GORILLA DECK® G3 DECK BOARDS

PVC Deck Boards

ENGINEERING REPORT (Update)

Date: November 16, 2019
Rev1: January 17, 2020

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NOTE:
Gorilla Deck® G3 Deck Boards has been approved for installation by the City of Ottawa Building Code Services. Approval granted on 17 January 2020.

This report must accompany Building Permit Applications

1. Introduction

The City of Ottawa Building Code Services has requested a submission of a document that fully describes the functionality and performance of Gorilla Deck® G3 Boards (PVC deck boards) limited to Part 9 Buildings.
This updated report in based on the original document approved by the City of Ottawa last 31Aug2012 and includes more recent testing performed on the product.
The name G3 was added to the report for marketing purposes. The deck boards in question are exactly the same as the ones previously approved.
This report supersedes the 31Aug2012 report.

2. Objectives

The aim of this document is to obtain approval from the City of Ottawa Building Department to use the Gorilla Deck® G3 Deck Boards (PolyVinyl Chloride (PVC) Deck Boards) as a construction material for balconies, porches and decks in Residential applications as per Part 4 and 9 of the Ontario Building Code.

3. Product description

Gorilla Deck® G3 Deck Boards (PVC Deck Boards) are a co-extruded profile with PVC substrate and either a PVC capstock or ASA capstock. The aim of this document is to obtain approval from the City of Ottawa Building Department to use the Gorilla Deck® PolyVinyl Chloride (PVC) Deck Boards as a construction material for balconies, porches and decks in Residential applications as per Part 9 of the Ontario Building Code.material. It has been manufactured by Homeland Vinyl Products (an Alabama, USA home-based company) since 2003.
The manufactured product is intended for use as an exterior walking deck board as an alternative for wood or composite decking.
The deck boards have four (4) chamber hollow co-extruded PVC profile, are manufactured in white, tan, gray, adobe and mocha walnut colours and are rectangular in shape. They also have a continuous screw flange for attachment and utilize a tongue and groove system for interlocking planks during installation.
The mixture used in the processing of the product is extruded through a continuous feed system and is produced as a deck board measuring a nominal 1-1/4 in thick and 7 in wide (32x178 mm) with the actual measurements being 1.25 by 7.02 inches (32x180 mm), and it is available in lengths of 16, 20 and 24 feet (4878, 6096 and 7315 mm). The top surface is flat on top with a wood-grain embossed texture. The top exposed surface of the deck board is capped (i.e. UV inhibitor layer).
As confirmed by different testing, the unique characteristics of G3 Deck Boards (PVC Deck Boards) make them a feasible option instead of wood: Deck boards do not rot, they are impervious to insect attack, do not absorb moisture, the special design allows for water shedding, they do not need painting or staining.
This alternative solution will achieve at least the same level of performance as wood under minimum design loads as per code.

4. Ontario building Code Provisions

The Gorilla Deck® G3 Deck Boards (PVC Deck Boards) comply with the following code provision: 4.1.1.3, 4.1.1.4.2 (a), 4.1.2.1., 4.1.3.4, 4.1.5.3 Table 4.1.5.3
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5. Firm Identification

The firm has vast experience in residential, multifamily and low rise commercial design in both Canada and USA.
Certificate of Authorization# 100161057 60533. P.Eng License: 100079708.

6. Limiting or Restricting Factors

To the best of our knowledge, Homeland Vinyl Products Inc does not know of particular environmental limitations for using the product. This specific product has been installed throughout the United States and Ontario since it was first produced in 2003. The Gorilla Deck® G3 Deck Boards (PVC Deck Boards) have been tested to safely withstand a superimposed load of up to 100 psf live load when supported at 24” centers.

- Impact testing has not been performed under controlled temperature conditions.
- Deckboards subject to excessive heat may exhibit warping. The heat impacts may be mitigated by the use of natural fiber floor coverings, awnings, or similar shade producing fixtures or accessories

Based on our knowledge, there are no limitations for using the Gorilla Deck Boards as alternative to wood decking for Part 9 residential buildings.

7. Testing

The Gorilla Deck® G3 Deck Boards (PVC Deck Boards) have been extensively tested in United States by Architectural Testing, an approved Testing Laboratory (T-1444) by International Accreditation Service and they are in compliance with ANS/ISO/IEC Standard 17025. The testing was performed using the methods as set forth in:

- ICC-ES AC174 Acceptance criteria for Deck Board Span Ratings and Guardrail Systems (Guards and Handrails)
- AAMA 306-01, PVC Exterior Plank Profiles Used for Decking and Dock Walking Surfaces.

This report is based on testing reports (53597.01-119-19 dated Jun. 13, 2005, 92221.01-119-19 dated August 13, 2009 and 85730.03-119-19 revision 1 dated Sep. 22, 2009), C1530.01-119-19 dated 03/07/13, C0270.01-119-19 dated 01/21/2013 and C0270.02-121-24 by Architectural Testing.

The Gorilla Deck® G3 Deck Boards (PVC Deck Boards) have been evaluated and approved by the International Code Council Evaluation Service (ICC-ES) ERS-1657 2005 and 2012, which is the approved USA nation-wide building product evaluation service. Recently, the Gorilla Deck G3 Deck Boards (PVC deck boards) were accredited by Pei Evaluation Service (ISO Standard 17065 Product Certifier)

The Gorilla Deck® G3 Deck Boards (PVC Deck Boards) were designed by Randy Heath, who holds a degree in Mechanical Engineering. All tests were performed on full size pieces of manufactured product, which is pulled at random from standard production runs. There is no selective sampling allowed within the AC174 process to ensure that the formulation and manufacturing is typical and not just for testing purposes. Sampling is done by a third party group to ensure that this policy is followed.

