



Portland Area Mainline Needs Assessment

DRAFT

Part-Time Shoulder Use: Working Paper #5

HNTB Corporation
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Table of Contents

1. Overview 1

2. Geometric Design Requirements 1

3. Safety 2

4. Capacity 3

5. Cost 3

6. Implementation & Operation 4

7. Application to Maine Turnpike between Exits 44 and 53 4

8. Conclusion 5

1. Overview

Part-time shoulder use is a transportation system management strategy that allows vehicles, usually restricted to certain classes, to use the left or right shoulder during specific time periods. Part-time shoulder use has been used in situations where there is limited right-of-way and recurring congestion due to lack of capacity, particularly when other alternatives to reduce congestion are infeasible or cost-prohibitive. There are three types of part-time shoulder use as outlined by the Federal Highway Administration (FHWA):

1. Buses only (BOS) to improve transit travel time and reliability;
2. Static Shoulder use (either for all classes or class specific) operating during peak periods; and
3. Dynamic Shoulder use to respond to real-time conditions.

While part-time shoulder use is a cost-effective strategy to reduce congestion during peak periods, it may not be an appropriate alternative if design requirements are not met or if it has an adverse effect on safety. Even if part-time shoulder use is deemed to be feasible, there are still unique design, safety, cost, implementation and operational challenges that need to be considered before being implemented.

This paper will serve to provide guidance on the state of the practice of part-time shoulder use and its implications on the Maine Turnpike between Exits 44-53.

2. Geometric Design Requirements

Implementation of part-time shoulder use occurs within the existing paved roadway envelope but may lead to shoulder redesign or other roadway infrastructure improvements to meet geometric requirements outlined by the FHWA. These requirements are:

- Adequate shoulder width and cross slope to accommodate a travel lane;
- Adequate vertical clearance and bridge width;
- Adequate physical and structural condition in terms of rideability and drainage; and
- Adequate stopping sight distance and lateral offset to obstruction.

Other considerations include determining if there are long enough roadway segments available and providing emergency refuge areas. Part-time shoulder use on short roadway segments could reduce the ability of the lane to handle congestion especially if there are interchanges present. The shortest roadway section utilizing part-time shoulder use in the United States from the FHWA guide is roughly 1.5 miles in Seattle, Washington. Emergency refuge areas are highly desirable because during shoulder use, by definition, the shoulder width will be reduced or eliminated. Based on the FHWA guide, emergency refuge areas should be placed every ½ mile, which may not be possible on bridge segments or if there is limited right-of-way. Therefore, a design exception would be required as shoulder width is a controlling design criterion. This often impacts other controlling design criteria and needs to be considered when determining if part-time shoulder use is feasible.

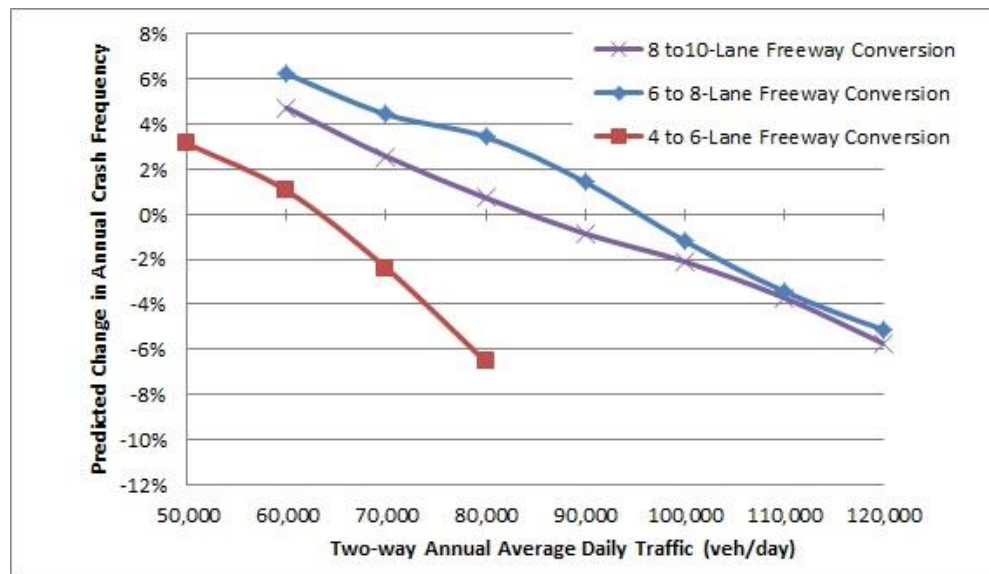
3. Safety

While research to date has not concluded whether part-time shoulder use negatively or positively impacts overall safety in the long run, there are a few conclusions that can be made based on existing data:

