第３章　アーチ橋

§１　基本事項

プロジェクト名：FEDERAL PROJECT NO. BRF 022(11)
STATE PROJECT NO. 8680-1-83

橋　　名　：ARROW HEAD BRIDGE

橋　　種　：HS20-44 (AASHTO)

形　　式　：アーチ橋

橋　　長　：１５４．６ｍ

支　　間　：１５２．４ｍ

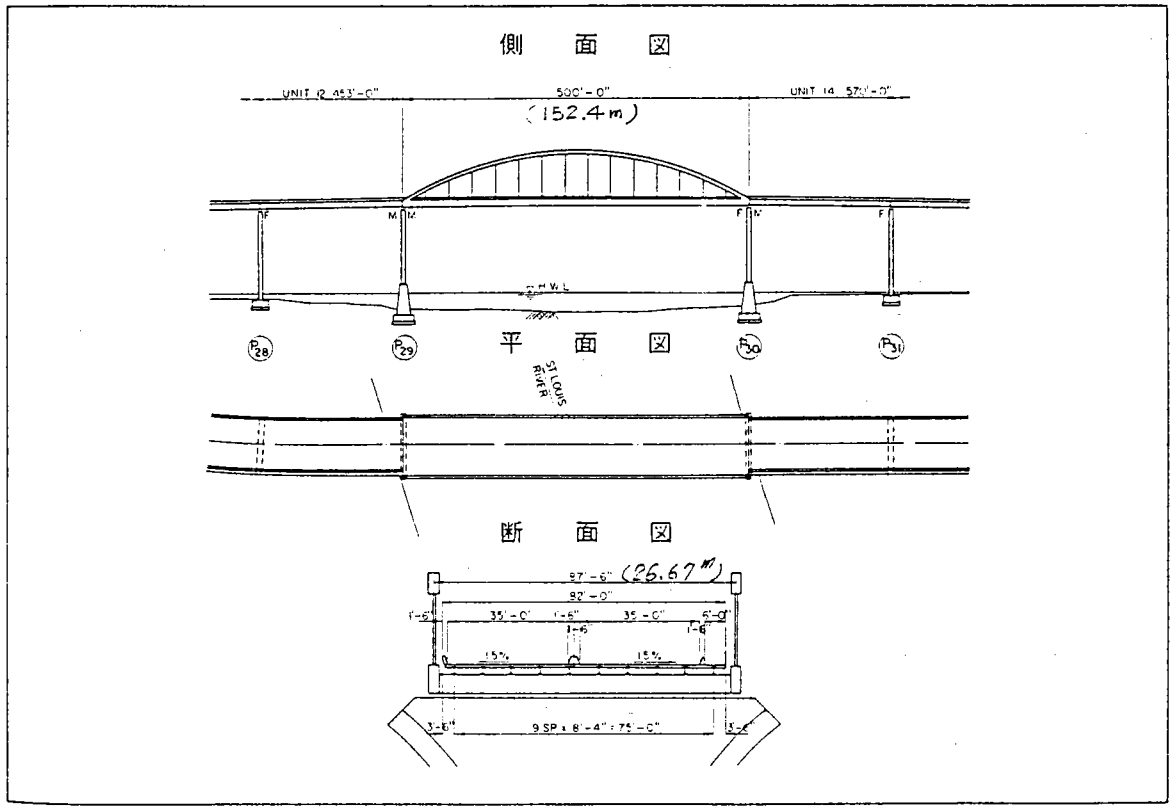
幅　　員　：　２４．５ｍ

施　　工　：STATE OF WISCONSIN. STATE OF MINESOTA
DEPARTMENT OF TRANSPORTATION

工　　期　：１９８０年５月～１９８１年５月

鋼　　重　：２４７４ TON

架 設 工 法：フローティングクレーンによるベント工法



General Note (No.1)

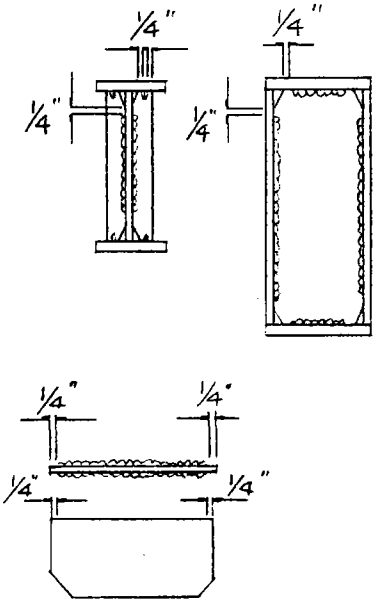
1. Applicable Specifications
   - Contract Plan Sheets, 1 Thru 26
   - Special Provisions
   - AWS Structural Welding Code D1.1-75 Rev. 76
   - WISC State, Dot.
     Standard Specifications for Road & Bridge Construction
     -75 Rev. 78, Rev. 77
   - AASHTO Material 1980
   - AASHTO Welding Standard Specifications 1977
   - ASTM Annual Mateiral Book, 1979
   - AASHTO Guide Specifications for Fracture Critical Non-Redundant Steel Bridge Members 1978

2. Steel Materials Used for This Project
   - ASTM A588 Grade A unless otherwise noted on the Drawings
   - ASTM A36
   - Carbon Steel Pipe for Ordinary Piping JIS G 3452 SGP
   - Rolled Steel for General Structure JIS G3101 Class 2 SS41
   - High Strength Bolts ASTM A325 TYPE 1 and TYPE 3
   - The others as noted on the Drawings.

3. Welding
   (1) The following welding Materials shall be used

   SMAW AWS A5.5 E7016-G
   AWS A5.5 E7018-G
   AWS A5.5 E8016-G*
   *Corrosion Resistant Type
   SAW AWS A5.17 F74-EH14
   AWS A5.23 F74-EG-W*
   AWS A5.23 F86-EW-W*
   GMAW AWS A5.18 E70S-3
   AWS A5.18 E70S-GB*

   (2) Weld Metals used in the fabrication of tie girder shall have a Charpy V-notch value of 25 FT-LBS at -30°F Min.
   (3) At the following indication, Fillet welding shall be stopped 1/4 inch short.



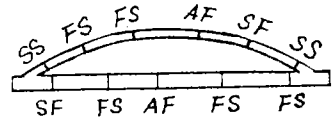
4. Drilling Sequence

F: To be Drilled to fullsize from the Beginning

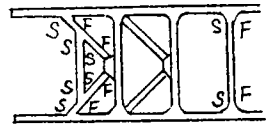
S: To be Drilled to subsize first, and then at Shop Assembly to be reamed to fullsize

A: To be Drilled to fullsize from solid at Shop Assembly

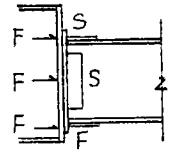
(1) Arch Rib + Tie Girder



(2) Arch Strut & Cross Bracing

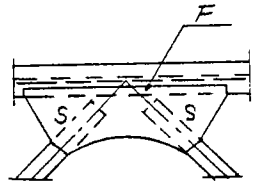


(3) Tie Girder + Floor Beam



(4) Lateral Bracing + Lateral Gusset Plate

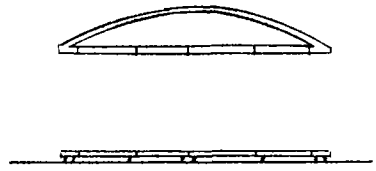
To be Drilled to subsize first and then at Shop Assembly to be Reamed to fullsize



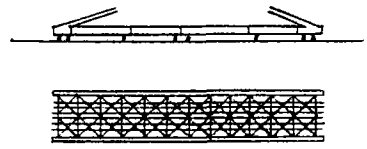
5. Shop Assembly

Shop Assembly shall be done as follows.

