LIGHTWEIGHT BRIDGE & SIDEWALK DECKING

New Products, New Designs, New Test Findings

by Gene Gilmore

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Presented By:

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INTRODUCTION

An obvious requirement for movable span structures is the need for lightweight deck and sidewalk systems. The lesser dead loads of lightweight deck systems help reduce the requirements for the mechanical systems and counterbalancing.

The object of this paper is to provide the engineer/owner with the latest up-to-date information on lightweight decking. The products, which are shown in figure 1, to be examined are:

> 1) Exodermic" - (thin reinforced slab composite with unfilled Steel Grid System); 2) Half Depth Grid reinforced Concrete Decking; 3) Aluminum Orthotropic Bridge Decking; 4) Open Steel Grid Designs (successful designs as a result of fatigue testing); and 5) Orthotropic Sidewalk Decks with Abrasive Surface.

In recent years, there has been considerable testing on many of the above products, and some of those results will be presented in this paper. For budgeting purposes, expected in-place costs have also been developed to assist in product selection and project estimates.

LIGHTWEIGHT BRIDGE DECK ALTERNATIVES

To organize and rationally present this portion of this paper, the product alternatives will be presented in decking weight categories. Those weight classes are: 1) 45 - 60 pounds per square foot; 2) 20 - 30 pounds per square foot; and 3) under 20 pounds per square foot.

45 TO 60 POUNDS PER SQUARE FOOT

The decks under this weight category are the Half Depth Grid Reinforced Concrete Decks and "Exodermic" Decking (thin reinforced slab composite with unfilled Steel Grid System).

Half-depth Grid Floors, (figure 2), have been in use since the 1950's. At that time manufacturers, in an effort to reduce even further the lightweight enjoyed by the Full-depth Grid Slab, designed a special rolled I-beam shape with an intermediate flange that permitted placement of the forming material approximately in the middle of the cross-section. Generally, all flush filled grid reinforced concrete decks should be overlaid, or an integral overpour of concrete should be placed above the grid plane to provide a smooth riding surface.

However, on movable span structures, the luxury of an overlay is not generally considered due to dead load constraints. Therefore, it is important to utilize a flush-filled grid that can provide the highest quality riding surface. This is achieved by using a grid which has tertiary diagonal members in addition to the standard rectangular patterned conventional grid system. The diagonal members main function is to reduce the opening between surface bars and greatly limit the "cupping" of the concrete between bars as the grid wears. Without the diagonal members, "cupping" of the concrete will occur (after many years of service), and provide a very rough and undesirable ride. Also, as the concrete surface wears, the open grid pattern will eventually cut through, and the diagonal bar will greatly reduce the tire "sway" and "tracking effect" which is common with the rectangular patterned grids.

The "Exodermic" deck is a recent innovation in grid variations.

Shown in figure 3, this modification does not require a wearing course. Its 3" or 4" composite concrete overlay is a wearing course in itself. This innovation was developed in the 1980's and was extensively tested by the Fritz Laboratories of Lehigh University. Its unique structure is a miniature T-Beam composite cross section. The neutral axis of this variation is located near the top of the steel grid. In positive moment, the concrete is in compression while the steel grid is in tension. Also, welds on the steel grid are located near the low stress area of the neutral axis. The slab is connected to the grid by shear studs, and also by an elevated grid bar that penetrates about 1" into the slab. Because of all these positive design features, the Lehigh University study stated, "...that an infinite in-service fatigue life can be expected...".* While Full-depth and Half-depth grids can be either precasted or poured in place, the "Exodermic" grid type is supplied only as a precast deck slab. Because of its composite design, see figure 4, "Exodermic" decks have very long span capabilities which can reduce the amount of structural steel required in the supporting structure./1/

<u>20 TO 30 POUNDS PER SQUARE FOOT</u>

This weight category has three (3) designs to be considered. These three (3) designs offer the designer/owner, in the author's opinion, the best options for lightweight decks on movable spans.

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* Daniels and Slutter, "Behavior of Modular Unfilled Composite Steel Grid Bridge Deck Panels", Lehigh University, Jan. 1985, page 21.

These options are: 1) Aluminum Orthotropic Decking; 2) Riveted OpenGrid Bridge Flooring (R/W Grid); and 3) Heavy Duty Open Grid Flooring with Diagonal Bars (5" 4 way HD Grid).

Let us examine the features each of these designs offer.

The Aluminum Orthotropic Decking shown in figure 5 has many advantageous design features. This system features a structurally strong, lightweight (20 - 25 pounds per square foot) aluminum deck panel, shop fabricated from highly corrosion resistant aluminum alloy plates and extrusions, along with a durable, skid-resistant, shop applied polymerconcrete wear surface. This system offers certain unique advantages toward a cost-effective and efficient bridge deck rehabilitation program. In a recent bridge conference, Mr. Robert Stemler of Alcoa, related the advantages of Aluminum Orthotropic Decking. An excerpt is presented here

> <u>LIGHT WEIGHT</u>
>
> The deck panels weighing approximately 20 - 25 pounds per square foot compare favorably to 100 - 120 pounds per square foot field-constructed reinforced concrete decks. Partially filled grid decks weighing 60 - 80 pounds per square foot are several times heavier than the aluminum panels./2/
>
> Open grid steel decking is comparable in weight to the aluminum system, but many engineers cite rideability, acoustics, weld failure, and through drainage of corrosives as concerns with open grid steel decking. The lightweight aluminum deck offers significant advantages in the following situations:/3/
>
> - Older bridges may be rehabilitated without substantial restrengthening of deteriorated steel and concrete members./4/
> - Live load capacity may be increased./5/
> - Lane additions to existing bridges may be made with minimal superstructure strengthening./6/
> - Lifting mechanisms and counter-weights or movable bridges can be less expensive and energy costs can be lower./7/

RAPID INSTALLATION

Lightweight shop fabricated deck panels with shop applied wear surfaces can be quickly installed with minimum traffic delays and detours. Significant cost savings can be realized from reduction in traffic control. Documented detour costs can be substantially reduced./8/

QUALITY ASSURANCE

Alcoa* is prepared to manufacture and market shop fabricated deck assemblies including polymer concrete wear surfaces. This promises a high level of quality assurance and reliability, excellent control of materials, and fabrication quality utilizing state-of-the-art technology./9/

LOW MAINTENANCE

The corrosion resistant aluminum alloys used in the Alcoa Bridge Deck System assure long structural life with minimum maintenance. The Smithfield Street Bridge deck has been in place for 19 years and many more years of useful life for the aluminum portion of the deck are anticipated. In Alcoa Laboratories testing, some of the epoxy based polymer concretes have exhibited durability equal to or better than portland cement concrete. Some of the wear resistant polymer concrete surfaces have experienced over 10 years of actual service with minimal deterioration./10/

COST REDUCTION

Significant reduction (up to 17%) in total bridge rehabilitation cost may be realized using the lightweight Alcoa Bridge Deck System, due primarily to the reduced need for steel superstructure strengthening. When widening existing bridges, additional lanes can be added with minimal reinforcement of the existing superstructure. Additional cost savings may accrue from reduced traffic control and detour requirements./11/

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* *Now marketed and manufactured by IKG Greulich, Pittsburgh, PA,* in a licensing agreement with Alcoa dated June 22, 1987.

The Aluminum Orthotropic Decking is the only solid/continuous riding surface deck in weights under 45 pounds per square foot, and actually weighing in the 20 - 25 pound category. With skidding and rideability being key elements in accidents and liability claims/insurance, serious consideration must be given to the Aluminum Orthotropic Decking even with its higher cost relative to its weight class partners of welded and riveted open grid flooring.

The only open grids to be recommended after an extensive series of static and fatigue tests recently on six different grid design variations completed at the University of West Virginia by Dr. H. V. S. GangaRao were riveted and 4-way welded (3 3/4" centered main bar) grid systems./12/ Both of those fatigue tested recommended designs are in the 20 - 30 pound per square foot weight class.

