# 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:

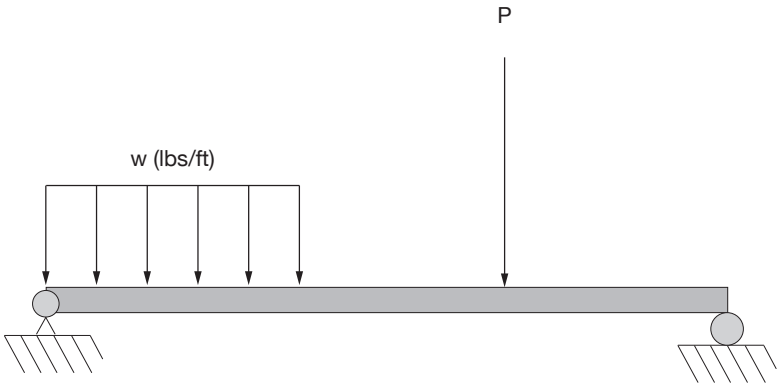



*Figure: Point load, P, and distributed load, w*

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.

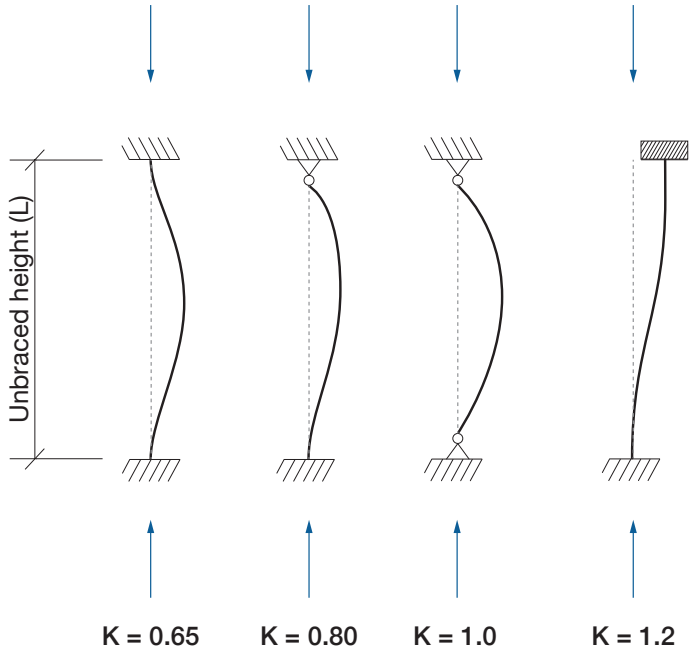



*Figure: Possible support conditions for columns include (from left to right): fixed-fixed, fixed-pinned, pinned-pinned, fixed-fixed/free.*

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.

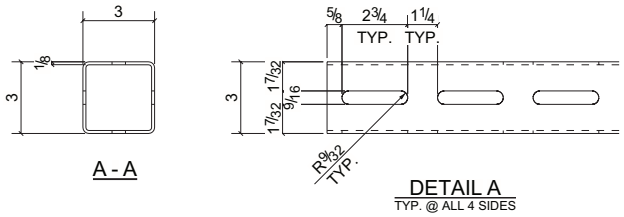
## DESIGN CONSIDERATIONS OF NEXSPAN2™ TUBES

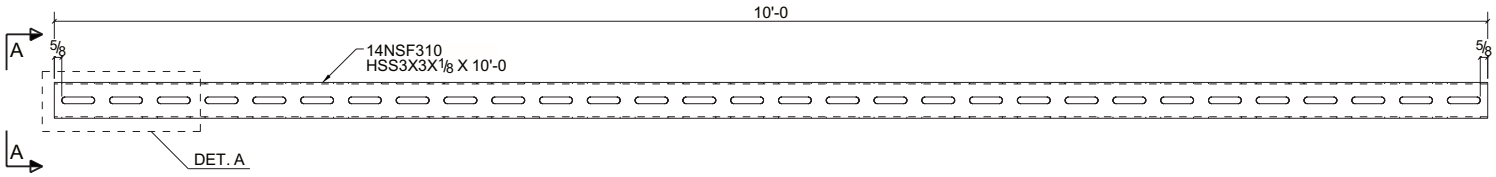
Selection of NexSpan2™ F Series tubes for a user application may be completed using the load tables in this document. If the user requires more capacity from the assembly than is provided by the load tables, it may be designed to AISC 360 by a qualified engineer. Contact Allfasteners for information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

