Traffic Engineering and Highway Safety Bulletin 12-02

Parking Lots and Garages

April 2012

Did You Know?

There are more than one-quarter billion vehicles within the United States. It is estimated that there are multiple parking spaces per vehicle. Therefore, there could easily be more than a billion parking spaces within the United States alone. Parking is the transitional activity between travel and a motorist's final destination. The lack of planned parking is often observed on military installations. This can result in wasted time, driver frustration, and increased crash potential, as well as an inefficient use of space.

In areas that are limited for space and lack sufficient parking, parking lots often exceed their capacity. When this occurs, people often park anywhere they can, which may include areas not intended for parking, as shown to the right.

If parking areas are not correctly marked, or if they lack markings, people may park randomly, which does not effectively use the available space (Exhibit 1).

Exhibit 1: Example of Random Parking

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Even when parking areas are correctly designed and marked, ensure markings are maintained for proper visibility. Faded markings have no effectiveness. Also, be sure that all signing is standard.

Parking Planning

In general, off-street parking is preferred over on-street parking due to lower crash rates. When planning a parking facility, consider the area and available distance to the facility it is intended to serve. If there is sufficient area available, surface parking is preferred due to its lower cost versus parking structures. Where land area is very limited, parking structures should be considered. Exhibit 2 shows rule-of-thumb costs for parking facilities.

Exhibit 2: Rule-of-Thumb Costs for Parking Facilities

Type	Construction Cost per Space	Cost per Square Foot
Surface Parking	$1500 to $3500	$5 to $10
Above ground Parking Garage	$10,000 to $20,000	$30 to $50

Source: Traffic Engineering Handbook, Chapter 14.

Walking Distance

When planning off-street parking, consider the distance between the parking area and the building it is intended to serve. Depending on the characteristic of the region as well as the facility it serves, this distance varies. Additionally, the parking duration influences the walking distance. Motorists parking for short-term expect to park closer than motorists parking for long-term. Work-related parking is typically considered long-term since it typically exceeds 6 to 8 hours. Retail-related parking is typically considered to be short-term.

Exhibit 3 shows common maximum walking distances between parking areas and the buildings they serve.

Exhibit 3: Common Walking Distances for Parking

Parking Characteristic	Average Walking Distance (feet)
Average, preferred for suburban areas	500
Long-term Parking in Central Business Districts	1000
Special or Sporting Event Parking	1500
Maximum	3000

Source: Traffic Engineering Handbook, Chapter 14.

What's Wrong With This Photo?

See page 10 for the answers.

Setbacks

Parking adjacent to buildings should be avoided to allow a buffer space for plantings and sidewalks. This space, or setback, should be a minimum of 20 feet between the parking area and adjacent buildings where force protection is not an issue. In addition, provide a minimum of 20 feet for the buffer strip separating the parking area from the street.

Force protection concerns often require a larger distance separating the parking area from an inhabited building. For parking within a controlled perimeter, which typically would include any installation that has entry control, the standoff distance requirements between a parking area and the building is 33 feet for an inhabited building, or 82 feet to a primary gathering building, billeting, or high occupancy family housing area. See Unified Facilities Criteria (UFC) 4-010-01 (9 Feb 12) *DoD Minimum Antiterrorism Standards for Buildings* for more information on standoff distances to parking areas.

Parking areas themselves are generally not considered to need standoff distance from other areas. For example, if a parking area is located adjacent to an installation perimeter fence, there is generally no need for standoff distance.

