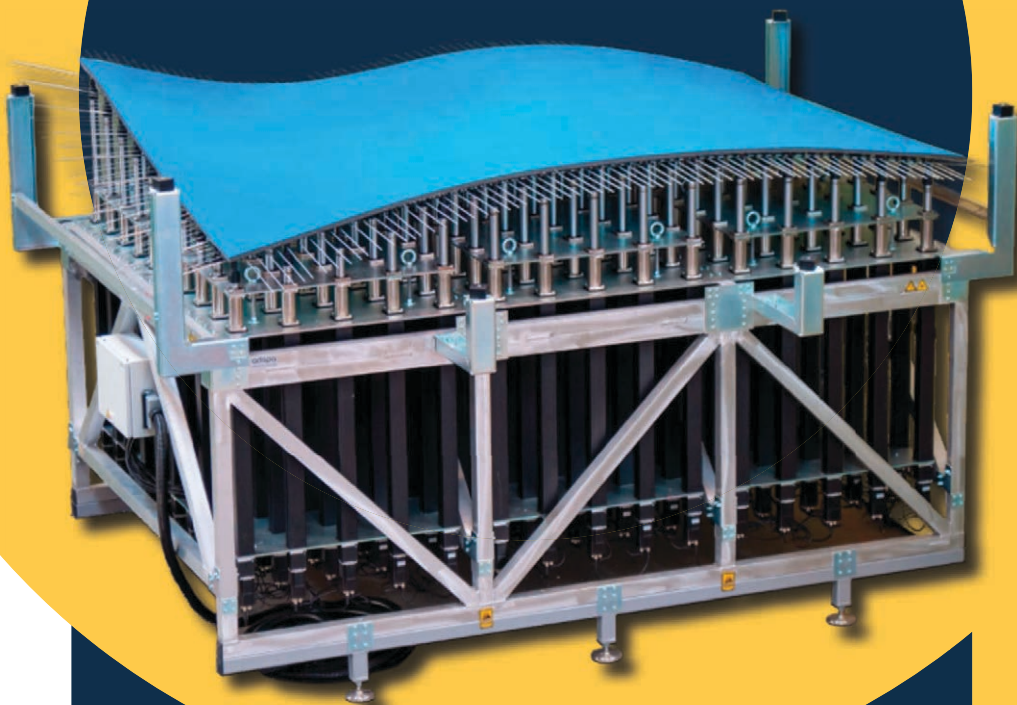


adapa

adaptive moulds

**The worlds leading
supplier of intelligent
reconfigurable moulds
for curved surfaces**

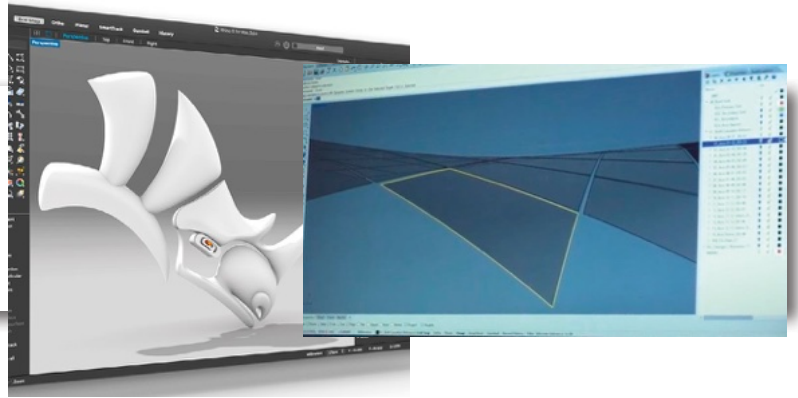


GAIN A COMPETITIVE ADVANTAGE BY OUR 5 KEY FEATURES

CONTENT

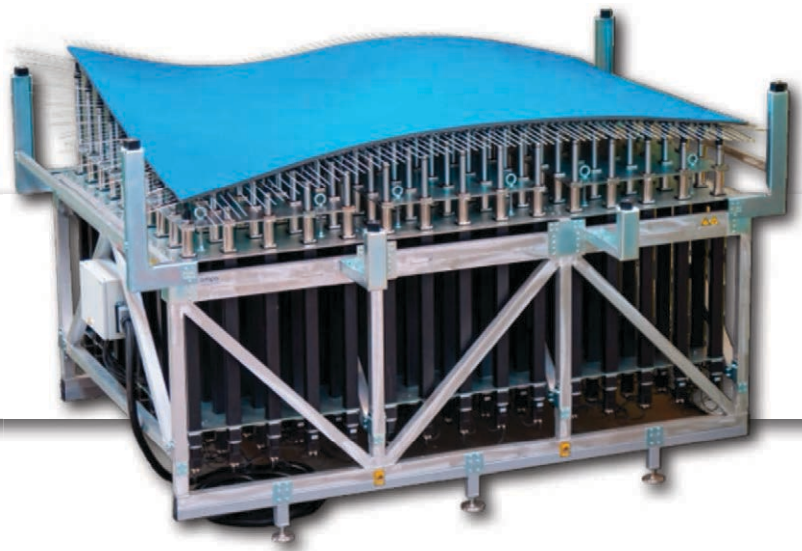
Technology Introduction	s. 02 1 7
Concrete, GFRC, GRG	s. 18 2 5
Composites, Glassfiber	s. 26 3 3
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Company Presentation	s. 36 4 0

