IN-LB	Inch-Pound Units
SI	International System of Units

An ACI Standard

Commercial Concrete Parking Lots and Site Paving Design and Construction—Guide

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Commercial Concrete Parking Lots and Site Paving Design and Construction—Guide

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Commercial Concrete Parking Lots and Site Paving Design and Construction—Guide

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Concrete parking lots serve many kinds of public facilities, commercial and retail developments, businesses, and multifamily housing projects. They primarily accommodate parked vehicles but may also provide maneuvering areas and access for delivery vehicles. The design and construction of concrete slabs for parking lots and outside storage areas share many similarities with the design and construction of industrial pavements, streets, and highways, but they also have some very distinct differences. A full appreciation of the differences and the modification of design and construction procedures to take these differences into account can result in economical concrete parking lots that will provide satisfactory service for many years with little maintenance.

This guide includes information on site investigation, thickness determination, design of joints and other details, durability considerations, paving operations, and quality-assurance procedures during construction. Maintenance and repair are also discussed.

Information related to the design and construction of concrete site paving for industrial and trucking facilities is in ACI 330.2R.

Keywords: commercial; concrete pavement; curing; finishing; joints; light duty; parking lot; subgrade; thickness; traffic loads.

CONTENTS

CHAPTER 1—INTRODUCTION AND SCOPE, p. 2
1.1—Introduction, p. 2
1.2—Scope, p. 3

CHAPTER 2—NOTATION AND DEFINITIONS, p. 4
2.1—Notation, p. 4
2.2—Definitions, p. 5

CHAPTER 3—PAVEMENT DESIGN, p. 5
3.1—Introduction, p. 5
3.2—Pavement stresses and cracking, p. 6
3.3—Traffic loads, p. 6
3.4—Subgrade support, p. 6
3.5—Concrete properties, p. 7
3.6—Thickness design, p. 7

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3.7—Jointing, p. 9
3.8—Steel reinforcement in parking lot pavements, p. 10
3.9—Fiber reinforcement in parking lot pavements, p. 11
3.10—Joint filling and sealing, p. 11
3.11—Pavement grades, p. 12
3.12—ADA/ABA-AG surface profile requirements, p. 12
3.13—Other design features, p. 12
3.14—Design examples, p. 13

CHAPTER 4—CONCRETE MATERIALS AND MIXTURE PROPORTIONING, p. 13
4.1—Introduction, p. 13
4.2—Cementitious materials, p. 13
4.3—Mixing water, p. 14
4.4—Aggregates, p. 14
4.5—Admixtures, p. 14
4.6—Fibers, p. 15
4.7—Concrete mixture analysis, p. 16

CHAPTER 5—CONSTRUCTION, p. 18
5.1—Introduction, p. 18
5.2—Subgrade and Subbase preparation, p. 19
5.3—Layout for construction, p. 20
5.4—Forming and the use of rigid screed guides, p. 21
5.5—Concrete placement, screeding, and finishing, p. 21
5.6—Tools and equipment for placing and finishing, p. 26
5.7—Installation of the different joint types, p. 26
5.8—Joint sealing or filling, p. 29
5.9—Curing, p. 29
5.10—Special considerations for adverse weather conditions, p. 29
5.11—Striping, p. 30
5.12—Opening to traffic, p. 31

CHAPTER 6—INSPECTION AND TESTING, p. 31
6.1—Introduction, p. 31
6.2—Site preparation and grading, p. 31
6.3—Subgrade and subbase, p. 31
6.4—Forming, p. 32
6.5—Reinforcing steel, p. 32
6.6—Concrete quality, p. 33
6.7—Concrete curing, p. 33
6.8—Jointing, p. 34
6.9—Surface texture, p. 34
6.10—Thickness testing, p. 34

CHAPTER 7—MAINTENANCE AND REPAIR, p. 34
7.1—Introduction, p. 34
7.2—Surface sealing, p. 34
7.3—Joint resealing and crack sealing, p. 34
7.4—Partial-depth repair, p. 35
7.5—Full-depth repair, p. 35
7.6—Stabilization and slab jacking, p. 35
7.7—Parking lot cleaning, p. 35

