Ceramic Wear Surfaces
For Forming & Press Sections

All ceramics are not the same

There are four basic ceramic materials that are commonly used for forming and press section wear surfaces:

- Alumina (AL)
- Zirconia (ZR)
- Silicon Nitride (SN)
- Silicon Carbide (SC)

Each Material has its own characteristics, its own set of advantages and disadvantages, which qualifies the ceramic for a certain range of applications and conditions.

Obviously, knowing which ceramic material to specify for each application is critical. Choose the wrong ceramic, and not only will you experience poor ceramic performance and reliability, you can also cause unnecessary downtime, damage expensive machine fabrics, and harm paper formation quality.

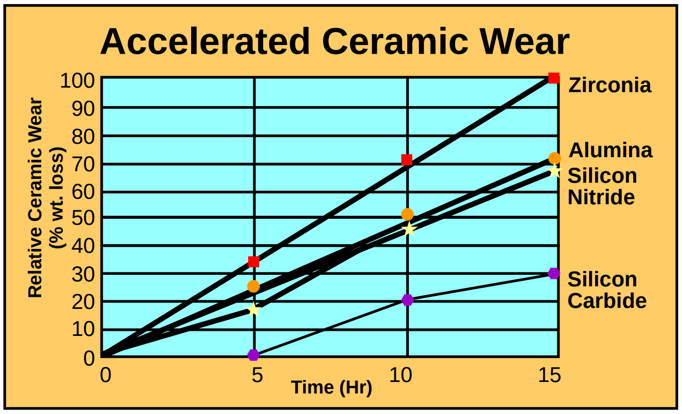

Fig. 1: Ceramic material wear over time

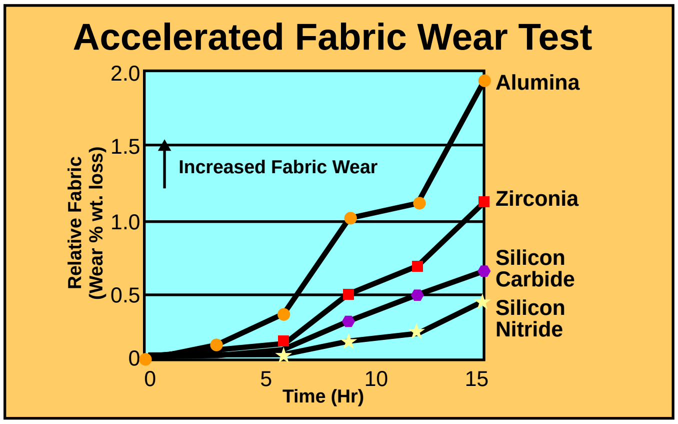

Fig. 2: Fabric wear over time

With our years of experience in paper machine forming section—and our on-going series of independent ceramic tests—we've learned where each material will work best. We've also determined that one commonly used ceramic material, zirconium oxide, is not well-suited to forming and press section service. And, we've discovered that ceramic "blends"—combinations of two separate ceramic materials—can actually do more harm than good. The unequal wear rates of the two dissimilar materials create an uneven abrasive surface that accelerates machine fabric wear.

Ceramic properties: how they affect material suitability

The following are th most important properties of ceramic wear surface materials.

Thermal Shock Resistance: How much sudden temperature change a ceramic can withstand without cracking. SN has the greatest resistance to thermal shock.

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Surface Finish: The smoothness of a ceramic. Surfaces at the wet end of the section can use a rougher material like AL, while dry end surfaces must have a smoother-finished ceramic like SN.

Flexural Strength: The ability of the material to withstand torsional and deflection loads found in applications like forming board lead blades, and where foils are frequently handled.

Thermal Conductivity: A material's ability to conduct, rather than absorb, heat. Higher conductivity will prevent unnecessary heat build-up that can damage fabrics. ZR has a very low conductivity rate.

Fracture Toughness: A measurement of how a material withstands physical shock. Important for position, like the forming board, where vibration and shock are particularly present.

