GRP

Cable Support Systems

Mita powered by Wibe Group

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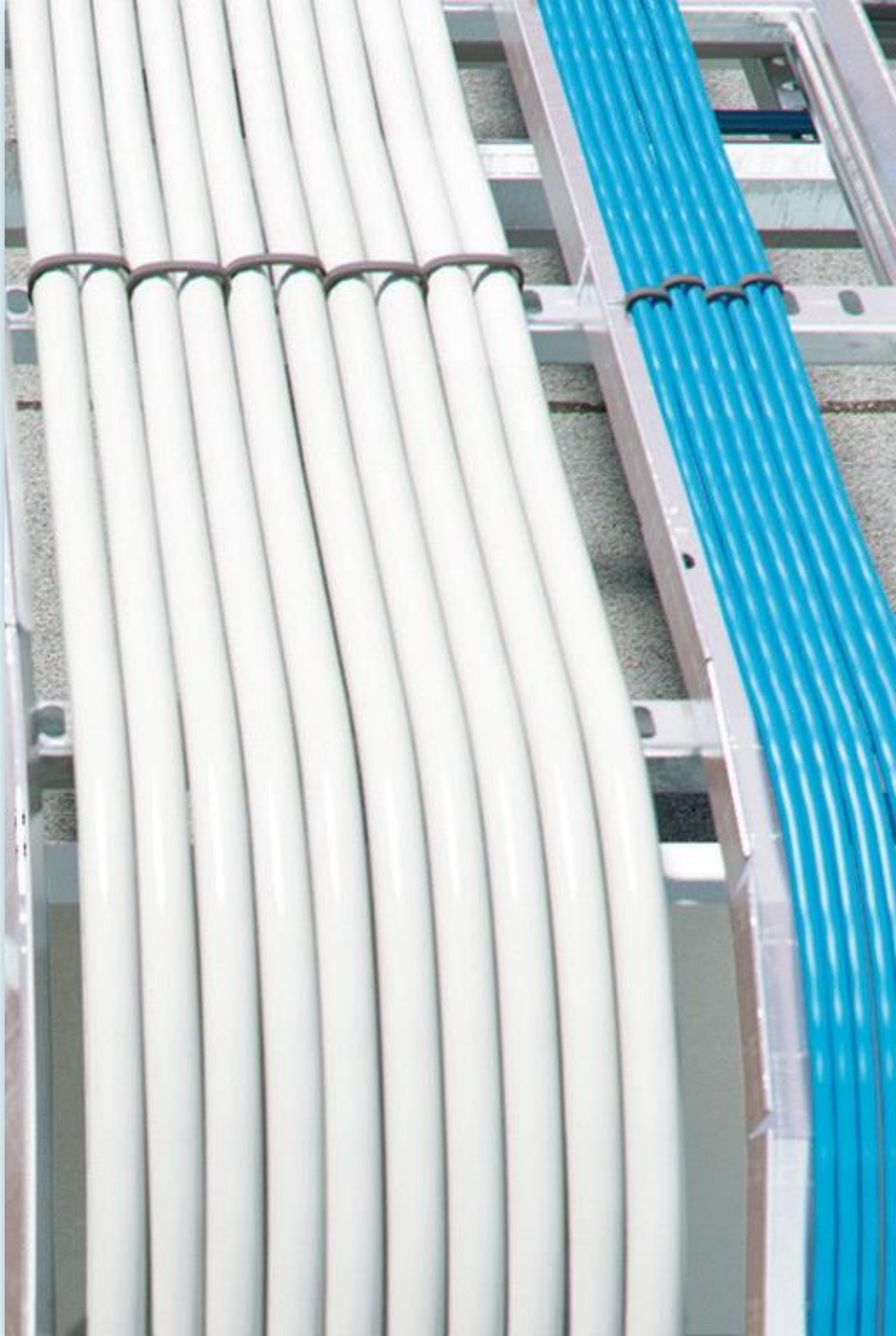
Agenda (45min)

1. Introduction to cable support systems (10min)
2. Composites (5min)
3. Environmental aspect and circular economy (5min)
4. What is GRP? (5min)
    a. Production methods
    b. GRP for cable support
5. Types of designs and resin capabilities (10min)
    a. Design types and capabilities
    b. Resin compliance and capabilities
6. Applications (10min)
    a. Applications
    b. Design vs applications
    c. Time and cost savings
    d. BIM modelling and cable routing software



1. Introduction to Cable Support Systems

Types, habits, components, different surface treatment types for every application

Cable support is the backbone of development

Wherever development is done, cable support is there to facilitate electrification and communication.

Cable support is the backbone of development

And it can come in different forms:

- Mesh Trays
- Cable Trays
- Cable Ladders

along with a wide variety of accessories.

Worldwide habits: how do we choose?

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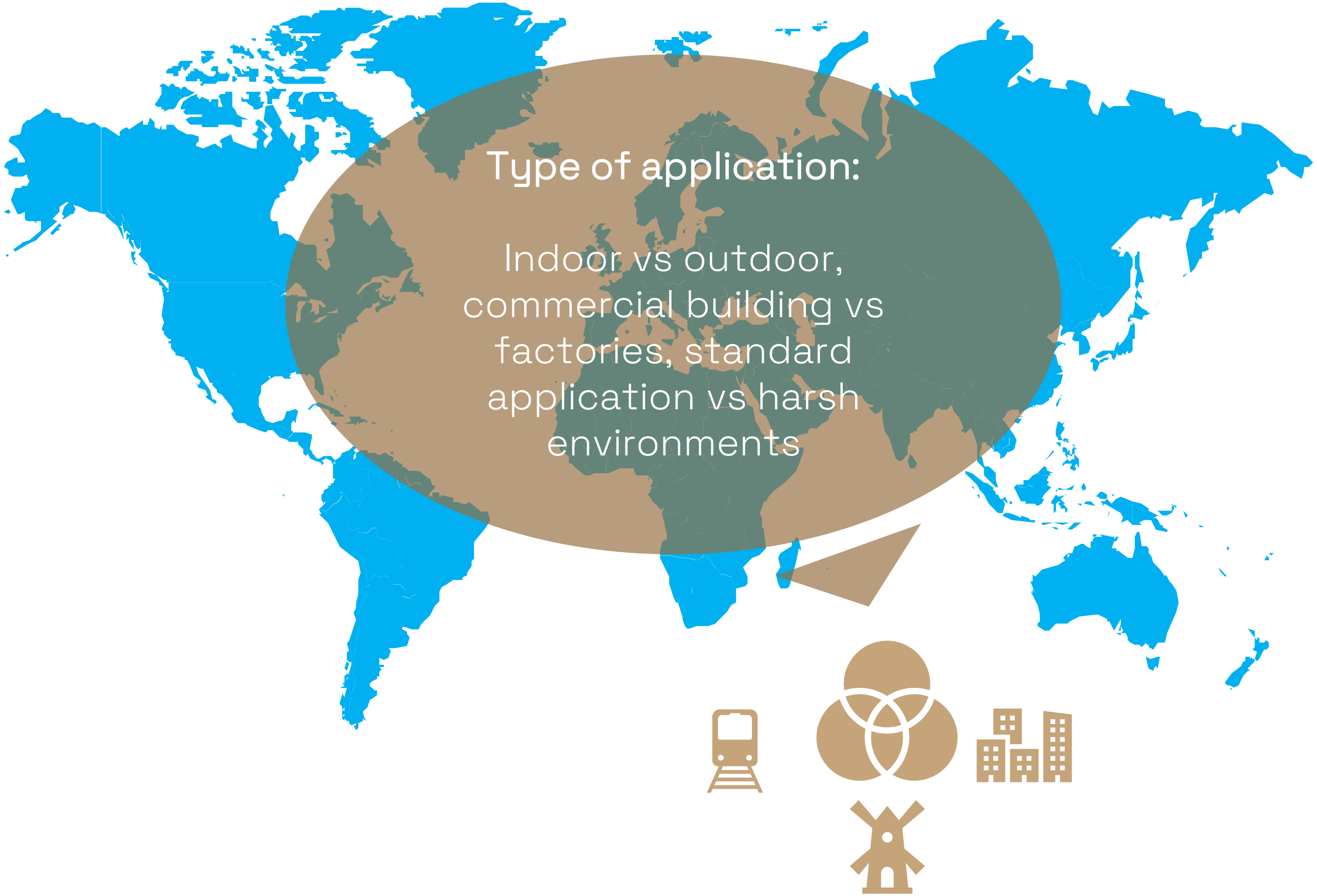

Worldwide habits: how do we choose?

