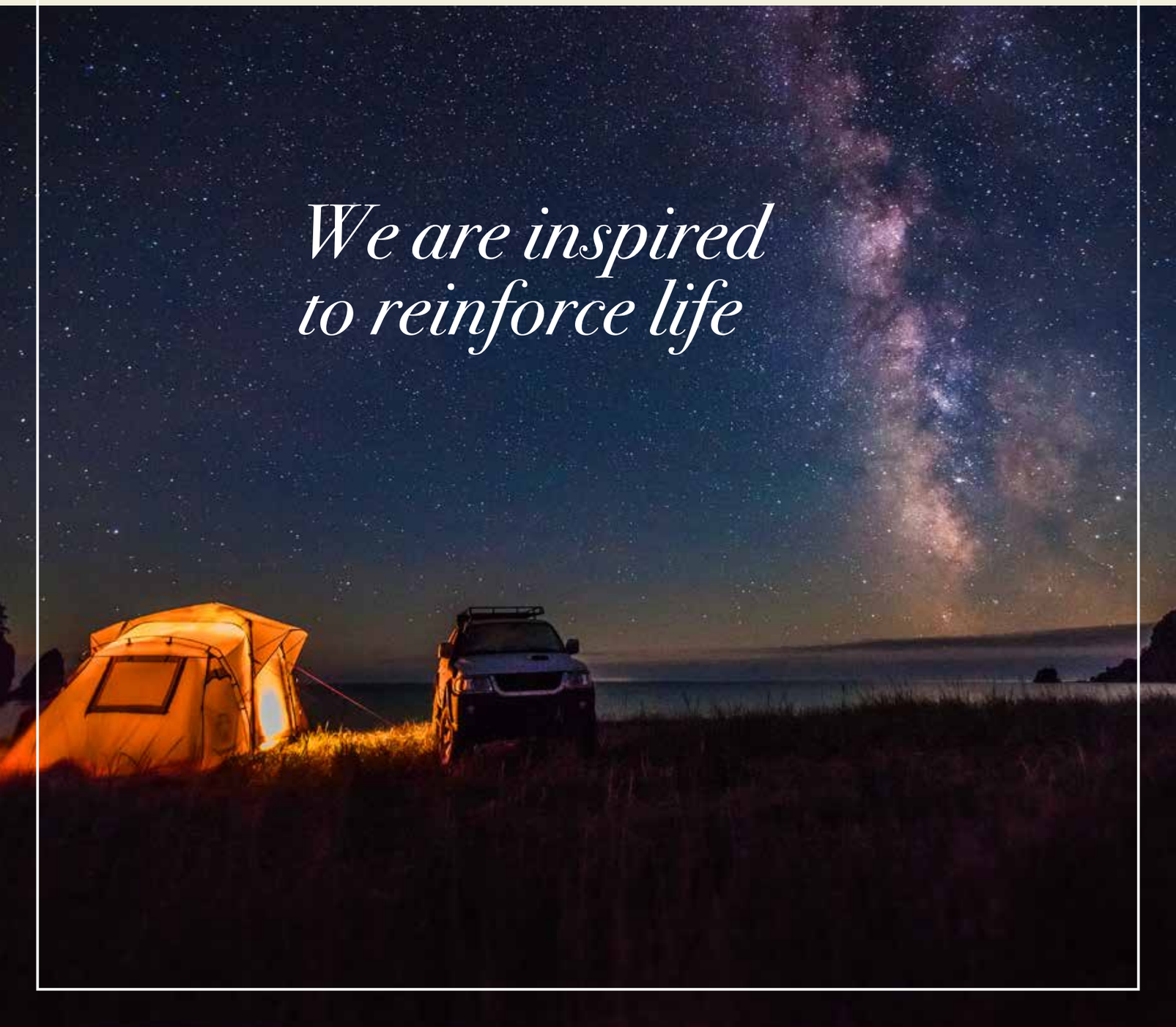
THE REINFORCER

KORDSA | BULLETIN | N.12 | 2020 | TURKEY

Determined to Create Value

KORDSA



We are inspired to reinforce life

In Kordsa, we are inspired to create a better future for all of us. We know that protecting the harmony of life is the first step and for this, we develop unique reinforcement solutions to touch every aspect of life.

KORDSA

THE REINFORCER

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Contents

We are inspired by the unique, joyful, peaceful and safe moments in life, and we use this inspiration to cultivate new ideas, to protect, sustain and enrich those moments.

Foreword

ALİ ÇALIŞKAN

CEO

Dear Esteemed Partner,

2019 has been a good year at Kordsa, with strong growth. We maintained our absolute commitment to reinforce life. We have set ambitious goals, partnered with industry leaders, made new investments, broadened our operation area, deepened our capabilities and done our best to make sure our customers and business partners also reach their goals.

As we are heading towards becoming a material company, it's good to look ahead and think about what 2020 may have in store. But first, let's take a quick look back. In the last two years, we made targeted acquisitions to gain knowledge and expertise, and we have acquired four major composite-based technology companies in the US. Our journey started with Fabric Development Inc. and Textile Products Inc. Our competency has expanded with the acquisition of Advanced Honeycomb Technologies. And finally, with the acquisition of Axiom Materials, we have created a growth platform in North America, which is the growth hub of the aerospace industry. As the need for high temperature materials increase, oxide-oxide ceramic matrix composites are gaining increasing attention as a mainstream material option for high-temperature components. With the acquisition of Axiom Materials, we have become one of worldwide qualified manufacturers of high temperature-resistant Oxide-Oxide ceramic matrix composites.

With an open innovation approach, we launched various major collaborations and are now seeking new opportunities in next-generation materials such as thin film and flexible electronics. We placed a focus on these smart materials of the future and launched the "Thin Films and Flexible Electronics" R&D platform in partnership with Sabancı University. Since May 2019, we have been engaged in a new project called "Nanosis-1004" funded by the leading Turkish research body, TÜBITAK. With this project, we aim to develop a new generation of flexible-type wearable healthcare sensors.

In the context of light-weighting, the current priority in the automotive industry, we have launched a new e-glass pre-impregnated material. This technology, which was developed in cooperation with Ford Otosan, is a game changer. The new innovative leaf spring lightens the chassis systems of heavy-duty vehicles over 16 tons and includes structural health monitoring systems used for process optimization, part qualification and online health monitoring purposes.

Since 2008, we have been working to eliminate the use of resorcinol and formaldehyde. Together with Continental, we developed a new sustainable adhesive technology, CoKoon, which has been used in the production of 250,000 passenger vehicle tires. CoKoon as an open innovation technology drew a lot of attention from the industry. More than 40 companies, including tire manufacturers, converters and textile suppliers, have asked for samples, which we were happy to supply. Now all interested parties are invited to join the pool to get free licensing and contribute to the development of this new green technology.

In construction reinforcement technologies, we participated in the Sao Paulo Concrete Fair, to extend and expand our construction reinforcement business line in South America with the help of our innovative concrete reinforcement synthetic fiber KraTos. We are constantly looking for more opportunities for networking in Brazil, the US and Europe.

With all the above steps, we have completed a phase on our journey to build a second Kordsa. Our dream to create new business lines and become a global player known as "the Reinforcer" has come true thanks to our profound know-how in reinforcement materials and processes, advanced R&D efforts and open innovation culture.

I am satisfied to see that our efforts, including our progress in the area of sustainability, have been appreciated with international awards, honors, and recognitions. In this regard, it is an honor for me to announce that in 2019, the Carbon Disclosure Project, the first and only NGO that assesses how publicly-traded companies manage climate change risk, raised our rating from C- (the first and lower step of the "awareness" level) to B (the second and upper step of the "management" level). This reflected the work we have carried out to manage risks and opportunities related to climate change. In the 2019 assessment period, when the global and European rating average was ranked as "C", we stood out as a leading company due to our performance in managing climate-change risks. This means a lot for us, as a company committed to producing sustainable technologies.

Of course, these wonderful results are only possible due to the work of each and every team member here, and the core values we share. We are inspired to reinforce life and seek to make a genuine difference. To make a difference means to completely rethink the way we do business. We relaunched our three pillar initiatives as Growth, Excellence and Innovation, and we will move forward with the passion to grow by achieving excellence through innovation.

Looking ahead, our focus will be on continuing to grow our business, both organically and through acquisitions.

As per business excellence, we will continue to transform our business to sustain our global leadership. Since one of the hot topics in today's world is digital transformation, we are adopting digitalization in our sites in order to become competitive and create sophisticated operations that deliver more value to our customers.

Innovation is and always will be on our agenda. We will continue to develop new products and technologies in our business lines.

Our vision is built on the strong foundation of our pillar initiatives and values. We know very well that true richness consists of the unique moments in life. We are inspired by the unique, joyful, peaceful and safe moments in life, and we use this inspiration to cultivate new ideas, to protect, sustain and enrich those moments. That's why we have changed our vision from "Agile Kordsa in High Value Business for Sustainable Growth" to "Inspired to Reinforce Life".

All these targets and dreams will be achieved through the dreams and inspiration of our Reinforcers. Based on our people-oriented management philosophy, our Reinforcers will do their utmost to reinforce you, our valuable business partners. I am grateful to all our employees for their contributions, ideas and hard work.

I am excited to see Kordsa evolve, building on its innovative culture in the quest for a sustainable future. This is a continuous journey, not a fixed destination. Based on our performance in 2019, we can look ahead with great confidence. It is time to dream more, set new goals and challenge ourselves to do even better. I am proud to be part of a great community that contributes in such meaningful ways and strives to make our lives safer, easier and better.

Read on to discover the highlights of our operations and projects that are shaping and reinforcing the future.

The monofilament line is one of the projects among many that show Kordsa is increasing its capability to design and develop not only its own processes but also the equipment needed for these processes.

High-Speed Parallel Winder Development

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Global Technology Project Leader, Kordsa

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Global Technology has been looking into alternative applications for Kordsa's products as well as trying to increase the utilization of its current assets in new products that can be produced with them. Last year, Kordsa successfully designed and constructed the first "High-Speed Vertical Monofilament Position" with minimum capital expenditure requirements and minimal modifications to its İzmit Line-2 NY Yarn Facility. The Position is capable of producing 300 tons per year of monofilament yarn with a range of 470 – 810 dtex.

In 2018, a second position investment was initiated in order to increase production capacity as well as to boost the sustainability of Monolyx production. Some minor modifications were integrated into the new equipment in order to increase product variety, enabling the production of larger diameter filaments up to 1100 dtex. This project also created an important opportunity to implement an online quality assurance system capable of measuring multi-end diameter simultaneously. (The previous model only offered single-end shift base control). The biggest handicap for the project was that the supplier of the high-speed parallel winding equipment informed Kordsa that they could not supply the equipment any more. It is essential for an R&D Global Engineering Team to be able to design and develop a high-speed winding system. This article discusses the significance of the new design winder of the Monofilament Second Position Deployment Project. The Project offers some important additional technology gains for high-speed parallel winding, which can also be used in single-end cord or fabric production.

The monofilament production system consists of:

- A monofilament spin pack
- A water quenching system with position and temperature control
- A dewatering system
- An interfloor vacuum system
- Faceplate modifications including steam jet application
- An online diameter monitoring system
- A 12-End high-speed winding system

At the end of the project, it proved possible to wind at a minimum speed of 1500m/min with a diameter of filaments up to 1100 dtex. The Continuous Six-End Diameter Measurement System not only measures all strands together, thus assuring continuous quality control, but also monitors all 12 ends in a position for inline quality assurance.

Monofilament Winder

This project constituted an important opportunity to make the winder fully automatic. This has borne fruit in a fully automatic change-over from the finished winding package to an empty flange tube, with full production speed (1000 m/min realized) for 12 winding heads.

Monofilament nylon is produced though an extrusion process that results in an output of filament at a constant speed. The technical details of the new winder are as shown in Figure 1. The monofilament yarn is wound onto a bobbin, which is driven by a shaft mounted to a servo-motor. This motor uses direct closed-loop tension control with dancer feedback by regulating speed with the help of the servo-drive. The master speed reference originates in the spinning line as linear speed (m/min). The PLC calculates the diameter of the bobbin with the aid of a motor encoder (angular speed).