Parking Demand

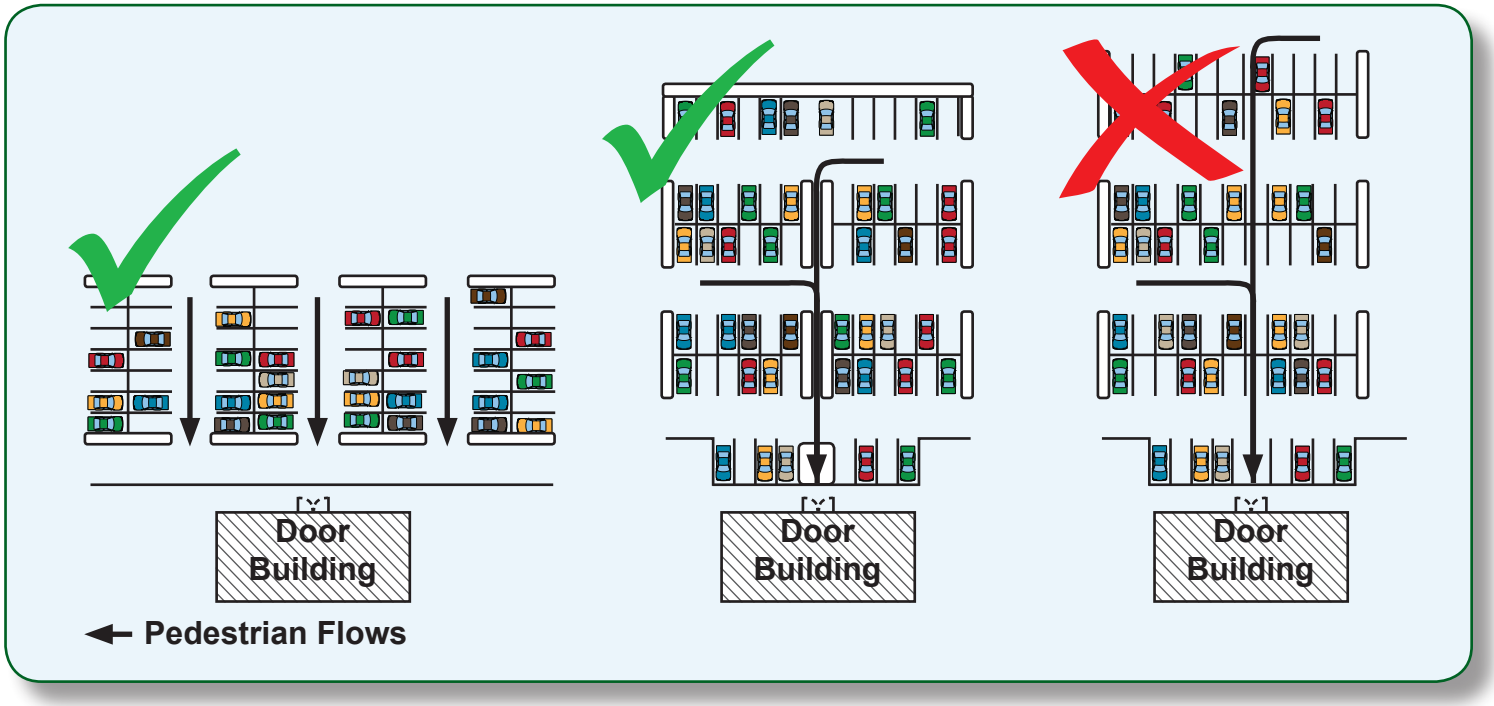
Future parking demand can be determined by using parking generation rates. A parking generation rate equates parking demand to a predictable characteristic, such as population, number of employees, or floor space. These rates have been developed for many types of facilities, and are published in Institute of Transportation Engineers' (ITE) *Parking Generation*, 2010.

For existing facilities, demand can be measured by performing a parking utilization study. This study compares the highest number of vehicles parked at each facility to the available parking supply. The survey should be conducted on a typical workday at 10:00 a.m. and again at 2:00 p.m. for long-term parking, and every 1 to 2 hours for short-term parking. Areas such as base/post exchanges and food courts should be surveyed during the lunch hour. Areas such as commissaries should be studied during peak shopping time periods, which may include weekends. As a general rule, short- and long-term parking areas should not be more than 85- and 90-percent full, respectively. If the parking utilization exceeds these figures, additional parking may be required.