**5 minutes from CAD file
to curved surface**



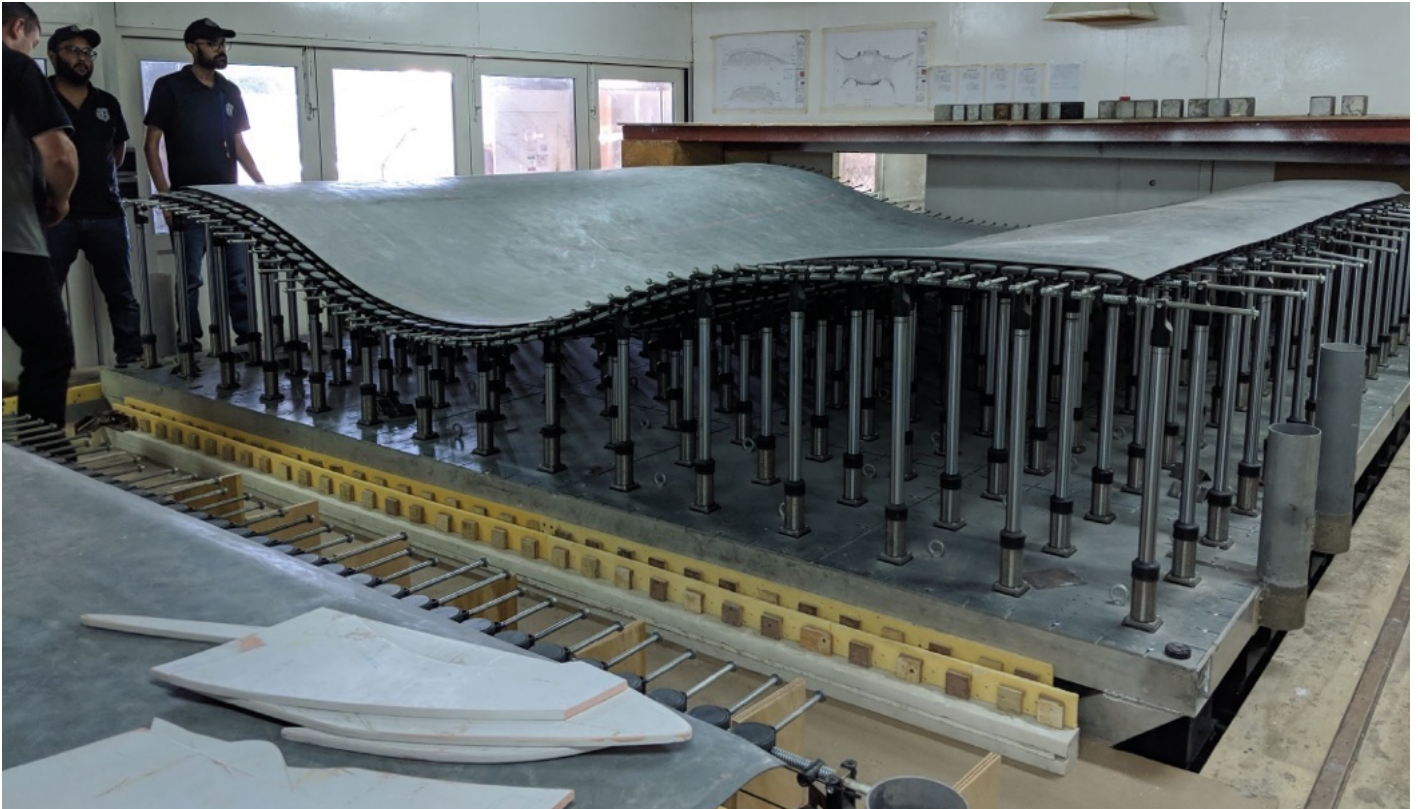
**Multiple laser guided
formwork possibilities**

**Tolerance within industry
standards with anticipated
warp effect programming**



**Easy HMI
touch
operation**

**Diagnostics of hardware
performance and logfile
documentation**



Easy and intuitive to use. One day of training and you are ready to fabricate.

