ESTIMATING HANGER ROD STIFFENER REQUIREMENTS

Introduction:

Determining the actual rod stiffener requirements for a specific hanger location on a specific project is beyond the scope of this manual. However, the intent of this appendix is to demonstrate how the rod stiffener requirements may be estimated in a general way for planning and cost estimating purposes.

The need for hanger rod stiffeners, the size of the rod stiffener angle, and the number of clamps used to attach the rod stiffener angle to the hanger rod is dependent on several variables.

1. The horizontal seismic force that is being restrained. This value depends on the design spectral acceleration seismic acceleration, the component importance factor, component amplification and response factors, the weight of the pipe or duct being restrained, the restraint spacing, and the elevation of the hanger rod attachment point in the building with respect to the roof line as measured from grade. In this appendix, the horizontal seismic force will be expressed as a Horizontal Force Class value, see Table A5.1-1. The numerical value assigned to the Horizontal Force Class will be the maximum force value in the range for each Force Class. The Horizontal Force Class number is the force that is applied at each restraint location. It may be computed from the information given in Sections S5.0 and S7.0, or obtained from the online tools provided by Kinetics Noise Control.
2. The hanger rod size. The buckling strength of the hanger rods in this appendix has been determined using the minor thread diameter and assuming that the rods are carbon steel and meet the minimum strength requirements of ASTM A307. The various hanger rod sizes are assigned a numerical code to streamline the data tables in the following sections of this appendix. The hanger rod size code and other hanger rod data are presented in Table A5.1-2.

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Table A5.1-1; Horizontal Seismic Force Class System Designations

Horizontal Force Class	Horizontal Seismic Force Range per Force Class (lbs)
I	$0 \le F_P \le 250$
II	$250 < F_P \le 500$
III	$500 < F_P \le 1{,}000$
IV	$1{,}000 < F_P \le 2{,}000$
V	$2{,}000 < F_P \le 5{,}000$
VI	$5{,}000 < F_P \le 10{,}000$

Table S5.1-2; Hanger Rod Size Code, Size, and Allowable Load Data

Hanger Rod Code	Hanger Rod Size UNC	Minor Thread Diameter (in)	Area Moment of Inertia (in^4)	Hanger Rod Allowable Load ASD (kips)
3	3/8 - 16	0.2992	0.000393	0.73
4	1/2 - 13	0.4069	0.001346	1.35
5	5/8 - 11	0.5152	0.003458	2.16
6	3/4 - 10	0.6291	0.007689	3.23
7	7/8 - 9	0.7408	0.014783	4.48
8	1 - 8	0.8492	0.025528	5.90
10	1 1/4 - 7	1.0777	0.066216	9.50

3. The supported weight of the pipe or duct. This is expressed as a weight per foot. Data for the weight per foot of various pipe and duct may be found in Appendix A2.0 and Appendix A3.0 of this manual respectively.
4. The hanger rod spacing. A 10 ft spacing of the hanger rods was assumed for the tables and analysis in this manual. This is a standard spacing that corresponds well with the usual recommended seismic restraint spacings, see Section S1.0.

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5. Seismic restraint installation angle. In a run of pipe and duct, the restraint installation angle may vary widely form restraint location to restraint location. This appendix provides a set of tables for restraint installation angle ranging from 0° up to and including 45°, Sections A5.2 and A5.4, and a set of tables for restraint installation angles ranging from 45° up to and including 60°, Sections A5.3 and A5.5.
6. Single hanger rod or trapeze supported pipe or duct. This affects the dead weight load carried by each hanger rod which will affect the magnitude of the compressive load that is applied to the hanger rod. The effects of using a single hanger rod or a trapeze to support the pipe or duct is demonstrated in Tables S8-3 through S8-10.

Hanger rod stiffeners may be nearly any rigid structural shape. Some of the components that have historically been used are as follows.

