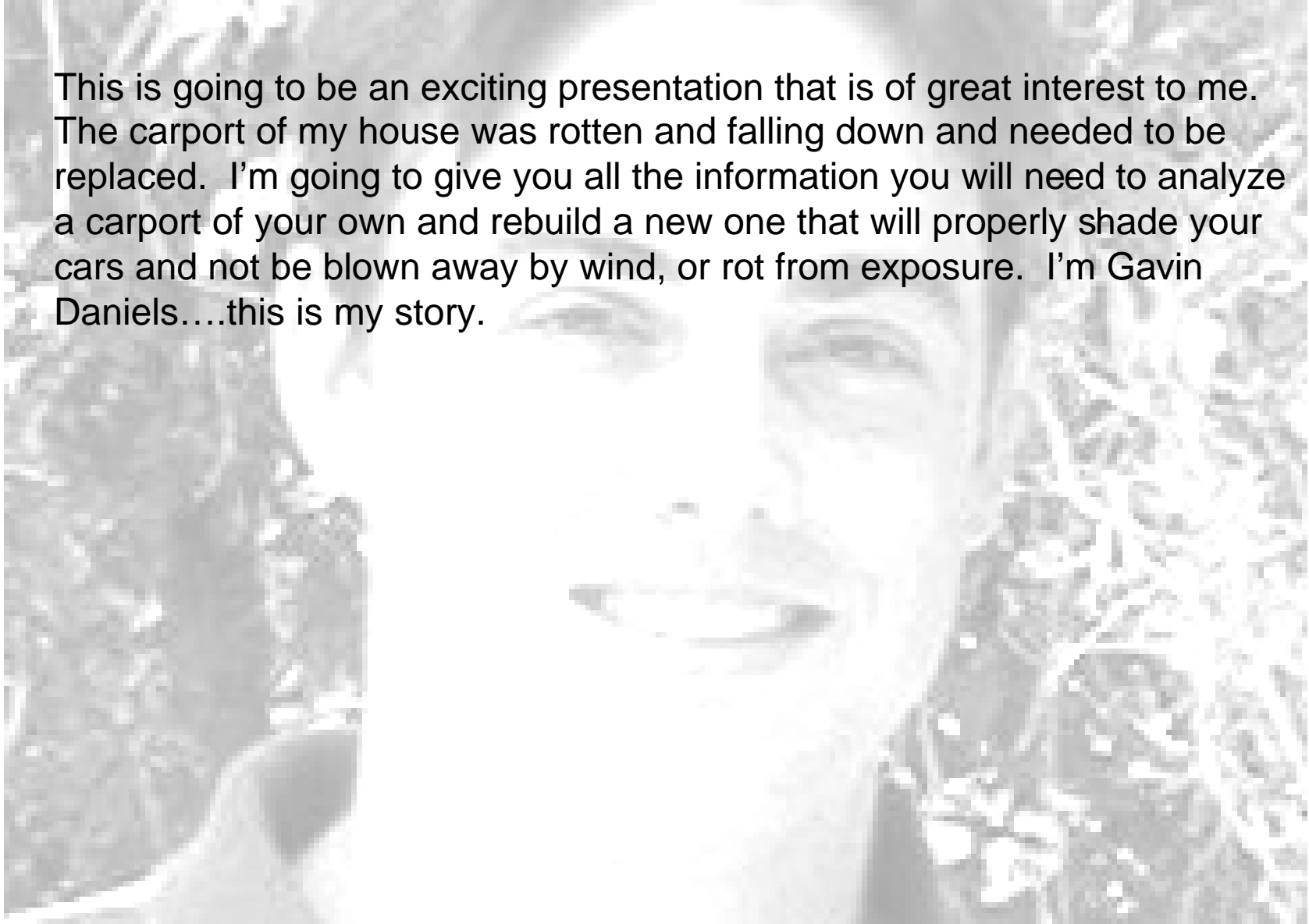


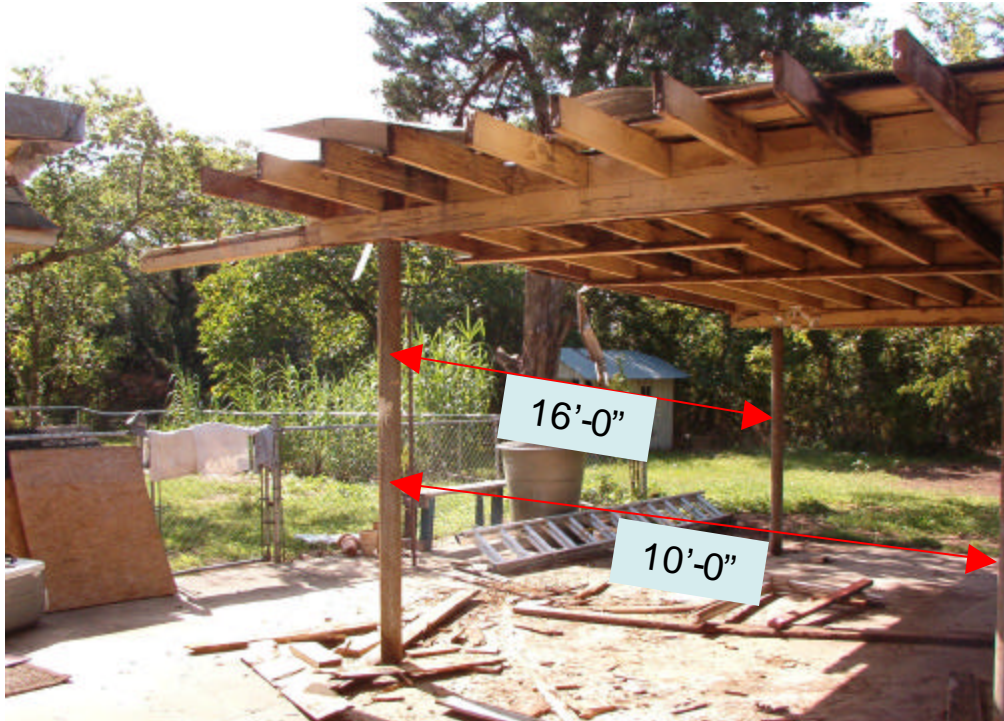
# The Carport - Bryan, Texas



This is going to be an exciting presentation that is of great interest to me. The carport of my house was rotten and falling down and needed to be replaced. I'm going to give you all the information you will need to analyze a carport of your own and rebuild a new one that will properly shade your cars and not be blown away by wind, or rot from exposure. I'm Gavin Daniels....this is my story.



# The Carport - Bryan, Texas



**ROTTEN!!**

The existing carport was a one way structure. The structure consisted of 6 5" dia columns with 4"x 6" beams spliced together across the 10' wide bays. The beams supported 2" x 6", 20' long joists with 1"x 6" decking and a sheet metal rolled roof. Over the 30+ years since it's initial construction lack of maintenance and an initial roof slope of 1" in 3' the carport began to leak. Years of rotting have rendered repair impossible, the only structural members still intact are the columns which show no signs of structural problems.

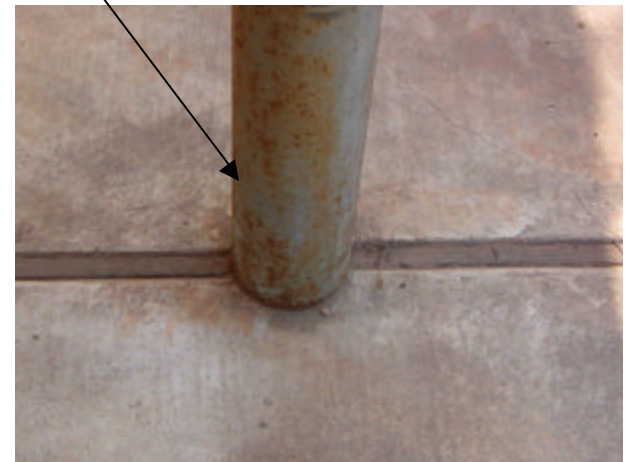
Existing Carport Analysis

# The Carport - Bryan, Texas



Rotten wood

