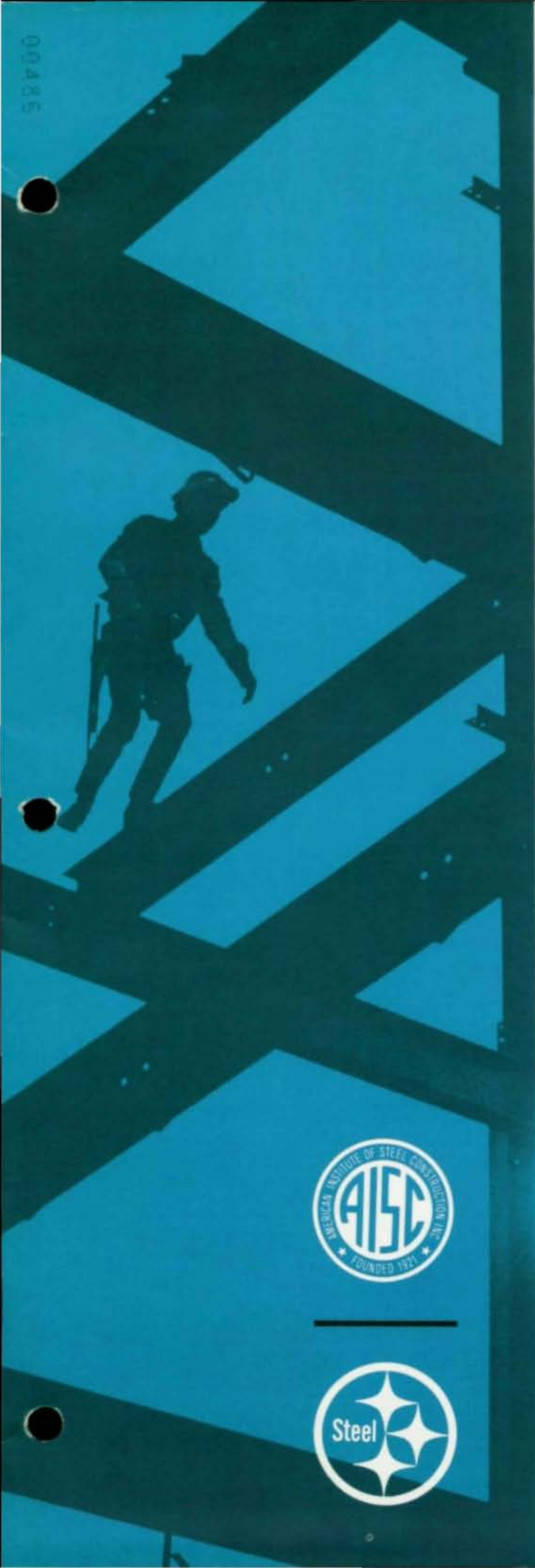
VOLUME XXI NUMBER 3/THIRD QUARTER 1981

MODERN STEEL CONSTRUCTION



New Standards in Environment
Room, and with a View
Composite System for 'Building on Building'
The Case for Mixed Construction
Showplace for the Champions

MODERN STEEL CONSTRUCTION

Published by

American Institute of Steel Construction

The Wrigley Building
400 North Michigan Avenue
Chicago, Illinois 60611

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VOLUME XXI NUMBER 3/THIRD QUARTER 1981

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1982 T.R. HIGGINS LECTURESHIP AWARD SET

The 11th annual T.R. Higgins Lectureship Award has been announced by the AISC Committee on Education. The Award recognizes an outstanding lecturer and author whose technical paper(s) are identified as an exceptional contribution to engineering literature on fabricated structural steel. Papers published within a five-year eligibility period ending January 1, 1981 will be considered.

The winner of the prestigious award will receive a $2,000 check during special ceremonies at the 1982 National Engineering Conference in Chicago when he presents his first paper.

Six eminent engineers from the fields of education, design and the fabrication industry select the award winner. They are:

***Eugene Chesson,** University of Delaware*
***Lester Herr,** T.Y. Lin International*
***Charles G. Salmon,** University of Wisconsin*
***Daniel H. Shahan,** Albert Kahn Associates*
***V.H. Thompson, Jr.,** Mosher Steel Company*
***W.A. Thornton,** Cives Steel Company*

Deadline for nominations is November 16, 1981. For complete information, write: Committee on Education, AISC, 400 North Michigan Avenue, Chicago, Illinois 60611.

NEW FELLOWSHIP AWARDS ANNOUNCED

The 1982 Fellowship Awards program, sponsored by AISC, has been released. This year, a maximum of eight $4,750 awards will go to engineering students who propose a course of graduate study related to the fabricated structural steel industry. Each award includes a $750 educational supplement to be used by the department chairman in administering the program.

The Fellowship Awards, designed to encourage expertise in the creative use of structural steel, is open to senior or graduate civil or architectural engineering students who are U.S. citizens, major in structural engineering—and who are accepted as full-time students into an accredited college or university for the 1982 academic year.

Complete information on the awards, and applications, may be obtained by writing:

AISC Education Foundation
400 North Michigan Avenue
Chicago, Illinois 60611

Fellowship Award winners are honored guests at the AISC National Engineering Conference. □

We invite you to join more than 6,000 of your associates who are now regularly receiving the AISC Engineering Journal. . . . The cost is only \$6.00 for one year or \$15.00 for three years; single issue \$3.00; (Foreign rates: \$8.00 for one year, \$18 for three years; single issue \$4.00). Simply fill out the attached form and send your check or money order to begin your subscription. *Payment must be enclosed with this order*. Make checks payable to AISC. *Foreign subscriptions are payable in U.S. funds only.*

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Profession or occupation:
☐ Engineer ☐ Architect ☐ Educator ☐ Other ________

Striking atrium in new Mitre Corporation headquarters building, Bedford, Mass. Overhead walkways maintain security while tying structures together.

The Mitre Corporation: New Standards in Environment

by Merle T. Westlake

To meet space demands incurred by its rapid growth, The Mitre Corporation, a high-level engineering and research organization in Bedford, Mass., engaged our firm to determine the feasibility of building additional space to accommodate 1,000 new people over the next several years. Our study analyzed functional, parking, open-space and circulation requirements of the existing complex.

From this investigation came a decision to construct, in two phases, two office buildings, designated "J" and "K," accommodating 500 people each. These would set a new standard for the working environment. The priorities of inter-building circulation and security were foremost in the design solution. Flexibility and view were also important in a facility that would accommodate standard 170-sq ft offices. The only other major program requirement was to provide a flexible conference room for 300.

Merle T. Westlake, AIA, is vice-president, Hugh Stubbins and Associates, Architects/Planners, Cambridge, Massachusetts.

Network of Bridges

The existing Mitre building complex was a U-shaped series of 10 buildings interconnected by a network of enclosed pedestrian bridges, or skyways, to permit interbuilding circulation within a high security zone. Our new buildings were designed,

Dramatic stairways grace handsome atrium, lend sense of openness to offices.

as part of the initial master plan, to be positioned within this central complex. These structures closed the fourth side of the U-shaped configuration, thus completing a closed circuit for inter-building movement. This continuous loop pedestrian path, relating also to the redesigned loop road and loop parking arrangement, permits easy access to the complex from a series of security lobbies.

Adding 1,000 people to the complex required a review of the overall campus plan to find ways both to integrate added parking and improve the overcrowded and complicated vehicular routes. Within the new structures, a created environment provides a maximum number of enclosed private offices, each space with natural light, a sense of openness and ready access to building functions without long walking distances.

Mitre "J," completed in 1979, used the construction management process with a Guaranteed Maximum Price format. Careful design, selection of materials and methods of construction permitted the building to be completed three months ahead of schedule, on a 15-month construction cycle, and 2% below the GMP. Total construction cost, including high-quality movable partitions which allow for flexible office space, carpeting, ceilings, lighting, etc., was $55.45 per sq ft.

Another assignment was to design a small addition to the computer center; the physical and operational hub of the complex. Careful coordination between client, user, architect, engineers and construction manager were essential for completion of this modest but crucial element of the building complex.

Success Breeds Success

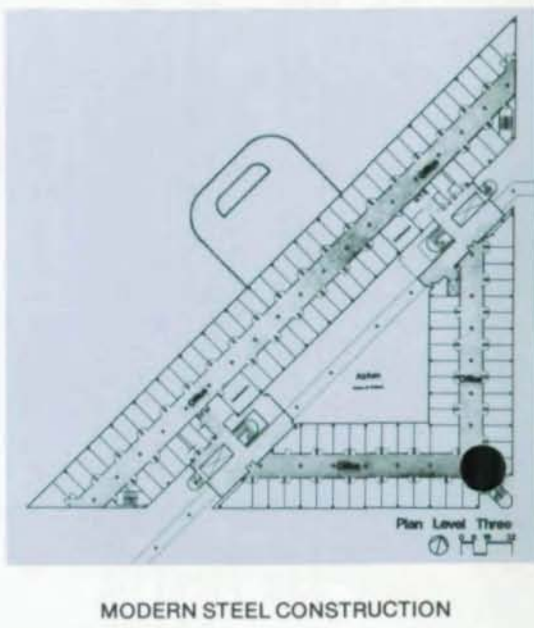
Because of the success of our first project, Building "J," in establishing a new standard for a working environment at low cost and within severe scheduling restrictions, the corporation authorized us to proceed with Phase Two. Building "K" is currently under construction and closely follows the form and concept of Phase One.

