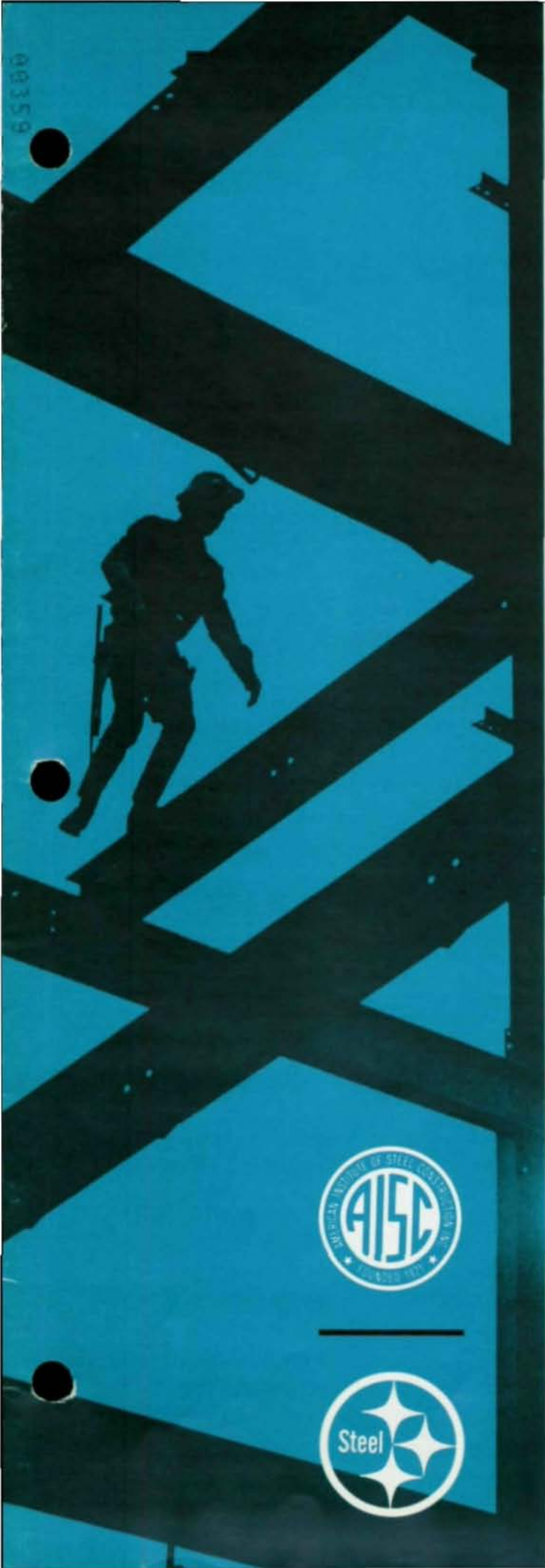
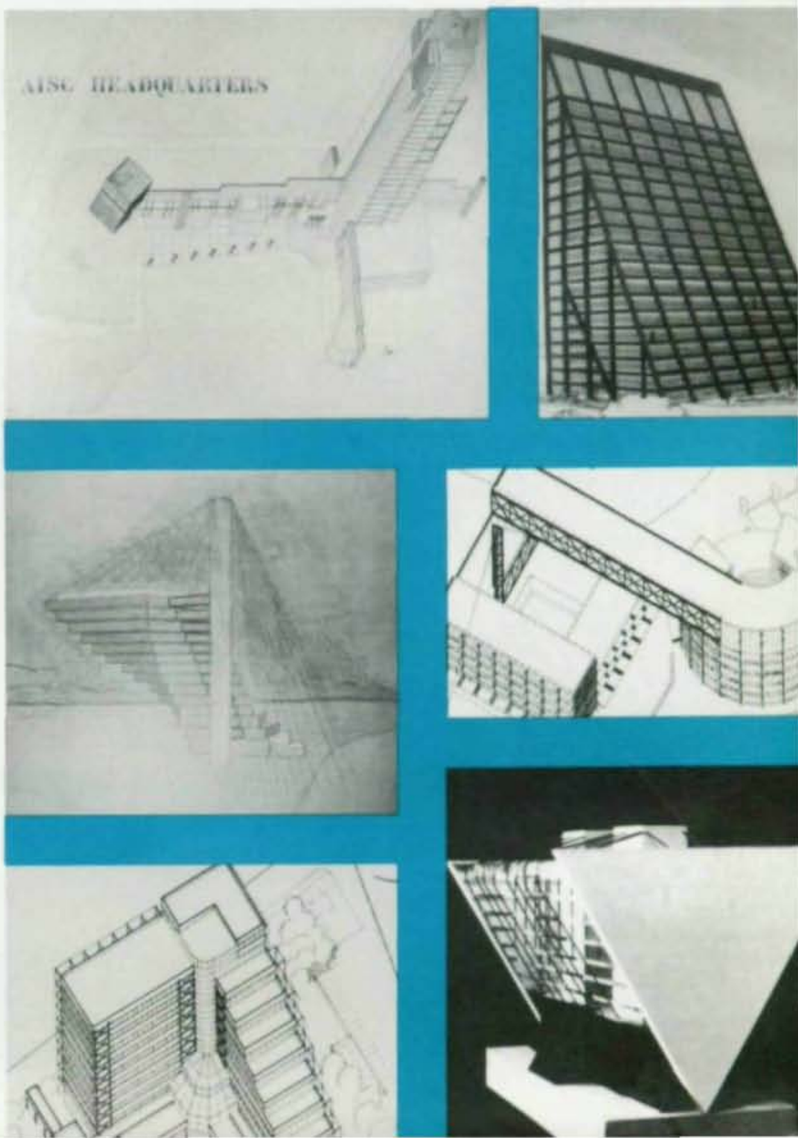


VOLUME XXIII NUMBER 3/THIRD QUARTER 1983

MODERN STEEL CONSTRUCTION

A Heavy Hitter at Fenway Park
Steeling for the "Big Blows"
A Tale of Two Towers
Going First Class—with Steel
Construction Left a Vapor Trail
20 Questions About Steel Roof Deck
ASC/AIA Awards Competition



DECK DESIGN DATA SHEET.

NO. 3

DESIGNERS CHECK LIST FOR DECK

Composite Floor Deck

☐ Check fire rating requirements.... Designs Dxxx in U.L.
☐ Check relative costs of lightweight and normal weight concrete.
Note: Light weight concrete can usually fulfill fire rating needs with thinner slabs.
☐ Check pour stop requirements—see Deck Design Data Sheet No. 1.
☐ Check hanger requirements—for ceilings, ducts, pipes, etc.
☐ Check maximum unshored spans to select deck gage and pattern.
Note: It usually costs less to have unshored construction.

Cellular (electrified) Floor Deck

☐ Check fire rating requirements... Designs Dxxx in U.L.
Note: If floors are to be accessed for electric power (and/or telephones) and a fire rating is required, then the deck must be 'fireproofed'; therefore a 2.5" cover of concrete (over the top of the deck) is usually chosen. Galvanized steel is always required for cellular deck.
☐ Check to determine which blend of cellular and non cellular deck will provide the needed wiring... blending of units saves money.
☐ Check load requirements in the trench header spans. Since the trench header interupts the slab, the loads must be handled by: (1) shortening the deck span that carries the trench; or (2) increasing the deck gage; or (3) reinforcing the slab as a cantilever on each side of the trench; or (4) placing the trench over (or close to) a beam; or (5) a combination of any of these methods.

Roof Deck

☐ Check fire rating requirements... Designs Pxxx in U.L.
☐ *Check loads for:*
(1) snow drifting; (2) additional dead load from ballasted roof systems; (3) maintenance loads... use SDI criteria.
☐ Check any other insurance requirements such as Factory Mutual.

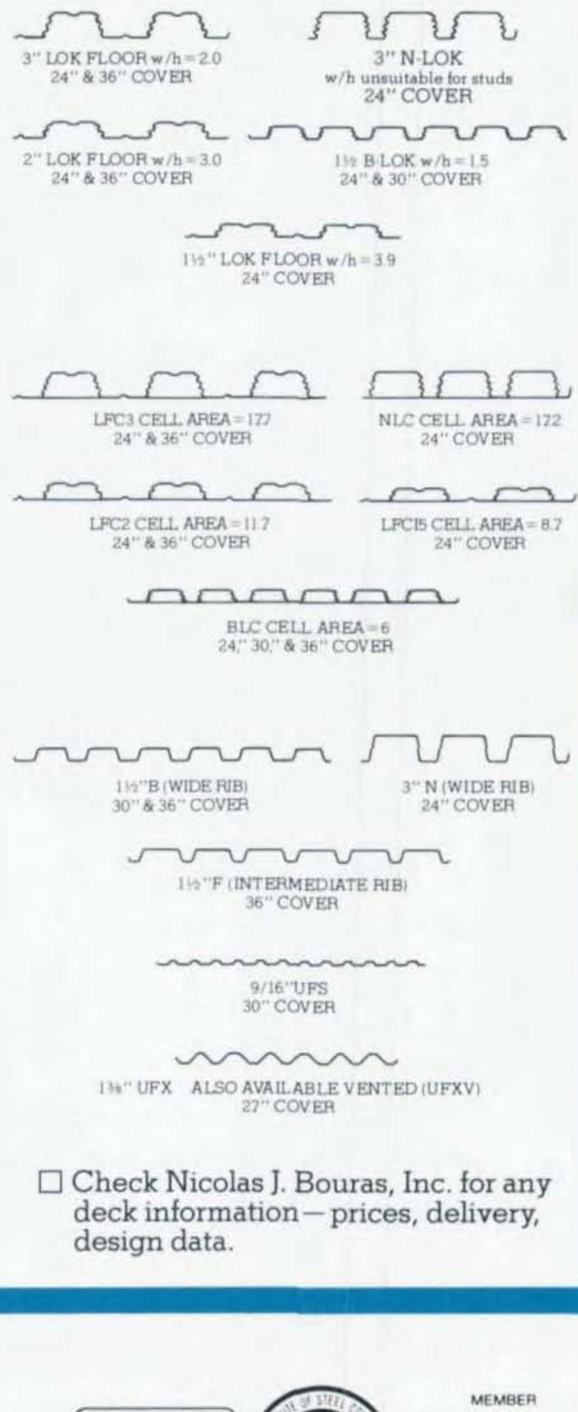
Form Deck (Centering)

☐ Check fire rating requirements... Designs Gxxx in U.L.
☐ Check requirements for finish. (If deck is galvanized it will last the life of the structure and will always carry the slab weight; if the deck is uncoated the slab should be reinforced to carry the slab weight as well as the live loads.
☐ Check venting requirements if the deck is supporting an insulating fill... always use galvanized deck for this purpose.

All Deck

☐ Check material specifications. The proper specification for galvanized steel is ASTM A446; for steel that is to be left uncoated or painted (but not galvanized) the ASTM specification is A611; minimum acceptable yield point of steel is 33 ksi. The proper specification that covers the galvanized coating is ASTM A525.

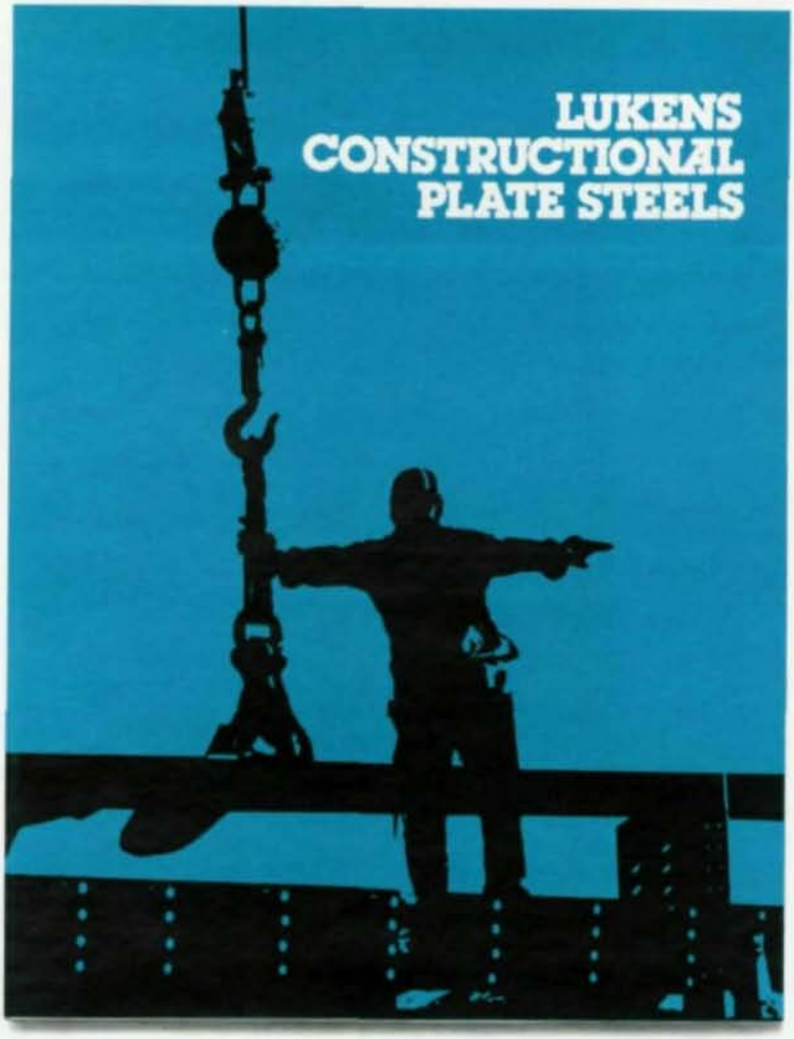
United Steel Deck Inc. Profiles



☐ Check Nicolas J. Bouras, Inc. for any deck information—prices, delivery, design data.

