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CENTER FOR PACKAGING AND UNIT LOAD DESIGN

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Pallet Design Evaluation

Test Report-No: 2014-FQA102

Client

Company: Universal Fastener Outsourcing
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Purpose of the Test

Determination of the fastener quality using MIBANT, bending yield moment test, and incline impact test of the pallet endboards.

Test Program

ASTM F680 – Standard Test Method for Nails
ASTM F1575 – Standard Test Method for Determining Bending Yield Moment of Nails.
ASTM D1185 – Pallets and Related Structures Employed in Materials Handling

Test Period

04/1/2014-04/11/2014

Test Performed By

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Fastener Specifications

The 3" x 0.120" Combo Head (SQ and PH) with YZ Coating was investigated in this study. The specifications of the investigated fastener design are presented in Table 1.

Table 1 Specifications of investigated fastener designs.

Component	Fastener Design
Fastener type	Helical
Wire diameter (in)	0.121
Thread crest diameter (in)	0.135
Nominal fastener length (in)	3.00
Thread length (in)	1.71

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Pallet Specifications

A partial-four way GMA stringer class pallet design was manufactured for this study. The pallet was manufactured using heat treated and kiln-dried SPF. The two lead deckboards of the pallet was manufactured out of 1 in. thick hardwood. The pictures and the specifications of the pallet design are presented in Figure 1 and Table 1.

Figure 1 Top and bottom view of the investigated pallet design.

Table 2 Component dimensions of investigated perimeter based pallet.

Component	Number of Pieces	Length (in)	Width (in)	Height (in)	Species
Stringer	3	48	1.5	3.5	SPF
Bottom deckboard	3	40	5.5	1.0	SPF
Lead top deckboard	4	40	5.5	1.0	Oak
Interior top deckboard`	2	40	5.5	1.0	SPF

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Bending Yield Strength Test

The bending yield moment of the investigated fastener design was measured following the guidelines of ASTM F1575 standard. The experimental setup for the test is presented in Figure 1. During the test the fastener designs were supported using two metal cylinders which were spaced 1.4 in. apart. The fastener was loaded with at the midpoint between its bearing points with cross head speed of 0.25 in./min. until failure. Failure was determined as 10% reduction of the maximum load. The deflection of the fastener was measured using the crosshead movement of the load applicator. The load and deflection was recorded using a computerized data acquisition system.

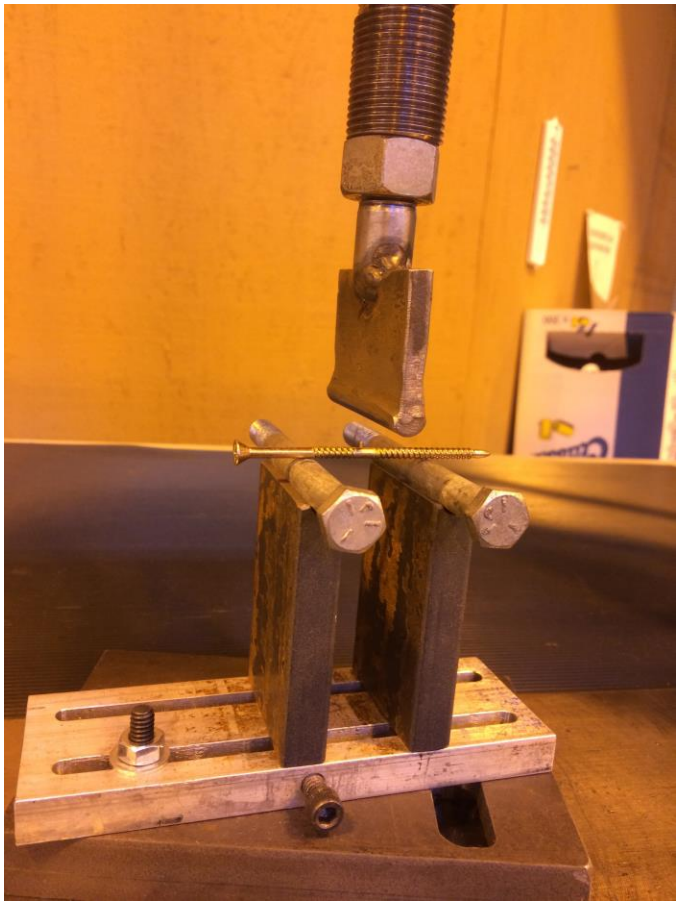

Figure 2 Experimental setup of the bending yield strength test.

