Get a competitive edge

Select the optimal finishing









Reduce cost,
decrease weight
and improve quality

Choosing the optimal finishing for a competitive edge

How do you define “competitive edge”? Is it when you can save money on your applications? Or when you surpass quality or weight goals? Most likely it is a specific combination of several strategic criteria that give your applications the edge.

A number of factors impact your ability to reach your goals for a specific application. Manufacturing process, core material, laminate and finishing all play important roles and influence each other. Selecting the optimal finishing has a distinct and profound impact, which is why DIAB offers this finishing knowledge guide based on our wide range of finishing options – in combination with our broad competence in core materials, composites design and manufacturing – to ensure you get an optimal selection.

This material outlines how to approach finishing selection as well as introduces the main groups and combinations DIAB offers. It also helps you clarify the particular edge you want for your application since this directly impacts the solution we propose. This is far from off-the-shelf, one-size-fits-all solutions. This is a springboard for detailed discussions that we as experts would like to have with you to find an optimal solution to fit your needs.

Why finishing matters

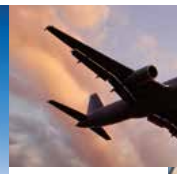
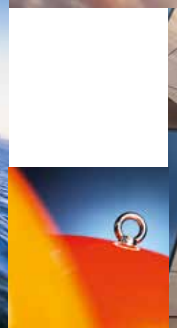
Finishing refers to the possibility to shape and design structural core materials to suit application needs, whether related to processing, design, weight or surface finishing, for instance. You can choose from a wide range of cuts, grooves, perforations, kerfs, etc. in different patterns, each serving a specific purpose.

So, why does finishing play such an important role in application success? Simply put, the right finishing saves you time, money and resources.

The benefits of choosing a suitable finishing option include cost-effectiveness and efficiency in creating curvature as well as the elimination of the need for external flow media.

Of course, different finishing options provide different benefits depending on a variety of factors, which is why it is so important to strategically choose a finishing option that fits your needs and circumstances.



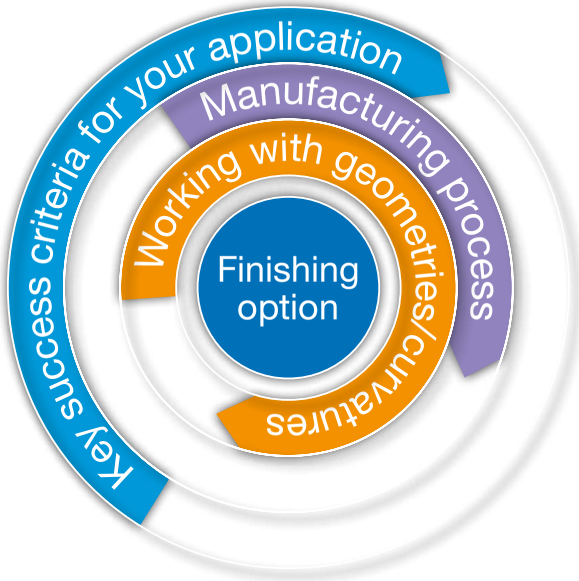





3 factors influencing finishing selection

Analyzing the three main influencing factors — success criteria, manufacturing process and geometries/curvatures — will help you decide which finishing to use to improve your application’s performance.

As you begin to evaluate and make decisions based on these factors, it is important to understand that they relate in unique ways depending on the type of application – meaning that each factor can influence the others. This is why a straightforward knowledge guide, coupled with DIAB experience, is invaluable. The following pages will give you a good basis for understanding and discussing the impact these factors have on your finishing selection.

Before you dive into your analysis, also note that the overall form, function and purpose of your application will determine to a great extent what you can accomplish in terms of meeting various criteria and which options you can choose. Design is a very comprehensive and complex element, which we do not bring into the finishing selection process other than how the application’s geometry influences the selection of finishing.



! Understanding the three main influencing factors and how they interrelate is crucial to making the best finishing selection.

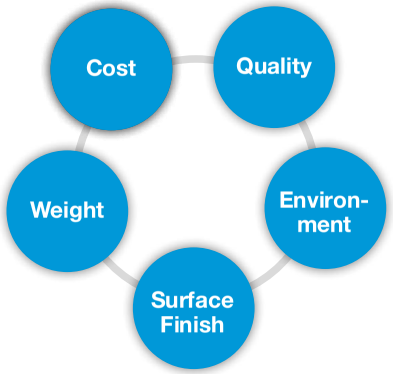





What are the key success criteria for your application?