Bulk Density: The weight of the material. An especially dense ceramic, like ZR, may prove too heavy for existing support system.

Vickers Hardness: A material's ability to withstand wear. SC has the highest Vickers Hardness; ZR has the lowest.

Coefficient of Friction: The amount of drag the surface exerts on the fabric. Higher friction coefficients mean more wear to machine fabrics—and more energy required for machine drives.

Cost: A ceramic's price—only one element to consider when determining cost-effectiveness. Others, like ceramic wear life, fabric wear, and fabric and ceramic replacement costs, must also factor into the equation.

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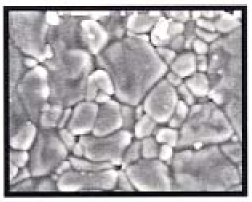
Ceramic Wear Surfaces
The Ceramic Materials

Alumina (AL)

Advantages: Low cost; good wear and corrosion resistance; moderate machine drag.
Disadvantages: Low thermal shock resistance; can cause high fabric wear.
Applications: Fourdrinier,
Except on flatboxes when calcium carbonate is used.

Magnified x500



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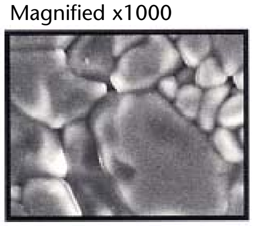

Silicon Carbide (SC)

Advantages: The hardest, most wear resistant ceramic; moderately high thermal shock resistance.
Disadvantages: High cost; susceptible to chipping; lower thermal shock than Silicon Nitride. Higher thermal stress than Silicon Nitride.
Applications: All applications where severe ceramic wear is present.

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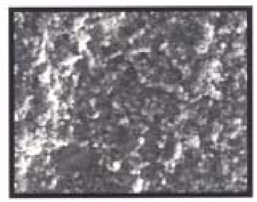

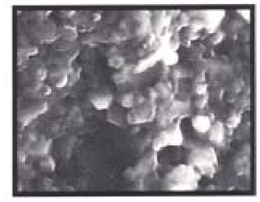

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Silicon Nitride (SN)

Advantages: High thermal shock resistance; low fabric wear, low drive load; best all-around combination of wear, chip and corrosion resistance.
Disadvantages: Cost
Applications: High stress applications, like suction boxes and felt strips; all applications where calcium carbonate is used.

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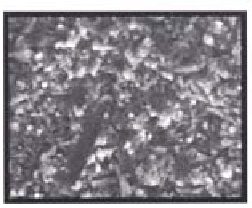

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Zirconia (ZR)

Advantages: Tough and chip-resistant
Disadvantages: Low wear resistance; moderate thermal shock resistance; molecular change with age—accelerated by moisture; wears to sharp edge than can damage fabrics; very heavy; low thermal conductivity.
Applications: Not recommended.

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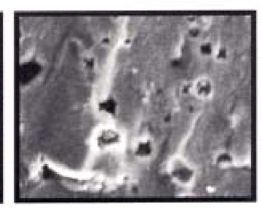

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Property	Kadant AES Ceramic				
	AL	SN	SC		SC*
Bulk Density	3.8	3.2	3.2		5.7
Flexural Strength (kg/m)	31	60	55		65
Vickers Hardness (kg/mm²)	1650	1400	2000		1250
Thermal Expansion (10^6/ºC)	1650	1400	2000		1250
Fracture Toughness (MN/m 3/2)	3.5	5.7	5.6		9.0
Thermal Shock Resistance (ΔT ºC)	200	550	400		300
Thermal Conductivity (cal/cm. sec.ºC)	0.06	0.05	0.15		0.009
Coefficient of Friction	High	Very Low	Moderate		Low

* Note: Kadant AES does not recommend Zirconia for use in any wear surface application.

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Ceramic Wear Surfaces
Design and Construction

The foundation for better performance.

