Performance Evaluation of 48 x 48 Coil Pallets Made from Recycled Plastic

RECYCLING TECHNOLOGY ASSISTANCE PARTNERSHIP ReTAP

PERFORMANCE EVALUATION OF 48 X 48 COIL PALLETS MADE FROM RECYCLED PLASTIC

FINAL REPORT

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1. INTRODUCTION

The All Service All Packaging (ASAP) company of Green Acres, Washington contracted the William H. Sardo Pallet & Container Research Laboratory to conduct an evaluation of their new coil pallet made from 100% recycled material. The coil pallet was designed specifically for the "heavy capacity" shipment of aluminum and steel coil.

The purpose of this project is to test the strength and durability performance characteristics of a recycled content plastic pallet for use in for validation into the "heavy capacity" pallet market. To simulate the loading of aluminum and steel coil, a simulated coil ballast load was used whenever possible. The test objectives were:

- To determine the average number of loss of functionality of the ASAP pallet in a simulated rough handling environment (as tested on the VPI FasTrack equipment).
- To determine the lateral collapse potential of the ASAP pallet.
- To determine the compression strength of the ASAP pallet when stacked 1-high and 2-high.
- To determine the compression strength of the ASAP pallet using forktine support.
- To determine the top deck edge impact resistance.
- To determine the stringer end impact resistance.

2. PALLET DESCRIPTION

ASAP supplied Virginia Tech with sixteen 48 x 48 coil pallets. The pallets have three (3) stringers at 5-1/2 inch wide x 5-1/2 inches high x 48 inches long. The pallets have five (5) top deckboards at 5-3/8 inches wide x 1-1/2 inches high x 48 inches long. The pallets have no bottom deckboards. The stringers are constructed of recycled, high density polyethylene (HDPE) reinforced with recycled fiberglass. The deckboards are also made from 100% recycled HDPE. Five pallets had black deckboards and eleven pallets had gray deckboards. The recycled resin was supplied by two recycled plastic processors in Washington State. Figure 1 contains a photograph of two ASAP coil pallets with dummy loads.

3. TEST METHODS

3.1 MODIFIED VPI FASTRACK

The VPI FasTrack is an accelerated material handling simulation developed by Virginia Tech and Proctor & Gamble for the grocery industry. The FasTrack was modified to test the ASAP coil pallet design. A 20,000 pound, rubber-tired forklift, with a 30,000 pound capacity was used for testing. To simulate the actual load and support conditions, a ballast load of 10,000 pounds was applied to each pallet tested. The ballast load was a 48 inch diameter, concrete-filled metal pipe.

The FasTrack consisted of two test areas. Test area number 1 is a gravel staging area for moving and stacking the loaded pallets in test and a smooth concrete surface for pushing the pallets in test. Test area number 2 was an airport tarmac, which is a rougher, more abrasive surface. Figure 2 contains a photograph of two ASAP pallets in the FasTrack, as tested on the gravel/concrete surface (test area 1).

One FasTrack material handling cycle consists of the following steps.

1. Load two empty pallets with one 10,000 pound ballast load per pallet.
2. Stack pallet two on top of pallet one.
3. Return pallet two to unstacked position.
4. Stack pallet one on top of pallet two.
5. Return pallet one to unstacked position.
6. Enter pallets with forklift, and push loaded pallets 60 feet, one pallet at a time.
7. Return loaded pallets to staging area.
8. Remove load and inspect pallets for damage.

Each FasTrack cycle consists of five individual handlings on average.

3.2 PALLET STRENGTH TESTS SIMULATING STACKS 1- AND 2-HIGH.

The pallet strength tests simulating stacks 1-high and 2-high were performed using a 30,000 pound dead load. Figure 3 contains a photograph of a loaded pallet. These tests were performed on the airport tarmac. The ambient temperature on the tarmac during testing was 123 degrees Fahrenheit. After the load was applied, the loaded pallet was inspected for damage. Three replicates of black

deckboard pallets and three replicates of gray deckboard pallets were tested, for a total of six replicates.

3.3 PALLET STRENGTH TESTS USING FORKTINE SUPPORT

A 30,000 pound dead load was used for the forktine support tests. Four inch wide I-beams were used as simulated forktines. Figure 4 contains a photograph of a pallet in test. The I-beams were placed with a 21.25 inch span center to center. An empty pallet was placed on the forktines and the 30,000 pound load applied. After the load was applied, the pallet in test was inspected for damage. Three replicates of each color deckboard were tested (six replicates total).

3.4 LEADING DECK EDGE \ INCLINEDIMPACT TESTS, ASTM D1185-94, SECTION 9.4

The top deck leading edge impact test were performed according to ASTM D-1185-94, section 9.4. The pallets were conditioned to -13 degrees F prior to testing. The pallet was positioned so that leading edge deckboards would be impacted on the center span of each deckboard between stringers. A 700 pound cargo load was applied throughout the test. The impact distances began at 12 inches and progressed through 24 inches, 48 inches, 72 inches, and 96 inches. Ten (10) impacts were performed at each energy level. The test was terminated when a deckboard was removed or broken from the stringer.

3.5 STRINGER END IMPACT TEST, ASTM D1185-94, SECTION 9.4.

The stringer end impact tests were performed according to ASTM D-1185-94, section 9.4. The pallets are conditioned to -13 degrees F prior to testing. The forktines are positioned so that they impact the stringer ends on center. Figure 5 contains a photograph of the test setup. The cargo load begins with 250 pounds at 6 inches. After 10 impacts with a 250 pound cargo and 6 inch distance, the load is increased to 700 pounds for the remainder of the test. The impact distances with the 700 pound cargo begin at 6 inches and progress through 12 inches, 24 inches, 48 inches, 72 inches, and 96 inches. Ten impacts are performed at each energy level. The test is terminated when a portion of the stringer end is broken off.

