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MODERN STEEL CONSTRUCTION

July-August 1990

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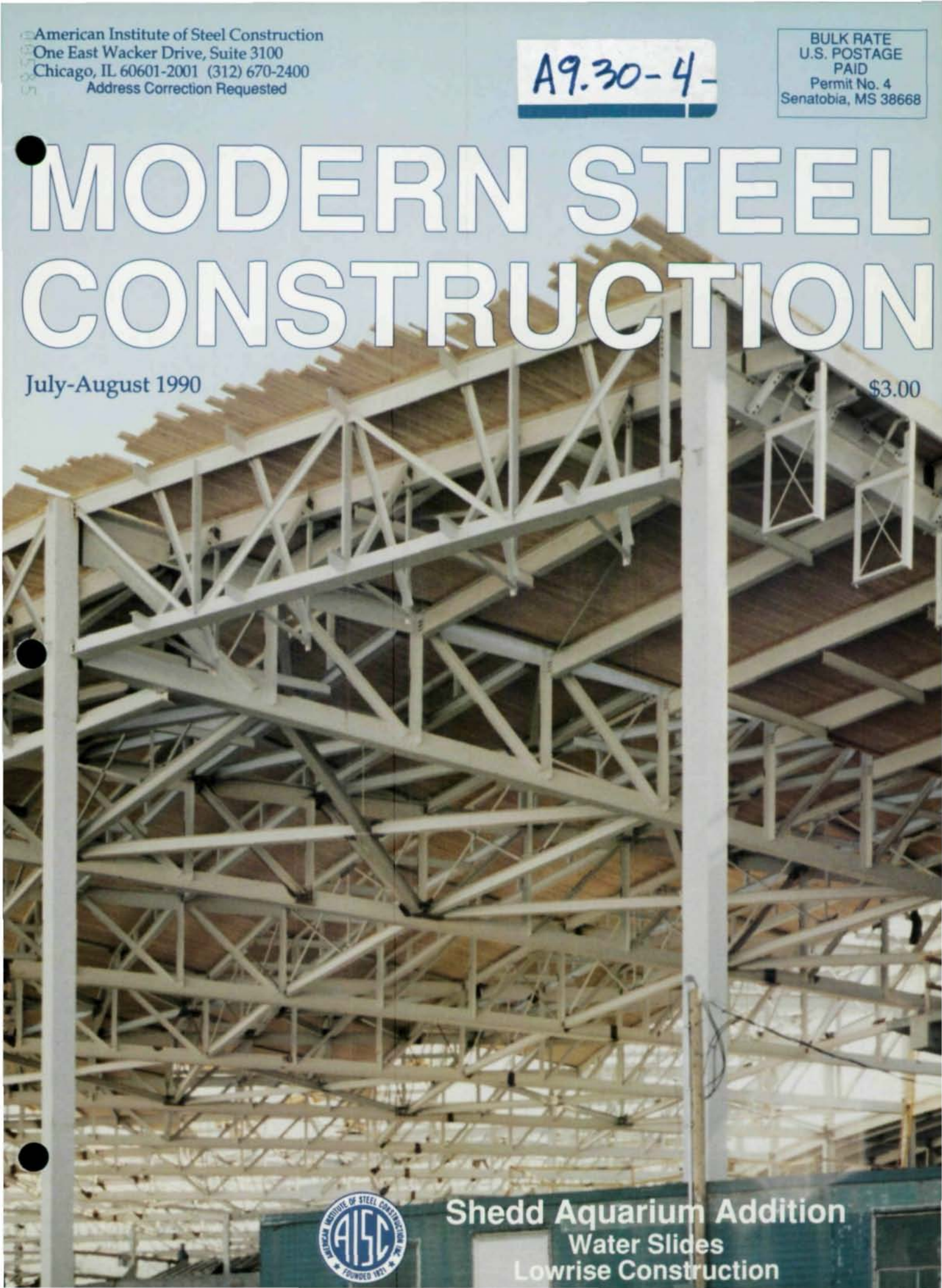

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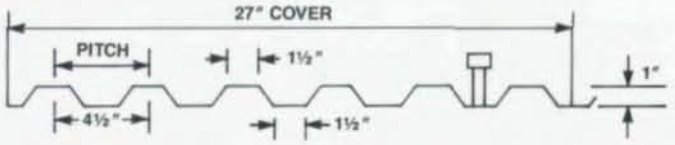

SECTION PROPERTIES (PER FT. OF WIDTH)					
GAGE	INCHES	I	Sp	Sn	WT. PSF
26	0.0179	0.040	0.066	0.072	1.0
24	0.0239	0.057	0.097	0.104	1.3
22	0.0295	0.074	0.128	0.136	1.6
20	0.0358	0.091	0.165	0.170	1.9

NOTES

1. Bottom flange of deck has room for ¾" diameter studs; w/h=2.25 Composite beam and girder tables are available on request.
2. Available with 1.5% venting for use with insulating fills.
3. Other gages and steel grades are available on special order.
4. Steel grade used as a basis for the table is grade E; Fy=80 ksi (ASTM A611 or ASTM A446).
5. Standard finishes are galvanized (G60 or G90) or bare (uncoated) steel. Painted finishes are available on special order.
6. Loads shown that are limited by 'STRESS' are the loads that will produce a stress of 36 ksi.
7. Loads shown that are limited by '1/240' or '1/180' are the loads that will produce a deflection of 1/240 or 1/180 of the span.
8. *The load that produces 1/240 or 1/180 deflection exceeds the limiting stress load.
9. The shaded area in the table indicates that a 200 lb. midspan concentrated load would cause a 1/120 deflection. Do not use the Gage/Span combination in the shaded area for lightweight fill roofs or for concrete forms.

SECTION	SPANS	LIMITING CONDITION	UNIFORM LOAD, PSF								
			SPAN, FEET								
			3'-0"	3'-6"	4'-0"	4'-6"	5'-0"	5'-6"	6'-0"	6'-6"	7'-0"
26 GA.	SINGLE	STRESS	176	129	99	78	63	52	44	37	32
		1/240	97	61	41	29	21	16	12	10	8
		1/180	130	82	55	38	28	21	16	13	10
	DOUBLE	STRESS	192	141	108	85	69	57	48	41	35
		1/240	*	*	99	69	51	38	29	23	18
		1/180	*	*	*	*	67	51	39	31	25
	TRIPLE	STRESS	240	176	135	107	86	71	60	51	44
		1/240	183	115	77	54	40	30	23	18	14
		1/180	*	154	103	72	53	40	31	24	19
24 GA.	SINGLE	STRESS	259	190	146	115	93	77	65	55	48
		1/240	139	87	58	41	30	22	17	14	11
		1/180	185	116	78	55	40	30	23	18	15
	DOUBLE	STRESS	277	204	156	123	100	83	69	59	51
		1/240	*	*	141	99	72	54	42	33	26
		1/180	*	*	*	*	96	72	56	44	35
	TRIPLE	STRESS	347	255	195	154	125	103	87	74	64
		1/240	261	164	110	77	56	42	33	26	21
		1/180	*	219	147	103	75	57	44	34	27
22 GA.	SINGLE	STRESS	341	251	192	152	123	102	85	73	63
		1/240	180	113	76	53	39	29	22	18	14
		1/180	240	151	101	71	52	39	30	24	19
	DOUBLE	STRESS	363	266	204	161	131	108	91	77	67
		1/240	*	*	183	128	94	70	54	43	34
		1/180	*	*	*	*	125	94	72	57	45
	TRIPLE	STRESS	453	333	255	201	163	135	113	97	83
		1/240	339	214	143	100	73	55	42	33	27
		1/180	452	285	191	134	98	73	57	44	36
20 GA.	SINGLE	STRESS	440	323	248	196	158	131	110	94	81
		1/240	221	139	93	66	48	36	28	22	17
		1/180	295	186	124	87	64	48	37	29	23
	DOUBLE	STRESS	453	333	255	201	163	135	113	97	83
		1/240	*	*	225	158	115	86	67	52	42
		1/180	*	*	*	*	153	115	89	70	56
	TRIPLE	STRESS	567	416	319	252	204	169	142	121	104
		1/240	417	263	176	124	90	68	52	41	33
		1/180	556	350	235	165	120	90	69	55	44

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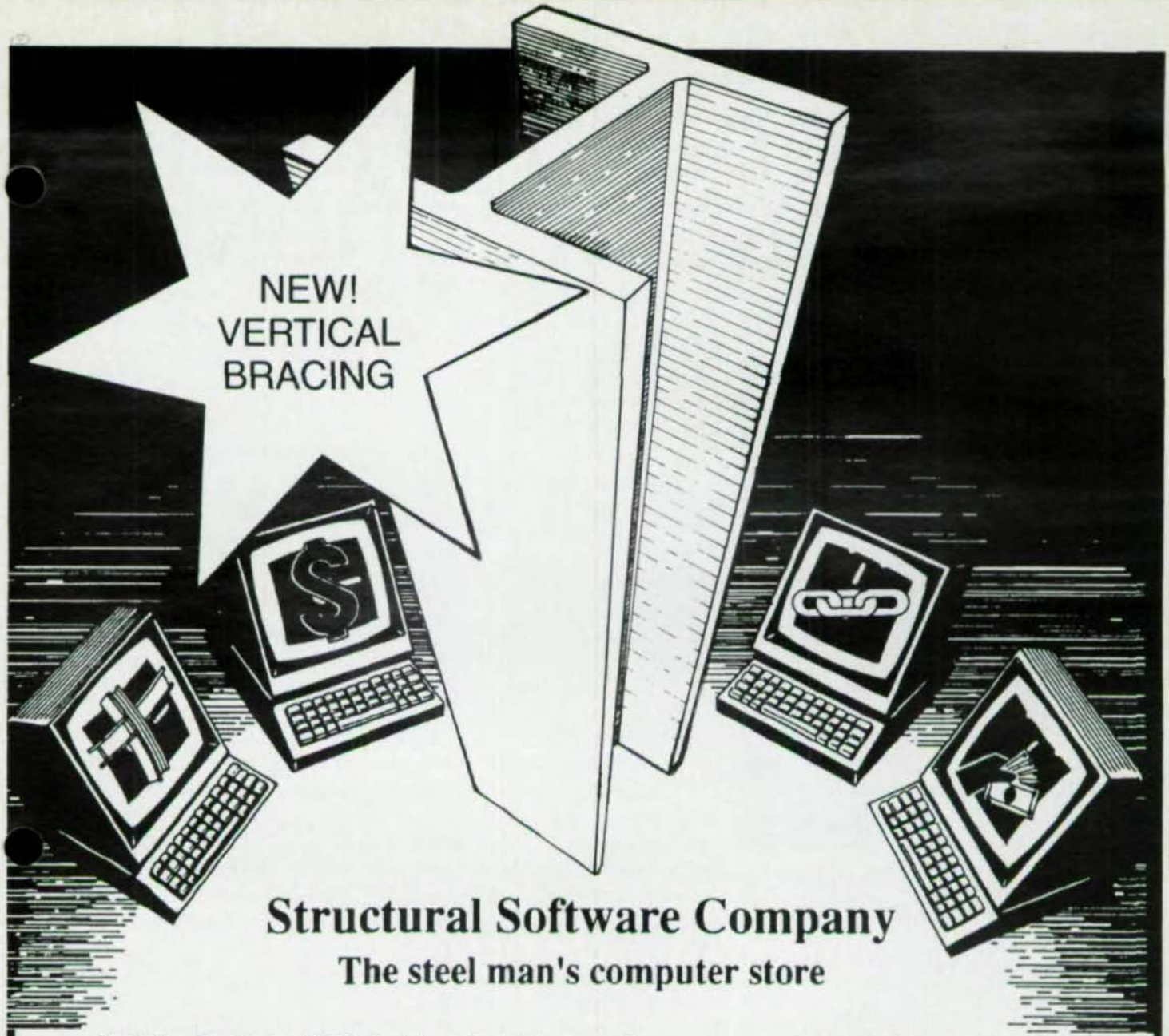

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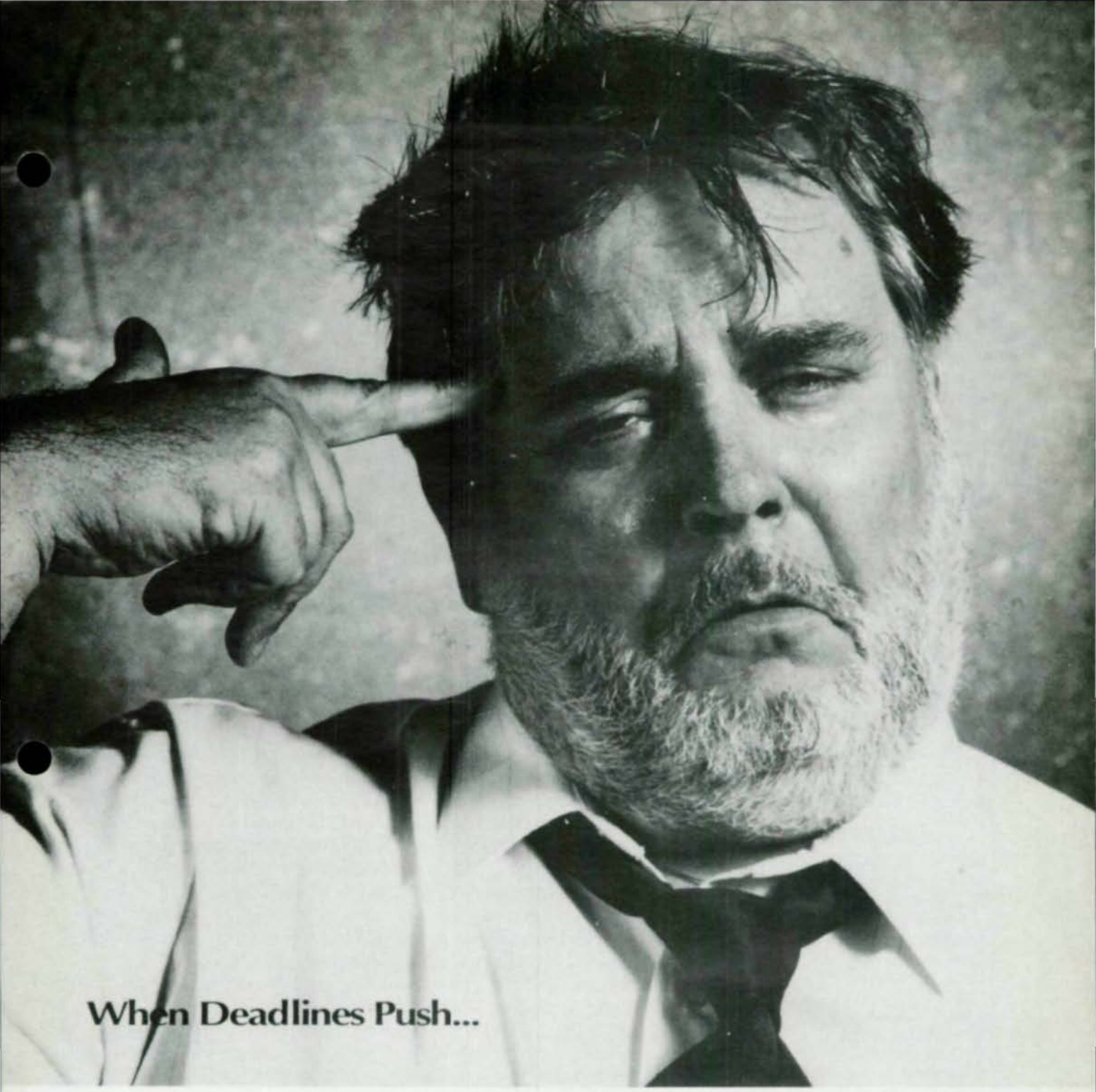
MODERN STEEL CONSTRUCTION

Volume 30, Number 4 July-August 1990

A 170,000-sq.-ft. addition to the Shedd Aquarium in Chicago will house whales, dolphins, seals, sea otters and other marine life in a series of five interconnected habitats totalling 3 million gallons.
Photo: McShane-Fleming Studios

FEATURES

NEWS AND DEPARTMENTS



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An Unnoticed View

I recently had the pleasure of attending a gala press reception at the soon-to-open 170,000-sq.-ft. Shedd Aquarium addition in Chicago. Since most of the editors and reporters in attendance were from the consumer press and were more interested in the new marine life than the new structure, it was only natural that the few architecture/construction writers huddled together.

