



14.2 PARKING DESIGN CONSIDERATIONS

Aesthetically pleasing and functional parking areas that fulfill the needs and requirements of the users should be the primary goal of the designer. A well-defined design process will greatly increase the probability of creating parking areas that satisfy this goal. This chapter will address the following factors of parking area design:

- **14.2.1 NEEDS ANALYSIS**
 - **14.2.2 PHYSICAL REQUIREMENTS**
 - **14.2.3 AESTHETICS AND SAFETY**
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14.2.1 NEEDS ANALYSIS

Air Force Handbook, 32-1084 provides criteria for parking associated with facility types. An excerpt of the handbook is provided in the Appendix for the designer's convenience. Commanders and managers who plan, program, review, certify, and approve Air Force projects should use the handbook as a guide.

Parking study

In determining needs for a specific facility, the designer must perform a comprehensive and detailed analysis. Often part of a larger transportation plan, a parking study can be a valuable analytical tool. A parking study can inventory existing parking areas, spaces, and their use to determine the adequacy and efficiency of current configurations. These studies can be used to determine deficiencies in the total number of spaces and how long the spaces are being occupied. The parking study may be used as the basis for recommending additional spaces as well as altering configuration or circulation patterns.

The parking study may include the following items:

- Inventory of total parking spaces within a specific area
- Analysis of specific problems such as poor location or deficiency of visitor or reserved parking areas and employee parking
- Determination of parking duration and turnover rates
- Identifying access difficulties and poor pavement or plant material condition

- Refuse collection or service access requirements

Parking requirement factors

Overall parking requirements can be influenced based on the following:

- Collocation of compatible facilities to use common parking areas
 - Reducing vehicle use through encouraging use of alternative transportation methods
 - Providing safe and attractively landscaped bike paths and walkways
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14.2.2 PHYSICAL REQUIREMENTS

- **Siting**
- [Miscellaneous](#)
- [Parking Area Types](#)
- [Geometry](#)
- [Access](#)
- [Maintenance](#)

Siting

To most people, the ideal parking space is a few steps from their home or office door. The designer must look at a number of concerns to logically, efficiently, and economically site parking areas. Some of these include:

- Minimizing excessive grading operations and balancing cut and fill
- Integrating adequate parking spaces with surrounding facilities and existing circulation patterns
- Locating parking areas convenient to building entrances
- Using topography and trees to mitigate negative visual impacts
- Separating customer and employee parking areas
- Preserving sight lines to entries and significant landscape and architectural features
- Minimizing negative impacts to the natural environment such as unnecessarily removing mature vegetation or degrading soil stability
- Preserving and integrating existing mature trees in future parking

Orientation

To create safe and convenient parking areas, the orientation and configuration of the parking area must be considered early in the siting process.

- Align rows of parking spaces perpendicular to the facility minimizing the number of pedestrian aisle crossings
- Provide access points and crosswalks from parking areas to facility entries

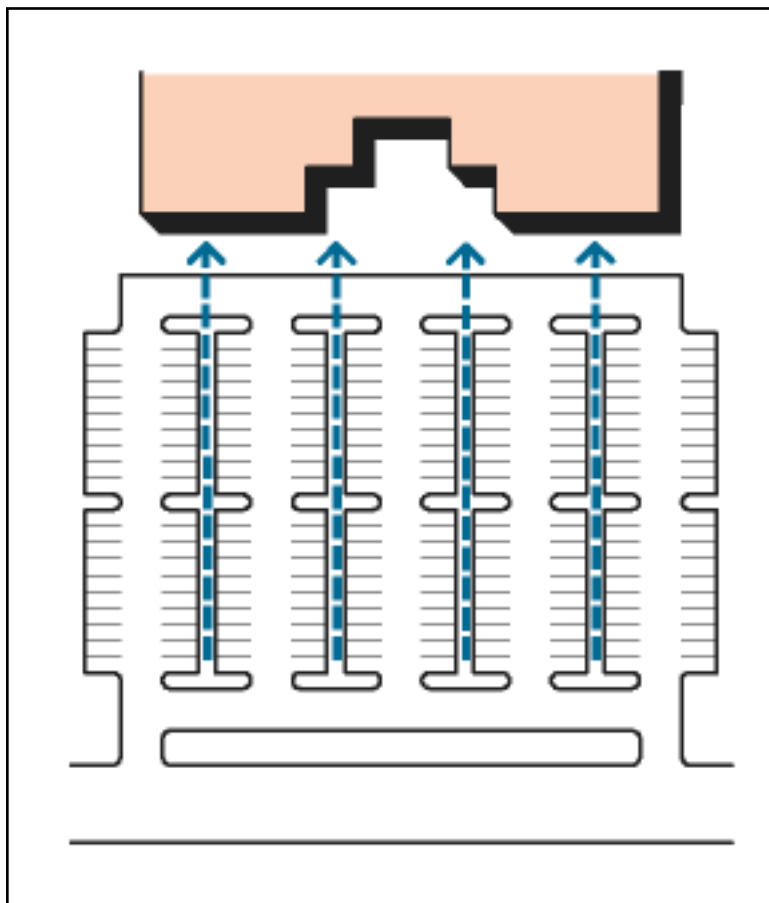


Figure 14-1a: Orient Parking Bays Perpendicular to Facility



Figure 14-1b: Orient Parking Bays Perpendicular to Facility

User walking distance

Long term users, such as employees, will generally accept longer walking distances from parking areas to their workplace. Short term users such as customers or visitors expect shorter walking distances. Parking spaces for a specific facility should not be more than 75 meters from the facility entrance.

Miscellaneous

General planning and design

Some common parking area planning and design guidelines are:

- Use 36 square meters per vehicle (includes entry, circulation, and parking spaces) as a typical planning and cost estimating factor
- Minimize parking area entrance and exit curb cuts
- Locate separate visitor and reserved parking at the front entry of the facility
- Eliminate dead-end parking areas
- Locate entrances and exits away from busy intersections
- Locate aisles and rows of parking parallel to the long dimension of the site with parking on each side of an aisle
- Use rectangular parking areas to minimize land area requirement

Setbacks

The designer should observe proper setbacks in designing parking areas:

Suggested Parking Area Setbacks

From	To	Minimum Distance (Meters)
Parking area curbing	Facility walls	6
Parking area entrances & exits	Roadway intersections	15-45
Parking area curbing	Perimeter screen walls	1.5
Parking area perimeter	Parallel roadway	6
Parking area curbing	Outside edge of adjoining walkways	2

Grading and drainage

Parking areas must be properly sloped and drained to take care of runoff. Apply the following

minimums:

- Ideal slope for all parking area pavements is 2%
- Longitudinal pavement slope should be between 1%-5%
- Pavement cross slope should be between 1%-10%
- Storm water should be collected on the perimeter of parking areas with a minimum of 2% slope along concrete curb and gutter

Curve radii

The radius of a parking area entry or exit curb return should be at least 4 meters. When significant use by buses or tractor trailers is expected, the radius should be increased to 13 meters. Interior radii for perimeter curbing and islands can be reduced to 2 meters. Care should be taken to provide an inside turning radius of at least 4 meters on all internal vehicle circulation aisles.

Islands

Curbed or painted non-parking zones inside a parking area are referred to as islands. They can increase safety and aesthetics and control circulation. Ideally, islands are curbed. They should be at least 2.5 meters wide if trees are to be planted.

Islands can be created using reflective striping or paint on the pavement surface. Painted islands do not provide a physical barrier to vehicle circulation. Plants should not be installed without curbed islands for protection.

