DESIGN OF NEXSPAN2™ F SERIES FRAMING SYSTEMS

PRE-ENGINEERED, MODULAR DESIGN

The Allfasteners NexSpan2™ F Series product line is a modular framing system that may be used to design support frames and platforms for use in a variety of industry settings. In these applications, the members may be analyzed as beams and columns. Beams support and transmit loads, and must be checked for bending, shear, torsion and deflection, combined with any axial loads that may be present. Columns are subject to axial compressive loads, and must be checked for buckling.

BASIC DESIGN METHODOLOGY OF BEAMS

The equations used for analysis of beam loading depend on the support condition and loading condition of the beam. The tables of loading information found on pages 5 and 6 are based on simply-supported beams, with four different loading configurations. In addition to the support and loading, the capacity is based on the material and cross-sectional properties. The material and cross-sectional properties for the NexSpan2™ F Series members can be found on page 4.

Beams are often categorized by their support conditions. A simply-supported beam is a beam that is restrained in all three directions but not resistant to rotating at the support locations. An example of this is a beam that is supported by a pin at one end and a roller or smooth surface at the other end.

A cantilevered beam has one fixed end that is restrained in all three dimensions and also cannot rotate, while the other end is free.

A fixed beam has both ends fixed such that it is restrained in all three dimensions and neither end can rotate, so both ends resist bending.

These three types of beams can be seen in the following diagram. Other types of beams include beams with overhangs and continuous beams, which are not pictured.

Figure: from left to right: simply-supported beam, cantilevered beam, fixed beam

Since beams are subject to transverse loads, shear forces and bending moments are produced within the beam. Possible loading conditions for beams include a point load, P (lbs), and a distributed load, w (lbs/ft). A point load is concentrated in one location on the beam, and a distributed load is spread uniformly over a length of the beam, as shown in the figure:

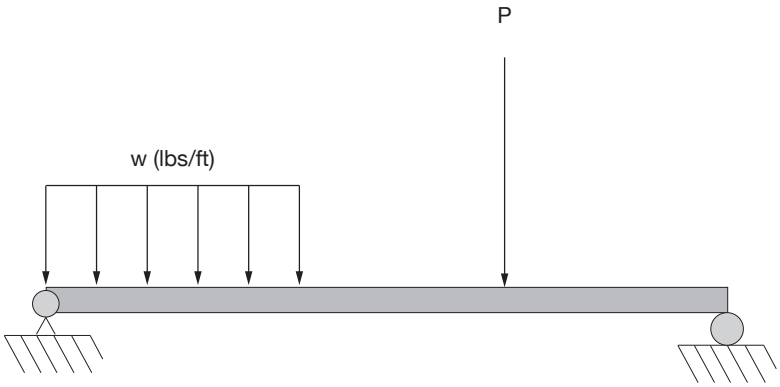


Figure: Point load, P, and distributed load, w

Note that a free body diagram can be used to apply the equations of equilibrium to simply-supported and cantilevered beams to find the reactions. For this reason, they are called statically determinate. This method, however, cannot be used to find the reactions within fixed beams, which are statically indeterminate.

BASIC DESIGN METHODOLOGY OF COLUMNS

The allowable load capacity of a column is based on intrinsic properties, such as material and cross-sectional properties, as well as external influences, including its support conditions, unbraced length/height, and the location of the applied load. The material and cross-sectional properties for the NexSpan2™ F Series members can be found on page 4.

The length of the column that spans the distance between the end locations is the unbraced length or height, L. Possible support conditions for columns can be seen in the figure below. The column will have a combination of fixed, pinned, and free end conditions; the impact of this combination can be thought of as effectively increasing or decreasing the column's unbraced height. This influences the column's capacity by means of the effective length factor, K. The default end condition is pinned-pinned, and for this scenario K=1.0. One or more fixed ends decreases the value of K, and a free end increases it. Values of K can be seen for each example below.