The right finishing option and manufacturing process make a big difference in reaching your goals. Of course, in order to hit a target, it helps to see it clearly. That is why it is vital to start by clearly defining the success criteria for the application.

There are five main factors to consider: weight, cost, surface finish, environment and quality. Most likely, you will have a combination of requirements for your application so it is important to understand how each one influences the others. Once you see where your application is positioned within the illustration below, you have the foundation for determining which processes and finishing options are the best match for achieving your unique criteria combination. DIAB's experts are always available to help you better understand the cross-influences so you can make the most accurate assessment of your criteria positioning.



Weight
Weight is of key importance for many applications. In this case, you may be interested in a finishing combination with low resin consumption. Weight as a key criterion often impacts the process manufacturing speed and total cost of the composite part.

Cost
When cost is a decisive factor, the best option is to select a finishing combination suitable for faster manufacturing, involving short lay-up time and fast resin flow. This decreases the throughput time in serial production. Having cost as a main driver can impact the resin consumption, weight and surface finish of the ready part.

Surface finish
Surface finish is a subjective criterion and needs to be discussed thoroughly to understand the requirements for the application. To obtain a high surface finish, the lay-up time is usually a bit longer. Additionally, the resin consumption may be higher, as well as the cost for consumables and materials.

Environment
Due to environmental regulations and demands placed on working conditions during processing, environment is a factor many must consider for their applications. Using a closed process decreases the amount of waste and also improves the working environment.

Quality
Quality level is naturally an important success criterion. Depending on the type of application, operational requirements and expected operational lifetime, it has an important impact on the process selection.

! With all the factors that play an important role in application success, DIAB highly recommends an expert consultation to help you take a holistic view for a complete and optimized solution.

Which manufacturing process do you use?

The finishing option you choose significantly impacts the manufacturing process you choose and vice versa. That is why it is important to know which questions to ask before you make your selection. For example, is resin flow a critical part of your process? Is air evacuation important? Etc.

The most common types of processes used in composite manufacturing of larger products are:

Infusion and Closed Molding
Uses two molds (Infusion uses a vacuum bag as top mold) and a pressure difference (vacuum) to saturate laminates and core.

Hand lay-up
Wetting out laminates manually with a roller in a mold. The process is repeated with curing in between until the intended thickness is achieved.

Vacuum bagging
A semi-step process used to draw out excessive resin and unwanted air while compressing the part to get a good laminate/bonding.

Core bedding
Similar to vacuum bagging, core bedding is used to facilitate good bonding between cured laminate and core.

Spray lay-up
Using a chopper gun, a fiber rowing is chopped up in shorter strands and is simultaneously saturated with resin, after which the laminate is compressed with a steel roller.

Prepreg, resin preimpregnated fibers
The process involves curing the material by adding heat and pressure.

One-off
Otherwise known as strip planking, this manufacturing technique builds up the product from the very beginning on a framework, which is covered with planks made of foam core material. After sanding and grinding, the part is laminated, cured and sanded repeatedly until a satisfactory sandwich is achieved.

What is the shape of your application?

Each finishing option is best suited to a particular type of geometry/curvature. DIAB has developed unique solutions specially suited to fit the needs of single- and double-curved designs so you can get the best performance out of every application. Naturally, you can have different finishing options within the same application if the geometry of the application is not uniform. If the shape is very complex, we propose using Computer Numerical Controlled machining (CNC).

Exploring your ideal finishing options

Having defined your key success criteria and understanding how process and geometry relate, choosing the best finishing becomes a much less daunting task. The key is to have an understanding of how the various finishing options help you optimize your application – from resin distribution and formable finishing options to the advantages of plain sheets and more. Based on the information given here, you should now have a good base to go deeper into the different options and suitable finishing combinations.

In the following pages, you can gain an overview of finishing options and how they are suited to the criteria and influencing factors you need to address.

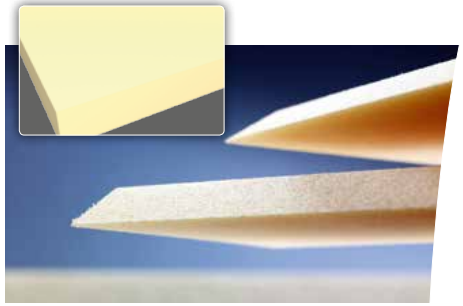
Yet, with all the factors that play an important role in application success and the myriad combinations and variations involved, DIAB highly recommends an expert consultation to help you take a holistic view for a complete and optimized solution.