Steel Columns embedded in concrete still in good condition

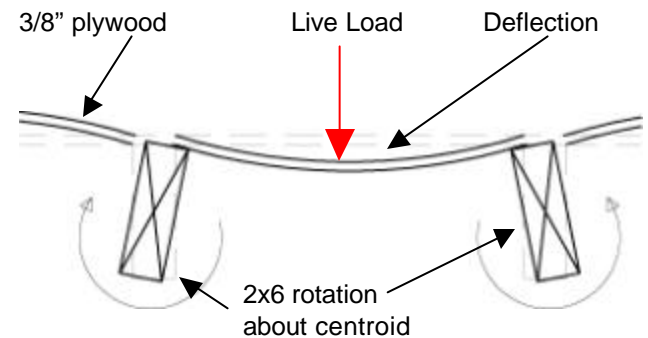


Metal Straps prevented uplift on the structure

Existing Carport Analysis

# The Carport - Bryan, Texas

- Code Enforcement
  - No permit required for demolition
  - A permit is required for new construction
- Sources
  - [http://www.bryantx.org/div\\_buildingservices/codes.htm](http://www.bryantx.org/div_buildingservices/codes.htm)
  - International Residential Building Code 2000
- Materials
  - Three 4x6 beams spanning the three bays was effective before and is well within the requirements of IRBC.
  - The IRBC allows 2x6 joists to span 16' as long as they are spaced less than 24" apart.
  - Initially 3/8" plywood decking was going to be used on top of the joists. I determined the deflection would be excessive during construction and provide undo torsional stress on the joists. The 3/8" thick plywood would not have provided enough material for the metal roof to attach to either. IRBC also recommended having at least 3/4" of material to fasten the roof covering to.
  - 1x4's placed 12" o.c. were used in lieu of the plywood. They would be more rigid and by using two nails at each 2x6 also help control lateral deformation of the 2x6's



