Comparison of Steel Overhead Sign Support Structures

Submitted by:

John W. van de Lindt, Kriselda Cuellar, and Stanley J. Vitton

Final Report – December, 2003

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16. Abstract

The Michigan DOT is required to implement the new *2001 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals*. This project had the objective of checking to ensure that the overhead sign support structures identified in *Optimization of Cost and Performance of Overhead Sign Structures* meet the 2001 AASHTO criteria including the 2002 revisions. One aspect of this project includes identifying problem areas for implementation of the new design criteria. All three (3) Michigan cantilever sign support structures were found to meet or exceed the new AASHTO 2001 specification. All Michigan bridge-type OH sign support structures met or exceeded the AASHTO 2001 design code requirements. Suggested alterations are presented in tabular form for any other sign supports that did not meet the code.

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Disclaimer

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Table of Contents

1. Background

Currently, Michigan uses two types of overhead sign supports: Sign trusses (referred to herein as "bridge type") and cantilevers. The Michigan DOT is planning to adopt the AASHTO 2001 Standard Specifications for Structural Supports as soon as possible. However, with the adoption of any new design code or provision, numerous issues can arise ranging from Michigan-specific subtleties that must be accounted for to contradiction within the specification itself. This report summarizes the results of a study to check the overhead sign support designs identified in a previous study (Ahlborn et al., 2003) entitled "Optimization of Cost and Performance of Overhead Sign Support Structures" sponsored by the Michigan Department of Transportation (MDOT).

2. Objective, Approach, and Scope of Research

This task will consist of documenting step-by-step comparisons between twelve (12) existing signs supports and the requirements of the AASHTO 2001 provisions. These details are provided in the CD included with this report (the calculation files are in PDF format). Shortcomings in each design are identified in the next section. An additional objective of this task is to provide a transition report for Michigan DOT personnel and consultants to use in new designs that will meet the AASHTO 2001 specifications. The twelve (12) signs that will be compared to the AASHTO 2001 requirements will consist of the six steel overhead sign support structures currently in use and six steel support structures from other states identified in another research study. The following lists the twelve (12) sign support structures proposed for comparison in this project:

(1) The three (3) cantilever-type signs currently in use in Michigan; Type C, Type D, and Type E.

(2) The two (3) bridge-type (referred to as "truss-type" in the Sign Support Typical Plans) signs currently in use in Michigan; Type C 70 ft, Type C 100ft, and Type D.

(3) The three (3) cantilever-type signs identified as "most likely to meet AASHTO 2001" in the project "Cost and Performance Optimization of Overhead Sign Support Structures." These appear in Table 1.

(4) The three (3) bridge-type signs identified as "most likely to meet AASHTO 2001" in the project "Cost and Performance Optimization of Overhead Sign Support Structures." These appear in Table 1.

A fairly standard approach was used in the design check procedure. It can be described in the following steps:

1. Loads to be applied to each of the twelve (12) OH signs were calculated according to AASHTO 2001 provisions. There were a total of 5 load combinations for the steel design check and three load combinations for the fatigue design check.

2. Finite Element Analysis (FEA) Models (*Visual Analysis 4.*1) of the twelve (12) OH signs were created.

3. The loads were then applied to there FEA models in *Visual Analysis*. Each of the twelve (12) OH signs was then analyzed and the resulting shears, moments, and axial forces within each structure was determined for each load case.

4. MathCAD files for connections at the base, chord splices, and chord/column and of column and chord members of concern were made.

5. The shear and moments taken from *Visual Analysis* were used in conjunction with the *MathCAD* software to determine the stresses on the connections or member.

6. These resulting stresses were compared against the allowable stress from the AASHTO 2001 provision or the current AASHTO LRFD Bridge Design Specifications (if referred by the 2001 provision).

3. Results

The purpose of this study was to suggest alternatives to the current structural sign support designs (see section 2) to enable the Michigan DOT to (1) provide a level of safety and compliance implied by the new AASHTO 2001 Specifications; and (2) to achieve a clearance height of 25-ft. Table 1 presents a summary of the overhead sign support structures, whether or not there were any components that did not meet the AASHTO 2001 criteria, and suggested alterations to meet or exceed the criteria.

TABLE 1a: Results Summary and Suggested Alterations to Overhead Sign Support Structures

Structure Description	Type of OH sign Support	Did the structure meet AASHTO 2001?	Description of Design Shortcomings	Suggested Alteration
Michigan Type C	Cantilever	YES	NA	NA
Michigan Type D	Cantilever	YES	NA	NA
Michigan Type E	Cantilever	YES	NA	NA
Colorado Monotube	Cantilever	YES	NA	NA
Indiana 2-arm	Cantilever	NO	Base welds failed in fatigue.	Increase weld size. Calculation could also be altered – see calculation notes on attached CD.
Wisconsin 4-chord truss	Cantilever	NO	Base bolts, base welds, arm-to-column bolts, and arm-to-column welds all failed in fatigue.	Base: Increase bolt diameter from ¾ in. dia to 1¼ in. dia. Increase weld size from ¼ in. to 3/8 in. Arm-to-column: Increase bolt diameter from 2 in. to 2 ½ in. Increase weld size from 3/8 in. to ½ in.
Michigan Type C-70ft	Bridge	YES	NA	NA
Michigan Type C-100ft	Bridge	YES	NA	NA
Michigan Type D	Bridge	YES	NA	NA
Minnesota 4-chord truss	Bridge	NO	Chord splice welds failed under load case G2C1.	Increase 5/16 in. weld to a 9/16 in. weld.
Florida 3-chord truss	Bridge	YES	NA	NA
Missouri 2-arm truss	Bridge	YES	NA	NA

TABLE 1b Summary of Foundation Checks (Full report included in Appendix B).

Foundation Type	Did the structure meet AASHTO 2001?	Issues
Michigan Type C Cantilever	Yes	Only meets for soils at 500 psf or higher strength
Michigan Type D Cantilever	Yes	Only meets for soils at 500 psf or higher strength
Michigan Type E Cantilever	Yes	Only meets for soils at 500 psf or higher strength
Michigan Type C (70 ft) Bridge	Yes	None
Michigan Type C (100 ft) Bridge	Yes	None
Michigan Type D (125 ft) Bridge	Yes	None
Florida 3-Chord Truss Bridge	Yes	Depends on the amount of longitudinal and transverse steel used in the design
Minnesota 4-Chord Truss Bridge	Yes	None
Missouri 2-ARM Bridge	Yes	None
Wisconsin 4-Chord Truss Cantilever	Yes	None
Indiana 1-ARM Cantilever	Yes	None
Colorado Monotube Cantilever	Yes	None
		None

TABLE 2: Michigan Type C Cantilever

Michigan Type C Cantilever

STEEL DESIGN

	Shear		Tensile		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual	Allowable
Base Bolts	3.498	19.95	12.972	33.25	0.183	1
Chord Splice Bolts	0.528	22.098	12.595	44.195	12.595(ksi)	55.244(ksi)

	Welds on column	
	Actual Stress (ksi)	Allowable Stress (ksi)
Base Welds	7.019	21
Chord Splice Welds	8.169	21

	Axial		Bending		Shear		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual (ksi)	Allowable (ksi)	Actual	Allowable
Arm Member	0.549	9.943	13.054	33	0.359	16.5	0.451	1
Column Member	0.219	8.66	15.369	33	4.021	16.5	0.534	1

FATIGUE

	Shear		Tensile	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)
Base Bolts	0.765	7	4.329	7
Chord Splice Bolts	0.445	7	6.73	7

	Welds on column	
	Actual Stress (ksi)	Allowable Stress (ksi)
Base Welds	2.295	7
Chord Splice Welds	2.146	4.5

TABLE 3: Michigan Type D Cantilever

Michigan Type D Cantilever

STEEL DESIGN

	Shear		Tensile		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual	Allowable
Base Bolts	4.161	15	14.43	25	0.41	1
Chord Splice Bolts	1.534	22.098	11.8	44.195	11.8(ksi)	55.244(ksi)

	Welds on column	
	Actual Stress (ksi)	Allowable Stress (ksi)
Base Welds	9.679	21
Chord Splice Welds	6.148	21

	Axial		Bending		Shear		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual (ksi)	Allowable (ksi)	Actual	Allowable
Arm Member	0.345	15.524	11.277	33	0.379	16.5	0.364	1
Column Member	0.242	8.406	16.385	33	4.366	16.5	0.576	1

FATIGUE

	Shear		Tensile	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)
Base Bolts	0.967	7	5.166	7
Chord Splice Bolts	0.581	7	5.804	7

	Welds on column	
	Actual Stress (ksi)	Allowable Stress (ksi)
Base Welds	3.469	7
Chord Splice Welds	1.571	4.5

TABLE 4: Michigan Type E Cantilever

Michigan Type E Cantilever

STEEL DESIGN

	Shear		Tensile		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual	Allowable
Base Bolts	4.745	19.95	19.685	33.25	0.407	1
Chord Splice Bolts	0.484	22.098	13.73	44.195	13.73(ksi)	55.244(ksi)

	Welds on column	
	Actual Stress (ksi)	Allowable Stress (ksi)
Base Welds	10.272	21
Chord Splice Welds	7.756	21

	Axial		Bending		Shear		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual (ksi)	Allowable (ksi)	Actual	Allowable
Arm Member	0.357	9.943	14.304	33	0.3	16.5	0.457	1
Column Member	0.228	8.66	16.137	33	4.358	16.5	0.567	1

FATIGUE

	Shear		Tensile	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)
Base Bolts	1.103	7	6.752	7
Chord Splice Bolts	0.328	7	6.339	7

	Welds on column	
	Actual Stress (ksi)	Allowable Stress (ksi)
Base Welds	3.679	7
Chord Splice Welds	1.95	4.5

TABLE 5: Colorado Monotube Cantilever

Colorado Monotube Cantilever

STEEL DESIGN

	Shear		Tensile		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual	Allowable
Base Bolts	18.324	15	7.285	25	0.737	1
Chord Splice Bolts	0.17	55.535	3.329	136.703	3.329(ksi)	170.878(ksi)

	Welds on column	
	Actual Stress (ksi)	Allowable Stress (ksi)
Base Welds	6.054	21
Chord Splice Welds	2.945	21

	Axial		Bending		Shear		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual (ksi)	Allowable (ksi)	Actual	Allowable
Arm Member	0	19.192	2.955	33	0.171	16.5	0.125	1
Column Member	0.227	9.988	11.199	33	2.836	16.5	0.539	1

FATIGUE

	Shear		Tensile	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)
Base Bolts	4.104	7	2.504	7
Chord Splice Bolts	0.179	7	2.478	7

	Welds on column	
	Actual Stress (ksi)	Allowable Stress (ksi)
Base Welds	2.204	7
Chord Splice Welds	1.328	4.5

TABLE 6: Indiana 2-Arm Cantilever

Indiana 2-arm Cantilever
STEEL DESIGN

	Shear		Tensile		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual	Allowable
Base Bolts	2.655	19.95	11.251	33.25	0.234	1
Chord Splice Bolts	0.694	22.098	33.619	44.195	33.619(ksi)	55.244(ksi)

	Welds on column	
	Actual Stress (ksi)	Allowable Stress (ksi)
Base Welds	17.025	21
Chord Splice Welds	9.78	21

	Axial		Bending		Shear		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual (ksi)	Allowable (ksi)	Actual	Allowable
Arm Member	0	5.09	6.531	33	0.152	16.5	0.198	1
Column Member	0.245	10.713	10.684	33	3.482	16.5	0.377	1

FATIGUE

	Shear		Tensile	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)
Base Bolts	0.607	7	4.813	7
Chord Splice Bolts	0.174	7	6.217	7

	Welds on column	
	Actual Stress (ksi)	Allowable Stress (ksi)
Base Welds	7.285	7
Chord Splice Welds	2.25	4.5

TABLE 7: Wisconsin 4-Chord Truss Cantilever

Wisconsin 4-chord truss Cantilever
STEEL DESIGN

	Shear		Tensile		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual	Allowable
Base Bolts	5.998	21.945	21.824	36.575	0.431	1
Chord Splice Bolts	1.8	12.201	15.495	24.402	15.495(ksi)	30.503(ksi)

	Welds on column	
	Actual Stress (ksi)	Allowable Stress (ksi)
Base Welds	13.577	21
Chord Splice Welds	12.726	21

	Axial		Bending		Shear		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual (ksi)	Allowable (ksi)	Actual	Allowable
Chord Members(truss)	9.074	24.382	NA	NA	NA	NA	NA	NA
Web Members(truss)	6.46	16.116	NA	NA	NA	NA	NA	NA
Column Member	0.228	8.66	15.255	33	5.134	16.5	0.697	1

FATIGUE

	Shear		Tensile	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)
Base Bolts	1.341	7	7.595	7
Chord Splice Bolts	1.297	7	14.848	7

	Welds on column	
	Actual Stress (ksi)	Allowable Stress (ksi)
Base Welds	4.849	4.5
Chord Splice Welds	5.329	4.5

TABLE 8: Michigan Type C (70 ft) Bridge Type

Michigan Type C-70ft Bridge
STEEL DESIGN

	Shear		Tensile		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual	Allowable
Base Bolts	1.497	15	21.352	25	0.739	1
Chord Splice Bolts	0.037	12.201	3.742	24.402	3.742(ksi)	30.503(ksi)
Chord/Column Bolt (upper)	0.479	7.854	3.233	24.402	3.233(ksi)	30.503(ksi)
Chord/Column Bolt (lower)	0.428	9.24	6.944	24.402	6.944(ksi)	30.503(ksi)
Chord/Column U-Bolt (upper)	2.13	8.245	-1.185	24.402	(-1.185)(ksi)	30.503(ksi)
Chord/Column U-Bolt (lower)	1.954	8.245	2.756	16.489	2.756(ksi)	20.611(ksi)

	Welds on column	
	Actual Stress (ksi)	Allowable Stress (ksi)
Base Welds	4.126	21
Chord Splice Welds	6.443	21
Chord/Column Weld (upper)	11.172	21
Chord/Column Weld (lower)	9.357	21

	Axial		Bending		Shear		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual (ksi)	Allowable (ksi)	Actual	Allowable
Chord Members(truss)	4.813	18.021	NA	NA	NA	NA	NA	NA
Web Members(truss)	3.497	15.497	NA	NA	NA	NA	NA	NA
Column Member	3.688	4.577	9.286	27.6	0.97	15.18	0.488	1
Column Web Members	4.374	15.185	NA	NA	NA	NA	NA	NA

TABLE 9: Michigan Type C (100 ft) Bridge Type

Michigan Type C-100ft Bridge
STEEL DESIGN

	Shear		Tensile		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual	Allowable
Base Bolts	1.506	19.95	28.013	33.25	0.716	1
Chord Splice Bolts	0.387	12.201	9.129	24.402	9.129(ksi)	30.503(ksi)
Chord/Column Bolt (upper)	1.38	7.854	7.97	24.402	7.97(ksi)	30.503(ksi)
Chord/Column Bolt (lower)	0.376	9.24	10.573	24.402	10.573(ksi)	30.503(ksi)
Chord/Column U-Bolt (upper)	0.647	8.245	1.374	16.489	1.374(ksi)	20.311(ksi)
Chord/Column U-Bolt (lower)	3.014	8.245	2.813	16.489	2.813(ksi)	20.611(ksi)

	Welds on column	
	Actual Stress (ksi)	Allowable Stress (ksi)
Base Welds	5.932	21
Chord Splice Welds	11.583	21
Chord/Column Weld (upper)	18.54	21
Chord/Column Weld (lower)	21.22	27.93

	Axial		Bending		Shear		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual (ksi)	Allowable (ksi)	Actual	Allowable
Chord Members(truss)	6.074	20.61	NA	NA	NA	NA	NA	NA
Web Members(truss)	4.657	15.257	NA	NA	NA	NA	NA	NA
Column Member	3.319	4.311	8.611	27.6	0.919	15.18	0.449	1
Column Web Members	5.492	15.185	NA	NA	NA	NA	NA	NA

TABLE 10: Michigan Type D Bridge Type

Michigan Type D Bridge
STEEL DESIGN

	Shear		Tensile		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual	Allowable
Base Bolts	1.891	19.95	24.967	33.25	0.573	1
Chord Splice Bolts	0.595	12.201	12.849	24.402	12.849(ksi)	30.503(ksi)
Chord/Column Bolt (upper)	2.1	7.854	8.047	24.402	8.047(ksi)	30.503(ksi)
Chord/Column Bolt (lower)	0.322	9.24	8.797	24.402	8.797(ksi)	30.503(ksi)
Chord/Column U-Bolt (upper)	0.632	12.201	2.008	24.402	2.008(ksi)	30.503(ksi)
Chord/Column U-Bolt (lower)	1.411	12.201	4.416	24.402	4.416(ksi)	30.503(ksi)

	Welds on column	
	Actual Stress (ksi)	Allowable Stress (ksi)
Base Welds	6.696	21
Chord Splice Welds	15.648	21
Chord/Column Weld (upper)	21.436	27.93
Chord/Column Weld (lower)	16.515	21

	Axial		Bending		Shear		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual (ksi)	Allowable (ksi)	Actual	Allowable
Chord Members(truss)	8.482	20.61	NA	NA	NA	NA	NA	NA
Web Members(truss)	4.605	14.605	NA	NA	NA	NA	NA	NA
Column Member	3.206	4.311	10.094	27.6	0.996	15.18	0.502	1
Column Web Members	3.937	15.185	NA	NA	NA	NA	NA	NA

TABLE 11: Minnesota 4-Chord Truss Bridge Type

Minnesota 4-chord truss Bridge
STEEL DESIGN

	Shear		Tensile		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual	Allowable
Base Bolts	0.285	15	9.962	25	0.159	1
Chord Splice Bolts	0.32	22.098	14.328	44.195	14.328(ksi)	55.244(ksi)
Chord/Column Bolt (upper)	NA	NA	NA	NA	NA	NA
Chord/Column Bolt (lower)	2.066	7.854	0.345	24.402	0.345	30.503(ksi)

	Welds on column	
	Actual Stress (ksi)	Allowable Stress (ksi)
Base Welds	22.883	27.93
Chord Splice Welds	33.626	27.93
Chord/Column Weld 1 (upper)	0.933	21
Chord/Column Weld 2 (upper)	7.24	21
Chord/Column Weld (lower)	1.978	21

	Axial		Bending		Shear		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual (ksi)	Allowable (ksi)	Actual	Allowable
Chord Members(truss)	11.58	20.918	NA	NA	NA	NA	NA	NA
Web Members(truss)	11.246	14.31	NA	NA	NA	NA	NA	NA
Column Member	0.377	11.913	23.879	30.36	0.388	15.18	0.804	1

TABLE 12: Florida 3-Chord Truss Bridge Type

Florida 3-chord truss Bridge
STEEL DESIGN

	Shear		Tensile		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual	Allowable
Base Bolts	0.589	16.5	8.161	27.5	0.089	1
Chord Splice Bolts	20.402	33.66	0.005	44.195	0.005(ksi)	55.244(ksi)
Chord/Column Bolt (upper)	9.55	12.201	1.54	24.402	1.54(ksi)	21.858(ksi)
Chord/Column Bolt (lower)	8.133	12.201	2.714	24.402	2.714(ksi)	30.503(ksi)

	Welds on column	
	Actual Stress (ksi)	Allowable Stress (ksi)
Base Welds	8.561	21
Chord Splice Welds	NA	NA
Chord/Column Weld 1 (upper)	3.625	21
Chord/Column Weld 1 (lower)	5.722	21
Chord/Column Weld 2 (upper)	1.943	21
Chord/Column Weld 2 (lower)	2.221	21

	Axial		Bending		Shear		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual (ksi)	Allowable (ksi)	Actual	Allowable
Chord Members(truss)	9.592	23.138	NA	NA	NA	NA	NA	NA
Web Members(truss)	6.36	16.515	NA	NA	NA	NA	NA	NA
Column Member	0.41	16.638	17.321	27.72	0.722	13.86	0.645	1

TABLE 13: Missouri 2-Arm Truss Bridge Type

Missouri 2-arm Bridge
STEEL DESIGN

	Shear		Tensile		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual	Allowable
Base Bolts	1.751	15	9.156	25	0.148	1
Chord Splice Bolts	0.205	35.353	11.724	70.706	11.724(ksi)	88.383(ksi)
Chord/Column Bolt 1	31.009	34.175	4.525	34.175	4.525(ksi)	42.718(ksi)
Chord/Column Bolt 2	1.8	8.245	13.381	16.489	13.381(ksi)	20.611(ksi)

	Welds on column	
	Actual Stress (ksi)	Allowable Stress (ksi)
Base Welds	20.075	21
Chord Splice Welds	11.187	21
Chord/Column Weld	NA	NA

	Axial		Bending		Shear		Combined	
	Actual Stress (ksi)	Allowable Stress (ksi)	Actual Stress (ksi)	Allowable Stress (ksi)	Actual (ksi)	Allowable (ksi)	Actual	Allowable
Chord Members(truss)	2.823	19.305	NA	NA	NA	NA	NA	NA
Web Members(truss)	2.954	17.368	NA	NA	NA	NA	NA	NA
Column Member	0.261	12.277	19.588	30.36	3.453	15.18	0.706	1

References

AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals*, 4th edition, (2001).

Ahlborn, T.M., J.W. van de Lindt, and M.E. Lewis. (2003). "Optimization of Cost and Performance of Overhead Sign Support Structures". *MDOT Research Report JN-56886*, October 2003, 150pp.

2002 Interim to AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals*, 4th edition, (2001).

Sign Support Typical Plans – English Version (2001), Michigan Department of Transportation Traffic and Safety Division.

Appendix A: Stresses Calculated for Each of the Twelve (12) OH Sign Supports Analyzed in this Study.

The attached CD contains summary tables for the stresses calculated using basic principles of structural analysis and design for each of the twelve (12) overhead sign supports checked. In addition, the enclosed CD contains 1,311 calculation files in 1.) PDF format, and 2.) The original *Mathcad* format.

	Structure Description	Folder name	# Files
Cantilevers	Michigan Type C	CC	50
	Michigan Type D	CD	50
	Michigan Type E	CE	50
	Colorado Monotube	CCO	50
	Indiana 2-arm	CIN	42
	Wisconsin 4-chord truss	CWI	55
Bridge Type	Michigan Type C-70ft	BC(70)	214
	Michigan Type C-100ft	BC(100)	214
	Michigan Type D	BD	233
	Minnesota 4-chord truss	BMN	123
	Florida 3-chord truss	BFL	117
	Missouri 2-arm truss	BMO	113

APPENDIX B
ADEQUACY OF OVERHEAD SIGN SUPPORT: STRUCTURAL FOUNDATION ANALYSIS

1. GENERAL BACKGROUND

The objective of this analysis is to determine if the existing MDOT foundation designs as well as select overhead foundation designs from a number of others states conform to the AASHTO document 2002 Interim to "*Standard Specification for Structural Support for Highway Sign, Luminaries and Traffic Signals*" when constructed in Michigan. The specifications allow the following three types of foundations: (1) drilled shaft, (2) spread footings and (3) piles. The foundation types analyzed in this report are the drilled shaft and spread footing. In general, foundation design is divided into geotechnical design and structural design as well as constructability issues. This report covers the structural design of the foundations investigated, although the drill shaft length design is reviewed when soil strength data ranges were provided in the design drawing.

According to AASHTO 2002 Interim to "*Standard Specification for Structural Support for Highway Sign, Luminaries and Traffic Signals,*" the structural design of both drill shaft and spread footings "should be in accordance with the provisions for the design of reinforced concrete given in the *Standard Specifications for Highway Bridges*. These standards allow either an Allowable Stress Design (ASD) or the Strength Design Method (Load Factor Design) for conducting structural design. However, the method used in this analysis follows the method provided in the FHWA (1999) publication FHWA-IF-99-025 titled "Drill Shaft: Construction Procedures and Design Methods." The FHWA procedure follows the ACI (1993) for drilled shafts, which is compatible with AASHTO (1994). However, where applicable the AASHTO (1994) and AASHTO (1999) specifications were used.

2. FOUNDATIONS ANALYZED

REPORT NUMBER ID	NAME	FOUNDATION TYPE
1	Michigan Type C Cantilever	Drilled Shaft
2	Michigan Type D Cantilever	Drilled Shaft
3	Michigan Type E Cantilever	Drilled Shaft
4	Michigan Type C (70 ft) Bridge	Spread
5	Michigan Type C (100 ft) Bridge	Spread
6	Michigan Type D (125 ft) Bridge	Spread
7	Florida 3-Chord Truss Bridge	Drilled Shaft
8	Minnesota 4-Chord Truss Bridge	Drill Shaft
9	Minnesota 4-Chord Truss Bridge	Spread
10	Missouri 2-ARM Bridge	Drilled Shaft
11	Wisconsin 4-Chord Truss Cantilever	Drilled Shaft
12	Indiana 1-ARM Cantilever	Drilled Shaft
13	Colorado Monotube Cantilever	Drilled Shaft

3. Assumptions Used in the Analysis

(a) Concrete Compressive Strength $f'_c = 3{,}000$ to $4{,}000$ psi
(b) Steel Reinforcement Grade 40 to 60 allowable $f'_y = 20{,}000$ psi to $24{,}000$ psi (8.15.2.2) [1]
(c) Normal Weight Concrete $w_c = 145$ pcf
(d) $E_c = w_c^{1.5}\, 33(f'_c)^{0.5}$ $w_c = 3000$ psi $E_c = 3{,}155{,}900$ psi (8.7.1)
(e) $E_c = w_c^{1.5}\, 33(f'_c)^{0.5}$ $w_c = 4000$ psi $E_c = 3{,}644{,}150$ psi (8.7.1)
(f) $E_s = 29{,}000{,}000$ psi (8.7.2)
(g) Possion Ratio for concrete = 0.2 (8.7.3)
(h) Modular Ratio: $n = E_s/E_c$ (8.15.3.4)

$f'_c = 4{,}000$ psi $n = 9$
$f'_c = 4{,}000$ psi $n = 8$

(i) No span length greater than 40 feet: Therefore no expansion and contraction (8.5)

4. General Design Considerations for Drilled Shaft Construction

According to Coduto (1999) drill shaft foundations suffer from a lack of well-defined code provisions for structural design. This led to the development of FHWA (1999). The general procedure used in FHWA (1999) is to design the drill shaft as a short column. In the design of drill shafts the follows general rules are cited in FHWA (1999) along with their application to the structural design of the sign foundations.

(a) The length of drill shafts should not exceed 30 times their diameter. None of the drill shafts investigated in this report exceed this limitation.
(b) According to FHWA (199) "Well-constructed drilled shafts are not normally stressed to a point where structural stress controls the design. Instead, the geometric properties of the drill shaft are usually governed by the requirement to construct the shaft with a length, perimeter area and cross-sectional area large enough to develop the necessary resistance."
(c) The minimum recommended diameter of a drill shaft should be three feet for construction purposes. All of the drill shafts investigated had a diameter equal to or greater than three feet (36 inches).
(d) FHWA (1999) uses the LRFD method of analysis. According to AASHTO (1994) the factored axial resistance of the drill shaft acting as a short column should be $\phi_a = 0.75$ regardless whether horizontal ties or spirals is used as transverse reinforcement.
(e) FHWA (1999) recommends $\phi_m = 0.90$ for bending where the axial load is small. In general, the axial loads on the sign foundations are relatively small compared to the applied moments.
(f) When there is no head shear present on the drill shaft, the bending moment at the shaft head is the highest bending moment along the shaft. However, this is not the

[1] Parentheses indicate reference section in the 1999 Interim Revisions to the *Standard Specifications for Highway Bridges*, 16th Edition, 1996.

case when there is head shear present and the greatest moment is below the head of the drill shaft. The shear loads on the drill shafts for all of the signs are very low in comparison to the applied moment. Consequently, the maximum moment is assumed to occur at the head of the drill shaft. To compensate for the shear load on the drill shaft the AASHTO load factor of 1.75 will be used on the nominal loads. That is, in this analysis the dead and live loads are combined and then a load factor of 1.75 is applied, instead of applying a factor of 1.25 to the dead load and 1.75 to the live load.

(g) Axial load capacity used equation 13.22 in FHWA (1999)

(h) Shear capacity used equation 13.23, 13.24 and assumed $A_v = 0.95\ A_g$ (gross drill shaft area) FHWA (1999)

(i) Transverse reinforcement is based on equation 13.26 FHWA (1999)

5. Foundation Loads

The foundation loads are provided following this section. There are five different loading conditions and all are unfactored loads, which combine both dead and live loads. The foundation analysis used an Excel Spreadsheet to determine the maximum load combinations to use for the critical analysis. In almost all cases, the G2C1 loading condition provided the maximum design loads on the foundations. When different size foundations were provided due to soil conditions, the smallest foundation size was used in the analysis.

6. Spread Footing Foundation Design

Spread footing design was based on the LRFD method of analysis, conducting both one-way and two-way shear analysis.

7. Summary of Analysis

All of the foundations analyzed, with the exception of the Florida drill shaft, met structural design requirements by a considerable margin. Due to high ice loads the Florida drill shaft did not have sufficient reinforcement steel to handle the moment loads on the foundation. However, using the steel requirement for the Michigan drill shaft foundation in the Florida design were sufficient to meet structural design requirements.

8. Analysis

8.1 Michigan Type C Cantilever

Foundation Type: Drill Shaft

Gross Diameter: 36 inches
Mean Diameter: 30 inches
Length: 14 to 15 feet
Longitudinal Steel: 9 #10 Bars equally spaced
Transverse Steel: #3 Bar/28 circles required or 5/8 inch spiral with 3 inch pitch

The structural foundation designs for the Michigan C Cantilevered sign foundations for the design loads are acceptable. In addition, the embedment length was also found to be acceptable for soils with a cohesive strength greater than 500 psf. For soils of lower strength the foundation's geotechnical design must be reconsidered.

8.2 Michigan Type D Cantilever

Foundation Type: Drill Shaft

Gross Diameter:	42 inches
Mean Diameter:	36 inches
Length:	13 to 15 feet
Longitudinal Steel:	9 #10 Bars equally spaced
Transverse Steel:	#3 Bar/28 circles required or 5/8 inch spiral with 3 inch pitch
Structural Design:	Meets Structural Design Standards

The structural foundation designs for the Michigan C Cantilevered sign foundations for the design loads are acceptable. In addition, the embedment length was also found to be acceptable for soils with a cohesive strength greater than 500 psf. For soils of lower strength the foundation's geotechnical design must be reconsidered.

4.1 Michigan Type E Cantilever

Foundation Type: Drill Shaft

Gross Diameter:	42 inches
Mean Diameter:	36 inches
Length:	14 to 15 feet
Longitudinal Steel:	9 #10 Bars equally spaced
Transverse Steel:	#3 Bar/28 circles required or 5/8 inch spiral with 3 inch pitch
Structural Design:	Meets Structural Design Standards

The structural foundation designs for the Michigan C Cantilevered sign foundations for the design loads are acceptable. In addition, the embedment length was also found to be acceptable for soils with a cohesive strength greater than 500 psf. For soils of lower strength the foundation's geotechnical design must be reconsidered.

4.2 Michigan Type C (70 ft) Bridge

Foundation Type: Spread Footing

Footing Width, B	7 ft.
Footing Length, L	7 ft.
Longitudinal Steel:	5 #5 Bars equally spaced
Transverse Steel:	6 #5 Bars equally spaced
Foundation Thickness, T	2 ft
Structural Design:	Significantly meets Structural Design Standards

4.3 Michigan Type C (100 ft) Bridge

Foundation Type: Spread Footing

Footing Width, B	7 ft.
Footing Length, L	7 ft.
Longitudinal Steel:	5 #5 Bars equally spaced
Transverse Steel:	6 #5 Bars equally spaced
Foundation Thickness, T	2 ft
Structural Design:	Significantly meets Structural Design Standards

4.4 Michigan Type D (125 ft) Bridge

Foundation Type: Spread Footing

Footing Width, B	7 ft.
Footing Length, L	7 ft.
Longitudinal Steel:	5 #5 Bars equally spaced
Transverse Steel:	6 #5 Bars equally spaced
Foundation Thickness, T	2 ft
Structural Design:	Significantly meets Structural Design Standards

4.5 Florida 3-Chord Truss Bridge

Foundation Type: Drill Shaft

Gross Diameter:	42 inches
Mean Diameter:	36 inches
Length:	Site Specific
Longitudinal Steel:	9 #10 Bars equally spaced
Transverse Steel:	#3 Bar/28 circles required or 5/8 inch spiral with 3 inch pitch
Structural Design:	Does not meet structural design standards

Due to the high loads due to ice, the foundation as design does not meet structure design standards. However, the structural design is adequate if additional reinforcement steel is added. Using the same steel ratio as in the Michigan C, D, or E designs in the drill shaft, the structural design is acceptable.

Modified Foundation Type: Drill Shaft

Gross Diameter:	42 inches
Mean Diameter:	36 inches
Length:	Site Specific
Longitudinal Steel:	6 #5 Bars equally spaced
Transverse Steel:	1 #3 Bar every 12 inches
Structural Design:	Meets structural design standards

4.6 Minnesota 4-Chord Truss Bridge – Drill Shaft

Foundation Type: Drill Shaft

Gross Diameter:	36 inches
Mean Diameter:	30 inches
Length:	Site Specific
Longitudinal Steel:	20 #9 Bars equally spaced
Transverse Steel:	#4 Bar Spiral
Structural Design:	Meets structural design standards.

4.7 Minnesota 4-Chord Truss Bridge – Spread Footing

Foundation Type: Spread Footing

Footing Width, B	9 ft.
Footing Length, L	14 ft.
Longitudinal Steel:	10 #7 Bars equally spaced
Transverse Steel:	14 #4 Bars equally spaced
Foundation Thickness, T	2 ft
Structural Design:	Significantly meets Structural Design Standards

4.8 Missouri 2-ARM Bridge

Foundation Type: Drill Shaft

Gross Diameter:	36 inches
Mean Diameter:	30 inches
Length:	Site Specific
Longitudinal Steel:	6 #5 Bars equally spaced
Transverse Steel:	#4 Bar at 12 inch intervals
Structural Design:	Meets structural design standards when transverse reinforcement is placed at six-inch intervals.

4.9 Wisconsin 4-Chord Truss Cantilever

Foundation Type: Drill Shaft

Gross Diameter:	42 inches
Mean Diameter:	36 inches
Length:	Site Specific
Longitudinal Steel:	12 #7 Bars equally spaced
Transverse Steel:	#4 Bars at 6 inch intervals
Structural Design:	Meets structural design.

4.10 Indiana 1-ARM Cantilever

Foundation Type: Drill Shaft

Gross Diameter:	36 inches
Mean Diameter:	30 inches
Length:	Site Specific
Longitudinal Steel:	11 #10 Bars equally spaced
Transverse Steel:	#3 Bars at 6 inch intervals
Structural Design:	Meets structural design.

4.11 Colorado Monotube Cantilever

Foundation Type: Drill Shaft

Gross Diameter:	36 inches
Mean Diameter:	30 inches
Length:	Site Specific
Longitudinal Steel:	13 #8 Bars equally spaced
Transverse Steel:	#4 Bar at 6 inch intervals
Structural Design:	Meets structural design.

REFERENCES

ASSHTO (1994), *AASHTO LRFD Bridge Design Specifications, SI Units, First Edition*, American Association of State Highway and Transportation Officials, Washington, D.C.

AASHTO (1999), *Interim Revisions to the Standard Specifications for Highway Bridges, 16th* Edition, American Association of State Highway and Transportation Officials, Washington, D.C.

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O'Neill, M.O., and L. Reese, 1999, Drilled Shafts: Construction Procedure and Design Methods, Volumes I and II, FHWA-IF-99-025, p 537.

Coduto, D. P., 2001, "Foundation Design: Principles and Practice, 2nd Edition, Prentice Hall, New Jersey, p.883.

SIGN DESIGN LOADS

MICHIGAN DEPARTMENT OF TRANSPORTATION SIGN DESIGN LOADS CANTILEVERED SIGNS

MICHIGAN TYPE C- Cantilevered
Moments & Shears from Visual Analysis*

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	0.00	4.23	0.00	0.00	0.00	21.42
G2C1	-0.07	4.23	3.38	81.17	-42.40	23.20
G2C2	-0.11	4.23	2.03	48.70	-25.44	24.10
G3C1	-0.09	5.22	1.96	44.67	-21.22	37.46
G3C2	-0.13	5.22	1.18	26.80	-12.73	38.57

MICHIGAN TYPE D- Cantilevered
Moments & Shears from Visual Analysis*

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	0.00	5.90	0.00	0.00	0.00	30.62
G2C1	-0.08	5.90	5.15	124.81	-66.38	32.63
G2C2	-0.12	5.90	3.09	74.89	-39.83	33.62
G3C1	-0.11	7.22	2.90	67.35	-33.22	51.66
G3C2	-0.16	7.22	1.74	40.41	-19.93	52.93

MICHIGAN TYPE E- Cantilevered
Moments & Shears from Visual Analysis*

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	0.00	6.25	0.00	0.00	0.00	31.39
G2C1	-0.09	6.25	6.47	157.22	-84.15	33.61
G2C2	-0.14	6.25	3.88	94.33	-50.49	34.72
G3C1	-0.12	7.76	3.59	84.09	-42.10	55.35
G3C2	-0.18	7.76	2.16	50.45	-25.26	56.78

Note: X = horizontal plane (right +), Y = vertical plane (up +), & Z = out of the page (out of page +)

Load Combinations	
G1	Group 1- Dead load
G2C1	Group 2- Case 1 - Dead + Wind
G2C2	Group 2- Case 2 - Dead + Wind
G3C1	Group 3- Case 1 - Dead + Ice + 1/2 Wind
G3C2	Group 3- Case 2 - Dead + Ice + 1/2 Wind
*** Values given are the resisting moments and shears to forces being applied**	

MICHIGAN DEPARTMENT OF TRANSPORTATION SIGN DESIGN LOADS
BRIDGE SIGNS

MICHIGAN TYPE C (70ft)- Bridge
Moments & Shears from Visual Analysis*

COLUMN #1

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	0.09	4.33	0.05	-0.14	0.01	-0.97
G2C1	-0.05	36.38	8.23	17.28	-0.65	1.23
G2C2	-0.19	23.44	4.96	10.31	-0.46	3.16
G3C1	0.13	23.26	4.16	8.56	-0.32	-1.03
G3C2	0.06	16.79	2.53	5.08	-0.23	-0.07

COLUMN #2

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	0.09	4.01	-0.05	-0.22	-0.02	-0.94
G2C1	-0.21	-28.21	0.98	7.87	-0.50	3.19
G2C2	-0.28	-15.36	0.57	4.64	-0.22	4.32
G3C1	0.04	-11.74	0.44	3.74	-0.30	0.08
G3C2	0.01	-5.32	0.24	2.13	-0.17	0.64

COLUMN #3

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	-0.09	4.42	0.07	-0.19	-0.01	0.98
G2C1	-0.41	37.39	8.54	15.52	0.54	5.21
G2C2	-0.48	24.32	5.15	9.24	0.23	6.37
G3C1	-0.36	23.81	4.33	7.65	0.26	4.27
G3C2	-0.40	17.28	2.64	4.50	0.11	4.84

COLUMN #4

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	-0.09	4.07	-0.07	-0.29	0.02	0.93
G2C1	-0.20	-28.73	0.68	5.29	0.72	2.77
G2C2	-0.34	-15.57	0.38	3.05	0.50	4.78
G3C1	-0.24	-11.98	0.28	2.39	0.41	2.88
G3C2	-0.32	-5.40	0.13	1.27	0.30	3.89

Load Combinations	
G1	Group 1- Dead load
G2C1	Group 2- Case 1 - Dead + Wind
G2C2	Group 2- Case 2 - Dead + Wind
G3C1	Group 3- Case 1 - Dead + Ice + 1/2 Wind
G3C2	Group 3- Case 2 - Dead + Ice + 1/2 Wind

*** Values given are the resisting moments and shears to forces being applied**

MICHIGAN TYPE C (100ft)- Bridge
Moments & Shears from Visual Analysis*

COLUMN #1

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	0.27	6.96	0.09	-0.21	0.08	-2.87
G2C1	0.00	49.05	10.68	20.47	-1.71	1.38
G2C2	-0.30	32.05	6.44	12.20	-1.21	5.62
G3C1	0.36	30.28	5.42	10.07	-0.74	-3.08
G3C2	0.21	21.78	3.30	5.93	-0.49	-0.96

COLUMN #2

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	0.26	6.56	-0.09	-0.44	-0.08	-2.76
G2C1	-0.38	-35.79	0.91	8.06	-1.30	6.28
G2C2	-0.52	-18.92	0.51	4.67	-0.62	8.50
G3C1	-0.15	-12.41	0.38	3.64	-0.76	-0.49
G3C2	0.08	-3.98	0.18	1.95	-0.41	0.62

COLUMN #3

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	-0.27	6.96	0.09	-0.21	-0.08	2.87
G2C1	-0.91	49.42	10.69	20.48	1.26	11.79
G2C2	-1.07	32.60	6.45	12.20	0.54	14.13
G3C1	-0.81	30.46	5.42	10.07	0.52	9.66
G3C2	-0.89	22.05	3.30	5.93	0.16	10.83

COLUMN #4

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	-0.26	6.56	-0.09	-0.44	0.08	2.76
G2C1	-0.50	-35.64	0.91	8.03	1.68	6.63
G2C2	-0.80	-18.69	0.51	4.64	1.19	10.87
G3C1	-0.60	-12.34	0.38	3.63	0.95	6.95
G3C2	-0.75	-3.86	0.18	1.93	0.70	9.07

Load Combinations	
G1	Group 1- Dead load
G2C1	Group 2- Case 1 - Dead + Wind
G2C2	Group 2- Case 2 - Dead + Wind
G3C1	Group 3- Case 1 - Dead + Ice + 1/2 Wind
G3C2	Group 3- Case 2 - Dead + Ice + 1/2 Wind

*** Values given are the resisting moments and shears to forces being applied**

MICHIGAN TYPE D (125ft)- Bridge
Moments & Shears from Visual Analysis*

COLUMN #1

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	0.59	8.64	0.12	-0.30	0.16	-6.16
G2C1	0.24	48.06	12.10	20.27	-1.71	-0.61
G2C2	-0.15	32.13	7.31	12.04	-1.28	4.76
G3C1	0.81	30.92	6.14	9.92	-0.66	-7.53
G3C2	0.62	22.96	3.74	5.80	-0.45	-4.85

COLUMN #2

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	0.56	8.18	-0.11	-0.53	-0.10	-5.89
G2C1	-0.26	-31.51	0.71	5.92	-1.20	5.44
G2C2	-0.43	-15.72	0.38	3.35	-0.52	8.26
G3C1	0.53	-9.18	0.27	2.53	-0.72	-4.21
G3C2	0.44	-1.29	0.10	1.24	-0.38	-2.80