Based on the test results, the Gorilla Deck adjustment factors are 0.78 for strength (ULS) analysis and 0.81 for stiffness/deflection (SLS) analysis.

The deck boards have been tested for the following parameters (see Table 1 for a summary of results):

- **Flexural:** design load: at least 100 psf; design span: 24”; F.S 2.5; deflection criteria l/240. The tests showed that when subjected to at least100 psf over 24” span, the boards performed adequately.
- **Freeze-thaw resistance:** No strength or stiffness loss due to freeze-thaw cycles
- **Creep relaxation**: All specimens recovered 97% or greater from the deflection at the indicated design load levels and exhibited unrecovered deflection less than 1/16”
- **Wind uplift resistance:** 44 psf
- **Impact resistance**
- **Static coefficient of friction**
- **Heat resistance and heat build-up in PVC building products**
- **Dimensional stability**
- **Weight tolerance**
- **Load duration**
- **Fire resistance:** Flame Spread Index: 15. Perform better than wood (above 50).
- **Slip resistance:** SCF (Static Coefficient of Friction): Dry: 0.79 ; Wet: 0.85.

Recently, Architectural Testing performed additional testing for the Mocha Walnut colour:

- Flexural temperature effect testing. The values obtained under extreme low and high temperatures were compared to values under control temperatures. See Table 2 below for summary of results.
- Moisture Effect: The product was not subjected to water absorption.
- Ultraviolet (UV): The purpose was to evaluate the effect of weathering on the performance of the product and compare it to control specimens (non-weathered). See tests summary below in Table 3.
- Freeze-Thaw Resistance: See tests summary below in Table 4.
- Flame Spread: Flame Spread Index: 20; Smoke Developed Index: 850

The following referenced standards we referenced during testing:

- Standard test methods for flexural properties of unreinforced and reinforced plastic lumber. ASTM D 6109-05
- Standard test methods for impact resistance of Poly PVC rigid profiles by means of a falling weight. AAMA D 4495-00
- Poly PVC exterior profile extrusions ASTM 303-98
- Standard test method for predicting heat build-up in PVC building products. ASTM D 4803-97.
- Standard specification for polyolefin-based plastic lumber decking boards. ASTM D 6662-01.
- Standard Methods for simulated service testing of wood and wood base finish flooring. ASTM D 2394-99.
- Test methods for flexural properties of unreinforced and reinforced plastics and electrical insulating materials. American Society for testing and Materials. ASTM D 790-99.
- Standard guide for evaluating mechanical and physical properties of wood-plastic composite products. ASTM D 7031-04.
- ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials

Test	Results
ASTM D 6109 Flexural Tests Baseline properties at standard conditions	Avg. Mu = 4638 in·lbs Avg. EI = 161625 lbs·in^2
Freeze-Thaw Resistance ASTM D 6109 Flexural Tests Post Freeze-Thaw Cycling	MOE & MOR loss <10%: Within allowable range
AC174 Creep Relaxation / Three Samples 100 psf Live Load at 24" Span	97% or Better Recovery >75% required Max. Permanent Set = 0.010" <1/16" allowed
Stair Tread Load on 24" Span (Midspan) (Two Span Condition)	Average Design Load Deflection = 0.45" Exceeds L/180 = 24/180 = 0.13" Does not meet requirement for stair tread.
300 pound Stair Tread Load at Support (End of plank)	Max. Deformation at D.L = 0.022" 88% or Better Recovery from 2.38 x Design Load
ASTM E 330 Wind Uplift Resistance / Three Samples	Min. = 115 psf, Max. = 146 psf, Avg. = 132 psf
ASTM S 4495 Impact Resistance	M.F.E. < 36 ft·lbs min. required
ASTM D 2394 Coefficient of Friction: Dry Conditions Avg. at Test Directions: 0, 180, 90, and 270°	Dry Conditions: 0° - 0.45, 180° - 0.47 Dry Conditions: 90° - 0.58, 270° - 0.50
ASTM D 2394 Coefficient of Friction: Wet Conditions Avg. at Test Directions: 0, 180, 90, and 270°	Wet Conditions: 0° - 0.67, 180° - 0.65 Wet Conditions: 90° - 0.77, 270° - 0.79
AAMA 303 Heat Resistance	No visible evidence of blistering, cracking, flaking or delamination on the exposed surfaces.
ASTM D 4803 Heat Build-Up	Average Horizontal Heat Buildup: 49.9°F
ASTM D 4726 Dimensional Stability	Avg. Change = 0.6% v. 2.2% allowed Max. Change = 0.6% v. 2.4% allowed
AAMA 306 Weight Tolerance	Measured Range: 1.190 -1.220 lbs/ft. v. Allowable Range: 1.170 - 1.430 lbs/ft.
ASTM D 790 Flexural Properties for End Use Adjustment Factors	M.O.R. @ +125°F: -22%; @ -20°F: +33%; Weathered: +8% M.O.E. @ +125°F: -19%; @ -20°F: +16%; Weathered: -3%

Table 1
Summary of results, Report # 53597.01-119-19
dated Jun. 13, 2005 Architectural Testing

