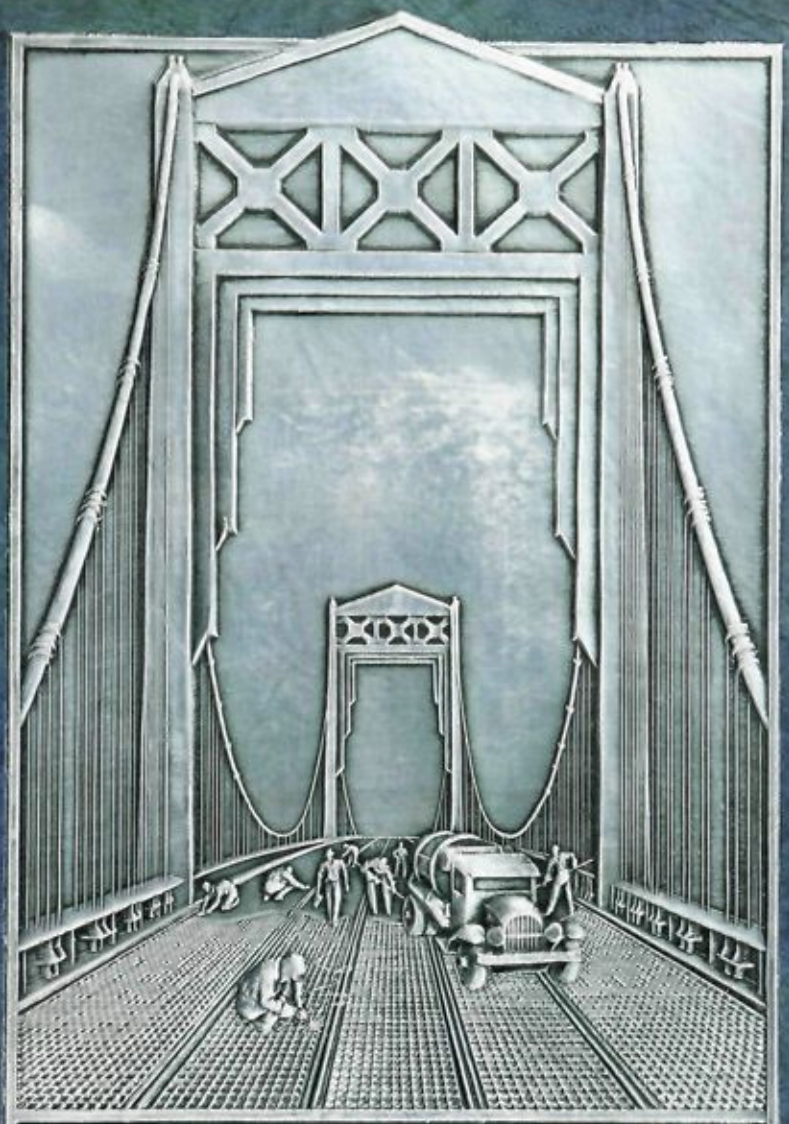
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Carnegie Steel Company



T-TRI-LOK BRIDGE FLOOR CONSTRUCTION

CARNEGIE STEEL COMPANY

Subsidiary of United States Steel Corporation

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T·TRI·LOK

BRIDGE FLOOR CONSTRUCTION

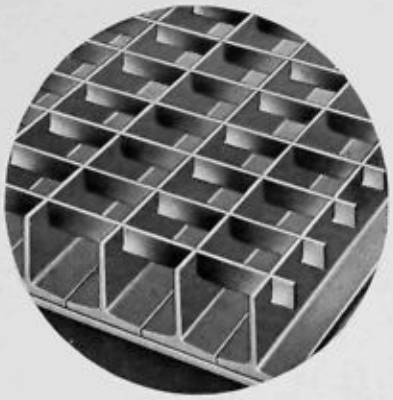
A LIGHT WEIGHT HEAVY DUTY FLOOR

WITH INTEGRAL ARMORING

CARNEGIE STEEL COMPANY
Subsidiary of United States Steel Corporation
PITTSBURGH • PA •

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T·TRI·LOK

BRIDGE FLOOR CONSTRUCTION

The requirements of modern vehicular traffic demand roadways and pavements having uniform, continuous and hard surfaces. They must offer sufficient friction to prevent skidding, and should be of permanent character to require as few repairs as possible. Roadways of bridges should, in addition, be fireproof. These requirements can easily be met, but the weight of such roadways is a serious factor; the more weight a bridge has to carry the more material will be required to build it. Engineers, therefore, are confronted with the problem of building strong and permanent roadways on bridges with the least dead load, for weight becomes a determining factor in long-span bridges.*

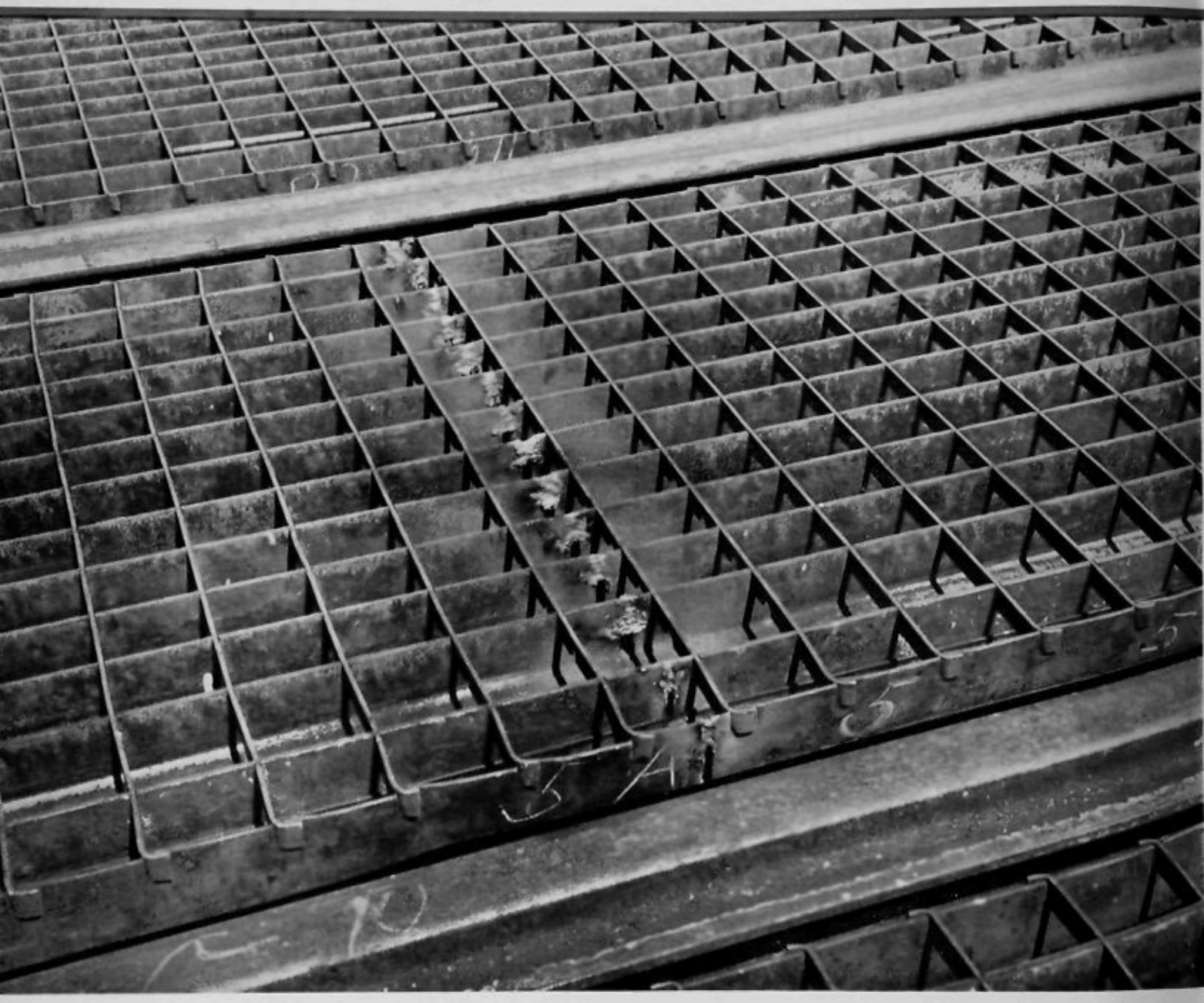
At the time when vehicular traffic was mostly horsedrawn and wheel load concentrations of trucks were naturally much less than those of today, wood block pavement supported on steel buckle plates was used on long-span bridges because of its light weight. But under present-day heavy traffic, this type has proved inadequate. The heavy concentrations distort the buckle plates and break the concrete filling. Asphalt pavement, weighing 30 pounds per square foot, while almost twice as heavy as wood, may still be considered light in weight, but it requires a solid floor foundation.*

To reduce the weight of roadway floor, engineers have endeavored to utilize a minimum thickness of floor to support the surface pavement. Early designs along this line are illustrated by the Delaware River Bridge where a roadway floor slab of a total thickness of 6 inches was used, in which were embedded steel reinforcing trusses 4½ inches deep, placed 6 inches center to center. Tests on large slabs of this floor construction furnished interesting information and showed the great efficiency in distribution and strength of this form of slab. This floor weighs 85 pounds per square foot without the wearing surface and while light compared to previous satisfactory floors, was still much heavier than an adequate 50-pound floor for which engineers were searching.

*Development Tests on a Light Floor for Bridges—By Leon S. Moisseiff. Engineering News-Record, January 9, 1930.

10th Street Bridge, City of Pittsburgh, Allegheny County, Pa.
American Bridge Company, General Contractor

T-TRI-LOK BRIDGE FLOOR CONSTRUCTION



Details of T-Tri-Lok as laid between car tracks, showing field welds joining two units

10th Street Bridge, City of Pittsburgh, Allegheny County, Pennsylvania—American Bridge Company, General Contractor

T-TRI-LOK BRIDGE FLOOR CONSTRUCTION

In an attempt to still further reduce the weight of the roadway slab and its wearing surface, a new form of slab construction involving structural tees in combination with lighter flat bars mechanically interlocked with the tees, known as *T-Tri-Lok* has been introduced by Carnegie Steel Company.



Arrangement of Slots

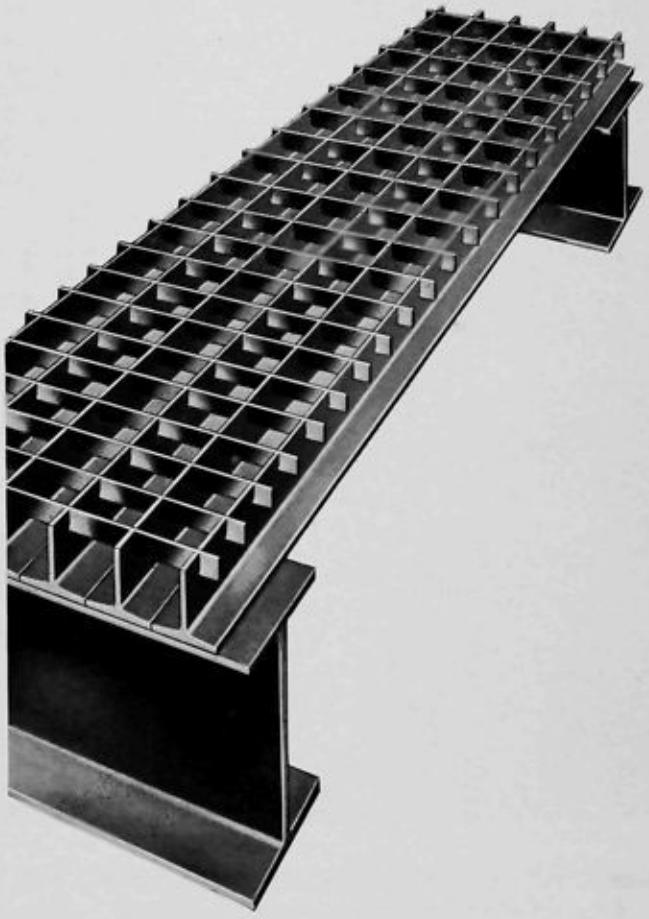
The stems of the tees are first punched above the neutral axis, usually at 4-inch intervals, *with curved slots*. The direction of the slots is alternated in adjacent tees so that when the cross bar is forced down into position it is twisted in alternate directions



Bars in Slots

in the successive tees. This feature assures stiffness and rigidity of construction without further fabrication, and also provides a mechanical interlock or bond between the concrete and steel. Standard units can be furnished in widths up to 4 feet and in lengths up to 30 feet or even greater if so desired. Various sizes of tees and cross bars are offered, the most common being 3″ x 3″ or 3½″ x 3½″ tees with 1″ x 3/16″ cross bars placed on 4-inch centers.

The T-Tri-Lok units are placed directly upon the supporting beams, to which they should be attached by



T-TRI-LOK BRIDGE FLOOR CONSTRUCTION



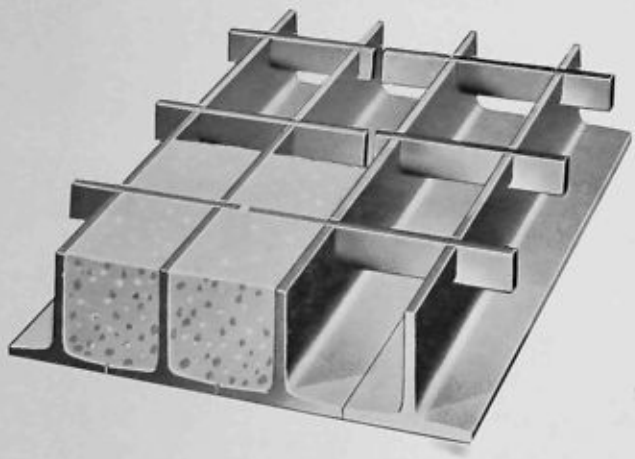
Details illustrating neatness and efficiency of construction at expansion joint

Illustrating typical method of installation

10th Street Bridge, City of Pittsburgh, Allegheny County, Pennsylvania

American Bridge Company, General Contractor

welding. Thus secured they are to be filled with concrete flush with the top of the tees and cross bars, to



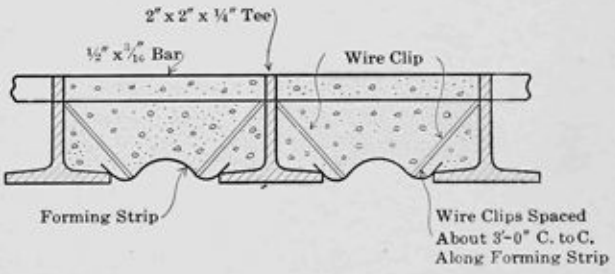
form an armored road surface, or an additional wearing surface of concrete, asphalt or other suitable material may be added to any desired thickness above the top of the steel. Vibrating the steel work with an air or preferably an electric vibrator immediately after pouring the concrete is recommended to obtain concrete of maximum density. The resulting structure is a unit slab of steel cells filled with concrete. As the tee flanges are placed close together, no forms for concrete are required.

The installations of T-Tri-Lok which have been in service under a wide range of conditions have demonstrated that it provides a roadway surface which meets all the requirements for smoothness, continuity, hardness and traction coupled with fireproof qualities, strength and lightness. Load tests have demonstrated that the construction using 3-inch tees is superior in strength to an economically designed reinforced concrete slab 8″ in depth or a special truss-reinforced slab 6″ in depth resulting in a possible saving of 35 to 50 pounds per square foot without taking into consideration the weight of the wearing surface, the necessity for which is eliminated by the use of T-Tri-Lok.

The significance of this light weight floor slab when considered in terms of economies which may be effected throughout the entire structure will be quite apparent to the reader.

Complete design data, for the various sizes will be found on pages 18 to 24.

Another recent development is the adaptation of the Tee-system of flooring to sidewalks and other structures for comparatively light loads. Tees 2″ x 2″ x ¼″ are used with ½″ x 3/16″ cross bars, both tees and cross bars being spaced on 4-inch centers. This leaves a 2-inch opening between the edges of the tee flanges which is filled by a No. 20 gauge steel forming strip held in place by No. 10 gauge wire clips. This steel structure is shipped completely



fabricated and when filled with concrete flush with the top of the tees has all the splendid characteristics of the heavier bridge roadway floor, but is much lighter

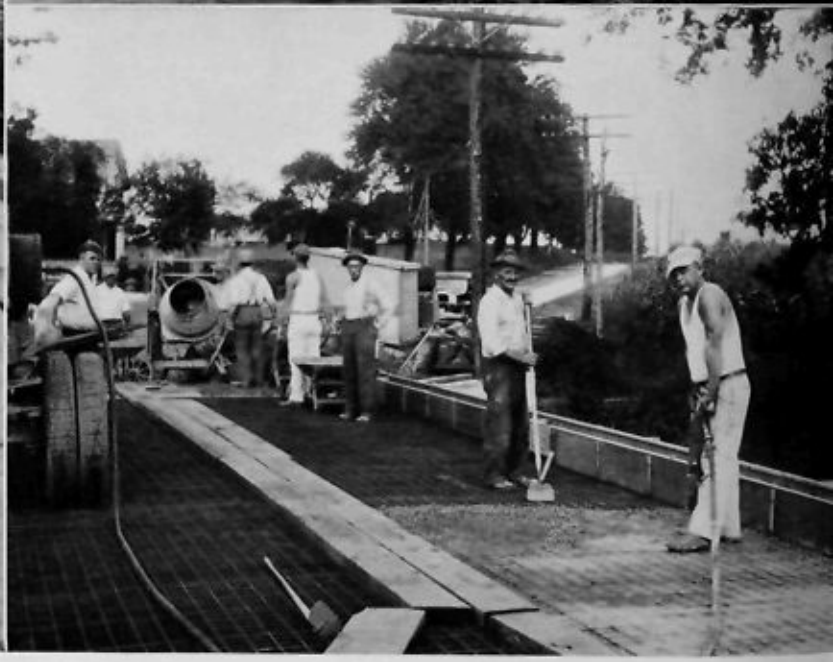
T-TRI-LOK BRIDGE FLOOR CONSTRUCTION



10th Street Bridge, City of Pittsburgh, Allegheny County, Pennsylvania

American Bridge Company, General Contractor





Bridge near Clarksfield, Huron County, Ohio

Burger Iron Company, General Contractor

weighing approximately 12.6 pounds per square foot for the steel alone and 30 pounds per square foot for the finished slab. Other sizes can be furnished to suit customers requirements. The merits of this will be apparent and it is particularly well adapted to the requirements of the sidewalk construction either for bridges, or adjacent to buildings where the area beneath the sidewalk is to be excavated, to warehouse and manufacturing buildings, piers and wharves, garages, office buildings and flat roofs. Tables shown on page 24 give unit stresses in steel and concrete for various spans and loads. *It must be noted, however, that these tables are very conservative in that the entire weight of the slab is included while actually the dead weight of the slab is carried by the steel and the only portion of the load that affects the stresses in the concrete is the live load.* Moreover with reference to 2" T-Tri-Lok the limiting spans are also determined using the total load which is correct for total deflection, but in view of the fact that live load only, influences deflection in its relation to plaster cracks, it will be advisable in critical cases where long spans are desired to modify the studies, increasing slightly the tension in the steel and decreasing the stress in the concrete, also increasing the maximum span on the basis of live load only.