Off-Street Surface Parking

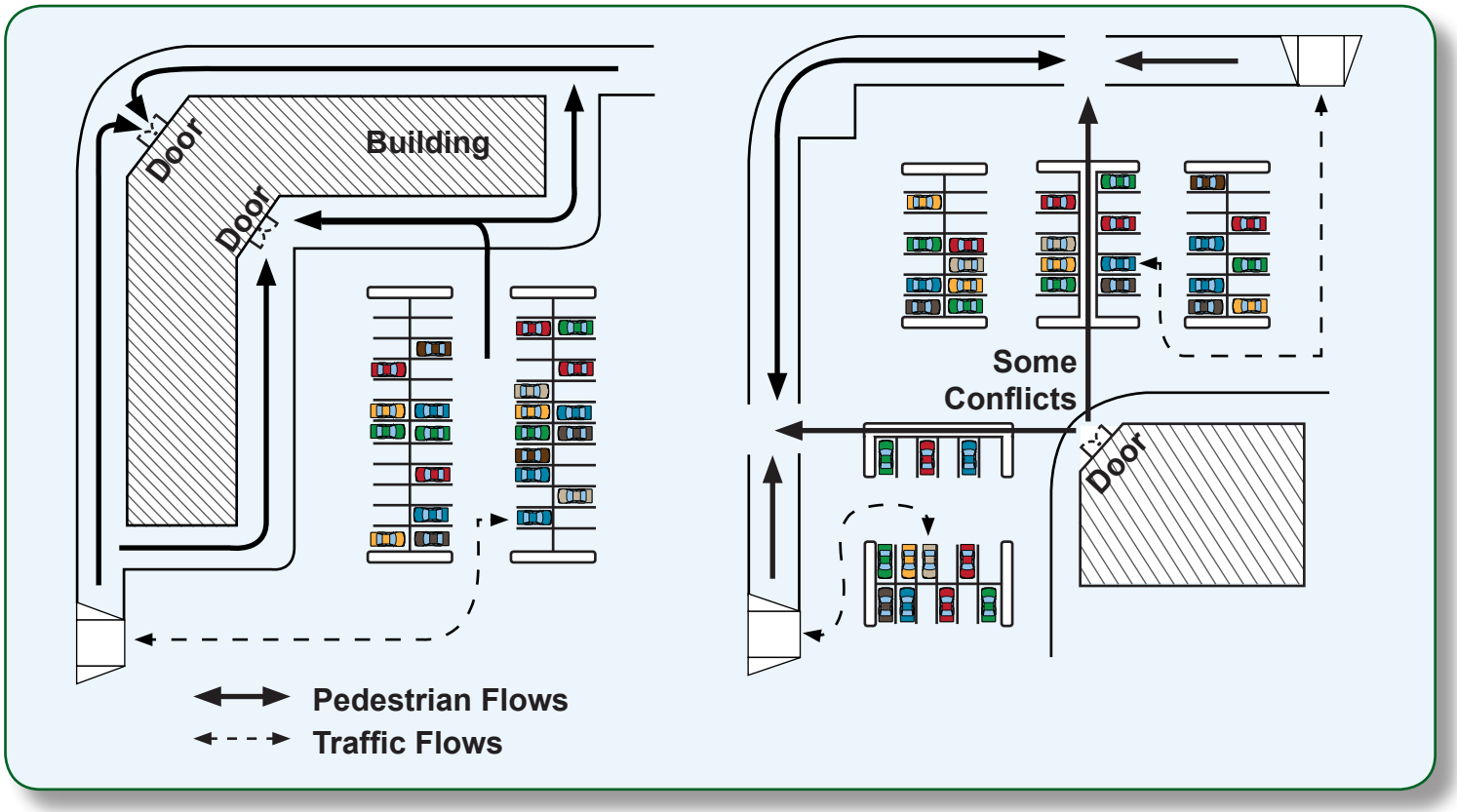
Certain design features can be incorporated into the design of off-street parking as it relates to the overall site. Parking facilities need to consider pedestrian traffic. Since pedestrians typically use the shortest path possible to their destination, pedestrian access through the parking area must be considered. When possible, align the parking aisles to provide the shortest desired walking lines to the front doors of the buildings (Exhibit 4). Where possible, align the parking to avoid pedestrians having to walk through bays of parked cars to reach a building destination.

Exhibit 4: Parking Aisle Configuration Relationship to Land Use



Because some land-use trips access a facility by modes other than motor vehicles, designing parking to balance access to the land is important. Orienting the building, building doorways, and parking such that the land use has a short, convenient walking route to adjacent streets; and sidewalks such that there are minimal conflict points with vehicular traffic is important for nearly all land uses (Exhibit 5).

Exhibit 5: Parking Relationship to Building Orientation



Access Point Location

Factors such as pedestrians, traffic control, turning restrictions, and traffic volumes will affect the design of parking facilities, particularly the location of entry and exit points. As shown in Exhibit 6, a minimum driveway turning radius of 20 feet is recommended. A driveway width of 25 feet is recommended for two-way traffic flow. Also, to minimize queuing between an intersection and driveway, try to locate driveways at least 200 feet from intersections, particularly for larger traffic generators. A qualified engineer should determine the exact spacing and location of access points.The number of access points needed for a parking facility depends on the number of parking spaces, characteristic of usage, and the operations with respect to the adjacent street. As a general rule of thumb, one access point can serve approximately 500 parking spaces. If the users of the parking facility all tend to enter and leave at approximately the same time, and if the adjacent roadway is relatively busy delaying traffic turning out of the access onto the roadway, then additional access points or intersection improvements may be needed. Contact SDDCTEA for additional assistance.