Match-Marked Sample Comparison Data
Control Set vs. High Temperature Set

Sample Number	Sample Color	Control MOR (psi)	High Temp. (125°F) MOR (psi)	Difference MOR	Control MOE (psi)	High Temp. (125°F) MOE (psi)	Difference MOE
1	Mocha Walnut	10390	9236	-11.1%	414700	349200	-15.8%
2		10350	8941	-13.6%	418200	341500	-18.3%
3		10400	8974	-13.7%	413700	344400	-16.8%
4		9983	8389	-16.0%	431700	321200	-25.6%
5		10210	8229	-19.4%	396800	300300	-24.3%
6		9819	8291	-15.6%	400400	320700	-19.9%
7		10490	8109	-22.7%	446400	326500	-26.9%
8		9938	7805	-21.5%	412000	307700	-25.3%
9		9950	8439	-15.2%	429700	343500	-20.1%
10		10390	8265	-20.5%	445300	344800	-22.6%
	Minimum:	9819	7805	-22.7%	396800	300300	-26.9%
	Maximum:	10490	9236	-11.1%	446400	349200	-15.8%
	Average:	10200	8500	**-16.9%**	421000	330000	**-21.6%**

Match-Marked Sample Comparison Data
Control Set vs. Low Temperature Set

Sample Number	Sample Color	Control MOR (psi)	Low Temp. (-20°F) MOR (psi)	Difference MOR	Control MOE (psi)	Low Temp. (-20°F) MOE (psi)	Difference MOE
1	Mocha Walnut	10390	14910	43.5%	414700	449000	8.3%
2		10350	15250	47.3%	418200	464800	11.1%
3		10400	15610	50.1%	413700	471200	13.9%
4		9983	15950	59.8%	431700	470900	9.1%
5		10210	15470	51.5%	396800	458600	15.6%
6		9819	15480	57.7%	400400	453300	13.2%
7		10490	16270	55.1%	446400	491700	10.1%
8		9938	15590	56.9%	412000	455700	10.6%
9		9950	16020	61.0%	429700	478400	11.3%
10		10390	16390	57.7%	445300	485700	9.1%
Minimum:		9819	14910	43.5%	396800	449000	8.3%
Maximum:		10490	16390	61.0%	446400	491700	15.6%
Average:		10200	15700	**54.1%**	421000	468000	**11.2%**

Table 2
Summary of results, Report #C0270.01-119-19
dated 21Jan, 2013 Architectural Testing

Match-Marked Sample Comparison Data
Control Set vs. Artificially Weathered Set

Sample Number	Sample Color	Control MOR (psi)	Artificially Weathered MOR (psi)	Percent Difference MOR (psi)	Control MOE (psi)	Artificially Weathered MOE (psi)	Percent Difference MOE (psi)
1	Mocha Walnut	10390	12940	24.5%	414700	541500	30.6%
2	Mocha Walnut	10350	12700	22.7%	418200	491400	17.5%
3	Mocha Walnut	10400	13330	28.2%	413700	498200	20.4%
4	Mocha Walnut	9983	12700	27.2%	431700	479900	11.2%
5	Mocha Walnut	10210	12750	24.9%	396800	468100	18.0%
Minimum:		9983	12700	22.7%	396800	468100	11.2%
Maximum:		10400	13330	28.2%	431700	541500	30.6%
Average:		10300	12900	**25.5%**	415000	496000	**19.5%**

Table 3
Summary of results, Report #C0270.01-119-19
dated 21Jan, 2013 Architectural Testing

Match-Marked Sample Comparison Data
Control Set vs. Freeze-Thaw Resistance Set

Sample Number	Sample Color	Control MOR (psi)	Freeze-Thaw MOR (psi)	Percent Difference MOR (psi)	Control MOE (psi)	Freeze-Thaw MOE (psi)	Percent Difference MOE (psi)
1	Mocha Walnut	10390	9613	-7.5%	414700	373700	-9.9%
2		10350	10350	0.0%	418200	417000	-0.3%
3		10400	10080	-3.1%	413700	400300	-3.2%
4		9983	10030	0.5%	431700	430400	-0.3%
5		10210	10120	-0.9%	396800	383900	-3.3%
	Minimum:	9983	9613	-7.5%	396800	373700	-9.9%
	Maximum:	10400	10350	0.5%	431700	430400	-0.3%
	Average:	10300	10000	**-2.2%**	415000	401100	**-3.4%**

Table 4
Summary of results, Report #C0270.01-119-19
dated 21Jan, 2013 Architectural Testing

The above referenced Standards are appropriate for the testing program done on the Gorilla Deck® G3 Deck Boards (PVC Deck Boards).
The boards tested were obtained from the manufacturing facility. The samples were selected randomly. The testing company observed the manufacturing of the boards and selected the testing samples.
Specified Loads: At least 100 psf.