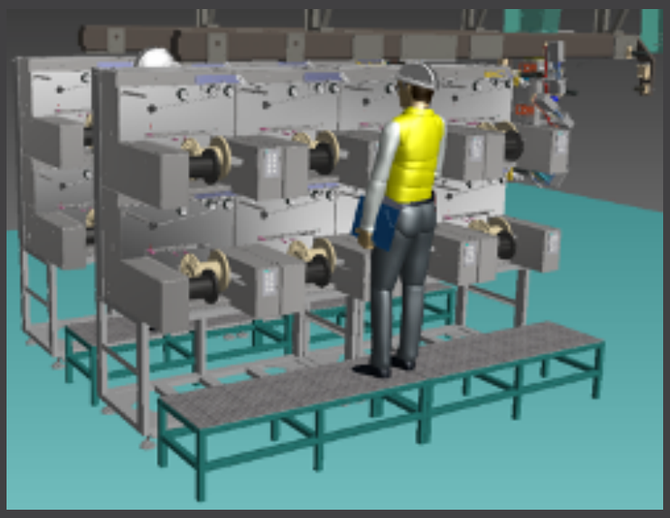

Figure 1: *Graphical design installation of the new winder*

The diagram in Figure 2 allows us to observe the Center-Driven Tension Control. To achieve accurate tension on the yarn, a freely moving, preloaded dancer arm mechanism is used. Speed trim, which is the output of the dancer PID, regulates the dancer position to keep it parallel to the ground. The gain of the speed-controller is adjusted by the inertia calculator so that it responds correctly at every diameter/weight.

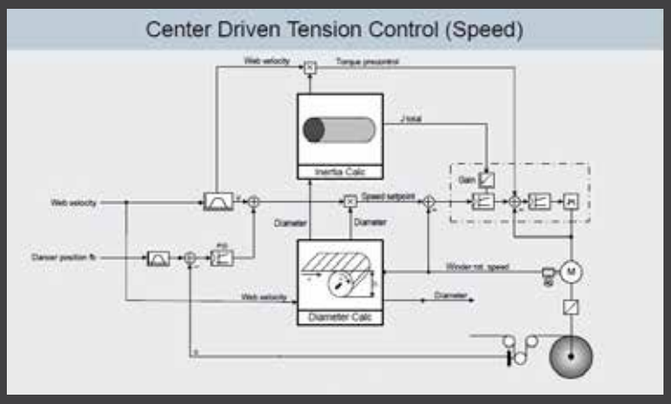

Figure 2: *Tension control of the filament with dancer roll feedback*

In the monofilament winder, multi-axis synchronization is used to move the traverse to guide the yarn along the bobbin. Instead of using mechanical gears for coordination, electronic gearing has been applied. Using this approach helps avoid mechanical wear in the gears, backlash problems, and costly mechanics. Besides this, it becomes easier to design a more flexible relationship between the axes. Using very soft and controlled movements, the stopping at the ends and the ramping of speed can be handled with a much higher degree of accuracy. Meanwhile, the bobbin that serves as the master axis turns the servo-motor encoder, which sends out pulses that are used to command the follower traverse axis. The traverse axis moves back and forth along the width, at a ratio to the bobbin rotation, utilizing an electronic camming curve. This coordinated motion enables the correct wrapping of the filaments as well as the preservation of the required limits. The themes identified in these types of equipment are presented in Figure 3. In addition, Table 1 presents the summary of machine requirements and the motion control requirements of the new monofilament winder.

Table 1: *General specification of machine and motion control*

Machine Requirements:	Motion Control Requirements:
• Controlled tension on monofilament	• 2 axes of coordinated motion
• Simple operator interface	• Linear interpolation
• High throughput	• Constant torque from the motor

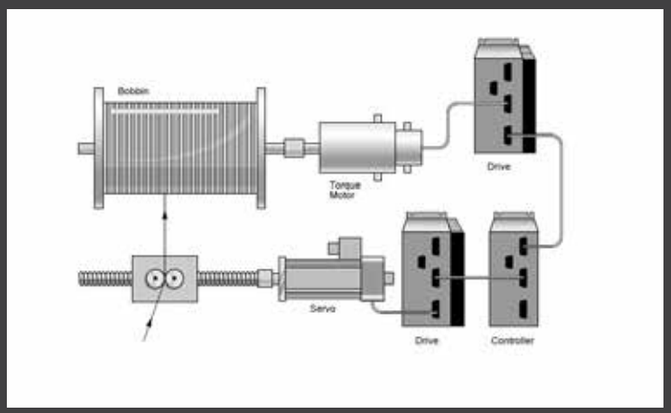

Figure 3: *Electronic gearing between the bobbin (Master) and the traverse (Slave) axis*

The operator can move the center offset using plus (+) and minus (-) buttons. The added offset value is used to calculate the new cam curve when the traverse comes to the center. A border stop angle parameter is used to stop the traverse, so as to wind a specified length of filament at the edges. This amount of filament helps to determine the edge quality of the bobbin.

The doffing from a 180/230 mm full bobbin to a 125 mm empty core is done automatically for all 12 ends at the same time. This is the most critical action during the winding. If any doff action is unsuccessful, all other ends break as well. The speed controller PID acts very rapidly with the help of the dancer feedback and recalculates the correct speed, so that the doffing will be successful.

Diameter Measuring System

The present study was designed to measure the diameter of yarn required to increase inline quality assurance for 12 ends. Thanks to the continuous monitoring of 6 ends in one device, Kordsa has achieved improvements in reliability. Firstly, we shall give a brief overview of the working principle of the Online Diameter Measuring System. The device is shown in Figure 4. The system is compact: a modular, single-plane diameter scanner with solid-state laser and telecentric precision optics. The laser and the optics are built in rugged housings (protection class IP 65) and guarantee high measuring accuracy, resolution and stability, while being insensitive to product positional instability. The table below illustrates some of the main properties of the device.

Table 2: *General specification of the diameter measuring system*

Specification	Value
Measuring field	60 mm
Minimum product diameter	0.10 mm
Scanning frequency	1000/s (option: 2000/s)
Scanning speed	157.7 m/s (option: 315.4 m/s)
Repeatability (± 3 sigma)	± 0.0003 mm

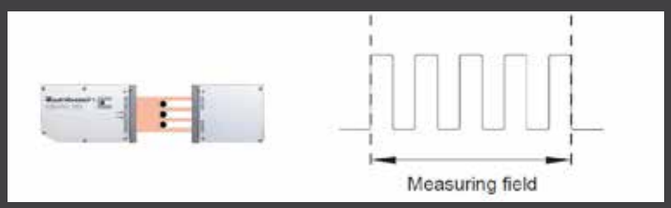

Figure 4: *Multiple measurement systems and the measuring field of the diameter*

OPC technology is a standard in the area of process control, such as SCADA or HMI. It defines a common interface for accessing the data of peripherals. The communication of the system is OPC UA-embedded and easily adaptable to all PLC and control systems. A software module is embedded into a supplied USYS (Data Acquisition / Data Processing and Display Systems (Processing Units) processor unit, in order to act as an interface between the Online Diameter Measuring System USYS Host protocol and a transfer to an industry-standard OPC UA protocol.

The measurement system operates with optical laser scanning technology. The laser beam generated by a semiconductor laser diode is deflected clockwise by the rotating mirror (scanner). The deflection mirror directs the ray into the emitter lens, from which it is sent to the measuring field as an absolute parallel beam. The receiver lens focuses the luminous beams onto photodiode by means of a deflection mirror. The photodiode does not receive any light when the laser beam is outside of the measuring field, or if there is a measured object in the path. The cast shadow is detected by the photodiode and converted into an electronic signal (analog video signal). After passing through a threshold comparator, the signal (now digitized) is sent through the line driver to the data acquisition system as video and chopper signals. The duration of the shadow cast by the object is measured by the data acquisition system, which converts it into a measured value. The data acquisition system watches for tolerances exceeded, carries out statistics, drives connected printers, controls processes and communicates with miscellaneous peripherals through interfaces. The themes identified in these types of equipment are presented in Figure 5.

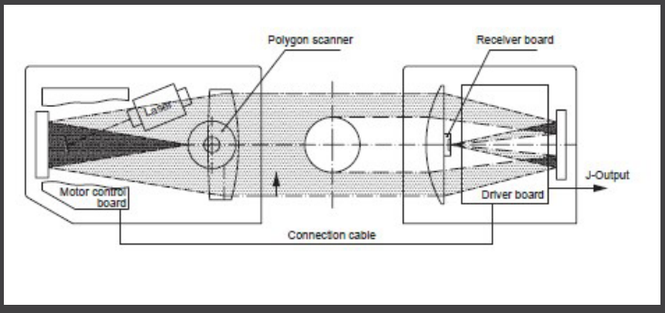

Figure 5: *Multiple measurement systems and the measuring field of the diameter*

Conclusion

Unique production techniques and equipment designs ensure the protection of new products and their intellectual properties. The monofilament line is one of the projects among many that show Kordsa is increasing her capability to design and develop not only her own processes but also the equipment needed for these processes. The increasing demand for new processes and products forces the R&D Global Engineering team to design and develop their own machinery. The decreasing dependence on equipment suppliers is also increasing Kordsa's bargaining power for better capital expenditure management. In this project, Kordsa acquired the technology of high-speed parallel winding. This can be applied to various product ranges in the form of single-end cord or fabric. The project also increased the capability to produce larger diameter filaments up to 1100 dtex and to boost the existing monofil production capacity. In addition, it included the opportunity to implement another visual inspection system for online quality monitoring; this fits in with Kordsa's general vision of maintaining its industry-leading quality.

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Drawing on its experience and know-how, Kordsa has started investing in automotive and industrial applications. Kordsa launched its woven based polypropylene and polyamide thermoplastic prepreg products as sheets with maximum dimensions of 1.2m x 1.2m.

Kordsa Successfully Produces Thermoplastic Prepregs

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Project Leader, Kordsa

Since 2015, Kordsa has been working on feasible thermoplastic prepreg production technology. The resin system used in thermoplastic prepreg can be applied in the form of powder, film or granules. Some of the commercially available resins are PP, PA6, PA6.6, PPS, PEI, and PEEK. Glass fiber is the primary reinforcing fiber for price-sensitive markets such as the automotive sector. When powder applications are used in thermoplastic prepreg production, homogenization problems arise in the distribution of resins. The high amount of waste occurring during production is also problematic. However, consistent and precise product quality is very important for customers and this is best provided by film application [1]. Kordsa performed experimental prepreg production trials with all the available technologies at different machine producers. Drawing on its experience and knowhow, Kordsa has started investing in automotive and industrial applications. Kordsa launched its woven based polypropylene and polyamide thermoplastic prepreg products as sheets with maximum dimensions of 1.2m x 1.2m. The resin systems were specially formulated by Kordsa.

The most important difference between thermoplastic and thermoset matrix systems is their thermal formability in terms of the reshapeability and recyclability of the thermoplastic matrix [2]. In contrast to thermoplastic materials, thermosets cure into the mold shape through thermal cross-linking, and they will not remelt after curing process [3]. Since thermoplastics do not crosslink like thermosets do, they conserve their thermal properties upon melting and reheating; subsequently, they do not degrade like thermosets unless the processing temperature is exceeded [4]. On the other hand, thermoset prepregs have enjoyed a long and glorious history in the aerospace and defense industries for more than four decades. However, there has been a growing interest in thermoplastic prepregs in the automotive, industrial, consumer goods, and sports and leisure sectors. This is due to their low cost, their lightweight and recyclable properties, and the ease of processing [5] [6].

The continuous fiber-reinforced thermoplastic prepreg market is expected to grow between 2018 and 2023 at a CAGR of 8.0% [7]. The usage of thermoplastic prepregs is currently very limited in the global prepreg market; however, the market is growing faster than the overall prepreg market. In the coming years, continued growth is expected, especially in the aerospace, defense and automotive sectors. Europe is expected to be the largest market for thermoplastic prepregs in the near future because of stringent regulations regarding fuel efficiency and carbon emissions, which are some of the key factors that are burgeoning the demand for thermoplastic prepregs. Bus bumpers, seat structures, fenders, TV tuners, front end carriers, battery cases, and underbody protection components are some of the automotive components made of thermoplastic-based continuous fiber-reinforced composites.

In thermoplastic prepreg production, reinforcing fibers such as glass and carbon fibers are completely impregnated with thermoplastic resin. Thermoplastic prepregs are used in composite part production through compression molding and over-molding production methods. In the compression molding method, thermoplastic composite parts are produced in a special press system which has heating and cooling capabilities. Compression molding is the most widespread process in the global thermoplastic prepreg market. In the over-molding method, the woven thermoplastic prepreg is heated and shaped in the mold and then back-injected with a thermoplastic matrix in granule form. It can be used to add ribs for extra stiffness. An over-molding process can be integrated into an injection molding operation and combined with almost all special manufacturing processes. This contributes to functional integration and allows a more complicated part design. Thanks to the highly automated over-molding production method, thermoplastic composites can be produced in short cycle times of under 1 minute, which obviously brings a competitive price advantage. In addition to this, thermoplastic prepregs have many advantages such as lightweight, high fracture toughness, high service temperature, no need for cold storage, and reprocessing and recycling potential.

