value**	**Pr(>F)**
	group	0.00	0.99
	gender	1.41	0.24
	age_category	4.29	0.02*
	group:gender	0.09	0.76
	group:age_category	0.48	0.62
	gender:age_category	0.47	0.63

* indicates difference is significant at the 90th Percentile; group indicates lane narrowing and base scenarios

Table 5 ANOVA test for roundabout (C3C/C3R, 40 mph)

Mean Speed	**Upstream**	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	88.436	<0.01*	45.072	<0.01*	26.212	<0.01*
	gender	0.314	0.58	0.326	0.57	2.052	0.16
	age_category	1.882	0.17	3.726	0.03*	7.12	<0.01*
	group:gender	0.132	0.72	0.619	0.44	1.439	0.24
	group:age_category	1.087	0.35	2.546	0.09*	4.32	0.02*
	gender:age_category	0.044	0.96	0.042	0.96	0.064	0.94
	Downstream	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	49.183	<0.01*	24.406	<0.01*	12.488	<0.01*
	gender	0.171	0.68	0.102	0.75	0.024	0.88
	age_category	4.547	0.02*	3.894	0.03*	3.364	0.05*
	group:gender	0.054	0.82	0.26	0.61	0.127	0.72
	group:age_category	2.341	0.11	1.546	0.23	1.775	0.18
	gender:age_category	1.331	0.28	1.755	0.19	1.301	0.28
85th Percentile Speed	**Upstream**	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	80.63	<0.01*	50.48	<0.01*	33.39	<0.01*
	gender	0.00	0.96	0.64	0.43	0.65	0.42
	age_category	1.27	0.29	3.44	0.04*	4.56	0.02*
	group:gender	0.68	0.41	0.00	0.96	2.80	0.10
	group:age_category	1.92	0.16	3.96	0.03*	4.83	0.01*
	gender:age_category	0.13	0.88	0.10	0.91	0.14	0.87
	Downstream	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	52.42	<0.01*	31.56	<0.01*	18.84	<0.01*
	gender	0.00	0.96	0.39	0.54	0.24	0.63
	age_category	4.00	0.03*	2.62	0.09*	2.59	0.09*
	group:gender	0.51	0.48	0.02	0.89	0.07	0.80
	group:age_category	3.41	0.04*	2.10	0.14	2.31	0.11
	gender:age_category	0.91	0.41	1.24	0.30	0.95	0.40
	* indicates difference is significant at the 90th Percentile; group indicates the roundabout and base scenarios						

Table 6 ANOVA test for pedestrian crossing treatment group (C3C/C3R, 45 mph)

Mean Speed	**Upstream**	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	110.61	<0.01*	21.06	<0.01*	6.78	<0.01*
	gender	0.40	0.53	0.05	0.82	0.50	0.48
	age_category	0.99	0.38	0.65	0.53	5.04	0.01*
	group:gender	0.37	0.69	0.12	0.89	0.24	0.79
	group:age_category	1.84	0.13	0.55	0.70	0.38	0.83
	gender:age_category	0.45	0.64	3.54	0.04*	0.99	0.38
	Downstream	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	38.55	<0.01*	15.55	<0.01*	6.22	<0.01*
	gender	5.31	0.02*	4.50	0.04*	2.02	0.16
	age_category	7.05	<0.01*	3.48	0.04*	0.95	0.39
	group:gender	2.00	0.14	1.58	0.21	0.61	0.54
	group:age_category	2.41	0.06*	0.51	0.73	0.80	0.53
	gender:age_category	0.02	0.98	5.14	0.01*	4.76	0.01*
85th Percentile Speed	**Upstream**	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	54.71	<0.01*	18.45	<0.01*	8.21	<0.01*
	gender	0.86	0.36	0.00	0.95	1.66	0.20
	age_category	0.50	0.61	1.37	0.26	6.17	<0.01*
	group:gender	0.60	0.55	0.33	0.72	0.52	0.60
	group:age_category	1.53	0.21	0.76	0.55	1.16	0.34
	gender:age_category	0.87	0.43	2.15	0.13	0.44	0.65
	Downstream	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	34.87	<0.01*	14.90	<0.01*	8.33	<0.01*
	gender	7.67	0.01*	6.32	0.01*	3.44	0.07*
	age_category	4.60	0.01*	1.73	0.19	0.55	0.58
	group:gender	1.62	0.21	0.71	0.50	0.28	0.76
	group:age_category	2.06	0.10*	1.05	0.39	1.34	0.27
	gender:age_category	0.19	0.83	4.88	0.01*	4.15	0.02*
	* indicates difference is significant at the 90th Percentile; group indicates the pedestrian crossing treatments (RRFB, PHB)						

Table 7 ANOVA test for lane narrowing (C3C/C3R, 45 mph)

Mean Speed		**F value**	**Pr(>F)**
	group	0.02	0.89
	gender	0.06	0.81
	age_category	8.38	<0.01*
	group:gender	0.02	0.90
	group:age_category	0.08	0.92
	gender:age_category	0.51	0.61
85th Percentile Speed		**F value**	**Pr(>F)**
	group	0.32	0.57
	gender	0.45	0.51
	age_category	8.43	<0.01*
	group:gender	0.27	0.61
	group:age_category	0.73	0.49
	gender:age_category	0.57	0.57

* indicates difference is significant at the 90th Percentile; group indicates lane narrowing and base scenarios

Table 8 ANOVA test for roundabout (C3C/C3R, 45 mph)

Mean Speed	**Upstream**	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	82.54	<0.01*	1.27	0.27	0.35	0.56
	gender	0.55	0.46	0.30	0.59	0.02	0.90
	age_category	10.15	<0.01*	4.96	0.01*	6.06	0.01*
	group:gender	0.46	0.50	0.19	0.67	0.00	0.99
	group:age_category	3.09	0.06*	0.24	0.79	0.30	0.75
	gender:age_category	0.24	0.79	0.07	0.94	0.41	0.67
	Downstream	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	91.12	<0.01*	37.98	<0.01*	24.77	<0.01*
	gender	2.73	0.11	1.24	0.27	1.25	0.27
	age_category	11.03	<0.01*	10.63	<0.01*	10.49	<0.01*
	group:gender	2.47	0.12	1.09	0.30	1.06	0.31
	group:age_category	2.18	0.13	2.93	0.07	2.83	0.07
	gender:age_category	0.72	0.49	0.56	0.58	1.02	0.37
85th Percentile Speed	**Upstream**	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	70.32	<0.01*	22.50	<0.01*	13.09	<0.01*
	gender	0.39	0.54	0.06	0.81	0.09	0.77
	age_category	7.29	<0.01*	4.84	0.01*	4.55	0.02*
	group:gender	1.62	0.21	0.30	0.59	1.33	0.26
	group:age_category	3.31	0.05*	4.47	0.02*	2.46	0.10*
	gender:age_category	0.05	0.96	0.08	0.92	0.27	0.76
	Downstream	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	82.50	<0.01*	41.58	<0.01*	32.86	<0.01*
	gender	1.33	0.26	0.29	0.60	0.53	0.47
	age_category	9.07	<0.01*	8.28	<0.01*	6.80	<0.01*
	group:gender	3.71	0.06*	1.61	0.21	2.71	0.11
	group:age_category	2.81	0.07*	3.84	0.03*	4.97	0.01*
	gender:age_category	0.54	0.59	0.38	0.69	0.85	0.43
	* indicates difference is significant at the 90th Percentile; group indicates the roundabout and base scenarios						

Table 9 ANOVA test for pedestrian crossing treatment group (C3C/C3R, 50 mph)

Mean Speed	**Upstream**	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	68.24	<0.01*	17.97	<0.01*	7.17	<0.01*
	gender	0.00	0.95	0.19	0.66	0.41	0.52
	age_category	1.95	0.15	0.63	0.54	4.24	0.02*
	group:gender	0.22	0.80	2.96	0.06*	3.69	0.03*
	group:age_category	1.17	0.34	0.74	0.57	0.58	0.68
	gender:age_category	2.36	0.10	8.24	<0.01*	6.36	<0.01*
	Downstream	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	46.84	<0.01*	11.91	<0.01*	4.75	0.01*
	gender	0.00	0.99	0.13	0.72	0.29	0.60
	age_category	8.08	<0.01*	7.09	<0.01*	6.65	<0.01*
	group:gender	1.89	0.16	0.18	0.84	0.40	0.68
	group:age_category	1.62	0.18	1.77	0.15	0.39	0.81
	gender:age_category	1.45	0.24	2.62	0.08*	4.54	0.01*
85th Percentile Speed	**Upstream**	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	39.85	<0.01*	18.76	<0.01*	10.26	<0.01*
	gender	0.07	0.79	0.43	0.52	0.05	0.83
	age_category	2.46	0.09*	0.36	0.70	6.60	<0.01*
	group:gender	0.17	0.85	5.54	0.01*	1.91	0.16
	group:age_category	1.36	0.26	1.56	0.20	0.11	0.98
	gender:age_category	0.50	0.61	7.84	<0.01*	3.56	0.03*
	Downstream	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	33.30	<0.01*	11.91	<0.01*	6.60	<0.01*
	gender	0.02	0.88	0.11	0.74	0.15	0.70
	age_category	6.13	<0.01*	5.44	0.01*	5.46	0.01*
	group:gender	1.23	0.30	0.12	0.89	0.57	0.57
	group:age_category	2.19	0.08*	1.31	0.28	0.39	0.81
	gender:age_category	1.81	0.17	2.93	0.06	5.00	0.01*
	* indicates difference is significant at the 90th Percentile; group indicates the pedestrian crossing treatments (RRFB, PHB)						

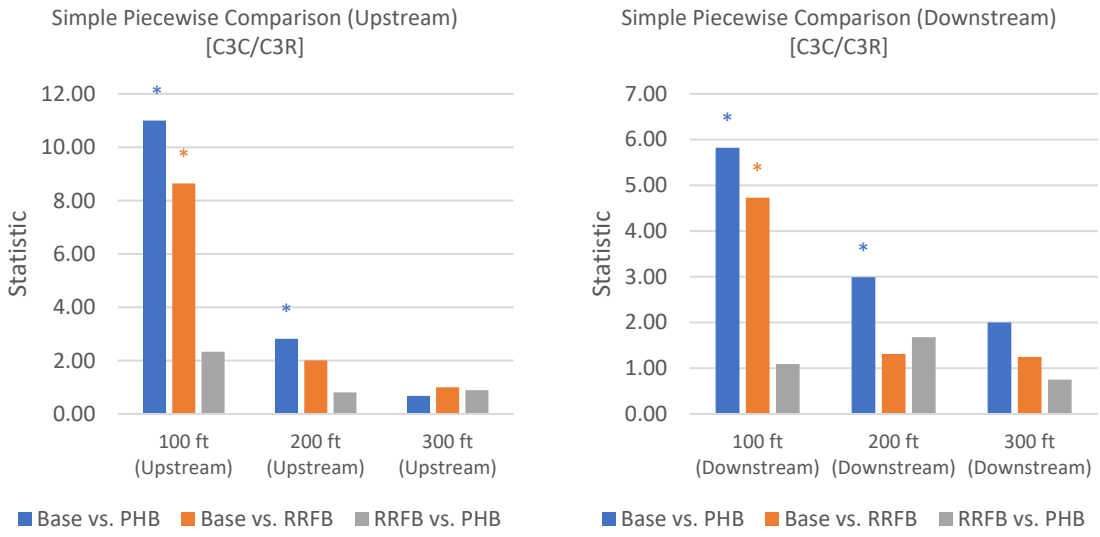
Table 10 ANOVA test for lane narrowing (C3C/C3R, 50 mph)

		F value	Pr(>F)
Mean Speed	**group**	0.14	0.72
	gender	2.75	0.11
	age_category	7.19	<0.01*
	group:gender	0.86	0.36
	group:age_category	0.17	0.84
	gender:age_category	0.29	0.75
85th Percentile Speed		**F value**	**Pr(>F)**
	group	0.00	0.97
	gender	2.57	0.12
	age_category	5.33	0.01*
	group:gender	0.39	0.54
	group:age_category	0.05	0.95
	gender:age_category	0.58	0.56
* indicates difference is significant at the 90th Percentile; group indicates lane narrowing and base scenarios			

Table 11 ANOVA test for roundabout (C3C/C3R, 50 mph)

	Upstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
Mean Speed	group	141.51	<0.01*	19.41	<0.01*	4.43	0.04*
	gender	1.51	0.23	1.31	0.26	0.27	0.61
	age_category	19.31	<0.01*	6.62	<0.01*	12.87	<0.01*
	group:gender	0.44	0.51	0.45	0.51	0.03	0.88
	group:age_category	5.71	0.01*	0.73	0.49	1.51	0.23
	gender:age_category	1.58	0.22	0.30	0.74	0.57	0.57
	Downstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	104.73	<0.01*	50.49	<0.01*	30.35	<0.01*
	gender	1.99	0.17	1.88	0.18	2.04	0.16
	age_category	5.63	<0.01*	4.54	0.02*	3.32	0.05*
	group:gender	0.77	0.39	0.70	0.41	0.72	0.40
	group:age_category	0.24	0.79	0.96	0.39	0.93	0.41
	gender:age_category	1.56	0.22	0.84	0.44	0.29	0.75
85th Percentile Speed	Upstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	57.52	<0.01*	19.47	<0.01*	6.17	0.02*
	gender	1.01	0.32	1.07	0.31	0.23	0.63
	age_category	7.81	<0.01*	6.26	<0.01*	9.32	<0.01*
	group:gender	0.09	0.76	0.06	0.81	0.22	0.64
	group:age_category	1.67	0.20	0.93	0.40	1.71	0.19
	gender:age_category	0.40	0.67	0.69	0.51	0.83	0.45
	Downstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	90.20	<0.01*	48.22	<0.01*	32.58	<0.01*
	gender	2.59	0.12	1.78	0.19	1.83	0.18
	age_category	4.13	0.02*	2.89	0.07*	2.27	0.12
	group:gender	0.65	0.42	0.28	0.60	0.25	0.62
	group:age_category	0.48	0.62	1.80	0.18	1.77	0.18
	gender:age_category	1.86	0.17	0.81	0.45	0.31	0.74
	* indicates difference is significant at the 90th Percentile; group indicates the roundabout and base scenarios						

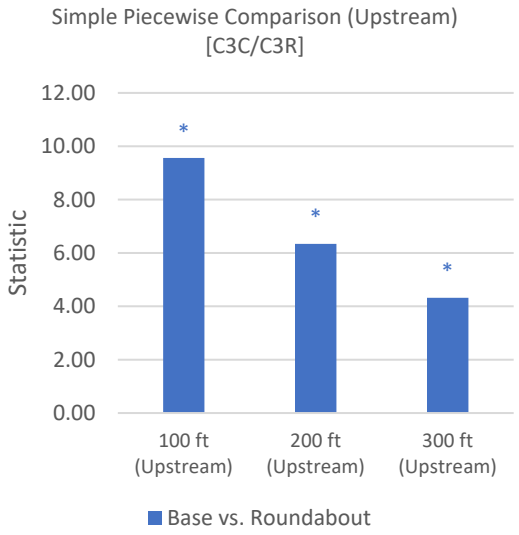
Based on the results of the ANOVA test for the recommended speed countermeasures for C3C/C3R, we can conduct a simple piecewise comparison test on the regions which we want to analyze. The speed countermeasures which showed significant differences between the base scenario, i.e. no speed countermeasures, and the test scenarios were the RRFB, PHB, and Roundabout. The simple piecewise comparions below will show the mean of the differences of the base scenario and the other test countermeasures. The RRFB and PHB were group together as Pedestrian Crossing Treatment (PCT) and the roundabout was grouped alone. The PHB was able to achieve more speed reduction upstream and downstream when compared to the RRFB. The differences of the speed reduction for each speed limit are shown in the figures below.

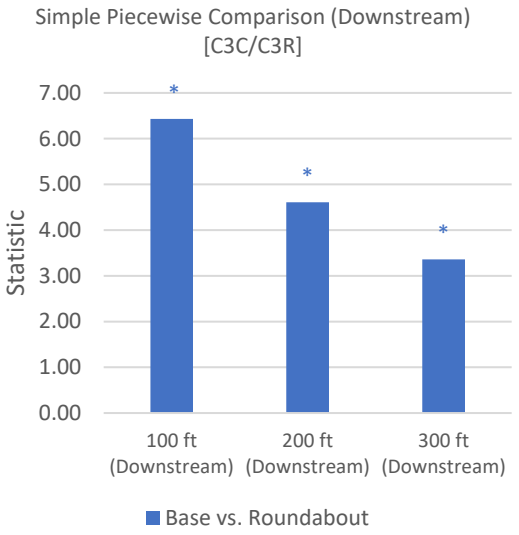


* * * indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

Figure 7 Difference of mean speed among pedestrian crossing treatment groups (C3C/C3R, 40 mph)

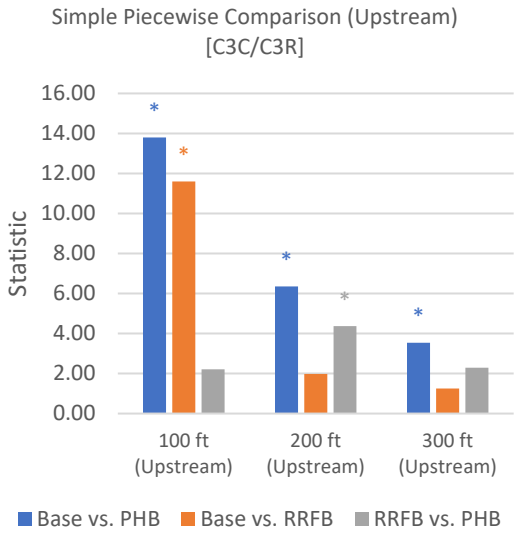


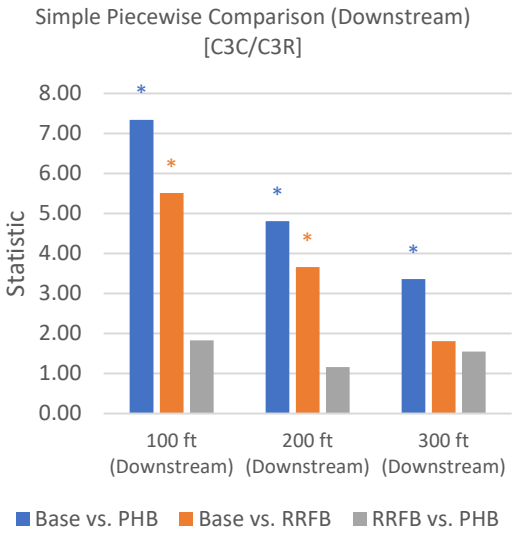


* indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

Figure 8 Difference of mean speed near the roundabout (C3C/C3R, 40 mph)

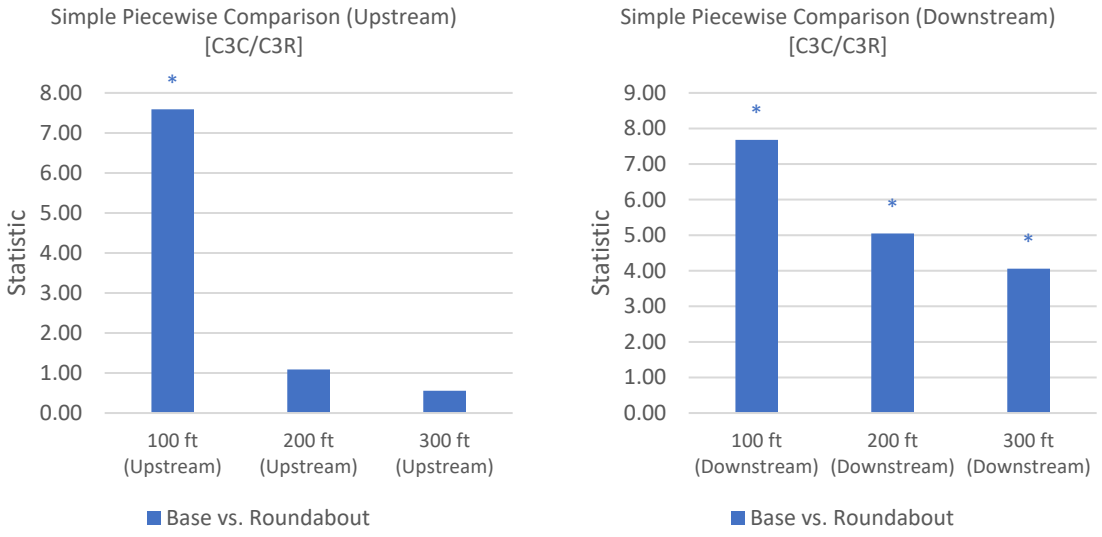




* * * indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

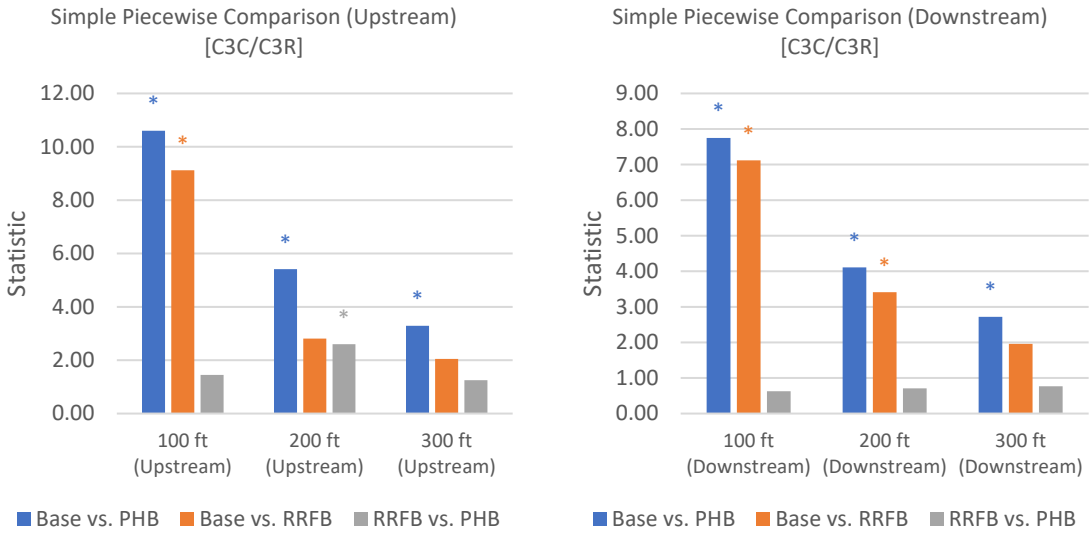
Figure 9 Difference of mean speed among pedestrian crossing treatment groups (C3C/C3R, 45 mph)



* indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

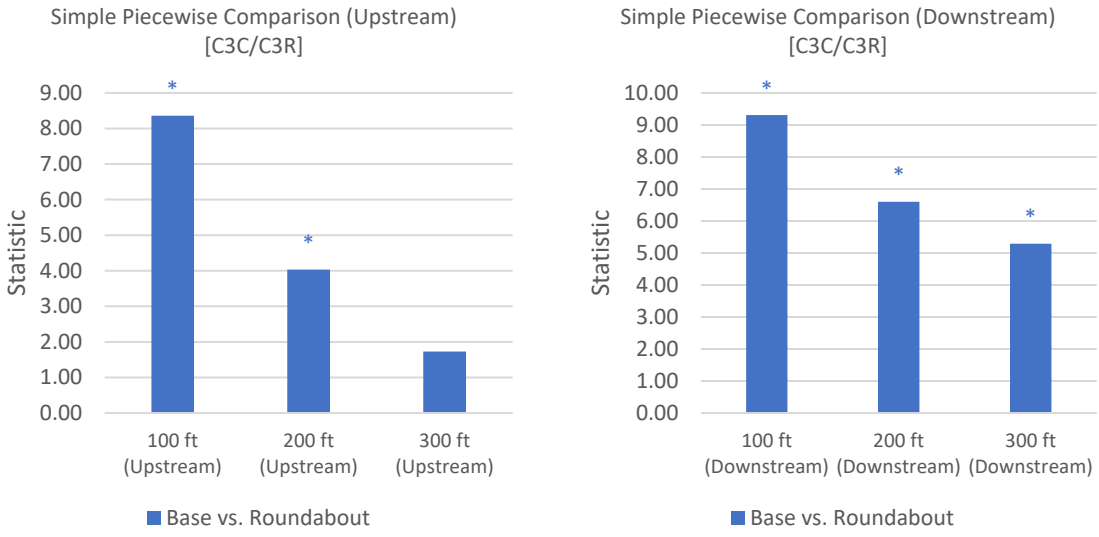
Figure 10 Difference of mean speed near the roundabout (C3C/C3R, 45 mph)



* * * indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

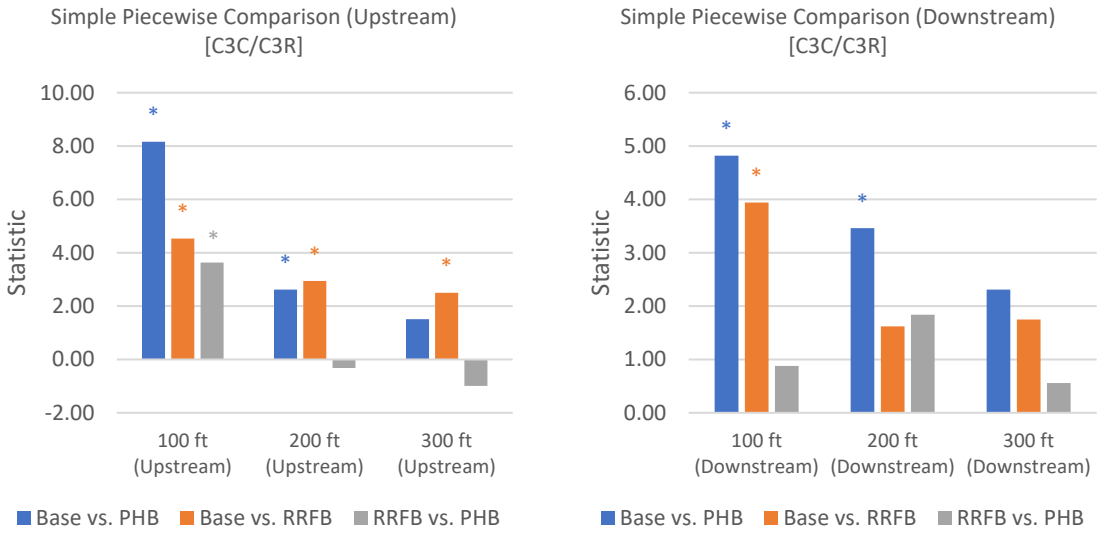
Figure 11 Difference of mean speed among pedestrian crossing treatment groups (C3C/C3R, 50 mph)



* indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

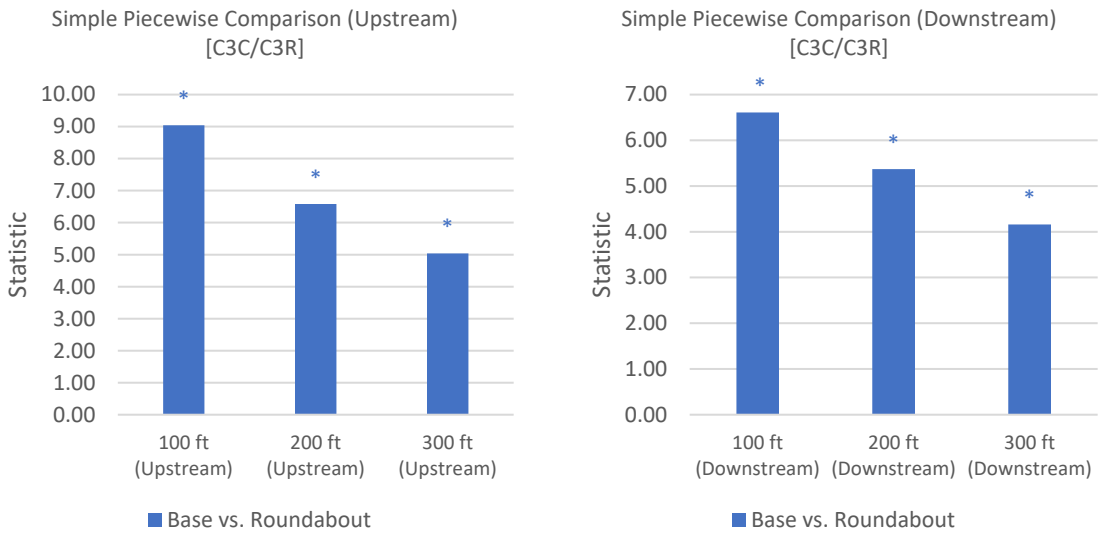
Figure 12 Difference of mean speed near the roundabout (C3C/C3R, 50 mph)



* * * indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

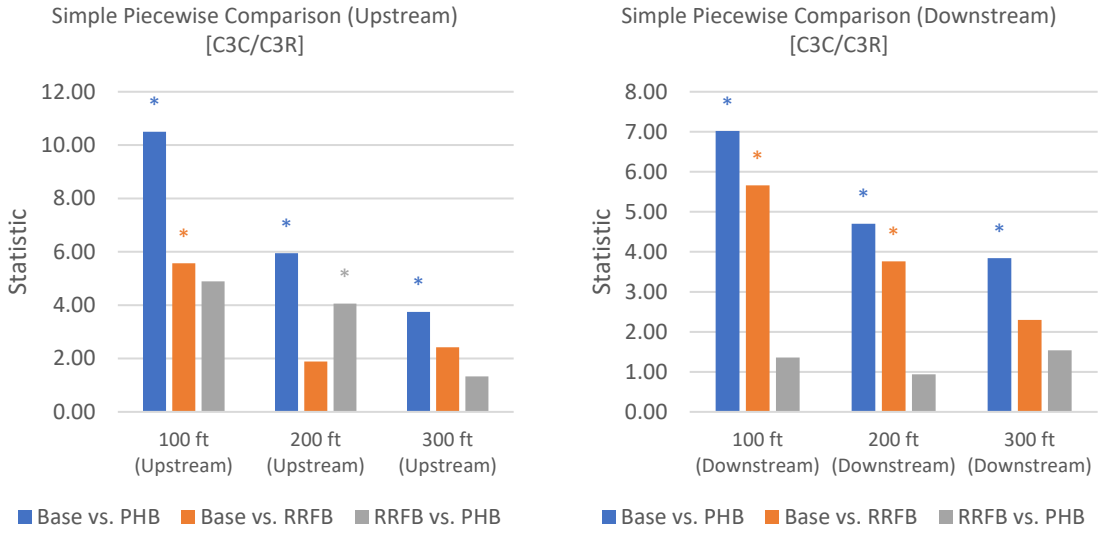
Figure 13 Difference of 85th percentile speed among pedestrian crossing treatment groups (C3C/C3R, 40 mph)



* indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

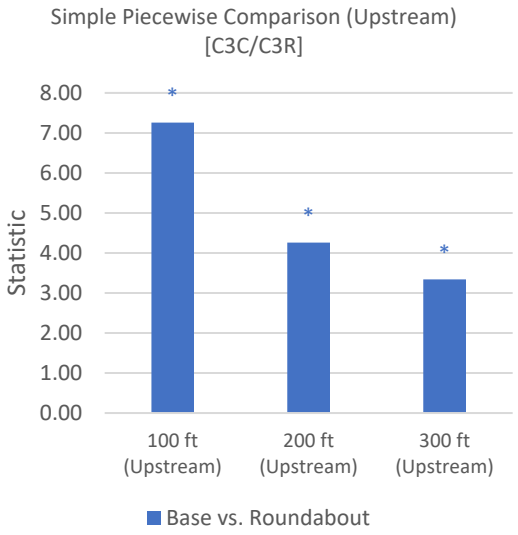
Figure 14 Difference of 85th percentile speed near the roundabout (C3C/C3R, 40 mph)

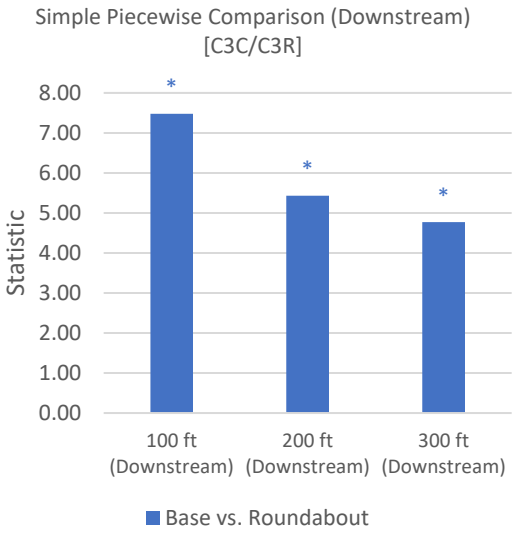


* * * indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

Figure 15 Difference of 85th percentile speed among pedestrian crossing treatment groups (C3C/C3R, 45 mph)

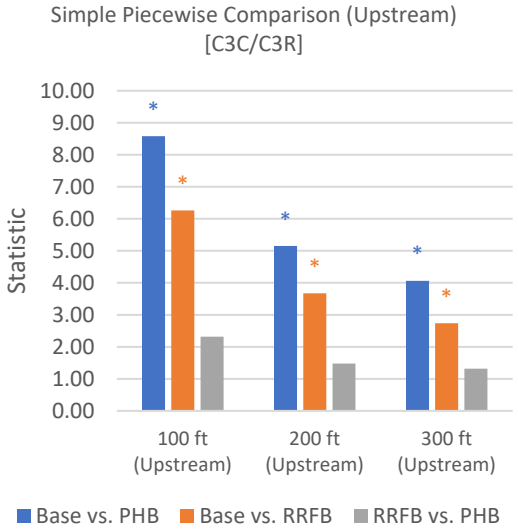


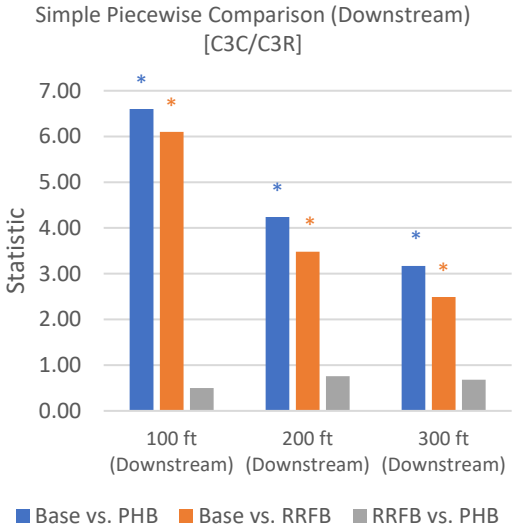


* indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

Figure 16 Difference of 85th percentile speed near the roundabout (C3C/C3R, 45 mph)

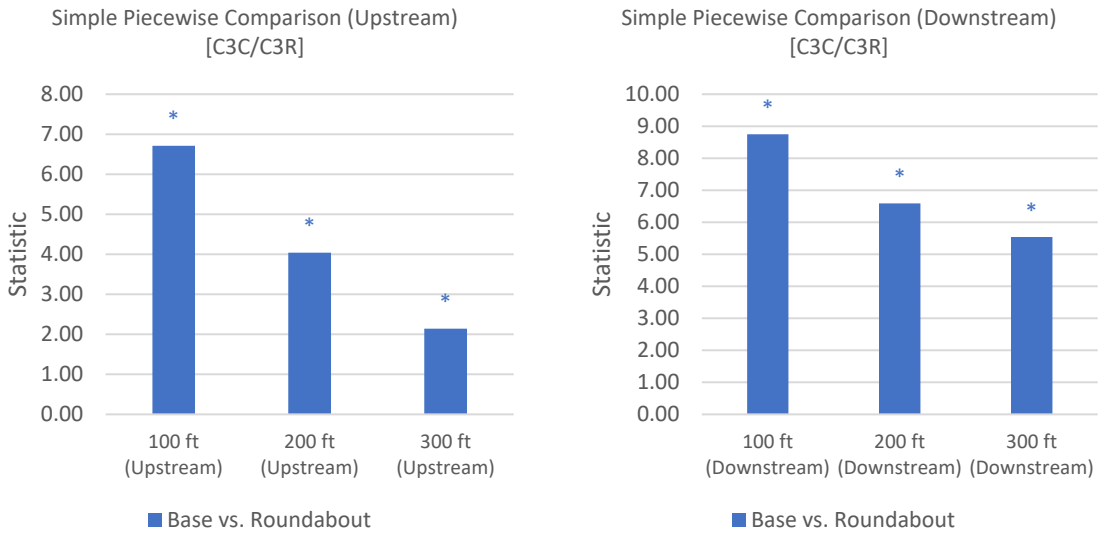




* * * indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

Figure 17 Difference of 85th percentile speed among pedestrian crossing treatment groups (C3C/C3R, 50 mph)



* indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

Figure 18 Difference of 85th percentile speed near the roundabout (C3C/C3R, 50 mph)

3.3 C4 Analysis Results

The results for the ANOVA tests conducted on the mean and 85th percentile speed for the analysis zones of the recommend C4 countermeasures are shown in the Tables 12-29. The results from these tables show that there are significant differences between the pedestrian crossing treatment groups (Base, RRFB, and PHB) regarding mean speed and 85th percentile speed for almost all speed limits, where the greatest difference appeared in the higher speed limit tested (40 mph). The gender and age parameters were significant in some of the upstream and downstream segments for the pedestrian crossing treatments. For the roundabout scenarios, which were compared against the base scenarios, there were similar results to the pedestrian crossing treatment groups. The age and gender parameter were also significant in some of the upstream and downstream segments.

For lane narrowing, street trees and on-street parking, none of the scenarios showed a significant difference between the lane narrowing, street trees, on-street parking, and base scenarios. For the short block scenarios, there were some significant differences upstream of the treatment, but the downstream did not show significant differences to the base scenario. Therefore, a simple piecewise comparison is done to show the amount of difference between the countermeasures which has a significant difference (RRFB, PHB, Roundabout, Short Block). The differences of speed metrics between each two different pedestrian crossing treatment, the roundabout, and the short block are present in Figures 13 - 30.