8. Full scale structure load Test

- **Flexural Test:**

1. The purpose of the test is to evaluate the performance of the boards under bending stress conditions.
2. Objective: to determine ultimate load, ultimate moment and deflection
3. Procedure: 15 specimens were obtained from different production deck planks. Overall length: 30 in; test span: 24". Testing was performed in a computer monitored and controlled SATEC Universal Test Machine (50UD) with a third-point loading arrangement. Specimens bearing: 1 ¼". Mid span deflection measured to an accuracy of 0.001 inches
4. Test Standard: ASTM D 6109: These test methods cover the determination of flexural properties of plastic lumber with rectangular or square cross-sections. The test specimens are whole "as manufactured" pieces without any altering or machining of surfaces beyond cutting to length. As such, this is a test method for evaluating the properties of plastic lumber as a product and not a material property test method. Flexural strength cannot be determined for those products that do not break or that do not fail in the extreme outer fibre.
5. Factor of Safety: 2.5
6. Results table

Sample	Ultimate Load (lbs)	Tangent Modulus (lbf/in)	Mu (in·lbs)	EI (lbs·in^2)
1	1134	641	4535	157286
2	1157	656	4628	160849
3	1147	631	4587	154865
4	1177	676	4709	165845
5	1166	675	4664	165488
6	1173	649	4691	159186
7	1165	659	4660	161613
8	1161	651	4642	159801
9	1157	701	4630	172030
10	1155	655	4620	160686
11	1165	655	4661	160588
12	1162	664	4648	162783
13	1165	653	4662	160262
14	1159	658	4638	161520
15	1148	659	4592	161568
Minimum:	1134	631	4535	154865
Maximum:	1177	701	4709	172030
Mean:	1159	659	4638	161625
Standard Dev.	11	16	43	3969
C.O.V.	1%	2%	1%	2%

- **Freeze-Thaw Resistance Test:**

1. The purpose of the test is to evaluate the effect of freeze-thaw cycles on the performance of the product.
2. Objective: Find out if performance is affected by temperature changes.
3. Procedure: Samples are subjected to Hygrothermal Cycling. Flexural test results are then performed on each sample and results are compared to identical test performed on a set of standard samples. Overall length: 30 in; test span: 24”.
4. Hygrothermal: 15 specimens were cut from 15 different production deck planks. Specimens are submerged in water for a period of 24hrs until reaching weight change less than 1% per 24h period. Then, the specimens were frozen at -29C for 24 h, then returned to room temperature. The process was repeated for a total of three cycles of water submersion and freezing.
5. Flexural: testing was performed in a computer monitored and controlled SATEC Universal Test Machine (50UD) with a third-point loading arrangement; Specimens bearing: 1 ¼”. Mid span deflection measured to an accuracy of 0.001 inches
6. Test Standard: ASTM D 6662: This specification covers polyolefin-based plastic lumber products for use as exterior residential decking boards. Plastic lumber products are currently made predominantly with recycled polyolefin plastics (in particular high-density polyethylene) where the products are more or less non-homogenous in the cross-section. However, this specification is also potentially applicable to similar manufactured plastic products made from other plastic and plastic composite materials that have non-homogenous cross-sections. Performance requirements to which the products should adhere to are flexural properties (allowable flexural stress, and effective modulus of elasticity and adjustment for creep), dimensional stability during thermal expansion, weatherability (surface appearance and flexural property changes, and hygrothermal cycling), fire properties, and slip resistance. Also detailed here is a procedure to calculate recommended span lengths for spacing of support joists..
7. Results table

Sample	Ultimate Load (lbs)	Tangent Modulus (lbf/in)	Mu (in·lbs)	EI ($lbs \cdot in^2$)
1	1205	709	4819	174015
2	1195	741	4779	181787
3	1191	731	4762	179447
4	1190	732	4760	179644
5	1193	719	4771	176291
6	1204	708	4817	173695
7	1220	744	4880	182513
8	1205	717	4819	175899
9	1191	712	4764	174785
10	1190	753	4761	184625
11	1205	710	4820	174208
12	1197	760	4790	186419
13	1156	716	4625	175767
14	1156	765	4624	187714
15	1171	676	4685	165742
Minimum:	1156	676	4624	165742
Maximum:	1220	765	4880	187714
Mean:	1191	726	4765	178170
Standard Dev.	18	24	72	5794
C.O.V.	2%	3%	2%	3%

Comparative Summary			
Property	Standard	Freeze-Thaw	
	Mean	Mean	% Diff.
Mu	4638	4765	+3%
EI	161625	178170	+10%

Conclusion: No strength or stiffness loss due to freeze-thaw cycles.

- **Creep Relaxation Test:**

1. The purpose of the test is to evaluate deflection and recovery of 16'' design span in response to temperature effects and 100psf live load.
2. Objective: to determine degree of recovery following deflection at indicated design load.
3. Procedure: One hundred pounds of dead weight was established as the design load of 100psf on a tributary area of 6'' by 24''. Deck planks were loaded directly to 2.38 x design load. After holding 2.38 x design load for 24 hours the load was removed to check recovery. Deflection readings were taken initially upon reaching 2.38 x design load, after 24 hours holding 2.38 x design load, immediately upon removing the load and a final time upon terminating the test. Test time, load and deflection were recorded at each test interval.
4. Results table

Creep Relaxation Test Sample #1

Test Description	Maximum Deflection	Notes
2.38 x Design Load (238 psf) 238 lbs Total Load	0.280"	Initial
	0.300"	After 24 hours
Zero Load	0.030"	Immediate
	0.009"	97% Recovery within 24 hours and unrecovered deflection <1/16"

Creep Relaxation Test Sample #2

Test Description	Maximum Deflection	Notes
2.38 x Design Load (238 psf) 238 lbs Total Load	0.270"	Initial
	0.300"	After 24 hours
Zero Load	0.010"	Immediate
	0.001"	100% Recovery within 24 hours and unrecovered deflection <1/16"

Creep Relaxation Test Sample #3

Test Description	Maximum Deflection	Notes
2.38 x Design Load (238 psf) 238 lbs Total Load	0.300"	Initial
	0.330"	After 24 hours
Zero Load	0.035"	Immediate
	0.010"	97% Recovery within 24 hours and unrecovered deflection <1/16"

5. Summary: All specimens recovered 97% or greater from the deflection at the indicated design load levels and exhibited unrecovered deflection less then 1/16inch.