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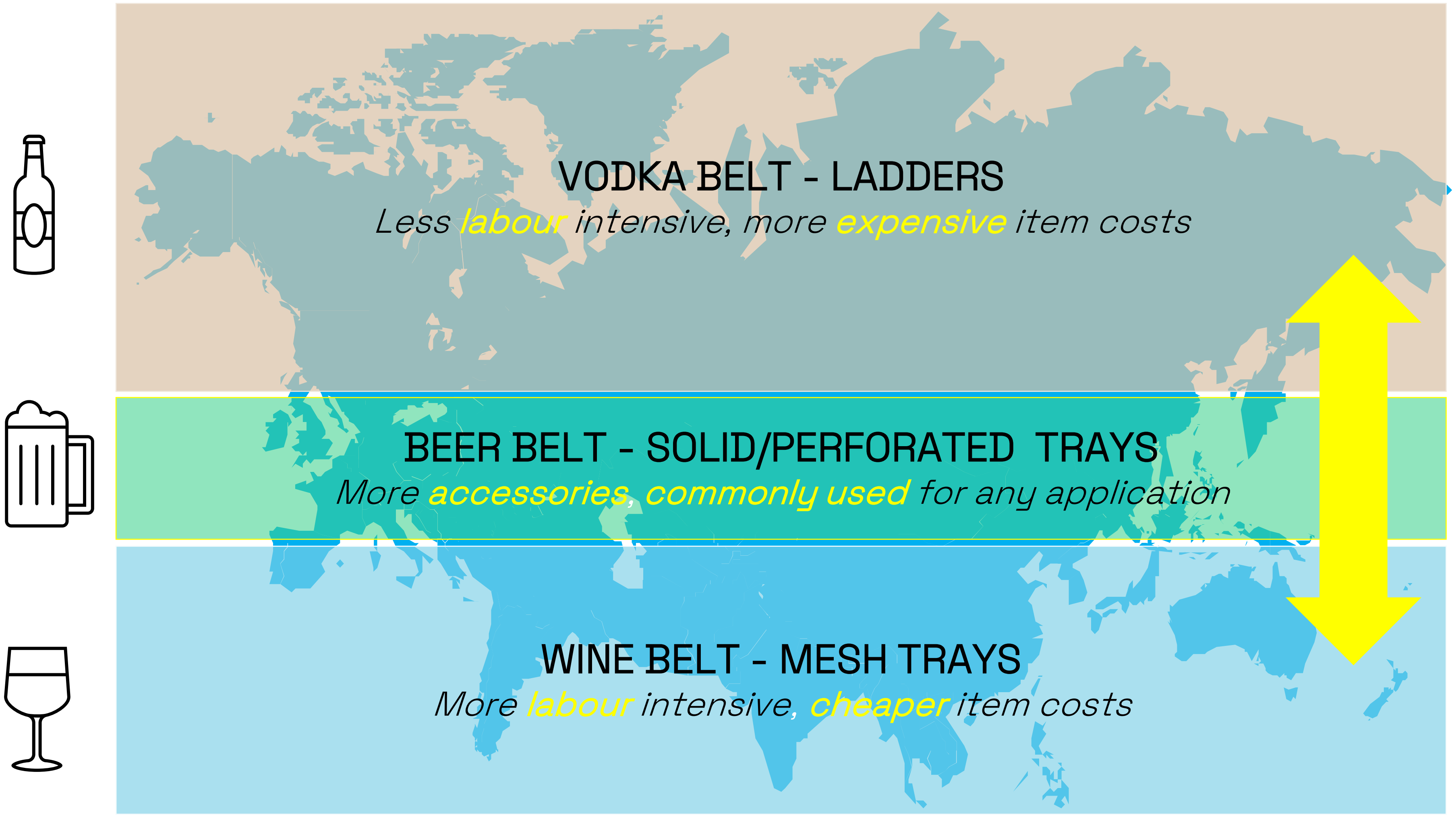
Worldwide habits: how do we choose?

The BELTS


VODKA BELT - LADDERS
Less labour intensive, more expensive item costs
BEER BELT - SOLID/PERFORATED TRAYS
More accessories, commonly used for any application
WINE BELT - MESH TRAYS
More labour intensive, cheaper item costs

A cable support system consists of…

Length Material

- 3,4,6 m or customize. Window part of the offer
- PG, HDG, SS, PVC, GRP

Fixing Forms & Accessories

- **Fixing Forms:** As Bends, Cross, T etc. Depending the system/solution this items are not required
- **Joints & Accessories:** Connect all the elements and allow link with other systems or services

Support System

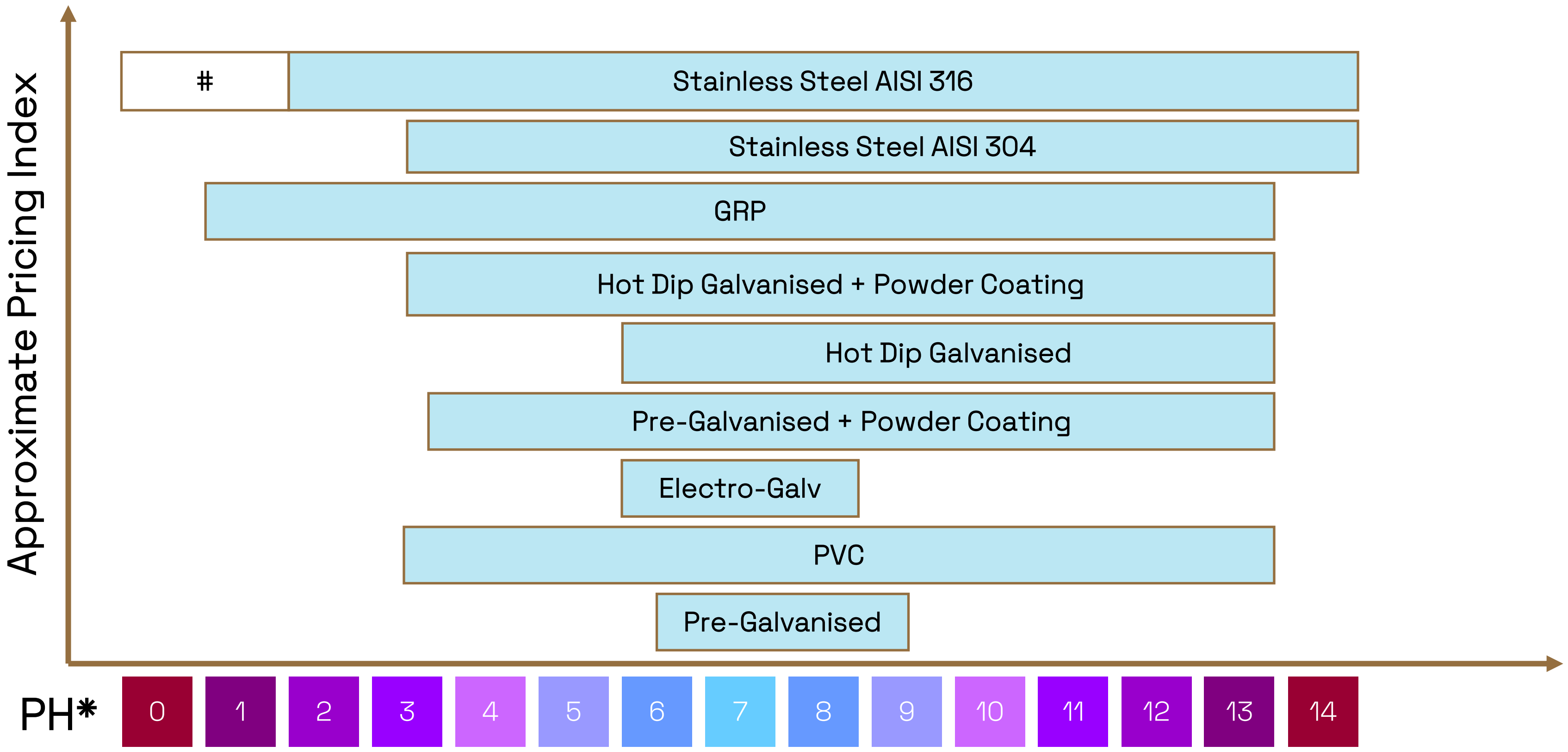
- This sub-system allows for the cable support elements to be fixed from Ceiling, Wall, or other possibilities

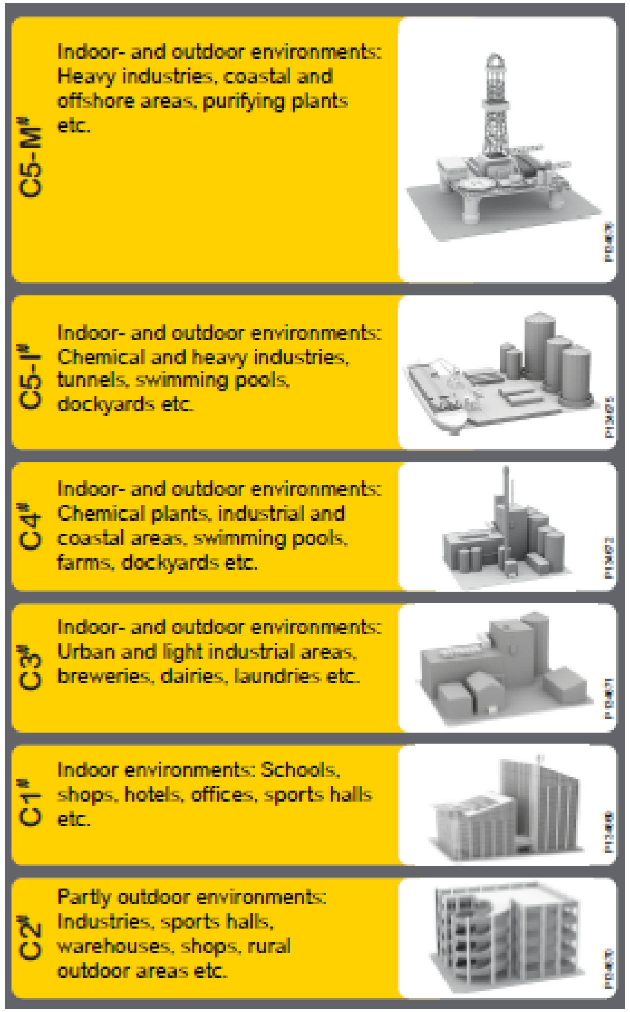
MANY MORE…

APPLICATIONS

A cable support system for every application

Generic Guidance





Corrosion classes stipulated by EN ISO 12944-2

** In addition to pH, UV exposure, humidity, salinity and temperature influence corrosion behavior.*
 # Limited performance in environments with high chlorine content.

C1

Very low environmental corrosivity

Indoor environments:

Schools, shops, hotels, offices, sports halls, etc.

