Research Project Work Plan

for

Safe and Effective Speed Reductions for Freeway Work Zones Phase 2

Submitted by:

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for

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May 2013

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1.0 IDENTIFICATION

1.1 Organizations Sponsoring Research:

Oregon Department of Transportation (ODOT)
Research Unit
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Federal Highway Administration (FHWA)
Washington, D.C. 20590

1.2 Principal Investigator (PI):

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1.3 Technical Advisory Committee (TAC) Members:

Jon Lazarus, ODOT Research Unit, Research Coordinator
Jeffrey Gower, ODOT State Construction & Materials Engineer
Anne Holder, ODOT Roadway Safety Program Manager
Michael Kimlinger, ODOT Traffic Standards Engineer
Scott McKanna, ODOT Traffic Control Plans Engineer
Robert Pappe, ODOT Statewide Traffic Engineer
John Rakowitz, AGC representative
Captain Michael Dingeman, Oregon State Police

1.4 Project Champion:

Robert Pappe, ODOT Statewide Traffic Engineer

1.5 Friends of the Committee:

Troy Costales, ODOT Transportation Safety Division Administrator

2.0 PROBLEM STATEMENT

Freeway pavement preservation projects (e.g. pavement overlays, “chip seal” operations, etc.) typically require construction workers to conduct their work in close proximity to ongoing traffic and often reduce traffic flow to a single lane while work is undertaken in an adjacent lane. During the lane closures, the paving operations place workers on the roadway within a protected work zone. In some places the workers only have a line of cones and a few feet, separating them from passing traffic. This situation creates considerable safety risk for both the workers and passing motorists. Inattentive or speeding drivers, careless workers, misplaced cones, and hazardous roadway conditions can lead to crashes and ultimately work zone injuries and fatalities. The severity of a crash intensifies as the speed of traffic increases. As a result, preservation projects on high-speed roadways present an increased risk of serious and/or fatal injuries to workers, motorists, and their passengers.

Vehicle speed is directly connected to the performance of work zone designs. There is a widely held perception that speed is one of the most significant factors in vehicle-related crashes on roadways (Mahoney et al. 2007). However, safely controlling and reducing vehicle speeds through work zones to reduce the risk can be difficult on high-speed roadways. On such roadways, it has been suggested that reducing traffic speeds to 35 mph would enhance the safety of the workers and traveling public. However, a reduction in speed from 65 mph to 35 mph is significant, and evaluation of the impacts of this differential in speed on interstate highways has been limited. Previous research reveals that work zone speed limit reductions of more than 10 mph show an increase in the number of crashes due to a greater speed differential between vehicles (WSDOT 2009). Additional safety measures in planning, signage, and notification to the driving public are needed to reduce the significant risks to motorists as they navigate through the active work zone and react to the large difference in speed. In addition, large speed reductions during nighttime work – a time when preservation projects are often conducted – can further complicate the jobsite conditions, be difficult to implement, and may increase risks to worker and motorist safety.

Research on controlling and reducing speeds on high-speed roadways, and on significant speed reductions, has been conducted but provides limited guidance for practical implementation. In a study of speed reduction measures conducted by Iowa State University on behalf of the Iowa Department of Transportation, the authors state that the most effective speed reduction will probably involve some combination of speed reduction techniques, as opposed to the use of just one type of control measure, although no quantified impact of each independent traffic control measure was provided (Maze et al. 2000). The researchers in Iowa conducted a survey of state transportation agencies and found that only a few agencies even consider reducing speed limits by 20 mph or more. The study also revealed that the use of regulatory speed limit signs and police enforcement is the most common practice for controlling and reducing speeds.

In response to concerns from the Associated General Contractors Oregon-Columbia Chapter and the Oregon Trucking Association about speed through work zones, the ODOT Traffic Roadway Section requested that ODOT Research investigate interstate preservation job safety enhancements. The request, made in the summer of 2011, was to assess the practicality and effectiveness of reducing speeds from 55-65 mph to 35 mph on highway preservation projects.

As an initial step, ODOT conducted a pilot study in September 2011 to investigate practical and safe means for significant speed reductions. The pilot study was conducted on Interstate 5 near Cottage Grove, OR. The traffic control plan included a 30 mph speed reduction from 65 to 35 mph implemented in two stages (65 to 50 mph, then 50 to 35 mph) using multiple OSP officers and other traffic control measures along the roadway prior to and within the work area. This strategy is similar to the use of a system of stepped speed limits (SSL) that was recently studied and recommended in the United Kingdom (ITS International 2011). On the pilot study, with law enforcement vehicles visible to passing motorists, passenger vehicle speed measurements through the work zone showed a mean speed of 33.0 mph for cars (n = 108 vehicles; 85th percentile speed = 36 mph; 22% of cars exceeding posted speed). For trucks, the mean speed was 33.23 mph (n = 145 vehicles; 85th percentile speed = 36 mph; 19% of trucks exceeding posted speed).

