PCI special report

Precast/Prestressed Concrete Parking Structures

Produced by the Prestressed Concrete Institute,
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Precast/Prestressed Concrete: Leader in Fighting Corrosion

Precast/prestressed concrete leads all competing structural systems in providing superior corrosion resistance for parking structures. Why? Because only precast/prestressed concrete can be fabricated and erected with the kind of stringent quality control that is a prerequisite for durability.

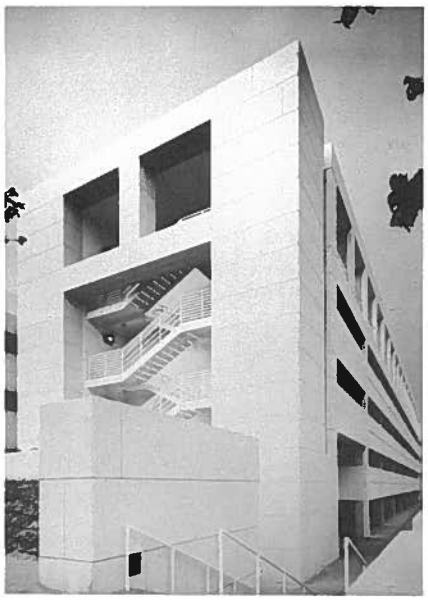
Corrosion in parking structures is a serious problem with costly consequences for owners and developers. In fact, it has been estimated that existing corrosion damage to North American parking structures, added to the well-known corrosion decay of bridge decks, may cost up to $75 billion to repair.

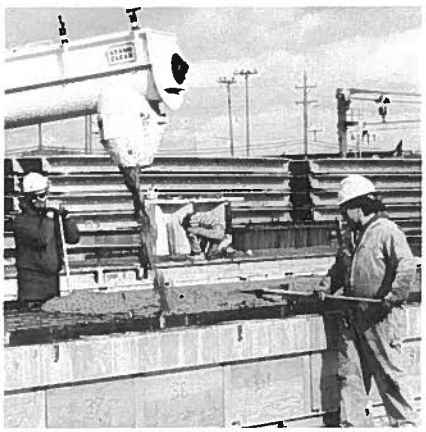
The most cost-effective way to deal with corrosion is to build corrosion-resistance into the parking structure, through the use of proper design and construction techniques. Parking structures can be made significantly more corrosion-resistant through the use of more impermeable concrete, increased cover over reinforcement, reducing the incidence and severity of surface cracking, and providing adequate drainage.

It is precisely these qualities that are built into every precast/prestressed concrete parking structure.

Water/Cement Ratio. Water/cement (w/c) ratio is thought to be the primary mix design factor in determining the degree of protection concrete offers to steel. The lower the w/c ratio is, the more impermeable the concrete will be, the more strength it will exhibit, and the less shrinkage-related cracking it will suffer.

Precast/prestressed concrete is typically cast with water/cement ratios as low as .40. In-plant casting makes it possible for precasters to handle low-w/c concrete, which is more difficult to place in the field than concretes with higher water content. In fact, some cast-in-place concrete contractors are often tempted to add water to the mix, despite design specifications, for the sake of easier handling.





Precast/prestressed concrete garages like the Charlotte-Mecklenburg Government Center Parking Structure, Charlotte, N.C. (above) will resist corrosion for many years. One reason: the quality control exercised at the precaster's plant (below).

Air Entrainment. Thermal contraction and expansion can cause surface scaling and cracking, which in turn increases the exposure of reinforcing steel to chlorides. The addition of microscopic air bubbles to concrete via air entrainment agents increases the concrete's ability to withstand freeze-thaw cycles.

Air entrainment can be adversely effected by a number of factors associated with the on-site placing and finishing of concrete. Factory-fabricated precast/prestressed concrete avoids all these conditions, guaranteeing proper air entrainment.

Clear Cover. One of the most important design factors controlling corrosion is the depth of concrete cover over reinforcing steel. It has been estimated that corrosion protection increases by as much as the square of the increased cover.