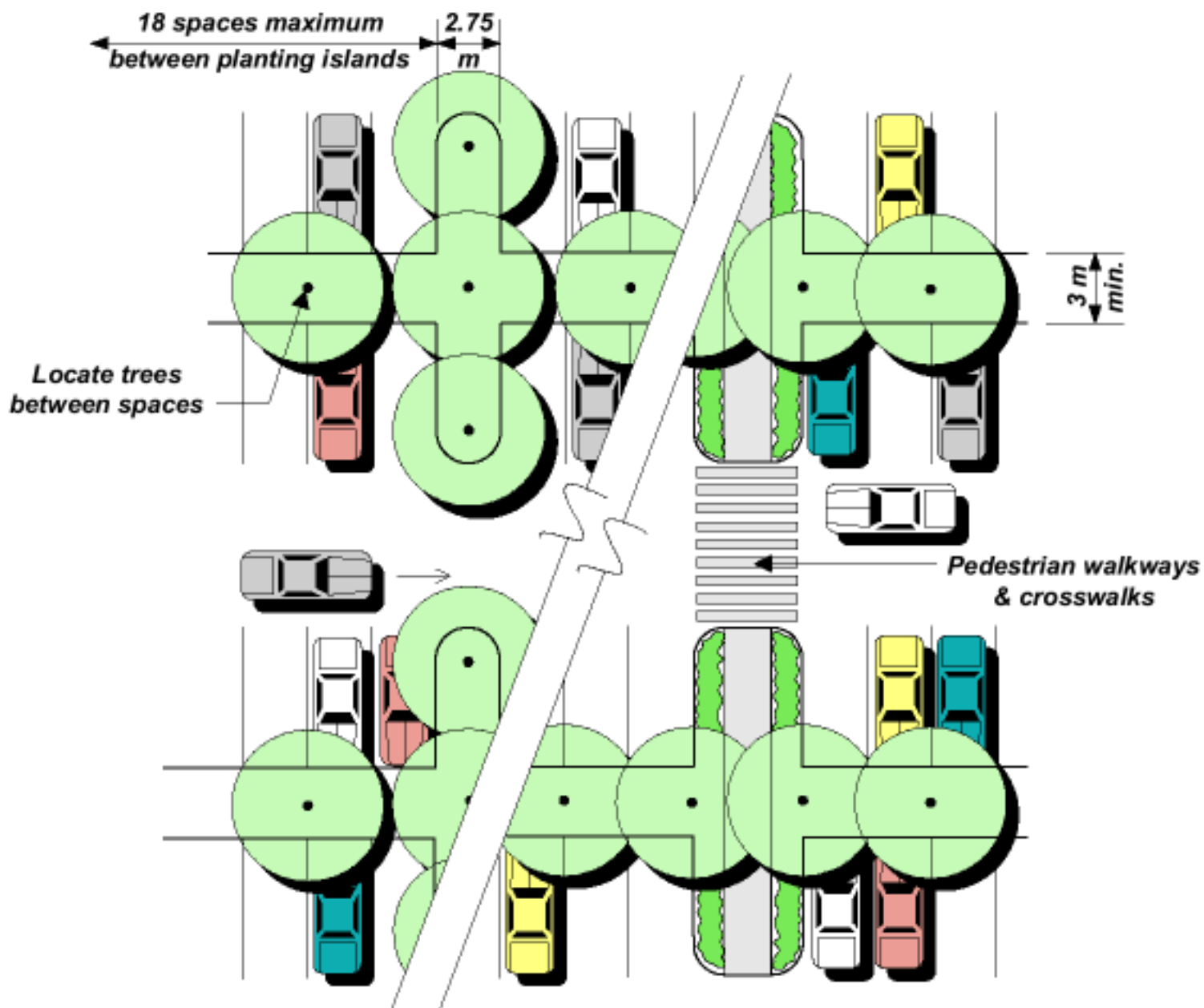


Figure 14-2a: Planting Islands and Pedestrian Paving

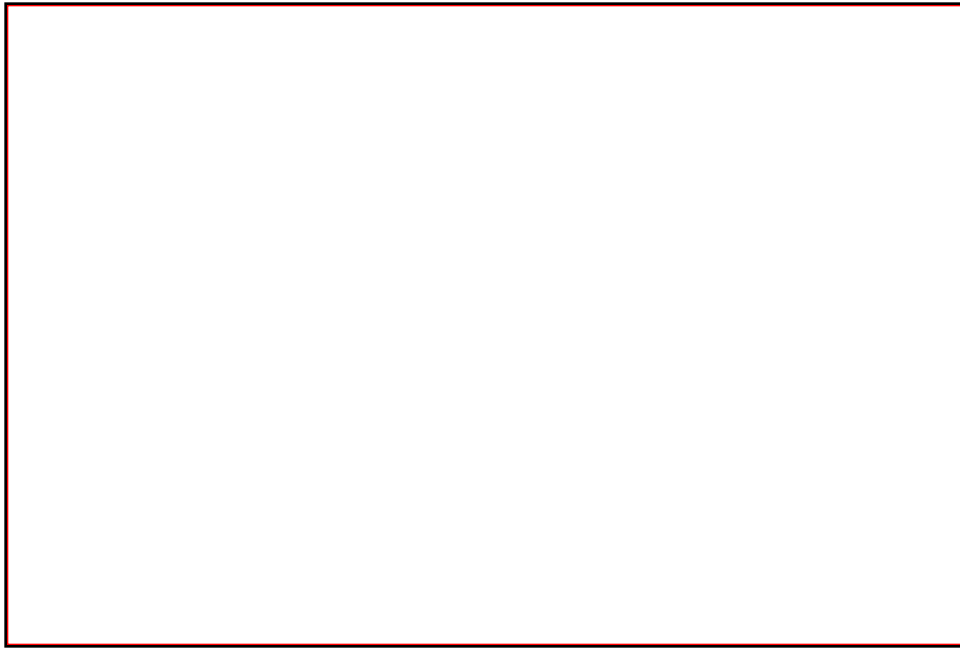


Figure 14-2b: Example of Pedestrian Paving in a Parking Island

Parking Area Types

Off-street

Off-street parking is the most common and accepted method of satisfying facility parking needs. In many cases, these areas are developed as one large mass parking area. The result is often an installation dotted with huge expanses of asphalt with little consideration of the negative visual impacts. When siting off-street parking areas, the designer should consider:

- Creating multiple smaller parking areas rather than one large mass
- Integrating planted islands to increase aesthetics
- Minimize extensive grading operations by designing to the topography
- Ensuring a distance of at least 15 meters is provided from proposed parking area entrances and exits to intersections
- Minimizing the number of entrances and exits

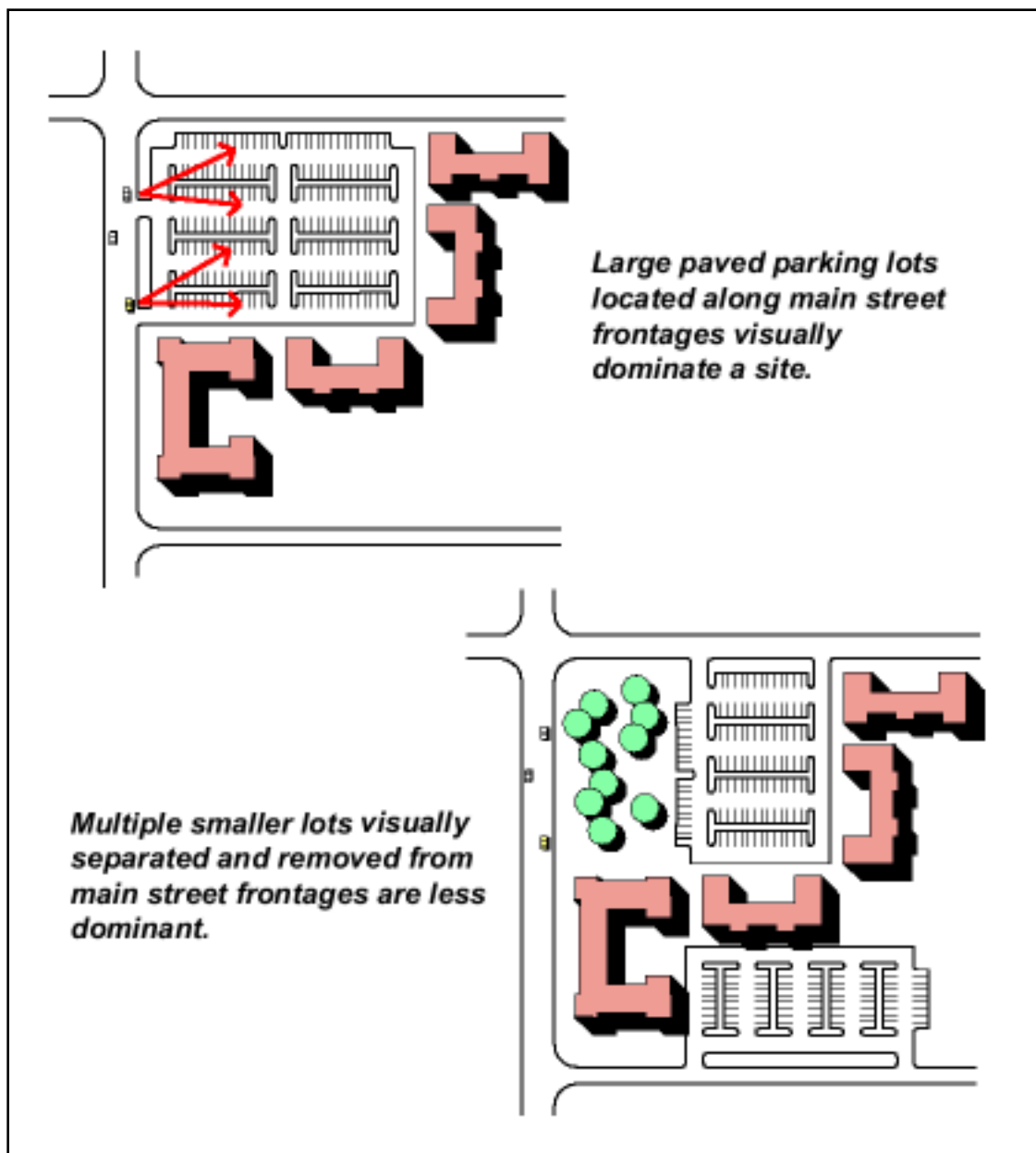


Figure 14-3: Multiple Smaller Parking Areas

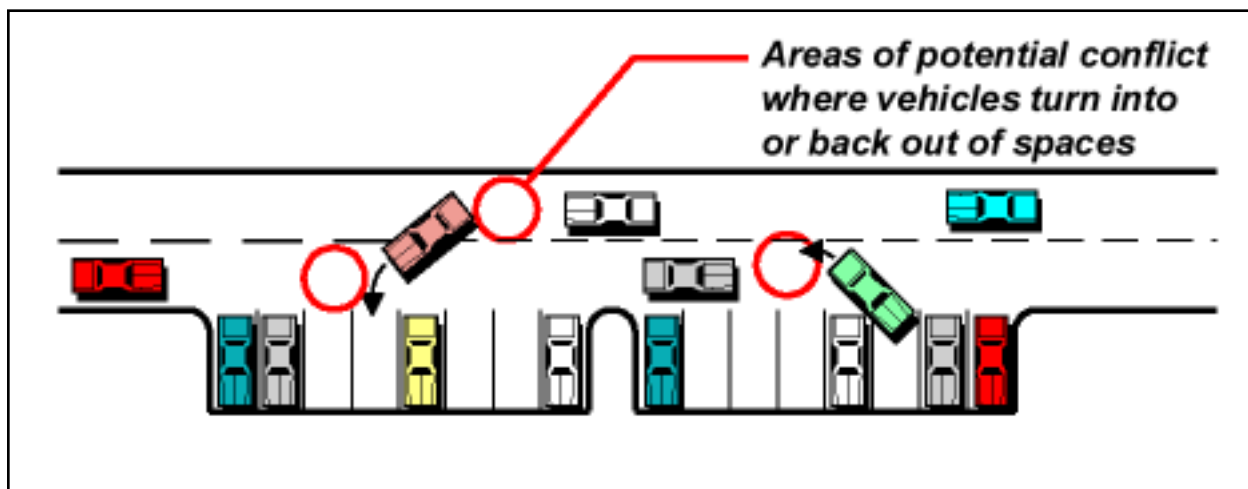


Figure 14-4: Avoid On-street Perpendicular Parking

On-street

According to Air Force Handbook, 32-1084, the Department of Defense does not support constructing streets that include on-street parking. Many installations however, are using existing streets to accommodate their parking needs this way. If on-street parking is used, the following factors must be considered:

