

Are You Next?

As steel-framed parking structures become more common, you may be asked to design one. We have resources that can help.

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STEEL FRAMED PARKING STRUCTURES ARE PROVIDING OWNERS WITH SAFE, EASY-TO-MAINTAIN, AND ECONOMICAL PARKING SOLUTIONS. More and more are built each year. You may be asked to design one.

As many parking structures are open deck, and are therefore exposed to the elements, considerations aside from those in typical steel framed construction need to be made and include the following:

Corrosion resistance for the steel framing. Exposed structural steel members need to be protected from the elements based on the severity of the atmospheric exposure. Steel-framed parking structures today are radically different than their predecessors. New high-performance paint systems and modern galvanizing techniques have satisfied corrosion concerns and provide a protective, attractive finish that lasts for decades and lowers life cycle costs below that of alternate materials.

Special detailing and design of the parking slab. Any of the common deck systems for parking structures can be utilized with a structural steel frame. Care should be exercised to specify the proper concrete mix with admixtures, drainage details, and surface treatments needed to provide a durable slab. The struc-

tural engineer may need to turn to specialists to assist with the slab design.

Temperature effects on the structure. Expansion and contraction of the concrete slab can lead to cracks and significant slab damage if not taken into consideration during the design. Expansion joints need to be properly spaced and the location of lateral restraint of the slab carefully examined to avoid these problems.

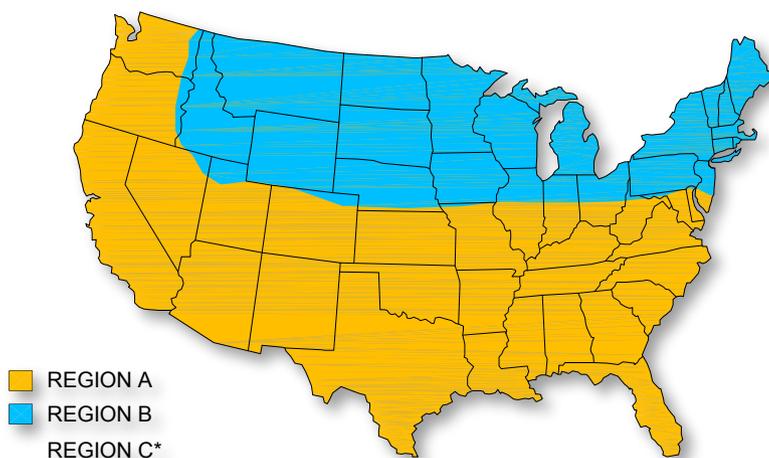
Structural engineers need to be able to evaluate the merits of various framing systems and understand the non-structural parameters that go into the planning of a parking garage, so that they will be able to provide professional guidance to garage owners and other members of the project team.

To assist structural engineers designing a parking structure for the first time we have compiled a short list of the most helpful resources providing both structural and non-structural guidance for steel-framed parking structures.

Parking Structures: Planning, Design, Construction, Maintenance and Repair

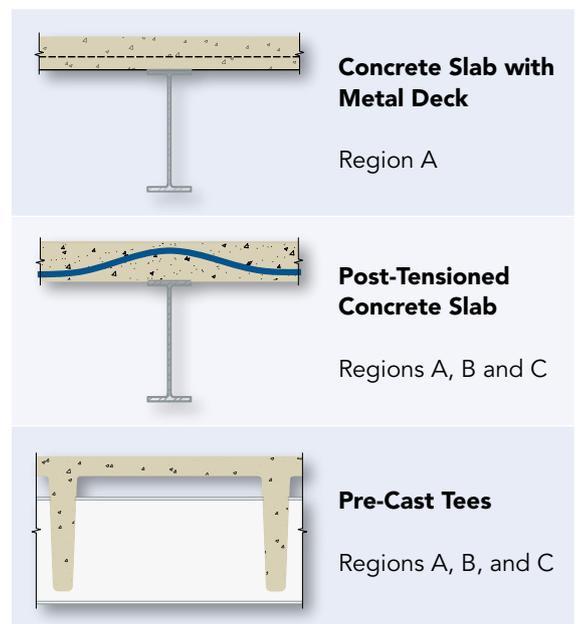
This book, by Chrest, Smith, Bhuyan, Monohan, Iqbal (2001), is the most comprehensive reference for parking structures from

Figure 1. Map of durability regions and recommended slab types.



- REGION A
- REGION B
- REGION C*

*Region C is defined as any site within 1/2 mile of a salt water body.



functional and structural design to maintenance. As the name suggests, there is extensive guidance on stall, drive lane, and ramp configuration along with discussions of building codes, fire-protection requirements, ADA requirements, and structural framing. The book offers guidance on what slab systems to choose and how to design them. Temperature and shrinkage effects are covered with suggested details and guidance on reducing cracking in the slab. The text includes a section on steel framing supporting concrete slabs.

Steel Design Guide 18: Steel-Framed Open-Deck Parking Structures

Published by AISC, this reference is the industry standard for steel-framed parking structural frame considerations throughout the life of a garage. The structural frame is covered in two parts: deck systems and framing systems.

Various deck systems are discussed, including cast-in-place post-tensioned flat slabs, precast double tees, and concrete-on-metal deck. Each system is evaluated for its advantages and disadvantages. Recommendations are made for deck selection depending on environmental exposure. Figure 1 indicates where the three main systems are generally most appropriate based on slab durability alone. In areas of high seismic activity the structural system should be evaluated for the increased demands, especially a system with a diaphragm consisting of precast double tees. Drainage, curing, temperature effects, slab cracking, construction and expansion joints, maintenance, and good practice for durable construction for deck systems are also covered.

