Center for Packaging and Unit Load Design
1650 Research Center Dr.
Blacksburg, Virginia 24061
P: (540) 231-7107 F: (540) 231-8838

Comparative Evaluation of the Durability of Two Bulk Container using Fork Tines with and without the Sumo Glove

Test Report-No: 2017-0078-3

Client

Company: Sumo Glove
Contact Name: Simon Ross
Email: simonross@sumoglove.com

Purpose of the Test

Evaluation of the durability of the durability of an ISO Bin and a 1210 Eurobin container designs when impacted using fork tines with and without sumo glove.

Test Program

Custom Pendulum Impact Testing

Test Period

11/01/2017-1/31/2018

Test Performed By

The Center for Packaging and Unit Load Design,
Virginia Polytechnic Institute & State University,
1650 Research Center Dr., Blacksburg, Virginia 24061.
Phone: (540) 231-7673 Fax: (540) 231-8868 email: lhorvat@vt.edu

1. Executive Summary

Effect of SUMO Glove on the Durability of ISO Bins and 1210 Eurobins.

The durability of two commonly used bulk container designs was evaluated using custom pendulum impact test. During the evaluation, different panels of the bins were impacted using fork tines with and without the SUMO Glove. The kinetic energy of the individual impacts was calculated to get information on the intensity of impacts experienced by the bins. Once the packages experienced failure, the cumulative intensity of the impacts was calculated. The results are presented in Figures 3-4. It was found that the ISO Bins can survive **more than 4 times more impact without any structural damage when the fork tines are equipped with the SUMO Glove. The test was stopped after 52 impact** from 16 in. because the panels of the bin **did not experience any structural damage**.

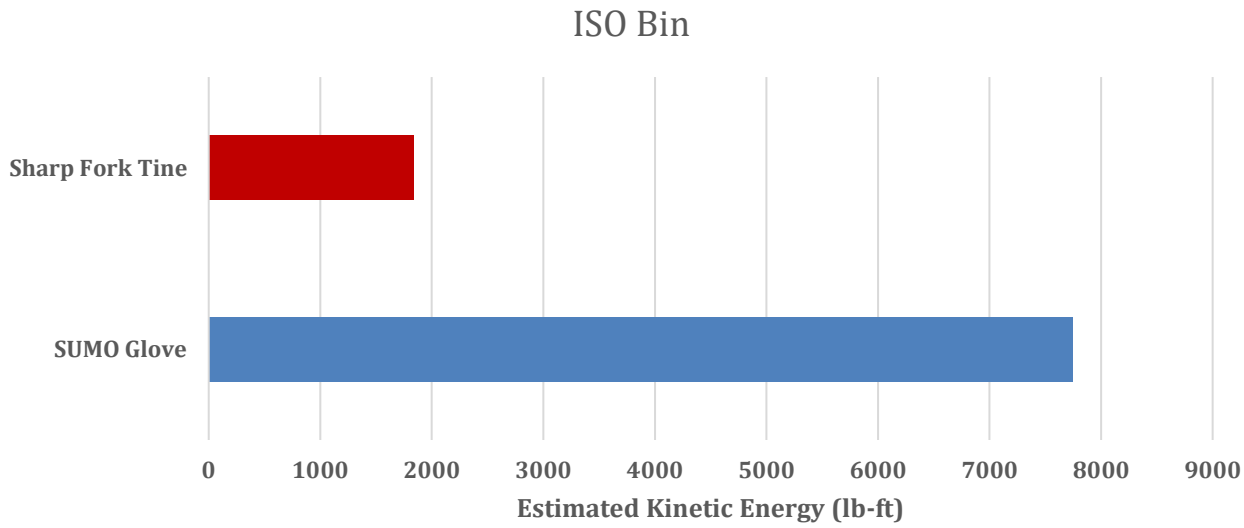

Figure 1 The estimated kinetic energy of the impact that caused the failure of side panels of the investigated ISO Bin. Note: The panels of the bin did not experience any failure when it was impacted with fork tines protected with the SUMO Glove.

It was found that the 1210 Eurobins can also survive **more than 4 times more impact without any structural damage when the fork tines are equipped with the SUMO Glove. The test was stopped after 73 impact** from 7.625 in. because the panels of the bin **did not experience any structural damage**.