Recommended choice of material/surface treatment:

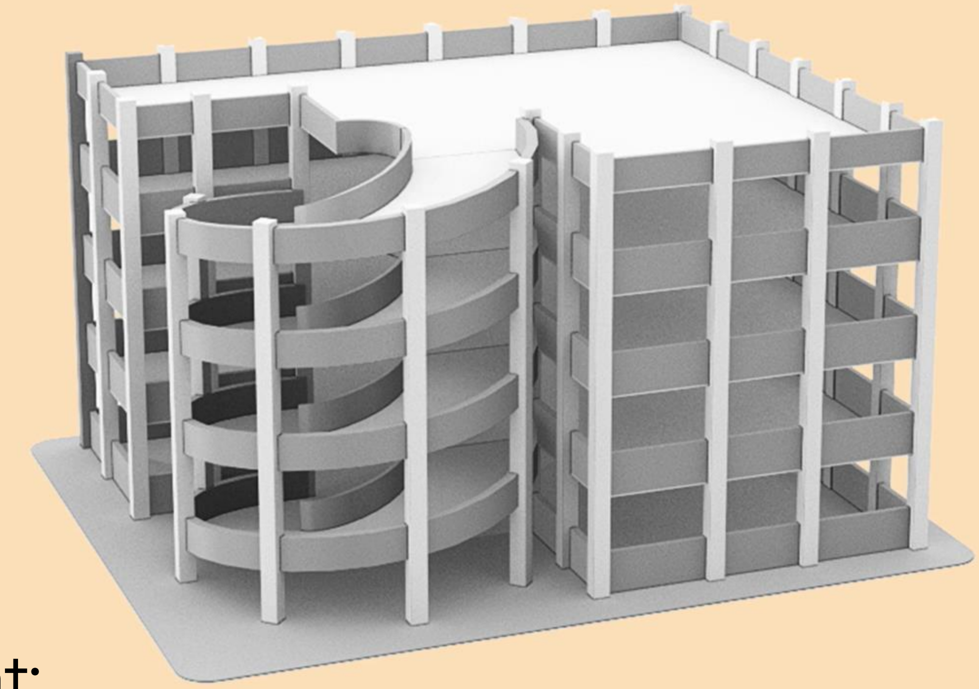
Electro-galvanized (EG) steel

C2

Low to moderate environmental corrosivity

Partly outdoor environments:

Industries, sport halls, warehouses, shops, rural outdoor areas etc.



Recommended choice of material/surface treatment:

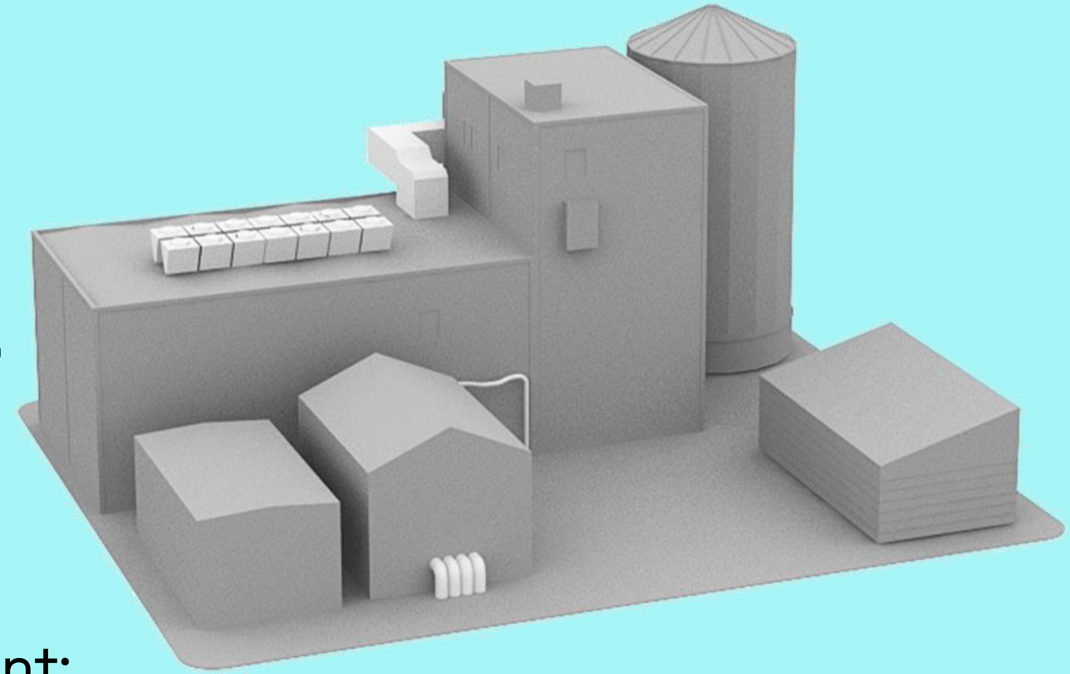
Pre-galvanized (PG) steel

C3

Moderate environmental corrosivity

Indoor-outdoor environments:

Urban and light industrial areas, breweries, dairies, laundries etc.

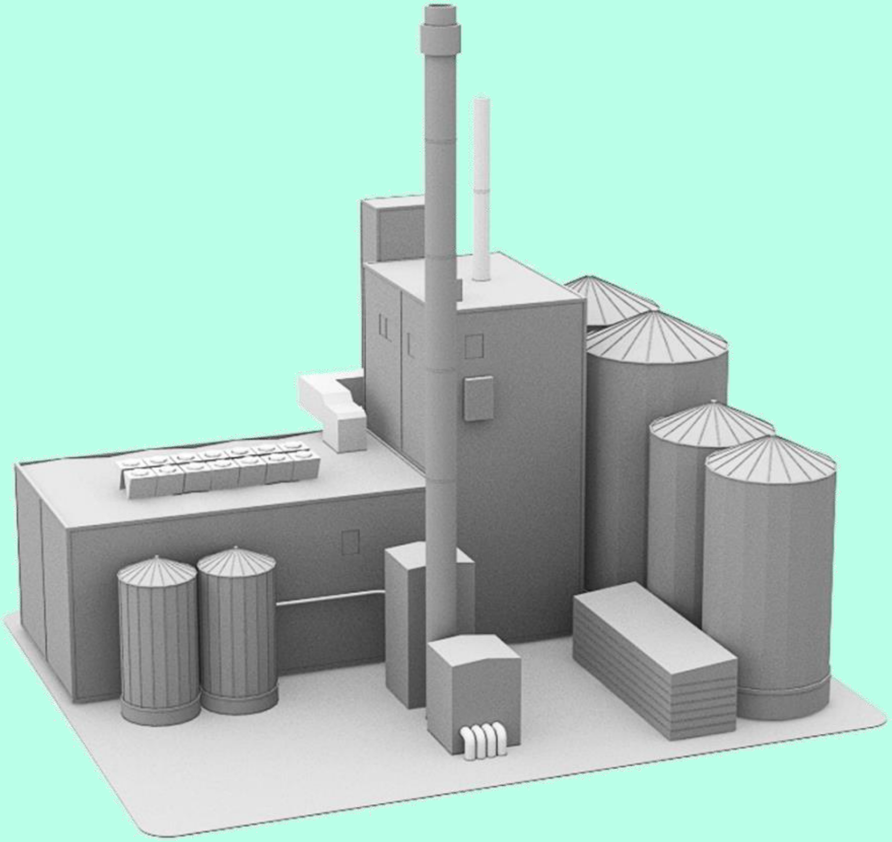


Recommended choice of material/surface treatment:

Hot-dip galvanized (HDG), zinc-coated PG steel, PVC

C4

High environmental corrosivity



Indoor-outdoor environments:

Chemical plants, industrial and coastal areas, swimming pools, farms, dockyards etc.

Recommended choice of material/surface treatment:

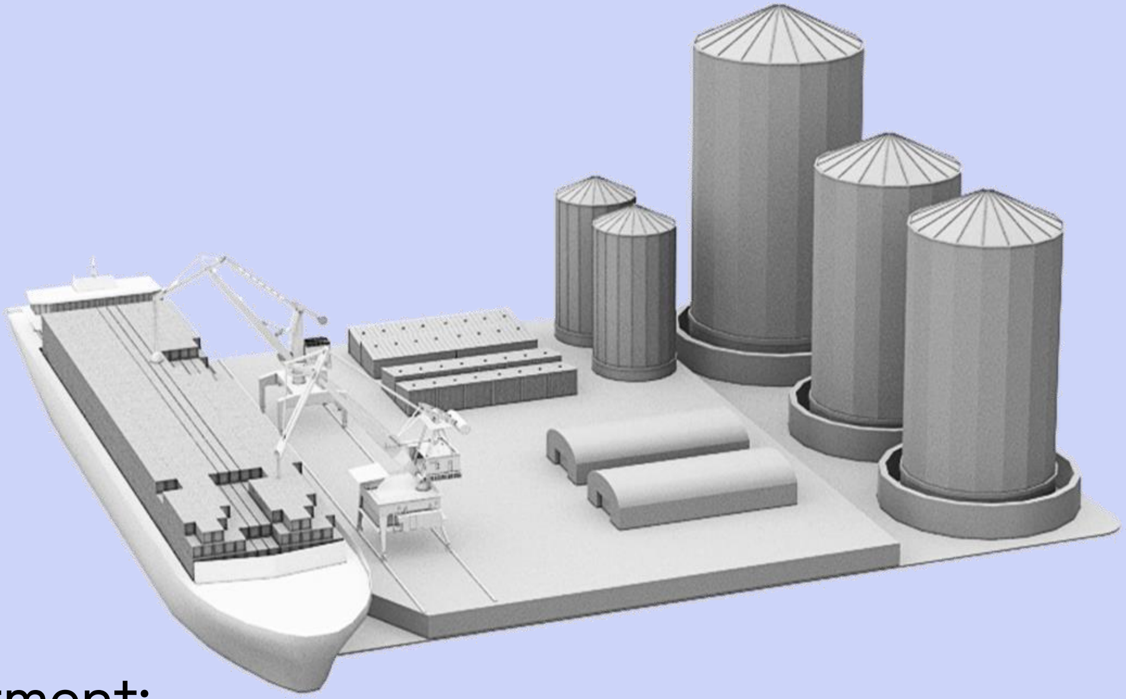
Hot-dip galvanized (HDG), zinc-coated PG steel, PVC, GRP

C5-I

Very high environmental corrosivity (industrial)

Indoor-outdoor environments:

Chemical and heavy industries, tunnels, swimming pools, dockyards etc.