COLUMN #3

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	-0.58	8.62	0.11	-0.31	-0.18	6.10
G2C1	-1.40	47.11	12.10	20.22	0.97	17.31
G2C2	-1.60	31.87	7.31	12.01	0.26	20.36
G3C1	-1.39	30.42	6.14	9.89	0.27	15.82
G3C2	-1.48	22.80	3.74	5.78	-0.08	17.35

COLUMN #4

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	-0.57	8.19	-0.11	-0.53	0.08	5.96
G2C1	-0.87	-30.03	0.71	5.88	1.68	10.96
G2C2	-1.25	-14.66	0.38	3.31	1.20	16.25
G3C1	-1.10	-8.42	0.27	2.51	0.94	12.47
G3C2	-1.29	-0.74	0.10	1.22	0.70	15.12

Load Combinations	
G1	Group 1- Dead load
G2C1	Group 2- Case 1 - Dead + Wind
G2C2	Group 2- Case 2 - Dead + Wind
G3C1	Group 3- Case 1 - Dead + Ice + 1/2 Wind
G3C2	Group 3- Case 2 - Dead + Ice + 1/2 Wind

*** Values given are the resisting moments and shears to forces being applied**

COLORADO DEPARTMENT OF TRANSPORTATION SIGN DESIGN LOADS

COLORADO MONTUBE- Cantilevered
Moments & Shears from Visual Analysis*

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	0.00	8.37	0.00	0.00	0.00	43.82
G2C1	-0.13	8.37	6.91	198.26	-100.06	47.84
G2C2	-0.20	8.37	4.15	118.95	-60.03	49.85
G3C1	-0.17	10.35	3.97	107.49	-50.14	80.65
G3C2	-0.26	10.35	2.38	64.49	-30.08	83.22

INDIANA DEPARTMENT OF TRANSPORTATION SIGN DESIGN LOADS

INDIANA 1-ARM- Cantilevered
Moments & Shears from Visual Analysis*

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	0.00	6.68	0.00	0.00	0.00	39.49
G2C1	-0.19	6.68	3.99	90.57	-59.10	44.14
G2C2	-0.28	6.68	2.39	54.34	-35.46	46.44
G3C1	-0.11	8.13	2.10	46.47	-29.55	64.05
G3C2	-0.17	8.13	1.26	27.88	-17.73	65.46

Load Combinations	
G1	Group 1- Dead load
G2C1	Group 2- Case 1 - Dead + Wind
G2C2	Group 2- Case 2 - Dead + Wind
G3C1	Group 3- Case 1 - Dead + Ice + 1/2 Wind
G3C2	Group 3- Case 2 - Dead + Ice + 1/2 Wind
*** Values given are the resisting moments and shears to forces being applied**	

FLORIDA DEPARTMENT OF TRANSPORTATION SIGN DESIGN LOADS

FLORIDA 3-CHORD TRUSS- Bridge
Moments & Shears from Visual Analysis*

COLUMN #1

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	7.88	23.74	0.00	16.46	-8.15	-79.07
G2C1	7.77	23.66	19.73	598.92	-40.59	-76.82
G2C2	7.78	23.69	11.84	365.95	-27.59	-77.04
G3C1	12.02	29.38	10.63	322.32	-28.68	-119.44
G3C2	11.77	29.36	6.38	200.11	-22.06	-114.56

COLUMN #2

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	-7.88	23.74	0.00	16.46	8.15	79.07
G2C1	-8.80	23.82	19.72	598.73	41.40	96.79
G2C2	-8.47	23.80	11.83	365.82	28.13	90.34
G3C1	-12.67	29.48	10.62	322.20	29.19	132.01
G3C2	-12.74	29.50	6.37	199.93	22.82	133.43

MINNESOTA DEPARTMENT OF TRANSPORTATION SIGN DESIGN LOADS

MINNESOTA 4-CHORD TRUSS- Bridge
Moments & Shears from Visual Analysis*

COLUMN #1

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	0.14	18.44	0.00	0.95	-0.01	-0.71
G2C1	-0.58	18.42	16.66	450.18	-1.66	17.65
G2C2	-0.89	18.41	10.00	270.48	-1.00	25.58
G3C1	-0.22	23.71	8.71	231.27	-0.84	10.39
G3C2	-0.42	23.71	5.23	139.15	-0.51	15.55

COLUMN #2

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	-0.14	18.44	0.00	0.95	0.01	0.71
G2C1	-0.52	18.45	16.81	448.97	1.66	10.11
G2C2	-0.75	18.46	10.08	269.77	1.00	16.07
G3C1	-0.48	23.73	8.78	230.67	0.84	7.36
G3C2	-0.62	23.74	5.27	138.80	0.51	11.10

Load Combinations	
G1	Group 1- Dead load
G2C1	Group 2- Case 1 - Dead + Wind
G2C2	Group 2- Case 2 - Dead + Wind
G3C1	Group 3- Case 1 - Dead + Ice + 1/2 Wind
G3C2	Group 3- Case 2 - Dead + Ice + 1/2 Wind

*** Values given are the resisting moments and shears to forces being applied**

Missouri Department of Transportation Sign Design Loads

MISSOURI 2-ARM- Bridge
Moments & Shears from Visual Analysis*

COLUMN #1

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	1.33	7.20	0.00	0.00	0.00	-11.82
G2C1	1.03	7.13	8.81	190.40	-61.54	-7.86
G2C2	0.88	7.09	4.86	114.36	-36.92	-5.88
G3C1	2.06	9.42	4.72	108.18	-35.74	-17.02
G3C2	1.92	9.38	2.83	64.91	-21.45	-15.13

COLUMN #2

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	-1.33	7.11	0.00	0.00	0.00	11.88
G2C1	-1.63	7.18	8.09	190.36	61.59	15.79
G2C2	-1.78	7.22	4.86	114.34	36.95	17.75
G3C1	-2.63	9.46	4.72	108.16	35.78	24.60
G3C2	-2.77	9.50	2.83	64.90	21.47	26.47

Wisconsin Department of Transportation Sign Design Loads

WICONSIN 4-CHORD TRUSS- Cantilevered
Moments & Shears from Visual Analysis*

	V_x (k)	V_y (k)	V_z (k)	M_x (k-ft)	M_y (k-ft)	M_z (k-ft)
G1	0.00	6.99	0.00	0.37	0.00	44.11
G2C1	-0.38	6.99	6.83	185.20	-124.25	54.81
G2C2	-0.57	6.99	4.10	111.26	-74.55	60.13
G3C1	-0.27	8.51	3.79	100.81	-62.12	75.81
G3C2	-0.40	8.51	2.28	61.54	-37.27	79.55

Load Combinations	
G1	Group 1- Dead load
G2C1	Group 2- Case 1 - Dead + Wind
G2C2	Group 2- Case 2 - Dead + Wind
G3C1	Group 3- Case 1 - Dead + Ice + 1/2 Wind
G3C2	Group 3- Case 2 - Dead + Ice + 1/2 Wind

*** Values given are the resisting moments and shears to forces being applied**

DRILL SHAFT
STRUCTURAL DESIGN

Michigan C Cantilever Foundation

Drill Shaft Dimensions:	
Outside Diameter (in):	36
Mean Diameter (in):	30
A_c: Area of Concrete (in^2)	767
A_g Gross Cross-section:	1105
Longitudinal Steel:	#10 Bars
Number of Bars:	9
Diameter of bars (in):	1.27
Area of Steel (in^2):	12.37
Transverse Steel:	#3 Bar
Diameter of Steel:	0.375
Vertical Load (k):	4.23
Moment (k-ft):	81.17
Shear Load (k):	3.38
Concrete Strength (psi):	4000
Steel Strength (Grade 60 - psi):	60,000
1. Factored Loads:	
Factored Axial Load (k):	7.4
Factored Shear Load(k):	5.9
Factored Moment (k-ft):	142.0
2. Axial Load/Resistance:	
Factor Axial Resistance:	
Capacity reduction factor - ϕa	0.75
Reduction Factor β:	0.85
Factor Axial Resistance (k):	2841.3
2,841 k > 7.4 k	**OK**
3. Shear Capacity:	
V_c - Limiting concrete shear stress (psi):	166.3
A_v - area of column effective in shear (in^2):	1049.6
Nominal Shear Capacity (k):	130.9
130 k > 5.9 k	**OK**
4. Apparent eccentricity	
$e = \phi M/\phi P$	19.2
5. γ_{cover}	0.83
6. Factor Load/Area	0.01
7. Factor Moment/Area*Diameter	0.01
8. Longitudinal Steel	
ACI Interaction Diagrams	> 0.005
Designed Steel Ratio:	0.0112
	OK
9. Transverse Reinforcement	
Required Steel ratio:	0.013
Designed Steel Ratio:	0.020
	OK

Michigan D Cantilever Foundation

Drill Shaft Dimensions:

Outside Diameter (in):	42
Mean Diameter (in):	36
A_c: Area of Concrete (in^2)	1105
A_g Gross Cross-section:	1504
Longitudinal Steel:	#10 Bars
Number of Bars:	9
Diameter of bars (in):	1.27
Area of Steel (in^2):	12.37
Transverse Steel:	#3 Bar
Diameter of Steel:	0.375
Vertical Load (k):	5.9
Moment (k-ft):	124.81
Shear Load (k):	5.15
Concrete Strength (psi):	4000
Steel Strength (Grade 60 - psi):	60,000

1. Factored Loads:

Factored Axial Load (k):	10.3
Factored Shear Load(k):	9.0
Factored Moment (k-ft):	218.4

2. Axial Load/Resistance:

Factor Axial Resistance:	
Capacity reduction factor - ϕa	0.75
Reduction Factor β:	0.85
Factor Axial Resistance (k):	3706.0
3,706 k > 5.9 k	**OK**

3. Shear Capacity:

V_c - Limiting concrete shear stress (psi):	166.3
A_v - area of column effective in shear (in^2):	1428.6
Nominal Shear Capacity (k):	178.2
178 k > 9.0 k	**OK**

4. Apparent eccentricity

$e = \phi M/\phi P$	21.2

5. γ_{cover}	0.86
6. Factor Load/Area	0.01
7. Factor Moment/Area*Diameter	0.01

8. Longitudinal Steel

ACI Interaction Diagrams	> 0.005
Designed Steel Ratio:	0.0082
	OK

9. Transverse Reinforcement

Required Steel ratio:	0.011
Designed Steel Ratio:	0.018
	OK

Michigan E Cantilever Foundation

Drill Shaft Dimensions:	
Outside Diameter (in):	42
Mean Diameter (in):	36
A_c: Area of Concrete (in^2)	1105
A_g Gross Cross-section:	1504
Longitudinal Steel:	#10 Bars
Number of Bars:	9
Diameter of bars (in):	1.27
Area of Steel (in^2):	12.37
Transverse Steel:	#3 Bar
Diameter of Steel:	0.375
Vertical Load (k):	6.25
Moment (k-ft):	157.2
Shear Load (k):	6.47
Concrete Strength (psi):	4000
Steel Strength (Grade 60 - psi):	60,000
1. Factored Loads:	
Factored Axial Load (k):	10.9
Factored Shear Load(k):	11.3
Factored Moment (k-ft):	275.1
2. Axial Load/Resistance:	
Factor Axial Resistance:	
Capacity reduction factor - ϕa	0.75
Reduction Factor β:	0.85
Factor Axial Resistance (k):	3706.0
3,706 k > 6.25 k	**OK**
3. Shear Capacity:	
V_c - Limiting concrete shear stress (psi):	166.3
A_v - area of column effective in shear (in^2):	1428.6
Nominal Shear Capacity (k):	178.2
178 k > 6.5 k	**OK**
4. Apparent eccentricity	
$e = \phi M/\phi P$	25.2
5. γ_{cover}	0.86
6. Factor Load/Area	0.01
7. Factor Moment/Area*Diameter	0.01
8. Longitudinal Steel	
ACI Interaction Diagrams	> 0.005
Designed Steel Ratio:	0.0082
	OK
9. Transverse Reinforcement	
Required Steel ratio:	0.011
Designed Steel Ratio:	0.018
	OK

Florida

Drill Shaft Dimensions:	
Outside Diameter (in):	42
Mean Diameter (in):	36
A_c: Area of Concrete (in^2)	1105
A_g Gross Cross-section:	1504
Longitudinal Steel:	#5 Bars
Number of Bars:	6
Diameter of bars (in):	0.625
Area of Steel (in^2):	2.00
Transverse Steel:	#4 Bar
Diameter of Steel:	0.5
Vertical Load (k):	23.66
Moment (k-ft):	599
Shear Load (k):	19.7
Concrete Strength (psi):	4000
Steel Strength (Grade 60 - psi):	60,000
1. Factored Loads:	
Factored Axial Load (k):	41.4
Factored Shear Load(k):	34.5
Factored Moment (k-ft):	1048.3
2. Axial Load/Resistance:	
Factor Axial Resistance:	
Capacity reduction factor - ϕa	0.75
Reduction Factor β:	0.85
Factor Axial Resistance (k):	3331.6
3,332 k > 41.4 k	**OK**
3. Shear Capacity:	
V_c - Limiting concrete shear stress (psi):	166.3
A_v - area of column effective in shear (in^2):	1428.6
Nominal Shear Capacity (k):	178.2
178 k > 34 k	**OK**
4. Apparent eccentricity	
$e = \phi M/\phi P$	25.3
5. γ_{cover}	0.86
6. Factor Load/Area	0.04
7. Factor Moment/Area*Diameter	0.03
8. Longitudinal Steel	
ACI Interaction Diagrams	> 0.005
Designed Steel Ratio:	0.0013
	OK
9. Transverse Reinforcement	
Required Steel ratio:	0.011
Designed Steel Ratio:	0.018
	OK

Florida w MI Steel

Drill Shaft Dimensions:

Outside Diameter (in):	42
Mean Diameter (in):	36
A_c: Area of Concrete (in^2)	1105
A_g Gross Cross-section:	1504
Longitudinal Steel:	#10 Bars
Number of Bars:	9
Diameter of bars (in):	1.27
Area of Steel (in^2):	12.37
Transverse Steel:	#3 Bar
Diameter of Steel:	0.375
Vertical Load (k):	23.66
Moment (k-ft):	599
Shear Load (k):	19.7
Concrete Strength (psi):	4000
Steel Strength (Grade 60 - psi):	60,000

1. Factored Loads:

Factored Axial Load (k):	41.4
Factored Shear Load(k):	34.5
Factored Moment (k-ft):	1048.3

2. Axial Load/Resistance:

Factor Axial Resistance:	
Capacity reduction factor - ϕa	0.75
Reduction Factor β:	0.85
Factor Axial Resistance (k):	3706.0
3,706 k > 41.4 k	**OK**

3. Shear Capacity:

V_c - Limiting concrete shear stress (|	166.3
A_v - area of column effective in shea	1428.6
Nominal Shear Capacity (k):	178.2
178 k > 34.5 k	**OK**

4. Apparent eccentricity

$e = \phi M/\phi P$ 25.3

5. γ_{cover} 0.86

6. Factor Load/Area 0.04

7. Factor Moment/Area*Diameter 0.03

8. Longitudinal Steel

ACI Interaction Diagrams	> 0.005
Designed Steel Ratio:	0.0082
	OK

9. Transverse Reinforcement

Required Steel ratio:	0.011
Designed Steel Ratio:	0.018
	OK

Indiana Type I Cantilever Foundation

Drill Shaft Dimensions:	
Outside Diameter (in):	36
Mean Diameter (in):	30
A_c: Area of Concrete (in^2)	767
A_g Gross Cross-section:	1105
Longitudinal Steel:	#10 Bars
Number of Bars:	11
Diameter of bars (in):	1.27
Area of Steel (in^2):	15.12
Transverse Steel:	#3 Bar
Diameter of Steel:	0.375
Steel Spacing:	
Vertical Load (k):	6.68
Moment (k-ft):	90.57
Shear Load (k):	3.99
Concrete Strength (psi):	4000
Steel Strength (Grade 60 - psi):	60,000
1. Factored Loads:	
Factored Axial Load (k):	11.7
Factored Shear Load(k):	7.0
Factored Moment (k-ft):	158.5
2. Axial Load/Resistance:	
Factor Axial Resistance:	
Capacity reduction factor - ϕa	0.75
Reduction Factor β:	0.85
Factor Axial Resistance (k):	2940.5
2,940 k > 11.7 k	**OK**
3. Shear Capacity:	
V_c - Limiting concrete shear stress (psi):	166.3
A_v - area of column effective in shear (in^2)	1049.6
Nominal Shear Capacity (k):	130.9
130 k > 7 k	**OK**
4. Apparent eccentricity	
$e = \phi M/\phi P$	13.6
5. γ_{cover}	0.83
6. Factor Load/Area	0.02
7. Factor Moment/Area*Diameter	0.01
8. Longitudinal Steel	
ACI Interaction Diagrams	> 0.005
Designed Steel Ratio:	0.0137
	OK
9. Transverse Reinforcement	
Required Steel ratio:	0.013
Designed Steel Ratio:	0.013
	OK

Minnesota Drill Shaft

Drill Shaft Dimensions:

Outside Diameter (in):	36	
Mean Diameter (in):	30	
A_c: Area of Concrete (in^2)	767	
A_g Gross Cross-section:	1105	
Longitudinal Steel:	#9 Bars	
Number of Bars:	20	
Diameter of bars (in):	1.27	
Area of Steel (in^2):	27.50	
Transverse Steel:	#4	Spiral
Diameter of Steel:	0.5	
Vertical Load (k):	18.42	
Moment (k-ft):	450.2	
Shear Load (k):	16.7	
Concrete Strength (psi):	4000	
Steel Strength (Grade 60 - psi):	60,000	

1. Factored Loads:

Factored Axial Load (k):	32.2
Factored Shear Load(k):	29.2
Factored Moment (k-ft):	787.9

2. Axial Load/Resistance:

Factor Axial Resistance:	
Capacity reduction factor - ϕa	0.75
Reduction Factor β:	0.85
Factor Axial Resistance (k):	3387.0
3,387 k > 18.4 k	**OK**

3. Shear Capacity:

V_c - Limiting concrete shear stress (psi):	166.3
A_v - area of column effective in shear (in^2)	1049.6
Nominal Shear Capacity (k):	130.9
130 k > 29.9 k	**OK**

4. Apparent eccentricity

$e = \phi M/\phi P$	24.4

5. γ_{cover}	0.83
6. Factor Load/Area	0.04
7. Factor Moment/Area*Diameter	0.03

8. Longitudinal Steel

ACI Interaction Diagrams	0.01
Designed Steel Ratio:	0.0249
	OK

9. Transverse Reinforcement

Required Steel ratio:	0.013
Designed Steel Ratio:	0.020
	OK

Wisconsin

Drill Shaft Dimensions:	
Outside Diameter (in):	42
Mean Diameter (in):	36
A_c: Area of Concrete (in^2)	1105
A_g Gross Cross-section:	1504
Longitudinal Steel:	#7 Bars
Number of Bars:	12
Diameter of bars (in):	0.875
Area of Steel (in^2):	7.83
Transverse Steel:	#4 Bar
Diameter of Steel:	0.5
Vertical Load (k):	6.99
Moment (k-ft):	185.2
Shear Load (k):	6.83
Concrete Strength (psi):	4000
Steel Strength (Grade 60 - psi):	60,000
1. Factored Loads:	
Factored Axial Load (k):	12.2
Factored Shear Load(k):	12.0
Factored Moment (k-ft):	324.1
2. Axial Load/Resistance:	
Factor Axial Resistance:	
Capacity reduction factor - ϕa	0.75
Reduction Factor β:	0.85
Factor Axial Resistance (k):	3542.1
3,471 k > 12.2 k	**OK**
3. Shear Capacity:	
V_c - Limiting concrete shear stress (p	166.3
A_v - area of column effective in sheai	1428.6
Nominal Shear Capacity (k):	178.2
178 k > 12 k	**OK**
4. Apparent eccentricity	
$e = \phi M / \phi P$	26.5
5. γ_{cover}	0.86
6. Factor Load/Area	0.01
7. Factor Moment/Area*Diameter	0.01
8. Longitudinal Steel	
ACI Interaction Diagrams	< 0.005
Designed Steel Ratio:	0.0052
	OK
9. Transverse Reinforcement	
Required Steel ratio:	0.011
Designed Steel Ratio:	0.067
	OK

Colorado

Drill Shaft Dimensions:

Outside Diameter (in):	36
Mean Diameter (in):	30
A_c: Area of Concrete (in^2)	767
A_g Gross Cross-section:	1105
Longitudinal Steel:	#8 Bars
Number of Bars:	13
Diameter of bars (in):	1
Area of Steel (in^2):	11.08
Transverse Steel:	#4 Bar
Diameter of Steel:	0.5
Vertical Load (k):	8.37
Moment (k-ft):	198.26
Shear Load (k):	6.91
Concrete Strength (psi):	4000
Steel Strength (Grade 60 - psi):	60,000

1. Factored Loads:

Factored Axial Load (k):	14.6
Factored Shear Load(k):	12.1
Factored Moment (k-ft):	347.0

2. Axial Load/Resistance:

Factor Axial Resistance:	
Capacity reduction factor - ϕa	0.75
Reduction Factor β:	0.85
Factor Axial Resistance (k):	2794.6
2,795 k > 14.6 k	**OK**

3. Shear Capacity:

V_c - Limiting concrete shear stress (ps	166.3
A_v - area of column effective in shear (	1049.6
Nominal Shear Capacity (k):	130.9
130 k > 12.1 k	**OK**

4. Apparent eccentricity

$e = \phi M/\phi P$	23.7
5. γ_{cover}	0.83
6. Factor Load/Area	0.02
7. Factor Moment/Area*Diameter	0.02

8. Longitudinal Steel

ACI Interaction Diagrams	< 0.005
Designed Steel Ratio:	0.0100
	OK

9. Transverse Reinforcement

Required Steel ratio:	0.013
Designed Steel Ratio:	0.011
	OK

Missouri

Drill Shaft Dimensions:	
Outside Diameter (in):	36
Mean Diameter (in):	30
A_c: Area of Concrete (in^2)	767
A_g Gross Cross-section:	1105
Longitudinal Steel:	#5 Bars
Number of Bars:	6
Diameter of bars (in):	0.625
Area of Steel (in^2):	2.00
Transverse Steel:	#4 Bar
Diameter of Steel:	0.5
Vertical Load (k):	7.18
Moment (k-ft):	190.4
Shear Load (k):	8.1
Concrete Strength (psi):	4000
Steel Strength (Grade 60 - psi):	60,000
1. Factored Loads:	
Factored Axial Load (k):	12.6
Factored Shear Load(k):	14.2
Factored Moment (k-ft):	333.2
2. Axial Load/Resistance:	
Factor Axial Resistance:	
Capacity reduction factor - ϕa	0.75
Reduction Factor β:	0.85
Factor Axial Resistance (k):	2466.8
2,467 k > 12.6 k	**OK**
3. Shear Capacity:	
V_c - Limiting concrete shear stress (psi):	166.3
A_v - area of column effective in shear (in^2):	1049.6
Nominal Shear Capacity (k):	130.9
131 k > 14.2 k	**OK**
4. Apparent eccentricity	
$e = \phi M/\phi P$	26.5
5. γ_{cover}	0.83
6. Factor Load/Area	0.02
7. Factor Moment/Area*Diameter	0.01
8. Longitudinal Steel	
ACI Interaction Diagrams	< 0.0015
Designed Steel Ratio:	0.0018
	OK
9. Transverse Reinforcement	
Required Steel ratio:	0.013
Designed Steel Ratio:	0.011 space at 6 inch interva
	OK

SPREAD FOOTING STRUCTURAL DESIGN

Michigan Type C Bridge 70 feet

		(in)	
B (ft)		7	84
L (ft)		7	84
Longtudinal Reinforcement	#5 Bar		5
Transverse Reinforcement	#5 Bar		6
Thickness, T (in)		24	
Effective Depth, d (in)		18	
Column Width, c (in)		36	
bo		54	
bw		168	
Diameter of Bars		0.625	
Conncrete strength, (psi)		4000	
Reinforcement Strength, (psi)		60,000	

		lbs
Axial Load (k)	36.4	36400
Shear Load, (k)	8.2	8200
Moment Load, (k-ft)	17.3	17300

1. Factored Loads

Axial Load (k)	63.7	63700
Shear Load, (k)	14.4	14350
Moment Load, (k-ft)	30.3	30275

2. One-way Shear

Shear Force on Critical Section, V_{uc}	9,630
Nominal One-way Capacity, V_{nc}	1,481,451
Resistance Factor, ϕ	0.75
ϕV_{nc}	1,111,089

1,111 k > 10 k **OK**

3. Two-Way Shear

Shear Force on Critical Section, V_{uc}	19,156
Nominal One-way Capacity, V_{nc}	952,362
Resistance Factor, ϕ	0.75
$\phi V_{nc,}$	714,271

952 k > 19 k

4. Reinforcement Steel

Resistance Factor, ϕ	0.75
Required A_s	0.037
Required Steel Ratio	2E-05
Designed Steel Ratio	0.001101216

OK

Michigan Type C Bridge 100 feet

		(in)	
B (ft)		7	84
L (ft)		7	84
Longtudinal Reinforcement	#5 Bar		5
Transverse Reinforcement	#5 Bar		6
Thickness, T (in)		24	
Effective Depth, d (in)		18	
Column Width, c (in)		36	
bo		54	
bw		168	
Diameter of Bars		0.625	
Conncrete strength, (psi)		4000	
Reinforcement Strength, (psi)		60,000	

		lbs
Axial Load (k)	49.05	49050
Shear Load, (k)	10.7	10700
Moment Load, (k-ft)	20.5	20500

1. Factored Loads

Axial Load (k)	85.8	85837.5
Shear Load, (k)	18.7	18725
Moment Load, (k-ft)	35.9	35875

2. One-way Shear

Shear Force on Critical Section, V_{uc}	12,909
Nominal One-way Capacity, V_{nc}	1,481,451
Resistance Factor, ϕ	0.75
ϕV_{nc}	1,111,089

1,111 k > 13 k **OK**

3. Two-Way Shear

Shear Force on Critical Section, V_{uc}	25,774
Nominal One-way Capacity, V_{nc}	952,362
Resistance Factor, ϕ	0.75
$\phi V_{nc,}$	714,271

714 k > 19 k

4. Reinforcement Steel

Resistance Factor, ϕ	0.75
Required A_s	0.044
Required Steel Ratio	3E-05
Designed Steel Ratio	0.00110122

OK

Michigan Type D Bridge 125 feet

		(in)	
B (ft)		7	84
L (ft)		7	84
Longtudinal Reinforcement	#5 Bar		5
Transverse Reinforcement	#5 Bar		6
Thickness, T (in)		24	
Effective Depth, d (in)		18	
Column Width, c (in)		36	
bo		54	
bw		168	
Diameter of Bars		0.625	
Conncrete strength, (psi)		4000	
Reinforcement Strength, (psi)		60,000	

		lbs
Axial Load (k)	47.11	47110
Shear Load, (k)	12.1	12100
Moment Load, (k-ft)	17.31	17310

1. Factored Loads

Axial Load (k)	82.4	82442.5
Shear Load, (k)	21.2	21175
Moment Load, (k-ft)	30.3	30292.5

2. One-way Shear

Shear Force on Critical Section, V_{uc}	12,459
Nominal One-way Capacity, V_{nc}	1,481,451
Resistance Factor, ϕ	0.75
ϕV_{nc}	1,111,089

1,111 k > 13 k **OK**

3. Two-Way Shear

Shear Force on Critical Section, V_{uc}	24,971
Nominal One-way Capacity, V_{nc}	952,362
Resistance Factor, ϕ	0.75
$\phi V_{nc,}$	714,271

714 k > 24 k **OK**

4. Reinforcement Steel

Resistance Factor, ϕ	0.75
Required A_s	0.037
Required Steel Ratio	2E-05
Designed Steel Ratio	0.00110122

OK

Minnesota Spread Footing

		(in)	
B (ft)		9	108
L (ft)		14	168
Longtudinal Reinforcement	#7 Bar		10
Transverse Reinforcement	#4 Bar		14
Thickness, T (in)		24	
Effective Depth, d (in)		18	
Column Width, c (in)		36	
bo		54	
bw		216	
Diameter of Bars		0.875	
Conncrete strength, (psi)		4000	
Reinforcement Strength, (psi)		60,000	

		lbs
Axial Load (k)	47.11	47110
Shear Load, (k)	12.1	12100
Moment Load, (k-ft)	17.31	17310

1. Factored Loads

Axial Load (k)	18.4	18420
Shear Load, (k)	16.7	16700
Moment Load, (k-ft)	450.2	450200

2. One-way Shear

Shear Force on Critical Section, V_{uc}	15,510
Nominal One-way Capacity, V_{nc}	1,904,723
Resistance Factor, ϕ	0.75
ϕV_{nc}	1,428,542

1,111 k > 15.5 k **OK**

3. Two-Way Shear

Shear Force on Critical Section, V_{uc}	9,324
Nominal One-way Capacity, V_{nc}	952,362
Resistance Factor, ϕ	0.75
$\phi V_{nc,}$	714,271

714 k > 9.3 k **OK**

4. Reinforcement Steel

Resistance Factor, ϕ	0.75
Required A_s	0.557
Required Steel Ratio	2E-04
Designed Steel Ratio	0.001079192

OK

GEOTECHNICAL ANALYSIS

EMBEDMENT LENGTH ANALYSIS

Embedment Length Calulation
MICHIGAN TYPE C - Cantilever

Loading G2C1	Mz-Vx			Mx-Vz		
Foundation Type	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**
Minimum Soil Strength (psf)	500	250	100	500	250	100
Safety Factor	2.5	2.5	2.5	2.5	2.5	2.5
Shear Load, V (k)	0.07	0.07	0.07	3.38	3.38	3.38
Moment Load, M (k-ft)	23.20	23.20	23.20	81.17	81.17	81.17
Factored Shear Load (k)	0.18	0.18	0.18	8.45	8.45	8.45
Factored Moment, (k-ft)	57.99	57.99	57.99	202.92	202.92	202.92
Drilled Shaft Diameter (ft)	3	3	3	3	3	3
Parameter, H	326.70	326.70	326.70	24.01	24.01	24.01
Paramter, q	0.01	0.03	0.07	0.63	1.25	3.13
Required Embedment Length (ft)	**8.7**	**10.4**	**13.9**	**13.6**	**17.8**	**27.0**
Designed Embedment Length (ft)	**14**	**14**	**15**	**14**	**14**	**15**

Loading G2C2	Mz-Vx			Mx-Vz		
Foundation Type	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**
Minimum Soil Strength (psf)	500	250	100	500	250	100
Safety Factor	2.5	2.5	2.5	2.5	2.5	2.5
Shear Load, V (k)	0.11	0.11	0.11	2.03	2.03	2.03
Moment Load, M (k-ft)	24.10	24.10	24.10	48.70	48.70	48.70
Factored Shear Load (k)	0.27	0.27	0.27	5.07	5.07	5.07
Factored Moment, (k-ft)	60.24	60.24	60.24	121.76	121.76	121.76
Drilled Shaft Diameter (ft)	3	3	3	3	3	3
Parameter, H	225.19	225.19	225.19	24.01	24.01	24.01
Paramter, q	0.02	0.04	0.10	0.38	0.75	1.88
Required Embedment Length (ft)	**8.8**	**10.6**	**14.1**	**11.4**	**14.6**	**21.3**
Designed Embedment Length (ft)	**14**	**14**	**15**	**14**	**14**	**15**

Loading G3C1	Mz-Vx			Mx-Vz		
Foundation Type	C1	C2	C3	C1	C2	C3
Minimum Soil Strength (psf)	500	250	100	500	250	100
Safety Factor	2.5	2.5	2.5	2.5	2.5	2.5
Shear Load, V (k)	0.09	0.09	0.09	1.96	1.96	1.96
Moment Load, M (k-ft)	37.46	37.46	37.46	44.67	44.67	44.67
Factored Shear Load (k)	0.22	0.22	0.22	4.90	4.90	4.90
Factored Moment, (k-ft)	93.65	93.65	93.65	111.68	111.68	111.68
Drilled Shaft Diameter (ft)	3	3	3	3	3	3
Parameter, H	418.55	418.55	418.55	22.79	22.79	22.79
Paramter, q	0.02	0.03	0.08	0.36	0.73	1.81
Required Embedment Length (ft)	**9.8**	**12.0**	**16.4**	**11.2**	**14.2**	**20.6**
Designed Embedment Length (ft)	**14**	**14**	**15**	**14**	**14**	**15**

Loading G3C2	Mz-Vx			Mx-Vz		
Foundation Type	C1	C2	C3	C1	C2	C3
Minimum Soil Strength (psf)	500	250	100	500	250	100
Safety Factor	2.5	2.5	2.5	2.5	2.5	2.5
Shear Load, V (k)	0.13	0.13	0.13	1.18	1.18	1.18
Moment Load, M (k-ft)	38.57	38.57	38.57	26.80	26.80	26.80
Factored Shear Load (k)	0.34	0.34	0.34	2.94	2.94	2.94
Factored Moment, (k-ft)	96.44	96.44	96.44	67.01	67.01	67.01
Drilled Shaft Diameter (ft)	3	3	3	3	3	3
Parameter, H	287.87	287.87	287.87	22.79	22.79	22.79
Paramter, q	0.02	0.05	0.12	0.22	0.44	1.09
Required Embedment Length (ft)	**9.9**	**12.2**	**16.7**	**9.6**	**11.9**	**16.6**
Designed Embedment Length (ft)	**14**	**14**	**15**	**14**	**14**	**15**

Embedment Length Calulation
MICHIGAN TYPE D - Cantilever

Loading G2C1	Mz-Vx				Mx-Vz		
Foundation Type	**D1**	**D2**	**D3**		**D1**	**D2**	**D3**
Minimum Soil Strength (psf)	500	250	100		500	250	100
Safety Factor	2.5	2.5	2.5		2.5	2.5	2.5
Shear Load, V (k)	0.08	0.08	0.08		5.15	5.15	5.15
Moment Load, M (k-ft)	32.63	32.63	32.63		124.81	124.81	124.81
Factored Shear Load (k)	0.21	0.21	0.21		12.88	12.88	12.88
Factored Moment, (k-ft)	81.56	81.56	81.56		312.03	312.03	312.03
Drilled Shaft Diameter (ft)	3.5	3.5	3.5		3.5	3.5	3.5
Parameter, H	393.08	393.08	393.08		24.23	24.23	24.23
Paramter, q	0.01	0.03	0.07		0.82	1.64	4.09
Required Embedment Length (ft)	**9.8**	**11.8**	**15.6**		**16.0**	**21.0**	**32.0**
Designed Embedment Length (ft)	**13**	**13**	**14**		**13**	**13**	**14**

Loading G2C2	Mz-Vx				Mx-Vz		
Foundation Type	**D1**	**D2**	**D3**		**D1**	**D2**	**D3**
Minimum Soil Strength (psf)	500	250	100		500	250	100
Safety Factor	2.5	2.5	2.5		2.5	2.5	2.5
Shear Load, V (k)	0.12	0.12	0.12		3.09	3.09	3.09
Moment Load, M (k-ft)	33.62	33.62	33.62		74.89	74.89	74.89
Factored Shear Load (k)	0.31	0.31	0.31		7.73	7.73	7.73
Factored Moment, (k-ft)	84.04	84.04	84.04		187.22	187.22	187.22
Drilled Shaft Diameter (ft)	3.5	3.5	3.5		3.5	3.5	3.5
Parameter, H	271.10	271.10	271.10		24.23	24.23	24.23
Paramter, q	0.02	0.04	0.10		0.49	0.98	2.45
Required Embedment Length (ft)	**9.9**	**11.9**	**15.8**		**13.4**	**17.1**	**25.1**
Designed Embedment Length (ft)	**13**	**13**	**14**		**13**	**13**	**14**

Loading G3C1 Foundation Type	Mz-Vx D1	D2	D3	Mx-Vz D1	D2	D3
Minimum Soil Strength (psf)	500	250	100	500	250	100
Safety Factor	2.5	2.5	2.5	2.5	2.5	2.5
Shear Load, V (k)	0.11	0.11	0.11	2.90	2.90	2.90
Moment Load, M (k-ft)	51.66	51.66	51.66	67.35	67.35	67.35
Factored Shear Load (k)	0.27	0.27	0.27	7.24	7.24	7.24
Factored Moment, (k-ft)	129.15	129.15	129.15	168.38	168.38	168.38
Drilled Shaft Diameter (ft)	3.5	3.5	3.5	3.6	3.5	3.5
Parameter, H	487.37	487.37	487.37	23.24	23.24	23.24
Paramter, q	0.02	0.03	0.08	0.45	0.92	2.30
Required Embedment Length (ft)	**11.0**	**13.4**	**18.2**	**13.0**	**16.5**	**24.1**
Designed Embedment Length (ft)	**13**	**13**	**14**	**13**	**13**	**14**

Loading G3C2 Foundation Type	Mz-Vx D1	D2	D3	Mx-Vz D1	D2	D3
Minimum Soil Strength (psf)	500	250	100	500	250	100
Safety Factor	2.5	2.5	2.5	2.5	2.5	2.5
Shear Load, V (k)	0.16	0.16	0.16	1.74	1.74	1.74
Moment Load, M (k-ft)	52.93	52.93	52.93	40.41	40.41	40.41
Factored Shear Load (k)	0.40	0.40	0.40	4.35	4.35	4.35
Factored Moment, (k-ft)	132.33	132.33	132.33	101.03	101.03	101.03
Drilled Shaft Diameter (ft)	3.5	3.5	3.5	3.5	3.5	3.5
Parameter, H	333.95	333.95	333.95	23.24	23.24	23.24
Paramter, q	0.03	0.05	0.13	0.28	0.55	1.38
Required Embedment Length (ft)	**11.1**	**13.6**	**18.4**	**11.1**	**13.8**	**19.3**
Designed Embedment Length (ft)	**13**	**13**	**14**	**13**	**13**	**14**

Embedment Length Calulation
MICHIGAN TYPE E - Cantilever

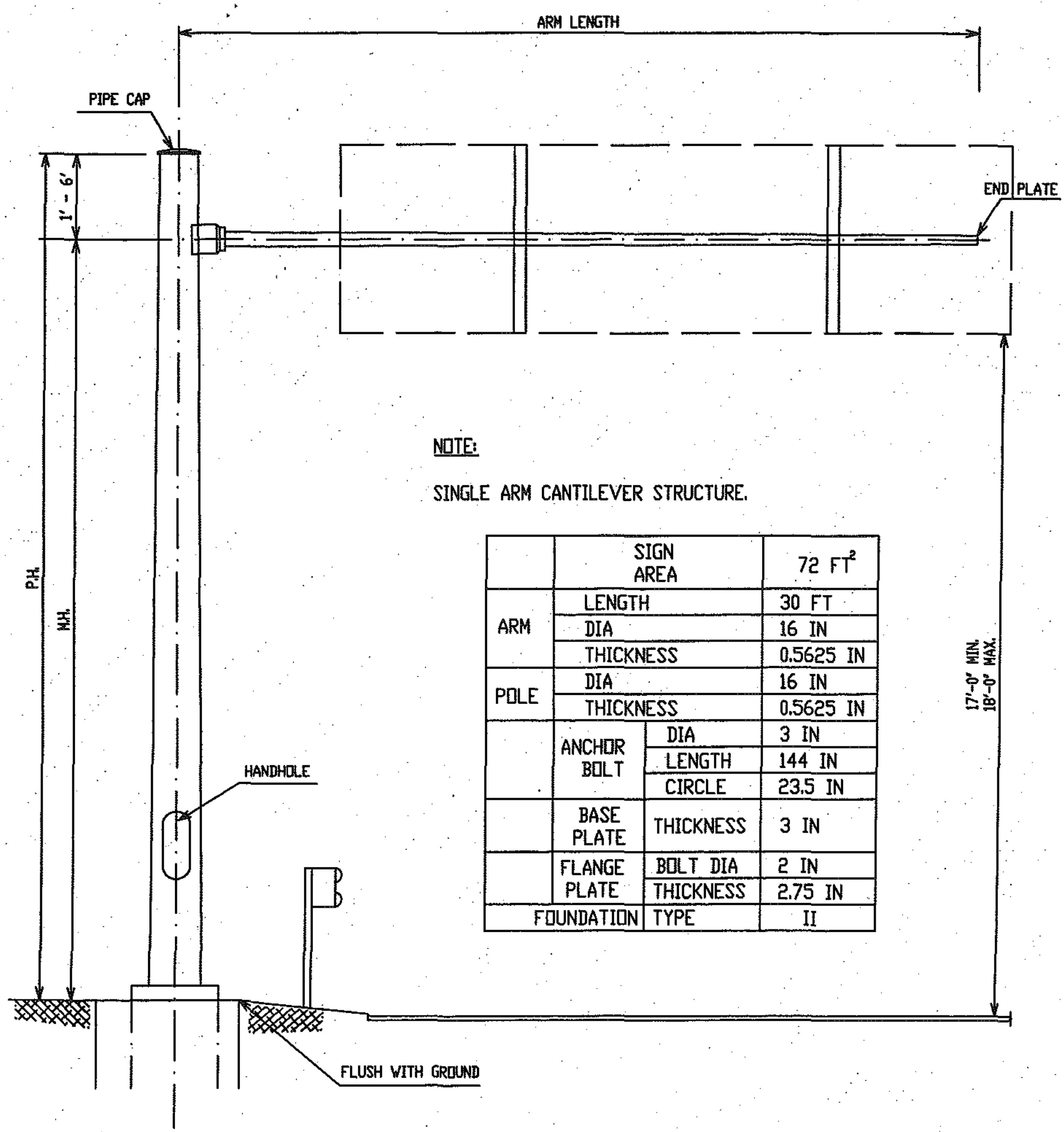
Loading G2C1	Mz-Vx				Mx-Vz		
Foundation Type	**E1**	**E2**	**E3**		**E1**	**E2**	**E3**
Minimum Soil Strength (psf)	500	250	100		500	250	100
Safety Factor	2.5	2.5	2.5		2.5	2.5	2.5
Shear Load, V (k)	0.09	0.09	0.09		6.47	6.47	6.47
Moment Load, M (k-ft)	33.61	33.61	33.61		157.22	157.22	157.22
Factored Shear Load (k)	0.23	0.23	0.23		16.17	16.17	16.17
Factored Moment, (k-ft)	84.03	84.03	84.03		393.05	393.05	393.05
Drilled Shaft Diameter (ft)	3.5	3.5	3.5		3.5	3.5	3.5
Parameter, H	365.33	365.33	365.33		24.31	24.31	24.31
Paramter, q	0.01	0.03	0.07		1.03	2.05	5.13
Required Embedment Length (ft)	**9.9**	**11.9**	**15.7**		**17.4**	**23.2**	**36.1**
Designed Embedment Length (ft)	**13**	**15**	**16**		**13**	**15**	**16**

Loading G2C2	Mz-Vx				Mx-Vz		
Foundation Type	**E1**	**E2**	**E3**		**E1**	**E2**	**E3**
Minimum Soil Strength (psf)	500	250	100		500	250	100
Safety Factor	2.5	2.5	2.5		2.5	2.5	2.5
Shear Load, V (k)	0.14	0.14	0.14		3.88	3.88	3.88
Moment Load, M (k-ft)	34.72	34.72	34.72		94.33	94.33	94.33
Factored Shear Load (k)	0.35	0.35	0.35		9.70	9.70	9.70
Factored Moment, (k-ft)	86.81	86.81	86.81		235.83	235.83	235.83
Drilled Shaft Diameter (ft)	3.5	3.5	3.5		3.5	3.5	3.5
Parameter, H	251.61	251.61	251.61		24.31	24.31	24.31
Paramter, q	0.02	0.04	0.11		0.62	1.23	3.08
Required Embedment Length (ft)	**10.0**	**12.0**	**16.0**		**14.4**	**18.7**	**27.9**
Designed Embedment Length (ft)	**13**	**15**	**16**		**13**	**15**	**16**

Loading G3C1	**Mz-Vx**				**Mx-Vz**		
Foundation Type	**E1**	**E2**	**E3**		**E1**	**E2**	**E3**
Minimum Soil Strength (psf)	500	250	100		500	250	100
Safety Factor	2.5	2.5	2.5		2.5	2.5	2.5
Shear Load, V (k)	0.12	0.12	0.12		3.52	3.52	3.52
Moment Load, M (k-ft)	55.35	55.35	55.35		84.09	84.09	84.09
Factored Shear Load (k)	0.30	0.30	0.30		8.81	8.81	8.81
Factored Moment, (k-ft)	138.38	138.38	138.38		210.23	210.23	210.23
Drilled Shaft Diameter (ft)	3.5	3.5	3.5		3.6	3.5	3.5
Parameter, H	469.07	469.07	469.07		23.86	23.86	23.86
Paramter, q	0.02	0.04	0.09		0.54	1.12	2.80
Required Embedment Length (ft)	**11.2**	**13.7**	**18.7**		**14.0**	**17.9**	**26.5**
Designed Embedment Length (ft)	13	15	16		13	15	16

Loading G3C2	**Mz-Vx**				**Mx-Vz**		
Foundation Type	**E1**	**E2**	**E3**		**E1**	**E2**	**E3**
Minimum Soil Strength (psf)	500	250	100		500	250	100
Safety Factor	2.5	2.5	2.5		2.5	2.5	2.5
Shear Load, V (k)	0.18	0.18	0.18		2.16	2.16	2.16
Moment Load, M (k-ft)	56.78	56.78	56.78		50.45	50.45	50.45
Factored Shear Load (k)	0.44	0.44	0.44		5.39	5.39	5.39
Factored Moment, (k-ft)	141.94	141.94	141.94		126.13	126.13	126.13
Drilled Shaft Diameter (ft)	3.5	3.5	3.5		3.5	3.5	3.5
Parameter, H	320.77	320.77	320.77		23.41	23.41	23.41
Paramter, q	0.03	0.06	0.14		0.34	0.68	1.71
Required Embedment Length (ft)	**11.3**	**13.9**	**18.9**		**11.9**	**14.8**	**21.2**
Designed Embedment Length (ft)	13	15	16		13	15	16

APPENDIX C
CAD DRAWINGS OF STRUCTURES



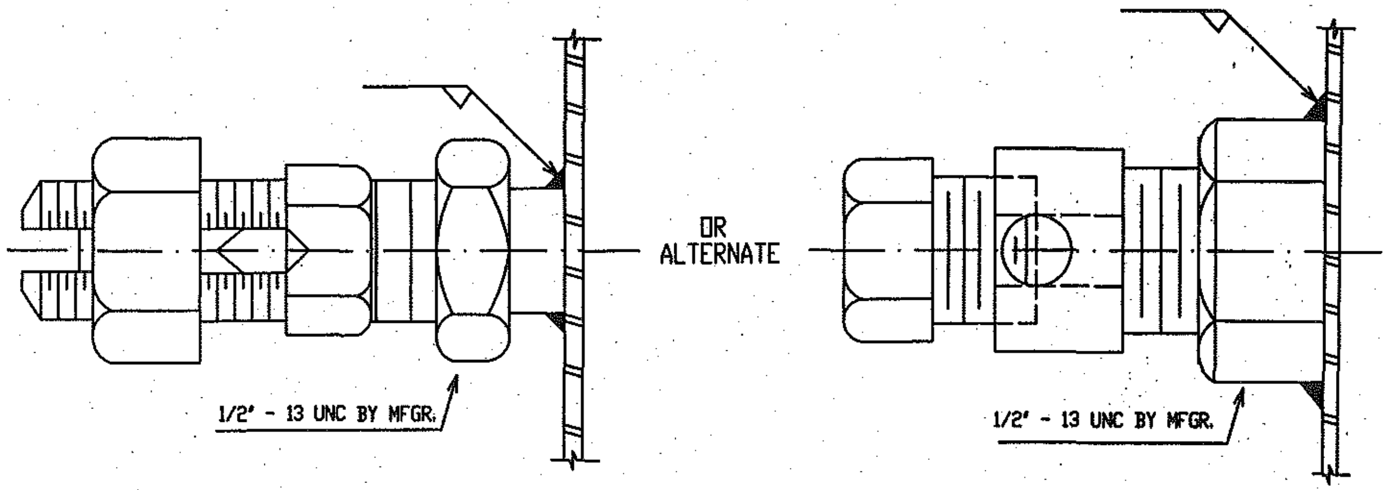
NOTE:

SINGLE ARM CANTILEVER STRUCTURE.