Codes & Materials

# The Carport - Bryan, Texas

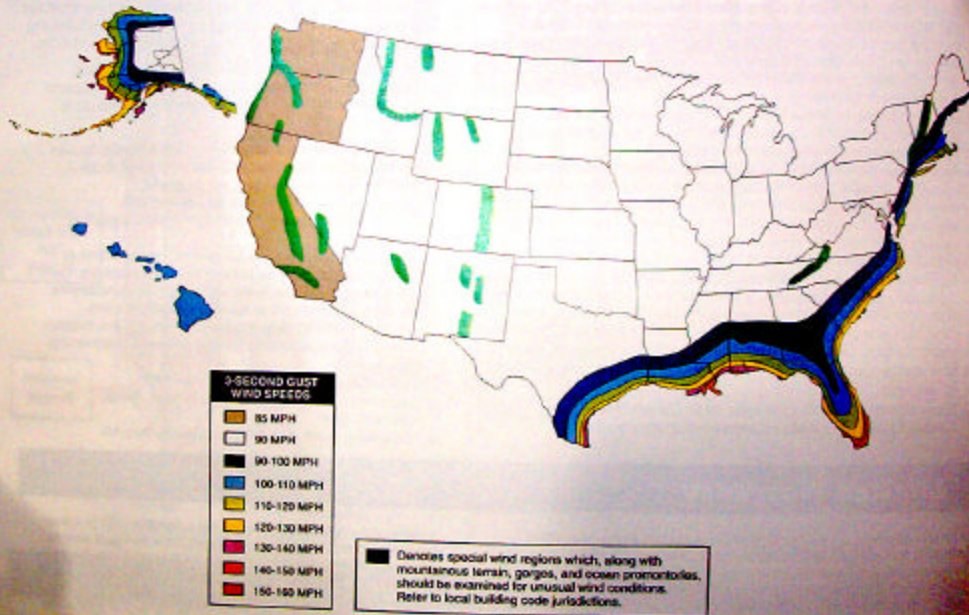
## Design Wind Speeds

The wind forces on building elements are determined from the basic wind speed, local terrain, and the structure's configuration. The map depicts the minimum basic wind speeds for the United States. This map, published in the ASCE 7-98 Standard, is also used in the IBC, IRC and FBC. It is important to note that the wind speeds and contour lines have changed from older wind speed maps.

The new map is based on a method of measuring windspeed that records the highest 3-second gust of wind, while previous maps were based on

measurements of the fastest-mile of wind. This new system results in higher stated wind speeds for the same wind.

Because of this change in the method of measuring wind, windspeeds for most areas have changed, and apparently increased from old maps. However, the actual design wind pressures produced by the new windspeed may or may not be much different from what has traditionally been used, depending on the location in the country.



Reproduced from ASCE 7-98, by the American Society of Civil Engineers, copyright 2000, with the permission of the publisher.

3 second gusts of 100+ mph wind must be withstood by the carport. There are no walls on the carport so, wind will create minimal lateral load on the carport (columns). The slope of the roof is 12" in 16'. This will encourage the uplift wind will surely produce on the carport. These forces must be counteracted through the use of proper fasteners and structural attachments.