The biggest problem of thermoplastic composites is that the resin cannot penetrate the reinforcing fibers easily because of its high melt viscosity at melting temperatures when compared to thermosetting resins. The use of a prepreg is the most popular solution in the manufacture of thermoplastic composite parts [8]. In thermoplastic prepreg production, pressure and temperature have the greatest effect on impregnation and void content, which are key parameters affecting the mechanical behavior of the composite part. However, high temperature and pressure cannot be applied to some thermoplastic polymers, since these process conditions may affect the degradation of polymers and/or distortion of reinforcing fibers. This causes a decrease in the mechanical properties. Moreover, when using a thermoplastic resin with low melt viscosity and low molecular weight in order to improve its impregnation property, the mechanical properties of the composite part are also reduced. In the case of using a resin with a high degree of crystallization and high molecular weight in order to improve the mechanical properties of a composite part, melt viscosity increases and the impregnation decreases. In other words, the formulation of the resin system is the most important part of thermoplastic composite production in terms of adjustment of viscosity and impregnation level [9]. Specific wetting agents are added to the resin to improve the quality of impregnation.

In order to be successful in the thermoplastic composite market, design capability is a must for low-cost production, and collaboration is the most important requirement for the project-based development. Raw material suppliers, intermediate material suppliers, part producers and OEMs should work together in order to realize optimal commercial projects. It is expected that this market will grow, with increased attention to mold design and greater experience in part production.

As of 2017, we have worked closely with Assan Hanil and Karel Kalıp teams to discuss the possibilities in terms of replacing metal to composite by evaluating parts regarding weight, annual production numbers, costs, alternative production techniques and client expectations. As a result of this knowledge sharing, we made a decision to create a joint project by bringing together the strategies and objectives of us. “Design and Development of Composite Seat Structure for Heavy Commercial Vehicle” became our first project, and there were several reasons behind this choice. Continuous Fiber Reinforced Composite Seat Structure is expected to be lightweight and produced in short cycle time, but at the same time is a structural part that is exposed to static and dynamic loads because of the safety belts. In the context of this project, Truck Driver Seat Backrest was produced by using glass woven based polypropylene thermoplastic prepregs in overmolding process.

Figure: *The prototype of composite seat structure*

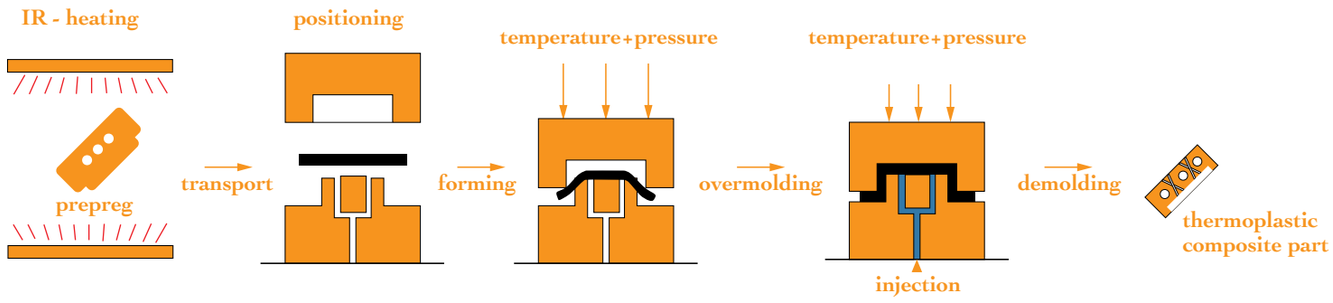

Figure: *Schematic representation of the overmoulding process*

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Design of Slab on Ground Concrete with Macro Synthetic Fiber

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İLHAN İZMİT

Yarn Production Group Manager - Kordsa

Synthetic macro fibers became available in the 1990s with applications such as slabs-on-ground, pavements, shotcrete, and some precast units. Synthetic macro fibers can be viable alternatives for full replacement of conventional steel bars in concrete elements with continuous support such as slabs-on-ground or shotcrete. They can provide crack resistance enhanced ductility, toughness, and durability. Macro synthetic fiber reinforcement conformity with the standard EN 14889-2 (Fibers - for use in concrete - Part 2: Polymer fibers - Definitions, specifications, and conformity). equivalent diameter› 0.3 mm are referred to as macro synthetic fiber.

Design Method
Yield Line Theory

Yield line theory considers formation of plastic hinges on ground and redistribution of moments. These plastic hinges formed enable displacement of elastic region while providing increase in positive bending strength. Plastic hinge formation is used in accurate determination of moment strength and ultimate bearing capacity status of ground. Plastic hinge formation is subject to toughness of stable and is determined by this value named toughness value Re3 (equivalent flexural ratio) being Re3≥%30. (ACI 360R-10, TR 34)

Experimental Study
Concrete design: Macro Synthetic Fiber

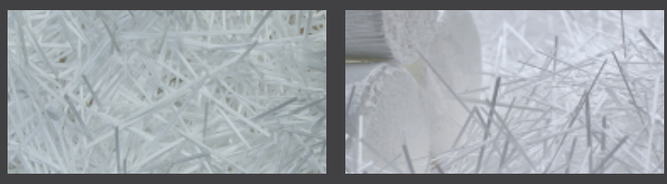


Figure 1: *: Kratos PP 54 / Macro Synthetic Fiber Reinforced*

Table 1: *Concrete Mixture Values*

Concrete Mixture Values	1 m³ concrete, kg/m³
Water	145
Cement	290
Coarse Aggregate	1008.8
Fine Aggregate	984.5
Super Plasticizer	2.9 (1%)
Kratos PP 54	3

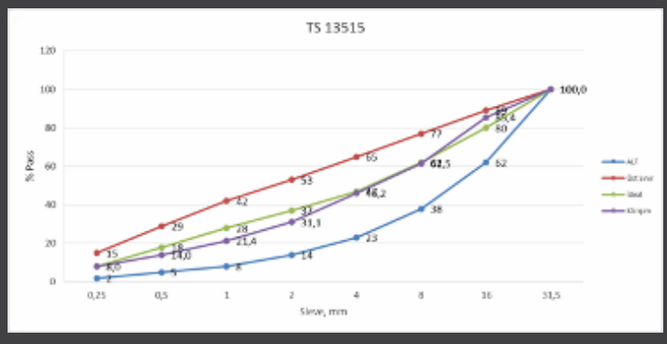


Figure 2: *Aggregate Sieve Analysis - (TS 13515)*

Table 2: *Kratos PP 54 Technical Specifications*

Length	54 mm
Equivalent diameter	0.72 mm
Tensile Stress	550 Mpa
Modulus of Elasticity	8.5 Gpa

ASTM C 1609 Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam with Third-Point Loading)

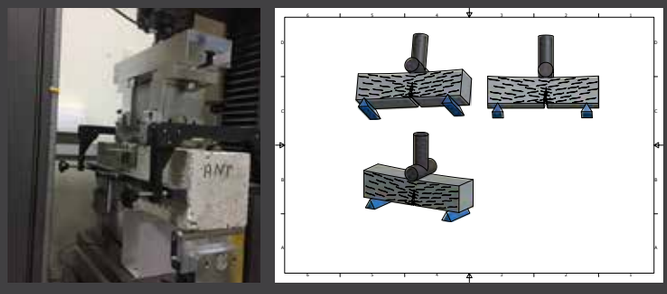


Figure 3: *ASTM C 1609 Test Equipment*

Bending experiments are performed on manufactured samples (3 pcs 15*15*50 cm) according to ASTM C1609 Standard. In the experiment performed, prisms are turned on side and their concrete surfaces contacting concrete forms are placed freely on two steel supports. Effective span is used as 450 mm in the experiment. Two equal loads are applied on upper surface of the prism at a distance of 1/3 of the effective span. Deflection in the middle point of the sample is measured by LVDT placed in the middle point. The subject experiment is performed in closed circuit displacement-controlled experiment machine. All experiments are performed on 28-day

samples and each experiment is performed on three samples. Load - deflection curves are obtained with a loading speed applied to form up to L/900 (0.5 mm) 0.018 mm/min, L/900-L/150 (0.5 mm- 3 mm) deflection gap of 0.12 mm/min. Obtained load – deflection curves are given.

Table 3: *Test Results*

Macro Synthetic Fiber	Peak Load (first crack load) (kN)	Peak Strength (MPa)	Peak Load Displacement (mm)	Max. Peak Load Strength (MPa)	Residual Strength (L/600= 0.75 mm for deflection) (MPa)	Residual Load (3 mm for deflection)(kN)	Residual Strength (L/450=3 mm for deflection) (MPa)	Toughness (3 mm for deflection) (joule)	Re3 (Average equivalentflexural strength ratio)
Kratos PP54 3 kg/m³	36.01	4.80	0.05	4.80	2.07	15.51	2.07	48	45

Fiber Type	Dosage kg/m³	Sample Dimension	Compressive Strength (Mpa)	Average
Kratos PP 54	3	15*15*15	42,26	41,82
			42,01	
			41,20	

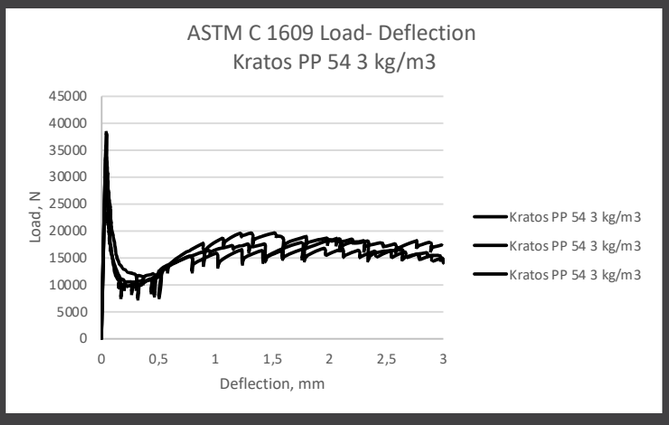


Figure 4: *3 kg/m³ Kratos PP 54 Macro Synthetic Fiber - ASTM C 1609 Load - Displacement Graphic*

Slab on Ground Concrete Design (according to TR 34)
Considered Parameters

Slab Thickness	200 mm, h
Modulus of Subgrade Reaction	0.03 N/mm³, k
Concrete Class	C30/37, Mpa
Wheel Load	60 kN
Wheel Contact Area	500,250 mm,mm
Equivalent Flexural Ratio, R_{e3}	45% (Kratos PP 54 3 kg/m³)

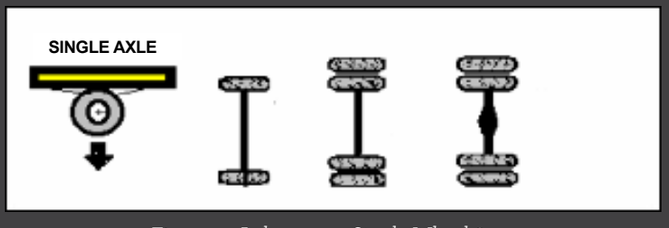


Figure 5: *Axle 12 tons, Single Wheel 6 ton*

Point Load Combination is Calculated

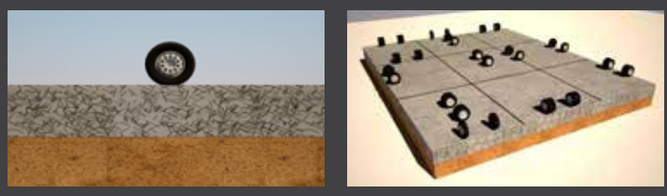


Figure 6: *Wheel Load*

Average Axial Tensile Strength of Concrete fctm = 2.90 Mpa

Characteristic Axial Tensile Strength of Concrete (5% fctk (005) = 2.03 Mpa

Flexural Tensile Strength in Bending of Plain Concrete fctk, fl = 4.06 Mpa

Average Compressive Strength of Concrete (cylinder) fcm = 38.00 Mpa

Modulus of Elasticity of Concrete Ecm = 32.84 GPa

Radius of Relative Stiffness (l) = 933.72 mm

Positive Moment Capacity of Slab Mp = 8.11 kNm (Mn*Re3) Kratos PP 54

Negative Moment Capacity of Slab Mn = 18.02 kNm (fctk,l*h^2/6)

