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KBI Flexi[®]-Pave HD2000

SPECIFICATIONS for Flexible Porous Paving (Revised 19th August 2020)

1. GENERAL

1.1 Abstract

Pervious pavement system is now being recognized as a best management practice by the Environmental Protection Agency and the state of Florida. The pervious pavements systems are designed to have enhanced pore size in surface layer compared to conventional pavements types, encouraging flow of water through the material. The advantages include reducing the volume of surface runoff; reduce need for stormwater infrastructure, less land acquisition for stormwater ponds, improved road safety by reducing surface ponding and glare, and a reduced urban heat island effect. The research project investigated the infiltration rates, rejuvenation techniques, sustainable storage of components and complete systems, water quality, and the strength properties of porous asphalt pavements. The work was conducted at the field labs of stormwater Management Academy at UCF.” Form DOT F 1700.7 (8-72) <14

KBI Flexi[®]-Pave leachate contains no organic compounds or heavy metals but does have elemental constituents all with concentrations less than 2.52 ppb. These values are far below primary and secondary drinking water standards, thus demonstrating KBI Flexi[®]-Pave’s leachate does not pose a threat to environmental quality of the watershed above the intake (or the aquifer around the well) and thus the drinking water resources. ASTM RE1252 <15

1.2 Introduction

Growth urbanization has a negative impact on the quantity and quality of runoff water entering our lakes and streams. <8 By replacing natural land covers (like grasslands and forests) with impervious surfaces (like parking lots and streets), we lose the water retaining role of the soil and vegetation.

Increased runoff from impervious surfaces causes dangerous floods, severe erosion damage to our stream channels, diminished recharge of groundwater, and degraded habitat for our fisheries. These same impervious surfaces can transport the many pollutants deposited in urban areas, such as nutrients, sediment, bacteria, pesticides, and chloride. In the worst cases, the amount of pollutants in urban runoff are high enough to prevent us from being able to swim or fish in our local waters.

1.3 Background

KBI’s KBI Flexi[®]-Pave solutions have been successfully used for more than 20 years in a variety of climates around the United States, Carribean, and Europe.

Providing a pavement surface that is also part of the stormwater management system, reducing stormwater runoff, pollutants, and replenishing groundwater.



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Installations of KBI Flexi®-Pave in parking lots, and trails and have lasted more than 20 years with no maintenance other than cleaning. A few of the signature projects are; Yellowstone National Park, Arlington National Cemetery, Pebble Beach, Key West, Smithsonian Institute.

1.4 Applications

Some Examples of the the most common uses of KBI Flexi®-Pave are:

Trails, Tree surrounds, Parking Lots, Sidewalks, Driveways, Fitness Trails, Equestrian, Roadside, Road Way Medians, Shallow Drainage, Embankment Stabilization, Multi Recreational, etc.

1.5 Storm Water Run Off

The KBI Flexi®-Pave allows for the release of Hydraulic Water pressures releasing through the 23% dynamic porous design at a porosity rate of 3000+ gallons per square foot per hour <3.

By controlling the runoff at the source, such as a parking lot, KBI Flexi®-Pave reduces the need for or the required size of a regional BMP, such as a wet detention pond, which saves money, and can allow increase in the development scope of works.

KBI Flexi®-Pave helps reestablish a more natural hydrologic balance and reduce runoff volume by trapping and slowly releasing precipitation into the ground instead of allowing it to flow into storm drains and out to receiving waters as effluent.

This same process also reduces the peak rates of discharge by preventing large, fast pulses of precipitation through the stormwater system with the 23% void capacity.

Provides drainage and evacuation of accumulative water through the natural porosity of the Flexi®-Pave system. <4

The KBI Flexi®-Pave can also solve multiple environmental struggles; Sound Abatement Solutions, Environmental Pollution, Storm Water Runoff and can be used as Retaining walls.

1.6 Sound Abatement

Acoustical properties were assessed according to ASTM C423. The data obtained show porous absorbers having a high sound absorption performance with low thicknesses and compared to some of the current models for the prediction of their absorptive properties.