Wind Uplift

# The Carport - Bryan, Texas

## Truss/Rafter to Wood Double Top Plates



| Model No. | Qty Req'd | Fasteners      |                | DF/SP Allowable Loads |   |  |              | SPF Allowable Loads                           |  |      |     |
|-----------|-----------|----------------|----------------|-----------------------|---|--|--------------|---|--|------|-----|
|           |           | To Rafter      | To Plates      | Uplift (133)          | Parallel to Plate (F <sub>1</sub> ) (133/150) | Perp. to Plate (F <sub>2</sub> ) (133/150) | Uplift (133) | Parallel to Plate (F <sub>1</sub> ) (133/150) | Perp. to Plate (F <sub>2</sub> ) (133/150) |      |     |
| H2.5      | 1         | 5-8d           | 5-8d           | 415                   | 415   | 150  | 150          | 365   | 365  | 130  | 130 |
| H5A       | 1         | 3-8d           | 3-8d           | 330                   | 420   | 115  | 180          | 245   | 245  | 100  | 120 |
| HGA10     | 1         | 4-50S1/4x1 1/8 | 4-50S1/4x3     | 435                   | 435   | 1165                                       | 940          | 375   | 375  | 870  | 815 |
| H8        | 1         | 4-8d           | 4-8d           | 455                   | 465   | 115  | 200          | 265   | 265  | 100  | 170 |
| H11       | 1         | 6-8d x 1 1/8   | 4-8d           | 490                   | 505   | 405  | 165          | 490   | 400  | 415  | 140 |
| H2.5A     | 1         | 5-8d           | 5-8d           | 600                   | 600   | 110  | 115          | 520   | 535  | 110  | 115 |
| LTS12     | 1         | 6-10d x 1 1/8  | 6-10d x 1 1/8  | 720                   | 720   | 75   | 125          | 620   | 620  | 75   | 125 |
| H8        | 1         | 5-10d x 1 1/8  | 5-10d x 1 1/8  | 620                   | 745   | —  | —            | 530   | 565  | —    | —   |
| H10-2     | 1         | 6-10d          | 6-10d          | 760                   | 760   | 455  | 395          | 655   | 655  | 300  | 340 |
| H2.5      | 2         | 10-8d          | 10-8d          | 830                   | 830   | 300  | 300          | 730   | 730  | 290  | 290 |
| H5        | 2         | 6-8d           | 6-8d           | 810                   | 930   | 390  | 400          | 530   | 530  | 200  | 340 |
| H10       | 1         | 6-8d x 1 1/8   | 6-8d x 1 1/8   | 805                   | 990   | 385  | 525          | 780   | 800  | 505  | 450 |
| MTS12     | 1         | 7-10d x 1 1/8  | 7-10d x 1 1/8  | 840                   | 1000  | 75   | 125          | 700   | 860  | 75   | 125 |
| H1        | 2         | 12-8d x 1 1/8  | 8-8d           | 980                   | 1170  | 970  | 320          | 800   | 800  | 890  | 280 |
| H2.5A     | 2         | 10-8d          | 10-8d          | 1200                  | 1200  | 220  | 220          | 1040  | 1070                                       | 220  | 220 |
| LTS12     | 2         | 12-10d x 1 1/8 | 12-10d x 1 1/8 | 1440                  | 1440  | 150  | 250          | 1240  | 1240                                       | 150  | 250 |
| HTS20     | 1         | 12-10d x 1 1/8 | 12-10d x 1 1/8 | 1450                  | 1450  | 75   | 125          | 1245  | 1245                                       | 75   | 125 |
| H16S      | 1         | 2-10d x 1 1/8  | 10-10d x 1 1/8 | 1470                  | 1470  | —  | —            | 1265  | 1265                                       | —    | —   |
| H10       | 1         | 2-10d x 1 1/8  | 10-10d x 1 1/8 | 1470                  | 1470  | —  | —            | 1265  | 1265                                       | —    | —   |
| H15       | 2         | 16-8d x 1 1/8  | 16-8d x 1 1/8  | 1810                  | 1980  | 1175                                       | 1050         | 1580  | 1590                                       | 1010 | 900 |
| MTS12     | 2         | 14-10d x 1 1/8 | 14-10d x 1 1/8 | 1680                  | 2000  | 150  | 250          | 1460  | 1720                                       | 150  | 250 |

1. "-" in the tables indicates that the product has not been tested in the particular load direction listed.  
 2. For connections to single top plates, see page 12.  
 3. Fasten multiple members together to act as a single unit.

**D7**

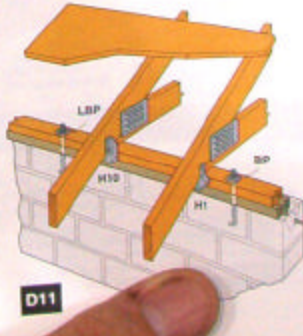
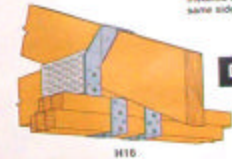
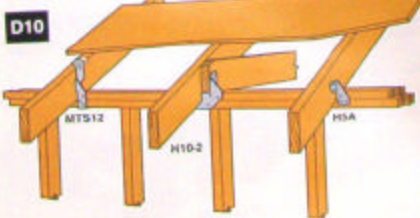
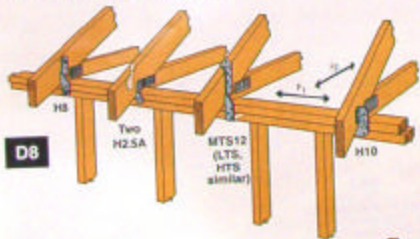
Hurricane Tie Installations to Achieve Twice the Load (Top View)



Install diagonally across from each other for minimum 2x cross.



Nailing into both sides of a single ply 2x plate may crush the wood to split. A minimum rafter thickness of 2" must be used when connections are installed on the same side.



The rafters on one end were placed on top of the 4x6 beam to increase the slope of the structure and encourage water flow off the roof. The hurricane straps used at this end were designed to withstand the high winds that are known to pass through this area. These winds would cause an uplift on the structure. When properly installed these ties can resist about 1,000 lbs of uplift. The straps are securely fastened with the manufacturer's recommended nails.



