

Refuge Areas for Drivers on Freeway Managed Lane Corridors

Introduction

Many managed lanes facilities are put into operation within the existing footprint of the roadway with no addition to the width of the cross-section or right-of-way. As a result, managed lanes facilities may have minimal shoulder width, which could result in little refuge for disabled vehicles to be positioned outside of the travel lanes. This paper discusses characteristics of refuge areas, existing design guidance and examples, comparisons to similar treatments, and potential safety effects of refuge areas and wider shoulders. **The objective of this paper was to review relevant existing material to better identify content for meaningful guidelines on refuge areas and fill existing gaps could be filled by future research.**

Current Domestic Practices and Existing Guidance

Multiple sources contain guidance on managed lane design, but in most of them, little is said about refuge areas on shoulders.

- **AASHTO HOV Guide (2004):** Discusses shoulder design in broader terms of the entirety of the available cross-section and how it can be distributed among the needed lanes, shoulders, and buffer areas.
- **AASHTO Green Book (2011):** Shoulder widths are in the context of the freeway as a whole, with recommended widths for the left shoulder of “normally 1.2 to 2.4 m [4 to 8 ft] wide, at least 1.2 m [4 ft] of which is paved and the remainder stabilized.”
- **Caltrans (2003):** Essentially silent on the provision for accommodating disabled vehicles and mitigating the safety effects on adjacent traffic.
- **TxDOT (1999):** Research suggested language to include consideration of “providing accident investigation sites if outside shoulders are not provided in a freeway section”, but refuge areas are not specifically described in current guidance.

International Applications

- Refuge areas are provided in **England** as part of active traffic management strategies that include hard shoulder running (i.e., dynamic shoulder use). They are located about every 800 m [2600 ft] and contain detection and communication hardware. (Jones et al, 2011)



Figure 1. Image of emergency refuge area from England (Jones et al, 2011)

- Similar provisions can be found in **Germany and the Netherlands**, though design details are not as easy to find.
- Additional research has been done in the **United Kingdom** to identify specific characteristics that discourage non-emergency use and encourage optimal stopping position, such as lighting and length of accel/decel zones. (Diels et al, 2009)

Examples of Similar Domestic Applications

- AASHTO HOV Guide and Caltrans provide guidance on enforcement areas. Katy Managed Lanes (KML) on I-10 in Houston were reconstructed with enforcement areas. (Goodin et al, 2013)



Figure 2. Harris County Constable officer enforcing HOV compliance on the KML. (Goodin et al, 2013)

- Mahoney et al (2007) described emergency and enforcement pullouts as ancillary design elements in work zones, with a need to provide sufficient sight distance (flat tangent sections) and typical spacing between 0.8 and 1.6 km [0.5 and 1 mi].

Safety Performance

- The CMF Clearinghouse (FHWA, 2015) has no crash modification factors for refuge areas, but there are over 400 CMFs related to shoulder width. In general, wider shoulders tend to reduce crashes and narrower shoulders have an increase in crashes.
- Recent research on cross-section elements related to managed lanes supports those trends. (Cothron et al, 2004; Jang et al, 2013; Srinivasan et al, 2015)

Conclusions

There is a need for national guidelines on the design and operation of refuge areas on freeway managed lanes. Appropriate spacing, geometric design elements (e.g., cross-section), and operational characteristics need to be described to design and located refuge areas for optimal performance, as well as considerations for which types of facilities may benefit most from refuge areas. **An existing research needs statement describes potential tasks and products of a research project that would help fill the current gap in guidance.**

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Selected References (full list of references in paper)

- AASHTO. *Guide for High-Occupancy Vehicle (HOV) Facilities* (2004) and *A Policy on Geometric Design of Highways and Streets*. (2011) Washington, DC.
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