With the exception of solid segment ceramic blades, which are held in place by stainless steel holders, all Kadant AES ceramic wear surface assemblies employ the same basic construction method, sharing three common components:

- Ceramic Wear Surface
- Epoxy Resin Adhesive
- Fiberglass Reinforced Vinyl Ester Carrier

Just as determining the proper ceramic material is the end result of years of testing and application experience, developing the proper ceramic support structures required a great deal of research design and revision, especially in two areas: bonding and thermal expansion.

Matching coefficients of expansion

Because ceramic wear surface assemblies are made of dissimilar materials, differing rates of thermal expansion between the materials are inevitable. These differing rates of expansion can cause ceramic surfaces to loosen or crack. But with the proper bonding technology, and careful design of the ceramic surface and the FRP carrier, coefficients of expansion can be closely matched and the effects of thermal expansion minimized.

Bonding: sticking with a superior system

The bond between carrier and ceramic surface is critical. Conditions like heat, shock, vibration, deflection, and thermal expansion can all damage the bond and loosen the surface. A loose surface not only will wear out quickly, it can also damage machine fabric and cause sheet imperfections in the process.

While some manufacturers still use a keyway system to attach ceramic to carrier, or a cable system to hold ceramic blades in place (see Fig. 11), most surfaces are now epoxy bonded—a technology first developed by Kadant AES over 15 years ago.

Since first adopting the Albanite epoxy bonding process in 1977, Kadant AES has worked with its suppliers to improve the properties of the adhesive.

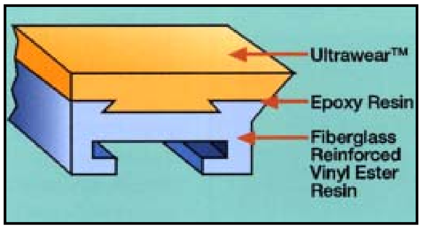

Fig. 7: The elements of a Kadant AES ceramic wear surface. (full-top blade shown)

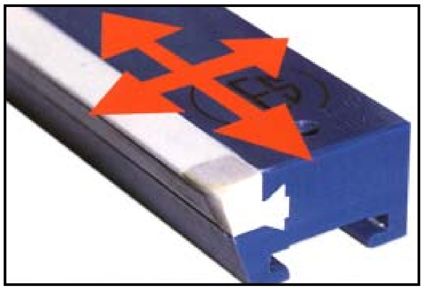

Fig. 8: Thermal expansion occurs in two planes—crosswise and lengthwise—at different rates for each material on either plane. (Ultrasert blade shown)

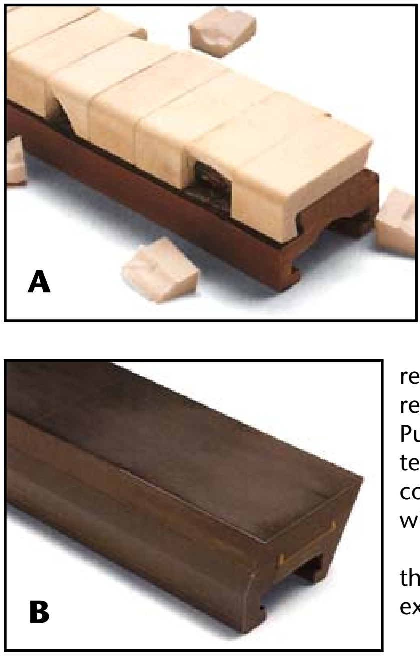

Fig. 9: With female foot designs (A) thermal expansion of the FRP base places the ceramic under stress than can cause cracking. The Kadant AES male foot design (B) eliminates preventable stress concentration points.

The latest generation of epoxy has greater elasticity, so it can better accommodate the differing rates of thermal expansion—in both places—between surface and carrier. It has better long-term stability under prolonged heating and cooling, expansion and contraction. And it's more resistant to mechanical stress and physical shock. The result is a dramatic reduction in piano-keying and premature surface failure— and the maintenance and product quality problems they cause.

Male vs. female footing

Traditionally, female footings have been used to position ceramic surfaces on their carriers. But since the FRP carrier has a higher coefficient of thermal expansion than the ceramic, it expands more quickly and places the ceramic under stress. Often, the result is ceramic cracking.