Hurricane Ties

# The Carport - Bryan, Texas

## Face Mount Hangers - Solid Sawn Lumber (SPF)

| Joist Size               | Model No. | Ga | Dimensions      |                 |                 | Fasteners |        |                                | Spruce-Pine-Fir Allowable Loads |       |             |      |            |      |            |      | Code Ref. |
|--------------------------|-----------|----|-----------------|-----------------|-----------------|-----------|--------|--------------------------------|---------------------------------|-------|-------------|------|------------|------|------------|------|-----------|
|                          |           |    | W               | H               | B               | Header    |        | Joist                          | Uplift                          |       | Floor (100) |      | Snow (115) |      | Roof (125) |      |           |
|                          |           |    |                 |                 |                 | 10d       | 16d    |                                | (133)                           | (160) | 10d         | 16d  | 10d        | 16d  | 10d        | 16d  |           |
| <b>SAWN LUMBER SIZES</b> |           |    |                 |                 |                 |           |        |                                |                                 |       |             |      |            |      |            |      |           |
| 2x4                      | LU24      | 20 | 1 $\frac{1}{8}$ | 3 $\frac{1}{2}$ | 1 $\frac{1}{2}$ | 4-10d     | 4-16d  | 2-10d $\times$ 1 $\frac{1}{2}$ | 210                             | 255   | 385         | 460  | 440        | 530  | 480        | 575  | 2, 43, 1  |
|                          | LUS24     | 18 | 1 $\frac{1}{8}$ | 3 $\frac{1}{2}$ | 1 $\frac{1}{2}$ | 4-10d     | —      | 2-10d                          | 390                             | 465   | 540         | —    | 625        | —    | 675        | —    | 4, 38, 87 |
|                          | U24       | 16 | 1 $\frac{1}{8}$ | 3 $\frac{1}{2}$ | 1 $\frac{1}{2}$ | 4-10d     | 4-16d  | 2-10d $\times$ 1 $\frac{1}{2}$ | 210                             | 250   | 385         | 460  | 440        | 530  | 480        | 575  | 26, 83,   |
|                          | HU26      | 14 | 1 $\frac{1}{8}$ | 3 $\frac{1}{2}$ | 2 $\frac{1}{2}$ | —         | 4-16d  | 2-10d $\times$ 1 $\frac{1}{2}$ | 210                             | 250   | —           | 465  | —          | 535  | —          | 580  | 26, 83,   |
| DBL 2x4                  | LUS24-2   | 18 | 3 $\frac{1}{8}$ | 3 $\frac{1}{2}$ | 2               | —         | 4-16d  | 2-16d                          | 440                             | 440   | —           | 640  | —          | 735  | —          | 800  | 1, 36, 84 |
|                          | U24-2     | 16 | 3 $\frac{1}{8}$ | 3               | 2               | 4-10d     | 4-16d  | 2-10d                          | 255                             | 305   | 385         | 460  | 440        | 530  | 480        | 575  | 26, 83,   |
|                          | HU24-2    | 14 | 3 $\frac{1}{8}$ | 3 $\frac{1}{2}$ | 2 $\frac{1}{2}$ | —         | 4-16d  | 2-10d                          | 260                             | 315   | —           | 465  | —          | 535  | —          | 580  | 26, 83,   |
|                          | LUS26     | 18 | 1 $\frac{1}{8}$ | 4 $\frac{1}{2}$ | 1 $\frac{1}{2}$ | 4-10d     | —      | 4-10d                          | 780                             | 935   | 700         | —    | 805        | —    | 875        | —    | 4, 38, 87 |
| 2x6                      | LU26      | 20 | 1 $\frac{1}{8}$ | 4 $\frac{1}{2}$ | 1 $\frac{1}{2}$ | 6-10d     | 6-16d  | 4-10d $\times$ 1 $\frac{1}{2}$ | 420                             | 505   | 575         | 690  | 660        | 795  | 720        | 860  | 2, 43,    |
|                          | U26       | 16 | 1 $\frac{1}{8}$ | 4 $\frac{1}{2}$ | 2               | 6-10d     | 6-16d  | 4-10d $\times$ 1 $\frac{1}{2}$ | 415                             | 500   | 575         | 690  | 660        | 795  | 720        | 860  | 26, 83,   |
|                          | HU26      | 14 | 1 $\frac{1}{8}$ | 3 $\frac{1}{2}$ | 2 $\frac{1}{2}$ | —         | 4-16d  | 2-10d $\times$ 1 $\frac{1}{2}$ | 210                             | 250   | —           | 465  | —          | 535  | —          | 580  | 26, 83,   |
|                          | HUS26     | 16 | 1 $\frac{1}{8}$ | 5 $\frac{1}{2}$ | 3               | —         | 14-16d | 6-16d                          | 1390                            | 1550  | —           | 2155 | —          | 2475 | —          | 2540 | 4, 38,    |



The joist hangers on the opposite end of the Hurricane Ties serve two purposes. They support the dead load of the 2x6, 1x4's and metal deck. They are also capable of resisting an upload of almost 1,000 lbs. This is well over any predicted worst case upload for this area and when paired with the hurricane ties assures the structure will remain intact during a storm.

Joist Hangers

# The Carport - Bryan, Texas

**TO ORDER:** Display Packages—available for N80 and N100 nails  
To order, specify:  
N80 MSTR CTN—25 display packs of 150 N8 nails  
N80S MSTR CTN—6 display packs of 600 N80 nails  
N100 MSTR CTN—25 display packs of 150 N10 nails  
N100S MSTR CTN—6 display packs of 600 N10 nails  
50lb Bulk Boxes—available for N8, N10 and N15 nails

**Strong-Tie nails and structural fasteners** have been developed as the optimum fasteners for connector products. Special lengths afford economy of purchase and installation. Nail specifications include head size, thickness, steel and shank design, and point configuration to ensure conformity to published values. For pneumatic nail use, see instructions to the installer, page 9.