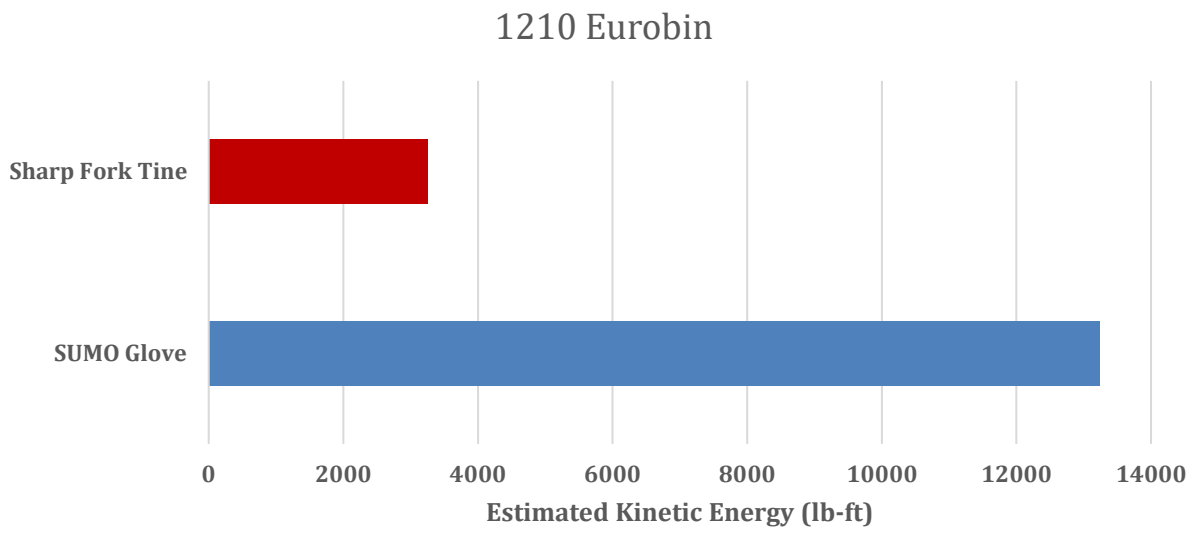

Figure 2 The estimated kinetic energy of the impact that caused the failure of the investigated 1210 Eurobin. Note: The panels of the bin did not experience any failure when it was impacted with fork tines protected with the SUMO Glove.

2. Pendulum Impact Test

Figure 3 Experimental setup for pendulum impact test of the bulk container using fork tines with and without the SUMO Glove.

The impact resistance of two bulk containers was evaluated using a custom pendulum impact test using fork tines with and without the SUMO glove. The experimental setup is presented in Figure 3. During the test, the bulk containers were placed next to the wall to prevent their movement due to the impacts. Multiple panels were selected on each bulk containers. To test the durability of the panels a custom pendulum test was used. Overall weight of the fork tines with the added weight was around 166 lbs. Only the sides without any access doors were tested. Each panel was impacted multiple times with the same intensity until the panel failed or the test was stopped. The panels of the ISO bins were impacted from 7.625 in. while the panels of the 1210 Eurobins were impacted from 12 in. (sharp forktine) and 16 in. (SUMO Glove protected fork tine). Two replicate tests were conducted for the 1210 Eurobin and three replicates were conducted for the ISO bin. The effect of the SUMO glove was evaluated by comparing average kinetic energy causing failure of the package using a fork tine with and without the SUMO glove.

The side view pictures of the investigated 1210 Eurobin and ISO bins are presented in Figures 4-5.

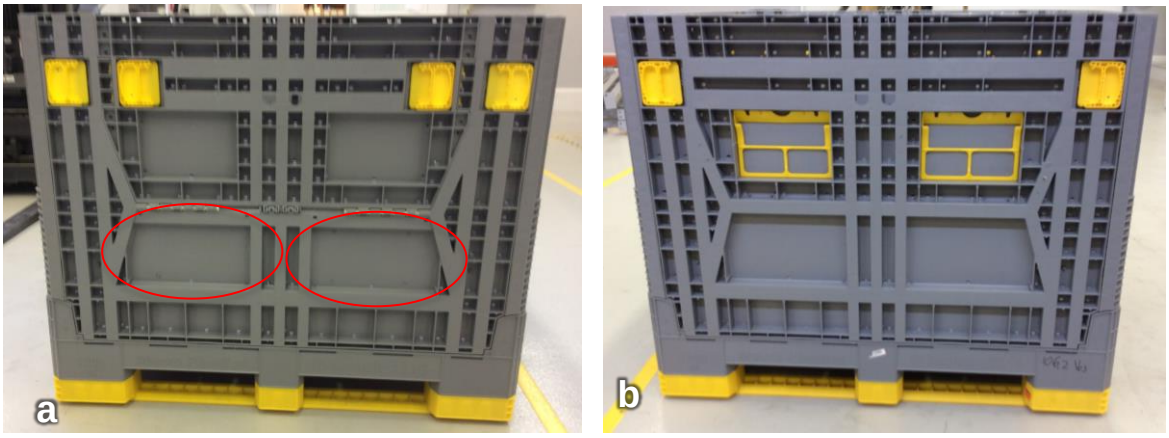

Figure 4 Side views of the investigated 1210 Eurobin. The locations of the panels that were tested are marked with a red circle.