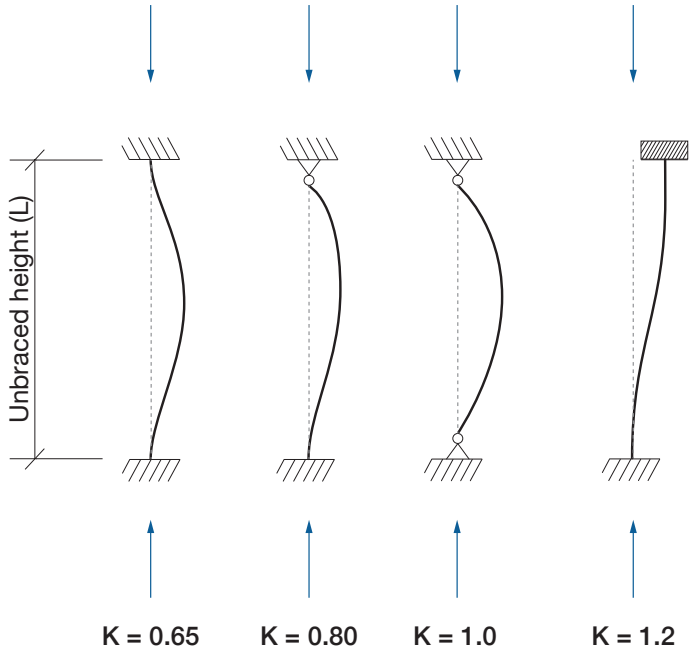


Figure: Possible support conditions for columns include (from left to right): fixed-fixed, fixed-pinned, pinned-pinned, fixed-fixed/free.

Since a column is subject to axially compressive loads, its typical geometry dictates that buckling is its primary method of failure. The longer and more slender, the more prone to buckling a column becomes. This relationship is represented by the slenderness ratio,

$$K L / r,$$

Where K and L are described above, and r is the radius of gyration, which can be found with the other cross-sectional properties mentioned above. Note, since the NexSpan2™ members are square, the radius of gyration is the same in both axes of the cross section. For columns with unequal values of r, the smaller r would be used.

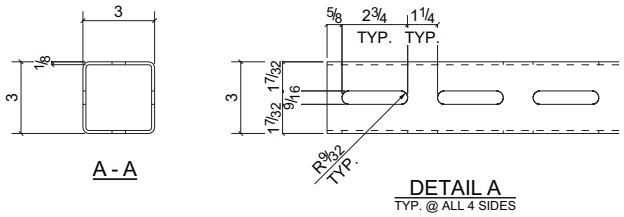
DESIGN CONSIDERATIONS OF NEXSPAN2™ TUBES

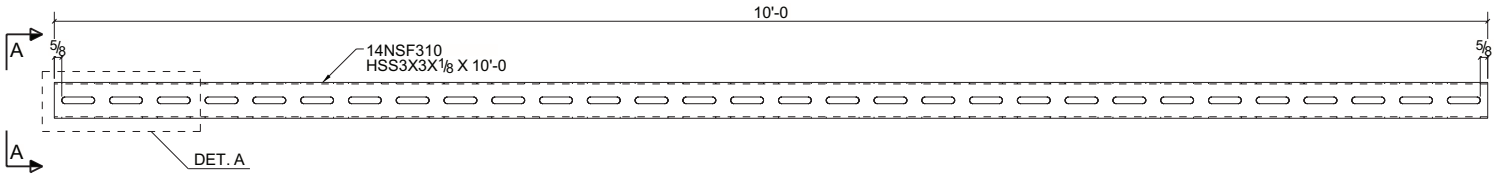
Selection of NexSpan2™ F Series tubes for a user application may be completed using the load tables in this document. If the user requires more capacity from the assembly than is provided by the load tables, it may be designed to AISC 360 by a qualified engineer. Contact Allfasteners for information on obtaining engineering services through one of our engineering partners.