Point Load Control

Wheel Load = 60 kN

Material Safety Factor = 1.6

Contact Area A = 500 mm

Contact Area B = 250 mm

Contact Area radius a = 199.47 mm

a / l = 0.21

Slab Internal Capacity = 366.48 kN

Slab Edge Capacity = 186.79 kN

Internal Load Control Pu > gamaf * P = 366.48 > 96.00 --- OK

Edge Load Control Pu > 0.8 * gamaf * P = 186.79 > 76.80 --- OK

Punching Control Face of the Loaded Area Vp= 0.51 MPa

Vp <= Vmax = 0.51 < 5.28 (VMAX) --- OK

Check for Punching

Length of The Perimeter at The Face of The Loaded Area

Internal = 1,500.00 mm

Edge = 1,250.00 mm

Length of The Perimeter at a Distance 2d From the Loaded Area (2d distance d = 0.75* slab thickness)

Internal = 3,384.96 mm

Edge= 2,192.48 mm

Punching Check at The Face of The Loaded Area

Internal 1,188.00 kN > 96.00 kN --- OK

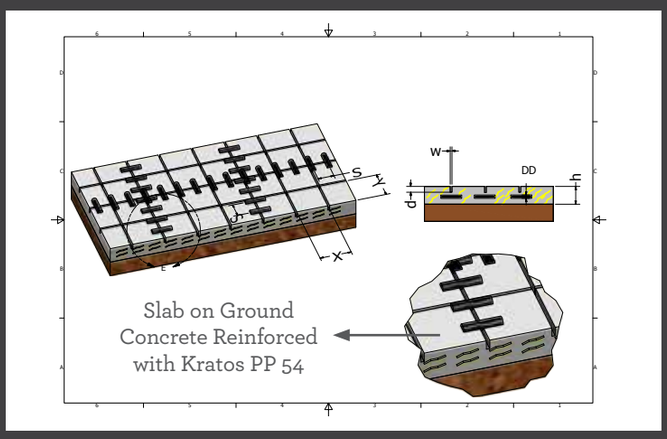
Edge = 990.00 kN > 76.80 kN --- OK

Punching Check at The Critical Punching Perimeter

Internal 275.31 kN > 96.00 kN --- OK

Edge 178.32 kN > 76.80 kN --- OK

Joint Cut and Details



Joint Cut Dimensions: Maximum 30 times of the Concrete Slab thickness, X-Y

Joint Cut Width: 3-4 mm, w

Joint Cut Depth: 25% of slab thickness, d

Joint Cut Time: After pouring concrete, it should be made generally 24 hours later (concrete should be strong enough to avoid damage in cut strips)

Dowel Length, Diameter and Spacing: 450 mm length, with 25 mm diameter, with 300 mm spacing (ACI 302.1R), DD-S

Joint Cut	6m*6m
Joint Cut Width	3-4 mm
Joint Cut Depth	50 mm
Dowel Diameter/Spacing and Length	25ø/300 – 450 mm length

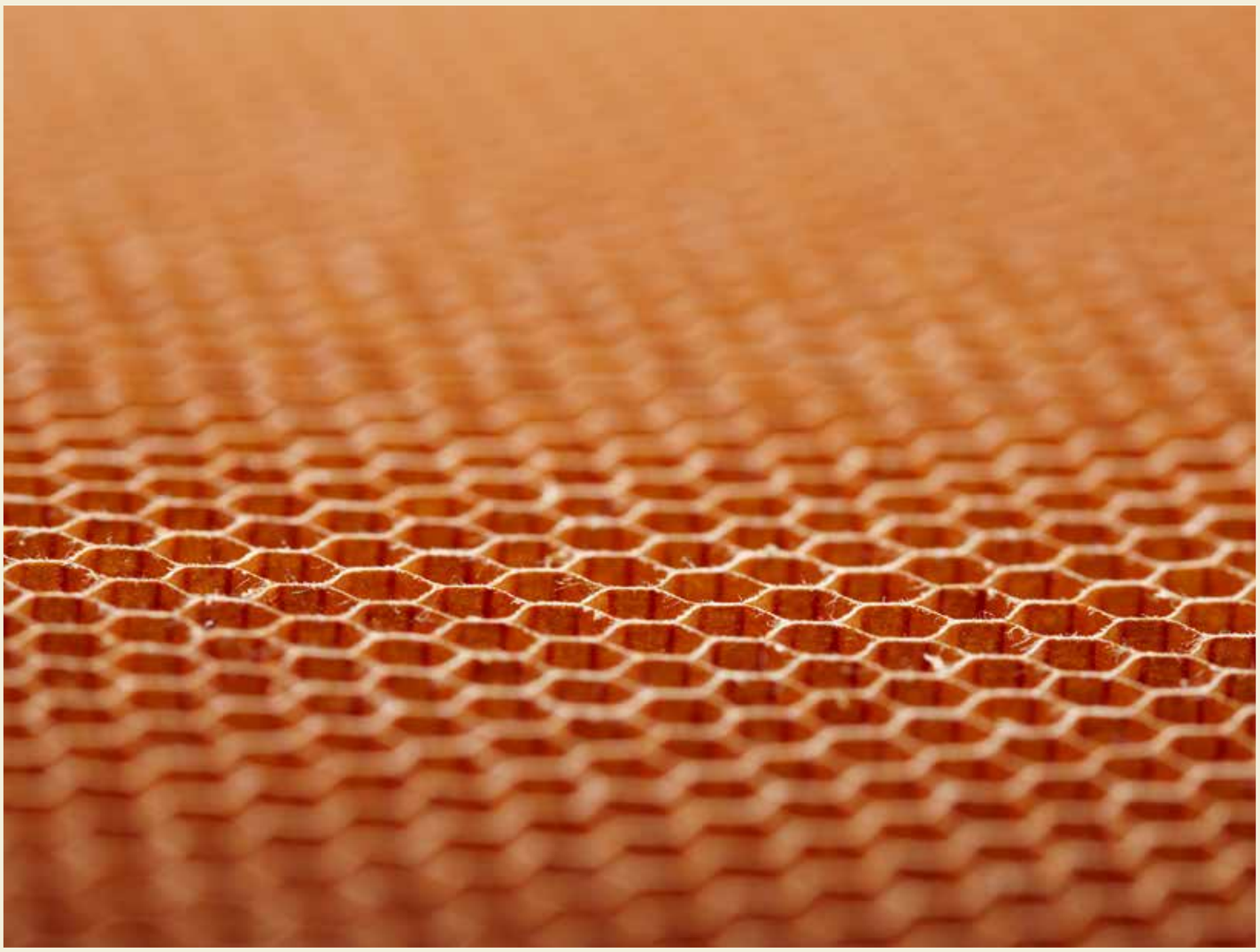
Hypothesis/Design Criteria	
k, Modulus of Subgrade Reaction, N mm^3	0.03
Concrete Compressive Strength, fck, MPa	30
Positive Moment Capacity, Mp kNm/m	8.11
Negative Moment Capacity, Mn kNm/m	18.02
Solution with Kratos®	
Slab Thickness, mm	200
Dosage, kg/m3	3
Fiber Type	54 mm (Kratos PP 54)
Re3 (Equivalent Flexural Ratio)	0.45

When solution for Wheel load 60 kN is made according to the project information given above, for 200 mm slab thickness, 3 kg/m^3 Kratos PP 54 Macro Synthetic Fiber product enabled required load and moment capacity and observed that it can be viable alternatives for full replacement of steel bars.

REFERENCES

- ASTM C 1609: Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading)
- TR 34: Technical Report No. 34, A guide to Design and Construction
- ACI 544.4R-18: Guide to Design with Fiber-Reinforced Concrete
- ACI 360R-10: Guide to Design of Slabs-on Ground
- ACI 302.1R: Guide for Concrete Floor and Slab Construction

The competition requires continuous improvements in cost and innovating solutions.



Which Bee Stung Us? From the Observation of Bees to its Application in Industry

DENIS GRANGER

Head of Sales, Europe - Kordsa

It was by analyzing the core of bees that mathematicians concluded that the shape of the hexagon enables the least material consumption for the best mechanical performance. Thus, combining a geometrical shape that entailed minimal consumption with a lightweight, mechanically efficient material, the sector was able to develop a solution that could bring inertia to such constructions.

Inventors have created multiple technologies that exploit this design, including aluminum foil, extruded plastic, and so on, but what interests us is the Honeycomb core made from aramid paper (Nomex® or Kevlar®) developed by DuPont and used in advanced composites. In addition to boasting an excellent mechanical performance and being light, this Honeycomb has outstanding fire-resistant properties, it is a non-electric conductor, and it absorbs acoustic waves. By thus, it is found everywhere in airplanes, whether in the wings, the engine nacelles, the freight compartments, the cabin interior, the galleys or the lavatories. The specific product used is either the core machine at the right geometry, or the sandwich panel made of Honeycomb and pre-impregnated skins.

(See the article by Fatih Oz, PhD in the 10th issue of The Reinforcer magazine.)

How is the Market for the Aramid Honeycomb Core?

In 2018, the global market for the product Aramid Honeycomb core for use in aerospace and defense was $770Mio, with a CAGR of 2.5% over 10 years (1). The product is also used in other fields, such as marine, wind, etc., but in smaller proportions. Aircraft manufacturers Airbus and Boeing together account for about 80% of the commercial aircraft sector's consumption, with the remainder mainly dominated by Embraer and Gulfstream (1).

The major core suppliers are Hexcel (USA), Euro-Composites (LU), Gill Corporation (USA) and Plascore (USA). They all produce in both the mainland USA and Europe.

To enter this market, it normally takes considerably time. It can take several years for organizations to complete the required certification steps and to acquire qualifications for its methods and products. This is an investment. In order to maintain long-term relationships, producers also need to be located close to their customers, so as to be reactive and to keep transport costs low. 95% of the volume of Honeycomb core is made up of air. The competition requires continuous improvements in cost and innovating solutions

In 2018, the Honeycomb market in China was worth $136Mio (1). However, local production is struggling to grow, and only the products of the company ACC are being considered by local aircraft manufacturer Avic. To benefit from know-how, in 2014 the Chinese company Comac acquired the Austrian FACC. To date, the Chinese market has been dominated by well-established global material and parts subcontractors who create JVs locally.

Large-scale introduction of the Aramid Honeycomb was for the Boeing 747, as early as 1969. This material is an old product which remains irreplaceable for the time being. Hexcel broke new ground by introducing acoustic membranes under the name "Acousti Cap"; Euro Composite has grown in the value chain, offering machined parts and sandwich panels, as well as manufacturing fully-finished segments such as galleys.

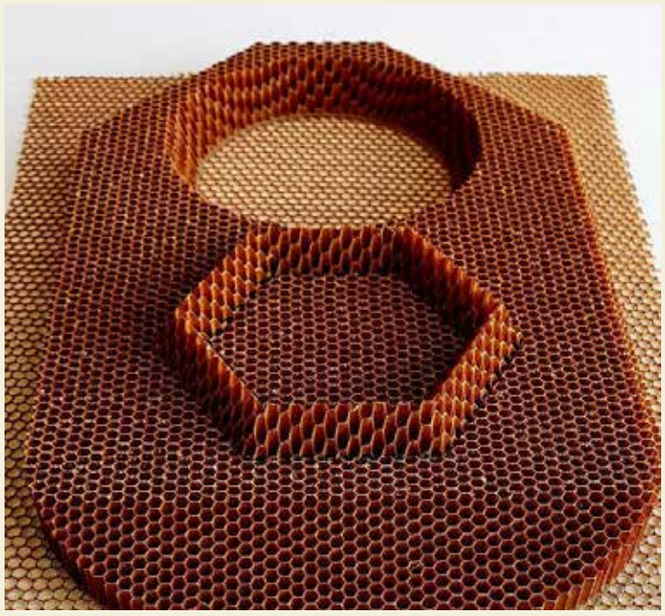
The New Player: Advanced Honeycomb Technologies

Kordsa's affiliate, Advanced Honeycomb Technologies, possesses an important asset that can be the key to impressive growth. The formulated phenolic resin is aqueous, reinforcing health, safety and having environmental minimum impact. The risk of fire and explosion during the curing cycle of the water-based resin is significantly lower than for those resins formulated with flammable solvents. It reduces exposure of volatile organic compounds (VOC's) in the workplace, which is a clear health priority. Within the same approach, our array of sandwich panels proposes low FST/OSU-HR Epoxy Prepreg from Kordsa's affiliate, Axiom Materials range, to replace the standard phenolic prepreg.