1.7 Environmental Infrastructure

Pollution: KBI Flexi®-Pave naturally incubates a “Bio - Film Bacteria” within the pore space of the structure which can remove up to 86% of dissolved Nitrates and Ortho- Phosphorous. 2 (Thereby reducing the concentration of nutrient pollutants as it passively cleans the water through the KBI Flexi®-Pave)

Cools stormwater temperature during summertime before discharge and mitigates heat island effects. <9



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Recharging of groundwater supplies. <10

Low impact development and cost-effective technology for stormwater management, by reducing need for drainage structures and rights of way. <11

Improves water and oxygen transfer to nearby plant roots. <13

Determining the void capacity and silt load recoverability of the material. Measuring the rate of water “upstream” of the sample install. Determining the recoverability after the embedment of soil. KBI Flexi®-Pave showed a superior void capacity. The material also showed extremely high recoverability after vacuuming. <19 ERIK Infiltration Testing

Water Storage, KBI Flexi®-Pave catches precipitation and surface runoff, storing it in the natural water vault that exists within the KBI Flexi®-Pave (Approx 0.6 of a gallon / square foot) while slowly allowing it to infiltrate into the soil below.

Water Conservation, Determining the materials effect on water quality, specifically in the reduction in Dissolved Nitrates and Ortho- Phosphorous concentrations. The material was tested using an enclosed capture well system that isolated the spiked water samples from intrusion by other water sources, this isolated the KBI Flexi®-Pave system, thus maximizing it as the major contributor to the test results.

Testing indicated that KBI Flexi®-Pave is effective in reducing Dissolved Nitrates and Ortho-Phosphorous loads to groundwater. <28 EPA 353.2 / EPA 365.4.

1.8 Testing

KBI Flexi®-Pave - components of this priority porous design consists of wire and fiber free different particle sizes repurposed tires, fractured face granite rock mixed with different proportions of custom binding agent. Priority procedure and formula. <5

Reduce Road Salt, another benefit of Flexi Pave™ is the reduced need to apply road salt for deicing in the wintertime. Researchers at the University of New Hampshire have observed the permeable surface only needs 0 to 25% of the salt routinely applied to normal asphalt. <6

Promotes Thawing, Other researchers have found that the air trapped in the pavement can store heat and release it to the surface, promoting the melting and thawing of snow and ice. <7 Hydrologic Performance

Permeability is tested through trials of varying conditions. KBI Flexi®-Pave exhibited a high degree of permeability in accordance with FL Dot requirements. <20 FL DOT FM 5-565 Permeability Testing

Slip Resistance, Determining the materials classification as a slip resistant walking surface. Testing the coefficient of friction to the surface with human locomotion. KBI Flexi®-Pave was determined to be a non-slip hazard surface. <26ASTM D 2047

Sustainable, ADA compliant and slip resistant with a 0.65 coefficient of friction rating. Flexi Pave™ is a LEED qualified construction material meeting 7 of 7 LEED Categories, providing up to 11 points.



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Loaded Wheel Test, Hamburg Loaded Wheel Test method determines the premature failure susceptibility of bituminous mixtures due to weakness in the aggregate structure, inadequate binder stiffness, or moisture damage and other factors including inadequate adhesion between the asphalt binder and aggregate. This test method measures the rut depth and number of passes to failure. A loaded steel wheel tracks over the samples in water, the deformation is observed vs. the number of loading passes. Flexi®-Pave performed excellent, recovering fully after 24 hours. (Note: conventional asphalt pavement typically does not exhibit this ability to deflect to this degree without cracking or separation.) <23 TX DOT 242-F.

Initial Scuff/Power Steering Resistance, Material was tested against surfaces stresses including power steering and other stresses. Material must withstand and show no signs of damage. Testing of surface toughness and stress resistance. Flexi®-Pave exhibited excellent cohesion properties; the specimen remained totally intact without visible deformation induced by the test procedure. Aggregates remained firmly bonded. <24 ISSA TB 100, Wet Track Abrasion / ISSA T B 139, Cohesion Measurement.

Resilient Modulus, Testing of the material core at temperatures up to 400 degrees and observing the effects on the material. Determining the impact of Heat Aging on the resilient modulus of a materials core. KBI Flexi®-Pave showed no deleterious effects of the heat aging. <25 ASTM D 4123.