The riveted open grid is made up of a series of flat bars (main bars spaced 2 5/16" apart), and connected by a crimp bar that is riveted to the main bars at 5" centers (see figure 6). Riveted bridge decks have a long history (60 years) of use, and have proven to be the most durable of the open grid systems. Its durability is directly linked to its lack of stiffness due to its riveted joint. This "Self Stress Relieving" joint feature was also concluded by the West Virginia University tests./13/ Drawbacks to the products use have traditionally been its higher weight, use of a flat bar rather than an I-beam shape for a main bar, and its field riveted connection between adjacent panels.

Although it has not overcome its weight restriction, (generally 5 - 10 pounds per square foot heavier than lightweight welded open grid systems), it is that weight that contributes to its durability and fatigue life success. The flat bar main bar is not generally considered to be structurally desirable. Not as efficient as the special I-beam shapes, it contributes to weight rather than strength, and concentrates load on a very thin area over the stringer. However, designs are now being perfected utilizing the special rolled I-beam shapes rather than flat bars. Although data, etc. are not available at this writing, designs will be on-line in 1988. (During this conference, a sample of this new design can be seen at the IKG Greulich exhibit booth).

The riveted field connection between adjacent units was always considered cumbersome and costly. It has been replaced by a bolted connection, see figure 7, which is a more efficient and desirable connection.

The third and final design in this weight category is the welded diagonal design with 5 3/16" I-beams @ 3 3/4" centers (5" 4 way HD design). Of the five (5) welded designs tested, only the 5" 4 way HD (24 pounds per square foot), adequately performed under fatigue, (see figure 8). This unique design is the only welded open grid design that has all of its secondary (diagonal bars - distribution bars) and tertiary (diagonal bars) supported at all intersections by a 5 3/16" I-beam main bar. Therefore, all stress in directly transmitted to the main load carrying member which greatly contributes to its superior fatigue performance. Also, the diagonal member acts like a truss to enhance stiffness and load distribution while greatly reducing the effects of "tire tracking" common in rectangular patterned open grids.

15 TO 20 POUNDS PER SQUARE FOOT

This weight class has ben the traditional choice for many movable span bridges. Unfortunately, it is also the weight class of lower performance open grid designs.

Rectangular patterned welded open grids, (see figure 9), have shown the least serviceability and Dr GangaRao's testing verifies this field performance observation. Three (3) different designs in this weight class were studied by Dr. GangaRao, they were:

> 1) 8" main bar spacing (approximately 16 pounds per square foot, rectangular grid); 2) 6" main bar spacing (approximately 19 pounds per square foot, rectangular grid); and 3) 4 way grid 7 1/2" main bar spacing (approximately 18 pounds per square foot, diagonal grid).

By far, the 4 way grid (see figure 10), out-performed its weight class rectangular grid counterparts. The fatigue life (cycles) for the three (3) designs in respective order were: 1) 250,000; 2) 500,000; and 3) 700,000.

The 4 way's 700,000 cycles was equivalent to the 4" main bar spaced rectangular grid which weighs 25 pounds per square foot, (almost 40% heavier)./14/

The clear choice in this lowest weight category is the 4 way grid @ 7 1/2" centers. Not only does it offer the best fatigue life, but it also features the diagonal bar for superior riding quality as compared to rectangular patterned open grids.

LIGHTWEIGHT SIDEWALKS

The newest product on the market is abrasive surfaced steel or aluminum plate, often reinforced by a grid structure to form an orthotropic design (see figure 11).

The older method of coating plate was traditionally an epoxy resin with grit. This coating can be subject to chipping and wear and gets tacky in the hotter weather.

These problems have been resolved by surfacing the plates with high purity molten aluminum spray while simultaneously dispensing aluminum oxide grit in a uniform manner. This metal surface is more durable and not tacky like epoxies, fully corrosion resistant, and the final product only weighs in the 5 - 15 pounds per square foot area. (Samples can be reviewed at the IKG Greulich exhibit).

TESTING

Recent testing on the above products covers three (3) different product groups. They are: 1) "Exodermic"; 2) Aluminum Orthotropic Decking; and 3) Open Steel Grid Decks. This paper will present only the recently completed open grid tests. For those who are interested, the "Exodermic" tests are available from---

Exodermic Bridge Deck Institute
P.O. Box 374
Westwood, NJ 07675
(there is a $20.00 charge)

The Aluminum Orthotropic Decking studies are available from---

IKG Greulich
R. D. #2
Route 910
Cheswick, PA 15024

The testing done by Dr. GangaRao of West Virginia University was both extensive and time consuming (two (2) years). It would be impossible to present all of his test findings, procedures, conclusions, and recommendations in this paper. Instead, an excerpt of his key findings and recommendations will be presented here:

FATIGUE TESTS

Fatigue tests on currently available open steel grid decks at different stress levels, revealed that no crack propagation occurs if the applied stress range is below 10 ksi. As the stress range exceeds 10 ksi, fatigue life decreases. Based on the experimental results, the most significant factor which controls fatigue life of welded grid decks is the spacing of main bars. Considering the same maximum loading range (13k to 29K), fatigue lives and stress ranges for different types of decks used in this experimental research program can be summarized as follows:

Type of Deck	Stress Range (ksi)	Fatigue life (cycles)
4" main bar spac.	13.5	700,000
6" main bar spac.	15.4	500,000
8" main bar spac.	17.3	250,000
4-way grid deck 7 1/2"	20.6	700,000
4-way grid deck 3 3/4"	13.9	no failure
Riveted deck 2 9/16"	15.6	no failure

PERFORMANCE OF RIVETED DECK

Riveted deck tested over a fatigue stress range of 15.6 ksi and 1.5 X 10 6 cycles did not exhibit any cracking. This may be attributed to:

1. The bars of riveted deck have uniform cross section along the length, whereas welded deckmembers have notches, discontinuities,and openings, which reduce the strength because of stress raisers.

2. Riveted decks are more flexible than welded decks under same loading conditions. Furthermore, the riveted connection of the deck is not moment resistant and not as "tight" as a weld deck. Hence, the relative moment of bars produce frictional forces creating damping, and providing longer service life because of the energy absorbtion.

Finally, Dr. GangaRao also concluded that the AASHTO method of load distribution on an open grid system was erroneous, and realistic load procedures need to be developed./15/

EXPECTED IN-PLACE COSTS

Expected In-Place Costs for the various alternatives have been presented in figure 12.

The user must not only consider these costs, but the features of the product (durability, weight and desired riding surface).

SUMMARY

Therefore, selecting a deck product that is right for your project requires more than opening a product catalog. The cost/benefit relationship of these various alternatives must be considered. Some of this information needed to make such a decision has been presented here, but consider consulting a reputable deck manufacturer for assistance when designing your project.

AFTER ALL, YOUR BRIDGES' ONLY DIRECT CONTACT WITH THE RIDING OR WALKING PUBLIC IS ITS DECK!