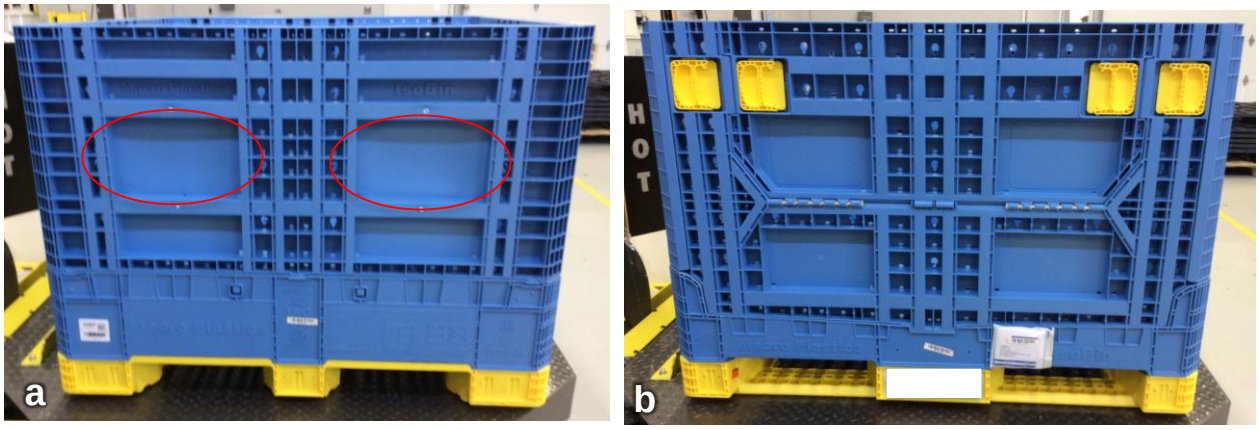

Figure 5 Side views of the investigated ISO Bin. The locations of the panels that were tested are marked with a red circle.

The results for the wood pallet are presented in Tables 1 and 2. The representative modes of failure of the panels of the investigated bins are presented in Figure 6-7.

Table 1 Summary table of the pendulum impact test of the gray 1210 Eurobin with and without the SUMO glove.

Fork Tine Type	Replicates	Cumulative Kinetic Energy (lb-ft)	Average Cumulative Kinetic Energy (lb-ft)
Sharp Fork Tine	**Replicate 1**	14,914	**13,245**
	Replicate 2	11,576	
SUMO Glove	**Replicate 1**	3,673	**3,256**
	Replicate 2	2,838	