To prevent the problem, Kadant AES surfaces use a male footing. With this design, the carrier moves away from the ceramic under thermal expansion, eliminating stress concentration points—and cracking due to carrier expansion. In addition, the male-footed design provides 50% more material thickness at the maximum deflection area, making the profile much stronger.

Pultrusions: building a better base

The stronger and more rigid a carrier is, the better job it will do of preventing ceramic surface deflection, piano-keying, and cracking.

While many carriers are made of molded resins or extrusions, Kadant AES uses fiberglass-reinforced vinyl ester structures called pultrusions. Pultrusions are comprised of up to 76% glass content, which gives the structures high resistance to compressive and tensile forces in both the crosswise and lengthwise planes.

The materials and shape (or geometry) of the pultrusion also help to control thermal expansion. By carefully controlling the glass content—and creating a specific geometry for each pultrusion type—our engineers can closely match the carrier's coefficient of thermal expansion to the ceramic surface's rate of expansion.

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Ultrasert F
Ceramic-Tipped Blades

More durable than poly.
Less expensive than full-top ceramic.

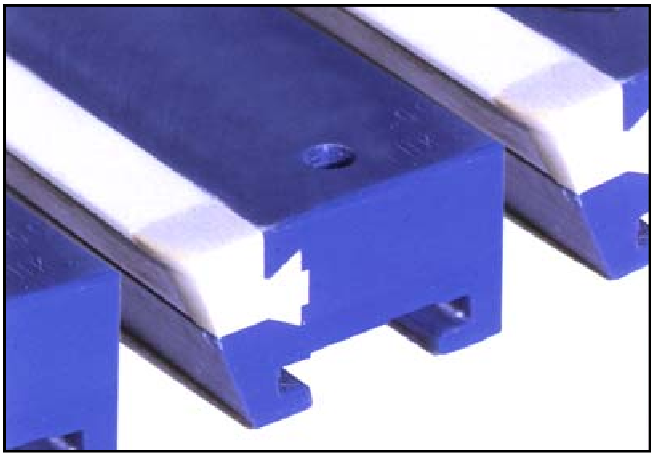

Fig. 10: Kadant AES Ultrasert F blades

Benefits:

- The low cost of polyethylene, the durability of ceramic.
- Epoxy bonding eliminates piano-keying.
- Lighter than full-top ceramic in all lengths (can be handled safely by one person).
- Can be refinished to increase foil angle.
- Blades can be repaired in the event of damage.
- No regular maintenance required.
- Available in standard T-Bar or Kadant AES wedge grip configurations.
- Supplied in one piece to span even the widest paper machine.

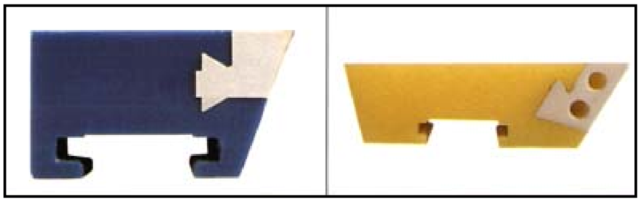

Fig. 11: Ultrasert F uses Kadant AES's epoxy bonding to hold the ceramic contact blade securely in place. The competition uses wires that loosen and expand.

Better bonding—with no strings attached

The Ultrawear ceramic contact surface on every Ultrasert blade is securely bonded to the poly/FRP carrier by an epoxy specially selected by Kadant AES to withstand thermal expansion and mechanical stresses. Additionally, the FRP is held in place by a stainless steel pin, which prevents the ceramic from shifting under thermal loadings. So, even after prolonged use, the ceramic surface stays in plane and in place.

By contrast, competitive poly/ceramic blades are held together with steel wires. While this is less expensive to produce, it has its drawbacks. Wire tension decreases over time, and high temperatures cause the wires to expand. The result is loose blades, piano-keying, and severe machine fabric damage.

