

A Critical Review on Planning & Designing Complete Intersections

Vanshika Vashisht¹, Shalini K.², Varsha Khetrapal³

¹Vanshika Vashisht, M.Plan(Urban Planning), Sushant University, Gurugram, Haryana, India

²Professor Shalini K. School of Art & Architecture, Sushant University, Gurugram, Haryana, India

³Professor Varsha Khetrapal, School of Art & Architecture, Sushant University, Gurugram, Haryana, India

Abstract – Complete Streets is a method of designing, managing, operating and maintaining streets that permits safe access for all users, including transit users of all ages and abilities like motorists, cyclists, and pedestrians. The challenging interests of the transit users are significant at intersections as everyone is fighting to save ‘time’ to cross the particular intersection. Driver expectations must change to include sharing the road with other modes in urban and suburban environments where intersection users will suffer delays and conflicts involving cars, pedestrians, and bikes. This review paper makes it clear that access management goals are to maintain street safety and mobility while enabling access to land uses by regulating access location, design, spacing, and operation. The paper provides a review of the complete intersection designs as guided by the North Carolina Department of Transportation (NCDOT).

Key Words: Pedestrians, Intersections, Conflicts, Delays, Cyclists, Transit, Street, Urban

1. INTRODUCTION

This strategy also places a focus on the needs of those who have suffered from systematic underinvestment or whose needs have not been satisfied by a conventional transportation approach, including older folks, people with disabilities, those without access to cars, and various other communities.

The "Complete Streets" policy has provided a basic framework for including multi modal system for the proposed infrastructure and the brown field projects, strengthening the older areas and taking burden off the streets. [1]

This strategy has the following advantages:

- Improving accessibility for travellers;
- Promoting the use of alternative modes and routes of transportation;
- Creating more sustainable communities and societies;
- Increasing connectivity between communities, streets, and transit systems;
- Improving safety for motorists, cyclists and drivers especially pedestrians.

1.1 Design of Complete Streets

There is no one specific design prescription for Complete Streets, even if it is a process and approach to street design. Each one is distinct and reacts to its local environment. One or more of the following may be found on a complete street: curb extensions, bike lanes (or wide paved shoulders), special bus lanes, comfortable and accessible public transportation stops, frequent and safe crosswalks, median islands, accessible pedestrian signals, accessible pedestrian signals, accessible pedestrian signals, sidewalks, roundabouts, and more.

Even when employing a Complete Streets concept, streets will still look different in rural, suburban, and urban regions because of the differences in environment and user needs.

2. NEED OF THE COMPLETE STREETS DESIGN

Countries all around the world have witnessed an increasing need to make it safer and easier for citizens to walk, cycle, use free public transportation and drive. As, a city’s population grow, more and more people seek urban amenities and better lifestyles. In western countries, healthcare costs and obesity, along with the rising fuel prices, still remain the number one reason of switching to public transportation.

According to Traffic Safety Facts [2] [3], a pedestrian was killed every 81 minutes in a traffic crash. **Table - 1** depicts the Pedestrian Fatalities data in North Carolina over a period of 10 years, from 2011-2020 [4].

Table - 1: Total Fatalities and Pedestrian Fatalities in Traffic Crashes, 2011–2020

Year	Total Fatalities	Pedestrian Fatalities	
		Number	Percentage of Total Fatalities
2011	32,479	4,457	14%
2012	33,782	4,818	14%
2013	32,893	4,779	15%
2014	32,744	4,910	15%
2015	35,484	5,494	15%
2016	37,806	6,080	16%

2017	37,473	6,075	16%
2018	36,835	6,374	17%
2019	36,355	6,272	17%
2020	38,824	6,516	17%

Source : Crash Stats, National Highway Traffic Safety Administration

The increasing pedestrian fatalities has been a major factor contributing towards the need of Complete Street Designs and Policies.