Major Aircraft makers and Tier 1 suppliers recognize our ability to develop quickly and efficiently with the help of our CTCE R&D teams, laboratories and development facilities. Our agility is our strength. We are fast, and our requirements with respect to Minimum Order Quantities (MOQ) are very acceptable. We are investing in the certifications and qualifications required by our customers in Europe, and we will probably be boosted by the fact that we will be producing close to them in Europe.

The challenge is exciting and in the hands of the Reinforcers.

(1) Source Counterpoint



Digital transformation is no easy task; the opposite is actually the case. In order to make this a more seamless transition, we have to apply a new kind of inter-company relationship, where we carefully listen to our clients and co-create personalized solutions, delivering the best possible results.

Digital Transformation

JAASIEL LOGAN DOS SANTOS DE CARVALHO

IT Analyst - Kordsa Brasil

Regardless of the industry, digital transformation is inevitable. It is a process that can't be avoided if an organization intends to be relevant and produce value.

When we talk about digital technology, we´re led to think of a means that allows us to take things and make them virtual. Historically, we´ve already taken many activities which used to be done by real people with pens and paper in offices and transformed them into things that happen in a virtual world. Alternatively, we could also call this the process of virtualization.

The process of digital transformation is having a huge impact on society, since it has been changing the fundamentals of human lives. Take, for instance, the nature of how people work; it has been completely reconfigured from the model we were familiar with before the industrial revolution.

All things considered, you might ask: what does all this mean for industries and companies? A short answer would be a fundamental transformation of the basic mode of operation. It completely changes the way the game is played. If a company wants to keep or create a competitive advantage, it must understand that what it has is probably temporary. Thus, there has to be an inner change, otherwise the company won´t survive. In times of rapid and constantly accelerating changes, inertia is the gravest mistake of all.

The human factor

Not only that— businesses and processes are important, but there´s a major factor we should consider when talking about changes: the human factor. Changes have been happening in such a fundamental manner that we could say we are undergoing a mutation, not only a transformation. As the key to such a shift, people are crucial. A while ago, Kordsa Brazil realized that to innovate and go far beyond we first had to change our inner culture, bringing people together to give their best through our widespread principles and clear purpose, so all of us can work as one to deliver value to our customers. Because we believe that people are the driving force for our present and future success, we will keep focusing on developing our teams so they can acquire new multidisciplinary skills like critical thinking and problem solving, consequently opening doors to diverse points of view and bringing an increasingly innovative mindset to our site.

Ready for the challenge?

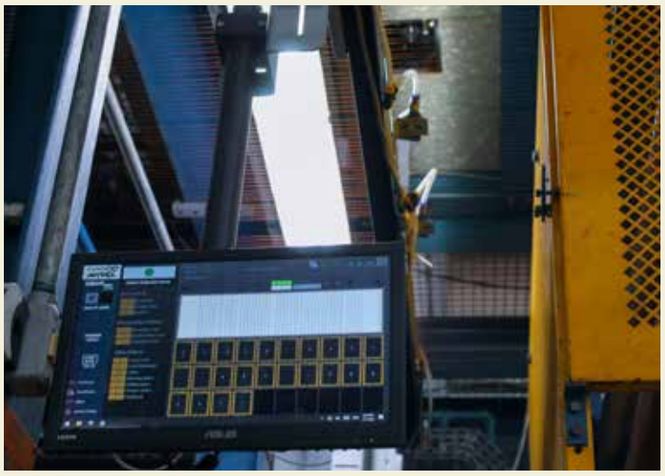
Digital transformation is no easy task; the opposite is actually the case. In order to make this a more seamless transition, we have to apply a new kind of inter-company relationship, where we carefully listen to our clients and co-create personalized solutions, delivering the best possible results. Besides that, we're constantly reassessing our internal needs, so that we can identify some of the major roadblocks we need to overcome in order to transform digitally. We're forever alert to the potential of innovation and to how we, as a company, can make digital transformation happen, being on top of the great changes due to occur and positioning ourselves as takers of opportunities when they become available.

What is going on in Kordsa Brazil?

With this is mind, we at Kordsa have been working to elaborate a digital assessment, respecting the individual needs of each site and the particular infrastructure and workforce available for the implementation of projects. One of the actions we´ve taken that turned out to be very effective was to visit our four main productive areas and listen to their voices, surveying people involved in a total of 57 projects. From there, we were able to start mapping work that helped us identify which fields they were related with and to undertake a prioritizing effort, mainly considering the impact on business. We also adopted a strategy of differentiating between short-, mid- and long-term projects, defining which ones could bring more and faster improvements to our sites based on our "behind the borders" visits to customers' plants. We were able to examine production efficiency and focus on the well-being of operators, so we can decrease the need for certain types of manual labor, for example, giving employees more time and power to think and work on improvements for our processes and products.

This way, we had the chance to focus on a few select themes that could potentially bring the biggest benefits. These included Data Science, which is the process of using a blend of tools applied to data to obtain meaningful insights; Process Automation, so we can diminish the amount of repetitive activities performed by

humans through the use of Robotic Process Automation (RPA); and Autonomous Robots, which will collaborate and contribute to a more effective production process. Another key theme was the Industrial Internet of Things (IIOT), a network of intelligent computers, devices and machines connected to each other and constantly generating data that can later be used, for example, to provide autonomous quality assurance or to facilitate visual inspection system projects in all of our four production areas. We could also implement real-time predictive maintenance in our machines and improve environmental and labor safety.



Everything connected to everything

Machines have a common denominator: all of them have the potential to generate a great amount of data. Gartner/IDC estimates that, by 2021, as many as 25 billion devices will be connected in the Industrial Internet of Things (IIoT), generating approximately 34 zettabytes (34 trillion gigabytes) of data. The most important thing, though, is what we're able to do with all this data. What matters is how we'll able to see what's within this large data volume and how we can prepare our company so that it doesn't lag behind the race to deliver superior benefits to our clients, at the same time as we develop competitive and personalized solutions.

The usage of data insights to manage or completely change a business is becoming the rule rather than the exception. To overcome what some specialists call data blindness, a company must embrace data culture, making people understand why there´s so much interest in it and what it means for the entire corporation. Moreover, data by itself can´t perform miracles; in its entirety, it can be complex, and most of the time it is unstructured while at other times deceiving. In order to arrive at meaningful insights, the right questions have to be asked and people have to stay focused on problem-solving, taking data analysis as a complementary tool to discover useful information and support decision-making.

Robots: Reshaping how things are done

The automation of industrial manufacturing is a very familiar action taken by businesses to enhance production processes, eliminating tiresome manual activities while boosting production. In Kordsa Brazil, we are undertaking this automation on two different fronts: logical and physical. On the logical side we have a piece of software, involving items widely known as bots, which are capable of automating rules-based and repetitive tasks performed by humans on legacy systems. This Robotic Process Automation (RPA) can potentially minimize errors and maximize productivity due to its autonomous nature, being the fastest-growing segment of the global enterprise software market, with (according to Gartner, Inc.) an estimated adoption rate of 40% in large enterprises.

On the physical side, we have just finished implementing one of our most eagerly awaited projects. As part of our short-term strategy, we're deploying a 2.5m robotic arm that is going to be setting up our machines with 10kg yarn bobbins in one of our production areas. This activity used to be performed manually by operators, taking much longer and, even worse, causing injuries due to a series of potentially non-ergonomic positions.

In the medium term, we're planning on developing specialized solutions through custom software. This way we will be able to get rid of production errors and to minimize the need for reworking. Lastly, for the long term, we aim to expand such solutions both internally and beyond our walls, so that we can bring more sophisticated solutions to our site, so we can keep up with our digital transformation process.

Kordsa Brazil is mature in the way it conducts its operations, making use of processes and procedures that have changed over time in order to keep ourselves healthy and competitive. We do know that we have a lot of room for continuous improvement and various opportunities for game-changing differentiations. But we also know that, now more than ever, we have to keep both eyes on our customers' needs, so we can be ahead of the changes when they happen, and they will.

In short, all the effort and investments in these and other near-future projects are our way of moving towards our goal of deploying technology for the purpose of sustainability.

Process-Induced Residual Stresses In Polymer Composites

DR. FATİH ERTUĞRUL ÖZ

Project Leader - Kordsa

1. Introduction

This article presents process-induced residual stresses and their distorting effects in the manufacture of thermosetting polymer composites. It shows the effect of the different properties of constituents, how they develop during the cure cycle, and how they cause cure shrinkage that results in residual stresses at the micro level and manufacturing distortions at the macro level.

2. Different thermomechanical properties

Advanced composite materials for structural applications make use of high performance fiber reinforcements such as the carbon fibers in thermosetting polymer matrix materials. Both have different mechanical and thermal characteristics. A comparison of the physical properties of a type of carbon fibre with those of an epoxy matrix is given in Table 1.

As the table indicates, the elastic modulus of carbon fibre is almost 60 times higher than that of epoxy. In addition to this, carbon fibre is an othotropic material, whose mechanical properties are not the same in all directions. A similar situation applies to thermal expansion coefficients. Moreover, the thermal expansion coefficient of carbon fibre is negative in a longitudinal direction. This means that, when exposed to a temperature gradient, carbon fibre behaves the opposite way to epoxy.

Mismatch in thermal expansion coefficients is the most important factor behind thermal residual stresses throughout the cure cycle.

Table 1: *Physical properties of carbon fibre, epoxy resin, and their composition.*

	Carbon Fibre	Epoxy Resin	Composite Material	
Density	1.8	1.2	1.5	g/cm^3
Elastic modulus in longitudinal direction	230	4	140	GPa
Elastic modulus in transverse direction	20	4	7	GPa
Thermal expansion coefficient in longitudinal direction	-1	60	0.2	10-6/°C
Thermal expansion coefficient in transverse direction	7	60	35	10-6/°C

3. Cure Cycle Of Composite Materials

Advanced composite products are manufactured through the consolidation of pre-resin impregnated fibres (prepregs) in autoclave. This consolidation is achieved through applying high temperature and pressure. During cure development, the resin undergoes various changes. An example of the cure cycle of an epoxy resin is shown in Figure 1. It can be summarized as follows [1, 2]:

- The blue lines represent the applied temperature, while the red markers show the development of the elastic modulus of the resin throughout the cure cycle.

- The elastic modulus is initially zero. Then it starts to develop when the temperature reaches the gelation point, which is on the second ramp.

- When the temperature reaches glass transition temperature during the second plateau, the rubber-like resin starts to turn into a solid material.

- Finally, at the end of the cooldown, the resin reaches its elastic modulus value in Table 1.

Figure 2 shows the through-the-thickness cure shrinkage of the unidirectional (UD) laminates throughout the cure cycle. Figure 2 can be summarized as follow [1, 2]:

- Prepregs experience thermal expansion and shrinkage during the first step (heating up to the first plateau) and the last step (cooldown) respectively.

- Consolidation becomes dominant during the first plateau, and the resin starts to shrink non-linearly.

- Then, thermal expansion competes with cure shrinkage during the second ramp.

- The resin expands until the gel point, after which cure shrinkage overtakes thermal expansion. Finally, consolidation occurs as a result of thermal shrinkage during cooldown to room temperature.

The aforementioned mechanisms throughout the cure cycle result in residual stresses and give rise to manufacturing distortions at the end of the cure cycle.

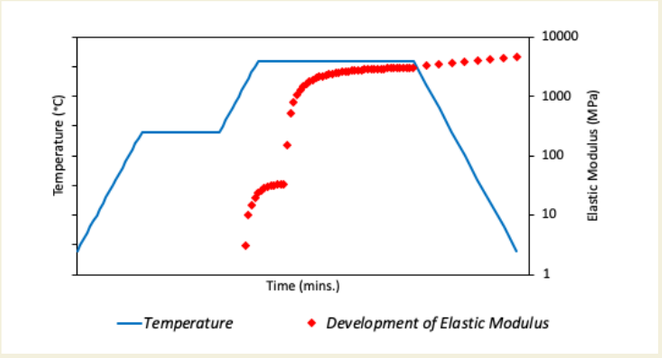


Figure 1: *Development of elastic modulus of resin throughout cure cycle [2]*

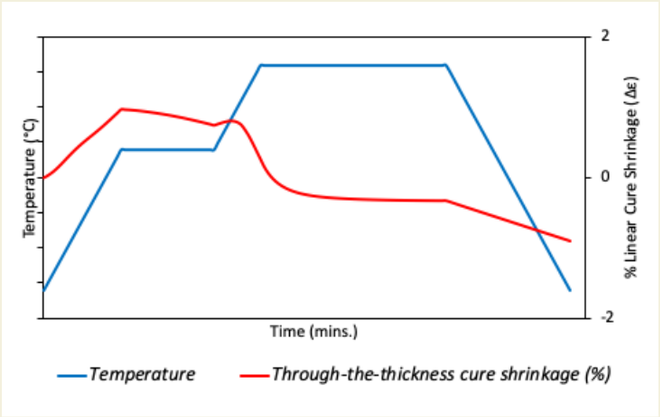


Figure 2: *Cure shrinkage of different composite laminates. [2]*

3. Development Of Residual Stresses In Composite Materials

Residual stresses are the stresses that remain in a material or structure after the source of these stresses has been removed. They can be caused by the application of external mechanical or thermal loads. While the former can be due to plastic deformations, the latter can be due to thermal gradients in a high temperature process.

