Sign Support Design

Standard Pipe, W Shape Supports, and Perforated Tube Material

The sign supports for ground mounted signs are designed as cantilever beams with uniform loads on the signs. Single post supported signs include a torsional load applied at 0.15 times the sign width offset from the center of the sign support.

Programs are written to calculate the support length and sizes for a particular sign. It also determines the maximum support length for the support selected. Standard pipe posts are used for single post signs and Gore Signs. Two or more post signs are designed using Standard Pipe and W-Shape.

The Signs Calculator is a Microsoft 2000 database and can be found on North Dakota Department of Transportation web site – Click on Manuals – Sign Calculator and follow instructions.

The program will start with one post and continue until a support will fit the design requirements.
If you start with perforated tube and the support configuration does not fit the design, it will indicate the design load exceeds the allowable design requirements and you will have to use the Round Pipe or W-Shape posts.

Design Requirements:

Formula: Lmax=(CRS x S x N)/Wp

LmaxBMaximum Lever Arm
SBSection Modulus of the supportBCubic inches
NBNumber of supports
CRSB <= 1.0 Where CRS=fa/Fa+Fb/CAFb+$(fv/Fv)^2$BPSI

CABCoefficient for Amplification
faBCalculated axial compressive stressBPSI
fbBCalculated bending stressBPSI
fvBCalculated torsional stressBPSI
FyBSpecified minimum yield stressBPSI
FbBAllowable unit bending stressBPSI
FvBAllowable unit shear stressBPSI

Wp=0.00256$(1.3V)^2$CdChA

WpBWind load on signsBlbs.
VBWind velocity: 85 MPH

CdBLength to Width Ratio (L/W)
L/W <1CCd=1.12
L/W <2CCd=1.19
L/W <5CCd=1.2
L/W <10BCd=1.23

ChBHeight Coefficent
Ch= 0.8 where the lever arm is<= 180 in.
Ch= 1.0 where the lever arm is > 180 in.
AB Area of the sign B Sq. ft.

Sectional Properties for Round Pipe, W-Shape, and Perforated Tube

Property	**Standard Pipe**	**W Shape**	**Perforated Tube**
Moment of Inertia (I)	3.14 R^3 t	**	5.33 R^3 t
Section Modulus (S)	3.14 R^2 t	**	5.33 R^2 t
Area of Section (A)	6.28 Rt	**	8.00 Rt
Shape Factor (Kp)	1.27	**	1.12
Radius of Gyration (R)	(1)	**	0.816 R
Thickness of Section (t)			

(1) R is measured to the mid thickness of the wall
** See Steel Construction Manual

Expressions of Maximum Stress

Stress	**Standard Pipe**	**W Shape**	**Perforated Tube**
Maximum Bending Stress (fb)	$fx^2 + fy^2$	$fx^2 + fy^2$	$fx^2 + fy^2$
Maximum Shear Stress due to Transverse Loads (vb)	2.0 Vs/A	1.5Vs/A	2.25 Vs/A
Maximum Shear Stress due to Torsion (vt)	$Mz/6.28R^2t$	$MzK/8.0bf^2 tf$	$Mzk/8.0R^2t$

Where K=(t^3 x L)/3
Q = Vy
t B Thickness
L B Length of section

Standard Pipe

Fy = 36,000 Fb = 0.66Fy Fv =0.33 Fy
Fy/E (r/t)<=0.063
$Fy/E(r/t)^{3/2} <= 0.44$

No.	Nominal Dia. – in.	R in.	t in.	Wt/Ft lbs.	S $in.^3$	A $in.^2$	R/T	Fy/E(R/t)
1	3 2	1.887	0.266	9.11	2.394	2.680	8.349	0.010
2	4	2.132	0.237	10.79	3.215	3.174	8.996	0.011
3	5	2.653	0.258	14.62	5.449	4.300	10.283	0.013
4	6	3.173	0.280	18.97	8.495	5.581	11.331	0.014
5	8	4.174	0.277	24.70	14.69	7.265	15.069	0.019
6	10	5.236	0.279	31.20	23.42	9.178	18.875	0.023
7	12	6.210	0.330	43.77	38.98	12.88	18.818	0.023

W Shape

Fy = 36,000 Fb = 0.60 Fy Fv = 0.33 Fy

Compact Section
$W/t < 2050/ Fy^{1/2} = 9.1679$
$D/t < 20200/ Fy^{1/2} = 90.33$
$D/t > 8120/ Fy^{1/2} = 36.3137$

No.	Nominal Size	Area $in.^2$	Web D in.	t in.	Flange W in.	t in.	Section Modulus(x-x) $in.^3$	W/t	D/t	
1	W4x133.83	4.16	0.280	4.060	0.345	5.46		11.8	14.9	
2	W5x164.68	5.01	0.240	5.000	0.360	8.51		13.9	20.9	
3	W6x205.87	6.20	0.260	6.020	0.365	13.4		16.5	23.8	
4	W8x247.08	7.93	0.245	6.495	0.400	20.9		16.2	32.4	
5	W8x288.25	8.06	0.285	6.535	0.465	24.3		14.0	28.2	
6	W8x319.13	8.00	0.285	7.995	0.435	27.5		18.4	28.1	
7	W10x39	11.5	9.92	0.315	7.985	0.530		42.1	15.1	31.5

Perforated Tubes

Fy = 55,000 Fb = 0.60 Fy Fv = 0.33 Fy

No.	size in.	t in.	wt./ft. lbs.	Section Modulus in.^{3}	Area in.^{2}	Radius in.	n=	t/R	Kt	Rt
1	2	0.105	2.416	0.372	0.590	0.9475	1.49	0.1108	1.187	1.571
2	2.25	0.105	2.773	0.499	0.695	1.0725	1.49	0.0979	1.200	1.242
3	2.50	0.105	3.141	0.643	0.803	1.1975	1.49	0.0877	1.225	0.980
4	2.5	0.135	4.006	0.783	1.010	1.1825	1.49	0.1142	1.180	0.781
5	2 & 2.25	0.210	5.189	0.871	1.285	1.0200	1.49	0.2059	1.100	0.629
6	2.25 & 2.50	0.210	5.914	1.142	1.498	1.1450	1.49	0.1834	1.115	0.506
7	2.1875 & 2.5	0.270	7.438	1.373	1.851	1.1150	1.49	0.2422	1.080	0.402

Foundation Design

Maximum Overturn Moment = Wp x Lmax
where:
Wp = (CRS x S) / Lmax
WpBWind Load on the SignBlbs.
CRSBCombined Stress Ratio
SB Section ModulusB in.^{3}
LmaxB Maximum Lever Arm

Formula**:** P/S1 = bD^2 / (2.37 D + 2.64 H)

Where: P B Load on the sign
D B Embedment Depth of Foundation
b B Width of Foundation
S1 B Soil Pressure
H B Load Lever Arm

Standard Widths of Foundations

Standard Pipe		W Shape	
Post Dia. in.	**Foundation Dia. ft.**	**Post Size**	**Foundation Dia. ft.**
3 2 & 4	b= 1'B 4"	W4x13	b = 1'B9"
5 & 6	b = 1'B9"	W5x16	b = 1'B9"
8	b = 2'B0"	W6x20	b = 2'B0"
10	b = 2'B4"	W8x24	b = 2'B4"
12	b = 2'B6"	W8x28	b = 2'B4"
		W8x31	b = 2'B6"
		W10x39	b = 2'B6"