WOOD COMPOSITE OVERLAY

Atta Zaghloul

Zeraus Products Inc, ON, Canada

CPD Construction Products, ON, Canada

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Abstract

An innovative concept of "Wood Composite Overlay" (WCO) has been developed to rejuvenate and beautify aged wooden decks without having to consider the costly alternative of deck replacement.

It is a multi-layer system that is liquid applied and cured to form composite thermoset plastic. WCO consists of a *highly penetrating "fortified" epoxy sealer, 30-40 mils thick self-leveling epoxy mortar and protective non-slip aliphatic polyurethane.*

The combined composite materials move together with the natural expansion and contraction of wood boards, reinforce and encapsulate them from moisture and rotting, and maintain their structural integrity.

Before

After (WCO)

Different WCO Finishes

Multi-colored

Solid Colored

Background & Facts Regarding Wooden Decks

- Eighty-five percent of all single-family homes have a wooden deck. Many of these homes will replace that deck within ten years
- The vast majority of decks are made from pressure-treated pine or cedar. Wood is the most unstable, hard to protect substrate in existence
- There is plenty of wood sealers and paints in the market but they provide no long-term protection and are not effective. They are oil-based, acrylic emulsion or water-reducible alkyd products

Why Common Wood Sealer & Paints Fail?

- Destructive UV rays
- Excessive moisture in the wood
- Elevated temperatures
- Thermal shock & temperature variation
- Natural expansion/contraction of wood
- Wood shrinkage & drying out
- Ineffectiveness of traditional oil-based coating or acrylic paints

Effects of UV- Radiation on Coating and Wood

- Degradation of lignin and destruction of cell structure (particularly with semi-transparent & transparent sealers) leading to flaking of the coating film
- The UV-radiation causes the paint/sealer to become brittle
- Discoloration & chalking

Effect of Moisture on Coating & Wood

- **Wood is highly porous and hygroscopic, and is in equilibrium with atmospheric water vapor**
- **Excessive water/moisture in the wood is the single most common cause of paint failure and peeling on exterior woods**
- **Wet wood or green wood containing high levels of moisture prevent penetration of the sealer leading to cracking and peeling off**
- **As wood ages (dries out) , its mechanical properties and physical dimensions change, leading to wood shrinking, swelling or cracking**
- **Water can soak into unprotected wood via cracks, eventually causing rot and/or peeling off of the coating**

Ineffectiveness of Oil Based Sealers

- Alkyd-based (oil-based) sealers consist largely of natural oils, which are edible food for algae and mildew
- The mildewcides of the sealer (which inhibit the growth of these organisms) are degradable with the combination of UV and rain, and are washed away over time
- Once the effectiveness of mildewcides is gone, the mildew and algae begin to feed on the sealer, turning the wood into dark greenish or grayish colours

Ineffectiveness of Acrylic Based Sealers/Paints

- Poor wet-adhesion: even the slightest damage to a coated surface enables water to creep underneath the paint, causing extensive flaking in a very short time
- Poor penetration
- Lack of structural integrity and toughness relative to thermoset polymers

What About Epoxy?

- Epoxy is one of the toughest plastic materials in existence and is stronger than wood itself
- As a structural material, epoxy provides additional benefits in its ability to fortify and strengthen wood fiber, preventing rotting
- Epoxy is a synthetic polymer that is totally impervious to moisture and fungus invasion
- Unlike acrylic or oil based sealers, epoxy has the highest strength and chemical/water resistance

Drawbacks of Conventional Epoxy as Protective Wood Sealers/Paints

- Conventional epoxy by nature is a brittle material. Most of them fracture and “pop out” from the wood under the stress of constant expansion and contraction
- Epoxy in thin film does not fare well under direct UV rays; it fades, chalks and ultimately breaks-down
- 100% solids (solvent free) epoxy has relatively high viscosity, hence poor penetration into wood; they also set relatively fast, which hinders its penetrating ability

Advantages of the New Generation of Exterior Epoxy Systems

- Outstanding penetration and ability to reach deep inside the wood
- Flexible to withstand the normal expansion/contraction of wood without cracking or popping out
- Outstanding adhesion properties and water resistance
- Excellent impact and thermal-shock resistance
- Stays flexible with age even at sub-freezing temperatures
- Much improved UV-resistance (nano technology, colour stable curatives/modifiers, advanced additives, etc.)