IMPERVIOUS CONDITION OF SLAB

Observations and service reports with respect to the Bull Creek Bridge near Tarentum, Allegheny Co., Pa., the oldest T-Tri-Lok installation, includes the following comments:

"The Bull Creek Bridge was put into service September, 1930, and was inspected by our representatives on November 17, 1933.

First. The bridge floor slab shows very high resistance to wear and no cracks have developed.

Second. There is no evidence of rust at the intersection of the concrete with the steel which is exposed in the surface, and this fact will undoubtedly warrant the assertion that the bond between the steel and concrete still remains intact. We might add that at certain places on this bridge floor a thin film of concrete was left over the top of the steel, about $\frac{1}{8}$-inch thick, and this film still remains even though in many cases its position on the bridge floor indicates that it has been subjected to the maximum wear.

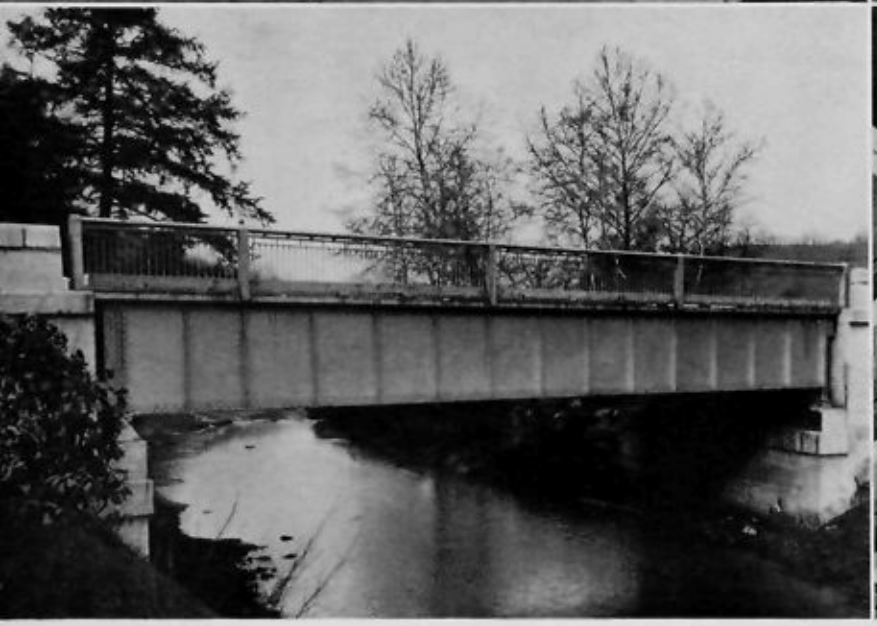
Third. No cupping has developed between the exposed edges of the steel or is so slight as to be negligible, notwithstanding the difference in degree of hardness between steel and concrete. It is our opinion that the concrete would naturally wear down slightly ahead of the steel, which, on account of its hardness, would greatly retard the deterioration due to abrasion and would undoubtedly protect the softer concrete between, the entire structure wearing down very slowly and uniformly.

Fourth. The inspection of the underside of the structure revealed the fact that while there are several places where moisture has found its way through the slab, it is practically waterproof. This feature we believe is due to the fact of vibrating the concrete, thereby securing a very dense structure which is impervious to water without any waterproof application being required. There were indications that some water had penetrated the floor at the intersection of the slab and the curb but this had been corrected with an application of tar or asphalt, and another inspection made during a heavy rain when the water was running freely over the slab and in the gutter, showed no indication of moisture on the underside."

T-TRI-LOK BRIDGE FLOOR CONSTRUCTION









Allegheny County Bridge over Bull Creek, near Tarentum, Pa.

Top—Floor surface after three years wear
Bottom—Typical view of under side of T-Tri-Lok floor

RESISTANCE TO WEAR

Some designers have expressed the thought that perhaps the steel grid in the surface would resist wear to better advantage than the concrete between, eventually presenting a cupped condition. It is no doubt true that owing to different densities of steel and concrete the latter would wear down slightly faster but it is reasonable to suppose that the harder steel protects the softer concrete, effectively retarding the wear of the entire surface more particularly when we consider that the exposed units of concrete are less than 3″ x 4″ or 3½″ x 4″ bounded on all four sides by steel. Inspection of bridges in the Pittsburgh district where T-Tri-Lok has been in service from one to three and one-half years shows no noticeable cupping.

DENSITY OF CONCRETE

One consideration must always be uppermost in the mind of the designer where concrete is to be subjected to wear, and that is its density. This is true with respect to a T-Tri-Lok floor no less than any kind of a concrete wearing surface. This density may be obtained by keeping in mind proper selection and grading of aggregate, proportion of fine and coarse aggregate, water-cement ratio, mixing and tamping. The latter operation should be done by some suitable mechanical vibrator, either electric or, if more convenient, excellent results may be had by using jack hammers or other suitable air-driven vibrators.

In addition to the items mentioned, it is generally agreed that in order to secure the best possible results, expert supervision must be maintained during every step of the process.

In some of the tests conducted, notably those at Washington by the Bureau of Public Roads, an effort was made to determine the effect of the loads on the concrete. A penetrating dye was puddled on top of the slabs about a year after the conclusion of the load tests and when the concrete was chipped out, it was found that the dye had not penetrated the slab at any point, that a good bond between the steel and concrete did exist and that this bond was maintained throughout the tests and until the time of demolition. For a complete report see "Public Roads," September 1932.

The observed impervious condition in the test slab is a condition which it is possible to secure in the field if proper procedure is followed throughout each stage of construction.

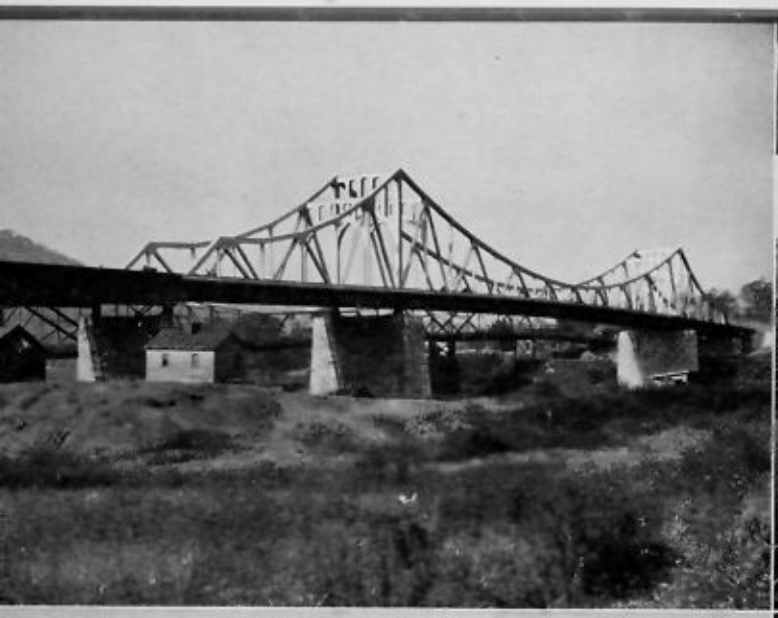
NEGATIVE MOMENT OVER SUPPORTS

Owing to continuity in the floor slab, tension due to negative moment must be resisted by the steel above the neutral axis. Experience in the test slabs on which detailed data is given later and on various installations indicate that no special provision need be made as the tee has enough net section to resist this tenson without being overstressed.

PERMANENCE OF LOCKED JOINT

Our method of manufacture, the unique shape of the slots with alternating curves, locks the cross bars so securely in place that there is no possibility of their loosening up or moving at any time during shipment or in service.

T-TRI-LOK BRIDGE FLOOR CONSTRUCTION









Boston Bridge near McKeesport, Allegheny County, Pennsylvania
Fort Pitt Bridge Company, Contractor

ADVANTAGE OF DEEP CROSS BARS

The thin cross bars present an ideal surface for the bridge floor. As compression members for crosswise distribution of load concentration, they are prevented from buckling sidewise by concrete; hence, full value in compression may be assumed and as a part of the steel floor for distributing loads from trucks and concrete mixers the 1″ depth of the bar contributes greatly. Moreover, the unusually large area in contact with concrete, 2-3/16 sq. in. of bond area per inch of cross bar length, assures the designer that an adequate bond between the cross bars and the concrete will be maintained throughout the life of the structure.

Another advantage of this unusually deep, flat cross bar is in connection with the interlocking edges of the units. The conventional method is to alternate long and short cross bars in adjacent slabs so that half the cross bars of each unit extend into the concrete of the adjacent unit and again the large area of the bar in contact with concrete gives assurance of a permanent bond.

In tests made at our works to determine the value of the slab at the edges of adjacent units midway between supports, a standard 3″ slab was loaded by means of an 8″ x 12″ x 3″ steel block and a hydraulic jack, applying various static loads up to 50,000 pounds maximum. The load block was placed so that the edge of the block came directly over the splice between the adjacent units, the center of loading being applied 4″ from this edge. In all cases the performance of the slab, so far as could be noted, was exactly the same as though loaded in the center of a continuous panel. These tests furnished conclusive evidence that our standard method of splicing at edges of units would not introduce any element of weakness nor detract from the value of the structure in any particular.

HIGHWAY BRIDGE DESIGN

In designing new bridges of any character a very substantial saving can usually be effected which will justify the inclusion of T-Tri-Lok in your specification.

In reflooring an existing structure we find many cases where the bridge originally designed for H-15 loading has been increased in live load capacity to H-20 due to a substantial reduction in dead load by means of the application of T-Tri-Lok floor. Moreover, there are many reflooring jobs where the original floor is of wood, in which case the only method is to renew the present wood floor with an ultimate life of perhaps three years or resort to the use of T-Tri-Lok floor having a presumable ultimate life equivalent to the life of the bridge itself.

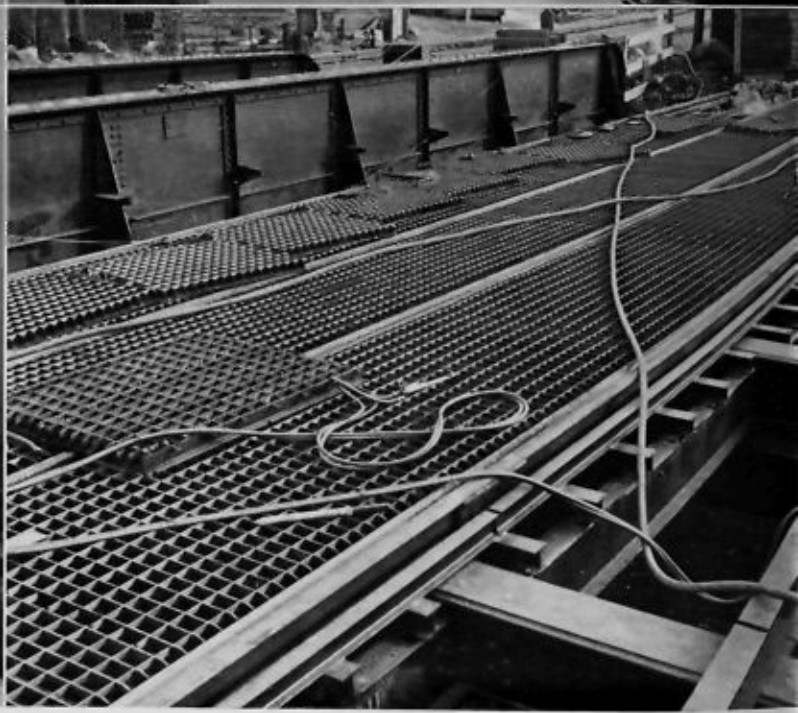
When we consider the tremendous advantage, particularly on long spans, of being able to use a floor slab whose total weight is only 52 pounds per square foot, it is quite apparent that this light weight bridge floor construction is one of the most vitally important developments that has taken place since the very beginning of motor transportation.

T-TRI-LOK BRIDGE FLOOR CONSTRUCTION









Top—*Bucks County Bridge, Newportville, Pa.*
M. & J. B. McHugh, Contractor

Bottom—*Bridge at Roseburg, Oregon*
Pittsburgh Des-Moines Co., General Contractor

Top—*Bucks County Bridge, Newportville, Pa.*
M. & J. B. McHugh, Contractor

Bottom—*Bridge at Etna, Allegheny County, Pennsylvania*
David Goldberg, General Contractor

T-TRI-LOK BRIDGE FLOOR CONSTRUCTION



Grantley Street Bridge over Codorus Creek, York, Pa.
M. and J. B. McHugh, General Contractor



Bridge at Zelienople, Butler County, Pa.
Ferris Engineering Co., Contractor

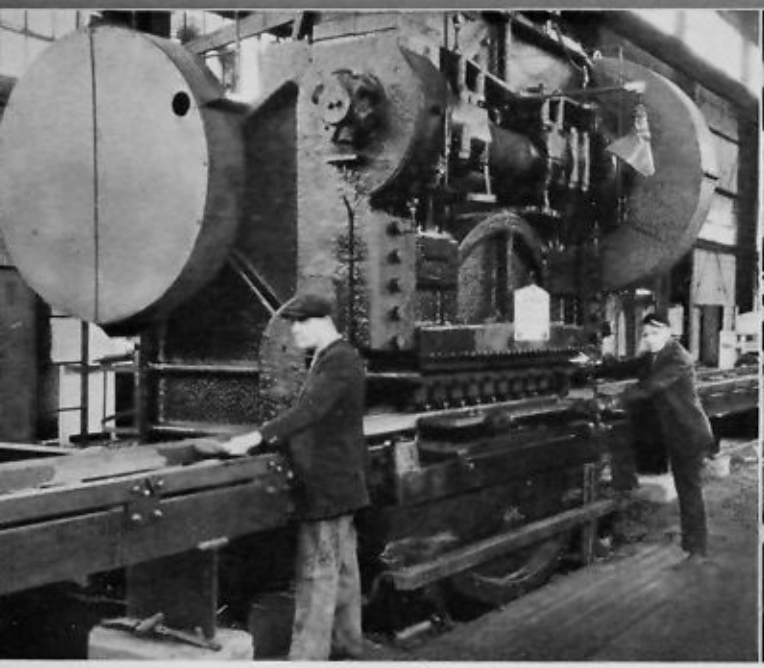
RAILWAY BRIDGE DESIGN

The application of T-Tri-Lok is much broader than merely for highway bridges. To designers contemplating the construction of a railroad bridge we submit this product. A timber deck laid on a steel structure is no longer considered adequate. The fire hazard presents many difficulties, is expensive and in spite of all precautions several disastrous fires within recent years with the resultant interruption to traffic, have convinced many railroad bridge engineers that fireproof ballasted deck bridges are destined to come more and more into general use. T-Tri-Lok will be found remarkably well adapted to such structures owing to the continuity of structure, ease of application, impervious condition of slab and good lateral distribution of concentrated loads which would be an important factor in cases of derailment.

SUMMARY OF IMPORTANT ADVANTAGES OF T-TRI-LOK BRIDGE FLOOR CONSTRUCTION

1. *LIGHT WEIGHT PER SQUARE FOOT, THUS REDUCING DEAD LOADS.*
2. *ARMORED ROAD SURFACE, MINIMIZING WEAR AND SKIDDING.*
3. *GREAT STRENGTH AS COMPARED WITH OTHER FLOORS OF COMPARABLE WEIGHT.*
4. *EASE OF ERECTION.*
5. *NO CONCRETE FORMS NECESSARY.*
6. *LOWER INITIAL COST FOR ENTIRE STRUCTURE.*
7. *LOW MAINTENANCE COST.*
8. *EASY REPAIRS WHEN NECESSARY.*
9. *SUBSTANTIAL SAVING OF TIME REQUIRED FOR COMPLETION.*

T-TRI-LOK BRIDGE FLOOR CONSTRUCTION



Punching Curved Slots in center of Beam



Splitting Beam through center on Rotary Shear

HOW T-TRI-LOK IS MADE

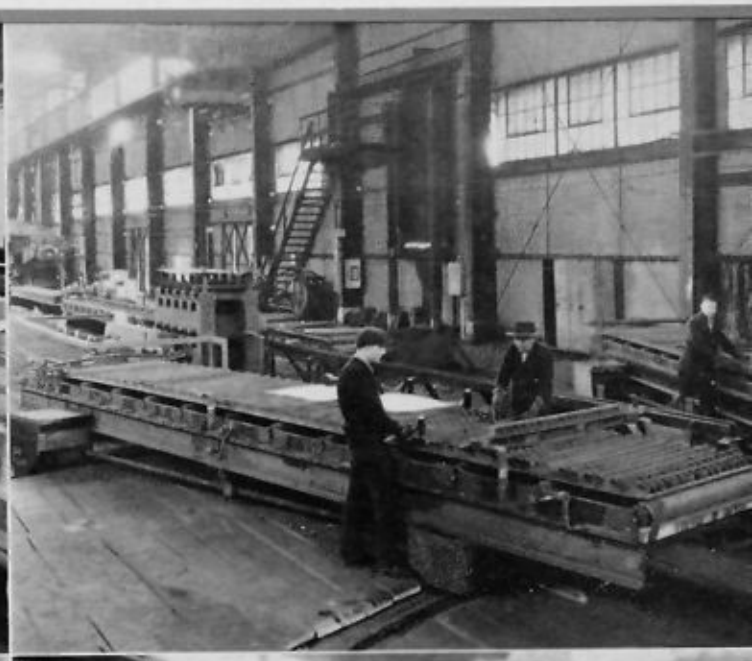
T-Tri-Lok is not made from standard Tee sections, as might commonly be supposed, but from I-beams. A beam twice the depth of the section required is first punched along the flanges for fastening down holes, then along the center of the web for the cross bar slots. Twenty slots are punched at one time by the equipment shown in photograph at upper left. The beam is then split on a rotary shear through the center of the web, making two equal tees. See illustration at upper right.