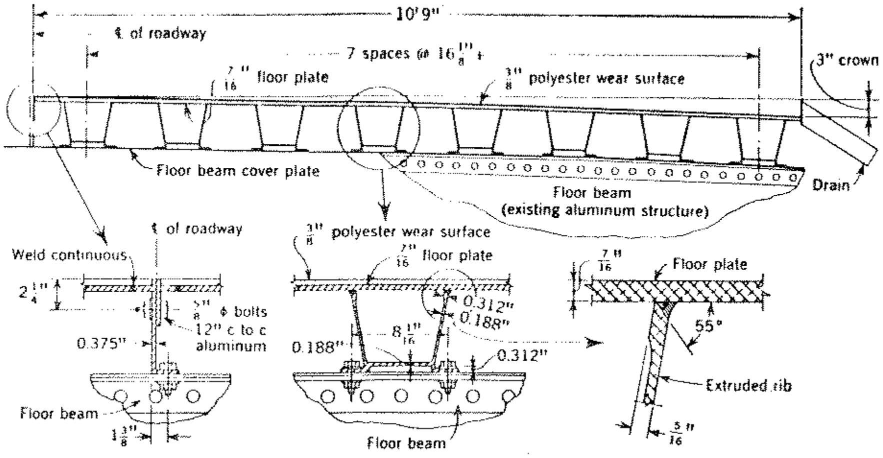
REFERENCES

1. Gene Gilmore. "Steel Grid Bridge Flooring", AISC Conference, New Orleans, LA, April 1987.

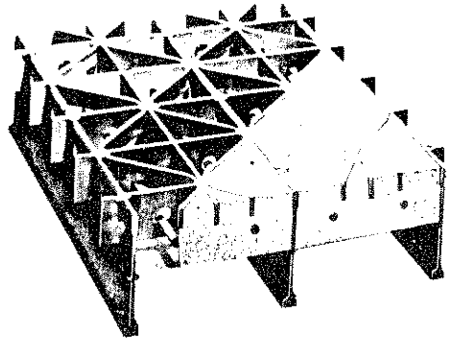
2 - 11. J. Robert Stemler. "Aluminum Orthotropic Deck System", Aluminum Company of America, Alcoa Center, PA, June 1986.

12, 14, 15. Hota V. S. GangaRao, William Seifert, and Hagop Kevork. "Design of Open Steel Grid Decks for Highway Bridges", West Virginia University, Morgantown, WV.

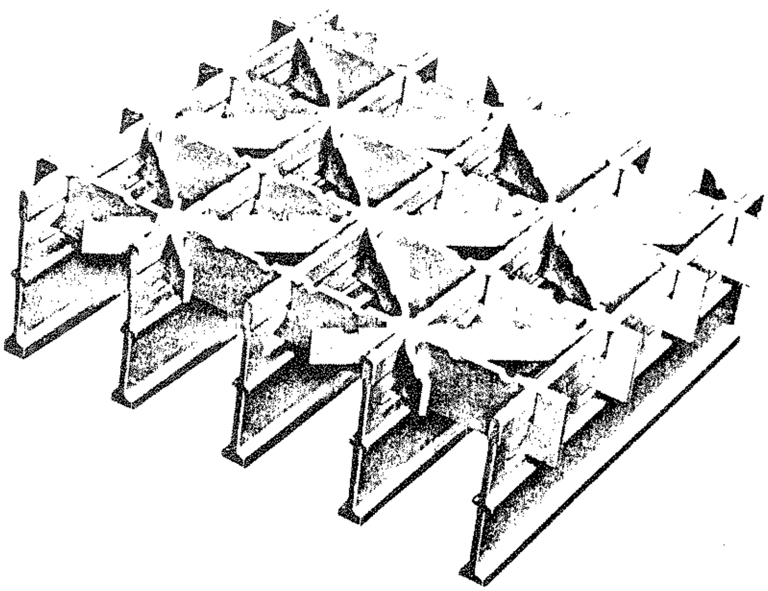
13. Hota V. S. GangaRao, William Seifert, and Hagop Kevork. "Behavior of Open Steel Grid Decks Under Static-Fatigue Loads", West Virginia University, Morgantown, WV.



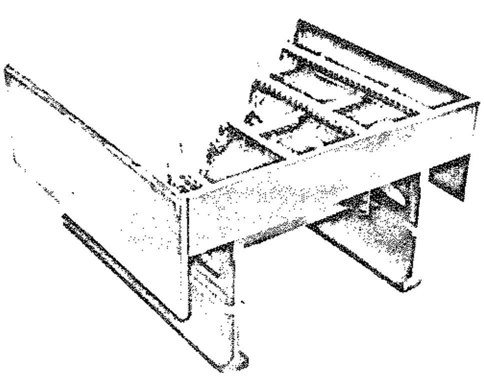
ALUMINUM ORTHOTROPIC DECKING

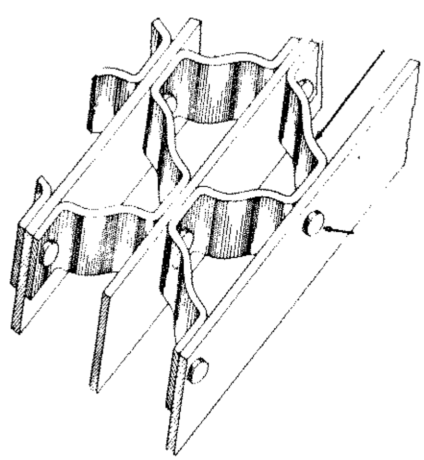


5 inch 4-way Half filled



5 inch 4 way HD





Riveted

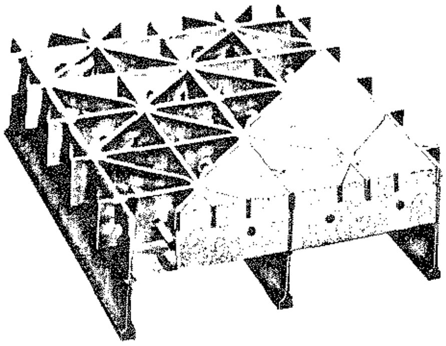
Exodermic

FIGURE 1

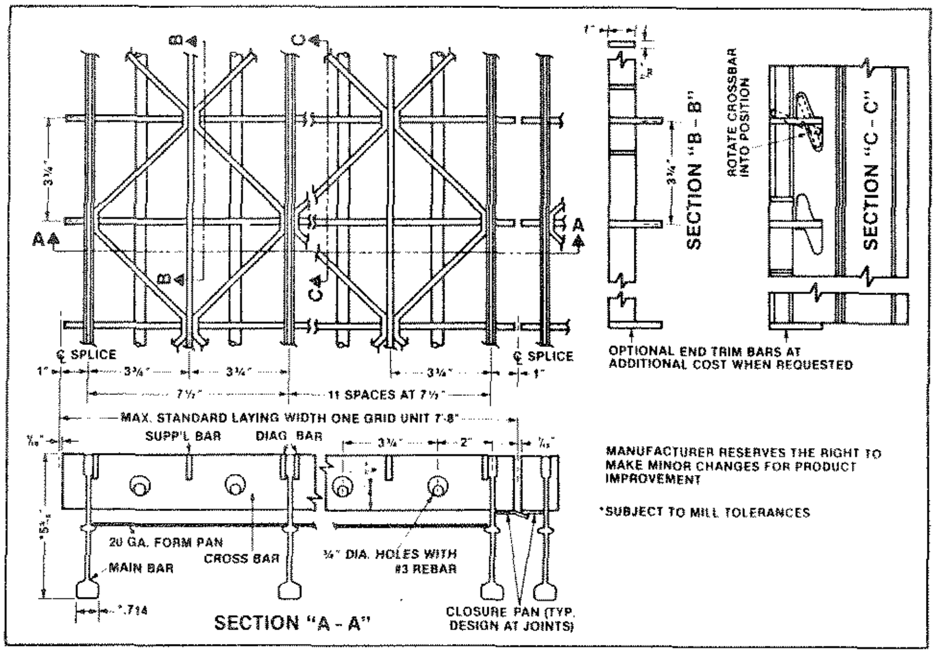
5 INCH 4 WAY™ Concrete-Filled

When concrete is added to the inique 5-Inch 4-Way Steel Grid, the result is a Bridge Flooring System that offers *all of the Open Grid System's benefits* plus maximum load-carrying capacity, rigid construction and economy. The system, with 2½ inches of concrete, weighs less than one-half that of a conventional reinforced concrete floor of equal strength.

5-Inch 4-Way Concrete-Filled may be used in conjunction with 5-Inch 4-Way Open in a combination grid bridge floor system, or where no wearing surface is to be provided.