Overview of finishing options

Each finishing option is suited to specific functions, criteria, materials and thicknesses. The overview presented here will give you valuable insight into which options are suitable for you. Use it as a quick reference guide or as a springboard for discussions with expert consultants when making your decision. Note: the options below are most often used in combination.

Plain sheets: where finishing starts

If possible, using a plain sheet is the most effective way to utilize a core with regards to material properties. However, plain materials usually do not fit manufacturing processes or applications without machining (adaptation). In the machining or finishing process, a core material starts off as a plain sheet before it is perforated, grooved, slitted or whatever is needed to make it as functional as possible for the end user's application or process.

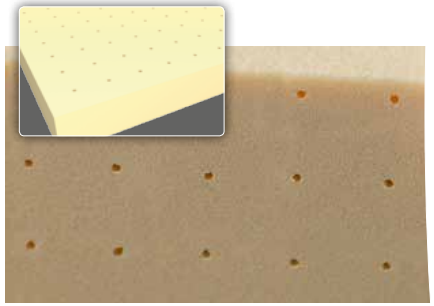


Plain Sheet

Resin distribution options

Perforations (PFC): avoiding trapped air and ensuring wet-out

When installing large sheets of rigid core, it is important there is no air trapped under the core. To avoid having air trapped between the core and the laminate, small perforations or grooves are often added symmetrically to the core. This technique is commonly used when doing hand lay-up, vacuum bagging or when using core bedding adhesives. In an infusion process, the perforations will transfer resin from one side of the core to the other – ensuring both sides are wetted out and avoiding trapped air as well. Depending on the process method and materials involved, different kinds of perforated sheets are available to fit both size and orientation.

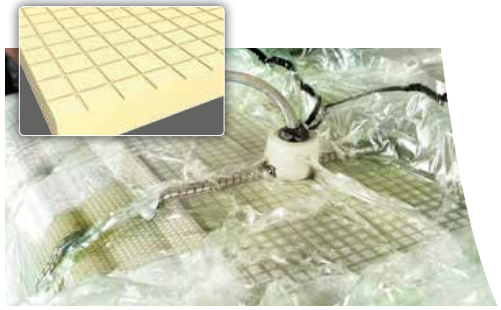


Perforations

Grooved and perforated materials (GRC, GRV, GPC)

When vacuum infusion was first introduced, it often incorporated a separate infusion medium on the surface of the laminate. However, it soon became apparent that the core itself, if grooved and perforated properly, could act as this infusion medium. There are a variety of options to choose from, allowing the user to pick which is most suitable for the process/application.

The various options for grooves and perforations can be successfully combined with formable options such as grid-scored material.

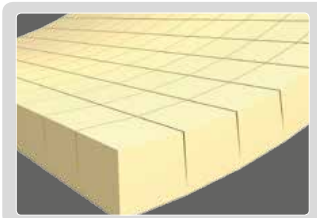


Infusion

Formable finishing options: creating curves

Grid-scored materials

Many composite applications have a complex shape, and grid-scored material is commonly used to make the core material conform easily to the mold.



GSC

Grid-scored materials contain a cut pattern on one side of the core – both lengthwise and crosswise – creating small blocks. The blocks are held together by a lightweight fiberglass scrim, creating a very flexible core sheet.

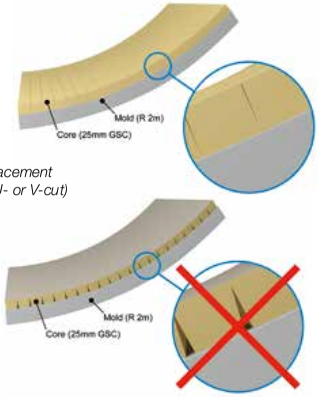
Grid-scored materials are divided into several subgroups with different purposes. GSW, etc. have unique cut shapes and widths for instance.

One-directional cut materials

ODC (one-directional cut) materials are a subgroup of GSC with the distinct characteristic of having cuts in only one direction. This configuration creates "rods" rather than small blocks.



ODC



Recommended placement in curved molds (U- or V-cut)

Single-cut materials

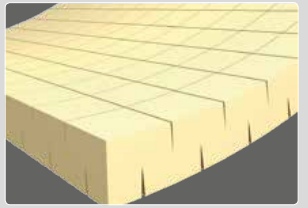
The number and size of cuts have an impact on the amount of resin the core takes up. This is especially important on curved surfaces where the cuts will close or open up to allow the sheet to contour to a particular shape. In order to reduce the number of cuts to a minimum, a single-cut configuration can be of interest (ODC, mentioned above, yields similar benefits). Single-cut sheets are scored longitudinally on one side and transversely on the opposite side, creating a perforation that enables air and resin to flow.