- Permit only parallel parking
- Maintain a minimum distance of 15 meters from on-street parking spaces to intersections and off-street parking area entrances
- Break up long lines of vehicles with occasional planting island projections if appropriate
- Ensure streets maintain required traffic-carrying capacities and provide safe vehicular and pedestrian passage

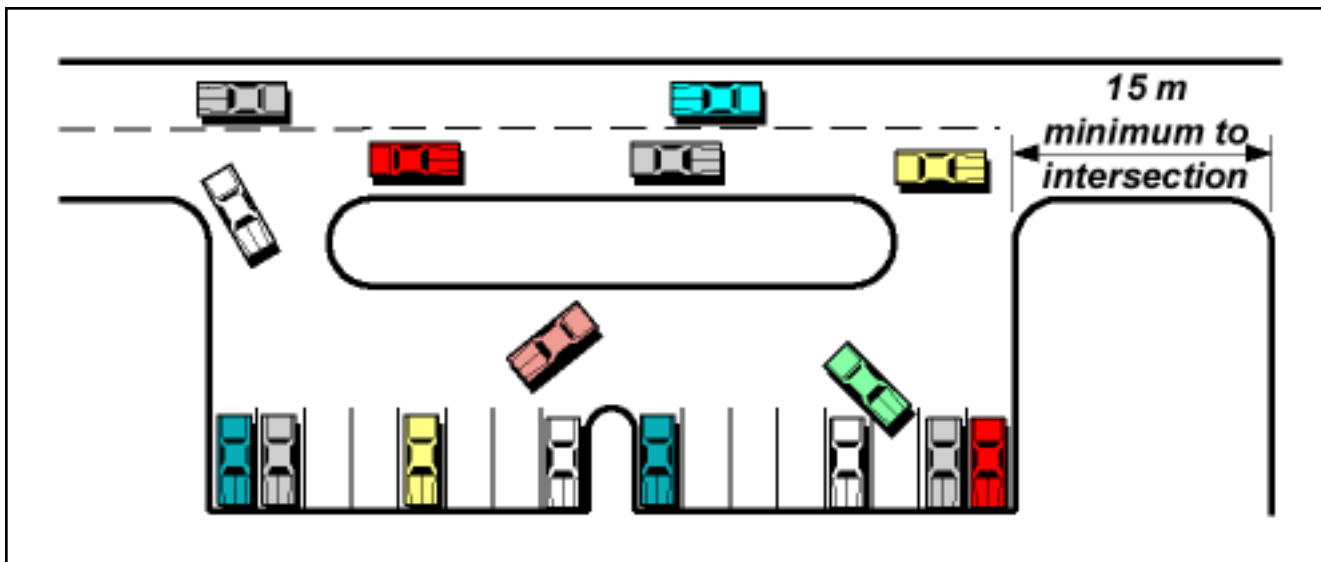


Figure 14-5: Off-street Perpendicular Parking

Geometry

Parking areas take on many configurations. Parking spaces may be parallel, perpendicular, or angled (30, 45, or 60 degree) to the driving lane, or aisle. A common factor among these various parking layouts is the size of the parking space. The minimum standard automobile parking space should be 6 meters long and 2.75 meters wide. Aisle widths vary based on the angle chosen and if they are one- or two-way. Two-way aisles should be a minimum of 7 meters wide.

The area required by each parking configuration will vary. As a general rule of thumb, the closer to perpendicular, the more vehicles can be parked per linear meter. Perpendicular, or 90 degree parking, accommodates 82 vehicles per 100 linear meters versus just less than 40 vehicles for 30 degree. A

summary of the dimensions and attributes of the parking area configurations is provided in the Appendix. Some of the advantages and disadvantages of the various parking configurations are addressed in the following paragraphs.

Parallel

For the designer, the parallel parking configuration can be used where suitable off-street parking cannot be accommodated or is not practical. For the driver, parallel parking requires experience, confidence, and patience.

Parking spaces should be a minimum of 7.5 meters long and at least 2.75 meters wide. On-street parallel parking spaces should be 3.35 meters wide.

Advantages

- Works well in extremely narrow, linear spaces
- Requires minimum pavement area

Disadvantages

- Difficult maneuvering for most drivers
- Less than ideal visibility of adjacent traffic
- Inefficient use of on-street space

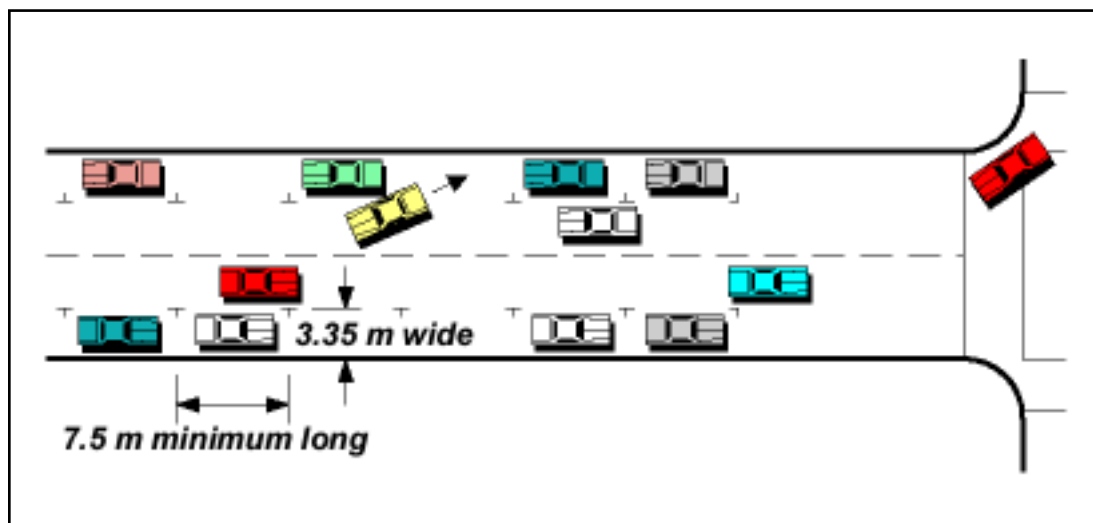


Figure 14-6: On-street Parallel Parking

Perpendicular

Especially effective in low turnover rate or long term parking areas, the perpendicular, or 90 degree

parking configuration is the most efficient and economical since it accommodates the most vehicles per linear meter. Standard dimensions for this configuration are:

Description	Dimension
Parking space width	2.75 meters
Parking space length	6 meters
Driving aisle width (2-way)	7 meters
Two rows plus aisle width	19 meters
Vehicles per 100 linear meter double row	82