	SIGN AREA		72 FT^2
ARM	LENGTH		30 FT
	DIA		16 IN
	THICKNESS		0.5625 IN
POLE	DIA		16 IN
	THICKNESS		0.5625 IN
	ANCHOR BOLT	DIA	3 IN
		LENGTH	144 IN
		CIRCLE	23.5 IN
	BASE PLATE	THICKNESS	3 IN
	FLANGE PLATE	BOLT DIA	2 IN
		THICKNESS	2.75 IN
FOUNDATION		TYPE	II

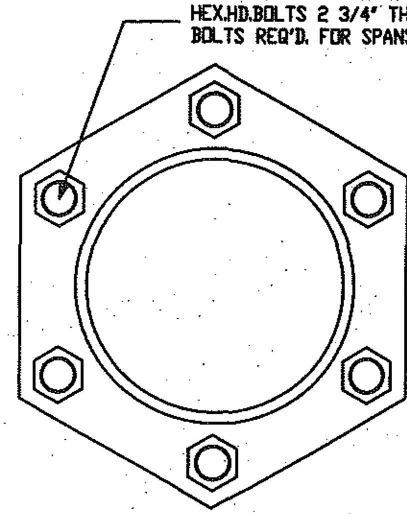
CANTILEVER (SINGLE MASTARM)

REPRODUCED FROM INDIANA DOT DRAWINGS	TYPE	A-1
	PAGE	SHEET 1 OF 4

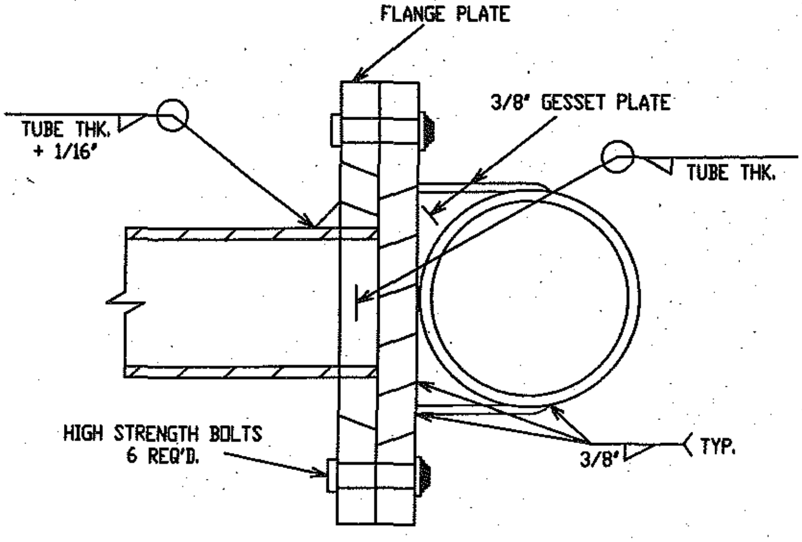


GROUNDING CONNECTION

NOTE:
THE GROUNDING CONNECTION SHALL BE LOCATED 12" FROM THE BOTTOM OF THE SUPPORT AND EASILY ACCESSIBLE FROM THE STRUCTURE MANHOLE. OXIDATION INHIBITOR SHALL BE LIBERALLY APPLIED TO ALL SURFACES THAT MATE WITH A DISSIMILAR MATERIAL.



SPAN ATTACHMENT



CANTILEVER ARM ATTACHMENT

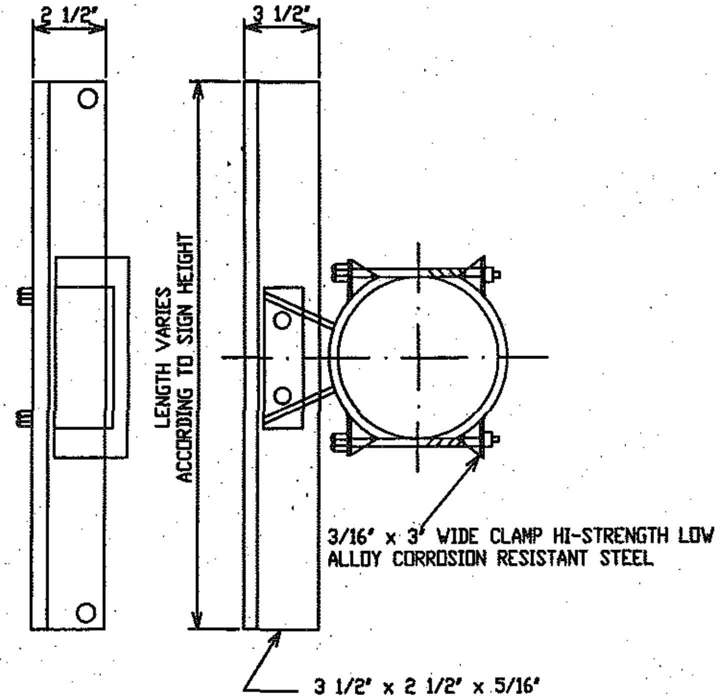
POLE AND ARM PLATE BOLTS TENSION TABLE:

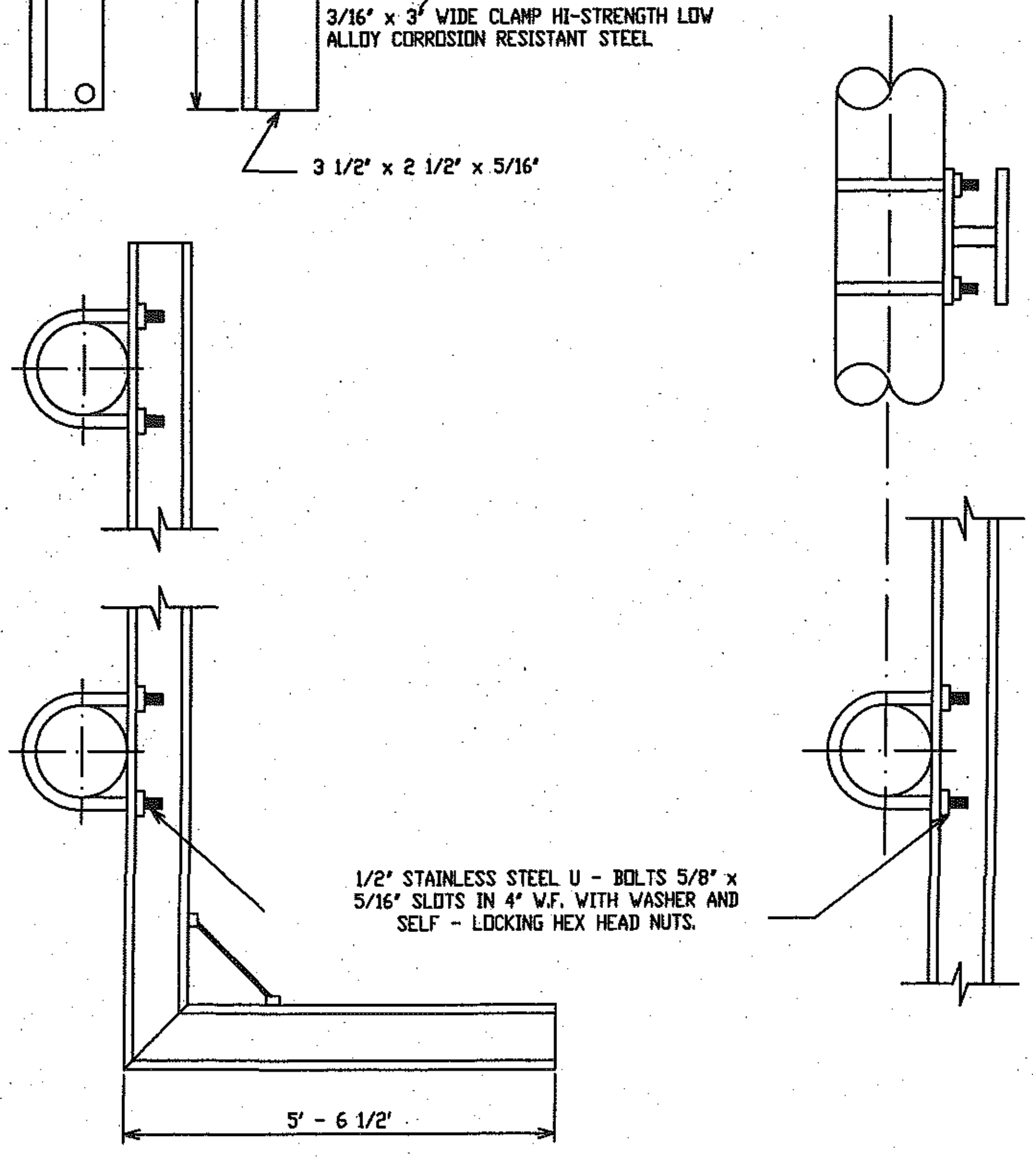
BOLT SIZE (INCHES)	TENSION (KIPS)
1.5	59
2	105

ARM FLANGE PLATE TIGHTENING:
TENSION MEASURING DEVICE SKIDMORE WILHELM CALIBRATED OR OTHER ACCEPTABLE BOLT TENSION INDICATING DEVICE SHALL BE USED. FASTENERS SHALL BE TIGHTENED BY ANY OF METHODS: 1) TURN-OF NUT TIGHTENING 2) CALIBRATED WRENCH TIGHTENING 3) DIRECT TENSION INDICATOR TIGHTENING.

REPRODUCED FROM INDIANA DOT DRAWINGS	TYPE	A-1
	PAGE	SHEET 2 OF 4

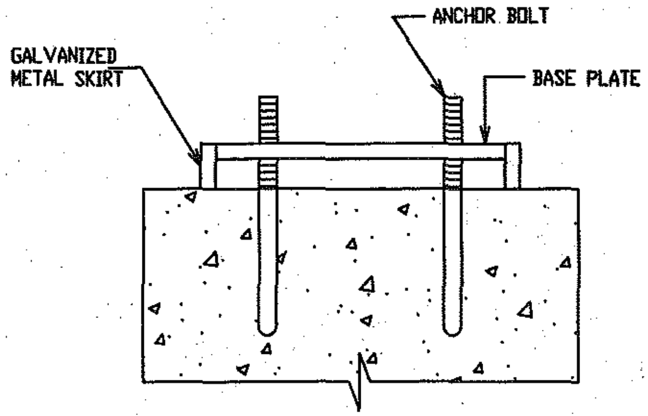
SINGLE MASTARM SIGN BRACKET ASSEMBLY



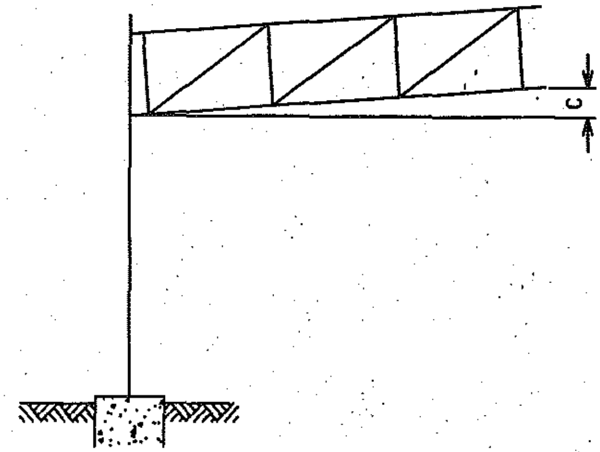


WALKWAY SUPPORT BRACKET

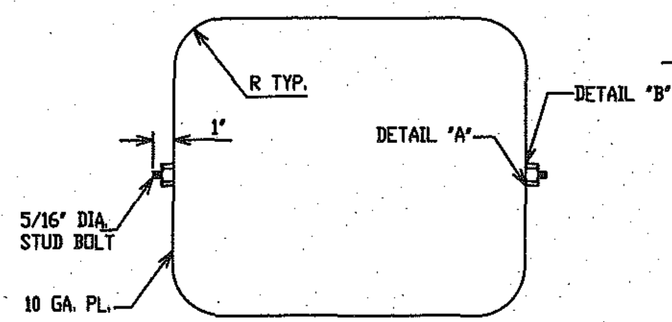
REPRODUCED FROM INDIANA DOT DRAWINGS	TYPE	A-1
	PAGE	SHEET 3 OF 4



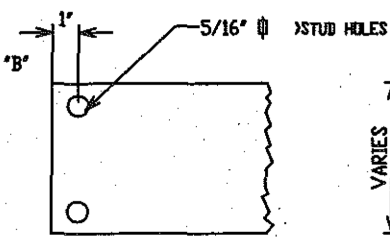
GALVANIZED METAL COVER



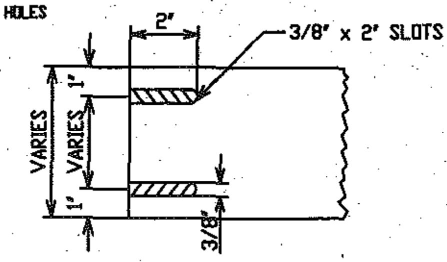
CAMBER FOR CANTILEVER



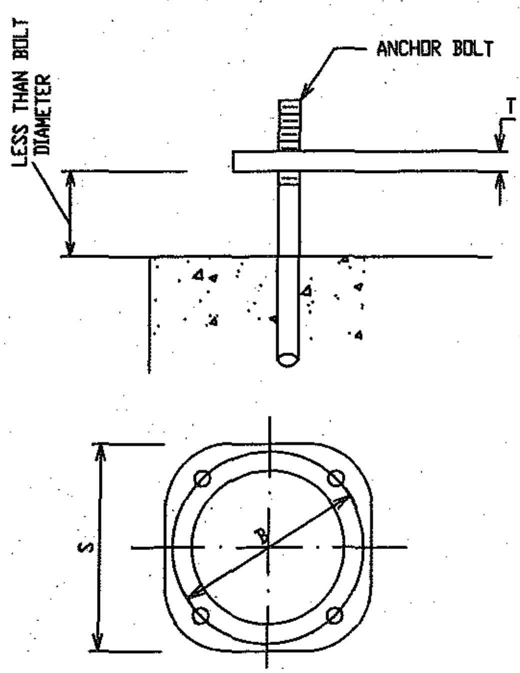
SKIRT DETAIL



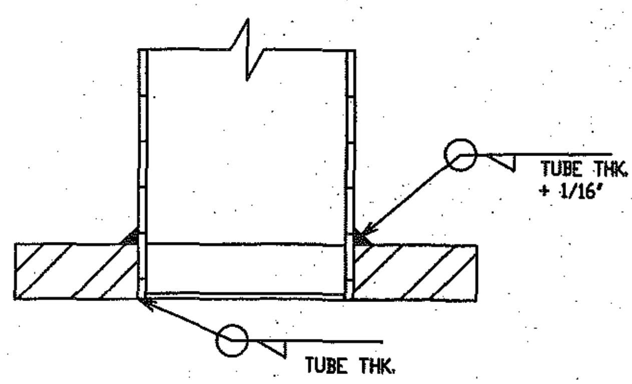
DETAIL "A"



DETAIL "B"



BASE PLATE



COLUMN- TO BASE PLATE OR MAST- ARM- TO- FLANGE-PLATE SOKET CONNECTIONS

BASE PLATE TIGHTENING:
METHOD OF BOLT TIGHTENING: TOP NUTS BE TIGHTENED TO ONE-SIXTH TURN BEYOND SNUG TIGHT. SNUG TIGHT WAS DEFINED AS THE CONDITION WHERE THE NUT IS IN FULL CONTACT WITH THE BASE PLATE. LOWER NUTS AND WASHERS SHOULD BE IN FULL CONTACT WITH THE BASE PLATE PRIOR TO SNUG TIGHTENING THE TOP NUT. AFTER TOP NUTS ARE FULLY TIGHTENED, THE LOWER NUTS SHOULD BE RETIGHTENED TO ASSURE THAT FULL CONTACT HAS BEEN MAINTAINED.

REPRODUCED FROM INDIANA DOT DRAWINGS	TYPE	A-1
	PAGE	SHEET 4 OF 4

GENERAL NOTE:

1. BARS, PLATES, AND SHAPES SHALL BE STRUCTURAL STEEL CONFORMING TO THE SPECIFICATIONS OF ASTM DESIGNATION: A 36.

2. HIGH-STRENGTH STEEL BOLTS, NUTS AND WASHERS SHALL CONFORM TO THE SPECIFICATIONS OF ASTM DESIGNATION: A 325. ALL OTHER BOLTS AND NUTS SHALL CONFORM TO THE SPECIFICATIONS OF ASTM DESIGNATION: A 307. SUCH BOLTS SHALL BE FURNISHED WITH COMMERCIAL QUALITY WASHERS.

3. PIPE POSTS SHALL BE WELDED OR SEAMLESS STEEL PIPE CONFORMING TO THE SPECIFICATIONS OF ASTM DESIGNATION: A 53, GRADE B. AT THE OPTION OF THE CONTRACTOR, POSTS MAY BE FABRICATED FROM STRUCTURAL STEEL CONFORMING TO THE SPECIFICATIONS OF ASTM DESIGNATION: A36. ANCHOR BOLTS SHALL BE MADE FROM STEEL BAR CONFORMING TO AASHTO M 314-90 WITH 55,000 PSI MIN. YIELD STRESS AND 75,000 PSI MIN. TENSILE STRENGTH.

4. SIGN STRUCTURES SHALL BE CONSTRUCTED TRUE TO DIMENSIONS, SHALL BE FREE FROM KINKS, TWISTS OR BENDS, AND SHALL BE UNIFORM IN APPEARANCE. THE COMPLETED SECTIONS SHALL BE ASSEMBLED IN THE SHOP AND SHALL BE CHECKED FOR STRAIGHTNESS, ALIGNMENT, AND DIMENSION. ANY VARIATIONS SHALL BE CORRECTED TO THE SATISFACTION OF THE ENGINEER.

5. MAST ARMS SHALL BE TEMPORARILY SUPPORTED TO TAKE ALL LOAD OFF OF THE FIELD SPLICES WHILE BOLTS ARE BEING TIGHTENED IN ORDER TO FIRMLY SEAT THE FLANGE PLATES.

6. POSTS FOR TUBULAR SIGN STRUCTURES SHALL BE FORMED TO THE RADII SHOWN ON THE PLANS BY HEAT TREATMENT OR FABRICATION TO SUCH RADII BY METHODS WHICH WILL NOT CRIMP OR BUCKLE THE INTERIOR RADII OF THE PIPE BEND.

7. CLIPS, EYES, OR REMOVABLE BRACKETS SHALL BE AFFIXED TO ALL POSTS AND MAST ARMS, AS NECESSARY, TO SECURE THE SIGN DURING SHIPPING AND FOR LIFTING AND MOVING DURING ERECTION. THIS IS TO PREVENT DAMAGE TO THE FINISHED GALVANIZED OR PAINTED SURFACES. BRACKETS ON TUBULAR SIGN STRUCTURES SHALL BE REMOVED AFTER ERECTION. DETAILS OF SUCH DEVICES SHALL BE SHOWN ON THE SHOP DRAWINGS.

8. HIGH-STRENGTH BOLTED CONNECTIONS, WHERE SHOWN ON THE PLANS, SHALL CONFORM TO THE PROVISIONS OF 509.28, CONNECTIONS USING HIGH-STRENGTH BOLTS. ASSEMBLY OF HIGH-STRENGTH BOLTED CONNECTIONS FOR SIGN STRUCTURES MAY BE PERFORMED WITH GALVANIZING OR PAINT ON THE CONTACT SURFACES.

9. BOLTS WITH DIAMETERS EXCEEDING BY UP TO 1/4 INCH THE DIAMETER OF THE BOLTS SHOWN ON THE PLANS MAY BE USED, PROVIDED THAT REQUIRED CLEARANCES AND EDGE DISTANCES ARE NOT REDUCED BELOW THAT REQUIRED FOR THE LARGER BOLT.

10. FOR STATIC SIGN, WALKWAYS SHALL ONLY BE LOCATED IN FRONT OF AND BETWEEN SIGN PANELS. DO NOT LOCATE WALKWAY UNDER ANY OTHER PORIONS OF SIGN STRUCTURE WHICH DO NOT HAVE SIGN PANELS. FOR DYNAMIC SIGNS, WALKWAYS SHALL LEAD UP TO THE CABINET ACCESS DOOR AND IN FRONT OF THE CABINET AS SPECIFIED ON THE SIGN X-SECTION SHEET IN THE ROADWAY PLANS.

11. ALL SIGN STRUCTURES SHALL BE FABRICATED INTO THE LARGEST PRACTICAL SECTIONS PRIOR TO GALVANIZING. SPLICE LOCATIONS SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL AND THE CONTRACTOR SHALL NOT COMMENCE FABRICATION UNTIL SUCH SPLICE LOCATIONS ARE APPROVED.

12. WELDING OF STEEL SHALL CONFORM TO THE REQUIREMENTS OF AWS D1.1. ALL AREAS TO BE WELDED SHALL BE GROUND TO BRIGHT METAL. NO BUTT WELD SPLICES WILL BE PERMITTED. ALL WELDING AND REQUIRED TESTING SHALL BE COMPLETE BEFORE ANY MATERIAL IS GALVANIZED. ALL

CIRCUMFERENTIAL AND STIFFENER WELDS SHALL BE NON-DESTRUCTIVELY TESTED USING THE ENHANCED MAGNETIC PARTICLE METHOD IN ACCORDANCE WITH SUBSECTION 509.18 (d). THE ACCEPTANCE CRITERIA ARE STATED IN TABLE 6.1 OF ANSI/AWS D1.1. ALL LONGITUDINAL WELDS WITHIN 6' OF FULL-PENETRATION CIRCUMFERENTIAL GROOVE WELDS SHALL BE FULL PENETRATION GROOVE WELDS AND SHALL BE INSPECTED AS SPECIFIED ABOVE. MAXIMUM WELD UNDERCUT SHALL BE 0.01".

13. ALL TUBE MEMBERS SHALL BE HOT-DIP GALVANIZED AS PER ASTM A123. WALKWAY GRATINGS, WALKWAY BRACKETS, GUTTERS, SAFETY RAILINGS, STEEL MOUNTINGS FOR LIGHT FIXTURES, AND ALL NUTS, BOLTS, AND WASHERS FOR SIGN STRUCTURES SHALL BE GALVANIZED AFTER FABRICATION AS PER ASTM A123 OR ASTM A153, AS APPROPRIATE, AND SHALL NOT BE PAINTED.

14. ALL CONCRETE SHALL BE CLASS BZ. REINFORCING STEEL: FY=60,000 PSI. CAISSON FOUNDATIONS SHALL BE COMPLETED AT LEAST 7 DAYS BEFORE SIGN STRUCTURES ARE ERECTED THEREON.

15. STRUCTURES SHALL BE GROUNDEDNIN ACCORDANCE WITH APPLICABLE ELECTRICAL CODES.

16. SHEETS IN THE INDEX MARKED WITH A PROVIDE INSTRUCTIONS TO DESIGNERS FOR THEIR USE IN THE PREPARATION OF THE SIGN X-SECTION SHEETS IN THE ROADWAY PLANS.

17. NPS=NORMINAL PIPE SIZE; O.D.=OUTSIDE DIAMETER.

18. PRIOR TO FABRICATION, SIX SETS OF SHOP DRAWINGS, WHICH COMPLY WITH THE REQUIREMENTS OF SECTION 105.02 OF THE STANDARD SPECIFICATIONS, SHALL BE SUBMITTED TO CDOT STAFF BRIDGE, 4201 E. ARKANSAS AVE. DENVER, COLORADO 80222.

19. INSTALL STRUCTURE IDENTIFICATION PANEL IN ACCORDANCE WITH M AND S STANDARD M-614-12 USING TWO 1/2" WIDE STAINLESS STEEL BANDS AND STAINLESS STEEL FLARED LEG BRACKETS WITH HEX HEAD BOLTS (BAND-IT D315 OR EQUIVALENT).

RESPECTIVELY / 20. CAISSON AND SURVEY WORK SHALL BE PAID FOR IN ACCORDANCE WITH BID ITEMS 503 AND 625

NOTE:

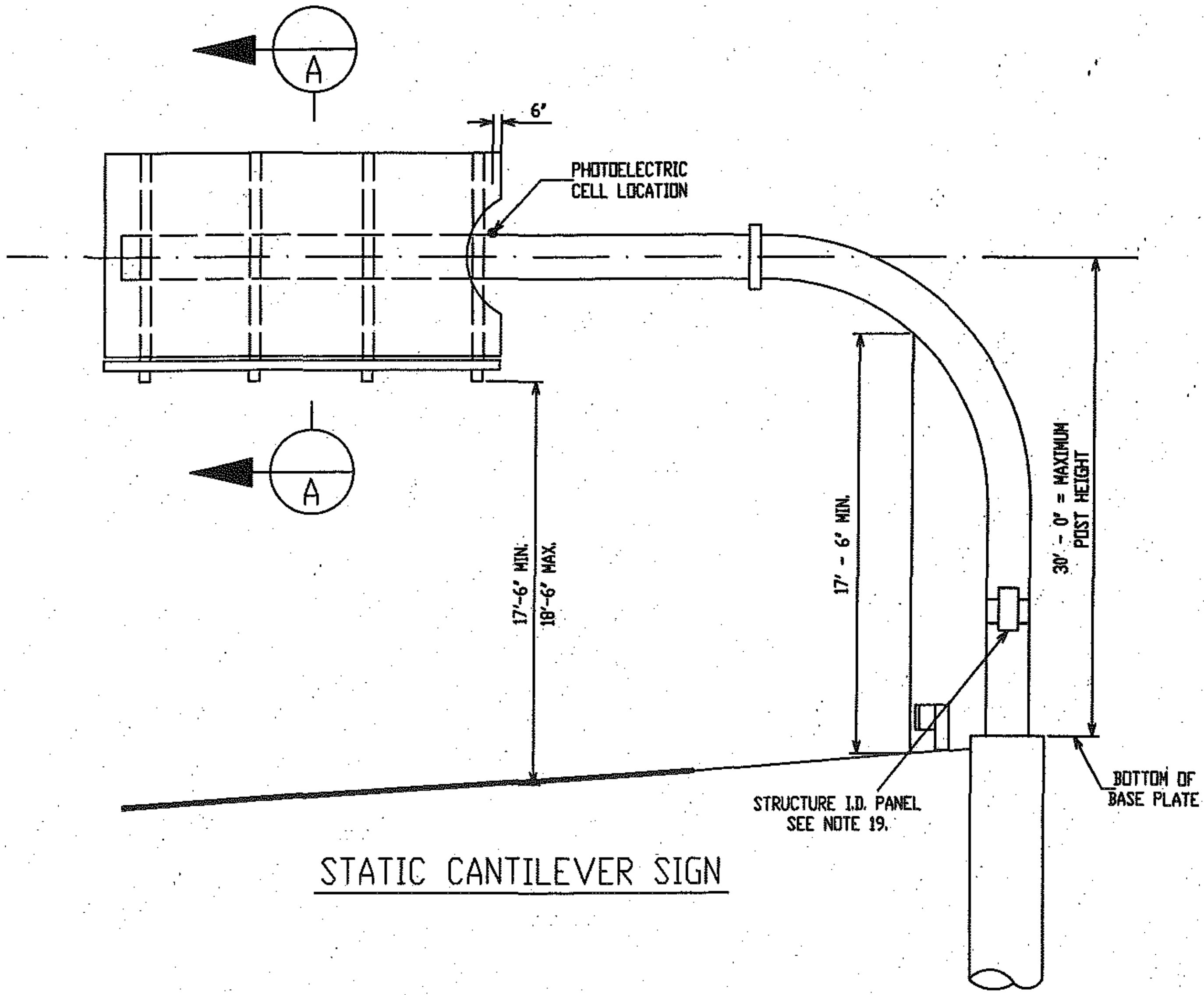
SPECIFICATION:
DESIGN: "STANDARD SPECIFICATIONS FOR STRUCTRAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES AND TRAFFIC SIGNALS", AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (1994 AASHTO), (STATIC SIGNS ONLY)

"STANDARD SPECIFICATIONS FOR STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES AND TRAFFIC SIGNALS", AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (2001 AASHTO), (DYNAMIC SIGNS ONLY)

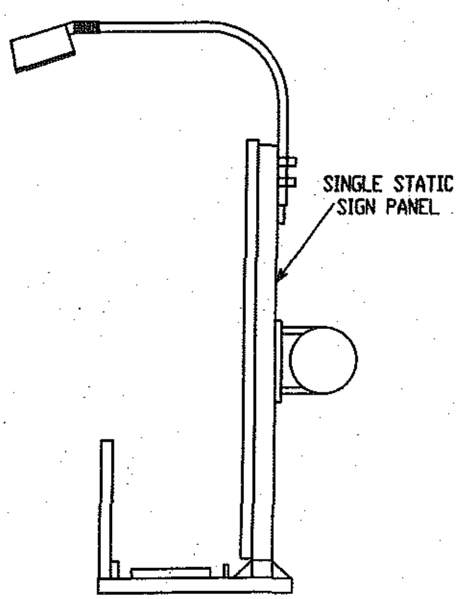
"FATIGUE-RESISTANT DESIGN OF CANTILEVERED SIGNAL, SIGN AND LIGHT SUPPORTS", NATIONAL OPERATIVE HIGHWAY RESEARCH PROGRAM (NCHRP) REPORT 412. 1998. (STATIC SIGNS ONLY)

SUBSECTION 17.4, SIGNS, IN THE STAFF BRIDGE BRANCH BRIDGE DESIGN MANUAL.

CONSTRUCTION: CDOT STANDARD SPECIFICATIONS, THESE STANDARD SHEETS AND THE PROJECT PLANS.
WIND LOADING: 80, 90 OR 100 MPH VELOCITY (STATIC SIGNS ONLY). 100 MPH VELOCITY (DYNAMIC SIGNS ONLY).



STATIC CANTILEVER SIGN



SECTION A

STATIC CANTILEVER NOTES:

1. THE MAXIMUM SIGN PANEL OVERLAP ONTO ELBOW SHALL NOT EXCEED 6'-0" FROM THE FIELD SPLICE.

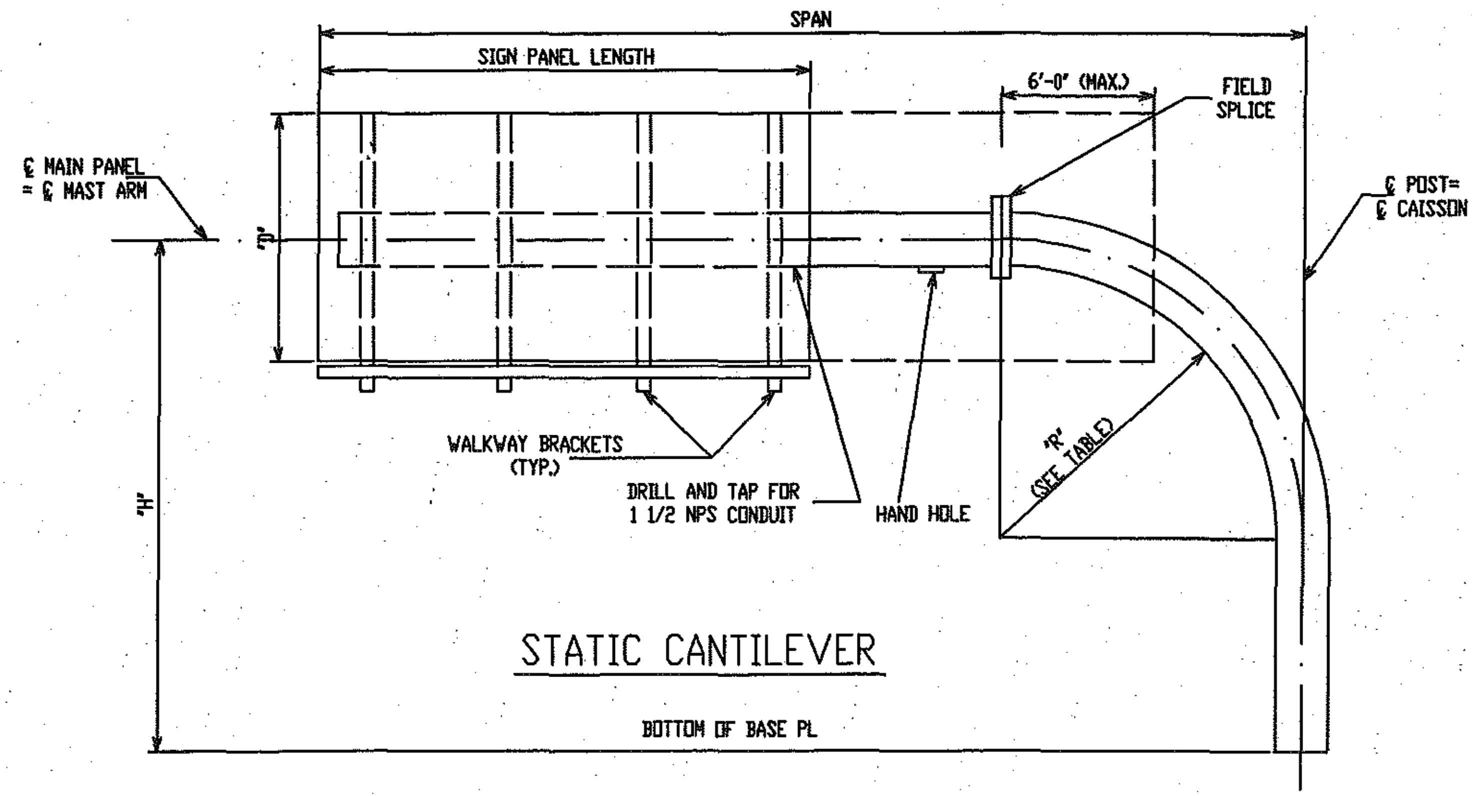
2. WHEN SEVERAL SIGN PANELS ARE TO BE INSTALLED WITH A SPACE BETWEEN THE PANELS, THE SPACE SHALL BE AS SMALL AS POSSIBLE AND 2'-0" MAXIMUM.

3. ALL POSTS BETWEEN BASE PLATE AND FIELD SPLICE SHALL HAVE A TUBE WALL THICKNESS OF 1/2". ALL MAST ARMS SHALL HAVE A TUBE WALL THICKNESS OF 3/8".

4. DURING SIGN ERECTION, THE POST SHALL BE ALIGNED BY USING THE LEVELING NUTS TO MAKE THE SIGN PANEL LEVEL.

5. FIELD SPLICE DETAILS ARE FOR BOTH CANTILEVER SIGNS AND SIGN BRIDGES. SEE SHEET 6 FOR ADDITIONAL FIELD SPLICE INFORMATION.