5-Inch 4-Way may be Concrete-Filled to half-depth, 2½ inches



Suggested Specifications

The bridge flooring shall be 5-Inch 4-Way Concrete-Filled type as manufactured by IKG GREULICH, or equal. The flooring shall consist of panels fabricated of A.S.T.M. __________ (A-36 or A-588) steel in maximum widths of 7'-8"* with Main Rolled Beams 5$^{3}/_{16}$" deep spaced on 7½" centers. Secondary Bars 2$^{1}/_{16}$" x $^{13}/_{64}$" (minimum area) with holes for #3 Reinforcing Bars spaced on 3¾" centers between Main Beams. Reinforcing Bars shall be shop installed. The Secondary Bars shall be intersected by Tertiary Bars 1" x $^{7}/_{32}$" which shall be spaced 3¾" on center with the Main Beams. Diagonal Bars shall be connected alternately at a Main Bar and a Tertiary Bar. A 20 gauge form pan shall be provided between the Main Beams and tack welded in the shop. The Main Beams, Secondary, Tertiary and Diagonal Bars shall be factory welded in accordance with manufacturer's standards. The flooring shall weigh approximately 18.0 lbs./sq. ft.

Finish

A.S.T.M. A-36 steel—areas of panel not in contact with concrete shall have a prime coat, shop applied. A.S.T.M. A-588 steel requires no painting. (Any approved finish may be specified and shop applied).

Concrete Requirements

Half-Depth (2½")—0.0070 cu. yds./sq. ft.
Full-Depth (5")—0.0147 cu. yds./sq. ft.

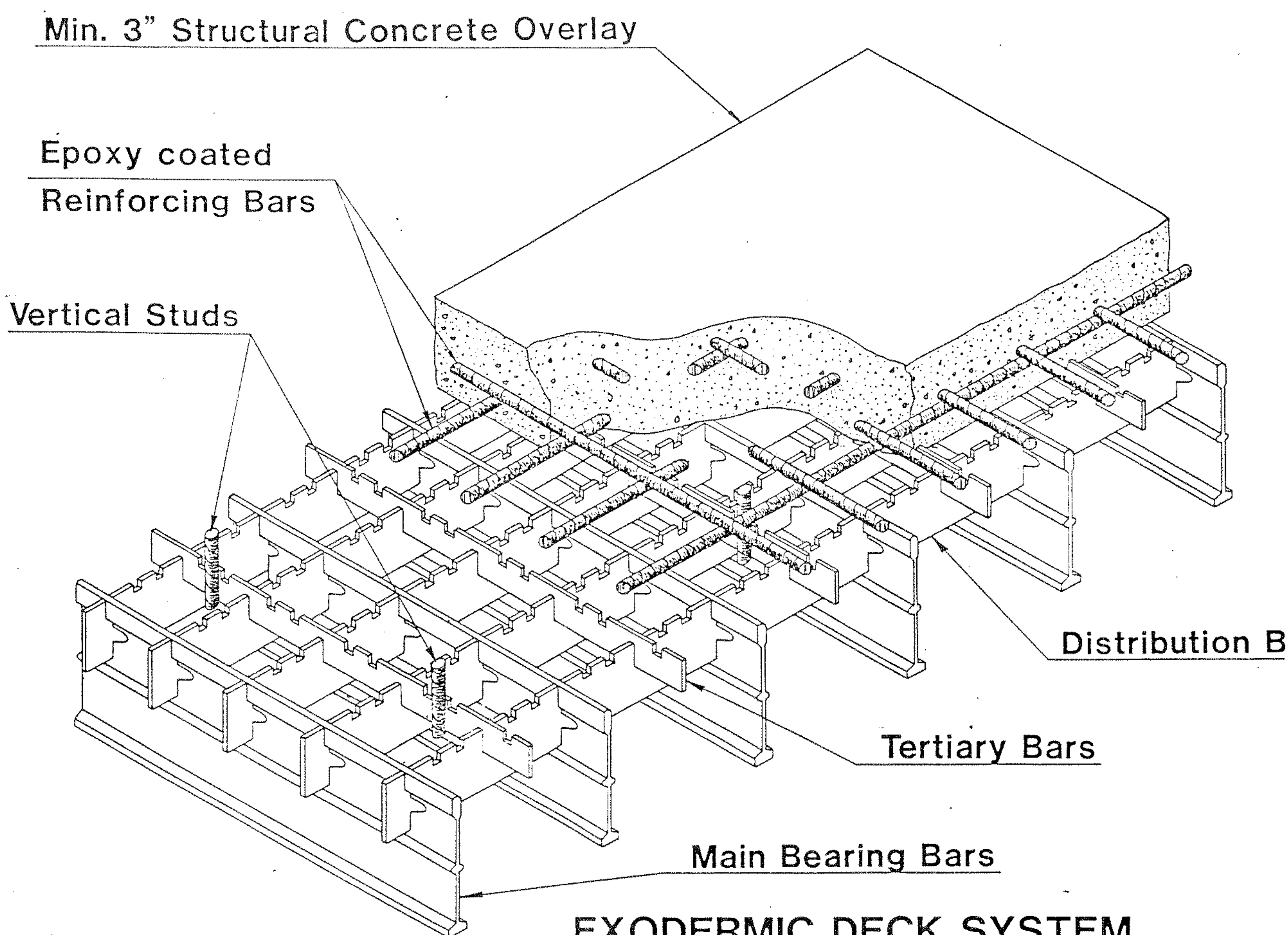
HS-20 Load Table— Half-Depth

Type of Steel	Weight ft²	Sectional Properties				Maximum Span for Allowable Stresses	
		Positive in.³/ft.		Negative in.³/ft.			
		Sc	Sst	Sc	Sst	Simple	Cont.
A-36	44.6	61.75	5.093	4.125	3.351	5'-0½"	6'-0½"
A-588	44.6	61.75	5.093	4.125	3.351	6'-5¾"	7'-9¾"

N = 10 fc = 1,200 psi fs = 20,000 psi A-36 fs = 27,000 psi A-588

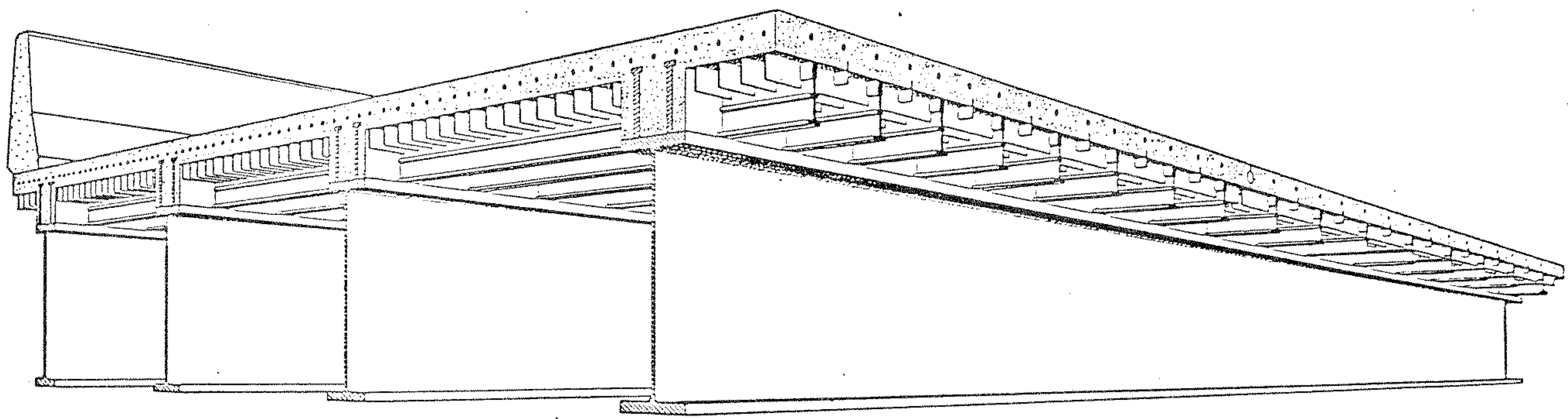
*Narrower units furnished when required at slab ends, transverse joints, or along edges of slabs adjacent to curbs.