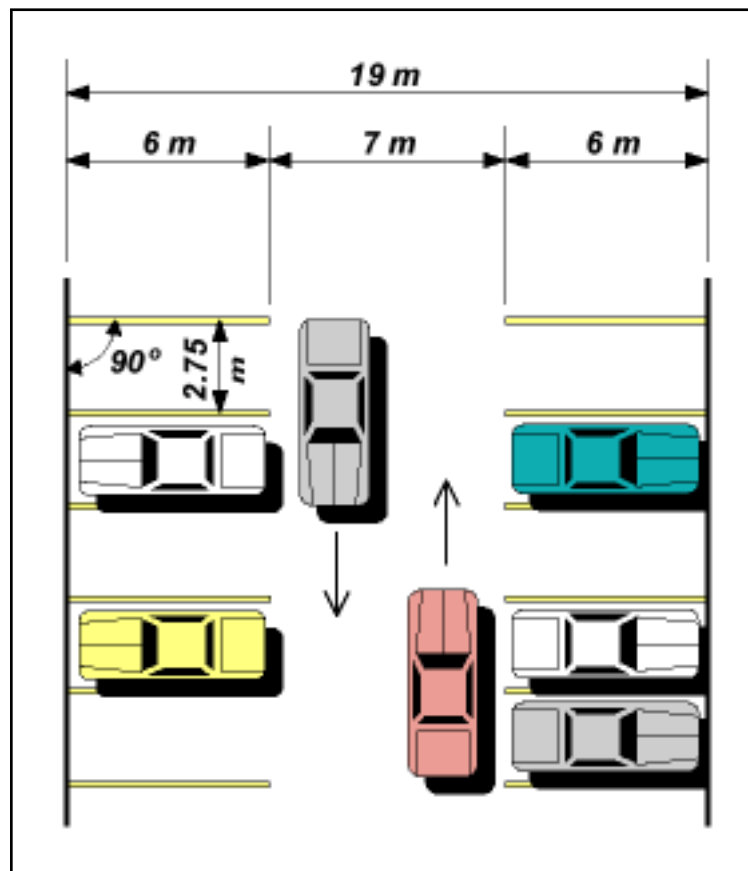


Figure 14-7: 90 Degree Parking Dimensions and Geometry

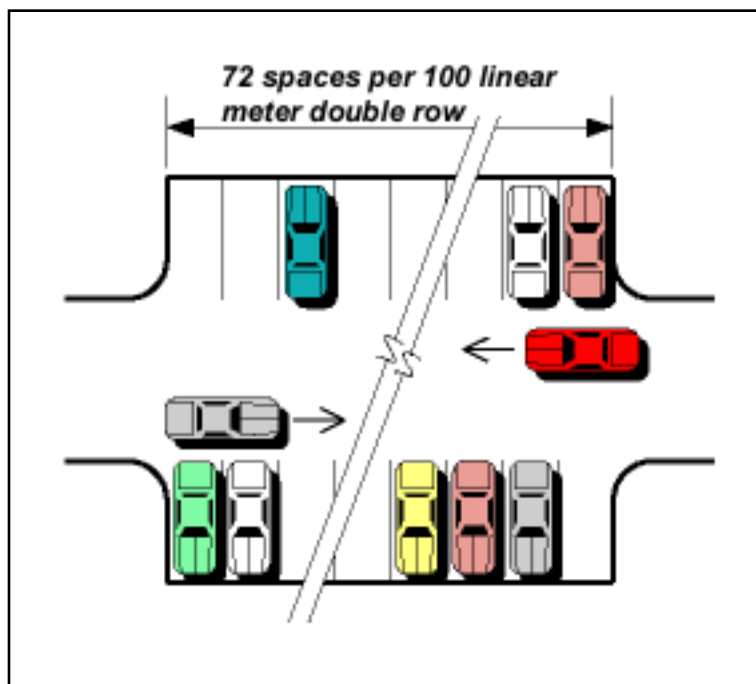


Figure 14-8: 90 Degree Parking Pattern

Advantages

- Works well with either one- or two-way aisles
- Handles the most vehicles per square meter of pavement
- Handles most vehicles per linear meter

Disadvantages

- Requires widest area
- Difficult maneuvering for some drivers
- Two-way traffic can create some visibility problems

Angled - 60 Degree

This parking area configuration is ideal for a fast turnover rate or predominantly short term use. This is often offset by difficulties of inefficient circulation patterns and one-way aisles. Standard dimensions for this configuration are:

Description	Dimension
Parking space width	2.75 meters
Parking space length	6 meters
Driving aisle width (1-way)	5.5 meters

Two rows plus aisle width	16.5 meters
Vehicles per 100 linear meter double row	65.6

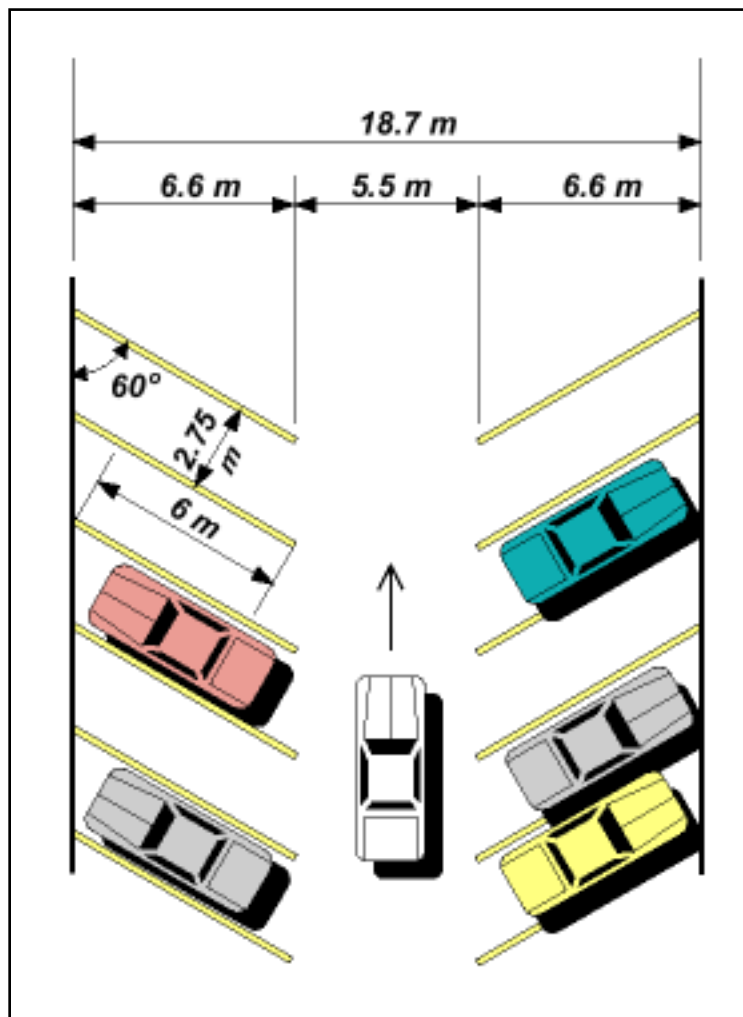


Figure 14-9: 60 Degree Parking Dimensions and Geometry

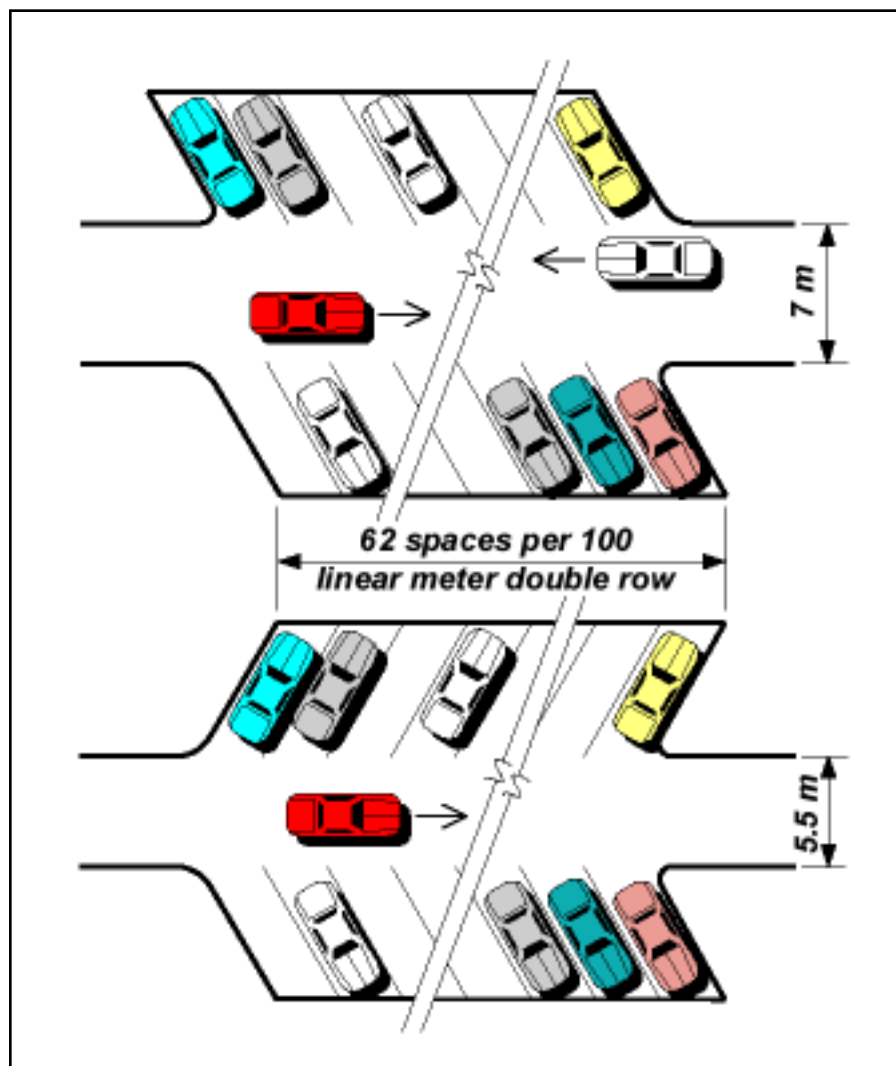


Figure 14-10: 60 Degree Parking One-way and Two-way Patterns

Advantages

- Easy maneuvering in and out of parking spaces
- Good visibility
- Lends itself to either one-or two-way aisles
- Most common short term parking configuration

Disadvantages

- Requires more pavement per vehicle than perpendicular configuration
- Handles less vehicles per linear meter

Angled - 45 Degree

The 45 degree angled parking configuration displays similar benefits and limitations as the 60 degree. Standard dimensions for this configuration are:

Description	Dimension
Parking space width	2.75 meters
Parking space length	6 meters
Driving aisle width (1-way)	4.5 meters
Two rows plus aisle width	14 meters
Vehicles per 100 linear meter double row	52.5