Optimum clear cover is almost never achieved in cast-in-place concrete parking structures, and is one of the primary causes of extensive problems with corrosion in these structures. It is also one of the main reasons precast/prestressed concrete has been virtually free of these problems. Precast/prestressed concrete members have their primary reinforcement located well down in the webs of the tee members, a significant distance from the wearing surface, where salts are present.

Curing. Concrete attains strength, durability, and resistance to chemical attack by virtue of the effect of the

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Precast/Prestressed Concrete Garages Are Becoming an Architectural Asset

Parking structures used to be thought of as drab gray boxes, relegated to inconspicuous areas of a development or complex. No more. Today, owners and developers are coming to realize that parking structures are a major visual element in any setting — and they must be made to perform as architectural assets as well as durable, efficient facilities.

Commercial developers increasingly demand parking structures that echo the design of the main buildings in a complex. Municipal leaders want their parking structures to enhance the visual flavor of their downtown areas. Hospitals, schools and other institutions look for structures that will contribute to the campus setting.

No available structural system is better adapted than precast/prestressed concrete for this new concern for aesthetics. Architects are coming to recognize the flexibility of this outstanding construction material, and are beginning to fully exploit the range of aesthetic statements now possible.

Precast/prestressed concrete puts a rich palette of colors, shapes and materials in the designer's hands:

Curvilinear shapes. Rounded and unusually shaped facades can be carefully created in the precaster's plant. Curvilinear shapes can be much more efficiently and cost effectively executed in a precast/prestressed concrete structure than in cast-in-place or structural steel parking garages.

Reveals and joints. Decorative reveals may be easily cast into concrete spandrel, making it possible for the architect to direct the lines of the structure as he sees fit. False joints can also be incorporated, giving the precast spandrels an uncanny resemblance to limestone or sandstone construction — without the costs involved in these older systems.

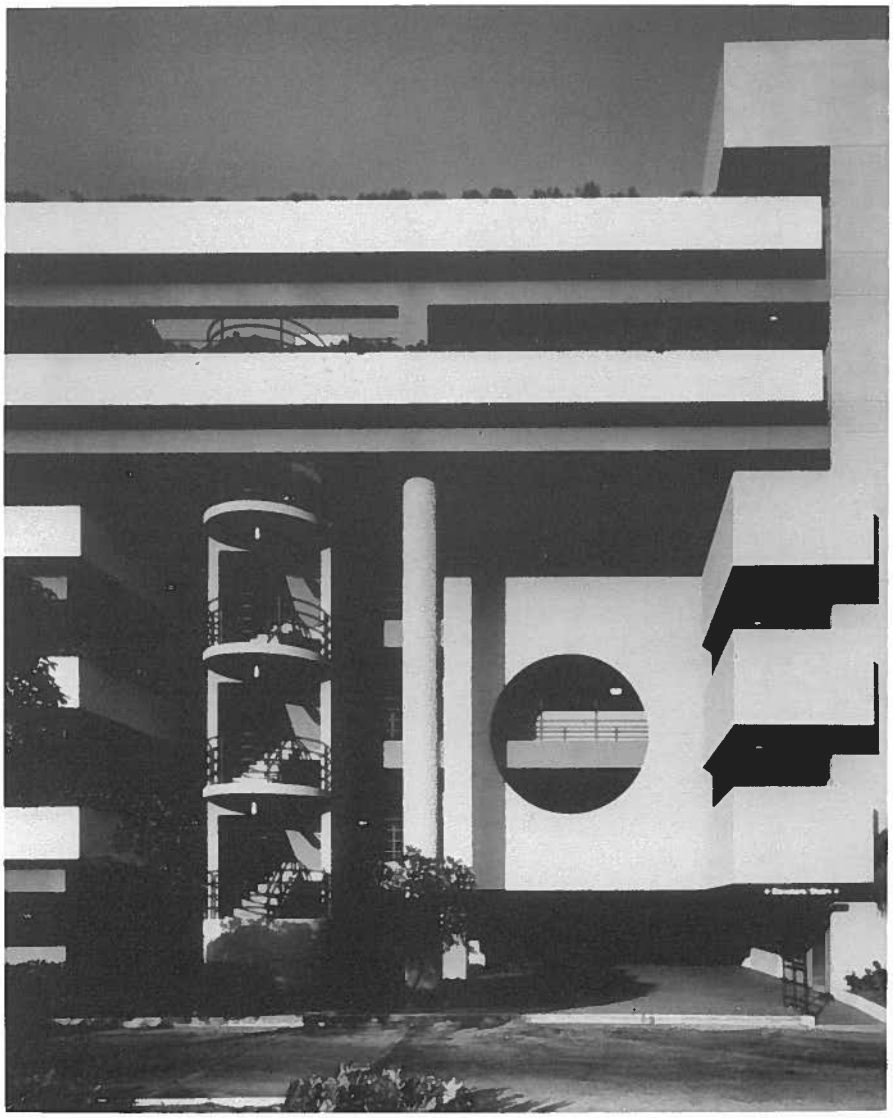
Aggregates and cements. An almost unlimited selection of stones can be incorporated into the concrete matrix. Depending on the way these aggregates are exposed at the precaster's plant, the resulting concrete can take on a dazzling array of colors and textures. Local gravels can be added to allow the parking structure to blend with its natural context. Exposed aggregates can effectively mimic the look of the granite or marble of surrounding buildings. Colored cements can also be used, to further enlarge the range of aesthetic possibilities.