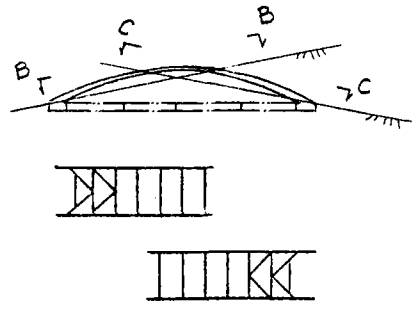
(1) Arch Rib + Tie Girder - Flat Assembly



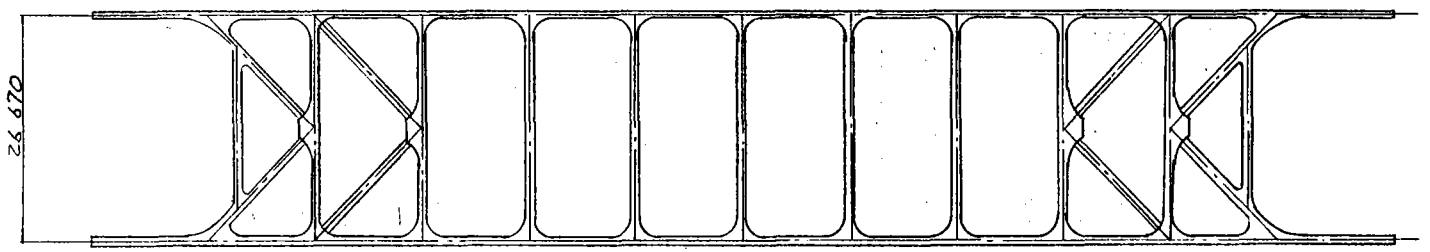
(2) Floor System Assembly

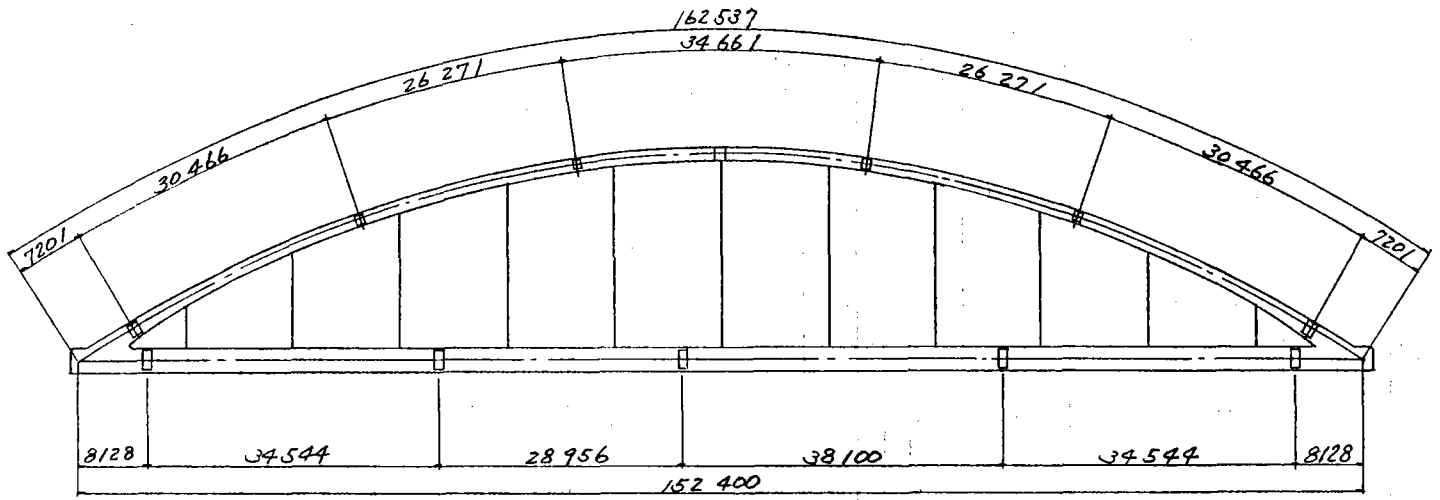


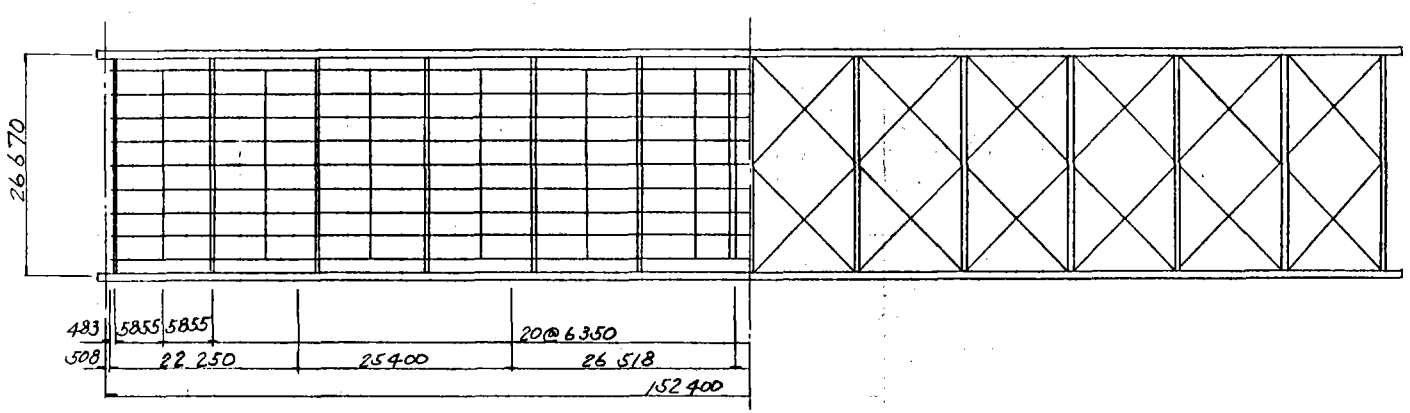
(3) Arch Rib + Arch Strut + Cross Bracing - Half by half
(As shown below)



Surface	Yard	Procedure	Paint		Color	Number of Coat	D.F.T (Mill/ Min./Coat)	Paint-ing Method	Averaged Coverage	Coating Interval
			General Name	Brand Name						
Exterior Arch rib Girder Upper lateral etc.	Mill	Surface Preparation	Blast Cleaning to SSPC - SP6						(g/m²/Coat)	(20°C) Within 4H
		Etching Primer	Prolonged Exposure Type Wash Primer	PRIMIGHT S-100	Dark Green	1	0.5 Ave.	Spray	130	4H - 3M
	Shop	Surface Preparation	Blush-off Blast Cleaning to SSPC-SP7							Within 4H
		Primer (1st Coat)	Basic Lead Silico Chromate Primer	AASHTO-M-229-78 TYPE II	Red Oxide	1	1.7	Spray	?	24H - 3M
		Primer (2nd Coat)	Basic Lead Silico Chromate Primer (WISCONSIN STATE STANDARD Para 517-2.4.2.3)	B.L.S.C. Primer for WISCONSIN STATE	Maroon	1	1	Spray	150	36H - 6M
Exterior (Floor system)	Mill	Surface Preparation	Blast Cleaning to SSPC - SP6							Within 4H
		Etching Primer	Prolonged Exposure Type Wash Primer	PRIMIGHT S-100	Dark Green	1	0.5 Ave.	Spray	130	4H - 3M
	Shop	Surface Preparation	Blush-off Blast Cleaning to SSPC-SP7							Within 4H
		Primer (1st Coat)	Basic Lead Silico Chromate Primer	AASHTO-M-229-78 TYPE II	Red Oxide	1	1.7	Spray	290	24H - 3M
		Primer (2nd Coat)	Basic Lead Silico Chromate Primer (WISCONSIN STATE STANDARD) per Special Provision	B.L.S.C. Primer for WISCONSIN STATE	Brown	1	1	Spray	215	24H-3M
Interior Arch rib Girder Upper lateral etc.	Mill	Surface Preparation	Blast Cleaning to SSPC - SP6							Within 4H
		Etching Primer	Prolonged Exposure Type Wash Primer	PRIMIGHT S-100	Dark Green	1	0.5 Ave.	Spray	130	4H - 3M
	Shop	Surface Preparation	Power Tool Cleaning to SSPC-SP3							Within 8H
		Primer	Basic Lead Silico Chromate Primer	AASHTO-M-229-78 TYPE II	Red Oxide	1	1.7	Spray	290	24H - 3M


26 670


162 537
34 661
26 271
26 271
30 466
30 466
7201
7201
8128
34 544
28 956
38 100
34 544
8128
152 400


