2018

ASPHALT PARKING LOT DESIGN GUIDE

WAPA
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Foreword

Purpose of this Guide

Many hours are spent in the design of aesthetically pleasing residential facilities, schools, and businesses. However, the same level of effort is often not afforded in the design of the adjacent parking areas.

Given the capital expense of the property owner in building a parking lot, putting effort into the design of a quality, high-performing lot is a must. A parking lot is an investment in the appearance of the property and in the safety and convenience of the property users: customers, students, residents, etc.

When properly designed and constructed, parking areas can be attractive, safe, and above all, easily and efficiently usable. In addition, they can be designed for low maintenance costs and ease of modification for changes in patterns of use.

(By contrast, parking areas with pavements that are initially under-designed can experience excessive maintenance problems and a shortened service life, and ultimately have a negative impact on the user's experience of the building itself.)

This 2018 Asphalt Parking Lot Design Guide has been prepared to assist readers in understanding all phases of asphalt parking lot design, including planning, construction and maintenance.

The parking area is the first part of a building complex seen by the user. It is the gateway through which all customers, potential customers, employees, visitors, and others pass. This first impression is very important to the overall feeling and atmosphere conveyed by the facility.

What's Inside

The primary objective of parking lot design is to provide safe and efficient access to parking stalls that serve business, transit and residential facilities. For business and commuter lots, the design must consider the use of the pavement by buses, trucks and other heavy vehicles.

The information contained in this document provides a general guide to proper parking area design, construction, and facility layout. Minimum pavement thickness designs are given for both small parking areas (50 passenger car stalls or less—Traffic Class I) and larger facilities (over 50 passenger car stalls—Traffic Class II).

The guide is organized into five chapters: **Assessment and Planning**; **Subgrade and Drainage**; **Construction**; **Maintenance**; and **References**.

Also included is a comprehensive **Inspection Checklist** (Appendix A) to help an on-site inspector follow best practices known to produce a quality pavement project.

WAPA's Objectives

WAPA and its members are dedicated to fulfilling the following objectives:

- Cultivation of sound relationships and cooperative effort among members, governmental agencies, and other similar organizations and associations.
- Stimulation of public interest in the durability, sustainability, economic responsibility, safety features, and other benefits gained through the use of asphalt paving materials.
- Advocacy of sound planning in highway construction and maintenance to ensure maximum benefit from the expenditure of public funds.
- Dissemination of information gathered from all available sources, including extensive research, related to the manufacture and use of asphalt paving materials.

The ultimate quality of an asphalt paving project is directly related to the experience, skill, professionalism, and equipment of the contractor doing the project. This is why WAPA urges consumers to be sure that bidders for their asphalt paving projects are properly qualified asphalt pavers.

WAPA takes pride in presenting this 2018 Asphalt Parking Lot Design Guide and will be happy to provide readers with additional information.

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1 Assessment and Planning

The first important step in designing a parking lot is assessing needs based on three major influences: **traffic (vehicular and pedestrian)**, **pavement life expectancy**, and **economy**. Planning considerations that follow are **general planning**, **pedestrian safety**, **parking angle**, **stall dimensions**, and **markings**.

Traffic

Among the three influences on parking lot design, traffic—specifically truck traffic—is by far the most crucial.

A large commercial parking lot might allow for low-cost thinner pavement design if there is little or no truck traffic. However, most commercial operations have dedicated loading areas and roadways that must accommodate heavy, slow-moving loads. A typical parking lot plan will show two or three pavement sections, typically identified as "Heavy Duty—Traffic Class III," "Medium Duty—Traffic Class II" and "Light Duty—Traffic Class I."

Investing time predicting vehicle loadings and traffic flow will allow a designer to accommodate actual expected traffic (rather than using a generic pavement that may fail prematurely).

Construction Traffic

Most pavement designs are based on the traffic that will use the pavement once construction is completed. However, *the heaviest traffic loadings often happen during the construction phase*.

The pavement design needs to take into consideration the size and weight of the construction equipment being used, and the pavement structure should use high-quality construction materials at proper thicknesses to handle the construction traffic and sequence of construction.

Special truck lanes are sometimes required to expedite traffic to loading areas, trash dumpsters, and equipment areas. The design thickness for these lanes or any pavement areas carrying this type of traffic should be increased accordingly. Proper use of a proof roll will indicate a firm and unyielding base to pave on (see additional details in Chapter 2 of this guide).

Pavement Life Expectancy

The typical life expectancy of a parking lot subject to Wisconsin weather is up to 25 years with proper maintenance. A design engineer should specify a pavement thickness to carry the traffic loadings identified above for this 20- to 25-year period.

Skimping on a pavement's design structure will shorten the life of the investment and lead to higher repair and maintenance costs in the future.

To extend the life of the parking lot and to maintain safety and aesthetics, there are many different maintenance options an owner can choose from. Refer to Chapter 4 of this guide for additional details.

Economy

To ensure the most economical design and quality construction, listen to your local engineers and contractors, discuss the construction process, solicit multiple bids, determine the construction time frame, discuss contingencies, check references, and understand exactly what you are buying and building.

"Quality, quality, and quality," should be your mantra. Choosing a quality contractor is always a good investment.

Construction projects inherently have unknowns, problems, and compromises. Consulting with and selecting a reputable design team, contractor and engineer will ensure that you are treated fairly and that your project will be completed in a timely manner.

WAPA has a vetted list of engineers and contractors committed to quality design and construction, and service for their customers. See **wispave.org/member-listing**.

Capacity, Flow and Access

In developing the parking area plan, several important factors should be considered.

The primary consideration should be providing the maximum convenient parking capacity with the best use of available space. The following guidelines should provide optimum use of the available parking area:

- Use rectangular areas.
- Make the parking area's long sides parallel.
- Use parking stalls along the perimeter.
- Use traffic lanes that serve two rows of stalls.

More details are provided in the section "Parking Angle" below.

Consideration should be given to the flow of traffic into and out of the area as well as within it. Keep entrances far away from busy street intersections and from lines of vehicles stopped at a signal or stop sign. Be sure that the entering vehicles can move into the lot on an internal aisle, thereby avoiding congestion caused by involvement with turning vehicles.