1. Crashes related to congestion may decrease;
2. Crashes related to driver behavior, confusion or suboptimal geometry may increase;
3. Crashes related to right-side ramp junctions may increase with right shoulder use; and
4. If part-time right shoulder use is utilized as part of an interchange system (i.e. closely spaced interchanges), crashes related to ramp junctions could further increase.

Overall, part-time shoulder use could reduce property damage only crashes and slightly increase fatal and injury crashes on a four 4- or 6- lane facility. This is because rear-end collisions would decrease, often associated with congestion, which have a lower probability to cause injury; and sideswipe, run-off the road and interchange related crashes would increase, due to driver confusion and the presence of multiple interchanges, which have a higher probability to cause injury. However, the perceived safety benefit is only valid with proper volumes and ideal geometric conditions, i.e. good sight distance, proper lateral and vertical clearance, etc.

Studies have shown that adding a lane and reducing shoulder width can improve safety if the volume is high enough. Graph 1 uses data from the Highway Safety Manual (HSM)¹ to compare the predicted change in annual crash frequency and Annual Average Daily Traffic (AADT) with a reduced shoulder width for different lane configurations. The graph represents an addition 12' travel lane and 4' reduced width shoulder.



Graph 1 – Predicted crash frequency associated with increasing number of freeway lanes and narrowing the right shoulder

¹ American Association of State Highway and Transportation Officials (AASHTO), “Highway Safety Manual, First Edition, with 2014 Supplement” (2014).

Graph 1 is used to help predict the potential safety impacts of part time-shoulder use, but there are a few limitations to the HSM methodology:

1. Graph 1 represents a full-time use lane and not a part-time use lane, therefore predicted crash frequency is only valid when the shoulder is open during peak periods;
2. Graph 1 cannot predict the safety impacts of a no shoulder scenario. 4' is the lowest shoulder width reduction available in the HSM; and
3. Graph 1 doesn't include potential safety impacts due to design exceptions or poor geometric conditions (i.e. sight distance, lateral offset, etc.) as their impacts vary from site to site.

Overall, Graph 1 is meant to show that as capacity is added and shoulder width is reduced, which is the case for part-time shoulder use, safety improves for roadways with higher AADT and safety reduces for roadways with lower AADT. Part-time shoulder use is the extreme case compared to the assumptions made in Graph 1, which includes some limitations when applied to part-time shoulder use as explained above. These limitations skew the overall safety impact and should be carefully considered before determining if part-time shoulder use is feasible.

4. Capacity

Lane utilization and capacity also need to be considered to determine if part time shoulder use is feasible. Vehicles have been found to travel 5-10 mph slower when using the shoulder as a travel lane. Slower speeds combined with a substandard shoulder and driver unfamiliarity result in a lower capacity. Based on simulations performed by the FHWA, part-time shoulders can expect to achieve a capacity of 1250-1700 vehicles per hour. A part-time shoulder use lane will achieve a lower capacity with a substandard freeway lane design (10' width), 50% single occupancy vehicle (SOV) utilization i.e. of the SOV's able to use the shoulder only 50% will, and no truck traffic. A part time shoulder use lane will achieve a higher capacity with a standard freeway lane design (+12' width), 100% single occupancy vehicle utilization and truck traffic. While part-time shoulder use will increase capacity of the roadway facility, it would only occur during peak periods and the capacity would be less than a typical travel lane. This is especially important to consider if congestion extends beyond peak periods, when widening may be a better option to avoid keeping the shoulder open for extended periods of time.

5. Cost

Part-time shoulder use may be a cost-effective solution to improving capacity issues in lieu of traditional widening, but there are still potential capital and operating & maintenance (O&M) costs to consider:

Capital Costs

- Engineering, testing, project management and feasibility documentation;
- Shoulder widening or reconstruction;
- Construction of emergency refuge areas;
- Ramp treatments such as widening or restriping;
- Maintenance and law enforcement training;
- Increased Emergency Patrols;
- Public Outreach; and

- Intelligent Transportation System (ITS) infrastructure.