Adaptive moulds that fit into standard shipment sizes can be set up with remote support from our engineers, while larger adaptive moulds are shipped in modules for final assembly in your facility.

The required electrical installation is a standard power input of 400 VAC 16A 5P connected to the control unit. The intuitive user interface enables easy surface calibration and during the initial shape test mechanical performance is automatically monitored by the embedded software.

Based on user preference for production management, the adaptive mould can either be handled as a stand-alone, network connected, or internet connected machine.

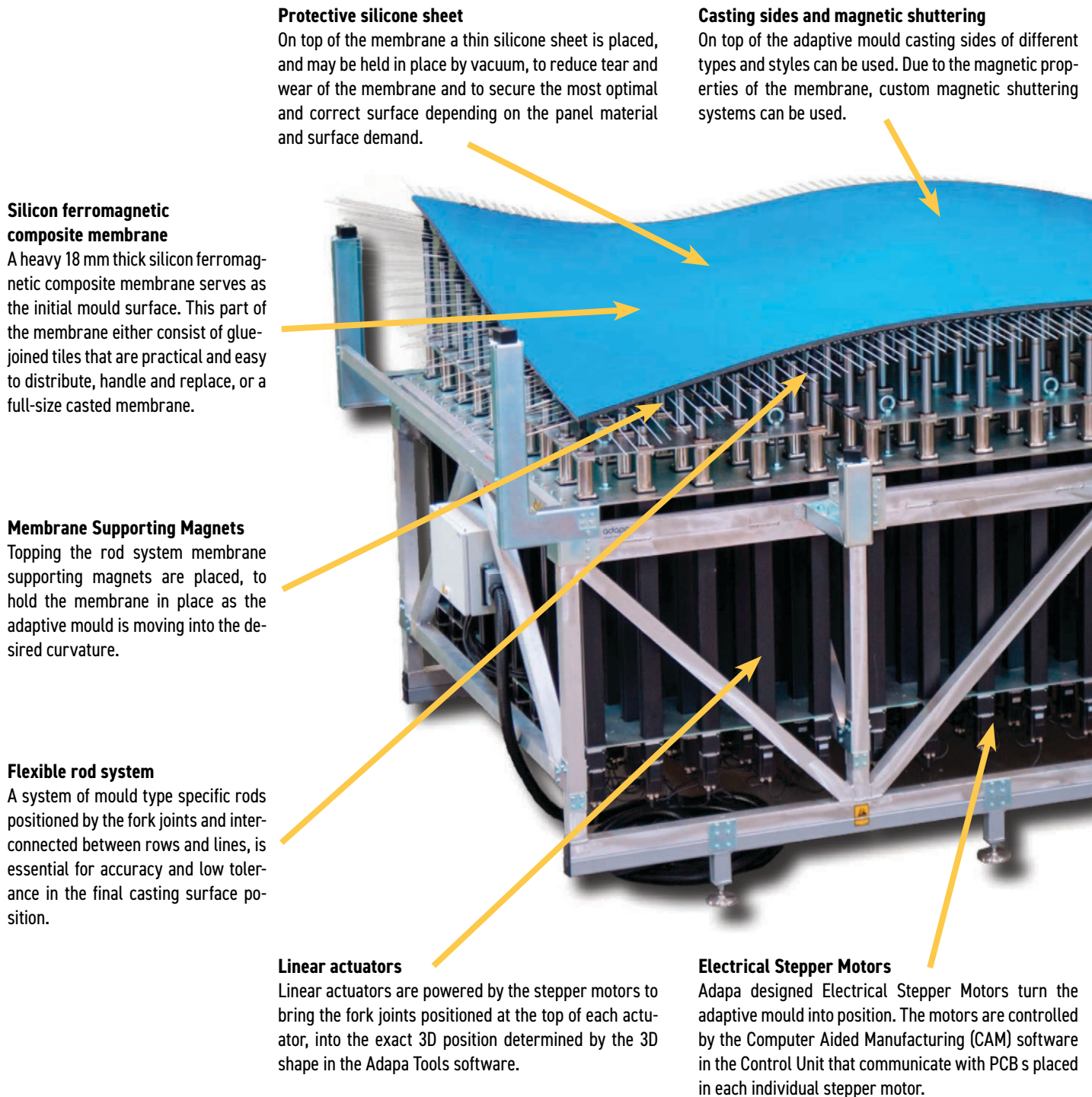


**Plug and play with our engineers
as remote support for adaptive
moulds that can be shipped
fully assembled**

ADAPTIVE MOULD COMPONENTS

Moulding components

That shape the surface to be used for formwork



Protective silicone sheet

On top of the membrane a thin silicone sheet is placed, and may be held in place by vacuum, to reduce tear and wear of the membrane and to secure the most optimal and correct surface depending on the panel material and surface demand.

