



PAINEL 2016
CONSTRUÇÃO CIVIL

Pultrusões de Fibra de Carbono

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Gerente de Vendas e Marketing – América do Sul

São Paulo, 14 de Abril de 2016

Conteúdo:

- **Sobre a Teijin, Toho Tenax e Diversified Structural Composites**
- **Fibra de Carbono e suas propriedades**
- **Definições sobre o Processo de Pultrusão**
- **Propriedades mecânicas de compósitos pultrudados em Fibra de Carbono**
- **Aplicações de Pultrusões de Fibra de Carbono na Construção Civil**

TEIJIN

Human Chemistry, Human Solutions



● Teijin Ltd.
Japan

- 150 Teijin Group companies world-wide
- 17,000 employees
- 745 billion JPY net sales (~ USD 7.4 billion)

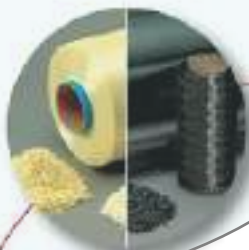
Advanced Fibers & Composites BG

High Performance Fibers BU

- Teijin Techno Products Limited
- Teijin Aramid B.V.

Carbon Fibers & Composites BU

- Toho Tenax Co., Ltd.
- Toho Tenax Europe GmbH



Healthcare BG

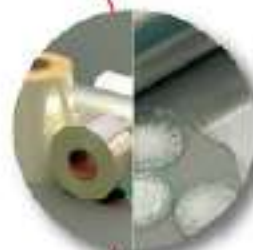
- Teijin Pharma Limited
- Teijin Home Healthcare Ltd
- Braden Partners L.P.



Electric Materials & Performance Polymer Products BG

Films BU

- Teijin DuPont Films Japan Limited
- Teijin Films Limited
- DuPont Teijin Films U.S. Limited Partnership
- DuPont Teijin Films U.K. Limited
- DuPont Teijin Films Luxembourg S.A.



Resin & Plastic Processing BU

- Teijin Chemicals Ltd.
- Teijin Polycarbonate Singapore Pte Ltd.
- Teijin Polycarbonate China Ltd.



New Business Development Group



IT BG

- Infocom Corporation



Products Converting BG

Products Converting BU

- N.I. Teijin Shoji Co., Ltd.

Polyester Fibers BU

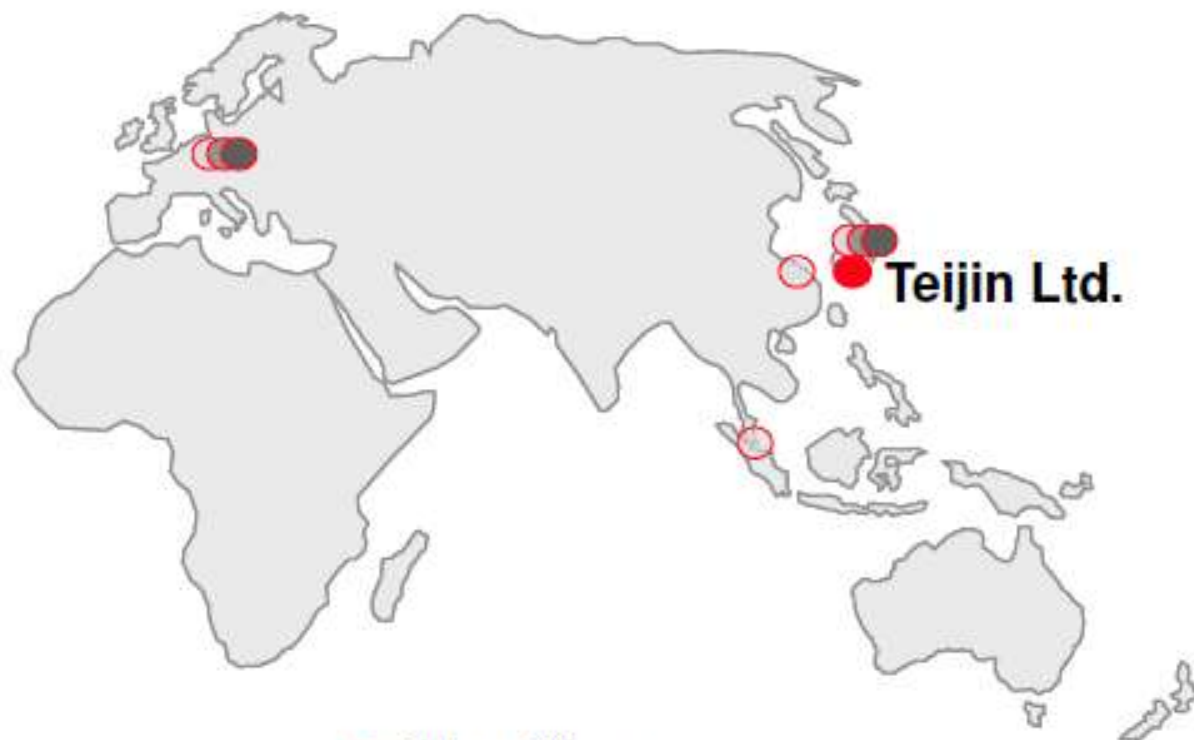
- Teijin Fibers Limited
- Teijin Polyester (Thailand) Limited



Toho Tenax America, Inc.
100 % Toho Tenax Co., Ltd.