**COMPATIBLE SIZES:** 55N8 = N8, 55B0 = B0 common; 55N10 = N10, 55100 = 10d common; 55160 = 16d common

**NAILS**

**Load adjustment factors for optional nails used with face mount hangers and straight straps**

| Catalog Nail                | Replacement Nail                      | Allowable Load Adjustment Factor |
|-----------------------------|---------------------------------------|----------------------------------|
| 16d common (0.182 x 3 1/2") | 10d x 1 1/2" (0.148 x 1 1/2")         | 0.64                             |
| 16d common (0.182 x 3 1/2") | 10d common (0.148 x 3")               | 0.84                             |
| 16d common (0.182 x 3 1/2") | 12d common (0.148 x 3 1/2")           | 0.84                             |
| 16d common (0.182 x 3 1/2") | 16d sinker (0.148 x 3 1/2")           | 0.84                             |
| 16d common (0.182 x 3 1/2") | 16d x 2 1/2" (N16) (0.182 x 2 1/2")   | 1.00                             |
| 16d common (0.148 x 3")     | 10d x 1 1/2" (0.148 x 1 1/2")         | 0.77                             |
| 16d common (0.148 x 3")     | 10d x 1 1/2" (0.148 x 1 1/2")         | 0.64                             |
| 16d common (0.148 x 3")     | 16d sinker (0.148 x 3 1/2")           | 1.00                             |
| 8d common (0.131 x 2 1/2")  | 8d x 1 1/2" (0.131 x 1 1/2")          | 0.96                             |
| 16d common (0.182 x 3 1/2") | special 8d x 2 1/2" (0.130 x 2 1/2")  | 0.70                             |
| 16d common (0.182 x 3 1/2") | special 10d x 3" (0.132 x 3")         | 0.83                             |
| 16d common (0.182 x 3 1/2") | special 16d x 2 1/2" (0.152 x 2 1/2") | 0.96                             |
| 16d common (0.148 x 3")     | special 8d x 2 1/2" (0.130 x 2 1/2")  | 0.83                             |
| 16d common (0.148 x 3")     | special 10d x 3" (0.132 x 3")         | 1.00                             |

10d x 1 1/2" or 16d x 2 1/2" nails may not be substituted for just nails in double shear hangers (i.e. LUS, MUS, HUS, HUSL). Contact factory for exceptions. Do not substitute 10d x 1 1/2" nails for face nails on slope and shear combinations or skewed only LSU and LSSU. This table does not apply to specials (see Hanger Options), or steel thicker than 10 gauge. Face mount hangers and straight straps may be installed with alternate nails. Use this table to determine the load adjustment factor.

**Nails are not to scale. (Order 7 NAIL GUIDE for actual size)**

**N100 Box**      **N80 Box**



| Dwg. No. | Deep-Fit-Locals/Jo. Pine Allowable Loads* |         |         | Space-Pine-Fit Allowable Loads* |         |         |
|----------|---|---------|---------|---------------------------------|---------|---------|
|          | Light Gauge                               | 3 Gauge | 3 Gauge | Light Gauge                     | 3 Gauge | 3 Gauge |
| 85       | 14  | 105     | 74      | 16                              | 90      |         |
| 89       | 14  | 105     | 74      | 16                              | 90      |         |
| 92       | 20  | 131     | 80      | 18                              | 112     |         |
| 92       | 20  | 131     | 80      | 18                              | 112     |         |
| 92       | 14  | 112     | 79      | 16                              | 97      |         |
| 92       | 14  | 112     | 70      | 16                              | 97      |         |
| 112      | 18  | 158     | 96      | 20                              | 136     |         |
| 112      | 18  | 158     | 96      | 20                              | 136     |         |
| 112      | 18  | 158     | 96      | 20                              | 136     |         |
| 112      | 18  | 158     | 96      | 20                              | 136     |         |
| 134      | 18  | 187     | 115     | 20                              | 163     |         |
| 134      | 18  | 187     | 115     | 20                              | 163     |         |
| 134      | 18  | 187     | 115     | 20                              | 163     |         |
| 145      | 14  | 174     | 125     | 18                              | 162     |         |
| 119      | 14  | 140     | 103     | 18                              | 122     |         |
| 107      | 14  | 180     | 145     | 18                              | 164     |         |
| 98       | —   | —       | —       | —                               | —       |         |
| 112      | —   | —       | —       | —                               | —       |         |
| 134      | —   | —       | —       | —                               | —       |         |

\*Common, 10d common, 12d common, 15d common, 16d sinker

**10** Nail info on N8 and N10 nail heads

**10** On all stainless steel nail heads

The metal ties and joist hangers could hold 1,000's of pound, but without the proper fasteners, they would be useless. 1.5" galvanized nails were used to attach the hangers per manufacturer's recommendation.