Table 12 ANOVA test for pedestrian crossing treatment group (C4, 30 mph)

	Upstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
Mean Speed	group	92.28	<0.01*	17.10	<0.01*	2.76	0.07*
	gender	0.85	0.36	0.24	0.62	0.96	0.33
	age_category	0.64	0.53	5.11	0.01*	6.54	<0.01*
	group:gender	0.28	0.76	0.33	0.72	0.41	0.67
	group:age_category	0.81	0.53	1.14	0.35	2.18	0.08*
	gender:age_category	0.92	0.40	2.33	0.11	1.03	0.36
	Downstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	0.98	0.38	0.57	0.57	0.47	0.63
	gender	0.01	0.91	0.01	0.93	0.02	0.88
	age_category	1.80	0.18	0.89	0.42	1.89	0.16
	group:gender	0.01	0.99	0.10	0.91	0.51	0.60
	group:age_category	0.43	0.79	1.30	0.28	0.92	0.46
	gender:age_category	1.09	0.34	0.95	0.39	0.23	0.80
85th Percentile Speed	Upstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	35.66	<0.01*	13.68	<0.01*	5.71	0.01*
	gender	0.02	0.88	0.48	0.49	0.22	0.64
	age_category	0.87	0.43	2.04	0.14	6.58	<0.01*
	group:gender	0.05	0.95	0.85	0.43	0.19	0.83
	group:age_category	0.55	0.70	0.84	0.51	1.62	0.18
	gender:age_category	1.82	0.17	0.79	0.46	1.10	0.34
	Downstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	1.68	0.20	1.06	0.35	1.17	0.32
	gender	0.03	0.87	0.00	0.97	0.00	1.00
	age_category	1.36	0.27	1.00	0.38	2.63	0.08*
	group:gender	0.07	0.93	0.12	0.89	0.38	0.69
	group:age_category	0.35	0.84	1.17	0.33	0.90	0.47
	gender:age_category	1.16	0.32	0.86	0.43	0.39	0.68
	* indicates difference is significant at the 90th Percentile; group indicates the pedestrian crossing treatments (RRFB, PHB)						

Table 13 ANOVA test for lane narrowing (C4, 30 mph)

		F value	Pr(>F)
Mean Speed	**group**	0.26	0.61
	gender	0.00	0.96
	age_category	1.54	0.23
	group:gender	0.04	0.84
	group:age_category	0.94	0.40
	gender:age_category	0.37	0.69
85th Percentile Speed		**F value**	**Pr(>F)**
	group	0.02	0.89
	gender	0.00	0.96
	age_category	1.31	0.28
	group:gender	0.10	0.75
	group:age_category	0.63	0.54
	gender:age_category	0.49	0.61

* indicates difference is significant at the 90th Percentile; group indicates lane narrowing and base scenarios

Table 14 ANOVA test for roundabout (C4, 30 mph)

Mean Speed	**Upstream**	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	136.10	<0.01*	17.01	<0.01*	3.17	0.08*
	gender	0.05	0.83	0.06	0.81	0.03	0.86
	age_category	1.78	0.18	1.28	0.29	1.26	0.30
	group:gender	0.01	0.94	0.14	0.71	0.09	0.76
	group:age_category	0.51	0.60	0.71	0.50	0.72	0.49
	gender:age_category	0.48	0.62	1.54	0.23	0.82	0.45
	Downstream	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	63.71	<0.01*	3.46	0.07*	1.38	0.25
	gender	1.61	0.21	1.37	0.25	1.36	0.25
	age_category	1.26	0.30	1.61	0.21	0.64	0.53
	group:gender	1.28	0.26	1.09	0.30	1.13	0.30
	group:age_category	0.27	0.77	0.52	0.60	0.15	0.86
	gender:age_category	1.70	0.20	0.45	0.64	0.18	0.84
85th Percentile Speed	**Upstream**	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	60.51	<0.01*	21.96	<0.01*	6.90	0.01*
	gender	0.50	0.49	0.03	0.86	0.03	0.86
	age_category	1.28	0.29	1.08	0.35	0.65	0.53
	group:gender	0.15	0.71	0.26	0.61	0.25	0.62
	group:age_category	0.43	0.65	0.63	0.54	0.30	0.74
	gender:age_category	0.61	0.55	0.84	0.44	1.01	0.38
	Downstream	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	64.43	<0.01*	2.54	0.12	0.11	0.74
	gender	1.96	0.17	1.08	0.30	1.85	0.18
	age_category	2.20	0.12	0.82	0.45	0.48	0.63
	group:gender	1.15	0.29	0.60	0.44	1.23	0.27
	group:age_category	0.91	0.41	0.22	0.81	0.08	0.92
	gender:age_category	1.80	0.18	0.47	0.63	0.25	0.78
	* indicates difference is significant at the 90th Percentile; group indicates the roundabout and base scenarios						

Table 15 ANOVA test for short block (C4, 30 mph)

	Upstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
Mean Speed	group	297.32	<0.01*	2.42	0.13	0.08	0.78
	gender	0.84	0.37	1.24	0.27	0.89	0.35
	age_category	2.25	0.12	2.19	0.13	0.73	0.49
	group:gender	1.13	0.30	1.56	0.22	1.21	0.28
	group:age_category	0.75	0.48	1.09	0.35	0.29	0.75
	gender:age_category	0.05	0.95	0.82	0.45	0.20	0.82
	Downstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	1.03	0.32	0.18	0.68	0.49	0.49
	gender	1.42	0.24	0.07	0.79	0.15	0.70
	age_category	1.52	0.23	2.07	0.14	4.22	0.02*
	group:gender	1.66	0.21	0.15	0.71	0.07	0.80
	group:age_category	0.78	0.47	1.01	0.38	2.24	0.12
	gender:age_category	0.20	0.82	0.06	0.95	0.93	0.40
85th Percentile Speed	Upstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	32.02	<0.01*	7.21	0.01*	1.17	0.29
	gender	1.60	0.21	0.86	0.36	0.76	0.39
	age_category	0.97	0.39	1.72	0.19	0.33	0.72
	group:gender	2.22	0.14	1.62	0.21	1.53	0.22
	group:age_category	0.46	0.63	0.65	0.53	0.04	0.96
	gender:age_category	0.37	0.70	0.23	0.79	0.12	0.89
	Downstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	0.05	0.82	0.26	0.61	3.58	0.07*
	gender	1.16	0.29	0.16	0.69	0.25	0.62
	age_category	1.34	0.27	1.72	0.19	3.09	0.06*
	group:gender	1.71	0.20	0.45	0.51	0.04	0.85
	group:age_category	0.64	0.53	0.78	0.47	1.58	0.22
	gender:age_category	0.06	0.95	0.12	0.89	1.27	0.29
	* indicates difference is significant at the 90th Percentile; group indicates the short block and base scenarios						

Table 16 ANOVA test for street trees (C4, 30 mph)

		F value	Pr(>F)
Mean Speed	**group**	0.05	0.83
	gender	0.14	0.71
	age_category	1.12	0.34
	group:gender	0.27	0.61
	group:age_category	0.40	0.67
	gender:age_category	0.01	0.99
85th Percentile Speed		**F value**	**Pr(>F)**
	group	0.13	0.72
	gender	0.02	0.88
	age_category	2.18	0.13
	group:gender	0.25	0.62
	group:age_category	0.98	0.39
	gender:age_category	0.11	0.90
* indicates difference is significant at the 90th Percentile; group indicates street trees and base scenarios			

Table 17 ANOVA test for on-street parking (C4, 30 mph)

		F value	Pr(>F)
Mean Speed	**group**	1.03	0.36
	gender	0.23	0.64
	age_category	4.34	0.02
	group:gender	0.40	0.67
	group:age_category	0.90	0.47
	gender:age_category	0.15	0.86
		F value	**Pr(>F)**
85th Percentile Speed	**group**	0.50	0.61
	gender	0.15	0.70
	age_category	3.56	0.03
	group:gender	0.38	0.68
	group:age_category	0.68	0.61
	gender:age_category	0.53	0.59

* indicates difference is significant at the 90th Percentile; group indicates the on-street parking and base scenarios

Table 18 ANOVA test for pedestrian crossing treatment group (C4, 35 mph)

	Upstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
Mean Speed	group	71.72	<0.01*	7.88	<0.01*	0.90	0.41
	gender	0.14	0.71	0.54	0.47	0.30	0.59
	age_category	0.11	0.90	3.38	0.04*	2.48	0.09*
	group:gender	0.03	0.97	0.24	0.79	0.27	0.77
	group:age_category	0.38	0.83	1.40	0.25	0.60	0.66
	gender:age_category	0.33	0.72	1.06	0.35	0.69	0.51
	Downstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	7.18	<0.01*	2.05	0.14	1.13	0.33
	gender	0.70	0.41	1.66	0.20	0.39	0.54
	age_category	0.89	0.42	1.88	0.16	2.11	0.13
	group:gender	0.19	0.82	0.35	0.71	0.14	0.87
	group:age_category	0.49	0.74	0.56	0.69	1.00	0.42
	gender:age_category	0.52	0.60	1.03	0.36	0.07	0.93
85th Percentile Speed	Upstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	25.81	<0.01*	7.37	<0.01*	2.52	0.09*
	gender	0.90	0.35	1.59	0.21	0.39	0.54
	age_category	0.43	0.65	2.88	0.06*	1.66	0.20
	group:gender	0.53	0.59	0.33	0.72	0.39	0.68
	group:age_category	0.09	0.99	1.25	0.30	0.41	0.80
	gender:age_category	0.08	0.92	2.10	0.13	1.05	0.36
	Downstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	7.62	<0.01*	3.52	0.04*	3.05	0.06*
	gender	0.82	0.37	1.53	0.22	0.19	0.67
	age_category	1.11	0.34	1.74	0.18	2.53	0.09*
	group:gender	0.22	0.81	0.39	0.68	0.16	0.85
	group:age_category	0.38	0.82	0.54	0.71	1.03	0.40
	gender:age_category	1.36	0.26	1.25	0.29	0.13	0.88
	* indicates difference is significant at the 90th Percentile; group indicates the pedestrian crossing treatments (RRFB, PHB)						

Table 19 ANOVA test for lane narrowing (C4, 35 mph)

		F value	Pr(>F)
Mean Speed	**group**	0.01	0.94
	gender	0.05	0.82
	age_category	0.46	0.63
	group:gender	0.00	0.95
	group:age_category	0.17	0.84
	gender:age_category	0.51	0.61
85th Percentile Speed		**F value**	**Pr(>F)**
	group	0.01	0.93
	gender	0.02	0.89
	age_category	1.29	0.29
	group:gender	0.00	0.96
	group:age_category	0.11	0.90
	gender:age_category	0.65	0.53

* indicates difference is significant at the 90th Percentile; group indicates lane narrowing and base scenarios

Table 20 ANOVA test for roundabout (C4, 35 mph)

Mean Speed	**Upstream**	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	98.14	<0.01*	15.97	<0.01*	1.81	0.19
	gender	0.71	0.41	0.67	0.42	0.39	0.54
	age_category	3.93	0.03*	1.73	0.19	0.93	0.40
	group:gender	0.49	0.49	0.49	0.49	0.23	0.63
	group:age_category	2.49	0.10*	0.77	0.47	0.30	0.74
	gender:age_category	1.78	0.18	0.98	0.39	0.96	0.39
	Downstream	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	58.45	<0.01*	8.77	0.01*	2.20	0.15
	gender	0.00	0.96	1.34	0.25	3.20	0.08*
	age_category	1.56	0.22	0.48	0.62	1.16	0.33
	group:gender	0.03	0.86	1.02	0.32	2.69	0.11
	group:age_category	0.73	0.49	0.02	0.98	0.41	0.67
	gender:age_category	2.55	0.09*	2.23	0.12	4.73	0.01*
85th Percentile Speed	**Upstream**	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	79.71	<0.01*	15.79	<0.01*	4.52	0.04*
	gender	1.17	0.29	0.58	0.45	0.05	0.82
	age_category	3.77	0.03*	1.82	0.18	0.97	0.39
	group:gender	0.88	0.35	0.40	0.53	0.01	0.94
	group:age_category	2.41	0.10	0.80	0.46	0.49	0.62
	gender:age_category	0.88	0.43	1.19	0.32	0.78	0.47
	Downstream	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	47.45	<0.01*	10.67	<0.01*	5.74	0.02*
	gender	0.00	0.99	1.53	0.22	2.49	0.12
	age_category	0.90	0.42	0.63	0.54	1.63	0.21
	group:gender	0.02	0.89	1.17	0.29	2.01	0.16
	group:age_category	0.29	0.75	0.03	0.97	0.33	0.72
	gender:age_category	1.45	0.25	3.23	0.05*	4.84	0.01*
	* indicates difference is significant at the 90th Percentile; group indicates the roundabout and base scenarios						

Table 21 ANOVA test for short block (C4, 35 mph)

	Upstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
Mean Speed	group	130.98	<0.01*	10.19	<0.01*	2.04	0.16
	gender	0.03	0.86	1.40	0.24	0.51	0.48
	age_category	0.75	0.48	0.71	0.50	0.31	0.73
	group:gender	0.08	0.78	1.12	0.30	0.31	0.58
	group:age_category	0.62	0.55	1.03	0.37	0.50	0.61
	gender:age_category	0.40	0.67	1.09	0.35	0.17	0.84
	Downstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	0.21	0.65	0.92	0.34	3.15	0.08*
	gender	0.36	0.55	0.45	0.51	0.15	0.70
	age_category	0.82	0.45	1.25	0.30	1.33	0.28
	group:gender	0.24	0.63	0.28	0.60	0.07	0.80
	group:age_category	0.41	0.67	0.44	0.65	0.78	0.47
	gender:age_category	0.92	0.41	1.28	0.29	0.57	0.57
85th Percentile Speed	Upstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	49.80	<0.01*	14.33	<0.01*	6.52	0.01*
	gender	0.09	0.76	0.72	0.40	0.13	0.73
	age_category	0.46	0.63	0.92	0.41	0.35	0.71
	group:gender	0.05	0.83	0.49	0.49	0.03	0.86
	group:age_category	0.53	0.60	1.96	0.16	0.68	0.51
	gender:age_category	0.79	0.46	0.99	0.38	0.17	0.85
	Downstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	1.04	0.31	3.00	0.09*	7.14	0.01*
	gender	0.43	0.52	0.55	0.46	0.10	0.75
	age_category	0.84	0.44	1.44	0.25	1.43	0.25
	group:gender	0.28	0.60	0.34	0.56	0.03	0.86
	group:age_category	0.28	0.76	0.38	0.69	0.95	0.40
	gender:age_category	1.15	0.33	1.76	0.19	0.67	0.52
	* indicates difference is significant at the 90th Percentile; group indicates the short block and base scenarios						

Table 22 ANOVA test for street trees (C4, 35 mph)

Mean Speed		**F value**	**Pr(>F)**
	group	1.16	0.29
	gender	0.94	0.34
	age_category	0.93	0.41
	group:gender	0.67	0.42
	group:age_category	0.16	0.85
	gender:age_category	1.01	0.37
85th Percentile Speed		**F value**	**Pr(>F)**
	group	0.23	0.63
	gender	0.28	0.60
	age_category	1.20	0.31
	group:gender	0.13	0.72
	group:age_category	0.07	0.93
	gender:age_category	1.03	0.37
* indicates difference is significant at the 90th Percentile; group indicates street trees and base scenarios			

Table 23 ANOVA test for on-street parking (C4, 35 mph)

		F value	Pr(>F)
Mean Speed	**group**	2.46	0.09*
	gender	0.46	0.50
	age_category	2.03	0.14
	group:gender	0.08	0.93
	group:age_category	0.27	0.90
	gender:age_category	2.24	0.12
		F value	**Pr(>F)**
85th Percentile Speed	**group**	1.34	0.27
	gender	0.35	0.56
	age_category	2.03	0.14
	group:gender	0.18	0.84
	group:age_category	0.29	0.88
	gender:age_category	1.64	0.20

* indicates difference is significant at the 90th Percentile; group indicates the on-street parking and base scenarios

Table 24 ANOVA test for pedestrian crossing treatment group (C4, 40 mph)

	Upstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
Mean Speed	group	142.45	<0.01*	20.07	<0.01*	9.72	<0.01*
	gender	4.20	0.04*	0.41	0.52	0.35	0.56
	age_category	0.98	0.38	3.72	0.03*	1.48	0.24
	group:gender	0.56	0.57	0.02	0.98	0.75	0.48
	group:age_category	0.39	0.81	2.69	0.04*	2.25	0.08*
	gender:age_category	0.46	0.63	1.35	0.27	1.90	0.16
	Downstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	13.39	<0.01*	4.78	0.01*	4.36	0.02*
	gender	0.95	0.34	1.39	0.24	11.18	<0.01*
	age_category	0.72	0.49	0.78	0.46	3.18	0.05*
	group:gender	0.75	0.48	0.55	0.58	3.00	0.06*
	group:age_category	0.85	0.50	0.33	0.86	0.56	0.69
	gender:age_category	0.83	0.44	0.13	0.88	0.78	0.46
85th Percentile Speed	Upstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	70.30	<0.01*	20.61	<0.01*	14.13	<0.01*
	gender	1.49	0.23	0.17	0.68	0.29	0.60
	age_category	1.22	0.30	3.17	0.05*	0.91	0.41
	group:gender	0.53	0.59	0.06	0.95	0.86	0.43
	group:age_category	1.23	0.31	3.06	0.02*	2.10	0.09*
	gender:age_category	1.70	0.19	1.54	0.22	1.65	0.20
	Downstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	13.11	<0.01*	7.05	<0.01*	7.28	<0.01*
	gender	0.23	0.64	1.68	0.20	8.86	<0.01*
	age_category	0.43	0.65	1.00	0.37	3.61	0.03*
	group:gender	0.37	0.69	0.63	0.54	2.72	0.07*
	group:age_category	0.71	0.59	0.28	0.89	0.68	0.61
	gender:age_category	0.40	0.68	0.37	0.69	1.28	0.29
	* indicates difference is significant at the 90th Percentile; group indicates the pedestrian crossing treatments (RRFB, PHB)						

Table 25 ANOVA test for lane narrowing (C4, 40 mph)

		F value	Pr(>F)
Mean Speed	**group**	0.25	0.62
	gender	1.44	0.24
	age_category	1.07	0.35
	group:gender	0.04	0.85
	group:age_category	1.24	0.30
	gender:age_category	0.59	0.56
		F value	**Pr(>F)**
85th Percentile Speed	**group**	0.61	0.44
	gender	1.09	0.30
	age_category	1.08	0.35
	group:gender	0.00	0.97
	group:age_category	0.92	0.41
	gender:age_category	1.18	0.32

* indicates difference is significant at the 90th Percentile; group indicates lane narrowing and base scenarios

Table 26 ANOVA test for roundabout (C4, 40 mph)

Mean Speed	**Upstream**	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	172.78	<0.01*	30.88	<0.01*	8.90	<0.01*
	gender	1.44	0.24	0.01	0.92	1.32	0.26
	age_category	1.48	0.24	1.03	0.37	0.32	0.73
	group:gender	0.14	0.71	0.66	0.42	0.10	0.76
	group:age_category	6.56	<0.01*	3.20	0.05*	1.11	0.34
	gender:age_category	0.64	0.53	1.80	0.18	0.30	0.75
	Downstream	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	233.73	<0.01*	72.85	<0.01*	11.70	<0.01*
	gender	0.89	0.35	0.77	0.39	1.46	0.23
	age_category	0.88	0.42	3.30	0.05*	2.42	0.10
	group:gender	0.00	1.00	0.02	0.88	0.18	0.68
	group:age_category	4.39	0.02*	7.02	<0.01*	2.40	0.10
	gender:age_category	0.45	0.64	1.25	0.30	0.58	0.57
85th Percentile Speed	**Upstream**	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	95.53	<0.01*	42.73	<0.01*	18.91	<0.01*
	gender	0.87	0.36	0.10	0.75	1.24	0.27
	age_category	1.12	0.34	0.65	0.53	0.50	0.61
	group:gender	0.05	0.82	0.28	0.60	0.05	0.83
	group:age_category	5.06	0.01*	2.48	0.10*	0.92	0.41
	gender:age_category	0.38	0.69	2.18	0.13	0.46	0.64
	Downstream	**100 ft**		**200 ft**		**300 ft**	
		F value	**Pr(>F)**	**F value**	**Pr(>F)**	**F value**	**Pr(>F)**
	group	247.17	<0.01*	63.05	<0.01*	15.26	<0.01*
	gender	0.90	0.35	0.90	0.35	1.51	0.23
	age_category	2.44	0.10	2.99	0.06*	2.69	0.08*
	group:gender	0.00	0.99	0.00	0.96	0.25	0.62
	group:age_category	6.50	<0.01*	5.40	0.01*	2.08	0.14
	gender:age_category	1.02	0.37	1.38	0.26	0.68	0.51
	* indicates difference is significant at the 90th Percentile; group indicates the roundabout and base scenarios						

Table 27 ANOVA test for short block (C4, 40 mph)

	Upstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
Mean Speed	group	280.77	<0.01*	13.15	<0.01*	4.45	0.04*
	gender	0.66	0.42	0.27	0.60	1.17	0.29
	age_category	1.15	0.33	0.24	0.79	0.89	0.42
	group:gender	0.02	0.89	0.00	0.98	0.20	0.66
	group:age_category	0.07	0.93	0.87	0.43	0.37	0.69
	gender:age_category	1.13	0.33	1.59	0.22	0.54	0.59
	Downstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	13.60	<0.01*	6.91	0.01*	4.35	0.04*
	gender	3.38	0.07*	3.72	0.06*	2.74	0.11
	age_category	0.32	0.73	0.20	0.82	0.13	0.88
	group:gender	1.42	0.24	1.37	0.25	0.97	0.33
	group:age_category	1.96	0.16	1.65	0.21	0.87	0.43
	gender:age_category	0.27	0.76	1.37	0.27	0.81	0.45
85th Percentile Speed	Upstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	59.29	<0.01*	14.99	<0.01*	7.35	0.01*
	gender	0.05	0.82	0.56	0.46	0.82	0.37
	age_category	0.01	0.99	0.41	0.67	1.15	0.33
	group:gender	0.05	0.82	0.04	0.85	0.07	0.80
	group:age_category	0.79	0.46	0.80	0.46	0.20	0.82
	gender:age_category	1.45	0.25	1.44	0.25	0.43	0.66
	Downstream	100 ft		200 ft		300 ft	
		F value	Pr(>F)	F value	Pr(>F)	F value	Pr(>F)
	group	17.20	<0.01*	12.14	<0.01*	8.99	<0.01*
	gender	3.71	0.06*	3.44	0.07*	2.61	0.11
	age_category	0.35	0.71	0.21	0.82	0.09	0.91
	group:gender	1.64	0.21	1.24	0.27	0.91	0.35
	group:age_category	1.99	0.15	1.57	0.22	0.79	0.46
	gender:age_category	0.53	0.59	2.01	0.15	1.00	0.38
	* indicates difference is significant at the 90th Percentile; group indicates the short block and base scenarios						

Table 28 ANOVA test for street trees (C4, 40 mph)

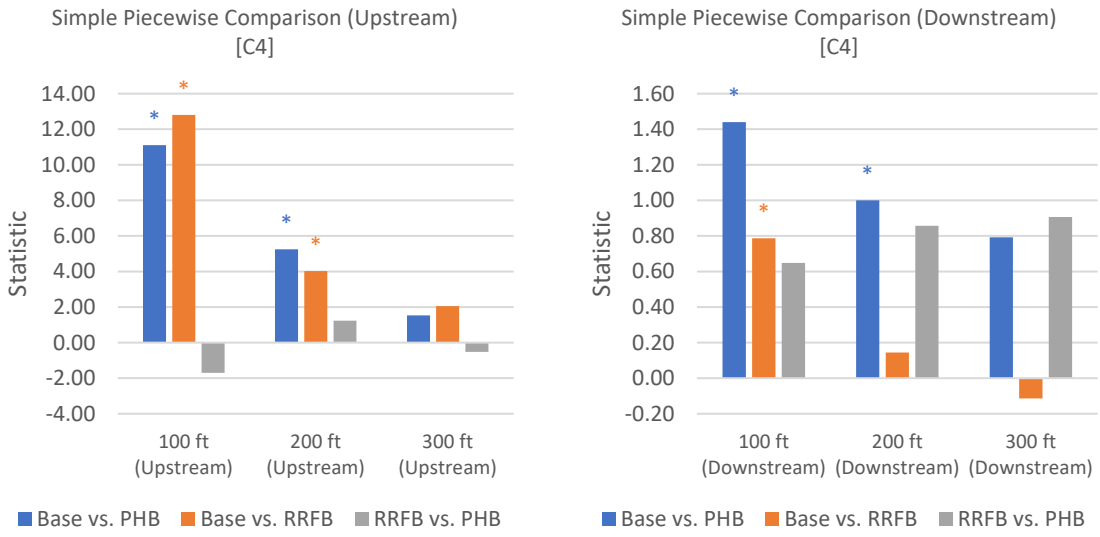
		F value	Pr(>F)
Mean Speed	**group**	0.50	0.48
	gender	0.86	0.36
	age_category	0.94	0.40
	group:gender	0.00	0.97
	group:age_category	0.32	0.73
	gender:age_category	0.32	0.73
85th Percentile Speed		**F value**	**Pr(>F)**
	group	0.01	0.92
	gender	0.18	0.68
	age_category	0.57	0.57
	group:gender	0.09	0.76
	group:age_category	0.52	0.60
	gender:age_category	0.20	0.82
* indicates difference is significant at the 90th Percentile; group indicates street trees and base scenarios			