Static Creep, Determining the resiliency and recovery properties of the material by placing and removing loads. Apply a static load to a sample and measure how it recovers when the load is removed. Flexi®-Pave exhibited superior resiliency and recovery properties when subjected to static load. <27 TX DOT 231-F.

Surface Burning, A method for determining the comparative surface burning behavior of burning materials. The purpose of the method is to determine the relative burning behavior of the material by observing flame spread along the specimen. The material was tested using varying temperatures and placed in a furnace and exposed to flaming fire. KBI Flexi®-Pave had a flame spread index of 15 and a smoke developed index of 300. <21 ASTM E84-11a.

Electrical Resistant, Determining the electrical resistivity of the material. Flexi®-Pave was shown to be resistant to electricity. The material was tested in and out of water to determine its electrical resistance capabilities. <17 ASTM G57-06

Freeze /Thaw, Material will be tested in multiple Freeze/Thaw cycles. Goal of test is to have no cracks, breaks or deterioration through 200 cycles of Freeze/Thaw. Flexi®-Pave exceeded goal and showed no cracks, breaks or deterioration through 300 cycles of Freeze/Thaw. Suitable for installation at subzero up to 120-degree desert conditions. <16 ASTM C 666/C/666M-03

1.9 Shock Absorbtion

Reduce Impact, Testing of material to determine the chance of injury from falling off playground equipment onto product P2000(KBI Flexi®-Safe) only material Testing of material to determine the chance of injury from falling off playground equipment onto the material.

Reduce Temperature, Evaluated for Impact Attention in accordance with the procedures outlined in ASTM F1292-09 “Standard Specification or Impact Attenuation of surfacing materials within the zone of playground equipment” at ambient temperature conditions only.(Applicable to P2000 KBI Flexi®-Safe)

Fall Criteria, Material must meet certain criteria for each fall height. That criteria is the “G” Max (G-max is the measure of the maximum acceleration (shock) produced by an impact) and the “HIC” (The Head Injury Criterion or HIC score is an empirical measure of impact severity based on



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published research describing the relationship between the magnitude and duration of impact accelerations and the risk of head trauma). KBI Flexi®-Safe was found to absorb sound at varying frequencies. <18 ASTM C423-09a and E795-05.

Reference

- <1 Riverbank Acoustical Laboratories Sound Absorption Test RAL™-A10-119 conducted: 29 June 2010
- <2 Mallard, Inc. Water sampling City of Dunedin Municipal Service Facility conducted: 13 January 2011
- <3 Constellation Technology Flexi Pave™ Perk Test conducted: 9 February 2015
- <4 Constellation Technology Flexi Pave™ Compression and Leach Test report conducted 9 April 2015
- <5 KBI FLEXI® Leeds Credits: SS credit 6 – stormwater management MR Credit 4 – Recycled Content
- <6 Houle, K., Roseen, R., Ballestero, T., Briggs, J., and Houle, J., 2009, Examinations of Pervious Concrete and Porous Asphalt Pavements Performance for Stormwater Management in Northern Climates: World Environmental and Water Resources Congress 2009: p. 1–18.
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- <8 Davis, A.P., 2005, Green engineering principles promote low-impact development: Environmental Science and Technology, A-pages, v. 39, no. 16, p. 338A–344A.
- <9 Lebens, M. (2012). Porous Asphalt Pavement Performance in Cold Regions. Report 2012-12. Minnesota Department of Transportation. St. Paul, Minn. Available online at www.dot.state.mn.us/research/documents/201212.pdf
- <10 UNHSC (2011). Regular Inspection and Maintenance Guidance for Porous Pavements. University of New Hampshire Stormwater Center, Durham, N.H. Available online at www.unh.edu/unhsc/sites/unh.edu.unhsc/files/UNHSC%
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- <12 Houle, J.J., R.M. Roseen, T.P. Ballestero, T.A. Puls, & J. Sherrard Jr. (2013). Comparison of Maintenance Cost, Labor Demands, and System Performance for LID and Conventional Stormwater Management. Journal of Environmental Engineering, Vol. 139, No. 7, pp. 932–938. DOI: 10.1061/(ASCE)EE.1943-7870.0000698
- <13 CTC & Associates Inc. (2012). Porous Asphalt Performance in Cold Regions. Report 2012-12TS. Minnesota Department of Transportation, St. Paul, Minn. Available online at www.dot.state.mn.us/research/TS/2012/201212TS.pdf
- <14 dot-bdk78-977-01-2-rpt FDOT Project Number: BDK78; Work Order #977-01 UCF Office of Research
- <15 ASTM E1252 Testing of leachate off of KBI Flexi®-Pave Material was tested to determine total solids and analysis of the solids for chemical identification.
- <16 ASTM C 666/C/666M-03 Material will be tested in multiple Freeze/Thaw cycles. Goal of test is to have no cracks, breaks or deterioration through 200 cycles of Freeze/Thaw.
- <17 ASTM G57-06. The material was tested in and out of water to determine its electrical resistance capabilities. KBI Flexi®-Pave was show to be resistant to electricity.
- <18 ASTM C423-09a and E795-05. Determining the materials sound absorption capabilities.
- <19 ERIK Infiltration Testing. KBI Flexi®-Pave showed a superior void capacity. The material also showed extremely high