All around us conversations swirled about such topics as the need for 364 tons of salt to salinate the water and how exciting it will be for schoolchildren in Chicago to see firsthand a 16-ft.-long beluga whale.

But I was too wrapped up in my conversation with Dennis Doordan to fully eaves-drop on anyone else. Doordan, an architecture professor at the University of Illinois who is writing an article on the aquarium for *Inland Architect*, was fascinated with the architectural differences between the old aquarium and the new. According to Doordan, when viewed side-by-side the two sections of the Shedd clearly represent the changing philosophy of animal exhibition and the move from pure exhibit space to the creation of more naturalistic environments.

As we toured the facility, we talked about the myriad of wonderful architectural features, such as the huge expanse of windows, the naturally sculpted rocks, the beautiful curve to the pools, and the wonderful millwork in the conference hall.

Finally, as we stood in the main hall, we looked up at the huge steel trusses overhead. We were entranced by the majesty of the steel and impressed with the clean connections. We spent several minutes talking about the difficult geometry of a curving space that required almost every member to be a different size. And we were intrigued by the steps taken to combat the corrosive effects of a salt-laden atmosphere, including applying silicone caulking to various joints.

After Doordan finished commenting on the architectural beauty of the steel, we both smiled. We knew that despite its marvelous intricacy, not one aquarium visitor in a hundred will ever even look up. And that somehow made the care lavished on the exposed structural system even more noteworthy. **SM**

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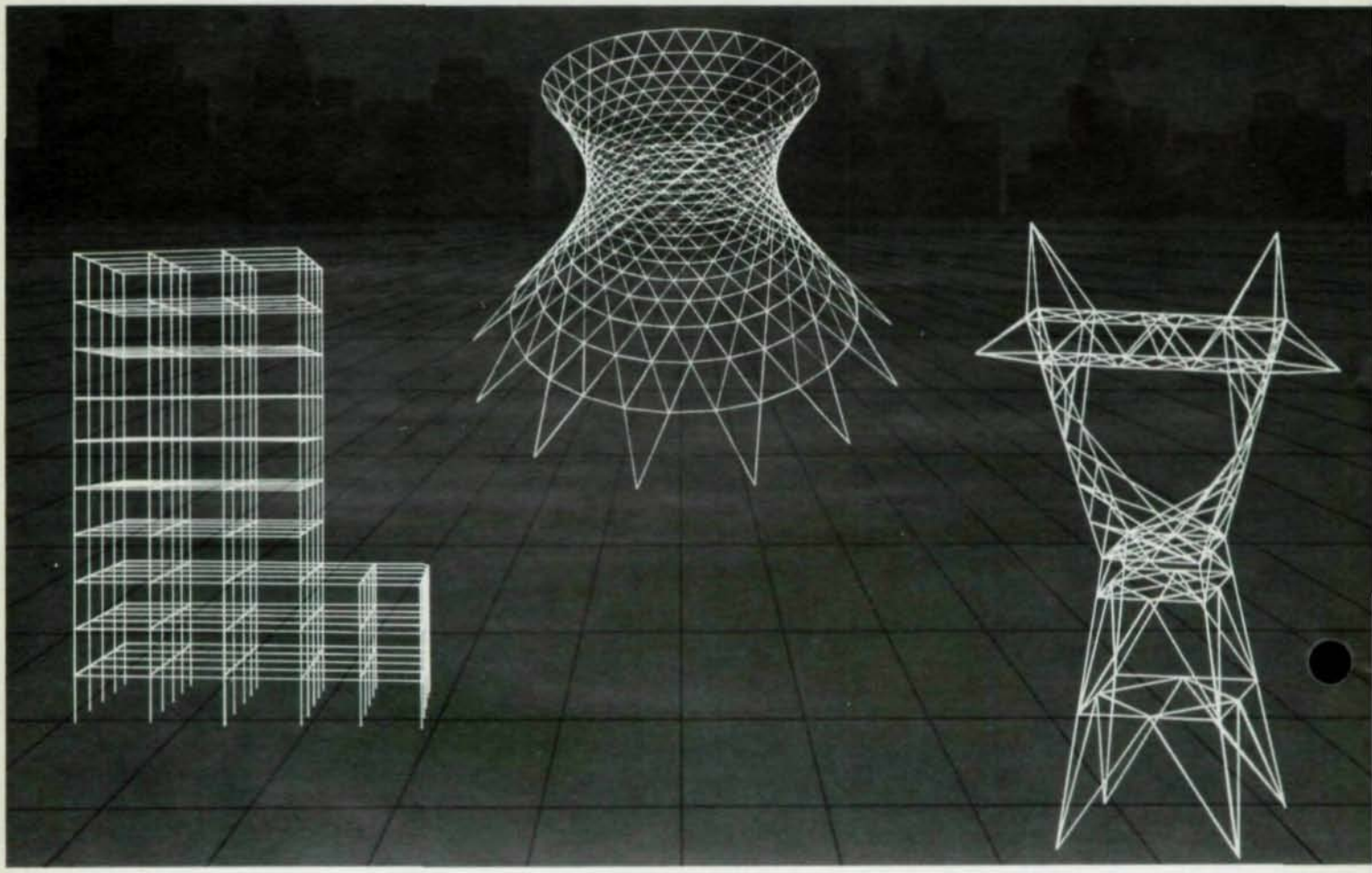

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Integral Bridge Design Is On The Rise

The use of integral abutments for continuous bridges is becoming commonplace and the length is increasing

By Martin P. Burke, Jr., P.E.

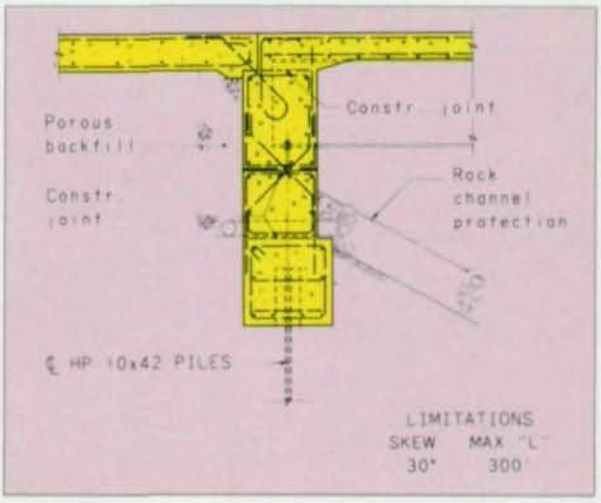
Both in the U.S. and Canada, integrated bridge construction is becoming the primary response to joint related bridge damage caused by the use of deicing chemicals and the restrained growth of rigid pavements. In most cases, engineers have found that bridges without deck joints—integral bridges—have performed more effectively since they remain in service for longer periods of time with only moderate maintenance and occasional repairs.

While using integral bridge construction causes some secondary stresses, it has been found that significantly more damage and distress has been caused by the use of deck joints than by the secondary stresses they are designed to prevent. In addition, elimination of costly joints and bearings—and the details and procedures necessary to permit their use—generally result in more economical bridges. Consequently, bridge engineers are increasingly willing to relinquish some of their control of secondary stresses to achieve simpler and less expensive bridges with greater overall integrity and durability.

Continuous Superstructures

Current design trends for continuous superstructures received their start more than six decades ago with the publication of a paper by Hardy Cross that introduced moment distribution and thus began the practice of avoiding

Pictured above is a State Route 739 bridge over US 33 in Union County, Ohio. The integral abutment detail shown at right is from the Ohio DOT. Even though there are similarities between Ohio's abutment details and those of other states, there also are differences that reflect the types of bridges being built.



troublesome deck joints at piers by providing continuous superstructures.

During the next half century, the industry moved from riveted field splices to butt-welded field splices and finally to high-strength bolting.

Currently, it appears that more than 85% of the transportation departments are using continuous construction for multiple-span bridges.

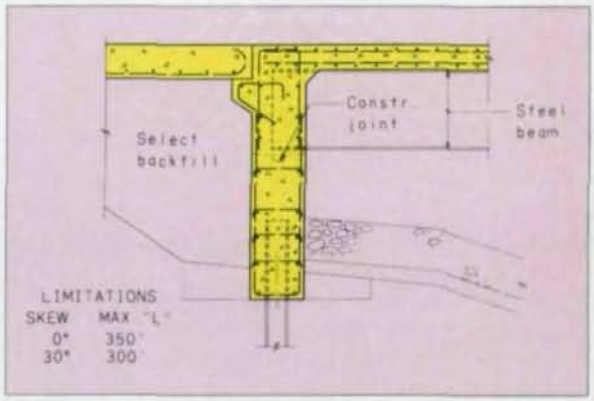
Also, the number of spans has increased. For example, the Long Island Bridge at Kingsport, Tenn., was constructed in 1980 with 29 continuous spans with an overall length of 2,800' center-to-center of abutment bearings without a single intermediate joint.

operate at very high stresses, stresses that cannot be easily quantified. These stresses are significantly above those permitted by current design specifications. In this respect, bridge engineers have become pragmatic. They would rather build less expensive integral bridges and tolerate these higher stress than build more expensive jointed bridges with their vulnerability to destructive pavement pressures and deicing chemical deterioration.

Integral Bridge Details

Even though there are similarities between the integral abutment details used by various transportation departments, there also are important differences. Most critical are the wide variety of methods engineers have used to deal with passive pressure and with pile stresses.

Shown at right is the North Dakota DOT's integral abutment detail.



Integral Abutments

Following the successful integration of multiple-span bridges to continuous spans, transportation departments also began a similar practice of building bridges without deck joints at abutments. In 1946, Ohio's initial length limitation for its standard continuous concrete slab bridge was 175'. Currently, 11 states are building bridges with integral abutments with lengths in the 300' range, and Tennessee reports lengths of 400' for continuous steel bridges, while Missouri reports steel bridges in the 500' range.

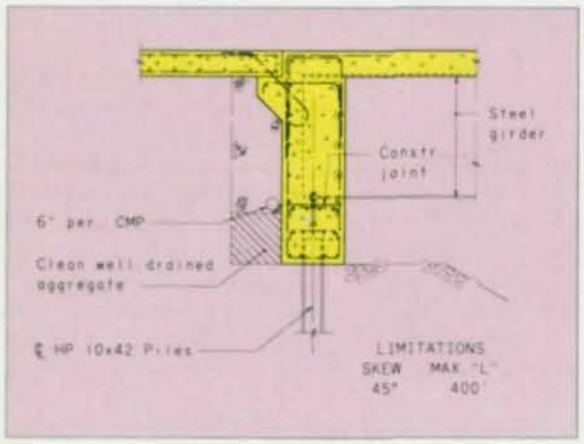
The attributes of integral bridges have not been achieved without cost. Parts of these bridges

To minimize passive pressure developed in abutment backfill by an expanding integral bridge, design engineers have used a number of controls, devices and procedures.

These include: limiting bridge length, structure skew and the vertical penetration of abutments into embankments; using select granular backfill and uncompacted backfill; providing approach slabs to prevent vehicular compaction of backfill or to permit the use of backfill voids behind abutments; using embankment benches to shorten wingwalls and using suspended turn-back wingwalls;

and using semi-integral abutment designs to eliminate passive pressure below bridge seats.

Knowing that longitudinal forces in superstructures are related to the resistance of abutment pile foundations to longitudinal movement, engineers have dealt with pile stresses by: limiting the foundation of integral bridges to a single row of slender vertical piles; limiting the pile types; orienting the weak axis of H-piles normal to the direction of movement; using pre-bored holes filled with fine granular material for piles; providing an abutment hinge to control pile flexure; limiting structure skew; and using semi-integral abutment designs for longer bridges to minimize foundation restraint to longitudinal movement.



Shown at left is the Tennessee DOT's integral abutment detail.

Integral Conversions

Following the trend toward the use of continuous construction and integral abutments, transportation departments are beginning to retrofit existing multiple span bridges from simple to continuous span. Presently, about 30% of the transportation departments studied have converted one or more bridges.

To give some direction to this movement, the Federal Highway Administration has issued Technical Advisory T5140.16 "Bridge Deck Joint Rehabilitation (Retrofit)." In part, the advisory recommends that a study of the bridge layout and existing joints be made "...to determine which joints can be eliminated and what modifications are necessary to revamp those that remain to provide an adequate functional system...."

For unrestrained abutments, "...a fixed integral condition can be developed full length of the shorter bridges. An unrestrained abutment is assumed to be one that is free to rotate, such as a stub abutment on one row of piles or an abutment hinged at the footing...where feasible, develop continuity in the deck slab. Remove concrete as necessary to eliminate existing armoring, and add negative moment steel at the level of existing top-deck steel sufficient to resist transverse cracking."

Although too recent to consider as a design trend, conversion of nonintegral to integral or semi-integral abutments for both single and multiple span bridges has begun.

Martin P. Burke, Jr., is a bridge consultant with the engineering and architectural firm of Burgess & Niple, Ltd., Columbus, Ohio. This article is based on documentation developed for NCHRP Synthesis 141, "Bridge Deck Joints," and the paper "Integral Bridges" that he delivered at the Transportation Research Board's 69th Annual Meeting in January, 1990. □

Seismic Issues Prove Popular At Structures Congress

By Nestor Iwankiw, AISC Director of Research and Codes

Seismic sessions dominated this year's American Society of Civil Engineers' Structures Congress both in frequency and interest generated, though other popular sessions included a discussion of the proposed world's tallest building and a review of the acclaimed Bank of China project.

The Eighth Congress, which met in Baltimore April 30 - May 3, attracted more than 500 registrants from the U.S., Europe, Canada, Mexico, Japan, and Australia.

Session topics ranged from general discussions of the design of bridges and buildings to specialized topics such as blast-shock loading and tension-fabric structures.

Particularly memorable was a presentation by Charles Thornton, P.E., president of Thornton-Tomasetti, P.C., New York City, on the new Miglin-Beitler building in Chicago. The building, which is still in the design approval stage, is planned to rise 120 stories, making it the world's tallest.

One of the major problems in designing this structure is to deal with tenant comfort due to the large amount of lateral motion inherent in a building of this height. The engineers are dealing with the serviceability issue by designing a composite structural system using concrete to stiffen the steel frame.

Another mega-project, the Bank of China Tower in Hong Kong, was discussed by Leslie Robertson, partner with Leslie E. Robertson Associates, New York City (see accompanying article).

One of the most popular sessions was offered by Vitelmo Bertero, a professor at the University of California-Berkeley and this year's AISC T.R. Higgins Award recipient, as well as ENR's Man of the Year award. The widely-recognized seismic expert gave an impassioned plea for the need to recognize the real hazard that earthquakes represent to a standing-room only audience. He also suggested building design code improvements to minimize the risk. (see March-April 1990 *Modern Steel Construction* for complete coverage). Bertero is scheduled to give a series of T.R. Higgins Lectures. For information, contact Robert Lorenz, director of education and training, AISC, One East Wacker Dr., Suite 3100, Chicago, IL 60601-2001 (312) 670-5406.

Perhaps the only criticism that can be leveled at the Structures Congress is a lack of a complete written proceedings that would have clearly captured the thoughts and ideas of all of the speakers for future reference. Instead, one- to two-page abstracts were available.

The Ninth ASCE Structures Congress will be held April 29 - May 1, 1991, in Indianapolis. For more information, contact the ASCE, 345 East 47th St., New York, NY 10017-2398 (212) 705-7350. □

Bank Of China Tower

Condensed from a talk by Leslie Robertson, partner, Leslie E. Robertson Associates, N.Y.

The 72-story Bank of China Tower in Hong Kong was completed in 1988 and is the world's fifth tallest building.

Its location resulted in special design considerations, such as the need for 4"-thick slabs, (which meant floor construction weighed 50% more than required in the U.S.), calculated live loads that were twice those required in the U.S., and wind loads that were twice those required in Chicago and four times larger than the seismic forces required in Los Angeles.

The unique building provided a step forward in the evolution of the structural engineering field. A megastructure composed of a pure space-truss, consisting of plane frames of structural steel bonded at their corners by columns of reinforced concrete, is used to support almost the entire weight of the building, including most of the weight of the service cores. That same system also is used to resist the lateral thrust of the typhoon winds. The central column, as well as most of the minor columns of the service cores and all of the minor perimeter columns, are carried by the megastructure to the four corner columns that form the 170' X 170' building.

By making use of a kind of logic in eccentricity, the system allows a moment-free transfer between the structural steel columns of the plane frames and the composite steel/concrete columns of the megastructure. This is accomplished by enfolding the edge columns of the plane frames in reinforced concrete. The combination creates a three-dimensional framework, but without the need for three-dimensional connections in the steelwork. Cross-grain tension in the steelwork is completely eliminated in the megastructure framing. The system also allows the use of larger fabrication and erection tolerances for the steelwork.