REPRODUCED FROM COLORADO DOT DRAWINGS	TYPE	A-2
	PAGE	SHEET 3 OF 14



STATIC CANTILEVER

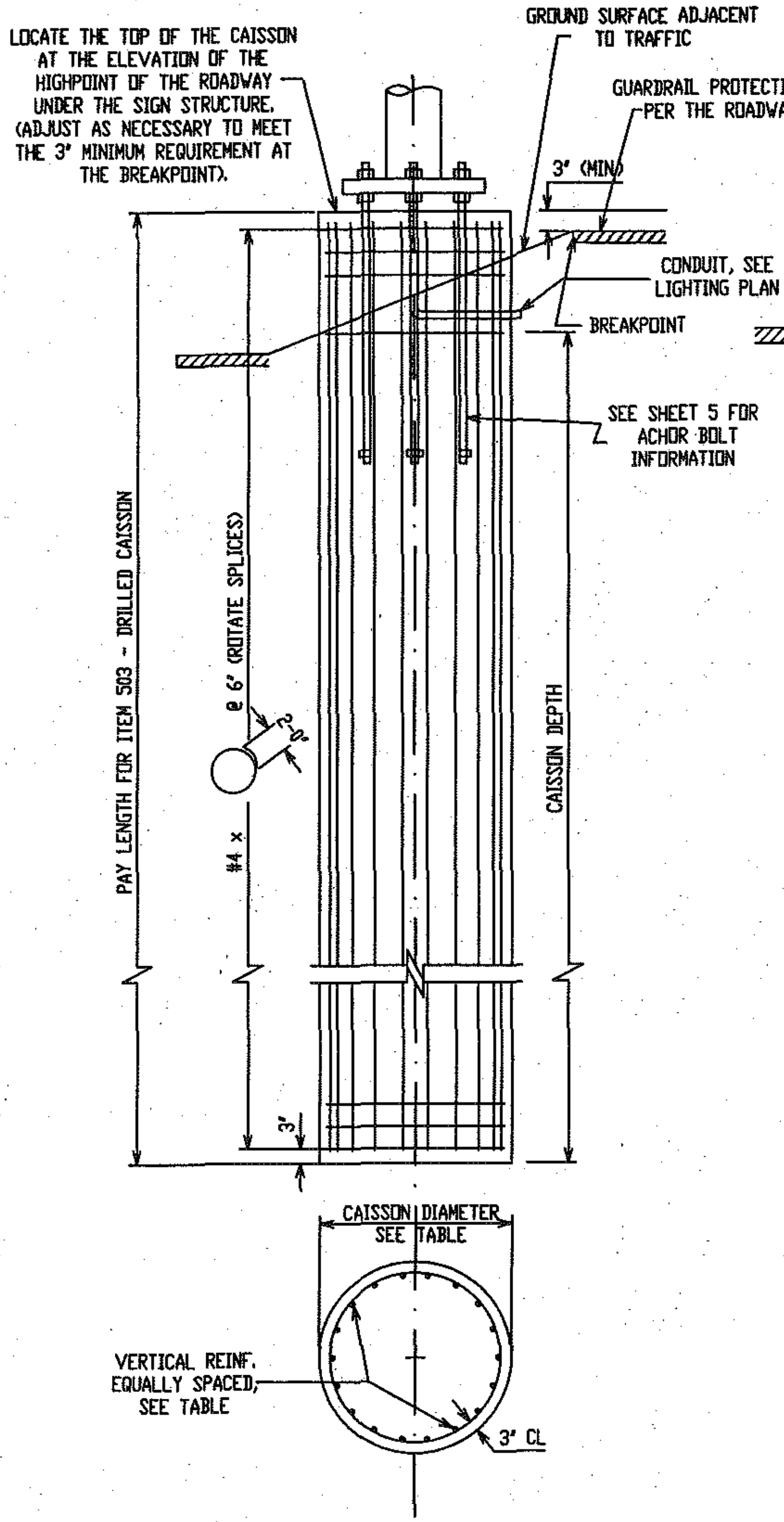
UP TO 50% COVERAGE CHART

100 MPH WIND							
"D" (FT.) →		10'		12'		14'	
"H" (FT.) →		H<25	25<H<30	H<25	25<H<30	H<25	25<H<30
SPANS ≤ (FT.)	20	16	16	16	18	18	18
	25	18	18	20	20	20	24
	30	20	24	24	24	24	24
	35	24	24	24			
	40						

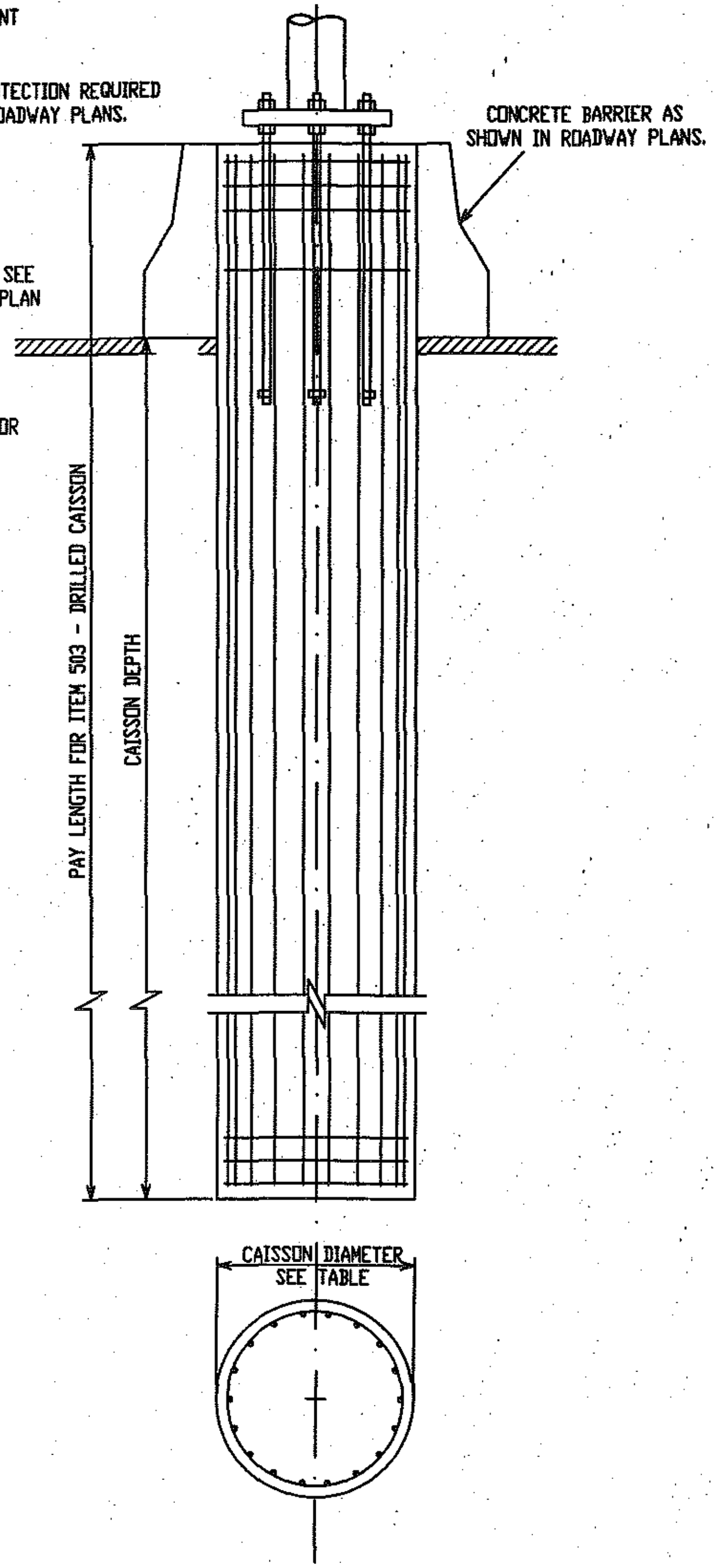
51-80% COVERAGE CHART

"D" (FT.) →		10'		12'		14'	
"H" (FT.) →		H<25	25<H<30	H<25	25<H<30	H<25	25<H<30
SPANS ≤ (FT.)	20	18	20	20	24	24	24
	25	20	24	24	24	24	
	30	24	24				
	35						

REPRODUCED FROM COLORADO DOT DRAWINGS	TYPE	A-2
	PAGE	SHEET 4 OF 14

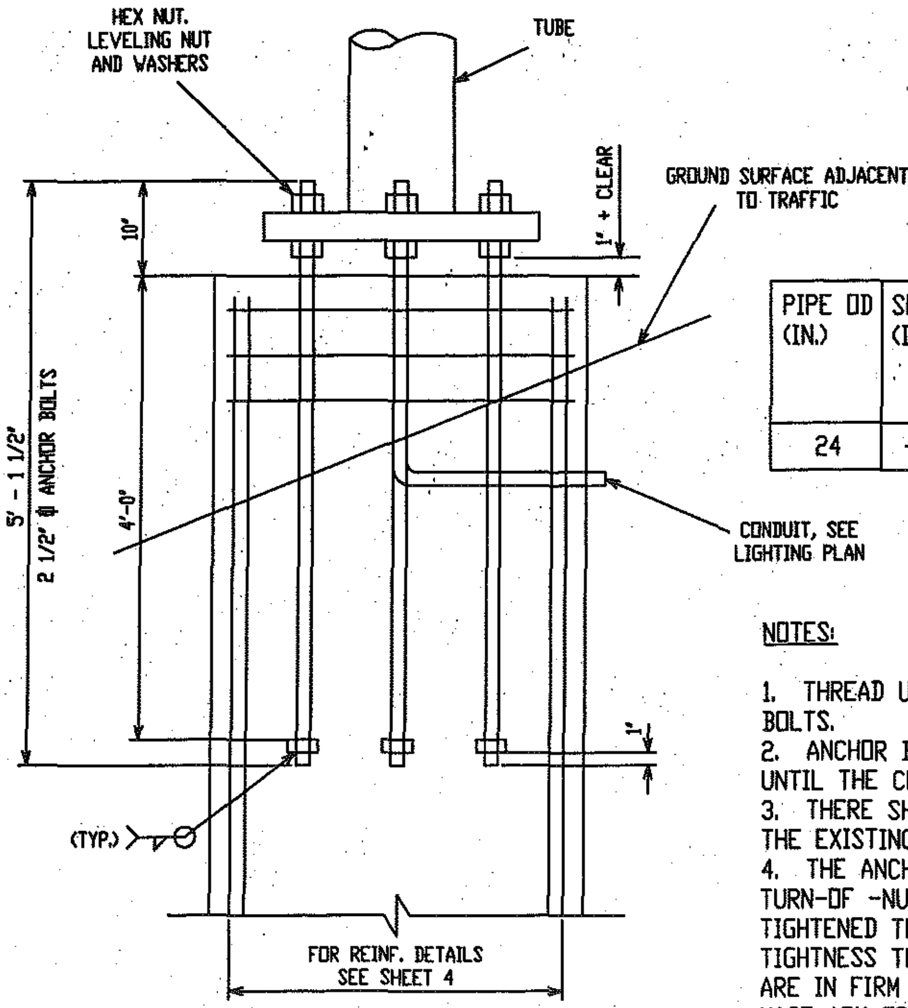


CAISSON FOUNDATION DETAILS
ROADSIDE SHOULDER INSTALLATION



CAISSON FOUNDATION DETAILS
MEDIAN RAIL INSTALLATION
(SEE ROADSIDE SHOULDER INSTALLATION FOR ADDITIONAL INFORMATION)

REPRODUCED FROM COLORADO DOT DRAWINGS	TYPE	A-2
	PAGE	SHEET 5 OF 14

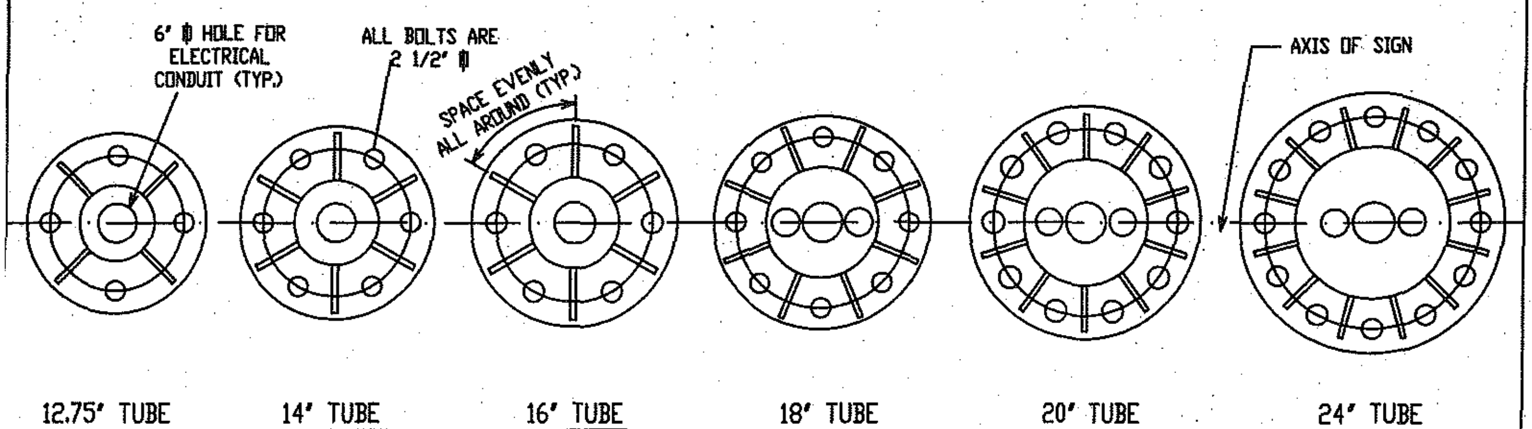


ANCHOR BOLT DETAIL

PIPE OD (IN.)	SPLIT (IN.)	BASE PL SIZE (DIAM. X THICK.) (IN.)	BOLT CIRCLE (IN.)	# OF ANCHOR BOLTS	# OF STIFF.
24	—	40" x 3.0"	33"	12	12

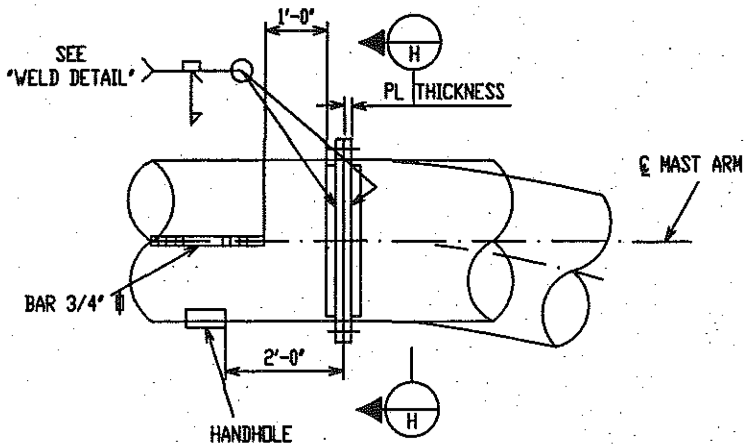
NOTES:

1. THREAD UPPER 9" GALVANIZE UPPER 1'-0" OF THE ANCHOR BOLTS.
2. ANCHOR BOLTS SHALL BE SET WITH A STEEL TEMPLATE UNTIL THE CONCRETE HAS CURED AT LEAST TWO DAYS.
3. THERE SHALL BE NO GROUT PAD INSTALLED ON TOP OF THE EXISTING FOUNDATIONS.
4. THE ANCHOR BOLTS SHALL BE TIGHTEED USING THE TURN-OF -NUT METHOD. THE BOLTS SHALL FIRST BE TIGHTENED TO SNUG TIGHT, WHICH IS DEFINED AS THE TIGHTNESS THAT EXISTS WHEN THE UPPER AND LOWER NUTS ARE IN FIRM CONTACT WITH THE BASE PLATE. WITH THE MAST ARM FREE TO DEFLECT, THE UPPER AND LOWER NUTS SHALL EACH THEN BE ROTATED AN ADDITIONAL 1/12 TURN (30° ±5°) A SLUGGING WRENCH.



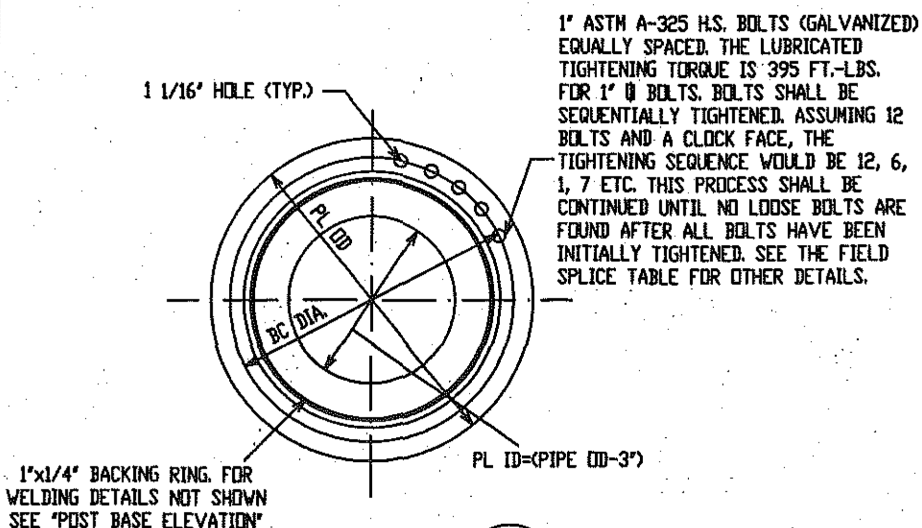
BASE PLATE DETAILS FOR CANTILEVERS

REPRODUCED FROM COLORADO DOT DRAWINGS	TYPE	A-2
	PAGE	SHEET 6 OF 14



FIELD SPLICE					
PIPE OUTSIDE DIA. (IN.)	PL THICKNESS (IN.)	BC DIA. (IN.)	PL OD (IN.)	# OF STIFF	# OF BOLTS
24	1 1/2	29	32	12	28

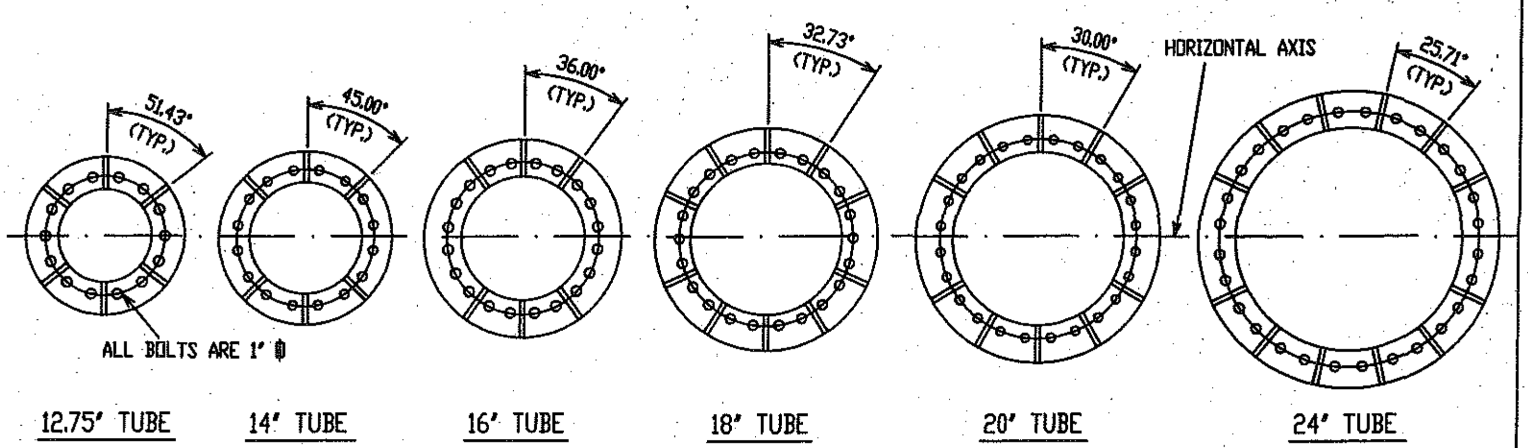
FIELD SPLICE



SECTION H

NOTES:

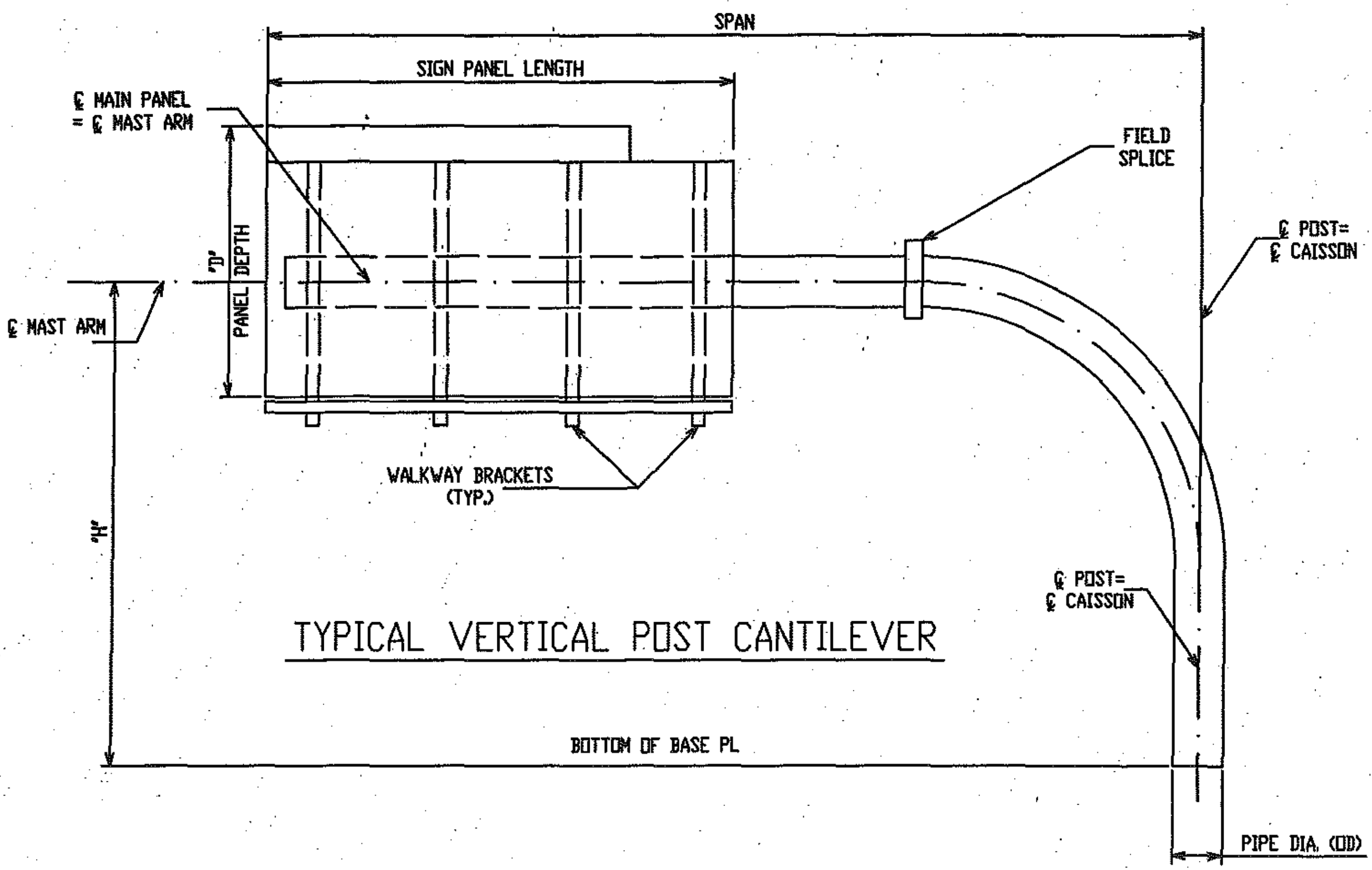
1. DESIGN BASED ON CAPACITY OF STANDARD PIPE.
2. NPS=NOMINAL PIPE SIZE. OD=OUTSIDE DIAMETER.



FIELD SPLICE DETAILS

STIFFENERS SHALL BE LOCATED ON BOTH SIDES OF THE FIELD SPLICE

REPRODUCED FROM COLORADO DOT DRAWINGS	TYPE	A-2
	PAGE	SHEET 7 OF 14



TYPICAL VERTICAL POST CANTILEVER

PIPE SELECTION PROCEDURE FOR VERTICAL POST CANTILEVERS:

A. COVERAGE PERCENTAGE = (SIGN PANEL LENGTH)/SPAN FOR THE SPAN LENGTH USE THE SPAN FROM ONE OF THE CHARTS (25', 35', ETC.)

B. PICK THE PIPE OUTSIDE DIAMETER (OD) FROM THE 0-50% OR THE 51-80% CHART. THE COVERAGE PERCENTAGE CHOSEN SHOULD BE HIGH ENOUGH TO INCLUDE ANY SIGN PANELS WHICH MAY POTENTIALLY BE PLACED ON THIS SIGN IN THE FUTURE.

C. TO DETERMINE 'D' FOR THE SECTION CHARTS ADD THE AREA OF THE NEXT PANEL, IF PRESENT, TO THE MAIN SIGN PANEL AREA. DIVIDE BY THE MAIN LENGTH TO OBTAIN 'D'.

D. IF NO TUBE IS SHOWN FOR A CERTAIN SPAN THIS INDICATES THAT THIS SPAN/SIGN PANEL/HEIGHT COMBINATION EXCEEDS THE LIMITS OF THIS STANDARD.

E. ON THE OVERHEAD SIGN X-SECTION SHEET INDICATE THE DIAMETER OF THE TUBE, THE HEIGHT 'H' AND THE SPAN.

F. OBTAIN THE DESIGN WIND SPEED FROM THE OVERHEAD SIGN X-SECTION SHEETS IN THE ROADWAY PLANS.

PROCEDURE TO DETERMINE THE DESIGN WIND SPEED:

80 MPH IS THE STANDARD DESIGN WIND SPEED FOR THE STATE OF COLORADO. THE STANDARD DESIGN WIND SPEED OF 80 MPH IS TO BE USED AT ALL LOCATIOS EXCEPT THE FOLLOWING:

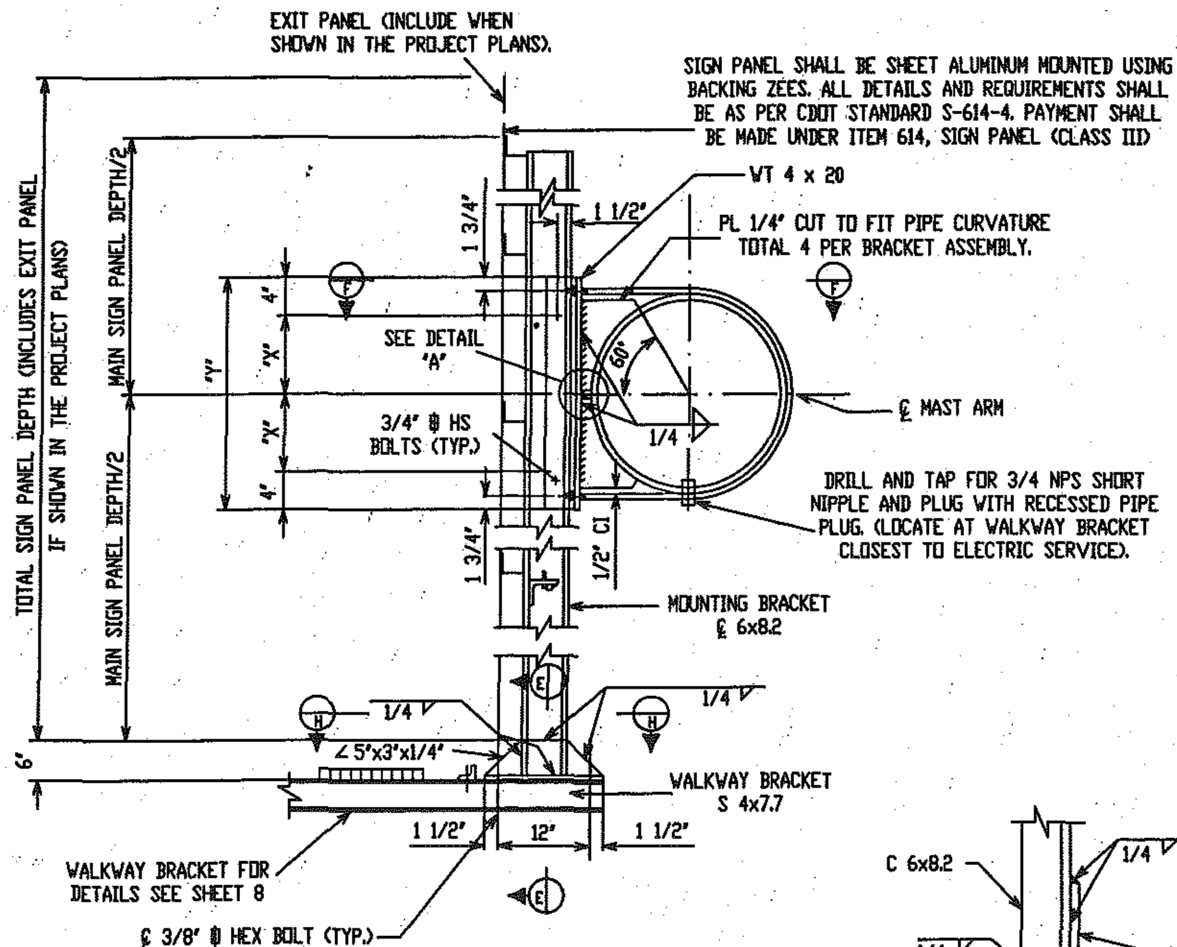
1. USE THE 90 MPH WIND SPEED FOR LOCATIONS WITHIN 4 MILES OF EITHER SIDE OF THE BASE OF THE FOOTHILLS ALONG THE FRONT RANGE OF THE EASTERN SLOPE.

2. USE THE 100 MPH WIND SPEED FOR LOCATIONS IN BOULDER COUNTY.

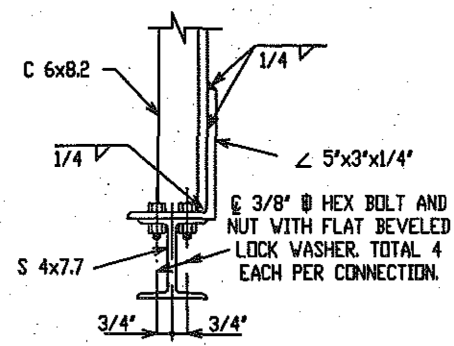
IF THERE ARE QUESTIONS CONCERNING THE PROPER DESIGN WIND SPEED CONTACT THE STAFF BRIDGE BRANCH.

PIPE POST	
PIPE OD (IN.)	'R' (FT.)
12.75	8
14	8
16	8
18	8
20	8
24	10

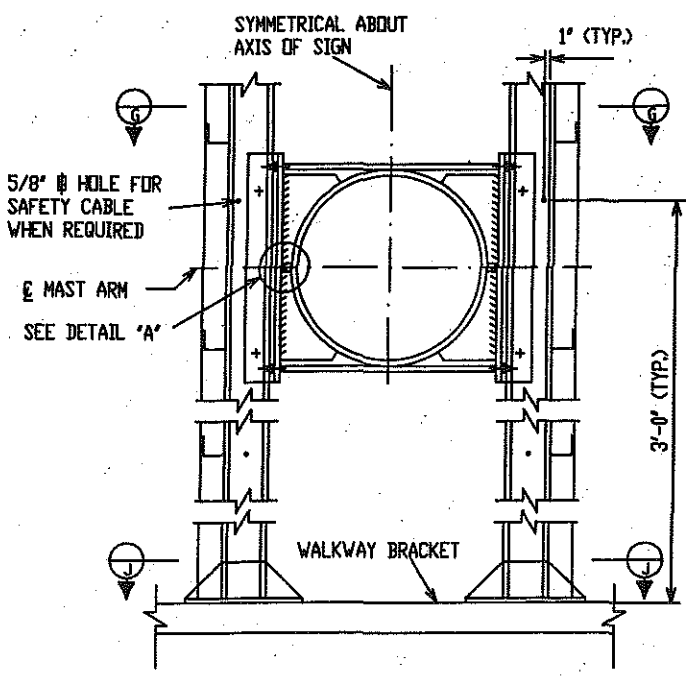
REPRODUCED FROM COLORADO DOT DRAWINGS	TYPE	A-2
	PAGE	SHEET 8 OF 14



SINGLE SIGN PANEL



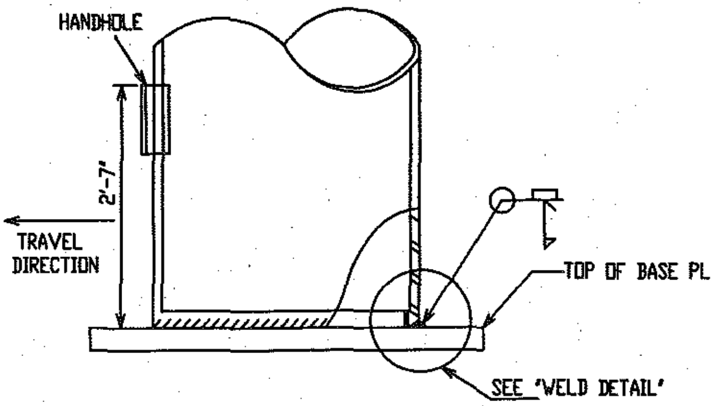
MOUNTING BRACKET ASSEMBLY DETAILS



NOTE:
FOR DETAILS NOT SHOWN OR NOTED SEE 'SINGLE SIGN PANEL'. ASSEMBLY DETAILS SHOWN APPLY TO TANGENT PORTION OF PIPE ONLY. FOR MOUNTING BRACKET ON ELBOW SEE DETAIL 'B'.

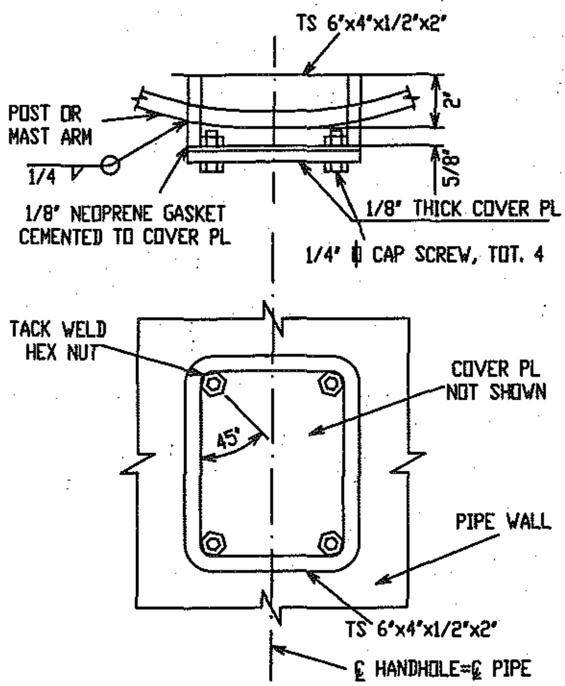
BACK-TO-BACK SIGN PANELS

REPRODUCED FROM COLORADO DOT DRAWINGS	TYPE	A-2
	PAGE	SHEET 9 OF 14

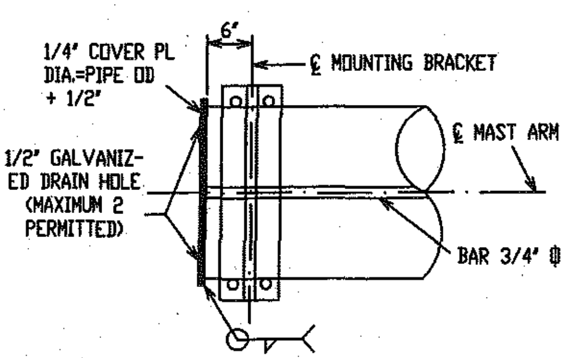


POST BASE ELEVATION

(FOR BASE PL DETAILS SEE 'FOUNDATION DETAILS' SHEETS)

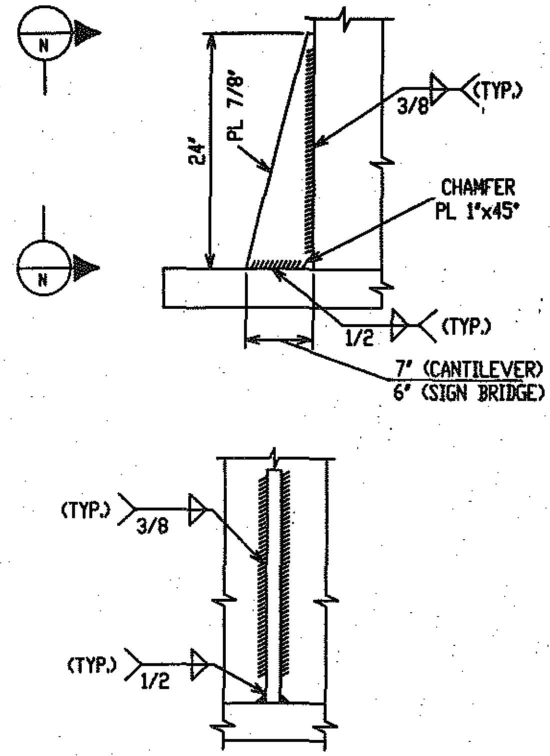


HANDHOLE AND COVER DETAILS



MAST ARM END DETAIL

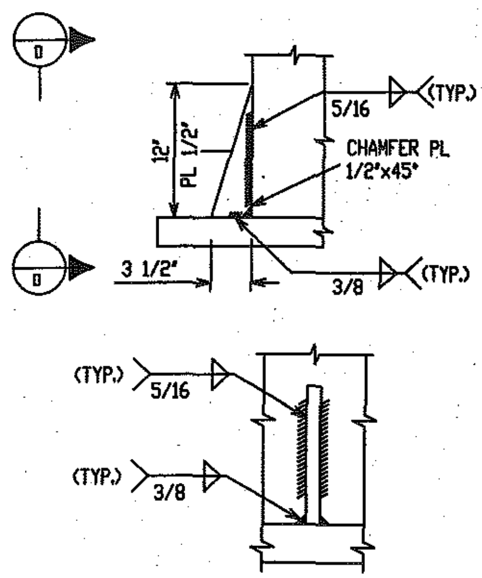
(FOR 'CANTILEVER TYPE' ONLY)



DETAIL N

STIFFENER DETAILS

(@ THE POLE BASE)

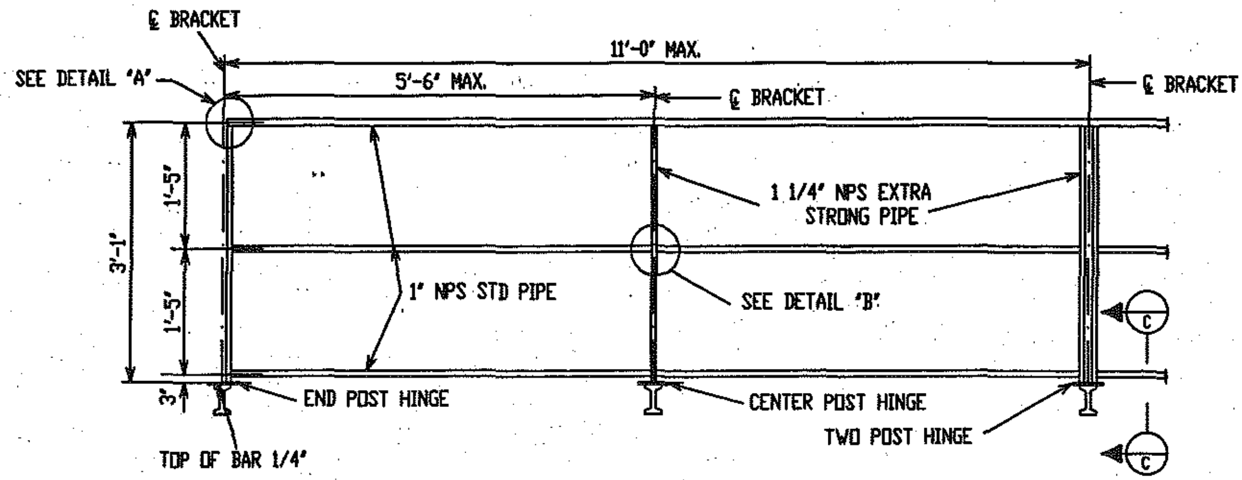


DETAIL O

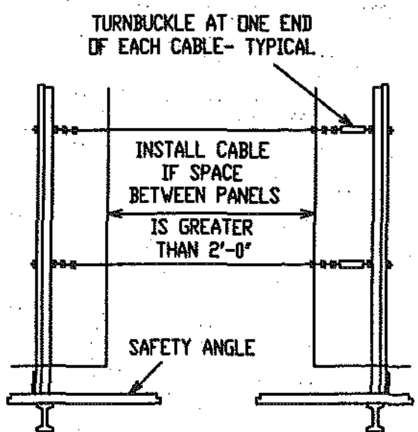
STIFFENER DETAILS

(@ THE FIELD SPLICE)