Building "K" presented the architects an unusual opportunity to build on the experience of the completed building. An intensive interview program was initiated at all levels of the Mitre organization. Additional comments were elicited from a large number of individuals.

On the basis of these evaluations, most of the original design concepts were reinforced, with certain modifications employed. The open-office secretarial work area at the building center was redesigned. The new plan gives the area a sense of order and definition by organizing work stations to one side—column placement, positioning of lighting and underfloor outlets provide a clear zone for circulation. Conference rooms, which opened into secretarial space in Building "J," were located in central core areas so meeting attendees would not disrupt secretarial work.

Both buildings are organized around enclosed, landscaped, multi-use interior atria. The width of each of the three wings enables two sets of offices to flank a central work space for secretaries, as well as provide through-wing circulation. This space gains a sense of openness from incorporation of sidelight office windows.

Interior offices look into an attractive, controlled atrium environment. Softly curved planters with continuous seating walls, combined with a variety of plants and trees, add a contrast to the sharp,



angular geometry of the buildings and lend a dynamic quality. Much of the Building "J" atrium's slate floor was left open for exhibits and social functions. In Building "K," a dining facility graces the atrium.

Significant Cost Benefits

The enclosed atrium plan offers significant cost benefits. Since much of the wall area normally exposed to weather elements is protected internally by the covered atrium, wall costs are reduced. In addition, the energy saved through minimal exterior wall heat loss is important in achieving an annual energy budget of less than 50,000 Btus per square foot. Each of two independent mechanical penthouses enables control over heat loss and gain by responding to loads as the sun moves around the building, thereby minimizing energy consumption.

The "J" Building, with a footprint corresponding to a 45° isosceles triangle, is supported by conventional spread footings bearing on natural sand and gravel. Each exterior leg of the triangle is approximately 300-ft long with a hypotenuse about 424-ft long. Corresponding dimensions of the skylight over the atrium are 65 ft and 92 ft, respectively.

The ASTM A36 basic system of the superstructure is a combination of unidirectional, welded moment-resisting structural steel frames on a predominant column grid of 20 ft by 25 ft. Typical composite floor construction is 2½-in. normal weight concrete (300 psi) topping, with welded-wire fabric, on 3-inch deep galvanized steel deck (non-cellular and cellular to accommodate electrical raceways) with spray-on fireproofing.

Structural steel filler beams, framing to composite as well as non-composite girders, are composite with the concrete/steel deck slab through the use of headed stud shear connectors. Similar construction is utilized on the roof, except that the structural steel is sloped to minimize the requirement for concrete fill used for drainage. Electrical raceways on the ground floor are encased in concrete fill poured on top of a concrete slab cast on grade.

Temporary and permanent expansion joints have been designed into the structural/architectural system to account for undesirable temperature effects related to the facade. Brick veneer on a stiffened and galvanized steel stud back-up system was employed as part of the architectural facade construction.

All "not-exposed-to-view" structural steel has been cleaned in accordance with SSPC - SP3 and painted in the fabricating shop prior to in-place application of spray-on fireproofing.

An "exposed-to-view" feature of the architectural design is a pyramidal skylight. Its primary structure is a structural steel tripod prevented from spreading by a triangular tension ring at roof level. Geometry dictated the location of the expansion joints, which terminated at two locations along the interior spandrel beam in the atrium. Consequently, the skylight tension ring has been floated on

Mitre Corporation's new structure. Plan shows enclosed atrium which offered substantial cost benefits.

Skyway network in Mitre's headquarters controls interbuilding circulation in security areas. Photo below details steel framing.

neoprene bearing pads to permit the expansion joints to function as intended. Another design feature is a light structural steel pedestrian bridge which passes through the atrium.

Construction of the Building "J" computer center involved expansion of the existing computer facility. Structural steel was chosen for this part of the work for two reasons: first, for the ease of connecting to the existing construction; and second, in recognition of the requirement for fast completion of construction.

Building on Experience

Implementation of the "K" Building, a virtual mirror image of "J," provided an opportunity to study the possibility of structural design modifications. A thorough on-site review of the exterior brick of "J" showed satisfactory performance after more than a year. Consequently, we decided to eliminate the permanent expansion joints and use only temporary expansion joints in the structural steel frame.

To set the "J" and "K" Buildings apart internally, the "K" Building column grid was modified to 20 ft x 18 ft and 20 ft x 31 ft. Further, this configuration suggested the placement of unidirectional, welded moment-resisting structural steel frames on the exterior and interior perimeter lines.

Based on guidance by the project's construction manager, in conjunction with the owner's schedule and construction market conditions at the time of each project, steel was chosen as the most appropriate structural system. Tight schedules were maintained by a fast-track process—which included early construction document packages for foundations and structural steel and steel deck. □

Architect
Hugh Stubbins and Associates
Cambridge, Massachusetts

Structural Engineer
LeMessurier Associates/SCI
Cambridge, Massachusetts

General Contractor
Gilbane Building Company
Providence, Rhode Island

Owner
Mitre Corporation
Bedford, Massachusetts

Southwest Forest Industries' new corporate headquarters in Phoenix, Ariz. boasts panoramas in all directions. Building was sited to take full advantage of environment.

Southwest Forest Industries: Room, with a View

New corporate headquarters for Southwest Forest Industries is a striking building on a scenic 8-acre site in the Arizona Biltmore resort complex near Phoenix, Ariz. The low-profile structure, sited to conform with city height and scenic view requirements, boasts dramatic panoramas of downtown, Squaw Peak and Camelback Mountain.

The new 85,000-sq ft structure embraces two building sections at oblique angles to each other. The site layout enabled the architect to take full advantage of existing desert terrain without disturbing the environment.

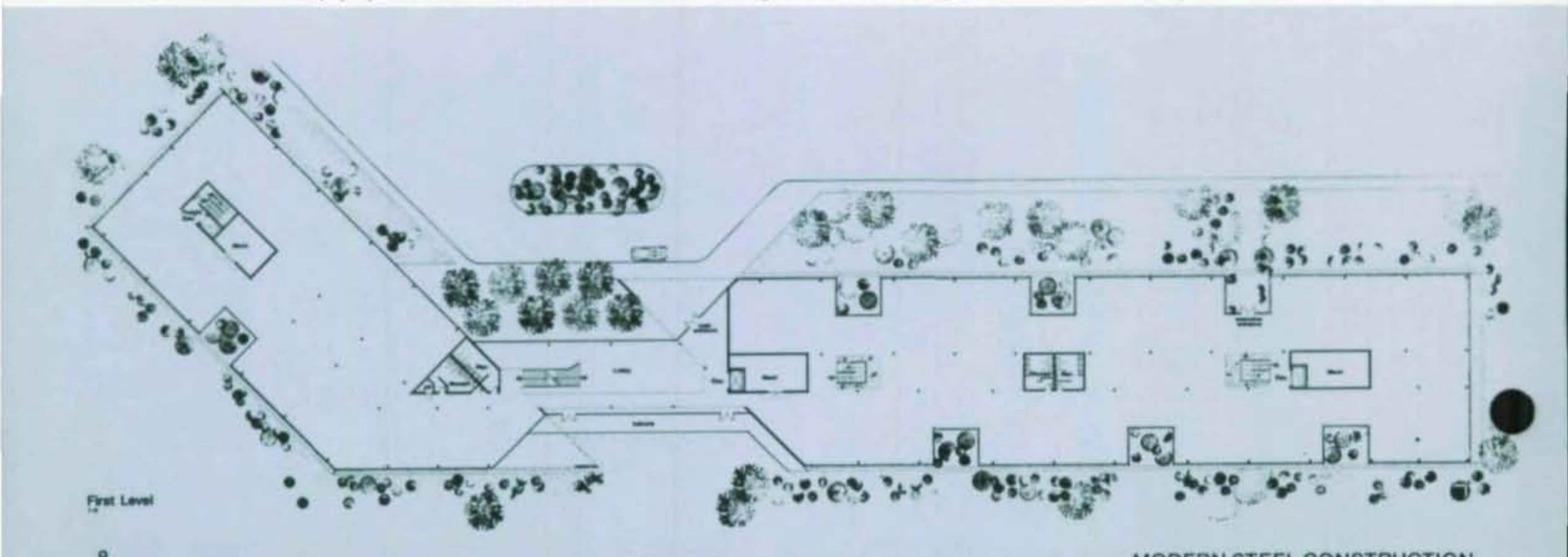
Gigantic glass-sheathed lobby featuring wood-paved court and eucalyptus tree grove serves both wings of magnificent building. Steel framing of Southwest Forest's structure, shown below, was sheathed with wood.