NJB
NICHOLAS J. BOURAS, INC.
P.O. BOX 662, 475 SPRINGFIELD AVE.,
SUMMIT, NEW JERSEY 07901 (201) 277-1617

USD
AMERICAN INSTITUTE OF STEEL CONSTRUCTION INC. AISC FOUNDED 1921
ASSOCIATE MEMBER
MEMBER
STEEL DECK INSTITUTE sdi


LUKENS
CONSTRUCTIONAL
PLATE STEELS

MODERN STEEL CONSTRUCTION

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American Institute of Steel Construction

The Wrigley Building
400 North Michigan Avenue
Chicago, Illinois 60611

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VOLUME XXIII NUMBER 3/THIRD QUARTER 1983

CONTENTS

THIRD ANNUAL AWARDS BANQUET TO HONOR WINNING ARCHITECTS

The third annual AISC Awards Banquet will be held November 1 in Chicago's Westin Hotel to honor this year's Architectural Awards of Excellence competition winners. A well-known panel of five jurors chose 13 of the most outstanding buildings from a record 166 entries. Winners will receive a special bas relief of AISC's handsome bronze sculpture, "Long Reach," created by nationally known artist Joe Kinkel.

The prestigious, black-tie banquet, now an industry tradition, provides a forum for leading architects, structural designers, contractors, fabricators and suppliers to the fabricated steel industry.

Winners of several other AISC awards will also be recognized, including: Omer Blodgett, T.R. Higgins Lectureship Award winner; Frank Michielli, John Hildreth and Richard Ilchert, first-prize winners of the 1983 ASC/AIA "Expressions in Steel" competition co-sponsored by AISC; eight student Fellowship Award recipients; and several Special Citation Award winners.

Guest speaker is Dr. Pat Choate, senior policy analyst for TRW, and author of a number of books on governmental economic policies.

Tickets for the event are available from: AISC, 400 N. Michigan Ave., Chicago, IL 60611 312/670-2400.

FELLOWSHIP AND T.R. HIGGINS AWARD PROGRAMS ANNOUNCED

The AISC Fellowship Award program provides eight $4,750 awards to civil engineering students who propose a course of graduate studies relating to fabricated structural steel. Winners of the 1984 Fellowship Awards are guests of honor at the AISC National Engineering Conference.

The 1984 Lectureship winner receives a $3,000 award as the principal author of the most significant paper related to structural steel published during the five-year period Jan. 1, 1978 to Jan. 1, 1983. The current T.R. Higgins Lecturer is Omer Blodgett, author of "Detailing to Achieve Practical Welded Fabrication."

Announcements of the two programs have been distributed and are available from any AISC regional office, or from: Committee on Education, AISC, 400 N. Michigan Ave., Chicago, IL 60611.

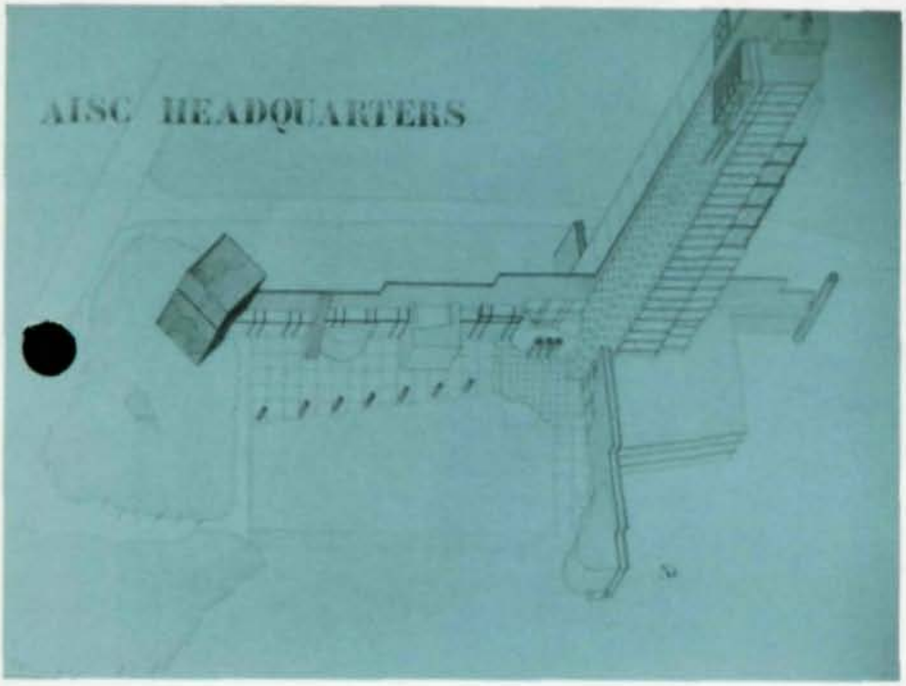
ASC/AIA Awards Competition:
New Approach to Tomorrow's Professionals

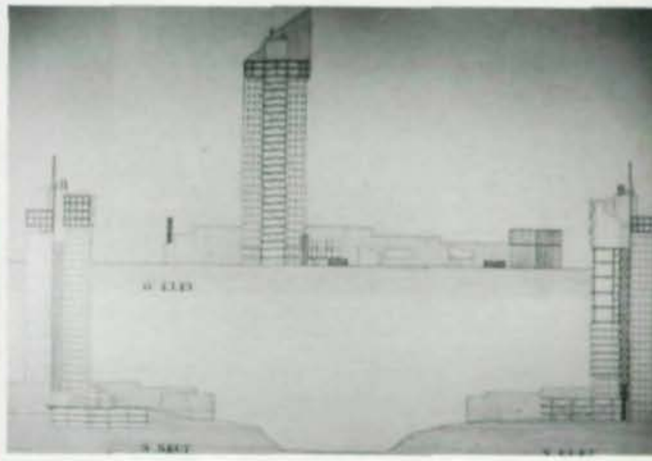
Student design competitions by the Association of Student Chapters of the American Institute of Architects have been going on for quite a few years.

But this year was different. Late in 1982, AISC's Committee on Marketing and Promotion proposed a new dimension to its promotional efforts. AISC would cosponsor the 1983 spring competition with ASC/AIA, with the ultimate goal of improving the awareness of the advantages of structural steel in the minds of undergraduates who were pursuing architecture and civil engineering courses.

Over the past two years, the Institute has greatly increased the awareness of steel's advantages to professionals—architects, engineers, construction managers and other decision-makers—through a series of national ads, direct mail and project features in major building trade journals.

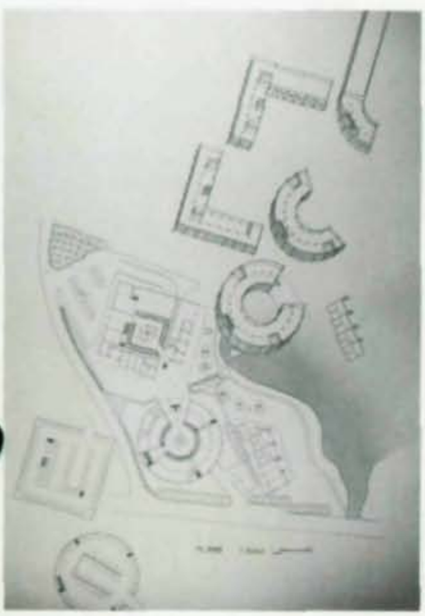
Now the COMAP Committee has taken it a step further—improve the long-range benefits to our industry by developing an appreciation for structural steel by architectural and engineering students.

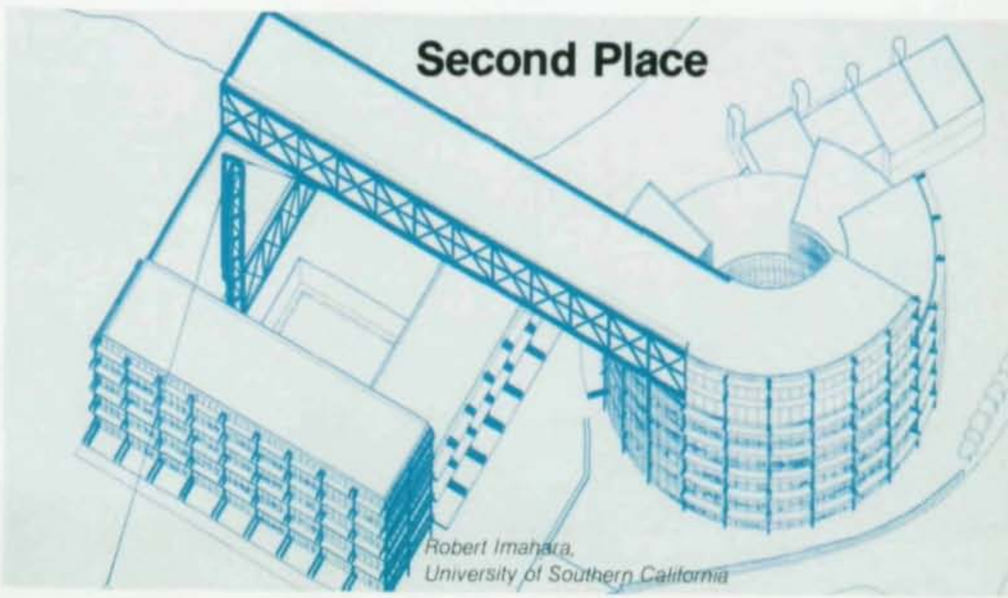




Frank V. Michielli, John Hildreth and Richard Ilchert, Catholic University of America

First Place—
"Expressions in Steel" Design Competition





Second Place

Robert Imahara, University of Southern California

A New Dimension

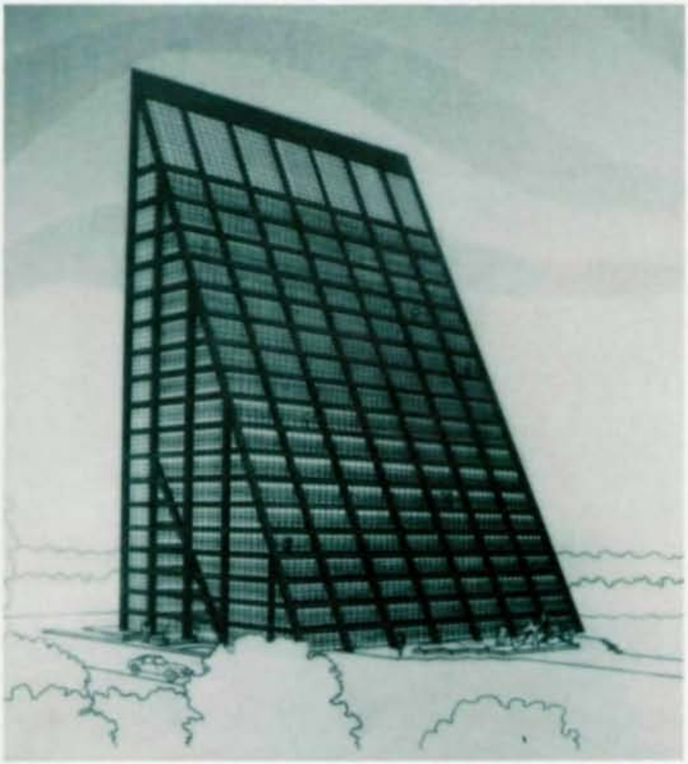
This year, the competition—previously restricted to architectural students—was also broadened to include civil engineering students, working as a design team with the architectural students. This interaction concept enables the students to understand the approach each discipline takes to solving a design problem. Thus, it gives them a real-world experience to what they will encounter in their future professional careers.

To accomplish this new dimension, letters inviting participation were sent not only to deans at schools of architecture but also to those at schools of engineering and architectural engineering. The letters were signed by the presidents of both ASC/AIA and AISC. In addition, posters for school bulletin boards were sent, along with application blanks. By February 1983 the program had been launched.

Introduction to Steel Fabrication

The COMAP Committee was not content just to add engineering students to the competition. They made arrangements to have all students who entered to tour AISC Member fabricating shops for a first-time, first-hand introduction to how steel is fabricated—to take the mystery out of it and get them to "thinking steel."