26 670
483
508
5855
5855
22 250
25 400
20@6 350
26 518
152 400

1. *Symbols for Joint Types*

B—butt joint
C—corner joint
T—T-joint
BC—butt or corner joint
TC—T- or corner joint
BTC—butt, T-, or corner joint

2. *Symbols for Base Metal Thickness and Penetration*

L—limited thickness, complete joint penetration
U—unlimited thickness, complete joint penetration
P—partial joint penetration

3. *Symbols for Weld Types*

1—square groove
2—single-V groove
3—double-V groove
4—single-bevel groove
5—double-bevel groove
6—single-U groove
7—double-U groove
8—single-J groove
9—double-J groove

AMERICAN INSTITUTE OF STEEL CONSTRUCTION

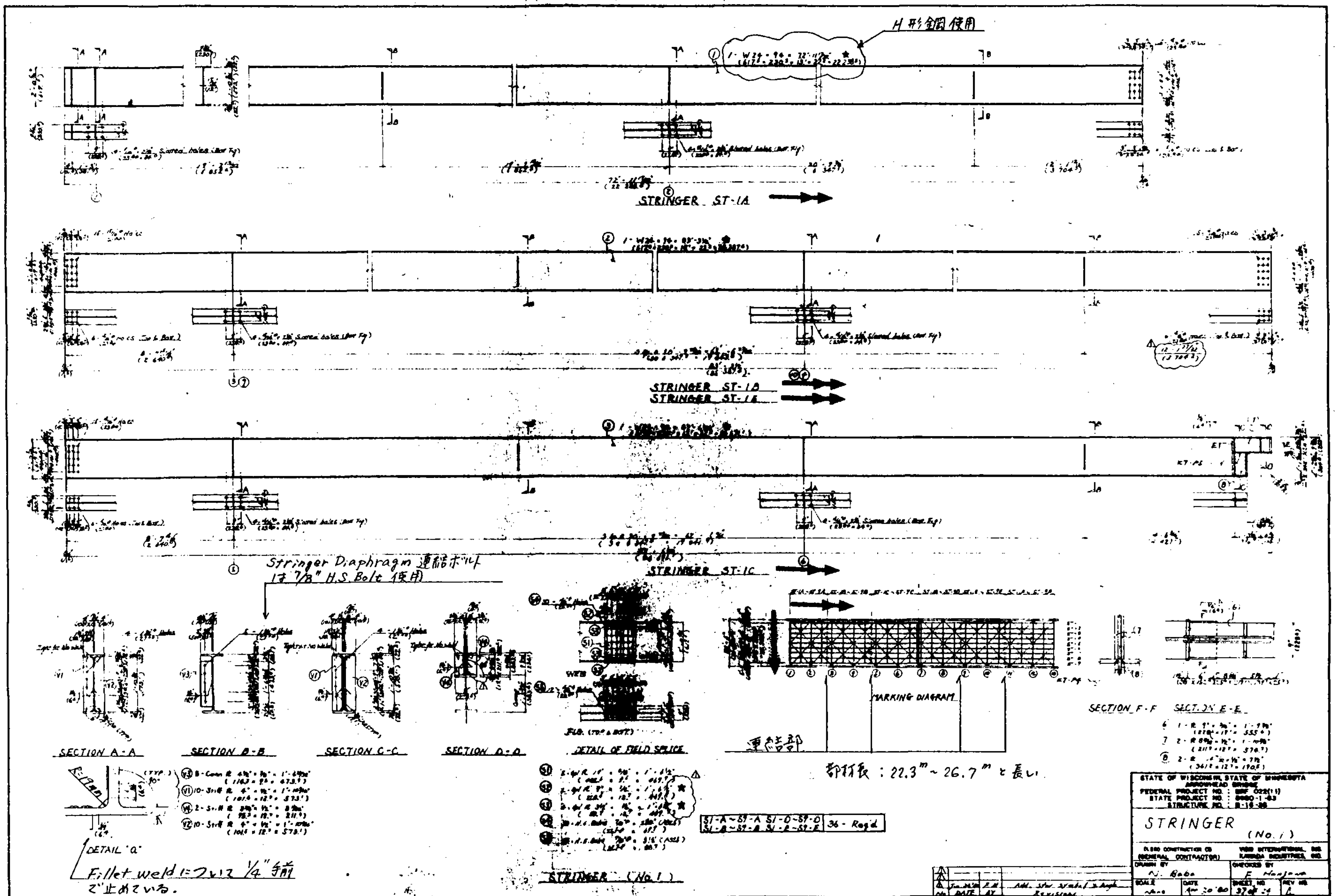
4. *Symbols for Welding Processes*

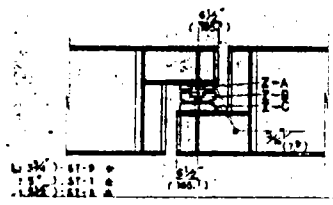
If not manual shielded metal arc (SMAW):
S—submerged arc welding (SAW)
G—gas metal arc welding (GMAW)
F—flux-cored arc welding (FCAW)

5. *Symbols for Welding Positions*

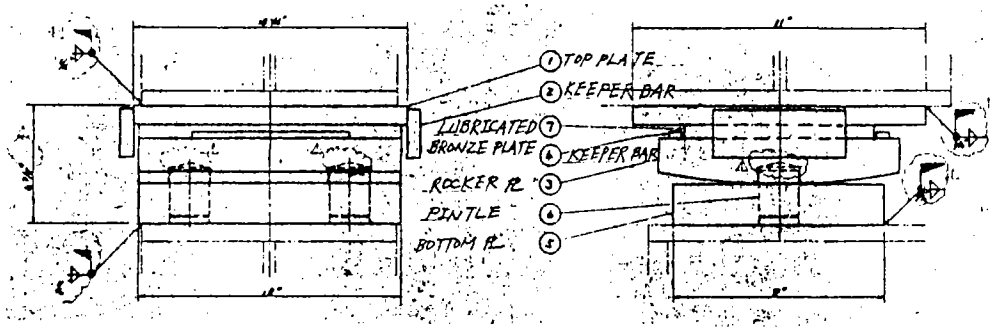
F—flat
H—horizontal
V—vertical
OH—overhead

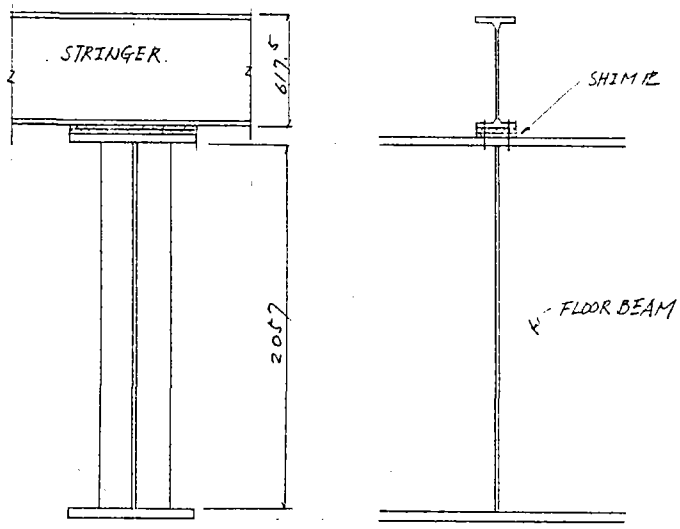
Welding process	Joint designation	Base metal thickness (U = unlimited) T_1	T_2	Groove preparation: Root opening, Root face, Groove angle	Tolerances: As detailed	Tolerances: As fit up	Permitted welding positions	Gas shielding for (FCAW)	Notes	Figure
SMAW	TC-U4a	U	U	R = 0 to 1/8 f = 0 to 1/8 α = 45°	+1/16,–0 +1/16,–0 +10°,–0°	+1/16,–1/8 Not limited +10°,–5°	All	–	C,J,V	
GMAW FCAW	TC-U4a-GF	U	U				All	Not req.	A,C,J,V	
SAW	TC-L4a-S	3/4 max	U	R = 0 f = 1/8 max α = 60°	±0 +0,–1/8 +10°,–0°	+1/4,–0 ±1/16 +10°,–5°	Flat	–	J,V,Y	
SAW	B-L2b-S	Over 1/2 to 1 inclusive	–	R = 0 f = 1/4 max α = 60°	±0 +0,–1/4 +10°,–0°	+1/16,–0 ±1/16 +10°,–5°	Flat	–	K	
SAW	B-L3-S	1-1/2 max	–	R = 0 f = 1/4 max α = 60°; β = 80° $S_1 = 2/3\ (T_1 - 1/4)$, $S_2 = 1/3\ (T_1 - 1/4)$	±0 +0,–1/4 +10°,–0°	+1/16,–0 Not limited +10°,–5°	Flat	–	M, K	
SAW	TC-U5-S	U	U	R = 0 f = 3/16 max α = 60°	±0 +0,–3/16 +10°,–0°	+1/16,–0 ±1/16 +10°,–5°	Flat	–	J, M, V	