Despite the building's irregular and eccentric form, it resolves the lateral thrusts from the wind and minimizes the static and the dynamic components of wind-induced mass and the volumetric centers can be kept in rigorous alignment.

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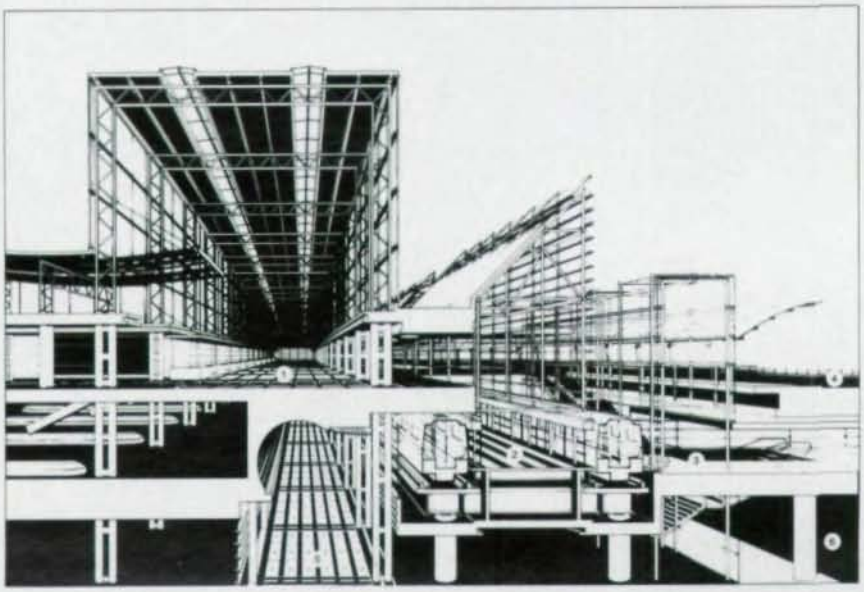


A section perspective of the new international Terminal at O'Hare Airport shows: (1) departure hall, (2) Airport Transit System station, (3) pedestrian bridge vestibule, (4) upper-level roadway for passenger drop-off, (5) meeters-greeters lobby, and (6) the lower-level arrivals roadway below.

As has been the trend with other recent projects at the airport, including the award-winning United Airlines Terminal and the renovation of the American Airlines Terminal, exposed steel will play a significant role in the project's design.

"There are exposed hollow structural sections in the front to create a high-tech expression," explained August Battaglia, associate principal with Perkins & Will, Chicago. "But it's different from the American and United terminals because it's lighter and lacier. We designed a modern interpretation of the traditional train stations from the turn-of-the-century."

The hollow structural sections were chosen to create a simpler structure visually. "They're less bulky than wide flange shapes," Battaglia explained.

Perkins & Will is the project architect/engineer in association with architect Heard & Associates, Ltd., and engineer Consoer, Townsend & Associates. Joint venture construction managers are Gilbane, UBM, Globetrotters Engineers, d'-Escoto, and Rubinos and Mesia Engineers.

The terminal's dramatic glass-enclosed ticketing lobby features a large exposed-truss roof system. Typical truss spans are 35', with a maximum span of 50'. The roof is arched, with a low-point of 14' and a high-point of 52'. The structure is designed with a moment-resisting frame with 40"-deep structural shapes over the lower level. The basement is laid out on a 30' x 40' grid.

"We mostly used fully-rigid moment resisting connections and rigid frames to resist the lateral earth pressure from the weight of the aircraft," explained Mark Zahn, project structural engineer. The structure will use in excess of 9,500 tons of A36 steel.

The 20-gate, 1,049,000-sq.-ft. terminal is scheduled for completion in the summer of 1993. □

LRFD Loads

In the article "LRFD: The Quiet Revolution," appearing in the May-June issue of *Modern Steel Construction*, the probabilistic basis for LRFD is illustrated by a diagram that I have always considered misleading at best. The same diagram appears in the *LRFD Manual of Steel Construction*.

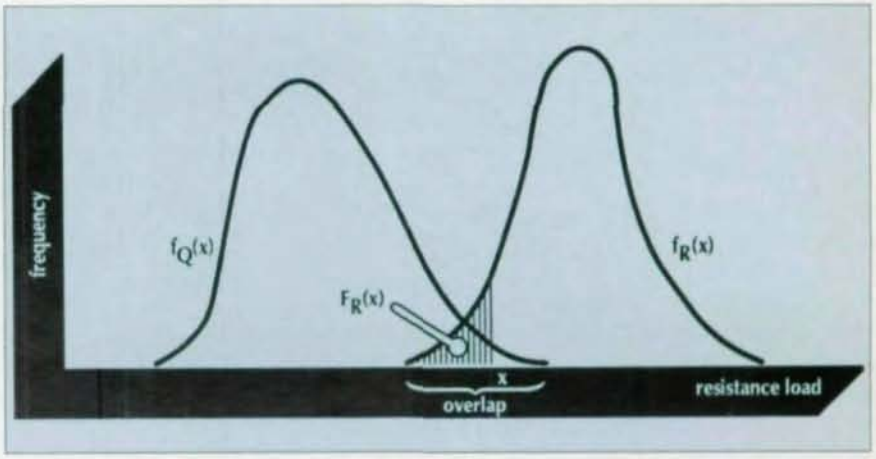
The diagram "portrays" the probability of failure of a structural element having random resistance R, under random load Q, by the area where the two corresponding frequency distributions cross. Several well known engineers have equated that area to the probability of failure, which is just plain wrong. Many students have probably jumped to the same wrong conclusion. Beyond observing that unless the two frequency distributions overlap, the probability is either zero or unity; and if the coincide the probability of failure is not unity (even though the overlap area is unity), not much more useful information can be obtained from the overlap concept.

Unless someone can define a far more significant relation between overlap area and probability of failure than has been done to date, let us do away with that concept altogether and hope as few people as possible have been misled by it. Instead, there are four simple, mathematically correct diagrams, two for the probability of failure and two for the probability of survival. They are the area under a transformed distribution, obtained by multiplying either of the above two basic frequency distributions by the appropriate cumulative frequency distribution of the other.

Douglas H. Merkle, Ph.D., P.E.
Associate
Applied Research Associates, Inc.
Tyndall Air Force Base, Fla.

Bruce Ellingwood, Professor of Civil Engineering at The Johns Hopkins University, Baltimore, responds:

Mr. Merkle is correct in his observation that the shaded area appearing in the diagram of frequency functions of load effect, Q, and resistance, R, is not the probability, P(P<Q), that R is less than Q. However, the possibility of failure indeed stems from the overlap in the frequency functions.



The figure above provides the correct interpretation. The curve labels $f_R(x)$ is the density (frequency) function of R; it is the theoretical counterpart to a histogram, and is used to describe the probability that the resistance takes on any of a set of values. For example, the shaded area to the left of x is the probability that R is less than or equal to x; this probability is defined by the distribution function, $F_R(x)$. The density function $f_Q(x)$ provides similar information on Q.

If load Q is determined and equal to x, the probability P(R<Q) is simply $F_Q(x)$. Of course, load Q is not deterministic; it is a random variable with possible values described by $f_Q(x)$. Thus, to obtain P(R<Q), we must weight $F_R(x)$ by the probability that Q=x. Mathematically, we have,

$$P(R<Q) \approx \sum_x F_R(x)\, P(Q=x)$$

or, in integral form,

$$P(R<Q) = \int F_R(x)\, f_Q(x)\, dx$$

The latter equation is the convolution to which Mr. Merkle refers. This summation (integration) cannot be portrayed conveniently in a two-dimensional plot such as the one above.

The diagram appearing in the Commentary to the LRFD Specification for Structural Steel Buildings (pp. 6-144), should be interpreted similarly.

Earthquake Reinforcing

I could not help but chuckle at the caption accompanying two pictures of a five-story building on page 11 of your May-June issue of *Modern Steel Construction* reading:

"Surprisingly, a relatively new five-story concrete office building came through the earthquake unscathed. Upon closer inspection it becomes apparent that damage was most likely prevented by reinforcing the soft story with steel-braced frames."

I know this building well. It is situated on Howard Street in San Francisco. If I remember correctly, this building WAS damaged by the October 1989 San Francisco Earthquake, and the bracing was installed AFTER the earthquake.

David S. Eliachar, P.E.
Consultant
Sausalito, Cal.

We are new members of AISC and have just started receiving our issue of *Modern Steel Construction*. On page 11 of the May-June 1990 issue is a picture of a building which is not only where our office is located, but also a

Continued on page 16

Letters, Cont.

building which was designed by my father's consulting engineering firm.

To set the record straight, the comments made were incorrect. First, the building is a six-story structure whose first four floors are constructed of reinforced concrete. The upper two stories are constructed of structural steel, with metal deck and concrete floors. The lateral system for the building is predominantly concrete shear walls and one pair of steel-braced frames which extend the entire height of the structure.

Levon H. Nishkian, C.E.
President
Nishkian and Associates
San Francisco

Architectural Award Entries Due August 4

All entries for the 1990 Architectural Awards of Excellence competition must be submitted by August 4. This AISC-sponsored biennial award program recognizes and honors outstanding architectural achievement in building design.

Entries can be submitted by any registered architect practicing professionally in the United States. All submitted projects must have a steel frame, though the steel does not have to be exposed. Also, the project must have been designed in the U.S. and the steel must have been fabricated and erected in the U.S. For more information, refer to the competition rules and entry form on pages 17-18 of this issue.

Winning architects will be honored at an evening banquet on December 5, 1990 in Chicago. The award-winning projects will be featured in the November-December issue of *Modern Steel Construction*.

1990 Jurors

Jurors for the 1990 competition include:

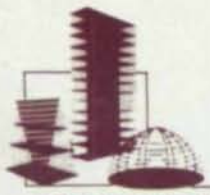
Robert Beckly, dean of the College of Architecture and Urban Planning, University of Michigan, Ann Arbor, Mich.;

J. Robert Hillier, chairman, The Hillier Group, Princeton, N.J.;

Joseph T. Colaco, principal, CBM Engineers, Houston, Texas;

Silvester Damianos, principal, Damianos Brown Andrew, Inc., Pittsburgh, Pa., and current president of the American Institute of Architects;

Thomas W. Ventulett, III, principal, Thompson, Ventulett, Stainback & Associates, Inc., Atlanta, Ga.



AISC 1990 ARCHITECTURAL AWARDS OF EXCELLENCE COMPETITION

COMPETITION RULES

Eligibility

All registered architects practicing professionally in the United States are invited to enter steel-framed buildings of their design constructed anywhere in the United States (the 50 states, District of Columbia and all U.S. territories), and completed during calendar years 1987, 1988 and 1989. Each building must have been designed, fabricated and erected in the U.S.

The structural frame of the building must be steel, although it is not a requirement that the steel be exposed or a part of the architectural expression. Buildings of all classifications are eligible, with equal emphasis given to all sizes and types in the judging. Older buildings which have undergone major reconstruction/rehabilitation using steel as the major structural material also are eligible for entry if they meet all other requirements of this competition. There is no limit to the number of entries by any individual or firm. Buildings named as previous AAE winners will not be eligible, except in the rehabilitation category.

Method of Presentation

Each entry should be submitted in an 8 ½ x 11" binder containing transparent window sleeves for displaying inserts back to back. The entry form included in the brochure must be easily removable, so that the identification of the entry can be concealed during judging. All information requested on the entry form must be included.

Awards

Winners will be notified before August 30, 1990. Public announcement of the winners will be made in the November/December issue of Modern Steel Construction magazine. Award presentations will be made to the successful architects' representative on the evening of December 5, 1990, at the AISC Ninth Annual Awards Banquet in Chicago. Local awards not presented at the banquet will be presented later to recognize owner, general contractor, structural steel fabricator, structural engineer and erector as appropriate for each winning structure.

All entries will be retained by AISC for publicity purposes. The use of any entry's submitted data, detail and/or photographs by AISC shall be unrestricted.

Entry Requirements

An entry must consist of an entry form, photographs and descriptive data, all as described below:

Entry Form

Entry Form must include the following:

1. Name, location and completion date of the building.
2. Name, mailing address, telephone number and contact of the following:

Architect	Structural engineer
General contractor	Steel fabricator
Steel erector	Owner

Photographs

1. 8" x 10" color prints should include a minimum of two exterior photographs, showing all principal exposed sides of the building or building group, several interior photographs, any innovative or outstanding applications of steel that might not be evident in exterior photographs. Similar 35 MM color slides are helpful.
2. Photographs (B & W or color) or 35 MM color slides of the building under construction and showing portions of the structural steel framing are encouraged.
3. All photographs should be of professional quality and must be previously cleared for use by AISC in publicity and publications.

Descriptive Data

The following descriptive data is required:

1. An architectural description of the owner's requirements, the design solution, the building's outstanding features and reasons for using a structural steel frame.
2. A site plan, a floor plan and any details that amplify and/or clarify architectural description.

All descriptive data must be on 8½" x 11" sheets.

Deadline for Submission

Entries must be postmarked prior to **August 4, 1990** and addressed to the Awards Committee, American Institute of Steel Construction, Inc., One East Wacker Drive, Suite 3100, Chicago, IL 60601-2001.

AISC 1990 ARCHITECTURAL AWARDS OF EXCELLENCE COMPETITION

ENTRY FORM

Entry date: _____

Name of building: _____ Completion date: _____

Location: _____ City, state, zip: _____

Descriptive data: Attach separate sheets (see completion rules)

No. of photographs enclosed: B & W _____ Color prints _____ 35 MM slides _____

Architectural Firm: _____
Phone

Address: _____
Street City and State Zip

Person to Contact: _____
Title

Structural Engineering Firm: _____
Phone

Address: _____
Street City and State Zip

Person to Contact: _____
Title

General Contracting Firm: _____
Phone

Address: _____
Street City and State Zip

Person to Contact: _____
Title

Steel Fabricating Firm: _____
Phone

Address: _____
Street City and State Zip

Person to Contact: _____
Title

Steel Erecting Firm: _____
Phone

Address: _____
Street City and State Zip

Person to Contact: _____
Title

Owner: _____
Phone

Address: _____
Street City and State Zip

Person to Contact: _____
Title

This entry submitted by:

Name: _____
Title

Firm: _____
Phone

Address: _____
Street City and State Zip

(Additional entries may be submitted on copies of this form.)

AISC Design Guide Series

D803 Serviceability Design Considerations For Low-Rise Buildings (Fisher & West, available summer 1990) $16.00

Steel Design Guide Series No. 3. Numerous serviceability design criteria exist, but they are spread throughout many different sources and documents. The purpose of this design guide is to gather these criteria together for a discussion on serviceability. The serviceability requirements of deflection, vibration, and drift are discussed in detail.

D802 Design Of Steel And Composite Beams With Web Openings (Darwin, 1990) $16.00

Steel Design Guide Series No. 2. Web openings have been used for many years in structural steel beams. This design guide summarizes the criteria for the practicing engineer and reviews the recent research and history of web openings. It presents a new unified approach to both steel and composite beams with web openings, including the requirements for reinforcement.

D801 Column Base Plates (DeWolf & Ricker, 1990) $16.00

Steel Design Guide Series No. 1. This design guide contains a compilation of existing information on the design and erection of base plates for steel columns in buildings. The intent is to provide engineers with the research background and an understanding of the behavior of base plates and to present information and guidelines for their design and erection. The design of anchor bolts also is covered.