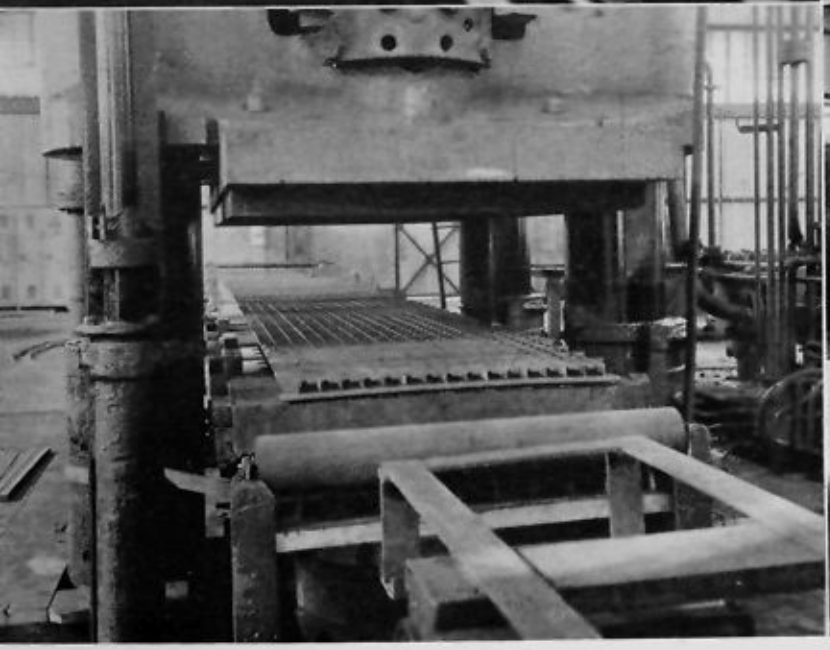
The tees are then run through a roll straightener (photographs on following page) and after being straightened are placed on assembly tables where they are arranged with the slots in the webs of adjacent tees turned in opposite directions. In this position the edges of the flanges are welded at proper intervals. Cross bars are then started into the slots with a hand hammer, and the unit is ready for the press. A 3500 ton press acts on a section about 4 feet wide by 10 feet long, which means that a pressure of as much as 7 tons can be applied for each intersection of cross bar and tee. In the pressing operation the cross bars follow the curve of the slots, giving the bars a series of twists in opposite directions, thus forming a positive lock with the tees.

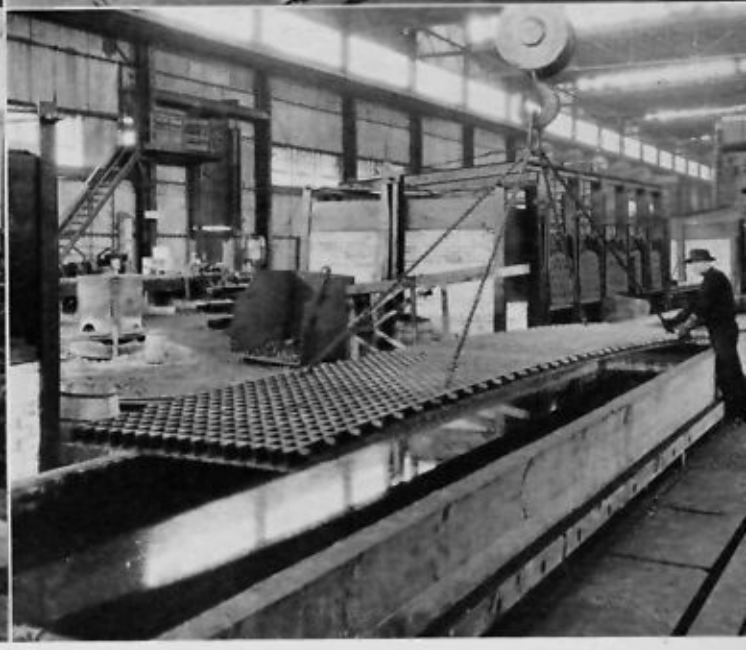
The units are given a very rigid inspection. All traces of grease or oil are removed by means of a solvent to insure a satisfactory bond with the concrete. When necessary the entire unit is dipped into a vat containing a hot bath of solvent solution.

T-TRI-LOK BRIDGE FLOOR CONSTRUCTION









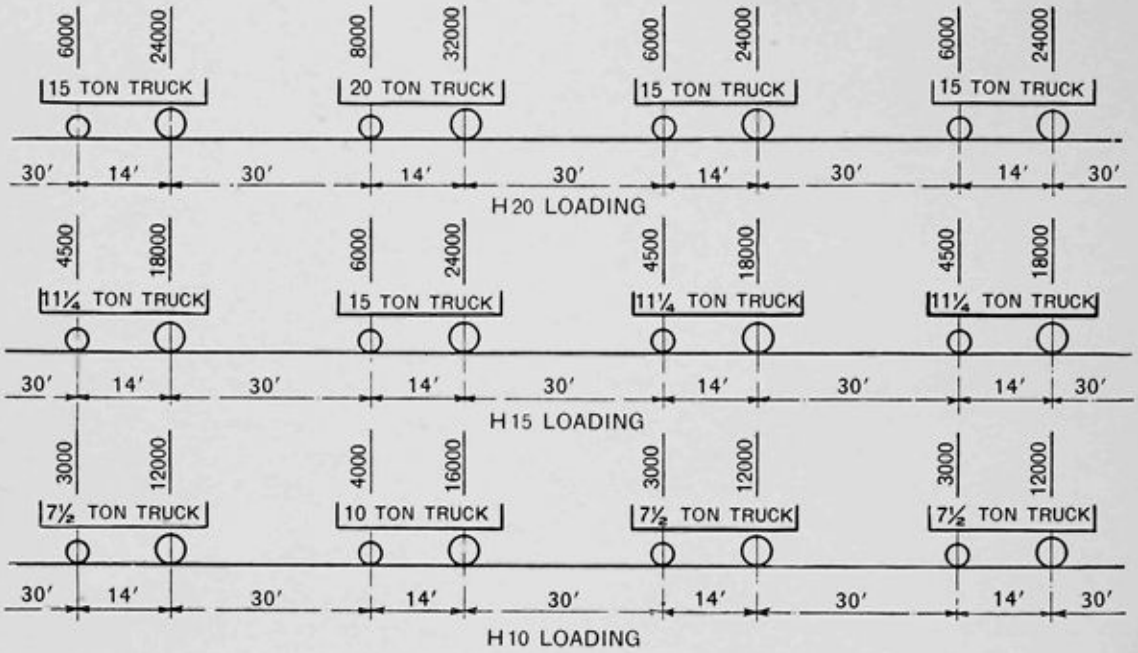
Top—*Tees passing through Straightening Rolls*

Bottom—*T-Tri-Lok Unit in 3500 ton Hydraulic Press*

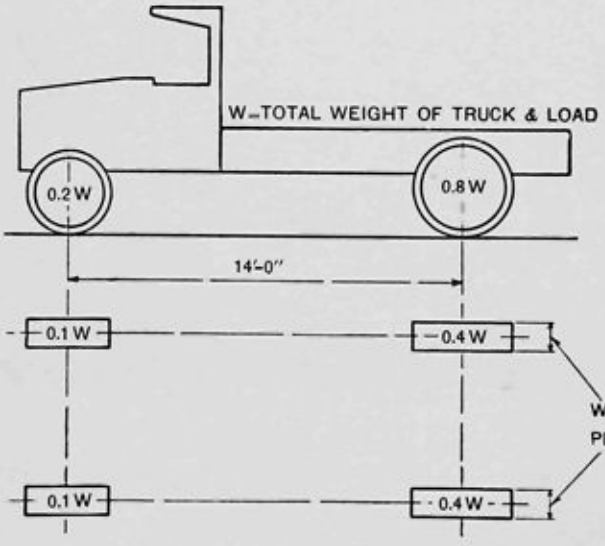
Top—*T-Tri-Lok Units on Assembly Tables*

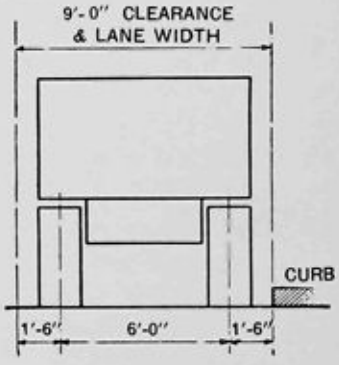
Bottom—*Removing Grease or Oil by dipping T-Tri-Lok Units in Hot Bath*

DISTRIBUTION OF TRUCK LOADS FOR HIGHWAY BRIDGES



TRUCK





ENGINEERING DATA

Since the first edition of the T-Tri-Lok pamphlet was published, a very important and significant change in design has been adopted as standard. The U. S. Department of Agriculture, Bureau of Public Roads, tested two slabs and published the results in "Public Roads," September, 1932. The first slab tested consisted of light tees and cross bars with no welding at the edges of the tee flanges, while the one designated as second slab consisted of heavier tees with the edges of the flanges welded together at about 4-foot intervals by welds 2-inches long. Our present standard practice conforms to the second slab with respect to the weight of tees and process of welding. These two factors are largely responsible for the increase in strength of the slabs and the lateral distribution of loads, so this second edition of T-Tri-Lok contains new design data based upon the results shown in the second test. Static loads ranging from 5,000 to 20,000 pounds in increments of 5,000 pounds were applied, and deflections and strain gauge readings were recorded. The static loads were then removed and 1,000 impact blows of 23,000 to 32,000 pounds intensity were applied. Static loads were again applied as before and this procedure continued with dynamic loads and static loads alternating, except that after the third impact series, static loads of 30,000 and 40,000 pounds were also applied. Strain and deflection readings were recorded under each application of static loads. The final test showed a maximum tension of 5,100 pounds in the flanges of the tees when subjected to a 20,000 pound load, with maximum deflection of .077 inch. Charts showing essential data on these tests are given on pages 26 to 35. A complete report of these tests appeared in "Public Roads," September, 1932.

The test data show conclusively that the load concentrations were distributed throughout the entire structure but in order that we may be able to predict the reaction of such a structure to spans other than that used in the test, as well as to provide a method of approach for other similar structures, it is necessary to interpret the tests in the light of allowable assumption of lateral distribution.

In the following presentation of design data, a sincere attempt has been made to reconcile the test results as reported by the Bureau of Public Roads with commonly accepted theories advanced by Westergaard (see "Public Roads," March, 1930), modifying and simplifying the entire procedure to make it more readily adaptable for everyday use. Studies were made for live load moments with traffic parallel and also normal to the direction of the tees. The moments for the latter were found to be slightly greater and the resulting formula for this case was then adopted as applying to both. Due consideration being given to the fact that where the distance between rear wheels of trucks in adjacent lines is normal (3 feet, see diagram, page 18), the second wheel load concentration has its influence on the moment where the stringer spacing is 5.08 feet or greater. As spans increased, the effect of the second and third wheel loads was added to obtain the total moment and plotted, thus making an irregular curve with breaks where the second and third wheels began to influence the moment.

Westergaard's theory was introduced as follows: For simple span determination effective width $E = .58L + 2C$ (See "Public Roads," March, 1930, Equation No. 65). In this formula L equals span in feet and C is assumed for the purpose of this study

to be 1.25 feet, the diameter of a circle whose area is practically equivalent to the area over which the load is applied due to tire spread. For multiple span determination a uniform curve was then selected which could be expressed in a simplified formula and which would represent safe practice for all cases of three or more continuous spans ranging from 2 to 7 feet. The curve representing live load moments for various spans can be plotted from the formula $M = \frac{WL}{4E}$, in which E, the effective width, becomes .165 L + 6.10.

For impact we have used, $\frac{50}{125 + L}$ % added to the live load moment. While this varies from 40 per cent at 0 span to 38 per cent at 7′-0″ span, for simplicity we have applied 40 per cent for all spans which is on the side of safety. Dead load moments are calculated using $M = \frac{wL}{10}$, making the total moment $M = \frac{1.4\ WL}{4\ E} + \frac{wL}{10}$ foot pounds.

The foregoing design data does not provide for the effect of loads near unsupported edges. Therefore, at the ends of the bridge and at intermediate supports where the continuity of the slab is broken, the edges of the slab shall be supported by diaphragms or other suitable framing. The outer edges of all slabs shall be supported by beams or other suitable framing capable of resisting one-half the moment produced by one wheel load, assuming no distribution.

Slabs designed for bending moment in accordance with the foregoing rules may be considered adequate for shear without additional special reinforcement.

The wheel load concentrations for H 20 and H 15 loading as shown are derived from the chart on page 18, 40 per cent having been added for impact, bringing the loads up to 22,400 and 16,800 pounds, respectively. Stresses shown in the tables are those resulting from the positive moment.

With regard to the tension stresses in the stems of the tees over the supports due to negative moment, reference to the test data given elsewhere will show very low unit stresses. This is due—

First, to the fact that the neutral axis in the T-Tri-Lok slabs is only about three-tenths of the depth above the bottom of the slab (1.1″ for 3½″ T-Tri-Lok). This leaves an appreciable amount of the tee stem above the neutral axis (1.4″ for 3½″ T-Tri-Lok) for resisting negative moment tension.

Second, the strength of the T-Tri-Lok slab is so great in relation to the strength of the individual stringers that the slab tends to deflect uniformly like a plate with very little negative moment over the stringers nearest the point of load application. Reference to deflection curves plotted for center lines normal to I beams shows this clearly.

NOTATIONS USED IN FORMULAS

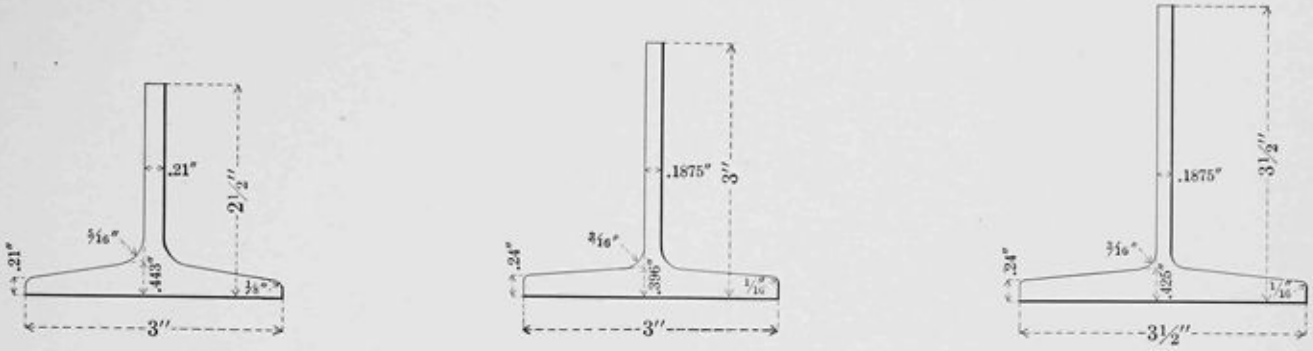
I	= moment of inertia of slab per foot of width, in inches^4
x	= distance from neutral axis to bottom, in inches.
y	= distance from neutral axis to top, in inches.
f_c	= unit stress in compression for concrete, lbs./sq. in.
f_s	= unit stress in tension for steel, lbs./sq. in.
Mmax.	= maximum bending moment, in inch-pounds.
L	= span, in feet.
l	= span, in inches.
W	= Average wheel load concentration per foot of slab width, in pounds.
w	= weight of slab per square foot, in pounds.
E	= effective width of slab, in feet.
n	= ratio of modulus of elasticity of steel to concrete = 15.

Live load Mmax. $= \frac{Wl}{4} = f_c \frac{I}{y}$ Dead load Mmax. $= \frac{12\ wL^2}{10}$

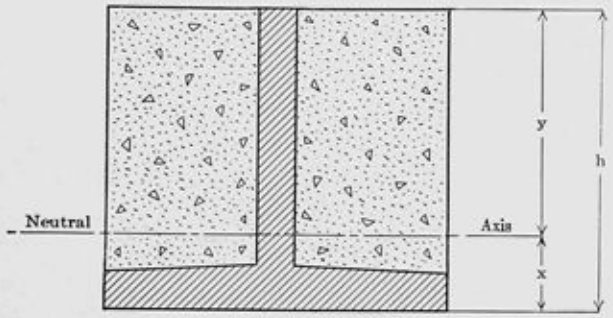
Live load $f_c = \frac{Wly}{4\ I}$ $f_s = \frac{15\ f_c\ x}{y}$

Dead load $f_c = \frac{12wL^2y}{10\ I}$

STANDARD TEE SECTIONS

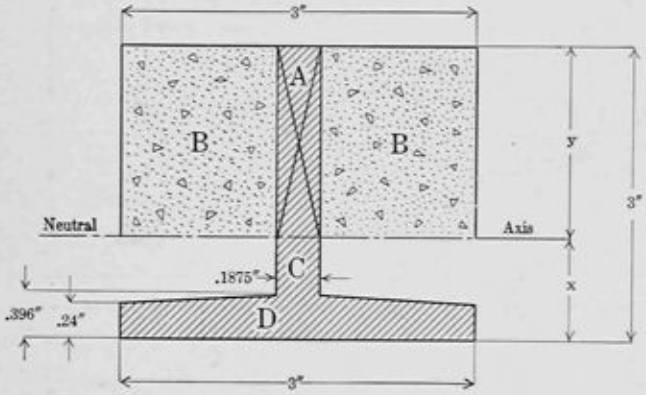


ELEMENTS OF T-TRI-LOK SLABS



Size of Tee				Area of Tee	Weight of Tee per Lin. Ft.	Weight of Tees per Sq. Ft. of Slab	Size of Cross Bars	Weight of Cross Bars per Sq. Ft. of Slab	Weight of Steel per Sq. Ft. of Slab	Total Weight of Slab per Sq. Ft.	I per Ft. of Slab Width	x	y
Flange	Stem	Min. Thickness											
		Flange	Stem										
In.	In.	In.	In.	In.²	Lbs.	Lbs.	In.	Lbs.	Lbs.	Lbs.	In.⁴	In.	In.
3	2½	.210	.210	1.435	5.0	20.0	1 x 3/16	1.9	21.9	45.4	63.6	.76	1.74
3	3	.240	.1875	1.440	4.9	19.6	1 x 3/16	1.9	21.5	51.1	101.9	.95	2.05
3½	3½	.240	.1875	1.765	6.0	20.6	1 x 3/16	1.9	22.5	57.8	151.0	1.11	2.39

CALCULATION FOR LOCATION OF NEUTRAL AXIS



COMPRESSION AREA, $A + 2B = (3 + 14 \times .1875)\, y = 5.625y$

Moment Arm $= \frac{y}{2}$

Moment of Comp. Area, $A + 2B = 5.625y \times \frac{y}{2} = 2.8125y^2$

(Tension in concrete below neutral axis is neglected.)

TENSION AREA, C $= (3 - .396 - y) \times .1875 \times 15$

Moment Arm $= \frac{(3 - .396 - y)}{2}$

Moment of Tension Area, $C = \frac{(3 - .396 - y)^2}{2} \times .1875 \times 15$

TENSION AREA, D =

$$\frac{(.24 + .396) \times (3 - .1875)}{2} + .396 \times .1875 = .96863 \text{ in.}^2$$

Average Thickness of Area, $D = \frac{.96863}{3} = .32288$

Moment Arm $= \left(3 - \frac{.32288}{2} - y\right)$

Moment of Tension Area, D =

$$.96863 \times 15 \times \left(3 - \frac{.32288}{2} - y\right)$$

Equating Moments of Compression and Tension Areas,

$$2.8125y^2 = \frac{(3 - .396 - y)^2}{2} \times .1875 \times 15 + .96863 \times 15 \times \left(3 - \frac{.32288}{2} - y\right)$$

Simplifying,

$$y^2 + 15.54005y = 36.10898$$

$$(y + 7.77003)^2 = 36.10898 + 7.77003^2 = 96.48235$$

$$y = \sqrt{96.48235} - 7.77003 = 2.05251 \text{ in.}$$

$$x = 3 - 2.05 = 0.95 \text{ in.}$$

CALCULATION FOR MOMENT OF INERTIA

I of Area A $= \frac{15 \times .1875 \times 2.05251^3}{3} = 8.10638$

I of Area 2B $= \frac{2.8125 \times 2.05251^3}{3} = 8.10638$

I of Area C $= \frac{15 \times .1875 \times .55149^3}{3} = .15725$

I of Area D $= \frac{(3 \times .32288^3) \times 15}{12}$

$+ 15 \times .96863 \times .78605^2 = .9.10357$

Total I for each tee $= 25.47358 \text{ in.}^4$

I per foot of Slab $= \frac{12 \times 25.47358}{3} = 101.9 \text{ in.}^4$

EXAMPLE OF T-TRI-LOK COMPUTATION

Find the stresses in concrete and steel using H 20 loading for 3½" T-Tri-Lok on 5 foot stringer spacing:

Dead weight of slab = 57.8 pounds per square foot.