H形鋼使用
STRINGER ST-1A
STRINGER ST-1B
STRINGER ST-1C
Stringer Diaphragm 連結ボルトは 7/8" H.S. Bolt 使用
SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D
DETAIL OF FIELD SPLICE
MARKING DIAGRAM
SECTION F-F
SECTION E-E
連結部
部材長：22.3m～26.7m と長い
DETAIL "a"
Fillet weld について 1/4" 手前で止めている。
STRINGER (No. 1)
STATE OF WISCONSIN, STATE OF MINNESOTA
ARROWHEAD BRIDGE
STRINGER
(No. 1)



STRINGER BEARING





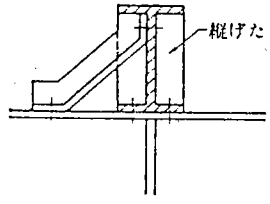
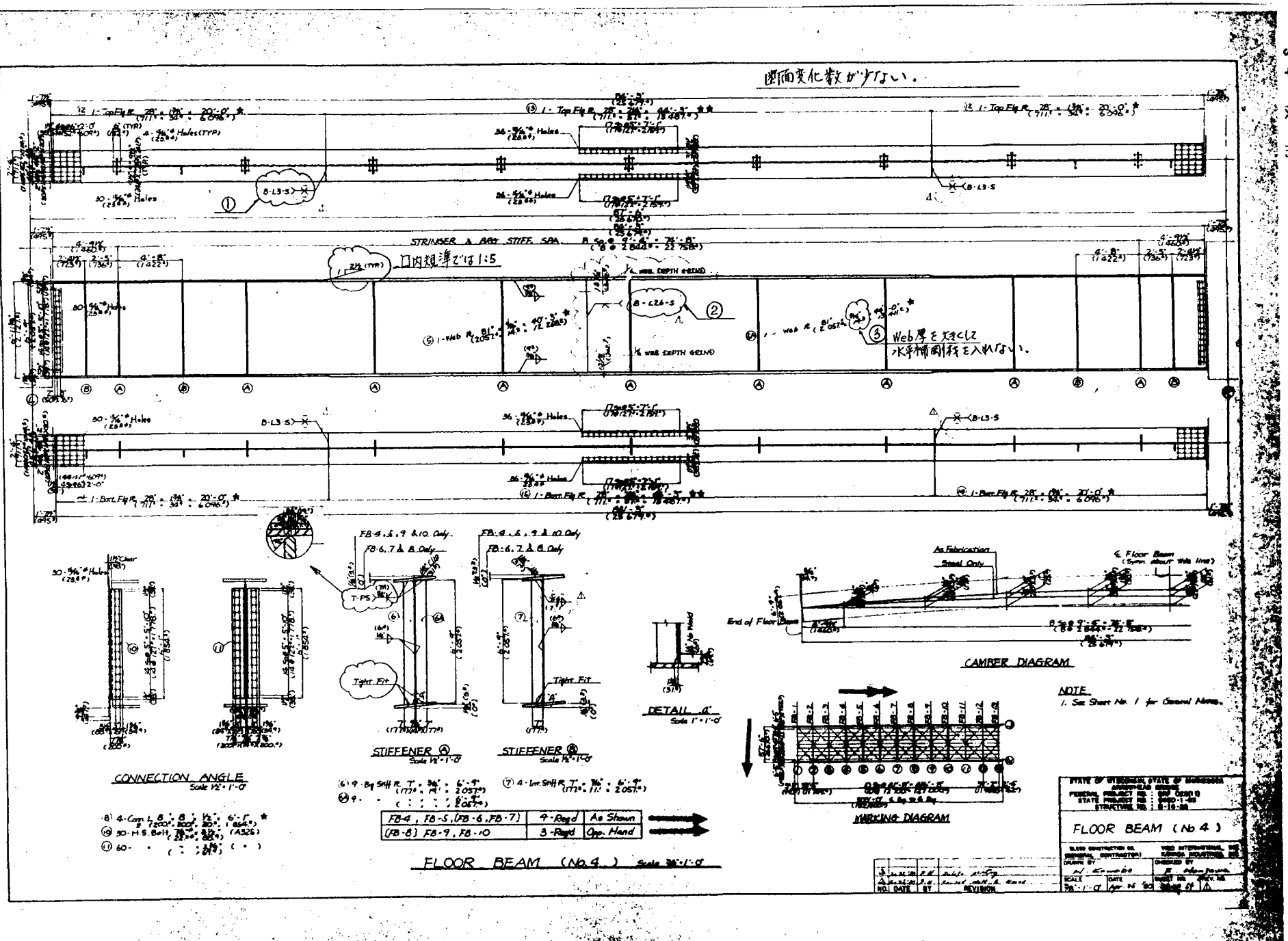


図-解 7.4.1 縦げたの床げたへの取付け方法の例


断面変化数が少ない。
STRINGER & BRG STIFF SPA
口内規準では1:5
Web厚を大きくして
水平補剛材を入れない。
CONNECTION ANGLE
STIFFENER Ⓐ
STIFFENER Ⓑ
DETAIL 'd'
CAMBER DIAGRAM
MARKING DIAGRAM
FLOOR BEAM (No.4) Scale 3/8"=1'-0"
FB-4, FB-5, (FB-6, FB-7) 4-Regd As Shown
(FB-8) FB-9, FB-10 3-Regd Opp. Hand
NOTE
1. See Sheet No. 1 for General Notes.
FLOOR BEAM (No.4)

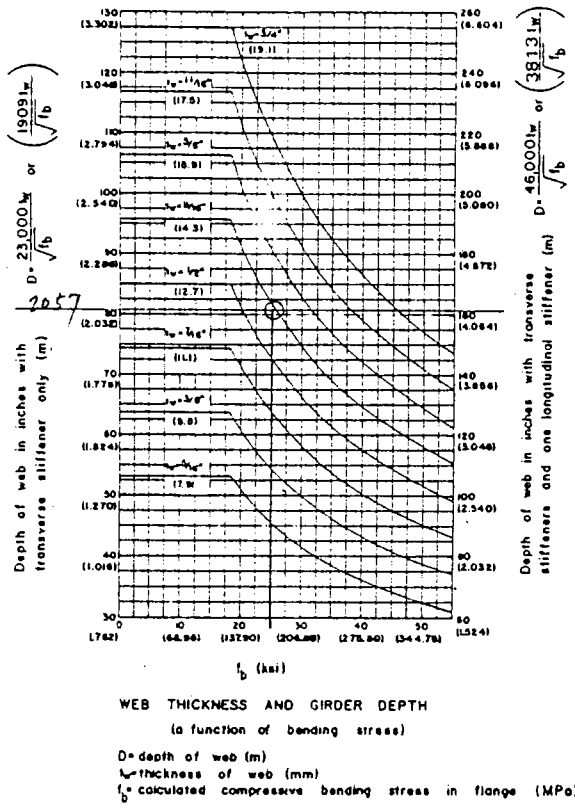
(C) Thickness of Web Plates

(1) Girders Not Stiffened Longitudinally

The web plate thickness of plate girders without longitudinal stiffeners shall not be less than that determined by the formula:

$$t_w = \frac{D\sqrt{f_b}}{23{,}000} \text{(See Figure 1.7.43(C)) or } \left(\frac{D\sqrt{f_b}}{1909}\right)$$

but in no case shall the thickness be less than D/170.