Effective Decking

Any effective decking must keep water away from the wood by tightly sealing it and making it capable of withstanding natural expansion and contraction.

Integrity needs to be maintained despite rain, snow, sunlight, and daily temperature and humidity changes.

Composite Decking

- The wood composite in the simple term is plastic-reinforced wood
- The revolutionary “Wood Composites” technology is the newest trend for decking and railing
- The overall U.S. market for decking is about $4 billion to $5 billion (2003 and 2004 respectively); composite decking represents approx. $875 M and $1B
- Wood-plastic composites are a 1.3-1.5-billion-lb market and are growing at approximately 20% annually

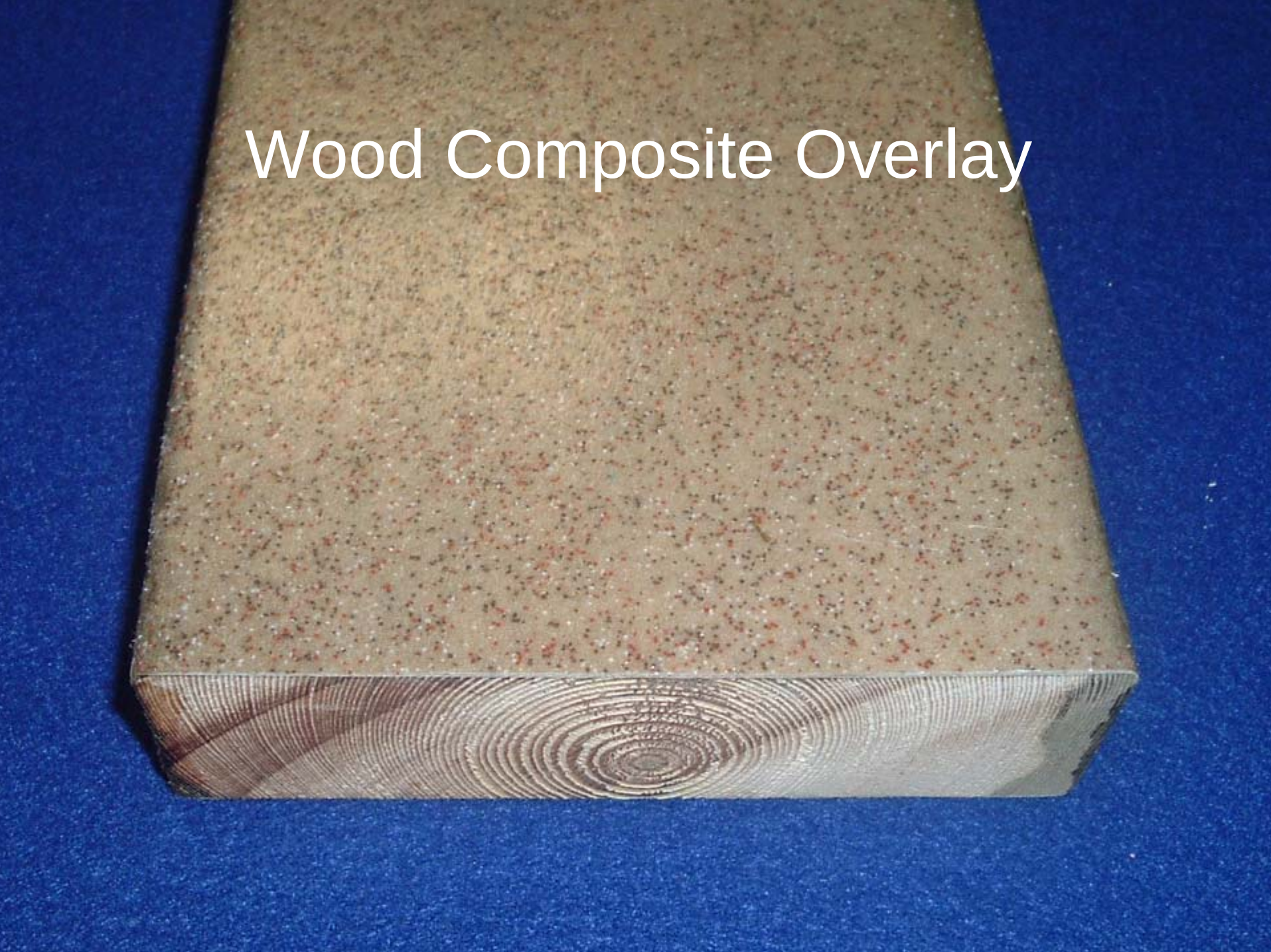
How Wood Composite is made?