- **Wind Uplift Test:**

1. The purpose of the test is to determine the ultimate uplift resistance of installed deck boards.
2. Objective: to determine the capacity of deck board anchored by specified fasteners.
3. Procedure: Three sample deck mock-ups were constructed from 2 x 8 Southern-Yellow-Pine lumber. Each mock-up utilized a two span condition containing eight planks each (49-1/2" in length) with no spacing between planks. A layer of 4-mil think polyethylene plastic was loosely draped between the joists of the mock-up prior to securing the deck boards in order to retain air pressure on the planks during testing. Deck planks were fastened to the deck mock-up with 1-#8 by 1-1/2" stainless steel screw per joist, in accordance with manufacturer's installation instructions. The mock-up deck assembly was installed into the test apparatus and a static air pressure load was applied to the underside of the mock-up causing an uplift pressure to the underside of all deck boards simultaneously. Test pressure was applied starting at 150psf and increasing in increments of 10psf with each load increment held for 10 seconds.
4. Test Standard: ASTM E 330-97: This test method is a standard procedure for determining structural performance under uniform static air pressure difference. This typically is intended to represent the effects of a wind load on exterior building surface elements.
5. Results table

Uplift Resistance

Test Sample	Maximum Sustained Load[1]	Comments
1	115 psf	Starter Strip/Adjacent Board connection disengaged
2	146 psf	Board/Board Tongue and Groove connection disengaged. (Boards 4&5)
3	136 psf	Starter Strip/Adjacent Board connection disengaged
Average	**132 psf**	

[1] *Held for 10 seconds.*

- **Static coefficient of Friction:**

1. The purpose of the test is to calculate the static coefficient of friction for Gorilla decking.
2. Objective: to determine the static coefficient of friction
3. Procedure: Three samples of deck board were cut to 9'' lengths and placed on a fabricated sliding unit specified by the ASTM D 2394 standard. The 26.52 pound sliding unit consists of a 25 pound calibrated weight, a wooden cleated sled and a 4-1/2'' by 4'' by ¼'' thick prime grade leather tile. The leather tile was the sliding surface in direct contact with the test board. Prior to each slip load measurement, the leather surface was lightly sanded and dry-brushed clean of debris. Using a universal testing machine equipped with a 50-pound x 0.01 pound load cell, the sled was attached by a single steel cable and pulled at a constant rate of cross-head motion equal to 0.05'' per minute until the load to break the static friction was reached. This value was recorded as the slip load. Tests were conducted parallel with the plank (0 degrees), 90 degrees, 180 degrees, and 270 degrees on three different dry specimens. Duplicate evaluations of the plank were conducted in wet conditions where the planks were soaked for 30 minutes prior to testing and the leather tile was saturated with a water spray that resulted in a standing puddle on the surface of the board. The sliding unit was again placed on top of the wetted surface, pulled to determine the slip load and the peak value recorded. The same quantity of readings were taken under wet conditions. All slip loads were recorded and divided by the sliding unit weight to determine the static coefficient of friction.
4. Test Standard: ASTM D 2394: These test methods cover procedures for measuring the performance of finish flooring including coefficient of friction.
5. Results table

Dry Slip Load (lb)

Test Direction	#1	#2	#3	Average	Coefficient of Friction[1]
0°	12.14	11.73	12.12	11.99	0.45
180°	12.11	12.25	13.17	12.51	0.47
90°	15.55	15.60	15.09	15.41	0.58
270°	13.36	13.41	13.12	13.29	0.50

Wet Slip Load (lb)

Test Direction	#1	#2	#3	Average	Coefficient of Friction[1]
0°	18.59	17.14	17.74	17.82	0.67
180°	17.24	18.16	16.29	17.23	0.65
90°	20.53	19.27	21.48	20.42	0.77
270°	21.71	20.64	20.11	20.82	0.79

[1] *Static Coefficient of Friction (S.C.F.) is calculated as follows:*

$$SCF = \left(\frac{Average\ Slip\ Load}{Sliding\ Unit\ Weight} \right)$$

- **Heat Resistance Test:**

1. The purpose of the test is to evaluate the performance of the boards under heat stress conditions.
2. Objective: to determine if degree of damage produced by heat exposure complies with the AAMA 303 standard.
3. Procedure: Five samples of deck plank were cut from production boards and prepared for testing by conditioning for a minimum of four hours. The samples were nominally 6'' long by one full board width (approximately 5-1/2'') and the full thickness of the production board. The specimens were then exposed to a forced draft oven at 300 +/-5◦F (149 +/-4◦C) for 30 minutes. After 30 minutes, the samples were removed and inspected for evidence of blistering, cracking, flaking, or delamination.
4. Test Standard: AAMA 303: Defines the minimum requirements for dimensional stability, impact resistance, weather ability, heat resistance, weight tolerance, heat build-up and lead compound content of rigid polyvinyl chloride (PVC) exterior profiles.
5. Deckboards subject to excessive heat may exhibit warping. The heat impacts may be mitigated by the use of natural fiber floor coverings, awnings, or similar shade producing fixtures or accessories
6. Summary: Upon completion of 30 minutes exposure, no evidence of blistering, cracking, flaking or delamination was observed on the walking surfaces or the ends of all five samples. The test samples were deemed to comply with the standard.