WEB THICKNESS AND GIRDER DEPTH
(a function of bending stress)

D = depth of web (m)
t_w = thickness of web (mm)
f_b = calculated compressive bending stress in flange (MPa)

FIGURE 1.7.43C

t w＝9/16”， D＝81” のとき F b＝25511 p s i ≒1794 kg/cm²

A S T M　A588 ＝S M50とすると国内規定によるプレートガーダーの最小腹板厚は

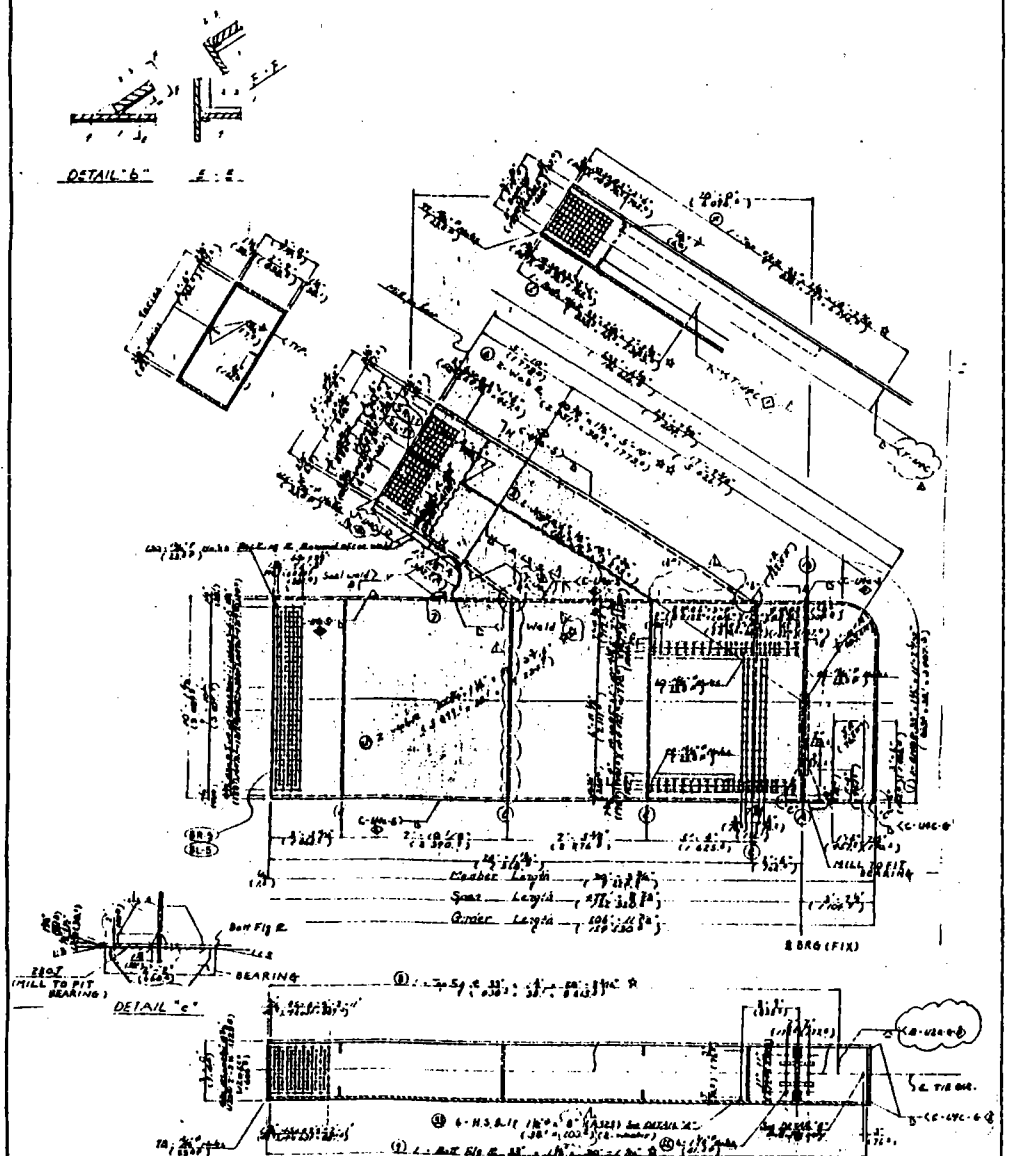
b／130＝2057.4／130≒15.8mm

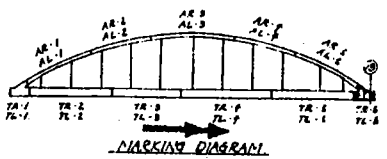
（水平補剛材のない場合）

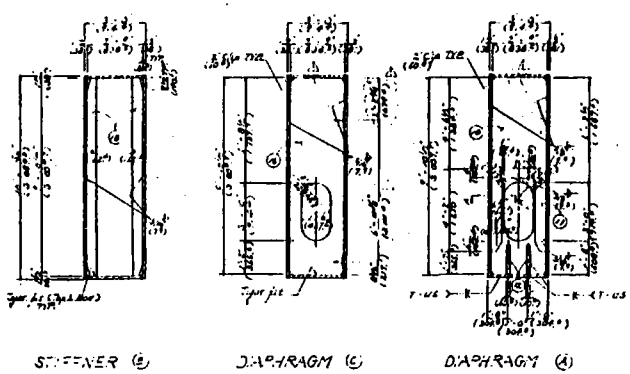
低減考慮の場合 $\sqrt{1900/1794}$ ＝1.029　∴ t w＝15.8／1.029 ＝15.3mm→16mm

本橋の板厚は9/16”（14.3 mm）となっている。

部位：TIE GIRDER（No.1）；偶角部の形状と各ダイヤフラムの断面



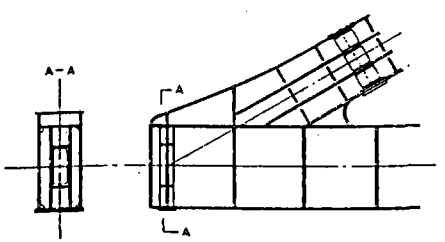




1. TIE GIRDE BOX サイズ
   914.4 × 3009
2. 材　質　ASTM A588
3. ダイヤフラムの溶接
   支点上(A)～両側ウェブと下フランジ
   中　間(C)～両端ウェブ溶接
   上・下フランジは面タッチ
4. 補剛材の溶接
   ウェブのみ溶接，上・下フランジは面タッチ
5. スカーラップ形状は2"の三角形形状
6. 支承は，ソールプレートを設けずに，直接ボルト止めしている。（Detail"e"参照）

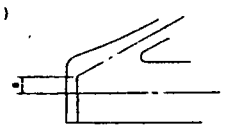
7. 国内における標準的な偶角部の形状及び考え方

b) 補剛桁が箱断面



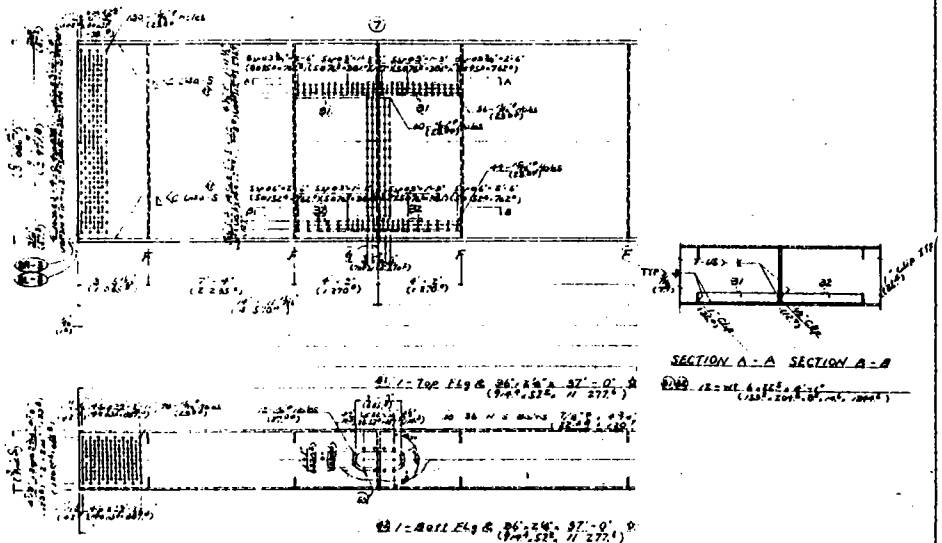
i) アーチリブと補剛桁の取合の隅角部においては補剛桁上フランジの応力集中を避けるため，ウェブをR処理する。