It should be noted that handicapped parking areas must also be provided at a location closest to the facility with slopes not steeper than 1:50 or 0.02 (measured in any direction for the parking stall and adjacent access aisle). For specific requirements and guidance related to handicapped parking areas, see **www.ada.gov** and **www.cedengineering.com/userfiles/ADA%20Parking%20Guidelines.pdf**.

Pedestrian Safety

Pedestrian traffic must also be taken into account when planning. Steps that lot designers and managers can take include the following:

- Install speed bumps or other traffic calming devices to slow down traffic. (Note that speed bumps may impact snow plowing operations; see the Snow Plowing section later in this chapter.)
- Prominently post regulations and safety tips.
- Make sure that space and aisle markings are kept in good shape for maximum visibility.
- Consider parking spaces to the rear or side of the lot to allow pedestrians alternative access to the sidewalk areas.
- Install lighting consistent with local code for added safety during evening hours.

Parking Angle

There are three parking angles commonly used for the rows of parking area stalls: 90°, 60° and 45°.

Generally, *the closer the parking angle is to 90°, the higher the stall capacity of the parking lot.* As such, the 90° angle is the most commonly used parking lot stall alignment. However, lower angles may be desirable to accommodate specific situations.

The 90° angle (Figure 1.1) achieves the highest parking stall capacity. This type of parking is more suited for all-day parking (such as employee parking) because it has the highest degree of difficulty for entering and leaving parking stalls. It is generally not preferred for "in and out" lots such as fast food restaurants and banks.

Figure 1.1. 90° Stalls

A 60° stall permits reasonable traffic lane widths and is easier to enter and back out of. However, angled parking will reduce the parking stall count.

With limited paving real estate, 45° stalls (Figure 1.2) are sometimes preferred. The small change in angle also permits the use of narrower aisles. This angle further reduces the parking stall count.

Figure 1.2. 45° Stalls

Figure 1.3 illustrates the typical layouts and dimensions of parking lots with parking angles of 90°, 60°, 45°, and 30°.

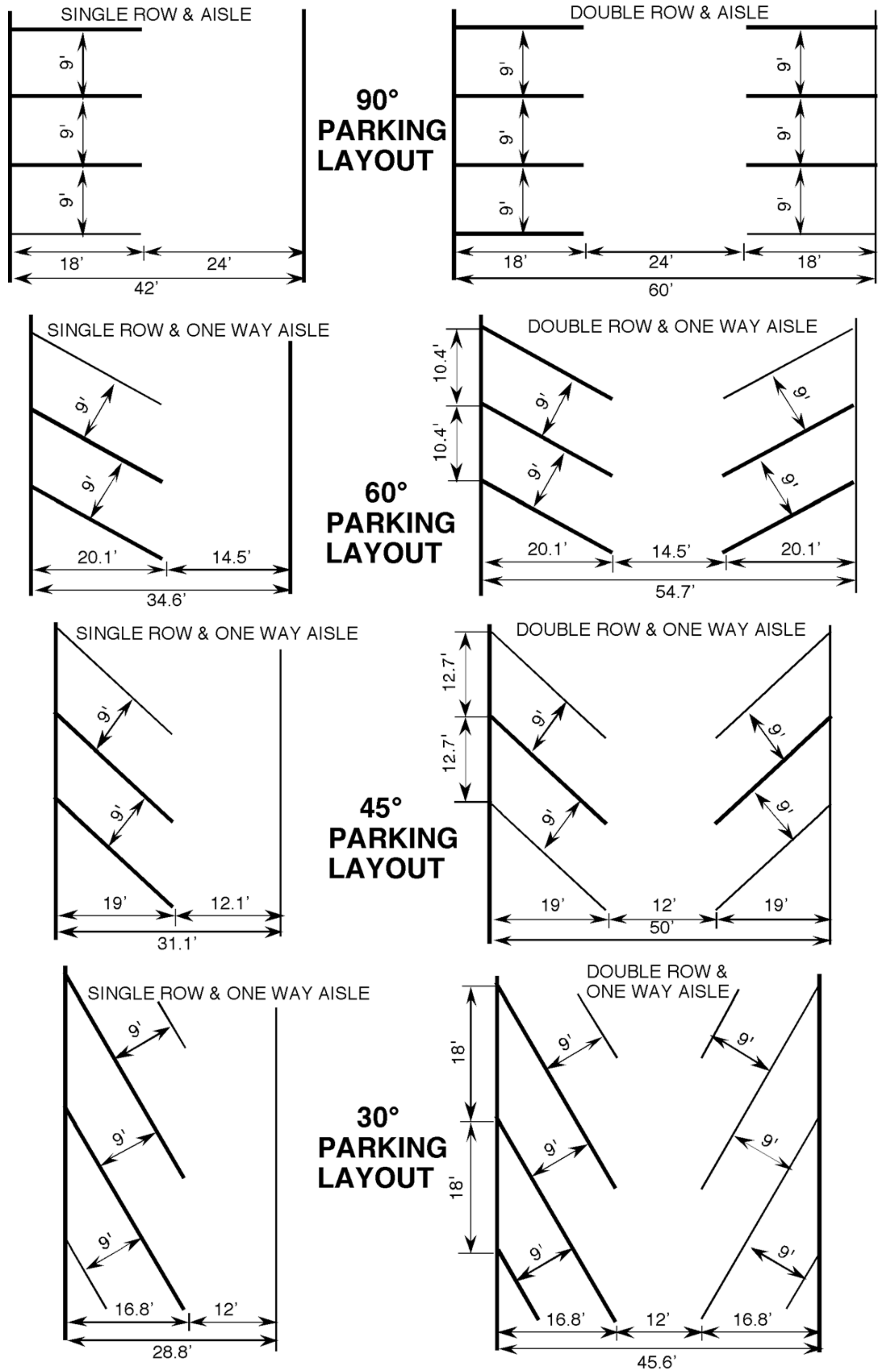

Figure 1.3. Typical Parking Lot Layouts and Dimensions

Stall Dimensions

Typical parking stall dimensions vary with the angle at which the stall is arranged in relation to the aisle.