- **Heat Build-up in PVC Building Products Test:**

1. The purpose of the test is to evaluate the heat build-up in Gorilla decking.
2. Objective: to determine the maximum heat build-up in test samples
3. Procedure: Five 3'' square by approximately 0.060'' thick test samples were cut from production boards and tested with the walking surface (embossed surface) facing the heat source. A black body reference plate was placed into the exposure box as

detailed in ASTM D 4803, Standard Test Method for Predicting Heat Buildup in PVC Building Products. The temperature of the black body was monitored using a thermocouple secured with aluminium foil adhesive tape to the underside of the colored walking surface at mid-length of the sample until a maximum temperature was maintained for a period of five minutes. This peak temperature was recorded and was used to evaluate the heat buildup of the test samples. The criteria used to determine the heat buildup were:

4. Ambient air temperature in laboratory = 69◦F.
5. Horizontal heat buildup for a black body under controlled conditions due to absorption of the sun's energy = 90◦F.
6. Test Standard: ASTM D 4803: This test method covers prediction of the heat buildup in rigid and flexible PVC building products above ambient air temperature, relative to black, which occurs due to absorption of the sun's energy
7. Results table

Homeland Vinyl PVC Gorilla Deck Boards

Sample	Max. Temp. (°F)	Temp. Rise, $\Delta T l_U$ (°F)	Heat Buildup, ΔT Horizontal (°F)
1	158.9	89.9	41.7
2	152.6	83.6	38.7
3	155.6	86.6	40.1
4	158.8	89.8	41.6
5	161.8	92.8	43.0
Average	**157.5**	**88.5**	**41.0**
Control	**228.7**	**159.7**	**N/A**

- **Dimensional Stability Test:**

1. The purpose of the test is to evaluate dimensional stability of the boards upon water exposure.
2. Objective: to determine if degree of dimensional change complies with AAMA 306-01, Voluntary Specification for Rigid Poly (Vinyl Chloride) (PVC) Exterior Plank Profiles Used for Decking and Dock Walking Surface.
3. Procedure: Three samples 6'' long by 2'' wide and the full thickness of the board were prepared for testing. Testing was performed according to ASTM D 4726 and D 1042 as referenced. Each sample was scribed with a 100mm carbon steel tipped scribe. Each sample was placed into a 180◦F water bath for a period of 30 minutes. At the completion of the water bath exposure, the samples were removed and allowed to cool for one hour by natural means at ambient room temperature. A second scribe was made on the sample using the original pivot point and the distance between the original and post-exposure scribes was measure recorded to the nearest 0.0005''. The percentage dimensional change was calculated as follows:

$$\Delta D\% = \Delta L/L \times 100$$

where:

$\Delta D\%$ is the sample dimensional change
ΔL is the distance between scribe lines
L is the original scribe length

4. Test Standard: ASTM D 4726, Section 10.3: This specification establishes requirements for the material properties, including dimensional stability, weatherability, and extrusion quality, of rigid poly(vinyl chloride) (PVC) exterior profile extrusions.
5. Results table

Specimen #1	Specimen #2	Specimen #3	Average
0.60%	0.60%	0.56%	0.59%

6. Summary: the samples did not exceed the maximum allowable shrinkage requirements per AAMA 306 of 2.2% for the average with no single value exceeding 2.4%.

- **Weight Tolerance Test:**

1. The purpose of the test is to evaluate the weight tolerance compliance of the Gorilla decking boards with AAMA 306.
2. Objective: to determine if weight tolerance complies with AAMA 306 requirements.
3. Procedure: Fifteen test samples 30'' in length and ranging in weight from 2.98 to 2.04 pounds were used for ASTM D 6109 flexural testsing. The unit weight for the samples ranged between 1.190 and 1.220 lbs/ft.
4. Test Standard: ASTM D 6109: These test methods are suitable for determining the flexural properties for any solid or hollow manufactured plastic lumber product of square, rectangular, round, or other geometric cross section that shows viscoelastic behavior.
5. Summary: All weights were within 10% of the manufacturers specified product weight of 1.300 lbs/ft. as required by AAMA 306.

- **Fire Resistance Test:**

1. The purpose of the test is to evaluate the relative burning behaviour of the material by observing the flame spreading along the specimen. Flame Spread and Smoke Developed index are reported.
2. Objective: to measure and describe the response of the Gorilla Decking material to heat and flame under controlled conditions.
3. Procedure: Test specimens were conditioned for 14 days at 70◦F and 50% relative humidity. Immediately prior to the test the specimens were mounted in the furnace with the side to be tested facing the test flame, using 2 in. hexagonal wire mesh with 0.25 in. diameter steel rods every 24 in. The flame front position and light obscuration were recorded throughout the 10-minute test and used to calculate the Flame Spread and Smoke Developed indices. The temperature at 23 feet was also recorded. The Flame Spread and Smoke Developed indices reported herein are relative to the results obtained for mineral fiber-reinforced cement board and select grade red oak (moisture content between 6 and 8%). The mineral fiber-reinforced cement board is the calibration material used to obtain 0 values for Flame Spread and Smoke; red oak decks were used to obtain 100 values for Flame Spread and Smoke. Four interlocking sections, 7 in.-wide by 96 in.–long forming a 24 in. by 96 in.-long deck by three decks at 96 in.-long.
4. Test Standard: ASTM E 84-03: This fire-test-response standard for the comparative surface burning behavior of building materials is applicable to exposed surfaces.

