TABLE OF CONTENTS

WATERSLIDE MAINTENANCE & REPAIR

Introduction

This document has been prepared for Water Park operators to provide information and guidelines on issues related to the maintenance and repair of fiberglass waterslides. The document describes the typical issues which affect the appearance and integrity of fiberglass and describes methods and procedures for addressing these issues.

The following key points are highlighted in the text that follows:

- Fiberglass waterslides are subjected to a number of weather- and usage-related forces which will affect their appearance from the day they are manufactured;

- A proper Preventative Maintenance Program is the absolute best method to slow the changes in appearance and integrity of fiberglass waterslides;

- Due to the nature of active usage of a fiberglass waterslide, repairs will inevitably be necessary as well from time to time and proper repair procedures, tools and material will yield the best results.

For many Water Park operators, budgeting for a Preventative Maintenance Program that includes an appropriate level of cleaning, care and attention to optimize the appearance of the fiberglass is a challenge. The fact is that when the rides are in operation, most of the cosmetic issues affecting the waterslides are not visible to the users and guests of the facility. It is only after everything is turned off that the extent of chalking, fading and yellowing becomes visible.

Given this reality, it is not unusual for attention to this issue to be deferred as more immediate concerns are addressed. The unfortunate consequence of this is that, when the day comes when the decision is taken to freshen up the appearance of the gel coat surfaces, the longer that the maintenance has been deferred, the more difficult and invasive is the procedure required to achieve the results desired.

With that in mind, it is hoped that this document will provide assistance to Water Park operators in formulating a Preventative Maintenance Program which matches their needs.

GEL COAT WEATHERING AND REPAIRS

Gel coated FRP parts have a shiny finish when new but, regardless of quality, over time the gel coat can dull and fade. The following is an explanation of what has occurred, how it can be prevented or slowed down, and what needs to be done to restore the gel coat.

Gel coats have evolved over many years. They provide very durable, water and weather resistant surfaces. Normally, gel coats are applied 10 to 20 times the typical thickness of paints. Even though these surfaces are very durable, they are not indestructible.

Synthetic and natural materials, when placed outside, slowly deteriorate. The part is exposed to sunlight, heat/cold, water, wind, dust and chemicals in the air. When something is used, it will eventually show wear and tear. How much wear and tear depends on how the product is treated and maintained. If a car isn't washed and waxed, its surface will deteriorate and it will have a poor appearance. If a product is allowed to deteriorate, it will require a good deal of costly repair work to restore its appearance. It is nearly always easier and cheaper in the long run to do a little maintenance periodically.

Aside from the quality of material used and careful procedures to make the fiberglass part, the only secret in keeping fiberglass looking like new is maintenance.

1. WEATHERING PROBLEMS

A. Chalking—Chalking results from a breakdown of a part's top surface into an extremely fine powder. When this happens, the color of the part whitens. Since chalking causes a color to appear lighter, it is easily interpreted as fade, but really stems from the whitish oxidation powder at the very surface. Most house paints are designed to chalk and then wash clean when it rains. Gel coat chalk, however, does not simply wash off.

B. Fade—Fade means that the color has changed uniformly. Fade can be interpreted as an unrecoverable change in color at the molecular level, less brightness/intensity, washed out appearance, and changes in hue (red, blue, yellow), chroma (brightness or intensity) and value (lightness and darkness). Because of differences in pigment and polymer, not all gel coats fade to the same degree. For example:

- Chalking makes the gel coat look lighter
- Pigments used in the system may have actually changed in color. In this case, a high gloss persists but the color has changed.
- The gel coat is bleached or stained by another substance.

C. **Yellowing**—Yellowing occurs when the gel coat has actually started to exhibit a yellow cast, which can be uniform or streaked. Usually non-uniform yellowing can be attributed to application. Streaks can be caused by chemical stains, residues, or by a covering that was left on the gel coated surface, which therefore shielded the surface from the environment.

D. **Gloss**—Gloss refers to the gel coat's shine. Any change in the surface (a light sanding, chalking, or dirt) will alter the gloss. ProSlide has found that parts restored after weathering will lose gloss faster upon re-exposure than will a new surface weathered for the first time.

Most of the changes are cosmetic. They appear on the surface of the gel coat and do not affect its strength. The surface is sound, but does not look as it did originally.

Once a part is made, it begins to change because it is immediately and inevitably attacked by the environment. The attack is from:

- Light
- Water
- Pollutants
- Temperature

These are strong forces which cause wooden boat owners to repaint and re-caulk almost every year, and which cause cars to rust, vinyls to crack, virtually every synthetic material to need repainting.