Leading into the large glass-sheathed lobby is a granite-paved entry court with a formal grove of eucalyptus trees and a reflecting pool. The two-story lobby overlooking the golf course serves the three-story wing to the south and the two-story executive wing running north. Penetrating the lobby are a bridge and a granite stairway that serves all levels. Exterior and interior architecture coordinate by continuing exterior wall planes and materials into the lobby.

Unique Skin

The outside of the building features a unique, lightweight composite panel material—aluminum-faced with a polyethylene core. The sea-wolf gray panels combine high durability and easy mainte-

Room, and with a view (r.)—plus coordination of architecture that brings outside into lobby. Plan below shows integration of two buildings.



nance with good insulation values. These facades are designed for individual conditions of their orientation. The east, west and south areas, subject to direct sunlight, have flush glass protected by curved aluminum brise soliel with integral louvers. The louvered areas extend below the window head to provide diffused daylighting. The north elevation and lobby are without sun shading.

The wall panel and sunscreen system is constructed of lightweight 4mm aluminum and polyethylene composite sheet material. Vision areas are solar grey glass set in a stopless exterior flush glazing that uses elastomer sealant for four-sided support.

The building has two wings. To the north, a two-story executive wing houses the bulk of Southwest Forest's employees. Many small courtyards have been set into the building along both sides to increase the number of corner offices and provide interior work stations with more outward views. Each department has a unique floor plan to provide the most functional arrangements possible. A third floor was added to the south, where the land slopes away. The ground floor serves data processing and office services needs. Two top floors are sub-leased.

The two wings are connected by a glass-sheathed lobby. Wood, the firm's principal product, graces the lobby floor with custom teak flooring and matched wall panels. A play of interior/exterior relationships coordinates the exterior architecture with the interior design by bringing exterior materials—wood, granite and aluminum—inside. Below the lobby on the ground floor, a large employee dining area features a 105-ft long wall lined with 36 large photos that depict company operations that stretch across the country.

Speed Major Consideration

A fast-track approach, to reduce construction time and erection costs, was a major consideration on this project. A steel frame facilitated those fast-track concepts, which permitted the structural steel to be ordered and fabricated before drawings were completed. The system selection also produced additional economies in foundations and lateral force distribution to masonry shear walls.

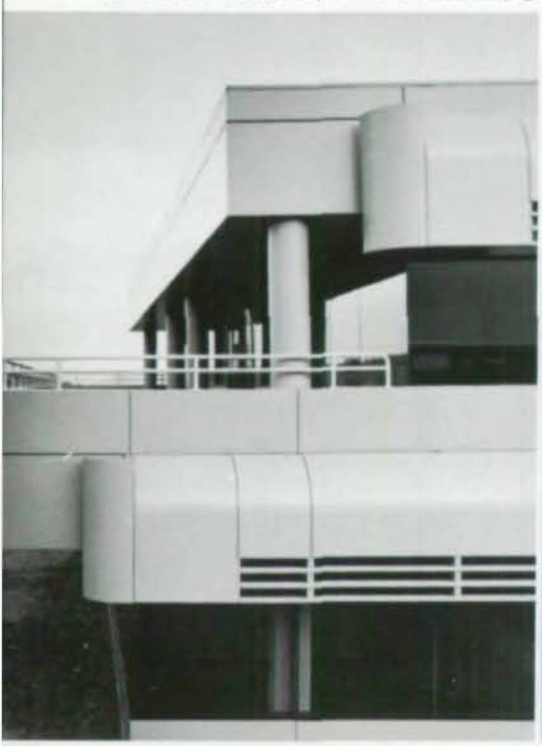
Typical bays for the steel framing system are 25-ft or 30-ft wide throughout the length of the building. In the opposite direction, bays are 30 ft, 15 ft and 30 ft to maintain a 75-ft wide structure. The layout provided the desired degree of flexibility and open space in the interior. A 3¼-in. slab over 24-ga. corrugated metal deck is supported on H-series steel bar joists at 4 ft o.c.

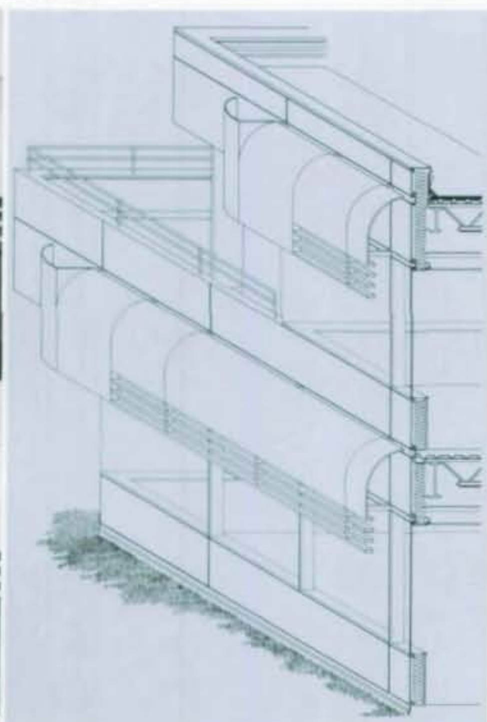
The steel girders, which run longitudinally, are supported on steel columns

Two building wings meet at oblique angle at lobby. Small, terraced courtyards along both sides provide views, create more corner offices.

and interior masonry block core walls that bear on rock and/or compacted fill. The core sections enclose mechanicals and elevators. The short-span joist system on the center bay permitted major duct runs the length of the building for HVAC distribution, without interference from large or deep structural sections. The steel beams were designed a uniform depth to accommodate mechanical/ electrical trades, thus reducing installation costs.

Closeup of exterior highlights lightweight skin and louver details that shade windows to provide diffused daylighting.





Walkway to a View

In the lobby area, a long-span steel bridge walkway between the two building sections opens the great outdoors of mountain or desert to viewing. A wide stairway, constructed of two 28-in. deep x 4-in. wide fabricated steel tubular stringers highlights the lobby area and opens public access to the second floor.

A separate steel bridge, for the executive entrance from the parking area, was constructed of exposed steel beams supported on piers. The walkway provides immediate access to the second floor directly from the parking lot.

The lateral resisting system consists of structural floor slabs that act as rigid diaphragms to transfer lateral loads to the interior core walls. These core sections deliver all wind and seismic forces to the foundation system.

In formally dedicating the new headquarters on July 25, President and CEO W.A. Franke commented, "Southwest Forest's decision to build its new corporate headquarters in Phoenix reaffirms our commitment to the community of Arizona . . . We are now one of three Fortune 500 companies with headquarters in Arizona. We consider this state our home, and look forward to a long and prosperous future here." □

Architect
Metz Train Youngren of Arizona
Phoenix, Arizona

Structural Engineer
Gervasio & Associates
Phoenix, Arizona

Mechanical/Electrical Engineers
Lowry-Sorensen-Willcoxson Engineers, Inc.
Phoenix, Arizona

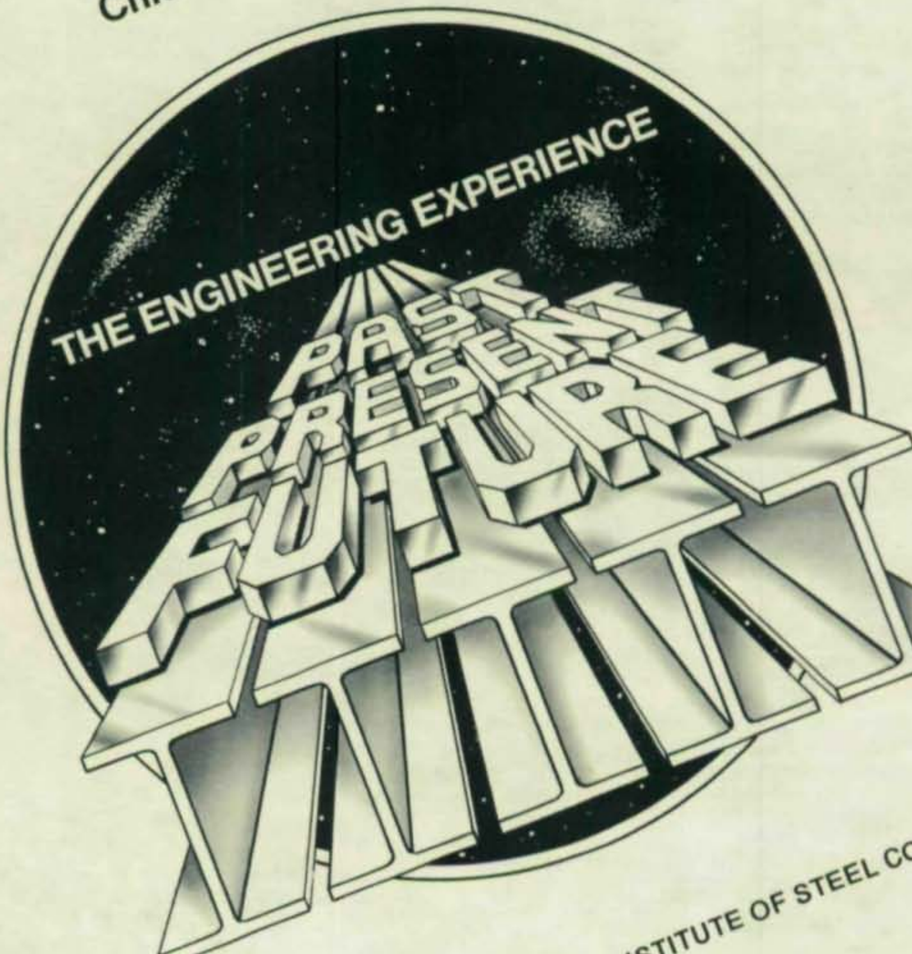
General Contractor
Kitchell Contractors, Inc.
Phoenix, Arizona