FIGURE 2



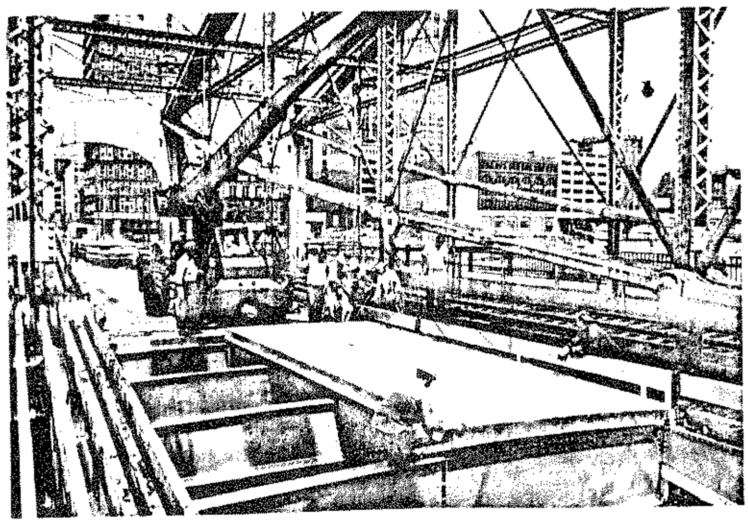
EXODERMIC DECK SYSTEM

FIGURE 3



Exodermic Composite Profile

FIGURE 4



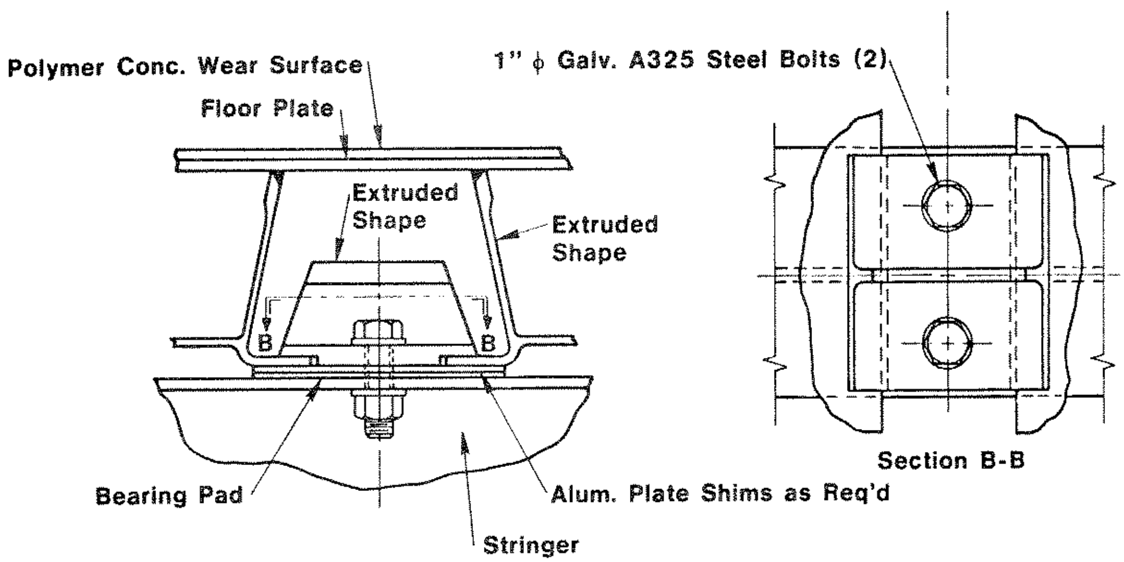


FIG. 5 - Panel Attachment to Stringers.

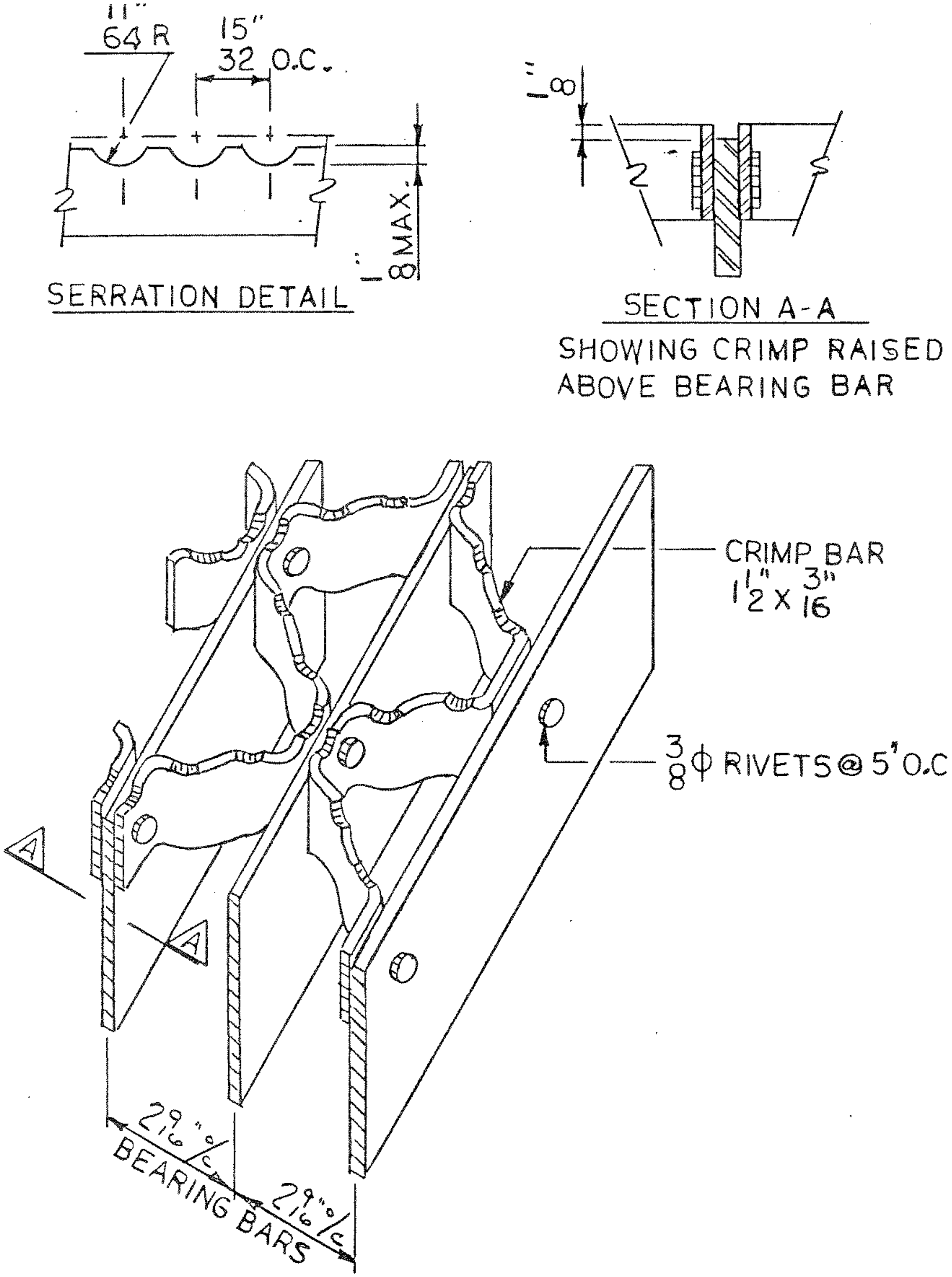
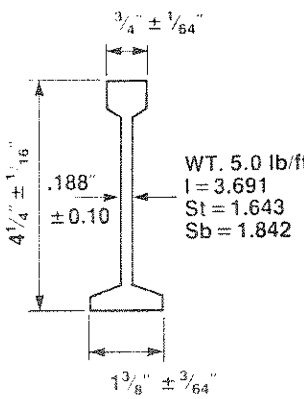