To augment the pilot study, ODOT began a research study (SPR-751) in FY2013 to look for ways to safely reduce speeds through work zones on preservation projects taking place on high-speed freeways. The recently completed study included two paving projects, one on I-84 near The Dalles and one on I-5 just north of the McKenzie River Bridge. On each project, different traffic control measures (TCMs) were implemented and speed data was collected both prior to and within the work zone. The TCMs, which were implemented after one treatment with the original traffic control plan (TCP), were:

- "SPEED 50" regulatory signs throughout the work zone
- PCMS signs on pavement rollers or stationary trailers
- Radar speed reader trailers
- Oregon State Police (OSP) patrolling work zone
- OSP parked at end of lane closure taper
- Tubular markers placed on both sides of the live travel lane
- Plastic drums placed on both sides of the live travel lane

Using the speed data recorded, the reduction in speed from the beginning reference point – "Road Work Ahead" (RWA) signs – to locations within the work zone was calculated along with the speed relative to the distance to the paver. Statistical analyses of the data show that each TCM helps to reduce the mean speed. The data also suggests a difference in the relative effectiveness of each TCM. However, confounding factors in the study and data collected limit confidence in this result. The SPR-751 study report was published in February 2013 (Link to SPR-751 report: http://www.oregon.gov/ODOT/TD/TP_RES/docs/Reports/2013/SPR751_SpeedReductions.pdf; and appendices: http://www.oregon.gov/ODOT/TD/TP_RES/docs/Reports/2013/SPR-751_SpeedReduction-Appendices.pdf).

Based on the results of SPR-751, the Technical Advisory Committee (TAC) members for the study suggested conducting additional case study projects to collect supplementary data and address the following issues and needs:

- More accurately determine the effectiveness of each TCM and improve confidence in moving forward with recommendations

- Collect additional speed data to better identify the advantages of one TCM over another
- Record speeds further upstream of RWA signs to determine if speeds are being reduced simply due to the presence of the work zone
- Conduct additional case study projects to allow for eliminating confounding factors due to project-specific conditions and data collection limitations

The present study outlined in this Work Plan is designed to supplement the initial SPR-751 study and address the concerns and recommendations of the TAC.

3.0 STUDY OBJECTIVES

The overall goal of the research is to assist ODOT with enhancing the safety of motorists and workers in construction work zones on high-speed roadways. The research includes conducting two additional case studies on paving projects similar to those studied in the SPR-751 study. In addition, as recommended in the SPR-751 final report, the research will include a fewer number of treatments focused on the following specific traffic control measures: "SPEED 50" signs, PCMS signs on a roller(s) or a stationary trailer(s), and radar speed reader trailers. The research is expected to enhance the data already collected on specific treatments and provide guidance to ODOT. The research will take an additional step toward further improvement in safety for highway workers and the driving public with the support of FHWA and the AGC. The specific objectives for this research study are to:

1. Identify potential case study projects and select two projects to study as part of the research.
2. Implement the selected traffic control measures ("SPEED 50" signs, PCMS signs, and radar speed readers) on the case study projects.
3. Compare the performance of the implemented treatments based on their ability to lower speeds a significant amount, ability to minimize speed variability, ease of use, and implementation cost.
4. Develop guidance for ODOT and construction contractors to reference when planning and implementing traffic control measures on highway preservation projects.

The research will focus on effective means to reduce actual speeds in work zones. This includes methods to safely reduce legal posted speeds as well as find measures that reduce actual speed without relying on a posted speed reduction. Research products may include advanced traffic control plans and guidelines for OSP activities under these conditions.

All of the resources and tools necessary for data collection and analysis are already available from the SPR-751 study. The researchers will be able to utilize their experience and knowledge learned to efficiently and effectively conduct the additional case studies.

3.1 Benefits

The most significant benefit of the research is expected to be a means for ODOT to further improve the safety of highway workers and the traveling public during preservation project operations. The research is expected to enhance the data collected from the SPR-751 study, and

provide guidance and support to ODOT for improving work zone safety. Importantly, the research will benefit construction workers and motorists by leading to safer work zones. Additionally, the research is expected to reveal how to promote efficient treatments for travel through work zones, and ultimately maintain a high level of mobility throughout the state. Lastly, successful completion of the research and implementation of the research results is expected to strengthen the partnerships between ODOT and the AGC Oregon-Columbia Chapter and the Oregon Trucking Association.

