

# Comparison of Road Geometric Design Standards in the Palestinian Guidelines with AASHTO from a Safety Perspective

Deema K. Karajeh<sup>1</sup>, Sameer A. Abu-Eisheh<sup>2</sup>

**Abstract**— Due to the impact of geometric design on traffic safety, this research aims to compare the geometric design standards included in the Palestinian guidelines (the Road and Transportation Planning Guide in Urban Areas and the Road Traffic Safety Guide) with AASHTO standards. The comparison focused on key design elements; cross sections (lanes, shoulders, and medians), alignment (horizontal and vertical), sight distances, intersections, roundabouts, and access points. The research results showed a Palestinian interest in design quality and enhancing safety. However, there were still aspects that required further development, such as providing design details and proper coverage for rural roads. Based on this comparison, the study proposed recommendations to develop a comprehensive and unified national guideline consistent with international standards and safety requirements, and conduct analytical studies to link geometric design with traffic safety accidents in Palestine.

**Keywords:** Geometric design, Traffic safety, Palestinian Road guidelines.

## I. INTRODUCTION

With the increase in the number of vehicles and distance traveled by vehicles around the world, the rate of accidents in the world has increased, making the issue of road safety a source of great concern around the world due to adverse socio-economic impacts [1]. According to World Health Organization statistics, there are approximately 1.19 million deaths annually, and 20-50 million are seriously injured [2]. In Palestine, the Palestinian Central Bureau of Statistics recorded 15,094 traffic accidents in 2024, with 111 fatalities, noting a 100% increase in traffic accidents over the past decade [3].

The primary goal of the transportation system is to provide safe and efficient movement of people and goods, so roads must be made secure to reduce the occurrence of accidents and their severity [4]. To achieve this, it is necessary to understand that there are three main factors that attribute to road accidents: human, vehicle, and roadway-related factors [5].

As stated in the Highway Safety Guide published by the American Association of State Highway and Transportation (AASHTO, 2008), road factors contribute to 3% of road

accidents, while 34% are attributable to a combination of road-related and other factors [5]. Therefore, road engineers continually strive to design and operate transportation systems in ways that reduce accident rates by ensuring that road design aligns with driver expectations [1]. Numerous studies have examined the relationship between road engineering design elements and accident occurrence. Key design elements that influence accident rates include the number and width of lanes, the presence and type of medians, access points, vertical grade, horizontal curvature, and shoulder width [6].

This research will specifically examine the geometric design of roads and their safety implications in Palestine, like other countries around the world, has sought to enhance traffic safety and reduce the risk of accidents by establishing the Supreme Traffic Council as the body responsible for regulating traffic safety affairs. The Ministry of Transport issued the "Road Traffic Safety Guide in Palestine" to serve as a reference for the Council's member institutions, the public and private sectors. The guide includes guidelines as well as procedures that support traffic safety in the areas of planning, design, implementation, monitoring, and evaluation [7]. The Ministry of Local Government also issued the "Road and Transportation Planning Guide in Urban Areas" to provide technical support to those working in the road and transportation sector planning, particularly in the preparation of urban plans and designs. It focuses on designing road components and transportation facilities according to international scientific principles, while taking into account the specificity of the Palestinian context and applicable regulations and instructions [8].

## II. OBJECTIVES

The research aims to compare the local guides considering its guides title, the Road and Transportation Planning Guide in Urban Areas, the Road Traffic Safety Guide with AASHTO guidelines, to identify the differences and similarities in geometric road design, explore opportunities for improvement in the local guidelines, and to provide recommendations for developing design standards and enhancing safety to reduce accidents in a manner consistent with the Palestinian reality.

## III. METHODOLOGY

This research used a comparative analysis methodology to study road design standards in the Palestinian guides in relation with AASHTO standards. Specific geometric design elements were selected for comparison, including those which impact traffic safety, such as horizontal and vertical alignments, main cross-section elements (lanes, shoulders, and medians), sight distances, intersections, roundabouts and

<sup>1</sup>Deema K. Karajeh is graduate student at the M.Sc. Program in Roads and Transportation Engineering, An-Najah National University, Nablus, Palestine (e-mail: deema3205@gmail.com).