1. AISI rolled structural angles
2. Pipe
3. Electrical conduit
4. UNISTRUT® channels, there are several different manufacturers of shapes similar to those provided by UNISTRUT®

Kinetics Noise Control has chosen to recommend the AISI rolled structural angles for use as hanger rod stiffeners because they give the hanger rod good lateral support, they are readily available, and they provide a great deal of flexibility for use with many hanger rod sizes. Kinetics Noise Control provides two basic models of rod stiffener clamps that cover a wide range of AISI rolled structural angles, and hanger rods. These clamps are shown in Figures A5.1-1 and A5.1-2. These two clamps will allow the use of hanger rods ranging from 3/8 – 16 UNC to 1-1/4 – 7 UNC, and AISI structural angles ranging from L1 x 1 x 1/8 to L2-1/2 x 2-1/2 x 1/4 for normal applications, and up to L2-1/2 x 2-1/2 x 1/2 for certain special applications. To make the tables and specifications easier, an alpha rod stiffener code has been assigned to the AISI structural angles recommended by Kinetics Noise Control. The AISI structural angles suitable for the Models

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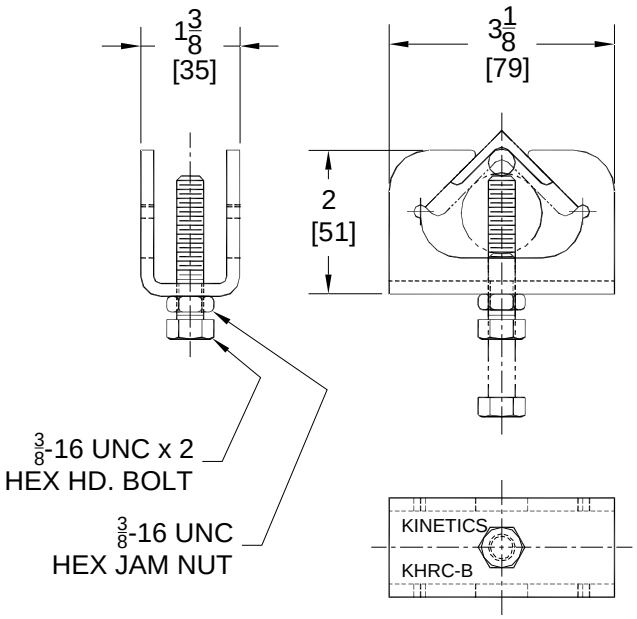
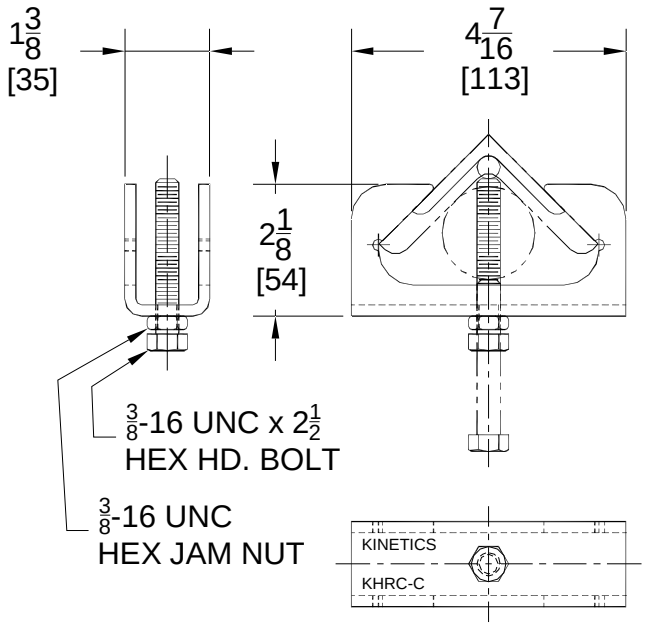
KHRC-B and KHRC-C hanger rod stiffener clamps are list by rod stiffener code letter in Table A5.1-3.



RANGE OF STIFFENER ANGLES	
AISC STANDARD	METRIC
1 x 1 x 1/8	25 x 25 x 3
1-1/4 x 1-1/4 x 1/4	30 x 30 x 5
1-1/2 x 1-1/2 x 1/4	40 x 40 x 6

RANGE OF HANGER RODS	
INCH STANDARD	METRIC STANDARD
3/8	M10
1/2	M12
5/8	M16
3/4	M20
7/8	M22
1	M24
1-1/8	M30

Figure A5.1-1; Kinetics Noise Control Model KHRC-B Small Hanger Rod Stiffener Clamp



RANGE OF STIFFENER ANGLES	
AISC STANDARD	METRIC
1-3/4 x 1-3/4 x 1/4	45 x 45 x 6
2 x 2 x 1/4	50 x 50 x 6
2 x 2 x 3/8	50 x 50 x 8
2-1/2 x 2-1/2 x 1/4	60 x 60 x 6