AISC Design Guide Series Order Form

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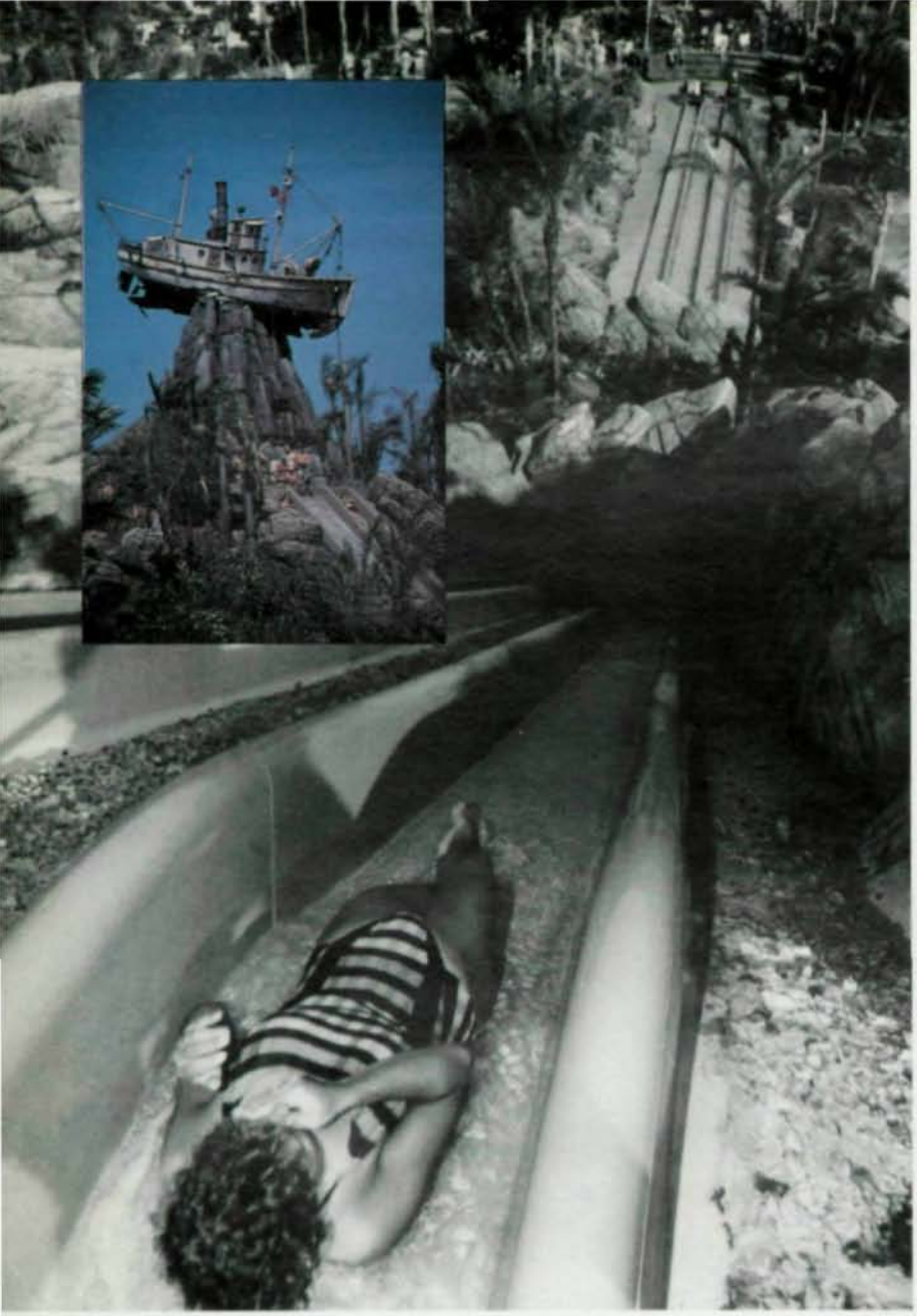

Wet And Wild

Steel supports provide strength and the desired beauty on waterslides throughout the country

For much of the country, thoughts of Florida conjure two images: beaches and Disneyworld. But if the folks at Disney have their way, the two images will soon become synonymous.

Last year Disney—to rave reviews—opened Typhoon Lagoon, one of the rapidly increasing number of water parks throughout the country. "Waterslides are increasing in popularity, especially as people become more concerned with pollution at beaches," explained Michael Desrosiers, marketing director with ProSlide Technology Inc., St.-Sauveur-des-Monts, Quebec. "Waterslides provide a controlled environment and the filtration equipment ensures that the water is crystal clear."

ProSlide, one of the four largest waterslide manufacturers in North America, was founded in 1986 and has already completed close to 70 major installations with more than 200 waterslides, mostly in the United States. The Orlando

Typhoon Lagoon (opposite page) is Disneyworld's version of a water park. It's considered a medium-sized installation with two "fast-tracks" and three giant "twisters". Unlike most water parks, however, Disney chose to enclose the steel support system within artificial rock.

The steel structural system essential to all large water slides is better seen on Jekyll Island in Georgia (above and right). Two speed slides are always built side-by-side and supported off of one column. A wide flange beam is used to support either side. The slide shown has a typical arm-column connection—a locking collar bolted on either side. The free-standing stair tower supports one end of the slide and is designed as a moment frame using A36 steel. While using X-bracing might reduce the cost, it wouldn't result in as "clean" a design.

The supporting arms on the giant "Twister" at Wild Waters in Sparks, Nev., are WF sections, though on other projects they are usually structural tubes.

installation, while slightly unusual in that the steel structure is covered with an artificial mountain, still provides a good example of the design process in constructing a custom waterslide, according to Richard Louis Servidio, P.E., principal of Richard Louis Servidio Structural Engineering Consultants, Burlington, Vt. As with most of ProSlide's projects, Servidio acted as the structural engineering consultant for the steel support structure.

Typhoon Lagoon is a medium-sized installation and features three giant "twisters" and two free-fall "fast-tracks", as well as a river raft ride, snorkeling tanks, and wave pools, with only the waterslides being provided by ProSlide. The twisters have a drop of 37' and an average grade of 12% over their slightly more than 300' lengths. The fast-tracks are 214' long, drop 50', and have an average grade of 56%. As the names suggest, a twister is a

curving ride, while fast-tracks are straight runs designed for speed. "A person travels around 25 miles per hour through the [fast-track] slide," Desrosiers stated.

The design of the slides themselves, which consist of series of premolded fiberglass sections, are done by Andreas Tanzer, manager of design and engineering at ProSlide.

The client states a desired length and type of configuration. After examining topographical and contour maps, as well as a report on the soil conditions, Tanzer creates an initial design. He then submits the design to the park client and an iteration process ensues until the final design is created. "We design the slides on a CAD system from the pool up," Tanzer explained. "It's a combination of our design criteria and the owner's preference for length and drop."

Tanzer's design includes the trackpoint coordinates, the location of joints between the fiberglass sections, the number of supporting arms, and the location of the arms. This information is then given to Servidio who determines the structural system needed to support the slide.

Essentially, the structural system consists of a stair tower that holds up one end of the slide, and a series of steel columns with projecting "arms" that support the rest of the slide.

Moment Resisting Frame

The stair tower—which in some installations reaches as high as 70'—is usually designed as a moment frame using A36 steel. "Though on exceptionally high towers, especially in seismic zones, we go to a grade 50 steel," Servidio noted.

While using X-bracing might reduce the price of the steel, Servidio explained, it would not result in as attractive a design. "A lot of the parks are geared towards aesthetics," added Tanzer. "The tower has to look strong, but be clean. And while moment connections may be more detail intensive in the shop, it is easier to erect in the field. Also, eliminating the X-bracing

The water slides at Wild Waters used 200 tons of structural steel, including the 40' high stair tower. The support columns are clean shaft with a base plate at the bottom with stiffener fins. At the top is a closure cap so nothing goes down the column.

Pictured above is the connection between the stair tower and the slide of a giant twister at Wild Waters in Sparks, Nev.

The steel columns for the fast-track at Wild Waters are located below the longer slide, and steel arms extend out to support the adjacent slide.

reduces maintenance requirements."

The stair towers are essentially free-standing, though they are connected to the slide at the very top. "Specifications allow a fair amount of movement in free-standing structures, but in this use it is essential to minimize the perception of movement," Servidio said. "So we design to a stiffer structure than is required."

The rest of the slide is supported on a series of columns, which are typically steel pipes with a diameter up to 24". The columns are mostly clean shaft with a base plate at the bottom with stiffener fins. At the top is usually a closure cap plate so nothing goes down the column.

The steel "arms" that extend from the column to the slide were structural tubes for Typhoon Lagoon, though on other projects they are occasionally WF sections. WF sections are not as stable as the tube shape due to torsional considerations. "Also, with WF sections, there is some problem with birds roosting," Servidio said. The arms typically have a 10' reach, though on some projects they extend up to 15'.

The slide is usually supported at every other joint, a distance of approximately 15'. "The amount of support is adjusted by location," Servidio explained. "In the north, there is more snow and ice and therefore heavier loads. For the most part, however, we'd rather adjust the steel rather than increase the number of supports."

For the fast-tracks, there are always two side-by-side slides supported off of a common column. For these slides, a WF beam is used to support either side.

A typical arm-column connection, as was used on Disney, is a locking collar bolted on either side. "It allows vertical and rotational movement during the field installation phase," Servidio explained. "After final positioning, it's field welded at the top of the collar to the face of the column." On the extended end of the arm is a small plate that is tilted to match the angle of the fiberglass slide. The plate is field welded to make sure the match is precise, and the slide is bolted to this plate.

Because steel can withstand a lot more movement than fiberglass, it is the fiberglass, rather than the structural loads, that determine the required stiffness of the structure. Also, because a lot of the slides are located in northern climates, the snow, ice, and wind loads are the controlling factors, rather than the weight of the moving water within the slide.

Water slides seem to be an increasingly popular phenomenon throughout the nation. For example, Wild Waters in Sparks, Nev., opened recently to the same enthusiastic reviews as did Typhoon Lagoon. Wild Waters includes two giant twisters and a giant continuous river inner tube ride coming off a 40'-high platform, and two fast-tracks coming off a 55'-high platform.

Wild Waters was fabricated by AISC member Reno Iron Works Co., Inc., Sparks, Nev. The slides use 200 tons of structural steel. Its finish was SSPC-SP6 Commercial

Blast Cleaned with a Tnemec coating.

Unlike at Disney, which had an elaborate approval process, the design and construction sequence for Wild Waters was very typical for a medium-sized water park, Servidio explained. Design began in the Fall of 1988, construction started in February 1989, and the installation was completed at the end of May 1989.

Several current projects are being fabricated by AISC member East Tennessee Steel, Inc., Knoxville, Tenn., including a huge park in Muskegon, Mich. According to the fabricator, some of the supports are galvanized while others are coated with an epoxy-based paint. East Tennessee is now recommending, however, painting the structures with a zinc-rich primer and then an epoxy topcoat to get the most attractive finish with the best rust-inhibiting qualities.

Michigan's Adventure includes two giant twisters, two fast-tracks, two giant continous river rides, and two enclosed-tube body rides.

In the future, some parks are expected to begin building what Pro-Slide calls Mammoth River rides, which use 8'-wide rafts in a 14'-wide slide. Servidio is currently doing initial design development for steel supports on these large rides, which are expected to rise 40' to 50', and be elevated on either a tri-pod or dual pole. Another option being considered is a heavy-duty radial arm with offsets.

Servidio is a licensed engineer in 20 states and his waterslide projects have ranged from Nevada to Ohio to Florida, though not all have been steel. "Right now, about 60% of the projects are steel and 40% are heavy timber," he said. "Heavy timber is dominant on the lower, smaller rides, while steel is really a necessity for any tower over 30'. Steel is cleaner, can be easily painted, and the members are smaller."

Interestingly, Tanzer is a naval architect by training. "There's a lot of similarity to designing structures that keep water out and structures that keep water in," he said. □

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Illinois Ocean

Three million gallons of salt water will provide a home for whales and dolphins at Chicago's Shedd Aquarium

The ocean is coming to Chicago, but don't worry, it has nothing to do with global warming.

Instead, it's the culmination of nearly two decades of dreaming and planning. In November, the Shedd Aquarium will open its new Cold Water Marine Mammal Complex: a 170,000-sq.-ft. structure that will be the home to beluga whales, false killer whales, dolphins, harbor seals, sea otters, penguins, and assorted anemones, crabs and mussels.

The project's scope is huge and will essentially double the size of the existing aquarium. But it is not simply the increase in space that is noteworthy; rather, it is how the space will be utilized.

The existing aquarium consists of a series of dark rooms with well-lit tanks—the fish are highlighted in much the same way a jewelry store highlights its displays. The largest tank is the 90,000-gallon coral reef exhibit.

The difference between the existing section and the new is literally that of between night and day. Instead of a "jewelry window" display, the new Oceanarium is a wide open space brightly lit by 215 east elevation windows offering a panoramic view of Lake Michigan. The space features five interconnected habitats totalling 3.0 million gallons—including a *two million* gallon habitat!

Natural Environment

And in keeping with modern design trends, instead of simply being an exhibition space, the new Oceanarium attempts to recreate a natural environment. Surrounding the pools are artificial rocks carefully crafted to look like a typical

The Shedd Aquarium—inside and out. The largest of the habitats will hold two million gallons of salt walter (top). Note that the steel trusses are still under construction. The addition's curving facade is a pleasing addition to Chicago's urban landscape. Top photo by McShane-Fleming Studios; bottom photo courtesy of Shedd Aquarium

The project was made more difficult by its location on Lake Michigan and its construction schedule that forced much of the steel erection to occur during the winter. The steel trusses were delivered to the site in two or three pieces, depending on their length, and field assembled. If you look closely at the trusses you can see the continuous slope from 8' at one end to 14' at the other. In case of accident, netting was installed during the erection to protect the workers, steel and deep tanks below. Photos by McShane Fleming Studios

Pacific northwest coastline. The designers and craftsmen went to such extreme care that castings of actual stone formations were made and then replicated, and specialized artists were hired to paint lichen and sea gull guano on the rocks for added realism. In addition, more than 70 different artificial trees, shrubs, and smaller plants were constructed to replicate a Pacific northwest rainforest.

While most visitors will be content to feast their eyes on the living inhabitants in the huge habitats, the 50,000-sq.-ft. of sloping rockwork and plantings, and the beautiful view of Lake Michigan, an occasional visitor is sure to look up and be just as impressed by the exposed steel trusswork that allows the creation of such a wide open environment.

The steel trusses provide a clear span of 127' to 158', and at the west side of the building have a 14' depth, which gradually decreases to 8' at the east end. The change in truss profile is designed to accommodate the architect's desire for a low roof line.

"We designed this large hall with column-free trusses to provide the most flexibility for exhibit space," explained Dirk Lohan, president of Lohan Associates, Inc., the project's architect. "The whole system is a semi-circular fan-shaped plan that derives from the shape of the land on which it sits and relates to the focal center of the old Shedd Aquarium. We've recreated inside the hall a naturalistic great walk. This was only possible in a column-free space and steel is ideal for spanning large open spaces."

Getting Started

To fully appreciate the project, it is first necessary to be familiar with its site on a peninsula jutting out into Lake Michigan. This small plot of land is home to three of Chicago's most notable cultural institutions: the Adler Planetarium, the Field Museum of Natural History, and, of course, the John G. Shedd Aquarium. As befits an aquarium, Shedd was constructed

directly adjacent to the lake. While this was a beautiful site, it effectively eliminated any room for an addition—unless it was to be built on landfill.

"To provide room for the new addition, we had to fill in nearly two acres of lake," explained Bob Tassone, Shedd's project manager. "The engineers designed a huge steel sheet-pile wall—in effect creating a huge bathtub—and pumped out 30 million gallons of lake water."

Structural engineer on the project was Rittweger & Tokay, Inc., Park Ridge, Ill., and the consultant for the re-entrant lake wall and foundations was STS Consultants, Northbrook, Ill. The piles and sheeting were driven by Thatcher Engineering Corp., Gary, Ind., and the concrete for the lakewall was poured by Pepper Construction Co., Chicago.

The 1,400'-long lakewall is supported on approximately 600 vertical and battered steel H-piles, which sit in turn on an embankment of stone. The stone had to be placed in the lake because of the poor soil conditions at the site, which consist of 25' to 50' of cinder, sand, and clay fill dating back to the Chicago fire. The seawall itself is concrete, with steel sheet piling in front as a cut-off wall.

"Building a wall in 15 or 20' of water, especially in something as volatile as Lake Michigan, was a very difficult task," said Ted Bushell, P.E., principal engineer with STS. The new structure itself is supported on 1,800 driven steel H-piles, varying in length from 60' to 80'. While the H-piles were principally used because they were less expensive than pipe piles filled with concrete, they also aided in reducing vibration in certain critical areas close to the existing building. Construction of the foundation took approximately one year, beginning in January 1988.

Complementary Design

The project's architect was faced with the difficult dilemma of needing to construct an addition as large as the existing aquarium, but at the same time creating a building that wouldn't detract attention from the original structure.

Lohan Associates' solution was a semi-circular design attached to the east face of the existing building and with a roof line that rises only 55'. "We wanted an understated addition to a highly-loved

Beluga whales can grow to about 16' and weigh about 3,000 lbs. The one pictured above is scheduled to arrive at the aquarium in August, and the Oceanarium will open to the public in November. The bulbous shape on the whale's forehead is called a "melon" and and its function is to focus the sounds used in echolocation (the whale's "sonar"). Photo by Mel Woods

Chicago landmark," Lohan explained. "Its roof is lower than the cornice line of the old building. And its location doesn't effect three sides of the building."