CHAPTER 8—REFERENCES, p. 35
Referenced standards and reports, p. 35
Authored references, p. 37

APPENDIX A—PROCEDURES FOR CONCRETE PAVEMENT DESIGN, p. 38
A.1—Source of thickness tables, p. 38
A.2—AASHTO procedure, p. 39

APPENDIX B—SUBGRADE, p. 39
B.1—Introduction, p. 39
B.2—Soil classification, p. 39
B.3—Problem soils, p. 39
B.4—Expansive soils, p. 39
B.5—Frost action, p. 40
B.6—Pumping, p. 40
B.7—Support uniformity, p. 40

APPENDIX C—SUGGESTED DETAILS, p. 41
C.1—Pavement jointing and design feature details, p. 41

APPENDIX D—PARKING LOT GEOMETRICS, p. 43
D.1—Parking requirements, p. 43
D.2—Entrances and exits, p. 43
D.3—Truck maneuvering areas, p. 43
D.4—Additional information, p. 45

APPENDIX E—DESIGN EXAMPLE: STRIP MALL, p. 45
E.1—Geotechnical/materials engineering report, p. 45
E.2—Loading data and traffic patterns, p. 45
E.3—Pavement area thickness and joint spacing design, p. 45
E.4—Tie-bars, dowels, and reinforcement, p. 47
E.5—Joint types, location, and sealing, p. 47
E.6—Curbs, p. 48
E.7—Panel sliding, p. 48
E.8—Texture, p. 48
E.9—Slopes, p. 48
E.10—Parking space layout (unless otherwise required by local ordinances), p. 48
E.11—Concrete mixture, p. 48

APPENDIX F—FIBER JOINT SPACING, p. 48

CHAPTER 1—INTRODUCTION AND SCOPE

1.1—Introduction

Concrete parking lots serve many different types of facilities and are generally similar in design and construction to other types of concrete pavements. They differ, however, in that the primary role of a parking lot is typically to accommodate storage of vehicles rather than moving traffic, and the pavement loads and geometry differ accordingly. Parking lots tend to be designed for slower vehicle movement, more random traffic patterns, and fewer design load repetitions than streets, highways, airport runways, intermodal yards, and industrial or trucking facility pavements.

The design of concrete parking lots should follow the generally accepted procedures outlined in this guide. Load-bearing capacity, drainage, crack control, life-cycle cost, constructability, safety, sustainability, and maintainability are important considerations that impact good design.

Concrete parking lots may be designed to accommodate light vehicles, heavy trucks, or a broad spectrum of vehicle loads as appropriate for the application. Where a variety of loads must be accommodated, the use of traffic controls to separate and channel the heavier trucks away from areas designed for automobiles and light trucks will result in a more economical and sustainable design. Facilities intended to serve only light vehicles may have concrete parking lot panels with thicknesses influenced by constructability and environmental effects rather than by the pavement stress created by vehicle loads. Durability-related distress is often the most critical maintenance concern for lightly loaded concrete parking lot pavements, which are subject to the effects of fuels and lubricants leaked from vehicles, precipitation and drainage, deicer salts, and other environmental influences. Vehicles in parking areas usually travel at low speeds, diminishing the importance of smoothness tolerances. Because parking lots must also accommodate pedestrians, designs and geometrics should reflect pedestrian safety considerations, including crosswalks, a slip-resistant surface texture, and night-time illumination.

Concrete parking lots range in size from small, such as at corner convenience stores, to medium, such as at multi-unit housing projects, to large, such as those for shopping centers and office or commercial developments. Most parking areas include driveways, some of which must accommodate relatively heavy loads. Special consideration may be needed if access to garbage trucks, dumpsters, and/or delivery trucks is to be included. Accordingly, concrete parking lots are constructed with a wide variety of construction equipment, ranging from hand tools and vibratory screeds to large highway paving equipment or laser-guided screeds.