ii) 補剛桁の桁高が大きい場合には，アーチリブと補剛桁の交差部が必要以上に大きくなりすぎることがある。この場合には骨組線を下図の様にしてもよい。（下図のe）

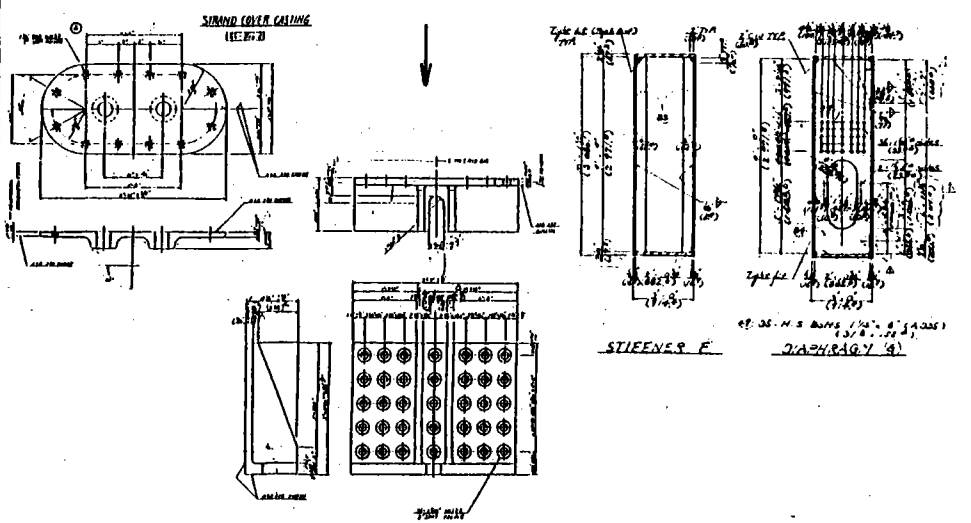


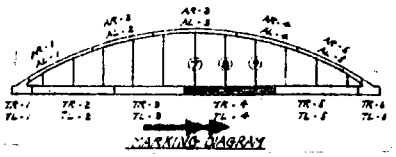
iii) アーチリブの継手は，一般に補剛桁に近い位置に設けるが，補剛桁の桁高が大きい場合には部材高が大きくなり，輸送上の制約条件を満足しないことがあるので留意する必要がある。

部位： ＴＩＥ　ＧＩＲＤＥＲ（No.2）；ＴＩＥ　ＧＩＲＤＥＲと吊り材との連結部



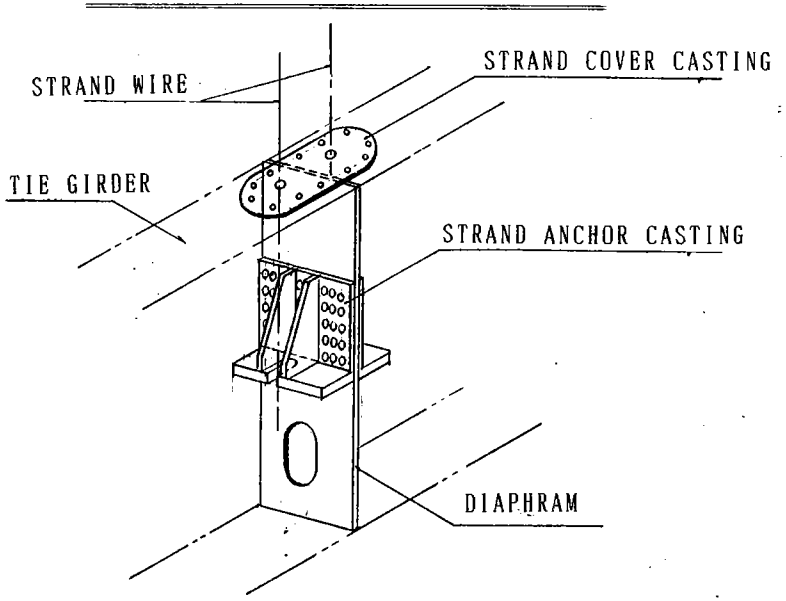
STRAND ANCHOR CASTING



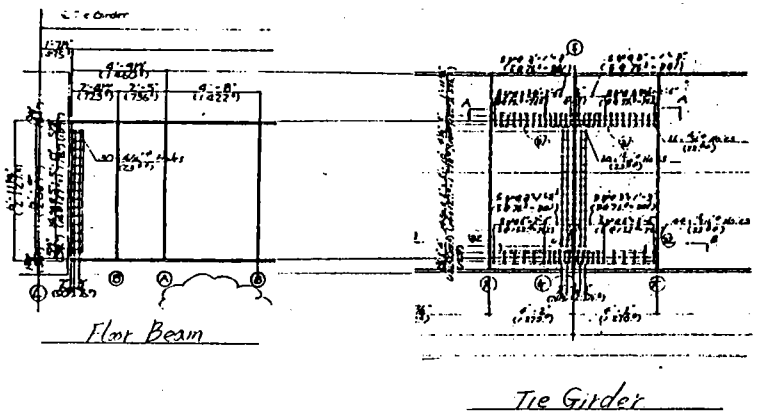


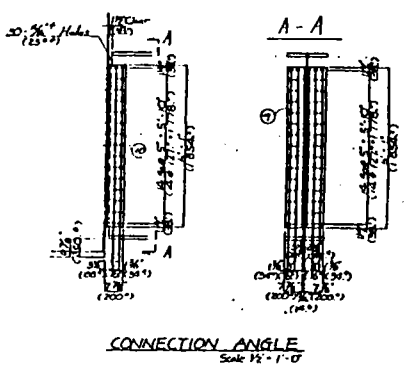
吊り材とタイガーダーの連結は STRAND COVER CASTING を介してダイヤフラムに取り付けたSTRAND ANCHOR CASTINGに止め付けている。

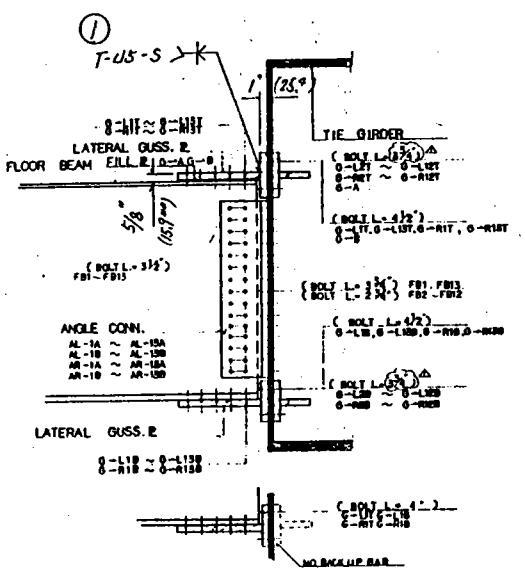
TIE GIRDER と吊り材の取り付け概要図



部位： ＴＩＥ　ＧＩＲＤＥＲ（No.３）　横桁との取り合い





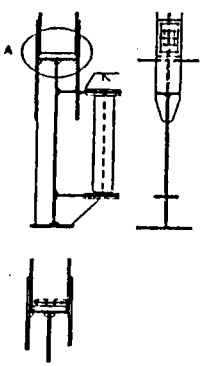


タイガーダーと横桁との連結部は，CONNECTION ANGLE（L8"×8"×½"）で，横桁ウェブをはさみ込み，ボルト止めする形式となっている。

3-2-2 載荷弦の格点構造

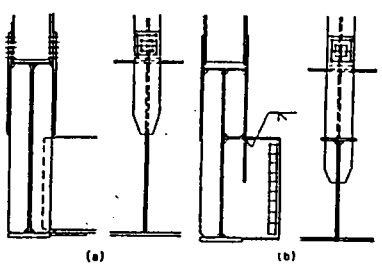
(1) 下路式

床組の位置が高い場合

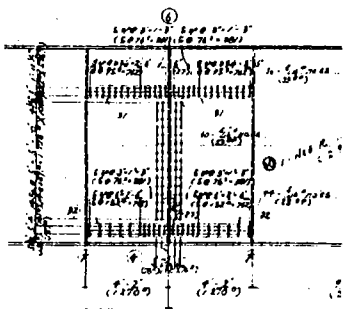


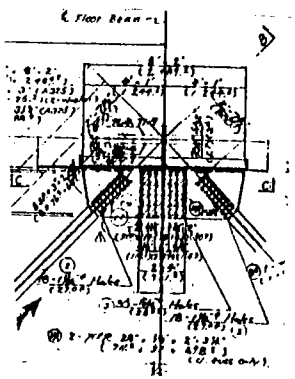
A部において吊材のウェブを連結してもよい。
横構の設けられない桁端付近の上弦材に取付く吊材のウェブは必ず補剛桁と連結する。