A fiberglass laminate must be protected by a thick coating to prevent the fibers from protruding through the surface (fiber bloom). In most cases, this thick protective coating is a gel coat.

Gel coats must retain their original color and gloss as long as possible.

1) Light—Light is a form of energy. The energy in light is made up of different components or wavelengths. A rainbow displays light separated into its individual wavelengths. Some of these components are stronger than others. Ultraviolet (UV) is considered to be the most destructive wavelength when it comes to weathering, but the others cannot be ignored. The energy in light attacks materials by breaking down their molecular or polymer structure (degradation). This energy can cause a chemical reaction to take place. This reaction is oxidation, chain splitting, or atomic extraction, and is noticed as color change (yellowing, chalking, or bleach fading).

2) Water—Water is called the universal solvent. It will dissolve more things than any other chemical.
Water attacks parts by dissolving or reacting with them. It penetrates materials and leeches out impurities or degraded materials. It can also contribute pre-dissolved chemicals, which can cause stains or degradation. It can change a non-corrosive material into a corrosive material.

3) Pollutants—The environment is not sterile. The atmosphere contains many foreign materials. Some of these are natural: pollen, mold spores, dust, aquatic grasses, organisms and dirt. Others are manmade: smog, acids, oxides, etc., as in exhaust from manufacturing plants. Some are harmless, some stain, and some attack whatever they land on.

4) Temperature—Sunlight generates heat and will raise the temperature of a part. How much the temperature will escalate depend on color. White reflects most of the sunlight and warms up only slightly (e.g., in 100°F air, white can be 120 to 130° F). Dark colors absorb more sunlight and warm up more (e.g., in 100° F air, black can be 150 to 170° F).

   As the part warms up, three things happen:
   a. The material softens slightly
   b. Additional cure can take place
   c. Chemical attack and reactions, and water penetration rates are increased.

2) **INFLUENCES ON WEATHERING**—When a change in a gel coat product is noticed, the owner may ask the following questions:
   - Does my part have a structural problem?
   - Why is my part faded and yellowed?

The answer to the first question is: No—not if the proper application procedure was used in making the part. Fading and yellowing happen on the surface and do not affect structural strengths. A good cleaning may restore the finish.

Yellowing is caused by the reaction of light, water, air pollutants and heat with any reactive sites in the gel coat which can include aromatic structures, unpolymerized maleic or styrene, or byproducts. Some of these 'sites' always exist. Achieving a good cure is necessary to keep these to a minimum.
Fading and chalking are the breakdown of the surface resin and pigment on a microscopic level. This breakdown, which is also caused by exposure to light and water, is so fine it appears to be white in color.

A. Gel Coat Types

1) General

a) Resins—The weather and water resistance of polyesters can be related to the resin type used. Certain glycols and acids offer better yellowing, chalking, and blister resistance than do others.

b) Other Ingredients—The other ingredients used in gel coats can improve or reduce the weathering characteristics of the base resin. Application, weathering, and blister resistance have to be balanced. These ingredients are:

- Fillers –type and amount
- Pigments
- Additives

2) Clears—Clear gel coats are the most susceptible to yellowing because of the absence of pigment. Because of this, UV light absorbers are useful in clears. Light absorbers work by absorbing the harmful sunlight and converting it into non-destructive energy. Light absorbers eventually are used up. They only slow down and even out yellowing. The part will change color with time.

The use of light absorbers in clear is a compromise. They add to the initial yellow color of the clear (as the better light stabilizers are yellow themselves) but this is balanced against slower yellowing upon aging.

Clears have greater gloss retention than standard gel coats due to the absence of pigments.

3) White and Off-White Gel coats—The weathering of whites and off-whites is partly controlled by the amount and grade of titanium dioxide (TiO_2) used. High exterior durability grades of TiO_2 are the best and also the most expensive. Whites are very forgiving as they do not show changes in gloss easily, but will yellow. White gel coats are highly pigmented and will chalk more than clears. The chalking is not as noticeable because it is white on white, but gloss will suffer.

4) Colored Gel coats—A wide variety of pigment types are used to make colors. All pigments do not weather equally. Normally, medium to dark colors do not yellow, but will chalk and fade. Color pigment must be checked out carefully. Colors that weather well in paints may not work in polyesters.