So now I was sure the 2x6's would not come loose. To ensure the 1x4's would stay in place during extreme uplift situations I used two 1.5" ribbed galvanized roofing nails at each overlap of 1x4 and 2x6. The IRBC recommends that metal roof decking be fastened every 36" into at least 3/4" of decking. I used 1.5" ribbed galvanized roofing nails with a neoprene washer around the head and fastened them in three evenly spaced runs every 24" along the length of the metal sheet.

The 4x6" beams are fastened to a metal plate welded to the top of each column. A 1/2" x 7" lag bolt was used for this with a 3/4" washer at both ends.



Fasteners



# The Carport - Bryan, Texas

400+ lbs – 2x6's; 100 lbs – 1x4's & Mtl Deck =  
500+ lbs Total Distributed Dead Load



83.33 lbs

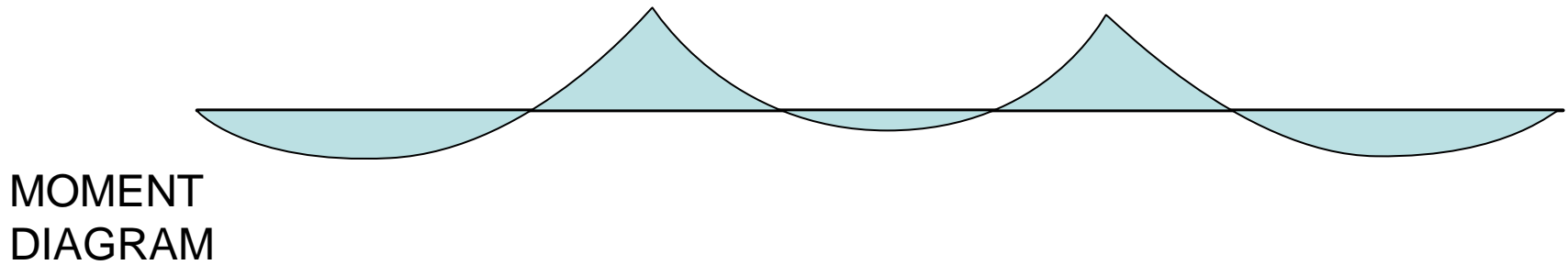
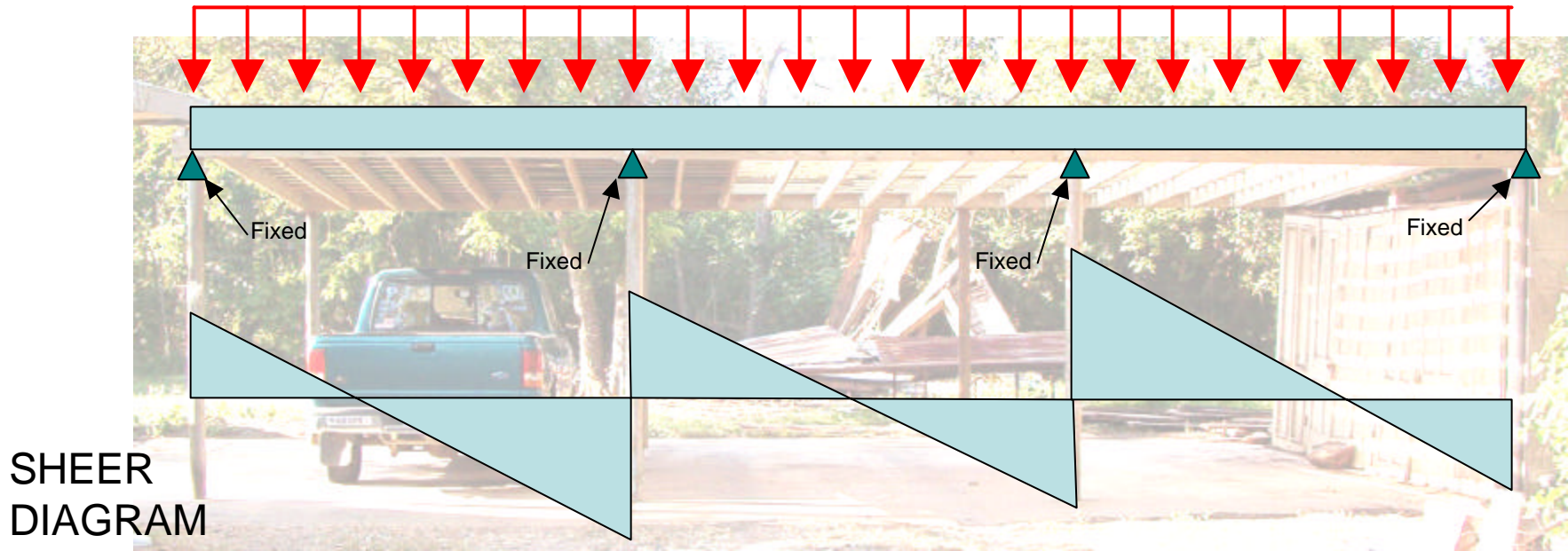
166.67 lbs