- Stall widths (measured perpendicular to the vehicle when parked) range from 8½ feet to 9½ feet.
- The minimum dimensions for public use parking spaces is 9 feet by 18 feet.
- Recommended stall dimensions for compact cars and similarly sized vehicles are 7½ feet by 15 feet. If a number of such spaces are to be provided, they should be grouped together in a prime area to promote their use.
- Stall widths for parking lots where shoppers generally have large packages, such as supermarkets and similar facilities, should be 9½ feet or even 10 feet wide.

It is noted that often local ordinances dictate stall and aisle dimensions.

Pavement Markings

Markings are a very important element of a good parking lot. The parking area should be clearly marked to designate parking spaces and to direct traffic flow.

Both yellow and white lines are commonly used in off-street parking lots. All pavement striping should be 4 inches in width. Other pavement markings (crosswalks, painted speed bumps, etc.) could be different widths as appropriate.

New asphalt surfaces are typically marked with latex marking paints specifically manufactured for traffic markings. For best results, allow the asphalt pavement to cure for several days before applying paint.

To minimize shrink cracking of the asphalt surface along the perimeter of the paint caused from the paint curing, consider applying paint at a light application rate on new asphalt pavements. A second coat of paint will likely be needed after a few years if a light application is used the first time.

ADA Requirements

The Americans with Disabilities Act (ADA) provides federal requirements for slopes, markings (Figure 1.4), clearances, and other features for accessible parking stalls. Such stalls should be designed and constructed per federal code and local requirements to ensure compliance.

Figure 1.4. ADA Pavement Markings

Snow Plowing

Snow plowing should be factored into the layout of the parking lot. Keep snow plow truck clearances and maneuverability in mind when designing parking stall wheel stops, medians, green spaces (Chapter 2), curbs and gutters (Chapter 3), and truck docks and dumpsters (Chapter 3). As noted earlier in the chapter, consider whether speed bump design and placement will present a challenge for snow plow operations.

Moreover, plan for not only for plowing routes and patterns but also plan for where snow piles may be placed.

2 Subgrade and Drainage

Pavements are designed as they are built: from the bottom up. Subgrade and drainage design is the next major consideration for asphalt parking lot design.

Soils Testing

An engineer should base pavement design on the local soil types as well as the local municipal rules and requirements. A soils test of a site is an absolute necessity prior to design and construction of the building and surrounding parking areas.

For rehabilitation projects, soil borings are a major asset as they provide the existing pavement cross section and type, strength, and moisture of the underlying sub-base. This will provide a historical look at what the pavement section was and how it performed (its service life), and is a great tool in designing the new section. The soil borings will identify structural loading capacity of the in-situ materials, possible groundwater issues, and the variance in soil structures across the site.

Subgrade Preparation

Because the subgrade must serve both as a working platform to support construction equipment and as the foundation for the pavement structure, it is important for an architect or engineer to see that it is properly compacted and graded. Laboratory tests to evaluate the load-supporting characteristics of the subgrade soil are desirable. However, if these tests are not available, designs may be based on careful field evaluations and previous projects and experience in the area.

Proof Roll

A proof roll is a guaranteed method to find any weak spots in a subgrade or aggregate base course. If a weak spot is discovered, the area should be corrected as required to produce a stable subgrade. Correction methods include replacement of unstable material with select fill or aggregate, and use of geotextiles, fabrics or grids. For large-scale issues, chemical stabilization may be required through soil modification (pulverizer and stabilization additive). When the subgrade is extremely poor (clayey, highly plastic, or incompactable), it may be necessary to remove the upper portion of the subgrade and replace it with select material

When the subgrade is weak due to excess moisture, consider one or more these remediation techniques:

- Stabilize the subgrade with a binding agent.
- Install underdrains to remove excess water.
- Remove the subgrade, dry it through reworking, return it to place, and recompact it.
- Remove and replace the subgrade with a stronger material.

The remediated layer can be further stabilized with a fabric prior to placing the next pavement layer, or the next pavement layers can be made thicker. Proper drainage is best addressed in advance, as detailed in the section Drainage Provisions below.

Verify the success of the reworked areas with a second proof roll. Repeat if necessary. Make sure the subgrade is stable and ready for the next phase of construction. When finished, the graded subgrade should be within ± 0.10 feet of the required grade and cross section.

Additional Preparation

All fill materials should be placed in thin lifts (12 inches maximum) at the proper moisture content and compacted prior to placement of the next lift. A properly prepared subgrade will not rut or deflect under the weight of a loaded truck. Prior to the start of paving operations, the subgrade soils should be checked for stability, moisture content, and proper grade.

The areas to be paved should have all rock, debris, and vegetation matter removed and be treated with a soil sterilizing agent (if necessary) to inhibit future flora growth. The subgrade should be compacted to a uniform density of 95% of the maximum theoretical density.

Drainage Provisions

Water is the enemy of pavements, and the cause of most pavement failures. Designing the site to remove groundwater is the first responsibility of an engineer.

Green Space

Many municipalities have rules or codes in place regarding the percentage of green space required for a commercial development or a fee structure based on impermeable parking lot square footage. These requirements may decrease the environmental impact of the parking lot, but they can add extra issues and cost to the project. When permitted by code, green space should be placed along the perimeter of the parking lot rather than placed internally.

The inclusion of trees and green space in a parking lot brings tremendous pressure on the underlying structure of the pavement. The green space areas allow water to infiltrate underneath the pavement structure and weaken the subgrade. Tree roots will eventually push up the surrounding pavement.

In addition, irrigation systems must be carefully monitored and evaluated to ensure that they are not oversaturating the green space and undermining the subgrade.

When building to gain stormwater management credit or U.S. Green Building Council LEED credit, the use of porous asphalt will provide the owner with a functional and environmentally sensitive pavement. The stone base below the porous asphalt acts as a stormwater detention pond that allows rainfall to slowly dissipate into the subgrade over time. Although porous asphalt is a tremendous environmental asset, this pavement choice does not come without additional costs and responsibilities. All porous or pervious pavements must be maintained through vigorous cleaning a minimum of twice a year. If considering a porous asphalt pavement, see WAPA's technical bulletin "Porous Asphalt Pavements" for more information: **www.wispave.org/wp-content/uploads/dlm_uploads/WAPA_Tech_Bulletin_Porous_Asphalt_Pavements_2015-09.pdf**.