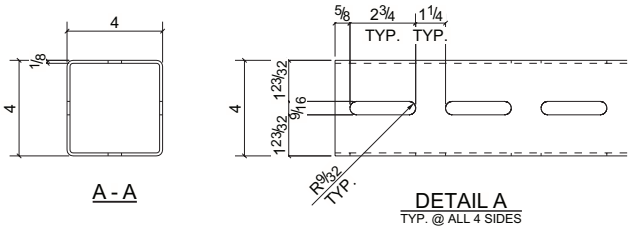
The load tables are based on elastic design, and allowable loads for the beams have been determined based on typical allowable deflections for a given span, specifically, 1/180, 1/240, or 1/360 times the span. The maximum deflection requirement may be set by building codes, specifications like contract documents, or user preference.

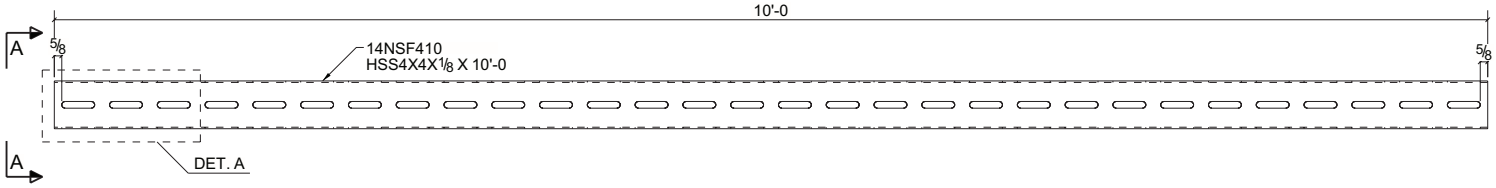
The NexSpan2™ tube end connections are designed such that the T-bolt slots will align with tubes cut at 4" increments. Other tube lengths can be used, but fit-up considerations must be accounted for, so that the T-bolts are able to be inserted and installed in all locations required.

NEXSPAN2™ F SERIES TUBE DIMENSIONS









NEXSPAN2™ F SERIES TECHNICAL PRODUCT INFORMATION

MEMBER PROPERTIES

	UNITS	AF-NS2-3	AF-NS2-4
Depth	in	3.000	4.000
Width	in	3.000	4.000
Thickness	in	0.125	0.125
Wt/ft.	lb/ft	4.4	6.0

SLOT DIMENSIONS

	UNITS	AF-NS2-3	AF-NS2-4
Height x Width	in.	9/16" x 2-3/4"	9/16" x 2-3/4"

MATERIAL INFORMATION

	UNITS	AF-NS2-3	AF-NS2-4
ASTM Specification		A500 Gr B	A500 Gr B
Minimum Specified Yield Strength	ksi	46	46
Minimum Specified Tensile Strength	ksi	58	58
Modulus of Elasticity	ksi	29000	29000

GROSS SECTION PROPERTIES

	UNITS	AF-NS2-3	AF-NS2-4
Design Thickness	in	0.116	0.116
Area	in^2	1.300	1.770
Moment of Inertia	in^4	1.780	4.400
Radius of Gyration	in	1.170	1.580

EFFECTIVE SECTION PROPERTIES

	UNITS	AF-NS2-3	AF-NS2-4
Effective Area	in^2	1.043	1.506
Effective Web Area	in^2	0.458	0.689
Effective Moment of Inertia	in^4	1.507	3.903
Effective Section Modulus	in^3	1.005	1.952
Effective Radius of Gyration	in	1.203	1.610

BEAM & COLUMN LOAD TABLES FOR NEXSPAN2™ 14NSF3

BEAMS

CASE 1 - UNIFORMLY DISTRIBUTED LOAD

SPAN (in.)	MAX ALLOWABLE LOAD P (lbs)	Δ AT MAX ALLOWABLE LOAD (in.)	SPAN/180	SPAN/240	SPAN/360
48	4568	0.15	NA	NA	4006
60	3647	0.24	NA	NA	2553
72	3031	0.34	NA	2656	1762
84	2590	0.47	NA	1940	1283
96	2258	0.61	1976	1474	971
108	1998	0.77	1550	1152	755
120	1790	0.95	1243	922	600