The stiffness of rigid concrete pavements distributes wheel loads over larger areas of the subgrade than do flexible asphalt pavements, resulting in lower subgrade stresses. Thus, thinner total pavement structures are usually possible for a given site when concrete is used. Additional benefits of concrete parking lots include the following:

a) Concrete surfaces resist deformation from maneuvering vehicles

b) Concrete surfaces drain well with only minimal slopes

c) Concrete has relatively simple maintenance requirements

d) Traffic-lane and parking-stall markings can be incorporated into the jointing pattern

e) Concrete is minimally affected by leaking petroleum products

f) The light-reflective surface of concrete can be efficiently illuminated with minimal energy requirements

g) Concrete parking lots reduce the impacts of the urban heat island effect relative to those of asphalt parking lots by producing lower surface temperatures, thus providing a cooler urban environment and reducing ozone production.

The sustainable construction benefits of concrete are considerable as compared with other pavement materials. Concrete parking lots typically have service lives of 20 years or more, negating the need for more frequent rehabilitation that would use additional aggregates and other nonrenewable resources. In addition to opportunities for the use of sustainable concrete component materials such as recycled aggregates and supplementary cementitious materials derived from industrial by-products, concrete's light-colored surface helps reduce reflected solar radiation, and its higher reflectivity can reduce illumination requirements considerably. Lower resulting energy requirements are realized throughout the facility's life cycle. Pervious concrete may be useful in reducing storm water runoff from the site (refer to ACI 522R). At the end of the service life, concrete can be recycled into aggregates and pavement subbase materials. These and other attributes of concrete can be useful in obtaining LEED Green Building certification for a project (NRMCA 2014).

1.2—Scope

This guide is based on the current knowledge and best practices for the design, construction, and maintenance of concrete parking lots placed on the ground. Some of these practices differ from those used in the design and construction of streets, highways, floors and other types of pavements and flatwork. This guide is not a standard or a specification, and it is not intended to be included by reference in construction contract documents; ACI 330.1 can be used for these purposes.

Parking lots have most loads imposed on interior slabs surrounded by other pavement. Highway and street pavements carry heavy loads along and across free edges and are subjected to greater deflections and stresses. Streets and pavements are usually designed to drain toward an edge where the water can be carried away from the pavement. Parking lots are usually designed so some of the water is collected internally and is conveyed away through underground systems. In urban areas where rainfall runoff from large impervious surfaces is regulated, parking lots often serve as detention basins (not addressed in this guide). This means that the pavement should store water for a period of time without incurring any damage due to loss of support from a saturated subgrade. Parking lots often accommodate appurtenances, such as lighting standards, drainage structures, traffic islands, and landscaped planting areas. Provisions for these appurtenances should be considered in the design of the jointing system and the layout for construction.

Some design methods for concrete parking lot pavements have been based on methods developed for the design of highway pavements such as the Portland Cement Association (1984a,b) method and the AASHTO (1993) design method. These methods are primarily concerned with limiting stresses in the slab (PCA) and the reductions in serviceability caused by mixed traffic (PCA and AASHTO), including heavy trucks, while parking lots usually serve fewer vehicles either parked or traveling at slow speeds. Additionally, AASHTO (1993) is a purely empirical method where the relevant range of vehicle types, subbase and subgrade materials, and pavement repetitions are generally outside of the relevant range for parking lots. Figure 1.2 presents a typical section through a concrete pavement showing subbase and subgrade layers. For many parking lots intended for only light traffic loads, the need for an extensive design process may be less

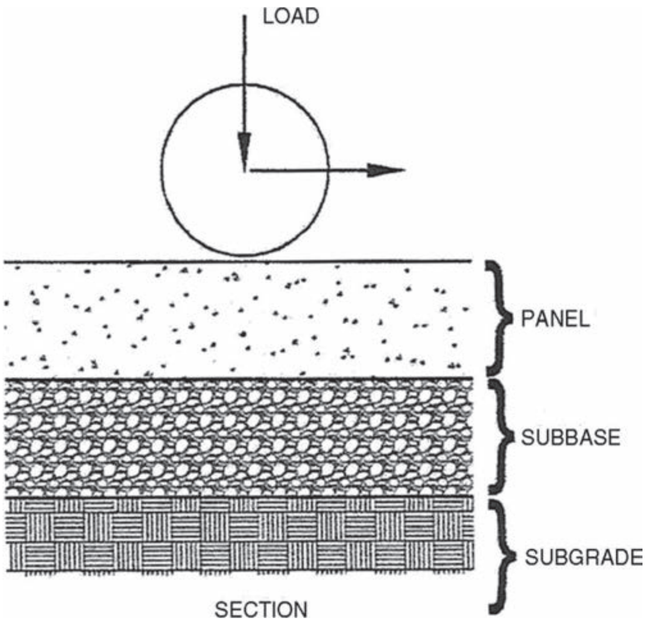

Fig 1.2—Panel support system terminology.

critical. For such projects, a designer can rely on past experience to select conservative values for the design criteria of subgrade soil support and imposed vehicle loads. In these cases, a conservative selection of pavement thickness is prudent practice.