Drainage

Adequate pavement drainage is of great importance to all pavement designs. Both surface and subsurface (groundwater) drainage must be considered. All drainage must be carefully designed and should be installed in the construction process as early as is practicable.

The primary drainage function of parking lots is to convey minor storms quickly and efficiently to the storm sewer or open channel drainage with minimal impact on the vehicle/pedestrian traffic and the surrounding environment. In addition, removing water quickly from paved surfaces will prevent water from reaching the subgrade, minimize cracks due to the weakened subgrade, reduce movement during freeze-thaw cycles, and prolong the life of the pavement in a parking lot.

Parking lot drainage requires consideration of surface drainage, gutter flow, inlet capacity, and inlet locations. The design of these elements is dependent on storm frequency and rainfall intensity.

Edge Collection

The pavement should also be constructed in a manner that will not permit water to collect at the pavement edge, and provisions should be made to intercept all groundwater from springs, seepage planes, and streams. When used, curb and gutter sections should be set to true line and grade. Marshy areas will require special consideration and should be addressed during the planning stage.

Subdrains

In some situations, subdrains are placed to intercept water that may flow under a pavement. This water is then allowed to flow out into a ditch or is put in a stormwater system.

Design of a subdrain system is site-specific and dependent on existing soils, landscape area layout, and drainage system outlet points. Using a drainable rock base layer will allow moisture to pass through the stone and be carried away by the subdrains. Make sure to specify an aggregate gradation that allows drainage but with enough fine material to compact and carry the construction equipment.

Sheet Flow

Runoff water forms sheet flow: a thin film of water that increases in thickness as it flows to the edge of the pavement. Factors that influence the depth of water on the pavement are the length of flow path, surface texture, surface slope, and rainfall intensity. Besides protecting against rainfall, the designer must also consider runoff from irrigation sprinkler systems often placed in parking lot islands.

Gutters and Surface Grades

Surface drainage for a parking lot consists of pavement slopes, gutters and inlets. When installing curbs and gutters, desirable grades should not be less than 2.0% (1 inch per 4 feet) for curbed pavements, with a minimum of 1.0% (1 inch per 8 feet).

To achieve adequate drainage, a slope between 2% and 5% is recommended for paved surfaces in a parking lot. Parking lots with grades flatter than 2% are subject to surface ponding and birdbaths.

Throughout the processes, designers must design the drainage in such a way that the project is constructible (that is, the grades listed on the plans need to be achievable for the paver width).

3 Construction

Base Construction

The subgrade must be graded to the required contours and elevations in a manner that ensures a hard, uniform, and well-compacted surface. All subgrade deficiency corrections and drainage provisions should be made prior to constructing the aggregate base.

The crushed aggregate base course should consist of one or more layers placed directly on the prepared subgrade, spread, and compacted to the uniform thickness and density as required on the plans or established by the owner.

The material may need to be watered in order to achieve the optimum moisture content and maximum density. Without proper moisture in the aggregate, proper compaction cannot be achieved.

All crushed aggregate material should meet Wisconsin Department of Transportation (WisDOT) specifications and be suitable for this type of application, with a minimum crushed aggregate thickness of six inches (see Table 3.1 and Table 3.2 for details).

Compaction around utility trenches and structures at times can be a difficult task. Some general best practices could include:

- Backfilling trenches and excavations immediately.
- Selecting and placing backfill materials with regard to the future safety of the utilities underneath.
- Selecting the same type of soil for backfill as the subgrade to promote uniform ground movement when temperatures vary and frost occurs.
- Compacting with suitable pneumatic tampers or steel drum rollers to the appropriate density required.

Asphalt Layer Construction and Compaction

The asphalt layer should be placed directly on the prepared area in one or more lifts, spread, and compacted to the pavement thickness indicated on the plans or established by the owner.

Compaction of asphalt mixtures is one of the most important construction operations contributing to the proper performance of the completed pavement. This is why it is critical to have a properly prepared and stable subgrade or aggregate base against which to compact the overlying pavement. The asphalt mix should meet the WisDOT specifications for the appropriate traffic level, binder grade and designation, thickness, and density requirements.

Tack Coat

Prior to placement of successive pavement layers, the previous course should be cleaned (if needed) and a tack coat of emulsified asphalt applied per WisDOT specifications. The tack coat should be applied uniformly and allowed to break prior to asphalt placement. (Breaking time is the time required for the water to evaporate, noted by transition from brown to black.) The tack coat will assist in adhesion between the layers of asphalt.

Surface Asphalt Layer Construction

Material for the asphalt surface course should be placed to the true lines and grade as shown on the plans or set by the owner. The asphalt mixture should conform to WisDOT specifications for the appropriate traffic level.

The asphalt surface should not vary from the established grade by more than ¼ inch in 10 feet when measured in any direction (handwork areas and those areas near drainage devices should be excluded). Any irregularities in the surface of the pavement course should be corrected directly behind the paver.

Rolling and compaction should start as soon as the asphalt can be compacted without displacement and continued until it is thoroughly compacted and all roller marks have disappeared.

Using a finer aggregate for the surface layer, typically a 9.5 mm (3⁄8" or #5) or a 12.5 mm (½" or #4) top size aggregate will give the mix a tight and uniform appearance. Contact a WAPA producer member to discuss which asphalt mixes are right for your project.

Pavement Structure

The pavement structure and materials used will change as a function of subgrade strength and construction approach. Most projects will use an aggregate base placed on compacted subgrade, but some could use a full-depth asphalt (i.e., asphalt placed directly on compacted subgrade). The aggregate base will be covered with one or more layers of asphalt.