Owner
Southwest Forest Industries
Phoenix, Arizona

· FOCUS '82 ·

THE NATIONAL ENGINEERING CONFERENCE

Chicago Marriott Hotel
March 11-13, 1982
Chicago, Illinois



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Chicago Marriott Hotel
March 11-13, 1982
Chicago, Illinois

AISC's 60th Anniversary Year

YOUR PROFESSION, STRUCTURAL ENGINEERING, from its earliest time has demanded not only the most exacting attention to existing technical information, but also full consideration of how functional the structural design will be from both the sociologic and economic points-of-view. This phenomenon places you in the position of needing to know that which has transpired in your profession, along with the present state of the art, plus what the future may hold. FOCUS '82 NATIONAL ENGINEERING CONFERENCE will take a look at "The Engineering Experience: Past, Present, and Future."

A total of fifteen subjects will highlight "The Engineering Experience" next March in Chicago. Presentations will include:

- *Economics of Low-Rise Steel Framed Structures*
  John L. Ruddy—Fletcher-Thompson, Inc.
- *Computer Graphics*
  William McGuire—Cornell University
- *Strength of Unbraced Beams with Deep Copes*
  Joseph A. Yura—University of Texas
- *Construction in Space*
  National Aeronautics and Space Administration
- *Simplified AISC Specification*
  Lynn S. Beedle—Lehigh University
- *Innovations in the Design of Steel Bridges*
  J.E. "Tom" Sawyer—Greiner Engineering Sciences, Inc.
- *How to Inspect Structural Steel*
  Edward M. Beck—Law Engineering Testing Co.

... and eight additional and important papers plus the perenially popular Field Trips. All of this at the continued low cost registration fee of only $110 if you register before February 1, 1982. (AISC Professional Members pay only $85 before February 1, 1982.)

THE FIELD TRIPS

On Friday afternoon, March 12, the National Engineering Conference offers four field trips. These special tours will afford you a unique view of Chicago—a vital, bustling, brawny city continuing one of its largest building booms.

1. **FABRICATING PLANT TOUR**—Visits to Wendnagel and Company, Inc. and Arlington Structural Steel Co., Inc. Limited to 100.

2. **INLAND STEEL COMPANY**—A preview of steel making through a film showing the complete process will start tour participants through this impressive facility. They will see a Basic Oxygen Furnace and slab caster, a slabbing mill, and a hot strip mill. The tour will also visit blooming and wide flange mills. Limited to 150.

3. **UNITED STATES STEEL SOUTH WORKS**—From the comfort of the bus you will drive past the impressive Blast Furnace Facility. From there you'll walk to the Basic Oxygen Steel Shop, see the blooming mill, the rolling and finishing of structural sections, and U.M. Plates. Limited to 150.

4. **ARTS AND ARCHITECTURAL TOUR**—Chicago is heralded as a city of more "municipal art" than any other in the United States. The work of Picasso, Chagall, Miro, and Calder are prominently displayed. It is the City of Louis H. Sullivan and Frank Lloyd Wright. The skyscraper was invented in Chicago ... and the world's tallest building pierces the clouds. This bus and walking tour is certain to increase your "take home value." Limited to 250.

Select your first, second, and third choice of field trip on the registration form. Assignments will be made on a "first come, first served" basis.

OPTIONAL FRIDAY EVENING ACTIVITY

CHICAGO-FIT FOR A KING—You are invited to the "King's Manor." A medieval paradise awaits you as you step back in time upon entering your restaurant for the evening. As the hours pass, you will feast on a six course dinner (no eating utensils allowed), freely savor wine, beer, and cider, and mix with your courtly hosts—the King, Minstrel, Jesters, and the "Singing Wenches." The spirit is of the dark ages but the feeling is joyful and bright. You'll board your "time machine" at the Hotel's Rush Street Entrance at 6:30 P.M. To reserve yourself a place(s) complete the section on the back of the registration form. Transportation, food, drink, and entertainment at $45.00 per person. Please make your reservation early.

SPECIAL PROGRAM FOR SPOUSES or "Chicago, As You Like It."

Thursday, March 11

7:30 am Registration
to
1:30 pm AISC'S Registration Desk will be open whatever your arrival time.

1:30 pm "*What Makes Chicago Tick?*"—A whimsical, spirited talk featuring CHARLOTTE KIRSHBAUM, a Chicago enthusiast and noted authority on the City—its many niches, secrets and idiosyncracies. Kirshbaum's style was featured in a *Parade* magazine article. Her viewpoint is never "ho hum." She mixes architecture, art, and native wit, and provides an exciting new and different dimension to Chicago—your kind of town.

2:30 pm Break

2:45 pm "How To Have The Time Of Your Life."—Getting the most out of life means getting the most out of time. SHEILA KIMMEL, experienced counselor and psychotherapist will heighten your own personal awareness of time misuse, of thinking ahead, and of learning to live with life's conflicts. Ms. Kimmel is in private practice, an adult educator, teacher, and psychology instructor at several of Chicago's colleges. She also conducts workshops and training seminars on a variety of topics involving the self, relationships, management, and job fulfillment.

4:00 pm Adjournment

6:30 pm AISC Reception

Friday, March 12

9:30 am Board busses at the Hotel's front entrance for an Art-See Chicago. Upon your arrival in the Hyde Park section of the City, you will enjoy an insiders look at Chicago's art world. Meet one of Chicago's most exciting and exceptional artists. Chat informally and discover how an urban environment can spark creativity ... how a love of nature is one of the keys to a stimulating and artistic metropolitan existence.
Also on your morning itinerary will be a visit to the magnificent Rockefeller Chapel on the University of Chicago campus. And then there's lunch at Geja's where you will experience the best in fondue dining. As you leisurely dip fresh vegetables, breads, and fruits into delicious imported cheese and chocolate fondues you can thank the Moorish Prince Geja who established the original Geja's in 723 A.D. at Mt. Tizi. Geja's has been termed "the most atmospheric restaurant in Chicago." You will find out why as you lunch and sip the house wine.
The trip back to the hotel is sure to please and you will arrive there at about 3 pm.

Saturday, March 13

This is a free day, but before you pack to leave Chicago why not visit the famous Marshall Field store on State Street, between Randolph and Washington. A copy of the *MAGASIN PRINTEMPS* in Paris Marshall Field is a shoppers delight. *We sincerely hope you will enjoy Chicago!*

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THE NATIONAL ENGINEERING CONFERENCE
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The American Institute of Steel Construction

Chicago Marriott Hotel
March 11-13, 1982
Chicago, Illinois

AISC's 60th Anniversary Year

AISC REGISTRATION AND ROOM RESERVATION FORM

Professional Member Fee: EARLY REGISTRATION (Postmarked *on or before* February 1, 1982)—$85.00.
Professional Member LATE REGISTRATION (Postmarked after February 1, 1982)—$115.00.

Regular Fee: EARLY REGISTRATION (Postmarked *on or before* February 1, 1982)—$110.00.
Regular LATE REGISTRATION (Postmarked after February 1, 1982)—$150.00.
(Registration Fee includes all NEC General Sessions, Luncheon, Reception, and Field Trip.)