However, establishing a clear policy is only the first stage of a much longer process that will impact street design practices. The projects that are created and how they are built are determined by these practices, which are the fundamental elements of establishing a full network that will serve everyone and link more people to destinations safely and effectively. These different stages are depicted in **Figure 1**.



Figure 1: Methodology of Developing Projects w.r.t Policies

Source : Author, 2022

3. ELEMENTS OF COMPLETE STREETS DESIGN

A basic understanding of land use, transportation network context is necessary for designers and planners while designing intersections. These are the general principles which could assist in developing complete intersections:

- Intersections generally pose the problem of increased conflicts between various modes of transportation and they should prioritize the movement of the cyclists and pedestrians. The main motive should be to reduce the crossing time at junctions for various modes.
- The number of lanes of the junctions determines the main design parameters. Intersections should be logically built so as to reduce the area of the crossing or simply the crossing distance.
- The speed for the intersections should be according to the type of roads leading to those intersections and according to the land use around. Driving at a slower speed gives the driver more time to see and respond to issues at junctions.
- Intersections should be constructed so drivers learn to anticipate pedestrians and bicycles, as collisions are often less severe if speeds are slower.

- Since a junction is a part of the larger network, the design should include suitable designs and amenities that are carried through the intersection and out to the street approaches.
- When approaching an intersection, drivers, bicycles, and pedestrians should be able to see and react to one another. By allowing sufficient sight distance at intersections, locations where vehicles are merging, and crosswalks, as well as by putting the proper pavement markings, signs, and signals, you can always make sure that pedestrians and bicycles are as visible as possible.
- At the junctions, channelizing islands to isolate conflicts might be a key design element. Islands with the right design may reduce conflict sites, create a pedestrian refuge space, break up pedestrian crossing maneuvers, and cut the crossing distance.

Figure 2 shows the elements of a complete street design.

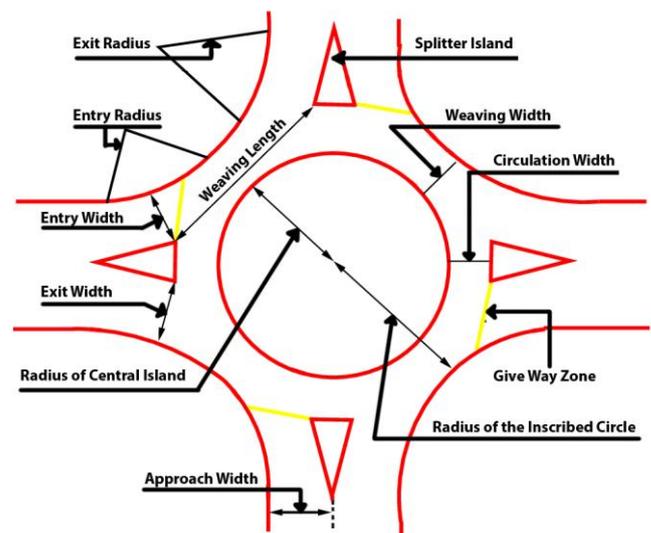


Figure 2: Design Elements of a Complete Intersection

Source : Prof. Tom V. Mathew, Traffic Rotaries, 2019

4. METHODS OF EVALUATION

In the context of North Carolina, various street patterns and networks were identified which could be aligned for the policy of complete streets [2]. These types are as below:

- Main Street Intersection
- Boulevard Intersection
- Avenue Intersection
- Parkway Intersection
- Other Intersections

4.1 Main Street Intersection

These intersections should prioritize pedestrian travel needs including high visibility crosswalks. [5] They are planned to carry vehicles at a much lower speed ranging from 30-35 km/hr. On -street parking should also be provided for the vehicles.

- Separate bicycle lanes should not be provided due to the volume of traffic and lower speeds of vehicles.
- Pedestrian signals with countdowns should be provided.
- No bus stops should be provided in close proximity of the intersections, along with no separate left or right turning lanes.