- In-situ polymerization of injected acrylic monomers (MMA, etc.) into soft wood fibers **(research stage)**
- Veneer lumber lamination of wood sheet into plastic, injection and compression molding
- Latitude composite decking technology at which plastic is extruded into wood

The injection molding and extrusion techniques, which are generally incorporated recycled materials, are by far the most common in the commercial composite decking.

What is the definition of composite?

"*Composite is a complex material, such as wood, in which two or more distinct, structurally complementary substances, combine to produce structural or functional properties not present in any individual component.*"


Wood Composite Overlay

What is Wood Composite Overlay (WCO)?

WCO is an innovative concept to rejuvenate and beautify old or aged decks without having to consider the costly alternative of wood replacement.

Unlike wood composites in the market, WCO is a liquid-applied chemically cured in-situ reaction atop existing aged wood to form a composite.

What WCO consists of :

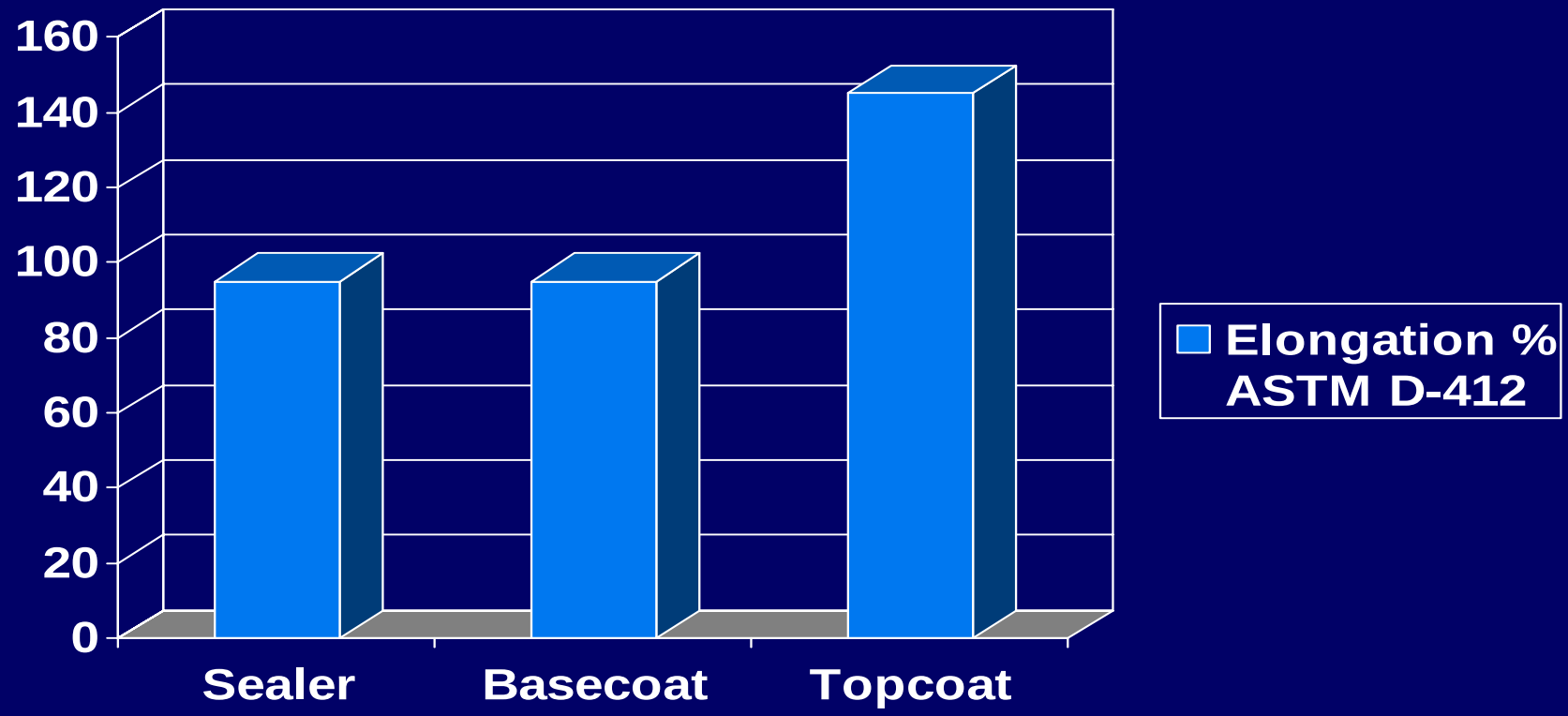
- **Fortified epoxy wood sealer:** capable of penetrating deep inside to bind wood fibers together, strengthen and protect against rotting and moisture infusion
- **Flexible epoxy gel:** to repair all cracks and damaged areas
- **Epoxy composite self-leveling mortar:** self-leveling epoxy overlay (up to 40 mils film) cures chemically to produce a sheet of plastic firmly adhered to the board (planks). Depending on the type of the finish required, it may be broadcasted (embedded) with a multi-coloured aggregate
- **Aliphatic polyurethane topcoat:** a non-slip (or smooth) protective UV-resistant clear (or coloured) aliphatic polyurethane coating

These two layers of plastic are engineered together to move with the natural expansion and contraction of wood