CASE 2 - CONCENTRATED LOAD AT CENTER

SPAN (in.)	MAX ALLOWABLE LOAD P (lbs)	Δ AT MAX ALLOWABLE LOAD (in.)	SPAN/180	SPAN/240	SPAN/360
48	2284	0.12	NA	NA	NA
60	1823	0.19	NA	NA	1596
72	1515	0.27	NA	NA	1101
84	1295	0.37	NA	1212	802
96	1129	0.49	NA	921	607
108	999	0.62	969	720	472
120	895	0.76	777	576	375

CASE 3 - TWO EQUAL CONCENTRATED LOADS EQUALLY PLACED

SPAN (in.)	MAX ALLOWABLE LOAD P (lbs)	Δ AT MAX ALLOWABLE LOAD (in.)	SPAN/180	SPAN/240	SPAN/360
48	1713	0.16	NA	NA	1469
60	1367	0.24	NA	NA	937
72	1137	0.35	NA	974	646
84	971	0.48	953	712	471
96	847	0.62	725	541	356
108	749	0.79	569	423	277
120	671	0.97	456	338	220

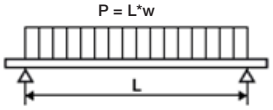
CASE 4 - THREE EQUAL CONCENTRATED LOADS EQUALLY PLACED

SPAN (in.)	MAX ALLOWABLE LOAD P (lbs)	Δ AT MAX ALLOWABLE LOAD (in.)	SPAN/180	SPAN/240	SPAN/360
48	1142	0.15	NA	NA	1048
60	912	0.23	NA	NA	668
72	758	0.33	NA	695	461
84	647	0.44	NA	508	336
96	564	0.58	517	386	254
108	500	0.74	406	302	198
120	448	0.91	325	241	157

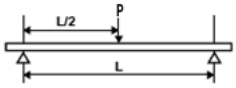
NOTES:

1. These load tables are based on the allowable stress method, using an elastic capacity with a factor of safety Ω of 1.67, and AISC 360 *Specification for Structural Steel Buildings*.
2. The load values in these tables are based on simply supported beams.
3. Beam weight has already been deducted from the tables.
4. Load values indicated as “NA” were found to be higher than the maximum allowable load, and therefore not applicable.

CASE 1:



CASE 2:



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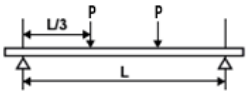
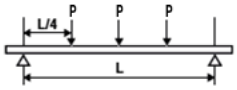


CASE 4:



COLUMNS

UNBRACED HEIGHT (in.)	ALLOWABLE CONCENTRIC LOAD (lbs.)			
	K=0.65	K=0.80	K=1.0	K=1.2
24	28406	28241	27970	27643
36	28007	27643	27050	26342
48	27458	26826	25812	24624
60	26768	25812	24303	22578
72	25949	24624	22578	20306
84	25012	23290	20696	17915
96	23973	21840	18719	15504
108	22848	20306	16706	13160
120	21653	18719	14711	10941

BEAM & COLUMN LOAD TABLES FOR NEXSPAN2™ 14NSF4

BEAMS

CASE 1 - UNIFORMLY DISTRIBUTED LOAD

SPAN (in.)	MAX ALLOWABLE LOAD P (lbs)	Δ AT MAX ALLOWABLE LOAD (in.)	SPAN/180	SPAN/240	SPAN/360
48	8922	0.11	NA	NA	NA
60	7127	0.18	NA	NA	6668
72	5928	0.26	NA	NA	4615
84	5070	0.35	NA	NA	3375
96	4425	0.46	NA	3877	2568
108	3922	0.58	NA	3047	2013
120	3519	0.71	3289	2452	1614

CASE 2 - CONCENTRATED LOAD AT CENTER

SPAN (in.)	MAX ALLOWABLE LOAD P (lbs)	Δ AT MAX ALLOWABLE LOAD (in.)	SPAN/180	SPAN/240	SPAN/360
48	4461	0.09	NA	NA	NA
60	3564	0.14	NA	NA	NA
72	2964	0.21	NA	NA	2885
84	2535	0.28	NA	NA	2110
96	2213	0.37	NA	NA	1605
108	1961	0.46	NA	1904	1258
120	1759	0.57	NA	1532	1009