REPRODUCED FROM COLORADO DOT DRAWINGS	TYPE	A-2
	PAGE	SHEET 10 OF 14

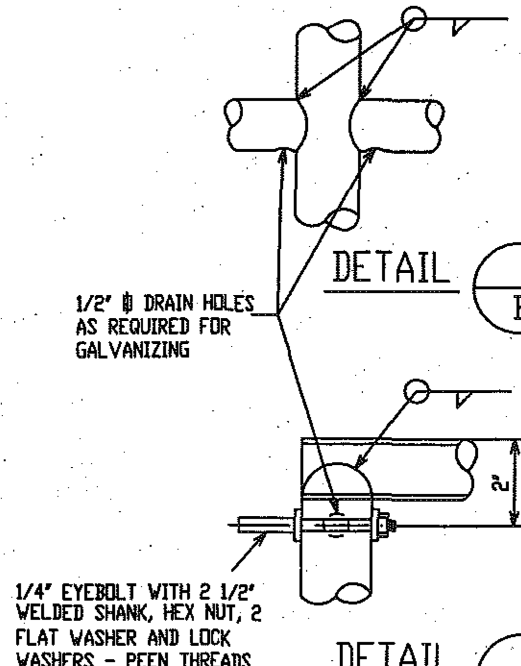


SAFETY RAILING ELEVATION



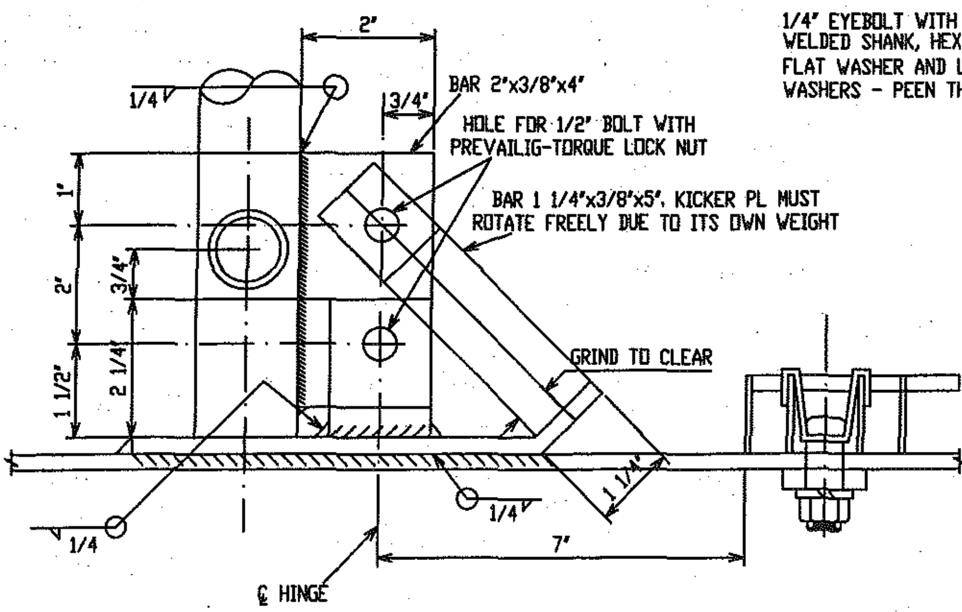
BETWEEN PANELS

SAFETY CABLE ELEVATION



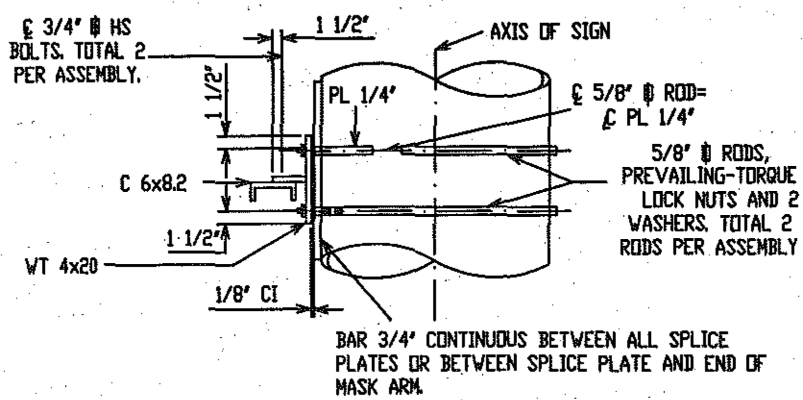
DETAIL B

DETAIL A

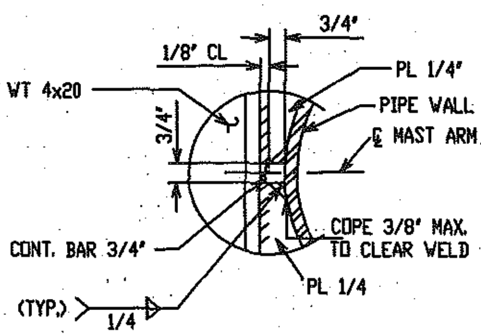


SECTION C

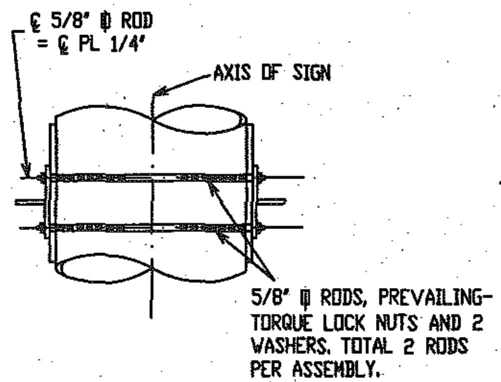
REPRODUCED FROM COLORADO DOT DRAWINGS	TYPE	A-2
	PAGE	SHEET 11 OF 14



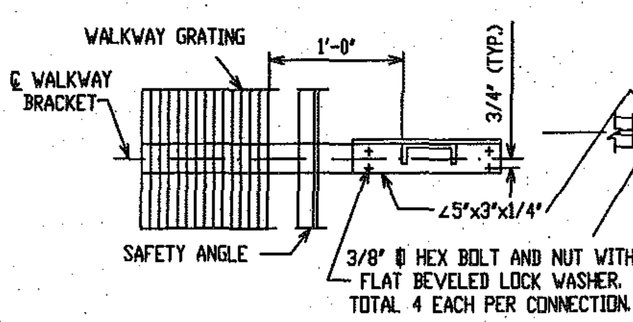
VIEW F



DETAIL A



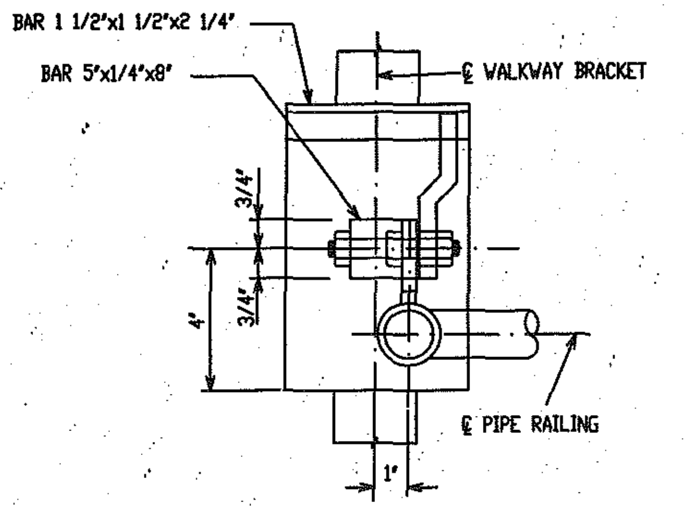
VIEW G



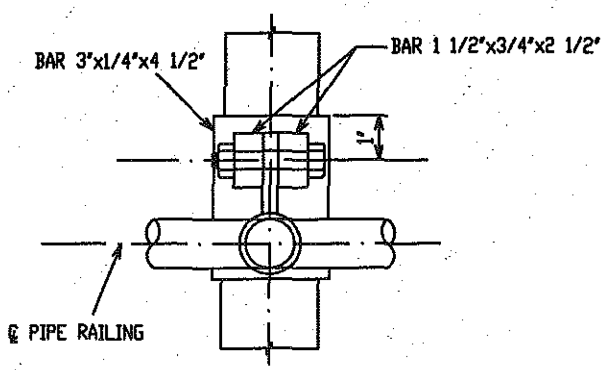
SECTION J

SECTION H

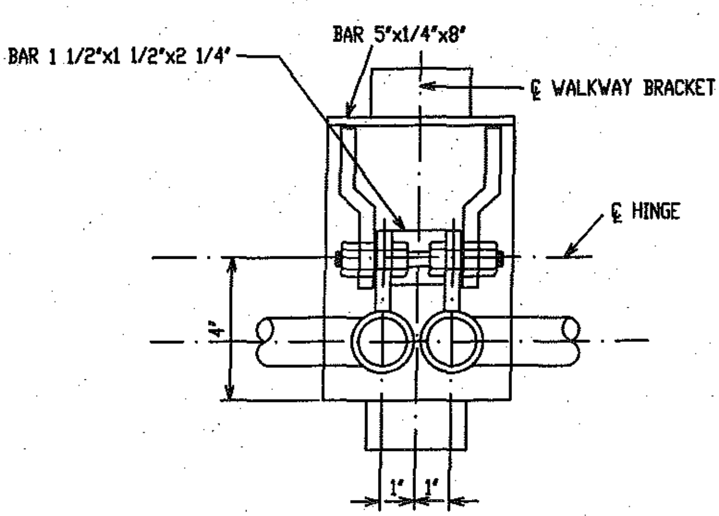
REPRODUCED FROM COLORADO DOT DRAWINGS	TYPE	A-2
	PAGE	SHEET 12 OF 14



END POST



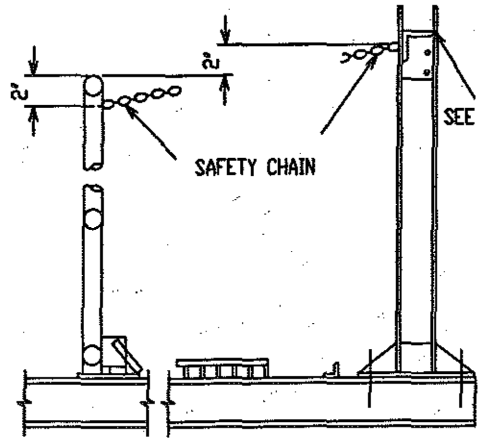
CENTER POST



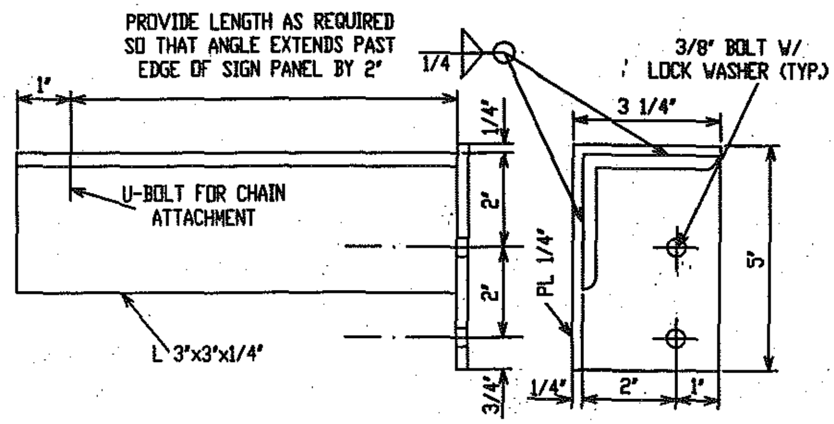
TWO POST

HINGE-PLAN

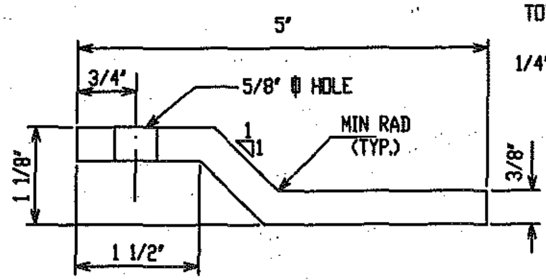
REPRODUCED FROM COLORADO DOT DRAWINGS	TYPE	A-2
	PAGE	SHEET 13 OF 14



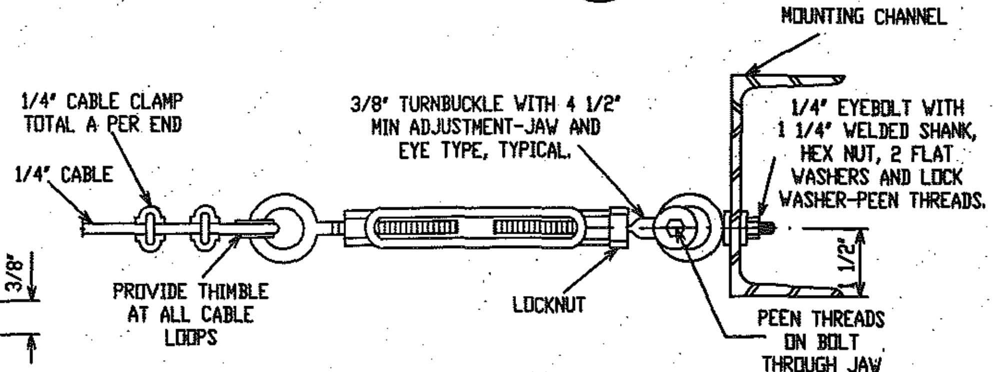
CHAIN ASSEMBLY



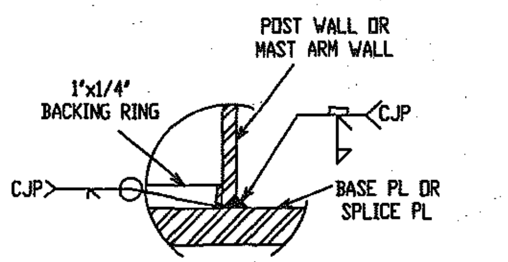
DETAIL C



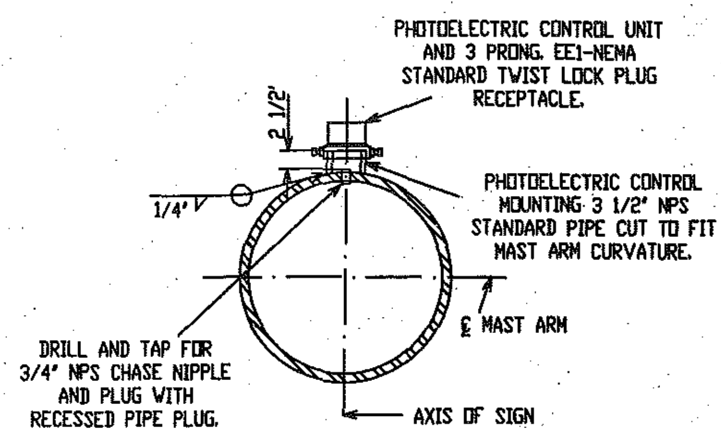
PLAN-KICKER BAR



TURNBUCKLE DETAILS

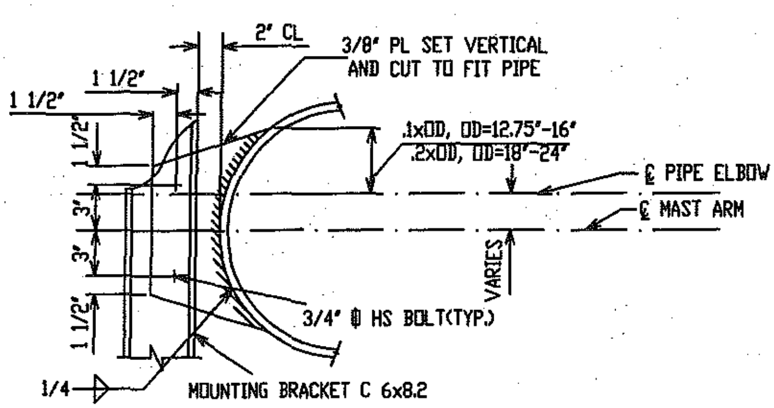


WELD DETAIL



PHOTOELECTRIC CONTROL DETAILS

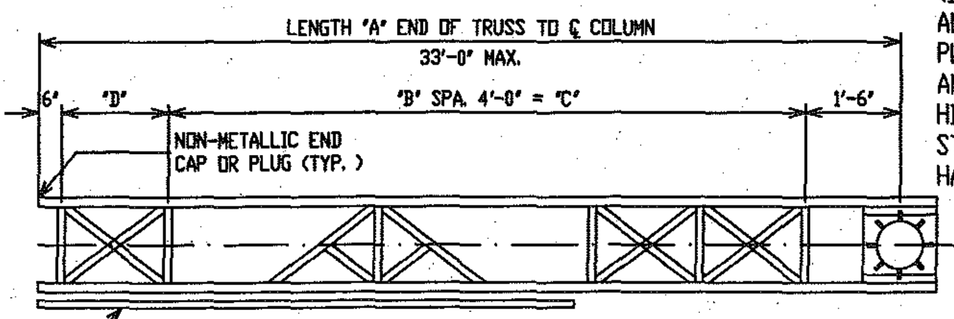
(SEE "LAYOUT" SHEET FOR LOCATION WHEN REQUIRED)



DETAIL B

REPRODUCED FROM COLORADO DOT DRAWINGS	TYPE	A-2
	PAGE	SHEET 14 OF 14

END PANEL "D": 2'-0" MIN.
6'-0" MAX.



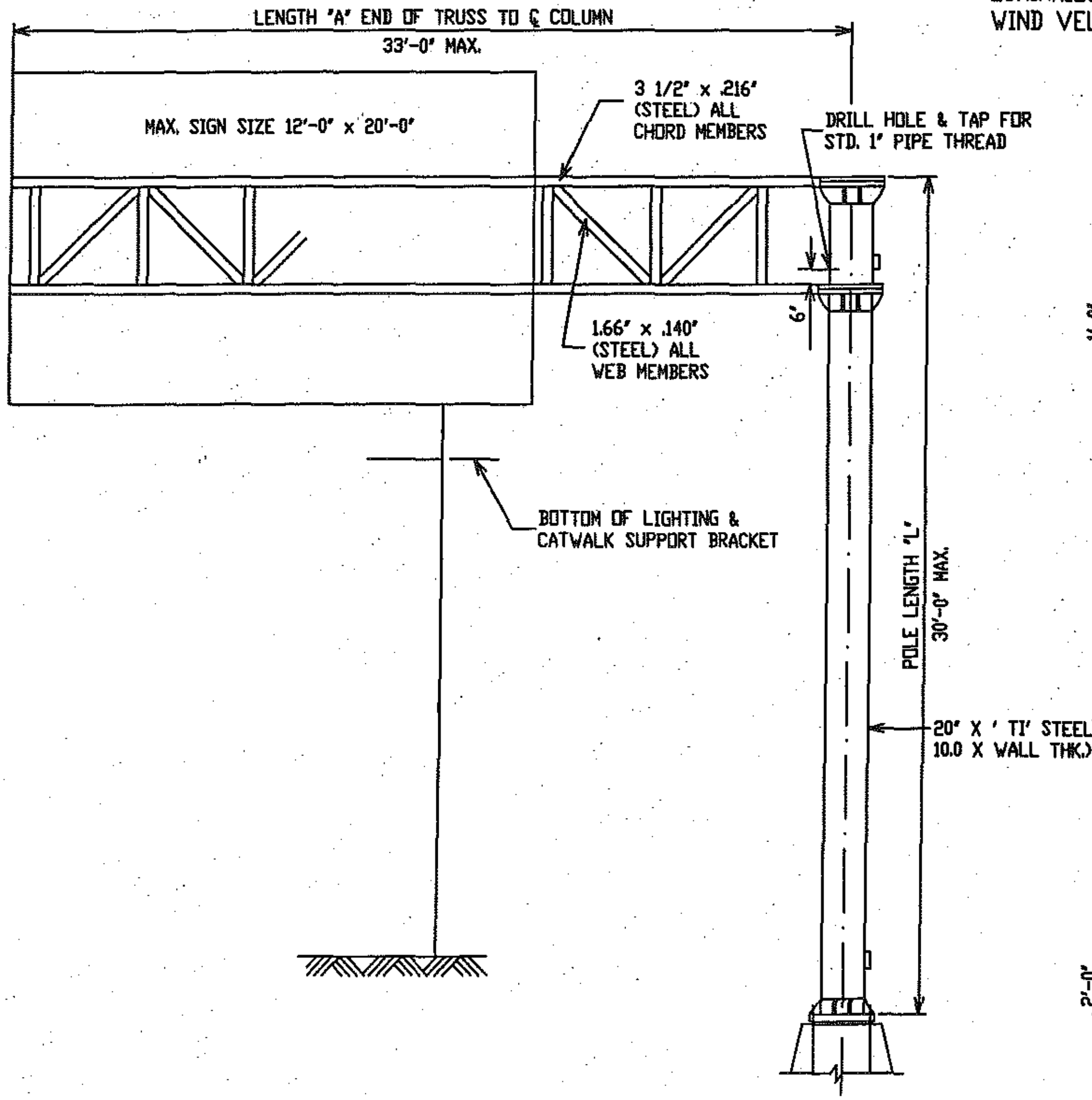
PLAN

ALLOWABLE DESIGN STRESS:

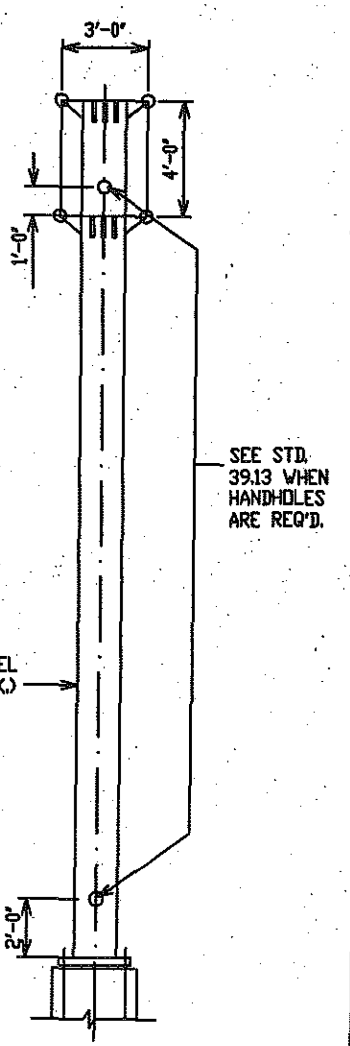
CHORDS & COLUMN (INCLD. HANDHOLE): API-SL-X42 Fy=42,000 PSI
ALL OTHER PIPE: A53,GRADE B Fy=35,000 PSI
PLATES & BARS: A709 Fy=36,000 PSI
ANCHOR BOLTS: AASHTO. M314 Fy=55,000 PSI
HIGH STRENGTH BOLTS: A325 Fy=92,000 PSI
STRUCTURAL MEMRERS GALVANIZED A123
HARDWARE GALVANIZED: A153 CLASS C

GENERAL NOTE:

DRAWINGS SHALL NOT BE SCALED.
DESIGNED ACCORDING TO A.A.S.H.T.O. 'STANDARD SPECIFICATIONS FOR STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS. LUMINAIES AND TRAFFIC 'SIGNALS'
WIND VELOCITY: 85 M.P.H.

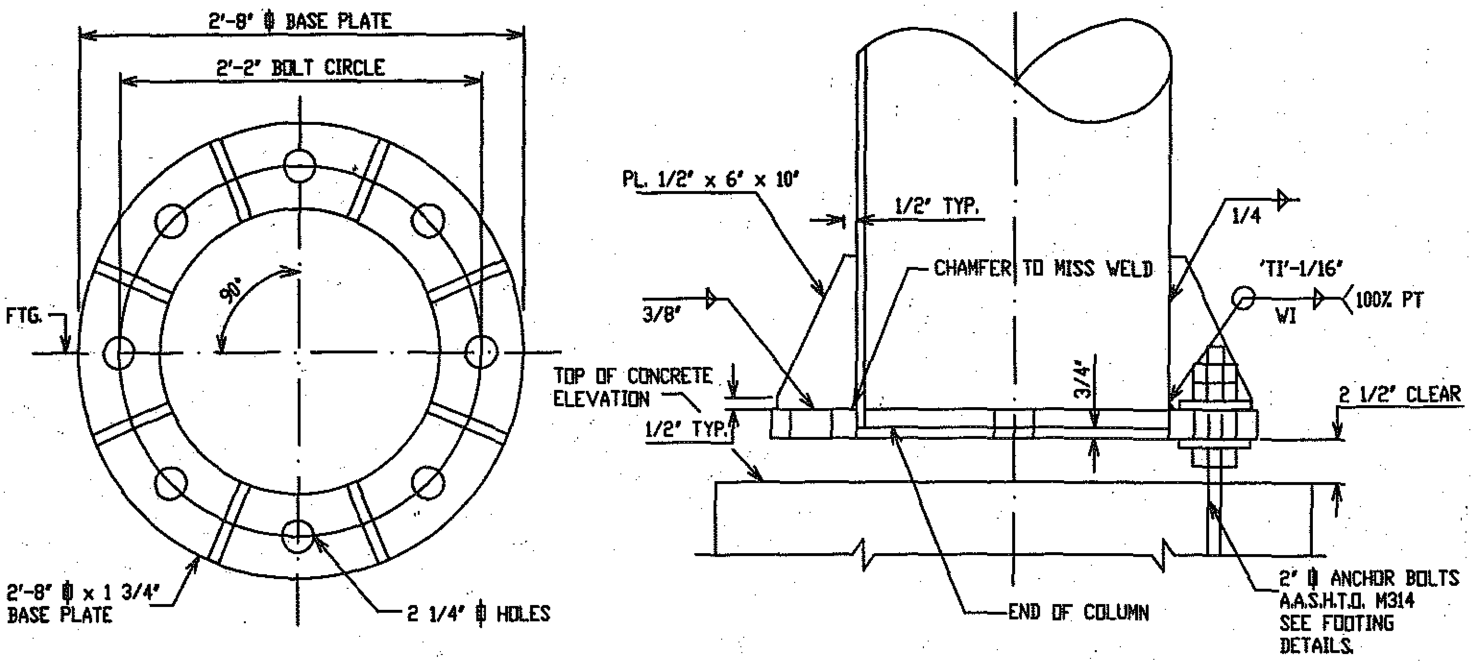


ELEVATION

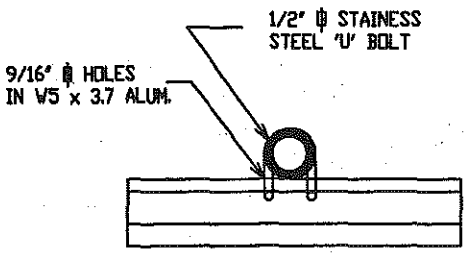


END VIEW

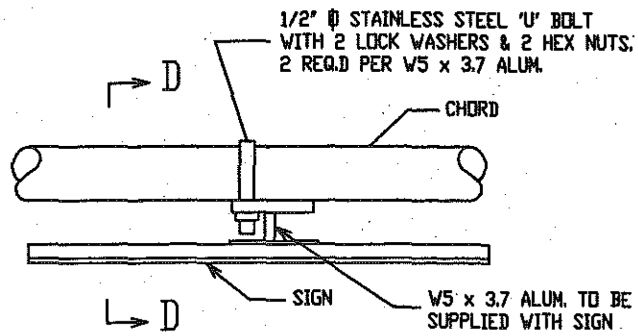
REPRODUCED FROM WISCONSIN DOT DRAWINGS	TYPE	A-3
	PAGE	SHEET 1 OF 5



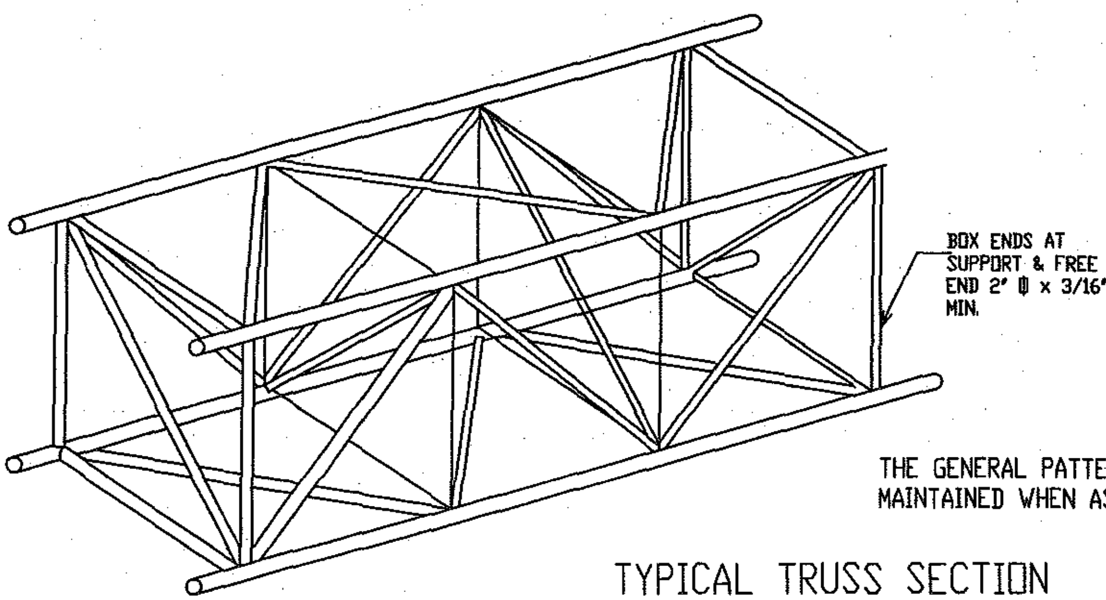
BASE PLATE DETAILS



SECTION D



TYPICAL SIGN CONNECTION

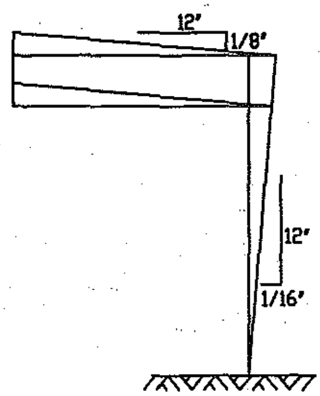


WELD SIZE "WI"	
POLE "TI"	"WI"
0.281"	1/4"
0.312"	1/4"
0.344"	5/16"
0.375"	3/8"
0.406"	3/8"
0.500"	3/8"

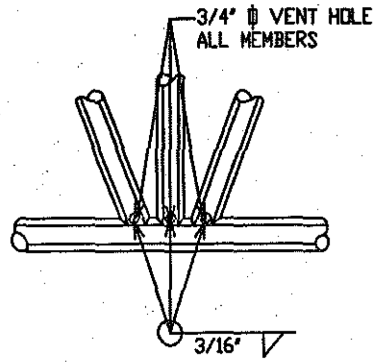
THE GENERAL PATTERN SHOWN ABOVE TO BE MAINTAINED WHEN ASSEMBLING TRUESSES.

TYPICAL TRUSS SECTION

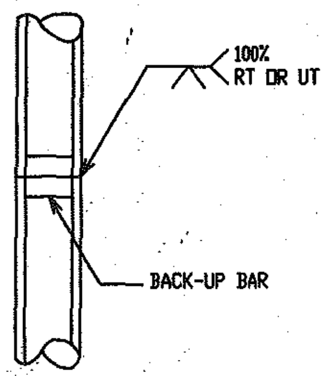
REPRODUCED FROM WISCONSIN DOT DRAWINGS	TYPE	A-3
	PAGE	SHEET 2 OF 5



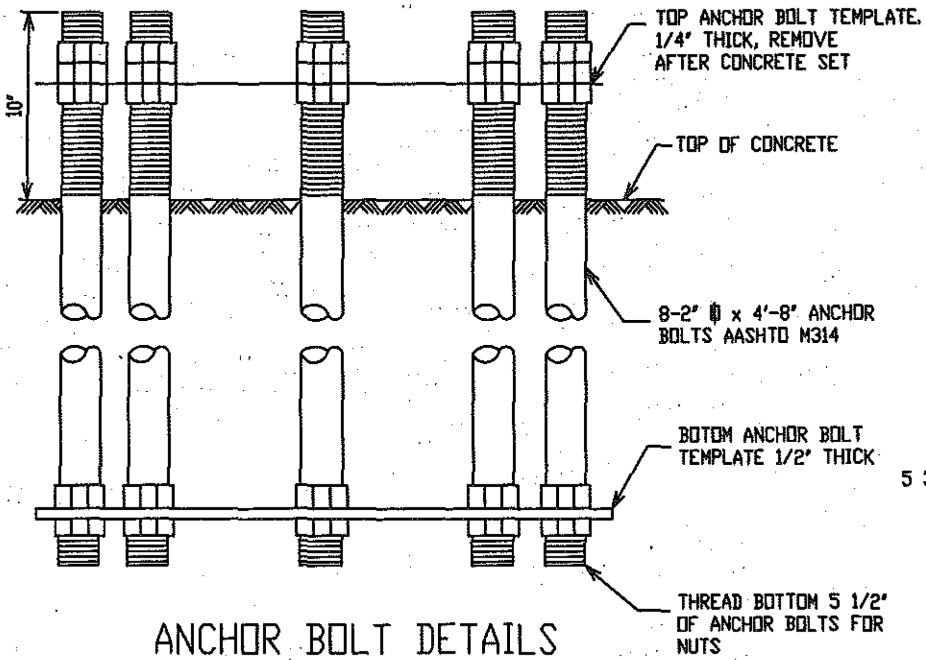
CAMBER DIAGRAM



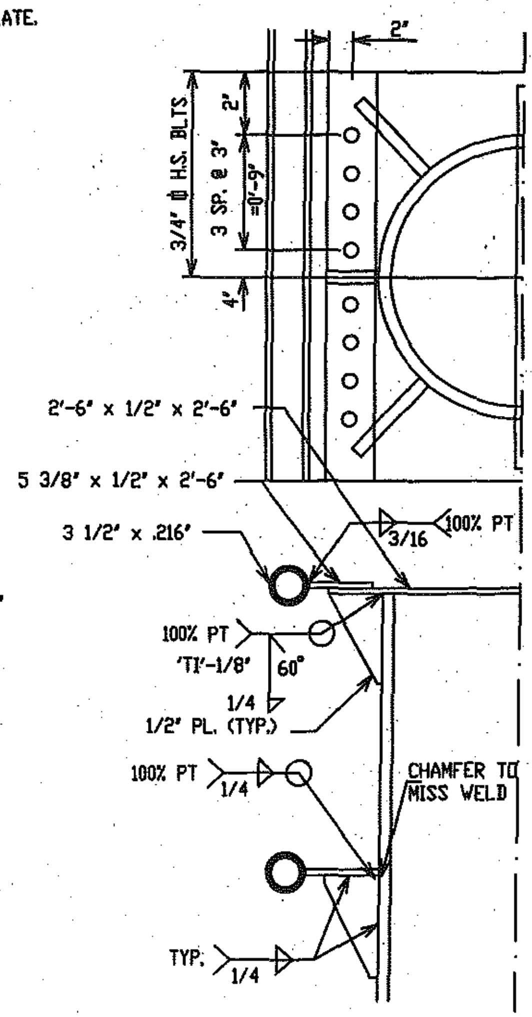
TRUSS JOINT DETAILS



OPTIONAL COLUMN OR CHORD SPLICE DETAIL



ANCHOR BOLT DETAILS



TRUSS TO COLUMN CONNECTION DETAILS

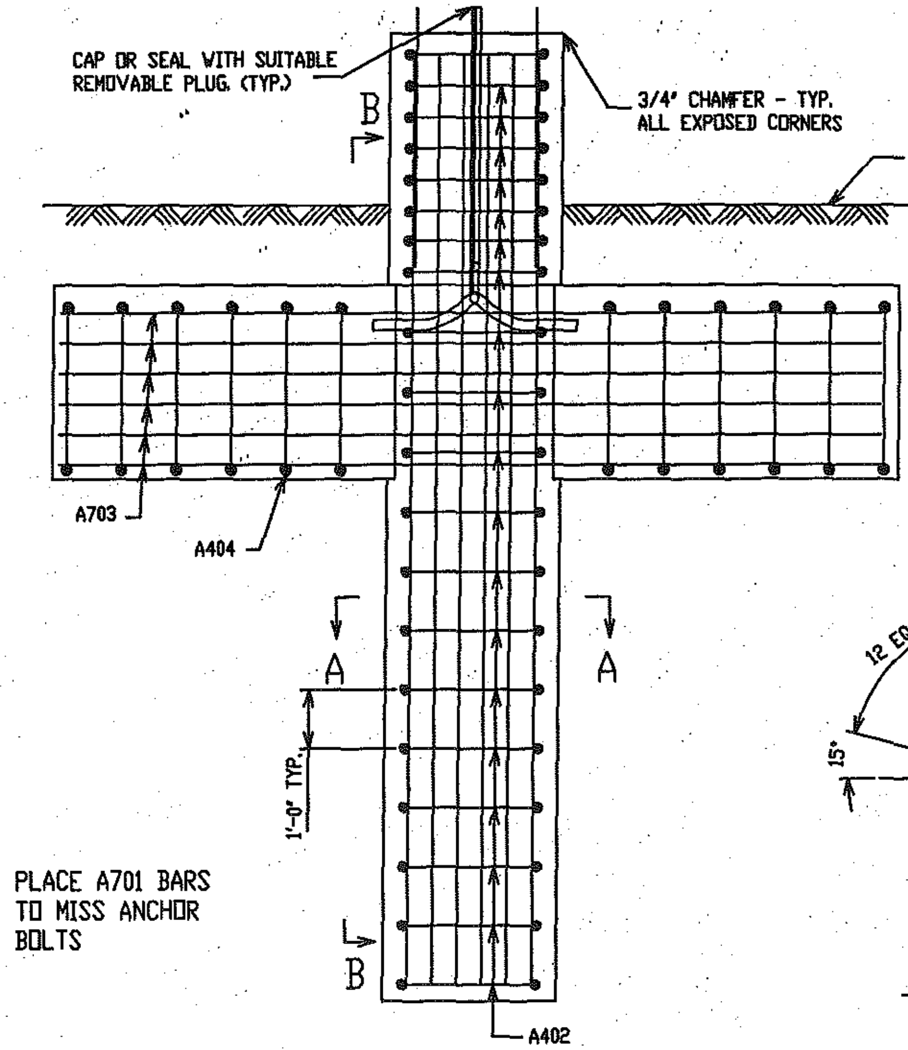
GENERAL NOTE:
DRAWINGS SHALL NOT BE SCALED.
BAR STEEL REINFORCEMENT SHALL BE EMBEDDED 3" CLEAR UNLESS SETAILED OTHERWISE.

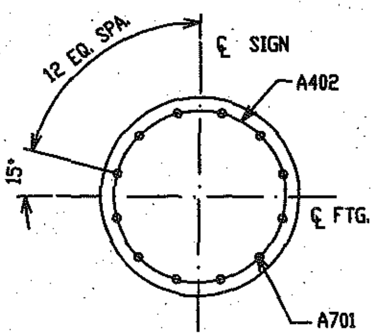
ALLOWABLE DESIGN STRESSES:
CONCRETE MASORY: F'c=3,500 PSI
HIGH STRENGTH BAR STEEL REINFORCEMENT:
GRADE 60: Fy=60,000 PSI
ANCHOR BOLS AASHTO M314: Fy=55,000 PSI

FOUNDATION DATA:
ALLOWABLE SOIL BEARING PRESSURE= 21/SQ.FT

TOTAL ESTIMATED QUANTITIES (1 FTG.)
CONCRETE MASONRY, SIGN SUPPORTS: 8 C.Y.
HIGH STRENGTH BAR STEEL REINFORCEMENT SIGN SUPPORTS: 980 LB.

REPRODUCED FROM WISCONSIN DOT DRAWINGS	TYPE	A-3
	PAGE	SHEET 3 OF 5

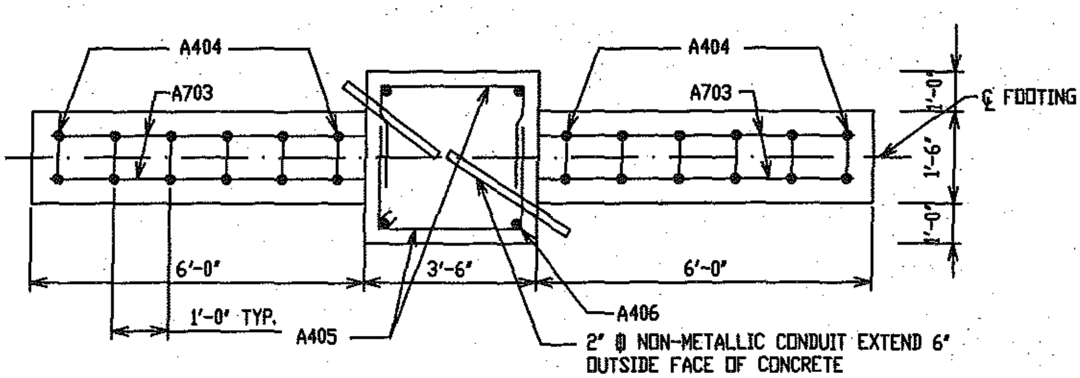




SECTION A

TRUSS FOOTING ELEVATION

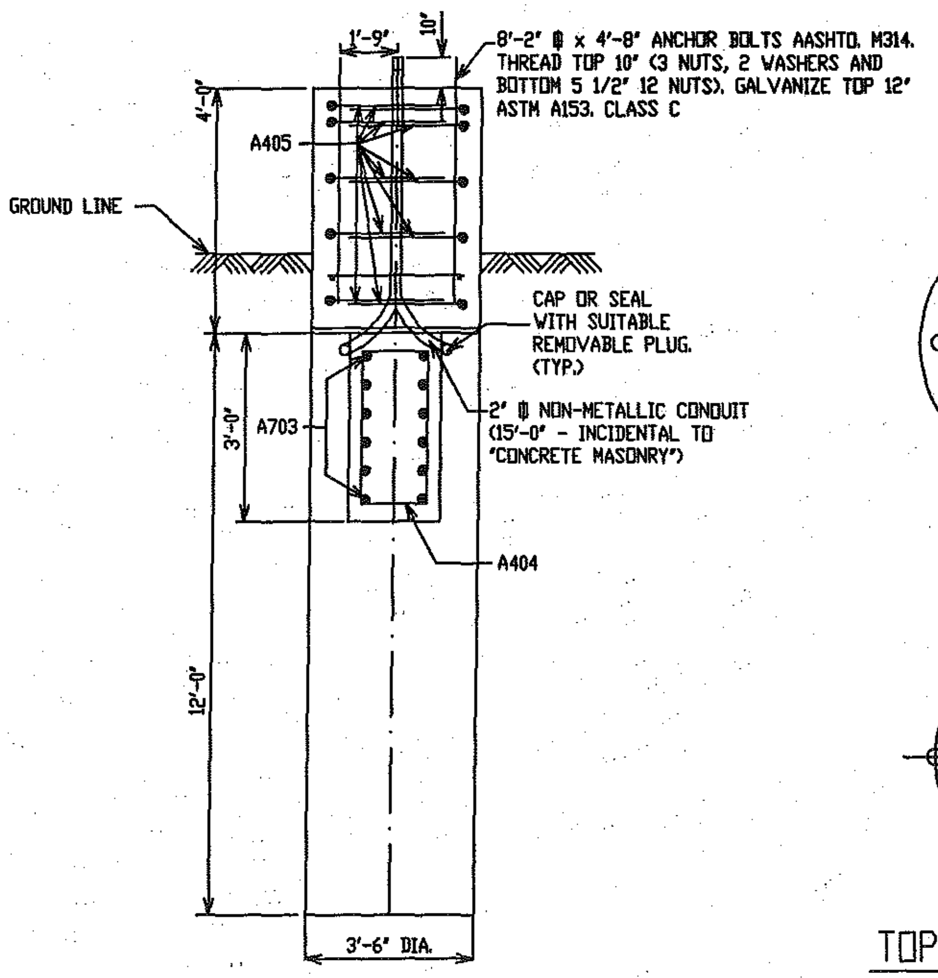
(B C.Y.)



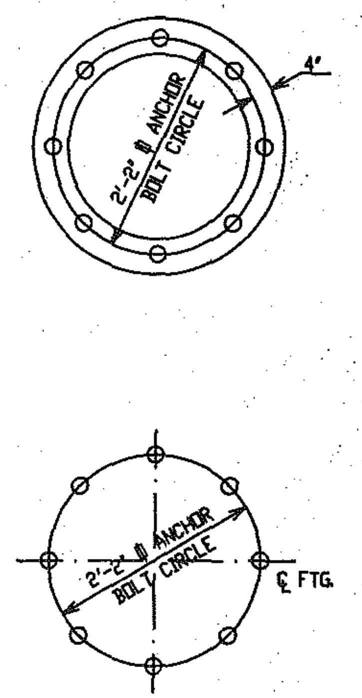
TRUSS FOOTING PLAN

NOTE:
ALL OTHER DETAILS SEE PAGE 5

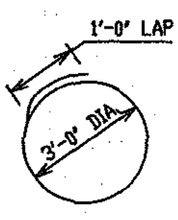
REPRODUCED FROM WISCONSIN DOT DRAWINGS	TYPE	A-3
	PAGE	SHEET 4 OF 5



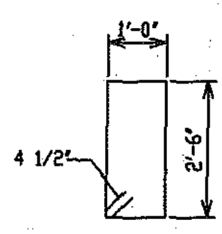
SECTION B



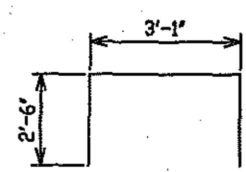
TOP VIEW OF TOP & BOTTOM TEMPLATES



A402



A404



A405

REPRODUCED FROM WISCONSIN DOT DRAWINGS	TYPE	A-3
	PAGE	SHEET 5 OF 5

SPAN SIGN STRUCTURE NOTES:

1) SIGN STRUCTURE MATERIALS SHALL BE AS FOLLOWS:
UPRIGHT & CHORDS (STEEL PIPE) -> API-5L-X42 (42 KSI YIELD) OR ASTM A500 GRADE B
WEBS AND SPLICES (STEEL ANGLES) -> ASTM A709 GRADE 36
STEEL PLATES -> ASTM A709 GRADE 36
WELD METAL -> E70XX
BOLTS (EXCEPT ANCHOR BLOTS & ALT. SPLICE BOLTS) -> ASTM A307 OR ASTM A325 TYPE I AS SPECIFIED ON S-2016 (SEE NOTE)
ANCHOR BOLTS -> ASTM F1554 GRADE 55
ALT. SPLICE BOLTS -> ASTM A325 TYPEI
NUTS FOR ANCHOR BOLTS -> ASTM A563 GRADE A HEAVY HEX

NOTE - ALL BOLTS (EXCEPT ANCHOR BOTLS) SHALL HAVE SINGLE SELF-LOCKING NUTS OR; IN LIEU THEREOF, REGULAR NUTS WITH A GALVANIZED 'PALNUT' LOCKING NUT MANUFACTURED BY TRW, INSTALLED IN ACCORDANCE WITH THE MANUACTURER'S RECOMMEDATAIONS. ANCHOR BOLTS SHALL HAVE DOUBLE NUTS.