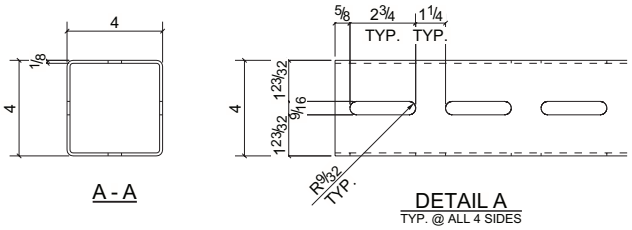
The load tables are based on elastic design, and allowable loads for the beams have been determined based on typical allowable deflections for a given span, specifically, 1/180, 1/240, or 1/360 times the span. The maximum deflection requirement may be set by building codes, specifications like contract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

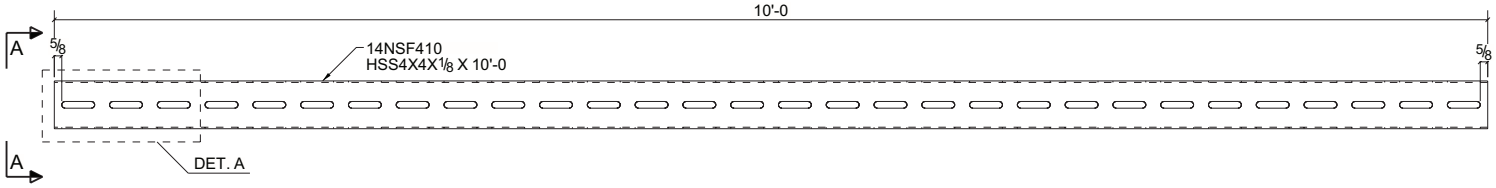
The NexSpan2™ tube end connections are designed such that the T-bolt slots will align with tubes cut at 4" increments. Other tube lengths can be used, but fit-up considerations must be accounted for, so that the T-bolts are able to be inserted and installed in all locations required.

## 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 |

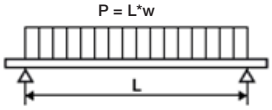
#### CASE 4 - THREE EQUAL CONCENTRATED LOADS EQUALLY PLACED

| 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 |

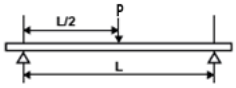
**NOTES:**

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.

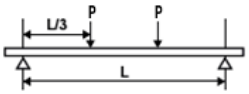
**CASE 1:**



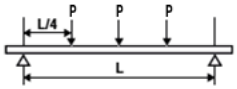

**CASE 2:**




**CASE 3:**




**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 |

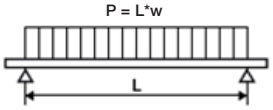
#### CASE 4 - THREE EQUAL CONCENTRATED LOADS EQUALLY PLACED

| 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 |

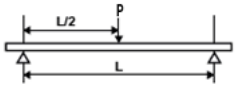
**NOTES:**

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.

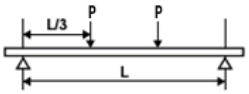
**CASE 1:**



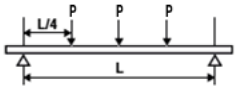

**CASE 2:**




**CASE 3:**




**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

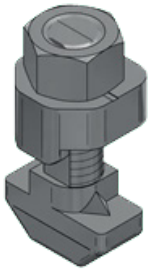
### NEXSPAN2™ T-BOLTS

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.