Figure 3: Main Street Intersection Layout

Source : Complete Streets Planning and Design Guidelines

4.2 Boulevard Intersection

These intersections most frequently serve as arterial roads to transport cars at a moderate pace. They are characterized as a thoroughfare that has a street median and many lanes. Due to faster speeds and larger amounts of motor vehicle traffic, broad walkways with ample plantation on the edges and medians and separate lanes for bicycles are required to support various other users like pedestrians, cyclists, etc. [6] Additionally, building setbacks will often be deeper than on avenues. Shelters and transit stations could be positioned inside the right-of-way, necessitating connections to walkways.

Parking on the street is not necessary. It is permitted when appropriate, although because of the nature of the street, it is

uncommon. Parking, if offered, should normally be located on a distinct, parallel frontage roadway that is divided by a side median.

- Boulevards have a tendency to attract higher volumes of traffic at much higher speeds which can be dangerous for users like cyclists and pedestrians.
- Boulevards typically have left-turn lanes and they permit right turn lanes and right turn islands.
- Boulevards always have a median and more lanes than avenues.
- If the roadway has five or more lanes of traffic or the crossing distance is longer than 50 feet, include a refuge island in the pedestrian crossing.
- Numerous refuge islands should be proposed when the number of lanes are seven or more. The goal is to limit the distance that pedestrians must cross to five lanes or fifty feet. This distance is without the presence of a refuge island to minimize the distance.
- These intersections should carry cycling lanes through the intersection.
- These intersections permit bus stops on the far side of the intersection including high visibility crossings and introduce pedestrian countdown signals.



Figure 4: Boulevard Intersection Layout

Source : Complete Streets Planning and Design Guidelines

4.3 Avenue Intersection

They may serve as an arterial, collector, or local road in a rural area, although it typically moves at slow to moderate speeds. They act as an urban thoroughfare that carries a variety of traffic between and among different area types. Transit stations, shelters, and other facilities are positioned along the route, ideally inside the right of way. Wide walkways and on-street cycling facilities are present.

- These intersections normally do not have medians but they should be minimum 6 feet wide, if provided.
- The basic avenue design includes lavish islands for landscaping, pedestrian crossing possibilities.
- They are less likely to have distinct right-turn lanes than boulevards or parkways and have tighter intersection spacing.
- If the street is of four or lesser lanes then no refuge island is needed. However, if the pedestrian crossing distance exceeds 50 feet or the street is 5 lanes or more, then a refuge island is mandatory.
- They will include a "receiving" bicycle lane the other side of the intersection and carry bicycle lanes through the intersection.
- In order to allow for bus stops on the opposite side, zebra crossings, and countdown pedestrian signals, the bicycle lane should be deleted shortly before the actual crossing.
- Avenues could or might not be a part of the network of key highways.



Figure 5: Avenue Intersection Layout

Source : Complete Streets Planning and Design Guidelines

4.4 Parkway Intersection

They serve as arterial roads mostly to cater cars moving at medium to high speeds. Landscaping or uncultivated plants along the sides of the road and in the medians are frequent features of urban or rural thoroughfares. Land uses are often not oriented toward the parkway and are set back from the street. Parkway intersections provide easy access to transit stations, bus stops, and parking lots. Pedestrian and bicycle traffic are typically accommodated on separate multi-use.

- These intersections generally do not traverse the main streets.
- They might have multiple lanes along with a median.
- They will allow dual right and left turning lanes.
- They will include refuge islands if the street is wider than 7 lanes.
- They should provide pedestrian signals with countdowns along with high visibility crossings.



Figure 6: Parkway Intersection Layout

Source : Complete Streets Planning and Design Guidelines

4.5 Other Intersections

Other intersection types, apart from the signalized and unsignalized intersections, are necessary to design complete streets. These intersections should be built to represent the context as well as to be enhance the user experiences. These include table top crossings and other elements like refuge islands, zebra crossings green strips, medians that are necessary for supporting the pedestrians and cyclists. [7]

Providing roundabouts at other intersections can help increase the intersection crossing time for all the users. The huge volume of traffic can easily flow through the roundabout without any delay and chaos.