But perhaps the crowning touch was reusing the existing marble cladding from the east wall to clad the new addition, and thereby perfectly mate the two structures. "The existing marble was 4" to 12" thick. It was sliced and used in most cases on the new addition," Tassone said. "It wasn't so much a cost savings as an architectural feature to tie contexturally the two facades together."

The addition features a glass wall along it's entire east face, affording a beautiful view of Lake Michigan. The water in the whale habitats extends right up to the glass, creating an illusion of an almost endless water-filled horizon. The roof sets back three times, and each setback features a vertical skylight, letting even more natural light into the exhibit hall. It is these setbacks that require the trusses to have a decreasing depth.

Complex Geometry

The semi-circular design of the building, along with the necessity for a highly engineered mechanical system, resulted in a complex structural system. "The entire structure is built around the life support system for the whales," explained Harold Erickson, S.E., project engineer with Rittweger and Tokay. "Nothing was repetitive; everything had to fit around the system."

For example, the filtration tank mass was so great that there couldn't be completely uniform column placement, said Bill Rittweger, S.E., of Rittweger and Tokay.

The drawings were laid out on a computer, and then a cartesian grid was laid out in the field. "The columns rotate on the radii of the structure itself, except for the perimeter glass wall," Erickson

said.

"There is very little repetition in the roof structure," Erickson said. For example, almost every purlin has a different dimension. Likewise, due to the curving east wall, each truss is a different size.

The structure has a wood roof deck that steps down in a sawtooth fashion to accommodate vertical skylights. The trusses slope in a uniform plane for 115', decreasing in depth from 14' at the west end to 8'. From that point, a constant 8'-deep truss extends to the perimeter wall. The architects required the fascia to be nominally 8', which in turn limited the truss depth to 8' on the east perimeter.

K-bracing was supplied at the top chord of the trusses to provide lateral support for the trusses.

900 Tons Of Steel

Erection of the steel structural system was complicated by site restrictions. "There was no place to store the trusses on site, so everything had to be carefully sequenced with the fabricator," explained Herbert Smith, regional manager with Broad, Vogt & Conant, Gary, the project's steel erector. The steel fabricator was AISC member Zalk Josephs Fabricators Inc., Stoughton, Wisc.

The trusses were delivered to the site in two or three pieces, depending on their length, and field assembled. "These were long and heavy clear span trusses," Smith said. The assembly included the diagonal bracing between the trusses and vierendeel trusses across the top chords of the clear span trusses," Smith said. "The job was built in the wintertime, in a downtown area, on the lake where the wind blows constantly." Steel erection took 3½ months, beginning in late December 1988. General contractor on the project is Pepper Construction, Chicago.

The project used A36 steel, except for the columns and truss chords, which are A572-Grade 50. Each truss weighs approximately 25 tons. For the most part, the connections were all water-tight welds to exclude salt-laden atmosphere. The roof deck is laminated stained cedar.

Because of the corrosive salt-water environment in the building, the steel was painted with a special coating from AISC associate member Tnemec. The steel received two primer coats at the shop and a finish coat on site. "The steel was left exposed both because it would have been very expensive to cover it and so the trusses can be periodically washed and inspected," Tassone said.

And, of course, it was left exposed as a beautiful architectural element which was carefully crafted to complement the beauty of the aquarium's marine inhabitants and artificial rocks and rainforest. □

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The GSA distribution facility in Palmetto, Georgia is large enough to hold 29 football fields.

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Improved Earthquake Performance

Eccentrically-braced frames are economically competitive due to reduced foundation costs and better seismic performance

Because the developer demanded a Class-A appearance, the architect of Charleston Place chose to design two steel-framed L-shaped buildings instead of a more typical "cookie cutter" tilt-up concrete structure. The L-shapes also allowed greater window space without creating a monolithic appearance.

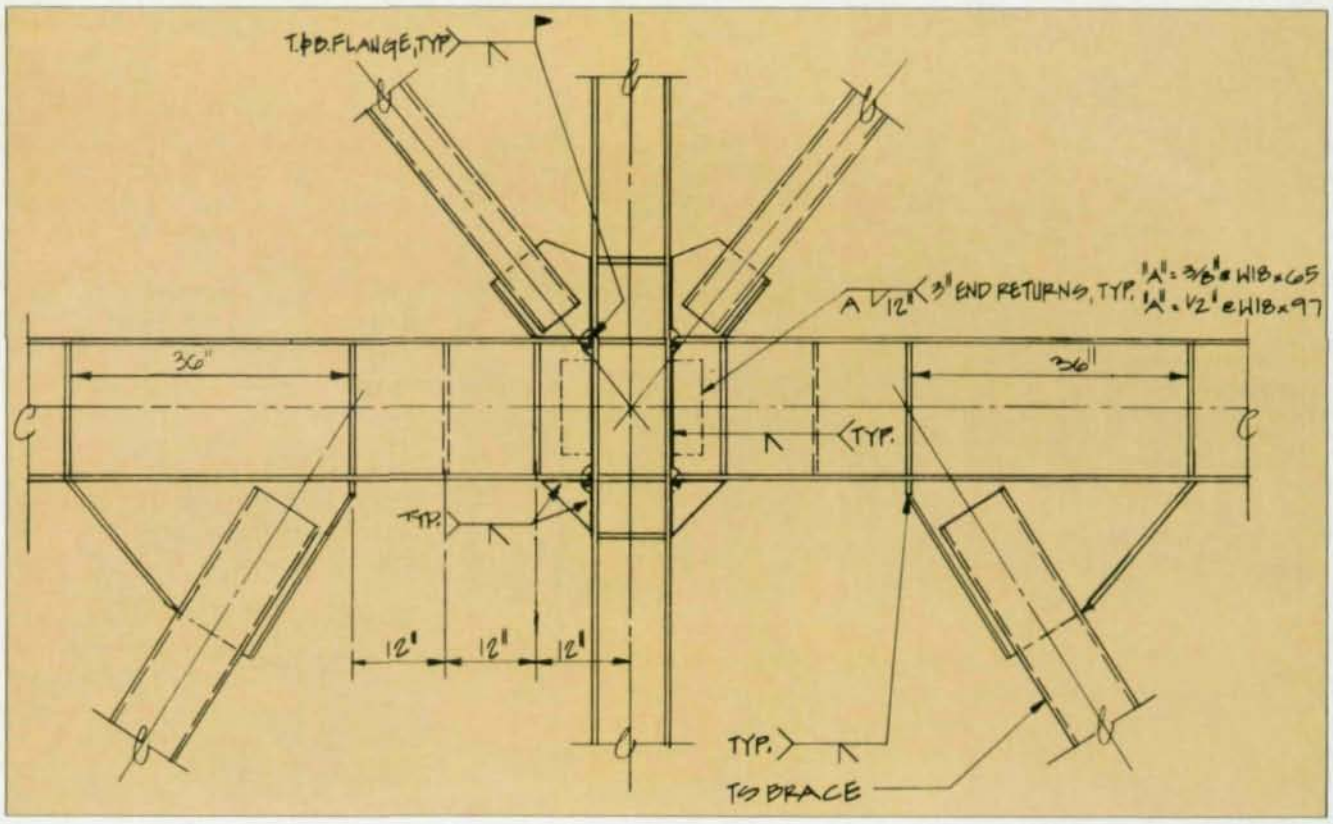
While most of the older low-rise office buildings in the area are tilt-up concrete, both the architect and the structural engineer of a new office complex in Mountain View, Calif., were determined to build steel-framed structures.

The framing system was crucial to the development of Charleston Place, which consists of two L-shaped buildings totalling 127,000 sq. ft., because The Mozart Development Co., the project's developers, wanted a Class A office center.

Better Quality Than Tilt-Up

"We were looking for a building that was a higher quality than the norm for the area," explained Gordon McDonald, AIA, the project's architect with Habitec, Inc., San Jose. "The area has a lot of tilt-up concrete speculative buildings," explained Tom K. Chan, S.E., regional manager with EQE Engineering, San Francisco, the project's structural engineer. "In order to market the building, we needed something approaching the San Francisco standard for Class A space."

"The options were steel or tilt-up concrete," McDonald explained. "We wanted more versatility in appearance than you could get with tilt up. The finish quality is higher, and the amount of glazing we wanted fit better with a steel-framed structure than



with a tilt-up building." The buildings are clad in precast panels.

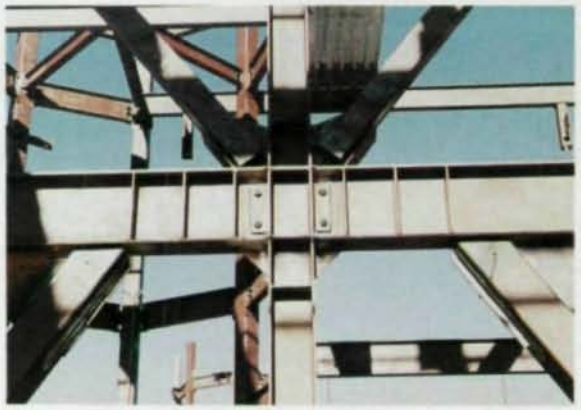
The siting of the two buildings also enhanced their appearance. The architect designed two-story L-shaped buildings both to break up the mass of the structure and to optimize the perimeter wall area. "An elongated rectangle would give the same perimeter space, but wouldn't have fit on the site," McDonald said. Also, the L-shape allowed the architect to create a center plaza.

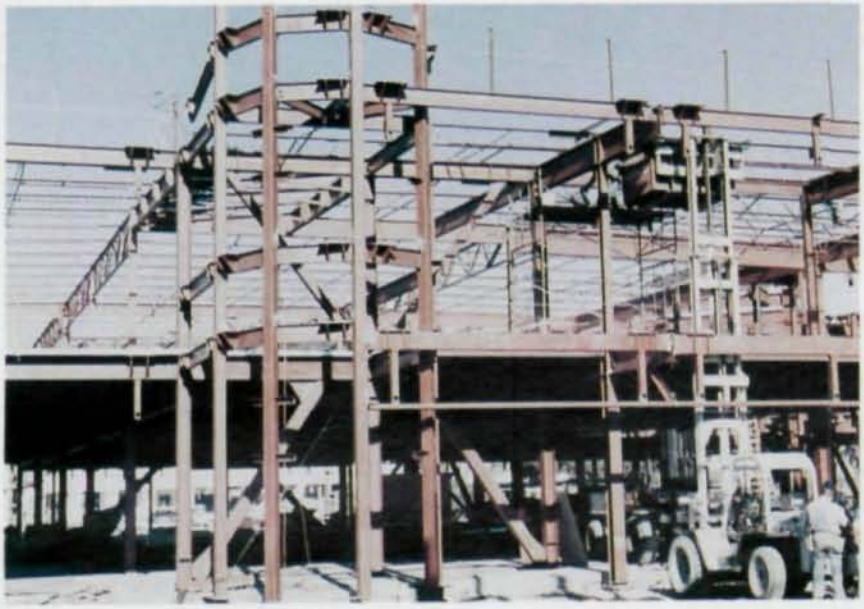
Eccentrically-Braced Frame

Mozart was very familiar with EQE's work from several post-design reviews the structural engineer had performed for them. As a result, EQE was brought into the project very early. "This allowed us to work very closely with the architect and resulted in a better performing building," according to Chan.

Because of the structure's siting in a seismic area, EQE recommended using an eccentrically-braced frame (EBF). "With eccentric bracing, the braces are spread apart, and the center lines

With an eccentrically-braced frame, the braces are spread apart and the center lines don't meet at a point. By connecting each bracing member to the beam a short distance from the beam-to-column connection or from another beam-to-brace connection, the ductility is greatly increased. Pictured above and top right is the framing situation where space was allocated for doorways and windows. Pictured bottom right is a more typical EBF connection.





The roof of the structure is composed of a steel deck supported by open-web steel joists and wide-flange girders. Because the building occupancy did not require fire-proofing the steel members as long as a sprinkler system was provided, it was more economical to use steel joists for the gravity loads. However, since wide flanges outperform steel joists in the lateral system, all of the collectors and perimeter beams are wide flange girders.

don't meet at a point—they miss each other by 1' to 3'," Chan explained.

By connecting each bracing member to the beam a short distance from the beam-to-column connection or from another beam-to-brace connection, the system's ductility is greatly increased. Each building has six EBFs for lateral resistance.

"Eccentrically-braced frames move the failure point to the beam, beam yielding is more predictable," he explained. The frames' stiffness and strength were adjusted to allow the buildings to react to seismic forces essentially without torsion.

Minimizing Torsional Forces

"By strategically placing the frames and adjusting their stiffnesses, we could reduce the torsional forces to a minimum," explained Stephen K. Harris, S.E., project engineer with EQE. "We

were able to place the frames in the optimal location because we were brought into the project so early and because of the great cooperation between our office and the architects'."

"An EBF is much better for resisting earthquakes than a concentrically-braced and is not much more expensive," Chan said. The reason for the higher cost is because of the code requirements for more extensive detailing. EBFs have additional stiffener plates and more full-penetration welding, however, the braces tend to be the same size as in conventional chevron-braced frames. "There's more engineering and more welding at the connections," Chan explained. "Also the beams are somewhat heavier and there are more complex connections."

Chan estimated that designing an EBF added less than 5% to the framing cost. However, this higher framing cost was recouped by a lower foundation cost. "An EBF produces lower lateral design forces than a concentrically braced frame," Chan said. "There's about 80% of the lateral force design requirement compared to a conventional system." As a result, the foundation didn't require any drilled piers, which would have been expensive due to the shallow water table at the site.

The cost of the building shell was approximately $45/sq. ft. The structure used 834 tons fabricated steel.

Reduced lateral force requirements for EBFs were first introduced in the 1988 UBC, which was not yet in effect in the city of Mountain View when the project was designed. EQE obtained special permission from the city to design using the new code to take advantage of the reduced loads.

The roof of the structure is composed of a steel deck supported by open-web steel joists and girders.

The rounded corners were created by placing small beams between the columns and hanging the precast cladding on the beams. The beam-column connections are provided by shear tabs welded to the columns and bolted to the beams.

The second floor is a steel deck with concrete fill, also supported by open-web steel joists and girders. The span requirements of the floor members are 30' to 36'.

Joists For Gravity Loads

"We used joists instead of wide flanges because they were more economical," Chan said. "Joists perform just as well for gravity loads. They don't perform as well in the lateral system, so all of the collectors and perimeter beams are wide flange girders."

The joists were economical because the building code in that area doesn't require fire proofing for that type of occupancy as long as the building is sprinklered. "If we had to fireproof the steel, joists would have been more expensive than wide flanges," Harris said.

The steel joists were supplied by Vulcraft, a division of AISC associate member Nucor. Contractor on the project was Devcon Construction, Milpitas, Calif.

An interesting architectural feature of the structure that effected the framing was the use of rounded corners to soften the building's appearance. "We placed tube columns around the perimeter at 45°. We framed small beams between the columns and hung the precast cladding on the beams," Harris said. The beam-column connections are provided by shear tabs. The shear tabs were welded to the columns and bolted to the beams. Small bottom angles also were welded to the columns.

EQE is involved with several other low-rise projects in California that are designed with an eccentrically-braced frame to resist seismic forces. These include North Point Business Park in San Jose, a 110,000-sq.-ft., two-story office building and the Quantum Corporation Headquarters Campus in Milpitas. The Quantum project, which is still in the design stage, is planned to include five one- and two-story buildings—all with EBFs—totalling more than 550,000 sq. ft. □

CALL FOR PAPERS

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Vertical Steel Addition Cures Hospital's Space Woes

The addition's structural system had to be able to minimize heights, meet a tight construction schedule, and come in on time and on budget

By Stephen J. Sopko, P.E., and Susan Benjamin

A four-story vertical addition was added to the existing three-story, 65,000-sq.-ft. main building of Ellis Hospital in Schenectady, N.Y. The sawtooth glass-clad area shown above was built over the main entrance. Because the structural system in this area was not adequate to support a vertical expansion, this section of the addition needed to be cantilevered.