Masonry veneers. When the parking structure will be built amid traditional brick structures, the designer can specify special brick facades for precast/prestressed concrete spandrels. This can be accomplished either by casting special thin bricks directly into the spandrel at the plant, or by casting in special voids that can be inset with bricks at the site. Either way, the resulting parking structure is expressive of a uniquely American aesthetic that only masonry provides.

Stone veneers. When only the most prestigious design statement will do, thin veneers of marble or granite can be incorporated into the spandrels, to match the stone of surrounding buildings. Lavish? Perhaps... but stone-veneered precast/prestressed concrete represents the most efficient available use of expensive stone.

Modern techniques such as these are just some of the ways that precast/prestressed concrete parking structures can be elevated from the prosaic to the spectacular. Moreover, most of these finishes are applied at the precaster's plant, so they are in place the moment the concrete is erected — not after weeks of delay.

For many years, grace, elegance and beauty were the last things you imagined when you thought of parking structures. Thanks to precast/prestressed concrete, those days are over.



Precast/prestressed garages leave the architect free to explore a wide range of shapes, textures and geometries. Above: Mount Sinai Medical Center Parking Structure, Miami Beach, Fla.

Precast/Prestressed Concrete Sets the Record for Erection Time

Every day, precast/prestressed concrete parking structures are making headlines, constantly setting new construction records. Today's precast/prestressed concrete parking structures are routinely built on schedules that would have been unimaginable just a decade ago — sometimes going from approval to completion in well under six months.

The greater speed of erection inherent in precast/prestressed concrete has a significance that goes beyond the record books, however. Shortened construction time means reduced financing costs and a faster return on investment for owners and developers.

Why can precast/prestressed concrete parking structures be built on such a fast track?

Early Fabrication. The fabrication of precast/prestressed concrete elements isn't dependent on events at the construction site — it takes place at the precaster's high-efficiency plant. Thus it's usually possible to begin fabricating the structural elements before site preparation has even begun. In fact, the fabrication of certain standard components can take place even before the design of the structure is finalized.

As a result, precast/prestressed concrete can be ready for erection the moment the structure's foundations are complete.

Fewer Weather Delays. For most other structural systems, cold, hot or inclement weather causes construction to slow down or halt entirely. Precast/prestressed concrete, on the other hand, can be erected in a much wider array of environmental conditions. Changes in temperature and humidity don't threaten concrete strength. Expensive on-site protection schemes are unnecessary. Only the most severe weather conditions are enough to stop construction.