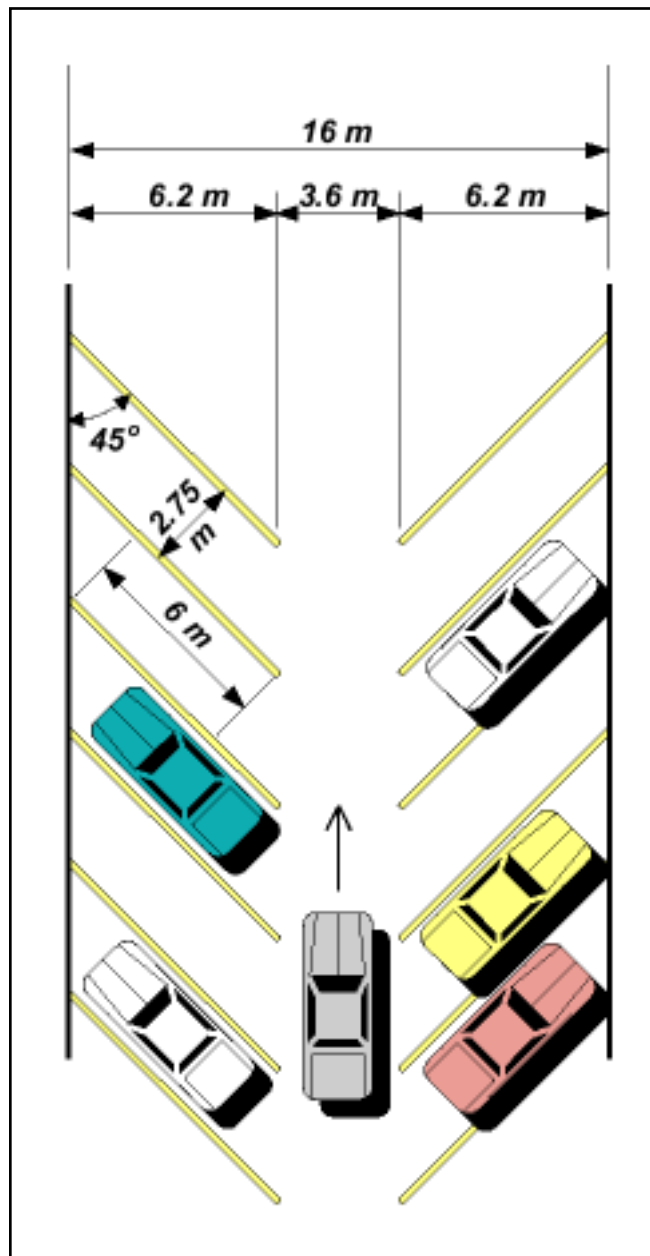


Figure 14-11: 45 Degree Parking Dimensions and Geometry

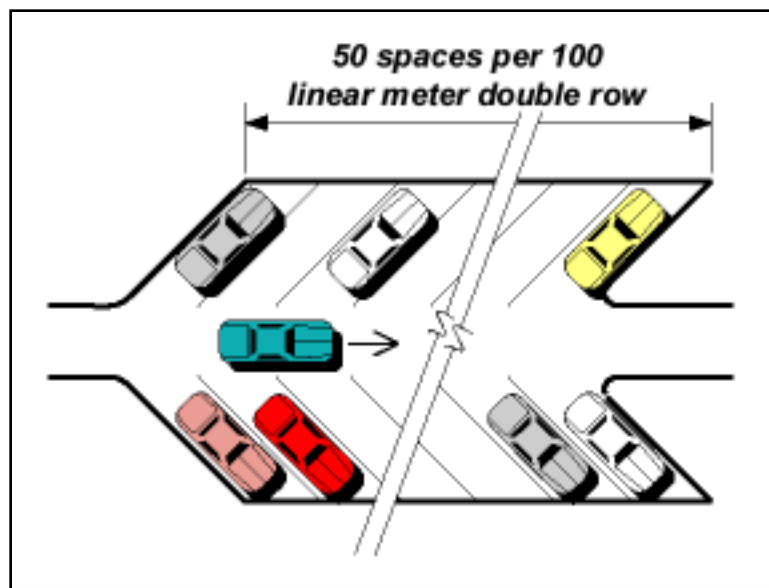


Figure 14-12: 45 Degree Parking Pattern

Advantages

- Reduced width requirements for layout
- Easy maneuvering in and out of parking spaces
- Good visibility to the rear

Disadvantages

- Doesn't work well with two-way aisles
- Requires more pavement per vehicle than perpendicular parking configuration

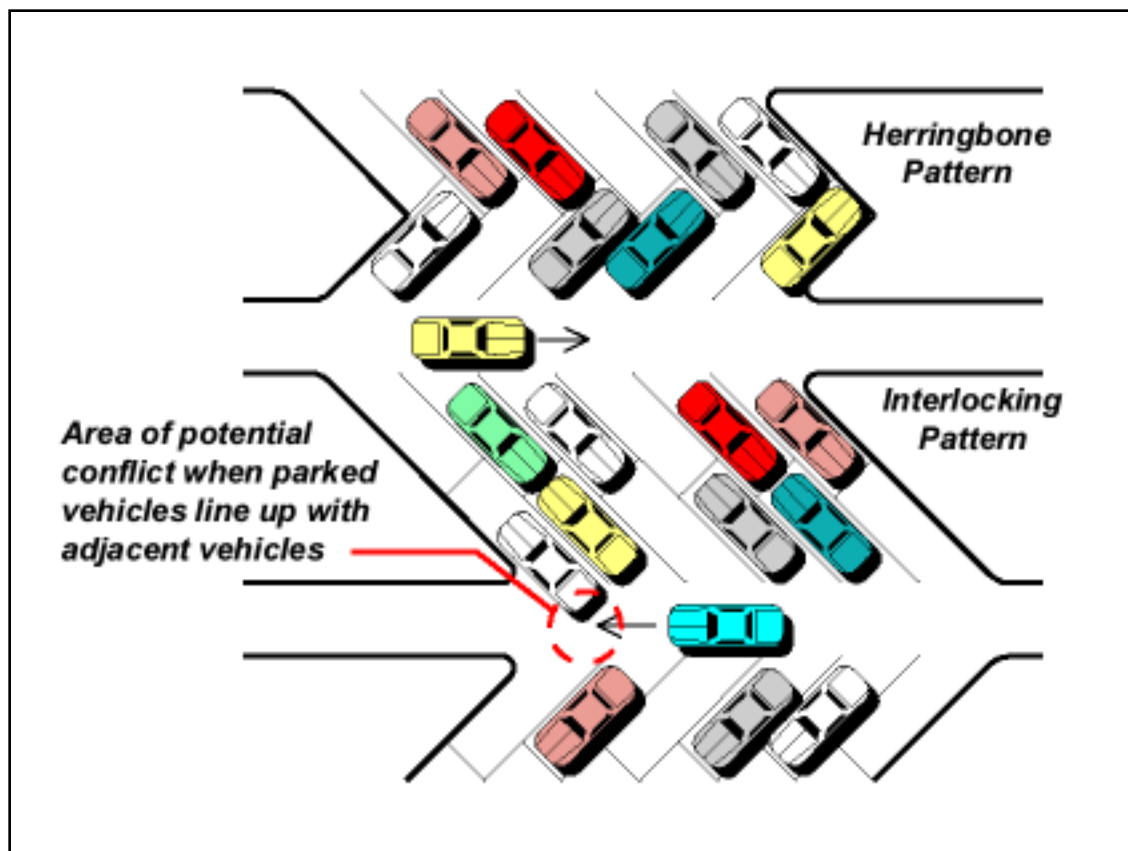


Figure 14-13: 45 Degree Parking Interlocking and Herringbone Patterns

Angled - 30 Degree

Standard dimensions for this configuration are:

Description	Dimension
Parking space width	2.75 meters
Parking space length	6 meters
Driving aisle width (1-way)	7 meters
Two rows plus aisle width	19 meters
Vehicles per 100 linear meter double row	39.4