I per foot of width = 151.0 in.^{4}

x = 1.11 in. y = 2.39 in.

E = .165 × 5 + 6.10 = 6.925 ft.

Wheel load = 16,000 + 40% for impact = 22,400 pounds.

Live load moment including impact = $\frac{1.4 \times 16{,}000 \times 60}{6.925 \times 4}$ = 48,520 inch-pounds.

Dead load moment = $\frac{57.8 \times 5 \times 60}{10}$ = 1,734 inch-pounds.

Total moment = 50,254 inch-pounds.

$f_c = \frac{50{,}254 \times 2.39}{151}$ = 795 pounds.

$f_s = \frac{15 \times 50{,}254 \times 1.11}{151}$ = 5,541 pounds.

RECOMMENDED PRACTICE FOR INSTALLATION

Experience on installations has convinced us—

First. That in order to take full advantage of the light weight, no over-fill should be used. The armored floor will not only resist the internal stresses resulting from the most severe traffic conditions, but will at the same time provide an ideal roadway surface which will have a long life, without showing unsightly cracks, no progressive failure, no maintenance to speak of except periodical inspection and painting underneath. However, if so desired, an over-fill of concrete, asphalt or other material may be installed at any time.

Second. To get the best possible wearing qualities and hardness in the concrete surface the following simple recommendations should be followed:

1. Do not use too much water in the mix.

2. Deposit and spread concrete to its final location as quickly as possible, vibrating the structure to assist in spreading and eliminating voids.

3. Float at once, bringing surface to proper level as quickly as possible and then avoid further work, being especially careful to avoid unnecessary lateral movement of the mixture at the surface. Do not attempt to secure a smooth finish by floating the finer aggregate to the surface but allow as much coarse aggregate as possible to remain at the top and immediately become part of the wearing surface.

4. When hard, cure the concrete under a wet cover.

Third. That a very good method of curing and one which we recommend is to apply a spray of emulsified asphalt immediately after concrete is finished. This seals the upper surface and prevents loss of water by evaporation, in a most effective manner. Other well known methods of curing by means of burlap or straw kept wet by sprinkling at proper intervals may be used.

Fourth. In the erecting of T-Tri-Lok units, care should be exercised to place each unit in its proper position, measuring in all cases to some fixed point, as otherwise a cumulative error in spacing is quite likely to appear, making necessary either flame cutting the final units or inserting some additional steel to fill up a gap.

In order to obtain a more uniform practice the specification on pages 36 and 37 is suggested. It may be modified or amplified whenever necessary to conform to any code or standard specification.

UNIT STRESSES IN STEEL AND CONCRETE FOR T-TRI-LOK SLABS

IN POUNDS PER SQUARE INCH

Span	3½" T-TRI-LOK				3" T-TRI-LOK				2½" T-TRI-LOK			
	H 20 Loading		H 15 Loading		H 20 Loading		H 15 Loading		H 20 Loading		H 15 Loading	
	f_c	f_s	f_c	f_s	f_c	f_s	f_c	f_s	f_c	f_s	f_c	f_s
2′—0″	335	2335	253	1759	425	2957	321	2227	578	3786	435	2849
2′—3″	375	2615	283	1971	476	3311	359	2494	647	4238	487	3190
2′—6″	415	2892	313	2181	527	3661	397	2759	715	4685	539	3529
2′—9″	455	3167	343	2390	577	4008	435	3022	783	5128	590	3865
3′—0″	494	3439	373	2597	626	4352	472	3283			641	4197
3′—3″	533	3709	402	2802	675	4693	510	3542			691	4527
3′—6″	571	3977	432	3006	724	5031	547	3799			741	4855
3′—9″	609	4243	461	3209	772	5366	583	4054				
4′—0″	647	4507	490	3411	820	5698	620	4308				
4′—3″	685	4768	518	3611	867	6027	656	4562				
4′—6″	722	5028	547	3810	914	6354	692	4809				
4′—9″	759	5285	575	4007	961	6678	728	5057				
5′—0″	795	5541	605	4213	1007	6999	763	5303				
5′—3″	832	5795	632	4399	1053	7318	798	5548				
5′—6″	868	6047	659	4593	1099	7635	833	5791				
5′—9″	904	6297	687	4786	1144	7949	868	6033				
6′—0″	940	6546	715	4978	1189	8261	903	6273				
6′—3″	975	6793	742	5169			937	6512				
6′—6″	1010	7038	769	5359			971	6749				
6′—9″	1045	7282	797	5548			1005	6986				
7′—0″	1080	7524	824	5736			1039	7220				

2" T-TRI-LOK—UNIFORMLY LOADED

2" x 2" x ¼" Tees, 4" Centers. Concrete Flush.

Load, Lbs. per Sq. Ft.	SPAN IN FEET																	
	4′—0″		4′—6″		5′—0″		5′—6″		6′—0″		6′—6″		7′—0″		8′—0″		9′—0″	
	f_c	f_s	f_c	f_s	f_c	f_s	f_c	f_s	f_c	f_s	f_c	f_s	f_c	f_s	f_c	f_s	f_c	f_s
100	115	1101	145	1394	179	1720	217	2082	258	2477	303	2908	351	3372	459	4404	581	5574
150	172	1652	218	2090	267	2581	325	3123	387	3716	454	4361	527	5058	688	6606		
200	229	2202	290	2787	359	3441	434	4163	516	4955	606	5815	703	6744	918	8809		
250	287	2753	368	3484	448	4301	542	5204	645	6194	757	7269						
300	344	3303	436	4181	538	5161	651	6245	774	7432								
400	457	4404	581	5574	717	6882	868	8327										

In the tables the stress f_c for concrete has been kept below 1200 pounds for the 3" and 3½" T-Tri-Lok sections, and below 800 pounds for the 2½" section.

n, ratio of modulus of elasticity of steel to concrete = 15.

Loads above heavy lines will not produce excessive deflections.

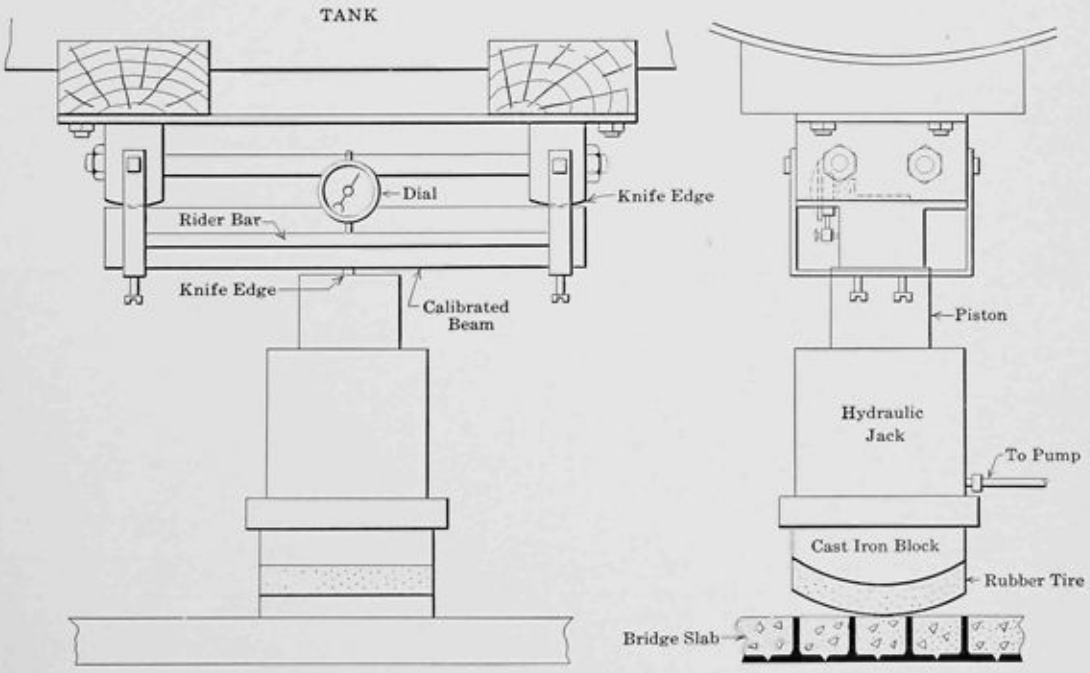
T-TRI-LOK BRIDGE FLOOR CONSTRUCTION



Oak Street Bridge, Toledo, Ohio
Standard Engineering Co., General Contractor

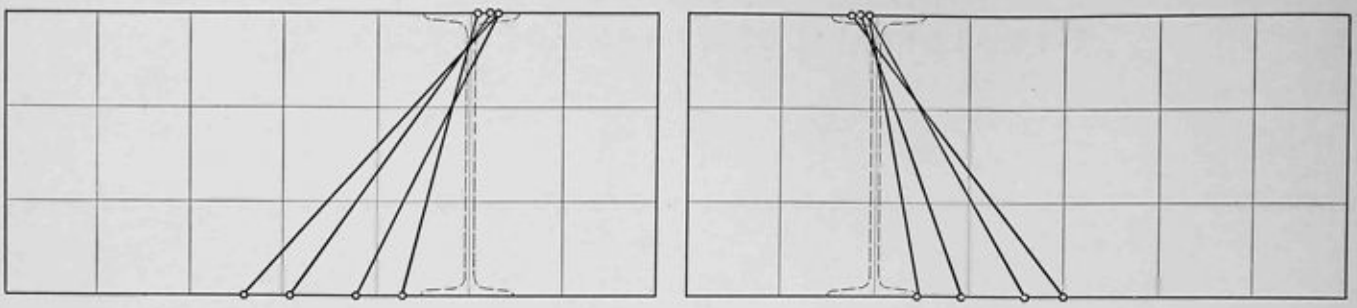


Dodson, Missouri, Bridge.
Dodson City Structural Steel Co., General Contractor

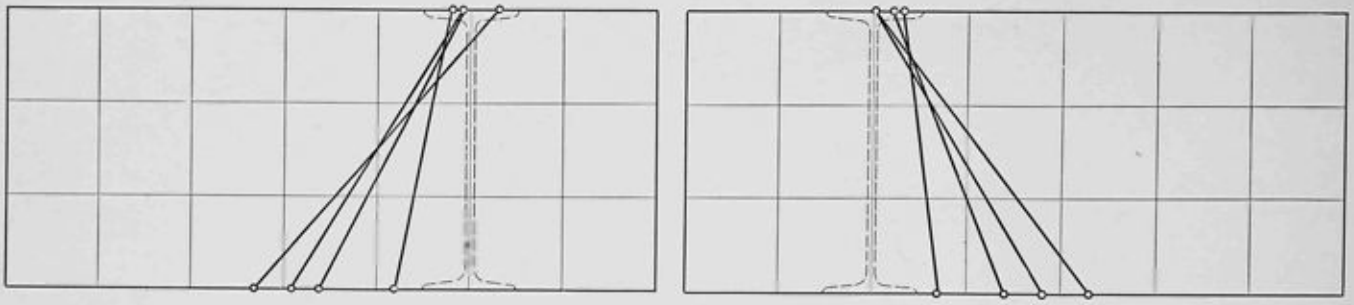


Apparatus Used in Application and Measurement of Load

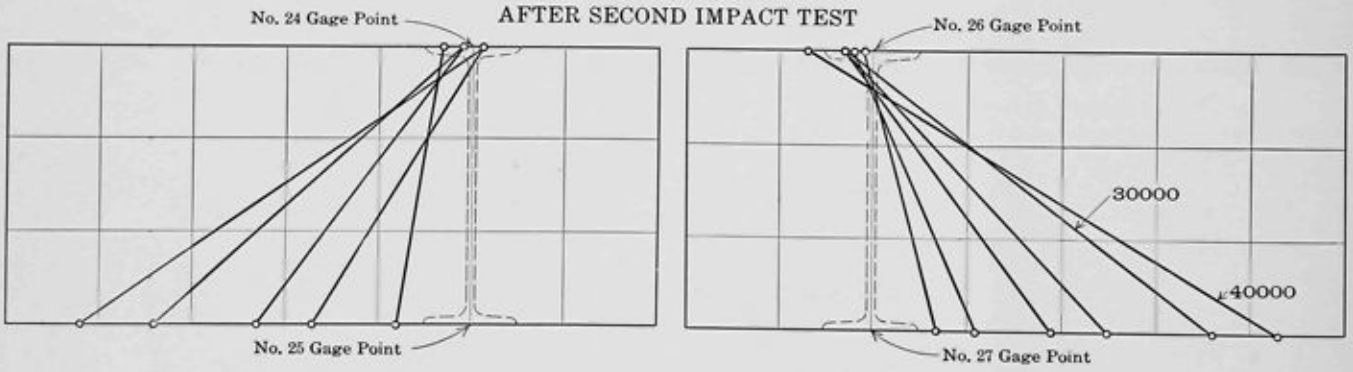
BEFORE IMPACT TESTS



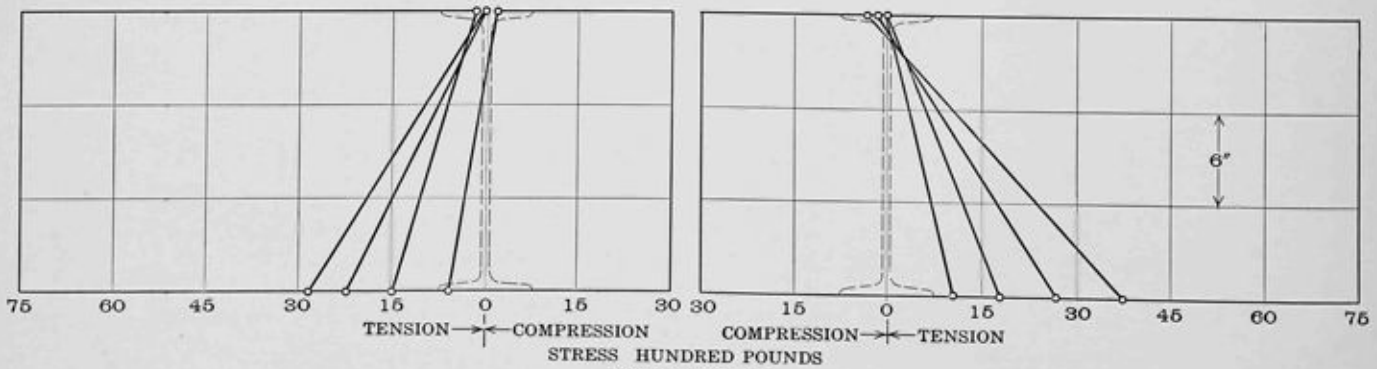
AFTER FIRST IMPACT TEST



AFTER SECOND IMPACT TEST

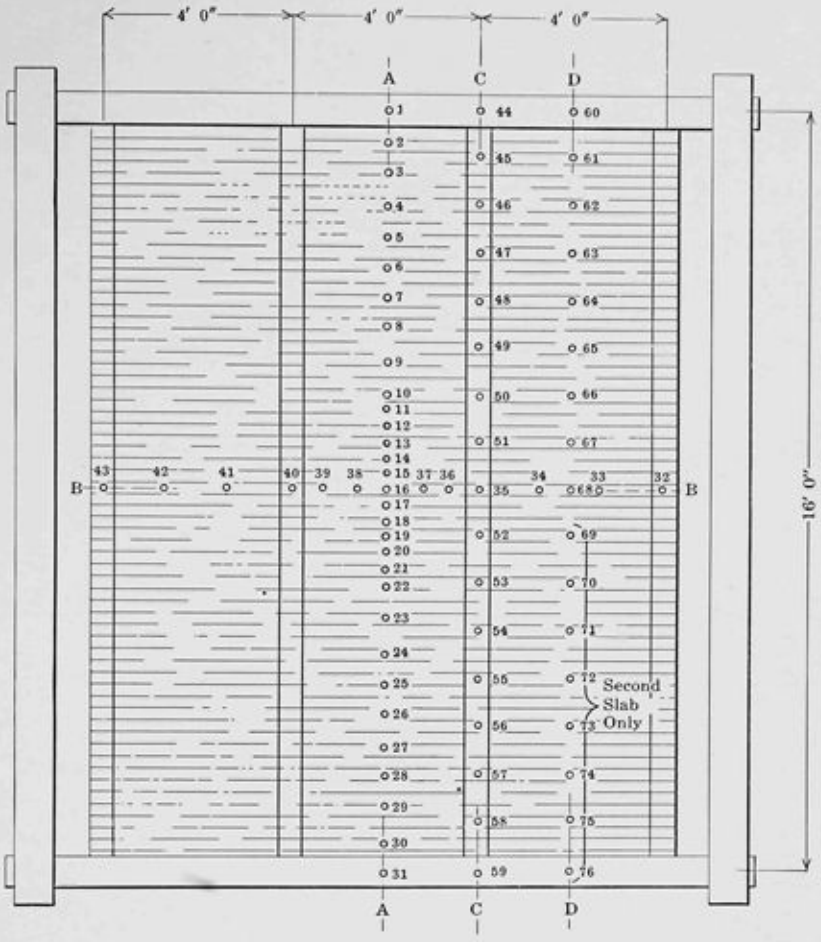


AFTER THIRD IMPACT TEST

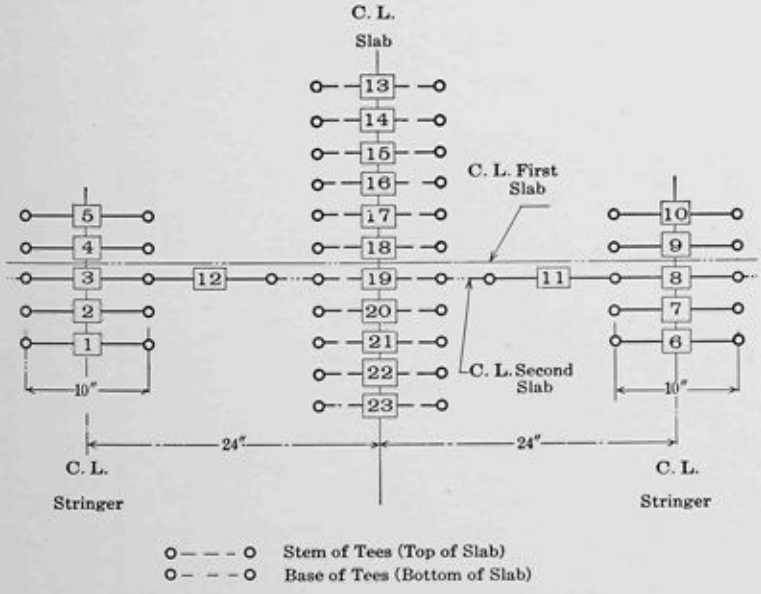


SECOND SLAB

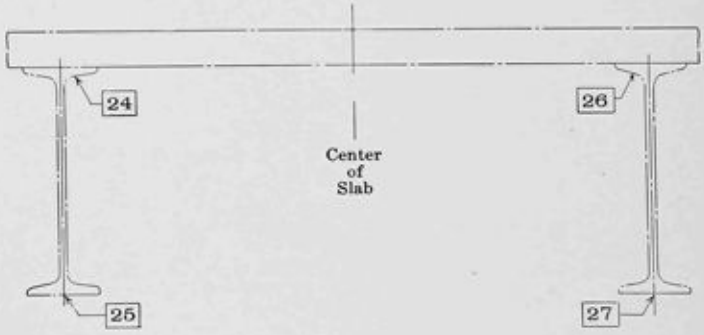
STRESSES AT MIDPOINT OF STRINGERS UNDER STATIC LOADS OF 5, 10, 15 OR 20 THOUSAND POUNDS