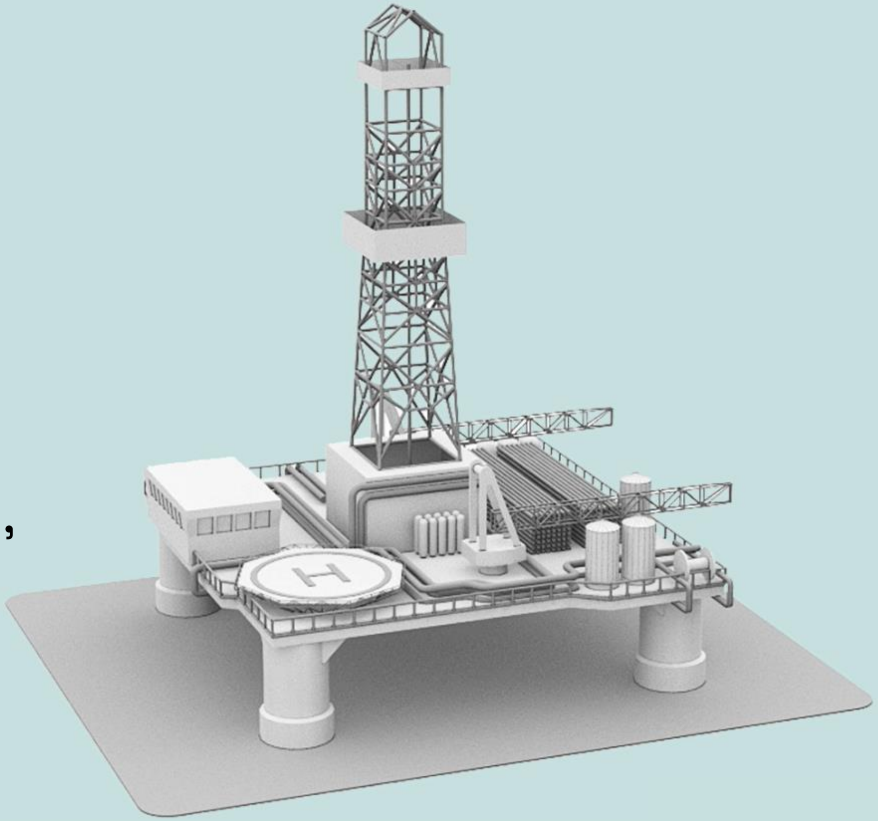


Recommended choice of material/surface treatment:

AISI304L stainless, zinc-coated HDG steel, GRP

C5-M

Very high environmental corrosivity (marine)



Indoor-outdoor environments:

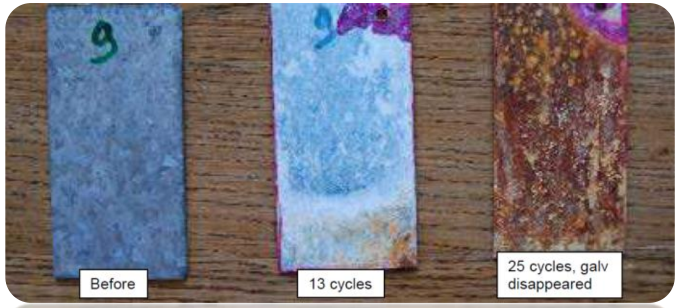
Heavy industries, coastal and off-shore areas, purifying plants etc.

Recommended choice of material/surface treatment:

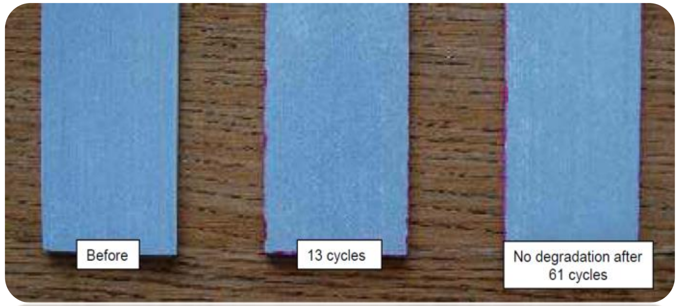
AISI316L stainless steel, GRP

Simulating C5-M
Salt spray test according to DIN 50018

Pre-Galvanised Steel



GRP



CORROSION CHAMBER

DIN 50018

2. Composites

Thermoplastics vs thermosets used in composites

Composites

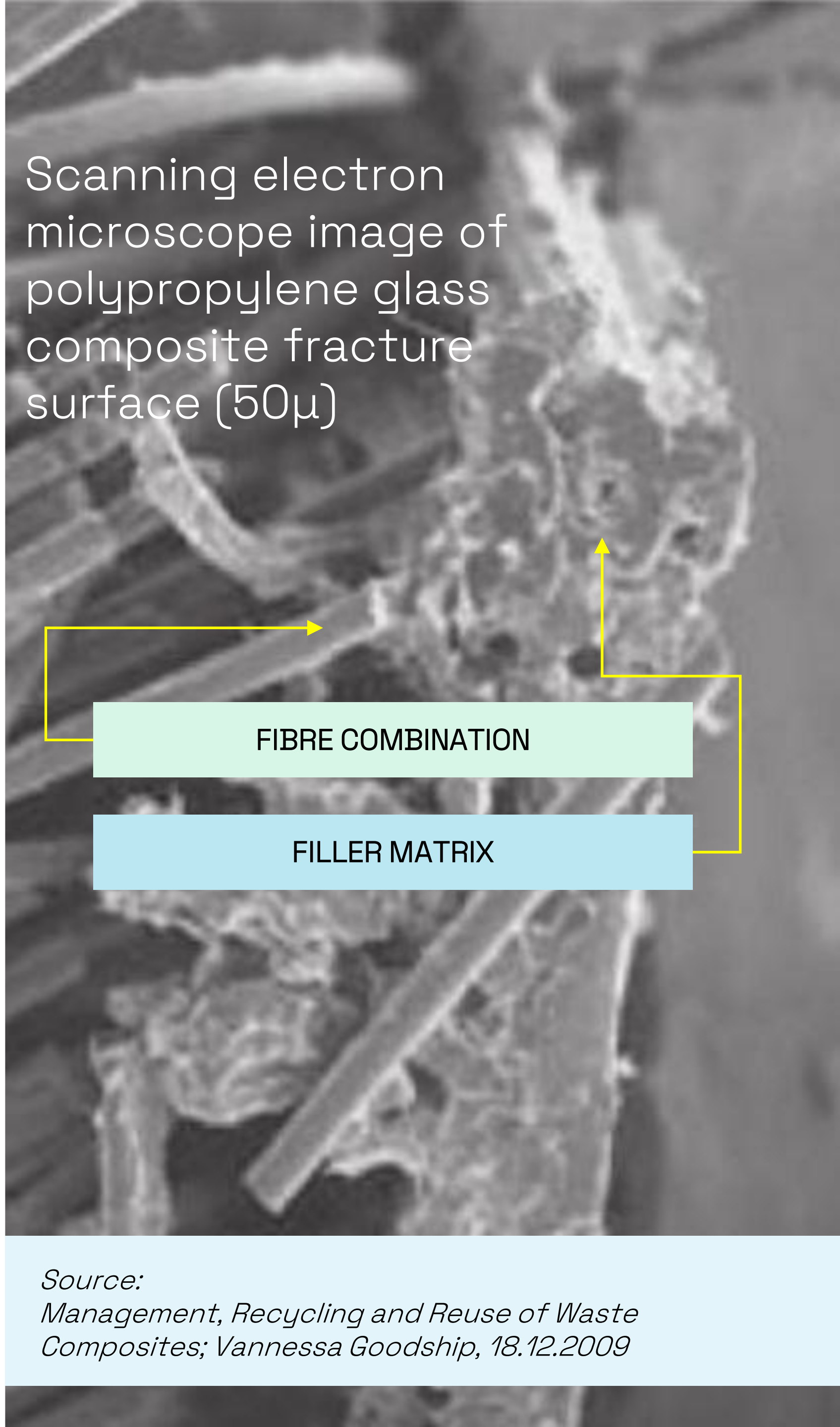
Composites are a combination of two or more natural or artificial components which could be with different physical or chemical properties. The manufacturing processes does not create a chemical reaction, meaning the components don't completely lose their individual identities.

Composites are typically **designed to have additional strength, efficiency and/or durability.**

Components can be grouped under,

1. Fiber combination: Provides strength and stiffness (glass, carbon etc.)
2. Filler matrix: Protects and transfers load between fibers (resins: polyester, epoxy, vinyl ester, others, and other fillers: additives for UV protection etc.)

There are 2 main groups of resins used as a filler in composite cable support systems: *Thermoplastics and Thermosets*



Scanning electron microscope image of polypropylene glass composite fracture surface (50µ)

Source:
Management, Recycling and Reuse of Waste Composites; Vannessa Goodship, 18.12.2009

Thermoplastics

Thermoplastic polymer matrices soften and melt with the application of heat. Any process step from the initial introduction of reinforcement fibres to the final moulding of a component, takes place with sufficient heating to melt the polymer.

Although this **ability to melt can limit the application of such composites** due to comparatively low maximum in-service temperatures, it does mean that end-of-life thermoplastic composite components can be shredded/grounded and readily re-processed via heating and moulding.