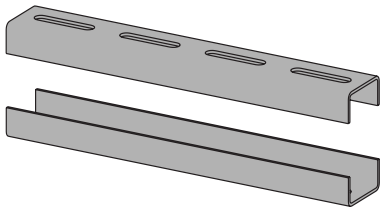
## NEXSPAN2™ PRODUCT LINE PART-SPECIFIC CONNECTION CAPACITIES

**PART NUMBERS 14NSF-S13**

| | | |
|---|---|---|
| Mx | 1100 | lbs-ft |

**PART NUMBERS 14NSF-S14**

| | | |
|---|---|---|
| Mx | 1467 | lbs-ft |



## NEXSPAN2™ PRODUCT LINE PART-SPECIFIC DESIGN CONSIDERATIONS

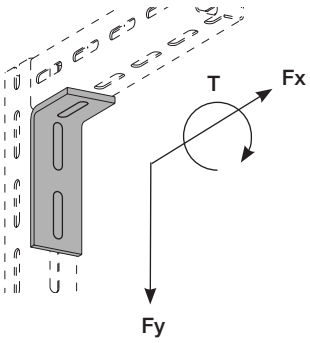
### 14NSF-A, ANGLES

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

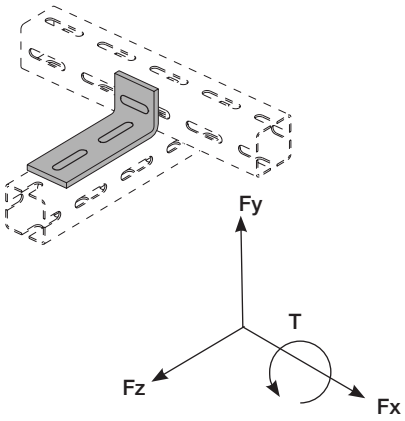
**PART NUMBERS 14NSF-A13, A14, A63, A64**

| | | |
|---|---|---|
| Fy | 4400 | lbs |
| Fx | 1348 | lbs |
| T | 433 | lbs-ft |




**PART NUMBERS 14NSF-A23, A24, A73, A74**

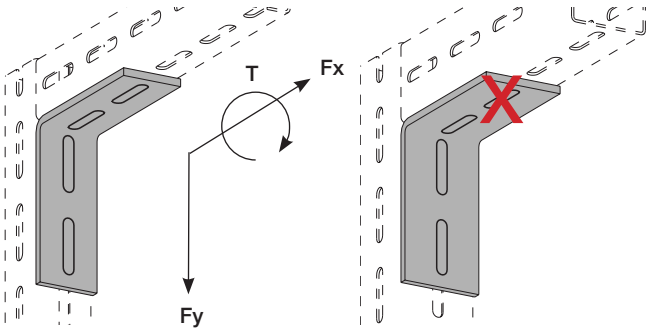
| | | |
|---|---|---|
| Fz | 4400 | lbs |
| Fy | 674 | lbs |
| T | 433 | lbs-ft |




**PART NUMBERS 14NSF-A43, A44, A83, A84**

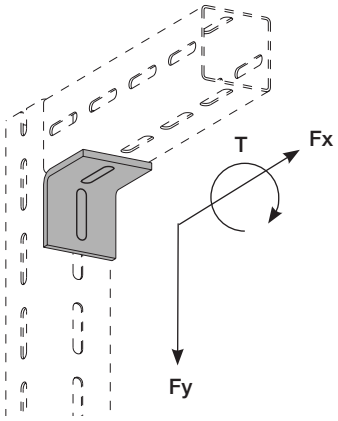
| 4 Bolts Used | | |
|---|---|---|
| Fy | 4400 | lbs |
| Fx | 1348 | lbs |
| T | 866 | lbs-ft |
| **3 Bolts Used - 2 Side & 1 Top** | | |
| Fy | 4400 | lbs |
| Fx | 1348 | lbs |
| T | 433 | lbs-ft |

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




**PART NUMBERS 14NSF-A53, A54, 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**

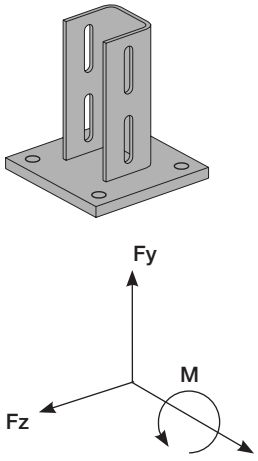
| | | |
|---|---|---|
| Fz | 8800 | lbs |
| Fy | 8800 | lbs |
| Mx | 2300 | lbs-ft |

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.

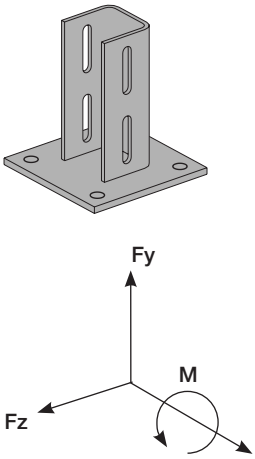



**PART NUMBER 14NSF-B23**

| | | |
|---|---|---|
| Fz | 8800 | lbs |
| Fy | 4400 | lbs |
| Mx | 0 | lbs-ft |

**PART NUMBER 14NSF-B24**

| | | |
|---|---|---|
| Fz | 8800 | lbs |
| Fy | 4400 | lbs |
| Mx | 0 | lbs-ft |

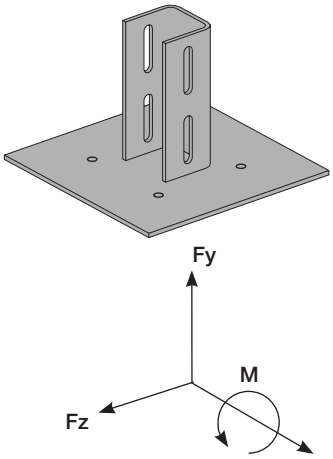



**PART NUMBER 14NSF-B33**

| | | |
|---|---|---|
| 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.