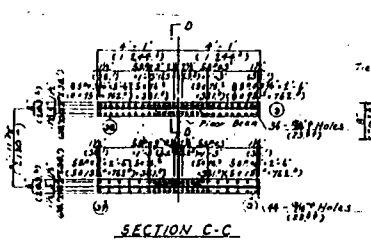
床組の位置が低い場合

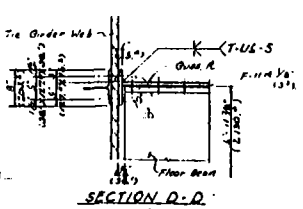


部位： ＴＩＥ　ＧＩＲＤＥＲ（No.４）　横構との取り合い及びＴＩＥ　ＧＩＲＤＥＲの断面構成





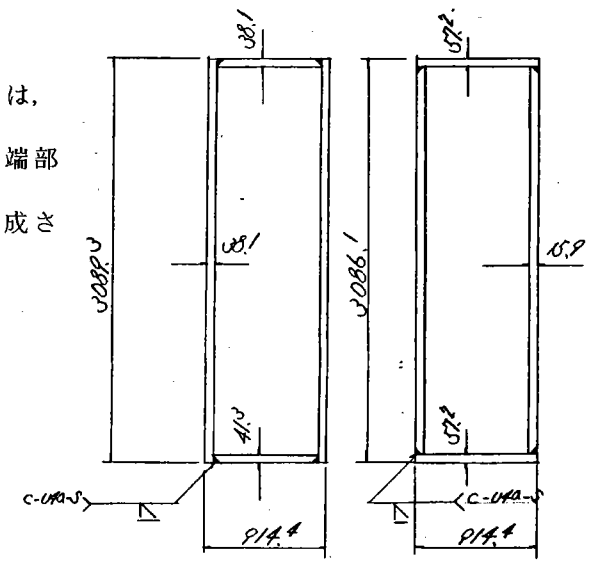




1. タイガーダーのウェブにガセットプレートを SECTION-Dのように突き合せ溶接し，それに横構，横桁の上フランジをボルト止めする型式で連結している。

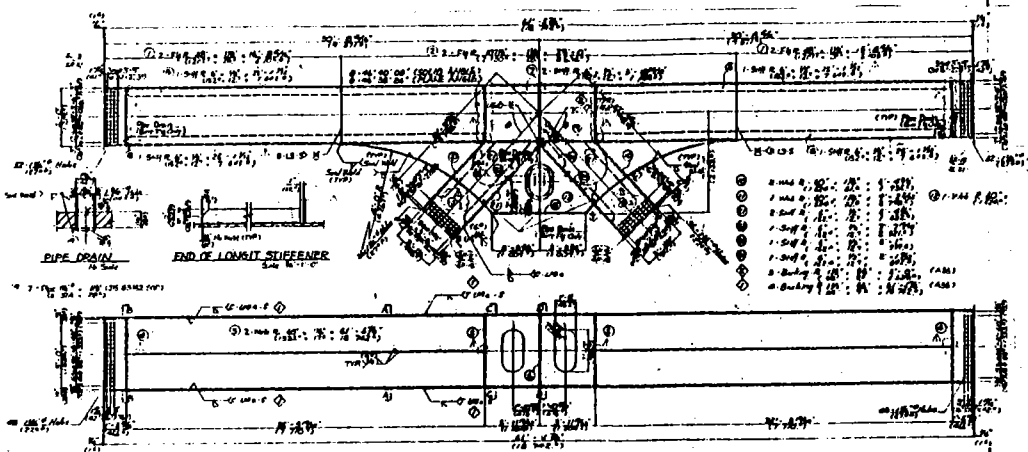
2. タイガーダー断面構成

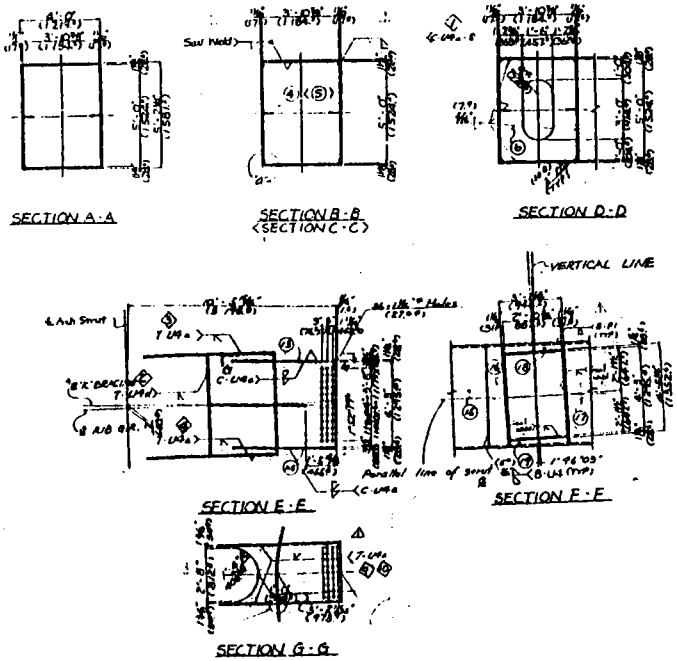
タイガーダーの断面形状は，右図に示した様になり，端部と中間部の２断面から構成されている。

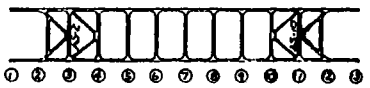


桁端部　　中間部

部位： ARCH STRUT (No.1)