11" 64 R
15" 32 O.C.
1" 8 MAX.
SERRATION DETAIL
1" 8
SECTION A-A
SHOWING CRIMP RAISED ABOVE BEARING BAR
CRIMP BAR 1 1/2" X 3/16"
3/8 φ RIVETS @ 5" O.C.
A
A
2 9/16" o/c
2 9/16" o/c
BEARING BARS

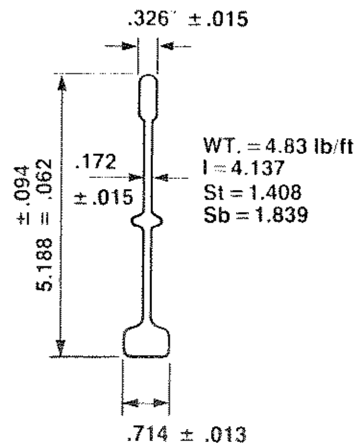
FIGURE 6

Construction Details

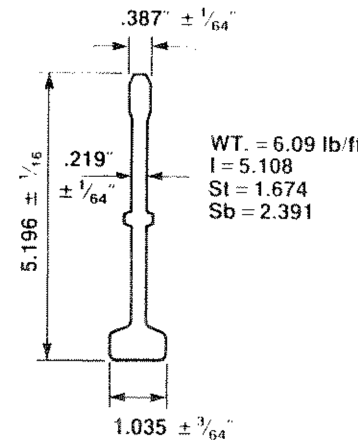
Shown are the 3 Greulich I-beam Sections available for use as open or concrete-filled grid floors. Construction details shown are recommended for durability and economy.



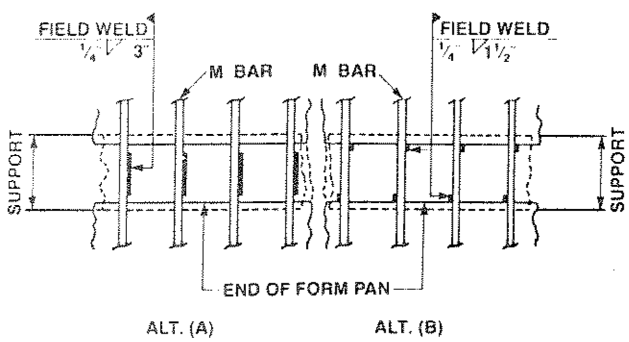
4¼" I BEAM



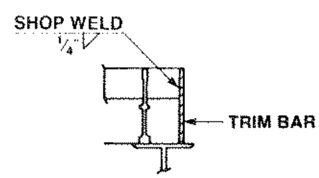
5" M BAR



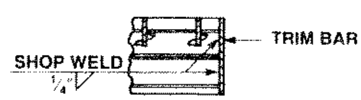
5" M BAR TYPE "H"



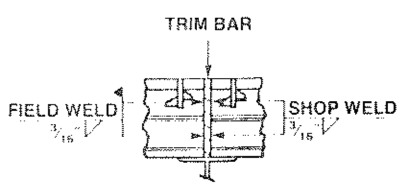
WELDING GRID FLOORING TO SUPPORTS



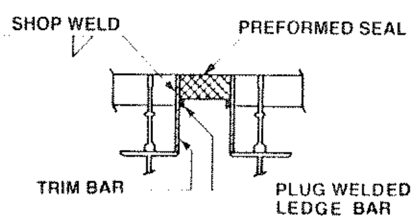
SIDE TRIM



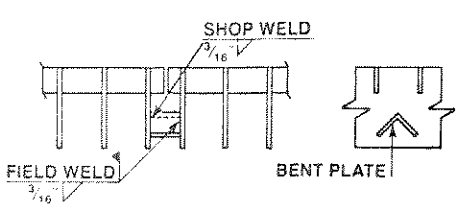
END TRIM



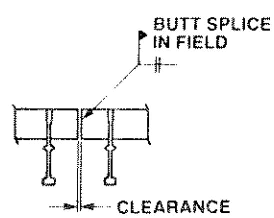
END SPLICE BETWEEN PANELS



RELIEF JOINT



CHEVRON SPLICE BETWEEN PANELS



BUTT SPLICE BETWEEN PANELS

SPLICING IKG BORDEN RIVETED GRATING

Splices can be made by on-site welding, riveting with special tools lent by IKG Borden or by bolting; a new, tested method which offers low cost, easy installation and minimum labor and equipment requirements.

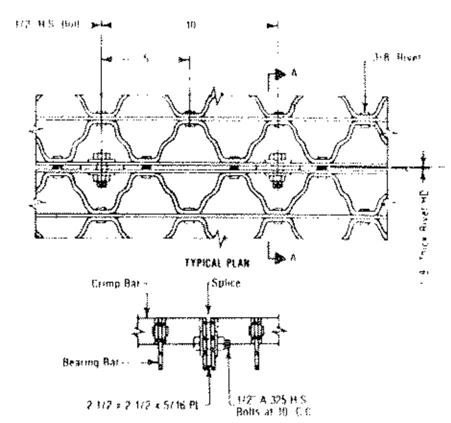
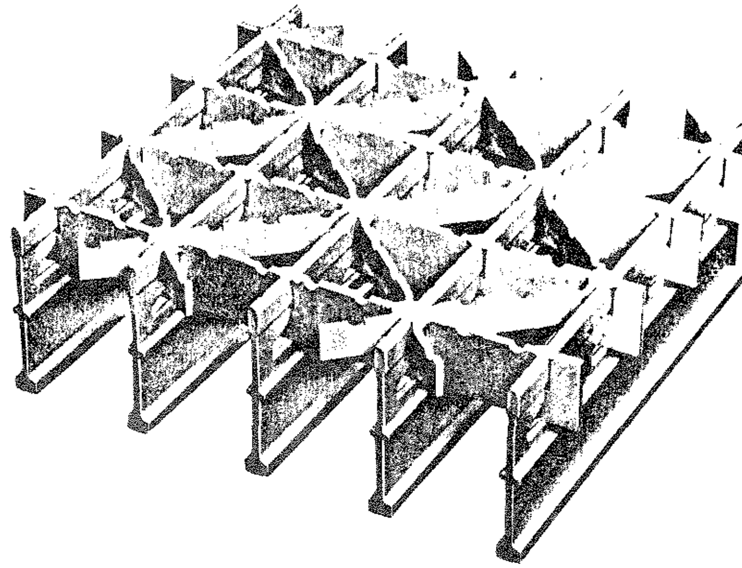


FIGURE 7

5 INCH 4 WAY™ HD (Heavy Duty) Open Grid



5-Inch 4-Way HD is an improved open grid design which adds greater strength to the proven performance features of GREULICH designed 5-Inch 4-Way. This strength is achieved by having the 5" Special Rolled Main Beams spaced on 3¾" centers. **5-Inch 4-Way HD decks are capable of carrying the heaviest highway traffic loads** and of withstanding the impact of extremely heavy off-highway road building and industrial "super vehicle" equipment. Added strength also means added durability.