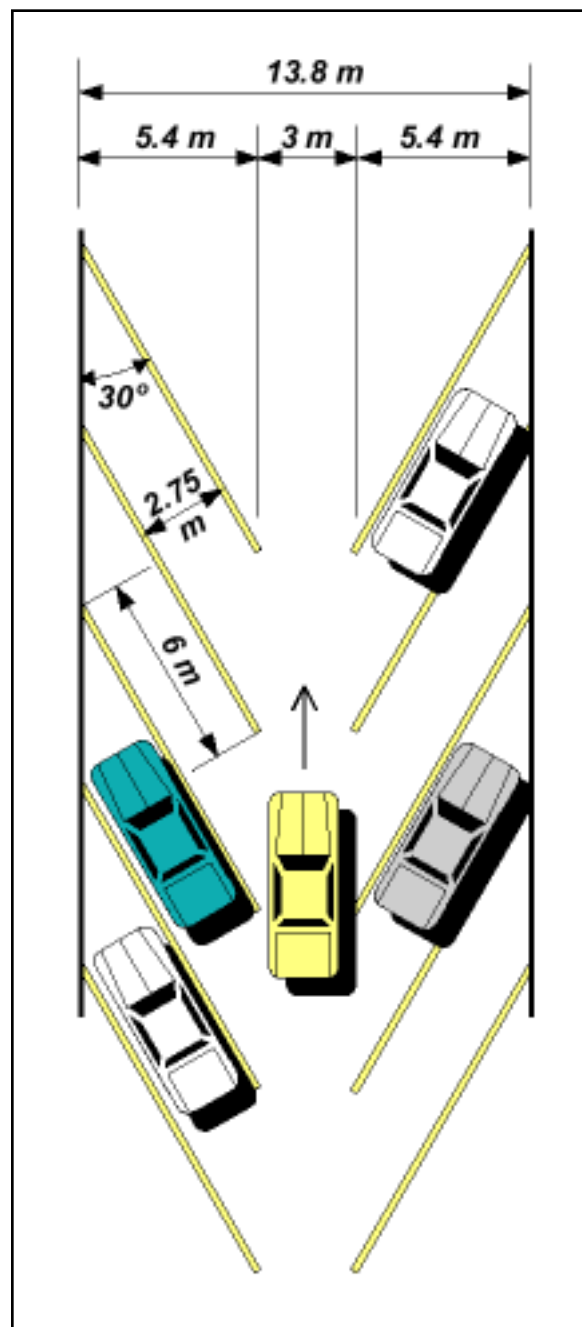


Figure 14-14: 30 Degree Parking Dimensions and Geometry

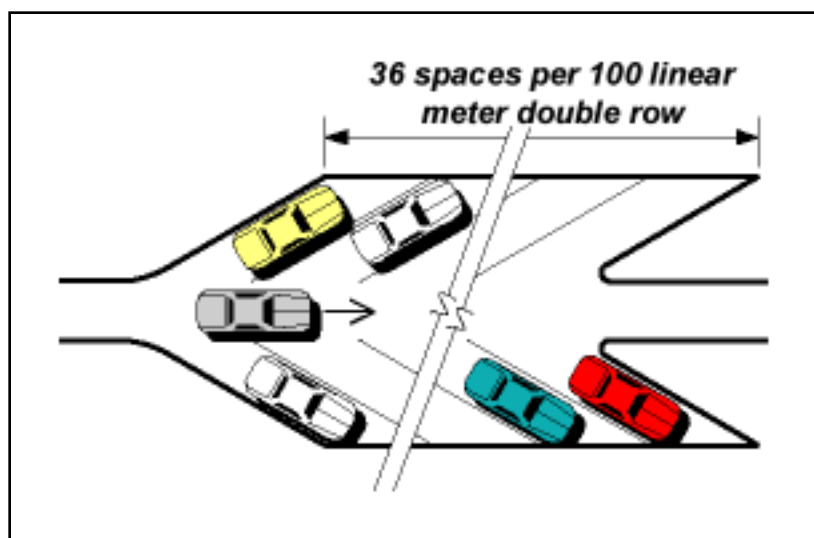


Figure 14-15: 30 Degree Parking Pattern

Advantages

- Easy parking
- Reduced width requirements for layout

Disadvantages

- Requires the most pavement per vehicle
- Doesn't work well with two-way aisles

Special Vehicles

In addition to automobiles, there are parking and circulation requirements for vehicles such as motorcycles, buses, refuse haulers, and tractor trailers. An overview of these requirements can be valuable to the designer.

Motorcycles

Many times parking areas are designed and built with little concern for motorcycles and their unique needs. Dormitories, dining facilities, major recreational facilities, and clubs are a few of the facilities that may require motorcycle parking. Rather than using leftover spaces for these needs, the designer should provide parking areas for motorcycles early in the project. Consult with the applicable facility managers to determine historical needs for motorcycle parking spaces.

Since motorcycles generally employ a kickstand for support when parked, a rigid surface such as concrete should be provided to ensure stability while minimizing potential pavement damage in summer months or at warm climate installations. Some standard parking dimensions for motorcycles are:

Description	Dimension
Parking space width	1.5 meters
Parking space length	2.5 meters

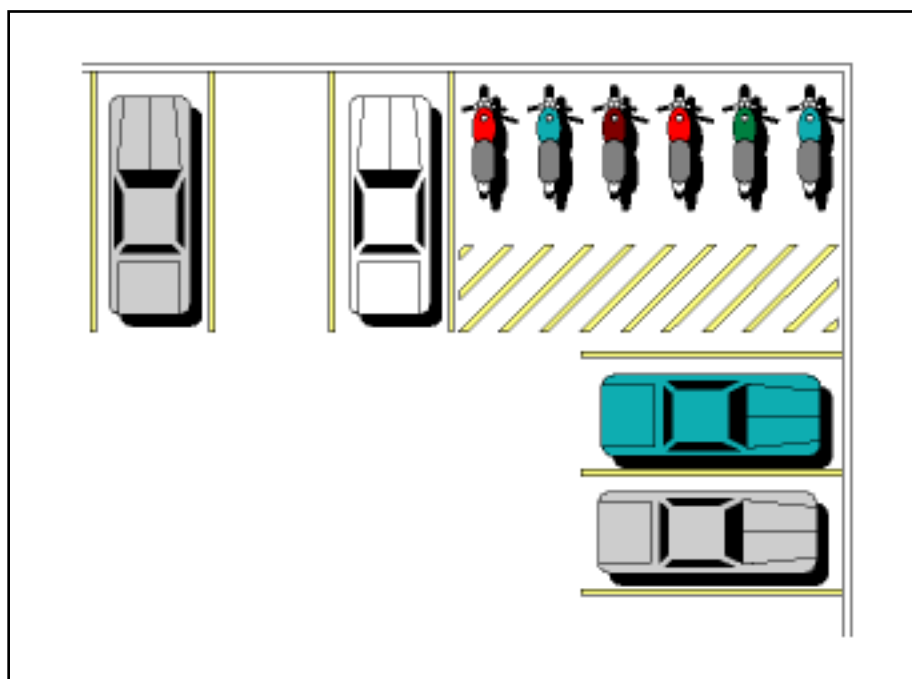


Figure 14-16: Motorcycle Parking Area

Buses

The designer must consider use of buses at dormitories, schools, training centers, clubs, dining halls, and major recreational facilities on the installation. Some of the key dimensions for the layout of parking and circulation of buses are:

Description	Dimension
Parking space width	3 meters
Parking space length	12-15 meters
Minimum turning radius	12 meters

Refuse haulers

Many installations use large, centrally-located dumpsters for disposal and collection of refuse and recyclable materials. Many are located in parking areas. Specially-designed vehicles are used to empty dumpsters. Most use a front-end method while others use the side of the vehicle. The designer must

consider refuse collection requirements during the layout and siting of parking areas. Dumpsters should be located to accommodate user convenience, ease of access for emptying, and aesthetic appeal.

Besides addressing refuse collection requirements in terms of siting, access, and circulation, the designer should consider:

- Screening dumpsters with fences, walls, or shrubs
- Coordinating grade requirements within dumpster areas in addition to overall parking area grading
- Providing protection with concrete-filled pipes or bollards for fences and walls from damage caused by vehicle operations

Tractor trailers

Large tractor trailers may have a need to access some installation parking areas. These vehicles have specific requirements. The designer should consider the following minimum dimensions when designing for tractor trailers:

Description	Dimension
Parking space length	15 meters
Parking space width	2.75 meters
Outside turning radii	18 meters
Vertical clearance	4.25 meters
Backing and maneuvering area	15 meters
Loading dock width	3 meters
Loading dock height	1.2 meters
Loading dock area	2x area of truck bed