RANGE OF HANGER RODS	
INCH STANDARD	METRIC STANDARD
3/8	M10
1/2	M12
5/8	M16
3/4	M20
7/8	M22
1	M24
1-1/8	M30
1-1/4	M36

Figure A5.1-2; Kinetics Noise Control Model KHRC-C Large Hanger Rod Stiffener Clamp

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Table A5.1-3; Rod Stiffener Angle Code Designation and Design Data

Rod Stiffener Code	AISI Angle Designation	Weight per Foot (lbs)	Section Area (in^2)	I_{X-X} or I_{Y-Y} (in^4)	Radius of Gyration *Z-Z* (in)	I_{Z-Z} (in^4)
A	L 1 x 1 x 1/8	0.80	0.234	0.022	0.196	0.0090
B	L 1-1/4 x 1-1/4 x 1/4	1.92	0.563	0.077	0.243	0.0332
C	L 1-1/2 x 1-1/2 x 1/4	2.34	0.688	0.139	0.292	0.0587
D	L 1-3/4 x 1-3/4 x 1/4	2.77	0.813	0.227	0.341	0.0945
E	L 2 x 2 x 1/4	3.19	0.938	0.348	0.391	0.1434
F	L 2 x 2 x 3/8	4.70	1.36	0.479	0.389	0.2058
G	L 2-1/2 x 2-1/2 x 1/4	4.10	1.19	0.703	0.491	0.2869
H[1]	L 2-1/2 x 2-1/2 x 3/8	5.90	1.73	0.984	0.487	0.4103
I[1]	L 2-1/2 x 2-1/2 x 1/2	7.70	2.25	1.230	0.487	0.5336

[1] These rod stiffener angles may be used with the Kinetics Noise Control Model KHRC-C rod stiifener clamp. Not all hanger rod sizes may work with these arrangements. Check with Kinetics Noise Control Engineering for your particular application.

Example No. 1:

1. CWS – Chilled Water Supply: 8″ insulated schedule 40 steel pipe & a supported weight of 55.84 lbs/ft from Table A2.1-2.
2. Single Hanger Rod Supported: Hanger rod size = 1/2-13 UNC (Hanger Rod Code = 4 from Table A5.1-2).
3. Cable restraints installed @ 45°.
4. Assume 10 ft hanger rod spacing.
5. Horizontal Force Class III
6. Hanger rod length $L = 36$ in.

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A. From Table A5.2-4 the maximum un-stiffened hanger rod length will be $L_{CR} = 11$ in. The actual supported weight falls just over the 50 lb/ft value in the table, therefore, to be safe, the hanger rod will require a stiffener.
B. From Table A5.4-4 the rod stiffener code that will apply is A (L 1 x 1 x 1/8). The actual hanger rod length is less than the maximum allowable angle stiffener length for rod stiffener code A.
C. From Table A5.6-4, the Maximum Rod Stiffener Clamp Spacing for 50 lbs/ft is 40 inches.
D. The number of Model KHRC-B rod stiffener clamps that will be required for this hanger rod is 3. The hanger rod is shorter than the Maximum Rod Stiffener Clamp Spacing.

Example No. 2:

1. CWS & CWR – Chilled Water Supply and Chilled Water Return: 8″ insulated schedule 40 steel pipe & a supported weight of 55.84 lbs/ft each from Table A2.1-2. Total supported weight is 111.68 lbs/ft.
2. Trapeze Supported: Hanger rod size = 3/8-16 UNC (Hanger Rod Code = 3 from Table A5.1-2).
3. Cable restraints installed @ 45°.
4. Assume 10 ft hanger rod spacing.
5. Horizontal Force Class II
6. Hanger rod length $L = 36$ in.

A. From Tables A5.2-9 and A5.4-9 hanger rod stiffeners are not required for:
    a. 3/8-16 UNC hanger rods supporting over 100 lbs/ft in a trapeze arrangement.
    b. Horizontal Force Class II.
    c. Restraint installation angle of 45° or less.

Example No. 3:

1. 54 x 108 rectangular duct with a supported weight of 70 lbs/ft.

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2. Trapeze Supported: Hanger rod size = 3/8-16 UNC (Hanger Rod Code = 3 from Table A5.1-2).
3. Cable restraints installed @ 60°.
4. Assume 10 ft hanger rod spacing.
5. Horizontal Force Class IV
6. Hanger rod length $L = 60$ in.