PLAN OF SLAB SHOWING DEFLECTION POINTS

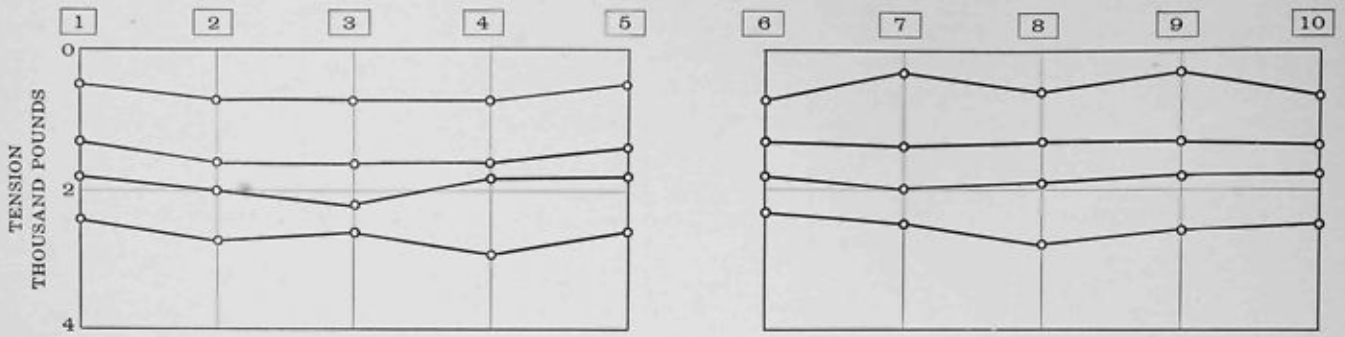


PLAN SHOWING LOCATION OF STRAIN GAGE POINTS IN THE TEES

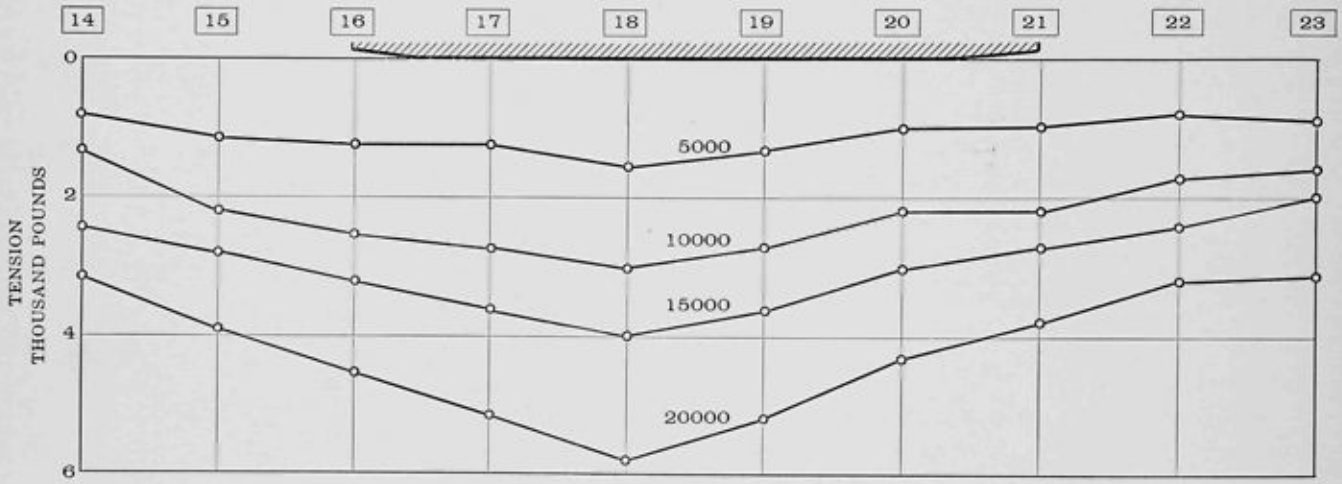


SECTION SHOWING LOCATION OF STRAIN GAGE POINTS AT MIDPOINT OF THE STRINGERS

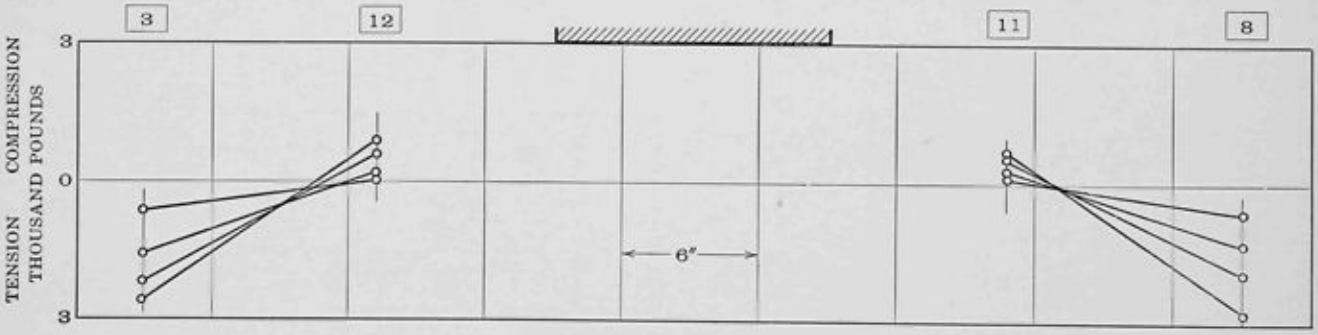
STRESSES IN STEM OF TEES



STRESSES IN BASE OF TEES



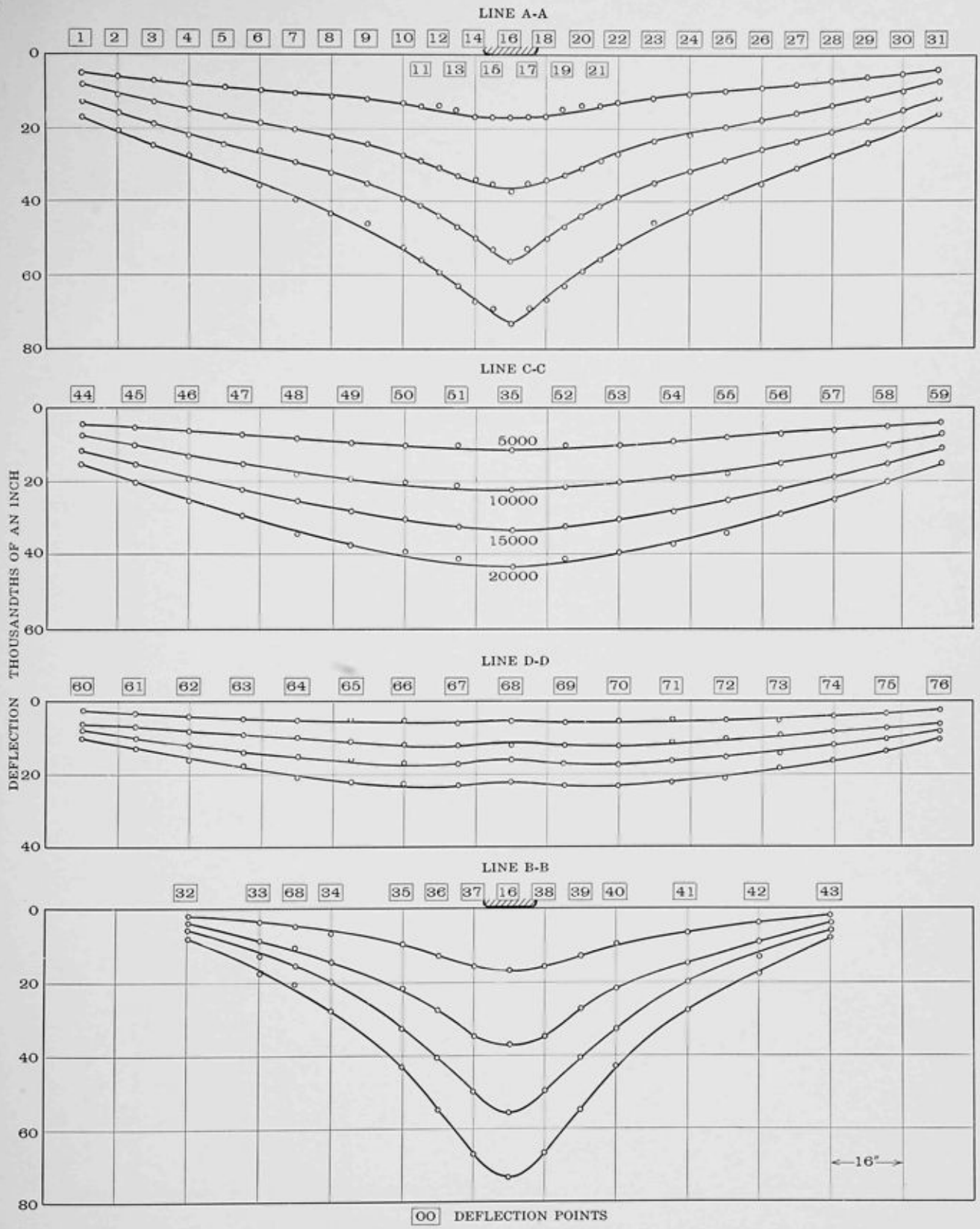
STRESSES IN STEM OF TEES



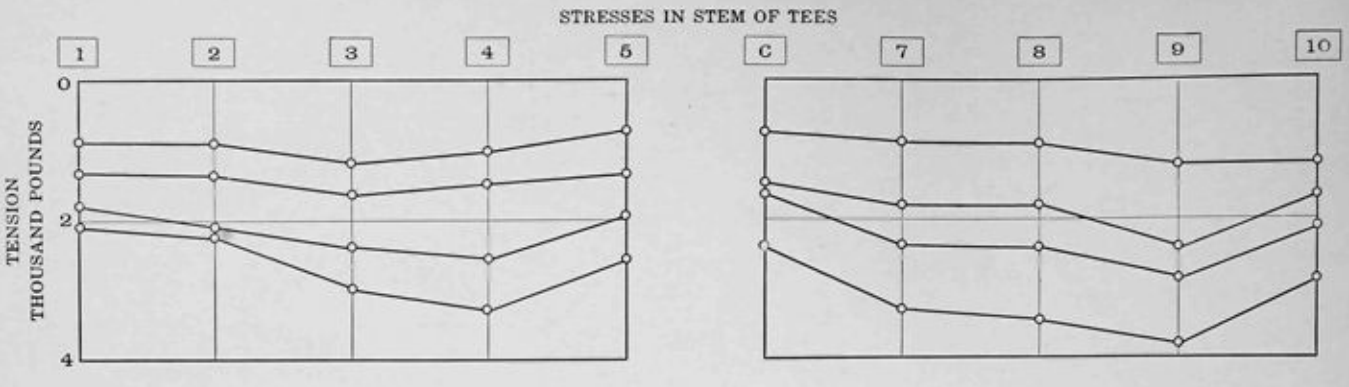
SECOND SLAB

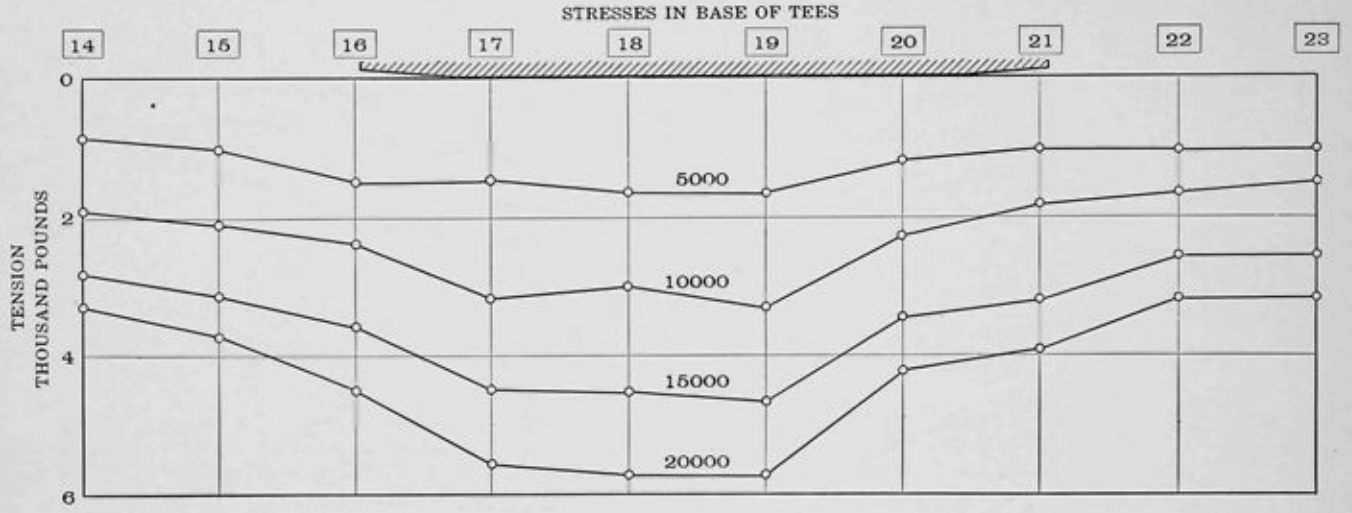
STRESSES DUE TO STATIC LOADS BEFORE IMPACT

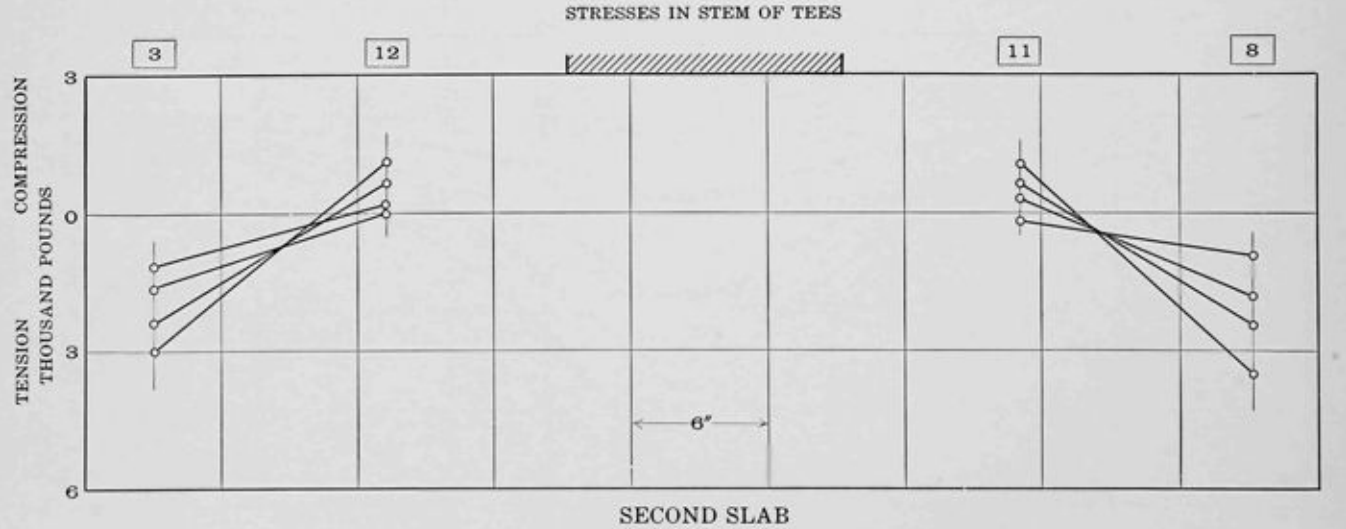
00 STRAIN GAGE POINTS



DEFLECTION OF SECOND SLAB
CENTER LOADING BEFORE IMPACT



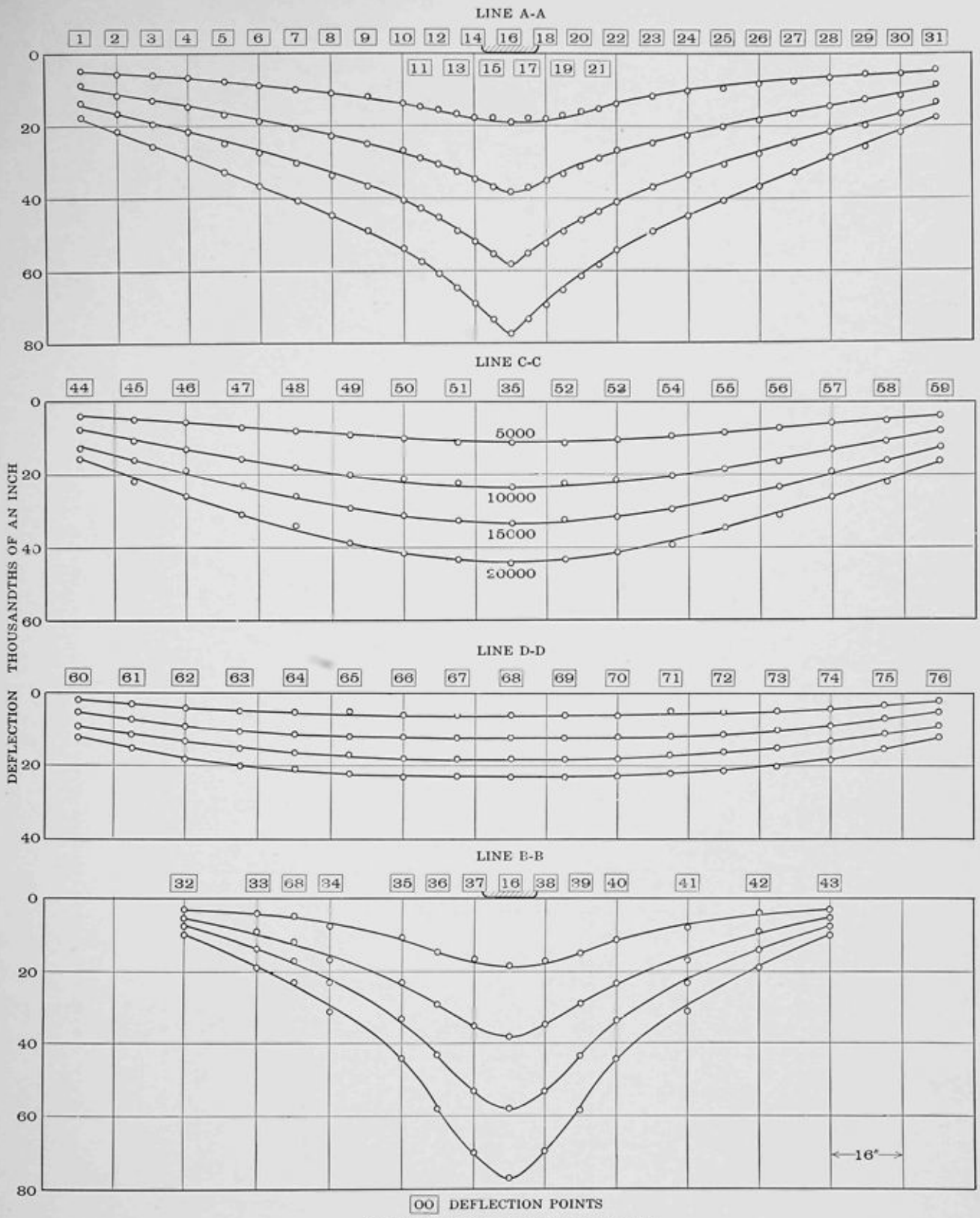




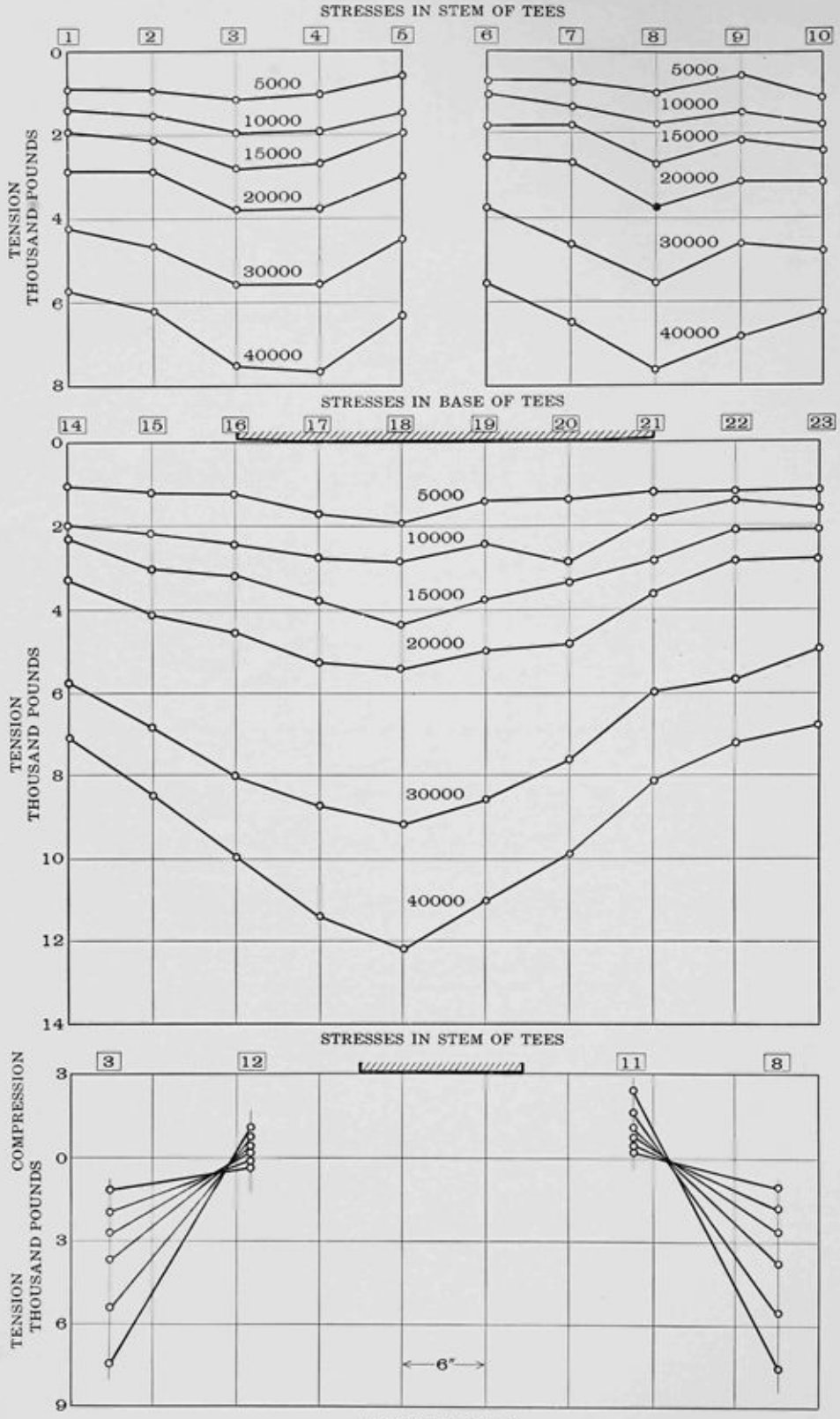
SECOND SLAB

STRESSES DUE TO STATIC LOADS AFTER FIRST IMPACT

00 STRAIN GAGE POINTS



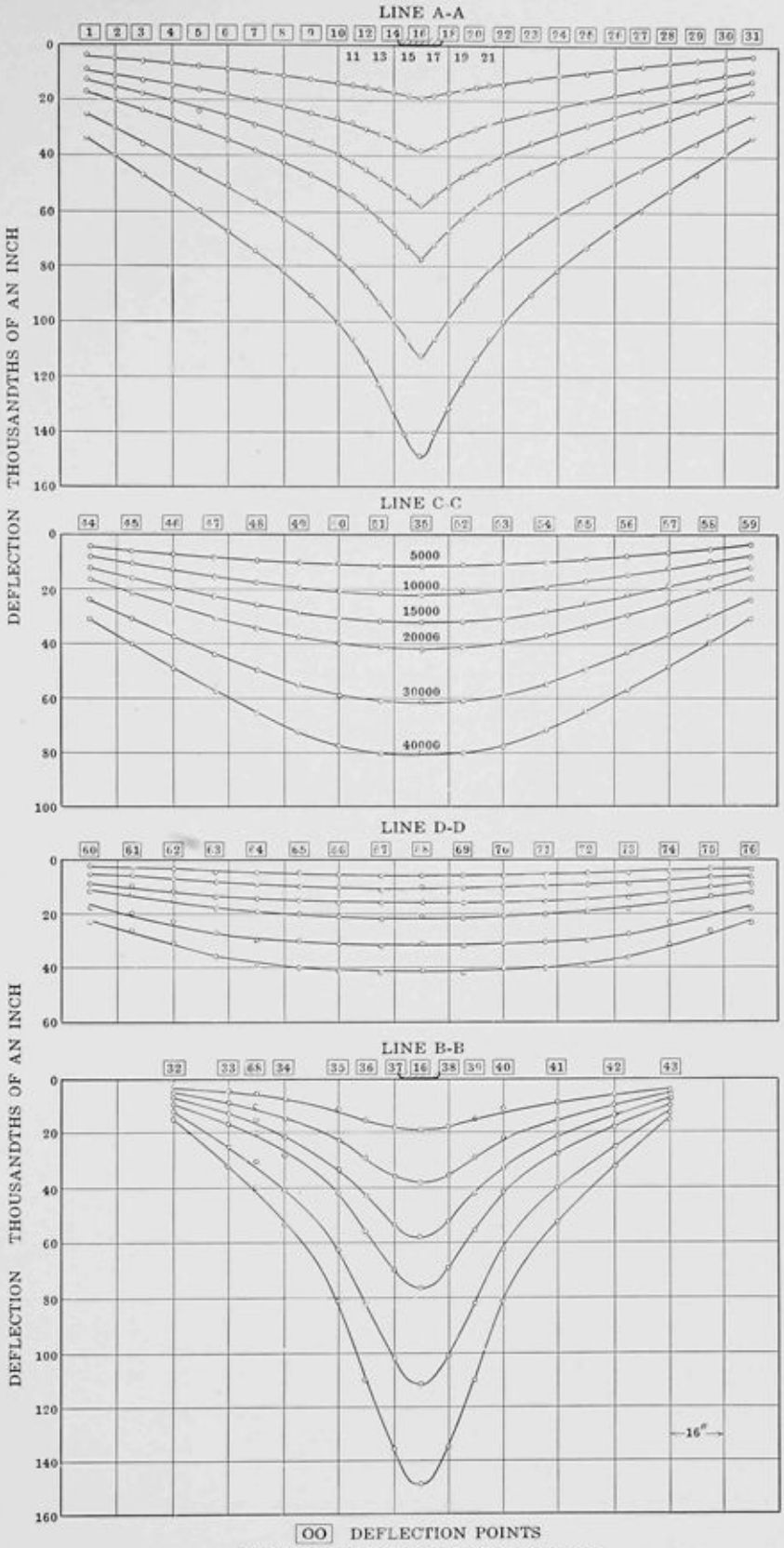
DEFLECTIONS OF SECOND SLAB
CENTER LOADING AFTER FIRST IMPACT



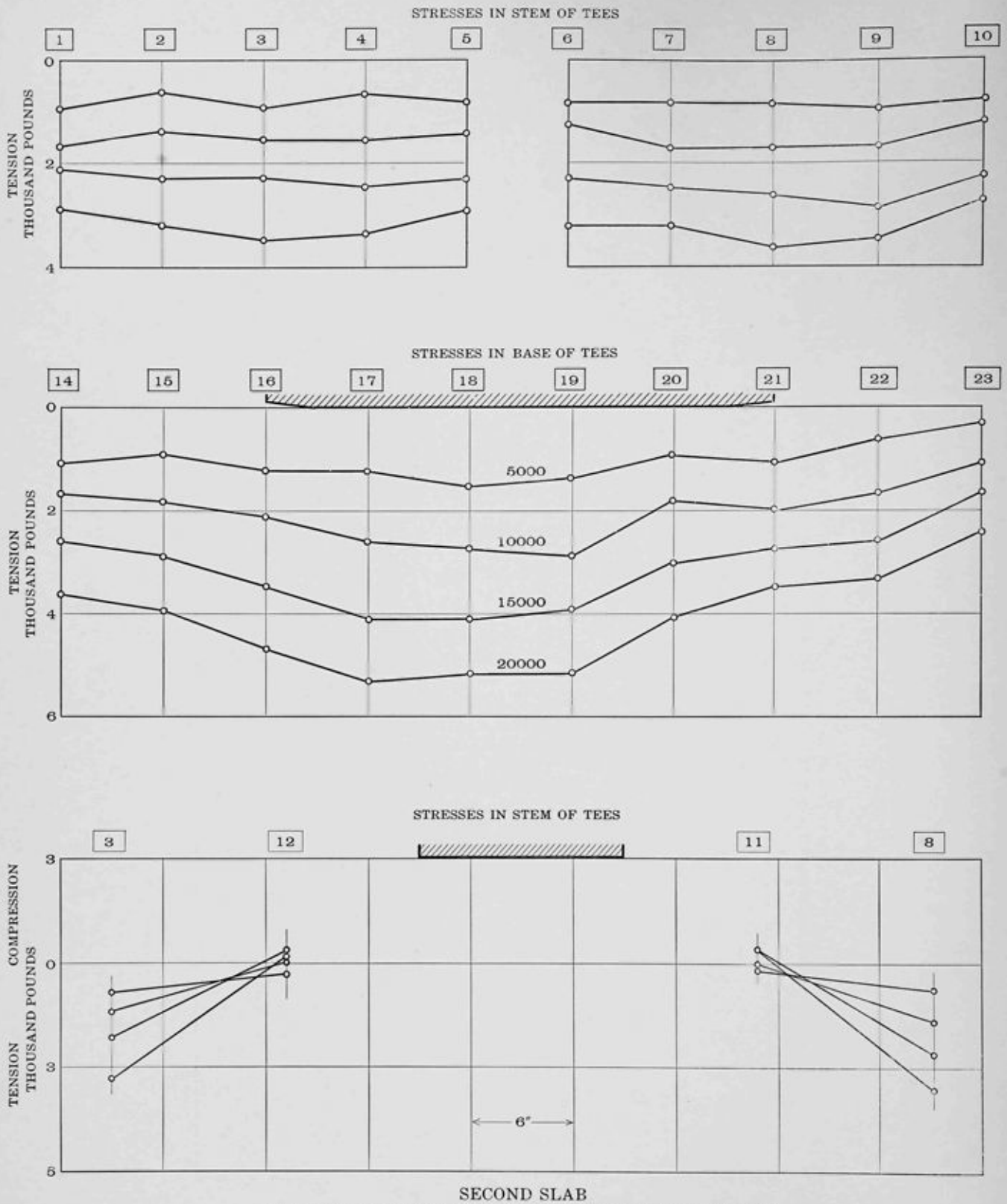
SECOND SLAB

STRESSES DUE TO STATIC LOADS AFTER SECOND IMPACT

[00] STRAIN GAGE POINTS



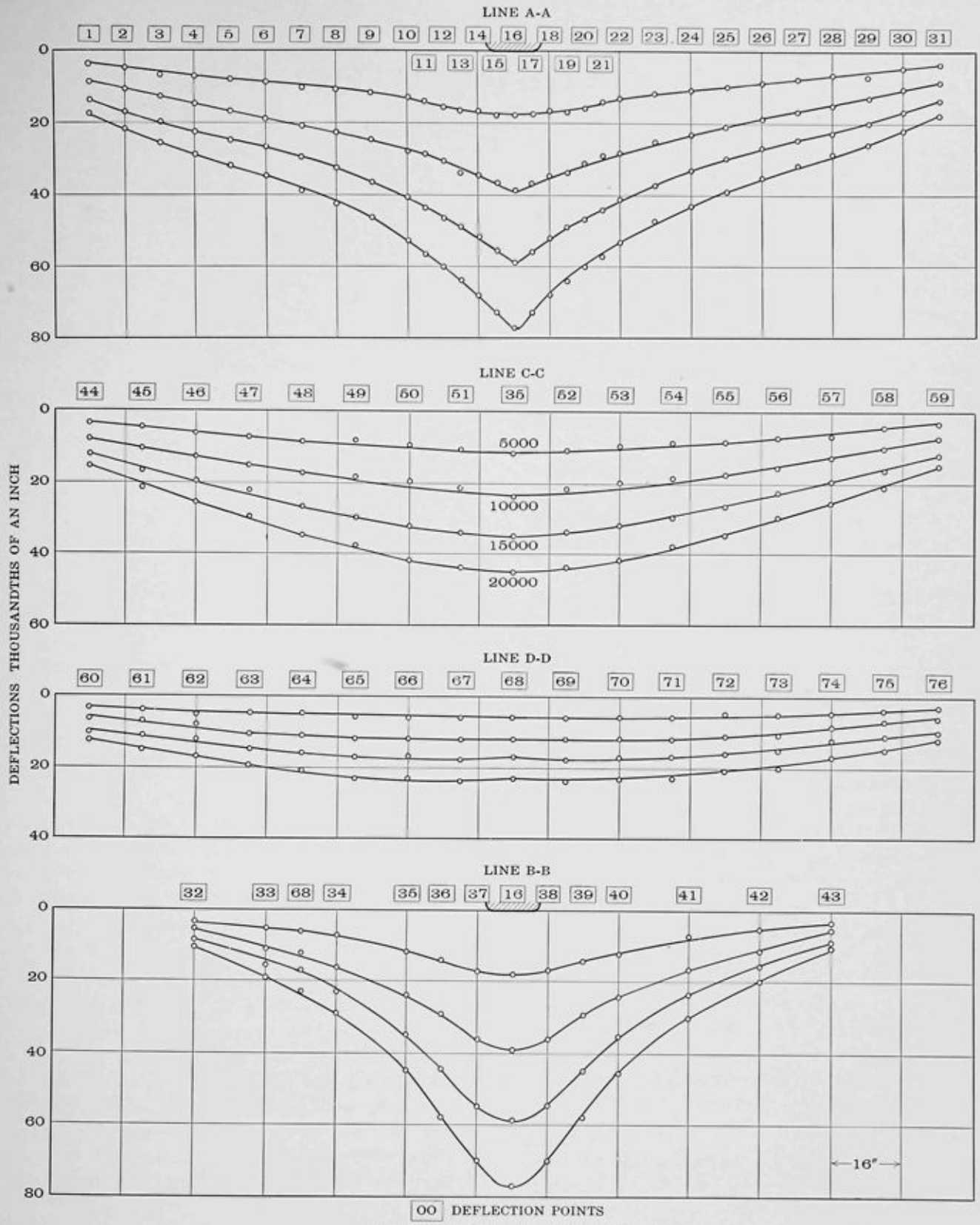
DEFLECTION OF SECOND SLAB
CENTER LOADING AFTER SECOND IMPACT



SECOND SLAB

STRESSES DUE TO STATIC LOADS AFTER THIRD IMPACT

[00] STRAIN GAGE POINTS



DEFLECTIONS OF SECOND SLAB
CENTER LOADING AFTER THIRD IMPACT

SPECIFICATION FOR T-TRI-LOK BRIDGE FLOOR CONSTRUCTION

DESCRIPTION. The bridge floor slab shall consist of units of T-Tri-Lok, a combination of T-shaped members with rectangular cross bars pressed into slots in the stems of the tees to form rigid units. The depth of the finished floor and the dimensions and weight of the tees and bars shall be as shown on the plans. After these units are erected and welded to the supporting members, the entire T-Tri-Lok structure shall be filled with concrete and finished flush with the tops of the stems of the tees and of the cross bars to form an armored wearing surface.

STEEL MATERIAL. All steel shall be furnished to the structural grade of A. S. T. M. Standard Specification for Bridges A7-29, except that the cross bars shall have a tensile strength of 50,000 to 60,000 pounds per square inch. All steel shall have a copper content of .2 per cent minimum.