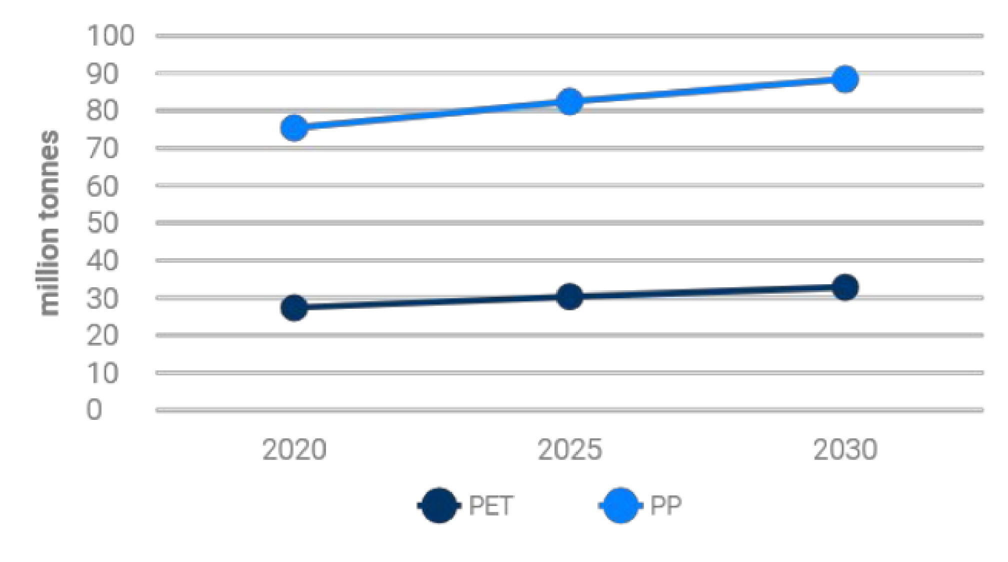
Common thermoplastic resins:
Polypropylene (PP)
Poly Vinyl Chloride (PVC)
Polyethylene terephthalate (PET)
Polystyrene (PS)
Polyamide (PA)

The most common thermoplastic resin used in composite material cable support applications today is polypropylene.

Production Worldwide in 2020 *(in Tons)*:

~400 M

Production forecast of thermoplastics worldwide from 2020 to 2030
(in million metric tons), Source: PreScouter



Thermosets

Thermosetting systems undergo a permanent cross-linking reaction when curing that, although resulting in a stiffer (and more brittle) matrix material, cannot be reversed with the application of heat. The application of heat after curing only degrades the cross-linked polymer matrix and will not melt it.

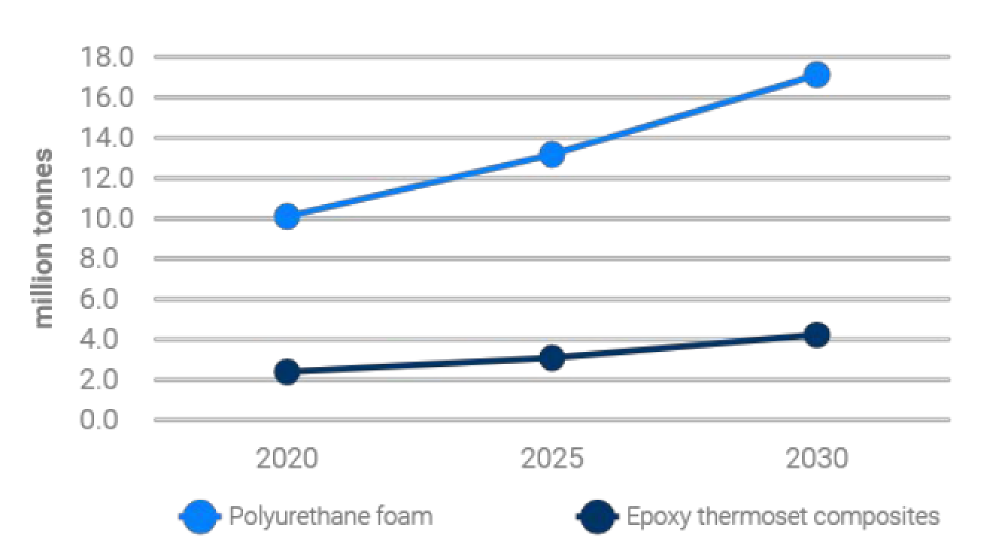
Today there are practical end-of-life recycling options through new chemical catalyzed reaction technologies in addition to incineration with energy recovery and the reuse of thermosetting composite (via regrinding) as a low value filler material.

Common thermosetting resins:
Polyester Resin
Vinyl Ester Resin
Epoxy
Phenolic
Urethane
The most common thermosetting resin used in composite material cable support applications today is epoxy resin (12M Tons[2]), followed by polyester resin (7.5M Tons[1]) and vinyl ester.

Production Worldwide in 2020 *(in Tons)*:

~42 M

Production forecast of thermosets worldwide from 2020 to 2030
(in million metric tons), Source: PreScouter



1- Global value for total manufacturing
Source: GM Insights https://www.gminsights.com/industry-analysis/unsaturated-polyester-resin-upr-market-report
2- Global value for total manufacturing
Source: PreScouter https://www.prescouter.com/

Thermoplastics vs thermosets

Considering cable support applications:

	THERMOPLASTICS *Polypropylene*	THERMOSETS *Polyester*
Tensile modulus (Gpa)	Light/Medium Duty 1.1	Heavy Duty x 3.27
Tensile strength (MPa)	Light/Medium Duty 30	Heavy Duty x 2.27
Specific gravity	Light/Medium Duty 0.9	Heavy Duty x 1.33

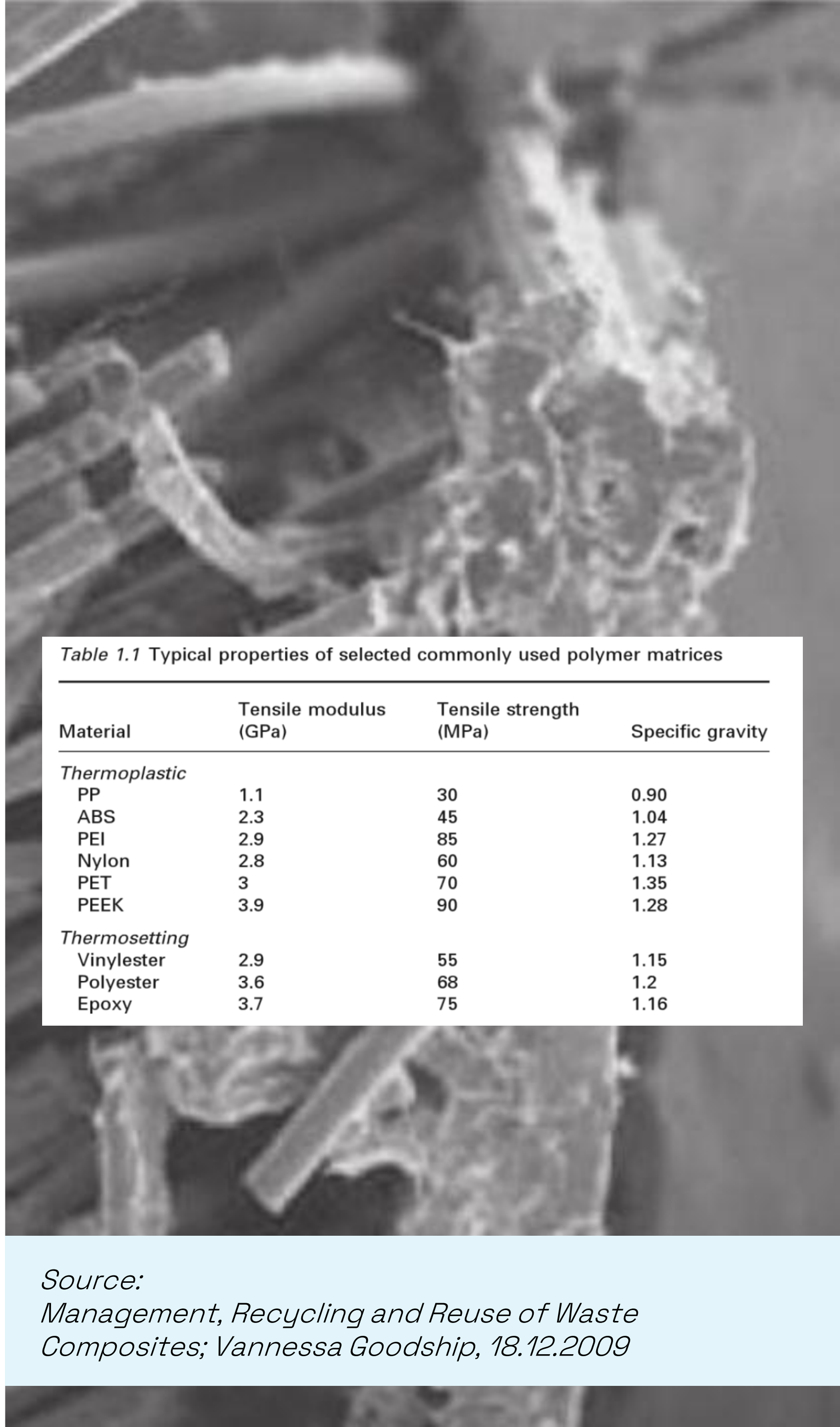


Table 1.1 Typical properties of selected commonly used polymer matrices

Material	Tensile modulus (GPa)	Tensile strength (MPa)	Specific gravity
Thermoplastic			
PP	1.1	30	0.90
ABS	2.3	45	1.04
PEI	2.9	85	1.27
Nylon	2.8	60	1.13
PET	3	70	1.35
PEEK	3.9	90	1.28
Thermosetting			
Vinylester	2.9	55	1.15
Polyester	3.6	68	1.2
Epoxy	3.7	75	1.16

Source:
Management, Recycling and Reuse of Waste Composites; Vannessa Goodship, 18.12.2009