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recoverability after vacuuming

<20 FL DOT FM 5-565 Permeability Testing, KBI Flexi®-Pave exhibited a high degree of permeability.

<21 ASTM E84-1 1a KBI Flexi®-Pave had a flame spread index of 15 and a smoke developed index of 300.

<23 TX DOT 242-F. Hamburg Loaded Wheel Test

<24 ISSA TB 100, Wet Track Abrasion / ISSA T B 139, Cohesion Measurement

<25 ASTM D 4123. Determining the impact of Heat Aging on the resilient modulus of a materials core.

<26ASTM D 2047 Determining the materials classification as a slip resistant walking surface.

<27 TX DOT 231-F. Determining the resiliency and recovery properties of the material by placing and removing loads.

<28 EPA 353.2 / EPA 365.4. Determining the materials effect on water quality, specifically in the reduction in nitrate and phosphorous concentrations.

2. SPECIFICATION of KBI Flexi®- Pave HD2000

- 2.1 The Flexible Porous Paving shall be KBI Flexi®-Pave HD2000 made from recycled passenger tires, crushed stone and a urethane binding agent as manufactured by K.B. Industries, Inc. (KBI), 4600 140th Ave. N, Suite 200, Clearwater, FL 33762. Tel 727 723 3300
- 2.2 All components, materials and compounds shall be 100% sourced and manufactured in the USA. The Flexible Porous Paving shall be supplied by a manufacturer with at least 10 years experience that can supply references for similar applications and installations in the USA.

2.3 Submittals

- 2.3.1 Certificates stating that materials meet or exceed the specified contract requirements.
Site handling and storage instructions.
- 2.3.2 Mixing and installation instructions.
- 2.3.3 A sample that reflects the characteristics of the material to be installed. The sample, upon approval, shall be maintained as the standard of minimum quality for all the proposed surfacing and paving work required for the project.

3. CONTRACTOR

- 3.1 The Contractor's craftsmen or crew chief, installing the KBI Flexi®-Pave Porous Paving shall attend a training webinar and an on-site installation training certification prior to installing KBI Flexi-Pave HD2000.
- 3.2 Contractors bidding on the installation of KBI Flexi®-Pave HD2000 may start the training process by contacting KBI and attending a training webinar prior to contract award. On-site installation training may occur after the contract is awarded.
- 3.3 The Contractor shall;
Furnish all labor, materials, tools, equipment, and incidentals required to install KBI Flexi®-Pave HD2000.
- 3.4 Provide an adequate number of skilled workers who are trained and experienced with installing KBI Flexi-Pave HD2000 and are familiar with the specified contract requirements and the methods needed for its installation.