FABRICATION OF STEEL. All steel shall be commercially straight and be assembled in a workmanlike manner. The tees shall be placed side by side with flanges at the bottom to form units approximately 4 feet wide but not exceeding 40 feet in length. The average distance between the edges of adjacent flanges of the tees in each unit shall not exceed $\frac{1}{8}$ inch but in no case shall the maximum opening exceed $\frac{1}{4}$ inch. Cross bars shall be spaced 4 inches center to center at right angles to the stems of the tees and when pressed into final position in the slots shall have their tops approximately flush with the tops of the stems of the tees. The cross bars shall have the ends projecting through the stems of the outside tees of the unit alternately long and short so as to produce staggered joints between units. See plan of typical arrangement on page 38. If it is considered advisable by the designing engineer to maintain continuous cross bar steel in the upper surface adjacent to area where moment is maximum, a few of the cross bars in the center of the span between supports may be over-lapped and welded in the field. Half holes $\frac{15}{16}$ inch in diameter, full holes or slotted holes shall be punched in the edge of every third tee to permit plug welding to the supporting members (at the discretion of the designer). The flanges of all tees in each unit shall be securely fastened together at the ends by means of welds 2 inches long, and midway between supports by welds 3 inches long for all spans up to 5 feet, and 4 inches long for spans greater than 5 feet. The reinforcement in these welds shall be at least $\frac{1}{16}$ inch thick and $\frac{3}{8}$ inch plus the clearance between the tee flanges in width. The depth of penetration shall be sufficient to insure complete uninterrupted integration of the weld metal with the base metal. After fabrication and before shipment all grease and oil shall be completely removed from all units by means of a hot lye solution or other approved solvent.

DRAWINGS. Shop detail drawings shall be furnished by the manufacturer to the purchaser for approval. Erection drawings shall be furnished to the contractor when the nature of the project warrants it for use in assembling and erecting material.

FIELD ASSEMBLY. The T-Tri-Lok units shall be placed by the erector as indicated on the erection diagram and plug welded to the supports through the holes provided for the purpose. Where units are placed transversely they shall be, if possible, of a length to span the entire roadway; otherwise, the ends of units shall be welded to provide continuity. Where the tees in the units are parallel to the direction of traffic, sufficient welding shall be done between the ends of abutting units to provide continuity.

CONCRETE. The concrete shall be composed of one (1) part of Portland cement and five (5) parts of fine and coarse aggregate approximating a 1:2:3 mix proportioned as follows: one (1) part of Portland cement, not more than two (2) parts of fine aggregate and not less than three (3) parts of coarse aggregate. See also recommended practice, page 23.

FINE AGGREGATE. Sand shall consist of clean, hard, durable uncoated grains, free from injurious amounts of dust, lumps of clay, organic matter, loam or other deleterious substances.

The grading shall be from fine to coarse with the coarser particles predominating. After being thoroughly dried, the sand shall meet the following requirements by weight:

Three eights (3/8) inch screen circular opening passing	100 per cent
No. 4 Sieve passing	85 to 100 " "
No. 16 " "	45 to 80 " "
No. 50 " "	5 to 30 " "
No. 100 " "	0 to 6 " "
Clay and silt removed by decantation test	Not over 3 " "
Coal	Not over 2 " "

COARSE AGGREGATE, GRAVEL. Gravel shall be clean, washed, free from clay or coating of any character and shall be tough and durable. Flat or elongated particles, soft stone or shale or run of the bank gravel will not be permitted.

BROKEN STONE. Broken stone if used as the coarse aggregate shall be clean, sound, of uniform quality and free from thin and elongated pieces. If obtained by crushing gravel, only that portion which has been retained upon a screen with 2-inch openings or larger shall be used.

Gravel or crushed stone shall be graded 3/8 inch to 3/4 inch, 95 to 100 per cent passing 3/4 inch mesh and 0 to 8 per cent passing 3/8 inch mesh.

WATER. The amount of water for mixing shall be approximately 5 to 6 gallons for each sack of cement weighing 94 pounds. The amount of water used shall not produce a slump of more than 2 inches.

PLACING. Concrete shall be placed and vibrated in place by means of a vibrating device acceptable to the engineer until all material is well settled and in close contact with the steel. The concrete shall be finished to a uniform surface even with the top of the steel without depressions or excess concrete covering the top of the steel.

If concrete is poured at a time when the temperature is 40° F. or lower, special care shall be taken to prevent freezing. The steel floor as well as the concrete shall be preheated to a temperature of 70° F. The contractor when so ordered by the engineer shall furnish and maintain a sufficient number of steam coils or other heating devices suitable to the engineer together with tarpaulins to supply an adequate amount of moist heat.

CURING. The slab shall be cured by means of emulsified asphalt sprayed on immediately after concrete is finished or by burlap spread over the entire surface and kept constantly moist by sprinkling or by other means, at the discretion of the engineer.

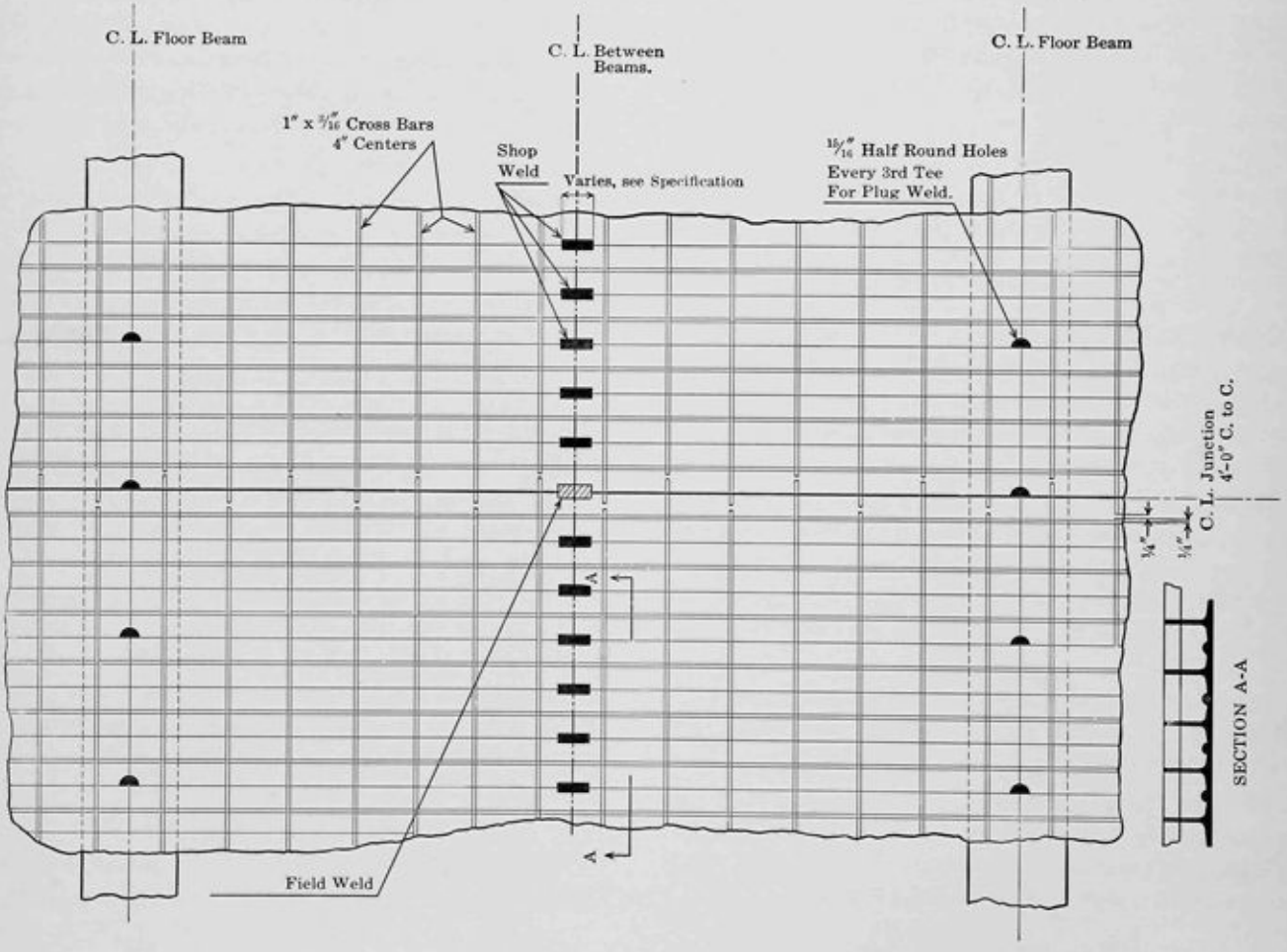
INSTALLATIONS

On page 44 is a partial list of T-Tri-Lok installations and elsewhere are shown photographs of a number of jobs in various stages, a study of which will reveal many essential features of erection, concreting, vibrating and finishing. One feature which never fails to receive attention and favorable comment, especially on the part of contractors and designers, is the fact that the T-Tri-Lok after being welded to the stringers affords a temporary floor over which traffic may move, thus expediting the delivery of material for the bridge, including all the concrete for the roadway slabs, which can be delivered to the exact spot desired in transit mixers; also curbs, sidewalks, handrails, tools and miscellaneous equipment, etc.

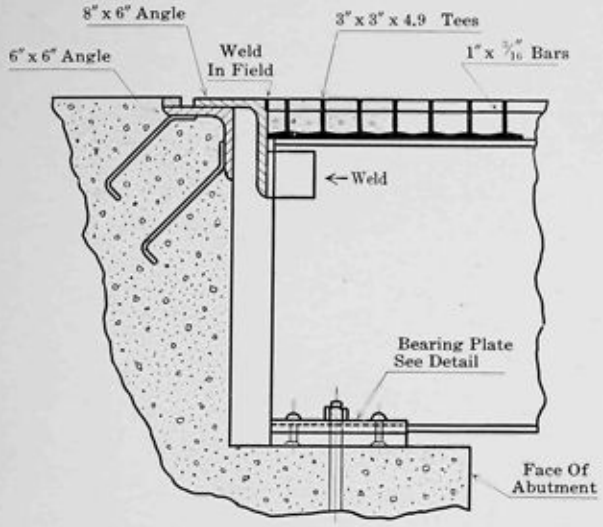
On the Boston Bridge, near McKeesport, over the Youghiogheny River, Allegheny County, Pa., two yard transit mixers were driven over the steel units depositing concrete as desired, the steel units showing no signs of distress. This job consisted of 3-inch T-Tri-Lok welded at every third tee to stringers spaced 4 feet apart.

Interested parties are invited to inspect some of these light-weight bridge floor installations under actual service conditions. Such visits can not fail to furnish convincing proof of the advantages obtained by the use of T-Tri-Lok in bridge floor construction.

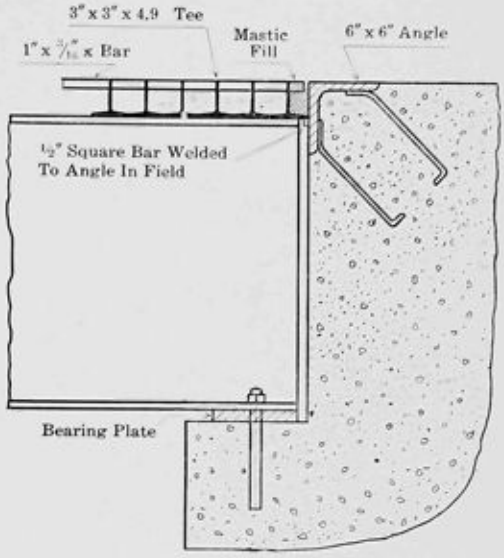
PLAN SHOWING ESSENTIAL CHARACTERISTICS OF T-TRI-LOK MANUFACTURE AND APPLICATION



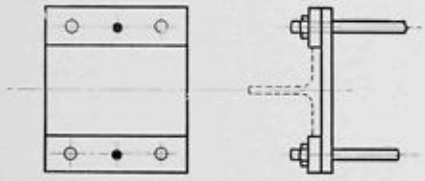
SUGGESTED DETAILS FOR T-TRI-LOK BRIDGE FLOORING



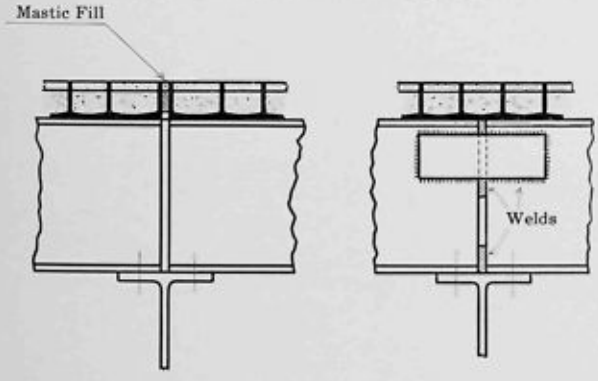
ARRANGEMENT OF EXPANSION AT ABUTMENT*



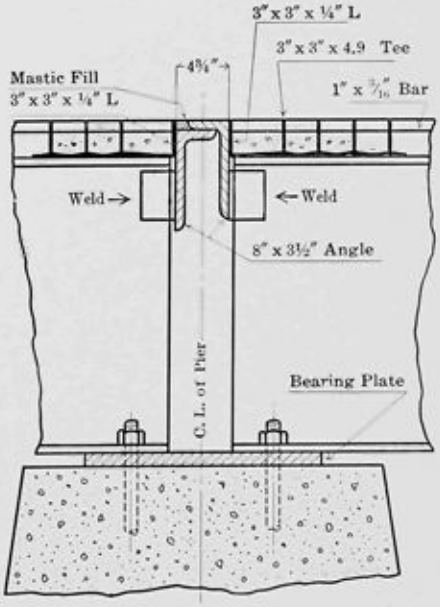
ARRANGEMENT OF FIXED END AT ABUTMENT*



BEARING PLATE AT EXPANSION END



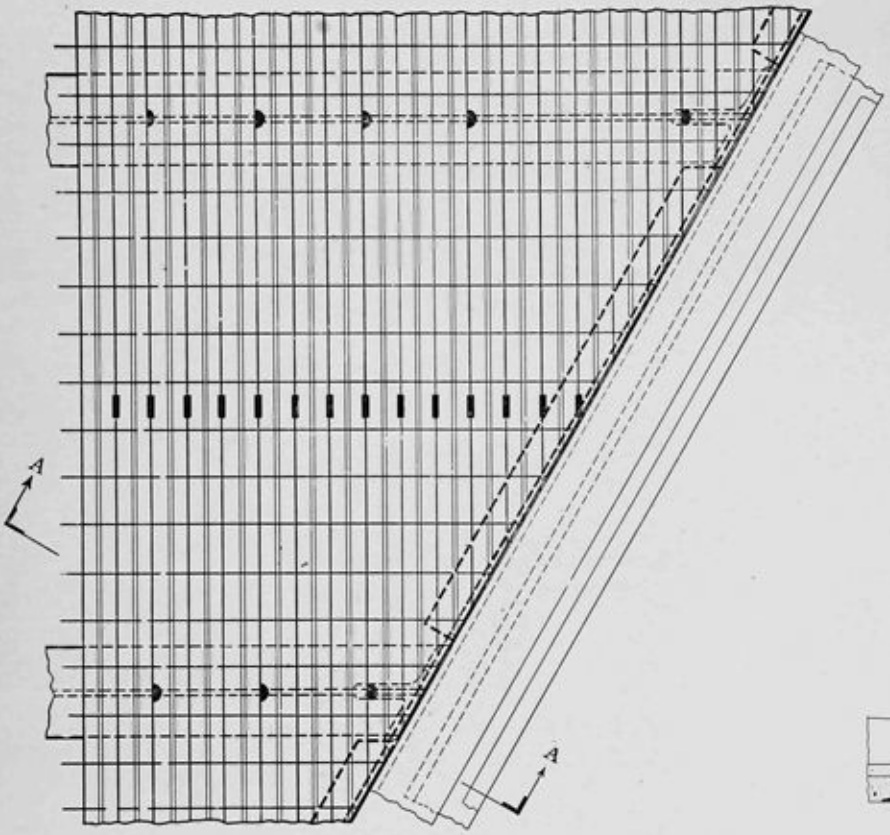
ALTERNATE SUGGESTIONS FOR ARRANGEMENT AT END OF STRINGERS*



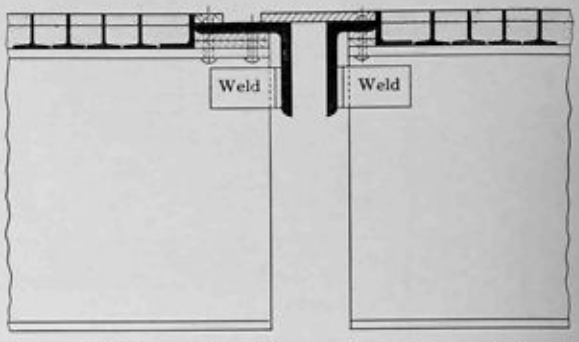
ARRANGEMENT OF FIXED ENDS AT PIER*

* Where continuity is broken, framing must be provided to resist one-half the moment produced by one wheel load without considering distribution.