Casting sides and magnetic shuttering

On top of the adaptive mould casting sides of different types and styles can be used. Due to the magnetic properties of the membrane, custom magnetic shuttering systems can be used.

Silicon ferromagnetic composite membrane

A heavy 18 mm thick silicon ferromagnetic composite membrane serves as the initial mould surface. This part of the membrane either consist of glue-joined tiles that are practical and easy to distribute, handle and replace, or a full-size casted membrane.

Membrane Supporting Magnets

Topping the rod system membrane supporting magnets are placed, to hold the membrane in place as the adaptive mould is moving into the desired curvature.

Flexible rod system

A system of mould type specific rods positioned by the fork joints and interconnected between rows and lines, is essential for accuracy and low tolerance in the final casting surface position.

Linear actuators

Linear actuators are powered by the stepper motors to bring the fork joints positioned at the top of each actuator, into the exact 3D position determined by the 3D shape in the Adapa Tools software.

Electrical Stepper Motors

Adapa designed Electrical Stepper Motors turn the adaptive mould into position. The motors are controlled by the Computer Aided Manufacturing (CAM) software in the Control Unit that communicate with PCB s placed in each individual stepper motor.

The robotic Adaptive Mould solution is divided into two main technology areas



3D laser

The casting sides can easily be placed using a 3D laser placed 3-5 meters above the adaptive mould. The laser also laser-guides correct placement of panels, ornaments, letters or alike to be placed on the casting surface.



Steering components For accurate 3D positioning of the mould surface



Software

Our own software Adapa Tools, is a Rhino plugin software that prepares the CAD files for the panel prior to fabrication. The software analyses and optimizes the design of each panel in accordance with the specific mould that is being used. The software supports files formats such as 3dm, iges, stl, stp, 3ds, dwg, etc.

Control unit

The 3D designs are transferred to the mould from the control unit, which acts as the central nervous system that manages mould operations and configurations.

Adaptive Moulds for the Concrete Industry

An intelligent tool for
competitive advantages
through automated manufacturing



THE ADAPTIVE MOULD FOR PRECAST CONCRETE, HPC, GFRC AND GRG ENABLES MANUFACTURING COMPANIES TO PRODUCE LOW-REPETITION CURVED PANELS FASTER, AFFORDABLY AND MORE SUSTAINABLY THAN ALTERNATIVE TECHNIQUES.





Enabling high volume of uniquely curved precast concrete in large scale projects

Limak produced 36.964 reinforced precast shell cassettes on just 85 adaptive moulds with a daily output of up to 160 pcs a day.

13.000 unique panel geometries were designed by Fosters + Partners in the iconic architecture of Kuwait International Airport Terminal 2.

If using traditional CNC milling to create 160 one-off moulds each day, there should have been used a minimum of 300 CNC milling machines. Thus, a facility size difficult to manage and a waste situation impossible to accept.

Besides enabling the construction of the curved architecture, the mould cost each m² was reduced by the adaptive moulds to a level not far from doing flat precast.

The adaptive moulds stood the test in the desert in Kuwait, enduring high temperatures and dusty conditions and yet still supporting the highly automated casting process.

Complex concrete megastructures can be built on a large scale even within tight constraints with regard to time and budget

Fabricate 2020

Compared to traditional one-off moulds

5 times less expensive

7 times reduction in facility space

150,000 m³ or 4,500 Ton polystyrene saved

31,000 Ton CO₂ emission saved



“

The CO₂ emission saved by adaptive moulds on the Terminal 2 construction, equals the equivalence of a full-grown forest for 4 years on the full 37.7 Km² area of Kuwait International Airport

adapa.dk

Advantages of computer aided manufacture on our adaptive moulds

Fast - One mould can take multiple shapes, and it can do so within minutes. This means that you have:

- ✓ The Possibility to fabricate different materials and designs with a single mould
- ✓ No waiting time for tooling
- ✓ Maximum flexibility for last-minute changes and design iterations

Affordable - The Adaptive Mould eliminates the need for manufacturing unique tooling for every panel, as you have:

- ✓ Minimal tooling costs
- ✓ Reduced space requirements in your production setup
- ✓ Shorter production time

Sustainable - The Adaptive Mould significantly reduces your potential waste of disposable moulds, as you have:

- ✓ Less logistical costs due to no transportation or storage of disposable moulds
- ✓ A more sustainable production and a smaller carbon footprint impact
- ✓ Significantly less waste to manage