O&M Costs

- Compliance enforcement;
- Sweeps (drive the facility) every day before opening to traffic;
- ITS maintenance and operations staff; and
- Roadway maintenance, sometimes complicated with snow removal.

Part-time shoulder use usually demands more training and public outreach than typical widening projects due to the lack of familiarity among the public and law enforcement agencies. Depending on the amount of reconstruction or widening of the shoulder required, costs could be greater than anticipated compared to a highway facility with adequate shoulder design or traditional widening. However, if bridge widening is needed for a third lane but not needed for part-time shoulder use, capital costs would be significantly less than traditional widening. Once part-time shoulder use is implemented, O&M costs could exceed traditional widening O&M costs due to the additional resources needed for enforcement and to maintain and operate ITS infrastructure.

6. Implementation & Operation

If part-time shoulder use is deemed feasible based on design, safety and capacity, there are a few implementation and operational challenges that need to be considered:

Legislative/Legal Action

- In some states, driving on the shoulder is prohibited by law;
- Complex part-time shoulder use projects may require a “request to experiment” submitted to the FHWA; and
- Depending on the complexity of ITS, further legislative action may be needed to establish a framework for implementation.

Enforcement

- Manual video enforcement or increased Police enforcement could be required to ensure shoulders aren’t being used during off peak hours; and
- Creates potential safety risk if vehicles are using the shoulder during off peak hours to accelerate/decelerate or maneuver through traffic.

Emergency Responses

- A substandard shoulder during peak hours reduces law enforcement official’s ability to respond to accidents and perform traffic management duties; and
- Emergency refuge areas help mitigate the risk but do not eliminate it.

7. Application to Maine Turnpike between Exits 44 and 53

Based on the FHWA guide and analysis of existing conditions, below are potential implications part-time shoulder use would have on the Maine Turnpike between Exits 44-53:

1. The right shoulder would have to be rebuilt and widened to at least 12' to accommodate part-time shoulder use (existing 8' shoulder);
2. The left shoulder would not be feasible for part-time shoulder use due to geometric constraints and the presence of bridge piers;
3. Further analysis would need to be done to determine if other design requirements are met or if a design exception is needed;
4. BOS would not be logical due to the current limited volume of bus traffic on the Turnpike;
5. Potential increase in ramp junction crashes, especially between exits 44-48;
6. By 2040, AADT's will be between 50,000 and 70,000 vehicles a day, resulting in a safety improvement for some sections and a safety reduction for others;
7. Less capacity available than adding an additional lane;
8. The number of short trips on the turnpike could reduce the effectiveness and capacity of the part-time shoulder use lane;
9. Reduced capital costs but potential increase in O&M costs as compared to widening;
10. State of Maine Law under MRS Title 29A, Chapter 19: Operation states: "8. Breakdown lanes. The operator of a vehicle may not overtake another vehicle on a limited-access way by driving on the shoulder or in the breakdown lane located on the right or the left of the travel lanes. [2003, c. 340, §6 (NEW) .]. While this is not a significant obstacle to overcome, it may still need to be rewritten to allow part-time shoulder use;
11. Increased public outreach, training and enforcement to educate the public and law enforcement on part-time shoulder use; and
12. Potential emergency response issues even with refuge areas.

8. Conclusion

There are many benefits to part-time shoulder use, especially for a facility with limited ROW and limited funding. However, design requirements, safety impacts, capacity constraints, Capital & O&M costs, implementation and operational challenges help planners and engineers determine if part-time shoulder use is feasible. Based on the findings of this technical memorandum as it relates to the Maine Turnpike between Exits 44 and 53, part-time shoulder use is not recommended for the following reasons:

- Potential increases in overall crashes, as well as fatality and injury crashes based on forecasted traffic volumes;
- Closely spaced interchanges, which may increase ramp junction crashes;
- Potential emergency response issues;
- Less capacity than adding an additional lane – will only be a short-term solution based on forecasted traffic volumes;
- Availability of ROW and funding to add an additional general-purpose lane; and
- Legal obstacles for shoulder use.

While part-time shoulder use is not recommended between Exit 44 and 53 for the Portland Area Mainline study, this does not mean that part-time shoulder use isn't feasible for other projects in Maine. A high-level bridge project where widening isn't feasible due to high costs may warrant part-time shoulder use to provide congestion relief. However, information from this report should be considered before part-time shoulder use is implemented.