5. Results table

TEST RESULTS (ROUNDED TO NEAREST 5)

FLAME SPREAD INDEX (FSI):	15
SMOKE DEVELOPED INDEX (SDI):	885

TEST DATA

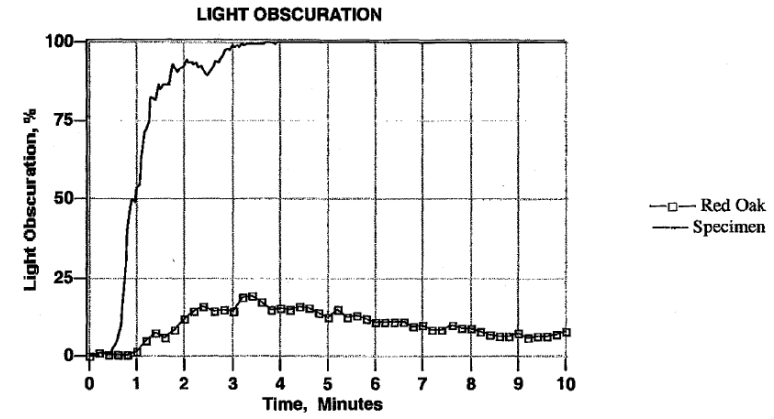
UNROUNDED FSI:	15.6
UNROUNDED SDI:	882.5
FS*TIME AREA (Ft*Min):	30.5
SMOKE AREA (%*Min):	889.1
FUEL AREA (°F*Min):	4283.3

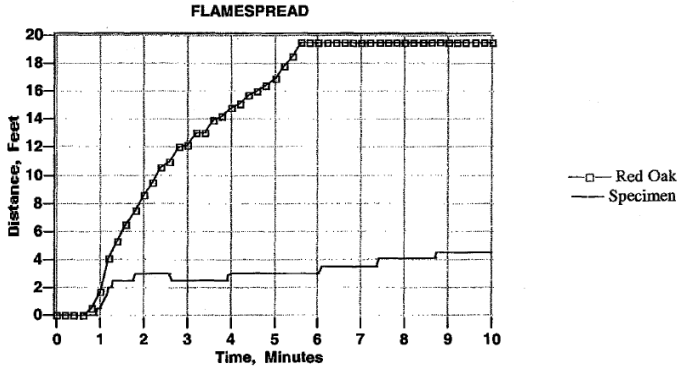
OBSERVATIONS DURING TEST

IGNITION TIME (Min:Sec):	0:51
MAXIMUM FLAME FRONT ADVANCE (Ft.):	4.5
TIME TO MAXIMUM ADVANCE (Min:Sec):	8:45
MAXIMUM TEMP. AT EXPOSED TC (°F):	506
TIME TO MAXIMUM TEMP. (Min:Sec):	10:00
TOTAL FUEL BURNED (Cu. Ft.):	52.0
DRIPPING (Min:Sec):	None
FLAMING ON FLOOR (Min:Sec):	None
AFTERFLAME TOP (Min:Sec):	3:00+
AFTERFLAME FLOOR (Min:Sec):	None

CALIBRATION DATA (LAST RED OAK)

RED OAK SMOKE AREA (%*Min):	100.2
RED OAK FUEL AREA (°F*Min):	8358.4
GRC BOARD FUEL AREA (°F*Min):	5149.9





- **Slip Resistance Test:**

1. The purpose of the test is to evaluate slip resistance of the Gorilla Decking hollow vinyl deck board for dry and wet conditions.
2. Objective: to determine the coefficient of friction (slip resistance) testing in accordance with ASTM D 2394-05.
3. Procedure: All testing was done in a laboratory setting to maintain temperature in the range 68 +/-4◦F and humidity in the range of 50 +/-5% relative humidity. All test specimens were stored in the laboratory environment for no less than 40 hours prior to testing. Two sets of tests (dry and wet conditions) were conducted on three test specimens for each set. Deck boards were provided pre-cut to 8 in. nominal lengths and measured a nominal 6 in. wide and 1-5/16 in deep. Testing was performed using the methods described by ASTM D 2394. The deck board was placed on a testing apparatus and placed under a 26.28 pound sled assembly consisting of a 25 pound calibrated weight, a wooden cleated sled, and a 4-1/2 in by 4 in by ¼ in thick prime grade leather tile, the leather tile being the sliding surface directly in contact with the test board. Prior to each slip load measurement, the leather surface was lightly sanded and dry-brushed clean of debris. The sanding process was accomplished with 150 grit coarse sandpaper, making five passes in each diagonal direction. Testing was performed in a SATEC Unidrive, Model MII 50 UD Universal Testing Machine with a 50 pound load cell, to which the sled was attached with a single steel cable. The sled was then pulled at a constant rate of crosshead motion equal to 0.05 in per minute until the load to break the static friction was reached. This value was recorded as the slip load. Tests were performed parallel with the deck board (0 degree), 90 degrees, 180 degrees, and 270 degrees on three dry and three wet specimens. All slip loads were recorded in the unit weight of pound and devided by the sled weight to determine the static coefficient of friction.
4. Test Standard: ASTM D 2394-05: These test methods may be used to compare different finish floorings as to their resistance to severe and ordinary service loads and also may serve as the means to set specification limits. The properties obtained by these test methods are needed in addition to such basic material properties as stiffness, strength, hardness, and dimensional stability.
5. Results table