Table 29 ANOVA test for on-street parking (C4, 40 mph)

		F value	Pr(>F)
Mean Speed	**group**	3.75	0.03*
	gender	0.92	0.34
	age_category	0.38	0.68
	group:gender	0.51	0.60
	group:age_category	0.80	0.53
	gender:age_category	0.06	0.94
		F value	**Pr(>F)**
85th Percentile Speed	**group**	3.89	0.03*
	gender	0.96	0.33
	age_category	0.70	0.50
	group:gender	0.80	0.46
	group:age_category	0.58	0.68
	gender:age_category	0.14	0.87

* indicates difference is significant at the 90th Percentile; group indicates the on-street parking and base scenarios

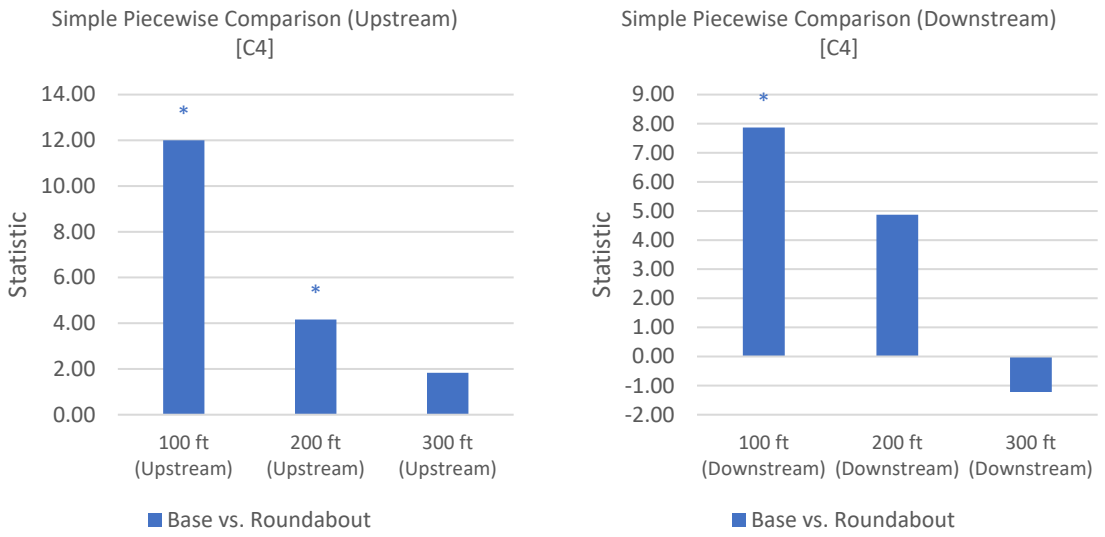
Based on the results of the ANOVA test for the recommended speed countermeasures for C4, we can conduct a simple piecewise comparison test on the regions which we want to analyze. The speed countermeasures which showed significant differences between the base scenario, i.e. no speed countermeasures, and the test scenarios were the RRFB, PHB, Roundabout, and Short Block. The simple piecewise comparions below will show the mean of the differences of the base scenario and the other test countermeasures. The RRFB and PHB were group together as Pedestrian Crossing Treatment (PCT) and the roundabout was grouped alone. The PHB was able to achieve more speed reduction upstream and downstream when compared to the RRFB, but the speed reduction difference was not as high as the C3C/C3R. The short block consisted of a crosswalk followed by an intersection 500 ft away. The upstream portion of the short block showed a significant decrease in the speed, but the downstream portion did not because the drivers had increased to their original speed before reaching the intersection. The differences of the speed reduction for each speed limit are shown in the figures below.



* * * indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

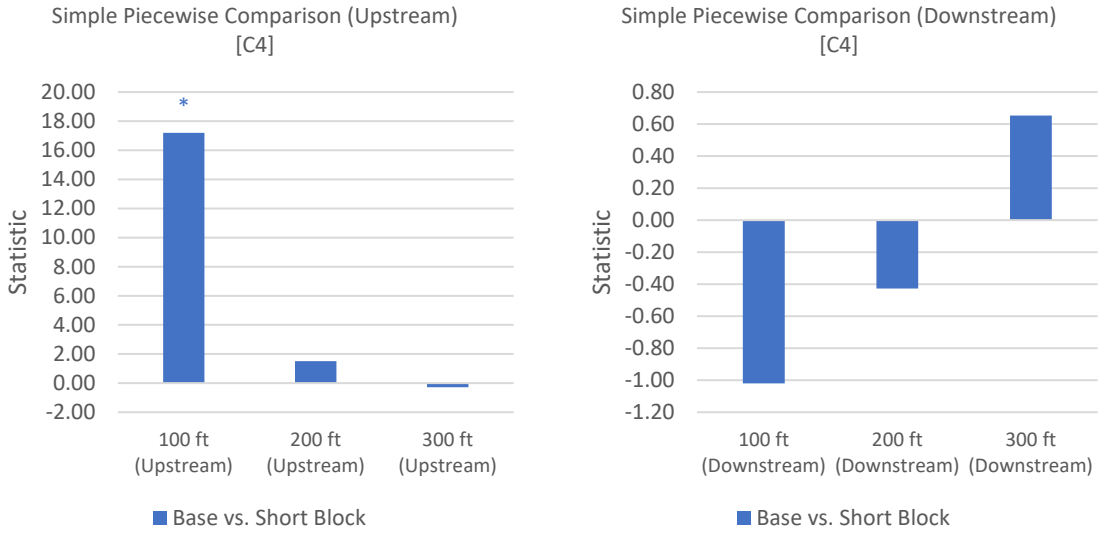
Figure 19 Difference of mean speed among pedestrian crossing treatment groups (C4, 30 mph)



* indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

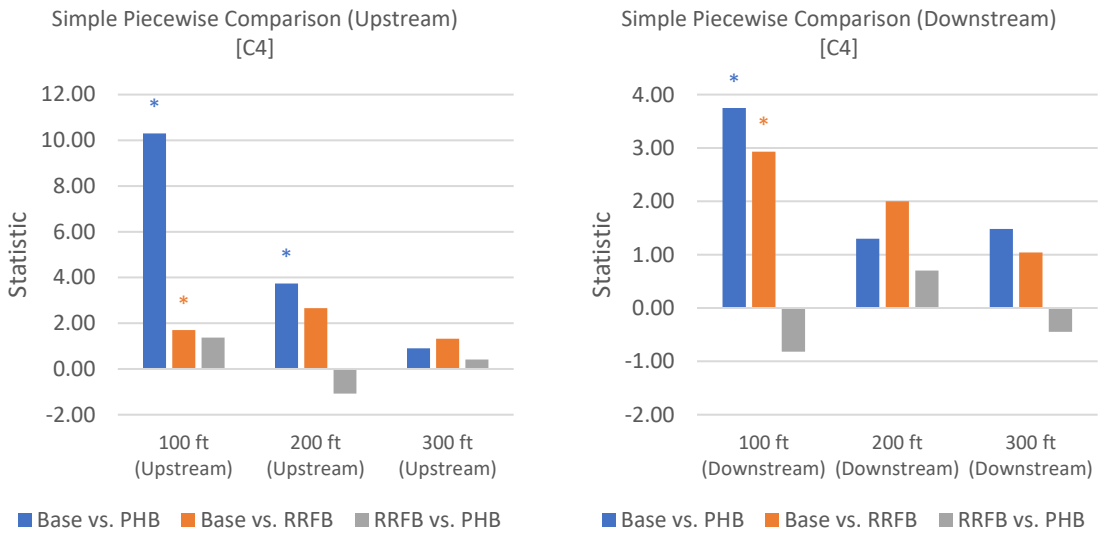
Figure 20 Difference of mean speed near the roundabout (C4, 30 mph)



* indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

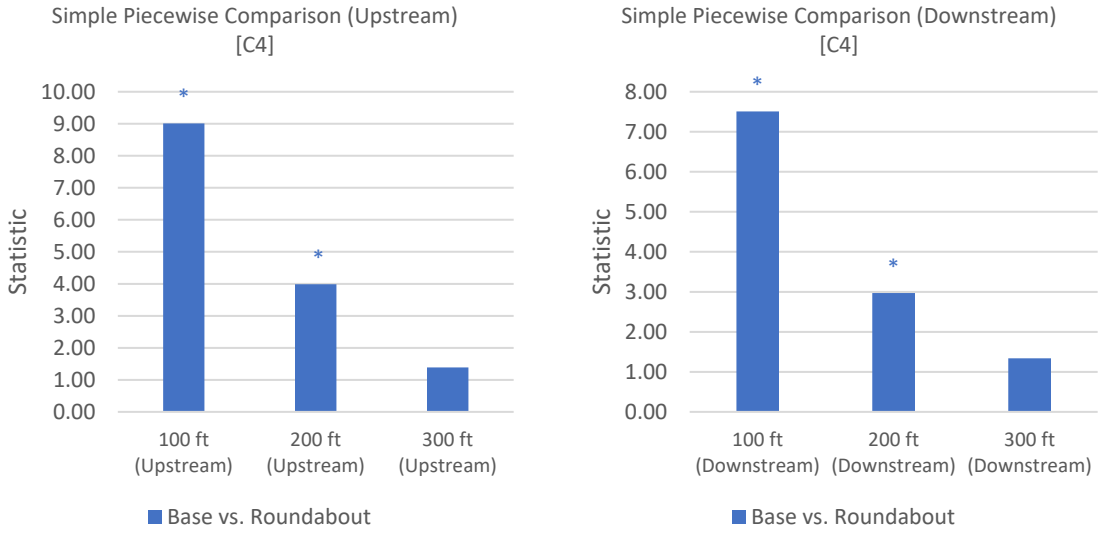
Figure 21 Difference of mean speed near the short block (C4, 30 mph)



* * * indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

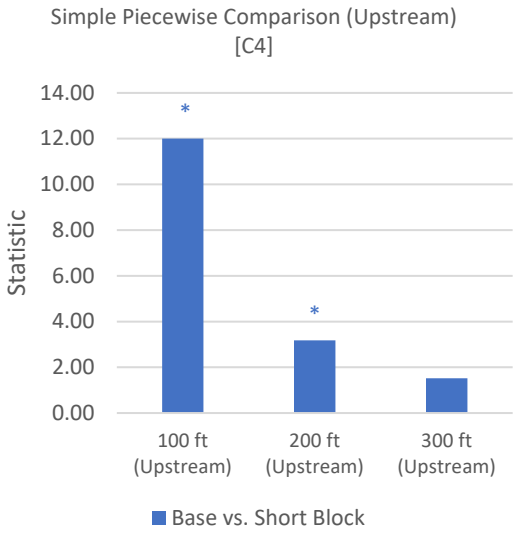
Figure 22 Difference of mean speed among pedestrian crossing treatment groups (C4, 35 mph)

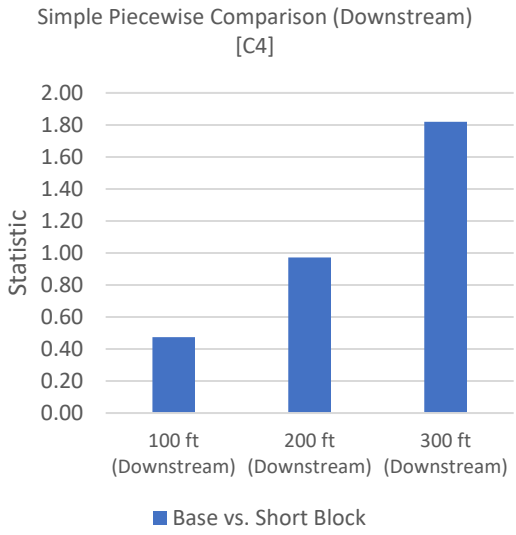


* indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

Figure 23 Difference of mean speed near the roundabout (C3C/C3R, 45 mph)