SCC

Double-cut materials

To introduce curvature into panels without applying a scrim, the double-cut contour configuration is often used. With double-cut, the core is cut in a 0-90 grid pattern on both sides of the core with a 50% offset between the sides and the cut extending to 55% to 60% of the thickness of the core. As with single-cut contours, the cuts overlap, allowing air and resin to easily flow through the core.



DCC

Thermoforming

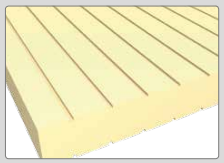
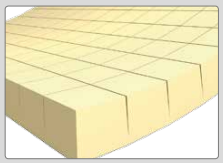
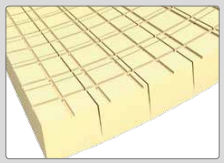
For curved panels in which uncut material is wanted, the only way to use rigid sheet is to thermoform the core into the proper shape. This can only be done with foam cores. Thermoforming is a rather complicated process that is usually time-consuming and costly. Yet, when weight and quality are prioritized more than cost, it is a very interesting alternative.

Combinations

DIAB offers an almost unlimited amount of finishing combinations since most options come in different measures.

The chart below gives you a quick view of the combinations we recommend for various applications, along with the main drivers for each one. Note: the list provides only an initial direction for the various options you can choose. Always consult DIAB to get further and deeper advice on choosing the optimal finishing.

USE FOR	Large superstructures, flooring and panels	Small-series production and prototyping	Large-series marine and industrial applications	Wind blades and single-curve applications	Nacelles and big-volume industrial applications
					
MAIN DRIVERS	**Cost**	**Adaptable and easy to work with**	**Shape & finish**	**Cost**	**Cost**
Cost	Critical	Important	Important	Critical	Critical
Surface finish	Not critical	Not critical	Critical	Not critical	Not critical
Weight	Important	Not critical	Important	Important	Not critical
Resin consumption	Important	Not critical	Important	Important	Important
Process	Closed molding	Hand lay-up	Closed molding	Closed molding	Closed molding
Cycle times	Short	N/A	Important	Important	Important

COMBINATION	GRC	GSC	GSC/GPC	ODC	GSC/GRC
Description	Grooved material	Grid-scored material suitable for various curvatures	Grid scores or plain sheet in combination with grooves and perforations	Scores in one direction; GRC and GPC can be suitable combinations	Grid scores in combination with grooves or grooves and perforations
					

Glossary

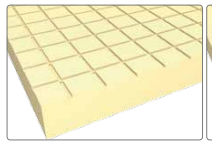
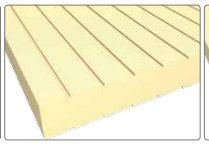
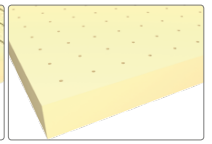
PSC Plain sheets
BSC Bonded sheets
GSC Grid-scored material with scrim
ODC One-directional cut material with scrim
DCC Double-cut contour (no scrim)
SCC Single-cut contour
PFC Perforated
GRC Grooved material
GRV V-grooved Material
GPC Grooved and perforated combination

Find the perfect core!

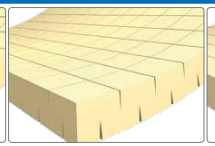
For more finishing options, please visit our website
diabgroup.com

Finishing options: quick reference

Resin Distribution Finishing Options

GPC	GRC	PFC
		
Grooved and perforated combination	***Grooved material***	***Perforated***
Grooves on either one or both sides of the core combined with 2 mm diameter square grid perforations. Grooves are available lengthwise and/or crosswise with 20 mm spacing between the grooves.	Groove patterns in the sheet surface. Grooves are available on one or on both sides of the core. The direction of the grooves can be: • Cross • Longitudinal only • Transverse only	Perforations in the sheet ranging in diameter from 1.6 mm to 3.2 mm depending on core thickness and density. Perforations are available in a variety of configurations.
Application Specially intended for resin infusion and closed molding processes. Provides optimum flow speed and secure wet-out.	Intended to allow resin to flow in closed molding applications such as infusion as well as expel trapped air.	Perforations are designed to release trapped air from under the core and/or allow resin to flow from one side of the core to the other.
Molding Process • Infusion • Closed Molding	• Infusion • Closed Molding	• Prepreg • Hand Lay-Up • Closed Molding • Press Molding • Infusion