Residual stresses in composites are classified into two categories: micro- and macro-residual stresses. Micro-residual stresses develop at the level of the constituents due to the difference in the thermal expansion coefficients and the cure shrinkage of resin, which may have an adverse effect on the mechanical properties of the final product due to fiber-matrix debonding. On the other hand, macro-residual stresses occur due to the interaction between plies and the mold material. They take place in the laminate and result in shape distortions after manufacturing.

A numerical, finite-elements model was developed to calculate the process-induced micro-residual stresses in carbon fibre-reinforced epoxy composite material [2]. The geometry of the model is a simple representative volume element, in which the fibers are distributed inside the resin in a hexagonal array, as shown in Figure 3. The circular regions in Figure 3 represent fibers and the remaining parts in the rectangle represent epoxy resin. The constant mechanical properties in Table 1 stand for carbon fibre, whereas the developing elastic properties in Figure 1 are associated with the epoxy resin. In addition to this, the model incorporates linear expansion/shrinkage variation throughout the cure cycle shown in Figure 2.

Since the strain variation in Figure 2 occurs as a result of chemical reactions and thermal gradients, residual stresses accumulate throughout the cure cycle and remain within the fibres and matrix at the end. Figure 4.a shows that there are tension (67.74 MPa) residual stresses in the matrix and compressive (-47.5 MPa) residual stresses in the resin. When a detailed examination is carried out in Figure 4.b of the resin, the regions where the fibres are closest to each other appear to display the lowest stress, whereas the fibre resin intersection regions, in which the fibres are furthest from each other, exhibit the highest tension residual stresses. This indicates that fibre/matrix debonding will be initiated from this region when a part is exposed to subsequent loading. The compressive and tension residual stresses in the fibres and resin are balanced with respect to the fibre volume fraction (59%) of this composite material at the micro level, as shown below:

$$67.74 \cdot (1-0.59) - 47.5 \cdot 0.59 = 0 \quad (1)$$

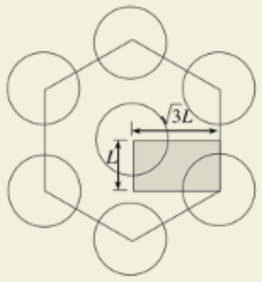


Figure 3: *Geometry of representative volume element*

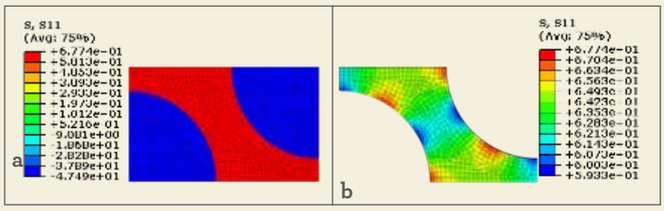


Figure 4: *a. Distribution of process-induced residual stresses in composite, b. Distribution of tensile residual stresses in resin, at the end of cure cycle [2].*

When UD prepregs are laminated and laid onto a mold, mechanisms due to tool-part interactions are activated, and this brings about macro-level residual stresses which lead to distortions in parts. They can be seen in a U-shape mold, as in Figure 5. The mechanisms causing these distortions can be summarized as follows [3]:

- When the tool and part are forced together through autoclave pressure and subjected to an increase in temperature, a shear interaction occurs between the tool and the part due to the fact that the metal and the composite have different thermal expansion coefficients.

- As this occurs prior to any significant degree of resin modulus development, the laminate modulus is very low and plies that are distant from the tooling are not loaded to the same extent as those close to the mold.

- This non-uniform stress distribution is locked in as the resin cures, and once the tooling is withdrawn.

- The resulting bending forces the part to fold away.

A macro-scale finite element model was developed to simulate the curing of 4-plies UD laminate on a U-shaped mold to see the resulting distortions at the end of the cure cycle [3]. The cure shrinkage and elastic moduli developments in Figure 1 and Figure 2 were applied to this model. The predicted manufacturing distortions at the end of a U-shaped part's cure cycle are presented in Figure 6. The resulting spring-in is evident. The magnitude of distortions is around 3 mm from both ends of the molds. The actual measurements of the manufacturing distortions of a real U-shaped part at the end of the cure cycle can be seen in Figure 7. The measurements are very close to the predicted values. Residual stresses always form in the composites and cause distortion. However, they should be considered during the design phase of the parts and the shape of the molds should be designed with an eye to the desired final shape of the products at the end of the cure cycles.

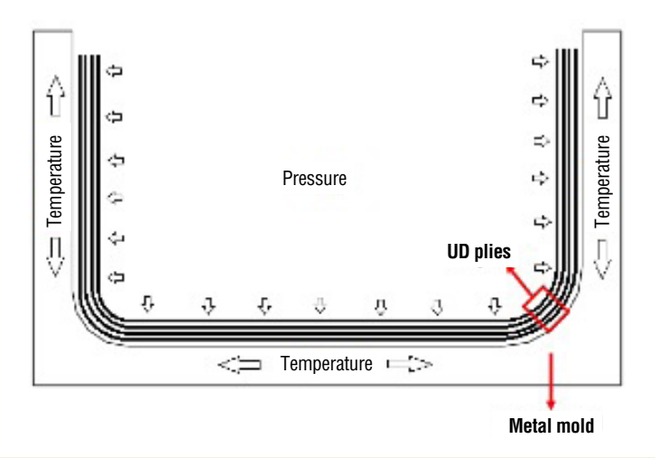


Figure 5: Prepreg layups on a U-shape mold [3].

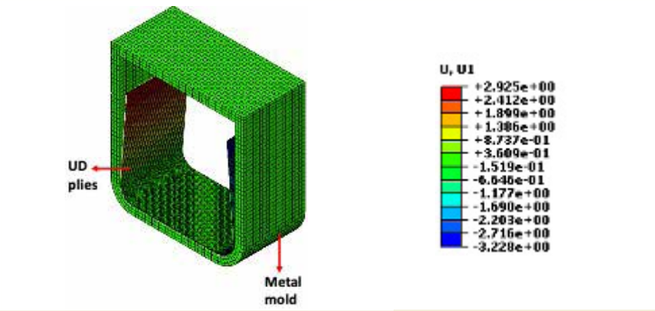


Figure 6: Finite elements predictions of manufacturing deformations at the end of the cure cycle [3].

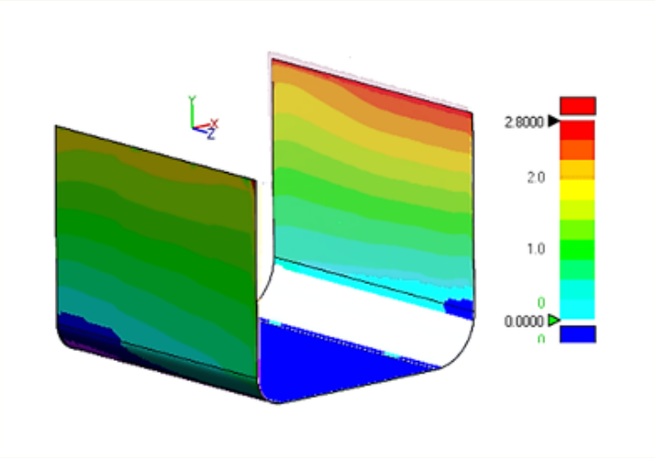


Figure 7: Measurement of manufacturing deformations at the end of the cure cycle [3].

4. Conclusion

The manufacturing of composite materials is a high temperature process in which two constituents with different mechanical behaviours are processed together. This mismatch is an inevitable attribute of composite materials and gives rise to different mechanisms throughout the cure cycle, causing the formation of residual stresses and shape distortions in final products. Process-induced residual stresses in composite materials are unavoidable, but they should be taken into consideration in both the design and manufacturing process in order to meet the twin requirements of dimensional accuracy and good property performance.

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A Novel Approach towards the Circular Economy of Plastics

ISOPREP: Ionic Solvent-based Recycling of Polypropylene Products

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Strong, lightweight, versatile, low cost and moldable, plastics have become an integral part of our lives. They are used in the production of thousands of different products such as packaging materials, textiles, and household appliances that bring convenience, comfort, and safety to our everyday lives. Additionally they enable technological innovations, especially in the medical, building, automotive and aerospace sectors, leading to new solutions and improvements. Plastics production ramped up from 1.5 million tonnes in 1945 to over 360 million tonnes in 2019. However, the remarkable rise in the use of plastics has coincided with an equally dramatic rise in environmental pollution problems [1].

Approximately 8.3 billion metric tons of plastics have been produced worldwide since 1950, less than 20% of which have been recycled or incinerated, leaving about 80% to accumulate in the environment. The million tonnes of plastic litter that end up in the landfills and oceans are the most visible signs of the environmental problems caused by plastics, which have also triggered growing public concern. Given these environmental problems and the ever increasing demand for plastics, there is an urgent need for new innovative recycling methods that will not only help protect the environment by eliminating waste and reducing greenhouse gas emissions and dependence on fossil fuels but also contribute to the circular economy by upcycling and by maximizing the value of recycled materials [2,3].

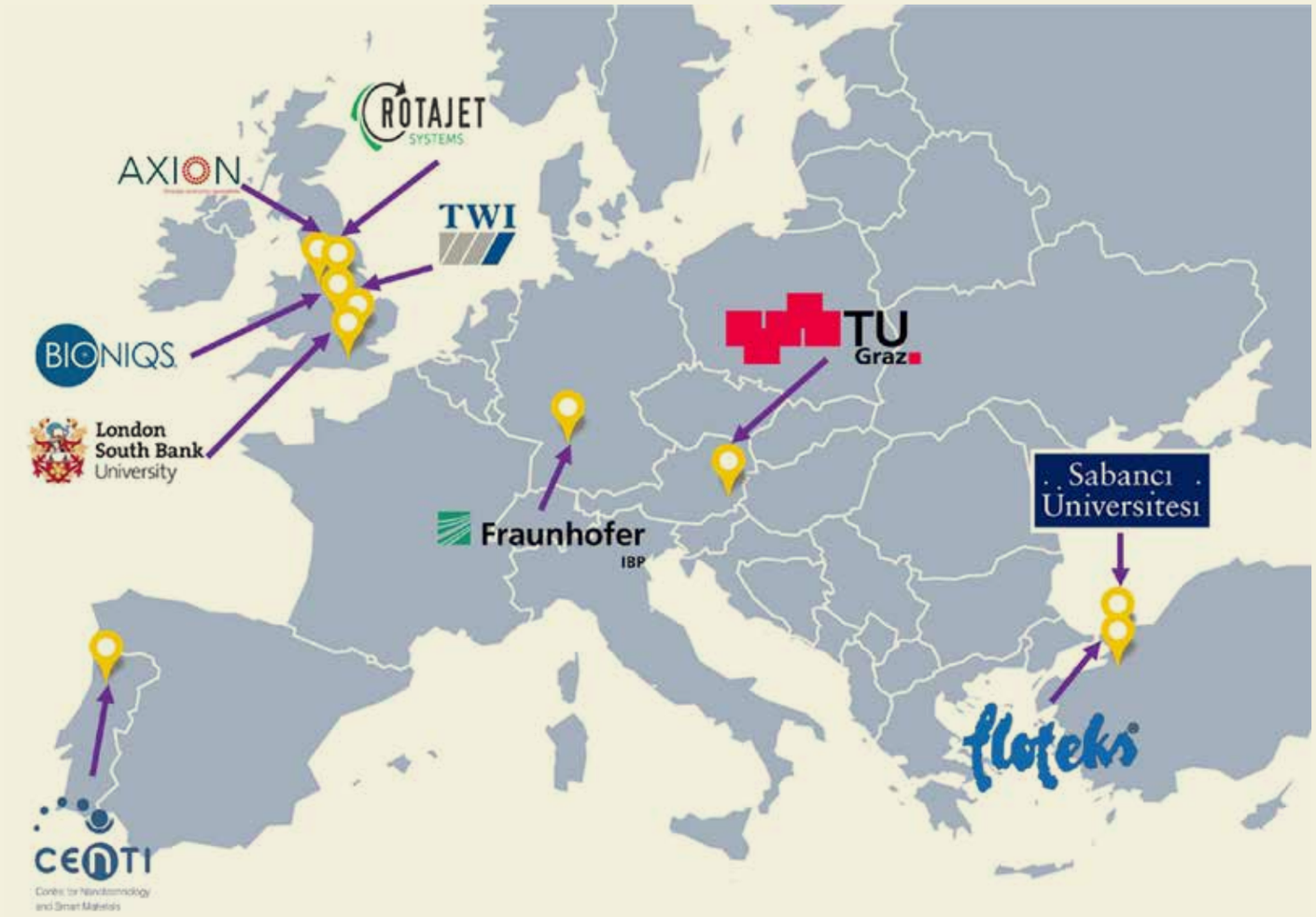
Figure 1: *The concept of the ISOPREP project.*

The ISOPREP project, the concept of which is shown in Figure 1, has officially joined the fight against plastic pollution, with a green solvent-based chemical recycling technology intended to recover virgin quality polypropylene from end-of-life polypropylene (PP) products.