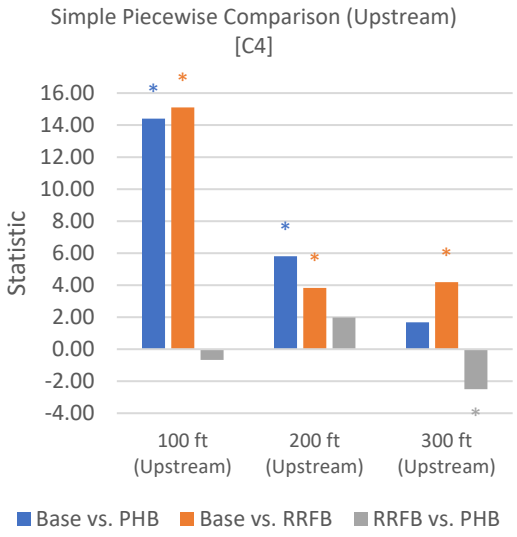


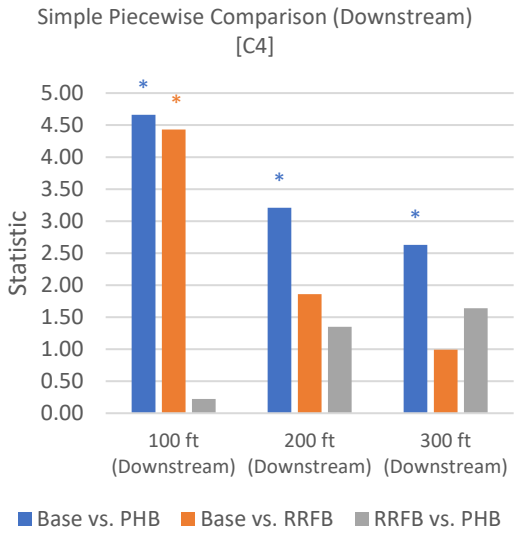


* indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

Figure 24 Difference of mean speed near the short block (C4, 35 mph)

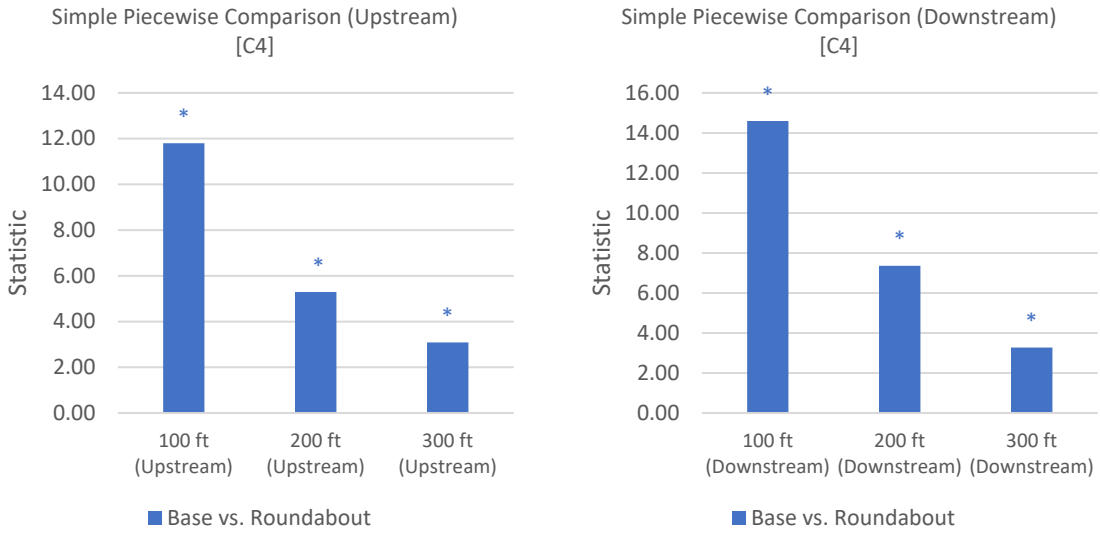




* * * indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

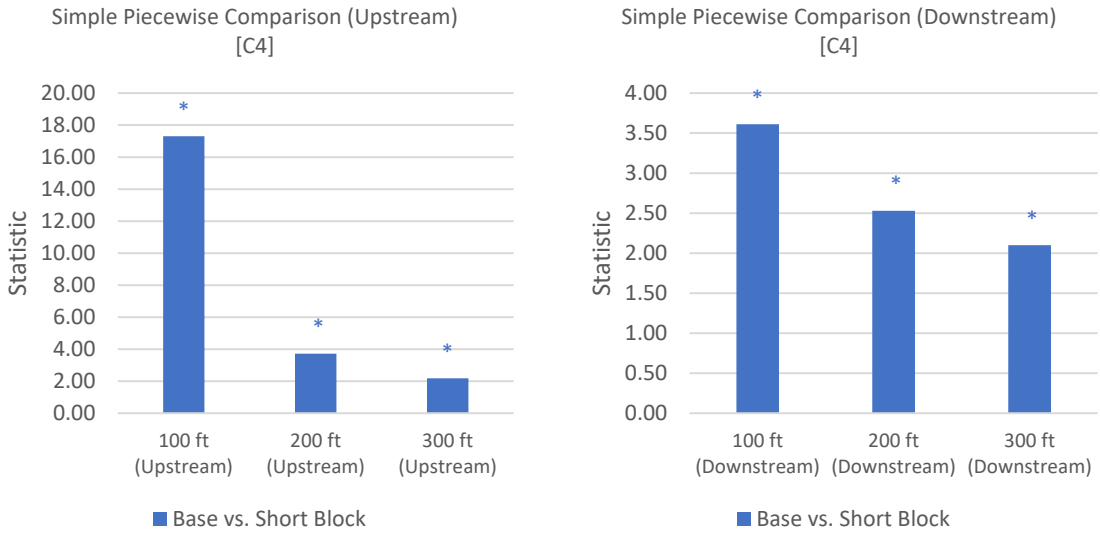
Figure 25 Difference of mean speed among pedestrian crossing treatment groups (C4, 40 mph)



* indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

Figure 26 Difference of mean speed near the roundabout (C4, 40 mph)



* indicate the difference is Significant at the 90th Percentile

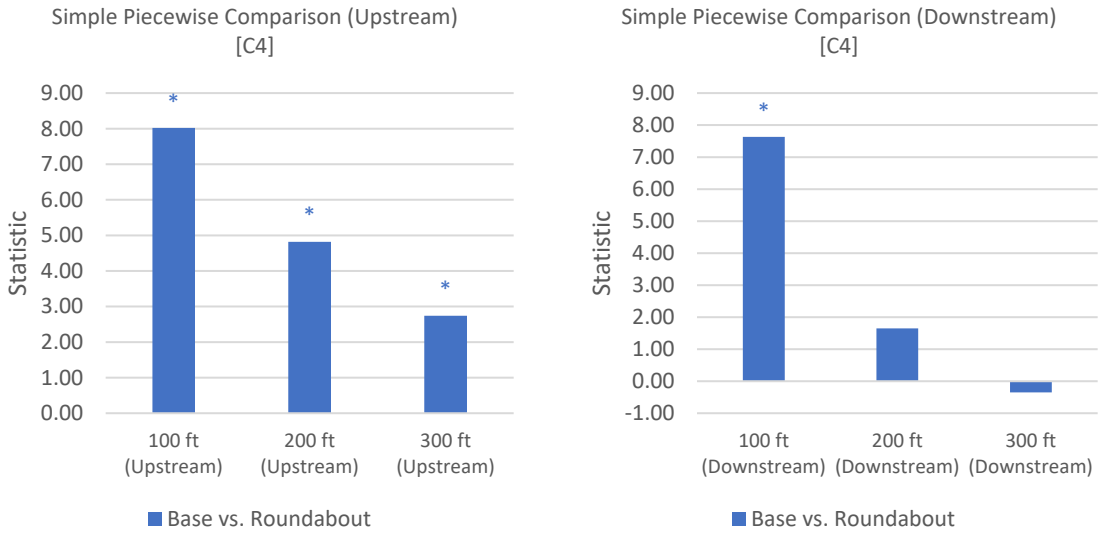
Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

Figure 27 Difference of mean speed near the short block (C4, 40 mph)

* * * indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

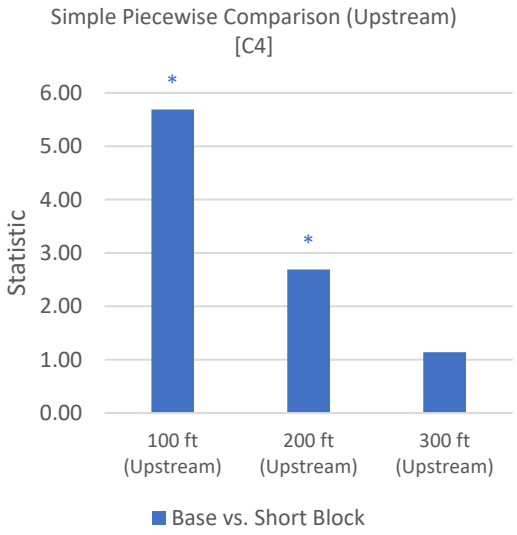
Figure 28 Difference of 85th percentile speed among pedestrian crossing treatment groups (C4, 30 mph)

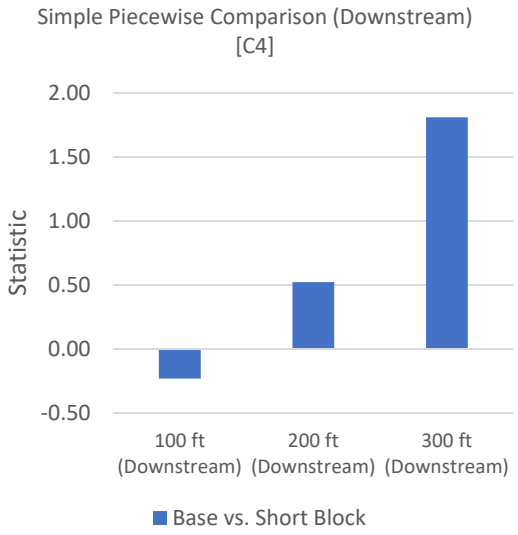


* indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

Figure 29 Difference of 85th percentile speed near the roundabout (C4, 30 mph)

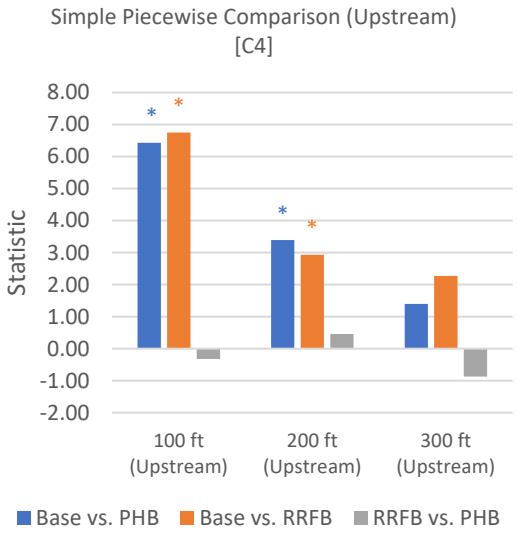


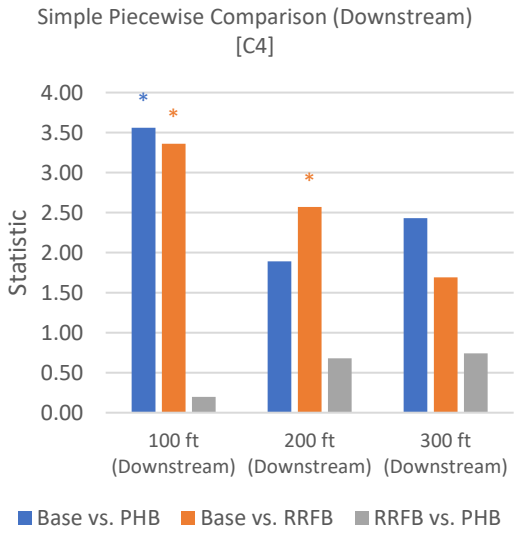


* indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

Figure 30 Difference of 85th percentile speed near the short block (C4, 30 mph)