3. Environmental aspect within circular economy

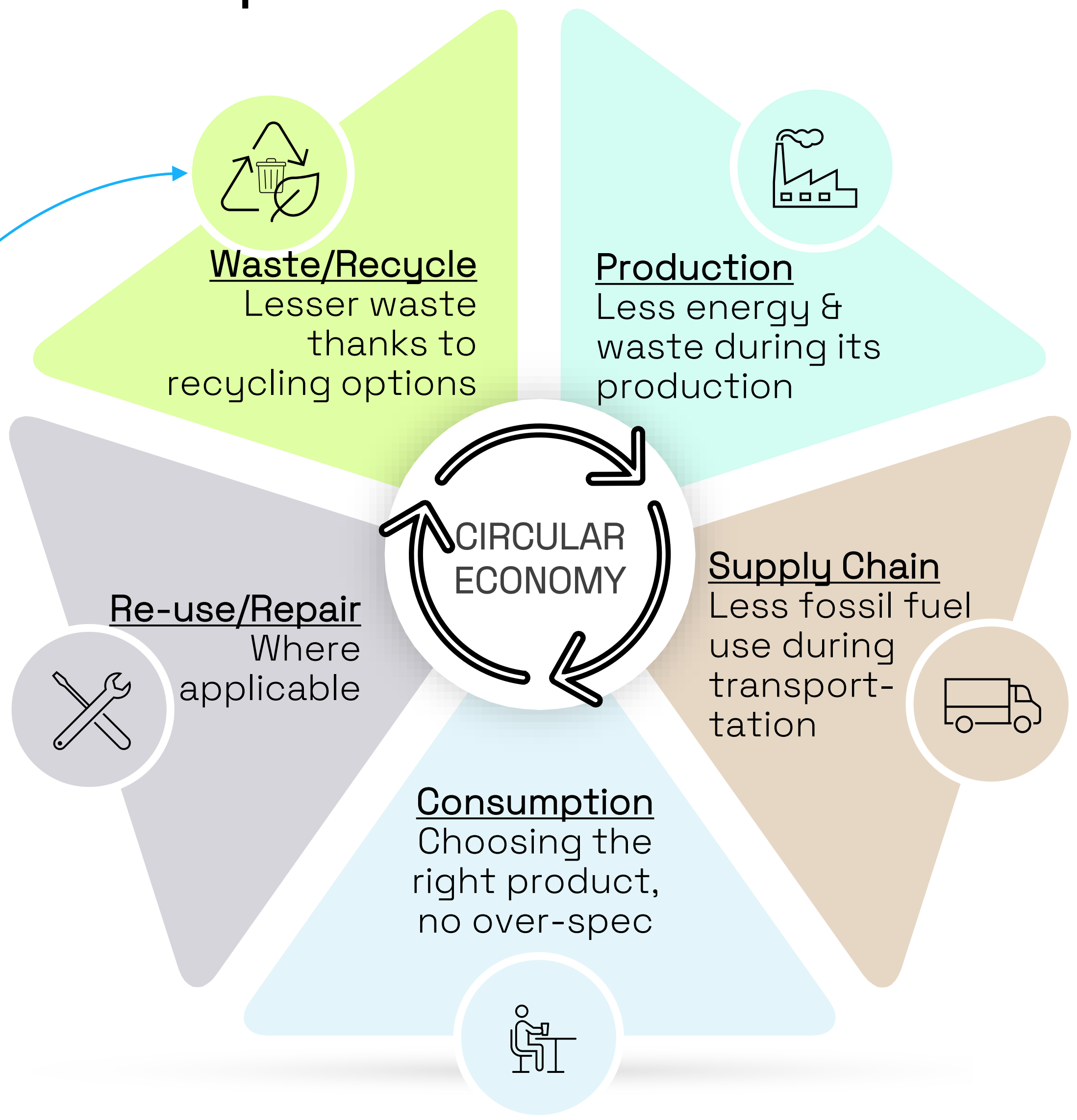
Impact on environment

Environmental aspect of composites within the circular economy

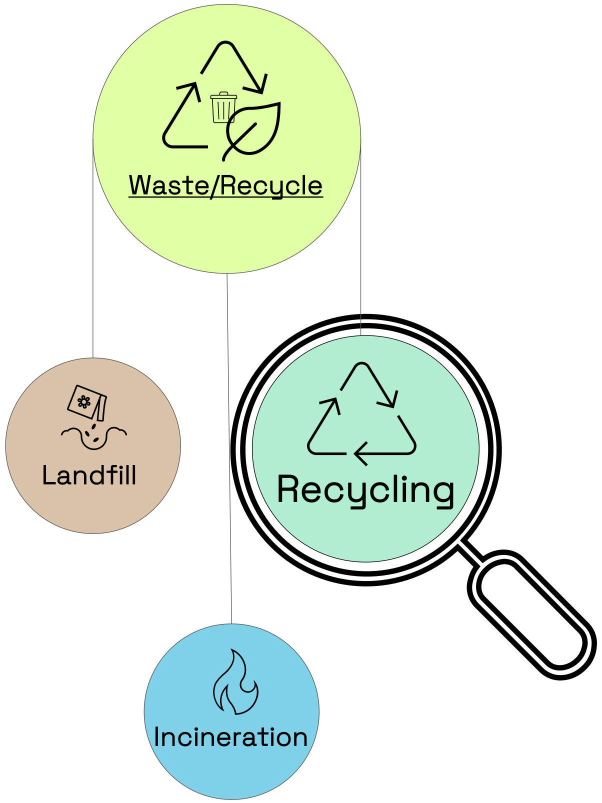
As previously demonstrated, composite materials can offer greatly enhanced performance over commodity materials.

They are of relatively high value and their usage pattern as engineering materials is generally in long-lived applications.

This longer life cycle means that potential end-of-life scenarios must be judged differently from those commodity materials that are used in higher volume/lower cost applications.



End-of-life scenarios for composites



Recycling Methods

1. Mechanical
   a. Cement-Kiln*
   b. Others
2. Chemical
   a. Solvolysis
3. Thermal
   a. Combustion
   b. Fluidised-bed process
   c. Pyrolysis
4. Electrical
   a. High voltage fragmentation

EoL Options	Retained Tensile Strength of Recycled Fiber Compared to Virgin Fiber [%]
Mechanical	~78%
Fluidized-bed process	~50%
Pyrolysis	~52%
Microwave Assisted Pyrolysis	~52% (**)
Chemical	~58%
High Voltage Fragmentation	~88%

As of today, the highest tensile strength retainment is obtained in rGF (recycled glass fibre) produced by High Voltage Fragmentation and the lowest values by the pyrolysis and the Fluidized-bed processes. Economically viable recycling to get quality rGF needs yet to be demonstrated.

** Cement-Kiln Method: This method involves the use of the GRP waste as an alternative fuel in the cement industry. It is one of the promising methods because during the process, 100% of the composite waste is "recovered" in the form of energy and raw materials, resulting in approx. 67% material recovery , is integrated into the clinker (the product of the cement kiln and the basic raw material for cement); and approx. 33% energy recovery—the organic polymer matrix is used as a substitute to fossil fuels. Sometimes this method is included in the recycling methods (e.g., mechanical recycling), and sometimes is viewed as a separate category.*

Source: Composite Material Recycling Technology—State-of-the-Art and Sustainable Development for the 2020s, https://www.mdpi.com/2504-477X/5/1/28

4. What is GRP?

Production methods of GRP cable support systems, design features & benefits

What is GRP?

GRP (Glass Reinforced Polymer)
FRP (Fibre Reinforced Polymer)
GFRP (Glass Fibre Reinforced Polymer)

GRP is a composite material formed of glass rovings/shavings together with resin fillers and additives. There are also different acronyms used by different manufacturers, such as FRP and GFRP, however, they all refer to the same type of composite.

The ***mechanical properties of GRP can vary*** widely depending on the matrix fibre combination, fillers, veils, reinforcement design, and **manufacturing methods.**

These properties allow an initial comparison of different types of composites as well as providing a benchmark against which to measure the success of the specific recycling process in achieving acceptable material properties.

Properties to be benchmarked while choosing the right product

- FIBRE COMBINATION
- FILLERS
- VEILS
- REINFORCEMENT DESIGN
- MANUFACTURING METHOD

Production methods

There are 2 common production methods for GRP cable support systems, which are moulding and lamination (through pultrusion) and do not produce the same results.

Injection or Compression Moulding:

Light / Medium Duty

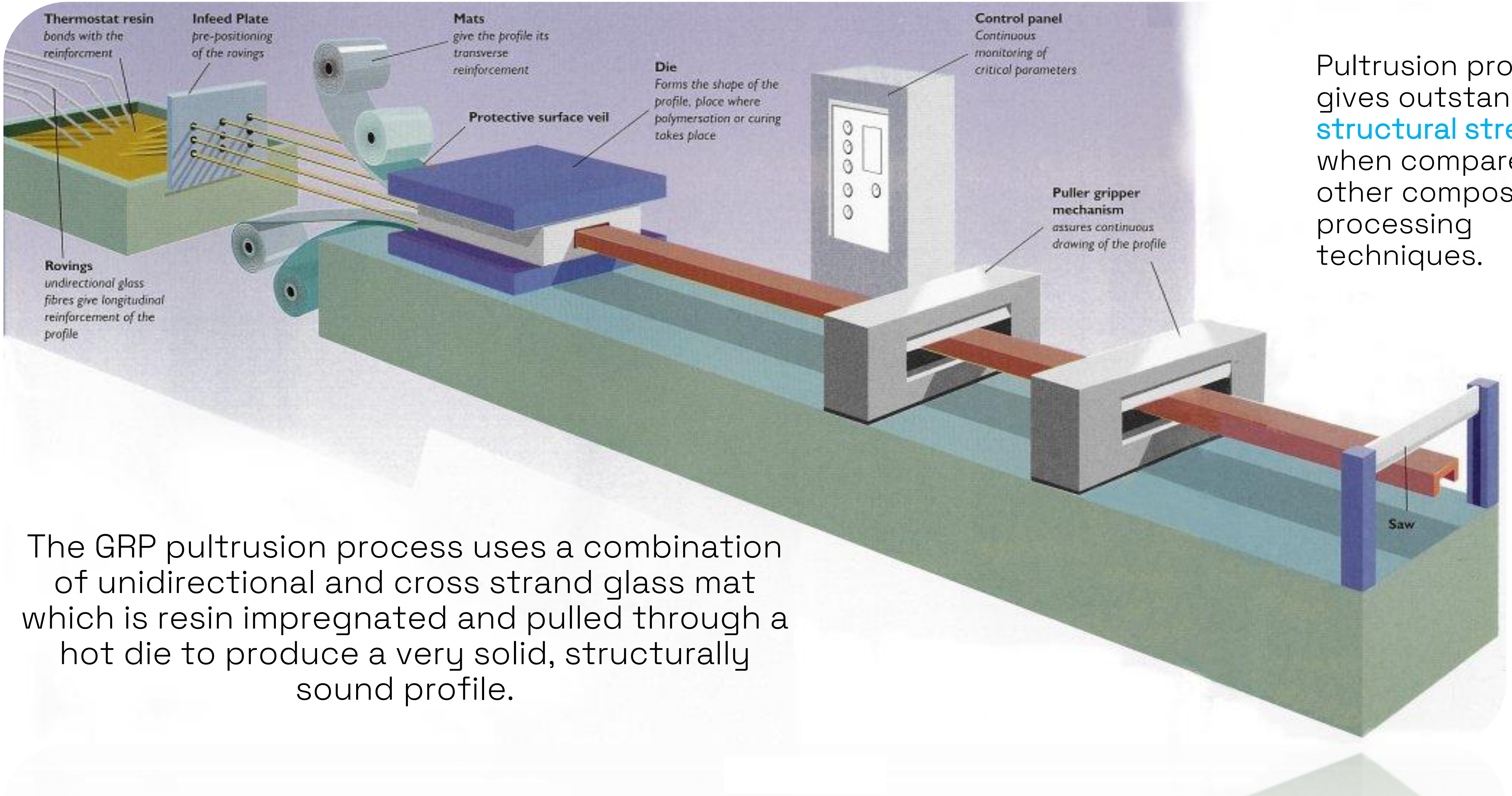
1. Enough structural strength for light and medium duty applications (Low/medium load carrying)
2. Glass content is around **20-25%**
3. High filler content
4. Isopthalic resin or Orthothalic resin which might end up having a low fire retardancy
5. Good for indoor applications, its manufacturing results in nice bends and better shape