Accelerated weathering must be compared against actual outdoor exposure. For example, some colors may look good in the weatherometer, but after six months in a hot and sunny climate, will have faded badly. Many pigments will bleach out when subjected to either

acids or alkalis. Blues and greens fade in color, while yellows and reds turn brown or become darker.

NOTE: The durability, cost, and shade of bright yellow, maroons and reds are changing due to EPA regulations. Lead, chromate, and other heavy metal pigments are being discontinued by pigment manufacturers.

5) Deep Colored Gel coats—Blacks, blues, reds, burgundies, and greens chalk as they weather. They may do so at the same rate as other colors, but the whitish chalking is more visible. This is due to the fact that deep colors highlight any chalking, making it stand out. Some colors absorb more sunlight, becoming hotter and weathering faster.

   In general, as they weather, clear, whites and off-whites will yellow. Colors will fade. Black and deep colors will chalk.

B. Maintenance—Weathering can be influenced by the care the finished part receives.

Weathering starts immediately. It does not depend on whether the part is immediately sold or if it sits at a dealer.

FRP parts need to be washed, waxed and taken care of like a car. They do not need repainting and caulking each year like wooden boats, but they do need care. A car dealer will wash his cars once a week to keep them looking good. A professional FRP dealer should do the same.

Chemicals and dirt can collect during storage. The gel coat can be attacked or stained when chemicals combine with rain or dew. They then can attack or stain the gel coat.

Reference should be made to ProSlide's *Waterslide Maintenance Manual* for specific information regarding recommended techniques and products for the maintenance and repair of waterslides. The following is a general overview of information pertaining to maintenance.

1) Cleaner—Polyester gel coats are very resistant to water and other chemicals, but care should be used that an overly harsh cleaner is not used. Avoid any strong alkaline (such as trisodium phosphate) or highly acidic cleaners. Bleach and ammonia should also be avoided. These materials, if left in contact with polyester, may attack or change the color.

2) Sanding and Buffing—The process of sanding and compounding a new part surface can cost 3 to 6 months of finish life. For weatherability's

sake, it is advantageous to operate with defect-free, high gloss molds (and good procedures) so that minimal finishing is required on the part.

The reason this causes a reduction in weatherability is that sanding and compounding remove the thin, resin-rich surface, which protects the part's surface and imparts higher gloss.

3) Rubbing Compounds—There is a wide variety of rubbing compounds. Like sandpaper, rubbing compounds are used to remove an extremely thin layer from the surface. These compounds range from very coarse to very fine grit.

4) Waxes—There are a number of waxes on the market. Try to use one specifically designed for fiberglass and that contains carnauba or PTFE (also known as Teflon®). Waxes formulated specifically for gel coat/fiberglass surfaces are handled by many boat dealer, shower stall dealers, and automotive retail stores.

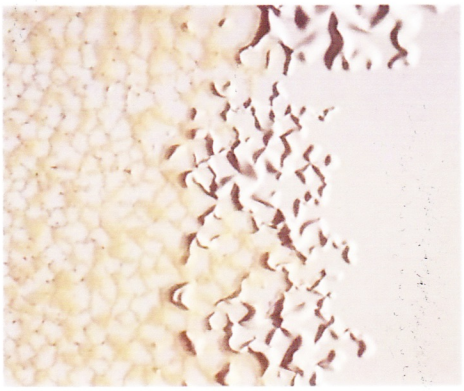
5) Sealants—While sealants may provide a wet luster or slick surface when applied to a new or sanded and/or compounded/exposed gel coat surface, ProSlide has not found them to significantly extend the gloss or color retention life of that surface.

6) Stains—Many fiberglass parts age as they are used and eventually pick up stains. These stains may be water-soluble or not and can result from dust, pollen, rust, and contaminants in the water.

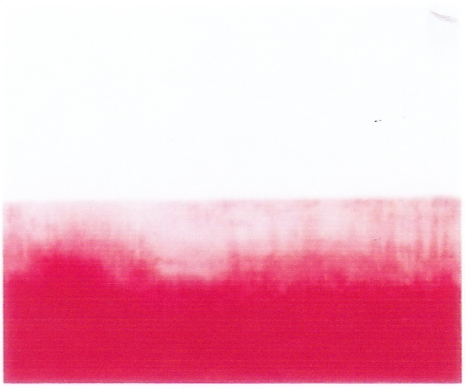
7) Scratches and Nicks—Scratches can occur from the simplest of causes. For example, a grain of coarse sand stuck to a lifeguard's shoe while inspecting the ride may scratch the surface. Small scratches will not detract from the functionality of the ride but larger ones that breach the gel coat surface will need to be repaired.