When designing the access point, pay particular attention to queuing, specifically these two cases:

- ✔ For exiting traffic, queues extending from the intersection of the access point with the external roadway should not extend to an internal intersection within the parking lot.
- ✔ For entering traffic, queues extending through the first internal intersection should not extend to the external roadway, thereby affecting traffic not destined for the parking area.

Exhibit 6: Preferred Parking Lot Dimensions

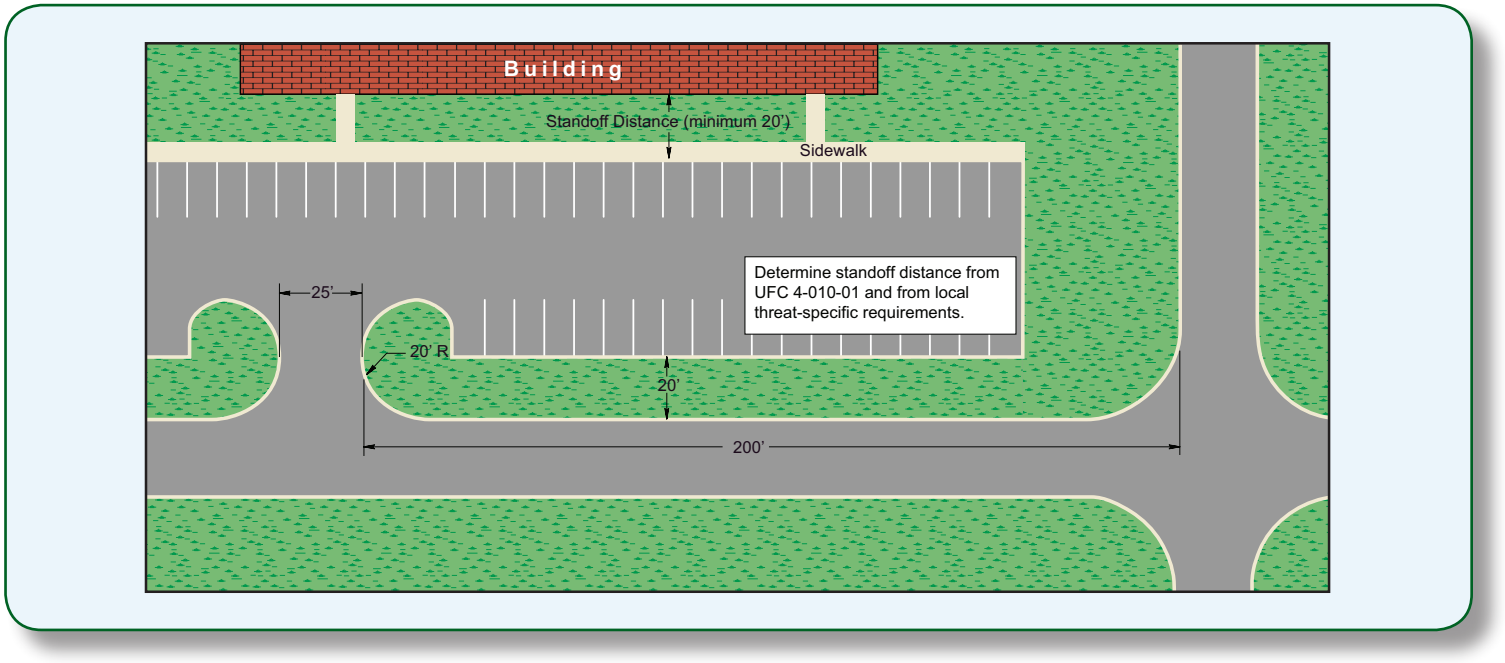


Exhibit 7: Common Parking Facility Signs

Sign	MUTCD No.	Title	Size* (inches)
Regulatory Signs			
	R1-1	Stop	18
	R1-2	Yield	18
	R1-5	Yield Here to Pedestrians	18
	R1-6	In-Street Pedestrian Crossing	12x36
	R2-1	Speed Limit	18x24
	R3-1/ R3-2	Turn Prohibition	24
	R5-1	Do Not Enter**	24
	R6-1	One Way	36x12 18x24
	R7-2a	No Parking, Time Limits	12x18