The arrangement of structural framing depends on the deck system and the parking layout. Efficient bay arrangements and typical steel member sizes for typical arrangements are tabulated. Lateral bracing, camber, connection design, and temperature effects are also discussed. The design guide contains in-depth examples of structural design for several framing systems.

Figure 2. Service Life for Galvanized Coatings (source: American Galvanizers Association).

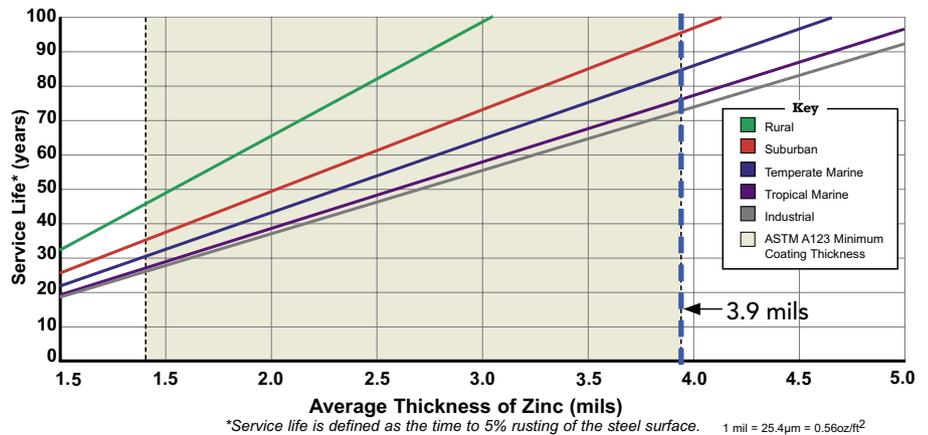


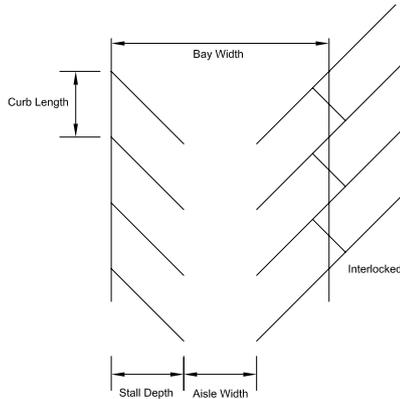
Figure 3. Building Code Requirements.

| Fire Resistive Requirement | NFPA 88A Type II | | IBC Type IIB | |
|----------------------------|---|----------------|---------------------------------------|----------------|
| | None | | None | |
| Definition of Open Side | 1.4 sq. ft of each linear foot distributed along 40% of the perimeter | | 50% of interior wall area of the side | |
| | sq. ft/tier | No. of tiers | sq. ft/tier | No. of tiers |
| 2 sides open | unlimited* | height ≤ 75 ft | 50,000 | 8 |
| 3 sides open | unlimited* | height ≤ 75 ft | 62,500 | 9 |
| 4 sides open | unlimited* | height ≤ 75 ft | 75,000 | 9 |
| Exception* | | | unlimited* | height ≤ 75 ft |

*The distance from any point on the deck may not be greater than 200 ft from an open side.

Figure 4. Level of Service.

| | Park Angle | | | | | | | |
|----------------------------|-------------|-------|-------|-------|-----------------|-------|-------|-------|
| | Interlocked | | | | Non-Interlocked | | | |
| | 45° | 60° | 70° | 90° | 45° | 60° | 70° | 90° |
| Curb length (ft) | 12.33 | 10.10 | 9.33 | 8.75 | 12.33 | 10.10 | 9.33 | 8.75 |
| Depth of stall (ft) | 13.60 | 16.60 | 17.50 | 17.75 | 17.50 | 18.75 | 19.00 | 17.75 |
| Aisle width (ft) | 13.67 | 15.50 | 17.50 | 25.00 | 13.67 | 15.50 | 17.50 | 25.00 |
| Bay width (ft) | 40.87 | 48.70 | 52.50 | 60.50 | 48.67 | 53.00 | 55.50 | 60.50 |



Durability of a parking structure is key to a successful project. Significant advances have been made in the corrosion protection of structural steel. High-performance paint systems have proven to be durable for decades, with some manufacturers providing a 20-year to 25-year guarantee of their product. The design guide offers guidance on the available systems and the required surface preparations. Galvanizing is also an excellent method of long term corrosion control. The expected life to 5% surface corrosion of galvanized steel is shown in Figure 2. Life expectancy is a function of the thickness of zinc applied in the galvanizing process. Structural steel is galvanized per ASTM A123, which typically requires a minimum zinc thickness of 3.9 mils. This thickness is indicated in Figure 2 with a dashed line. The design guide offers detailed guidance on choosing a system and even provides a sample protective coating specification.

Under the International Building Code stand-alone, open-deck parking structures under 75 ft tall do not require fire protection. Figure 3 indicates the area and height limits for varying degrees of openness. Fire protection requirements for mixed-use buildings and enclosed parking garages are also discussed.

Innovative Solutions in Steel: Open-Deck Parking Structures

This design aid published by AISC provides the information an engineer needs beyond the structural frame to help work with the design team to select the ideal framing system. The aid contains the basics on parking layout, including stall depth, aisle width and bay width, as shown in Figure 4. There is also information on ramp configurations and required lengths, clear height requirements, ADA requirements, and safety and security considerations.

Suppliers

Fabricators, galvanizers and paint manufacturers are a great resource for detailed information about their product, including life cycle, maintenance, specification, and cost. The Solutions Center can help you find these suppliers.

Steel Solutions Center

Questions on how to design a steel-framed parking structure? Technical support is only an email or phone call away (866.ASK.ASIC or solutions@aisc.org). The Solutions Center can help you look into the benefits of a steel-framed solution and help you determine the optimal solution for your project. **MSC**

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