Please register and make room reservations for the following individuals: *(Please Type or Print)*

NAME ______________________ TITLE ______________________

Arrival ____________ (date) Time ____________ Departure ____________ (date) *Will Spouse Accompany you to Conference?* ☐
(If yes, see registration form on reverse side)

Accommodations Desired: *(Indicate Rate—See Below)* ☐ **Single** ________ ☐ **Twin/Double** ________

Friday Field Trips: *(Indicate Preference 1st, 2nd, or 3rd)*
☐ **FABRICATING PLANT TOUR**
☐ **INLAND STEEL COMPANY**
☐ **UNITED STATES STEEL SOUTH WORKS**
☐ **ARTS AND ARCHITECTURAL TOUR**

Optional Friday Evening Activity—*See Reverse Side*

NAME ______________________ TITLE ______________________

Arrival ____________ (date) Time ____________ Departure ____________ (date) *Will Spouse Accompany you to Conference?* ☐
(If yes, see registration form on reverse side)

Accommodations Desired: *(Indicate Rate—See Below)* ☐ **Single** ________ ☐ **Twin/Double** ________

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☐ **INLAND STEEL COMPANY**
☐ **UNITED STATES STEEL SOUTH WORKS**
☐ **ARTS AND ARCHITECTURAL TOUR**

Optional Friday Evening Activity—*see reverse side*

STANDARD RATES:
SINGLES: $65
TWIN/DOUBLES: $78

(Rates subject to City and State Sales Tax—9.1%)

IMPORTANT NOTICE: THE CHICAGO MARRIOTT HOTEL will honor and guarantee those reservations postmarked on or before February 11, 1982. In order for you to reserve the accommodations of your choice at a guaranteed rate, please mail this form promptly.

THIS RESERVATION IS SUBMITTED BY: ______________________

COMPANY OR AFFILIATION ______________________ Telephone

ADDRESS ______________________
Street City State Zip Code

Mail Completed forms and registration fee to: **AMERICAN INSTITUTE OF STEEL CONSTRUCTION, 400 North Michigan Avenue, Chicago, Illinois 60611—*Attention:* Convention Services**

REGISTRATION FORM FOR SPOUSES

REGISTRATION FEE: $85.00 (Includes AISC Reception, Thursday, March 11, and Special Program for Spouses, Thursday and Friday, March 11 & 12.)

Please register the following for the Spouses' Program: (Please Print or Type)

COMPANY or AFFILIATION ______________________________

ADDRESS ______________________________

NAME ______________ NICKNAME ______________ TOUR ______________

NAME ______________ NICKNAME ______________ TOUR ______________

NAME ______________ NICKNAME ______________ TOUR ______________

REGISTRATION FORM FOR OPTIONAL FRIDAY EVENING ACTIVITY

Chicago—Fit For A King
FEE: $45.00 Per Person

Please register __________ persons as listed below:

Mr. & Mrs. ______________________________

Mr. & Mrs. ______________________________

Mr. & Mrs. ______________________________

Please refer to the enclosed folder for description of Optional Friday Evening Activity.

Dramatic One Corporate Center building, Hartford, Conn. "lands" on municipal garage on steel legs.

Composite Structural System for Unique 'Building on Building'

by Irwin G. Cantor

Almost as if descending from space, with landing gears lowered, the One Corporate Center office building appears to have "landed" atop the Hartford Municipal Garage, Hartford, Conn.

Irwin G. Cantor, P.E., is president of the architectural firm of The Office of Irwin G. Cantor, Farmington, Connecticut.

Rising 16 stories *on top of the roof* of the garage, One Corporate Center represents an excellent example of the versatility and economy of a composite structural steel design.

The unique center was planned as an addition to the garage completed late in 1979. Its "landing gears" are actually large, V-shaped skew columns. The columns were engineered to transfer loads to a base structure that is smaller than the top part of the project. The top element of the complex is a 384,000-sq ft office facility resting upon a 20,000-sq ft commercial area which houses retail stores/shops.

All loads for One Corporate Center are transferred to the existing columns of the municipal garage. These connections between new and existing columns of the building represent one of the more demanding aspects of the $22-million project.

The Center, supported on a minimal number of columns (28), features very large span areas—up to 45 feet. The longer spans were engineered to maximize the amount of rentable office and commercial space in the facility. Especially noteworthy was the combination of a diagonal vertical steel bracing network (as an inner core) and rigid-frame connections between all beams and columns—a system which resulted in significant cost savings to the owners.

A total of 2,940 tons of structural steel went into the One Corporate Center project, with high-strength A588 steel in the base plates and A36 steel used for columns and framing.

Difficult Column Connections

Engineering the connections between existing columns in the garage to new columns for the Center addition was a crucial aspect of the structural design. Very careful cutting of rebars in existing columns had to be specified to allow for erection of the 400,000 + sq ft building.

Four large, heavily reinforced concrete columns in each of the six typical bays in the parking structure served as column connection points. The top part of concrete on the roof of the garage had to be cut 2 in. to 3 in. to expose the rebars. After the required dowel locations were located, by drilling holes in the existing concrete, base plates were set.

Columns were then installed on the base plates and attached by bolts and welding. Holes for the new column connections were then filled with non-shrinking grout.

A composite beam constructed of 3¼"-thick concrete slab (3,000 psi) and 3"-deep steel deck encased in concrete were engineered on the first-floor level of the 16-story office building. These provide the needed horizontal bracing at the transfer deck.

An inner core of diagonal steel bracing runs the entire height of the Center's office building. Housing elevators and other mechanical services for the facility, the visible part of the inner core is encased in concrete. It appears centrally located between the skew columns that join the commercial area and office building.

Rigid Connections

An especially economical approach to structural design was taken in engineering the composite girders to be *rigidly connected* to steel columns. By employing the composite structural steel system, we used concrete to minimize the amount of steel that would have normally been required for this unique project.

Exposed structural steel framing reveals crucial engineering of connections between existing and new columns (r., and below).

If the composite system were not utilized, more diagonal bracing, or steel of a heavier grade, would have been needed, thus increasing the cost of the project.

Spandrel beams on the building exterior featured as a facade glass curtainwall construction. Shear walls were provided in the transverse direction only to transfer wind forces to the garage foundation.

Structural steel was also used to design the sloped skylight over the main lobby of the commercial area. A series of tubular steel trusses "carry" the 40-ft x 60-ft skylight. The steel members cope with wind pressures and loads created by frequent heavy accumulations of snow.

Time and Cost Savings

Composite construction was selected for a variety of budgetary and scheduling reasons. Steel, as the least expensive framing system, also constituted the fastest method to erect the structural frame and for subsequent phases of construction.

With a predominantly steel building frame, the dead load of the Center was significantly lower when compared to concrete construction. Additional support for existing footings and foundation of the garage would have been required with a totally concrete frame. Such additional support would have increased the project cost.

A significant cost—revenue-producing—benefit of the composite structural steel design was also realized by the Center's owners. Two additional, rentable floors were design-engineered for One Corporate Center. This was possible because the composite structural system (as opposed to a concrete frame) required no reinforcing supports to footings and foundation of the existing garage, even with the two added floors.

The owners also saved on construction time by opting to employ the composite structural system. They saved the extra production time that would have been required to cast a totally concrete frame and flooring system. □