Design Steps

The following steps can be used to determine pavement thickness for parking lots:

1. Based on the total number of parking spaces, select the appropriate Traffic Class (TC).
   - Lots under 50 stalls are typically TC I.
   - Lots of 50 stalls or more are typically TC II.
   - See Figure 3.1 below for a visual guide to all TCs.
   - See Chapter 6 of the WAPA Asphalt Pavement Design Guide, **www.wispave.org/designguide**, for more information about TCs.
2. Using project soil data, including the soil support value (SSV), select the subgrade type.
   - Good-to-excellent — Gravels and coarse sands. SSV ≥ 5.0
   - Medium — Clays and silts with low plasticity. SSV = 4.0 - 4.9.
   - Poor — Clays and silts with high plasticity; sugary (incompactable) sands. SSV = 2.5 - 3.9.
   - See Chapter 6 of the WAPA Asphalt Pavement Design Guide for more information about subgrade types.
3. Based on the TC (step 1) and the subgrade type (step 2), refer to Table 3.1 or Table 3.2 to select a design thickness.
   - Note in Table 3.1 and Table 3.2 that layer thickness listed is the compacted thickness.
   - Tables for other TCs not commonly used for parking lots may be found in Chapter 7 of the WAPA Asphalt Pavement Design Guide.

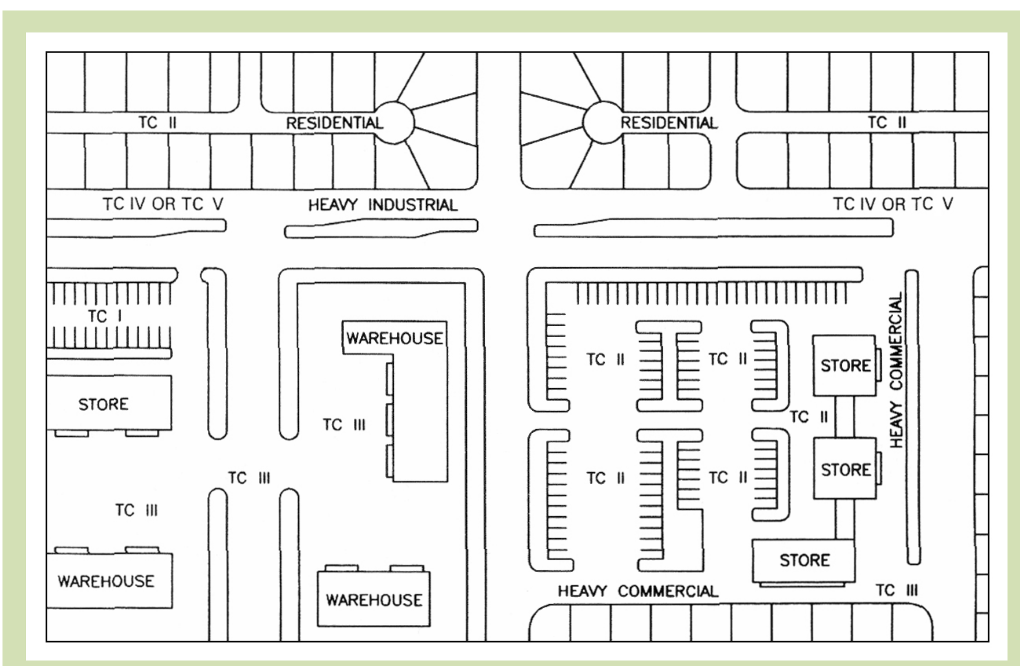

Figure 3.1. Typical Zones of Traffic Classes (TCs)

Table 3.1. Pavement Thickness for Traffic Class I							
20-Year Design ESALs	Typical Use	Asphalt Mixture Type	Subgrade Type		Asphalt with Crushed Aggregate Base		Recommended Surface Layer PG Binder Designation
			Rating	Description	Total Asphalt Thickness (in.)	Base Thickness (in.) [1]	
< 2 million	Residential driveways School and recreational areas Playgrounds and tracks Bike paths Sidewalks **Parking lots (<50 stalls)**	LT	Good-to-excellent	Gravels and coarse sands. SSV ≥ 5.0	3.0	6.0 – 8.0	S
			Medium	Clays and silts with low plasticity. SSV = 4.0 - 4.9.	3.5	6.0 – 10.0	S
			Poor	Clays and silts with high plasticity; sugary (incompactable) sands. SSV = 2.5 - 3.9.	4.0	9.0 – 12.0	S

Table 3.2. Pavement Thickness for Traffic Class II							
20-Year Design ESALs	Typical Use	Asphalt Mixture Type	Subgrade Type		Asphalt with Crushed Aggregate Base		Recommended Surface Layer PG Binder Designation
			Rating	Description	Total Asphalt Thickness (in.)	Base Thickness (in.) [2]	
< 2 million	Low-volume roadways Subdivision streets Collector streets Town roads County roads **Parking lots (≥50 stalls)**	LT	Good-to-excellent	Gravels and coarse sands. SSV ≥ 5.0	3.0 – 3.5	6.0 – 10.0	S or H
			Medium	Clays and silts with low plasticity. SSV = 4.0 - 4.9.	3.5 – 4.0	6.0 – 12.0	S or H
			Poor	Clays and silts with high plasticity; sugary (incompactable) sands. SSV = 2.5 - 3.9.	4.0 – 4.5	9.0 – 14.0	S or H

[1], [2]. Because a parking lot asphalt pavement is likely to be re-constructed in the future without replacing the base, it may be desirable to use a thicker base course than those specified here. Consider adding up to four inches when considering base thickness for parking lot pavements.

Construction Practice Recommendations

Proper Paver Setup

It is essential to visually inspect the paver and components to look for any issues that could affect operation or safety before the hot mix goes into the hopper.

Proper machine preparation and screed setup can save time and effort. The screed and paving components (including extensions) are set to the project specifications for width, mat thickness, crown and slope. After ensuring the paver is in top working condition, the crew must then focus on the factors that will yield the best quality pavement.

Laying a Quality Mat

The two most important factors for laying a quality mat are all about consistency:

- Consistent head of material in front of the screed.
- Consistent paving speed.

Material Level

More than 95 percent of imperfections in asphalt paving are due to an improper head of material in front of the screed. The head of material is the amount of mix that lies directly in front of the screed.

If the head of material fluctuates greatly during the course of paving, it is nearly impossible to produce a level and smooth pavement surface.

- If the head of material increases, then more material is being forced under the screed, causing it to rise. This fluctuation in mat depth translates into a wavy surface.
- If the head of material decreases, there will be less material passing under the screed and supporting the weight of the screed. The screed will gradually drop, reducing the mat thickness and causing flaws to show up in the mat.

Paving Speed

Paving speed also has an impact on the quality of mat. In an ideal paving operation, the paver will operate nonstop throughout the day, because a change in paving speed can directly affect the ability to lay a uniform mat.