5. FINDINGS & CONCLUSIONS

While comparing all the intersections discussed, we clearly see that the medians are mandatory while designing Boulevards and Parkways. Main streets might never include medians while it is not necessary to include continuous medians in the avenues. The purpose of not providing continuous medians on avenues is to avoid long distance intersections and logical route options. If the hierarchy of roads is considered parkway and boulevard intersections might be located on the higher hierarchy of roads i.e, arterial roads or primary collector roads [5]. The secondary collector roads and local roads might include the main streets and avenues which carry vehicles at lower speeds.

We concur that by regulating access placement, design, spacing, and operation aims to build a safe street while incorporating different modes of transportation and providing easy access to all kinds of land uses. The focus might be on pedestrians and bicyclists but planning and designing complete intersections is inclusive and takes the need of all users into account, including the people of all ages and abilities. [8] [9] These guidelines to designing complete intersections will support the aim of providing convenient, safe and comfortable travel for all users.

ACKNOWLEDGEMENT

I would like to express my honest and deepest appreciation to **Prof. Shalini K. and Prof. Varsha Khetrpal**, who have constantly guided me, helped me structure my paper and with every difficulty with their utmost professionalism.

I would like to thank them for always having the attitude and the substance of a genius: they continually and convincingly conveyed a spirit of adventure regarding this paper and excitement regarding teaching. Without their guidance and persistent help, this paper would not have been possible.

REFERENCES

- [1] North Carolina Department of Transportation, "Complete Streets Planning and Design Guidelines," North Carolina Department of Transportation, 2012.
- [2] (NHTSA), National Highway Traffic Safety Administration, "Traffic Safety Facts," U.S. Department of Transportation, 2022.
- [3] N.C Department of Transportation, "National Pedestrian Safety Facts," May 2021. [Online]. Available: <https://oshr.nc.gov/facts-and-figures>.

- [4] J. E. B. J. T. P. H. S. T. Roy Cooper, "North Carolina 2020 Traffic Crash Facts," North Carolina Division of Motor Vehicles, 2021.
- [5] UTTIPEC, "Street Design Guidelines," UTTIPEC, 2009.
- [6] C. K. K. C. C. R. Hwan NamGung, "Research Progress of Road Intersection Design Analysis," *International Journal of Scientific Research in Science, Engineering and Technology*, vol. 7, no. 6, pp. 245-256, 2020.
- [7] M. A.-A. Ma'en Mohammad Ali Al-Omari, "Evaluation of a New Intersection Design, "Shifting Movements"," *Sage Journals*, vol. 2675, no. 10, 2021.
- [8] R. Rauf, "Complete Streets - A Case Study of Boulder, Colorado, and the Great Streets Initiative," Niehoff Studio, University of Cincinnati, Cincinnati, 2010.
- [9] T. Jagannath, "Pedestrianized Streets Create Important Public Spaces," *Interviews and Articles on Art & Public Spaces*, 17 October 2016.

BIOGRAPHIES



Vanshika Vashisht, Architect from USAP, GGSIP University, currently pursuing her Masters of Planning (Urban Planning), Sushant University, Gurugram. Her area of interest is to work for the better streets and better cities.



Prof. Shalini K., Bachelor's in Physical Planning and Master's in Urban Planning from School of Planning and Architecture - New Delhi. Research Associate with Centre for Policy Research (CPR) and Institute of Town and Country Planning, India (ITPI).



Prof. Varsha Khetrpal, Architect and Environmental Planner from SPA, New Delhi. Her area of research is on street planning and designing and its evaluation. She has almost 2 decades of experience in the field of architecture and planning, including academics and industry. She has published articles in various journals and conferences.