CASE 3 - TWO EQUAL CONCENTRATED LOADS EQUALLY PLACED

SPAN (in.)	MAX ALLOWABLE LOAD P (lbs)	Δ AT MAX ALLOWABLE LOAD (in.)	SPAN/180	SPAN/240	SPAN/360
48	3346	0.12	NA	NA	NA
60	2673	0.18	NA	NA	2446
72	2223	0.26	NA	NA	1693
84	1901	0.36	NA	1865	1238
96	1659	0.47	NA	1422	942
108	1471	0.59	NA	1118	739
120	1319	0.73	1207	899	592

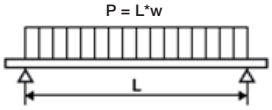
CASE 4 - THREE EQUAL CONCENTRATED LOADS EQUALLY PLACED

SPAN (in.)	MAX ALLOWABLE LOAD P (lbs)	Δ AT MAX ALLOWABLE LOAD (in.)	SPAN/180	SPAN/240	SPAN/360
48	2231	0.11	NA	NA	NA
60	1782	0.17	NA	NA	1745
72	1482	0.25	NA	NA	1208
84	1268	0.33	NA	NA	883
96	1106	0.44	NA	1015	672
108	981	0.55	NA	797	527
120	880	0.68	861	642	423

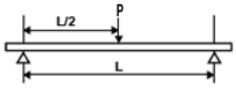
NOTES:

1. These load tables are based on the allowable stress method, using an elastic capacity with a factor of safety Ω of 1.67, and AISC 360 *Specification for Structural Steel Buildings*.
2. The load values in these tables are based on simply supported beams.
3. Beam weight has already been deducted from the tables.
4. Load values indicated as “NA” were found to be higher than the maximum allowable load, and therefore not applicable.

CASE 1:



CASE 2:



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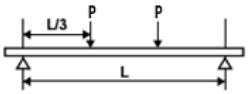
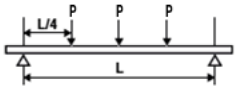


CASE 4:



COLUMNS

UNBRACED HEIGHT (in.)	ALLOWABLE CONCENTRIC LOAD (lbs.)			
	K=0.65	K=0.80	K=1.0	K=1.2
24	41221	41088	40867	40599
36	40897	40599	40111	39521
48	40448	39925	39075	38060
60	39877	39075	37783	36261
72	39191	38060	36261	34177
84	38394	36895	34542	31868
96	37496	35595	32659	29397
108	36503	34177	30648	26827
120	35424	32659	28548	24219

NEXSPAN2™ PRODUCT LINE PART-SPECIFIC DESIGN CONSIDERATIONS

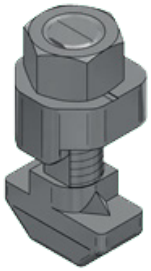
NEXSPAN2™ T-BOLTS

NexSpan2™ T-bolts are used to connect the NexSpan2™ F Series components. Care must be taken to install the T-bolts per the provided installation instructions.

NEXSPAN2™ PRODUCT LINE PART-SPECIFIC CONNECTION CAPACITIES

PART NUMBERS 2TLB1240

Allowable Bolt Shear Load	2200	lbs
Allowable Bolt Tension Load	674	lbs



PART NUMBERS 2TLL1240

Allowable Bolt Shear Load	674	lbs
Allowable Bolt Tension Load	674	lbs

NEXSPAN2™ PRODUCT LINE PART-SPECIFIC DESIGN CONSIDERATIONS

14NSF-S, SPLICE CONNECTORS

Nexspan2™ splice connectors are used when two tubes need to be connected. The splice connectors are placed internal to the tubes.