When selecting a paving speed, several considerations should be made. These include the number and size of trucks, volume and output of the asphalt production facility, rolling and compaction rates and crew capabilities, and the distance from the mixing plant to the paver.

The asphalt material needs to arrive at the site hot enough to allow for proper laydown and compaction. Once speed is selected, it should be consistently maintained. Ripples, waves and irregular mat depth can occur when paving speed doesn't remain relatively consistent.

Changes in speed also create challenges with the timing of asphalt delivery to the hopper in order to keep the hopper at least a third full. Consequently, changes in paving speed are commonly caused by trucks inconsistently arriving at the job site, or bumping the paver during the truck exchange. Even the smallest bump can create a depression behind and beneath the screed. Subsequent rolling may not fix this surface defect and can often be felt by traffic after the fact. To avoid negatively impacting the mat, truck drivers should stop 1 to 2 feet in front of the paver, allowing the paver to initiate contact.

Compaction

It is important to compact the mix to a sufficient density to ensure the longest life possible for the pavement. Using small parking lot rollers in areas where the placement of the mix is slowed by the need for hand work, and stop-and-go short pulls with the paver, often result in low densities and rough finishes.

A contractor should ensure that the mix does not sit in trucks for long periods of time, and that it is not placed without being compacted for long periods of time. The contractor should also make sure to compact the mix within the recommended temperatures to ensure adequate density.

Joint Construction

A chain is only as strong as its weakest link, and for asphalt pavement, that link tends to be the joints that are created during construction. Paving should be as nearly continuous as possible without creating a joint. Joints should be placed between old and new pavement, and between fresh and previously cooled work to ensure bonding for the entire depth of the layer or layers being constructed.

Joints for continuing work are formed by cutting back into the previously placed material to expose the entire depth of the layers. When a new mat is adjoining an old mat, the joint shall be formed by saw-cutting the old mat transversely on a straight line to provide a butt joint for the entire depth of the new mat. Prior to commencing paving operations, a contractor should clean the contact surfaces of the joints prior to applying a tack coat.

The asphalt pavement should be constructed to minimize longitudinal joints from being located within the wheel paths of a driving lane.

Cold Weather Considerations

Compaction is of special concern during colder-weather paving (40 °F to 32 °F) because as ambient temperatures decrease, asphalt cool-down rates increase, and the time available for compaction is reduced. Therefore, if paving during cold weather is deemed necessary, special care should be exercised to ensure the HMA is sufficiently compacted before cessation temperature is reached in order to achieve the anticipated pavement life.

WAPA does not recommend paving when temperatures are below freezing (32 °F). Even when the ambient temperature is above 32 °F, other factors may have a cooling effect (high wind, precipitation, paving on a cold surface) that might recommend against paving.

Other Construction Considerations

Curb and Gutter

Many parking facilities have some form of curbing within and around the perimeter for both functional and aesthetic reasons (Figure 3.2).

Figure 3.2. Parking lot curbs can be both functional and aesthetic.

There are three common types of systems that are successfully used in Wisconsin: concrete curb and gutter;

vertical concrete curb; and concrete sidewalks constructed with a monolithic vertical curb face.

Truck Docks and Dumpsters

Areas in and around truck loading docks (Figure 3.3) and trash dumpsters represent severe loading conditions for the pavement and should be carefully considered when designing the parking lot. Light duty pavement sections used in these areas can be prone to premature failures. A designer should take two factors into consideration: the location of the loading dock or dumpster, and the pavement thickness in that area.

Figure 3.3. Truck Loading Area

If possible, locate the dumpster in such a way as to minimize the route that the garbage truck must travel through the parking lot to and from the dumpster pad. Routine truck traffic in an otherwise light duty section will result in a much thicker pavement design than is necessary for the project as a whole and will increase costs. It is typically more cost-effective to isolate a dumpster area and truck traffic to a small portion of the parking lot and address this area with a separate heavy-duty pavement design.

For areas with heavy waste containers and dumpsters, special pads and approaches are required to handle their special dynamic loading. Often, full-depth concrete or asphalt pads are constructed to handle this particular loading type. A common mistake made at many facilities is constructing pads that are only large enough for the dumpster to sit on. The severe loading and potential to damage the pavement structure come also from the trash trucks, not just the dumpster. Therefore, the pads need to be large enough to accommodate the trash truck (the front tires at a minimum) when servicing the dumpster.

Bumpers and Stops

There are a wide variety of bumpers, stops, and barricades commercially available for parking areas. Steel bollards are usually used to protect pedestrian walkways, fire plugs, structural supports, and other features. The application and use of these should be evaluated and included in the plans or contract.

Planned Stage Construction

Planned stage construction is the construction of an HMA parking lot or roadway in two or more stages, separated by a predetermined interval of time: the placement of a minimum depth of pavement during initial construction, and a final surface course at a planned future date.

As an example, for financial reasons, the owner of a new department store with a 350-space car parking lot may decide to stage-construct a 6½" depth asphalt parking lot. Stage 1 is constructed at the time the store is built, with a total depth of 4½" of HMA. Stage 2, consisting of the final surface course of 2", is placed at a later date. The truck loading zones and the dumpster areas are paved the full depth during initial construction.

Staged construction has the advantage of providing a thoroughly adequate all-weather pavement for the initial development of an area. Any damage to the Stage 1 pavement caused by traffic, settlements, or utility tear-ups can be repaired prior to placement of the final surface. With a proper asphalt tack coat, a Stage 2 pavement bonds to the old surface and becomes an integral part of the entire pavement structure.

Surface water drainage can be a problem if staged construction is planned for a project. Methods to allow water to drain off the lower pavement layer should be part of the design. These methods could include interim inlets (inlets temporarily placed at a lower elevation), curbs set lower at drainage points, and landscaping set lower at drainage points. Often the drainage points are raised once the asphalt surface is installed.

Staged construction requires careful planning. The parking lot construction costs can be minimized by reducing the number of project mobilizations by the contractor. The more times the contractor has to move in and move out of a project, the higher the cost. Therefore, it is important for the property owner or representative to plan the work to minimize the number of project mobilizations by the contractor.