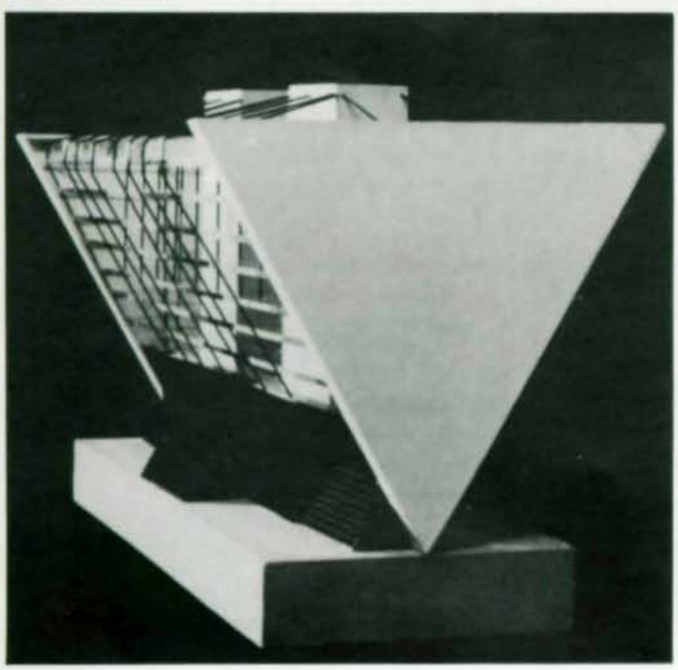
Plus, additional arrangements were made for students to consult our industry engineers. The student-team engineers/architects were encouraged to ask questions about their structural design problems from AISC



Robert Laumeyer and Bobby Otten, University of Tennessee

Honorable Mention

Richard Holben and Paul C. Milano, Pennsylvania State University



Frank Genese, University of New York-Buffalo

Runners Up

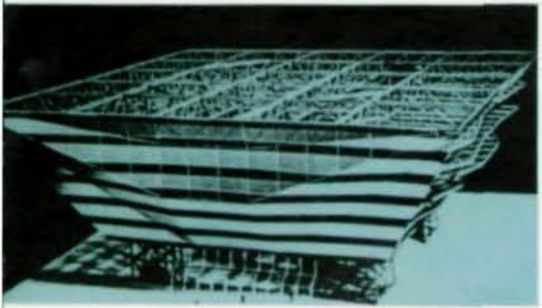
regional engineers or those from the fabricating shops they toured. Consulting engineers were also on hand if needed.

AISC's participation in the student competition opened new vistas to interested students—doors that had never opened before. New opportunities for students to learn about the structural steel industry were unending—and unequalled. Except for the Institute's "Hands On Steel" program, students have never had this kind of a learning opportunity before.

Hypothetical AISC Headquarters

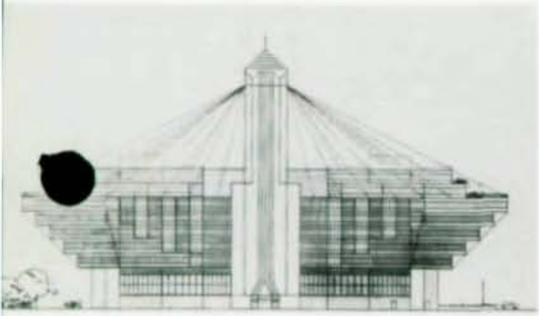
To give students who entered the competition a challenge, designing a new hypothetical headquarters for AISC was the program. They were each given site, area and topographical maps of an actual site just west of Chicago's O'Hare International Airport, one within walking distance of a luxury hotel with convention facilities and a golf course. Anticipated space requirements for AISC's office, conference, storage and mailroom facilities were estimated to be 17,000 sq ft. By adding space not presently available in current headquarters, department directors planned greater service and efficiency than now available.

But to add greater challenge and realism to the project, speculative space of some 160,000 sq ft was incorporated in the project, with the opportunity to design food service facilities, commercial space and atrium areas. The entire project enclosed some 300,000 sq ft—an impressive project for a student to tackle.

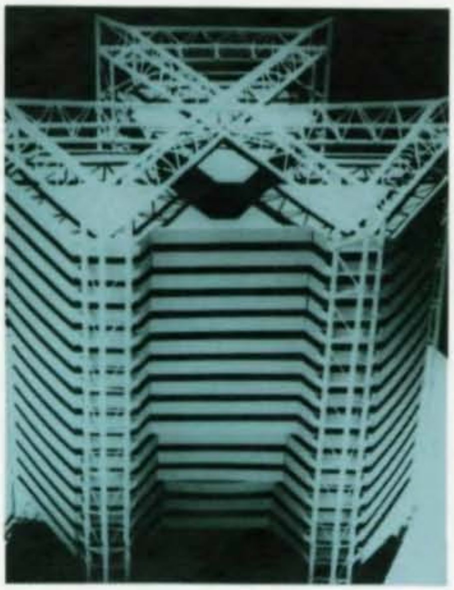


Kirk Van Cleave, University of Michigan

Eric Powers, University of Tennessee

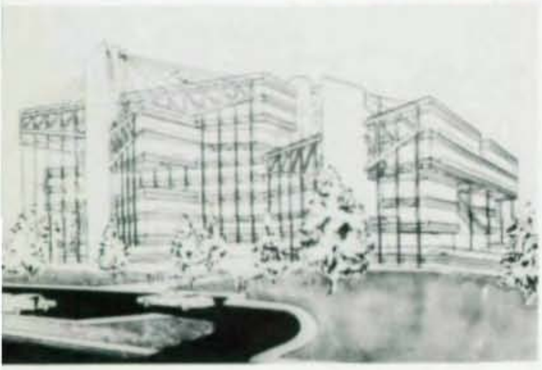


Jayant Goyle, Penn State



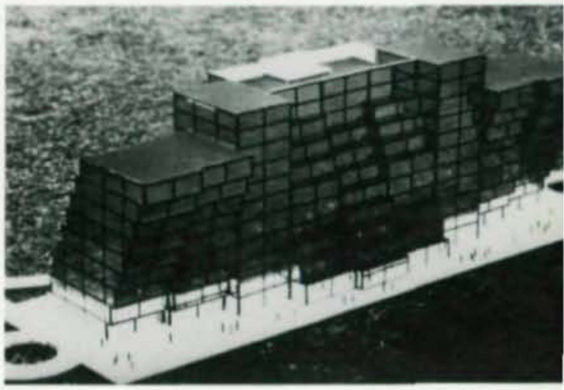
Rob Decker, Mark Kukuvka, John Long and Rodney Sidney, University of Cincinnati

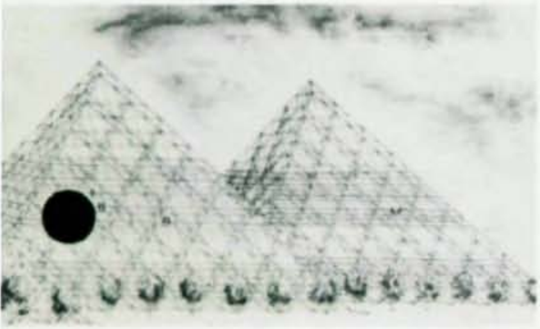
Kim Landau, University of Southern California



Keith Lott, University of Oklahoma

Eric Andresen, Arthur Bell, Penn State





Niall Christopher Cain, Carnegie Mellon University

Runners Up (continued)

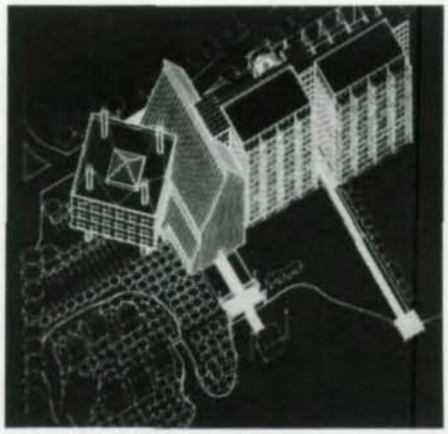
Burning the Midnight Oil

ASC/AIA advised AISC that students from some 81 schools entered the competition. Some schools entered as a class project, critiquing entries and entering only the top ones. Others established teams, or worked on their own, burning a lot of midnight oil to produce their entries. It is estimated that 400 to 500 students actually worked on the competition. And after the critiques, 103 entries rolled in. They were judged prior to the AIA National Convention in New Orleans, May 21. Jurors included Helmut Jahn, Irwin Cantor, and two students, one from engineering and the other from architecture. After a full day's deliberation and much hard work, first and second place winners and three merit awards were chosen.

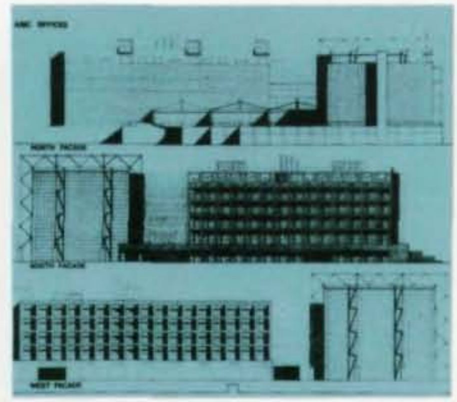
Exciting Results

First place winners were a team of three students from Catholic University of America, Washington, D.C., who took first prize of $5,000. The team included an architectural student and two from civil engineering. The second award went to an architectural student from the University of Southern California. Working all on his own, his entry received a $3,000 award. And three $600 awards of merit were given. Students not only won awards for themselves, they won awards for their schools. The students at Catholic University won $2,000 for their school, $1,000 each for the Department of Civil Engineering and the Department of

Mark Spatz, Eric Lash, California Poly-Pomona

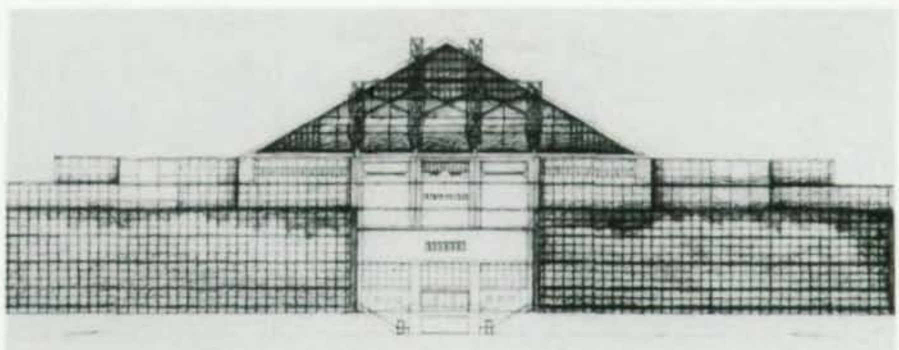


Robert Crockett, University of Southern California



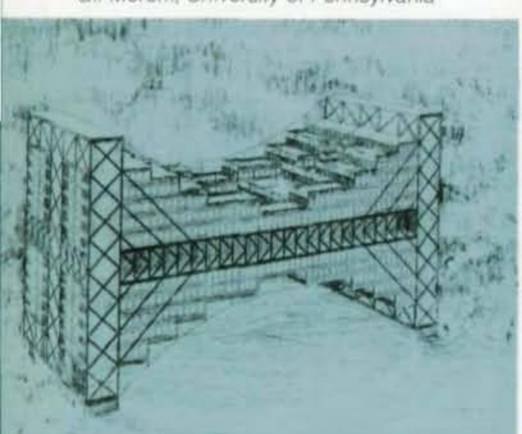
Allison Hoadley, USC

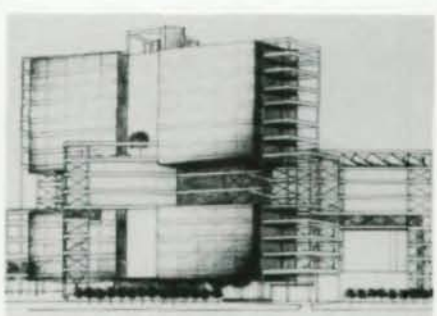
Terry Tull, University of Oklahoma



Sherry Shippy, Reza Dadashi and Hossein Kolahi, University of Illinois, Chicago

Gil Merom, University of Pennsylvania





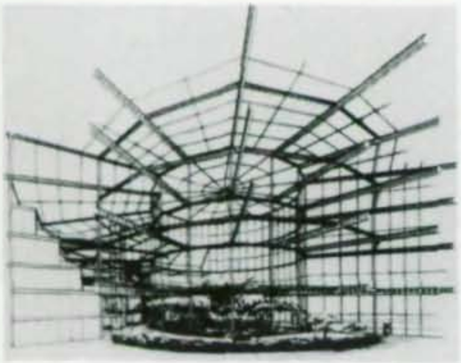
Wendi Lorbeer, University of Southern California

John Schlinke, University of Virginia

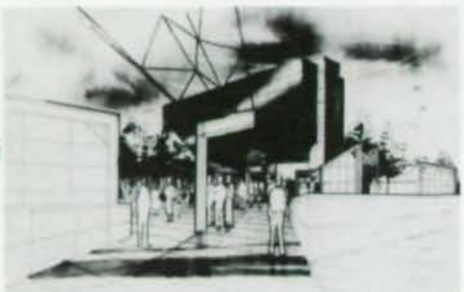
Architecture. The second place winner won $1,000 for his school, and each merit winner won $100 for the school's department in which he studied.