<sup>2</sup> Sameer Abu-Eisheh is Professor of Roads and Transportation in the Department of Civil and Architectural Engineering, An-Najah National University, Nablus, Palestine (e-mail: sameeraa@najah.edu).

access points. The analysis dealt with how the two indicated Palestinian guidelines handle these design elements compared to AASHTO, evaluating differences, and defining areas where the local guidelines could be enhanced. Based on this analysis, recommendations were developed to improve local guidelines in alignment with AASHTO principles to enhance traffic safety and ensure the specificities' compatibility with the Palestinian reality.

#### IV. DATA COLLECTION AND ANALYSIS

Geometric design information was collected from the three guides for the elements being compared. The standards adopted in each guide for each element were then presented. This is followed by analysis and suggestions to improve road design in Palestine in a manner which is consistent with the global system. The following summarizes the outcome of the analysis for each of the considered key design elements.

##### 1. Cross-section elements

- Lane Widths:
  - The Transportation Planning Guide in Urban Areas specifies minimum and preferred lane widths for different urban road classes, including in the special cases when there is a need for reducing the lane width to a minimum of 2.75 meters.
  - The Road Traffic Safety Guide does not provide detailed descriptions, but does specify minimum, preferred, and maximum widths of 3.0 m, 3.6 m, and 3.75 m, respectively.
  - AASHTO provides detailed guidelines concerning lane widths for road classes, based on design speed and design volume for roads.
- Shoulder Widths:
  - The Transportation Planning Guide in Urban Areas specifies the minimum and preferred shoulder widths for use in urban areas, with a minimum range of 0.6 m to 2.4 m. It outlines the factors affecting these values, such as road class and terrain characteristics.
  - The Road Traffic Safety Guide specifies the minimum shoulder widths ranging from 2.0 to 3.0 m and shows the factors affecting these values, such as road class, terrain characteristics, traffic volume, and design vehicle. It highlights the role in enhancing safety and suggests using rumble strips to reduce run-off-road crashes, especially on highways.
  - AASHTO provides detailed guidelines of shoulder widths for road classes, based on design speed and design volume for the road.
- Medians:
  - The Transportation Planning Guide in Urban Areas provides a table of minimum and preferred median widths for multi-lane urban roads. It recommends at least 1 m for collector roads and 2 m for arterials and expressways.

- The Road Traffic Safety Guide recommends a minimum median width of 1 m and a preferred width of at least 5 m. It also provides design recommendations for the minimum width to be used, such as using raised medians, and ideal cases when equipped with a guardrail.
- AASHTO provides detailed information on median design, including widths, types, and components for medians in collectors, arterials, and expressway roads.

- Analysis outcome for cross section elements:

Developing local guidelines should be enhanced to include more comprehensive design standards for key cross section elements including lanes, shoulders, and medians, not only in terms of dimensions, but also considering other aspects such as shoulder surface materials, the safety implications of lane numbers, separation methods between lanes and shoulders, and measures to prevent vehicle lane departure.

For widths, adopting the AASHTO approach is recommended to determine optimal lane and shoulder widths based on traffic volume and design speed, ensuring designs are suited to local conditions such as road closures and traffic detours.

For medians, clearer guidance is needed on median design, specifying types, dimensions, suitability by road classes, along with specifying appropriate materials and dimensions within the constraints of available road widths in Palestine.

##### 2. Road Alignment:

- Horizontal Alignment:
  - The Transportation Planning Guide in Urban Areas focuses on the planning and design of simple horizontal circular curves only in urban areas. It includes a table of minimum radius values based on design speed and limited urban superelevation (4% - 6%). However, it does not include the mathematical equations for radius calculation or detailed guidance on superelevation design and application; instead it refers users to external engineering references for these calculations.
  - The Road Traffic Safety Guide does not provide detailed information on designing curves, but highlights the importance of carefully designing them with consideration for safety and smooth traffic flow and applying appropriate standards for determining minimum curve radius, superelevation, and adequate sight distance to achieve safety.
  - AASHTO provides a comprehensive overview of horizontal curve design, including simple, compound, and spiral curves in urban and rural areas. It explains the relationships between design speed, superelevation, and lateral friction in determining the minimum curve radius, supported by relevant equations and practical design tables. It includes

considerations such as lane widening on curves to improve truck accommodation and overall safety.