The widely accepted PCA method has been incorporated and extended into the web based Uniform Pavement Design software (PavementDesigner.org) and is the principal design tool used in this guide. Its ability to model traffic spectra typically encountered in parking lots, and its stress/fatigue-based mechanistic-empirical algorithm make it an appropriate procedure for parking lot design. Conversely, the AASHTO (1993) procedure is based on limited testing and materials used over a half-century ago for high-volume highway traffic at high speeds. It is not a stress- or fatigue-based method and its applicability is outside the relevant range of vehicle types, base and subgrade materials, and pavement repetitions typically encountered in parking lots. It is not used in this guide and is not recommended for parking lot design.

Although thickness design is important, other aspects of parking lot design are equally critical. Often, if a concrete parking lot has performed poorly, it is due to non-thickness-related design and construction issues. These may include:

a) Unsuitable subgrade support

b) Improper joint spacing and patterns

c) Improper placement and detailing of isolation and construction joints

d) Inappropriate use of deformed steel reinforcing bars for odd-shaped panels, tying certain panels together, and other specific functions

e) Poor construction aspects such as concrete mixture proportioning, placement and finishing methods, curing, and saw-cutting

f) Insufficient maintenance for joints and pavement, as needed

These layout and construction issues are addressed in this guide.

Determining and specifying practical thickness tolerances for pavements is important. Reduction of the pavement thickness beyond tolerance recommendations can unacceptably increase pavement stresses, reduce pavement structural capacity, and reduce pavement life. Although construction smoothness tolerances are not critical for parking areas for low-speed traffic, smoothness is important where concrete surfaces are expected to drain well and carry water long distances across pavements with minimal slope.

Aesthetic considerations of surface texture and crack control in parking lots can be important because of close scrutiny from pedestrians and the owner's desire to project a quality image. In large parking lots, it is important to direct traffic into designated driving lanes and deter heavy vehicles from crossing thin pavements. The future expansion of a parking lot and the facility it serves should also be considered during initial design so that light-vehicle pavements are not required to accommodate future heavy loads. Industries and shopping centers served by public transportation, and schools served by buses are examples where expansion can transform auto parking areas into more robust truck or bus driveways.

Previous versions of this document were intended to address a relatively broad scope of traffic types and loads, including truck traffic up to 700 trucks per day and concrete thickness of up to 9 in. (225 mm). In 2017, however, ACI Committee 330 published ACI 330.2R, "Guide for Design and Construction of Concrete Site Paving for Heavy Industrial and Trucking Facilities," which covers the design and construction of pavements for higher volumes of over-the-road trucks, and some special vehicles and applications. Because 330.2R more completely addresses pavements for heavier loadings, including more detailed design of subgrades and subbases, load transfer at joints, and other challenges, the scope of 330R has been reduced relative to design for higher truck volumes and heavier vehicle loads. Therefore, this guide is now written for light-duty, unreinforced, undoweled concrete parking lots. It is applicable for:

a) Passenger vehicle parking areas, where vehicles other than cars and light-duty trucks are channeled to other areas

b) Driveways and drive lanes that can include some trucks, busses, or fire trucks

c) Delivery and trash pickup areas that may see moderate numbers of loaded tractor trailers, delivery trucks, and/or garbage trucks

While there will naturally be some overlap between the two documents, the user is encouraged to consider referring to 330.2R whenever designs approach or exceed the upper limits of loading scenarios, and/or when the designer chooses to incorporate dowels or reinforcing for load transfer.

CHAPTER 2—NOTATION AND DEFINITIONS

2.1—Notation

Notation used in the Appendixes are not listed herein but are shown immediately after the corresponding figure or