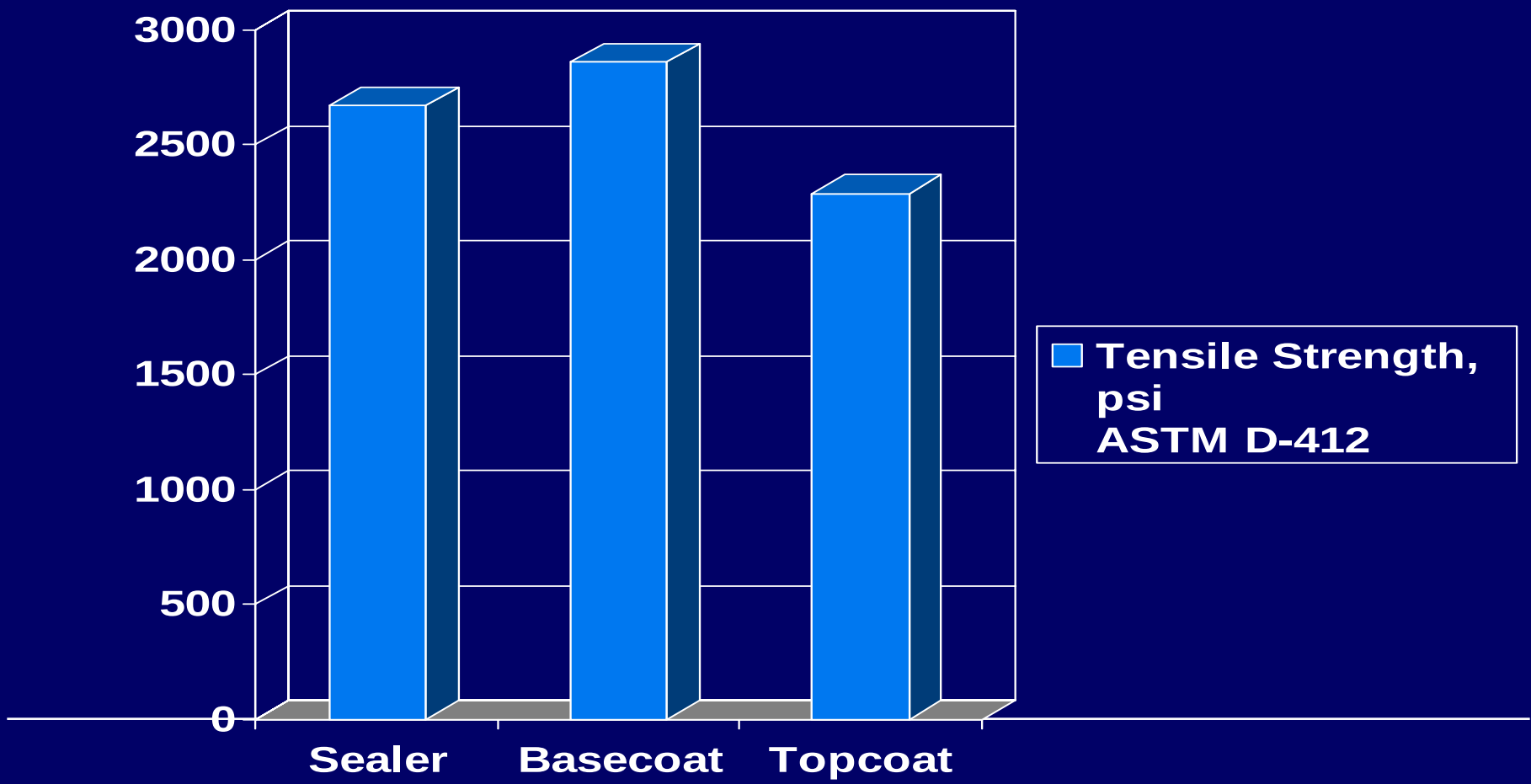
Requirements for an effective WCO

- High porosity (aged wood)
- Very low moisture content
- Excellent penetration of epoxy fortified sealer
- Encapsulation of wood board (sealing all sides of wood) if possible
- Excellent inter-coat adhesion
- Excellent flexibility/strength of all components (sealer, adhesive, basecoat, topcoat)
- Good UV resistance; maintains colour fastness (if possible) and polymer integrity
- Non-slip properties

Properties of WCO



Properties of WCO



Benefits of WCO

- Consolidates, strengthens and rejuvenates aged wood
- Non-slip finish, even when wet to prevent slippage
- Tough and tolerant to rain, snow, salts, oil and grease
- Resistant to insects, moisture, mildew and rot
- Does not chip, peel or delaminate from the wood
- Flexible to accommodate the natural expansion and contraction of the wood
- Easily repaired/restored if damaged or scratched from sharp objects, animal claws, etc.
- Can be painted with quality polyurethane coating
- Does not contain nails that may cause rusting and delamination (all nails, screws and holes are filled with epoxy gel prior to the application)

Creative Designs

Procedure for Applying Decking System:

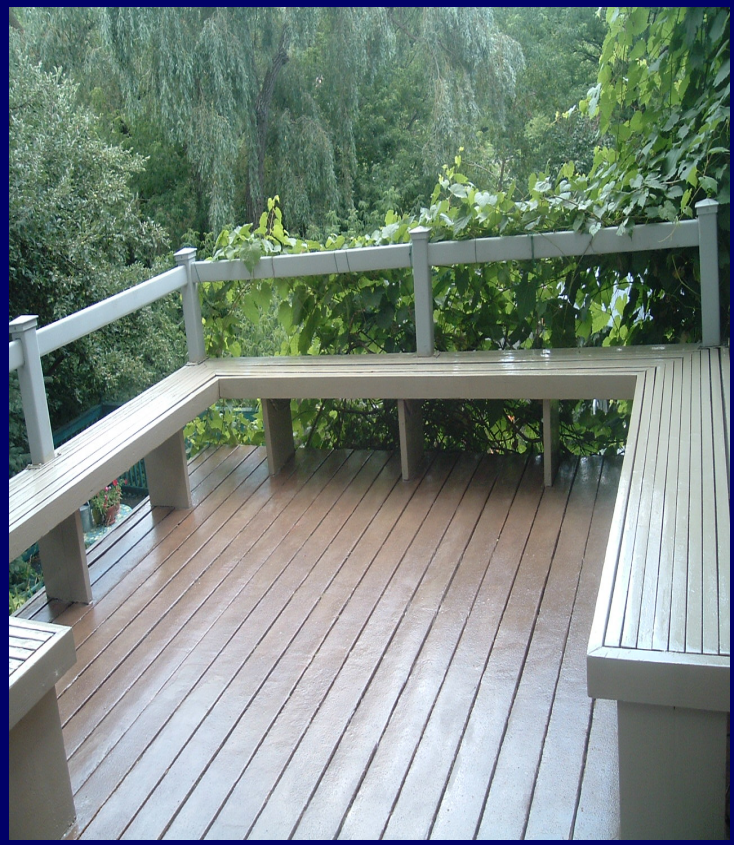
- Step 1: sanding
- Step 2: epoxy sealer application
- Step 3: repairing the cracks
- Step4: self-leveling epoxy basecoat
- Step 5: aliphatic polyurethane topcoat

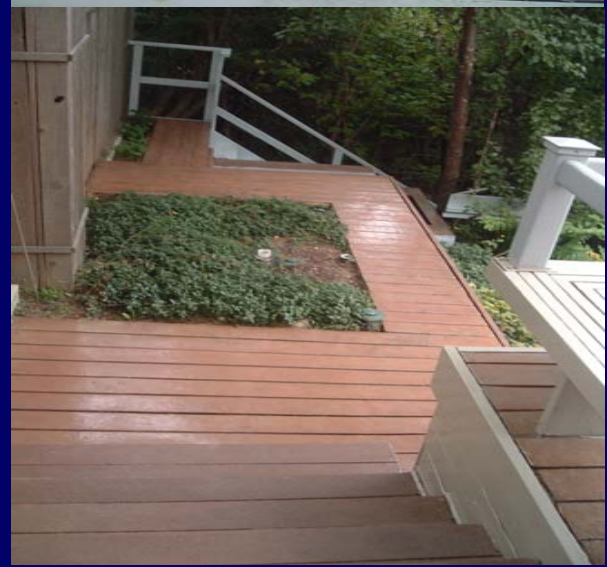
Before

After

before

after





Step 1: Surface Preparation:

- Surfaces should be clean, dry, and free of mildew
- Remove any old paints or sealers
- Sand to bare wood

Step 2: Sealer Application:

- Apply with high quality solvent-resistant brush to saturation

Step 3: Repair Cracks and Imperfections:

- Firmly hammer the nails onto the deck
- Remove all materials lying loosely about the decayed area
- Fill out and repair all cracks, nail holes, damaged or missing areas with flexible epoxy gel
- Sand it to obtain a smooth surface

Step 4: Application of the Basecoat:

Combine the three-components (Part A & B plus powder) together and mix thoroughly

Mixing WCO Basecoat

- Immediately pour the mixed material onto the wood plank then spread evenly with the notch spatula over the entire length
- Immediately remove any excess materials falling on the sides
- Apply the roller to evenly level the matrix (paste). Wait for two minutes until the material is self-leveled