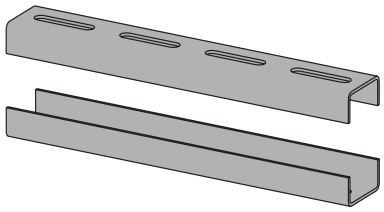
NEXSPAN2™ PRODUCT LINE PART-SPECIFIC CONNECTION CAPACITIES

PART NUMBERS 14NSF-S13

Mx	1100	lbs-ft

PART NUMBERS 14NSF-S14

Mx	1467	lbs-ft



NEXSPAN2™ PRODUCT LINE PART-SPECIFIC DESIGN CONSIDERATIONS

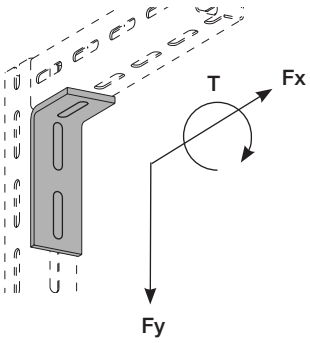
14NSF-A, ANGLES

NexSpan2™ angle parts are 90-degree bent plates, and can be categorized as either angle corners or cross connectors. Angle corners have slots all in the same plane, and are used to connect beams to columns, applying a face load on the column. Cross connectors are used to connect two beams in perpendicular planes.

NEXSPAN2™ PRODUCT LINE PART-SPECIFIC CONNECTION CAPACITIES

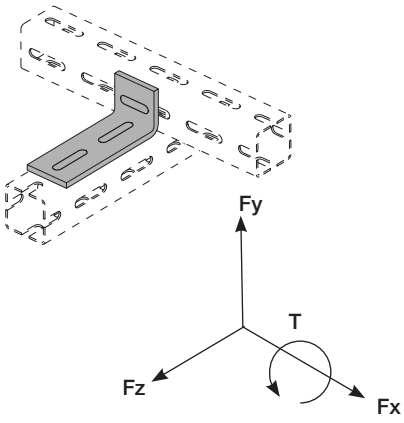
PART NUMBERS 14NSF-A63, A64

Fy	4400	lbs
Fx	1348	lbs
T	433	lbs-ft



PART NUMBERS 14NSF-A73, A74

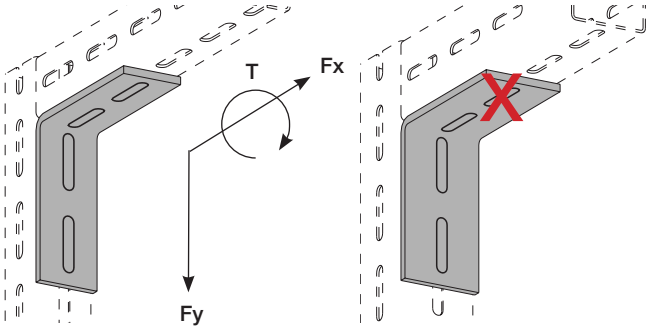
Fz	4400	lbs
Fy	674	lbs
T	433	lbs-ft



PART NUMBERS 14NSF-A83, A84

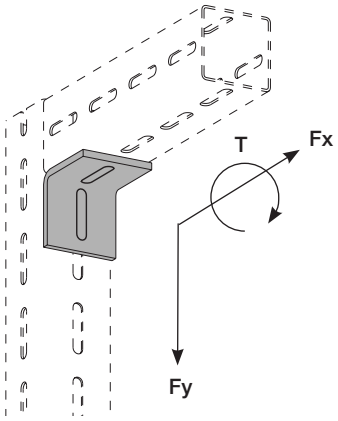
4 Bolts Used		
Fy	4400	lbs
Fx	1348	lbs
T	866	lbs-ft
3 Bolts Used - 2 Side & 1 Top		
Fy	4400	lbs
Fx	1348	lbs
T	433	lbs-ft

NOTE: Red "X" indicates location of omitted T-bolt, when only using 3 T-bolts.



PART NUMBERS 14NSF-A93, A94

Fy	2200	lbs
Fx	674	lbs
T	215	lbs-ft



NEXSPAN2™ PRODUCT LINE PART-SPECIFIC DESIGN CONSIDERATIONS

14NSF-B, POST BASES

NexSpan2™ post bases are used to anchor columns by affixing them to supporting structures or concrete.