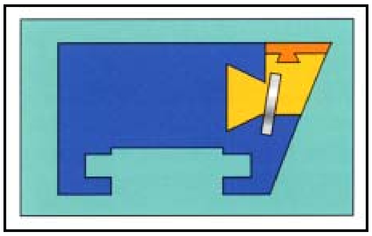

Fig. 12: A stainless steel pin connects the FRP blade holder to the poly carrier to prevent shifting under thermal loads.

Specifications

Application	Size Available	Angle	Step	Holddown		Material	Surface Finish (Max) Ra (10^{-6}) μ in.
				Tee	Wedge Grip		
Forming Board Trail Position	1.5" - 4"	0º - 4º	—	1" - 2"	yes	AL, SN	16
Foil	1.5" - 4"	0º - 4º	—	1" - 2"	yes	AL, SN	16
Deflector	1.5" - 4"	0º - 4º	—	1" - 2"	yes	AL, SN	16
Vac Foil	1.5" - 4"	0º - 4º	—	1" - 2"	yes	AL, SN	16
Step Foil	1.5" - 4"	—	.015 - .060	1" - 2"	yes	AL, SN	16

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Ultratop Full-Top
and Solid Ceramic Blades

Solid, Secure and Stable

Benefits:

- Solid ceramic surface construction assures long wear life and less deflection under demanding conditions.
- Blades can be repaired in the event of damage.
- No regular maintenance required.
- Available in standard T-Bar configuration.
- Blades can be repaired in the event of damage.
- Supplied in one piece to span even the widest paper machine.

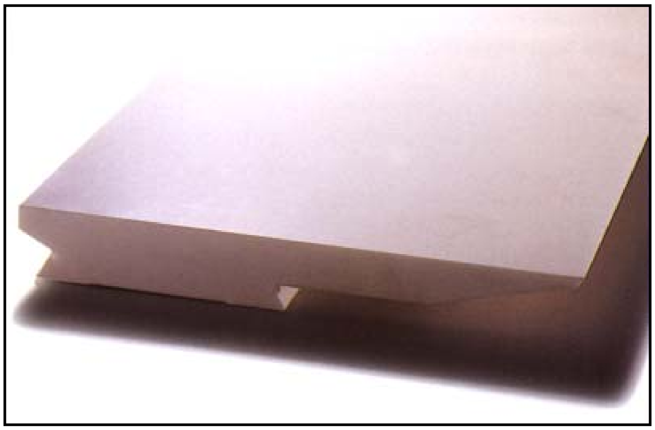

Fig. 13: Kadant AES solid blade

Designed to withstand tough conditions

Ultratop full-top ceramic blades are an effective choice for zero degree applications where the wire contacts the entire wear surface. Far more durable than poly, full-top blades wear more slowly and maintain proper blade angles longer. This greater durability not only impacts maintenance, downtime and surface replacement costs, it also affects sheet quality. A more consistent wear surface helps produce more uniform dewatering, a more even profile—and a better quality sheet.

Kadant AES solid ceramic blades are used in deflector and forming board lead positions—which experience the toughest conditions in the entire forming section. Thermal expansion, loading forces, and torsional stress can make blades deflect and damage the ceramic. Yet maintaining accurate blade angle is crucial here. Any inconsistencies in angle can produce sheet breaks, streaks, pin holes, worms, and poor sheet formation. Therefore, a solid blade is the only configuration that can provide the needed durability in these critical applications. Kadant AES solid blade geometry incorporates a relief that helps accommodate blade holder expansion with less stress to the ceramic surface.