4.0 IMPLEMENTATION

The research results will be combined with those from the SPR-751 study and used by the Traffic/Roadway Section through procedures outlined to the Region Tech Centers, and implemented through the State Traffic/Roadway Engineer. The results will be used by the Statewide Construction Office for these types of projects and implemented through communication and education of the Construction Project Managers statewide, as approved by the Statewide Construction and Materials Engineer. The results will also be used by the Transportation Safety Division through the request of police agencies participating in these types of projects, and by the Region Transportation Safety Coordinators in each Region through contact with the police agencies providing enforcement efforts.

5.0 RESEARCH TASKS

The following table presents the tasks that will be undertaken to conduct the entire research study. The order in which the tasks will be conducted and their timing are shown in Section 6.0. The timing and duration of the case study evaluations will depend on the construction projects available to, and selected by, the research team and TAC. It is expected that the selected case study projects will be undertaken in the 2013 and/or 2014 construction season. All reports will be produced in the standard ODOT Research Unit report format unless another format is deemed to be more appropriate as a supplement to the ODOT format.

ID	Task
1.	**Select Case Study Projects** Task 1 consists of collecting information about upcoming ODOT pavement preservation projects, and meeting with the TAC to discuss and select two case study projects for the research study. The projects will be similar in size, scope, and site conditions to the I-84 and I-5 projects on the SPR-751 study (i.e., high-speed freeways in rural areas with two lanes in each direction). The timing and location of each project will depend on the selected case study projects. If possible, the projects will be selected such that the timing allows for the added traffic control measures to be included in the construction bid package so that a representative cost of the measures can also be obtained. It is anticipated that the projects will be undertaken in the summer of 2013 and/or 2014. *Cost*: $5,365[1] *Duration*: 2 months (June-July 2013) *Deliverable*: Detailed description of the two case study projects and planned treatments on each project. *TAC Decision/Action*: Initial TAC meeting with the PI to discuss and affirm the research objectives, tasks, and timeframe, and to select the case study projects and treatments on each project.
2.	**Implementation and Monitoring of Traffic Control Measures** Task 2 will comprise implementing the TCMs on the selected case study projects. The researchers will work with ODOT, OSP, and the construction contractors to implement the traffic control measures and monitor their impact on the work zones and traffic. Data collection will include recording performance relative to the following metrics: • vehicle speeds and volumes through the work zone; • speed variability through the work zone; • time, cost, and resources required to implement the traffic control measures; • limitations/barriers to implementing the measures; • construction worker safety, safety perception, and productivity; and • motorist safety. In addition, the researchers will document the ability to implement the traffic control measures based on project and site attributes (e.g., size, location, type of roadway, etc.). It is expected that each case study will entail multiple nights of paving. Along with the original TCP, the research plan will include implementing each additional measure for a period of several days to minimize daily impacts. Researcher travel to and overnight accommodations at each case study location may be required depending on the locations of the case study projects. *Cost*: $45,130 *Duration*: 4 months total (summer 2013 and/or summer 2014)

[1] No more than $5,000 to be spent in June 2013.

	Deliverable: Interim report describing the results of Task 2. *TAC Decision/Action*: TAC shall meet with the PI as needed to discuss the case study projects and review progress related to this task. TAC to provide research team with comments and feedback on the deliverable, and suggest guidance on high-speed reductions during future ODOT activities.
3.	**Data Analysis and Evaluation** The data collected from the case study projects will be analyzed to determine the impacts of the applied traffic control measures and their viability on future projects. The evaluation will be based on the performance metrics listed above in Task 2. Where appropriate, the results relative to each performance metric will be aggregated to determine the overall performance of the implemented traffic control measures. Comparisons will be made between the case study projects and between individual TCMs to evaluate the benefits and impacts provided by the implemented traffic control measures. *Cost*: $23,805 *Duration*: 3 months total (following completion of Task 2) *Deliverable*: A written draft of the data collection and analysis. The PI will also present the information to the TAC regarding data collected and analysis of the results. *TAC Decision/Action*: TAC shall meet with the PI as needed to review progress related to this task and provide input on the analysis. TAC to provide research team with comments and feedback on the deliverable.
4.	**Final Research Report** A draft research report will be prepared and submitted to ODOT for review and comment. The draft version may be provided to the TAC at ODOT's discretion, depending on completeness. The draft report will be revised based on the comments received, and a final research report will be prepared and submitted to ODOT for publication. It is expected that the final report will be a public document, ready for publication in ODOT Research report specifications and not have any spelling or grammatical errors. The PI will provide ODOT a guidance section to be considered for addition into the final report. ODOT will determine appropriate guidance recommendations for inclusion into the final report. *Cost*: $15,660 *Duration*: 3 months total (following completion of Task 3) *Deliverable*: The PI will provide ODOT a draft and final version of the report using ODOT Research report format. The PI will present the final findings to the TAC. ODOT may invite other ODOT staff or committees to attend the final presentation. *TAC Decision/Action*: TAC shall review all deliverables and provide guidance and feedback to the PI.