NEXSPAN2™ PRODUCT LINE PART-SPECIFIC CONNECTION CAPACITIES

PART NUMBER 14NSF-B13

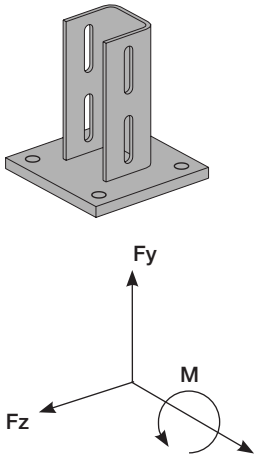
Fz	8800	lbs
Fy	8800	lbs
Mx	2300	lbs-ft

Mx: dependent on a minimum separation of 4" between T-bolts.

PART NUMBER 14NSF-B14

Fz	8800	lbs
Fy	8800	lbs
Mx	3000	lbs-ft

Mx: dependent on a minimum separation of 4" between T-bolts.

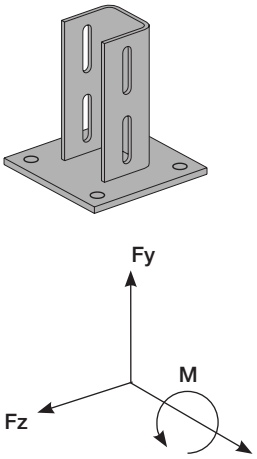


PART NUMBER 14NSF-B23

Fz	8800	lbs
Fy	4400	lbs
Mx	0	lbs-ft

PART NUMBER 14NSF-B24

Fz	8800	lbs
Fy	4400	lbs
Mx	0	lbs-ft

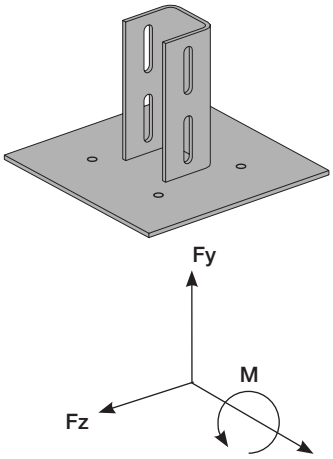


PART NUMBER 14NSF-B33

Fz	8800	lbs
Fy	0	lbs
Mx	0	lbs-ft

PART NUMBER 14NSF-B34

Fz	8800	lbs
Fy	0	lbs
Mx	0	lbs-ft



NEXSPAN2™ PRODUCT LINE PART-SPECIFIC DESIGN CONSIDERATIONS

14NSF-P, PLATES

NexSpan2™ plate parts are used to connect beams to columns, placing a concentric load on the column. The number of T-bolts required to be used with the plate parts may vary depending on whether it is meant to create a fixed versus pinned connection. A joint that uses a single T-bolt to connect one tube to another creates a pinned connection for that tube, whereas a joint that uses two T-bolts to connect the tube to another tube creates a fixed connection.

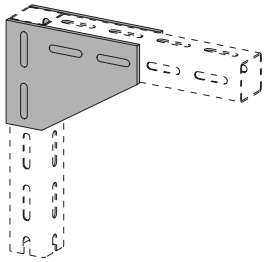
Note: For those parts that indicate a 4" moment arm used, the EOR must specify this on the drawings. Moment capacities are for non-cantilevered conditions. Additional configurations and loading conditions can be reviewed by the EOR for capacity determination.

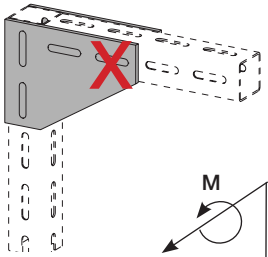
NEXSPAN2™ PRODUCT LINE PART-SPECIFIC CONNECTION CAPACITIES

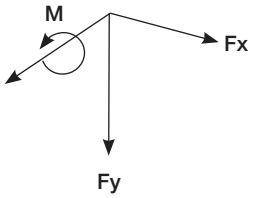
PART NUMBERS 14NSF-P63, P64

8 Bolts Used		
Fy	8800	lbs
Fx	8800	lbs
Mz	1467	lbs-ft
Using a 4" moment arm		
6 Bolts Used		
Fy	4400	lbs
Fx	4400	lbs
Mz	0	lbs-ft

NOTE: Red "X" indicates location of omitted T-bolt, when only using 6 T-bolts.