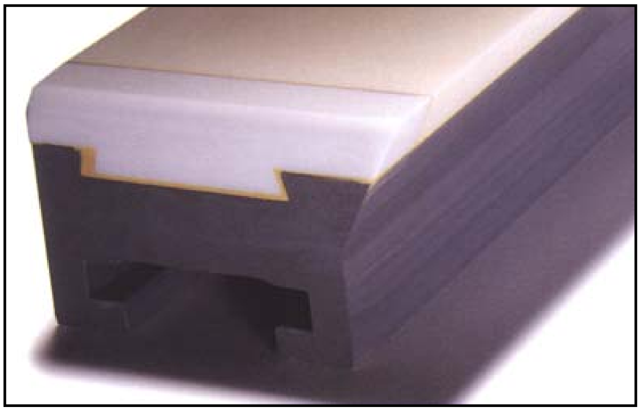

Fig. 14: In zero degree applications, full-top ceramic surfaces provide a far more durable and consistent surface with better long-term accuracy.

Specifications

Application	Size Available	Angle	Step	Holddown Tee	Material	Surface Finish (Max) Ra (10^{-6}) μ in.
Full-Top Blades						
Forming Board Trail Position	1.5" - 3"	0º - 4º	—	1" - 2"	AL, SN	16
Foil	1.5" - 3"	0º - 4º	—	1" - 2"	AL, SN	16
Deflector	1.5" - 3"	0º - 4º	—	1" - 2"	AL, SN, SC	16
Vac Foil	1.5" - 3"	0º - 4º	—	1" - 2"	AL, SN	16
Step Foil	1.5" - 3"	—	.015 - .060	1" - 2"	AL, SN	16
Solid Blades						
Forming Board Lead	2" - 10"	—	—	Dovetail	AL	16
Deflector	2" - 4"	0º - 4º	—	Dovetail	AL, SN, SC	16

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Multislot Flatbox
and Curved Box Covers

Greater dimensional stability.
More rigid support.

Benefits:

- Stainless steel framework provides a rigid base for cover strips, takes stress off FRP carrier for greater long-term durability.
- Damaged wear strips can be replaced individually—in the mill—without replacing the entire cover.
- Kadant AES bonding technology provides greater long-term dimensional stability for ceramic surfaces—leading to more consistent dewatering.
- Lubricated end deckle option for reduced wire edge wear.
- Can be used with any new or existing single- or multi-compartment structure.
- Designed for optimal results with Kadant AES's proprietary high vacuum dewatering technology.

Designed for longer life and easier repairs

Many slotted covers are one-piece units that use a single composite piece for a carrier. Kadant AES Multislot flatbox and curved box covers utilize a 316 stainless steel structure to support the individual ceramic surface/FRP carrier assemblies. Obviously, the steel structure provides greater rigidity, letting Multislot covers withstand greater deflection and vacuum loads without flexing—which can cause ceramic surfaces to crack and loosen.

However, if a Multislot surface should be damaged, that single surface can be unbolted and replaced, right in the mill. One-piece covers, on the other hand, must be completely replaced if damage occurs to one area of the ceramic.

Like other Ultrawear ceramic surfaces, Multislot covers utilize Kadant AES's proprietary design and construction features—epoxy bonding, high strength FRP pultrusion carriers and male-footed ceramic segments—all of which further contribute to long-term consistent wear surface performance.

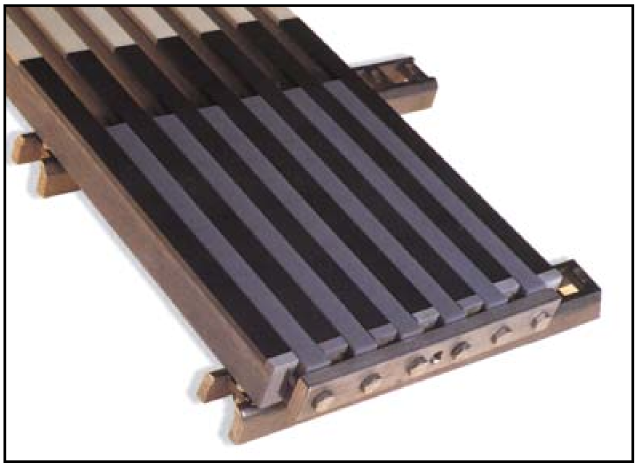

Fig. 15: Multislot flatbox covers

Fig. 16: Curved box covers

Fig. 17: Supported by 316 stainless steel channels, the FRP holder for each ceramic cover strip is retained by removable studs. The stud shoulder takes loading strains off the holder to prevent cracking or splitting.

