Designing Quality Concrete Parking Areas





Best Practices for Engineered Quality and Value

Concrete Delivers

Engineered concrete solutions for sustainability, durability and value.

www.concreteparking.org

The Value of Quality

The parking area of a building has become an integral part of total site development. Examined within the broad context of a building's construction and financing, the value of concrete for parking areas and the advantages to the building owner become evident:

- Competitive first cost
- Low life-cycle cost
- Upscale appearance
- Higher reflectivity means improved safety
- Environmentally friendly

Key role in sustainable development

To achieve these benefits it is important to follow some basic cost-savings guidelines.

Preparing the Subgrade For Best Performance

Proper subgrade preparation will ensure superior performance of your concrete pavement. While no special subbase is required, it is important that the soil type, moisture content, and density of the subgrade be uniform. Replace non-uniform subgrade areas with materials that are similar to the rest of the area.

Compaction should be performed when the moisture content of the soil is slightly above its optimum.

The subgrade must also be reasonably smooth and without tire ruts so that the concrete placed over it will be uniform in thickness. Compaction, when necessary, should be performed when the moisture content of the soil is slightly above its optimum. Pavement thickness requirements and performance strength depends on strength and uniformity of the subgrade. Refer to *ACI 330 - Guide for Design and Construction of Parking Lots* for detailed information regarding subgrade *k* values.

Material & Proportions

Quality concrete starts with a well-chosen mixture using consistently high quality materials. ASTM C 94, *Specification for Ready Mixed Concrete*, addresses requirements for production and delivery of ready mixed concrete.

Concrete with a specified 28-day compressive strength of 4000 psi (28 MPa) is adequate for most areas of the country, unless a more rigorous design analysis of load bearing capacity or durability considerations dictate a higher strength. Compressive strength is the most common and easiest property of concrete to measure, and as such, it is the property most used when specifying concrete. Flexural strength is not used for acceptance of concrete for parking area pavements. Empirical relationships between flexural and compressive strengths of concrete can be used if the former property is needed in design. ACI 330 suggests $M_R = 2.3 f'^{(2/3)}_c$ in psi.

In regions where the parking area pavement will be subjected to freeze-thaw cycles, air entrainment is essential. See Table 1 for recommended air contents based on the size of coarse aggregate used. The Severe Exposure category applies to situations where deicing chemicals will be used on the parking area. Air entrainment in concrete also enhances workability and reduces bleed water. This will improve the ability to place and finish the pavement and for that reason air entrainment can be an option even where freeze-thaw conditions do not exist. Concrete mixture with a slump between 3 - 5 inches is of the appropriate consistency to place and finish a good quality pavement for parking areas. Curing of concrete is a very important step to ensure a long lasting durable pavement.

Table 1 - Recommended Air Contents for Durable Concrete

Maximum Size Aggregate		Total Target Air Content Percent	
		Severe Exposure	Moderate Exposure
3/8 in	(9.5 mm)	7-1/2	6
1/2 in	(12.5 mm)	7	5-1/2
3/4 in	(19.0 mm)	6	5
1 in	(25.0 mm)	6	4-1/2
1- 1/2 in	(37.5 mm)	5-1/2	4-1/2
2 in	(50.0 mm)	5	4

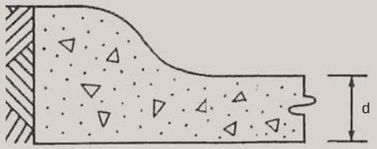
Selecting the Optimum Concrete Thickness

The thickness of a concrete parking area should be selected according to the kind of traffic loading it will receive, the type of subgrade on which it is to be built, and the strength of the concrete to be used.

For passenger cars and panel or pick-up trucks only: 4-in. (100 mm) thick nonreinforced concrete is usually satisfactory.