Fewer On-Site Labor Delays. Other structural systems require most of the work to be done on the site. This labor-intensive approach is inherently vulnerable to manpower shortages and work-force slowdowns.

Precast/prestressed concrete erection procedures require much less manpower on site. There's less risk of delay. Fewer surprises to disrupt your schedule.

Ready To Proceed Immediately. Once precast/prestressed concrete has been erected, it is immediately ready for other contractors to proceed. Stall boundaries may be painted. Electrical systems may be installed. Hardware can be added.

The Naperville Municipal Parking Structure, Naperville, Ill., went from approval to completion in just over five months —proof of the fast-track construction schedules that can be met with Precast/prestressed concrete.

The same can't be said for other structural systems, which require a period of curing of each cast-in-place concrete deck before further construction can proceed.

Using precast/prestressed concrete means that your parking structure won't just be erected faster — it will be finished faster.

Precast/prestressed concrete parking structures have become synonymous with fast track construction. A typical example: the Naperville Municipal Parking Garage, Naperville, Illinois, a three-level, 530-car structure that went from approval to completion in just over five months — just in time for the holiday shopping season.

Because precast/prestressed concrete was selected for the structure, the precaster was able to speed construction by beginning fabrication even before the structure's design was completed. The precaster began fabrication on August 1, and began erection at the site September 1. Concrete erection was completed on October 14 — several days ahead of schedule.

The precaster closely coordinated activities with the foundation crew, to get an early start on precasting. As a result, the precaster was able to ship the first precast elements to the site almost the moment the foundations were finished.

The fast-track construction schedules made possible by precast/prestressed concrete can have an enormous impact on your bottom line. Faster erection means your financing costs can be sharply reduced. In the case of a $2.5 million loan at 12 percent interest, a 15-week reduction in construction time can result in an interest savings of more than $86,000. Even greater savings are possible.

Just as importantly, the faster the parking structure is completed, the faster it can start providing a return on your investment — and the sooner it will start meeting crucial parking needs. Fast construction means your project will spend less time as a liability. . .and more time as an asset.

Efficiency and speed. They're what make precast/prestressed concrete the smart choice for parking structures.

Precast Provides Quality In A Tight Space

If you've got to squeeze a lot of parking space into a small area, consider precast/prestressed concrete.

Especially in congested urban areas, parking structures are often planned for relatively inaccessible sites. For other structural systems, impaired site access can cause critical problems. These systems require plenty of space for concrete forms, scaffolding, storage of steel structural elements, concrete transporting and placing equipment, post-tensioning equipment, etc.

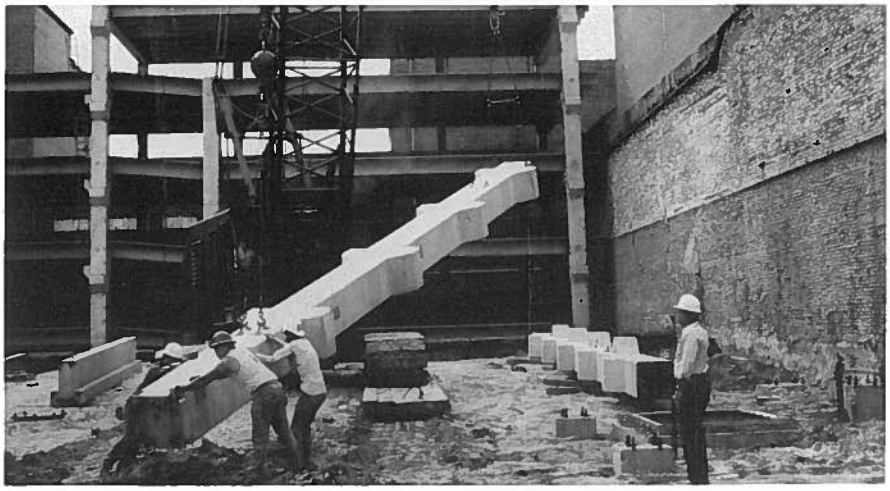
Limited site access poses no problem for precast/prestressed concrete erection crews, however. Most of the work for a precast/prestressed concrete parking garage is done in the precaster's plant — not on site. The entire concrete superstructure can usually be erected with minimal traffic disruption. In many cases, massive precast/prestressed concrete spandrels have been placed within inches of surrounding buildings — a feat few other structural systems can match.

