PACIFIC PARKING

At the Station Oaks Parking Structure in Walnut Creek, CA, ventilation requirements to maintain an open deck rating were cleverly achieved by moving one exterior wall 5' away from the edge of the parking slab.

Scott Kennedy, P. Eng.

For well over a decade, Kensco Engineering Ltd., Vancouver, BC, has worked extensively with owners, engineers, contractors and steel fabricators to evaluate the use of steel in building structures. This work has included working with all members of the construction team, and most critically the engineer of record, to develop steel solutions to complex building issues, optimize steel budgets and establish realistic schedules. Many of these projects have met the parking requirements of mixed-use developments through the use of steel framing systems or the design of a stand-alone steel framed parking structure.

Four stand-alone parking projects where Kensco has served as a consultant demonstrate the benefits of a steel solution. These four projects overcame the skepticism of utilizing a steel framing system. In doing so they serve as examples to owners who may hesitate to capture the cost savings associated with the construction of a less familiar system and may be uncertain about the appearance of steel framed structure, particularly if fireproofing is required or may fear long term maintenance costs related to corrosion.

One such project demonstrating the effective use of steel framing is the Station Oaks Parking Structure in Walnut Creek, CA. This five level structure currently under construction with 33,600 sq. ft. tiers is adjacent to an eight story office tower in 2001. The exterior of the structure was designed to blend in with the architectural appearance of the tower. Ventilation requirements to maintain an open deck rating were cleverly achieved by moving one wall 5′ away from the edge of the parking slab. A structural steel frame was specified with a composite steel deck and was chosen as a cost effective deck system in the Walnut Creek area based upon Walnut Creek's location in a temperate area. Salt and other de-icing chemicals that can deteriorate a deck by penetrating the concrete through cracks are not used for ice and snow removal.

A standard steel deck with concrete fill and composite steel construction was used following the guidelines of the Steel Deck Institute and the deck manufacturer, Verco. The SDI guidelines state:

1. Slabs should be designed as continuous spans with negative bending reinforcing over the supports;
2. Additional reinforcing should be included to deter cracking caused by

Do steel framing systems provide a viable solution to the special challenges faced by parking structures on the Pacific Coast? The answer is a definite yes. Steel framed parking structures exhibit long-term resistance to corrosion, cost effective design, rapid construction schedules and unobtrusive handling of seismic loads.

Exterior view of parking structure at 12th and K street in Sacramento, CA. The original design for this parking structure called for reinforced concrete.

large temperature differences and provide load distribution; and,

3. In areas where salt water, either brought into the structure by cars in winter or carried by the wind in coastal areas, may deteriorate the deck, protective measures must be taken. The top surface of the slab must be effectively sealed so that salt water cannot migrate through the slab to the steel deck. A minimum G90 (Z275) galvanizing is recommended, and the deck should be protected with a durable paint. The protective measures must be maintained through the life of the building. If the protective measures cannot be assured, the steel deck can be used as a stay-in-place form, and the concrete can be reinforced with mesh or bars as required.

Following these guidelines, a 3″ minimum depth of regular weight concrete was used over the top of the 3″ deck to allow more cover of the rebar. In addition, instead of mesh, rebar was used perpendicular to the flutes as distribution steel and parallel to the deck flutes for shrinkage. Bars parallel to the flutes were added as negative reinforcement over the beams.

The deck was designed and constructed to ensure positive drainage and then sealed. These actions were taken to minimize the opportunity for water to seep into the slab and deteriorate the deck. Great care was also taken to ensure that the concrete was correctly cured to prevent excessive cracking and spalling.

An earlier project at the Sherman Oaks Fashion Square Mall in Sherman Oaks, CA, was constructed in 1994 following the Northridge Earthquake. The structure was later expanded in 1996 with an additional level of parking and was required to rapidly and cost-effectively replace a concrete structure damaged beyond repair in the Northridge earthquake. The structure was originally designed with two levels of structural steel suspended slab, with provision for a third level over the existing parking at grade. It is 186′ wide and 1,020′ long and is split into three sub-structures in the longitudinal direction. A third level was added to a portion in 1996. The concept was decided upon, and design commenced in May 1994; steel was fast tracked and erection completed in September. It was open for parking by the 1994 Thanksgiving holiday and has not required any painting or repairs over the past eight.

A parking structure at the Sherman Oaks Fashion Square Mall in Sherman Oaks, CA was constructed in 1994 after the Northridge earthquake to replace a reinforced concrete parking structure damaged beyond repair.

This structure is a good example of the designer's ability to keep the steel design cost competitive with other structural alternatives through the selection of a cost effective lateral system. It utilizes a 28' by 60' bay size with W16x26 beams on 10' centers used in the shorter direction. W30x116 beams are used in the long direction. For architectural reasons, hollow structural sections were used for columns, except in the braced bays. W12x162 columns were used for the braced bays both for their ease of connection and for their high strength. The building was designed in accordance with the seismic provisions of the 1994 UBC, and two braced frames were located on each side of the building at each level. If this building were to be constructed today under the 1997 UBC seismic provisions, a special concentrically braced frame would be used with more braces to reduce redundancy factors. The bracing would be reconfigured as double story X-braces with SCBF gusset plates and controlled width to thickness rations for bracing members.