Moreover, for staged construction (or whenever the placement of the surface lift will be delayed), the pavement section placed should be established so adequate depth of asphalt is provided for construction traffic.

4 Maintenance

Timely and consistent maintenance of a parking lot helps achieve the maximum life for the facility. The tools below will help ensure that the investment pays long-term dividends for the owner while providing users with a safe and attractive entry to the establishment.

Crack Sealing

All pavements will crack, and due to Wisconsin's extreme freeze/thaw cycles, it is extremely important to deal with cracks when they first appear in the pavement's life. Therefore, the first and most important of all maintenance activities is crack sealing.

The ideal time to do this maintenance is early spring when the cracks will be at their widest. As the ambient temperatures increase, the cracks will shrink and drive the crack filler deeper into the pavement. It may also be timely to perform crack sealing in the late fall to protect pavements against snow and ice damage. Crack sealing pavement cracks minimizes water infiltration into the pavement structure, and is a critical step in extending the service life of asphalt pavements.

Minor Repairs

As the pavement ages and isolated failures occur, these should be repaired as part of ongoing maintenance. The process is straightforward: identify the areas, saw-cut and remove the damaged pavement, over-excavate and stabilize the underlying subgrade as needed, fill in the area with asphalt mix, and compact. Alternatively, repairs may be conducted using infrared heaters or milling operations, depending on the type and severity of the damage.

Overlays

An asphalt overlay can be considered a maintenance technique if it is used early in the life cycle of a pavement to extend the time to reconstruction or replacement. This consists of repairing the isolated failed areas within the existing pavement structure followed by the installation of a new asphalt surface over the existing pavement. Please note:

- Milling of the existing surface in whole or part can be used to maintain elevations and drainage patterns.
- A leveling layer may be needed to re-establish smoothness prior to the overlay.
- Overlays should be constructed at a minimum of 1.5 inches.

Sealers

Asphalt sealers have been considered as a viable addition to a parking lot maintenance program, but they are only effective in certain circumstances.

If used, sealers should be applied early in the life of the parking lot and reapplied as necessary to provide protection against oxidation of the asphalt surface. Additionally, sealers can provide aesthetic benefits by giving the parking lot a new black look and allowing new pavement marking to stand out.

It is cautioned, however, that sealers are sometimes applied to old asphalt surfaces with the hope that this will extend the pavement life and delay replacement. This far exceeds the capabilities of sealers. Sealers are a surface treatment and as such they will wear off quickly under high traffic volumes and effectively do nothing for a pavement that is failing or has failed.

5 References

National Guidance

Asphalt Pavement Alliance.
www.asphaltroads.org

National Asphalt Pavement Association.
www.asphaltpavement.org

State Guidance

Colorado

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Iowa

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"Building the Perfect Parking Lot," Asphalt Paving Association of Iowa.
www.apai.net/Files/content/Iowa%20Asphalt%20Report/APAINewsletterWinter2017.pdf

Kentucky

"Asphalt Parking Lot Guide," Plantmix Asphalt Industry of Kentucky
www.paiky.org/wp-content/uploads/2013/05/Parking-Lot-Guide.pdf

Virginia

"Parking Lot Design," Virginia Asphalt Association.
www.vaasphalt.org/parking-lot-design/

Wisconsin

"Asphalt Parking Lots: The Smoothest Way to Welcome Customers," Wisconsin Asphalt Association and the Asphalt Pavement Alliance.
www.wispave.org/print-ads

Appendix
Inspection Checklist

To achieve the longest life and best performance from an asphalt parking lot, the entire construction process should be monitored for quality in both materials and workmanship. This begins with the subgrade and base layers, and continues throughout the paving process. The checklist on the next page is designed to help an on-site inspector identify key aspects of the process and follow best practices known to produce a quality pavement project.

The checklist is divided into the following categories.

- Safety
- Subgrade and Aggregate Base Layer Preparation
- Pre-Delivery Check
- Asphalt Mixture
- Asphalt Paving
  - Site Preparation
  - Paving Operation
- Compaction/Density
  - During Compaction
  - After Compaction
- After Completion

The checklist follows a brief discussion of each of these.

Safety

The most important key to a quality construction project is safety! Heavy construction can be dangerous, and steps should be taken to always keep workers and the public safe.

Subgrade and Aggregate Base Layer Preparation

A parking lot is only as good as the preparation of the subgrade and base materials. Extra effort spent making sure the pavement subgrade and base is correct will ensure a longer life for the parking lot. The subgrade (subsoil) and crushed aggregate base ultimately have to carry the load of the vehicles and pavement structure, so they need to provide a uniformly stable platform upon which to construct the asphalt pavement layers. It is crucial to correct any soft/unstable areas in the subgrade and base so they are stable (do not move) under construction traffic. Proper grading of the finished subgrade and base surfaces directs water to the drainage structures and prevents ponding.

Pre-Delivery Check

Before the asphalt mixture is delivered to the project, inspection of several items will ensure the site is ready for construction.

Asphalt Mixture

In the project specifications, design engineers will have determined the type of asphalt mixes suitable for this project. It must be verified that those mixes are the ones being delivered to the site. This is confirmed by checking the haul truck delivery tickets.

Asphalt Paving

Prior to the start of paving, the foreman and crew should determine the boundaries of the project and identify the paving lanes in sequence on the subgrade or milled surface. Once the paving has started, an inspector must monitor many items: temperature, layer thickness, smoothness, possible segregation of the mix, joint construction, yield checks, and other items. This is done through observation and use of such tools as a straight edge and thermometer.

Compaction/Density

Compaction is a critical part of the pavement installation. Proper levels of compaction can only be achieved when the asphalt mix is still hot and pliable. Proper mix compaction equates to low permeability, which keeps water out of the pavement and prevents moisture-related problems. The inspector should make arrangements to monitor the level of compaction in concert with a density gauge technician or by agreement with the paving contractor's quality control personnel. Continuous visual inspection of the paving operation is recommended during placement and compaction. The inspector should look for uniform pavement texture, straight lines at joints, good matching/tie-ins at physical features (sidewalks, curbs, planters, etc.) and proper attention to isolated areas that might be difficult to reach with a roller (valve boxes, manholes, obstructions, etc.).