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The results of the bending yield strength test is presented in Tables 2. The load-deflection diagrams for the investigated fastener designs are presented Figures 3.

Table 3 Results of the bending yield test for the investigated fastener design. StDev – Standard Deviation, COV – Coefficient of Variance.

Replicates	Bending Yield Moment (lbs.)	Ultimate load (lbs.)
1	138.17	202.35
2	150.40	165.00
3	N.D.	181.73
4	134.00	169.10
5	143.40	165.30
6	N.D.	186.10
7	140.80	156.90
8	N.D.	177.30
9	148.30	174.30
10	151.00	171.20
Average	**143.70**	**174.90**
StDev	**6.50**	**12.90**
COV (%)	**5**	**7**

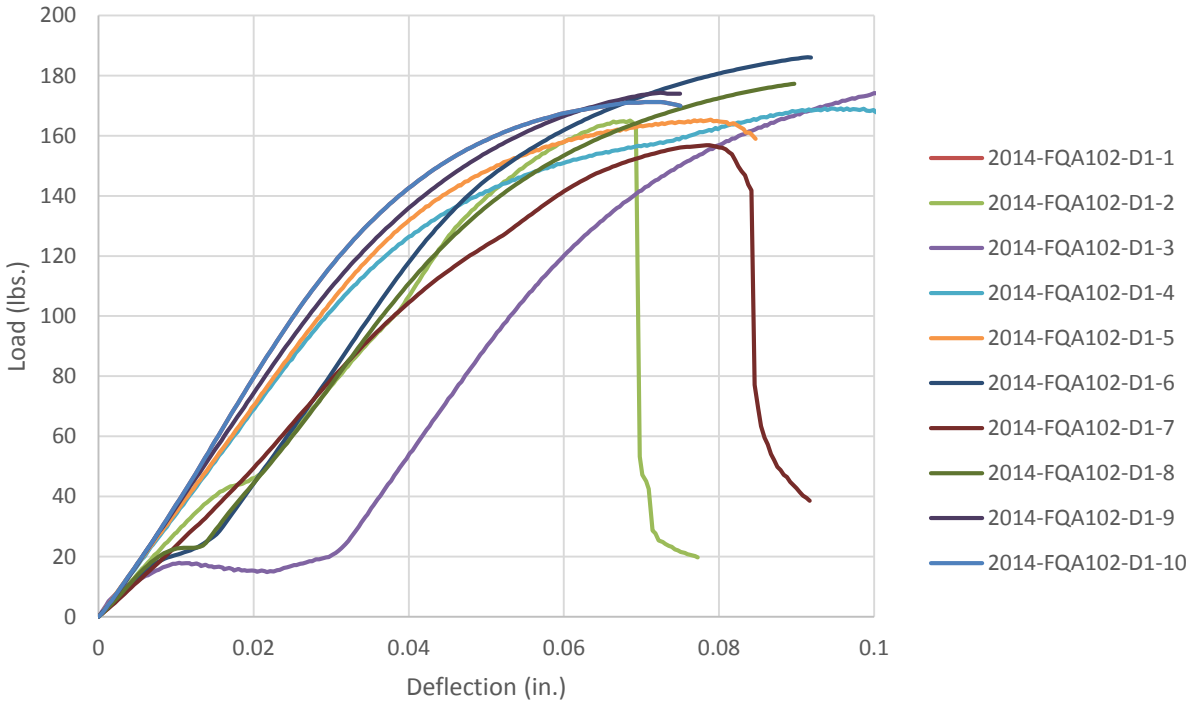

Figure 3 Load-deflection of the investigated fastener design after the bending yield strength test.

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MIBANT Test

Morgan Impact Bend-Angle-Nail Tester (MIBANT) was used to test the quality of the fastener design. During the test the fastener was secured into the MIBANT tester and a 3.5 lbs. weight was dropped to exert 3.33 ft-lbf energy to the head of the fastener. The bending of the fastener was measured and the Fastener Withdrawal Index (FWI) and Fastener Shear Index (FSI) was calculated based on calculation method published in ANSI MH1 (2005). The experimental setup is presented in Figure 4 while the results of the test are published in Figure 5.