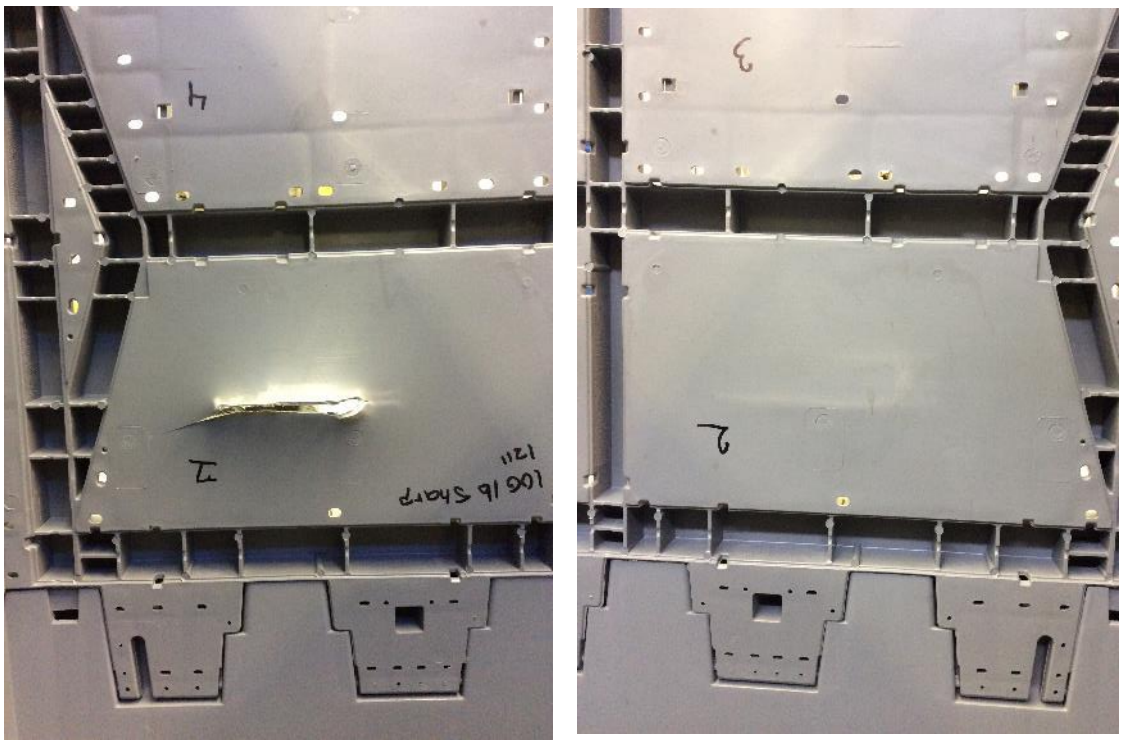

Figure 6 Representative damages of the 1210 Eurobin after the impact with the (left) sharp fork tines and the (right) impact using the SUMO gloves protected fork tines.

Table 2 Summary table of the pendulum impact test of the blue ISO Bin with and without the SUMO glove.

Fork Tine Type	Replicates	Cumulative Kinetic Energy (lb-ft)	Average Cumulative Kinetic Energy (lb-ft)
Sharp Fork Tine	**Replicate 1**	7744.3	**7,744**
	Replicate 2	7744.3	
	Replicate 3	7744.3	
SUMO Glove	**Replicate 1**	1697.4	**1,839**
	Replicate 2	1909.6	
	Replicate 3	1909.6	

Figure 7 Representative damages of the ISO Bin after the impact with the (left) sharp fork tines and the (right) impact using the SUMO gloves protected fork tines.

3. Standard Terms and Conditions

The Virginia Tech Center for Packaging and Unit Load Design (CPULD) recognizes that cost-effective testing is a matter of subjective judgment as determined by the Client. Therefore, we offer a range of testing services to meet the specifications of each Client. The Scope of Statement forms the sole contractual understanding between the herein named Client and CPULD, and is the result of the information and objectives provided by the Client, and any other written communications (including email) which may serve to augment or modify the terms herein.

Standards and Accuracy: All lab testing will be done on a best efforts basis in accordance with the specified or applicable Standards (ISO, ASTM, etc.) to the degree specified by the Client and/or CPULD, or to the limits of the laboratory. Due to the nature of Standards testing, it is likely that Standards will change over time, as will the degree to which CPULD can adhere to them. Client is advised that deviations from the published Standards may affect the degree to which the results are transferrable or generalizable. While CPULD takes reasonable measures to ensure accuracy in testing, variations are to be expected.

Materials: In the absence of specifications to the contrary in the Scope of Statement, all materials supplied by the Client (including but not limited to products, tools, equipment, pallets, packaging materials, etc.) will be disposed of by CPULD within two weeks after CPULD submits the final report to the Client and will not be returned to the Client at the conclusion of testing.

Timing of Deliverables: Client is advised that testing cannot begin until the Scope of Statement is signed and delivered to CPULD, the required fee or down payment must be paid, and all materials to be provided by the Client are actually received at CPULD. If materials are not provided in a timely manner, the deliverables may not be completed in accordance with the time estimates provided in the Scope of Statement. From time to time, additional testing materials to be provided by the Client may be required to complete the testing, in which case completion of deliverables may be affected. As an

academic research center, the demands of the academic calendar at Virginia Tech may also affect the availability of test equipment and testing personnel, which may impact delivery timetables.

Reports: The deliverable report(s) shall not be reproduced, except in full, without the written approval of CPULD.

Warrantees: The Center for Packaging and Unit Load Design at Virginia Tech assumes no responsibility or guarantees / warranties regarding (stated or implied) performance and only assumes responsibility for the test data reported. All other warranties expressed or implied, including any warranty that the product, pallet, or package tested is merchantable, fit for a particular purpose or application or is in compliance with any industry, state, or federal compliance, is disclaimed.

Disputes: In the event of a dispute of any sort relating to any aspect of this Scope of Statement and the performance of CPULD (including but not limited to research, testing, or deliverables) produced by CPULD, the Client shall notify CPULD in writing within 30 days of receipt of the last deliverable under the agreed-upon Scope of Statement.