EXHIBIT "A"
SAMPLES OF GEL COAT DAMAGE

1. Air Bubble



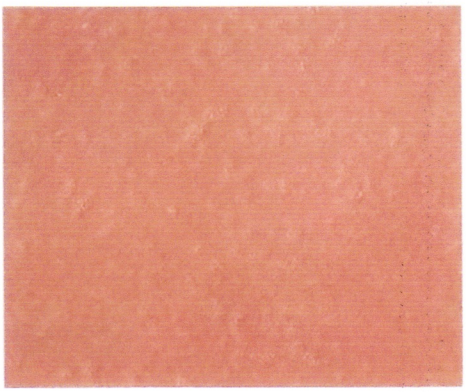
2. Alligatoring
(Yellow area indicates resin)



3. Bleeding

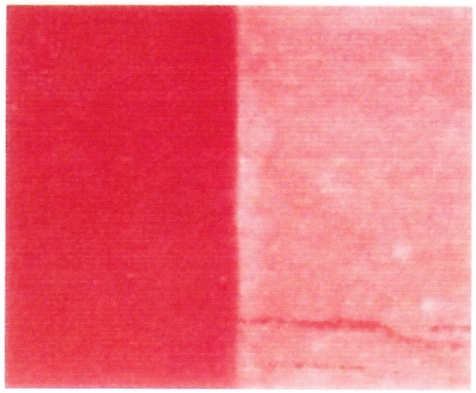
4. Blisters — caused by catalyst drop

5. Blisters — Osmotics
Small blisters — gel coat, large — laminate



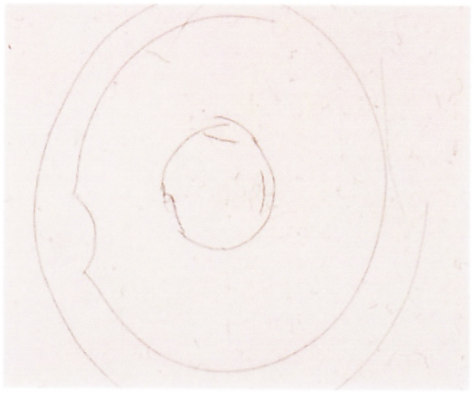
6. Catalyst Drop Gassing
(can likely blister as in photo #4)