The program has received national publicity in a number of trade magazines, the AIA *Journal* and the ASC/AIA newsletter CRIT, distributed to 35,000 architectural student members. The winners, and 20 runners up, will be published in a booklet available soon from ASC/AIA.

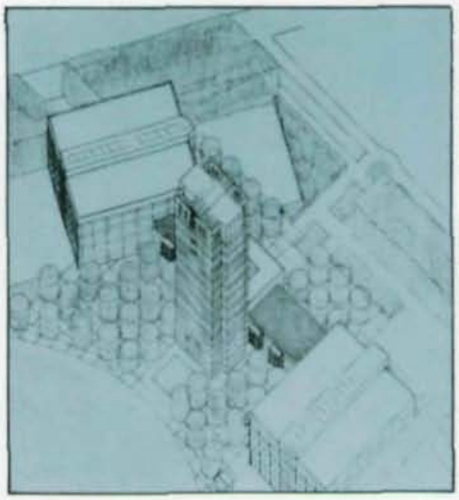
The COMAP Committee feels participation in their first AISC student design competition has been so successful they have already expressed a desire to sponsor future competitions. Certainly the opportunity to start the future designers of our environment down the path to building a better place to live and work is worthy of our time and energy. And to help them think of using fabricated structural steel to accomplish their design goals is well worth our consideration. □



Stan Schachne and Chris Urbanczyk, Illinois Institute of Technology

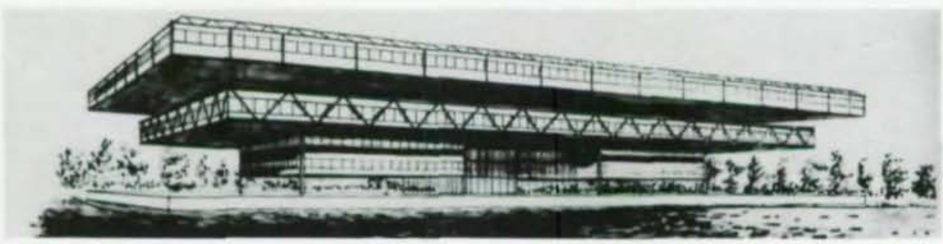


◀ *Stephen Wille, Paul Cholipski, Chris Pienton, University of Illinois, Champaign-Urbana*



Kim Toufectis, University of Virginia

Stacey Fore, University of Oklahoma



Robert Bizot, Stephen Kucharceyk, Kenneth Calongne, and Phillip Wingo, Louisiana State University

4 New BOOKS FROM AISC . . .

2

Detailing for Steel Construction (1st Edition, 1983). Brand new textbook geared to beginning detailer's needs. Comprehensive guide includes chapters on: Fabricating Techniques; Drafting Equipment/Procedures; Analysis of Stresses; Bolted and Welded Connections; Column Details; Framing for Industrial Buildings. 332 pgs. $32.

1

Manual of Steel Construction—Lightweight Edition—a go-anywhere traveling companion for field or business trips. Only half as thick—and half the weight of standard 8th Edition *Manual*. Yet complete in every detail! 832 pgs. $36.

4

Engineering for Steel Construction (1984). Completely updated and keyed to advanced detailer or design engineer. Text covers suggested design procedures for more complex structures and connections. Soon to be released. (Jan,1984). $52.

3

Torsional Analysis of Steel Members (1983). Text helps reduce computation time required for complete analysis of loading of structural members. Tables/charts solve torsion problems and investigate restraining effects of continuous framing conditions. 84 pgs. $16.

Note:
Detailing for Steel Construction and *Engineering for Steel Construction* are self-contained texts—and have some common material.

American Institute of Steel Construction
P.O. Box 4588
Chicago, IL 60680

Enclosed is $ ______ for the following books:

1/ ____ copies @ $36. — $ ____
2/ ____ copies @ $32. — $ ____
3/ ____ copies @ $16. — $ ____
4/ ____ copies @ $52. — $ ____

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Fenway Park:
Steel's Flexibility a Heavy Hitter!

One of the surest ways to incite a riot amongst Boston Red Sox fans would be to disturb the charm and character of what they refer to as their "big green monster"—Fenway Park.

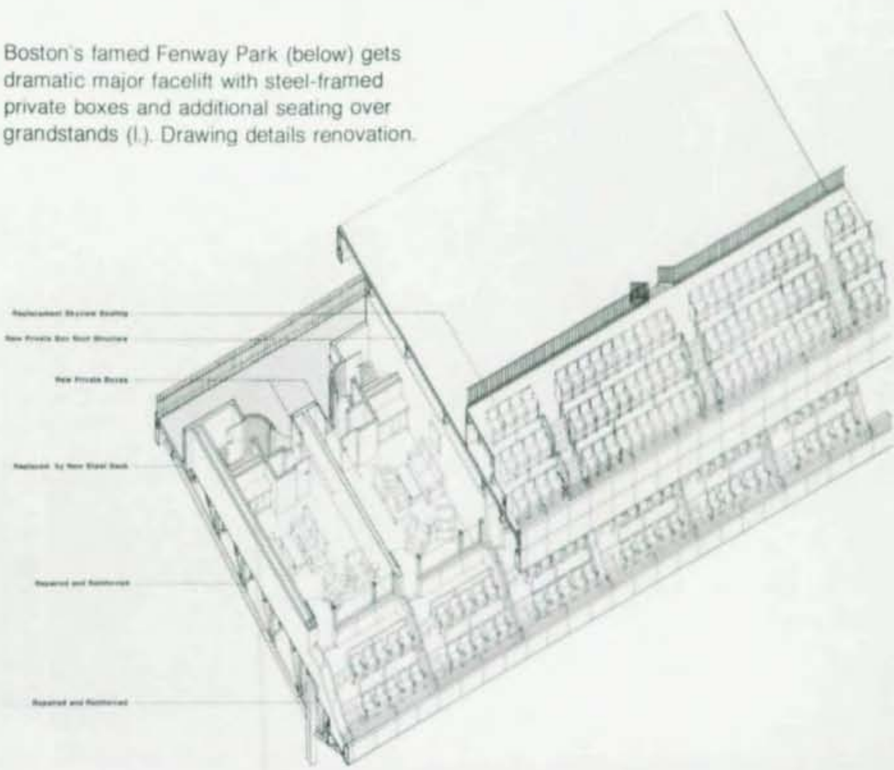
Originally built in 1912, Fenway Park had stood the test of time, but was badly in need of renovation. The third oldest major league park in the country, it has many of the special qualities and an architectural scale that newer stadiums lack—qualities that endear it to rabid Red Sox fans and players alike.

Thomas Yawkey bought the Red Sox in 1933 and subsequently extended the right and left field grandstands, changing the temporary wood structures to permanent stands. A roof over the grandstand was built of steel columns, beams and trusses.

In the latest renovation of Fenway Park, one of the most critical requirements was that the work—in two phases—be done during the off-season. The Sox had to play ball in it during the regular season. Greater capacity and new amenities were badly needed. The new additions consisted of a number of private boxes over the existing roof, and another six rows of seating above the roof of the private boxes.

First, the structural feasibility of the additions required checking the capacity of existing foundations and superstructure. For the proposed new loading, both the belled caissons (added in 1933) and the spread footings had to be reinforced. A safe

Boston's famed Fenway Park (below) gets dramatic major facelift with steel-framed private boxes and additional seating over grandstands (l.). Drawing details renovation.



soil bearing pressure permitted enlarging these footings. It was done by drilling, and grouting a larger number of deformed dowels into the piers above the footing for a total of about 10 ft.

Then, a new concrete jacket was built around the piers down to a new caisson poured around the footings. Reinforcing bars wrapped around existing footings to overcome separation of old and new concrete. The caissons were reinforced by driving new steel piles and tying them together with a tie beam.

The existing steel structure required extensive reinforcement to carry the new loads. Yield strength of steel used in 1912 and 1934 varied from 27 to 30 ksi. The existing connections were riveted. Reinforcement of the old truss members was done by welding plates, angles or tubes to the individual members. Connections were reinforced by welding around existing gusset plates, or adding new plates. Low fusion welding materials had to be used to avoid burning through the existing steel. Columns were designed as an element of a frame to resist gravity as well as wind loads. Large reinforcing plates had to be used on four sides of existing columns for their full height.

Steel Bats 1,000

Since the park had to be undisturbed during the playing season, renovation was spread out over two seasons. Phase 1, completed in June 1982, consisted of:

- 21 new private boxes, all steel-framed
- Steel stairway for access to boxes and skyview seats
- Wood deck roof and structure replaced with steel and plywood deck
- Existing steel under boxes reinforced
- Red Sox locker room rebuilt
- Two existing light towers removed, shortened and replaced on top of private boxes

Steel was used throughout Phase I because it fulfilled the critical concerns for speed of construction, weight and compatibility with the existing structure. The private boxes, containing a lounge area, a bar and bath and 10 viewing seats, were built of structural steel because it blended so well with the old structure. Plus the fact it would be built quickly during the off-seasons.

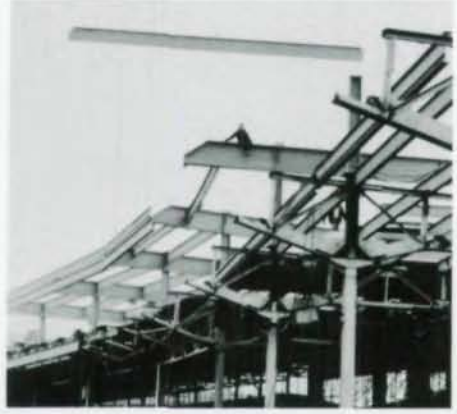
This new construction above the roof was mainly steel columns, and beams and heavy gage steel decking. The lateral resisting system of the private boxes was designed as a story high truss system interconnected with the top chord of existing roof trusses. The design for lateral loads was done in such a way that the capacity of existing trusses was utilized as efficiently as possible.

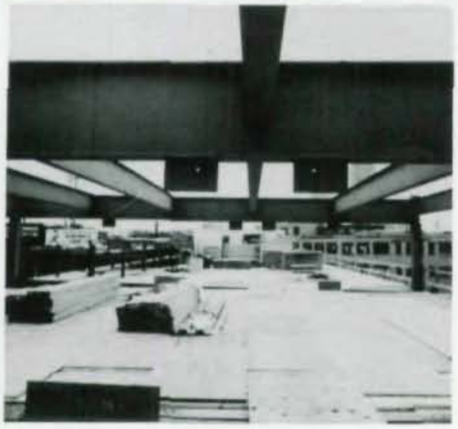
Phase 2 work, begun in October 1982 and completed in time for the 1983 season, included:

- 24 additional private boxes above the left field grandstand

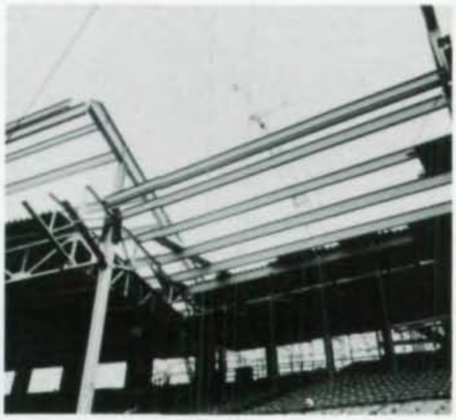
New steel framing for skyview box level erected above existing roof level.

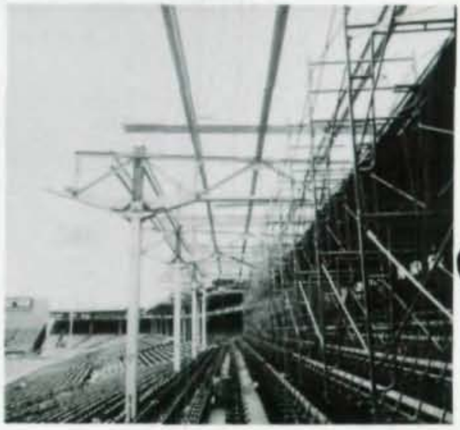
New 40-ft W21 transverse roof beam drops into place over skyview box section. Trusses of existing roof were cut back 10 ft. New girders are W36x160. Bottom photo, new W12x20 column extensions support W21 beams and W36 girders that frame skyview box level.