2) REINFORCING STEEL SHALL BE ASTM A615-96A, GRADE 60.

3) CONCRETE SHALL BE CLASS IV (DRILLED SHAFT) WITH A MINIMUM 28-DAY COMPRESIVE STRENGTH OF 4 KSI FOR ALL ENVIRONMENTAL CLASSIFICATIONS.

4) GROUT SHALL HAVE A MINIMUM 28-DAY COMPRESSIVE STRENGTH OF 5 KSI AND SHALL MEET THE REQUIREMENTS OF SECTION 934.

5) ALL WELDING SHALL CONFORM TO AMERICAN WELDING SOCIETY STRUCTURAL WELDING CODE (STEEL) ANSI/AWS D1.1 (CURRENT EDITION).

6) ALL STEEL ITEMS SHALL BE GALVANIZED AS FOLLOWS:
ALL NUTS, BOLTS AND WASHERS -> ASTM A153 CLASS C OR D DEPENDS ON SIZE
ALL OTHER STEEL ITEMS -> ASTM A123

7) THE STRUCTURE MUST BE ASSEMBLED AFTER GALVANIZING AND PRIOR TO SHIPMENT TO THE SITE TO ASSURE FIT UP. IT MAY BE DISASSEMBLED FOR SHIPPING.

8) THE DESIGH WIND SPEED IS IN CONFORMANCE WITH THE 'PLANS PREPARATION MANUAL', (CURRENT EDITION).

9) ALTERNATE DESIGNS FOR THIS STRUCTURE ARE NOT ALLOWED.

10) SHOP DRAWINGS FOR THIS STRUCTURE ARE REQUIRED AND FABRICATION SHALL NOT BEGIN UNTIL THESE SHOP DRAWINGS ARE APPROVED. SHOP DRAWINGS SHALL INCLUDE THE CONTRACTOR'S FIELD VERIFICATION OF ALL UPRIGHT HEIGHTS AND FOUNDATION ELEVATIONS NECESSARY TO INSURE MINIMUM VERTICAL CLEARANCES AS PER TRAFFIC PLANS. SHOP DRAWINGS SHALL ALSO INCLUDE ANCHOR BOLT ORIENTATION WITH RESPECT TO C TRUSS AND THE DIRECTION OF TRAFFIC.

11) THE FOUNDATION FOR THE SIGN STRUCTURE SHALL BE CONSTRUCTED IN ACCORDANCE WITH SECTION 455 OF THE SPECIFICATIONS EXCEPT THAT NO PAYMENT FOR THE FOUNDATION SHALL BE MADE UNDER SECTION 455. THE COST OF PROVIDING THE FOUNDATION SHALL BE INCLUDED IN THE PAY ITEM FOR PROVIDING THE COMPLETE SIGN STRUCTURE. PAYMENT FOR ANY INCIDENTAL ITEMS INCURRED IN FURNISHING AND INSTALLING THIS SIGN STURCTURE SHALL BE INCLUDED IN THE PAY ITEM FOR PROVIDING THE COMPLETE SIGN STRUCTURE.

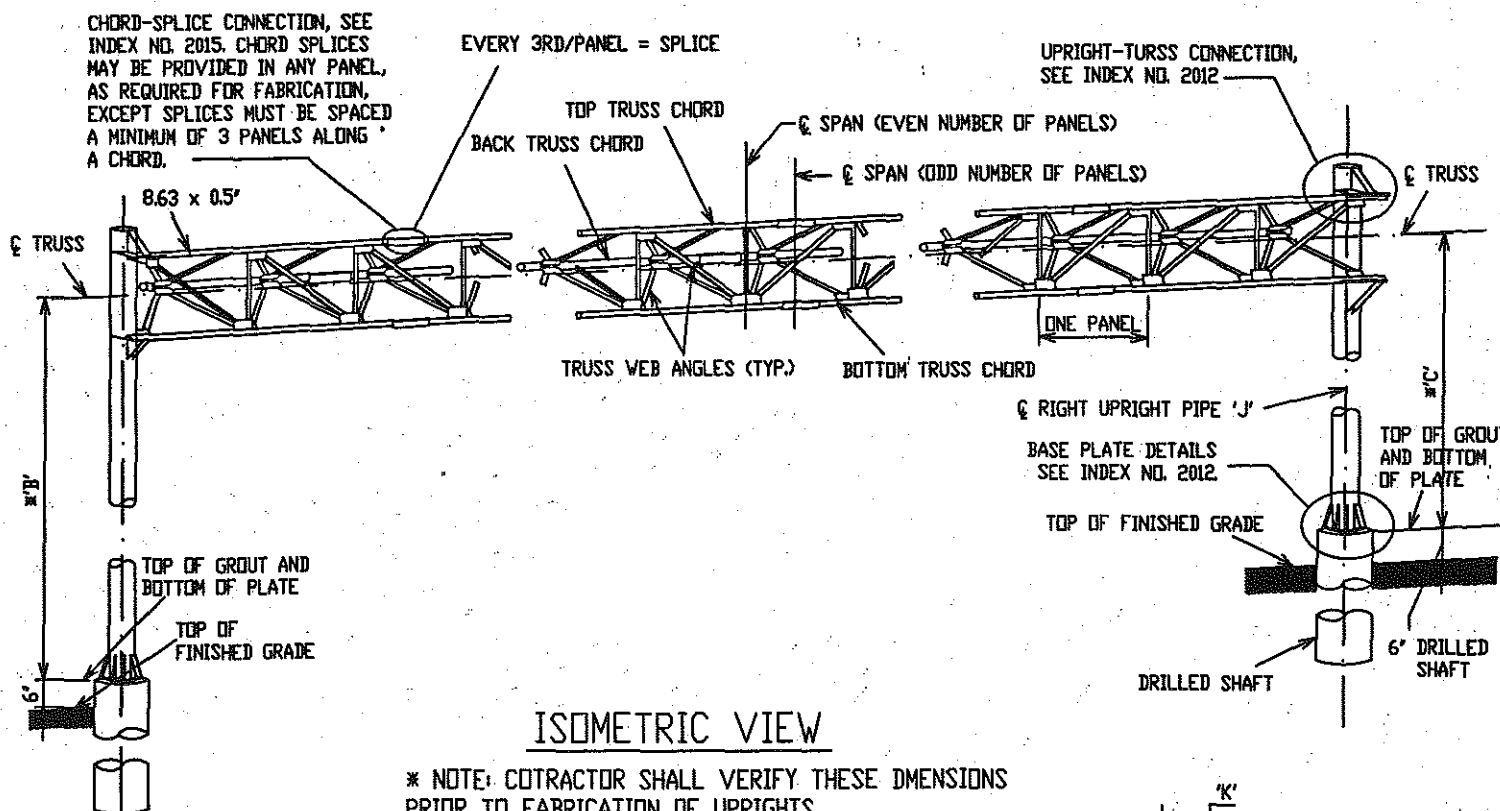
12) EXCEPT FOR ANCHOR BOLTS, ALL BOLT HOLE DIAMETERS SHALL BE EQUAL TO THE BOLT DIAMETER PLUS 1/16", PRIOR TO GALVANIZING. HOLE DIAMETERS FOR ANCHOR BOLTS SHALL NOT EXCEED THE BOLT DIAMETER PLUS 1/2"

13) SEE ELEVATION DRAWING FOR SIZE AND LOCATION OF SIGN PANELS. SIGN PANELS SHALL BE ALUMINUM.

14) PROVIDE A PARABOLIC CAMBER WITH THE MAXIMUM UPWARD DEFLECTION AS CALLED FOR ON THE CAMBER DIAGRAM. INDICATE ON THE SHOP DRAWINGS THE METHOD TO BE USED TO PROVIDE REQUIRED CAMBER. MEMBER DIMENSIONS MAY BE ALTERED SLIGHTLY TO PROVIDE CAMBER.

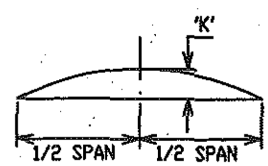
15) CHORD SPLICES ARE EITHER THE STANDARD SPLICE OR THE ALTERNATE SPLICE. SPLICE TYPES SHALL NOT BE MIXED ON A STRUCTURE.

16) PRIOR TO ERECTION, THE AS BUILT LOCATION OF THE ANCHOR BOLTS SHALL BE SURVEYED AND THIS INFORMATION REPORTED TO THE ENGINEER.

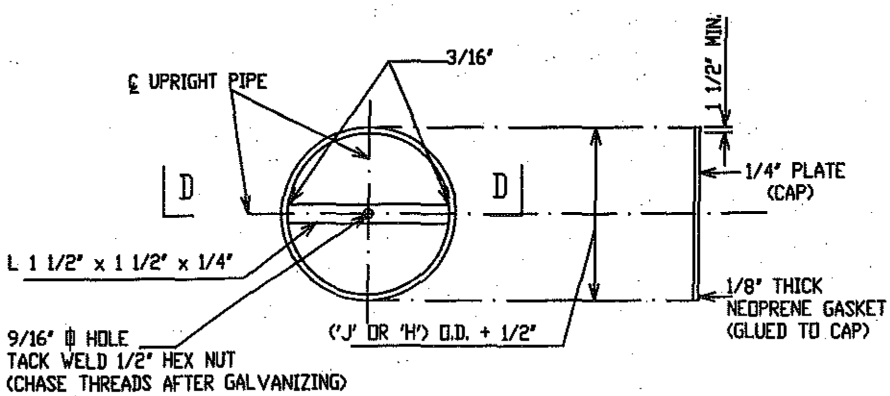


ISOMETRIC VIEW

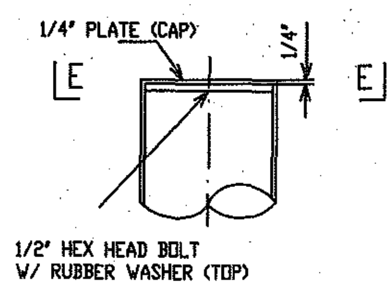
* NOTE: COTRACTOR SHALL VERIFY THESE DMENSIONS PRIOR TO FABRICATION OF UPRIGHTS.



CAMBER DIAGRAM

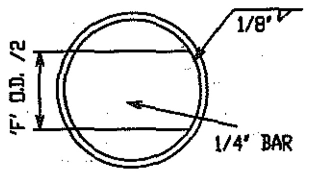


SECTION E-E SECTION D-D



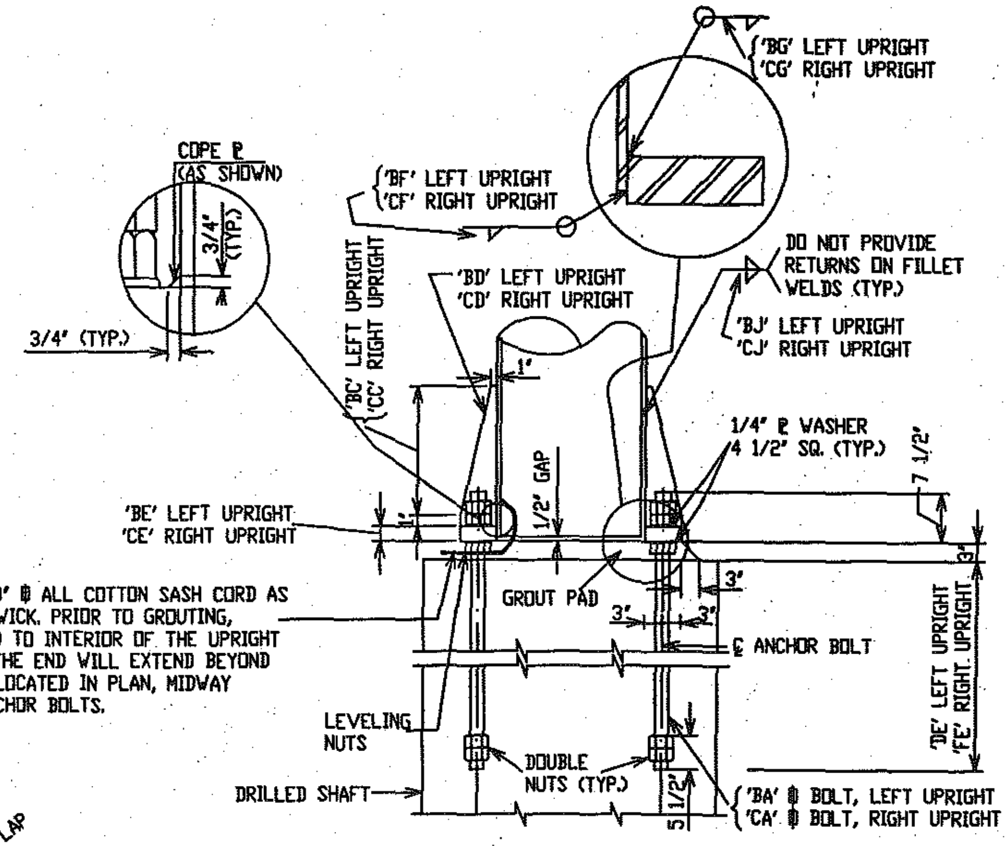
UPRIGHT CAP DETAIL

REPRODUCED FROM FLORIDA DOT DRAWINGS	TYPE	B-1
	PAGE	SHEET 2 OF 7

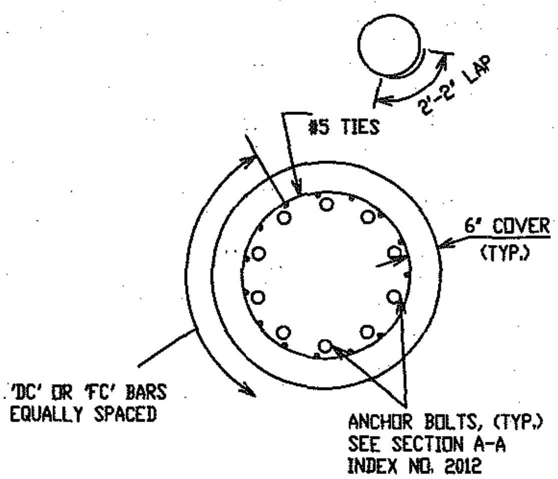


PLUG DETAIL

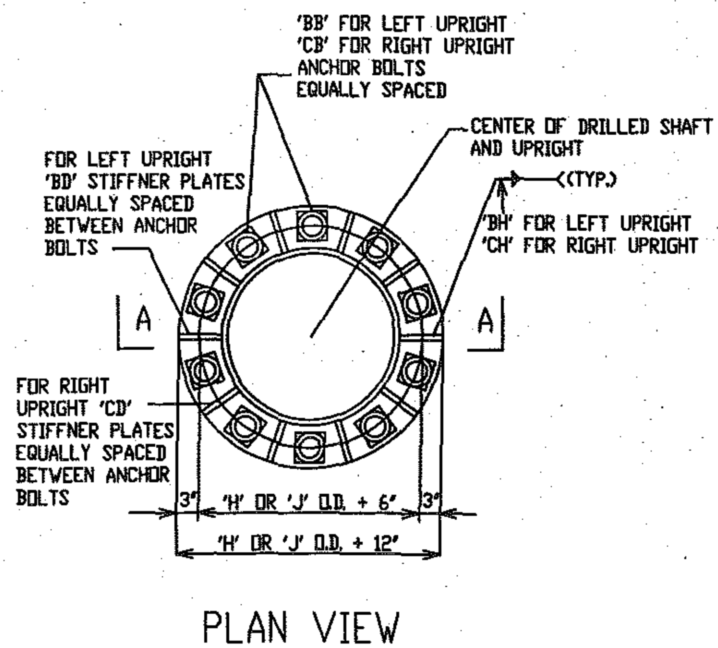
(EACH END OF BACK TRUSS CHORD)



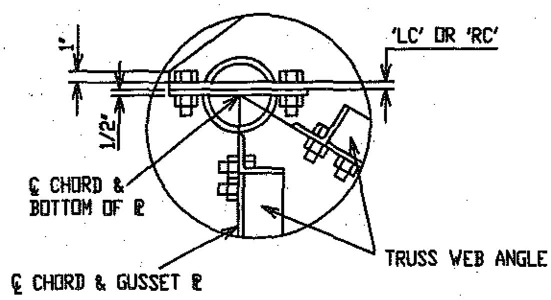
SECTION A-A



PLAN VIEW
DRILLED SHAFT

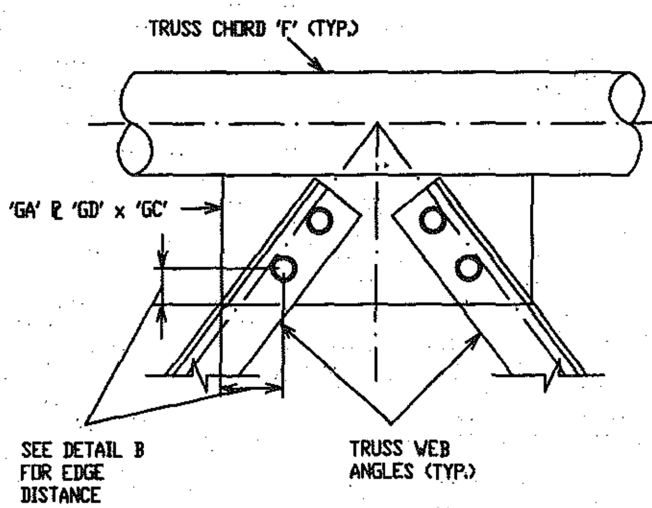


PLAN VIEW
BASE PLATE

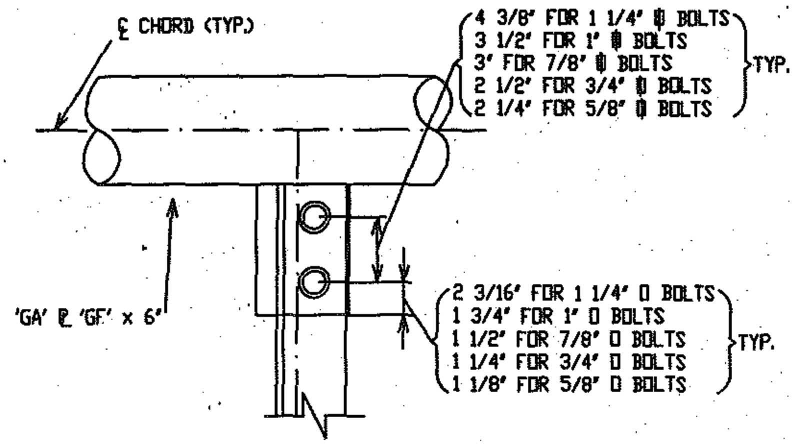


DETAIL D

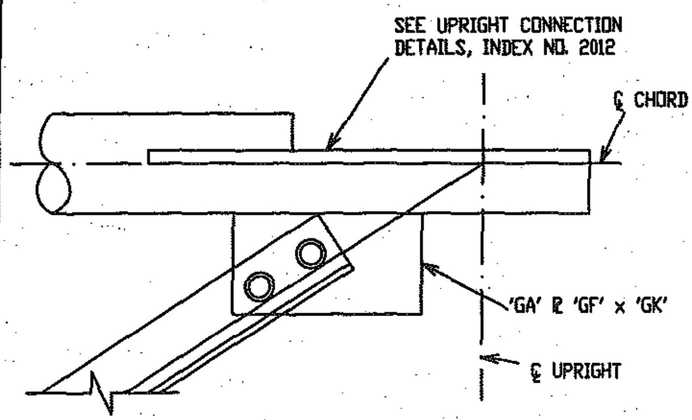
REPRODUCED FROM FLORIDA DOT DRAWINGS	TYPE	B-1
	PAGE	SHEET 3 OF 7



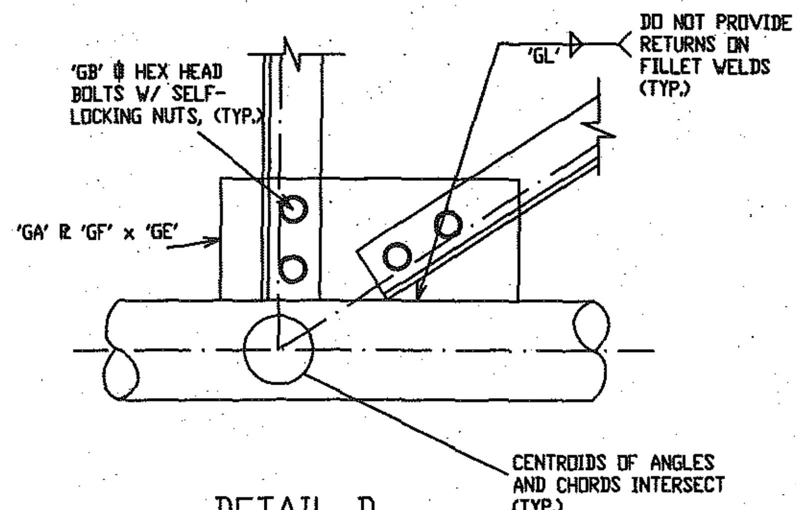
DETAIL A



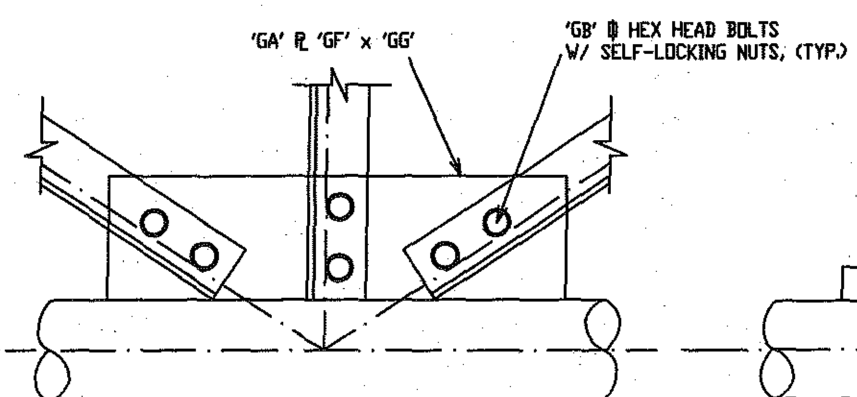
DETAIL B



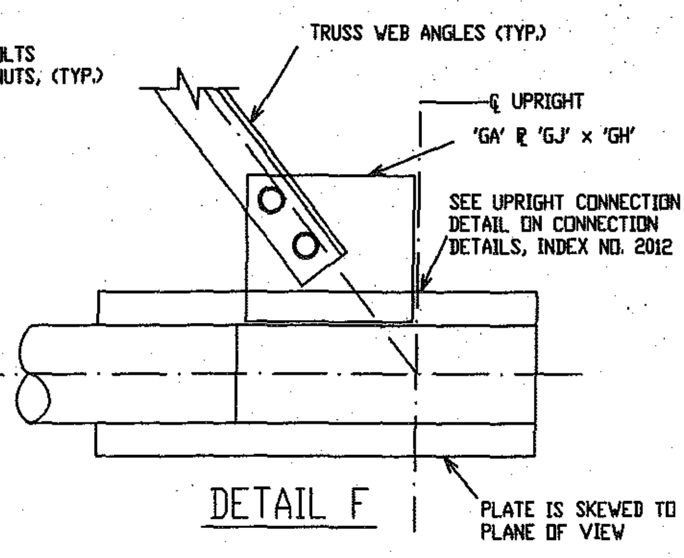
DETAIL C



DETAIL D

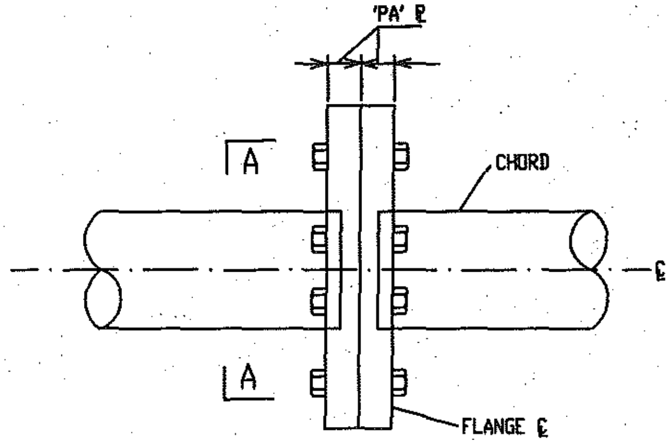


DETAIL E



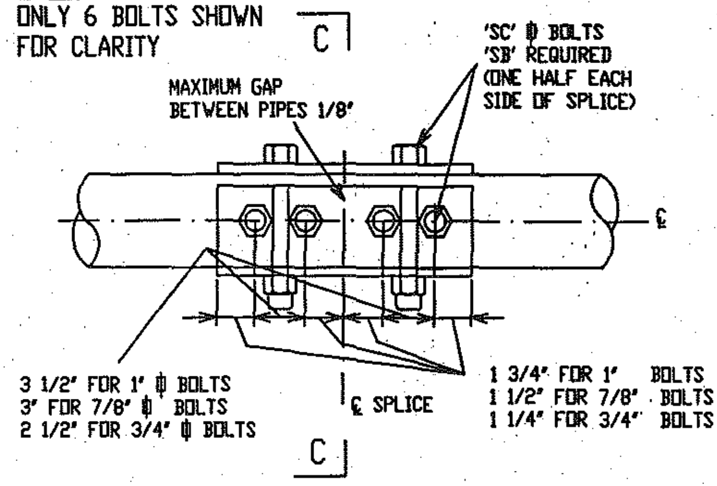
DETAIL F

REPRODUCED FROM FLORIDA DOT DRAWINGS	TYPE	B-1
	PAGE	SHEET 4 OF 7

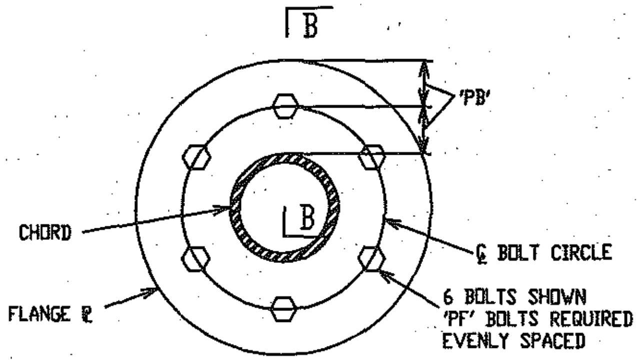


ELEVATION ALTERNATE SPLICE CONNECTION

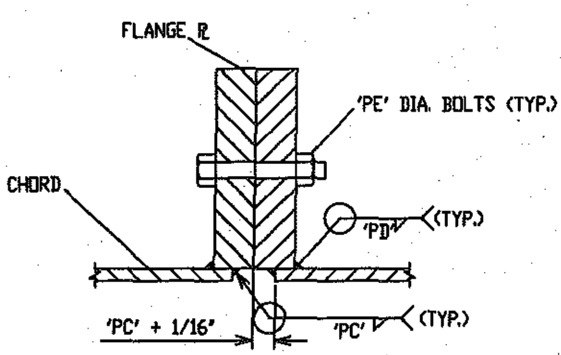
NOTE:
ONLY 6 BOLTS SHOWN FOR CLARITY



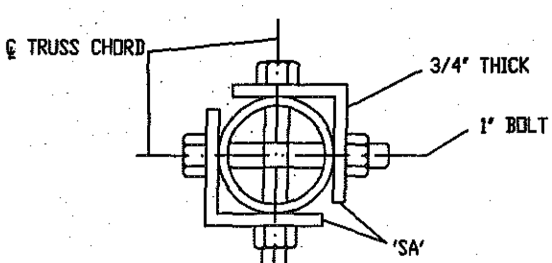
ELEVATION SPLICE CONNECTION



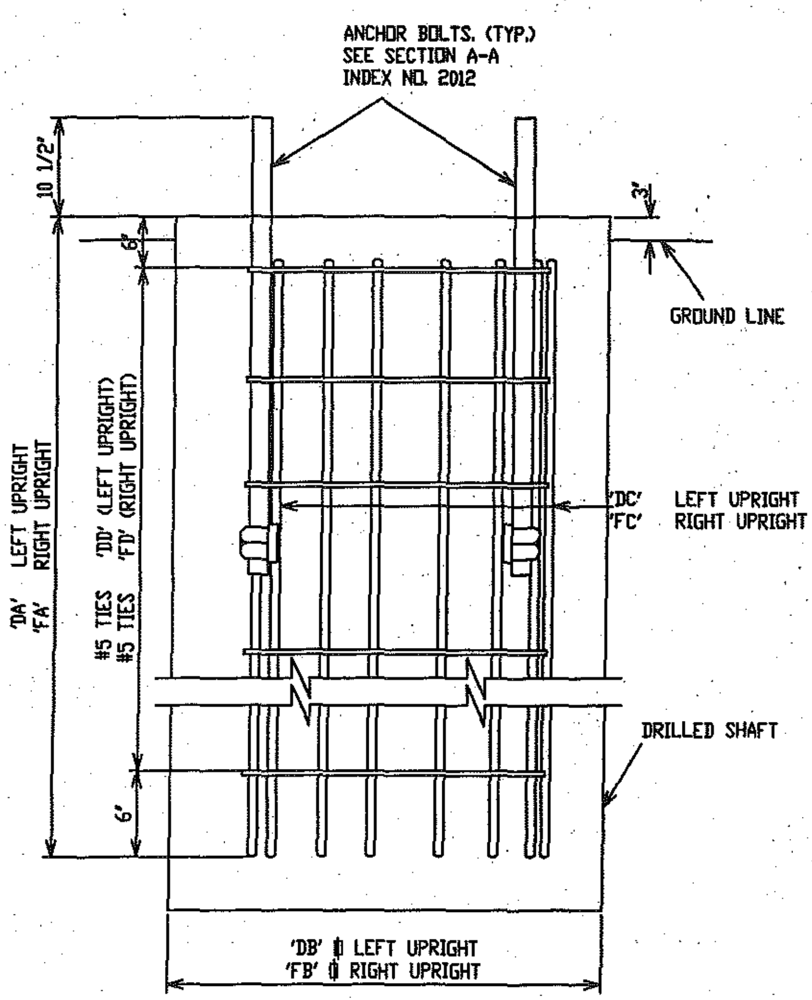
SECTION A-A



SECTION B-B

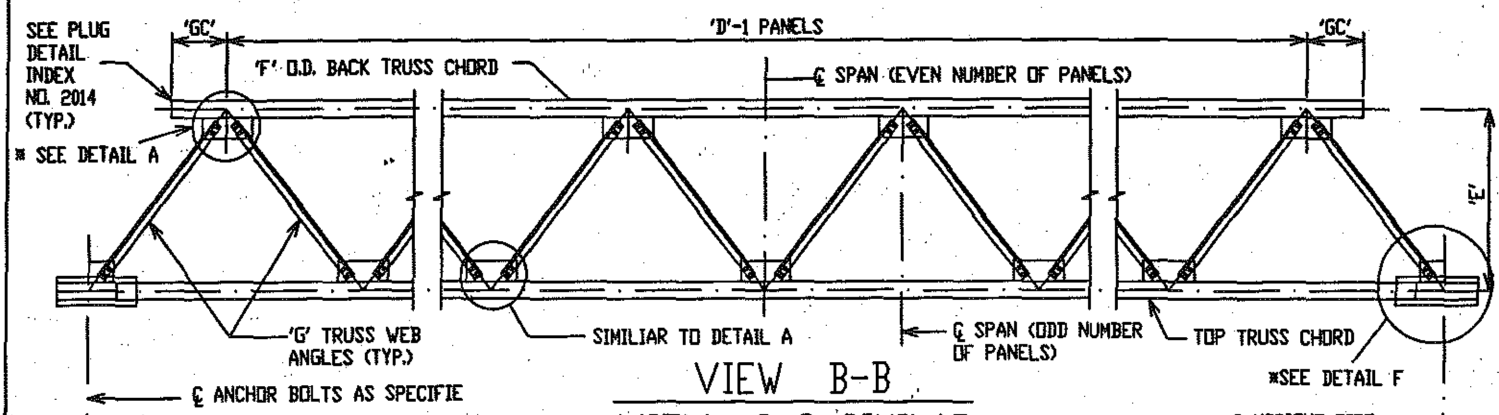


SECTION C-C



ELEVATION DRILLED SHAFT

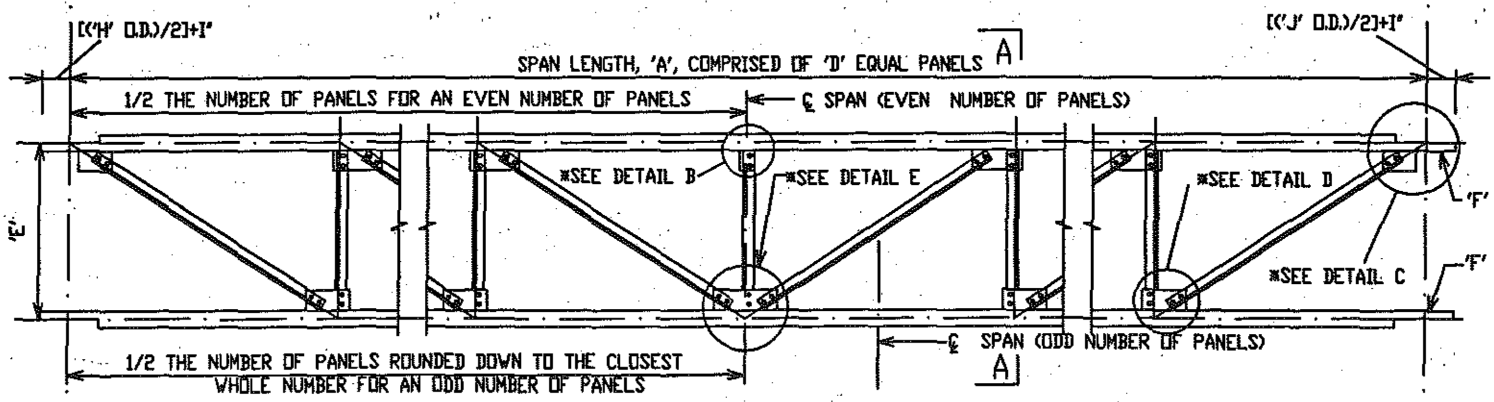
REPRODUCED FROM FLORIDA DOT DRAWINGS	TYPE	B-1
	PAGE	SHEET 5 OF 7



VIEW B-B

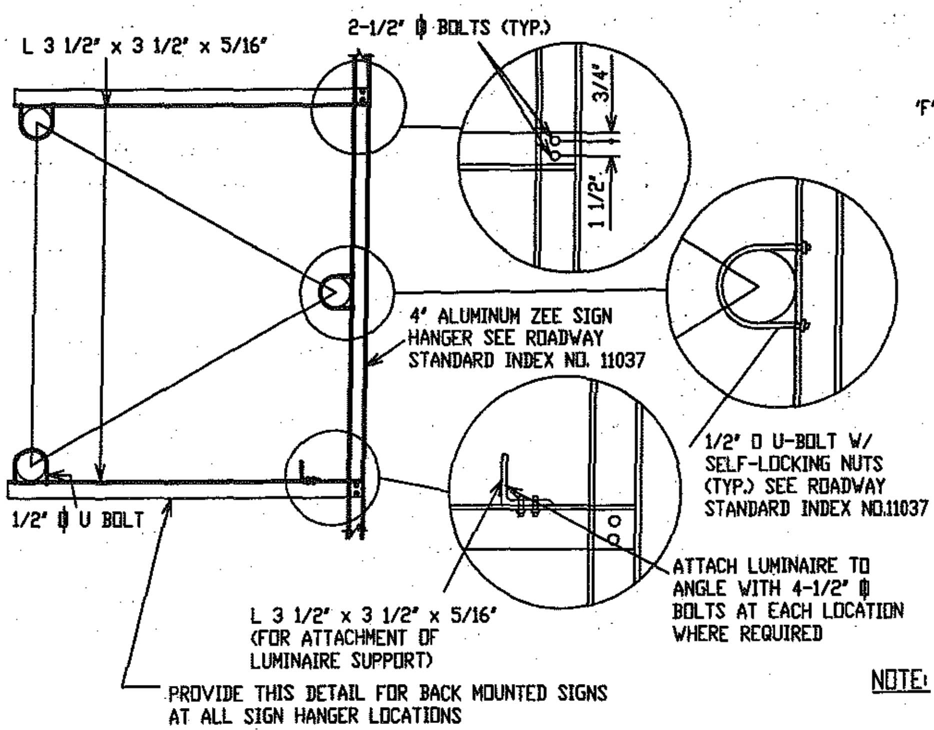
VIEW C-C SIMILAR

(OUT-OF- PLANE MEMBERS NOT SHOWN FOR CLARITY)

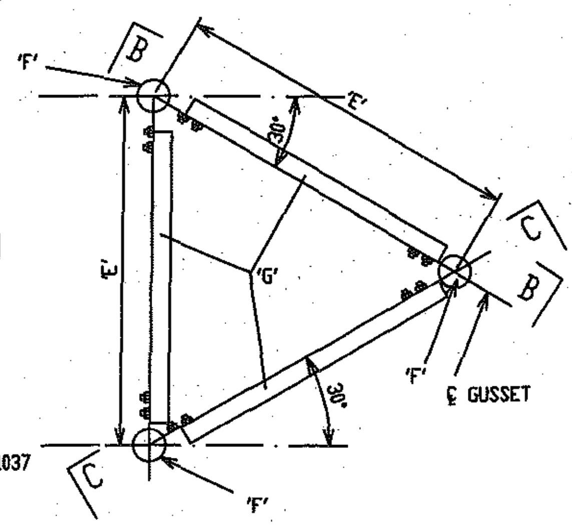


FRONT OF TRUSS ELEVATION

(BACK TRUSS CHORD AND ATTACHED ANGLES NOT SHOWN FOR CLARITY)



BACK-SIDE SIGN MOUNTING DETAIL

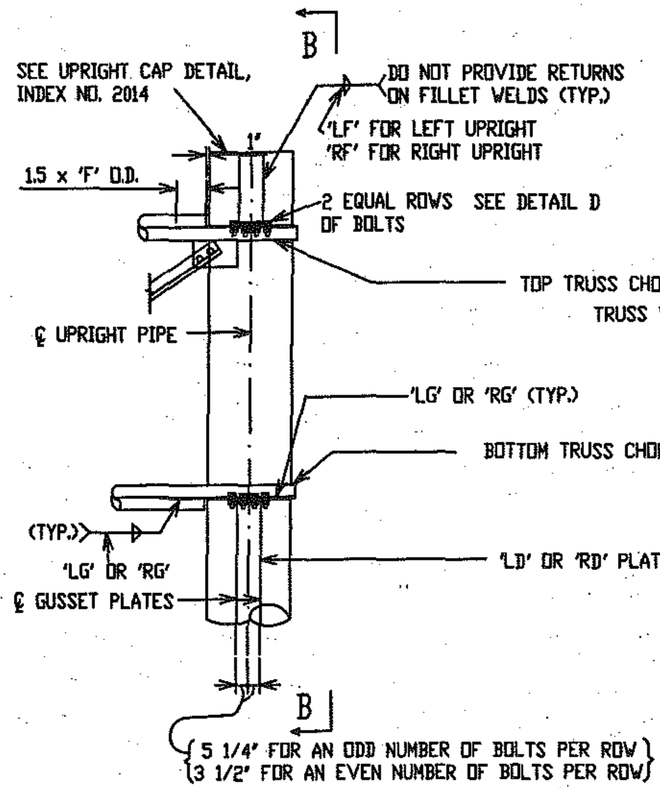


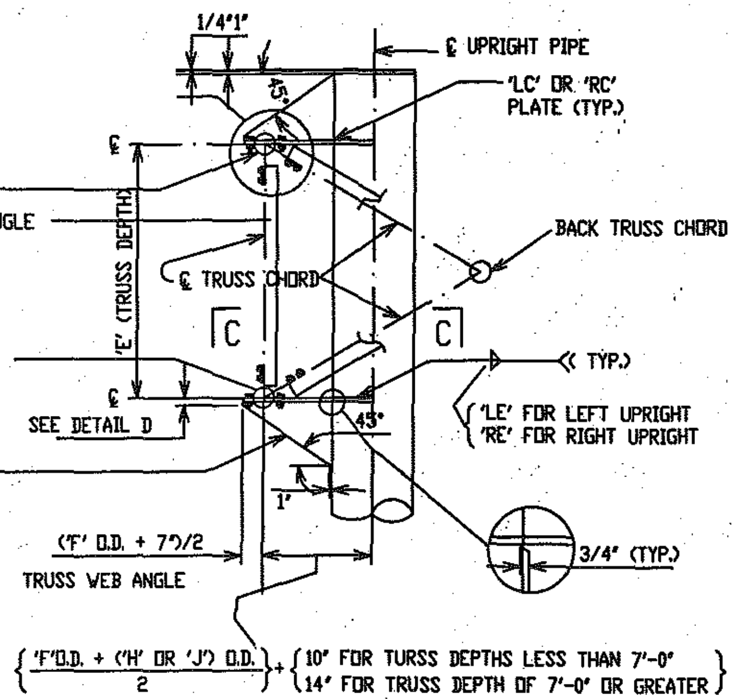
SECTION A-A

NOTE:

FRONT-SIDE MOUNTED SIGN DETAILS ARE SHOWN ON ROADWAY STANDARD INDEX NO.11037.