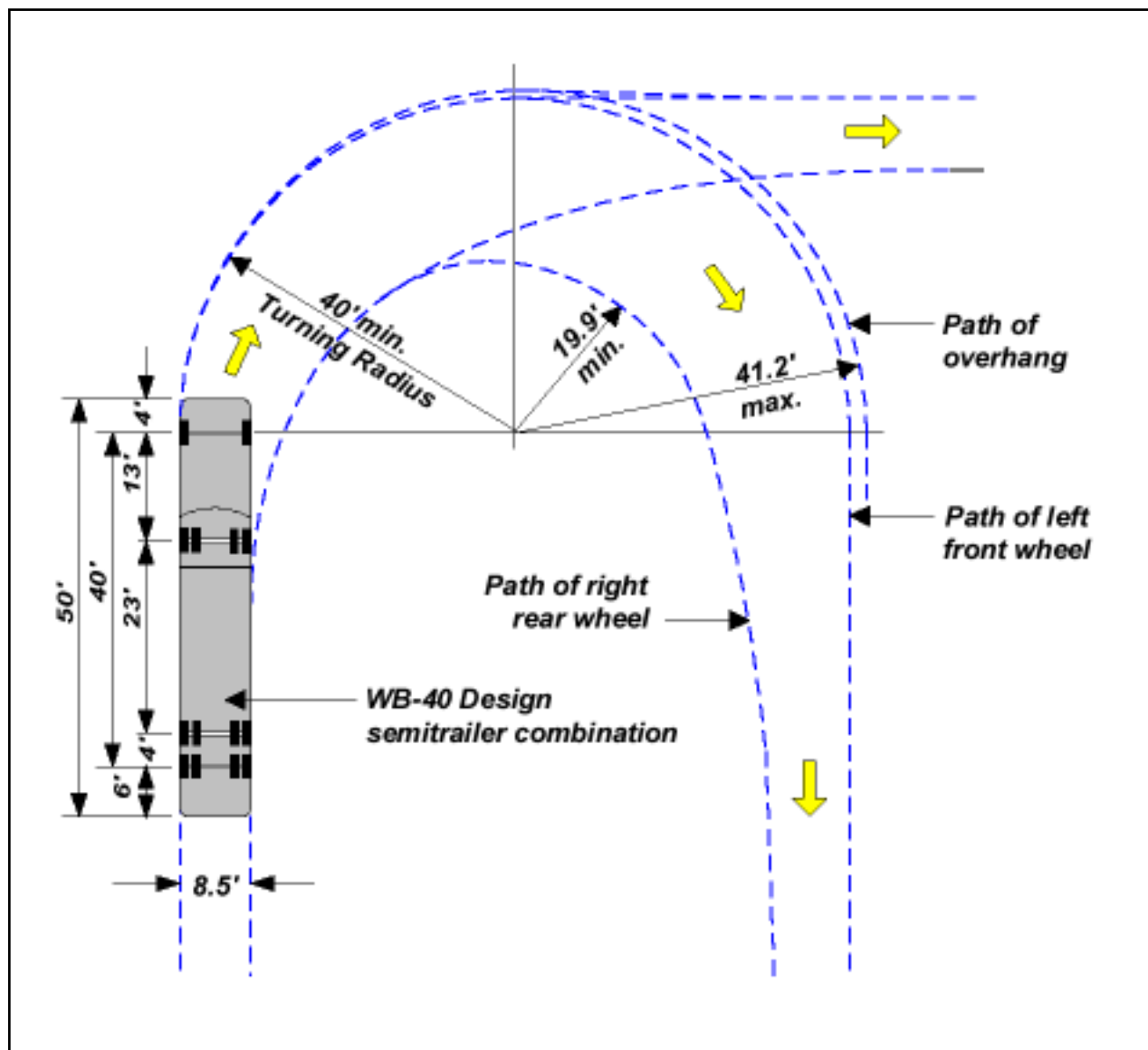


Figure 14-17: Tractor Trailer Turning Geometry

Access

Good parking area design provides convenient and safe access of vehicle occupants within parking areas to adjacent facilities. This includes those who are physically challenged. The designer should:

- Provide separated pedestrian walkways whenever possible and integrate with planted, curbed islands
- Provide walkway access from all parking spaces to facility entrances
- Minimize the number of vehicle circulation aisles pedestrians must cross to enter adjacent facilities
- Integrate parking area walkways with existing installation pedestrian network

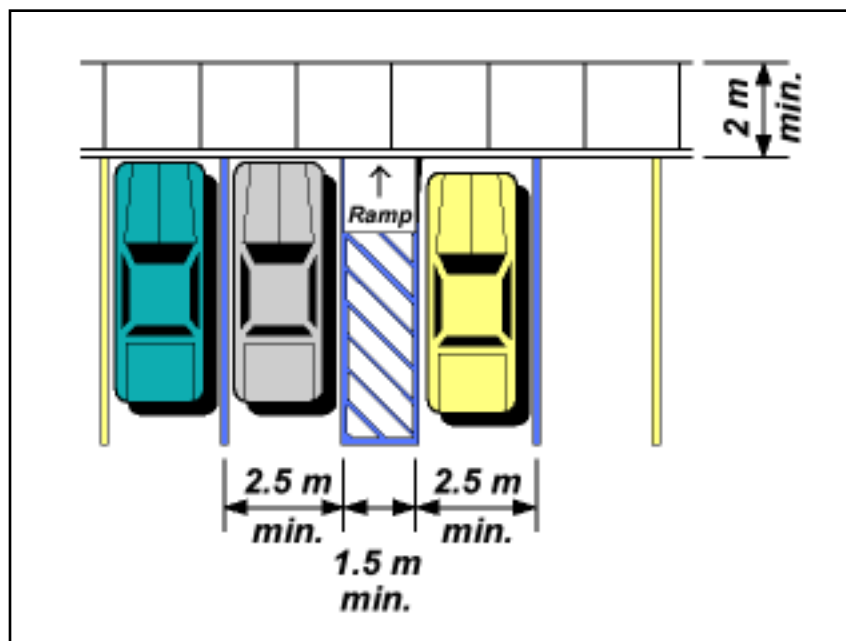


Figure 14-18: Accessible Parking Space

ADA requirements

The Federal Register (56 Fed. Reg., 35,464, 35,483, 1991) details the requirements of the Americans with Disabilities Act (ADA). An excerpt of those requirements for parking is provided below.

Required Accessible Spaces

If parking spaces are provided for employees and/or visitors, then accessible spaces will be provided in conformance with the table below:

Total spaces in parking area	Required minimum number of accessible spaces
1 to 25	1
26 to 50	2
51 to 75	3
76 to 100	4
101 to 150	5
151 to 200	6
201 to 300	7
301 to 400	8
401 to 500	9

501 to 1000	2% of total
1001 and up	20 plus 1 for each 100 over 1000

Location

Accessible parking spaces serving a specific facility should be located on the shortest accessible route of travel from the adjoining parking area to an accessible entrance. In parking areas that serve several facilities, accessible parking should be located on the shortest accessible route of travel to an accessible pedestrian entrance of the parking area. If facilities have multiple accessible entrances, accessible parking spaces should be dispersed and located closest to the accessible entrances.

Space sizing, access aisles, and slope

Accessible parking spaces should be at least 2.5 meters wide. Parking access aisles should be part of an accessible route to the facility entrance. Two accessible parking spaces may share a common access aisle. Parked vehicle overhangs should not reduce the clear width of an accessible route. Parking spaces and access aisles should be level with surface slopes not exceeding 1:50 or 2% in all directions.

Signage

Accessible parking spaces should be designated as reserved by a sign showing the symbol of accessibility. Such signs should be located so they cannot be obscured by a vehicle parked in the space.

Maintenance

Regular maintenance can greatly prolong the life and utility of parking area pavements. They should be regularly policed for litter and plant material debris. Parking spaces should be restriped as required.

Removal of debris and snow are special considerations for the designer. Elements such as islands and curbs can interfere with expediency of these activities. Street sweepers have difficulty effectively reaching confined areas created by perimeter or island curbing. Snow removal becomes especially difficult in these areas as well.

The designer must also consider ample and well-located snow piling areas where frequent and significant snow accumulation is expected.

14.2.3 AESTHETICS AND SAFETY

The most attractive parking areas are well landscaped. Trees are the most valuable additions to parking

areas, whether planted in curbed islands or on perimeters. They provide shade, visually reduce the mass of open pavement, and mitigate heat gain. Use plant materials to improve installation parking areas:

- Incorporate appropriately-scaled, well-graded and planted earth berms on parking area perimeters to screen the parking area from streets and other facilities
- Minimize the use of medium to tall shrubs on internal curbed parking islands
- Integrate regionally native groundcovers and small shrubs at island ends to add interest while maintaining visibility of pedestrians and vehicles
- Provide convenient and accessible walkways from all parking spaces to facility entrances

Horticultural Requirements

Parking areas are not conducive to healthy plant growth. Reflected sunlight, heat gain, and exhaust fumes each contribute to this problem. Plants can become weak and unsightly making them susceptible to further damage and reduced lifespans.

Non-porous pavement limits important oxygen and water exchange between plant roots and the atmosphere. Construction practices further hamper proper growing conditions through soil compaction.

For healthy plant growth, it is imperative to protect vital plant components - roots, trunks, and leaves.

Roots

Large roots near the trunk serve to anchor the plant. Fine, fibrous roots at the root tips along the drip line take up moisture and minerals from the soil. Roots spread radially from the trunk and are rarely more than a meter deep. Some species have a taproot that can search out moisture to depths of 15 meters or more. Any damage to the root zone of plants should be accompanied by pruning to balance the ratio of roots to leaves. Protect plant roots through the following practices:

- Avoid compacting the soil around existing trees
- Consider the use of porous pavements such as cast-in-place, monolithic turf and concrete combinations over specimen tree roots to allow water and air exchange if paving around the tree is required

Trunks

The trunk transports water and micronutrients from the roots to the leaves through the cambium which lies just below the bark. This thin layer is responsible for the plant's growth. It is the most vital part of any plant. Small horizontal cuts or abrasive damage to the cambium can severely stunt a plant's growth or kill the plant. It is extremely important to avoid damaging the trunks of all plants.

- Use curbs for planted islands

- Ensure parking spaces provide sufficient separation from trees and shrubs to avoid damage
- Protect existing tree or shrub trunks during construction activities