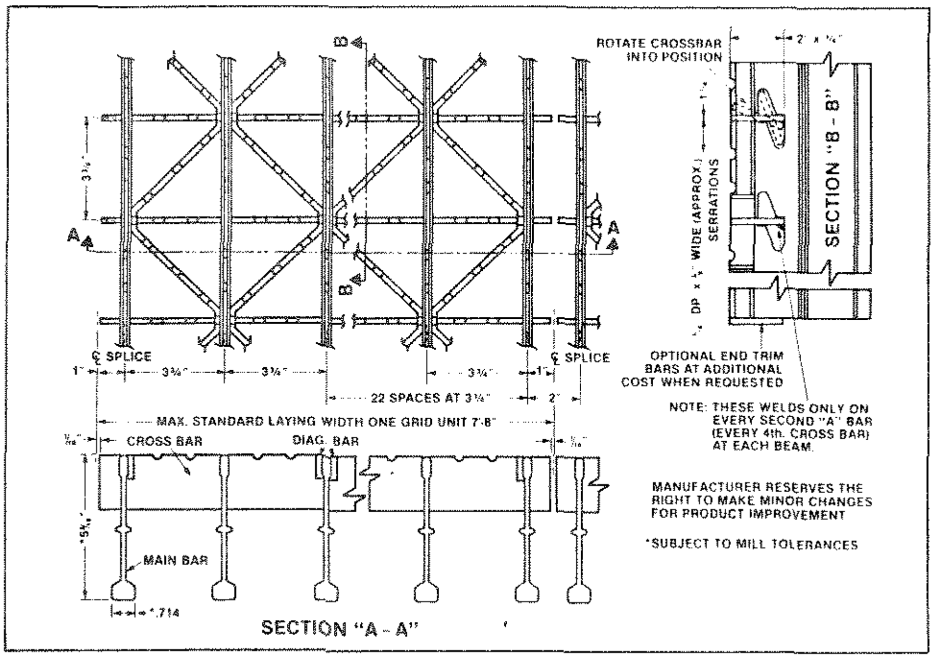
Suggested Specifications

The bridge flooring shall be 5-Inch 4-Way HD open steel grid as manufactured by IKG GREULICH or equal. The flooring shall consist of panels fabricated of A.S.T.M. ________ (A-36 or A-588) steel in maximum widths of 7'8"* with Special Rolled Main Beams 5³/₁₆" deep spaced on 3¾" centers. The Main Beams shall be intersected at right angles by Secondary Bars 2¹/₁₆" x ¹³/₆₄" (minimum area) which shall be spaced on 3¾" centers and interlocked with the Main Beams. Tertiary Diagonal Bars 1" x ⁷/₃₂" shall be connected to alternate Main Beams. The Main Beam, Secondary and Tertiary Diagonal Bars shall be welded in accordance with manufacturer's standards. The top edges on all members shall be serrated and notched. Notches shall be ³/₁₆" deep x ³/₈" wide. The top surface shall be in the same plane. The floor shall weigh approximately 24.5 lbs./sq. ft.

Finish

A.S.T.M. A-36 steel shall have a prime coat, shop applied. A.S.T.M. A-588 steel requires no painting. (Any approved finish may be specified and shop applied).

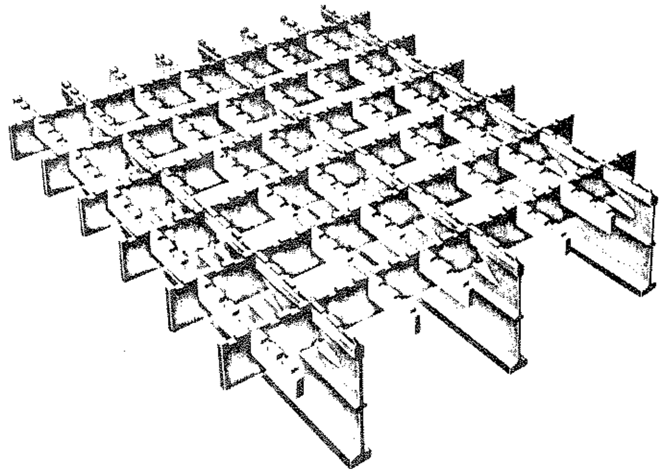
*Narrower units furnished when required at slab ends, transverse joints, or along edges of slabs adjacent to curbs.



HS-20 Load Table	Continuous Spans	
Sectional Properties (per foot of element)	**A-36**	**A-588**
Moment of Inertia (in.⁴)	12.461	12.461
Section Modulus (in.³)*		
Top	4.541	4.541
Bottom	5.522	5.522
Main Bar Spacing (in.)	3.75	3.75
Maximum Span H-20 (effective)	4'8½"**	6'0½"**
Approx. Weight (lbs./sq. ft.)	24.5	24.5

*Section Modulus based on 50% of Diagonal Bars active.
**Span shown per AASHTO formulation, for longer span capabilities contact our Engineering Department for details.

FIGURE 8



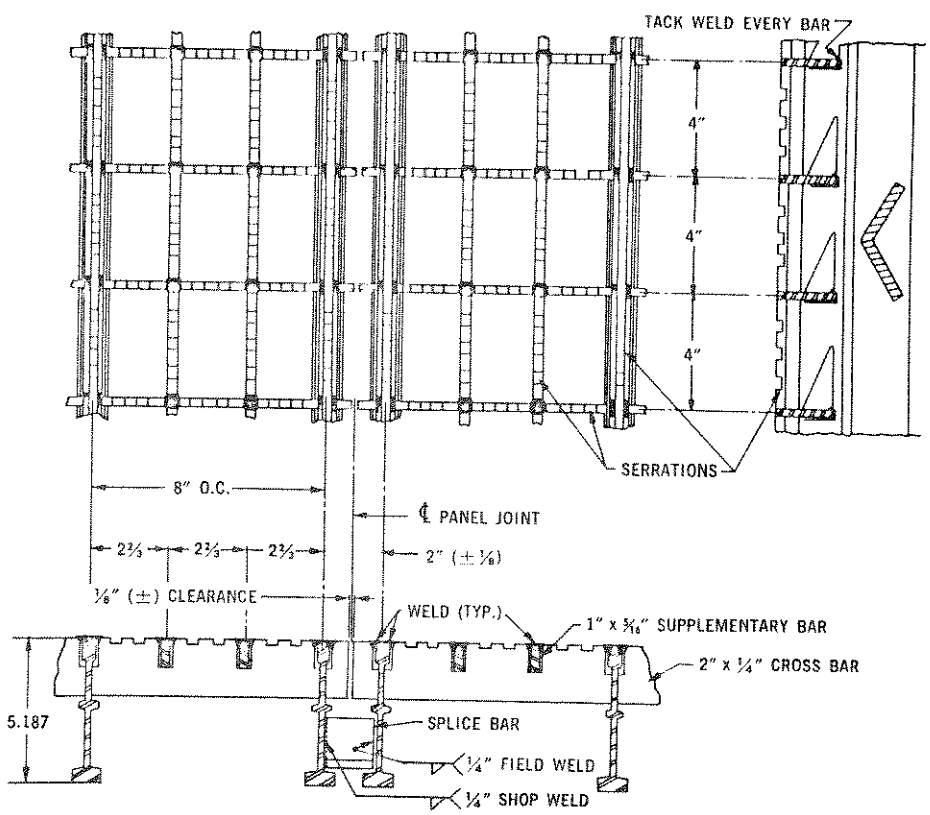
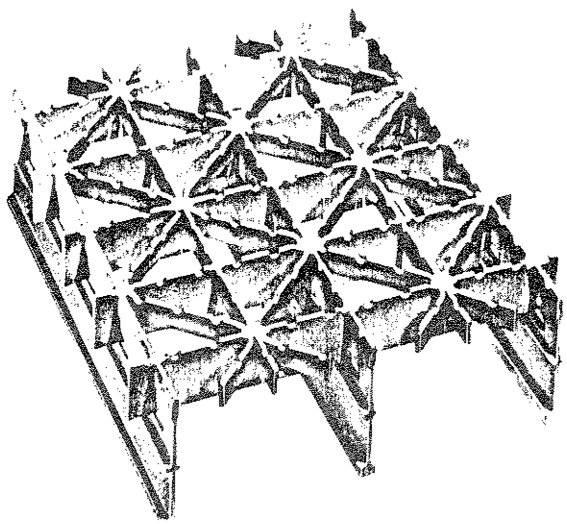

TACK WELD EVERY BAR
4"
4"
4"
SERRATIONS
8" O.C.
℄ PANEL JOINT
2⅔
2⅔
2⅔
2" (±⅛)
⅛" (±) CLEARANCE
WELD (TYP.)
1" x 5/16" SUPPLEMENTARY BAR
2" x ¼" CROSS BAR
5.187
SPLICE BAR
¼" FIELD WELD
¼" SHOP WELD

FIGURE 9

5 INCH 4 WAY™ Open Grid

This unique GREULICH design is the ultimate in steel grid design and construction. 5-Inch 4-Way meets or exceeds all requirements for bridges carrying normal traffic loads. 5-Inch 4-Way decks resist distortion and reinforce bridge spans against side-sway. This design also provides wider, effective load distribution to more beams with minimal deflection and maximum recovery. 5-Inch 4-Way offers greater skid resistance in all directions and reduces the tracking effect on tires. The diagonals provide additional top flange area while increasing rigidity and strength at joint connections.