After Completion

The last inspection step is ensuring that the finished product is ready to accept traffic before it is opened.

Inspection Checklist for Parking Lots

PROJECT:	INSPECTOR:	
Safety	**Completed**	**Comments/ Corrective Action**
1. Have you checked the site for possible safety issues?		
2. Has vehicle movement around the site been planned?		
3. Are overhead wires or obstructions clearly identified and marked?		
4. Have all utilities been located and marked?		
5. Have all underground objects been checked and marked?		
6. Can pedestrians navigate the site safely?		
7. Can all construction vehicles enter and exit the site safely?		
8. Are construction warning signs in place and easily seen on the site?		
9. Are cones and barriers being used to clearly mark the work zone?		
Subgrade and Aggregate Base Layer Preparation	**Completed**	**Comments/ Corrective Action**
10. Is the subgrade and base structure sound and stable? Has the subgrade and base been checked for adequate compaction with no visible water or movement? – If the soil is saturated or displaced under loaded trucks, the job should be postponed until the site can be proof rolled and uniform stability obtained.		
11. Are the subgrade and base layers smooth to ½" change over 10 feet?		
12. Is the correct amount and type of crushed aggregate material being installed on the project?		
13. Does the lot appear to be graded properly?		
14. Does it appear that the design layout will allow for proper water flow to catchbasins and curbs?		
15. Are all utility structures set at the proper grade to accept all layers of hot mix asphalt?		
16. Are all structures (catchbasins) cleaned and protected?		
17. Has the site been cleaned of debris and vegetation?		

(continued)

Inspection Checklist for Parking Lots (continued)

PROJECT:	INSPECTOR:	
Delivery Pre-Check	**Completed**	**Comments/ Corrective Action**
18. Is the subgrade or base compacted and ready to be paved upon?		
19. If a milled surface, is the milling pattern uniform?		
20. Is the depth of the milling correct for the depth of asphalt to be added?		
21. Are all structures adjusted to the proper grade?		
22. Are there any areas that need to be patched prior to paving?		
23. If a milled surface, has the milled surface been cleaned?		
24. Are potential obstructions to the construction equipment/trucks accounted for and protected/marked (e.g., fire hydrants, shallow utilities, cast-in-place concrete crossings)?		
25. Are construction equipment/delivery truck crossing points protected against damage (e.g., concrete driveways, existing paved surfaces)?		
26. Has the daily tonnage quantity been verified?		
Asphalt Mixture	**Completed**	**Comments/ Corrective Action**
27. Are the correct mix/mixes being used for the project per layer and at the appropriate layer thickness?		
28. Does the truck delivery ticket match the approved mix design?		
29. Review the tonnage estimate to be used to pave the project. Conduct yield checks on an ongoing basis and at the end of the day.		
30. Are there enough trucks to haul the mix needed to complete the job? (The goal is to balance the mix delivery schedule to avoid having to stop and start the paving operation.)		
31. Are the truck beds free of debris and tarped when they arrive on site?		
32. Is an approved biodegradable release agent being used? Diesel fuel is not allowed.		
Asphalt Paving	**Completed**	**Comments/ Corrective Action**
Site Preparation		
33. Was the project clean and free of debris/swept prior to tack application?		
34. If overlaying an existing pavement layer, has the surface received a tack coat application? – What is the specified application rate for the tack coat? – Is the application uniform? Does it cover the entire paving width? – Has the material been given enough time to break (for water to evaporate)?		

(continued)

Inspection Checklist for Parking Lots (continued)

PROJECT:	INSPECTOR:

Asphalt Paving	Completed	Comments/ Corrective Action
Paving Operation		
35. Is the equipment properly maintained and in good working order?		
36. Does the foreman have intimate knowledge of the project? – Are the paving lanes and passes painted out> Is a clear vision of the project apparent? – Has the proper rolling pattern been established?		
37. What is the specified compacted thickness in inches? How thick is the crew laying the mixture prior to compaction? (A rule of thumb is that a loose mat compacts ¼ inch per 1 inch.)		
38. Is the finished mat smooth, with no deviations greater than ¼ inch over 10 feet?		
39. Are there any signs of pattern segregation in the mix, particularly at the joints?		
40. Is the paving crew maintaining a continuous slope/grade between paver passes?		
41. Are both transverse and longitudinal joints being constructed properly?		
42. Are efforts being made not to broadcast mix onto the mat and to remove excessive coarse aggregate, especially in handwork areas?		

Compaction/Density	Completed	Comments/ Corrective Action
During Compaction		
43. Is the proper number of rollers and proper equipment being used to achieve the specified density?		
44. Has adequate time been allowed to ensure proper compaction given the conditions (weather, ground temperature, wet base, wind speed, etc.)? – Check the pavement temperature prior to compaction. It is recommended that a probe thermometer be used to check the internal temperature of the mat.		
45. Are the roller operators continuing to stay in motion and not parking equipment on the fresh mat while compaction is still progressing?		
46. Has adequate time been allowed to ensure proper compaction given the current weather?		
47. Ensure that extra compaction is performed in handwork areas.		
48. Is a density testing gauge used?		
49. Density targets are called out in the specification. Are they being achieved?		

(continued)

Inspection Checklist for Parking Lots (continued)

PROJECT:	INSPECTOR:	
Compaction/Density	**Completed**	**Comments/ Corrective Action**
After Compaction		
50. Upon visual inspection, does everything look correct?		
51. Are there any signs of depressions or water puddles on the mat?		
52. Is the final lift thickness correct after compaction?		
53. Are all joints properly compacted?		
54. Upon completion, is the project area neat and clean?		
55. Has the mat cooled sufficiently to support traffic? – To avoid scuffing, be sure the surface has cooled prior to opening to traffic.		
56. Has additional curing time been provided when paving is performed on a hot day?		
57. Has the striping plan (layout, colors, symbols, signage, etc.) been verified prior to striping?		
After Completion	**Completed**	**Comments/ Corrective Action**
58. Do you have copies of all truck delivery tickets?		
59. Do you have a record of all the density measurements you took during the project?		
60. Do you have all the necessary temperature recordings?		
61. Has a walk-through inspection of the completed project been scheduled with the owner to ensure satisfaction with the workmanship and finished product?		