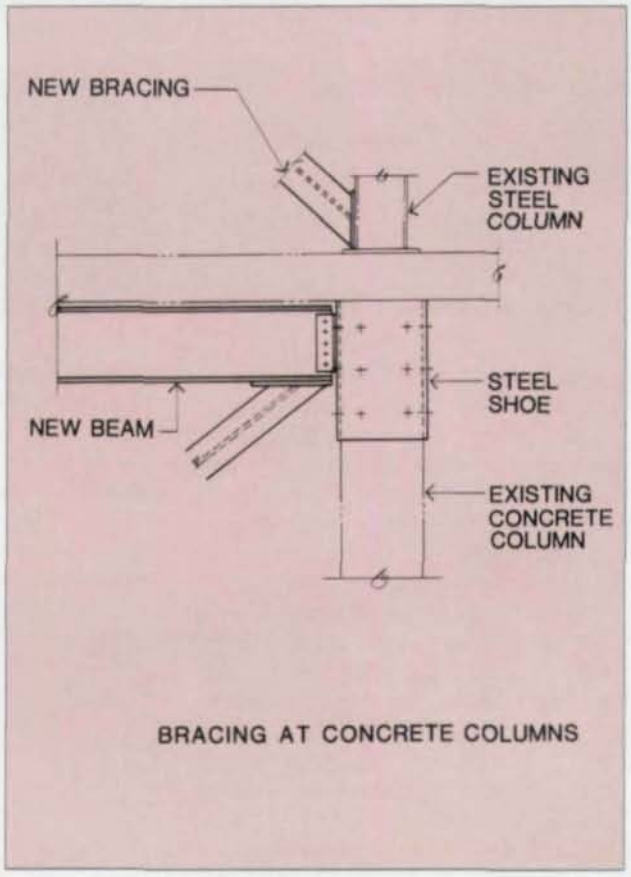
As the needs of its community increased during the past century, Ellis Hospital in Schenectady, N.Y., continually expanded. By 1984, though, it had become obvious that further growth was limited by the surrounding buildings and streets.

Since additional room was still needed, a plan was developed to add a four-story vertical addition to the three-story, 65,000-sq.-ft. main hospital building. The tight site, and the tight timetable, combined to make steel the obvious choice for the building's structural system.

The Clinical Services Building, which was constructed in 1976, was a steel-framed, three-story structure with concrete-slab on metal deck floors. The building is supported by caissons extending to rock. When the building was designed, some allowances were made for a possible future expansion, but these efforts were severely restricted by budgetary constraints. For example, the lateral bracing system incorporated into the lower floors of the original construction was not adequate for the building extension. A feasibility study determined that the caissons and building columns were capable of supporting additional floors, though the number of additional floors varied by location.

Over the operating theater, the vertical expansion had to be limited to one additional floor due to caisson capacity. The structure is on a 25' sq. grid and the caissons

The main limiting factor to vertical expansion was the lack of a lateral bracing system. At the ground floor level, the bracing was incorporated into the existing concrete columns and slab. Steel beams were added below the slab to act as compression members. Steel diagonal members were connected to the existing concrete columns with steel shoes.



BRACING AT CONCRETE COLUMNS

on alternate bays had excess capacity. In order to add an additional floor, the new roof would require 50′ spans. Two other sections could be expanded four stories, however, while a fourth section over the entrance couldn't support any additional stories. Due to architectural requirements and the hospital's needs, though, this area needed to be expanded, so a new structural system was designed for the space.

In the final scheme, one section was expanded for the full allowable height, while only one floor was added on the other section. The columns and new roof slab were designed to allow for future vertical expansion, however. Project architect was Einhorn Yaffee Prescott, Albany, and general contractor was the Schenectady office of Turner Construction Co.

Lateral Bracing

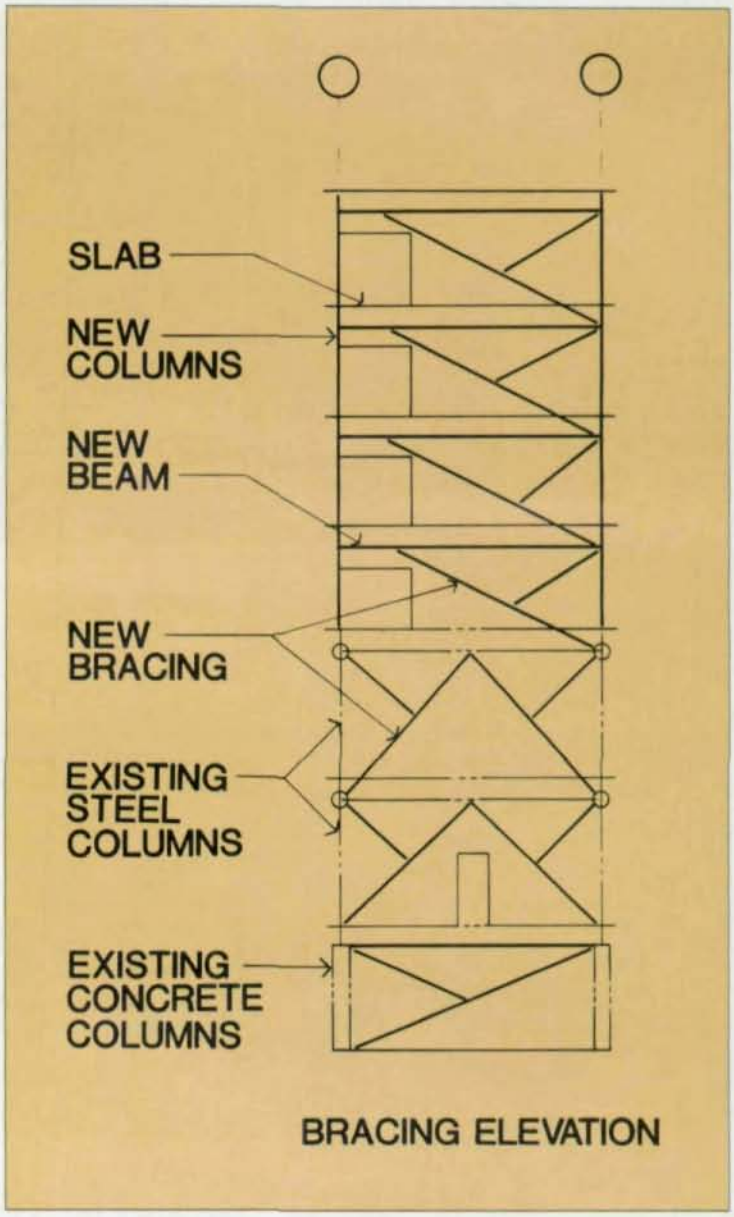
The main limiting factor to vertical expansion was the lack of a lateral bracing system in the original building that could accommodate the lateral loads from the wind and seismic forces of a seven-story building. Another concern was that the existing building had to remain in operation with minimal disturbances during construction. The length of time needed for construction also was critical as the hospital urgently needed the additional space.

In addition, mechanical ducts, piping, and conduits needed to be coordinated with the architectural concept and structural requirements. Floor-to-floor heights were limited by the need to mate the new addition to the existing elevator core.

Regardless of these problems, it was crucial that the new framing system meet a variety of critical requirements, including: economizing the cost; meeting a tight construction schedule; minimizing the load of the new structure on the existing columns and caissons; and minimizing the floor-to-floor height.

The system selected was a steel-framed structure with a

The most complicated aspect of the project was incorporating a bracing system in the new and existing structures to resist wind and seismic forces. However, the number of locations and the configuration of the bracing was limited because it was crucial that the floor not be disturbed or limited. A scheme of eccentric compression bracing along with inverted "V" bracing was used to avoid mechanical runs, doors, and windows. Pictured above is a steel brace placed in the existing building against the concrete frame.



lightweight concrete slab on metal deck utilizing composite steel beam design. Because of fire code considerations, steel joists could not be used. A 5¼" slab was used to maintain a two-hour fire rating for the floor structure. The steel beams were fireproofed and spaced 9′ on center.

For the 20′ spans, 12" beams were used; for the 25′ spans, 14" beams were used. Also, 24"-deep girders spanning up to 30′ were supported on 12" columns. The exterior veneer was supported by a relieving angle at each floor. A36 steel was used for all of the members except the columns, which required Grade 50 steel to minimize sizes.

This system allowed the building envelope to be completed within nine months, during which time hospital operations were not interrupted.

Eccentric Bracing

The most complicated aspect of the design was incorporating a bracing system in the new and existing structures to resist wind and seismic forces. The number of locations and the configuration of the bracing was limited, however, because it was crucial that the floor use not be disturbed or limited.

A scheme of eccentric compression bracing along with inverted "V" bracing was used to avoid mechanical runs, doors, and windows. At the ground floor level, the bracing was incorporated into the existing concrete columns and slab. Steel beams were added below the slab to act as compression members. Steel diagonal members were connected to the existing concrete columns with steel shoes.

Each bracing location was unique with very little repetition, especially in the existing structure. The bracing was placed in the existing portion as the steel frame was erected to save time.

The framing over the main entrance needed to be cantilevered.

As previously noted, the section over the entrance needed an addition even though it was not rated for vertical expansion. An analysis determined that retrofitting would be prohibitively expensive, so instead a framing scheme was developed where this section of the building was cantilevered with moment connections from the new structure. The concrete slab also was designed as a cantilever with the steel being shored until the concrete reached design strength.

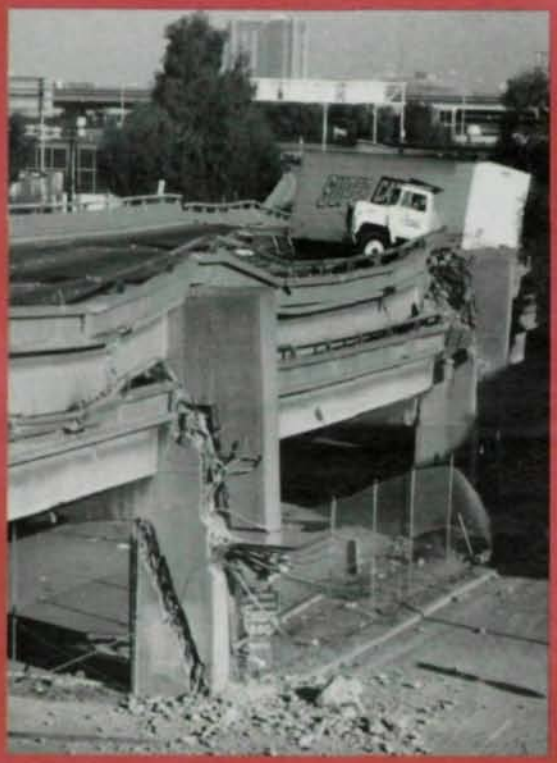
In addition, tube columns were placed between the floor levels to tie the structure together. However, the tube columns did not continue to the existing level.

For mechanical coordination, holes 13" x 30" were placed in the new steel girders for duct runs. Numerous penetrations were required in the existing concrete decks, which required the existing framing to be analyzed and reinforced. At the same time, due to the partial composite design, live load deflection was held to L/1000, or just over ¼". The new steel was connected to the existing columns at the interface with the existing elevator core.

Stephen Sopko is an associate with Ryan-Biggs Associates, P.C., Troy, N.Y. and Susan Benjamin is the firm's marketing manager. □

Cypress Viaduct, Oakland, CA,
Completed 1957

October 17, 1989



Photograph: Tom Levy/San Francisco Chronicle

June 17, 1990

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San Francisco-Oakland Bay Bridge
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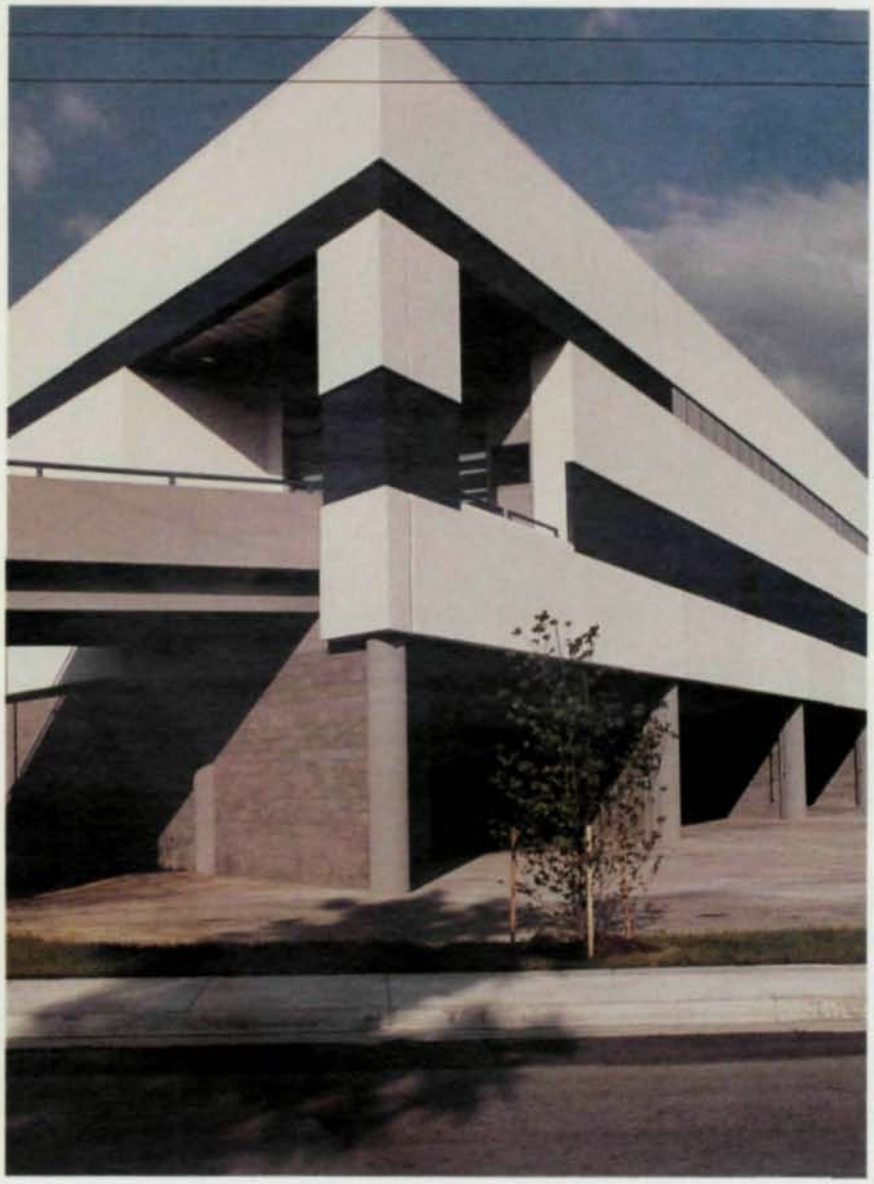
Overcoming Obstacles



Because it hoped that its new maintenance and parking facility would spur additional development in an economically depressed area of the city, the Greater Roanoke (Va.) Transit Co. wanted a design with some pizzazz. The steel-framed building is clad with a composite insulated system with the appearance of sugar-cubed precast concrete. Photos by David Jones/Hayes, Seay, Mattern & Mattern

Public policy dictated the placement of a new bus facility on an otherwise undesirable site

By Michael N. Biscotte, P.E.

Despite poor soil conditions, a poorly configured urban site, and periodic flooding, the Greater Roanoke (Va.) Transit Company (GRTC) was determined to build a new maintenance and parking facility for their bus fleet in an area that needed new economic development.

GRTC operates a bus fleet for public mass transit in the Roanoke Valley. Previously, the bus maintenance was performed in an inadequately equipped and poorly ventilated garage facility, while parking was outside on paved lots. Office and administration functions also were inadequate. A study determined that a new or renovated facility was crucial to adequately maintain their existing fleet; provide subcontracted maintenance for private bus clients; provide covered parking; and have a centralized office and administration core.