166.67 lbs

83.33 lbs

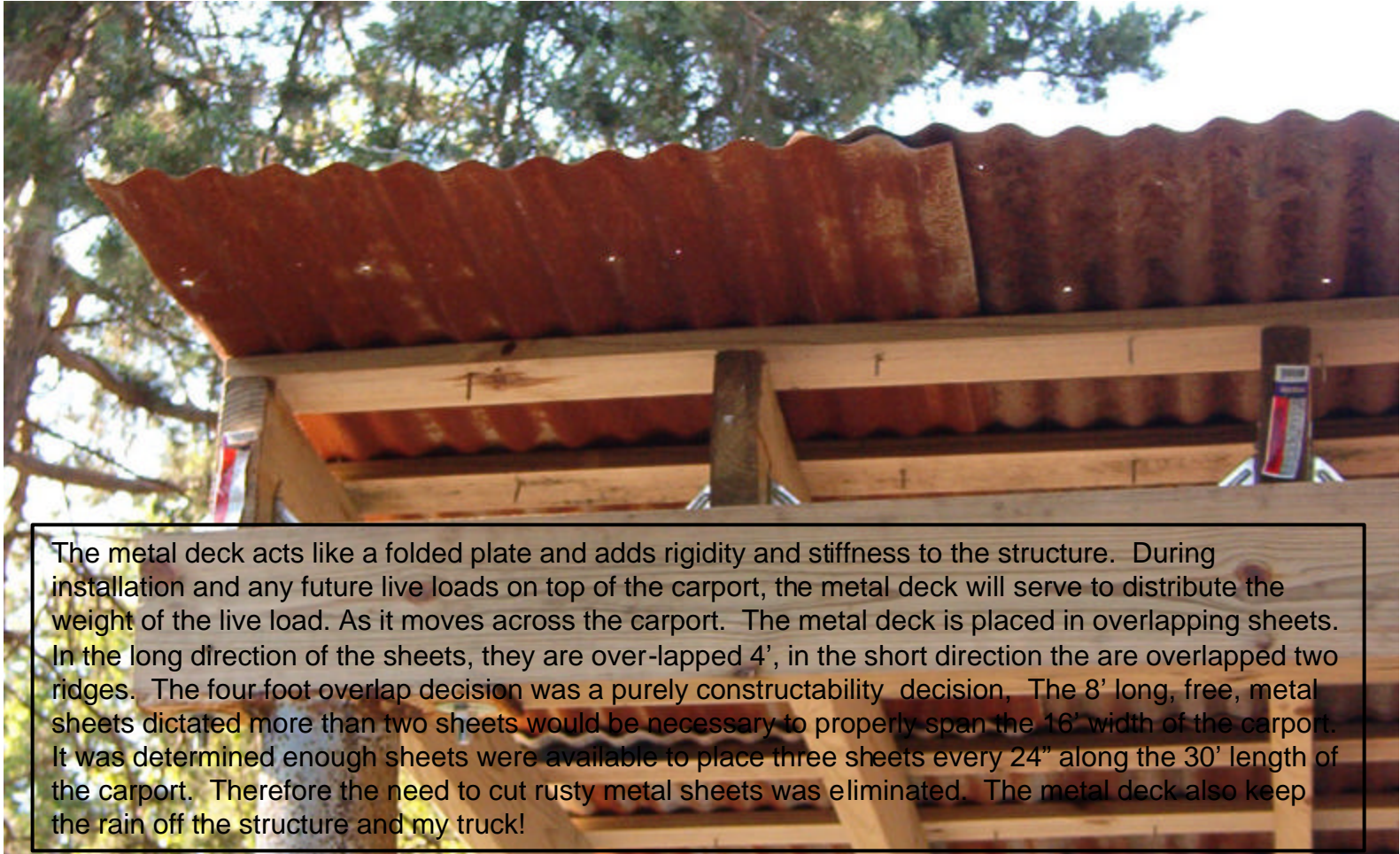
Loads

# The Carport - Bryan, Texas



Sheer & Moment

# The Carport - Bryan, Texas



The metal deck acts like a folded plate and adds rigidity and stiffness to the structure. During installation and any future live loads on top of the carport, the metal deck will serve to distribute the weight of the live load. As it moves across the carport. The metal deck is placed in overlapping sheets. In the long direction of the sheets, they are over-lapped 4', in the short direction the are overlapped two ridges. The four foot overlap decision was a purely constructability decision, The 8' long, free, metal sheets dictated more than two sheets would be necessary to properly span the 16' width of the carport. It was determined enough sheets were available to place three sheets every 24" along the 30' length of the carport. Therefore the need to cut rusty metal sheets was eliminated. The metal deck also keep the rain off the structure and my truck!

Folded Metal Plate

# The Carport - Bryan, Texas



I am quite certain that were my truck to run into a column, the column would win. The column is fixed at the ground and pinned at the top ( $K=0.7$ ). The deflection of the columns under an extreme lateral load is shown above in red. Let's hope this never happens!

Columns Under Lateral Load (My Truck)



In conclusion, the carport was built and it hasn't fallen down.

**THE CARPORT  
AUGUST 2003, BRYAN, TEXAS**

Special thanks to my Dad for his help during the construction of the carport. He's a badass!