Multi Stage Forming - The flexible properties of the Adaptive Mould allow for multi-stage forming, including a process such as the following:

- ✓ Lay-up surface layer in flat stage
- ✓ Adjust the mould into the curved shape
- ✓ Release the panel by selectively lowering the actuators

High precision - The Adapa Tools software eliminates the need for manual measuring and support you to benefit from the advantage of:

- ✓ Low mould surface tolerances
- ✓ Guidance by accurate 3D laser
- ✓ Guided positioning of inlays, brackets and fixtures

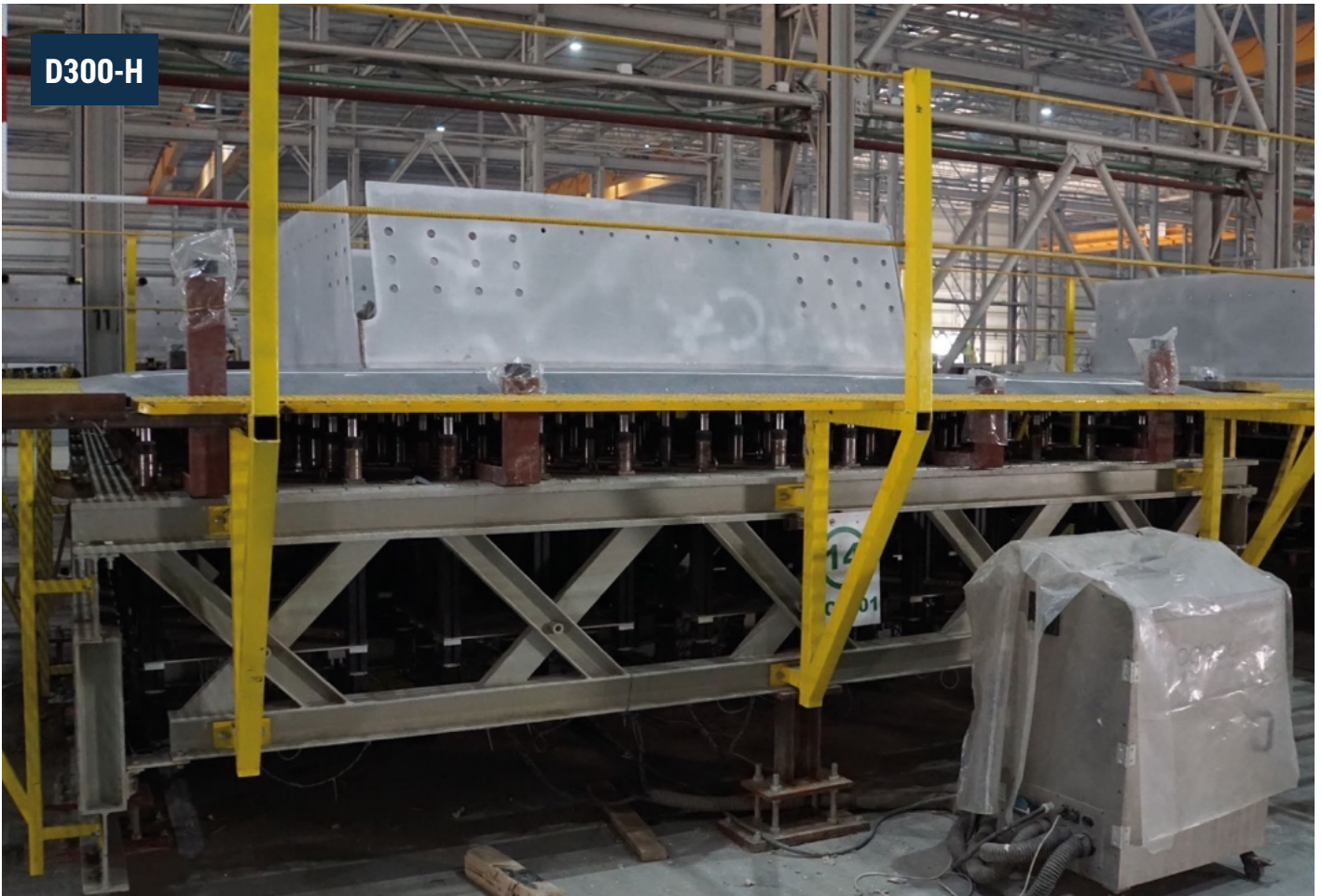
Collaborative Technologies - The Adaptive Mould is designed to handle surface temperatures up to 200° C and collaborate with several technologies:

- ✓ Magnetic silicon sides and shuttering for panel edge precision
- ✓ Top liners for patterns or inlays
- ✓ Spray gun and heating mats
- ✓ Robotic lay-up or post processes