The selection and use of details can greatly impact the cost competitiveness of a steel structure. The selection of design details at Fashion Square Mall resulted in a cost savings of nearly 20% over the concrete alternative. However, on another California project in the Los Angeles area, the architect rejected the use of gusset plates forcing the use of an OCBF (Ordinary Concentrically Braced Frame) design with large wide flange braces and very complex connections, rather than the SCBF (Special Concentrically Braced Frame) system with gusset plates and tube braces. The end result was the loss of the cost competitiveness of the steel alternative.

One of Kensco's early parking projects, the 12th and K Street parking structure in Sacramento, CA, was constructed in 1989. This is a small five level parking structure detached but adjacent to the 28-floor 12th and K Street office building. Originally designed in concrete, the parking structure required fire rating due to the architectural skin requirement. A hardener with a smooth troweled finish was applied over the fireproofing to overcome the owner's concern regarding the appearance and durability of sprayed on fireproofing.

Whenever possible, a stand-alone structure should be designed and located in such a way that fireproofing of the structural steel is not required. Fireproofing is not architecturally appealing and significantly adds to the cost of the structure. While a creative design enabled fireproofing to be eliminated from the Station Oaks project, it was not possible to do so on the 12th and K Street project. On several projects, fireproofing has been required, and a smooth colored hardener over the spray on fireproofing was used to improve durability and appearance.

For non-fireproofed structures, the selection of a coating of the structural steel is critical for the long-term maintenance of the project. There are several coating applications for non-fireproofed structural steel that may be applied depending upon exposure, performance requirements and local conditions. Articles that appeared in the April and May 2001 issues of *Mod-*

Interior of parking structure at Creekside Development, San Leandro, CA. The fire-protected beams and columns have not yet been finished with a troweled-on hardener.

ern Steel Construction are particularly helpful in understanding and selecting a coating system (reprints are available online). In the case of these west coast structures where initial cost has been important, a good, cost effective paint system has been selected in an attempt to balance initial cost with long term maintenance. Cleaning of the steel to the minimum of a SSPC-SP6 has been required, followed by a zinc-rich shop primer and a field applied finish coat.

Another Kensco west coast project, currently under construction is the Creekside Development parking structure in San Leandro, CA. This structure is a simple rectangular two level-braced frame structure measuring 120′ by 240′ in size. Once again, the architectural skin requirements for this structure did not allow sufficient room for ventilation and rating as an open deck structure, necessitating the fireproofing of the steel. As in most steel framed structures, the interior of the Creekside structure is "clean, open, light, airy and attractive." This look and feel is radically different from one of the major drawbacks of concrete systems: the appearance of a heavy, dark structure with concealed areas which results from the necessary inclusion of shear walls and large columns.

The Creekside structure is a good example of a relatively light steel structure with an effective lateral system being a very cost effective solution for parking structures on the west coast where a temperate climate is combined with heavy seismic activity and frequently poor soil conditions. The Creekside project benefited from competitive pricing, a rapid delivery schedule and smaller foundations.

If this is the case, then why are so few steel-framed parking structures built in steel on the west coast? The answer is often the lack of familiarity with the benefits of steel framed systems on the part of owners, developers, consultants and structural engineers. At Kensco we have found that we need to have ready answers to the common concerns voiced about steel framed parking, concerns that are often myths, and show our clients examples of existing steel framed parking structures that have performed well over time. Kensco has historically drawn on information from AISC to help dispel the myths and emphasize the benefits of steel framed parking, as well as local knowledge of existing steel framed parking structures in the project area to use as examples for our clients.

In the end, our clients have been very happy with the the results: well-built, durable, cost effective, easily maintainable and rapidly delivered parking structures.

D. Scott Kennedy, P. Eng., is an engineer with Kensco Engineering Ltd., Vancouver, B.C.

STATION OAKS PARKING STRUCTURE WALNUT CREEK, CA

Structural Engineer
Liftech, Oakland, CA
Architect
JWD, Oakland, CA
Steel Erector
Mid-States Steel, Stockton, CA (NEA member)
Steel Detailer
Vachon Drafting, Reno, NV (NISD member)
Software
RAM Structural System

SHERMAN OAKS FASHION SQUARE PARKING STRUCTURE A, SHERMAN OAKS, CA

Structural Engineer &Architect
ANF and Assoc., El Monte, CA
Steel Fabricator
Bannister Steel, San Diego, CA (AISC member)
Steel Erector
Mid-States Steel, Stockton, CA (NEA member)
Software
RAM Structural System

12TH AND K STREET PARKING STRUCTURE, SACRAMENTO, CA

Structural Engineer
Middlebrook and Louie, San Francisco, CA

Architect
HOK, San Francisco, CA
Steel Erector
California Erectors, Benicia, CA (NEA member)

CREEKSIDE DEVELOPMENT, SAN LEANDRO, CA

Structural Engineer
Paradigm, San Francisco, CA
Architect
MCG, San Francisco, CA
Steel Erector
Mid-States Steel, Stockton, CA (NEA member)
Software
RAM Structural System