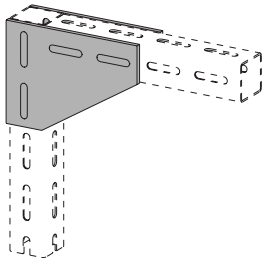
**Note:** For those parts that indicate a 4" moment arm used, the EOR must specify this on the drawings. Moment capacities are for non-cantilevered conditions. Additional configurations and loading conditions can be reviewed by the EOR for capacity determination.

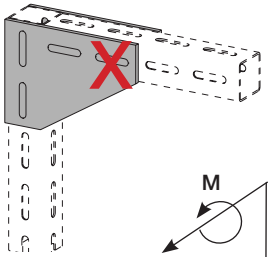
## NEXSPAN2™ PRODUCT LINE PART-SPECIFIC CONNECTION CAPACITIES

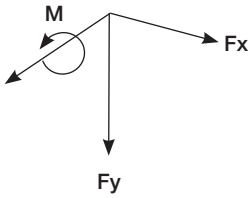
**PART NUMBERS 14NSF-P13, P14, P63, P64**

| 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.

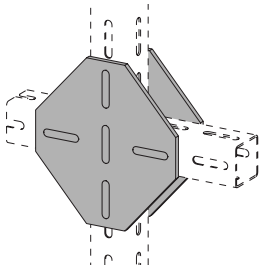




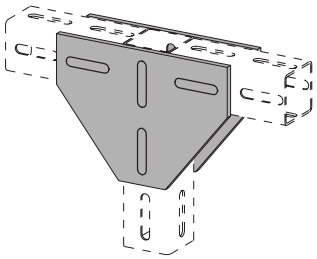

**PART NUMBERS 14NSF-P33, P34, P83, P84**

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



**PART NUMBERS 14NSF-P23, P24, P73, P74**

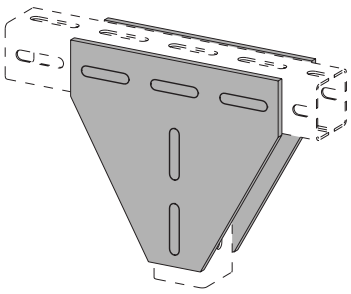
| | | |
|---|---|---|
| Fy | 4400 | lbs |
| Fx | 4400 | lbs |
| Mz | 0 | lbs-ft |
| Fy/Fx per horizontal member | | |

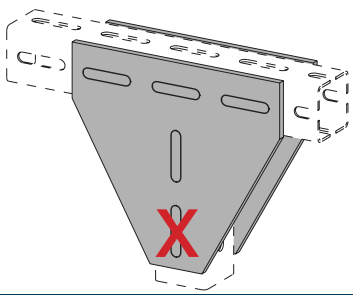


**PART NUMBERS 14NSF-P43, P44, P93, P94**

| 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.



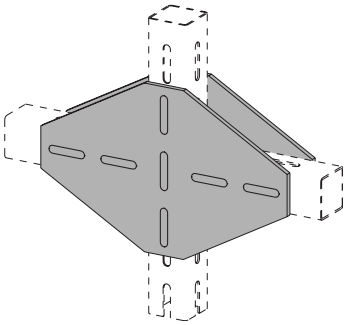


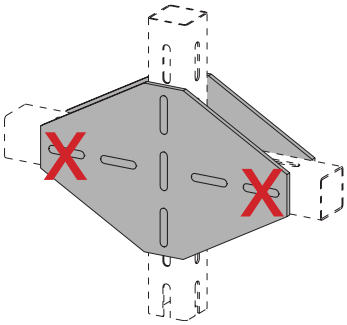
## NEXSPAN2™ PRODUCT LINE PART-SPECIFIC CONNECTION CAPACITIES

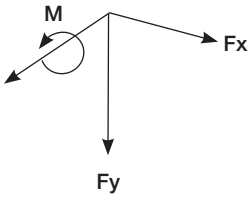
**PART NUMBERS 14NSF-P53, P54, P03, P04**

| 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.