4. TESTING RESULTS

4.1 VPI FASTRACK

Table 1 contains the results from the VPI FasTrack. One-hundred percent of the failures occurring during FasTrack involved the shearing and withdrawal of the leading edge deckboard and fasteners from the stringer. Nine percent of the failures (1 pallet) included a combination of the deckboard/fastener removal and a broken stringer end caused by forktine impacts. Figures 6 and 7 contain both of the failure modes associated with the FasTrack. The lateral and horizontal forces which cause the shear and withdrawal of the deckboard stringer joint are associated with forkheel impacts and lifts from the forklift and from shifting of the coil on the pallet.

Table 1: Durability Results From the VPI FasTrack

Pallet ID	Deckboard Color	Test Area	Actual Number of Handlings Until Failure	Expected Number of Trips Until Failure at 10 Handlings per Trip	Expected Number of Trips Until Failure at 15 Handlings per Trip
1	Black	Gravel/smooth concrete	1160	116	77
2	Black	Gravel/smooth concrete	1120	112	75
3	Gray	Gravel/smooth concrete	535	54	36
4	Gray	Gravel/smooth concrete	175	18	12
5	Black	Tarmac	355	36	24
6	Black	Tarmac	270	27	18
7	Gray	Tarmac	310	31	21
8	Gray	Tarmac	415	42	28
9	Gray	Tarmac	380	38	25
10	Gray	Tarmac	370	37	25
11	Gray	Tarmac	405	41	27

4.2 PALLET STRENGTH TESTS SIMULATING STACKS 1- AND 2-HIGH

Under a compression load with a dead weight of 30,000 pounds, no pallet failures occurred. Because of the rigidity and flatness of the coil load, virtually no bending stresses are imparted to

the top deck of the pallet. No failures were expected in this test. Three pallets with black deckboards and three pallets with gray deckboards were tested.

4.3 PALLET STRENGTH TESTS SIMULATING FORKTINE SUPPORT

As in the stack tests in section 4.2, no pallet failures occurred or were expected because of the rigidity of the coil load. Three pallets with black deckboards and three pallets with gray deckboards were tested.

4.4 LEADING DECK EDGE IMPACT TESTS / INCLINED PLANE IMPACT TEST

Table 2 contains the results from the ASAP leadboard inclined impact testing, as well as results from impact tests on three 48" x 40" hardwood GMA style pallets owned by the Canadian Pallet Council.

Table 2: Results of the ASTM D1185 Inclined Plane Impact Tests on the ASAP Coil Pallets and Three Timber Pallets from the Canadian Pallet Council

Sample # (and deckboard color for ASAP pallets)	Number of Impacts to Leading Edge Failure			
	12 in. 700 lbs	24 in. 700 lbs	48 in. 700 lbs	72 in. 700 lbs
1 - Gray	10	10	10	4
2 - Black	10	10	8	---
3 - Black	10	10	10	2
1 - Wood	---	---	40	1
2 - Wood	---	---	2	---
3 - Wood	---	---	12	---

Figure 8 contains a photograph of a typical failure of the ASAP pallet from inclined plane impact testing.

4.5 STRINGER END IMPACT TESTS

Table 3 contains the results from the stringer end impact tests on the ASAP pallets and the stringer end impact tests on three 48. x 40. hardwood GMA style pallets owned by the Canadian Pallet Council. Figure 9 contains a photograph of a typical failure mode in the stringer end impact tests.

Table 3: Results of the ASTM D1185 Stringer End Impact Tests on the ASAP Coil Pallets and Three Timber Pallets from the Canadian Pallet Council

Sample	Number of Impacts to Stringer End Failure					
	6 in. 250 lbs	6 in. 700 lbs	12 in. 700 lbs	24 in. 700 lbs	48 in. 700 lbs	72 in. 700 lbs
1 – ASAP	10	10	10	10	10	5
2 – ASAP	10	10	10	10	10	---
3- ASAP	10	10	10	10	10	3
1 – Wood	---	---	---	---	20	---
2 – Wood	---	---	---	---	10	---
3 – Wood	---	---	---	---	10	---

5. CONCLUSIONS AND DESIGN RECOMMENDATIONS

The ASAP coil pallets were designed specifically for the coil industry. The ASAP coil pallet will function safely and effectively based on the given material handling conditions, the pallet design, and the flatness and rigidity of the coil load. No compression failures were observed during any of the FasTrack or pallet strength testing. All of the pallet failures in the FasTrack involved an initial failure of the fastener at the stringer/leading edge deckboard joint.

The failure modes of the ASAP coil pallets in the leading deck/ inclined impact tests were a combination of lag bolt withdrawal and brash failure of the leading edge deckboards. Each of the failures propagated from an area of the deckboard with a bolt hole present. If the lag bolts had not been withdrawn or pushed back, it is likely that the leading edge deckboard would have resisted additional impacts.

The most critical and most stressed connection of a coil pallet is the joint of the leading edge deckboard and stringers. With respect of the failure modes from pallet testing at Virginia Tech, a different type of fastener is recommended in the leading edge deckboards. The fastener must have greater withdrawal resistance and greater shear resistance. A bolt countersunk in the bottom of the stringer and on top of the deckboard with locking nuts would increase the withdrawal resistance. Increased shear resistance may be obtained through higher grade or larger diameter fasteners.

6. REFERENCES

American Society for Testing and Materials. ASTM D1185-94, SECTION 9.4.
Testing procedures and protocols from Virginia Polytechnic Institute & State University

7. ACKNOWLEDGEMENTS

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APPENDIX:

PHOTOGRAPHS OF TESTING

(Not included in this electronic file but available upon request)