Lamination through Pultrusion:

Heavy duty

1. High structural strength for heavy duty applications (high load carrying)
2. Glass content is around **40-55%**
3. Low filler content
4. Isopthalic polyester resin which has a good corrosion/fire performance, and Acrylic resin resulting in better corrosion, fire performance and low smoke/fumes
5. Good for indoor and outdoor applications thanks to the UV surface veil applied during the lamination

Lamination through pultrusion



Pultrusion process gives outstanding **structural strength** when compared to other composite processing techniques.

The GRP pultrusion process uses a combination of unidirectional and cross strand glass mat which is resin impregnated and pulled through a hot die to produce a very solid, structurally sound profile.

GRP for cable support

GRP cable trays and ladders are made to support any type of power circuit, cable, data and instrumentation.

Being that by nature, GRP,

- Is a non-conductive material and can be formulated as a perfect fire retardant,
- Have extra durability against adverse weather conditions,
- UV and corrosion resistant, and,
- Has lighter weight compared to the steel systems,

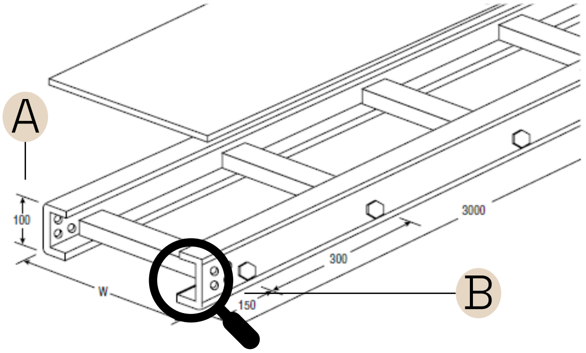
it unlocks,

- An increased installation safety,
- Lower transportation and installation costs,
- To have no EMC liability, no earthing requirements, and
- Low cost of ownership and a lifetime performance.

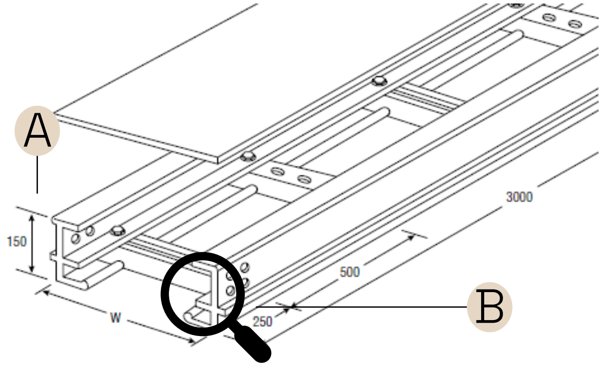
5. Types of designs and resin capabilities

Design types at a glance, design capabilities, resin compliance and capabilities, product characteristics

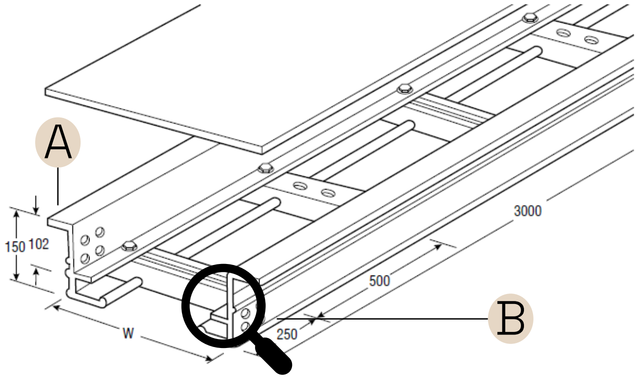
Types of designs at a glance



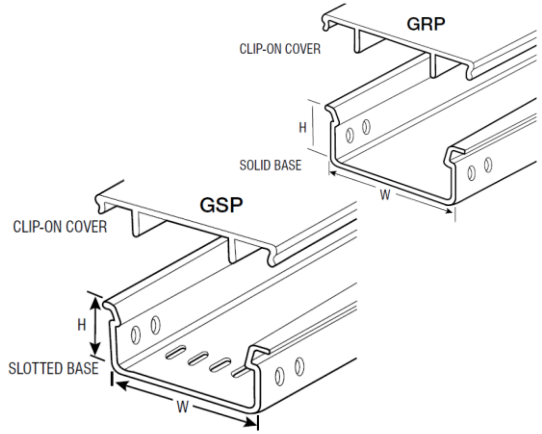
C-Section Ladders



E-Section Ladders

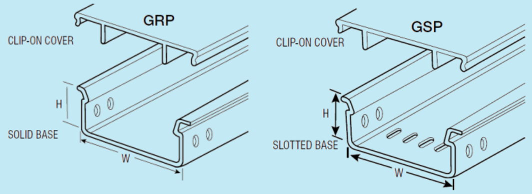
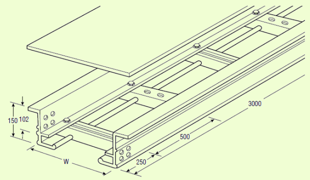
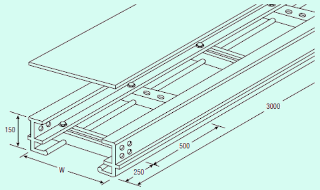
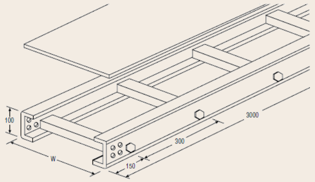


Z-Section Ladders



Solid and Perforated Trays

Design capabilities

DESIGN	VIBRATION	NO WASHER & BOLTS	CLEAT	
Trays Clip-on covers, comes with GRP posts (can be elevated from ground)	◎			
Z-section ladders w/rung facing up Accepts cleats and covers assembled with nut, bolt & washers	◎		◎	
E-section ladders w/rung facing up Accepts cleats and covers assembled with self-tapping screws		◎	◎	
C-section ladders w/rung facing down Covers assembled with self-tapping screws		◎		

Resin type capabilities

RESIN	UV RESISTANCE	HIGH CHLORINE ENVIRONMENT	INFLAMMABLE	SPREAD OF FLAME 5VA	LOW SMOKE EMISSIONS	EXPLOSIVE ENVIRONMENT
PY1 *Polyester Class 1*	☺		☺	☺		
MX *Acrylic with low smoke*	☺		☺	☺	☺	
PY2 *Polyester Class 2*	☺		☺			
PY1C *Polyester Class 1 with carbon loading*	☺		☺			☺
VE *Vinylester*	☺	☺	☺			

UV Resistance:
BS 2782 describes the UV Accelerated Weathering Test Chamber

Inflammability:
BS EN 60695 explains the glow wire test checking how reactive the material is to fire. This standard is mentioned in Building Regulations.

Spread of Flame - Resistance to fire:
BS476-pt7 & pt6, UL94 is interested in the damage caused by burning, the speed of burning and whether the material adds any heat to the fire or not.

Low smoke emissions - Products of combustion:
BS6853 D8.4/B.2, NES713 (Off-shore), NFX 70-100 (LUL) all are interested in what level of smoke, gases, and halogens are released during burning.