K.B. Industries, Inc. 4600 140th. Ave North Ste 200, Clearwater Florida, USA. www.kbius.com

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- 3.5 Install the crushed stone sub-base as described in the specifications and shown on the contract drawing unless the sub-base is installed/provided.
 - 3.5.1 Flexible Porous Paving at 2” (50mm) thick base requirement 4” (100 mm) thick. “Heavy traffic”
 - 3.5.2 Flexible Porous Paving at 1½” (35mm) thick base requirement 4” (100 mm) thick. “Pedestrian traffic”
 - 3.5.3 Flexible Porous Paving at 1” (25mm) thick base requirement to be an existing engineered base (Concrete, Asphalt, or Wooden) “Over Pour Conditions”
 - 3.5.4 Maintain subgrade during construction to the maximum extent practical. regrade subgrade disturbed by delivery vehicles or other construction traffic, as needed.
- 3.6 Install the KBI Flexi®-Pave HD2000 to depth and width as described in the specifications and shown in the contract drawings.
- 3.7 Reduce the risk of damage to the KBI Flexi®-Pave surface by not allowing track vehicles (metal or rubber), forklifts (warehouse-variable reach), main lifts (booms or scissors), and/or dumpsters or roll-off containers on the KBI Flexi-Pave HD 2000 either during or following installation. Any explicit or implied warranty is voided through failure to comply with this section.

4. PRODUCTS

- 4.1 The KBI Flexi®-Pave HD2000 shall be installed in accordance with the manufacturers written instructions to an average depth of 1.5 inches over the prepared sub-base.
 - 4.2 The KBI Flexi-Pave HD2000 shall be Natural colors; Black / Cypress / Redwood / Bark Brown / Green / Granite or ZX vibrant colors Brick Red / Concrete / Emerald / Mahogany / Olive Brown / Pitch Black / Sand Stone / Sky Blue / Slate in color.
 - 4.3 The KBI Flexi-Pave HD2000 shall be mixed with a urethane binding agent based on MDI Polyether Polyols and shall be free of extender oils to prevent leaching over time. Binders that use extender oils will not be acceptable.
The KBI Flexi®-Pave HD2000 shall be cured and fit for use within 24 hours of installation.
 - 4.3.1. Cure Time Rule Exceptions to 4.3:
 - (a) 24 hours when installed in 45°F - 95 °F conditions
 - (b) 48 hours during very cold temperatures at or near freezing conditions.
 - (c) 72 hours when installed in subzero conditions. and not until the porous paving is accepted
- Note:** In all cases it is important that the hardness of the KBI Flexi-Pave be verified by the KBI Certified contractor before use
- 4.4 The KBI Flexi®-Pave HD2000 shall have a composition of 50% stone aggregate and 50% chipped rubber tires by weight.

5. TESTING REQUIRMENTS (And In accordance with the KBI Testing Portfolio Referenced)

The Contractor is responsible for supplying and installing a warranted material that meets, or exceeds, the manufacturer’s specifications and testing:

- 5.1 ASTM C 666/C/666M- Freeze-Thaw testing with no cracks or breaks through 300 cycles of testing.
- 5.2 Designated as “Highly Permeable” under FL DOT FM 5-565 permeability testing.
- 5.3 Independent testing showing a perk rate of 2400 gph (40 gpm) per sq. ft. or higher.
- 5.4 Accelerated Weathering using ASTM 4798.
- 5.5 Hamburg Loaded Wheel Testing TX DOT 242-F, must be equivalent or better than 2.3 rut depth at 8,000 cycles and full recovery within 24 hours.
- 5.6 Static Creep Testing TX DOT 231-F, shall be equivalent to or better than total strain +2.703% and permanent strain equal to 0.514%.
- 5.7 Resilient Modulus Testing in accordance with ASTM D 4123 shall be equivalent or better than 68,495 pounds.
- 5.8 Slip resistant and ADA compliant, in accordance with ASTM D 2047 testing.
- 5.9 Heat resilient to 400 degrees in accordance with ASTM D 4123 testing.



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- 5.10 Sound absorbent, in accordance with ASTN C423-09a / E795-05 testing.
- 5.11 Compression tested and be able to withstand 250 psi without permanent deformation or damage.
- 5.12 Has a leachate less than 6 parts per billion and containing no organic compounds or heavy metals.
- 5.13 The material shall be resistant to the following elements: transmission, hydraulic, and brake fluids, gasoline, diesel, saltwater, oil, chlorine, ozone, bromine, and muriatic acid.