REPRODUCED FROM FLORIDA DOT DRAWINGS	TYPE	B-1
	PAGE	SHEET 6 OF 7

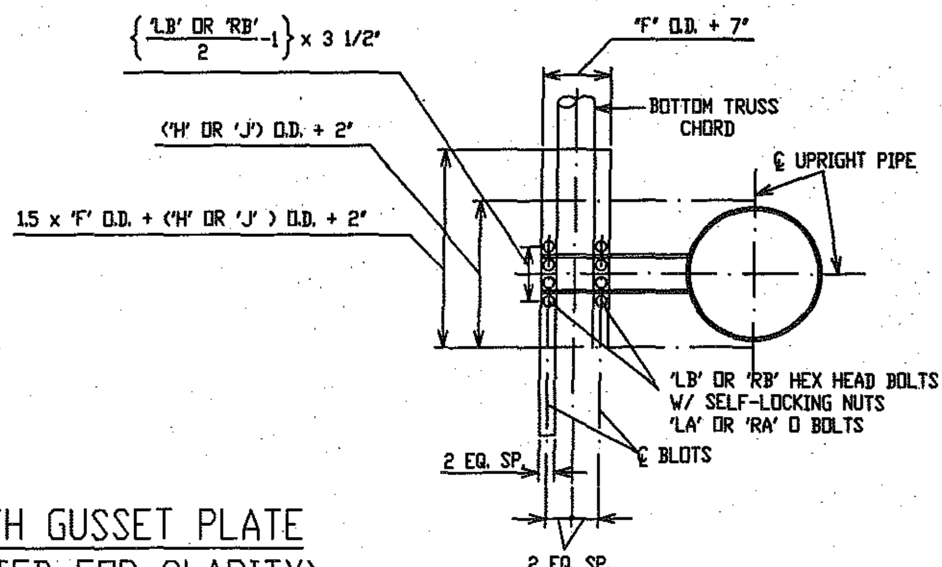




RIGHT UPRIGHT-TRUSS CONNECTION DETAIL (LEFT UPRIGHT-TRUSS CONNECTION SIMILAR)

(WEB MEMBERS FROM BACK TRUSS CHORD OMITTED FOR CLARITY)

VIEW B-B



SECTION C-C (WITH GUSSET PLATE AND ANGLES OMITTED FOR CLARITY)

REPRODUCED FROM FLORIDA DOT DRAWINGS	TYPE	B-1
	PAGE	SHEET 7 OF 7

TABLE 2 - TRUSS TYPE SELECTION
SIMPLE SPAN STRUCTURE WIH CONVENTIONAL SIGNS

SIGN AREA (SQ. FT.)	SPAN LENGTH (FEET)																							
	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	146
1000											B	C	C	C	C	C	C	C	C	NA	NA	NA	NA	NA
900										B	B	C	C	C	C	C	C	C	C	NA	NA	NA	NA	NA
800								A	B	B	B	C	C	C	C	C	C	C	C	NA	NA	NA	NA	NA
700							A	A	A	B	B	B	C	C	C	C	C	C	C	C	NA	NA	NA	NA
600					A	A	A	A	A	B	B	B	B	C	C	C	C	C	C	C	C	NA	NA	NA
500				A	A	A	A	A	A	A	B	B	B	B	C	C	C	C	C	C	C	C	C	NA
400		A	A	A	A	A	A	A	A	A	A	A	B	B	B	B	C	C	C	C	C	C	C	C
300	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	B	B	B	C	C	C	C	C	C
200	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	B	B	B	B	C	C	C
100	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	B	B	B	B	B	B	C

'A' INDICATES TRUSS TYPE A. 'B' INDICATES TRUSS TYPE B.
'C' INDICATES TRUSS TYPE C. 'NA' NOT ALLOWED.
SEE DRAWINGS ST-5 THROUGH ST-7 FOR TRUSS DETAILS.

TABLE 7 - POST SELECTION - SIMPLE SPAN SIGN STRUCTURE

SIGN AREA (SQ. FT.)	POST HT. (FT.)	SPAN LENGTH (FEET)																						
		30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	146
1000	16											3	3	3	4	4	4	4	4	4					
	24											6	6	6	5	5	5	7	7	7					
	26											5	5	5	5	5	7	7	7	7					
	28											5	5	5	7	7	7	7	7	7					
	30											7	7	7	7	7	7	7	7	7					
900	16										2	2	3	3	3	4	4	4	4	4					
	24										6	6	6	6	6	5	5	5	5	5					
	26										6	6	6	5	5	5	5	7	7	7					
	28										6	5	5	5	5	7	7	7	7	7					
	30										5	5	5	7	7	7	7	7	7	7					
800	16								2	2	2	2	3	3	3	3	4	4	4	4					
	24								4	4	4	6	6	6	6	6	5	5	5	5					
	26								4	6	6	6	6	6	5	5	5	5	7	7					
	28								5	6	6	6	5	5	5	5	7	7	7	7					
	30								5	6	6	5	5	5	7	7	7	7	7	7					
700	16							1	1	2	2	2	2	3	3	3	3	4	4	4	4				
	24							3	4	4	4	4	6	6	6	6	6	6	5	5	5				
	26							4	4	4	6	6	6	6	6	5	5	5	5	5	5				
	28							4	4	5	6	6	6	5	5	5	5	5	7	7	7				
	30							5	5	5	6	5	5	5	5	7	7	7	7	7	7				
600	16					1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	3	3			
	24					3	3	3	3	4	4	4	4	6	6	6	6	6	6	6	6	5			
	26					3	3	4	4	4	4	6	6	6	6	6	6	5	5	5	5	5			
	28					4	4	4	4	5	6	6	6	6	5	5	5	5	5	5	5	7			
	30					4	4	4	5	5	6	6	6	5	5	5	5	7	7	7	7	7			

REPRODUCED FROM MINNESOTA DOT DRAWINGS

TYPE	B-2
PAGE	SHEET 1 OF 13

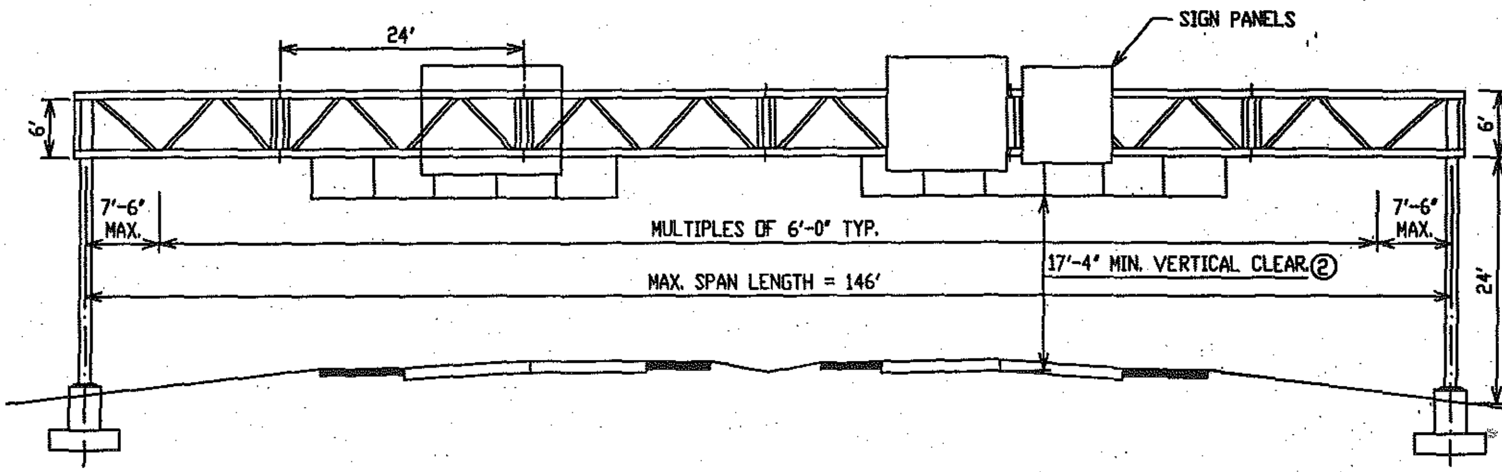
TABLE 7 - POST SELECTION - SIMPLE SPAN SIGN STRUCTURE (CONTINUE)																									
SIGN AREA (SQ. FT.)	POST HT. (FT.)	SPAN LENGTH (FEET)																							
		30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	146
500	16				1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	3	
	24				2	2	2	3	3	3	3	4	4	4	4	4	6	6	6	6	6	6	6	6	
	26				2	2	3	3	3	4	4	4	4	4	6	6	6	6	6	6	6	6	5	5	
	28				3	3	3	4	4	4	4	6	6	6	6	6	6	6	5	5	5	5	5	5	
	30				3	4	4	4	4	4	5	6	6	6	6	5	5	5	5	5	5	5	7	7	
400	16		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
	24		1	1	1	2	2	2	2	3	3	3	3	3	4	4	4	4	4	4	4	6	6	6	6
	26		1	1	2	2	2	3	3	3	3	3	4	4	4	4	4	6	6	6	6	6	6	6	6
	28		1	2	2	2	3	3	3	4	4	4	4	4	4	6	6	6	6	6	6	6	6	6	5
	30		2	2	2	3	3	3	4	4	4	4	4	6	6	6	6	6	6	6	5	5	5	5	5
300	16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2
	24	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	4	4	4	4	4	4
	26	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	4	6
	28	1	1	1	1	2	2	2	2	3	3	3	3	3	4	4	4	4	4	4	6	6	6	6	6
	30	1	1	1	2	2	2	3	3	3	3	3	4	4	4	4	4	4	4	6	6	6	6	6	6
200	16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
	24	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3
	26	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	4	4	4
	28	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4
	30	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4	6
100	16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	24	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
	26	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	3
	28	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3
	30	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	4

TYPE A TRUSS | TYPE B TRUSS | TYPE C TRUSS

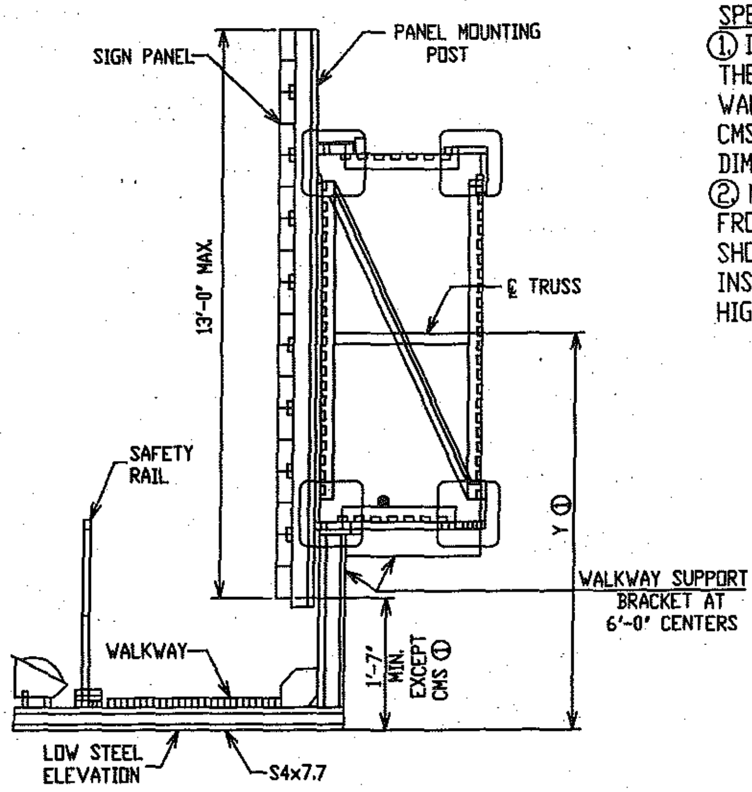
GENERAL NOTE:

DESIGN SPECIFICATIONS:
TRUSS, POST, & HARDWARE:
AASHTO STANDARD SPECIFICATIONS FOR STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES AND TAFFIC SIGNALS DATED 1999.
LOADING:
WIND LOAD 90 M.P.H. NORMAL TO SIGN FACE IN COMBINATION WITH OTHER LOADS OUTLINED IN THE DESIGN SPECIFICATIONS.
UNIT STRESSES:
CONCRETE ------------------------------ Fc= 1,600 PSI
REINFORCEMENT STEEL-------------------- Fs= 24,000 PSI
FOOTING SOIL PRESSURE----------------- 1-1/4 TONS PER SQ.FT.
MATERIALS:
STRUCTURAL STEEL (EXCEPT POST, TUBES)- Mn/DOT 3306
POST STEEL------------------------------ VARIES
HIGH STRENGTH BOLTS-------------------- Mn/DOT 3391.2B
ANCHOR RODS----------------------------- Mn/DOT 3385
CASTINGS-------------------------------- Mn/DOT 3322
REINFORCEMENT
BARS-------------------------------- Mn/DOT 3301
SPIRAL------------------------------ Mn/DOT 3305 NO SPLICES
WALKWAY GRATING--------------------- FEDERAL SPECIFICATIONS RR-G-661b, TYPE 1, STEEL
CONCRETE---------------------------- Mn/DOT 2461 (MIX 3Y43)
FINISH:
ALL COMPONENTS SHALL BE GALVANIZED AFTER FABRICATION EXCEPT REINFORCEMENT BARS, LOWER PORTION OF ANCHOR RODS, ALUMINUM, AND OTHER NON FERROUS INCIDENTALS. GALVANIZING SHALL CONFORM TO Mn/DOT 3392 OR Mn/DOT 3394 AS APPLICABLE. BEARING SURFACES MUST BE SMOOTH.
FABRICATION:
FABRICATION OF STRUCTURAL METALS SHALL BE IN ACCORDANCE WITH Mn/DOT 2471, Mn/DOT 2564 AND THE APPLICABLE SPECIAL PROVISIONS. ALL WELDING TO BE CONTINUOUS. ALL CONTACT SURFACES MUST BE COMPLETELY SEALED.
INSPECTION:
INSPECTION BEFORE AND AFTER GALVANIZING PER Mn/DOT 1511 AND Mn/DOT 2471.

REPRODUCED FROM MINNESOTA DOT DRAWINGS	TYPE	B-2
	PAGE	SHEET 2 OF 13



SIMPLE SPAN



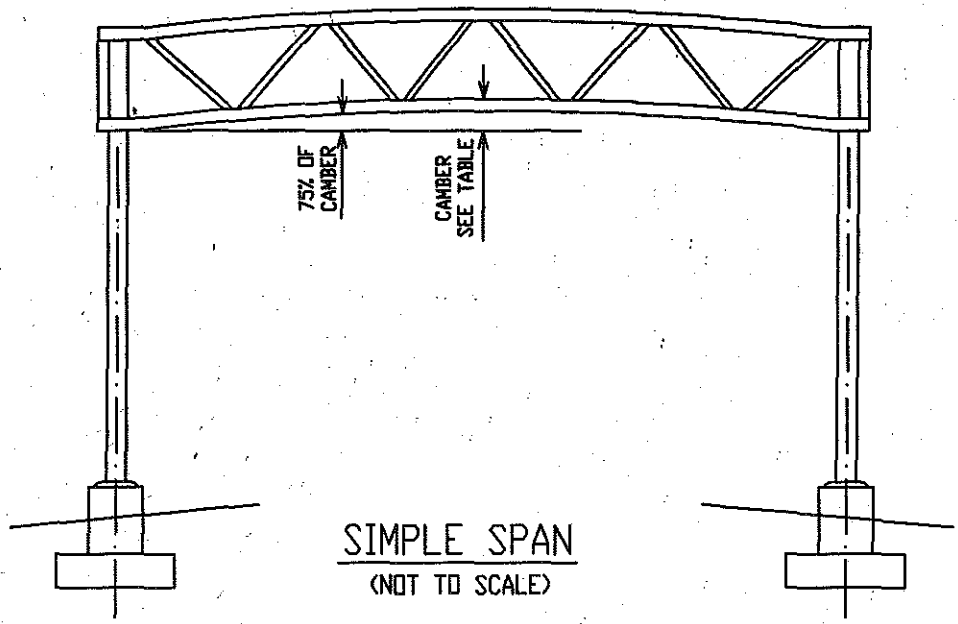
SECTION

SPECIFIC NOTES:

① DIMENSION Y IS CONSTANT AND BASED ON THE DEEPEST SIGN PANEL ABOVE THAT WALKWAY. WHEN STANDARD SIGN PANEL(S) AND CMS ARE MOUNTED ON THE SAME SPAN, DIMENSION Y SHALL BE GOVERNED BY THE CMS.

② MINIMUM CLEARANCE WILL BE MEASURED FROM THE HIGHEST ELEVATION OF PAVEMENT, SHOULDERS, AND MOUNTABLE CURBS, OR IF INSURMOUNTABLE CURBS ARE USED, THE HIGHEST ELEVATION BETWEEN CURB LINES.

REPRODUCED FROM MINNESOTA DOT DRAWINGS	TYPE	B-2
	PAGE	SHEET 3 OF 13



SIMPLE SPAN
(NOT TO SCALE)

TABLE 1 - POST IDENTIFICATION					
POST IDENTIFICATION NUMBER	BASEPLATE DESIGN	PERMISSIBLE PIPE SECTIONS			
		MIN. YIELD=35 KSI		MIN. YIELD=42 KSI	
		OUTSIDE DIAMETER (INCH)	WALL THICKNESS (INCH)	OUTSIDE DIAMETER (INCH)	WALL THICKNESS (INCH)
6	B	20	0.594	20	0.500
7	B	N.A.	N.A.	20	0.812
WALL THICKNESS IS MINIMUM, THINNER WALLS WILL NOT BE APPROVED					

	SPAN	CAMBER	DL DEF-LECTON	RESIDUAL CAMERA
SIMPLE SPAN TRUS CAMBER	40	1/4	0	1/4
	50	7/16	1/16	3/8
	60	5/8	1/16	9/16
	70	13/16	1/8	11/16
	80	1 1/16	1/4	13/16
	90	1 3/8	3/8	1
	100	1 11/16	9/16	1 1/8
	110	2	13/16	1 3/16
	120	2 3/8	1 1/8	1 1/4
	130	2 13/16	1 1/2	1 5/16
	140	3 1/4	2 1/16	1 3/16
	150	3 3/4	2 11/16	1 1/16

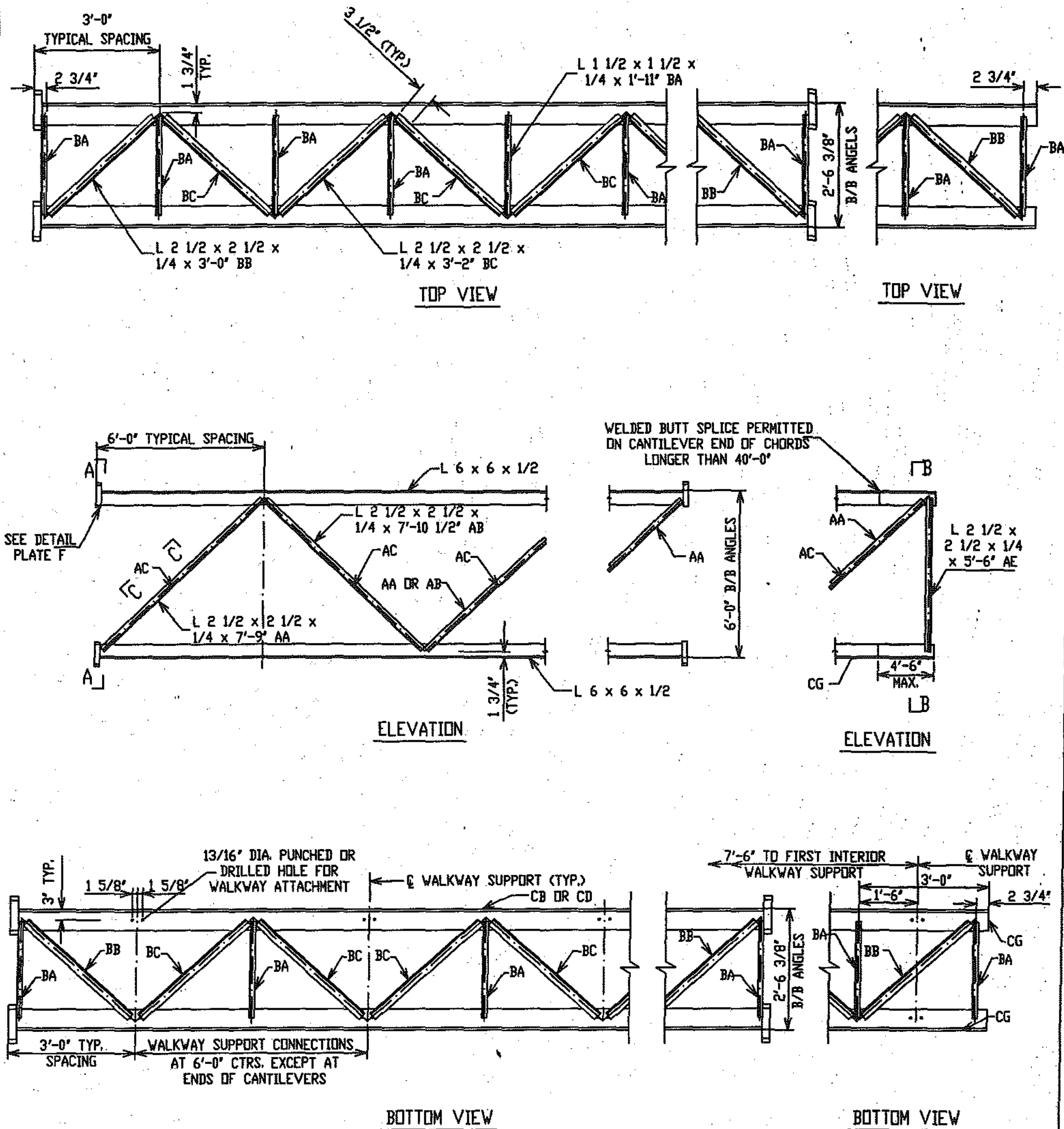
POST IDENTIFICATION NOTES:

*POST MATERIAL SHALL CONFORM TO ONE OF THE FOLLOWING SPECIFICATIONS:
ASTM A709, GRADE 36
ASTM A53, GRADE B
API 5L, GRADES B, x42, x46, x52, x56, x60, x65
*CONTRACTOR SHALL DEMONSTRATE THAT THE POST MATERIAL MEETS THE REQUIREMENTS OF ONE OF THE ABOVE CITED SPECIFICATIONS AND THE MINIMUM YIELD STRENGTH.
*NO SPLICES OF ANY KIND WILL BE PERMITTED IN POSTS INTENDED FOR USE IN CANTILEVER TYPE STRUCTURES (BRIDGE TYPE BC).
*ONE OF TWO POSTS FOR SIMPLE SPAN STRUCTURES (BRIDGE TYPE S)MAY INCORPORATE ONE WELDED CIRCUMFERENTIAL BUTT SPLICE CONFORMING TO AWS D1.1 DETAIL B-U2 IN THE UPPER 1/3 OF ITS LENGTH. BACK UP RINGS FOR THESE WELDED SPLICES SHALL BE COMMERCIAL PRODUCTS. BUTT WELDS REQUIRE RADIOGRAPHIC INSPECTION (Mn/DOT 2471.3)
*ALL RADIOGRAPHIC INSPECTIONS AND MAGNETIC PARTICLE TESTING REPORTS AND RADIOGRAPHIC FILMS SHALL BECOME THE PROPERTY OF THE DEPARTMENT.
SEE DRAWING ST-4 FOR BASEPLATE DETAILS.

NOTE:
CAMBER AND DEFLECTIONS SHOWN ARE AT ℄ SPAN. THE DEFLECTIONS AND CAMBER AT THE QUARTER POINTS SHALL BE APPROXIMATELY 75% OF THESE VALUES.

WALKWAY WEIGHTS:
1. USE 3'-4 3/4" WIDE GRATING @ 44 LBS/FT.
2. WEIGHT INCLUDES HANDRAIL (12 LBS/FT.) AND FIXTURE MOUNTING CHANNELS (4 LBS/FT.).

REPRODUCED FROM MINNESOTA DOT DRAWINGS	TYPE	B-2
	PAGE	SHEET 4 OF 13



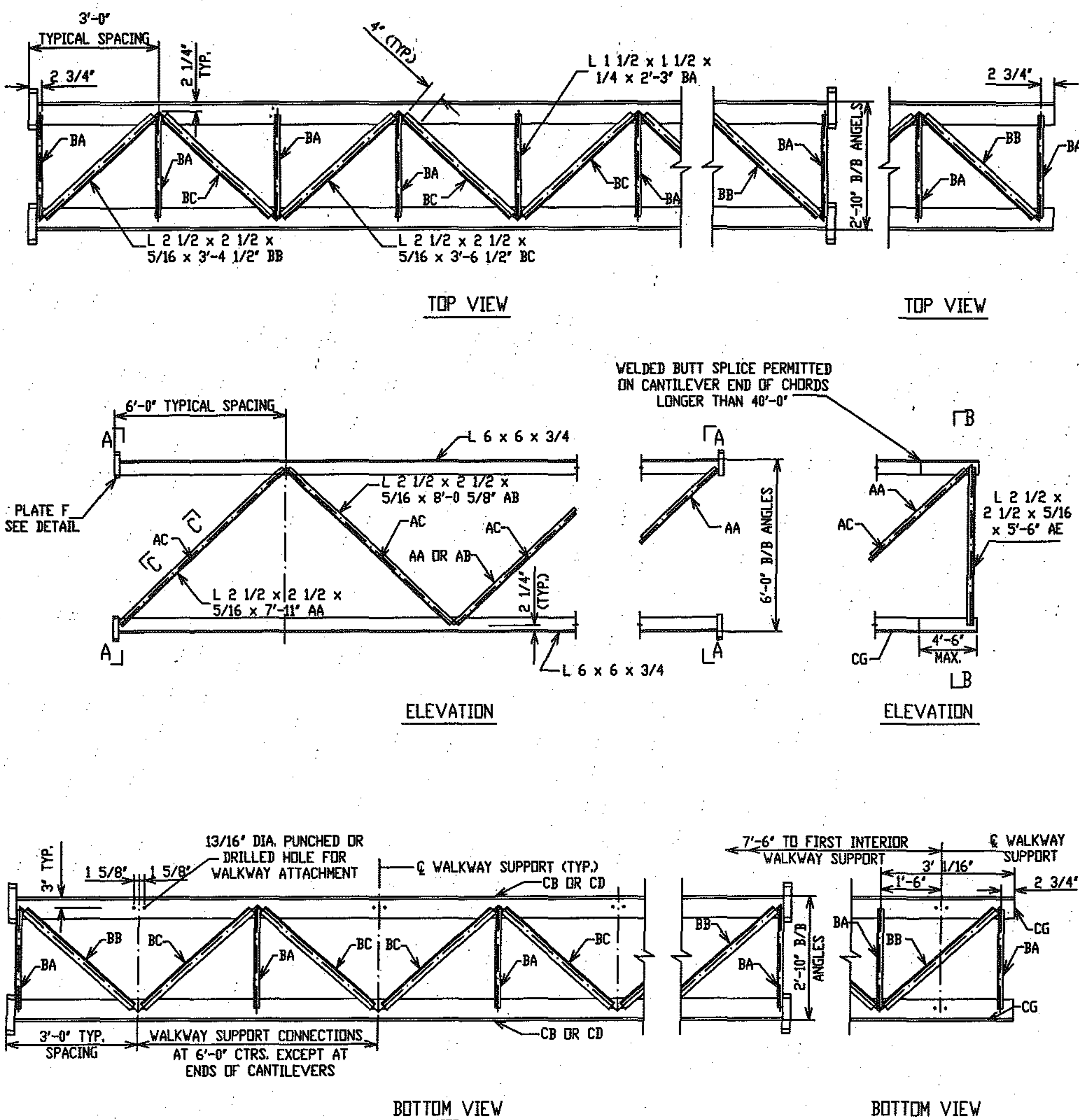
SIMPLE SPAN

CANTILEVER END

NOTE:
FOR TETAILS SEE PAGE 8

TRUSS TYPE A

REPRODUCED FROM MINNESOTA DOT DRAWINGS	TYPE	B-2
	PAGE	SHEET 5 OF 13



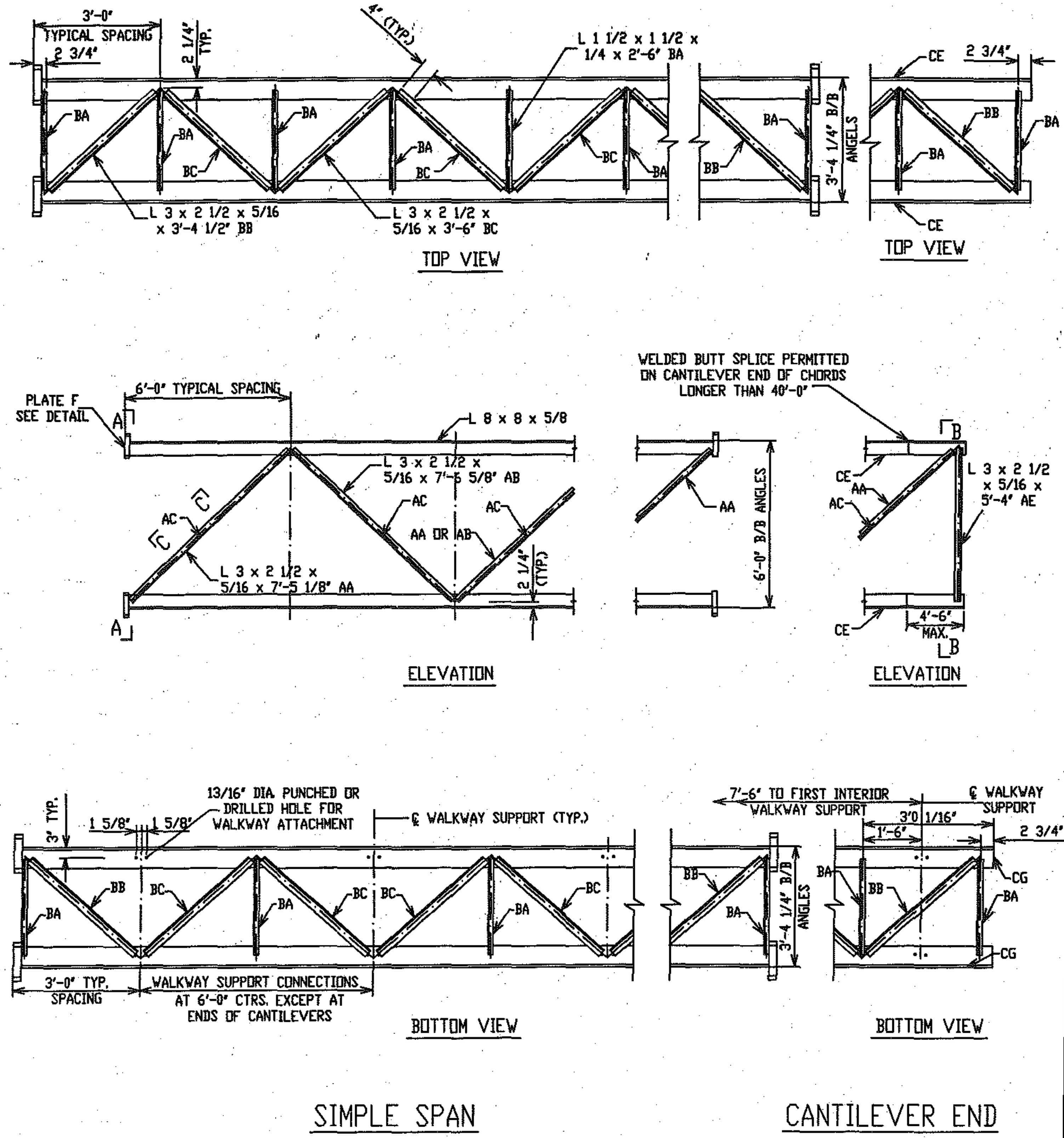
SIMPLE SPAN

CANTILEVER END

NOTE:
FOR TETAILS SEE PAGE 8

TRUSS TYPE B

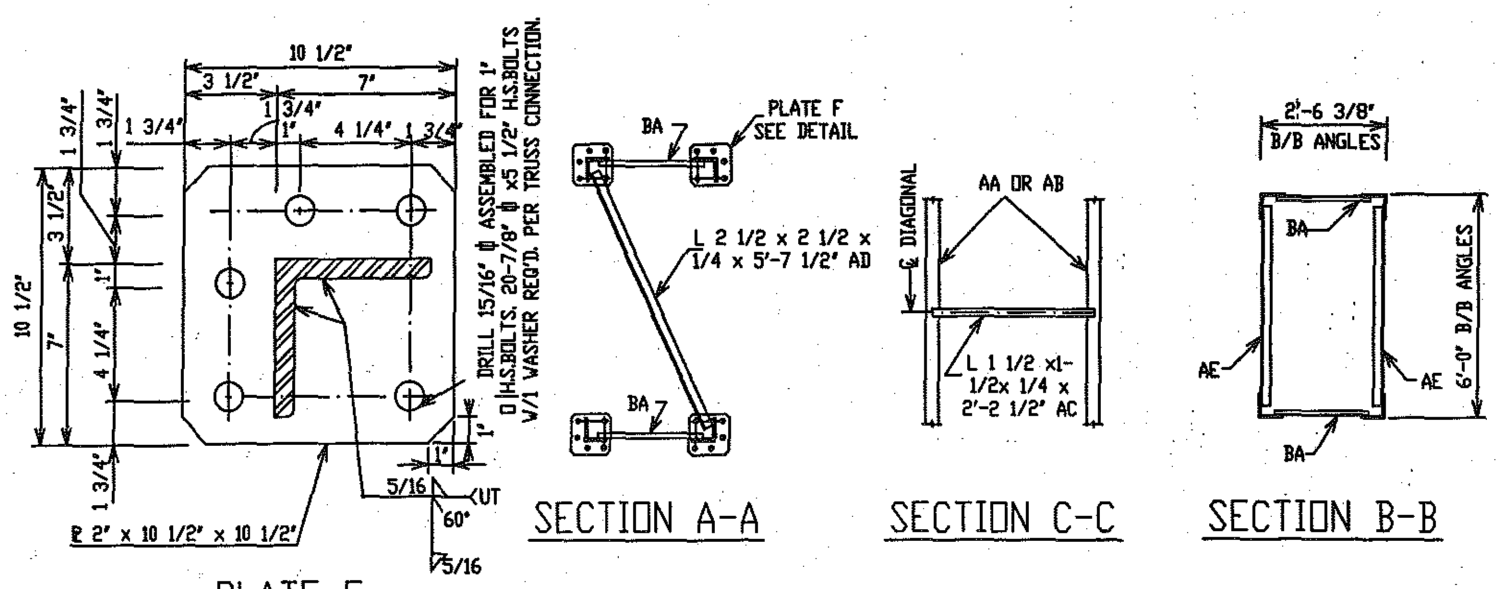
REPRODUCED FROM MINNESOTA DOT DRAWINGS	TYPE	B-2
	PAGE	SHEET 6 OF 13



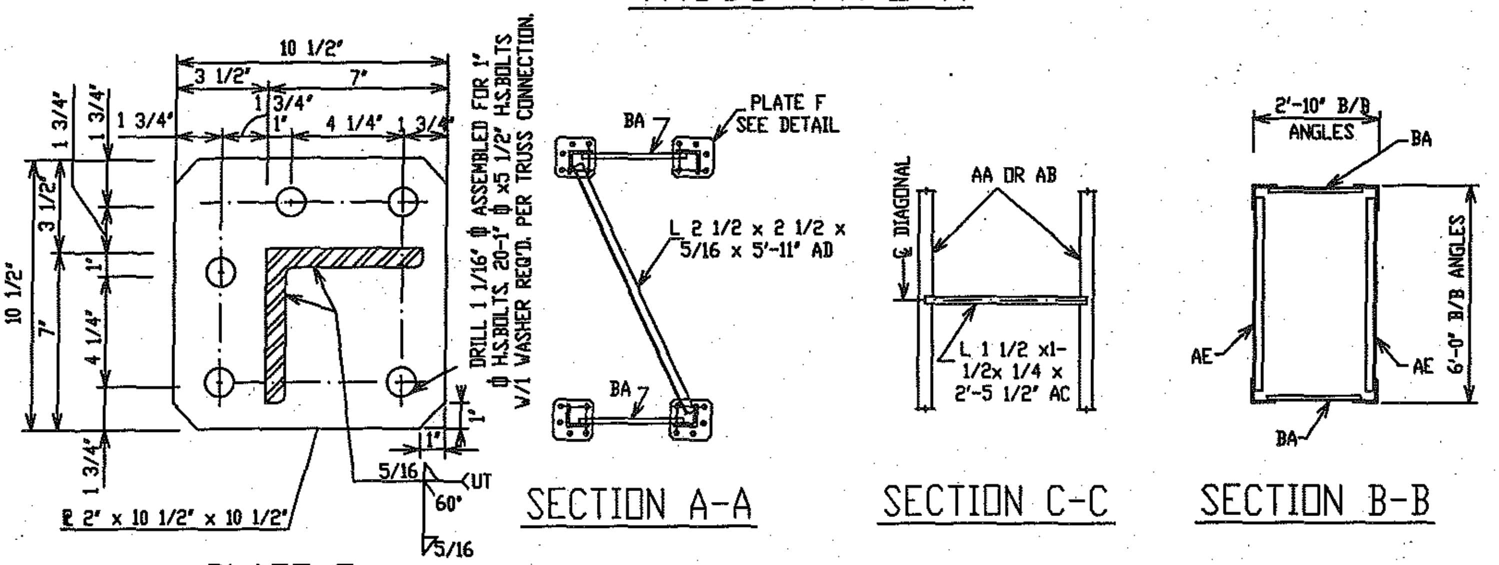
NOTE:
FOR TETAILS SEE PAGE 8

TRUSS TYPE C

REPRODUCED FROM MINNESOTA DOT DRAWINGS	TYPE	B-2
	PAGE	SHEET 7 OF 13



TRUSS TYPE A



TRUSS TYPE B

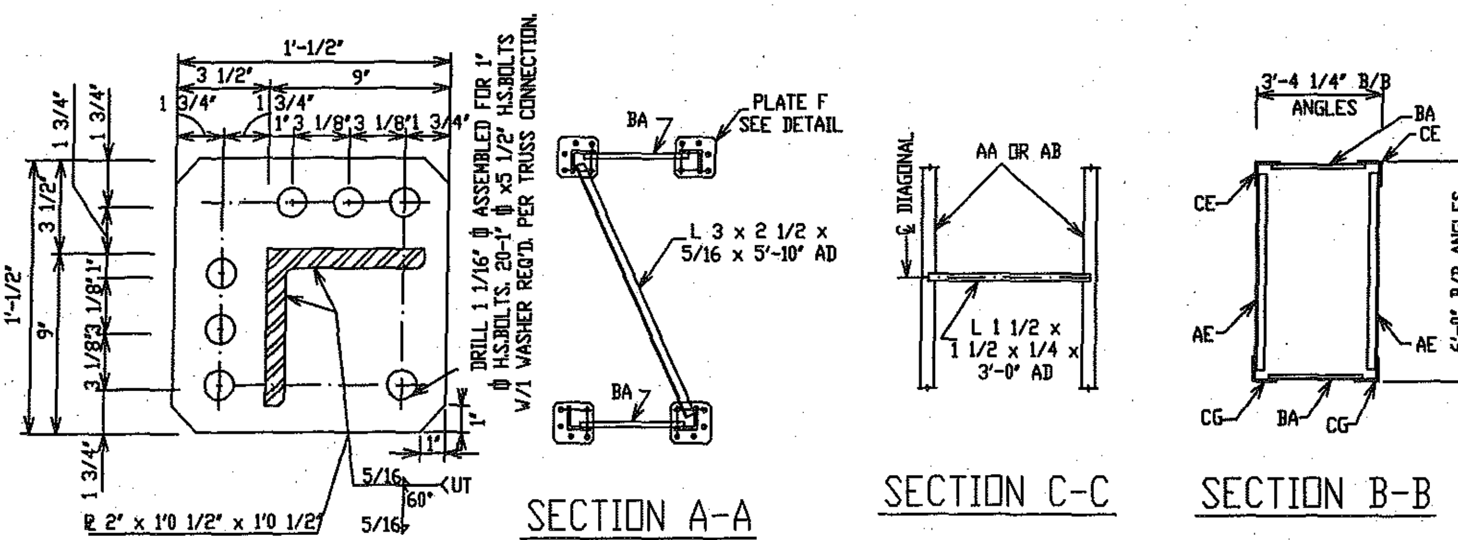
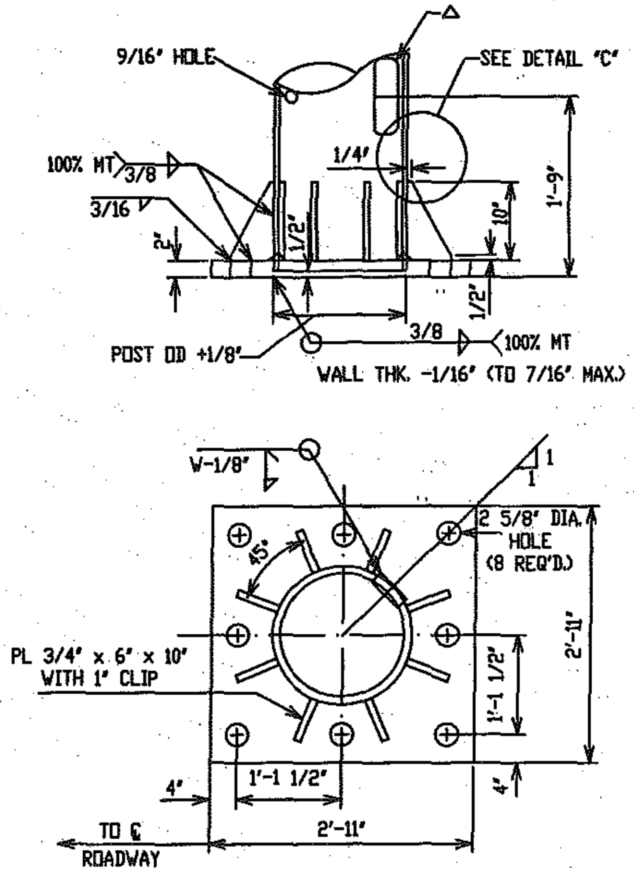


PLATE F

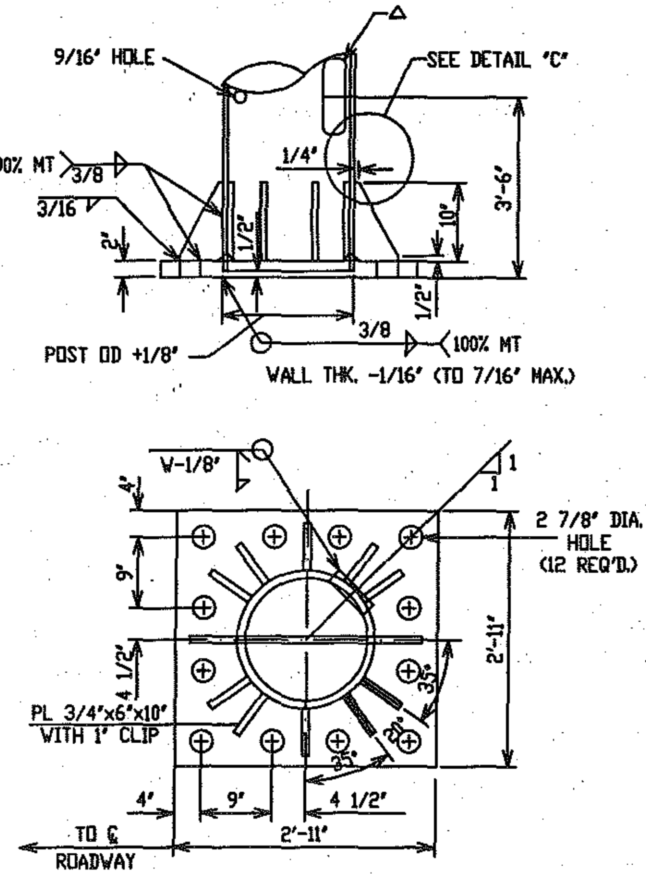
TRUSS TYPE C

REPRODUCED FROM MINNESOTA DOT DRAWINGS	TYPE	B-2
	PAGE	SHEET 8 OF 13



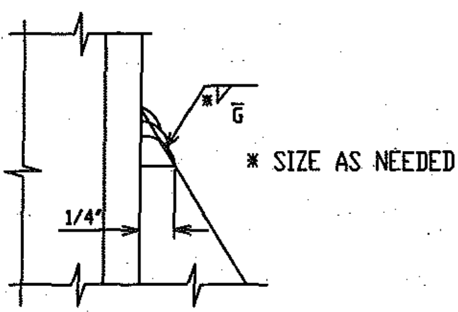
PLAN & ELEVATION-
BASEPLATE TYPE A

POST NO.1 THRU 4



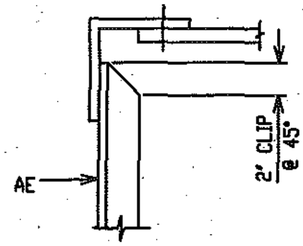
PLAN & ELEVATION-
BASEPLATE TYPE B

POST NO.5 THRU 7

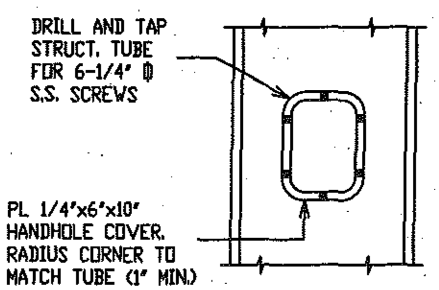


* SIZE AS NEEDED

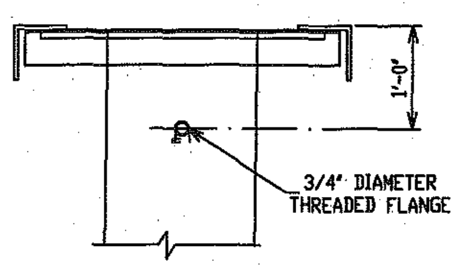
DETAIL "C"



VIEW A-A



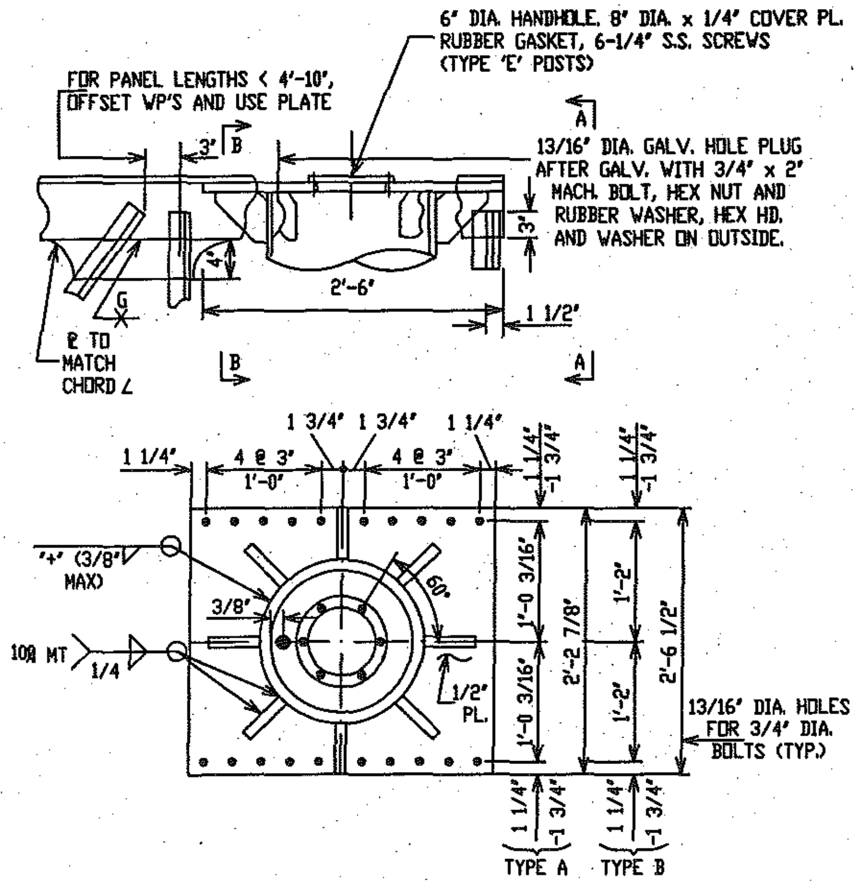
△=FOR TYPE 'E' POST ONLY:
LOCATE 45°
AWAY FROM TRAFFIC.
10"x6"x1/2"x0'-2" STRUCTURAL
TUBE OR EQUAL W/ 1/4"
RUBBER GASKET.