Explosive environments - Anti-static:
BS 60079-0 is on explosive atmospheres and specifies the general requirements for construction, testing, and marking of equipment

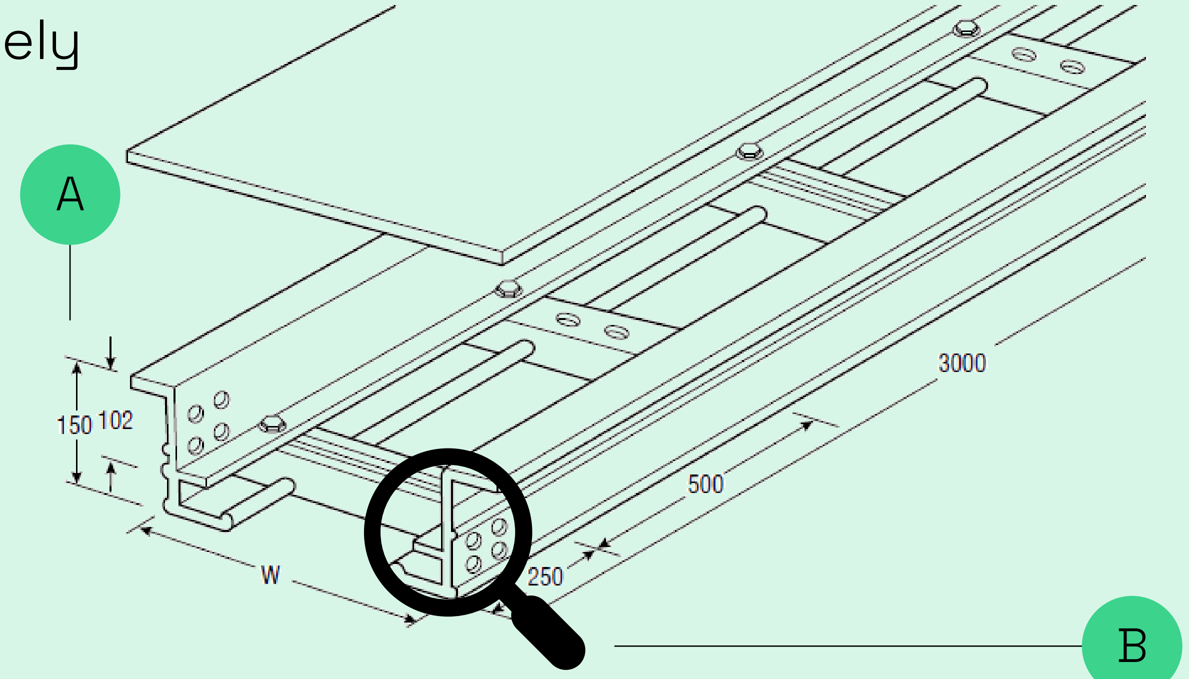
High chlorine environment:
pH reaching to the level 0-2

E.q.: Z-Section Cable Ladders

Excellent durability and stability in extremely harsh and vibrating environments.

Properties to check:

- Available resin types and compliance
- Height
- Width
- Length
- Rung spacing: distance and facing up or down
- Angle of Bends
- Radius Bends
- Mounting and assembly accessories
- Support distance



Ladders

A: 150MM HEIGHT, B: "Z"-TYPE SECTION

6. Applications

Type of applications, suggested design and resins for specific applications, time and cost savings

Applications

TRANSPORT

Railways
Tunnels
Airports
Ports
Etc.

WATER

Desalination
Water Treatment
Utilities
Pools
Etc.

PLANTS

Chemical
Pharma
Food & Beverage
Data Centers
Etc.

POWER & GRID

Wind
BioMass, Waste
Solar
Hydrogen
Etc.

Design vs Application

Recommended

DESIGN	RESIN	TRANSPORT: RAIL	TRANSPORT: TUNNEL	TRANSPORT: PORT	WATER: TREATMENT	WATER: WASTE	WATER: POOL	PLANT: CHEMICAL	PLANT: DATA CENTER	PLANT: OFF SHORE	POWER: RENEW	POWER: BIOMASS	POWER: HYDROGEN
Trays Clip-on covers, comes with GRP posts (can be elevated from ground)	PY1	●						●					
	MX	●	●										
Z-section ladders Accepts cleats and covers assembled with nut, bolt & washers	PY1	●									●		
	MX	●	●										
E-section ladders Accepts cleats and covers assembled with self-tapping screws	PY2			●	●	●	●	●	●			●	●
	PY1C									●			●
C-section ladders Covers assembled with self-tapping screws	PY2			●	●	●	●	●			●	●	●
	VE			●	●	●	●					●	

Time savings through the support structure

Below example is based on estimated time to build the required infrastructure for 1km elevated route

- Labour accounts for digging, manpower and tools required to drill holes
- Overhead costs are based on ~25 per hour

Product	Time (minutes)	1.5 Meter Spacing		2 Meter Spacing		2.5 Meter Spacing		3 Meter Spacing		3.5 Meter Spacing		4 Meter Spacing	
		Units Req.	Time (Hrs)	Units Req.	Time (Hrs)	Units Req.	Time (Hrs)	Units Req.	Time (Hrs)	Units Req.	Time (Hrs)	Units Req.	Time (Hrs)
Steel Post	10	667	111	500	83	400	67	333	56	286	48	250	42
Bracket	5	667	56	500	42	400	33	333	28	286	24	250	21
Fixings	5	667	56	500	42	400	33	333	28	286	24	250	21
Concrete	5	667	56	500	42	400	33	333	28	286	24	250	21
Labour	15	667	167	500	125	400	100	333	83	286	72	250	63
Transport	5	667	56	500	42	400	33	333	28	286	24	250	21
Total Time (Hours)			445		375		300		250		215		188
% of Original Time			100%		84%		67%		56%		48%		42%
Overhead Costs			£ 11,117		£ 9,375		£ 7,500		£ 6,244		£ 5,363		£ 4,688

**Actual timings may vary but percentage variations should not significantly change

Cost savings through the support structure

Below example is based on estimated cost to build the required infrastructure for 1km elevated route

- Labour accounts for digging, manpower and tools required to drill holes
- Transport is based on approx. 10% of labour costs

Product	Costs	1.5 Meter Spacing		2 Meter Spacing		2.5 Meter Spacing		3 Meter Spacing		3.5 Meter Spacing		4 Meter Spacing	
		Units Req.	Cost	Units Req.	Cost	Units Req.	Cost	Units Req.	Cost	Units Req.	Cost	Units Req.	Cost
Steel Post	£ 41.00	667	£ 27,347	500	£ 20,500	400	£ 16,400	333	£ 13,653	286	£ 11,726	250	£ 10,250
Bracket	£ 13.00	667	£ 8,671	500	£ 6,500	400	£ 5,200	333	£ 4,329	286	£ 3,718	250	£ 3,250
Fixings	£ 2.00	667	£ 1,334	500	£ 1,000	400	£ 800	333	£ 666	286	£ 572	250	£ 500
Concrete	£ 5.00	667	£ 3,335	500	£ 2,500	400	£ 2,000	333	£ 1,665	286	£ 1,430	250	£ 1,250
Labour	£ 60.00	667	£ 40,020	500	£ 30,000	400	£ 24,000	333	£ 19,980	286	£ 17,160	250	£ 15,000
Transport	£ 6.00	667	£ 4,002	500	£ 3,000	400	£ 2,400	333	£ 1,998	286	£ 1,716	250	£ 1,500
Total Cost			£ 80,707		£ 63,500		£ 50,800		£ 42,291		£ 36,322		£ 31,750
% of Original Cost			100%		79%		63%		52%		45%		39%

**Actual costs may vary but percentage variations should not significantly change

No possession costs have been accounted for within the example

BIM modelling and cable routing software

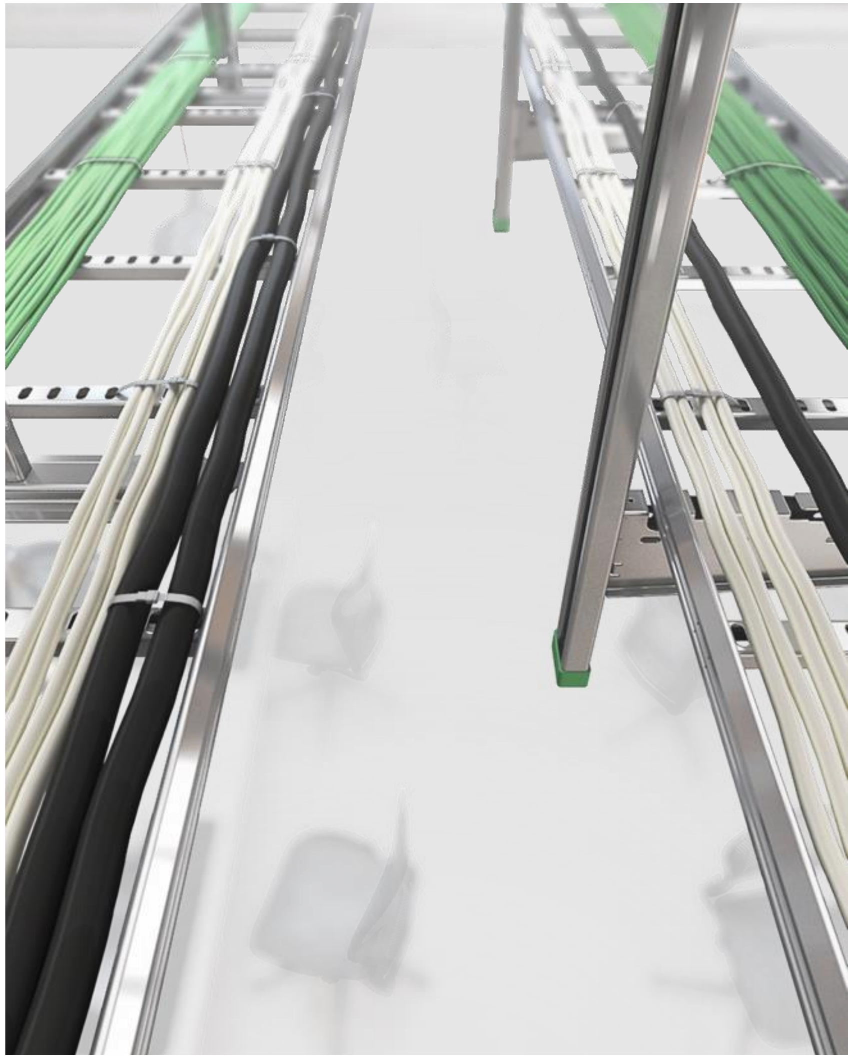
There are software allowing the design of raceway and cable systems together with the complete structure in one platform.

This enables:

- time savings and reduced costs through the integrated system for layout, routing, and material estimating.
- fast track of the project with automated workflows for conceptual and detailed design phases.
- prevention of construction delays by using an intelligent 3D model to spot clashes, ensure spacing, and get accurate take-offs.

GENERAL FEATURES

- Fast and easy 3D modelling of cable trays, conduit, and other raceway systems
- Manual or fully automatic routing of cables
- Dynamic check of raceway fill factor as the design proceeds
- 3D visualization of the cables
- Bill of quantity, cable length report, and cable pull card reports
- Clash detect raceway against 3D reference models



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