Precast/prestressed concrete members can be erected as soon as they arrive.There's no need to find room on site to stockpile materials.

The West Pine Street Parking Garage in Hattiesburg, Mississippi provides a good example of the way precast/prestressed concrete performs in tight spaces. Designers had to provide a multistory, 210-space parking garage on a relatively small site — just 114 feet by 150 feet — closely hemmed in by adjacent buildings. Lack of space meant little room for trucks and construction equipment.

The designers selected precast/prestressed concrete. Their use of a combination of precast rectangular beams with cantilevered double tees allowed the parking structure to extend to within inches of existing buildings. Precast construction allowed the majority of the work to be completed off-site, which resulted in an erection time of only thirty working days.

So if your parking requirements are large but your site is small, remember precast/prestressed concrete. When it comes to excellence in tight spaces, it beats other structural systems cold.



The West Pine Street Parking Garage, Hattiesburg, Miss., under construction.

Upcoming Publications Highlight The Benefits of Precast

Three upcoming Prestressed Concrete Institute publications will highlight the benefits of precast/prestressed concrete for parking structures.

Beautiful, Durable, Profitable. . . Precast/Prestressed Concrete Parking Structures will appear as a 12-page insert in an upcoming issue of *Progressive Architecture*. The brochure will detail the corrosion resistance, efficiency and aesthetics inherent in precast/prestressed concrete parking structures. The publication features photographs and descriptions of outstanding parking structures.

A PCI parking design manual is scheduled for publication this fall. The manual will discuss aspects of functional and structural design, and will examine the techniques for constructing corrosion-resistant parking structures. Recommended fabrication and erection procedures will also be discussed.

PCI also plans to release a parking structure maintenance manual later this year. The manual will outline recommended procedures for maintaining precast/prestressed concrete parking structures, and will show how these steps can be taken cost-effectively.

For reprints of *Beautiful, Durable, Profitable. . . Precast/Prestressed Concrete Parking Structures,* and for further information on the PCI design and maintenance manuals, contact Brian Goodmiller, The Prestressed Concrete Institute, 175 W. Jackson Blvd., Chicago, IL 60604. Phone: (312) 786-0300; FAX: (312) 786-0353.

Corrosion

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chemical reaction between cement and water. This reaction proceeds at its most rapid rate when external humidities are kept at their highest levels.When concrete is cast on site, temperature and climactic conditions become critical.

In contrast, curing conditions in a precasting plant can be more carefully controlled than is true for most cast-in-place jobs. Temperature is also typically well controlled by the precaster. FHWA tests have shown that heat-cured, precast, prestressed concrete members are better protected from chloride corrosion, compared to reinforcing bars in moist-cured reinforced concrete members. The heat-cured precast prestressed samples in the test absorbed 30 to 50 percent less chloride in the first one-inch of concrete compared to moist cured members.

Drainage. Providing proper drainage is essential for insuring a durable structure. Eliminating ponding reduces the saturation of chlorides and moisture, decreasing the incidence of freeze-thaw damage and corrosion.

While surface planeness is seldom a problem for precast floor elements, it can be difficult to insure when the entire floor slab is cast in place, due to the greater surface area. Especially on sloped floors, wavy surfaces can result when the cast-in-place concrete is made too flowable.

The more you know about the causes and prevention of corrosion, the more you'll see that precast/prestressed concrete has what it takes to remain durable in any environment.