VIEW B-B
(TYPE 'E' POSTS)

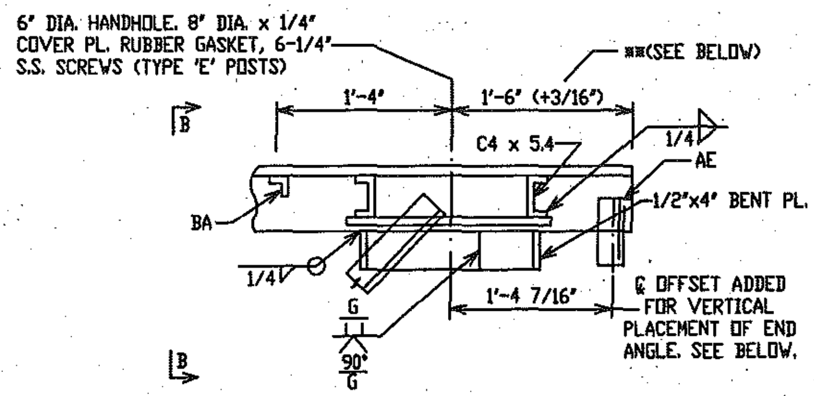
HANDHOLE & COVER PLATE
DETAIL (TYPE 'E' POSTS)

REPRODUCED FROM MINNESOTA DOT DRAWINGS	TYPE	B-2
	PAGE	SHEET 9 OF 13

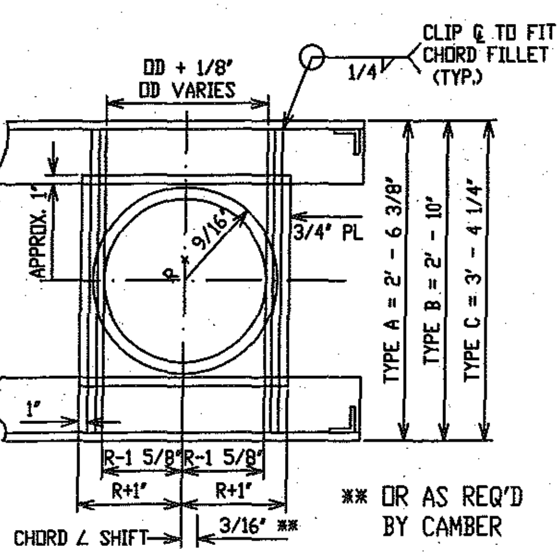


CANTILEVER TRUSS

NOTE: CHOKER PLATES AND HANDHOLE COVERS SHALL BE GALVANIZED SEPARATELY.



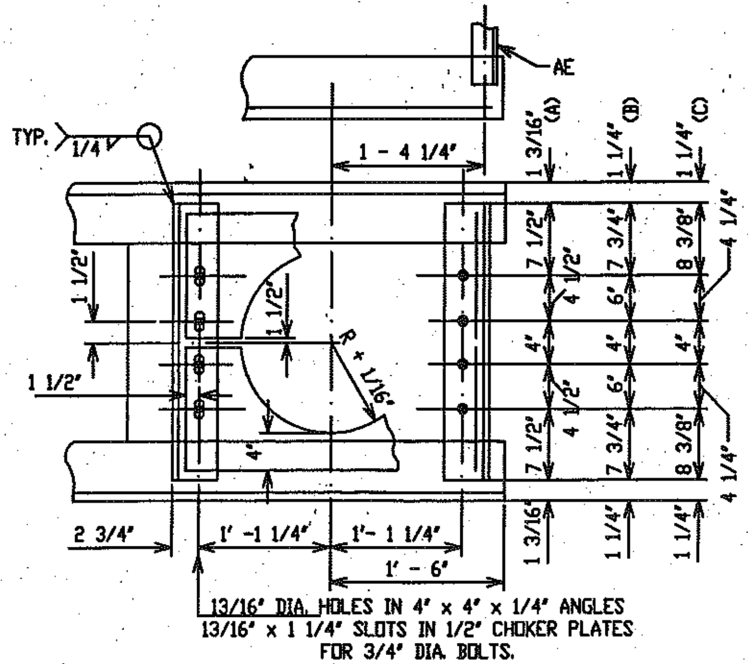
SIMPLE TRUSS



** OR AS REQ'D BY CAMBER

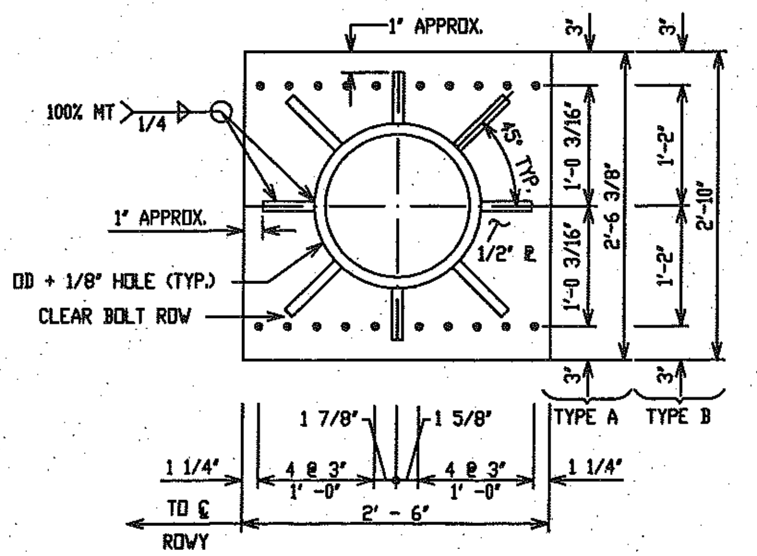
UPPER JUNCTION

REPRODUCED FROM MINNESOTA DOT DRAWINGS	TYPE	B-2
	PAGE	SHEET 10 OF 13

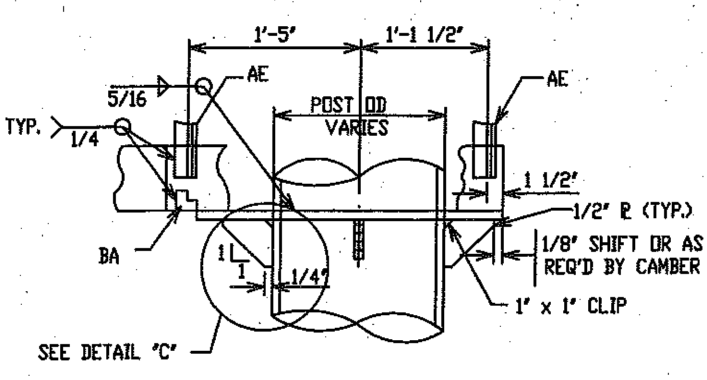


SIMPLE TRUSS

NOTE: CHOKER PLATES AND HANDHOLE COVERS SHALL BE GALVANIZED SEPARATELY.

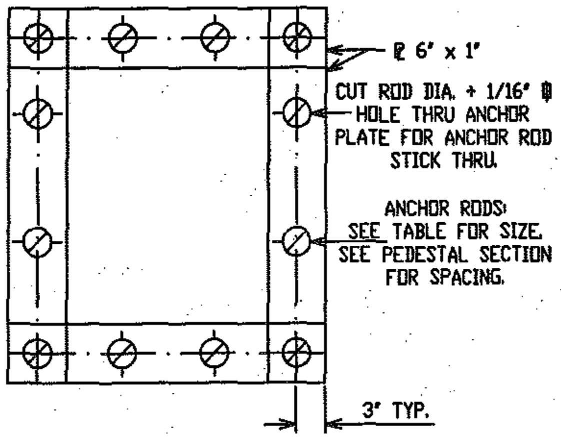


CANTILEVER TRUSS



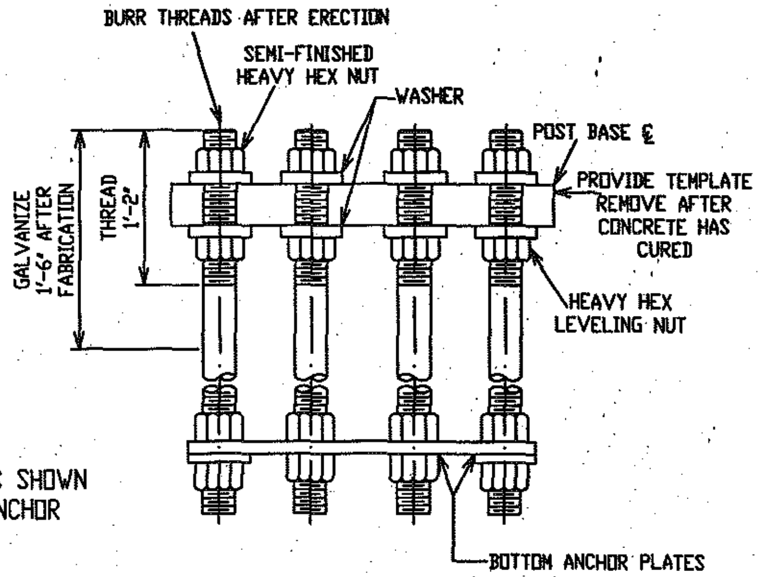
LOWER JUNCTION

REPRODUCED FROM MINNESOTA DOT DRAWINGS	TYPE	B-2
	PAGE	SHEET 11 OF 13



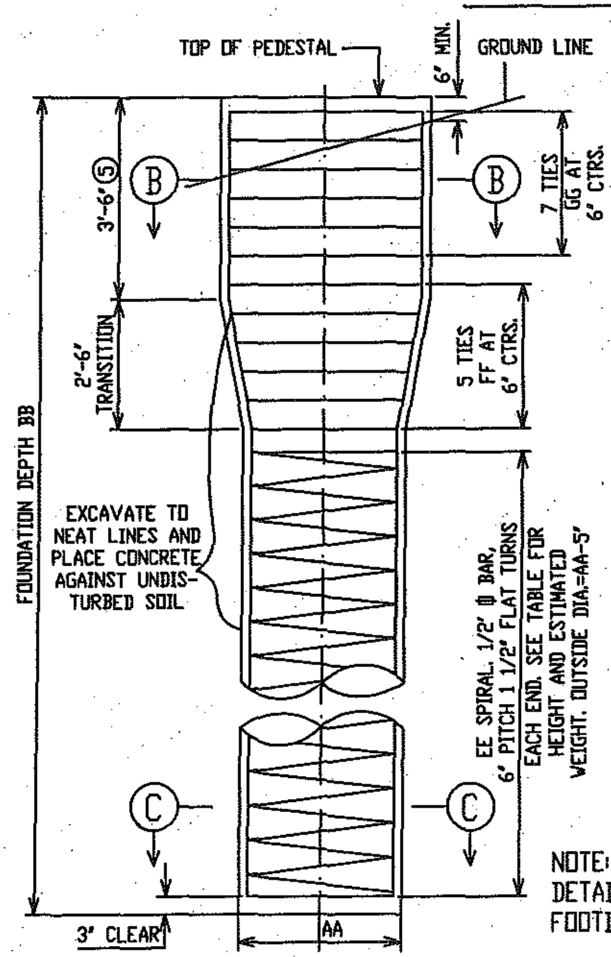
NOTE: ACHOR PLATES SHOWN TYPICAL FOR ALL ANCHOR ROD SPACING.

ANCHOR PLATE PLAN



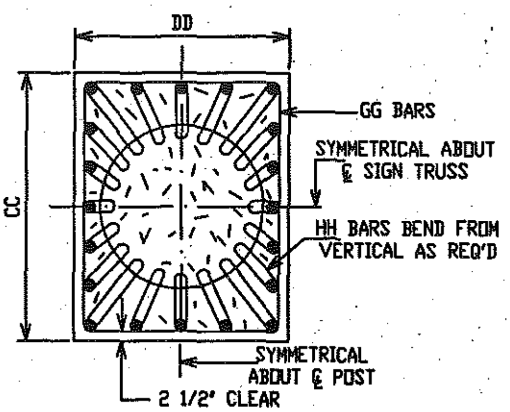
ELEVATION

ANCHOR ROD DETAILS

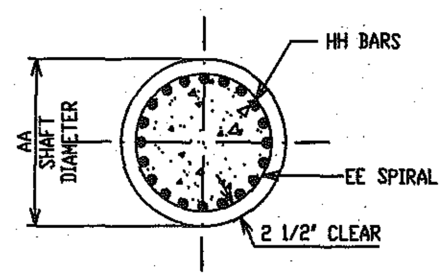


SHAFT DIAMETER ELEVATION

NOTE (5): MUST BE FORMED A MINIMUM OF 6" BELOW THE GROUND SURFACE. THE EXCAVATED AREA FOR FORMING SHALL BE BACKFILLED AND TAMPED WITH EQUIVALENT TO SURROUNDING MATERIAL.



SECTION B-B

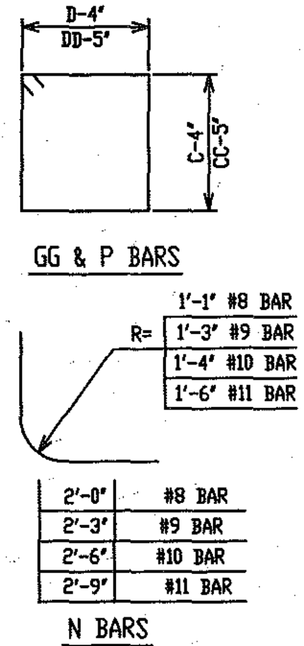


NOTE: FOR ANCHOR ROD DETAILS, SEE SPREAD FOOTINGS.

SECTION C-C

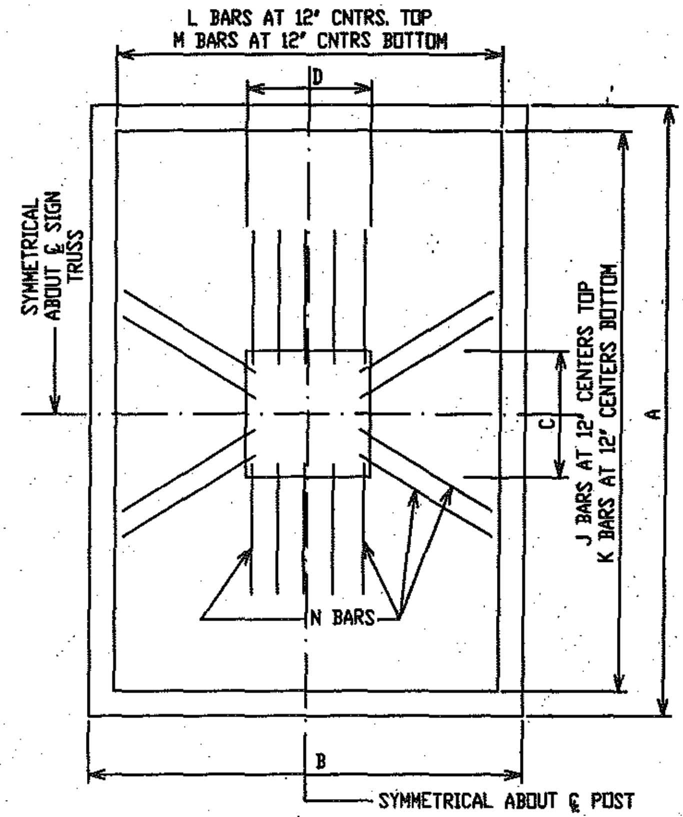
DRILLED SHAFT

REPRODUCED FROM MINNESOTA DOT DRAWINGS	TYPE	B-2
	PAGE	SHEET 12 OF 13

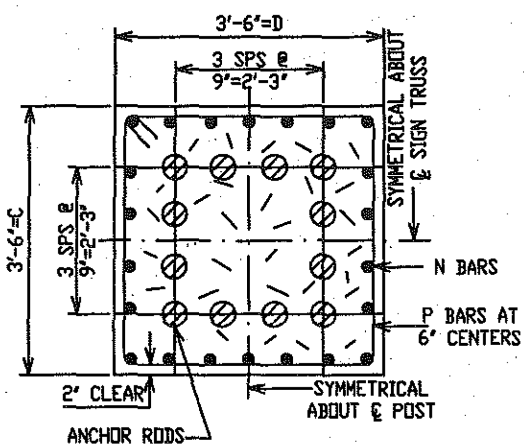


J,K,L,M,FF AND HH ARE STRAIGHT BARS

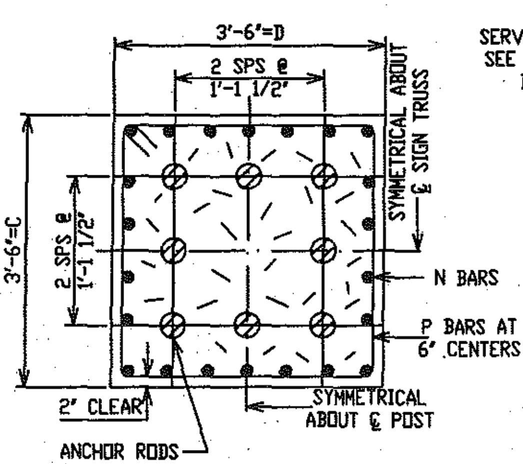
BAR BENDING DIAGRAMS



PLAN

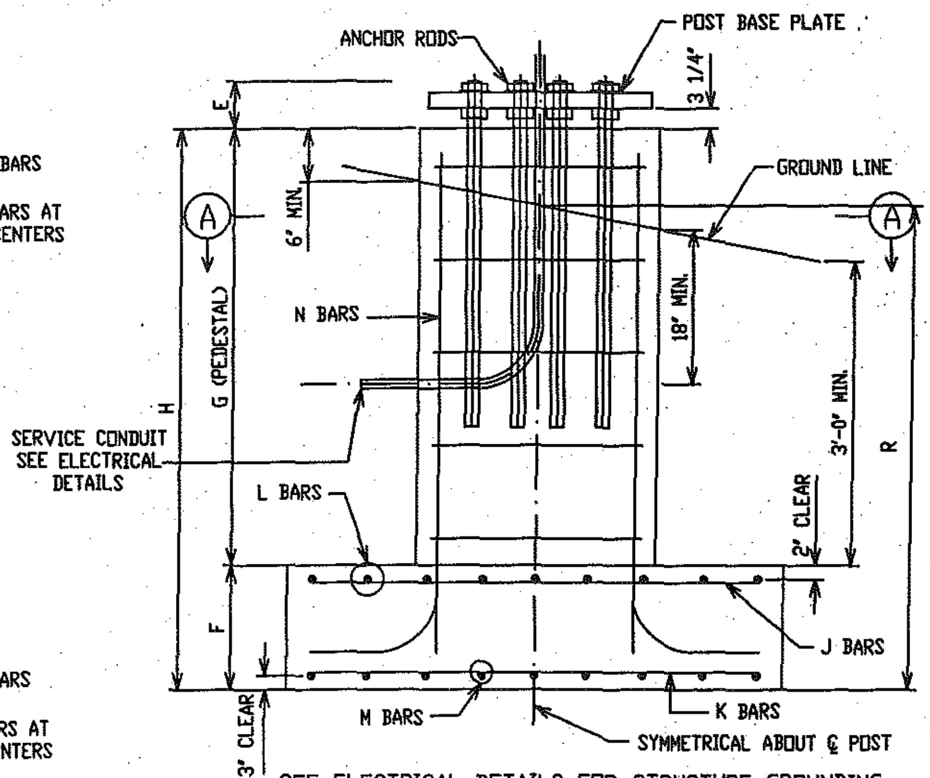


POST 5-7



POST 1-4

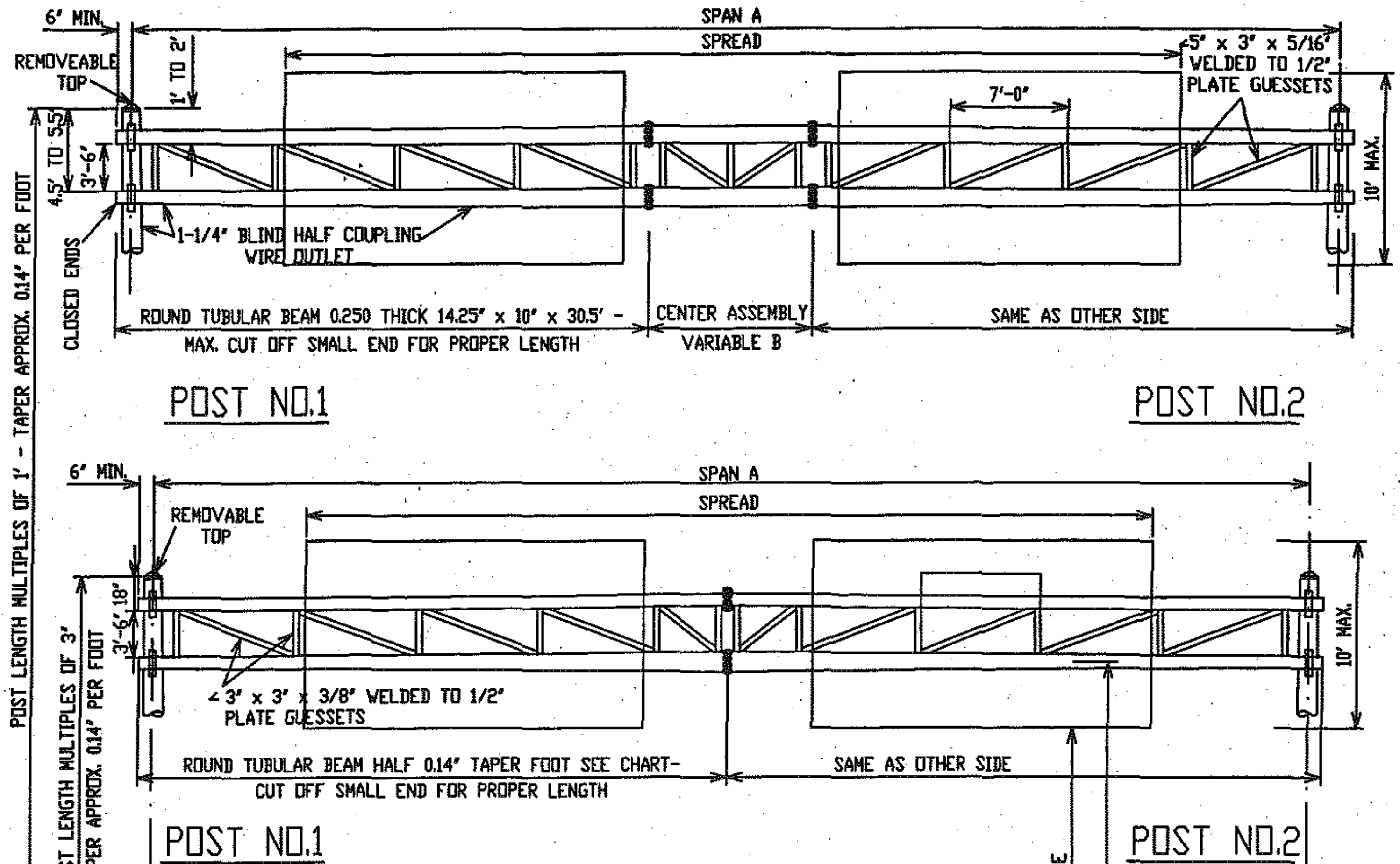
PEDESTAL CROSS SECTIONS A-A

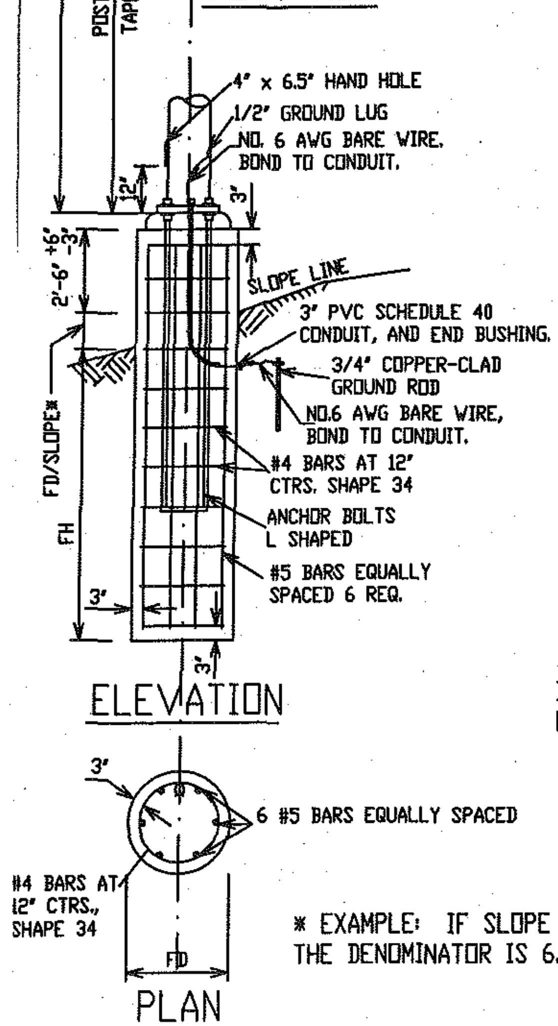


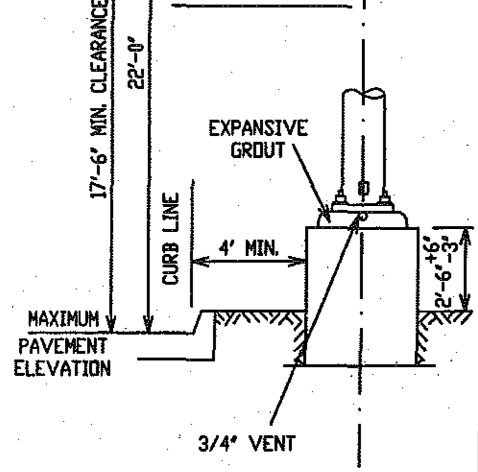
SEE ELECTRICAL DETAILS FOR STRUCTURE GROUNDING

ELEVATION SPREAD FOOTINGS

REPRODUCED FROM MINNESOTA DOT DRAWINGS	TYPE	B-2
	PAGE	SHEET 13 OF 13







GENERAL NOTE:

DESIGN SPECS: AASHTO STANDARD SPECIFICATIONS FOR STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES , AND TRAFFIC SIGNALS-1975.

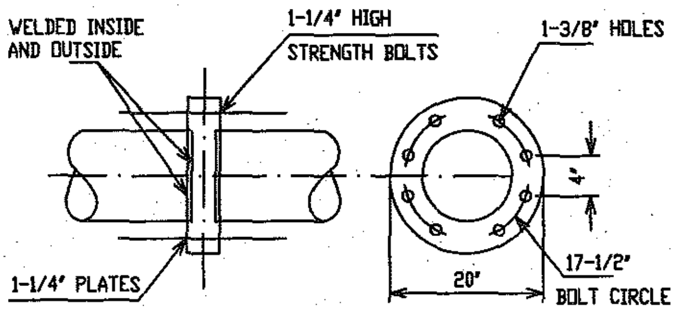
USE LONGEST POST AND SPAN A (NEXT GREATER IF NOT CHARTED) TO DETERMINE END POSTS AND STRUCTURE DESIGNS. MAXIMUM SIGN AREA FOR GIVEN SPREAD (INTERPOLATE FOR UNCHARTED SPREADS) NOT TO BE EXCEEDED. SUPPORTS DESIGNED BY END POST TYPE AND SPAN A. (I.E. S-2315-40 ETC).

ALL SIGNS CENTERED VERTICALLY.

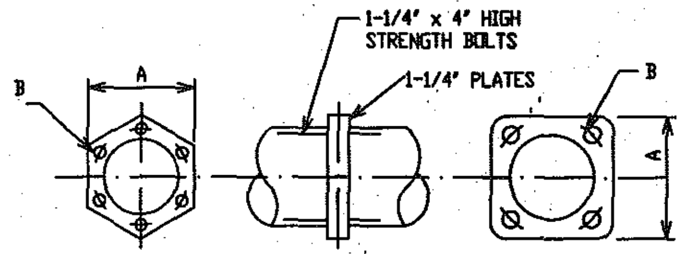
SEE STD. PLAN 903.09 FOR LIGHTING DETAILS IF LIGHTING THE SIGN IS NECESSARY.

* EXAMPLE: IF SLOPE IS 6:1, THE DENOMINATOR IS 6.

REPRODUCED FROM MISSOURI DOT DRAWINGS	TYPE	B-3
	PAGE	SHEET 1 OF 3



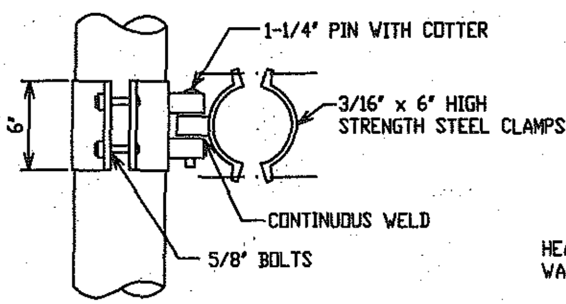
SPANS 76' & OVER



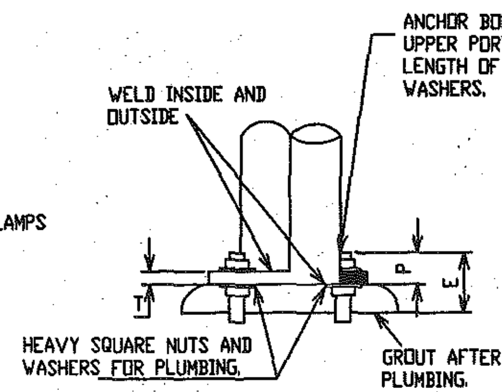
TUBE DIA.	A	B	NO. OF BOLTS
9.5"	11-1/2"	12-1/2"	4
10.5"	14-5/8"	14"	4
14.0"	17-1/4"	17"	6

SPANS UP TO 76'

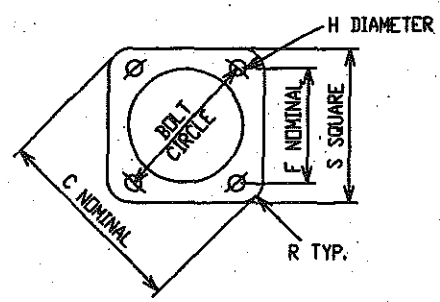
CENTER JOINT DETAIL



BEAM CLAMP DETAIL



ELEVATION

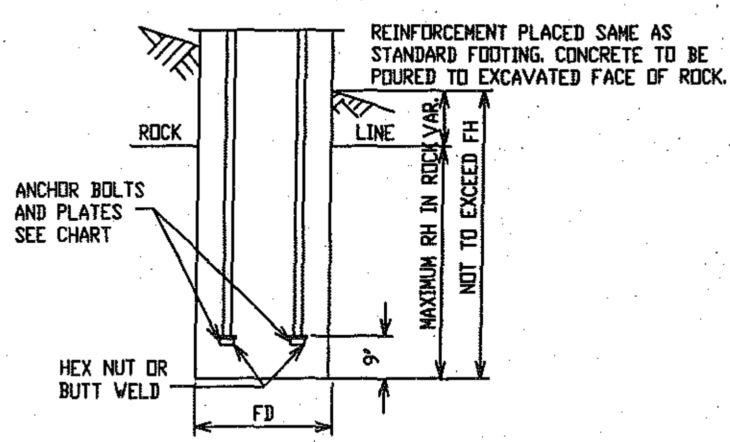


PLAN

POST BASE DETAIL

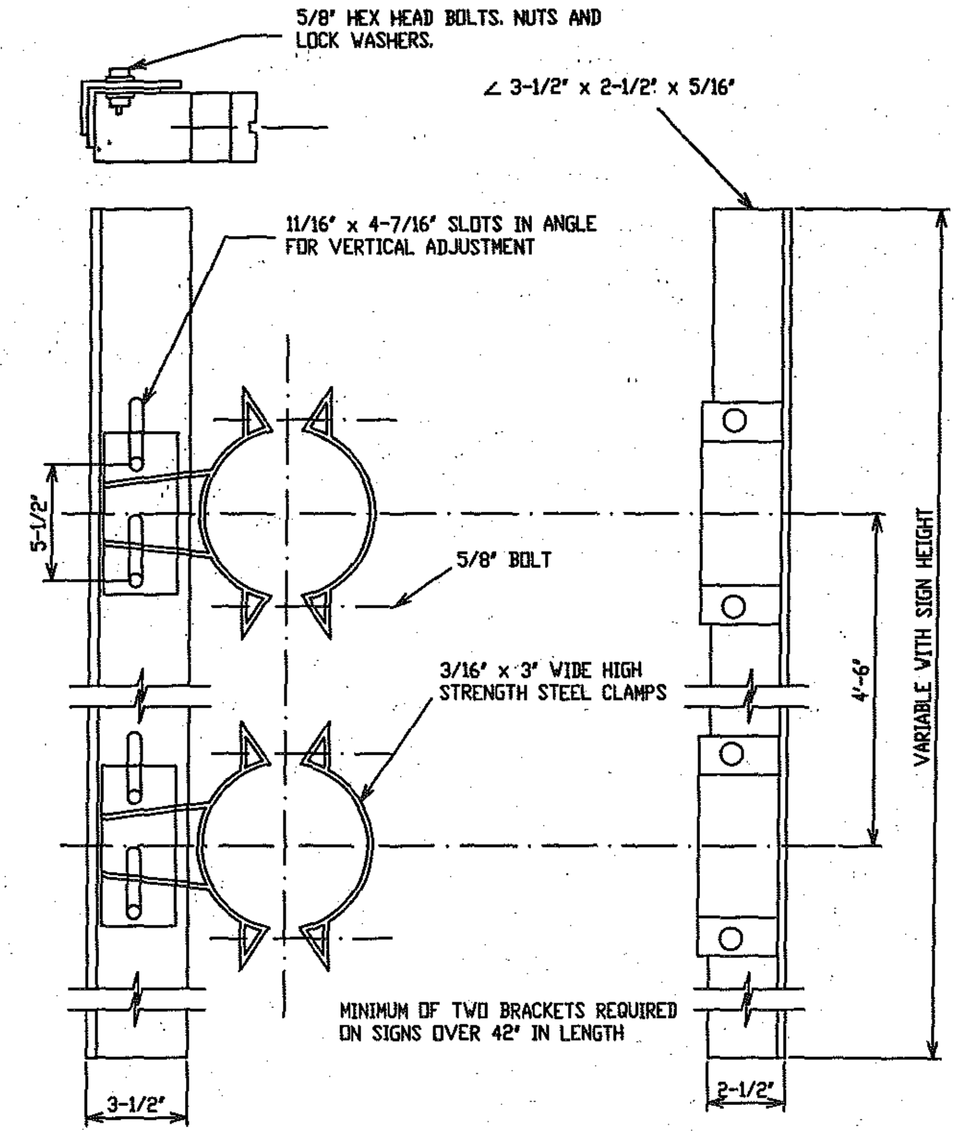
TWO END POST			
TYPE	GA	D INCHES	ALLOWABLE MOMENT-FT-LBS.
S-20018	0+0	18	453 000

SIGN HEIGHT INCHES	48 & UNDER	60	72	84	96	108	120
MAX. LIN. FT. OF SIGN WIDTH PER BRACKET	16	16	15	11	6	4	3



MODIFIED FOOTING IN SOLID ROCK

REPRODUCED FROM MISSOURI DOT DRAWINGS	TYPE	B-3
	PAGE	SHEET 2 OF 3



GALVANIZED SIGN BRACKET ASSEMBLY

BASE DATA										FOOTINGS (IN SOLID ROCK)			
											ANCHOR BOLTS		
TYPE NO.	BOLT CIRCLE	C	F	H	P	R	S	T	E	RH MAX	DIA.	LENGTH	PLATES
S-20018	25-1/2"	33"	18"	3-3/8"	7"	5-1/2"	26-1/2"	3"	12"	5'	3"	AS REQUIRED SEE ROCK FOOTING	5'x5'x1"

SPAN A	STRUCTURE						SPREAD IN FEET												
	TUBULAR BEAMS			CENTER SECTION B															
FT.	GA	LARGE DIA.	MIN. L	THICK-NESS	O.D.	LENGTH	30	35	40	45	50	55	60	65	70	75	80	85	90
90	3	14.25'	30.5'	312"	14.238'	30'	269	280	294	310	327	345	363	385	403	426	446	466	485

REPRODUCED FROM MISSOURI DOT DRAWINGS	TYPE	B-3
	PAGE	SHEET 3 OF 3

Comparison of Steel Overhead Sign Support Structures

Submitted by:

John W. van de Lindt, Kriselda Cuellar, and Stanley J. Vitton

Final Report – December, 2003

Michigan Tech Transportation Institute
Center for Structural Durability

MDOT Research Report JN 56893
CSD-2003-05
JWV-CEE-MTU-07

Technical Report Documentation Page

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7. Author(s) John W. van de Lindt, Kriselda Cuellar, and Stan J. Vitton		6. Performing Organization Code MTU
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		14. Sponsoring Agency Code

16. Abstract

The Michigan DOT is required to implement the new *2001 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals*. This project had the objective of checking to ensure that the overhead sign support structures identified in *Optimization of Cost and Performance of Overhead Sign Structures* meet the 2001 AASHTO criteria including the 2002 revisions. One aspect of this project includes identifying problem areas for implementation of the new design criteria. All three (3) Michigan cantilever sign support structures were found to meet or exceed the new AASHTO 2001 specification. All Michigan bridge-type OH sign support structures met or exceeded the AASHTO 2001 design code requirements. Suggested alterations are presented in tabular form for any other sign supports that did not meet the code.

17. Key Words: Overhead sign support, steel design, AASHTO 2001, fatigue.	18. Distribution Statement No restrictions. This document is available to the public through the Michigan Department of Transportation.

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