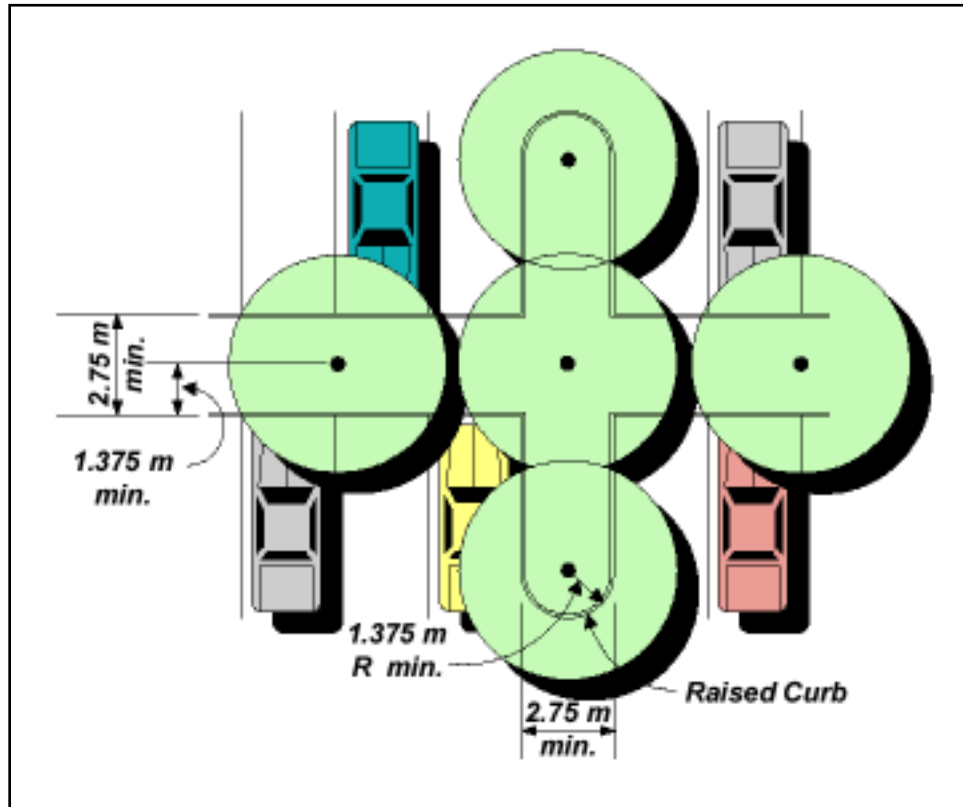


Figure 14-19a: Tree Protection

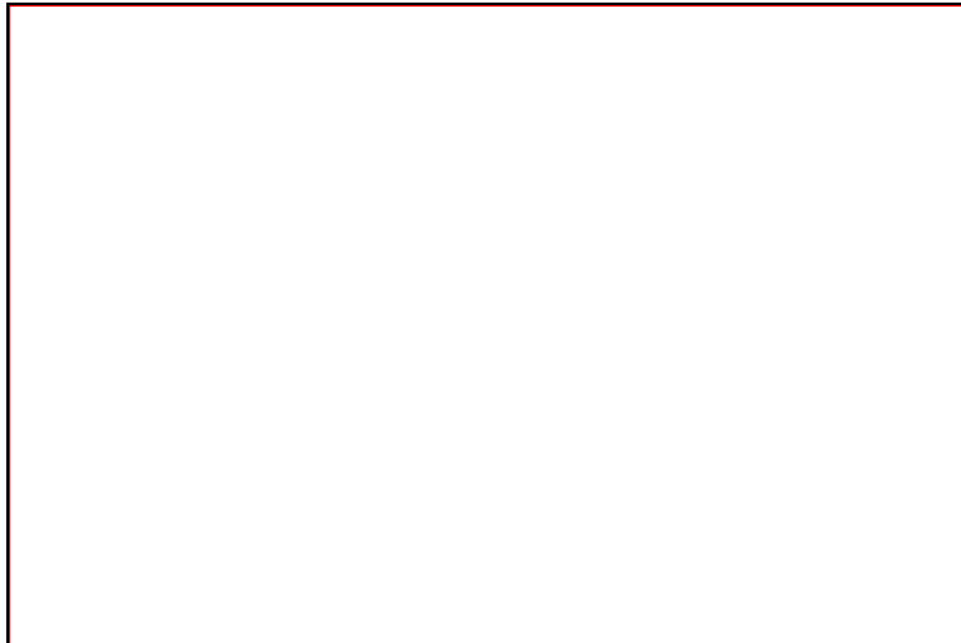


Figure 14-19b: Example of Tree Protection in Parking Island

Leaves transpire oxygen and excess moisture to the atmosphere while absorbing carbon dioxide. Without healthy leaves, plants will eventually die. Vehicle exhaust fumes can damage foliage. Constant foot traffic on woody groundcovers damages plants and creates an unsightly appearance.

- Use regionally native drought and heat tolerant species whenever possible
- Ensure plants installed in or around parking areas receive proper irrigation that encourages deep root growth

Tree Selection Criteria

Trees do the most to improve the aesthetics of parking areas. There are reasons to avoid using some species and reasons to select others.

Avoid:

- Large-leafed deciduous trees like some maples that can clog drains and make walking hazardous
- Trees with messy fruits or berries, like the female ginkgo, olive, or mulberry
- Brittle-limbed species such as the Siberian elm, eucalyptus, or poplar
- Trees susceptible to insects and diseases such as American elm, birch, hawthorn, and mountain ash
- Short-lived trees such as Lombardy poplar, Arizona ash, and willow
- Trees that can damage pavements such as Norway maple, silver maple, and sycamore

Select trees:

- That cast medium to dense shade in summer
- Have normal lifespans over 60 years
- That thrive in pollution and direct and indirect heat of a typical urban environment
- That demonstrate salt and deicing compound tolerance such as red oak, white oak, and red cedar
- Which require little pruning and are structurally sound
- Which are resistant to insects and diseases

Lighting

Lighted parking areas are an important consideration for facilities that expect early morning, late afternoon, or night time use. All parking areas should be safely illuminated. Intersections with major pedestrian routes and at parking area entrances and exits are especially important when choosing light fixtures and locations. The designer should provide lighting for parking areas that meet the minimums of 1-2 foot-candles and 10-20 lux. Lighting should not disturb nearby residential areas.

Lighting standards or poles vary from 6-9 meters tall and should be located in islands or on parking area

perimeters. Poles that are not protected by a curb or other structure should be constructed with a concrete base at least 1 meter high or be buffered by concrete filled pipes or bollards.

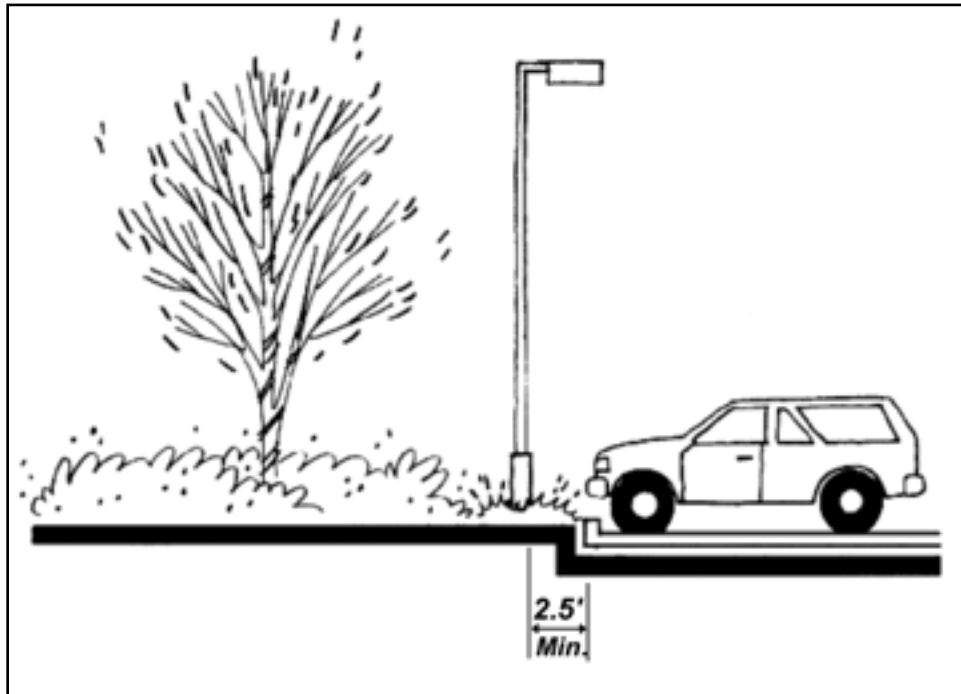


Figure 14-20a: Light Fixture Location

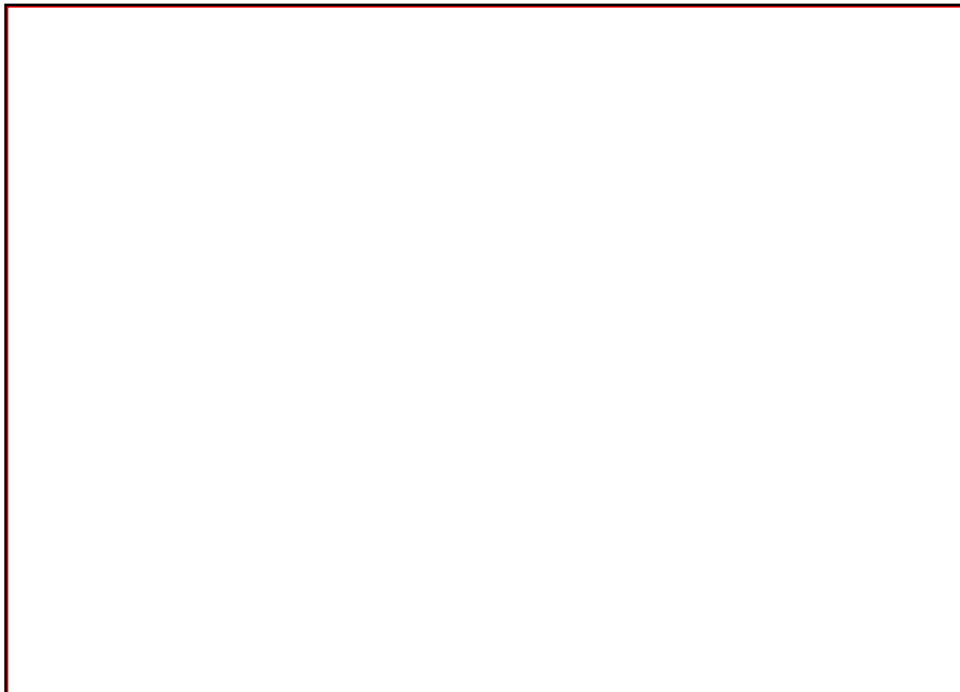


Figure 14-20b: Example of Light Fixture Location

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