Figure 4 Experimental setup for the MIBANT test.

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File Date: 4/1/2014

Fastener Specifications

Customer's Fastener ID: 3" x .120 Combo Head (SQ and PH) with YZ coating.
Fastener ID: 2014-FQA-102-D1

Fastener Type:	Helical	
Fastener Length:	2.80	inches
Thread Length:	1.71	inches
Thread Diamter:	0.135	inches
Wire Diameter:	0.121	inches
Head Diameter:	0.276	inches
Flutes:	N.A.	
Helixes:	25	
Thread Angle:	N.A.	
Calculated Thread Angle:	N.A.	
MIBANT Angle:	20	
FWI:	169	
FSI:	111	

Minimum Fastener Withdrawal Index (FWI)		Minimum Fastener Shear Index (FSI)	
Multiple Use	Limited Use	Multiple Use	Limited Use
65	50	55	40

Fastener Sample Measurement Data

Thread Diameter (in.):

0.134	0.134	0.135	0.134
0.135	0.135	0.134	0.135
0.135	0.135	0.135	0.135
0.135	0.134	0.134	0.135
0.135	0.134	0.135	0.134
0.135	0.134	0.135	0.134
0.135			

Minimum: 0.134 Maximum: 0.135
Average: 0.135 CV (%): 0.14

MIBANT Angle (Degrees):

19.0	23.0	19.0	18.0
18.0	18.0	20.0	21.0
19.0	20.0	21.0	20.0
19.0	19.0	20.0	21.0
24.0	19.0	20.0	20.0
21.0	23.0	21.0	20.0
18.0			

Minimum: 18.0 Maximum: 24.0
Average: 20.0 CV (%): 7.95

Partial Shank Failures:	0
Complete Shank Failures:	0
Head Failures:	0
MIBANT Drop Weight:	3.5

**Average adjusted to standard 3.50lb

Figure 5 Results of the fastener quality evaluation of investigated fastener design using MIBANT test according to ASNI MH1 (2005).

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The fastener was classified as **Multiple Use** based on the criteria defined by ANSI MH1 standard as listed in Table 3.

Table 3 Industry Recommended Minimum Fastener Quality Levels Based on Pallet Service.

	FWI	FSI
Repair	40	30
Limited Use	50	40
Multiple Use	65	55

Incline Impact Test on Pallet Edges

Figure 6 Experimental setup for incline impact test on pallet edges.

The durability of the pallet edges were tested on the incline impact tester. The test setup is presented in Figure 6. More information about the experimental setup can be found in ASTM 1185. The impact started 12-inches with a 250-pound sled on top of the pallet. After 10 impacts, 450 pounds were added to the sled and another 10 impacts performed. The distance was then increased increments of 12-inches.Ten (10) impacts were repeated for each of the increments until significant strength reduction occurred or the usability of the pallet was compromised. The speed of the pallet was recorded and the potential kinetic energy was calculated. Three (3) samples were tested from each design.

The results of the incline impact test on pallet endboards are presented in Tables 4-5. The representative mode of failure of the pallet design are presented in Figure 7.

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Table 4 Results of incline impact resistance on pallet edges. StDev.- Standard deviation, COV- coefficient of variance.

Pallet ID	Impacted Side	Number of Impacts to Failure						
		12 in. 250lbs	12 in. 700lbs	24 in. 700lbs	36 in. 700lbs	48 in. 700lbs	60 in. 700lbs	72 in. 700lbs
Pallet 1	40” End	10	10	1				
Pallet 2	40” End	10	10	1				
Pallet 3	40” End	10	10	2				
Average		**10**	**10**	**1.33**				
StDev		**0**	**0**	**0.58**				
COV (%)		**0**	**0**	**43**				

Table 5 Average estimated kinetic energy caused by the impact of the pallet edges of the investigated pallet design

	Average Estimated Kinetic Energy (lb-ft)	COV (%)
Wooden pallet design with the investigated fastener	1,184	13
Wooden pallet design with 3” x 1.20 standard helical pallet nail	386	N.A.

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Figure 7 Representative mode of failure of the investigated pallet design during the incline impact test on pallet edges.

Disclaimer

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