We support you in your preference for customized formwork solutions

Adapa support you in design and manufacture of customized formwork solutions according to your request and your preference in manufacture and purchase. We support you by offering:

- ✓ Full-service design and manufacture on your request
- ✓ Provide sub-supplier information for your purchase department
- ✓ Deliver drawings and manufacture specification for you own manufacture



Examples of mould types

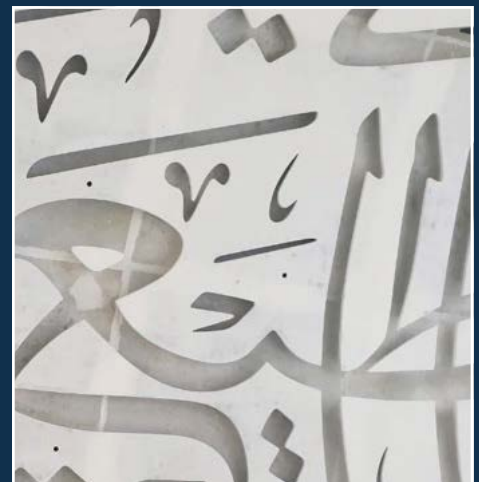


Adaptive Moulds for the Composite Industry

**An intelligent tool
for competitive
advantages
through automated
manufacturing**



The Adaptive Mould for Composites, Thermoplastic, Infusion and Glass fiber enables manufacturing companies to produce low-repetition curved panels faster, affordably and more sustainably than alternative techniques.





Enabling high volume of uniquely curved glass fiber panels in large scale projects

Advanced Fibreglass Industries produced 3.500 m² curved glass fiber composite for the internal facade on Museum of the Future on only 3 adaptive moulds.

230 individual curved panels with individual calligraphy recess pattern were manufactured within +/- 2 mm tolerance of the 3D model for this iconic architecture designed by Killa Design.

If using traditional CNC milling to create 230 one-off moulds and finish the production within same time frame, there should have been used a minimum of 12 CNC milling machines. Thus, a facility size difficult to manage and a waste situation impossible to accept.

Besides enabling the construction of the curved architecture, the mould cost each m² was reduced by the adaptive moulds to an affordable level.

The adaptive moulds stood the test demonstrating the importance of rapid curved surface and the ease of laser guided mould work, reducing facility space, manpower and waste.

The future belongs to those who can imagine it, design it, and execute it. It isn't something you await, but rather create.

***Prime Minister of UAE,
Sheikh Mohammed bin Rashid Al Maktoum***

Compared to traditional one-off moulds
4 times less expensive
5 times reduction in facility space
1,750 m³ or 26 Ton polystyrene saved
181 Ton CO₂ emission saved



Adapa's adaptive moulds were used for the interior of Museum of The Future and which supported the desire for reduction in waste and CO² emission.



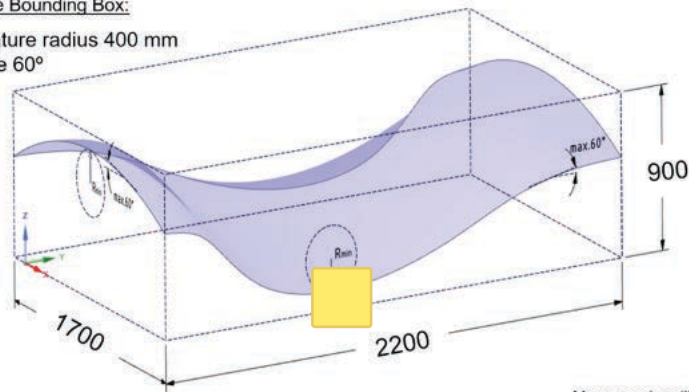
Adaptive mould types for manufacture of curved GLASS FIBER, COMPOSITES and THERMOPLASTICS

D100 – ideal for Composites and Thermoplastics with double curved geometry

Typical size Bounding Box Length 2200 mm x Width 1700 mm x Height 900 mm

Limitations inside Bounding Box:

Minimum curvature radius 400 mm
Maximum angle 60°



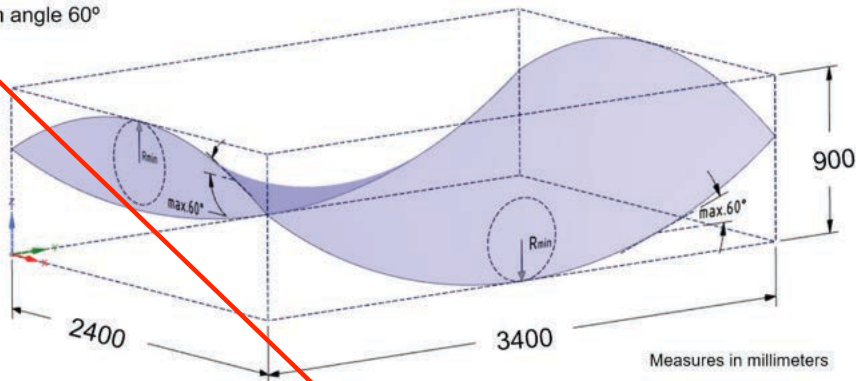
Measures in millimeters

D200 – ideal for Composites and Thermoplastics with double curved geometry

Typical size Bounding Box Length 3400 mm x Width 2400 mm x Height 900 mm

Limitations inside Bounding Box:

Minimum curvature radius 900 mm
Maximum angle 60°



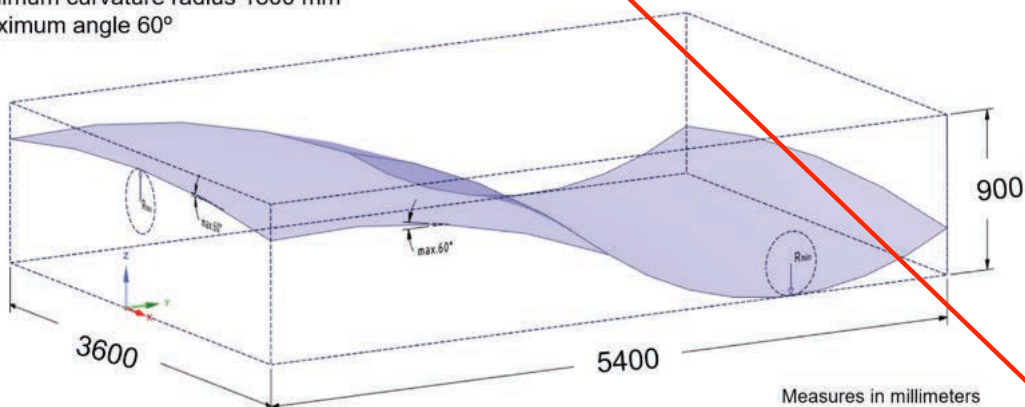
Measures in millimeters

D300 – ideal for Glass Fiber and Composites with double curved geometry

Typical size Bounding Box Length 5400 mm x Width 3600 mm x Height 900 mm

Limitations inside Bounding Box:

Minimum curvature radius 1800 mm
Maximum angle 60°



Measures in millimeters

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- ✓ Top liners for patterns or inlays
- ✓ Vacuum and infusion
- ✓ Heating mats
- ✓ Robotic lay-up or post processes

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Technical Data for Double Curved Adaptive Mould Types for Glass Fiber, Composites and Thermoplastics

Technical Data

Double Curved

~~D300~~

~~D200~~

D100

Features Double Curved Adaptive Moulds

Minimum curvature radius	mm	1800	900	400
Maximum casting area	mm	5400 x 3600	5400 x 3400	3600 x 2160
Maximum casting height (actuator travel)	mm	1000	1000	1
Maximum payload	Kg/m ²	225	225	280
Surface Tolerance	+/- mm	2.5	2.0	1.5

Motors and Actuators

Actuator Density / Distance	mm	300 x 300	200 x 200	120 x 120
Stepper motor Force each	Newton	2000	1000	600
Stepper motor Watts each	Watt	60	32	22
Stepper motor Travel speed	mm/min	300	300	300

Rod system

Steel rod Ø	mm	10	6	6
CFRP Alignment rod Ø	mm	2.0	1.8	1.8
Magnet Cup Diameter	mm	25	25	15
Magnet Cup Density	Pcs/m ²	550	625	1100

Silicone Ferromagnetic Composite Membrane 1 x 1 m

Magnetic Silicone Composite	Shore	55A	40A	40A
Thickness	mm	18	18	18
Weight	kg/ m ²	40	50	50
Surface Roughness	Ra[µm]	1.6	1.6	1.6
Magnetic Surface Pulling Force	Newton	18	30	30