Sign	MUTCD No.	Title	Size* (inches)
Regulatory Signs (continued)			
	R7-8	Accessible Parking	12x18
	R7-8	Van Accessible	12x6
	R8-3	No Parking	12
Warning Signs			
	W1-6/ W1-7	Large Arrow (left, right, or both ways)	24x12
	W4-4	Cross Traffic Does Not Stop	24x12
	W8-1	Bump	18
	W11-2	Pedestrian	18
	W12-2	Low Clearance***	48x12
	W14-2a	No Outlet	36x8

** This is the smallest standard size for reference to match slow-speed parking design applications.*
***24 inches may be appropriate in parking facilities (30 inches shown in sign book).*
**** 12 inches may be appropriate in parking facilites (84x24 inches shown in sign book).*

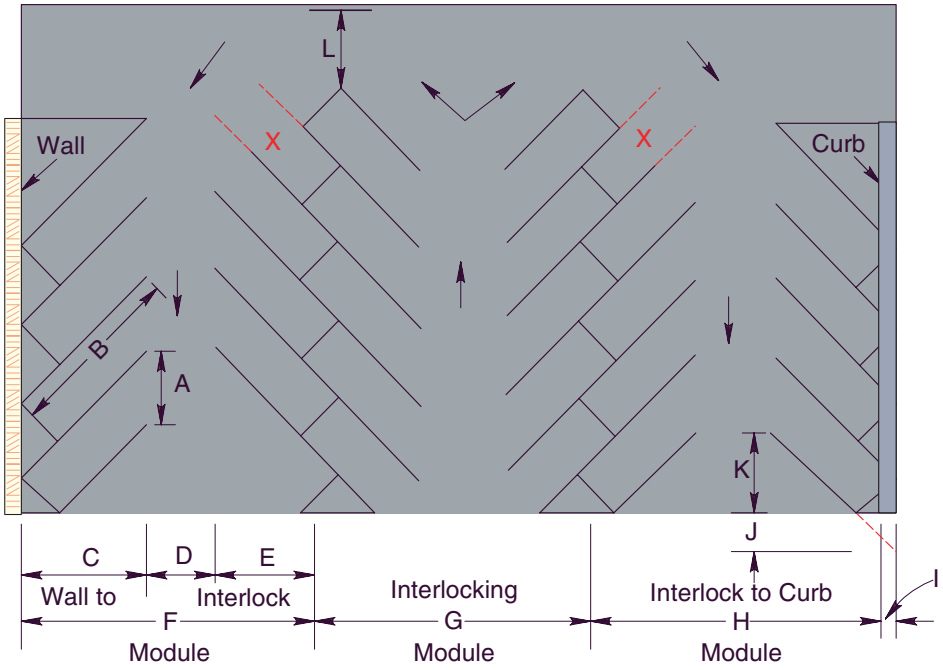
When designing access points to parking lots, be sure to use the same design standards for signing and pavement markings as are used for adjacent roadways. Common signs for parking facilities are shown in Exhibit 7.

Parking Stall Layout

Ideally, parking lots should be rectangular with parking on both sides of access aisles. For two-way traffic flow, parking spaces perpendicular (90 degrees) to the aisles provide the most efficient design. The efficiency decreases as the parking angle decreases. Where a fast turnover rate is expected or where site limitations dictate, 60-degree or 45-degree angle parking with one-way aisles may be used. However, the advantage of easy pull-in and pull-out that angle parking provides is often offset by the inconvenience of one-way aisles, and the tendency of motorists to attempt to pull into a space from the wrong direction. Exhibit 8 provides stall layout dimensions for various parking angles.

Site dimensions, topography, and vehicle type affect the design of parking lots. As a general rule, about 300 square feet is required per parking space to account for traffic aisles, space between adjacent cars, and entrance and exit lanes.