6.0 TIME SCHEDULE

This section specifies the timeline for the project, listing the task headings and showing monthly and/or quarterly time blocks in which each task will be accomplished. Also shown are interim and final deliverables.

For the purposes of this work plan, the starting date is planned for July 1, 2013. As indicated above, the completion of the case studies will depend on the availability of applicable ODOT preservation project. The exact timing of the tasks will depend on the timing and duration of the selected case study projects. The timeline shown below assumes that the case study projects will be conducted in the summer of 2013. The timeline may change if one or both of the case study projects are conducted at a later date.

Project Tasks	**FY12-13**	**FY13-14**				**FY14-15**	
	Q4	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**
	Apr. – June 2014	July – Sept. 2013	Oct. – Dec. 2013	Jan. – Mar. 2014	Apr. – June 2014	July – Sept 2014	Oct – Dec 2014
Task 1: Select Case Study Projects Duration: 1 month Deliverable: Detailed description of selected case study projects and planned treatments		*					
Task 2: Implementation and Monitoring of Traffic Control Measures Duration: 4 months Deliverable: Interim report with results of Task 2			†*			†*	
Task 3: Data Analysis and Evaluation Duration: 3 months total Deliverable: Presentations(s) on case study analysis results to TAC				†*			†*
Task 4: Final Research Report Duration: 3 months total Deliverable: Implementation guidelines; draft report; final report				*			*

* = Deliverable
† = TAC Meetings
Hatched cells = timing of activities if a case study is delayed until summer 2014

7.0 BUDGET ESTIMATE

An itemized budget for the project is shown below that presents the expenditures for each item by fiscal year and the total anticipated expenditures. The total budget estimate for the entire study is $104,960[2,3].

Item	FY12-13	FY13-14
Personnel		
John Gambatese, OSU (PI)	$ 1,000	$ 20,299
Graduate Research Assistant(s), OSU	$ 2,000	$ 19,473
Undergraduate Research Assistant(s), OSU	$ 0	$ 0
Total Salaries	$ 3,000	$ 38,772
Fringe Benefits		
Faculty	$ 500	$ 10,150
Graduate Research Assistant(s)	$ 356	$ 2,192
Undergraduate Research Assistant(s)	$ 0	$ 0
Total Fringe Benefits	$ 856	$ 12,342
Total Personnel Costs	$ 3,856	$ 52,114
Travel	$ 104	$ 4,896
Services and Supplies	$ 0	$ 1,000
Minor equipment	$ 0	$ 1,000
Total Direct Costs for OSU (sum of items above)	$ 3,960	$ 59,010
Indirect Costs for OSU Activity (26.0%)	$ 1,030	$ 15,342
Student Tuition	$ 0	$ 10,618
Sub-total	$ 4,990	$ 84,970
ODOT Administration	$ 0	$ 15,000
Total Project Costs	**$ 4,990**	**$ 104,960**

[2] A total of $15,000 for ODOT administration includes overtime for on-site participation during in-field case studies.
[3] The indirect cost rate for this study is 26% regardless of the source of funds.

8.0 REFERENCES

ITS International (2011). "Safety Boosted by Steps in Speed." *Advanced Technology for Traffic Management and Urban Mobility*, www.itsinternational.com, Nov./Dec. 2011.

Mahoney, K.M., Porter, R.J., Taylor, D.R., Kulakowski, B.T., and Ullman, G.L. (2007). "Design of Construction Work Zones on High-Speed Highways." National Cooperative Highway Research Program (NCHRP) Report 581, Transportation Research Board, Washington, DC.

Maze, T., Kamyab, A., and Schrock, S. (2000). "Evaluation of Work Zone Speed Reduction Measures." Center for Transportation Research and Education (CTRE), Management Project 99-44, Iowa State University, April 2000.

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