- Vertical Alignment:
  - The Transportation Planning Guide in Urban Areas briefly indicates that the design of vertical curves (crest and sag) involves calculating the minimum curve length and ensuring adequate sight distance for safety. It refers to the return of external references and textbooks for these calculations.
  - The Road Traffic Safety Guide does not provide detailed information on designing vertical curves, but emphasizes the importance of ensuring safe operation, particularly regarding sight distance requirements and driver comfort.
  - AASHTO provides detailed guidance on design for vertical curves—both crest and sag—for smooth driving, adequate sight distance, vehicle control, aesthetics, and proper drainage. It provides equations, figures, and tables to determine safe and convenient lengths of crest and sag curves depending on design speed and sight distance requirements.
- Sight distance:
  - The Transportation Planning Guide in Urban Areas provides the need for sufficient stopping sight distance on both vertical and horizontal curves. It is necessary to provide the minimum horizontal curve radius and an obstruction-free distance for adequate stopping sight distance. It includes a figure illustrating the relationship between the horizontal curve radius and the design speed to determine stopping sight distance, but no information about vertical curves or passing sight distance.
  - The Road Traffic Safety Guide generally provides that the available sight distance on all parts of roads should be greater than the minimum required for stopping distance, especially at vertical and horizontal curves, illustrating this concept through the stopping sight distance equation.
  - AASHTO provides detailed sight distance requirements, including stopping sight distance for all road classes, using equations or tables based on the design speed and gradient. It also displays the passing distance on two-lane roads using equations or tables based on the design and vehicle speeds, and include requirements decision sight distances for complex situations.
- Analysis outcomes for Road Alignment:

There is a need to unify and coordinate local guidelines content for alignment design, and add equations and tables for calculating minimum horizontal curve radius and sight distances on urban and rural roads. Furthermore, it includes guidance on the various types of horizontal curves, such as compound curves and passing distances. These elements should be clearly explained, detailing their intended purposes while considering Palestine's terrains and constraints consistent with international standards, such as AASHTO.

### 3. Intersections:

- The Transportation Planning Guide in Urban Areas presents the topic of intersections in a practical and simple manner, explaining their various geometric types such as three - and four-leg intersections, and the importance of the type adopting right-angle intersections between roads to achieve better visibility and reduce accidents. It emphasizes that the distance between intersections should not be less than 60 meters to ensure safety. It also outlines the design requirements for pedestrian crossings, including safe sidewalks and clear crossing areas. From a design perspective, it addresses the design of turning lanes and displays the turning radius values in a table using simple curves. It explains the requirements for the sight triangle necessary to ensure adequate visibility for drivers approaching the intersection, specifying a single value for the horizontal and vertical distances required to form this triangle.
- The Road Traffic Safety Guide outlines the design of intersections to minimize conflict points and improve traffic safety. It recommends that intersections be spaced at least 50 meters apart, and that access points be at least 10 meters from the intersection. It explains their various geometric types such as three and four-legged and addresses the design of turn lanes and intersection control methods. It also includes tables specifying the horizontal and vertical distances clear of obstructions according to the design speed, to ensure a safe sight triangle when approaching an intersection in different cases.
- AASHTO offers a comprehensive overview of intersection design, including at-grade intersections, grade intersections, and interchanges. It considers land use, capacity, conflict points, and user requirements (pedestrians, cyclists, and trucks) to balance safety, operation, and cost. It also clarifies design details of intersection components such as alignment, sight distances, medians, auxiliary lanes and various geometric types such as three and four legged.
- Roundabouts:
  - The Transportation Planning Guide in Urban Areas indicates that roundabouts are unsuitable for areas with high traffic density and heavy pedestrian traffic, due to safety and regulatory challenges. It emphasizes balancing safety, capacity, space, operation, and large vehicle traffic in roundabout design. Roundabouts are classified into three categories: small, single-lane, and multilane roundabouts. It includes tables outlining general design considerations in urban areas, such as road classification, traffic volume, design speed, land use, and vehicle type. In addition, it specifies design criteria for roundabout elements, with overall diameters ranging from 13 to 55 meters.
  - The Road Traffic Safety Guide This guide outlines the basic principles for the operation and design of roundabouts. It identifies the appropriate conditions for using roundabouts, such as low-volume locations.

It also includes important design considerations, such as design speed, design vehicle, and pedestrian needs. It explains the details of geometric elements of roundabout design and includes a table classifying roundabout types, design components, and overall diameters ranging from 13 to 60 meters.