Exhibit 8: Stall Layout Dimensions



X = Stall not accessible in certain layouts

Parking layout dimension (in feet) for 9 ft. stalls at various angles

Dimension	On Diagram	Angle			
		45°	60°	75°	90°
Stall width, parallel to aisle	A	12.7	10.4	9.3	9.0
Stall length of line	B	27.5	23.7	20.9	18.5
Stall depth to wall	C	19.5	20.5	20.0	18.5
Aisle width between stall lines	D	12.0	16.0	23.0	26.0
Stall depth, interlock	E	16.5	18.5	18.5	18.5
Module, wall to interlock	F	48.0	55.0	62.0	63.0
Module, interlocking	G	45.0	53.0	61.0	63.0
Module interlock to curb face	H	46.0	53.2	59.5	60.5
Bumper overhang (typical)	I	2.0	2.3	2.5	2.5
Offset	J	6.4	2.6	0.6	0.0
Setback	K	13.1	9.3	4.8	0.0
Cross aisle, one-way	-	14.0	14.0	14.0	14.0
Cross aisle, two-way	L	24.0	24.0	24.0	24.0

Additional Design Considerations

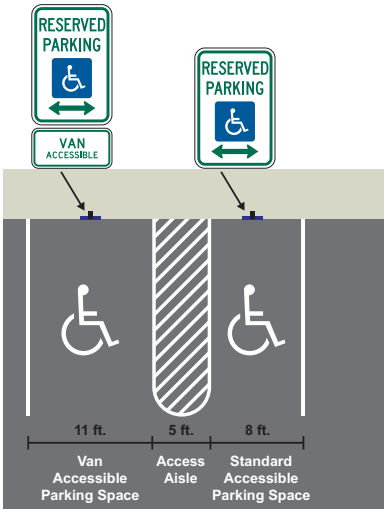
Exhibit 9 shows additional design considerations for surface parking.

Exhibit 9: Other Off-Street Parking Design Considerations

Accessible Parking

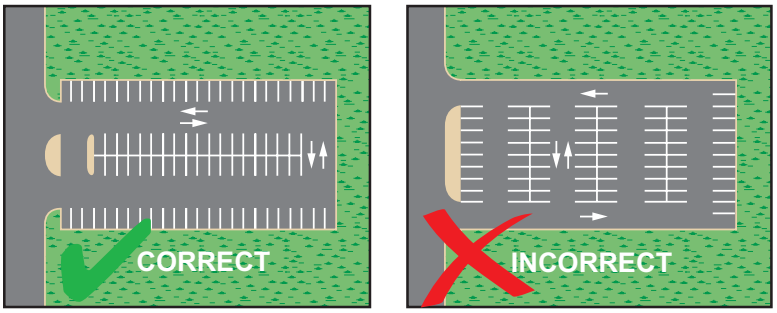
Both the Americans with Disabilities Act and Architectural Barriers Act require that a certain number of parking spaces be set aside for accessible parking. Generally, this amounts to about 4 percent of the total number of spaces within a lot for the first 100 spaces; 3 percent for 101-200 spaces; and 2 percent for 200 or more spaces. Medical facilities require additional accessible parking.

Accessible spaces should be located immediately adjacent to the nearest building entrance; or in the case of a remote parking lot or garage, the location where pedestrians exit. Provide a 60-inch access aisle and a ramp. Display the wheelchair symbol on a signpost at the head of the stall.



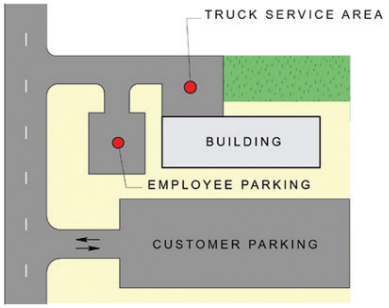
Aisles

Provide aisles parallel to the long side of the lot with cross aisles every 30 spaces in large parking areas. This layout results in a 20 percent increase in lot capacity compared to aisles oriented parallel to the short side of the lot.



Employee Parking

The employee parking lot for a facility should be separate from the main parking lot. Providing a separate lot helps to avoid a mixture of all-day parking with short-term customer parking.



SEPARATE PARKING AREAS

Pavement Markings

Per the *Manual on Uniform Traffic Control Devices* (*MUTCD)*, with exception for accessible parking which may be blue, white is required for marking stall lines. All lines should be 4 inches wide. (*MUTCD* 3B 19.03).