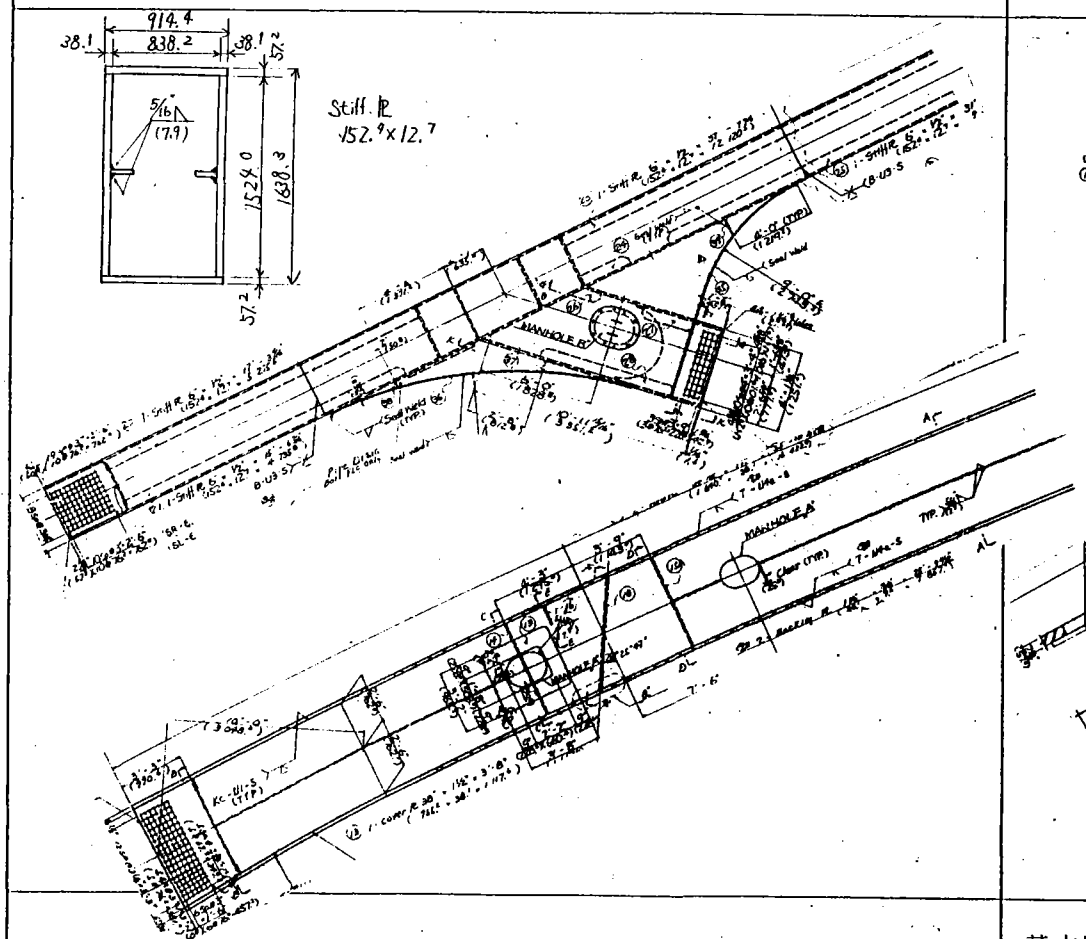


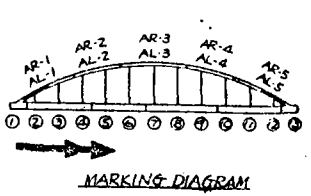
1. ARCH STRUTは両端にK形横構，中央部にはフィーレンディール形式の横構を設けて，橋門構を省略した構造としている。

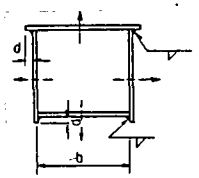
2. 横構サイズ～1219.2×1524

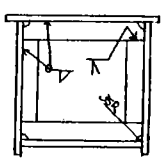
3. 材　　質～ASTM A588

部位： RIB GIRDER









基本断面　長方形箱断面　レ形グループ溶接→ﾌﾗﾝｼﾞ,ｳｪﾌﾞ突出部なし

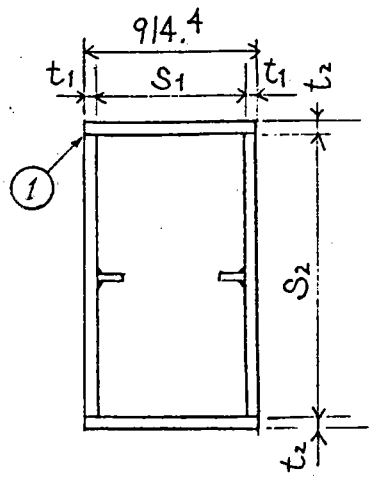
水平補剛材　5/16”（7.9㎜）のスミ肉溶接

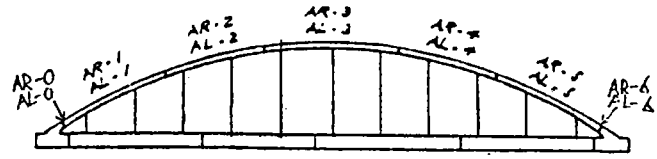
基本断面　　箱断面　　すみ肉溶接

突出部，ｄ＝溶接サイズ＋10㎜

サブマージアーク溶接を行う場合フラックスがこぼれ落ちないようにする。

桁 断 面 変 化 表

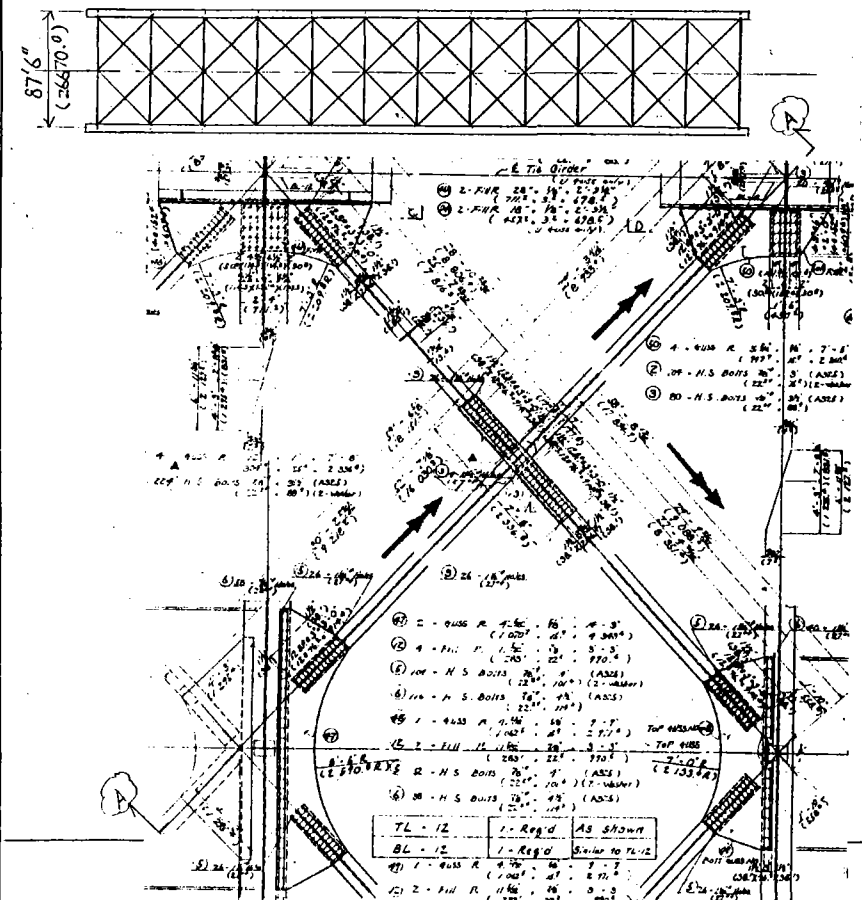


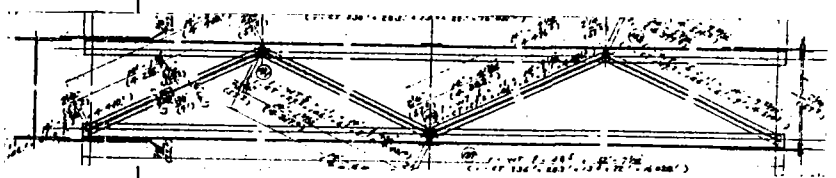


	t_1	t_2	S_1	S_2
AR－0，AL－0	38.1	57.2	838.2	1590
AR－1，AL－1	38.1	57.2	838.2	1524
AR－2，AL－2	31.8	57.2	850.9	1524
AR－3，AL－3	28.6	50.8	857.3	1524
AR－4，AL－4	31.8	57.2	850.9	1524
AR－5，AL－5	38.1	57.2	838.2	1524
AR－6，AL－6	38.1	57.2	838.2	1590

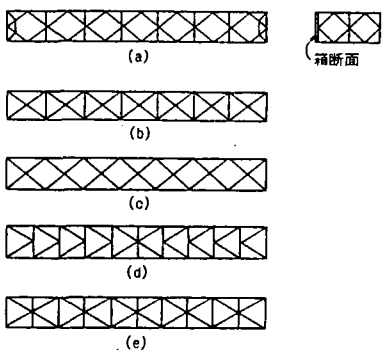
（単位：mm）

部位： LOWER LATERAL BRACING





A - A



国内における一般的なブレースの組み方

ＣＴ形鋼　　トラス構造　　236.1×283.1×13.6×22.1

129.2×146.1× 6.1× 9.1