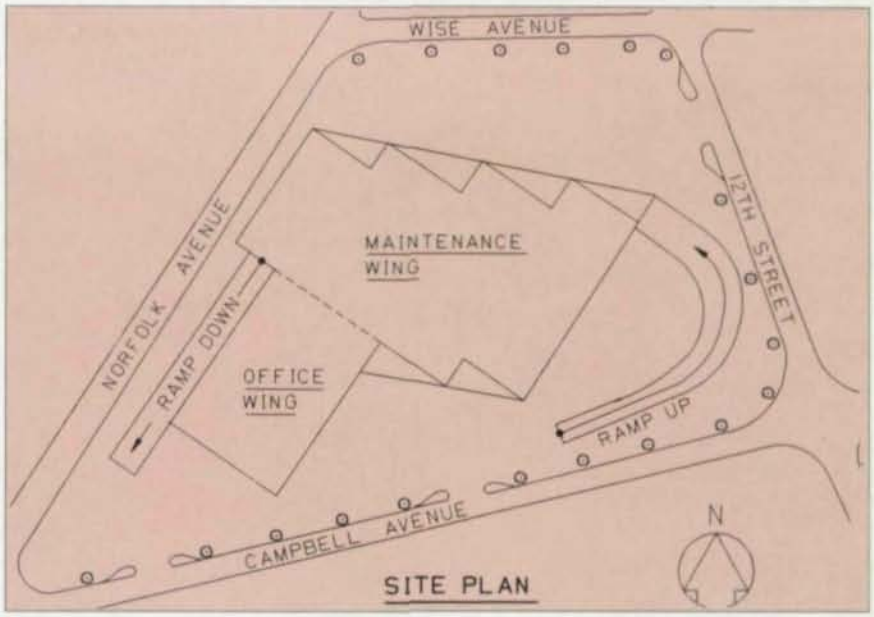
The agency first investigated renovating its existing maintenance building. But this was deemed unsuitable because it would require significant structural modifications and extensive ventilation and environmental considerations, all of which would have greatly escalated the project cost. Next, the agency investigated renovating a nearby old horse barn on a site adjacent to the existing

maintenance building. This approach, however, also proved unacceptable, again mostly due to the costs involved in completing the required structural modifications.

Although neither of these alternatives proved cost-effective, GRTC was determined, as a matter of public policy, to preserve their presence in the southeast area of the city. As a result, the agency decided to raze the old horse barn and build the new facility on that site.

Site Constraints

Unfortunately, the site was not ideally situated for its new use. The site is narrow and triangular, which made it difficult to orient the building to allow a smooth traffic flow. Also, at grade level the site is approximately 8' below the flood plain, which meant that all occupied spaces had to be located on the upper level, while the ground floor could only be used for parking. Therefore, in addition to providing easy entry and exit, the building's orientation had to allow for bus ramps up to and down from the maintenance facility on the second floor.



Because the site at grade level was 8' below the flood plain, the ground floor could only be used for parking. Framing sizes ranged from W8 x 24 for the lightest columns to W30 x 99 for the heaviest girders. The 75,000-sq.-ft. project used 550 tons of steel.

The upper level is divided into two basic areas: an office wing and a maintenance wing, each of approximately 20,000 sq. ft. The 40,000-sq.-ft. lower level is almost exclusively parking for buses and cars.

The mixed occupancies on the upper level imposed varied occupant and vehicular loading conditions and equipment requirements on the structural framing system. To meet all of these usage and site requirements, a rectangular maintenance wing, angled away from a rectangular office wing, was designed for the building footprint.

Foundation Considerations

Ground conditions varied throughout the site, but basically consisted of fill and refuse materials on top of relatively weak soil layers, with competent limestone below.

Both steel pile foundations and large spread footings on select fill were considered. And even though pile driving in the dipping rock beds of the Roanoke Valley can be difficult, this method was determined to be superior to shallow spread footings. Using spread footings would have required an expensive layer of select fill on top of questionable bearing materials.

Steel Framing System

Due to the unusual building geometry, the difficult foundation conditions, and the variable-loading considerations, the project's structural engineer, Hayes, Seay, Mattern & Mattern, Inc., Roanoke, selected a steel framing system. Structural steel's flexibility with respect to both adverse geometry and varied loading conditions, along with its inherent weight advantages, proved to be a cost-effective solution to these problems.

The basic gravity-load-resisting system consists of 3"-thick concrete fill on 3" composite steel floor deck in the office area, and an 8"-thick concrete slab in the shop area. Composite steel beam and girder construction is used in both areas for stiffness and economy. The basic lateral-load-resisting system consists of moment-resisting fixed frames in the north-south direction and steel angle cross-bracing in the east-west direction.

Lateral forces consist of wind loads, seismic loads, bridge cranes, and flooding waters. Bracing could only be used in the east-west direction because of the office layout requirements and, more importantly, because of the open parking areas on the lower level. Two masonry stair towers also were utilized for lateral resistance, and several "tension" piles were employed to transmit the lateral loads from the masonry walls to the foundation system.

The member sizes for the beams, girders and columns ranged from W8x24 for the lightest columns to W30x99 for the heaviest girders. The 75,000-sq.-ft. project used 550

tons of steel, or 15 lbs. per sq. ft. The structural steel cost $750,000, or $10 per sq. ft., and the steel piles added another $360,000. Steel fabricator was AISC Member Owen Steel Co., Inc., Gastonia, N.C.

Connection Design

Due to the magnitudes of the member forces and the sizes of the members, the connection design proved to be extremely critical, particularly for the fixed-frame moment connections. Complete joint penetration field-welded flange plates were used for the beam-column moment connections, as bolted end-plate moment connections proved to be too massive and expensive. Shear connections were shop-welded and field-bolted single-plate and double-angle standard shear connections.

Because of the critical nature of the welded moment connections, the contractor, Branch and Associates, Inc., Roanoke, elected to use only one welder to perform all moment connection weldments. While this approach on the nearly 300 linear ft. of welding was slower than using multiple welders, it served to ensure the quality of the most critical welded connections on the project. As an additional precaution, all field-welded connections were specified to be tested by either radiographic or ultrasonic nondestructive test methods.

GRTC did not want a mundane "industrial" metal siding appearance for the facility, since it is hoped that this project will help spur additional development in a relatively economically depressed area of the city. Instead, it was decided to use a composite insulated panel facade. This facade system consists of a composite fill and finish system applied over rigid insulation, which is then adhered to gypsum sheathing and attached to frames of structural metal studs and runners.

The facade system has the appearance of sugar-cubed precast concrete, but has much more flexibility and approximately one-eighth the weight. The individual panels were fabricated off-site in shop conditions to control their color, finish, and curing. The exterior color scheme, which consists of alternating bands of blue and white, was chosen to match the color of the GRTC buses.

Michael N. Biscotte was the lead structural engineer on the project for Hayes, Seay, Mattern & Mattern, Inc., Roanoke, which also was the architect and civil engineer for the bus maintenance and office building.

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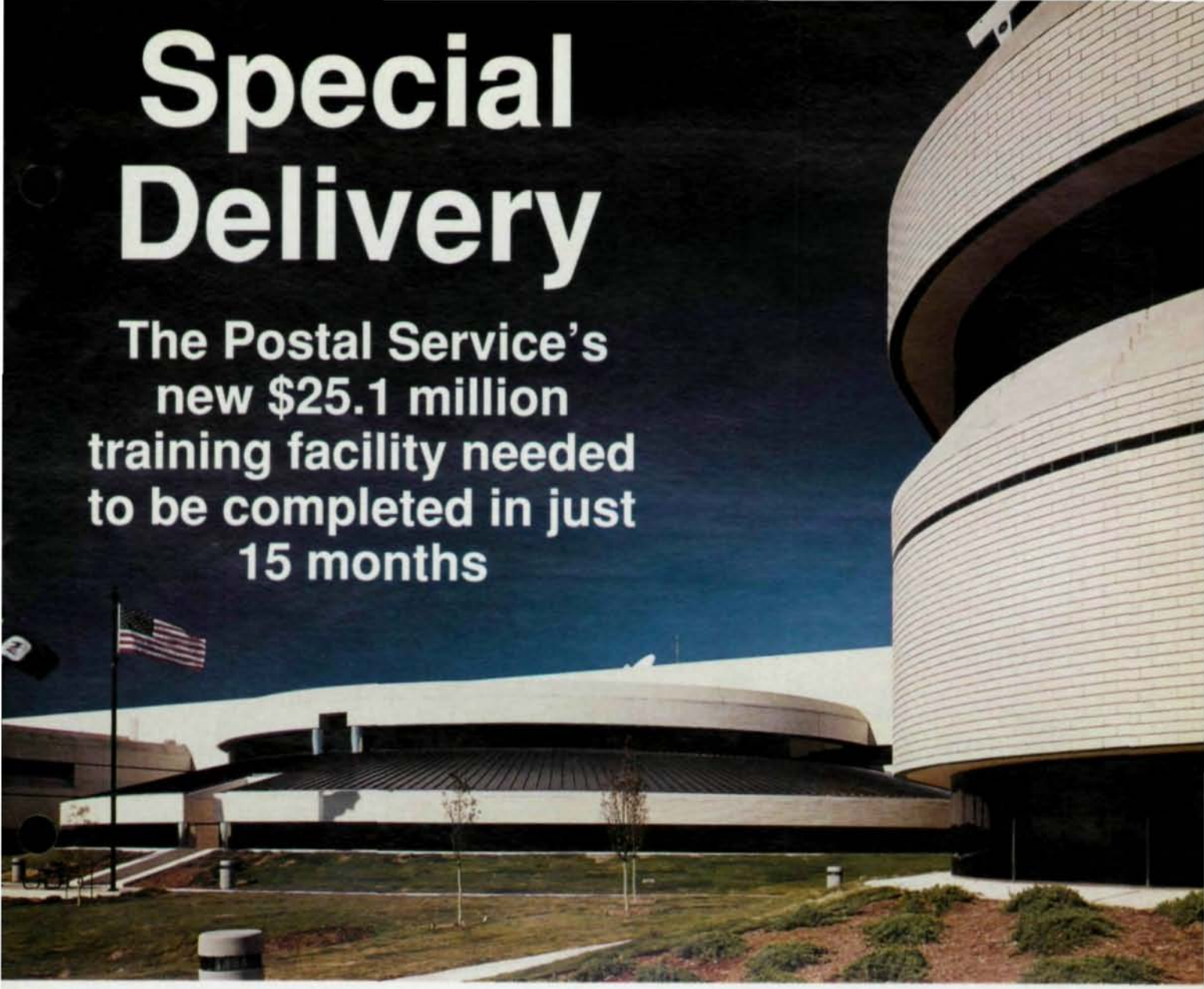
Special Delivery

The Postal Service's new $25.1 million training facility needed to be completed in just 15 months



By Jim Ladesich

In 1989, the United States Postal Service (USPS) delivered more than 161 billion pieces of mail. In an effort to hold down costs as the volume of mail continues to increase, the USPS during the past 15 years has increasingly turned to automated processing and sorting.

These changes demand a highly-trained workforce, a mission now consolidated in a $25.1 million USPS Technical Training Center in Norman, Ok. Previously, the Postal Service leased space in a variety of buildings in and around Norman. However, a cost analysis showed that the USPS could better perform its training task at a lower cost in a unified setting.

HTB, Inc., Oklahoma City, Ok., was selected as the project's architects and civil engineers. The building needed to accommodate the latest environmental/data-processing/telecommunications technology while also being energy efficient and fully accessible to the handicapped. In addition, the USPS required that the design be a departure from the often "drab" look that characterizes many federally-funded facilities. "The USPS wanted the building to look some-what high-tech, though they still wanted it to look slightly conservative," explained Larry J. Keller, AIA, HTB's director of design.

HTB's design for the 291,000-sq.-ft. structure responded both to the USPS's program criteria and to

The project's most difficult design element was the semi-circular administrative center. The circular design resulted from the architect's desire to maximize the amount of perimeter space The circumferential shape results in a tremendous amount of torsion. To deal with the problem, bridging was introduced at the quarter points to relieve the torsion in the beams. Photo by Jon Peterson Photography

The $25.1 million USPS Technical Training Center in Norman, Ok., has a structural steel frame clad with glazed brick and horizontal bands of tinted glass. A moment resisting space frame was chosen for the project because it was more economical than concrete construction and had better vibration characteristics than a bar joist system.

Oklahoma's climatic extremes. Located on a 15-acre campus, the facility contains administrative, instructional and student spaces in a series of interconnected modules. The six primary modules are connected by a 500'-long, 20'-wide central spine—a "Main Street" for pedestrian traffic.

Two-story training wings are located on each corner of the structure, with the administrative structure and the student center sandwiched between on either side of the central spine.

The corners of the structure, where student lounges were installed, are rounded in part to soften the facility's bulk. "Also, we felt that a curve was appropriate for the space," Keller added.

In addition, the curves reflect back to the central administrative area, which is curvilinear in form. "The administrative section is office space instead of instructional space. Since it has a different function that the rest of the complex, it made sense to express that portion of the building somewhat different than the rest," Keller said. "Also, everyone wanted a view to the outside, and with a circle, you get much more perimeter space and a view in two directions."

For programmatic reasons, the upper floor of the administrative area is substantially smaller than the lower floor. The roof of the lower level, where it extends out from the upper level, is a sloping metal standing seam system. "A gravel roof would have detracted from the view from the second floor," Keller said. The sweeping circular form also incorporates a continuous band of horizontal glazing.

Economic Framing System

A structural steel frame, clad with glazed brick and horizontal bands of tinted glass, provided the most cost-effective solution. Steel delivered the clear spans needed for flexible interiors and best accommodated the anticipated floor penetrations, according to Wesley

Britson, P.E., deputy director of structural engineering at HTB.

HTB also considered cast-in-place and precast concrete, but both were rejected as too expensive. In addition, a pan joist system was considered, but it was rejected because of the building's serviceability requirements.

"We wanted a solid floor because of the computer equipment," Britson said. "We needed to keep vibration down so we didn't want a light-weight bar joist system."

Moment-resisting space frame construction is utilized for the lateral load resisting system. Both the training wings and the traffic/utility spine are framed with ASTM A36 structural steel. Nominal bay spacing is 25' x 31' 6". "A moment-resisting frame was an architectural consideration," Britson explained. "X-bracing would have interferred with the desired wide-open spaces and windows. We needed a lot of flexibility in design because there are not a lot of permanent walls. Also, approximately 80% of the floor is raised access to accommodate the computer and other equipment."

The connecting spine is isolated from the training wings with double-column expansion joints.

Floor framing is composed of a composite concrete slab system with 5¼" of lightweight concrete integral with a 2"-thick, 20-gage composite steel deck. Floor beams spanning 31' 6" are typically W18 x 35 on 8' 4" centers. Floor girders span 25' and are W24 x 76. Construction depth at the girders is 2' 5¼" and at the floor beams is 1' 11¼".

The roof of the training wings and connecting spine also is steel framed. The framing supports open-web steel joists on 5' centers. Over the joist is a 1'5⁄16", 20-gage vented formed steel deck supporting cellular concrete.

The project's most difficult design element was the curvilinear administrative center. Framing for this portion of the building consists of WF columns and W8 x 13 beam rolled to a radius conforming to the roof's geometry.

The six primary modules are connected by a 500'-long, 20'-wide central spine.

"The semi-circular space required a lot of analysis to make it work properly," Britson said. "It's a true geometric shape with no surface irregularities. The biggest problem is making sure the beams are rolled to the proper radius. The key to making the curved roof is that the rolled beams are circumferential."

The beam to girder connections are 6" WF welded to radial girders. The rolled beams are bolted to the 6" WF.

"When you do a circumferential building, you induce a tremendous amount of torsion," Britson explained. "We induced bridging at the quarter points to relieve the torsion in the beams. The trick is to put enough bridging in the space to eliminate the torsion but still allow the beam size to remain small enough that the fabricator can roll them circumferentially."

The administrative area has an 18 degree arc, which results in interior bay spacing of 19' and perimeter bay spacing of 27' 4".

When the project went out to bid, the USPS requested bids for both a 21-month schedule and a 15-month schedule. After considering the cost of their current leases, the Postal Service opted for the "Special Delivery" 15-month schedule.

"The fast-track schedule meant that there were a lot of different trades working at the same time in a tight area," said Ronnie Peace, project manager with Flintco, Inc., the project's Tulsa-based general contractor. Gilbane Building Co., Providence, was the project's construction manager.

Horizontal courses of glazed brick provide a low-maintenance skin with enough density to combat heat and cold infiltration. Accenting bands of tinted glass provide a visual contrast to the beige masonry. The glass is dark enough (14% transmission of visible light) to prevent excessive brightness and glare in the office areas. Also, deep sills were designed as a "light shelf" to reflect ambient light off the perimeter ceilings where it is then carried deep into the interiors by large interior glass re-lites.

Jim Ladesich is a free-lance writer and marketing consultant based in Kansas City and specializing in architecture and construction. □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Tight Site

Building a large movie theater underneath an elevated roadway created unique construction challenges

Building a 10-screen theater complex under an elevated highway could have been an aesthetic disaster, but through careful material selection, the architects managed to create an attractive and popular recreation center.

St. Louis Union Station's huge popularity as an entertainment drawing card has created a not-so-unusual problem for an urban area: A lack of space for further development. The answer for the designers of a neighboring 10-auditorium theater complex was to capitalize on the theater's lack of a need for a view, which allowed it to be "tucked away" beneath an elevated highway structure.