A. From Table A5.3-11 the 3/8-16 UNC hanger rod is not recommended for a trapeze application for any listed supported load when the Horizontal Force Class is IV and the installation angle is 60°. The first hanger rod that may be used is a #5 rod which is 5/8-11 UNC. The maximum un-stiffened hanger rod length is $L_{CR} = 7$ in.

B. From Table A5.5-11 the rod stiffener code that will apply is C (L 1-1/2 x 1-1/2 x 1/4).

C. From Table A5.7-11, the Maximum Rod Stiffener Clamp Spacing is 16 in.

D. The number of Model KHRC-B rod stiffener clamps that will be required for this hanger rod is $N_{RC} = \left(\frac{L}{S_C}\right) + 1 = \left(\frac{60}{16}\right) = 3.75 = \underline{4}$.

Example No. 4:

1. 44 x 44 square duct with a supported weight of 23.6 lbs/ft.
2. Trapeze Supported: Hanger rod size = 3/8-16 UNC (Hanger Rod Code = 3 from Table A5.1-2).
3. Cable restraints installed @ 60°.
4. Assume 10 ft hanger rod spacing.
5. Horizontal Seismic Design Force @ Restraint Point = 793 lbs (Horizontal Force Class III from Table A5.1-1).
6. Hanger rod length $L = 120$ in.

A. From Table A5.3-10 the 3/8-16 UNC hanger rod is not recommended for a trapeze application for any listed supported load when the Horizontal Force Class is III and the

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installation angle is 60°. The first hanger rod that may be used is a #5 rod which is 5/8-11 UNC. The maximum un-stiffened hanger rod length is $L_{CR} = 10$ in.

B. From Table A5.5-10 the rod stiffener code that will apply is E (L 2 x 2 x 1/4).

C. From Table A5.7-10, the Maximum Rod Stiffener Clamp Spacing is 22 in.

D. The number of Model KHRC-C rod stiffener clamps that will be required for this hanger rod is $N_{RC} = \left(\frac{L}{S_C}\right) + 1 = \left(\frac{120}{22}\right) = 3.75 = \underline{7}$.

Example No. 5:

1. 114 x 50 rectangular duct with a supported weight of 92.4 lbs/ft.
2. Trapeze Supported: Hanger rod size = 1/2-13 UNC (Hanger Rod Code = 4 from Table A5.1-2).
3. Cable restraints installed @ 60°.
4. Assume 10 ft hanger rod spacing.
5. Horizontal Seismic Design Force @ Restraint Point = 3,105 lbs (Horizontal Force Class V from Table A5.1-1).
6. Hanger rod length $L = 120$ in.

A. From Table A5.3-12 the 1/2-13 UNC hanger rod is not recommended for a trapeze application for any listed supported load when the Horizontal Force Class is V and the installation angle is 60°. The first hanger rod that may be used is a #7 rod which is 7/8-9 UNC. The maximum un-stiffened hanger rod length is $L_{CR} = 9$ in.

B. From Table A5.5-12 there is no available rod stiffener for this application and hanger rod length. Reduce restraint spacing to reduce the Horizontal Force Class, or consult with the Kinetics Noise Control for recommendations.

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Example No. 6:

1. Chilled Water Supply: 12″ insulated schedule 40 steel pipe & a supported weight of 106.45 lbs/ft each from Table A2.1-2
2. Single Clevis Supported: Hanger Rod Size = 3/4-10 UNC (Hanger Rod Code = 6 from Table A5.1-2).
3. Cable restraints installed @ 60°.
4. Assume 10 ft hanger rod spacing.
5. Horizontal Seismic Design Force @ Restraint Point = 2,384 lbs (Horizontal Force Class V from Table A5.1-1).
6. Hanger rod length $L = 60$ in.

A. From Table A5.3-6 the 3/4-10 UNC the maximum un-stiffened hanger rod length is $L_{CR} = 7$ in.

B. From Table A5.5-6 the rod stiffener code that will apply is F (L 2 x 2 x 3/8).

C. From Table A5.7-6, the Maximum Rod Stiffener Clamp Spacing is 15 inches.

D. The number of Model KHRC-B rod stiffener clamps that will be required for this hanger rod is $N_{RC} = \left(\frac{L}{S_C}\right) + 1 = \left(\frac{60}{15}\right) = \underline{4}$.

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