Broadcasting of Coloured Aggregate

- **For decorative multi-colored finishes:** slowly and lightly broadcast colored quartz aggregate in uniform manner over the entire area

- **For other finishes** (solid colors): this broadcasting step is eliminated

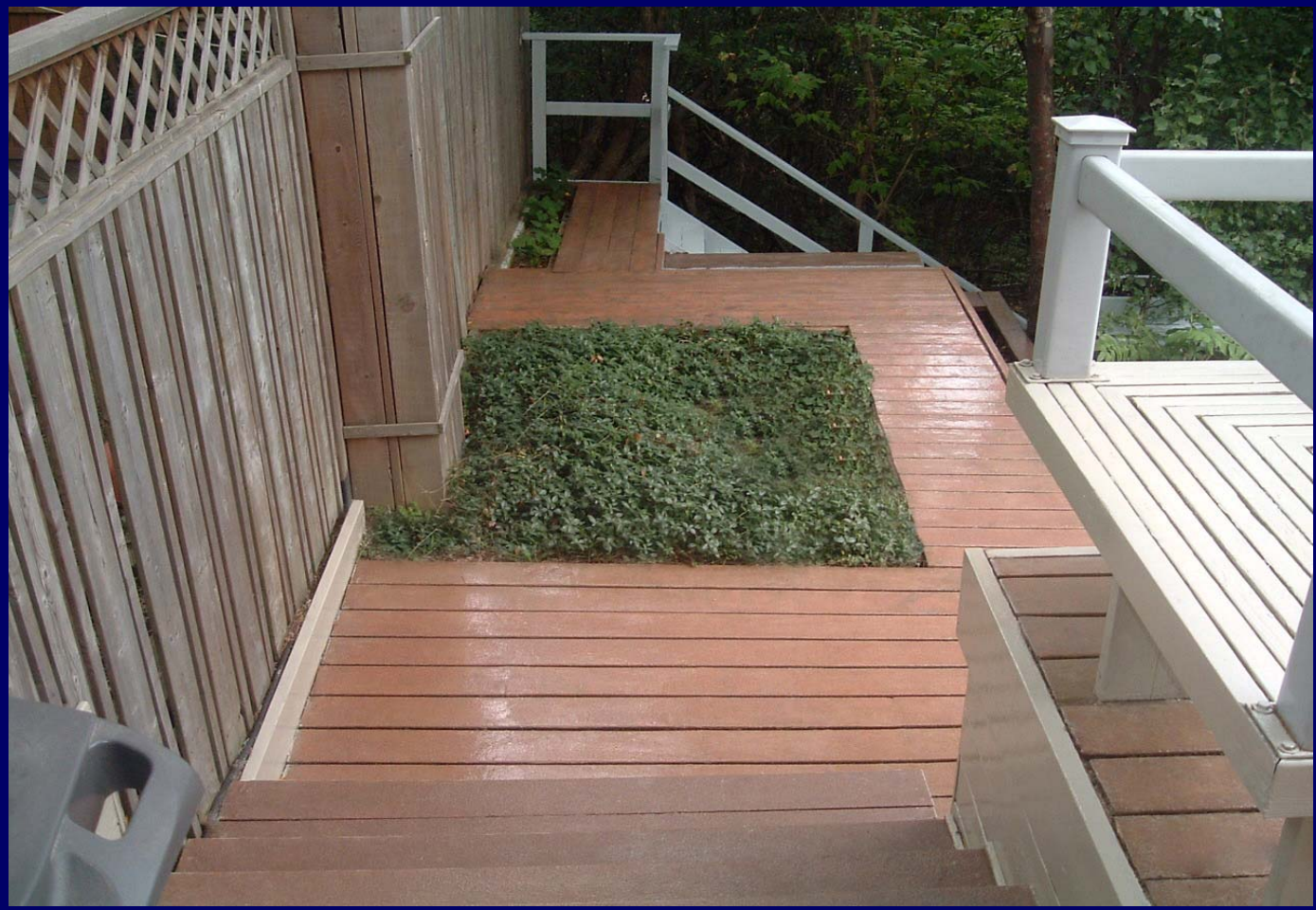
Step 5: Application of the Clear Topcoat