PP, with a global market expected to reach $133 billion/year by 2023, is the second most used commodity polymer after polyethylene. As only 1% of PP is currently being recycled, it is one of the main factors in environmental pollution. A notable source of PP waste arises from used carpets, which make up 17.6% of the PP product market. In the UK alone, approximately 400,000 tons of waste carpet are generated each year, 66% of which ends up in land fill and takes 20-30 years to completely decompose in a natural setting. The majority of the carpet waste is incinerated to produce energy, which not only releases CO_2 into the atmosphere but also disregards the value of PP as a resource and necessitates further consumption of fossil resources to replace the lost PP within the plastics supply chain. On the other hand, existing methods for the recycling of PP mainly rely on mechanical processing, which results in an impure product that can only be used for lower value applications or at best requires re-blending with virgin material [4].

By contrast, the aim of the ISOPREP project is to develop a process that recycles end of life PP back into its original virgin quality, making it completely suitable for re-use in high value applications. The proprietary recycling technology in ISOPREP will be scaled up in a 1 ton pilot plant to produce virgin quality PP. The project will also run on the basis of a full life-cycle analysis within the framework of the circular economy.

ISOPREP is a 3-year project with a budget of € 6.3M, funded by the Horizon 2020 programme under a specific call to provide efficient recycling processes for materials containing plastics. ISOPREP is a venture undertaken by a multidisciplinary consortium (Figure 2) represented by 10 partners across 5 different European countries. The project is coordinated by TWI Ltd. (Cambridge, United Kingdom), and the consortium partners include the Advanced Resins and Coatings Technologies Innovation Centre (ARCTIC), Floteks, Fraunhofer, Sabanci University, Bioniqs Ltd., the Institute of Processing and Engineering (IPPE), RotaJet Systems Ltd., Axion Recycling Ltd., and the Centre for Nanotechnology and Smart Materials (CENTI).



As part of the ISOPREP consortium, Sabancı University's Integrated Manufacturing Technologies Research and Application Center (SU-IMC) has received €723,000 for the optimization of the proposed PP recycling steps in SU-IMC laboratories and for the verification of the whole recycling process in the laboratory-scale pilot plant. The center will also contribute to material characterization efforts throughout the project and to the exploration of different application areas in which the recycled PP polymer can be utilised. The ISOPREP project at SU-IMC is led by Asst. Prof. Serkan Ünal, and the team members include Prof. Yusuf Menceloğlu, Assoc. Prof. Bekir Dizman, Dr. Serkan Güçlü, Dr. Nuray Kızıldağ and Erdal Balcı.

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WE REINFORCE LIFE

News

Reinforcing Global Partnerships

Reinforcer Kordsa, a global player in the tire, construction reinforcement and composites technologies markets, has teamed up with the University of Sheffield's Advanced Manufacturing Research Centre (AMRC). Kordsa, which has been investing heavily in composite technologies over the last few years, sees this collaboration as an opportunity to step up its business journey within the field of composite technologies. In 2016, in cooperation with Sabancı University, Kordsa inaugurated its Composite Technologies Center of Excellence, intended to be a technology hub of the future which will push back the boundaries of advanced composite material technologies. Fusing AMRC's groundbreaking manufacturing techniques with its own expertise in composite materials, Kordsa aims to become one of the major players in the UK aviation and automotive network by developing new advanced composite technologies.

A visit was made to the AMRC for the signing of a Memorandum of Understanding (MOU), according to which the University of Sheffield, Kordsa and Sabancı University agreed to cooperate in the composite field. The Memorandum also underlined the desire to establish a link between Sabancı University in Istanbul and the University of Sheffield.

Axiom Materials Made a Presentation at the International Ceramics Conference

Mr. Antonios Tontisakis, the Technical Director of Kordsa's affiliate Axiom Materials, introduced the new ceramic products at the International Ceramics Conference held in France. Companies, universities and institutes operating in the aerospace and defense industries attended the conference, and Axiom Materials' products attracted a great deal of attention

Indo Kordsa Celebrated Its 34th Anniversary

Indo Kordsa celebrated its 34th anniversary with a ceremony marking the achievements obtained throughout the year and awarding the best performances. The winners of the sports tournaments that took place during the year were announced at the ceremony, where employees who have served for many years were also awarded. The ceremony ended after the dance and music performances.

Kordsa at Composites Europe, Europe's Major Industry Meeting Point

Composites Europe, Europe's major meeting in the field of composite materials and equipment, attended every year by thousands of visitors, took place between 10th and 12th September in Stuttgart, Germany.

At this important gathering, this year Kordsa exhibited automotive parts and a rudder. Kordsa applies a one solution-partner approach, providing its customers with services such as design, analysis, material library and prototype production in accordance with customer needs, while also developing prepregs, fabrics and resin formulations. It also provides customized and cost-effective composite intermediate materials for a variety of industries, notably the aerospace, and automotive industries, as well as for sports and marine equipment. Kordsa informed visitors about the Company's competencies.

Kordsa Made a Presentation in the 3rd International Metrorail Forum

Kordsa made a presentation titled "Concrete Reinforcement Applications with Macro and Micro Synthetic Fiber Reinforcements Produced Domestically with Kordsa's Technology" in the "Local and National Production in Rail Systems" session of the International Metrorail Forum on metro, rail systems and urban transport systems, held for the third time this year.

Kordsa America receives ISO 14001: 2015 Environmental Management System Certification

Kordsa's Laurel Hill plant in the US successfully completed environmental management system inspections and received ISO 14001:2015 certification. The Environmental Management System certificate includes commitments related to efficient use of energy and natural resources, conservation of biodiversity and combating climate change.

Kordsa Presented at the Digital Transformation 2019 Conference

Kordsa delivered a presentation called "Kordsa's Digital Journey" at the Digital Transformation 2019 Conference, where strategies, technologies and applications used in digital transformation were shared. Kordsa's digitalization efforts and advanced data analytics projects were shared in the presentation.

Kordsa Presents Flexible Electronics Technology

Kordsa's Technology Director Devrim Ozaydın briefed the participants on flexible electronics technology and Kordsa's work on this subject during the session on Nanosensors and Possible Applications in Industry at EEMKON 2019 Electronics and Electrical Engineering Congress.

Kordsa Leaders Come Together in Istanbul

Executives from Kordsa's production facilities around the world came together at the annual Global Leadership Summit, reviewing 2019 and discussing the company's goals for 2020. In his opening speech, Kordsa's CEO Ali Çalışkan emphasized Kordsa's motto "Inspired to Reinforce Life" and stated: "We have been engaged in a rapid transformation since 2018, with both acquisitions and new reinforcement technologies. We have deepened our competencies and expanded our field of operation. In this rapidly changing world, we will continue to develop new technologies and reinforce more areas by listening to people and being inspired by their needs. With our competencies and know-how, we have the capacity to produce a wide range of high-tech materials that serve sectors ranging from tire reinforcement to the aerospace industry."

World-renowned speakers Peter Marsh, the author of The New Industrial Revolution, and Chris Barez-Brown, founder of Upping Your Elvis, were also present at the summit. In his presentation on the circular economy, Peter Marsh underlined the importance of cooperation for a sustainable future and sustainable economy, stating: "As the world population is growing and living standards are rising, human consumption is increasing and natural resources are decreasing more rapidly. In a rapidly changing world, it will be crucial to devise new technologies that will help the circular economy to function. Technology development companies have a key role here. Increasingly they will need to collaborate with other companies, often in different industries, to devise the most suitable circular economy processes."

"I believe that everyone is creative; the important thing is to know how to reveal this creativity," said Chris Barez-Brown in his speech on creative and innovative thinking. He added: "The best ideas never come to mind when you're sitting at your desk. They happen when you're feeling relaxed, having fun and are tuned into your emotions as well as your knowledge."

Kordsa Presents Digital Transformation In Manufacturing Industry

Kordsa made a presentation at the Manufacturing Industry Digit-ALL Transformation Conference, where digital transformation trends in industrial production, the latest technologies and the future of transformation are shared. Speaking on behalf of Kordsa, Director of Operational Excellence Suat Hayri Bekircan shared Kordsa's digital transformation journey and work in the field of advanced data analytics with participants.

Kordsa Unveils Composite Technologies In Big2019

Kordsa took part in the Big2019 event organized by Ford Otosan on December 16-17, where professionals shared their knowledge of connected vehicles, autonomous vehicles, electric vehicles, C02 reduction and weight reduction. Kordsa presented the solutions to the automotive sector through its composite technologies.

Kordsa Attends Horizon 2020 Information Meeting

Kordsa participated in the European Union Project Horizon 2020 Program information day organized by the General Secretariat of Istanbul Minerals and Metals Exporters' Association (IMMIB). Kordsa shared its experience in European Union projects at the information meeting organized by TUBITAK officials (The Scientific and Technological Research Council of Turkey) regarding grant programs that companies can benefit from individually or as part of a partnership.

Kordsa Successfully Completed Automotive Quality Management System Standard Audit

Kordsa successfully completed the Automotive Quality Management System IATF 16949 inspection, developed to ensure continuous improvement, prevent errors, highlight disruptions and prevent loss in the supply chain. Kordsa will continue to work for the development and dissemination of good practices.

Kordsa Presented its New Composite Technology Developed for Commercial Vehicles

Kordsa gave a presentation at the Turkish Composite 2019 Summit titled "Kordsa's Development of Materials for Composite Leaf Spring Production in Heavy Commercial Vehicles". Kordsa also provided information about the new technology developed in cooperation with Ford Otosan that lightweights the chassis systems of heavy commercial vehicles, including structural health monitoring systems.

Kordsa Shared Its Experiences in TUSIAD SD² STEP Panel

Kordsa participated in the STEP event, where the talks to create a match between technology users and technology suppliers were held under the TUSIAD Digital Transformation in Industry (SD²) program. Kordsa shared its experiences from last year in the "Why Are We Part of SD²?" panel organized before the talks.

Training on KraTos Synthetic Fiber Reinforcements From Kordsa

Kordsa conducted a training on the use of synthetic fiber reinforcements in tunnel applications at the 16th Regional Directorate of the Highways. Within the scope of the two day-training, field trials were carried out and the advantages of high performance, time and labor of the reinforcements were explained in practice.

Accident-Free Hour Celebration at Kordsa's Laural Hill Facility

The Annual Occupational Safety and Quality Workshop at Kordsa's Laural Hill facility in the US celebrated nearly 2 million accident-free hours this year. Within the scope of the event, the things that need to be done in order to continue the accident-free hours covering a 5-year period in a sustainable manner, were reviewed.

Occupational Health and Safety Certificate Granted to Kordsa

Kordsa's Izmit facility and Composite Technologies Center of Excellence received ISO 45001:2018, the International Occupational Health and Safety Standard Certificate, which replaced the OHSAS 18001 standard last year, for their work and procedures in compliance with occupational health and safety rules.

ISO International Organization for Standardization
ISO 45001:2018

Kordsa Sets Record in the Production of Aramid

Kordsa reached the highest monthly amount of aramid ever produced at the Composite Technologies Center of Excellence, and realized its largest shipment in one time. Kordsa celebrated this success with a shipment ceremony attended by all the employees of the center.