Existing roof was framed with riveted trusses supported on 20-ft columns, which were reinforced to carry added loads. Bottom, scaffolding supported ironworkers' activities during renovation.





- Skyview seats above both left and right field private boxes
- Steel stairway and an elevator
- Four new light towers with new 1,500-watt halide lamps

Play Ball!

The job was done on time. The field was ready—because most of the work could be done in the fabricator's shop, and during the cold months. The critical concerns of speed and weight and adaptability to an existing structure were all met. A new wall system, a plywood-backed steel skin, was added and painted the traditional "green monster."

The work has been so well received that Red Sox fans have commented it is difficult to tell where the old stadium leaves off and the new construction begins—a tribute not only to the builders and designers, but also to the flexibility of structural steel from 1933 to 1983—and beyond.

It was time to "play ball"—but steel had already hit another home run! □

New W21 floor beams installed over existing trusses, which vary in depth from 3 to 6 ft. Rods (1-in dia.) brace top and bottom chords. All field connections to existing members were welded.

Architect
Skidmore, Owings & Merrill
Boston, Massachusetts

Structural Engineers
SOM, Boston (Phase I)
Weidlinger Associates (Phase II)
Cambridge, Massachusetts

Steel Fabricator/Erector
L. Antonelli Iron Works, Inc.
Quincy, Massachusetts

Owner
Boston Red Sox

Steel Design—Current Practice:
New AISC Lecture Series to Hit the Road

Starting in the Fall of 1983, AISC—in cooperation with ASCE—will conduct a major lecture series, "Steel Design—Current Practice." The six-lecture series will be presented to an estimated 6,000 design engineers in 60-70 cities over a period of six to eight months.

The lectures, developed by the AISC engineering staff, present the fundamentals of steel design, and introduce the latest procedures based on recent research. Emphasis is on the actual design of beams, columns and connections. Varying from one to two hours long, the lectures will cover: axially loaded columns; bending members; bending members—buckling, torsion and bracing; beam-columns; connections and composite design.

Since the previous AISC lecture series in 1975—"*Simplified Steel Design*"—a new *Specification* and a new *Manual of Steel Construction* have been published. The new "Steel Design—Current Practice" series reflects the many changes made in these documents.

Each registrant receives a complete set of lecture notes, including graphics, which will serve as a valuable reference to the engineer in his daily practice. The program meets criteria for the nationally accepted Continuing Education Unit. Each participant who successfully completes the series will earn one CEU.

For complete information on the time and location of the Lecture Series in your area, contact your local AISC regional engineer listed on page 4 of this magazine. □

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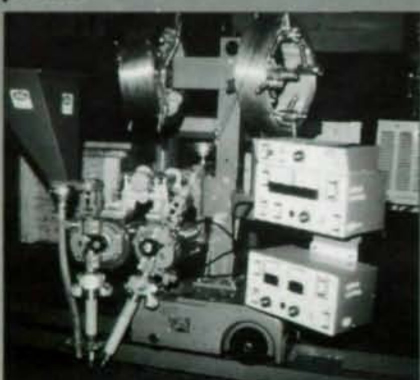

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UNION CARBIDE

Miami International: Steeled for the "Big Blows"

by Jeffrey S. Ward

Jeffrey S. Ward, P.E., is project manager for the engineering firm of Wilbur Smith and Associates, Miami, Florida.

Expansion of, and modification to, Concourse B at Miami International Airport represents the character of upgrading the Gateway to the Americas is presently undergoing. The new concourse will soon be one of the most visually exciting terminals for air travelers.

The task given the architects and engineers was to design a memorable terminal complex concourse expansion at one of the busiest airports in the world—while maintaining the existing operating concourse with little interruption. In coordination with the Facilities Department of the Dade County Aviation Dept., the architects and engineers developed a program to meet all project requirements, which include:

- Space-planning for a high volume of air passenger traffic
- Phasing construction of the concourse building and surrounding area to permit maintaining present airside and concourse operations
- Providing an impressive "welcome" of South Florida metropolitan area to all visitors, both domestic and international

Miami International's new terminal expansion (l. and below), soon to be a "visually exciting terminal," employed structural steel for both architectural considerations and need for rigid framing to withstand big blows of Florida weather.

- Coordinating construction to avoid interruption of the extensive underground utility services which service the numerous airport operations

Architectural Considerations

To present an impressive initial reaction to deplaning patrons and a pleasant atmosphere for waiting passengers, the architect developed an open-air feeling with aesthetically pleasing surroundings. Some of the elements designed to provide this atmosphere include:

- An open atrium in the middle of the concourse, with a glass-enclosed elevator running along it
- Extensive use of curved walls and other elements
- Widely spaced columns
- Extensive use of two-story curved glass enclosures for the exterior

Why Structural Steel?

South Florida structural designs are dominated by various types of concrete structures, so one might wonder why this three-story complex would be constructed of structural steel. The engineers evaluated many structural systems and materials which would match the open, long-span conditions required by the architectural design. Even though many typical systems are in use in South Florida for long spans in one direction, very little could be found that would economically provide for long-span framing in both directions. Rigid framing was required in both directions because the open interior and exterior conditions did not permit any shear walls or bracing for lateral stability. Therefore, rigid frames were required in both directions to withstand South Florida "big blow" hurricane loadings.

Steel for the "Big Blows"

Based on these and other requirements, structural steel rigid framing was selected. Structural steel framing was able to furnish the long spans and yet provide the stiffness required to offset wind loads from any direction. Structural steel also accommodated easily the extensive use of long cantilevers, necessary because of the many exterior architectural conditions in which columns were set back from the glass enclosures.

Another restriction met by structural steel was the very restricted plenum space. This space was shared by the structure, plus the heavy utilities and air conditioning ducts. The plenum space of the existing terminal, with its much closer column spacing, had to be maintained during the concourse expansion. This plenum restriction dictated that beam depths had to be held to a minimum to provide room for utilities and ducts.

Structural steel was also selected because of restricted access to the construction site. Trucks shared the open space with aircraft. The structural steel was delivered and erected in a relatively short time, thus reducing the amount of construction traffic.

Structural Steel Design Aspects

Since all the structure's lateral stability had to be provided by rigid frames, the majority of column-to-beam connections had to be rigid moment connections. Alternates were allowed for the detailing of these connections. The fabricator chose to use full penetration welds for the flanges to carry the

Composite photos show framing around open atrium (above) and future glass-enclosed elevator areas.

moments, and bolted connections in the web to carry the shear.

Many of the framing beams had to be kept to a maximum of 24-in. depth because of restricted plenum space. This requirement resulted in heavier members and also larger moments in the columns. With these moments in both directions, the columns had to be quite large. Also, exterior columns were placed back from the exterior enclosure, requiring beams to cantilever as much as 20 ft. Some have to carry two floors and the roof, while others carry one floor plus the large glass panels which run from the second floor, past the third floor and curve back to the roof.

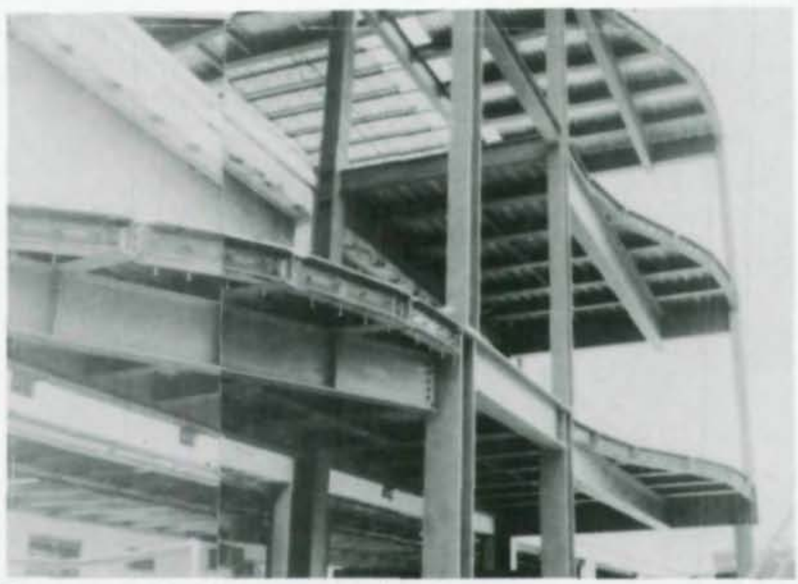
One technique used to keep the floor and framing beams' depth and weight to a minimum was the use of a composite deck with 3¼-in. lightweight concrete topping and studded beams to provide composite action. However, to circumvent cracking in negative moment regions, framing beam studs were not used for a one-fourth span distance from any moment connection.

Fire protection for the structural steel was provided by spray-on cementitious fireproofing on the beams. Columns are encased in concrete for both aesthetics and fire protection.

Other Important Structural Aspects

Because of the column spacing and the crush loading of a passenger terminal facility, column loads are greater than normally expected from a three-story building. Also, the column bases are fixed to decrease the column size, which results in biaxial overturning moments on the footings. Therefore, a vibroflotation process was used to increase the bearing capacity of the sand and limerock mixed condition to 6,000 psf.

Miami International truly was steeled for the "big blows." □



Expansion steel framing and decking prior to forming concrete soffits.

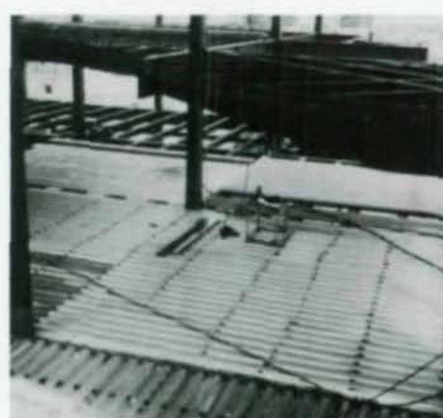
Architect
Bouterse Perez and Fabregas
Miami, Florida

Structural Engineer
Wilbur Smith and Associates
Miami, Florida

General Contractor
Shafer & Miller, Inc.
Miami, Florida

Owner
Dade County Aviation Department
Dade County, Florida

Steel decking on second floor near atrium. Composite deck kept floor and framing beams' depth and weight to minimum.



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Kannapolis Middle School: A Study in Function and Economy

by Donald Haigh

Donald Haigh is director of structural engineering for the architecture/engineering firm of Odell Associates, Inc., Charlotte, North Carolina.

On a 33-acre site in a residential area, the new Kannapolis, N.C. Middle School houses a comprehensive academic program for 950 students in the 7th and 8th grades. The design concept of the 102,500-sq ft facility arranges eight academic modules around two landscaped courtyards, with the library and special classrooms forming the nucleus of the school. In addition to academic spaces, there are laboratories, shop facilities, music and auditorium space, physical education facilities, cafeteria and administrative offices.

Soft, residual soils were encountered under approximately one-third of the proposed building area. This soil was undercut an average of six feet and replaced with suitable engineering fill, placed and compacted in 8-in. lifts. The foundations are isolated column spread-footings and continuous strip footings beneath the load-bearing masonry walls with an allowable bearing of 3,000 psf.

A distinctive roof shape on the academic modules lends identity and human scale to the single-story structure. Each module is a 66 x 72-ft rectangle consisting of perimeter load-bearing masonry walls—with steel beams and bar joists comprising the roof structure. The bar joists, spaced approximately 4 ft o.c., were especially fabricated with corresponding sloped bearing plates to support a total load of 50 psf at a 4:12 slope. Spans of the bar joists range from 3 ft to 33 ft, and are supported by 24-in. deep hip beams spanning from the four corners of the academic module. The hip beams are supported at the center of the module by a tapered plate girder at the roof ridge. The tapered plate girder, supported at each end by 6-in. diameter pipe columns, varies in depth from 1 ft to 3 ft-5 in. and spans 21 ft-8 in.

Free spanning structural steel trusses were used to provide a large column-free area for the gymnasium. These trusses, fabricated of standard 8-in. W sections, are spaced at 20 ft o.c., and have a net clear span of 78 ft-8 in. Truss support is provided by steel columns in masonry piers at the exterior walls.

The remainder of the vaulted hipped roofs were framed similarly to the academic modules, with standard rolled W shapes for hip beams and ridge beams. Bar joists slope at 4:12 between the load-bearing masonry walls and steel beams. The maximum span for the sloped bar joists is 54 ft at the north and south ends of the gymnasium wing. The typical sloped roof construction consisted of 3-in. tongue-&-groove cementitious deck, covered with two layers of felt and Class A asphalt shingles.

The structural system, in conjunction with

Kannapolis School's large, column-free gymnasium was created by free-spanning structural steel trusses.

the other building systems, emphasize economy and function throughout the facility. Careful design consideration and execution provide a quality educational facility for less than $45 per square foot.