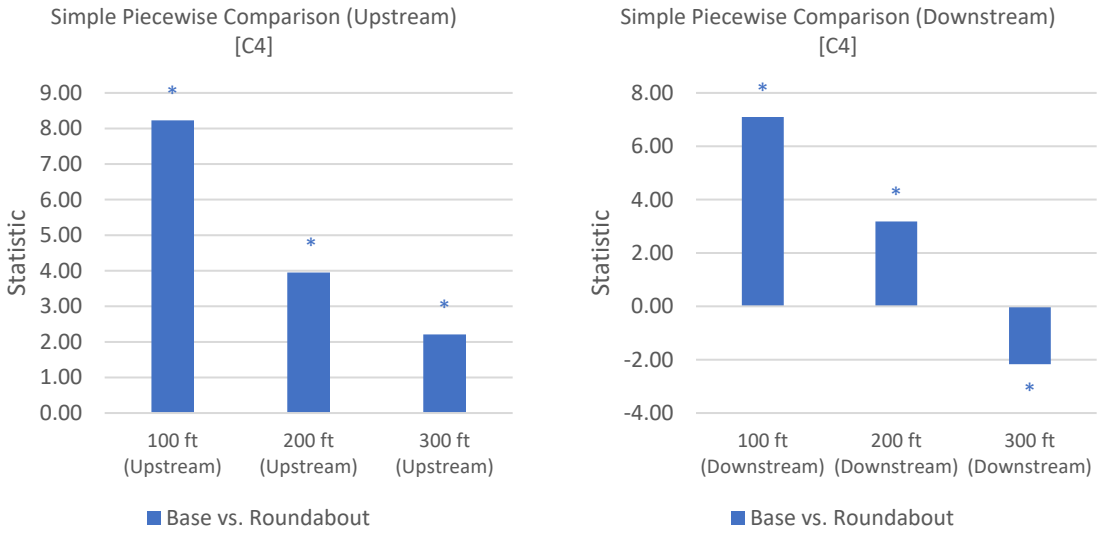




* * * indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

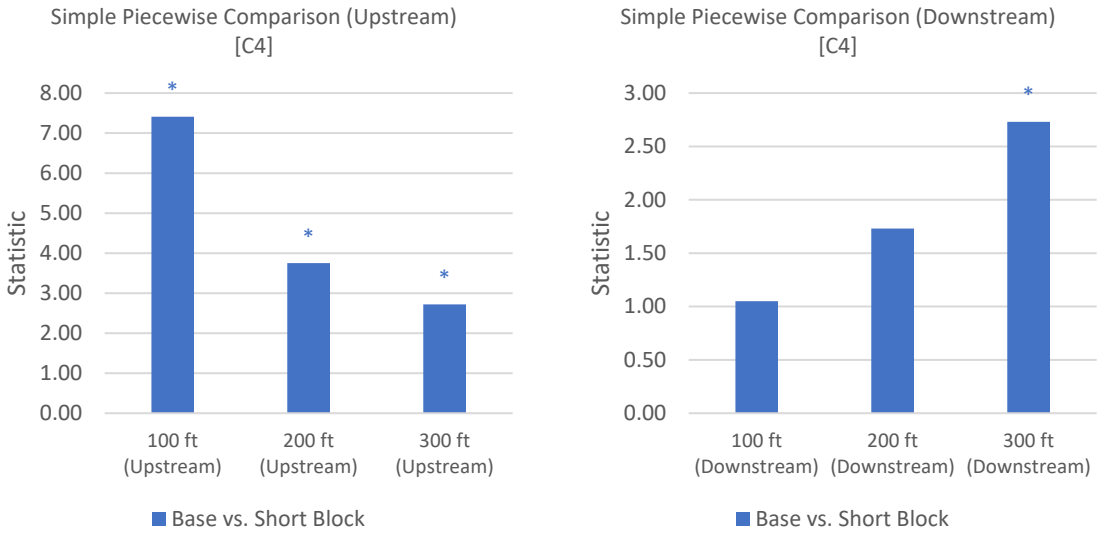
Figure 31 Difference of 85th percentile speed among pedestrian crossing treatment groups (C4, 35 mph)



* indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

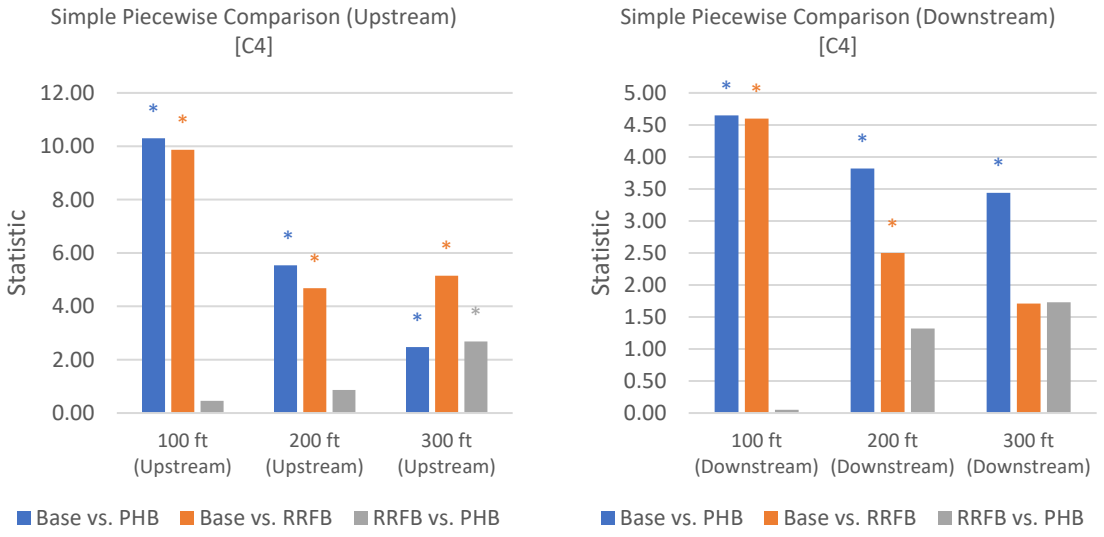
Figure 32 Difference of 85th percentile speed near the roundabout (C4, 35 mph)



* indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

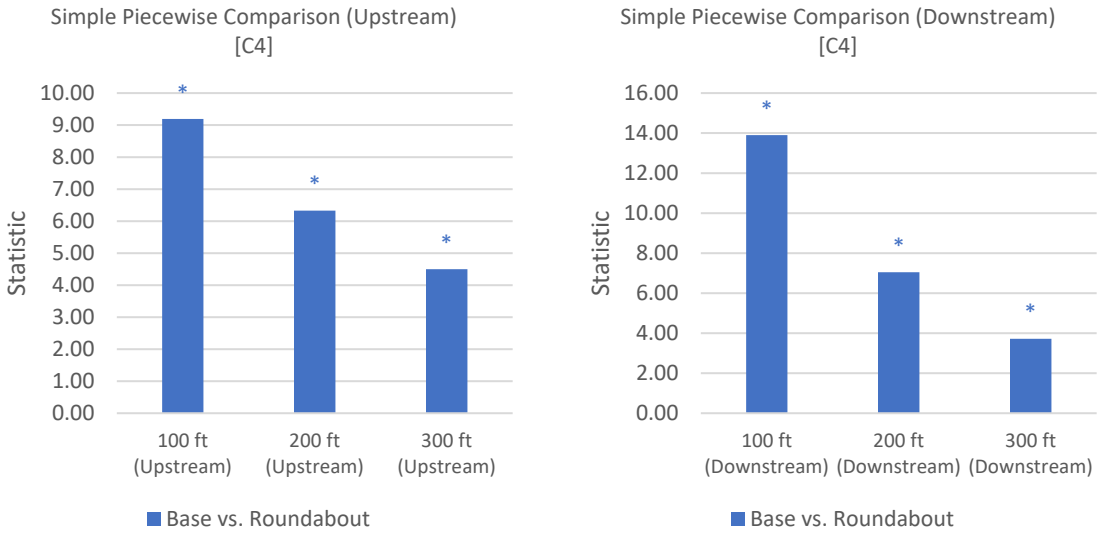
Figure 33 Difference of 85th percentile speed near the short block (C4, 35 mph)



* * * indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

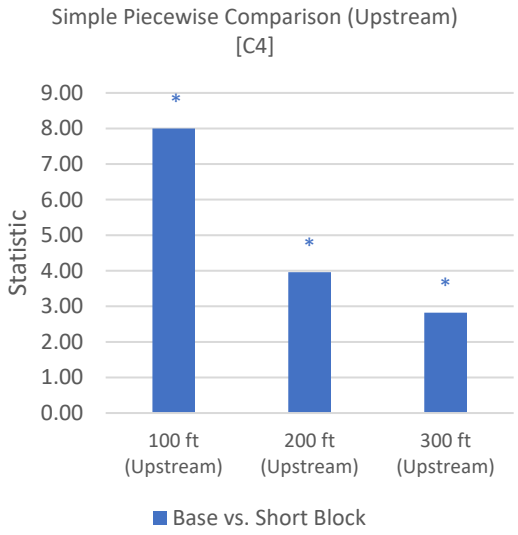
Figure 34 Difference of 85th percentile speed among pedestrian crossing treatment groups (C4, 40 mph)

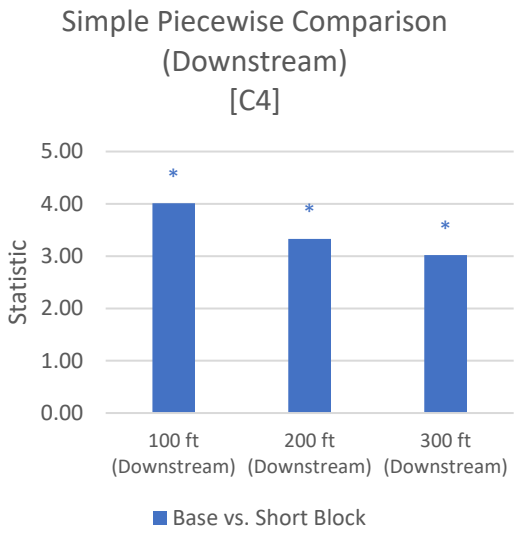


* indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

Figure 35 Difference of 85th percentile speed near the roundabout (C4, 40 mph)





* indicate the difference is Significant at the 90th Percentile

Note: The bar indicates the difference of mean values of speed for each pair of groups and the bar of 'Group A vs Group B' is the 'mean speed value of Group A' minus the 'mean speed value of Group B'.

Figure 36 Difference of 85th percentile speed near the short block (C4, 40 mph)

CHAPTER 4: CONCLUSIONS

This task conducted comprehensive studies to explore the effects of arterial characteristics and speed management countermeasures on drivers' speed choice. A driving simulator study was conducted on roads modeled after C3C/C3R and C4 characteristics. The study scenarios were developed according to roads in the real world to reflect the true driving environment of C3C/C3R and C4. For the selected critical segments, the detailed trajectory data could be obtained and different speed metrics including mean speed and 85th percentile speed were computed. ANOVA test was conducted on all speed management countermeasures recommended for the specific context classification (RRFB, PHB, Lane Narrowing, Short Block, Roundabout, On-Street Parking, and Street Trees) on drivers' speed choice. Table 30 summarizes the effects of different speed management countermeasures identified in the driving simulator experiment analysis study.

Table 30 Summary of speed management countermeasures' effects based on simulator experiment

Speed management countermeasures	Evaluation metrics	Identified effects	
		C3C/C3R	C4
PHB	Mean speed	↓	↓
	85th percentile speed	↓	↓
RRFB	Mean speed	↓	↓
	85th percentile speed	↓	↓
Lane Narrowing	Mean speed	NS	NS
	85th percentile speed	NS	NS
Short Block	Mean speed	-	↓
	85th percentile speed	-	↓
Roundabout	Mean speed	↓	↓
	85th percentile speed	↓	↓
On-Street Parking	Mean speed	-	↓
	85th percentile speed	-	NS
Street Trees	Mean speed	-	NS
	85th percentile speed	-	NS
Note: '↓' indicates a significant reduction; 'NS' indicates not significant; '-' indicates not a countermeasure for the corresponding types of roads.			

The speed management countermeasures that have significant effects are:

- **PHB and RRFB**. The two countermeasures could significantly reduce the mean speed and 85th percentile speed (i.e., operating speed) on both C3C/C3R and C4. On average, C3C/C3R drivers reduced 7 – 10 mph (40 – 50% speed reduction) for the PHB and 5 – 7 mph (30 – 36% speed reduction) for the RRFB upstream, and reduced 4 – 6 mph (22 – 23% speed reduction) for the PHB and 3 – 5 mph (14 – 19% speed reduction) for the RRFB downstream, depending on the speed limit. On average, C4 drivers reduced 7 – 10 mph (40 – 47% speed reduction) for the PHB and 2 – 9 mph (40 – 44% speed reduction) for the RRFB upstream, and reduced 4 – 6 mph (7 – 16% speed reduction) for the PHB and 1 – 3 mph (3 – 13% speed reduction) for the RRFB downstream, depending on the speed limit. Although PHB could reduce more than RRFB on C4 roads as well, there was not much difference between them. A reason is that the C3C/C3R scenarios had 6 lanes and C4 scenarios had 4 lanes, meaning the drivers could see the RRFB sign better when they were driving at lower speeds with less number of lanes. The PHB was easily seen in both the C3C/C3R and C4 scenario roads.
- **Short block**. It was found that short blocks could reduce the mean speed and 85th percentile speed upstream, but not downstream on C4 roads. On average, C4 drivers reduced 8 – 11 mph (34 – 43% speed reduction) upstream. A reason is that the short block starts with a crossing walk followed by an intersection 500 ft away. The drivers reduced their speeds for the crosswalk but returned to their speed before reaching the intersection 500 ft away.
- **Roundabout**. It was found it could efficiently reduce the operating speed on C3C/C3R and C4 roads. On average, C3C/C3R drivers reduced 4 – 8 mph (19 – 28% speed reduction)

upstream, and reduced 6 – 8 mph (23 – 29% speed reduction) downstream, depending on the speed limit. On average, C4 drivers reduced 7 – 9 mph (29 – 32% speed reduction) upstream, and reduced 5 – 11 mph (19 – 33% speed reduction) downstream, depending on the speed limit.

No significant effects of lane narrowing, on-street parking, and street trees based on the driving simulator experiment.