- AASHTO categorizes roundabouts into small, single-lane, and two-lane types, specifying appropriate urban and rural applications. It includes a table summarizing design and operational elements, such as overall diameters (ranging from 13 to 91 meters), and relates each type to the expected daily traffic volume. Design depends on factors such as the surrounding areas, capacity requirements, available space, number of lanes, design vehicles, and site-specific conditions. The guide also emphasizes critical geometric elements to enhance safety, including maintaining low speeds, accommodating pedestrians, ensuring sufficient sight distances, and enabling smooth vehicle movement.
- Analysis outcomes for Intersections:

There is a need to update and expand the local guidelines to include a more detailed intersection design for rural and urban areas, with a focus on sight distances, element dimensions, and traffic volumes. In addition, showing the places where different types of roundabouts are used and determining their dimensions in a manner that is proportional to the volume of traffic, consistent with AASHTO standards and restrictions on Palestinian space.

Moreover, the local guidelines need to clarify intersection control mechanisms, as these are closely related to geometric design, specifying where each type should be used, and design quality assurance standards.

#### 4. Access points:

- The Transportation Planning Guide in Urban Areas describes access points in general for urban streets without a minimum allowable distance or explanation of control methods.
- The Road Traffic Safety Guide describes the concept of access control (full, partial, or limited) on rural roads only, without urban roads, based on road classification, and specifies the minimum allowable distance between them.
- AASHTO explains access points in detail for all classifications of roads. It outlines access control methods, including those related to geometric road design, and clarifies the benefits of these in reducing accident rates.
- Analysis outcome:

There is a need to include minimum distances between access points in local guidelines for all road classes in urban or rural areas, taking into consideration land use, traffic density, and accident frequency.

Study and definition of appropriate and type of access points during the planning and design phases of road projects for the specific road class is essential.

## V. RESULTS AND DISCUSSION

A comparison is conducted in this paper between the Palestinian local guides (The Transportation Planning Guide in Urban Areas and The Road Traffic Safety Guide) and the AASHTO geometric design guidelines for major road elements, such as alignments, key cross section elements, intersections, and access points. The outcome clarifies the concerned ministries in the State of Palestine commitment to improve geometric design and enhance traffic safety in line with global standards. The local guides presented basic standards and specifications used in the planning and design of road projects.

However, the comparison revealed areas that could be improved in the local guides, such as the level of detail, the extent of coverage, and the precision in some standards compared with AASHTO. The local guides lack detailed guidelines for directly geometric design appropriate to Palestinian reality, such as tables for stopping and passing sight distances or information on the determining minimum horizontal curve radii. This lack of comprehensiveness, forces engineers to refer to other references and guidelines.

The Transportation Planning Guide in Urban Areas also focuses primarily on urban areas and links design to urban planning, without sufficient coverage or clear mention of road design requirements in rural communities. The Road Traffic Safety Guide does not specify certain design criteria, which just mentions some important design issues, such as safety related aspects concerning alignment.

Therefore, there is a need to develop and expand the content of the local guides to include more detailed and comprehensive standards for proper design and improvement of safety levels, consistent with Palestinian reality and international standards, such as those related to the design of medians and access points.

## VI. CONCLUSIONS AND RECOMMENDATIONS

This study presents a comparative assessment of the content of Palestinian guidelines related to geometric design standards for key design elements compared to the AASTO standards. It showed that there is a Palestinian concern toward enhancing traffic safety and improving the quality of geometric design. However, some aspects require further development to improve design efficiency and reduce road accidents in a manner consistent with the Palestinian reality. For example, access point management, which AASTO highlighted as beneficial in reducing accidents, can be managed through geometric design [9]. The study also clarified that local guidelines do not provide sufficient detail for rural roads, limiting their usefulness as a comprehensive design reference suitable for the Palestinian reality.

The study provides recommendations to enhance the reality of Palestinian road geometric design and improve its consistency with safety principles and international standards.

The recommendations include conducting analytical studies to link geometric design and traffic accidents in Palestine, aiming to develop effective design solutions to improve safety. Moreover, it is recommended to develop a comprehensive and unified national guideline that includes

proper information, such as tables, figures, and equations, for designing road geometric elements, consistent with local international standards and safety requirements.

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