	Direction	Slip Load (lb)				S.C.F. [1]
		Test No. 1	Test No. 2	Test No. 3	Average	
Dry	0°	21.07	20.93	20.42	20.81	0.79
	90°	23.74	27.13	27.11	25.99	0.99
	180°	20.02	21.33	21.32	20.89	0.79
	270°	26.21	26.03	26.29	26.18	1.00
					Average Longitudinal:	0.79
					Average Transverse:	0.99

[1] S.C.F. - Static coefficient of friction

	Direction	Slip Load (lb)				S.C.F. [1]
		Test No. 1	Test No. 2	Test No. 3	Average	
Wet	0°	22.80	22.55	22.03	22.46	0.85
	90°	26.87	26.48	25.51	26.28	1.00
	180°	22.92	22.54	21.94	22.47	0.85
	270°	26.46	26.66	24.92	26.01	0.99
					Average Longitudinal:	0.85
					Average Transverse:	0.99

[1] S.C.F. - Static coefficient of friction

- **Impact Test:**

1. While not a factor under AC174, impact resistance is tested under Homeland Vinyl Products' quality control process.
2. Under the QC process, Gorilla Deck samples are subject to a minimum impact of 80 lb-ft (108 N-m).
3. The performance requirement, obtained from CAN/CSA-O325.0-92, Table 2, "Required Resistances to Concentrated Static and Impact Loads for Construction Sheathing is 102 N-m for 400 mm o.c. span.
4. CAN/CSA-0325.0-92 and ASTM E 661 (Standard Test Method for Performance of Wood and Wood-Based Floor and Roof Sheathing Under Concentrated Static and Impact Loads) are the standards used by the Canadian Construction Materials Centre (CCMC) to evaluate impact testing.
5. The typical impact failure mode is cracking of the top side of the deck board, with some cracking of the vertical rib within the hollow section of the board. The cracking is usually localized to the point of impact (a 2" diameter 20 lb cylindrical falling weight), and does not usually spread to the bottom of the board.
6. Impact testing has not been performed under controlled temperature conditions.

9. Performance

a. Design Basis: the unique characteristics of G3 Deck Boards (PVC Deck Boards) make them a feasible option instead of wood: Deck boards do not rot, they are impervious to insect attack, do not absorb moisture, the special design allows for water shedding, they do not need painting or staining.
b. The Gorilla Deck® G3 Deck Boards (PVC Deck Boards) are designed to withstand a load of at least100 lbs/sqft when supported at 24" o.c. The design loads easily surpass Building Code requirements for decks.
c. Fatigue: 90 days duration of load testing showed no tertiary creep or sign of failure due to static loads for sustained time.
d. Deflection: Temperature effect is considered in the ICC testing and is a non-issue, coefficient of thermal expansion falls within ASTM spec for vinyl fence and railing and the decking meets the same requirement for the VFDRMA decking standard (there is not an ASTM spec for vinyl decking).
e. Decay: moisture does not affect PVC, as it does not absorb water, there is no potential for decay or insect consumption as there is no cellulose material in the product.
f. Due to the characteristics of the PVC and based on the testing reports available, the Gorilla Deck® G3 Deck Boards (PVC Deck Boards) would be at least as durable and as strong as treated lumber and they are maintenance-free.
g. After a fire test (as per ASTM E-84) conducted on March 21, 2005 by SwRI, the Gorilla Deck® G3 Deck Boards (PVC Deck Boards) obtained a Flame Spread Index (FSI) of 15. S.P.F. has a FSI of above 50. The higher the number, the faster the fire will spread.

10. Warranty

The Gorilla Deck® G3 Deck Boards (PVC Deck Boards) come with a limited warranty of 30 years by the manufacturer Homeland Vinyl Products Inc

11. Responsibility

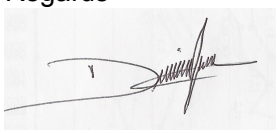
This report is based on testing reports (53597.01-119-19 dated Jun. 13, 2005, 92221.01-119-19 dated August 13, 2009 and 85730.03-119-19 revision 1 dated Sep. 22, 2009), C1530.01-119-19 dated 03/07/13, C0270.01-119-19 dated 01/21/2013 and C0270.02-121-24 by Architectural

Testing by Architectural Testing, The firm taking responsibility of the structural evaluation is Estructura Inc. Installation to follow the Gorilla Deck G3 Deck Boards (PVC Deck Boards) installation guidelines.

12. Concluding remarks

Based on reports from Architectural Testing and the Department of Fire Technology, as mentioned above, The Gorilla Deck® G3 Deck Boards (PVC Deck Boards) can safely withstand a maximum superimposed load of at least 100 psf when supported @ 24" o.c.
It is our conclusion that the Gorilla Deck® G3 Deck Boards (PVC Deck Boards) meet the requirements of the Ontario Building Code 2012 Part 9. Also, the product meets the safety objectives of the Ontario Building Code as defined in Division A Section 2.2 Table 2.2.1.1 Category 0S2 and OS2.1.
If you have any further questions, please contact the undersigned

Regards



Estructura Inc