- There are two different finishes available to choose from: non-slip or smooth
- Apply the polyurethane topcoat containing non-slip additive just like paint
- Two finishes: clear or colored polyurethane, depending on the finish required

before

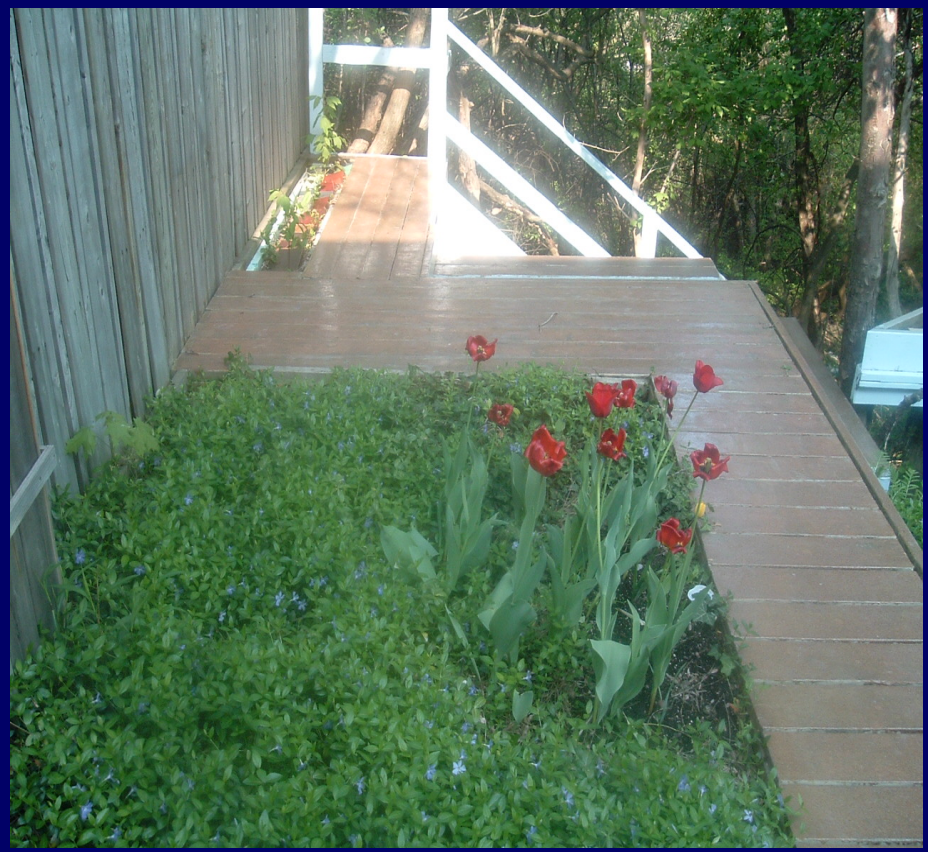
after

First Summer



Winter Exposure

Second Summer



Third Summer

Conclusion

- WCO is an effective and innovative approach to rejuvenate and beautify existing old wood
- There are no other long-term effective solutions to protect exterior wood in the market today
- This presentation demonstrates the simple “Do It Yourself” (DYS) step-by-step procedure used for installation of WCO on an aged (15 years old) wooden deck
- The WCO has maintained integrity and protective performance in outdoor exposure over a period of 3 years
- At this stage, WCO technology is a “concept’, that can be exploited and further studied as a guideline for future development of wood protection
- Based on this work, we have been able to advance a number of spin-off wood protective technologies, including DYS epoxy wood sealers, stains and coatings

Acknowledgment

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