Soon after the Kannapolis seventh and eighth graders began the school term last autumn in this new facility, the former antiquated junior high school was totally destroyed by fire. Not only was the new Middle School in use, but the building's unique features were already available to both the students and adults of the city's 40,000 residents. □

Architect/Structural Engineer
Odell Associates, Inc.
Charlotte, North Carolina

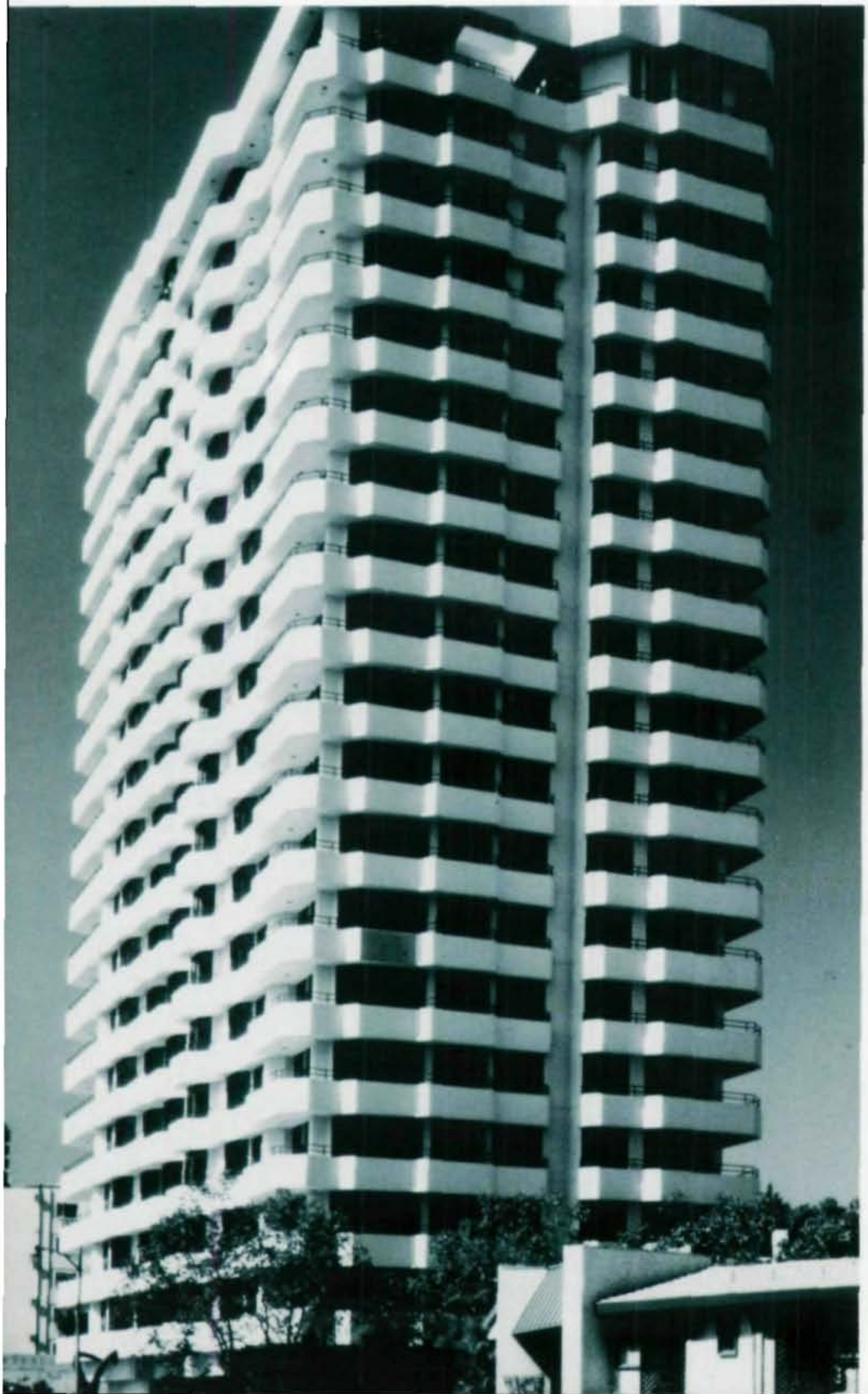
General Contractor
L. P. Cox Company, Inc.
Concord, North Carolina

Steel Fabricator
Steelfab, Inc.
Charlotte, North Carolina

Owner
Kannapolis Board of Education
Kannapolis, North Carolina

Kannapolis (N.C.) Middle School arranges eight academic modules around landscaped courtyards. Distinctive roof lends human scale to one-story structure. Steel beams and bar joists form roof of rectangular modules.

Wilshire House: Going First Class—with Steel



Can you believe? A condominium with an $11-million price tag? Seven bedrooms and eight and a half baths? Key-operated elevators to the owner's private foyer? Private screening rooms, garden solariums and separate guest suites?

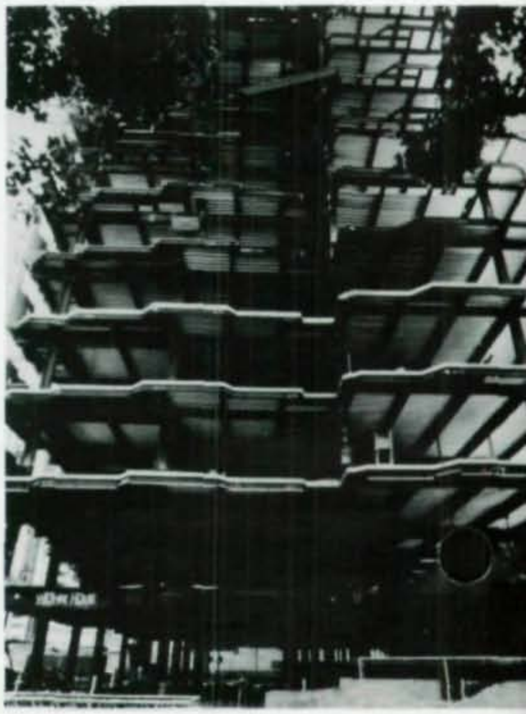
Believe it—because that's Wilshire House, a recently completed spectacular condominium "designed for persons of discriminating taste, the ultimate in affluent lifestyle." The luxury structure, situated on Wilshire Gold Coast, a one-mile strip between Westwood and Beverly Hills, Cal., is one of 11 newer projects built or under construction on this affluent strip of Los Angeles. Total cost of these projects nears the $1-billion mark.

Careful siting set the Wilshire House back from the street, tasteful landscaping combined with an elegant granite facade to provide a visual break from the "row" appearance. Terraces literally create a garden off every room and a one-way circular driveway reduces traffic delays. The development, opened in late 1982, contains 67 luxury units priced from $1.5 to $11 million in its 21-story glass- and granite-clad steel tower. Fifteen floor plans are offered.

Steel Along the Gold Coast

The vertical loads of the tower floors and roof are supported on composite steel deck and slab, which is in turn supported by steel purlins, beams and columns. Structural

Wilshire House (l.), luxury condominium on Los Angeles' Gold Coast, boasts $11-million dollar unit—and steel frame (below).



steel ductile moment-resisting space frames resist lateral loads of wind or seismic force. The composite steel deck and slabs serve as rigid diaphragms to distribute loads to the frames. The frames unload at the ground level into a concrete diaphragm, which in turn delivers loads into concrete shear walls.

Friction between footing and earth resist the forces in the shear walls. Rigid frame columns, pinned at the top of the footings, extend to the top of the building. A dynamic analysis was used to design these rigid frames. A36 steel was used in the space frames, with sizes governed by deflection requirements.

The building's structural steel frame permits an optimum parking arrangement in the three-level underground garage. At the same time, it provides a disposition of columns on upper floors suited to the most flexible floor planning for the units. This system was designed when it was shown that, due to the physical constraints of the site, the columns would restrict parking, unless a different approach was used.

The solution is a series of seven massive plate girders, each weighing about 10 tons. Four on the second floor and three on the third floor function as transfer members for the columns. They employed high-strength structural steel, A572, Gr. 50, for web and flange plates. The second floor girders, which carry columns supporting 18 floors and a roof, are five feet deep, with spans varying from 24 to 30 ft. The third floor girders are cantilevered eight to 14 feet to support loads from 17 floors and the roof. All, about seven feet deep, are comprised of welded flange and web plates of high-strength structural steel. Girders are connected to the columns by high-strength bolts.

If it were not for these seven transfer member girders, columns would have to run from the roof to the underground parking area, interfering with the parking layout and the architectural design of the condominiums. Because of this system, one set of columns is placed in the optimum position for parking, while another column grouping is situated to permit greatest usage of floor space for condominiums and the two-story lobby.

Particular emphasis was placed on design features that expose residents and guests to the ultimate experience of total luxury, all the way from the circular drive through the luxurious lobby and recreational areas into the spacious condominium units. The units range in size from 2,600 to 4,700 sq ft, with two 7,000 sq ft penthouses. Each unit is situated on one or more corners of the building, affording three or four views of the city. Key-operated elevators, private vestibules, distinctive lobbies replete with granite and greenery, and a magnificent chandelier over a 15-ft waterfall add to the feeling of opulence. Add to that massive fireplaces, oversize master suites, his & her baths, 1,000-sq ft garden terraces, sitting rooms and maids' quarters and they create the "grandeur of a private estate without the responsibilities of upkeep" that the developer planned.

Truly, "thar's gold in them thar (Beverly) hills"—and the architect's going first class—with steel—made Wilshire House more adaptable and livable for its discriminating residents. □

Massive steel girders move into place to provide both flexible floor planning above, and maximum parking arrangements below for luxurious structure's tenants.

Architects
Gruen Associates
Los Angeles, California

Structural Engineer
John A. Martin & Associates
Los Angeles, California

General Contractor
M. J. Brock & Sons, Inc.
Los Angeles, California

Owner
Pierce Management Co.
Los Angeles, California

"Red Rex" Graces Condo

Described by its sculptor as "kingly yet primitive," this work of art at Wilshire House seems to evoke either love or hate. Red Rex is actually a 20-ft high, 60,000-lb. sculpture composed of an inner steel frame covered with concrete into which has been embedded thousands of pieces of scored brick.

The framework, fabricated in two sections of square and rectangular tubing, involved a very close working relationship between sculptor and steel fabricator. The sections were mated and headed studs were welded to the steel frame. At the site, rebar was welded to the stud heads and the frame draped with wire mesh to hold the concrete.

Love it or hate it, Red Rex has not slowed the sale of Wilshire House's posh units. Nor is it likely to be moved!

Sculptor
Daniel Sinclair, New York, New York

Structural Engineer
Grossman & Speer, Glendale, California

Steel Fabricator
Ross-Carter Corporation, N. Hollywood, California

Emery Air Freight Hub: Construction Left a Vapor Trail

Speed is the watchword of the air freight business. And when Emery Air Freight decided to build a new super-hub terminal complex in Dayton, Ohio they expected some speed.

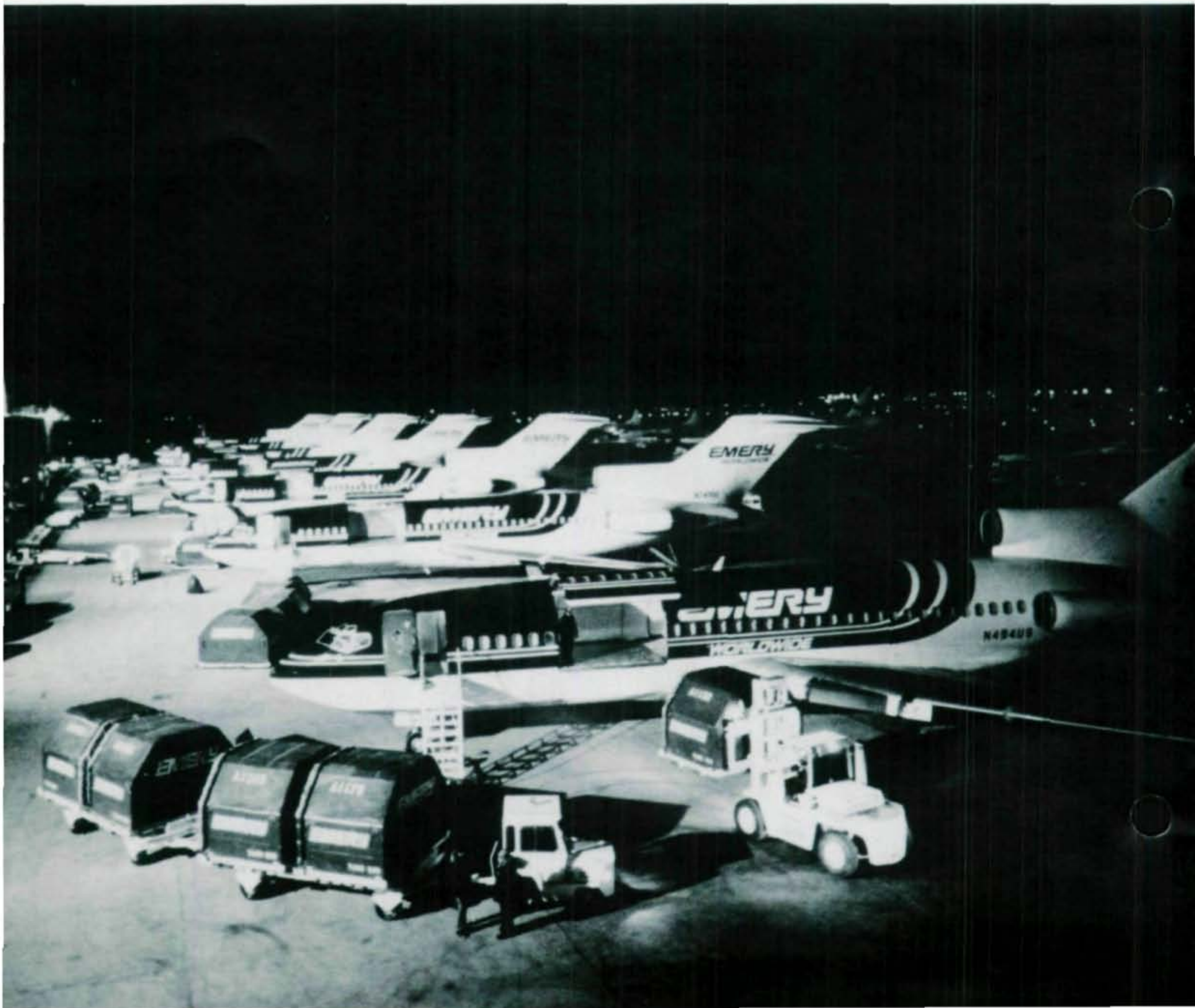
The job was to build 210,000 sq ft of terminal, 1.8 million sq ft of cargo aprons, 153,000 sq ft of blacktopped areas for future buildings and 175,000 sq ft for parking. The terminal complex, with its sophisticated conveyor system, required a 230-ft x 900-ft structure with a 32-ft clear height. A project of this enormity would normally require 24 months—the design/build team did it in six!