EXHIBIT "B"
SAMPLES OF GEL COAT DAMAGE



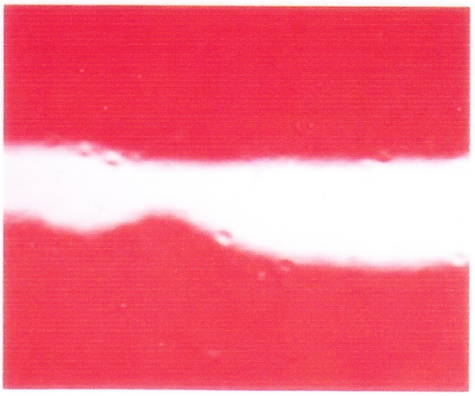
7. Chalking

8. Cracks - reverse impact (spider/star)

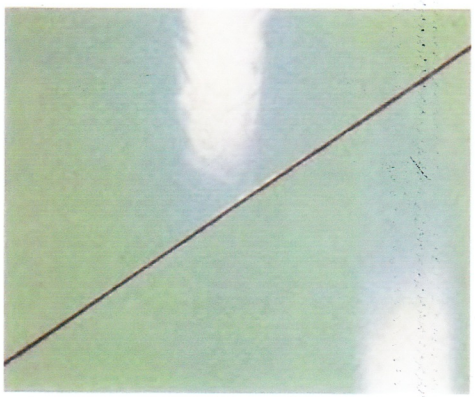


9. Cracks - frontal impact

10. Cracks - stress

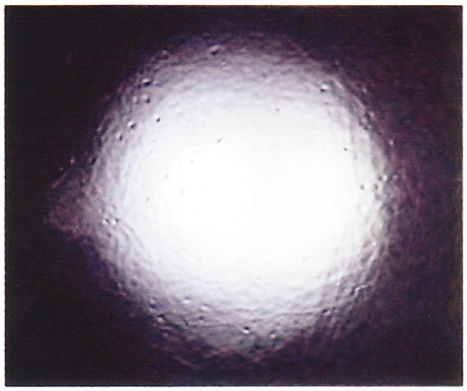


11. Dimples

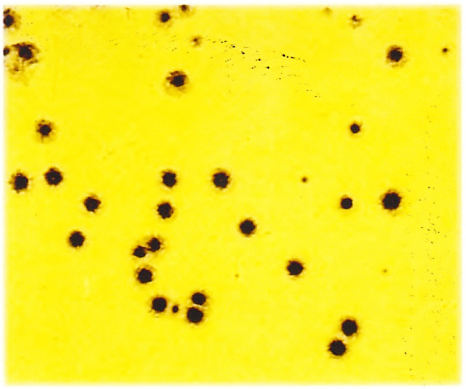


12. Distortion — top panel shows distortion

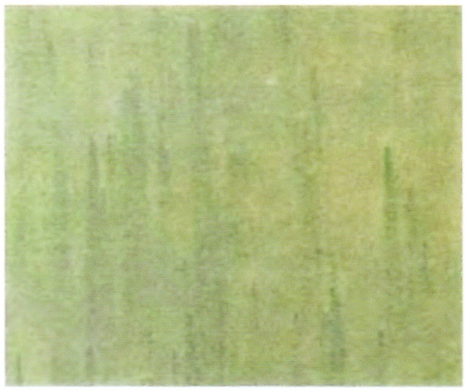
EXHIBIT "C"
SAMPLES OF GEL COAT DAMAGE



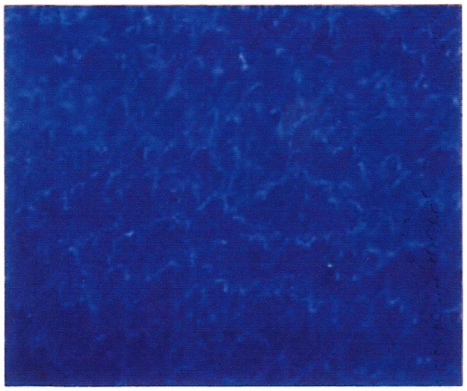
13. Fiber Pattern & Distortion
(Note: also exhibits dimples)



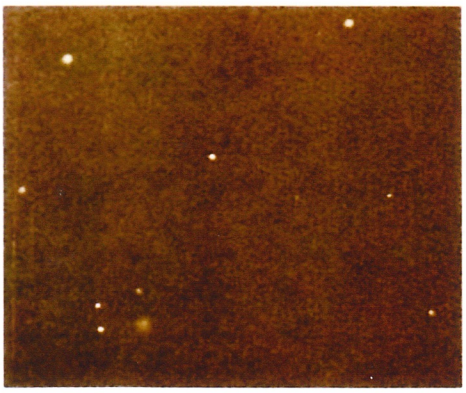
14. Fisheyes



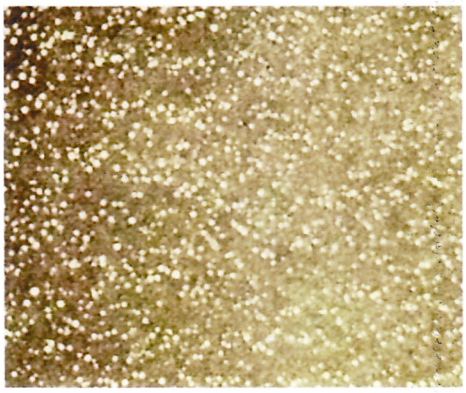
15. Pigment Darting



16. Pigment/Color Separation



17. Pinholes



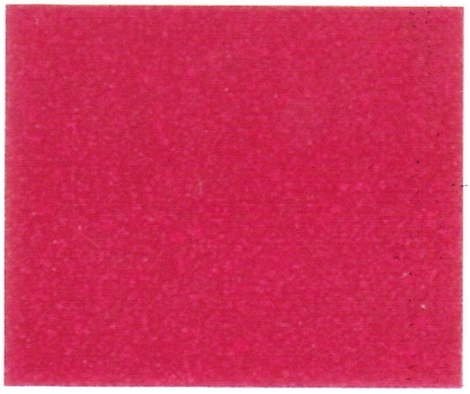
18. Porosity (magnified 10x)

EXHIBIT "D"
SAMPLES OF GEL COAT DAMAGE

19. Pre-Release
(Gel coat, before lamination)

20. Pre-Release
(Gel coat, during or after lamination)

21. Resin Tearing



22. Solvent Contamination

23. Water Spotting

24. Yellowing caused by thick gel coat
(inset shows 55 mil thickness of white gel coat)