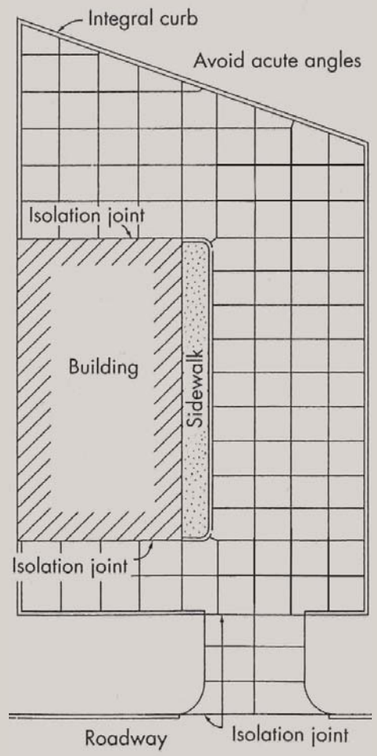
For driveways and parking areas accommodating light trucks: 5- or 6-in. (125-150 mm) thick pavement may be required for heavier industrial and commercial needs. Refer to *ACI 330 - Guide for Design and Construction of Parking Lots* for thickness design guidelines. Table 2 is an excerpt from ACI 330.

A thickened edge is recommended on the outside of slabs subjected to wheel loads. This thickened edge usually takes the form of an integral curb. Fill material should be compacted behind the curb or thickened edge to minimize lateral movement of the outside slabs. Consider flowable fill for this application.



Integral curbs strengthen the edges of parking area slabs to enhance load-carrying capacity.

If possible, designate truck lanes on the plans for the parking area. This will allow the use of different thicknesses for different loads, which can mean substantial savings on large projects.



Typical parking area joint layout. Joint spacing should not exceed 24 to 30 times the pavement thickneess with a maximum spacing of 15 ft (4.5 m).

Jointing Guidelines

Joints in concrete parking areas aid construction and control the location of cracks.

Laying out joints in a slab requires good engineering judgment based on a few basic rules.

It is recommended that you follow these guidelines unless local experience indicates otherwise.

- Joint spacing should not exceed 24 to 30 times the pavement thickness with a maximum spacing of 15 ft. (4.5m).
- Lay out joints to form square panels. When this is not practical, rectangular panels can be used if the long dimension is no more than 1.5 times the short.

Contraction joint cross-section

- Contraction joints should have a depth of at least one-fourth the slab thickness.
- Isolation joints should extend the full depth and should be used only to isolate fixed objects abutting or within the paved area.
- Contraction joints should run continuously and extend through integral curbs. Joints can be terminated and offset at isolation joints.

- Adjust jointing layout or location of manholes, catch basins, small foundations, and other built-in structures so that the joints will line up with the corners of the structures.
- Offset contraction joints to avoid acute angles or small pieces of slab at curves. Offsets should be at least 1-1/2 ft. (0.5 m).
- When sawing contraction joints, begin as soon as possible without raveling the new concrete.
- Construction joint location should be determined by the contractor's equipment and procedures.

Table 2 - Design Thickness in Inches for Various Categories of Use

Traffic Category See Legend Below	CBR = 3 k = 100 pci				CBR = 10 k = 200 pci				CBR = 26 k = 300 pci			
M_R(psi)	650	600	550	500	650	600	550	500	650	600	550	500
≈f'_c (psi)	4750	4200	3700	3200	4750	4200	3700	3200	4750	4200	3700	3200
A	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
A-1 (ADTT = 1)	4.0	4.5	4.5	5.0	4.0	4.0	4.5	4.5	4.0	4.0	4.0	4.5
A-1 (ADTT = 10)	5.0	5.5	6.0	6.0	4.5	5.0	5.5	5.5	4.5	4.5	5.0	5.5
B (ADTT = 25)	5.0	5.5	6.0	6.5	4.5	5.0	5.5	6.0	4.5	4.5	5.0	5.5
B (ADTT = 300)	5.5	6.0	6.5	7.0	5.0	5.5	6.0	6.5	5.0	5.5	5.5	6.0
C (ADTT = 100)	6.0	6.0	6.5	7.0	5.5	5.5	6.0	6.5	5.0	5.5	6.5	6.0
C (ADTT = 300)	6.0	6.5	7.0	7.5	5.5	6.0	6.5	7.0	5.5	5.5	6.0	6.5
C (ADTT = 700)	6.5	6.5	7.0	7.5	6.0	6.0	6.5	7.0	5.5	6.0	6.5	6.5
D (ADTT = 700)	8.0	8.0	8.0	8.0	7.0	7.0	7.0	7.0	6.5	6.5	6.5	6.5