Emery chose Dayton for its terminal center because of its location, and the cooperation the city offered in getting the complex built. It is the company's only hub for all their air freight operations. Freight arrives in the evening and is sorted and loaded on departing flights. So they wanted the building—and now.

The contract for the design/build package was accepted on a March 30—and the building was to be completed by November 1. To assure it would happen, a $5,000 a day penalty was a part of the contract.

Move It!

The design/build team—consulting engineers, general contractor, fabricator and erector—worked together to produce an economical foundation and a structural steel framing system that would minimize construction time, and permit erection of the conveyor system and other trades under roof. Since the fabrication and erection time was a major consideration, readily available beams with end-plate moment connections were used in a rigid-frame system, even though this added 10% to framing costs.



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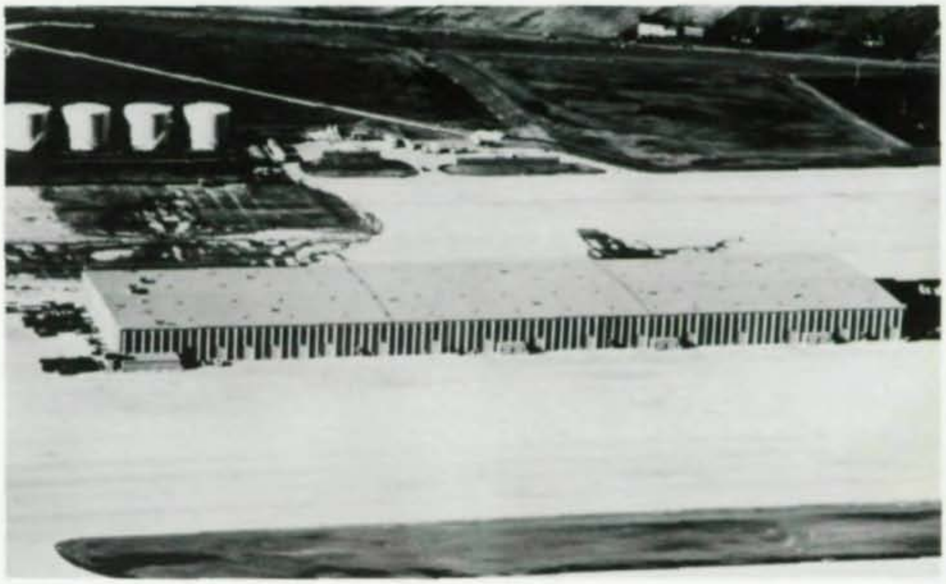
The frame was designed as a four-span rigid frame in the short dimension with pinned column bases. In the long direction, a braced frame was broken into 300-ft sections. Beams were used as struts at the columns, with 30-ft joists as purlins spanning between the frames. Columns were fabricated with the 8-ft high pipe collar column protection shop-attached to save time. Erection started just six weeks after the contract award, and finished one month later—two full weeks ahead of schedule.

The frame was designed for jet blast loads, plus an additional 40 psf live load for



Emery's superhub at Dayton International Airport handles shipments from 130 major cities nightly (l.). Steel-framed 217,000-sq ft. facility (r.) provides loading area for 48 aircraft.

the roof system, in addition to normal wind and snow loads. This provided flexibility in supporting the conveyor system. A modular wall system used 10-ft wide x 40-ft high precast panels, floor to eave. Three panels fit into each 30-ft bay to permit easy changing of opening locations.

On Time—at 40% Savings

Despite 41 rain day delays, the project was completed on time. On November 1, the first Emery plane rolled up, and by the end of the month a million pounds of cargo per night were being handled. The contractor had finished the job on time—and at a $15-million (40%) savings.

Fast-tracking with structural steel had really left a vapor trail! □

Architect
Levin, Porter & Smith, Inc.
Dayton, Ohio

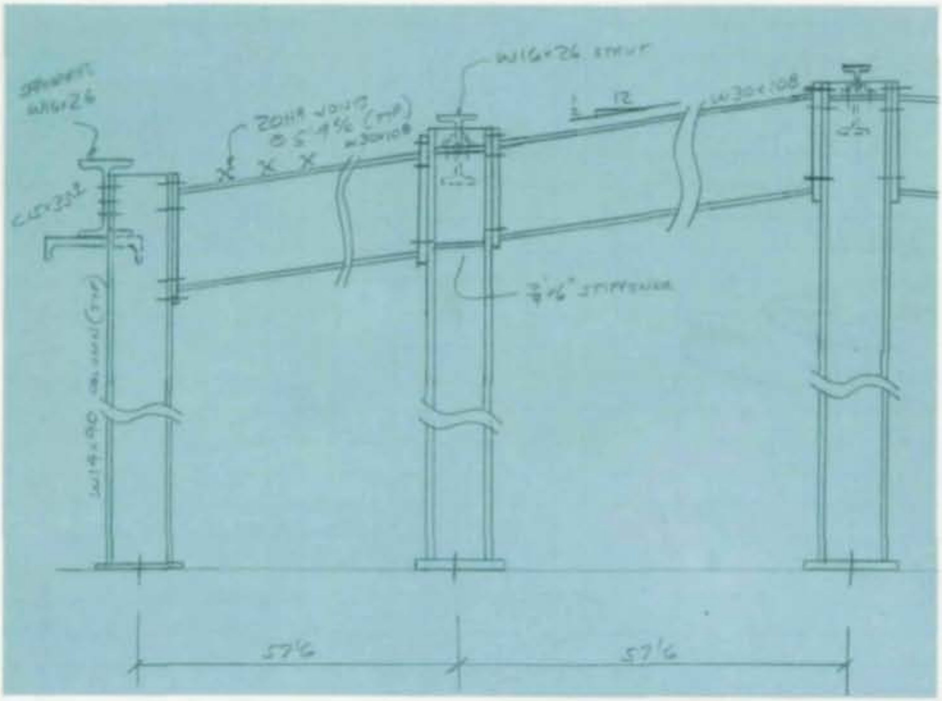
Structural Engineer
Middough Associates, Inc.
Cleveland, Ohio

Consulting Engineer
KZF Incorporated
Cincinnati, Ohio

General Contractor
Shook, Inc.
Dayton, Ohio

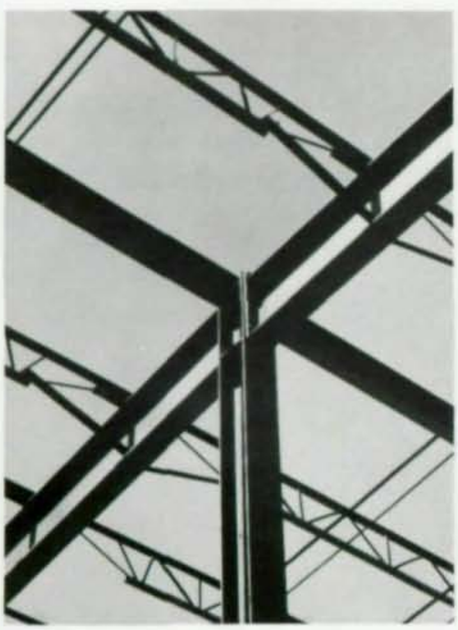
Steel Fabricator/Erector
The Dayton Fabricated Steel Company
Dayton, Ohio

Owner
City of Dayton
Dayton, Ohio



Typical frame cross-section

Computer-assisted conveyor system sorts over 1.5 million pounds of cargo nightly.



Beam and column moment connection (far l.); closeup of connections with flange backing plate (l.).

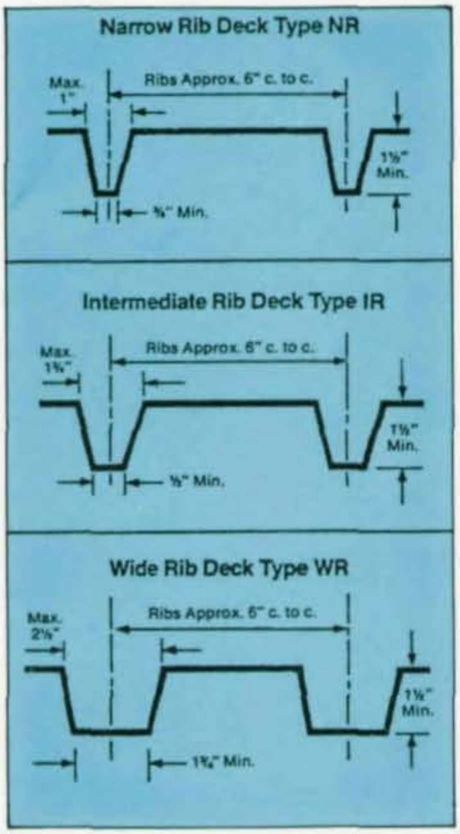
Twenty Questions—About Steel Roof Deck

by Richard B. Heagler

Steel roof decks have become such a common building material that one might think there were no questions left to ask about the product. But questions still come up, they reflect the desire to obtain design information as well as general knowledge. This article answers some of the recurring questions that have come up over the years.

Richard B. Heagler, P.E., is director of engineering for Nicholas J. Bouras, Inc., Summit, New Jersey.

Figure 1



1. Is there such a thing as "standard" roof deck?

The Steel Deck Institute gives standards for 1½-in. deep decks of three profiles: narrow-rib, intermediate-rib and wide-rib roof decks (see Figure 1). All 1½-in. roof deck sections produced within the SDI dimensions can be called standard sections. Within the dimensions shown, there *are* variations from manufacturer to manufacturer—enough to cause section properties to be a little different.

2. How about other depths?

No other standards are presently defined, but 3-in. deep deck with ribs at 8-in. centers is such a commonly used section that it is almost standard. The rib opening of this deck is similar to the 1½-in. wide-rib deck. Other depths of deck are made, but there are many variations in rib spacing and geometry.

3. Why the variations in rib geometry; and, of the three "standard shapes" which is the most common?

Thinner insulation boards may require a narrower deck rib opening. Most boards 1 in. or thicker can be used on the wide-rib deck. But the insulation board should be checked to make sure it can span the rib opening. The wide-rib deck is by far the most popular. It has higher section properties (per in. thickness) than the other patterns and, therefore, it can span greater distances. As energy requirements become more stringent, we will probably see even more use of the wide-rib profile because insulation boards will get thicker and rib openings will be less of a consideration.

4. What are the differences between roof deck, floor deck and form deck?

For application purposes, roof deck, when used in built-up roof systems, is the load-carrying member for service loads for the life of the structure. Its geometry is based on loading requirements and, as mentioned before, the insulation board thickness. Floor deck has deformations or other shear transfer devices built-in to make it composite deck. It is usually a more open pattern than roof deck (although the

Typical construction of roof deck, steel joists on steel framing wide-rib roof deck pattern is used to make composite deck). Floor deck carries construction loads and the wet concrete. Once the concrete hardens, the deck becomes tensile reinforcement, so that its loading condition changes from the construction stage to the service stage. Form deck is simply a stay-in-place form for concrete. The slab is reinforced as a conventional slab. Roof deck is sometimes used as a form deck.