Specifications

Application	Slot Size	Strip Width	Holddown	Material	Surface Finish (Max) Ra (10^{-6}) u in.
Flatbox Covers	.5" - .625" - .75	0.625"	Clamp or Dovetail	AL, SN, SC	12
Curved Box Covers	.5" - .625" - .75	0.625"	Clamp or Dovetail	AL, SN, SC	8

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Ultratop
Felt Wear Strips

Longer life for surfaces and felts.

Benefits:

- Longevity—Ultrawear SN wear strips have up to twelve times the life of poly strips.
- Can handle thermal shock conditions without cracking better than any other wear surface material.
- Male-footed blade design eliminates cracking from thermal expansion.
- Ultrawear SN structural density reduces surface abrasiveness, helps felts last longer—especially when calcium carbonate fillers are used.
- Epoxy bonding eliminates piano-keying.
- Lowest coefficient of friction of any available surface material for less drag load on drives.
- Fully interchangeable with most poly wear strips.

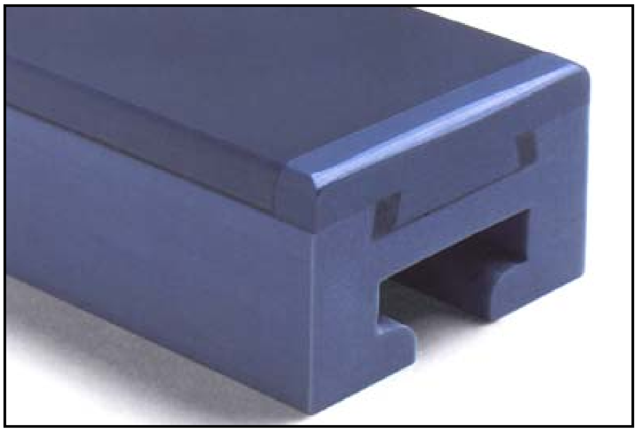

Fig. 18: An Ultrawear SN wear strip

Ultrawear SN: the only suitable material for felt strips

There is only one overwhelming factor to consider in felt wear strip applications: thermal shock. It occurs so often that only the most shock-resistant ceramic, silicon nitride, can provide any real protection against thermal shock-induced cracking and piano-keying.

Accordingly, all our felt strips are made of Kadant AES's silicon nitride: Ultrawear SN. Developed by a leading ceramics supplier, Ultrawear SN combines an especially smooth surface (8 RA max.) to reduce fabric wear and drive loads, optimum wear and chemical corrosion resistance, and outstanding fracture toughness to minimize cracking. Coupled with its thermal shock resistance, Ultrawear SN assures superior longevity and surface stability.

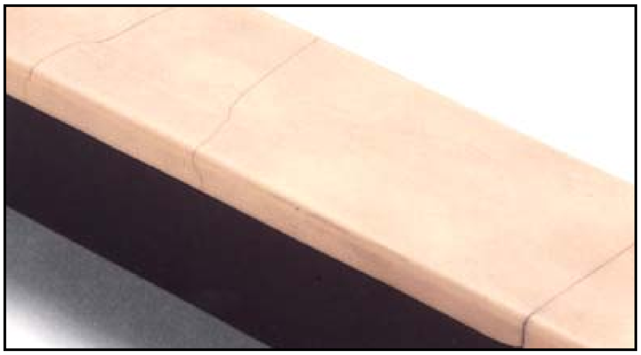

Fig. 19: When exposed to the severe thermal shock felt strips experience, these Al ceramic strips crack. SN stays intact.

Specifications

Application	Slot Size	Strip Width	Holddown	Material	Surface Finish (Max) Ra (10) u in.
Press Fabric Cleaning Assembly Wear Strips	Adjustable	1.5 - 1.625 - 1.875	Male Tee Female Tee Dovetail	SN	8

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