Formables

Grid-scored material	Double-cut material	One-directional cut material
		
Grid-scored material with scrim	***Double contour***	***One-directional cut material with scrim***
Cut pattern on one side of the core, both lengthwise and crosswise, creating small blocks, or rods, depending on configuration chosen. The blocks are held together by a lightweight fiberglass scrim, creating a very flexible core sheet.	Cut pattern in which both sides of the core are cut in both directions to a depth of 55-60% of the core thickness, creating a somewhat flexible core sheet.	One-directional cut material is cut in one direction only, thus reducing the amount of cuts by 50%. However, it bends in single-curved applications only.
Application Bonding core to simple or slightly complex surfaces. May be used with a chopped mat bedding layer, but vacuum bagging or bedding into core bedding adhesive is strongly recommended to fill the cuts between blocks.	Bonding the core to very simple or minimally complex shapes. Can be used with chopped strand mat bed layers, but vacuum bagging or bonding with core bedding adhesive is recommended to fill the cuts.	Used in blades – usually in combination with grooved material or a flow media.
Molding Process • Hand Lay-Up • Closed Molding • Press Molding • Vacuum Bagging	• Hand Lay-Up • Closed Molding • Vacuum Bagging	• Infusion • Closed molding

Combining finishing options for top performance

To achieve the best results, formables and resin distributors are normally used in combinations to fit each application's specific needs — giving you a virtually boundless range of possibilities. These quick reference charts are helpful tools for narrowing your scope to the best possible choice for your application based on what you have determined as your main drivers. You will find quick guides to our formable and resin distribution finishing options as well as a handy reference chart for some of DIAB's most used combinations.









Further support for optimizing your applications

As you can see, finishing is both a vital and complex element influencing success for your application. We hope this guide helps you better understand the options available to you as well as the factors influencing your decision. Of course, there are other elements to consider for optimizing your applications, including material selection and kits. With these, as in everything, DIAB's goal is to help you every step of the way. That is why we prioritize solutions and services to help you reach your overall goal. Please feel free to contact us to learn more.

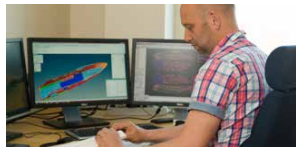
Kits

To realize the full benefits for your application – including increased efficiency, lower cost and improved quality – finishing should be used in combination with the right kit. With DIAB's unrivaled kit concept, each piece is pre-cut, shaped and formed as necessary and numbered to fit exactly into its designated place in the mold – eliminating the need for on-site shaping and cutting of flat sheets. The kit can consist of sheets only or 3D shapes made with CNC machining.



DIAB Technical Services

Technical Services makes sure our customers get the most out of their composite solution. Technical Services is an excellent speaking partner in terms of core, kits and finishing selection, assisting our customers in optimizing the full solution.



Composites Consulting Group, CCG

Composites Consulting Group, an independent DIAB Group company, provides world-class composite services to companies with a desire to make innovative products in composites. Extensive engineering and manufacturing experience from a wide range of industries and a broad understanding of customers' requirements enables CCG to provide a complete set of specialty composite technology services including design, engineering, testing, tooling, process optimization and training.

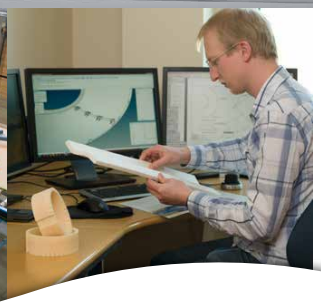


COMPOSITES CONSULTING GROUP

ccg-composites.com







www.pyramid.se December 2014

Making you more competitive

DIAB is a world-leading supplier of sandwich composite solutions that make our customers' products stronger, lighter and more competitive. Our extensive experience in providing sandwich composite solutions to customers has made DIAB a leading partner in the sandwich composite industry. DIAB's solutions combine high-performance core materials, value-added kits, engineering and process services.

Core materials | Knowledge | Kits | Processing | Engineering | Training | Global presence – local service

DIAB Group

Box 201
SE-312 22 Laholm, Sweden

Phone: +46 (0)430 163 00
Fax: +46 (0)430 163 96
E-mail: info@se.diabgroup.com

DIAB, Divinycell, Matrix and ProBalsa are registered trademarks in countries all over the world.

diabgroup.com