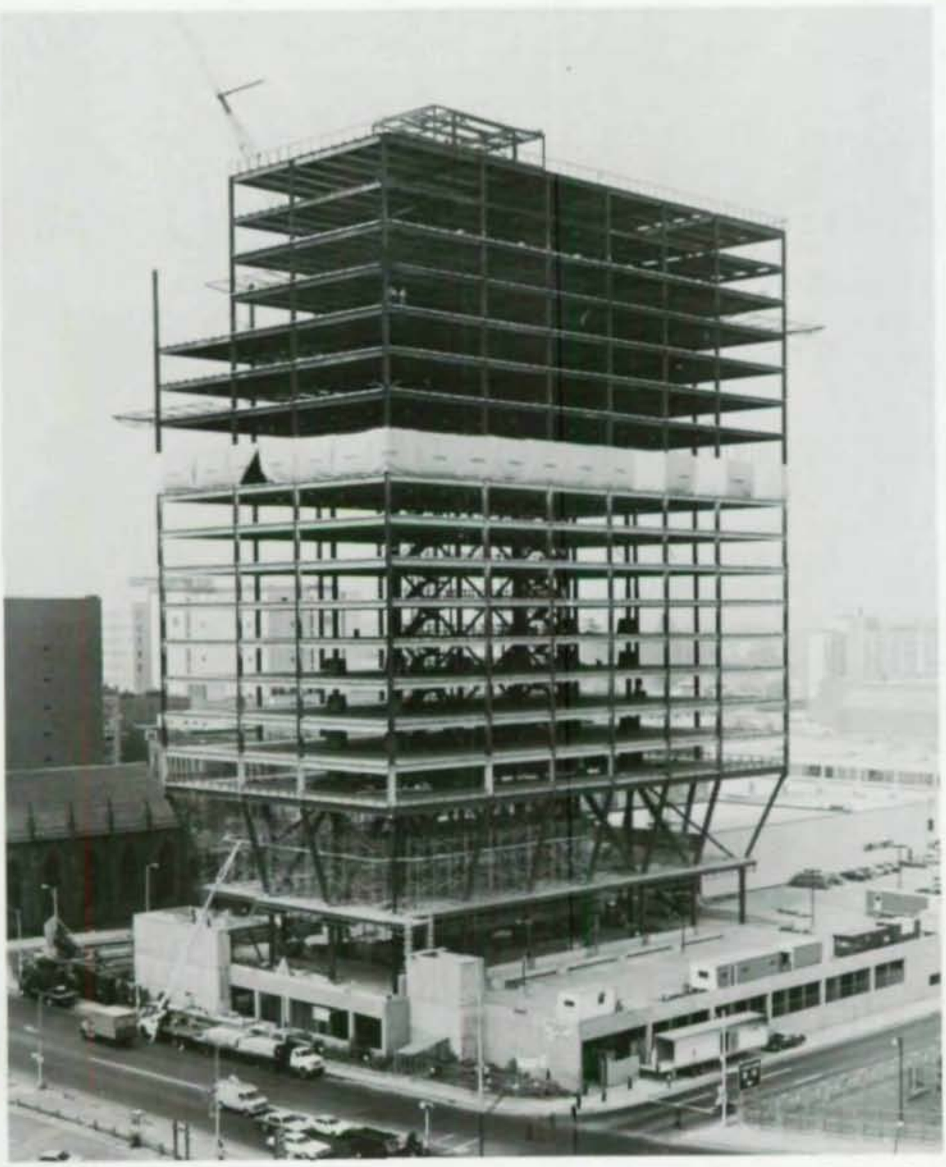


Photo courtesy Bethlehem Steel

Architect
Irwin Joseph Hirsch & Associates, Inc.
Farmington, Connecticut

Structural Engineer
The Office of Irwin G. Cantor, P.C.
New York, New York

General Contractor
El Construction Co.
Milford, Connecticut

Steel Fabricator
Bethlehem Fabricators, Inc.
Bethlehem, Pennsylvania

Steel Erector
Topper & Griggs
Plainville, Connecticut

Owners
Chase Enterprises Inc. and Olympia & York
Hartford, Connecticut

Several vantage points provide views of Love Field parking deck reassembled at downtown Oklahoma Osteopathic Hospital, Tulsa, Okla.

The Case of the Portable Parking Deck

It was November, 1968. A 1,750-car parking deck had just been completed for Hayes Properties, Inc. The valet parking structure was built to serve the then-prosperous Love Field in Dallas, Tex.

But this parking deck was different. A steel-frame structure with 5¼-in. concrete on a composite steel deck, it was designed to be moved—a temporary structure with an expected useful life of six to eight years. Periodic measurements and observations were taken to insure that deflections, ramp and paved surface wear were within reason. Results proved the structure fully serviceable. In fact, it exceeded expectations.

Time moves on. In 1976, the deck was dismantled to make room for new hangars at Love Field. And, with the coming of the giant Dallas-Ft. Worth Airport, the parking deck was no longer economically feasible. Ramps, slabs and metal decking were torn away from the steel frame, which was dismantled and stored in a local steel company's yard, just three blocks from the airport.

Three years passed. A brochure on the availability of the disassembled steel framing crossed the desk of W.H. Noble, president of Builders Steel Co., Tulsa, Okla. He, in turn, talked with John Craig of American Parking Company, Tulsa. Alert to business in the area, Craig realized that a hospital in the downtown area—the Oklahoma Osteopathic—was growing, and would soon need additional, multi-story parking facilities.

Four months of pencil work, and lots of homework later, Noble felt it was time to look at the project and see if the numbers were really there. Putting heads together with executives of the Roy J. Hannaford Construction Co., they came up with estimated savings to the hospital of $750,000 to $1,000,000 over the average cost of the same structure nationwide.

Subsequent meetings with the hospital's architects and their structural engineer indicated a four-story parking deck for 880 cars was a feasible project. Further consultation with H.H. Robertson Co. brought some recommendations on decking materials. They had provided the deck at Love Field. And now, based on studies of the original structure, they recommended a different deck with a stronger floor. The new deck was lighter, but with a different configuration. The result meant even greater construction economies on the unique project.

Moving Day

The price agreed upon, Builders Steel started the task of bringing 800 tons of steel from Dallas to Tulsa. The steel had been carefully stored and marked against the day it would be used again. More steel from mills and warehouses filled in what was lacking from the Love Field facility.

Erection took a little longer than usual because detailing was so very complicated. In fact, complete detailing took almost four months from start to finish. Noble stated, "This project was one of the most interesting we have undertaken. However, I would not recommend it to someone who does not have the patience and desire to do something nobody else wants to do."

Noble points to this project as an ideal situation where steel can be reused economically—and the ultimate consumer can save a lot of money. Says Noble, "This is a fine example of saving the customer money—and being able to show how steel not only stands for the future, but also can be reused in the future." □

Architect
Murray Jones Murray
Tulsa, Oklahoma

Structural Engineer
Al Solnok & Associates
Tulsa, Oklahoma

General Contractor
Roy J. Hannaford Construction Company
Tulsa, Oklahoma

Steel Fabricator/Erector
Builders Steel Company
Tulsa, Oklahoma

Owner
Oklahoma Osteopathic Hospital
Tulsa, Oklahoma

The Case for Mixed Construction: Steel and Concrete

by Walter P. Moore, Jr.

This article deals with the current use of mixed systems that involve the combined use of structural steel and reinforced concrete. Most of it deals with structures designed by our firm, since we are more familiar with them. However, I have tried to pick out aspects of our projects which have design features as well as design and construction problems in common with other projects which use composite construction.

Since almost all steel structures built recently have used composite floors, there is little reason to dwell on them. But, we have found one item which I suspect is sometimes overlooked: to obtain a two-hour rated floor assembly required by Underwriters Laboratories, the engineer must provide a minimum thickness of 3¼" over the top of the metal deck for lightweight concrete and 4½" for normal weight concrete.

Walter P. Moore, Jr., Ph.D., P.E. is president of a 135-person consulting engineering and planning firm, Walter P. Moore and Associates, Houston, Texas.

The item overlooked is the lightweight concrete air-dry unit weight. UL D196 specifies this value of 114 pcf to 116 pcf dry unit weight be obtained from a batch weight of 118 pcf to 120 pcf. If the concrete is pumped, some lightweight aggregate is replaced by sand to reduce friction. This increases the batch weight to 122 pcf to 124 pcf, with a corresponding dry unit weight around 117 pcf to 119 pcf. UL D840, which has also been specified in the past for floor system ratings, allows a more liberal dry concrete weight ranging from 107 pcf to 116 pcf. Underwriters Lab has agreed to write a letter allowing a lightweight concrete weight in this same range for UL D916.

The point to this discussion is: that if the concrete is pumped, there is a chance the air-dry concrete weight will exceed 116 pcf. This, according to UL, requires the concrete be considered normal weight concrete, and the thickness be increased from 3¼" to 4½" to maintain a two-hour rating without spraying the underside of the deck.

Some Complications

The situation is further complicated by a new trend—a fully sprinklered building. With the fully sprinklered building, Houston Code allows for a reduction from two hours to one hour for the floor assembly. This requires 2½" of lightweight concrete over the top of the metal deck, or 3½" of normal weight concrete. Naturally, this reduction affects the economics of the composite floor system, as well as the economics of columns and foundation. However, it offers several more options to the structural engineer who must decide on the best and most economical system to use.

A relatively new system, at least to us and our part of the country, is the composite joist floor system (Figure 1). This system, known as the Hambro System, has been a competitive option to bar joists. In the past several years, we have used the system successfully on the lower buildings ranging from three to eight stories. However, one of our current projects under design uses the Hambro System on a 34-story condominium.

The attractive option of the system is that steel beams which support the composite joists can be made composite with

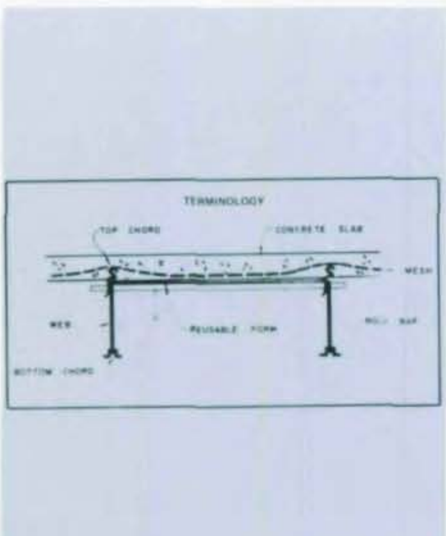


Figure 1

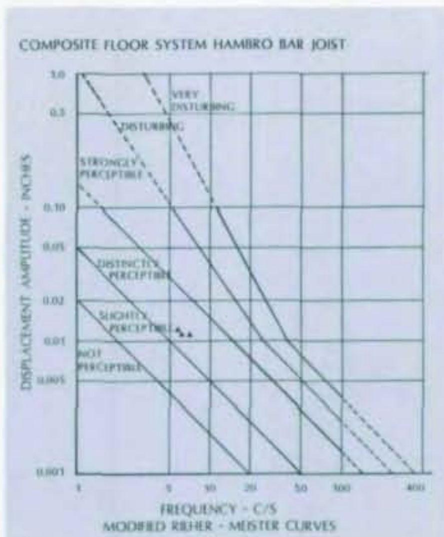


Figure 2

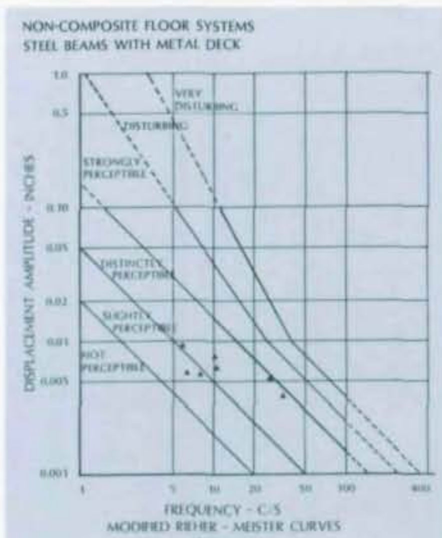


Figure 3

the floor. You do not have the conventional 2½" joist seat with conventional bar joists. Furthermore, you can have the studs applied in the shop. The concrete slab is 2½" thick (normal weight) for the 2-hour assembly. The applicable tests from UL are G213, G228 and G524. In this system, the joists are spaced at 4'-1¼" on center. The slab reinforcing is 6" x 6", #8 x #8 welded wire fabric with a yield strength not less than 60,000 psi. Care should be taken in placing the reinforcing, since it determines the strength of the slab — there is no permanent metal deck.