6. PROJECT CONDITIONS

- 6.1 The Contractor shall provide appropriate and adequate protection to adjacent areas including but not limited to:
- 6.2 Protection of adjacent work space from splashing of Flexible Porous Paving materials.
- 6.3 Remove all stains from exposed surfaces of paving, structures, and grounds.
- 6.4 Remove all waste and spillage.
- 6.5 Provide suitable protection to assure no damage or disturbance to existing improvements or vegetation before starting work and maintain protection throughout the course of the work.
- 6.6 Restore and repair areas, at no additional cost to the owner, that have been damaged as a result of construction work, including existing paving on or adjacent to the site, to their original condition or repair as directed to the satisfaction of the Owner's Representative.

7. WEATHER

- 7.1 KBI Flexi®-Pave HD2000 urethane binder is engineered based on the geographical location of the project and climate expectations during installation. KBI will provide the appropriate binder for each installation and the materials delivered will be based on project location and seasonality.
- 7.2 KBI Flexi®-Pave HD2000 shall not be installed when the ambient air temperature in the shade near the installation site is above 95° F or below 32° F. Temperatures below 50° F can extend the curing time and would fall outside of normal “use ready in 24 hours” guidelines.
- 7.2.1 Exceptions to 7.2 :
KBI Flexi®-Pave HD2000 can be installed in 45°F to Subzero and temperatures, and over 95 °F BUT should be evidenced by the manufacturer that the certified installer carries the extended certification from the manufacturer to carry out this exception to rule 7.2
- 7.3 The urethane binder shall be stored on site at between 40°- 77° F and used within 12 months of delivery.
- 7.4 The Contractor shall not pave on days when rain or snow is forecast, unless a change in the weather results in favorable paving conditions as determined by the Owner's Representative.
- 7.5 In the event of rain on days prior to installation, the sub base must be dry and not contain any standing or moving water.

8. SAFETY AND TRAFFIC CONTROL

When construction work will interfere with existing, traffic and sidewalks the Contractor shall notify and cooperate with local authorities, and other jurisdictional organizations, and provide temporary barriers, signs, warning lights, flaggers, and other protections as required by the authorities to assure the safety of pedestrians and vehicles around the construction area and to organize the smooth flow of traffic.



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9. MAINTENANCE

- 9.1 KBI Flexi®-Pave HD 2000 installations are designed to operate and function trouble free with only minimal routine maintenance over the lifetime of the product.
- 9.2 The frequency and scope of the routine maintenance required will largely be dependent on the application and project location. The key objective will be to keep the surface clean and clear of debris to maintain the hydraulic conveyance capacity of KBI Flexi®-Pave over time as well as maintaining the aesthetic appeal of the surface.
- 9.3 Prior to undertaking routine maintenance of KBI Flexi- Pave it is recommended that an annual inspection be completed to evaluate the condition of the surface. The following are suggested annual maintenance inspection points:
 - 9.3.1 Inspect the surface of the KBI Flexi®-Pave for evidence of sediment deposition, organic debris, staining or ponding. If any signs of clogging are noted, schedule a vacuum sweeper (no brooms or water spray) to remove deposited material. Cleaned sections may then be tested by pouring water from a five-gallon bucket to ensure full hydraulic conveyance capacity has been restored.
 - 9.3.2 Inspect the structural integrity of the KBI Flexi®-Pave surface, looking for signs of damage or surface deterioration, such as raveling, slumping, cracking, etc. Replace or repair affected areas, as necessary.
 - 9.3.3 Check for potential need to overspray/roll with urethane binder after 4-6 years.
 - 9.3.4 If in doubt or should any unexpected situations or observations occur during the maintenance inspection, please contact KBI for consultation and advice

10. WARRANTY

- 10.1 The KBI Flexi- Pave HD2000 shall have a material warranty of 1 year from the date of installation (extended warranties are available with the addition of a maintenance program)
- 10.2 The Manufacturers' warranty shall be issued on completion of the installation and final inspection.
- 10.3 The Manufactures' warranty can only issued when the installation has been completed by a KBI Flexi®-Pave Certified Contractor or a direct KBI Corporate Crew. Faulty workmanship by tradesmen will be cause to void the warranty.



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SPECIFICATIONS

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An Atlantic Wind and Solar Company (OTC – Traded AWSL)

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