Traffic Category Legend

A - Car parking areas and access lanes

A-1 - Truck access lanes

B - Shopping center entrances and service lanes

B - City and school bus parking areas and interior lanes

B - Single unit truck parking areas and interior lanes

C - Bus parking areas-entrance and exterior lanes

C - Single unit truck entrance and exterior lanes

D - Multiple unit truck entrance and exterior lanes

Construction Practices

Many types of equipment are available for paving parking areas, from simple hand screeds and floats to sophisticated slip form paving machines. The choice of construction methods should be made by the contractor based on project size and available equipment. Once the type of equipment has been selected, a paving sequence and jointing plan should be developed to assure smooth operations.

Where feasible, a small key should be used at construction joints to minimize differential vertical movement of adjacent slabs.

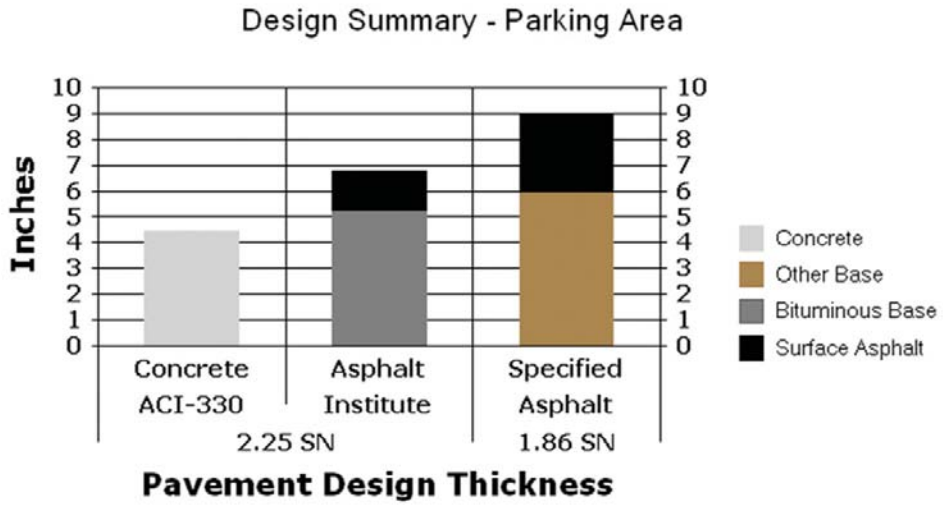
Other procedures that will ensure a quality job are listed below:

- Slope pavement 1% or 1/8-in. per foot (10 mm per meter) to drainage points
- With dry and windy conditions, moisten subgrade just prior to placement of concrete.
- Avoid overfinishing slabs. Generally a bullfloat finish, followed by a light broom texturing provides a durable, skid resitant surface.
- Cure fresh concrete. Liquid membrane-forming curing compound is usually the most cost-effective curing method.
- Keep automobile traffic off the slab for 3 days and truck traffic off the slab for 7 days, unless tests are made to determine that the concrete has gained adequate strength. This is usually 3000 psi (20.7 MPa).

NRMCA Concrete in Practice series covers several topics on good practices for construction of exterior slabs. www.nrmca.org.

Try Concrete Pavement Analyst - A powerful, easy-to-use design and costing tool from NRMCA

Concrete Pavement Analyst (CPA) software quickly, accurately and easily quantifies the differences between concrete and asphalt pavements. Using ACI and Asphalt Institute recommendations, CPA provides thickness design guidelines based on soil support and traffic. CPA allows designers to evaluate local specifications as well, to determine if designs are sufficient for intended use. CPA also compares total ownership costs; giving engineers specifiers, and owners the information they need to make sound pavement selection decisions. It is a flexible, market-specific, and comprehensive tool packaged with *ACI 330 Guide for Design and Construction of Parking Lots*, *Specification for Unreinforced Concrete Parking Lots*, and other important electronic tools to support parking area design needs. For a demo, or to order, call 1-888-84-NRMCA.



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