In the Hambro System, bottom-chord bridging is not required, based upon tests and structural calculations. The required roll bar spacing provides resistance and maintains the lateral stability, position and alignment of the joists during construction without bottom chord bridging. After construction is completed, the concrete slab embeds the top chord of the composite joist in such a manner as to restrain it laterally and torsionally.

Tests have been performed on the joist assembly to determine the factor of safety on the non-composite system. The load at failure was 72 psf, based on two tests to collapse. Tests have also been performed on the completed composite joist assemblies, and they have performed as predicted. Combined with composite beams, the resulting floors reduce steel tonnage substantially over the conventional bar joist floor. Therefore, our experience with the system in the smaller office building has been satisfactory.

As floors become lighter because of the use of higher strength materials, lightweight partitions, etc., attention must be given to serviceability requirements of the floor system. The first and most obvious concern is the deflection of the composite floor beams and joists under the dead weight of the concrete. (This is also true when stub girders are used.)

Keeping the final floor level is a much greater problem than simply insuring the structural capacity of the floor. My observation of composite floors has been that not enough attention has been given to the deflection of steel members during placement of wet concrete. One solution is to shore the beams, but this is usually too costly. The other solution is to camber the beams for the dead weight of the concrete.

Transient Vibrations a Factor

Another, but equally important, serviceability requirement of lighter composite floors is the effect of transient vibrations on occupants. Human response to steady state vibrations was originally documented by two Germans, H. Rieher and F.J. Meister, in 1931. These ratings have been found to be too severe for the design of building floors subject to transient vibrations caused by human activity. An American, K.H. Lenzen, recently modified the Reiher and Meister rating scale by multiplying the amplitude scale by 10 to account for the transient nature of vibrations. The modified curves account implicitly for damping, an inherent property of a floor system (Figures 2, 3, 4 and 5). Points are shown indicating typical joists and beams commonly used in floor construction.

This data was taken from actual jobs, then verified in the field. In all cases, the floors were found to behave satisfactorily, even though several points fall in the distinctly perceptible region.

Another response rating, the one we use currently, was developed by J.W. Wiss and R.A. Parmelee. Based on experimental data, they developed a mathematical method which enables prediction of human response to transient vibrations as a function of frequency, peak amplitude and damping. Based upon a response rating R, the program classifies anticipated human response into one of five categories:

Vibration is . . .

1. imperceptible $R \leq 1.5$
2. barely perceptible $1.5 < R \leq 2.5$
3. distinctly perceptible $2.5 < R \leq 3.5$
4. strongly perceptible $3.5 < R \leq 4.5$
5. severe $R > 4.5$

The response factor R can be expressed as:

$$R = 5.08 \left(\frac{F \times A}{D^{.217}} \right)^{.265}$$

where F = frequency in cycles per second
A = displacement in inches
D = damping ratio expressed as a ratio of actual damping to critical damping
R = response rating (Figure 6.)

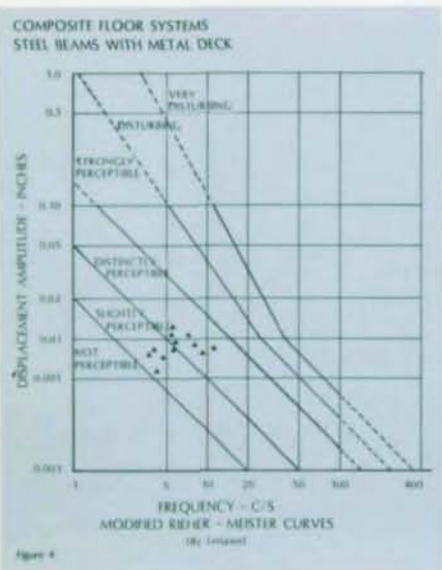


Figure 4

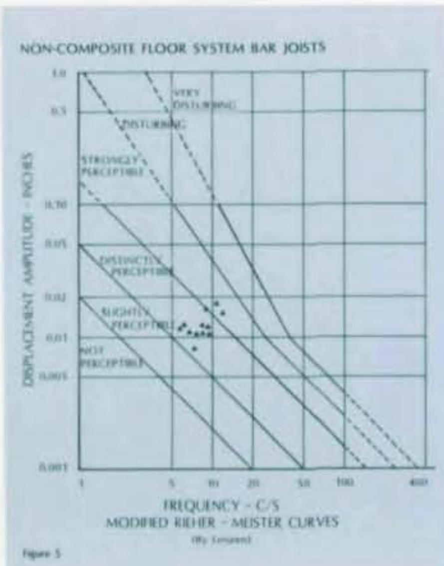


Figure 5

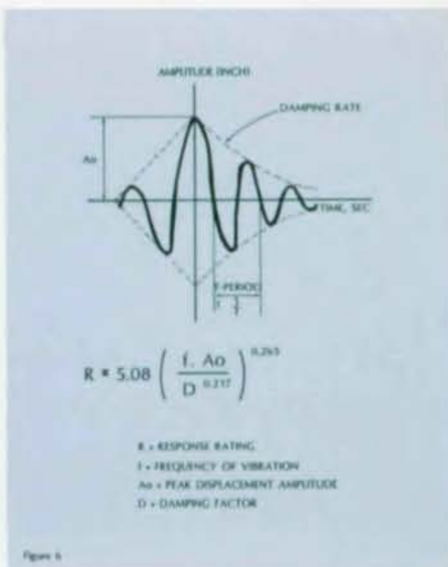


Figure 6

It should be noted, the coefficient of damping cannot be determined theoretically, but must be estimated based upon judgement and experience. For a rough guideline, the Canadian Standards Association suggests these values:

D = 0.03 — bare floor

D = 0.06 — finished floor (ceiling, ducts, flooring, furniture)

D = 0.13 — finished floor with partitions

Methods such as the one described above can be used easily to check on the acceptable serviceability of lighter floor designs. We have developed a simple computer program which instantly provides us with the values of these response factors, R, so that we can check serviceability of floors. Great care should be taken when we know in advance a floor will contain open planning.

Major New Use

The major new use of mixed systems is the combined steel and concrete vertical supporting systems. The most frequently used item is the composite column. The concept is fairly simple. Steel erection columns, unassisted, are used to carry the dead load of a limited number of stories during construction. Reinforced concrete is later added around the steel core to provide a composite column that will support all working loads.

The idea is to combine the erection speed of structural steel with the economy of reinforced concrete in compression. In the final column, the structural steel erection column becomes another reinforcing bar. Typically, the erection column is designed to support approximately four floors of steel, metal deck and concrete floor, plus another six floors of structural steel and metal deck only. The savings in structural steel tonnage on this type of system is large. As a result, remarks need to be tempered when structural efficiencies are measured in terms of pounds per square foot of structural steel. A composite structure of this type will effect considerable economy in the use of structural steel. It will also have an advantage over an all-reinforced-concrete structure in that the speed of construction will be comparable to an all-steel-framed structure.

Obviously, these composite columns have been used in our part of the country because they save money. However, there are disadvantages to the system. The first is the size of the column. To minimize steel tonnage, the physical size of the composite column rivals that of the ordinary reinforced concrete column. The second disadvantage is the great difficulty in building interior composite columns. Usually, interior columns have steel beams framing into them on all four sides, which complicates the placement of reinforcement steel in the columns and the placing/removal of column forms. Hence only the perimeter columns, open on one side, are generally made composite. This use of partial composite and partial pure steel columns leads to differences in column shortening, which we will touch on later. Finally, it is a slow process to use composite columns on the non-typical floors lower in the building. Generally this tends to either halt normal steel erection or force the designer to allow the pure steel columns to proceed further in front of the concrete placement. Ultimately this process will increase structural steel tonnage—and reduce possible economies.