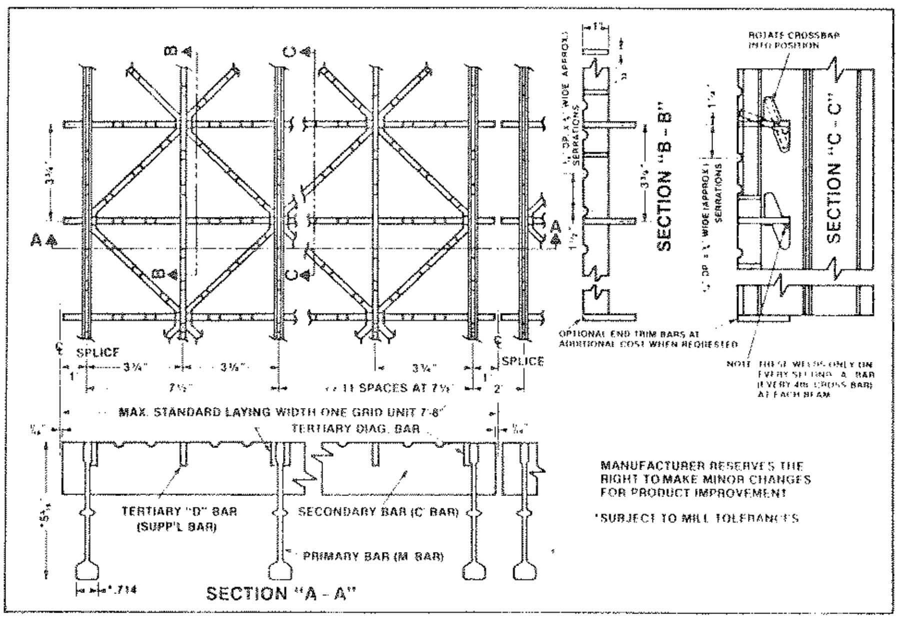
Suggested Specifications

The bridge flooring shall be 5-Inch 4-Way open steel grid as manufactured by IKG GREULICH or equal. The flooring shall consist of panels fabricated of A.S.T.M. ________ (A-36 or A-588) steel in maximum widths of 7'-8"* with Special Rolled Main Beams 5³/₁₆" deep spaced on 7½" centers. The Secondary Bars, intersecting Main Beams at right angles and interlocked with the Main Beams and spaced 3¾" on centers, shall be 2¹/₁₆" x ¹³/₆₄" (minimum area). The Secondary Bars shall be intersected by Tertiary Bars 1" x ⁷/₃₂" which shall be spaced 3¾" on center with the Main Beams. Diagonal Bars 1" x ⁷/₃₂" shall be connected alternately at a Main Beam and a Tertiary Bar. The Main Beams, Secondary, Tertiary and Diagonal Bars shall be welded in accordance with manufacturer's standards. The top edges of all members shall be serrated and notched. Notches shall be ³/₁₆" deep x ¾" wide. The top surface shall be in the same plane. The floor shall weigh approximately 15.4 lbs./sq. ft.

Finish

A.S.T.M. A-36 steel shall have a prime coat, shop applied. A.S.T.M. A-588 steel requires no painting. (Any approved finish may be specified and shop applied.)

*Narrower units furnished when required at slab ends, transverse joints, or along edges of slabs adjacent to curbs.



HS-20 Load Table	4.83 lb. BEAM		6.09 lb. BEAM	
Sectional Properties (per foot of element)	A-36	A-588	A-36	A-588
Moments of Inertia (in.⁴)	7.856	7.856	9.981	9.981
Section Modulus (in.³)* Top	3.268	3.268	3.854	3.854
Bottom	3.196	3.196	4.142	4.142
Main Beam Spacing (in.)	7.5	7.5	7.5	7.5
Maximum Span (effective) **	4'-6½"	5'-10"	5'-4"	6'-11"
Approx. Weight (lbs./sq. ft.)	15.4	15.4	17.4	17.4

*Section modulus based on 50% of Tertiary and Diagonal Bars active.

**spans shown are continuous.

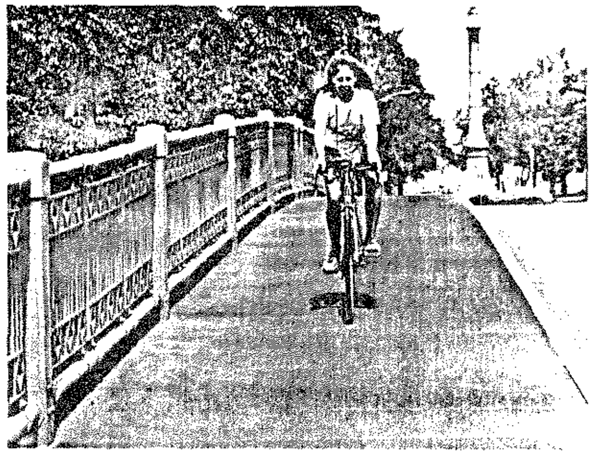
FIGURE 10

Orthotropic Sidewalks

MEBAC Orthotropic Sidewalks offer the ultimate in high strength, lightweight sidewalks. They install rapidly since only field bolting of panels to supports is required. Greulich panels also feature the abrasive non-slip surface of MEBAC, which offers superior traction even in damp weather.

Suggested Specifications

The sidewalk flooring shall be IKG GREULICH Truegrit® Orthotropic Sidewalk or equal fabricated from 3/16" plate with ________ stiffner bars at 6" centers. The plate and stiffners shall be welded in accordance with manufacturers standards. Top surface of the plate shall receive a 1/8" coating of Mebac abrasive non-slip surface as manufactured by IKG Borden Metal Products. The decking can be furnished in mild carbon steel prime painted or A588 unpainted weathering steel. Panel sizes up to 4' x 12' can be supplied.



For Live Loads of 100 PSF		
Wt. # PSF	Stiffner Bar Size	Recommended Max. Span
10.8	1 x 5/16	4'-0"
11.6	1¾ x ¼	5'-0"
12.1	2 x ¼	6'-0"
For longer spans or detailed information, please contact the Greulich Engineering Dept.		

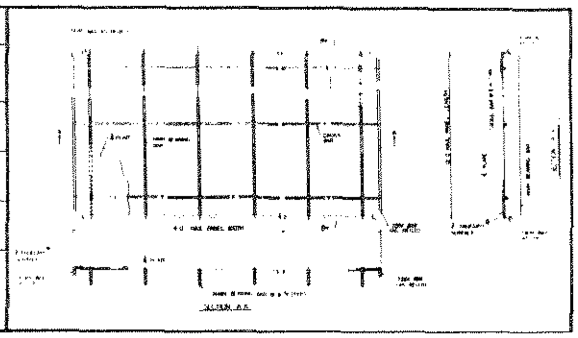


FIGURE 11

EXPECTED IN PLACE DECK COSTS $PSF**

TYPE OF DECK	"EXODERMIC"	4 WAY HALF FILLED	7" ALUMINUM DECK	5" RIVETED 2 9/16" CENTERS	4 WAY 3 3/4" CENTERS	4 WAY 7 1/2" CENTERS
MANUFACTURING COST	$18	$16	$55	$19	$18	$14
CONCRETING COST	10	3	---	---	---	---
ERECTION COST	10	9	12	12	10	8
CORROSION PROTECTION*	2	3	---	3	3	2
TOTALS	$40	$31	$67	$34	$31	$24

*Assumed to be Galvanizing
**Based on a 5,000 SF Bridge

FIGURE 12