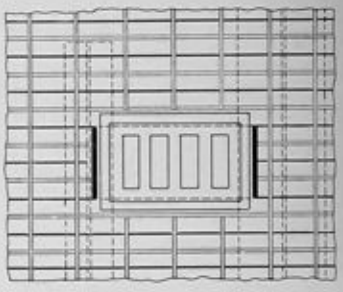
T-TRI-LOK BRIDGE FLOOR CONSTRUCTION

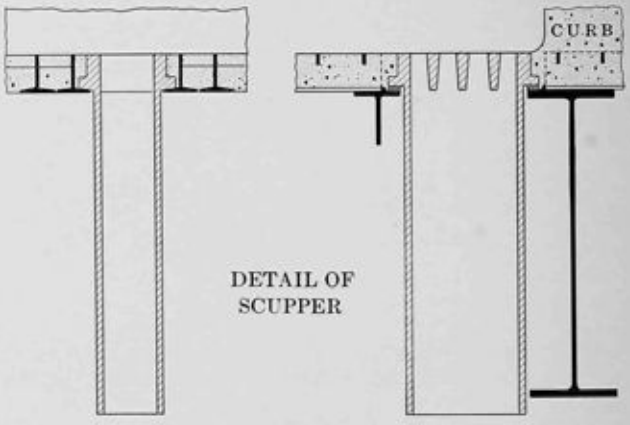


PLAN

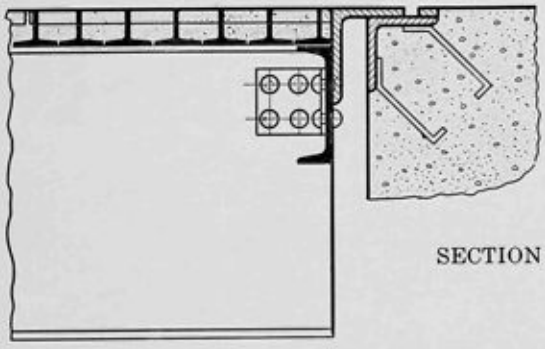


SUGGESTION FOR EXPANSION JOINT*



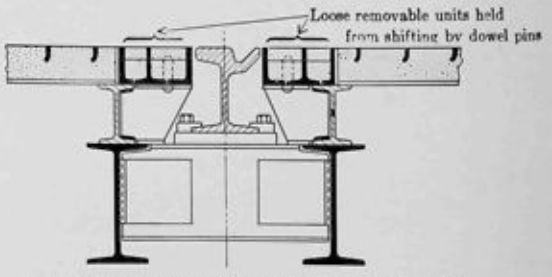


DETAIL OF SCUPPER



SECTION A-A

SUGGESTION FOR FRAMING AT SKEWED END OF BRIDGE†

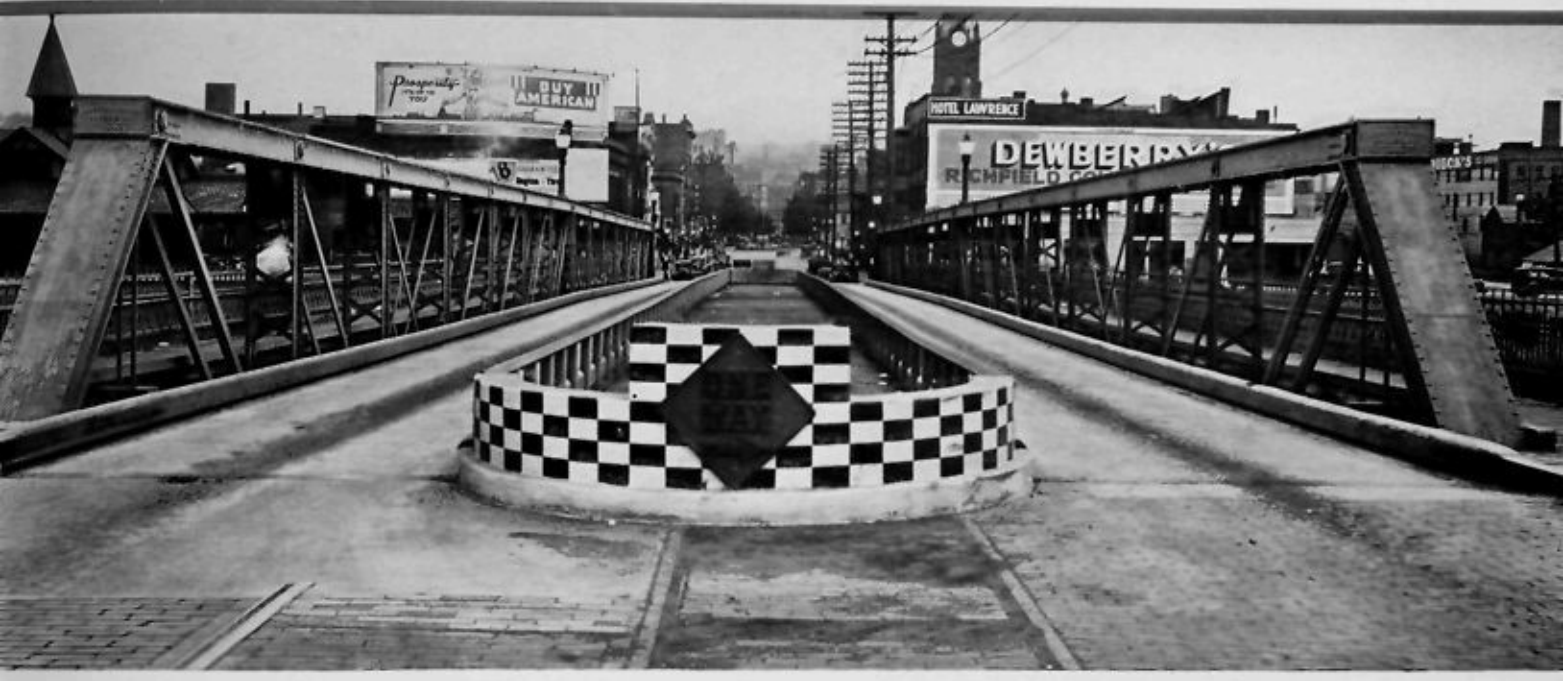


DETAIL OF TROLLEY RAIL SUPPORT

†On skewed ends framing must take entire wheel load concentration

* Where continuity is broken, framing must be provided to resist one-half the moment produced by one wheel load without considering distribution

T-TRI-LOK BRIDGE FLOOR CONSTRUCTION



West Washington Street Bridge, New Castle, Pennsylvania
Pittsburgh-Des Moines Steel Company, Contractors

USEFUL LIFE OF THIS BRIDGE EXTENDED

T-Tri-Lok is proving its economic worth in the rehabilitation of many old bridges.

The Washington Street bridge accommodating three lanes of traffic and two street car tracks had trusses whose strength was insufficient for the present heavy traffic.

According to the design of the county engineer, Thomas Gilkey, a light-weight T-Tri-Lok floor was substituted for the old construction, some parts of the structure were reinforced and the center portion of the bridge was blocked off providing for two lanes of traffic. During the reconstruction at least one lane for traffic was maintained.

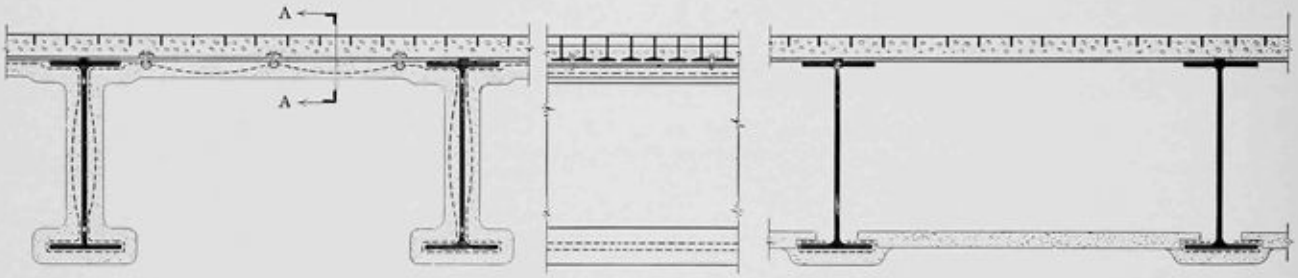
Considerable money was saved over the cost of a new bridge and the life of the structure has been greatly lengthened.

Where a bridge is overstressed, it is very important to investigate the possibilities of substituting a light-weight T-Tri-Lok floor to reduce the dead load sufficiently to enable the existing structure to be kept in service. This will mean a large saving over the cost of a new bridge.

T-TRI-LOK BRIDGE FLOOR CONSTRUCTION



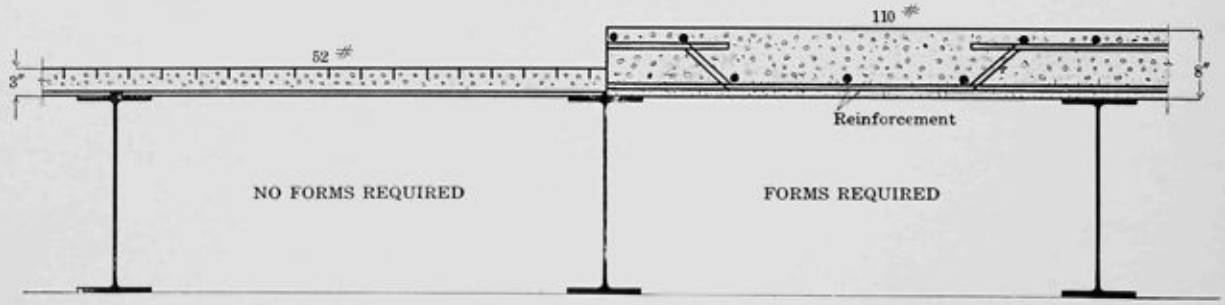
TYPES OF END DAMS



GUNITE PROTECTION

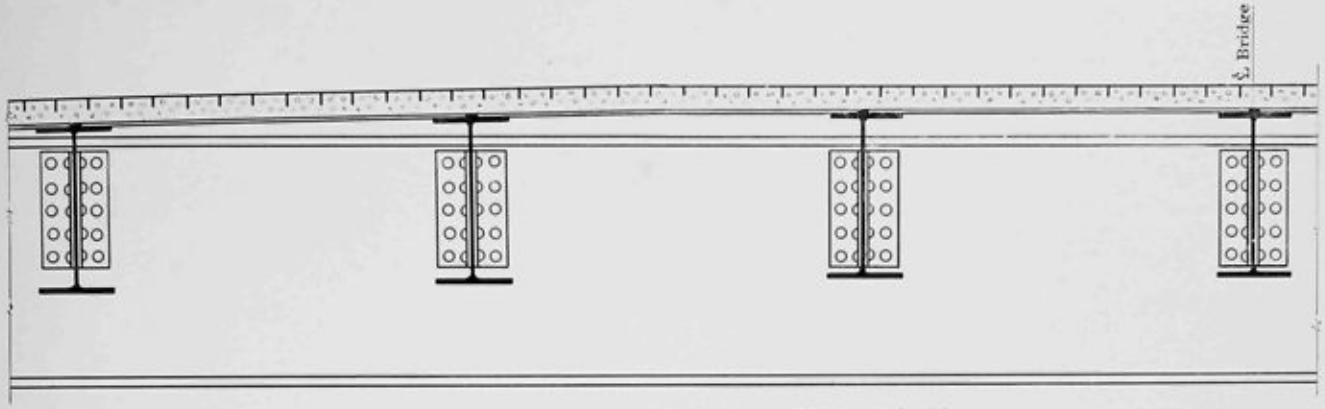
SECTION A-A

PRE-CAST SLAB PROTECTION

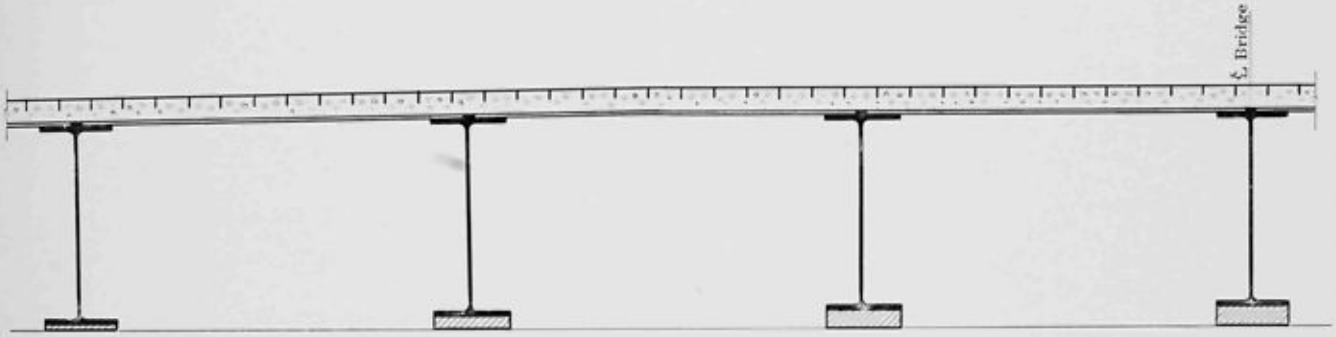


T-TRI-LOK VS. CONCRETE FLOOR

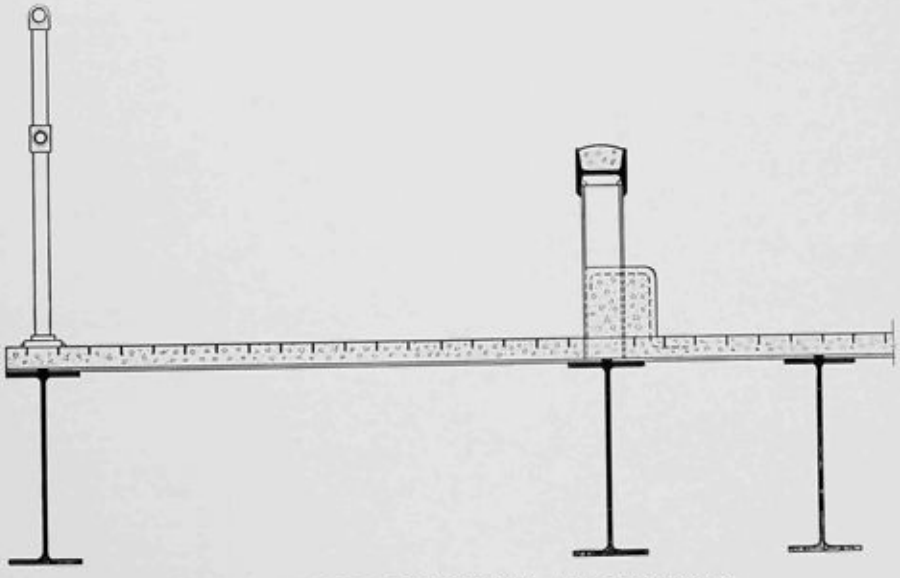
T-TRI-LOK BRIDGE FLOOR CONSTRUCTION



CANTED STRINGERS AND CONNECTION ANGLES



BEVELED FILLERS UNDERNEATH



DETAIL OF CURB, GUARD-RAIL AND HAND-RAIL

T TRI-LOK INSTALLATIONS

Location	Designers	Size of Tees, Inches	Sq. Ft.
Bridge Tarentum, Pa.	Allegheny County Bridge Dept.	4 x 3	2020
Boston Bridge Allegheny County	Allegheny County Bridge Dept.	3 x 3	36020
Tin Mill Floor Gary, Ind.	American Sheet & Tin Plate Co.	3 x 3	344
Roadway South 10th St. Bridge Pittsburgh, Pa.	Allegheny County Bridge Dept.	3 x 3	44303
Sidewalk South 10th St. Bridge Pittsburgh, Pa.	Allegheny County Bridge Dept.	2 x 2	17662
Bridge, Huron Co., near Norwalk, O.	Huron County Engineers	3 x 3	542
Crescent Ave. Bridge Etna, Pa.	Allegheny County Bridge Dept.	3 x 3	1997
State Bridge Cadiz, Ohio	Ohio State Highways Dept.	3 x 3	551
State Bridge Barnesville, Ohio	Ohio State Highways Dept.	3 x 3	415
State Bridge Barnesville, Ohio	Ohio State Highways Dept.	3 x 3	337
Bridge Tremont City, O.	Clark County Surveyor	3 x 3	2074
Bridge, Bucks Co., near Croyden, Pa.	Carson & Carson, Engineers	3 x 3	3110
Bridge, Huron Co., near Clarkefield, O.	Huron County Engineers	3 x 3	2581
Bridge Roseburg, Oregon	United States Govt. Vet. Admin. Con. Serv.	3 x 3	6284
Bridge Sidney, Ohio	C. L. Ramsey, Engineer	3 x 3	1513
Bridge No. 14 Glens Falls, N. Y.	New York State, Public Works Dept.	3 x 3	975
Blue River Bridge Dodson, Mo.	Missouri State Highways Dept.	3 x 3	4496
State Bridge Oswego, N. Y.	New York State Public Works Dept.	3 x 2½	1800
Oak Street Bridge Toledo, Ohio	City of Toledo, Engineers	3 x 3	4755
Grantley St. Bridge York, Pa.	James B. Long, Engineer	3½ x 3.66	5987
Franklin Bridge Erie, Pa.	Penna. State Highways Dept.	3½ x 3.66	1164
Bridge Zelienople, Pa.	Penna. State Highways Dept.	3½ x 3.66	3943
W. Washington St. Bridge New Castle, Pa.	Lawrence County Engineers	3 x 3	4730
Bridge Hudson Falls, N. Y.	New York State Public Works Dept.	3 x 3	1173
Floor for McKay Milk Products Co. New York, N. Y.	Jacob Feld, Ph. D., Engineers	3½ x 3.66	908
Bridge, Salem Co., near Bridgeton, N. Y.	Salem County Engineers	3 x 2½	510
Bridge, Milford, N. J., to Upper Black Eddy, Pa.	Penna.-New Jersey Joint Commission	3½ x 3½	13161
Loading Platform for Geo. F. Blake, Inc., Worcester, Mass.	Lester W. West, Engineer	3 x 3	548
Bridge for Minneapolis, Minn.	City of Minneapolis, Engineers	3½ x 3½	15834
Bridge, Berrien Co., near Niles, Mich.	Berrien County Engineers	3 x 3	2380
Bridge Grayling, Mich.	Michigan State Highways Dept.	3½ x 3½	1714
Bridge, Northampton Co., near Portland, Pa.	Northampton Co. Engineers	3 x 3	860
Roadway, Portland St. Bridge St. Johnsbury, Vt.	City of St. Johnsbury, Engineers	3 x 2½	3688
Sidewalk, Portland St. Bridge St. Johnsbury, Vt.	City of St. Johnsbury, Engineers	2 x 2	1240
Foot Bridge, Holyoke, Mass.	Raymond Palmer, Engineer	2 x 2	3201

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Bessemer Pig Iron
Ferro-Manganese

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Crushed Slag
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Standard Beams
H Beams
Channels
Ship Building Channels
Car Building Sections
Bulb Angles
Angles
Tees
Elevator Tees
Conductor Tees
Zees
Cross Tie Sections
Carnegie Steel Sheet Piling
Miscellaneous Sections

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Carnegie Steel Sheet Piling
T-Tri-Lok Floor Construction

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Fish Plates
Tie Plates
Frog Fillers
Reinforcing Bars
Track Spikes
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Cross Ties for Mine Track
Cross Ties for Portable Track

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  Circular
  Sketch
Universal Mill Plates
Base Plates for Columns and Machinery
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  Annealed
  Quenched and Tempered
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  Steam Railroad Car
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  Locomotive Trailing
  Tender
  Mine Car
  Industrial Car
  Armature Shafts—Carbon
Wheels—
  Rim Toughened
  Solid Wrought, Carbon Steel
  Electric Railway
  Steam Railroad
  Industrial Car
  Mine Locomotive
  Industrial Locomotive
  Crane Track
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Brake Drums for Trucks

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Blooms
Billets
Slabs
Sheet Bars

Bar Products

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Angles
Automobile Body Sections
Automobile Bumper Sections
Automobile Rim Sections
Barrel Sections
Bevel Sections
Cam Sections
Can Ring Sections
Casement Sections
Channels
Concrete Reinforcement Bars
Cooperage Steel
Crescents
Flat Discs for Automobile Parts
Flat Rolled Steel
Flats under ¼"
Grooved Flats
Half Ovals
Half Rounds
Hame Sections
Hexagons
Hoop and Band Steel
Key Sections
Locking Bar Sections
Magneto Sections
Neck Yoke Sections
Nut Sections
Ovals
Pipe Coupling Sections
Pole Cap Sections
Pole Sections
Round Cornered Squares
Round Edge Flats
Rounds
Scarfed Skelp
Skelp
Special Sections of Various Kinds
Spring Steel Sections
Square Edge Flats
Squares
Tees
Window Sash Sections
Zees

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Bessemer

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U S S Stainless and Heat Resisting Steels

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Foundry Coke

Domestic or Nut Coke
Coke Breeze

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  Industrial 90%
  Motor
Toluol, Industrial
Xylol, Industrial

Naphtha—
  Industrial Refined Light
  Industrial Crude Heavy
  Industrial High Test
Ammoniacal Liquor
Ammonium Sulphate
Crude Naphthalene

Tar
Creosote Oil
Cresylic Acid
Phenol
Cresol
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