Visit to Kordsa on the Third Meeting of the EU-funded Horizon 2020 Project PolynSPIRE

In 2018, inspired by its openness to collaboration and its belief in innovation, Kordsa joined the EU-funded PolynSPIRE project, taking place within the framework of the Horizon 2020 program. The project aims to develop a set of innovative and sustainable solutions for efficient plastic recycling by means of strengthening the research and technology development capacity of Europe and promoting and improving university-industry cooperation.

22 project partners from 11 countries, including major players in the European chemical industry such as Arkema, Novamont and Repsol, participated in the third meeting. On the last day of the three-day event, participants visited Kordsa's İzmit facility.

It is predicted that, during the 48-month duration of the PolynSPIRE project, 60 kilotons of plastic waste will be recycled or reused, there will be a 300 kiloton reduction in equivalent carbon emissions, and 70 kilotons of oil-equivalent fossil resources will be saved. The 20-year targets set are to treat 4.5 million tons of residue annually, and each year to reduce CO_2 emissions by 45 million tons and recover 10 million tons of oil-equivalent fossil fuel.

Kordsa Attends Road2Tunnel, Showcasing its Innovative Concrete Reinforcement Synthetic Fibers, KraTos Macro PP and KraTos Micro

Kordsa participated for the second time in the International Road, Bridges and Tunnels Fair "Road2Tunnel" held in Ankara between 9th and 11th October. At this major sectoral meeting, which brings together administrators, subcontractors and designers, Kordsa provided information on its diverse product range related to infrastructure and superstructure projects, briefing customers about its products' technical features and applications. Kordsa enjoyed the opportunity to tell visitors about its innovative and 100% domestic engineering solutions. What attracted particular attention were Kordsa's polypropylene monafilament fiber reinforcements, a new type of KraTos, which are produced in the more advanced polypropylene monofilament fiber reinforcement line commissioned in İzmit in June 2018.

The Minister of Industry and Technology visits Kordsa

The Minister of Industry and Technology, Mustafa Varank visited the Composite Technologies Center of Excellence. Mr. Varank conducted detailed observations from the center's laboratories to the production line. Mr. Varank expressed his appreciation for the center, and added that the center will be a great contribution to the country's economy.

Visit to Indo Kordsa From Sampoerna University Students

Industrial Engineering students of Sampoerna University in Jakarta, Indonesia, visited Indo Kordsa. Students who learned about Kordsa's company culture had the opportunity to study Kordsa's weaving and bending manufacturing processes on-site.

Kordsa Releases its Interactive Sustainability Report

Kordsa has published its fifth sustainability report. Kordsa's 2018 Sustainability Report includes comparisons with previous years in terms of the company's key sustainability issues such as its managerial, economic, social and environmental goals, the actions it has taken to achieve these goals, the level of progress achieved, and the practices developed by its employees.

Differently from the reports for previous years, the 2018 Sustainability Report offered a schematic explanation of the value chain and the sustainability effects of tire reinforcement and composite technologies business lines. Unlike in previous years, attention was focused on R&D and total productive maintenance (TPM) projects that serve sustainability goals, with the results and achievements of these projects being foregrounded, thus making the report more focused and briefer. Also, the content of the report has been enriched with supporting websites, documents and videos, which can easily be accessed via the links incorporated into the report.

Kordsa Showcases its Innovative Composite Technologies at Türk Kompozit 2019

Kordsa attended the Türk Kompozit 2019 Composite Summit held in Istanbul between 10th and 12th October. At the Summit, Kordsa ran a stand and gave two presentations covering manufacturing, processing and applications specific to the composite industry.

In its presentation titled "The Yesterday, Today and Tomorrow of Kordsa's Composite Capabilities", Kordsa informed participants about its R&D studies, strategic investments, expanding composite portfolio and competencies.

Kordsa's second presentation, titled "Kordsa's Material Development for Composite Leaf Spring Production for Heavy Commercial Vehicles" emphasized the importance for the competitiveness of the automotive industry of producing lighter vehicles. Listeners were informed about the technology that Kordsa developed conjointly with Ford Otosan, which not only lightens the chassis systems of heavy-duty vehicles but also drives structural health monitoring systems that serve the purposes of process optimization, part qualification and online health monitoring.

Team Reinforced by Kordsa's Composite Material is the Champion!

Çukurova University's "Çukurova Electromobile Team", reinforced thanks to Kordsa's provision of composite materials, won the Efficiency Challenge Electric Vehicle competition held by TÜBİTAK as part of the TEKNOFEST that took place between September 14 and 19. Reinforcement leader Kordsa will continue to support youth projects.

Thai Indo Kordsa Participated in Career Fair

Indo Kordsa participated in the Career Fair organized by JobsDB. Kordsa gave detailed information about the company and its products to senior college students, especially students from the faculties of engineering and science, at this fair where the prestigious companies of Thailand took place. Kordsa's booth attracted a great deal of attention by the students.

Vehicle Reinforced by Kordsa Becomes Champion

The BluePoint vehicle of Belgium's The Agoria Solar Team, reinforced by the honeycomb structure and sandwich panels that Kordsa produced for Dupont, was victorious at the Bridgestone World Solar Challenge 2019, finishing the 3020 km distance at an average speed of 86.6 km per hour. Every year, solar vehicles compete in the Bridgestone World Solar Challenge, held in Australia.

Indo Kordsa Receives Tax-Friendly Company Award

Kordsa received the "Tax Friendly Corporate" award at the "Tempo Country Contributor Awards 2019" organized by well-known Indonesian National Media Tempo Inti Media in cooperation with the Indonesian Taxation Analysis Center (CITA). At the award ceremony held with the participation of the Indonesian Coordinating Ministry for Economic Affairs., 23 companies were awarded among 631 companies.

WE REINFORCE LIFE

CSR Projects

Indo Kordsa Donates Computer Donation To Students

Indo Kordsa donated computers to the SDN Gununngsari School along with the Bangun Sekolah Association, founded under the leadership of Indonesia's pageant queen Maria Harfanti, and provided basic computer education to the students. Consequently, students reinforced by Kordsa will be able to prepare for the selection and placement exam that they will take in the coming days.

Wheelchair Donation From Kordsa Brazil Employees

Employees at Kordsa's facility in Brazil supported the Lacre do Bem (Good Seal) campaign, which donated wheelchairs in exchange for PET bottles and aluminum cans they had accumulated. Kordsa reinforcers took part in the ceremony for the delivery of 10 wheelchairs to disabled citizens in need.

Kordsa Reinforces Children's Future in Indonesia

Kordsa has once again reinforced the future of children in the region of Bogor, where Kordsa has operations in Indonesia. Kordsa taught the computer office programs while donating laptops to the school during a ceremony at the SDN Gunungsari school, which they renovated with Indonesia's pageant queen Ms. Maria Harfanti.

Kordsa Continues to Reinforce Future Generations with its Projects for Teachers and Schools

Kordsa aims to contribute to the society in every country it operates , which is why for the last five years it has chosen every year to renovate a school from the inside to the outside, including substructure renovation, library construction, educational equipment purchase and wall-painting. This year, Kordsa continued to reinforce the future of children by renovating the Akçaova Primary and Secondary School in the Akçaova district of İzmit, where Kordsa's main facility is located. Aware that teachers play a major role in the education and development of children, this year for the first time, before renovating the school, Kordsa reinforced the teachers of Akçaova Primary and Secondary School as well as teachers of the surrounding schools through a joint training project carried out in conjunction with the Teachers' Academy Foundation as part of the Foundation's "Learning Leader Teacher" program. As well as supporting the intellectual, personal, professional, emotional and social development of teachers, the program is designed to help teachers become leaders who teach their students how to learn instead of what to learn.

Outstanding Achievement From Dupont Elementary School, Kordsa's Sister School In America

Dupont Elementary School, Kordsa' sister school in the US that is regularly supported by donations and visits as part of social responsibility efforts, has increased its performance score from level one to level five, the highest level in the past four years. Kordsa's reinforcements will continue to support the education of children in the coming periods.

WE REINFORCE LIFE

Awards

Kordsa among the Best Employers in Thailand for 10 Consecutive Years: The Value of Outstanding Labor Relations Management and a High Employee Welfare Level.

For the 10th time in a row, Kordsa has received the award that the Thailand Ministry of Labor grants to an "Excellent Establishment in Labor Relations and Welfare", honoring companies operating in Thailand for their practices in managing labor relations and employee welfare. Thai Indo Kordsa, a Kordsa company operating in Thailand, received the award at the Business Relations Excellence Award Ceremony. Thai Indo Kordsa's Managing Director Özgür Kaya and Executive Director Yuthana Vipasawad received the award from Thailand's permanent secretary of labor, Suthi Sukosol.

Kordsa was Honored as the Company of the Year in Brazil

Kordsa has added another prestigious award to its growing list of accolades, being honored as the company of the year in Brazil. After surveying all of Kordsa's employees, Você S.A., one of Brazil's most prestigious magazines, named Kordsa "the best company to work for", "the best company in textiles to work for" and "the best small company to work for with less than 500 employees". Also, among the 150 best companies to work for, Kordsa Brazil received an impressive job happiness index of 87.5%.

Kordsa's accomplishment of raising its job happiness rate since 2011 through its people management practices testifies to the company's employee-centered leadership policies. These are focused on inspiring, reinforcing, developing and caring for its employees, so that the company can overcome challenges together. Every year, Kordsa's CEO and senior managers regularly visit their facilities around the world to meet with their employees and exchange ideas.

Kordsa among the "Great Places to Work" in Brazil for the Fourth Year in a Row

Kordsa has been listed among the best employers in Brazil for the fourth time by the Great Place to Work Institute (GPTW).

In the 23rd edition of the award, among 2645 registered companies, GPTW recognized 80 large-sized companies, 35 national medium-sized and 35 multinational medium-sized companies as constituting the 150 top places to work in Brazil. This result was based on comprehensive quantitative and qualitative surveys conducted among managers and employees. Listed as the 25th best company in 2016, the 31st in 2017 and the 18th in 2018, Kordsa ranked 17th this year in the multinational medium-sized companies' category.

This fourth Great Place to Work award demonstrates Kordsa's commitment to placing people at the center of its business and proves the success of Kordsa's management strategy as a driver of synergy and business evolution.

International Award for Kordsa Sustainability Report

Kordsa's 2017 Sustainability Report received the silver award among 2,100 applicants from 34 countries in the sustainability report category of the 33rd International ARC Awards, organized this year by Mercomm in the US. The ARC Awards were created to honor overall excellence in corporate reports and to encourage noteworthy and vital writing, as well as creative and original design.

"Best Supplier Award" for Kordsa from Pirelli

Kordsa has been given the "Best Supplier Award" by Pirelli. Since 2014, Kordsa has been prioritizing sustainability in every one of its actions, and it recognizes that ensuring self- sustainability is the first step to sustainability. Kordsa also carries out a comprehensive sustainability assessment of its suppliers. In this regard, Kordsa requires its suppliers and business partners to operate in accordance with the principles set out in its "Statement on the Code of Business Ethics", which derive from the Kordsa Ethics Code, and to monitor the environmental and societal effects of their actions.

Similarly, the global tire giant Pirelli assesses its own suppliers in terms of the quality of their products and services, as well as with regards to the criteria of speed, sustainability, innovative approach, global presence and service level. In view of Pirelli's assessment criteria, Kordsa was granted the "Pirelli Supplier Award" for its global presence and service level. The award recognized Kordsa's criteria for the selection and evaluation of its own suppliers, and its positions on labor and human rights, health and safety, environmental protection, ethics and management practices.

Quality Team of the Year Award to Kordsa

Kordsa was granted the bronze award in the private sector category of the "Most Successful Team Awards" organized under the leadership of the İzmir branch of KalDer, the Turkey Quality Association. Kordsa was evaluated based on criteria including the effectiveness of its Total Quality Management, its efforts in sharing knowledge and experience, and its compliance with the EFQM Excellence Model.

Kordsa Receives Two R&D Awards

Kordsa received first prize in the "Project Capacity" and "R&D Centers with 51-75 employees" categories at the 7th Technology Development Zones and R&D Centers Award Ceremony organized by the Turkish Ministry of Industry and Technology. Kordsa Board Member Semiha Yaşar and Technology Director Devrim Özaydın were presented the awards by the Minister of Industry and Technology, Mustafa Varank.

We are inspired to reinforce life

In Kordsa, we are inspired to create a better future for all of us. We know that protecting the harmony of life is the first step and for this, we develop unique reinforcement solutions to touch every aspect of life.