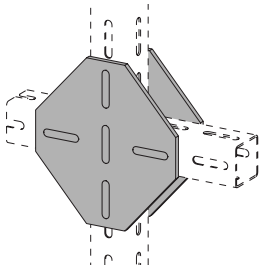






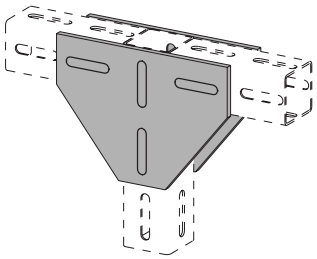
PART NUMBERS 14NSF-P83, P84

Fy	4400	lbs
Fx	4400	lbs
Mz	0	lbs-ft
Fy/Fx per horizontal member		



PART NUMBERS 14NSF-P73, P74

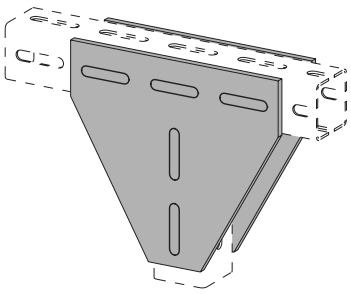
Fy	4400	lbs
Fx	4400	lbs
Mz	0	lbs-ft
Fy/Fx per horizontal member		

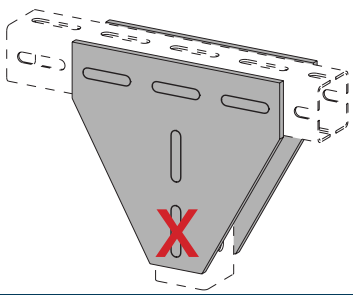


PART NUMBERS 14NSF-P93, P94

10 Bolts Used		
Fy	8800	lbs
Fx	8800	lbs
Mz	1467	lbs-ft
Using a 4" moment arm		
8 Bolts Used		
Fy	4400	lbs
Fx	8800	lbs
Mz	0	lbs-ft

NOTE: Red "X" indicates location of omitted T-bolt, when only using 8 T-bolts.



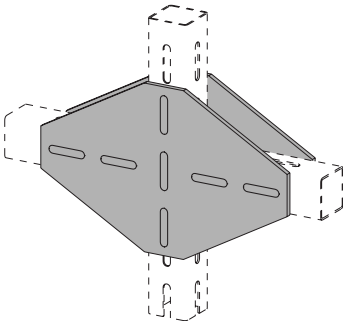


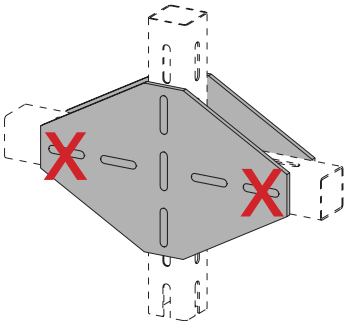
NEXSPAN2™ PRODUCT LINE PART-SPECIFIC CONNECTION CAPACITIES

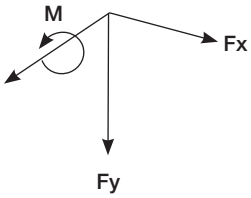
PART NUMBERS 14NSF-P03, P04

14 Bolts Used		
Fy	8800	lbs
Fx	8800	lbs
Mz	1467	lbs-ft
Using a 4" moment arm		
10 Bolts Used		
Fz	4400	lbs
Fx	4400	lbs
Mz	0	lbs-ft
Fy/Fx per horizontal member		

NOTE: Red "X" indicates location of omitted T-bolt, when only using 10 T-bolts.







NEXSPAN2™ PRODUCT LINE PART-SPECIFIC DESIGN CONSIDERATIONS

14NSF-PS, PIPE SUPPORTS

The pipe supports require the use of two T-bolts to prevent rotation of the part. They may only be used in two orientations: that where they are used to secure a pipe that is resting with its weight on a beam, or vertically to secure the pipe to a beam, unless the EOR evaluates for some other use.