As for section properties of the three types, roof, floor and form, they are all calculated with the same procedures.

5. Can section properties, often confusing, be calculated in the same way as any other steel section?

Roof deck is made by cold-forming (forming at room temperature) sheet steel. Products made by this process are analyzed using the AISI *Specification for the Design of Cold Formed Steel Structural Members*. This specification (in Section 2) gives the formulas necessary to calculate the section properties of flexural members, including deck. For most deck sections, the width-to-thickness ratio of the compression flange is such that the concept of "effective width" is used. Briefly, this concept simplifies the actual stress distribution in a compression flange by eliminating, for analysis sake, some of the material. The amount of material eliminated depends on the magnitude of the compression stress and on the width/thickness ratio. The stress depends on the location of the neutral axis, which in turn depends on the amount of material (effective width) being used. You can see that iterative (trial and error) process is set up. For negative bending, over supports, the compression flange in "standard" deck is smaller and the section must be analyzed again for this case. Finally, the effective width formula for deflection is different than the formula for stress, so the process is again repeated. The result is that the S is obtained for positive bending; an S for negative bending; and, finally, an I for deflection. Values are usually published for a one-foot wide deck.

6. What other deck values are checked using the AISI specification?

The usual—shear in webs, combined shear and bending in the webs, and web crippling. For the standard 1½-in. decks, these values seldom govern the allowable service loads, although some of the deeper deck units may have their loads limited by web crippling.

7. Are the results accurate?

Yes. The AISI specification does a very good job in predicting deck behavior under load. For instance, deck deflection can be predicted as accurately as the E (elastic modulus) is accurate. Stress calculations are usually conservative since the steel used for deck is assumed to have a yield point of 33 ksi, when in reality it is seldom less than 40 ksi.

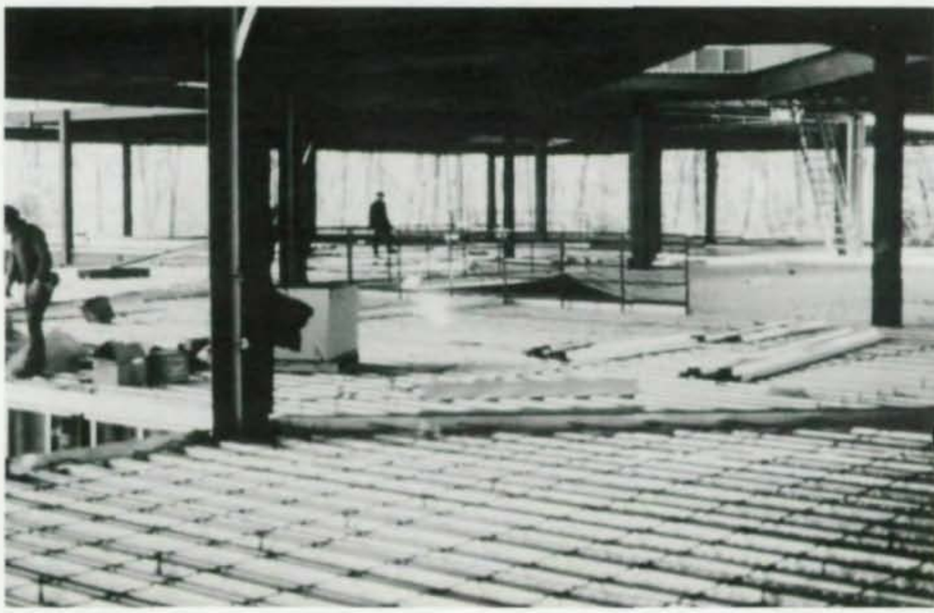
8. Why do most manufacturers show load tables that include deck spans longer than those normally used?

Deck is used for many applications besides roofs, such as siding, shelving and form material, so it is necessary to show some extensions on the tables.

9. What limits the spans of deck for roofs?

The SDI shows a span limitation based on a 200-lb. concentrated maintenance load. The 200 lbs. may seem low but actually it is a fairly conservative number as it is only spread over a one-foot width. Tests on bare deck show the actual distribution to be about 15 in., and with insulation board in place, a much larger distribution occurs.

Typical floor deck. Note skewed framing and studs through deck.



10. Is wind uplift a problem?

The deck stiffness (I) is a little greater with reverse loading. And, unless very long spans and very sparse fastening is used, the stress in the fasteners is low, so uplift problems on the deck itself are rare. Standard fastening patterns are generally sufficient to prevent any uplift of the deck units. There have been cases where insulation boards have been lifted by the wind, so most insuring agencies require mechanical fastening of the boards to the deck in high uplift regions, such as the perimeter of the building.

11. Do many designers take advantage of the horizontal bracing the deck provides?

Yes. The deck provides a good diaphragm to resist wind and earthquake loading, and many structural engineers take advantage of this fact. It is almost like getting something for nothing, because the deck's main function is to carry the gravity loads. But once it is attached to the frame, it can supplement the bracing, or in some cases replace the bracing entirely.

12. What fastening is required to make the deck into an effective diaphragm?

The strength and stiffness of the diaphragm is highly dependent on the fastening—fastening to the frame, and fastening deck unit to deck unit. You will get some diaphragm service from almost any pattern or method of attachment. But, to increase the abilities of the system, increase or upgrade the fastening. Methods of calculating diaphragm strength and stiffness may be obtained from references in the Reference List.

13. Is welding the most used fastening method?

Yes, for both deck-to-structure and deck-to-deck at the sidelaps. Other fastening methods are becoming more common, and frequently the deck is welded to the structure with self-drilling screws used at the sidelaps. Pneumatically driven pin fasteners, screws and powder-driven fasteners are also used to attach deck to frame.

14. When welding deck to supports, should welding washers always be required?

No. Most deck sections range between 0.0598 in. and 0.0280 in. thickness. For decks less than 0.0280-in. thick, welding washers are recommended; for thicker steel, washers are not recommended. Most deck falls in the not-recommended range (see Table 1 for gage thickness relation), and stronger welds are obtained without washers.

Table 1. Design Thickness Table

Gage	Decimal Thickness in.	Decimal Thickness mm.
28*	.0149	0.378
26*	.0179	0.455
24*	.0239	0.607
22	.0295	0.749
20	.0358	0.909
18	.0474	1.204
16	.0596	1.514

*Not usually used for roof deck

15. How can weld quality be controlled?

The American Welding Society in its *Specification for Welding Sheet Steel in Structures* defines a procedure where a rod melting rate is established in producing successful welds. The Steel Deck Institute's *Diaphragm Design Manual* presents another method where a test panel is welded to a structural angle and loaded to failure. If the *deck* fails in buckling or tearing, the weld is good. If the *weld* fails, the amperage and melting rate must be adjusted until a sheet failure is obtained. In both methods, the object is to establish a performance procedure that can be used as field conditions vary. Both methods are practical, and

Roof deck, joists and framing

are job-site methods, not laboratory procedures that must be duplicated in the field.

16. How important is side-lap fastening?
Most in the deck business feel it is very important. Side-lap fasteners add to diaphragm strength and stiffness; prevent differential deflection between deck units; and help distribute loads. The SDI specifies that deck units spanning more than five ft be fastened at the side laps at a maximum spacing of three ft. This specification is based on experience.

17. What are the most common mistakes in specifications concerning roof deck?
Specifying finishes. The standard manufacturers' finish on standard roof deck is a coat of primer. The primer coat, intended to provide "tooth" for a finish coat of paint, does not provide protection from the weather for a long period of time. If the job is going to be closed in fairly quickly, then the primer coat of paint will be sufficient. If extended exposure is anticipated, a more durable coating, such as galvanizing, should be specified. The proper ASTM material numbers are A611 for steel used to make painted deck and A446 for galvanized steel. Galvanizing itself is covered in ASTM A525.

18. What is the most common field problem?
Probably it is construction abuse. Since the roof deck serves as a working platform, it gets a lot of traffic, particularly if there are low roof areas. In high traffic areas, such as areas where masons might be staging their bricks or stones, the deck should be protected from damage.

19. When deck is used as concrete form, are there any differences from conventional forming that the designer should know about?
For one thing, the use of shoring can be reduced or eliminated, which can be a significant cost savings. If galvanized deck is used, and is unshored, it can be considered capable of carrying the concrete dead weight for the life of the building. And the slab will need to be reinforced only for loads applied after the concrete sets. Voids caused by the deck ribs can reduce the concrete compression area in negative bending regions, so the designer should figure accordingly. Also, composite steel beams (studs) can be used. Composite beams do not require the use of composite deck, even though they are usually used together. Studs can be welded through the deck.

20. Are new developments coming up?
Most new things on the horizon are information items rather than new deck products. The SDI will soon be publishing new diaphragm information, based on additional testing and analysis done by Dr. Luttrell at West Virginia University. The new publication will also provide very practical design examples as well as suggested details. The SDI is also planning to include 3-in. deep deck—with ribs spaced at 8 in.—as a "standard," which should help designers in specifying deck for longer spans. □

Floor deck and roof deck

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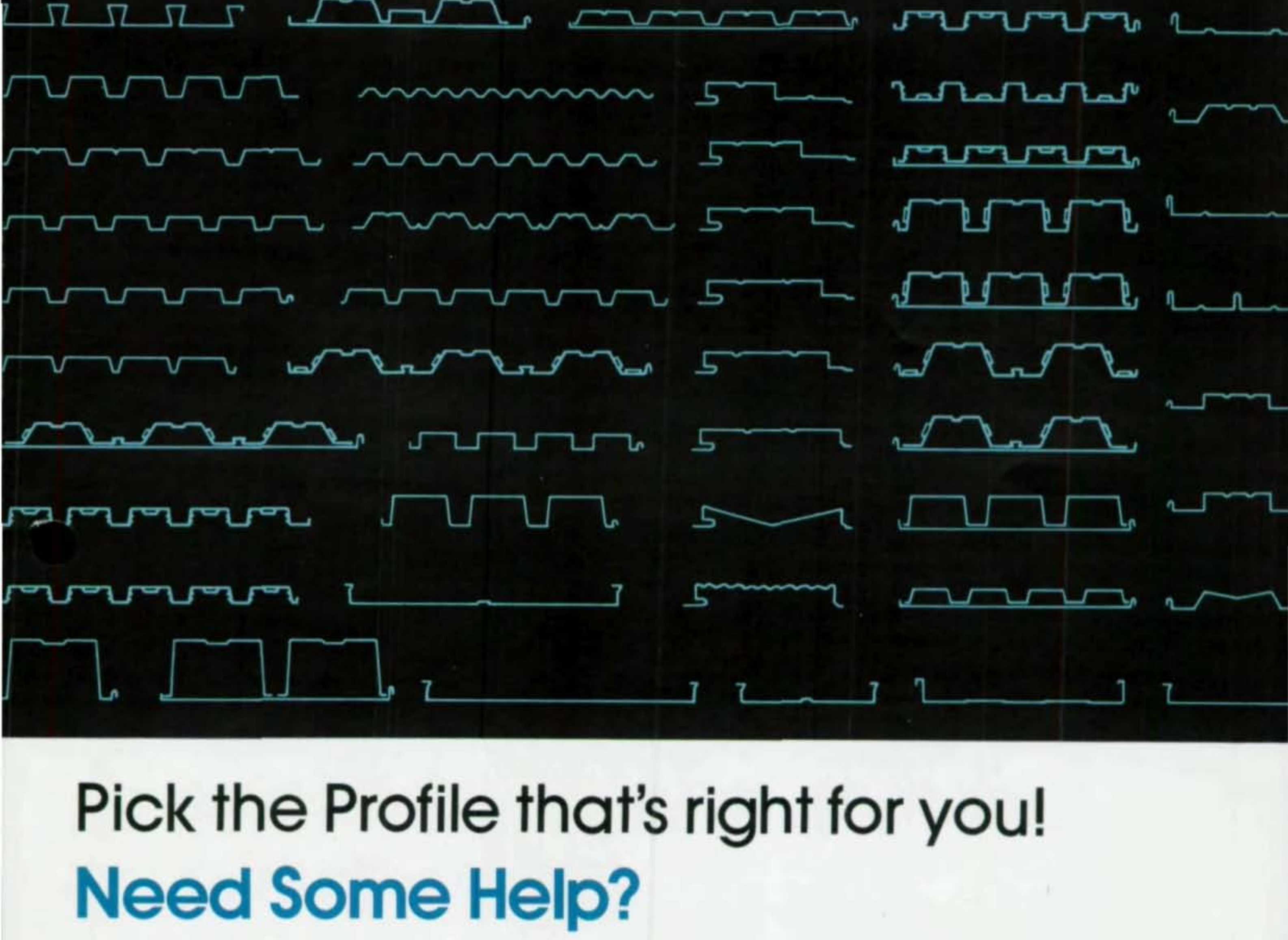

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