Another Variation

Another variation in the mixed system approach to design is to use concrete spandrel members. The small steel spandrel beams used in this approach are swallowed up by concrete in the final design. Often, the concrete spandrel offers increased stiffness and provides backup for the attachment of certain types of curtain wall—particularly granite or precast. The disadvantage is placement of reinforcing steel, which causes considerable congestion to occur at the

COMPOSITE COLUMN DESIGN ASSUMPTIONS

1. AT FAILURE, ϵ_{cu} = 0.003
2. LINEAR STRAIN DISTRIBUTION
3. PERFECT BOND
   A. REINFORCING STEEL TO CONCRETE
   B. WF SECTION TO CONCRETE
4. $f_{sr} = E_s \epsilon_{sr} \leq f_{yr}$ REINFORCING STEEL
   $f_{sw} = E_s \epsilon_{sw} \leq f_{yw}$ WIDE FLANGE
   f_{sr}, ϵ_{sr} = STRESS & STRAIN IN REINF. STEEL
   f_{yr} = YIELD STRESS OF REINF. STEEL
   f_{sw}, ϵ_{sw} = STRESS & STRAIN IN WIDE FLANGE
   f_{yw} = YIELD STRESS OF WIDE FLANGE
5. RECTANGULAR CONCRETE STRESS FUNCTION
6. CONCRETE CARRIES NO TENSILE STRESS

Figure 7

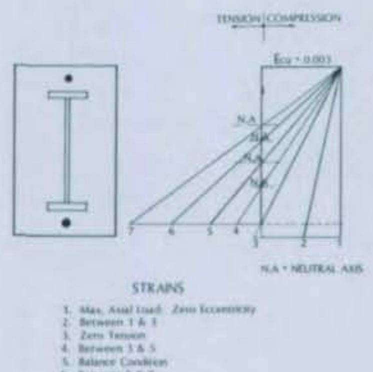


Figure 8

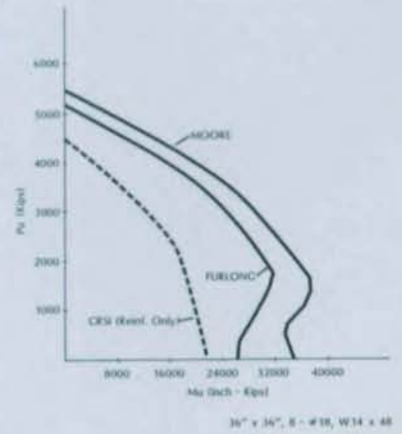


Figure 9

intersection of the spandrel and the column section. It then becomes necessary to draw large details to insure that reinforcing steel can be contained in the space allowed.

Finally, you can eliminate steel erection columns entirely, and build columns and shear walls completely of reinforced concrete. The floor remains steel, and obviously, the structural steel tonnage is further reduced. But you introduce erection difficulties.

Once again, I want to emphasize that uses of mixed systems are proposed to introduce building economy. This includes the effect of pounds of structural steel per square foot. But that is not the only variable.

More Research Needed

The design of composite columns is relatively new, and a great deal more research is needed. The only practical approach, in view of this dilemma, is to be somewhat conservative. The approach in our office is to assume the steel section behaves as a piece of reinforcing steel. Bond to the reinforced concrete is assured by welding ordinary metal studs to the steel section. The studs are sized to take the entire vertical force from the steel beams framing into the steel column, and are uniformly distributed along the column length. Note that recent research indicates the studs may not be required. But it is our present opinion that more testing must be done before these studs are eliminated.

Once an assumption concerning steel shape has been made, you can generate interaction diagrams for various combinations of reinforcing steel, structural shape and concrete column size. Assumptions in computing the interaction curves are shown in Figure 7.

Various points on the interaction diagram are shown in Figure 8. Three case studies are given in Figures 9, 10 and 11. Figure 9 illustrates a light structural steel shape. Figure 10 has a heavier steel shape, while Figure 11 contains a very large structural shape. In all cases, the interaction curves are compared with the method developed by Professor Richard Furlong at the University of Texas, and with the interaction curve for the same concrete column, without the embedded structural steel shape.

In the case of the light structural shape, our procedure indicates there are higher capacities than those shown by Furlong. But in the case of a very heavy structural shape, our results are more conservative than his. We are in fairly good agreement in the middle range. Regardless of the method we choose, large increases in column capacity occur when structural shapes are added.

Estimating Shortening Important

Earlier, we discussed the problem of uneven column shortening. Considerable care should be taken in estimating column shortening. Some of this problem can be eliminated in the fabrication stage. Certain columns can be made slightly longer than their nominal length to account for axial shortening. However, in the final structure, there are so many unknowns that some form of adjustment is usually required. This adjustment can be in the form of shim plate, but we are examining currently the use of an adjustable column splice (Figure 12). This splice occurs every six to 10 floors and allows for column length adjustment just prior to pouring concrete around the steel column. Considerable discussion is taking place as to whether this can be done in the field. But the process is currently slated for the 52-story Three Houston Center/Gulf Tower Building, just beginning steel erection.

We feel that use of composite building systems are in the beginning stage. If, as it appears, economies continue to be achieved, composite systems will be used more frequently across the country.

It is our hope that a great deal of research and laboratory testing will be initiated, so the design profession will have the solid ground in this area on which to proceed. □

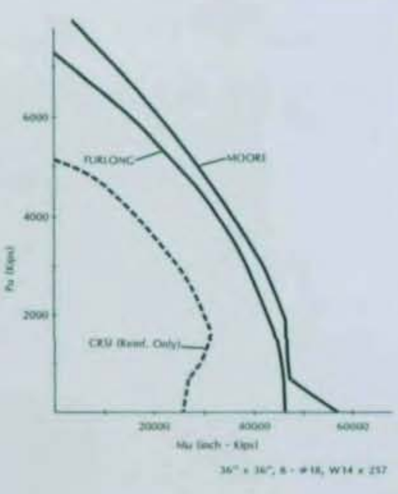


Figure 10

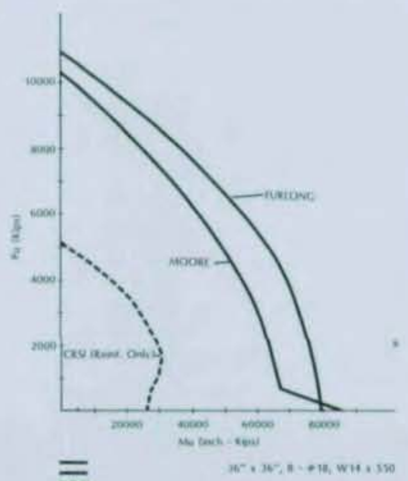
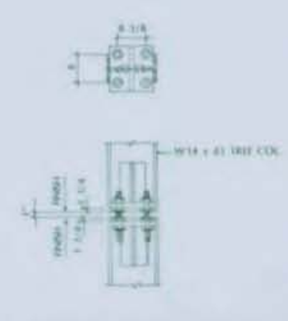


Figure 11



TYPICAL TREE COLUMN ADJUSTABLE SPLICE

Figure 12

AMERICAN INSTITUTE OF STEEL CONSTRUCTION
The Wrigley Building, 400 North Michigan Avenue
Chicago, IL 60611

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Olympic Center: Showplace for Champions

The mandate for design of a world-prominent building—Olympic Ice Center at Lake Placid, N.Y.—included three elements: provide a very large, column-free interior; express the beauty and strength of the steel structure; and establish a clear circulation pattern for both spectators and competitors.

The new 175,000-sq ft Ice Center, a permanent part of the Lake Placid complex, accomplished all three. Inside, huge 11-ft deep horizontal steel trusses, spaced 27.5 ft o.c., span the main arena —240 ft. Their depth is sufficient for the many mechanical services and walkways required. Eleven vertical steel trusses, exposed on the south face of the building (photo) carry the structural loads to the ground. Interconnecting members provide added wind bracing and give this main facade a lively geometry of form and shadows. The exposed white trusses create festive contrasts with the brilliant red seats and bright blue walls.

The structural engineer gave detailed consideration to shape, geometry, connection, bracing and other elements in the design of this showcase structure. The trussed bents were chosen for their economy, the ability to adjust to a restricted, hilly site and other project need accommodations.

Though appearing light and simple in form, the arena is structurally complex, designed for snow loads of 60 psf or a depth of 10 ft. Top and bottom chord bracing provide additional strength, and with the exception of two end bays and the perimeter, bracing between trussed bents was omitted. The extended trusses afford 600 ft of continuous structure—and a beautiful, functional, cost-efficient design solution.

Olympic Ice Center, Lake Placid, N.Y.

Architect
Hellmuth, Obata & Kassabaum, New York, N.Y.

Structural Engineer
Jack D. Gillum & Associates, St. Louis, Mo.

Construction Manager
The Gilbane Co., Providence, R.I.

Owner
Olympic Organizing Committee