The unusual siting for Union Station Cinema was mostly due to the premium land values in the area, explained John Guenther, AIA, project designer with Mackey Associates, St. Louis. The steel-framed building is 302' x 165' and can seat 2,300 people.

Because of the site constraints posed by highway above, traditional steel erection techniques could not be utilized. Since there was no access from above, a crane could not be used to lower the steel into position. Instead, the steel was hoisted up from below with a hydraulic jack.

The highway's four piers extend through the theater's lobby (top). To eliminate any vibration, the piers were isolated from the theater's structural system.

The steel-framed entrance canopy (above and right) reflects back to both the nearby train shed's butterfly canopies and the highway overhead.

The Missouri Highway Department reserved easements both horizontally and vertically so that the overpass structure would remain accessible for inspection and maintenance at all times. The structure's height was therefore limited to 23' 4". "We provided for additional loading on the roof so the highway department could come in with their maintenance equipment when needed," explained Melvin Young, P.E., project manager with Engineering Design & Management, Inc., St. Louis, the project's structural engineer.

The roof itself is 4"- to 8"-thick concrete (depending on which auditorium it covers) on metal decking to minimize noise problems, and the exterior walls are double thickness concrete block. Below this deck, the auditoriums have two ceilings. The upper ceiling is a gypsum board layer hung from acoustical isolating supports, above which is 11" of thermal/acoustical insulation. The lower ceiling is an acoustical ceiling tile that also is hung on acoustical isolating supports. And above the lower ceiling is 3½" of acoustical insulation.

In addition to providing support for the highway's maintenance equipment, the roof's steel joist structural system is designed to support exceptionally heavy snow loads. "We designed for live loads of nearly 100 lbs. in case during snow removal from the roadway the snow was dumped onto the building's roof," Young explained.

Because of the siting, four of the highway's concrete piers extend through the theater's lobby. To eliminate any vibration, the piers were isolated from the theater's structural system. The space between the piers and the roof is closed with rubber booting material.

"The highway has a very shallow curve in it," explained Guenther. "The process of defining exact points was a bit complex. By using a CADD program we were able to come up with a drawing describ-

ing exactly where the easements were."

Given its location next to a famous train shed and beneath a highway, transportation became a logical architectural theme. A large steel-framework entrance canopy was created that both resembles the train shed's butterfly canopies—which were at one time used for boarding trains—and also alludes to the structure of Highway 40 above, explained Guenther. The building's light and dark bands of gray brick relate to the concrete deck of Highway 40, as well as the broad-based nature of the train shed.

The theater is part of a three building complex known as Power House Place. Also recently completed is the office building portion of the complex. The building rests on the foundation of the old power house from which the complex gets its name. "The old building was in such terrible condition that it was more economical to tear it down than to attempt to repair it," Guenther said.

The Power House Office Building is a braced steel frame with 24'-column spacing. "The unusual part of the project was using the existing foundation," Young said. To distribute the building's concentrated loads, a 2'-wide x 4'-deep bolster beam was added to the foundation and the new steel columns were connected with anchor bolts.

"The office building needed to fit into a historic context," Guenther noted. "It has the same footprint as the original building, and has a gable roof. We did add an additional story, however, and a 'notch' in the south end for an elevator lobby and to orient the building correctly. A lot of people think it's the original building."

The third building in the complex is currently out for bid, and will also be a steel-framed building. The new building will have 20' column spacing and will feature an exposed steel truss that will support a barrel vaulted roof that architecturally reflects back to the Union Station train shed. □

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At the same time, the Institute wishes to convey its apology and express its appreciation to those whose patience was tested during the delay in receiving a manual. We sincerely apologize to you for our inability to service each and every one of you on a personal and timely basis during this past year.

Our commitment is to serve the industry. New orders are now being processed in a timely manner. General delivery is 3-4 weeks for book post, 2-3 weeks for UPS. Please refer to the AISC Publications List for information on ordering the Ninth Edition and other publications available through AISC.

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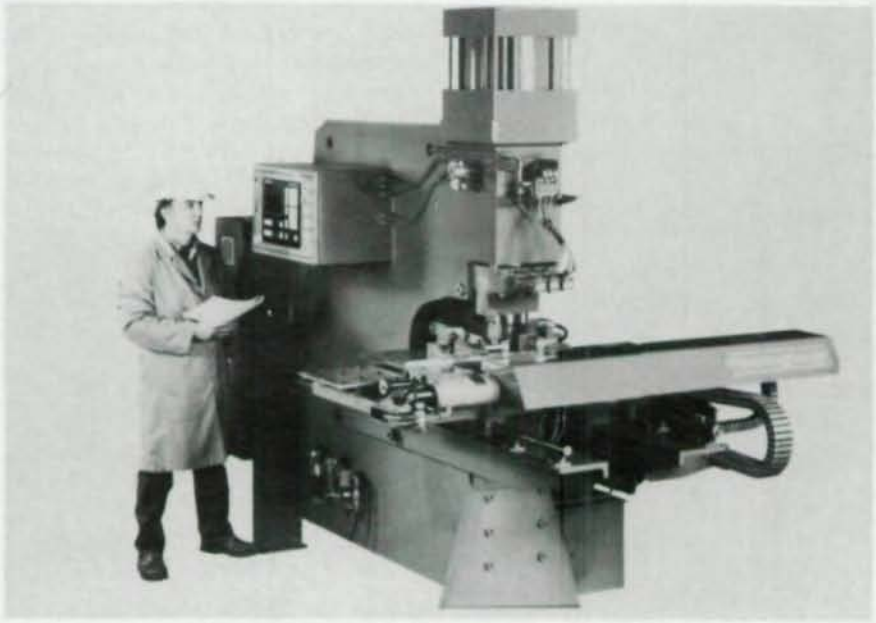

Peddinghaus

A totally integrated CNC system to drill and burn steel plate is now available. This two axis CNC system positions the plate in the X (length) axis and the drill heads and Oxy Fuel torch in the Y axis. The simultaneous movement of both axes not only eliminates the layout of holes, but also provides the capability to burn contours in the plate.

Peddinghaus is sponsoring an "Oktoberfest" open house for steel fabricators September 24 through October 5, 1990. Highlighted will be automated processes for beam, angle, channel, and plate fabrication. In addition to Peddinghaus, a variety of steel detailing companies will exhibit their products, including Design Data, Lincoln Electric, Dogwood Technologies, Geometric Data Flow, Mountain Enterprises, SteelCad, Steel Solutions, and Structural Software.

For more information, contact: Peddinghaus Corp., 300 N. Washington Ave., Bradley, IL 60915 (815) 937-3800.

Behringer

The company's expanded product line now includes the HBP-530/1100G and HBP-800G Heavy Duty Miter Bandsaws. The former cuts beams up to 19.6" X 43.3", while the latter cuts beams up to 19.6" X 31.5". With a fixed datum line and center rotation point in line with the backfence, there is no need for excessive material handling. Manual or motorized angle setting and length measuring provides simple to highly sophisticated semi-automatic horizontal bandsaws for the structural industry.

For more information, contact: Behringer, Inc., 6775 Inwood Dr., P.O. Box 1989, Columbus, IN 47202 (812) 342-2336.

Kaltenbach

Two new models have been added to the manufacturer's line of circular cold saws. The HDM-1000 and the HDM-1400 structural saws are designed for use in a "tandem system" with the firm's structural CNC drill. Unique design features include a traveling saw arm and fixed datum fence to insure maximum capacity of cutting range. New saws include miter cutting, opti-feed, and vertical clamp. Options include CNC control for 89 cutting angles and the FABCUT software package.

For more information, contact: Joseph A. Dick, Exec. VP, Kaltenbach, Inc., 6775 Inwood Dr., Columbus, IN 47201 (812) 342-4471.

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Harrington

The new Peerless LB Lever Hoist has capacities ranging from 3/4 to 9 tons. With a rugged steel housing, it has the quality components to handle a variety of industrial and construction jobs. The combination of double reduction gearing and a 15 degree recovery stroke allows for precise spotting a minimum effort for raising or lowering of the load.

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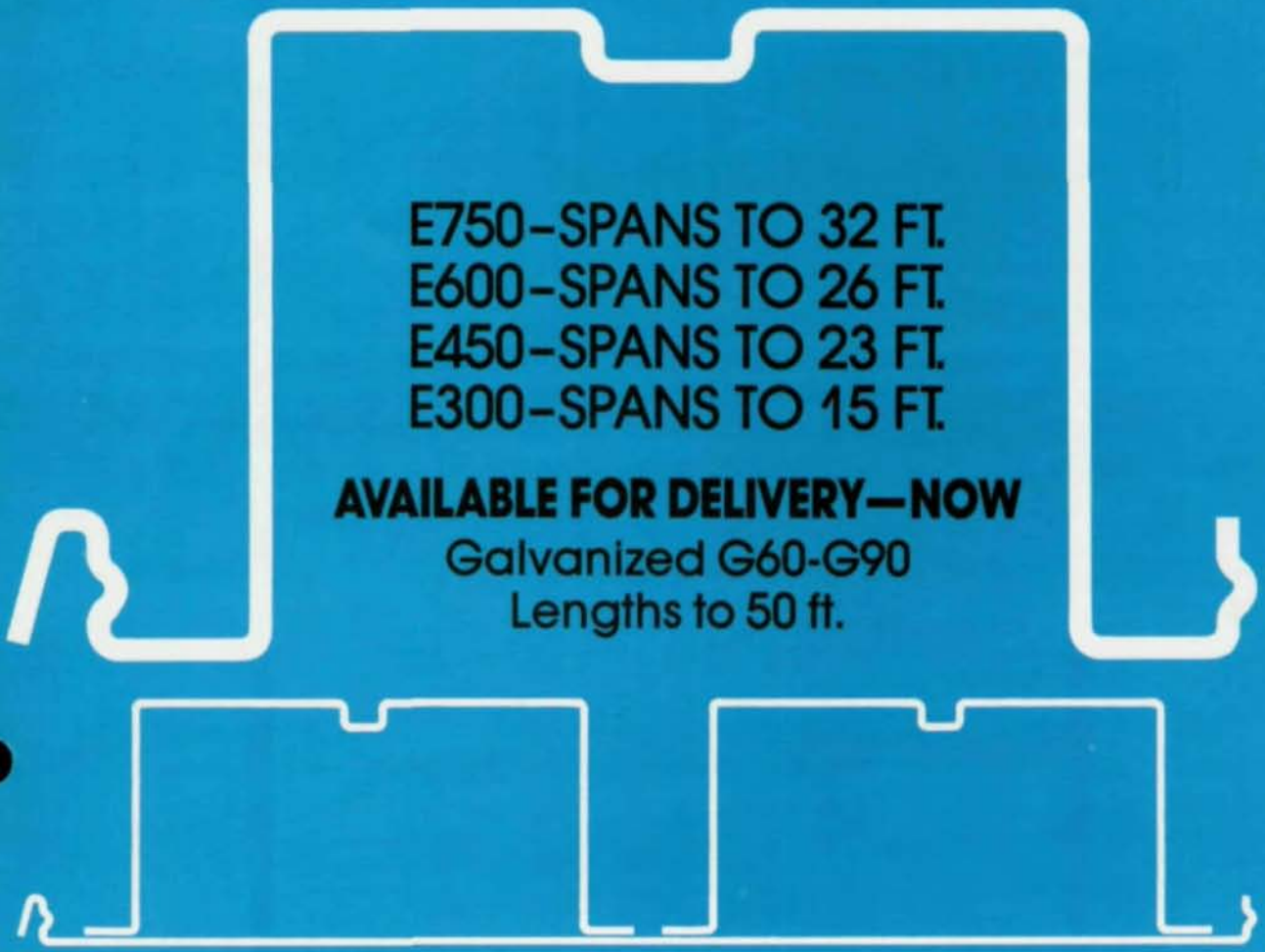

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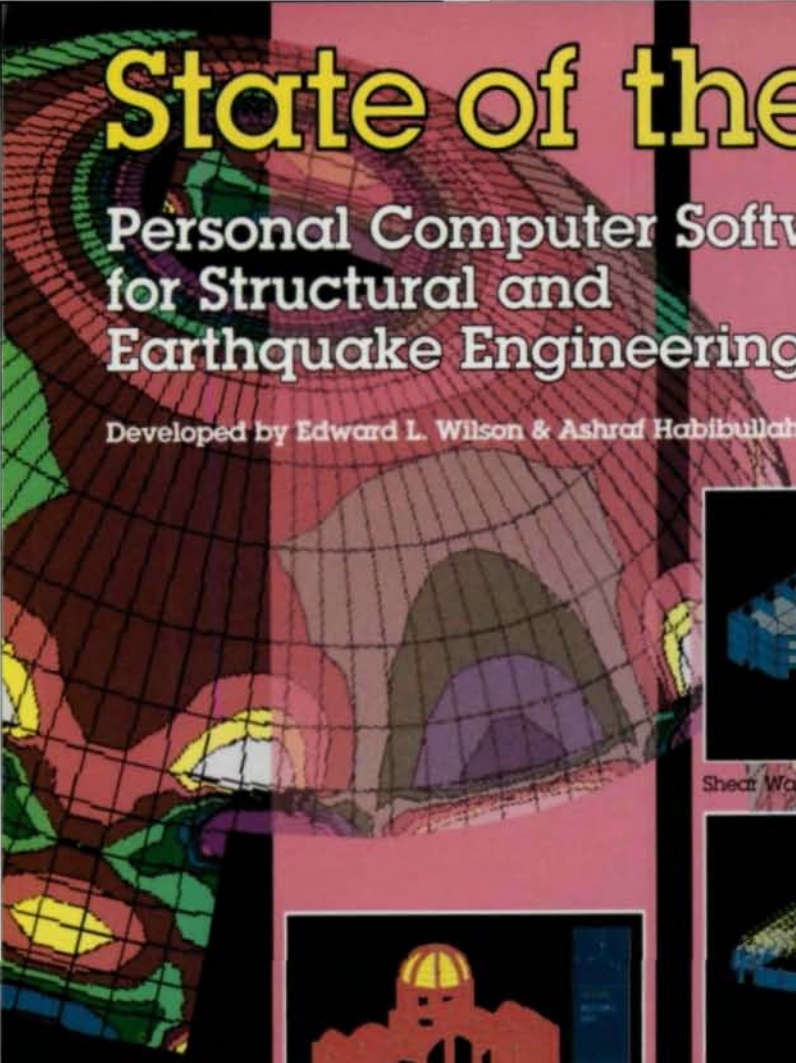

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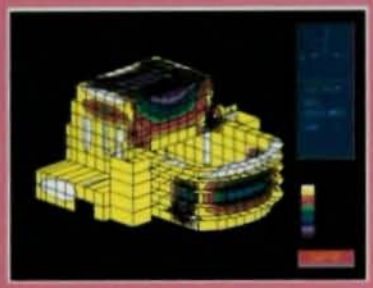

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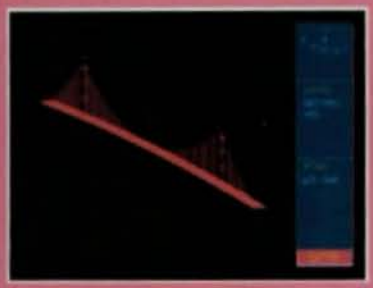

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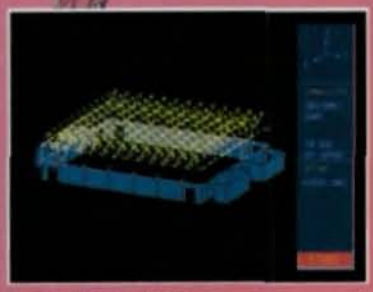

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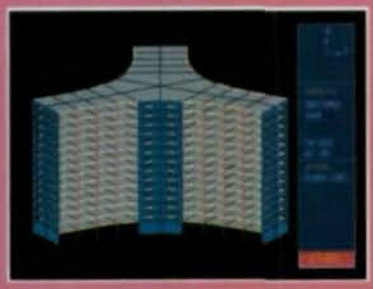

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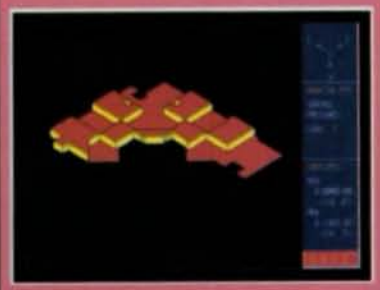

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