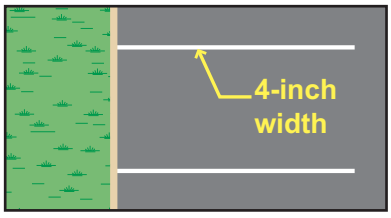


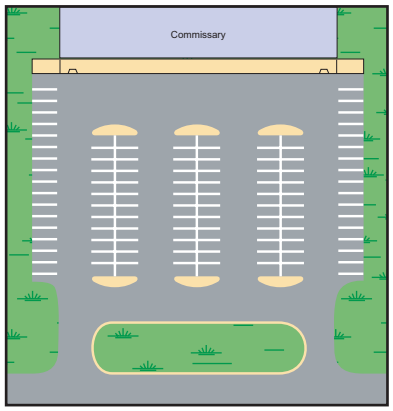
Exhibit 9: Other Off-Street Parking Design Considerations (continued)

Entrances and Exits

Design entrances and exits to serve as a continuation of traffic aisles. Avoid sharp turns whenever possible. Another good practice is to prohibit stalls so close to the entry/exit point that parking maneuvers would obstruct traffic flow.

Rows

Parking rows should be perpendicular to buildings for the safety and convenience of pedestrians; however, perpendicular rows less than 130 feet long are not practical. In this case, rows parallel to the front of buildings are recommended.



Wheelstops

Wheelstops are often used along the site boundaries of uncurbed lots, where large landscaped areas extend beyond the edge of pavement. Wheelstops in the interior of a parking lot have a few disadvantages: they may hinder people walking between cars; they are often a hazard when hidden from view by parked cars; they tend to trap blowing debris; and they adversely impact snow removal.

Surface Treatment

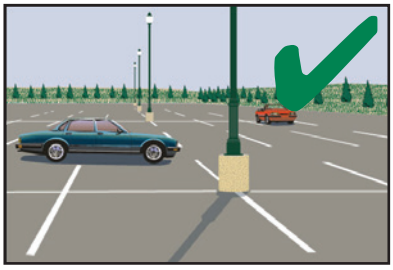
Paved parking areas are desirable for many reasons including controlling drainage, reducing mud and dust, improving walking surfaces, reducing maintenance costs, and providing a pleasing appearance. Paved parking lots should be marked to provide safe, efficient, and enforceable parking lot operations.

Maintenance

For good visibility, repaint markings as needed, and replace old signs. Clean light fixtures at least annually, and replace bulbs before burnouts occur. A properly designed lot is great, but a good maintenance plan is necessary to keep it that way.

Lighting

Locate parking lot light fixtures away from traffic aisles and parking stalls. Light poles are ideally located in center or side islands, and protected by raised curbs. When light poles are within parking rows, locate the poles at the junctions of adjacent stalls as shown. Mounting height and spacing of luminaires should be sufficient to distribute the desired lighting intensity to the entire parking area.



Parking Garages

Parking garages are often used where there is a considerable demand for parking with a significantly low amount of available space. Parking garages can provide the same amount of parking spaces while using only a fraction of land when compared to surface lots.

The primary drawback to parking garages is the cost. Parking garages often cost an average of $15,000 per parking space. Therefore, parking garages are often not the first alternative when running out of available space for parking. When there is no space available for parking, consider possible alternatives:

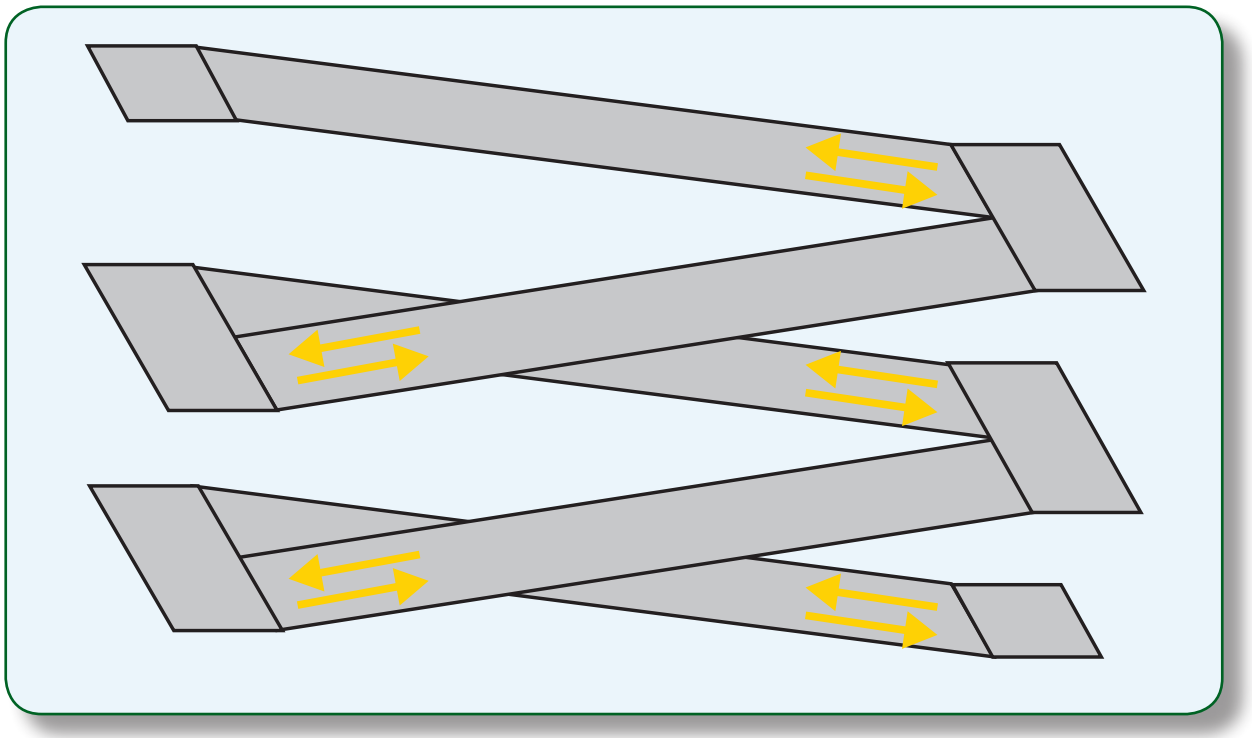
- ✔ Implement a shuttle system. Parking for buildings can be located at a location farther away from the building it serves, and a shuttle can transport people to and from their buildings.
- ✔ When planning the location of a building, if there is no available space for parking, consider relocating it to a more open area where there is plenty of available land for the building and its parking area.
- ✔ Utilize demand management strategies to reduce parking demand. Encourage the use of public transportation, carpooling, or working from home.

When these alternatives are not viable, a parking garage may be your best solution.

When planning a parking garage, keep access points spaced a minimum of 100 feet apart. This will maximize the available space between the access and the adjacent street. Exits should be located on low volume streets to reduce delay to traffic leaving the garage. The most common circulation pattern used in the United States is the continuous ramp (Exhibit 10), where sloping floors with aisles and parking spaces along both sides of the aisle provide access to the parking spaces themselves and the garage's circulation route. If stairs are the only means of pedestrians changing floors in the garage, as would typically be if there are only two to three floors, at least one stairway should be provided facing major destinations. Generally, one elevator serving a parking garage should be provided for every 250 spaces when the garage is multilevel.

Standoff distance for parking garages is not considered to be needed since they are not considered to be inhabited. Standoff distance is needed between the parking garage and inhabited buildings.

Exhibit 10: Continuous Ramp – Two-Way Traffic



Answers from Page 3

- ✔ This photo shows head-in parking off of a through roadway. Head-in parking is not desirable because traffic backs out into the roadway. Compared to angle or parallel parking, this style of parking is worse since vehicles can back out and try to turn either direction.
- ✔ This scenario shows a lack of sufficient parking since people are parking in undesirable locations.
- ✔ There are no parking space markings.
- ✔ Although the railroad track appears to no longer be used, parking over unused railroad tracks can lead to tripping hazards.
- ✔ Without pavement markings and curbstops, vehicles do not park in line with each other. This randomness can be hazardous to pedestrians who may not be seen and could be struck as a vehicle is parking, particularly if they are hidden by a larger vehicle.

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OFFICIAL BUSINESS

Reference List

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- ✔ UFC 3-210-02, POV Site Circulation and Parking, 2004 with changes through 2010
- ✔ *Traffic Engineering Handbook, 6th Edition*, Institute of Transportation Engineers, 2009
- ✔ *Dimensions of Parking, Fourth Edition*, Urban Land Institute, 2000.
- ✔ *Parking Generation, 3rd Edition*, Institute of Transportation Engineers, 2004.

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