Protective Silicone Sheet 3.6 m

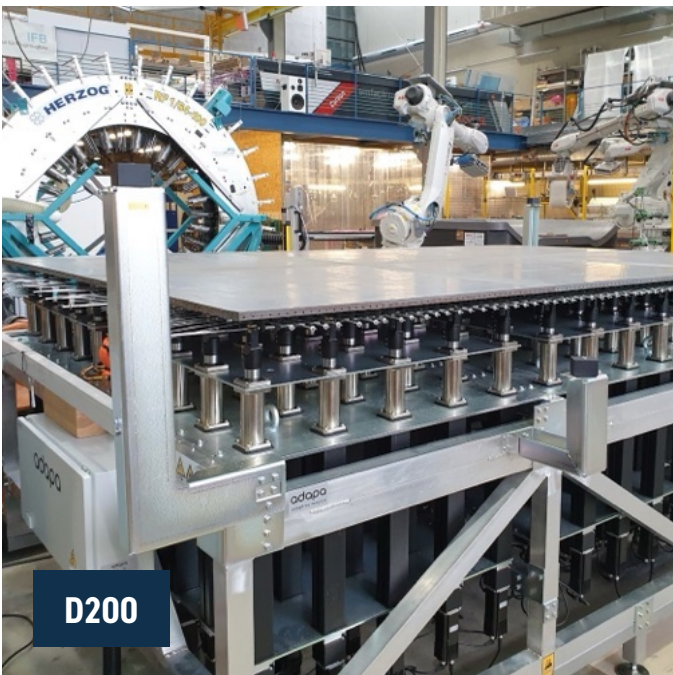
Thickness	mm	3	3	3
Weight	kg/ m ²	15	15	15
Surface roughness	Ra[µm]	1.6	1.6	1.6

Magnetic surface properties, are defined by a pulling force created between a standard NdFeB DIA25x10 N38 magnet and the silicone composite surface

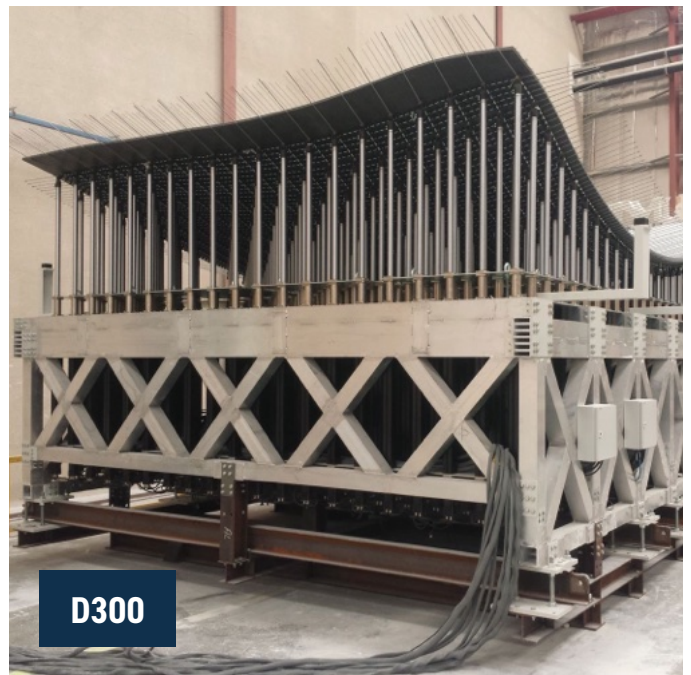


D100

Examples of mould types



D200



D300



Sustainability

Our commitment is expressed in reusability

Adapa is committed to contributing in whatever way we can, to reduce the impact that greenhouse gas emissions have on our planet.

We urge our industry partners to contribute as well, by looking at non-polluting, environment-friendly methods of production for their future projects. These principles influence the way we think and act and can be recognized in the fact that, we use materials like aluminum because it is durable and easy for us to reuse, just as we do not paint our machinery because it is easier to recycle materials without paint.

SUSTAINABILITY IS A CORE PRINCIPLE

Adapa is built on the foundation of reusability, and we will continue to strive to incorporate this belief into everything that we do.

Development of our adaptive mould technology is driven by customer demand and market needs.

The way we design solutions, manufacture machinery and service our customers are based on the principles that we:

- innovate to make the manufacture of complex curved surfaces sustainable
- plan to secure transport and production methods with the lowest environmental impact
- choose the materials and parts that are easiest to reuse or recycle
- guarantee the option to return machinery, parts, and materials to our production in Aalborg

One-off polystyrene moulds create the same CO2 emission as the cement in an equal sized 20 cm thick precast element that will last for 100 years

CARBON IMPACT REDUCTION IS A CONTRIBUTION

One of the biggest environmental pollutants is polystyrene, as it contains toxic substances such as styrene and benzene.

And yet, it continues to be used as the primary component to make moulds in the manufacturing and construction sectors.

Polystyrene emission facts

- 1 kg polystyrene = 7 kg CO2 emission
- 210 kg CO2 each 1m³ polystyrene
- one-off polystyrene moulds create the same CO2 emission as the cement in an equal sized 20 cm thick precast element that will last for 100 years
- one adaptive mould saves 69 truckloads of polystyrene

Further facts and figures on our website.