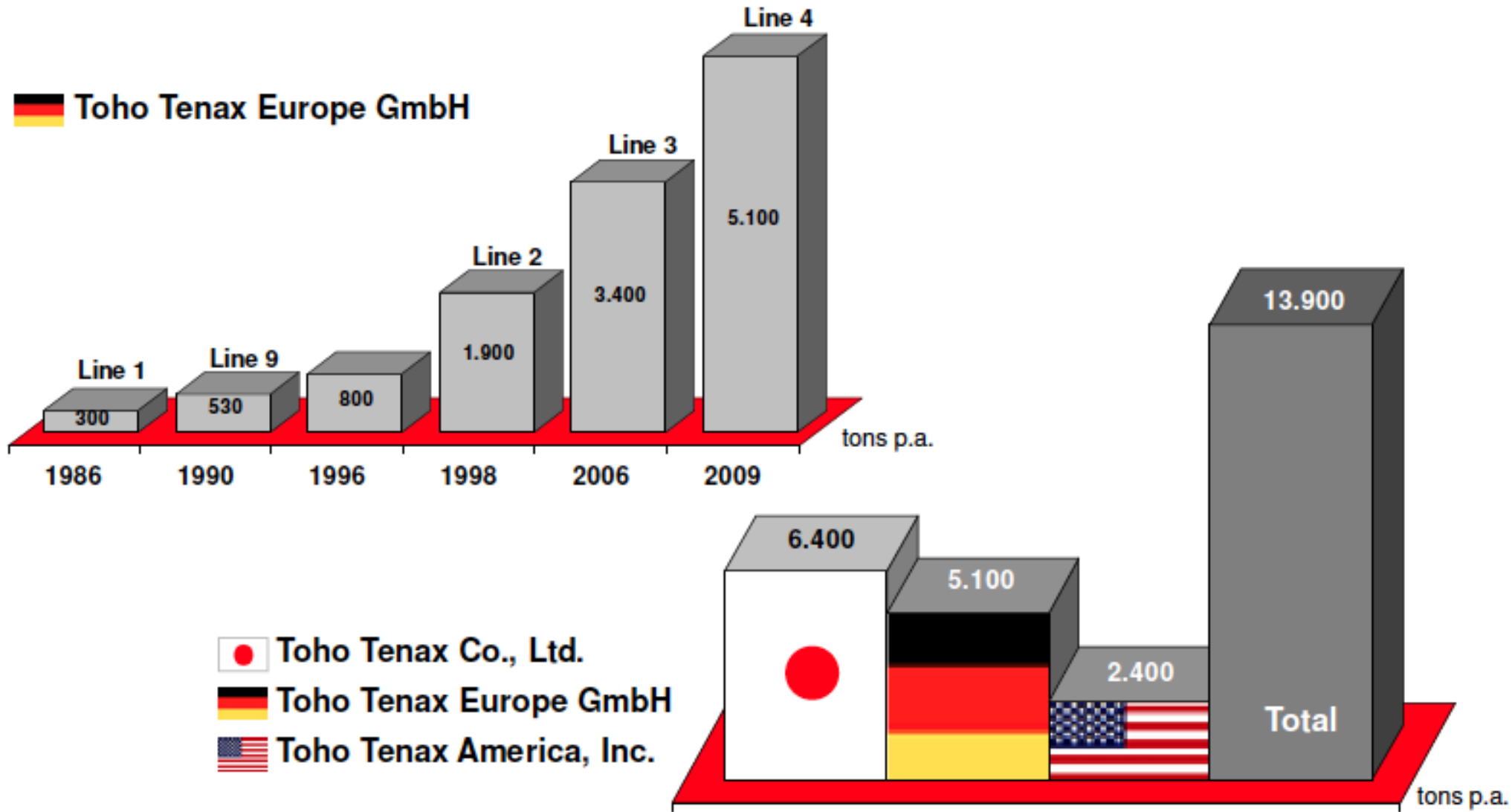


Toho Tenax Europe GmbH
100 % Toho Tenax Co., Ltd.

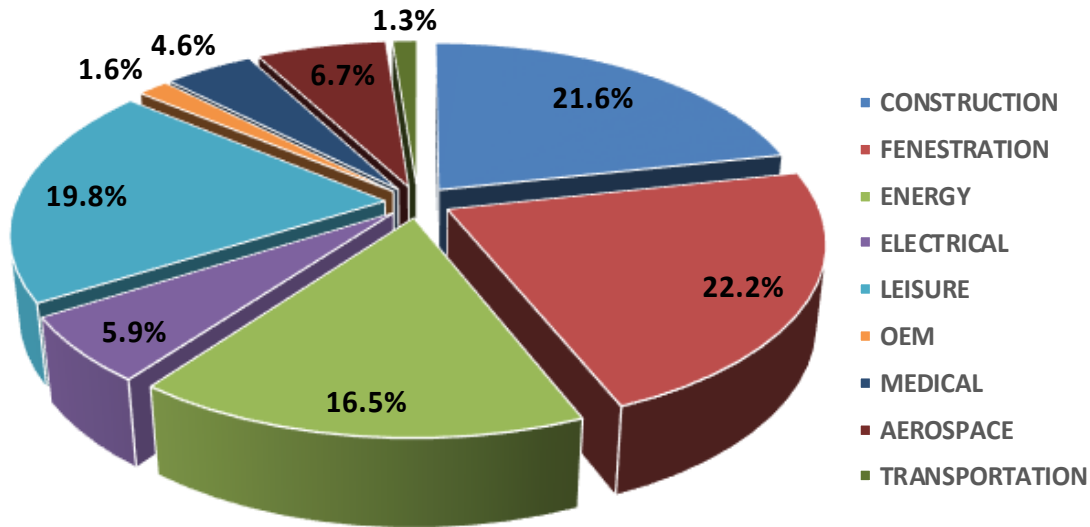


Toho Tenax Co., Ltd.
Japan

- Sales Office
- Production
- Research

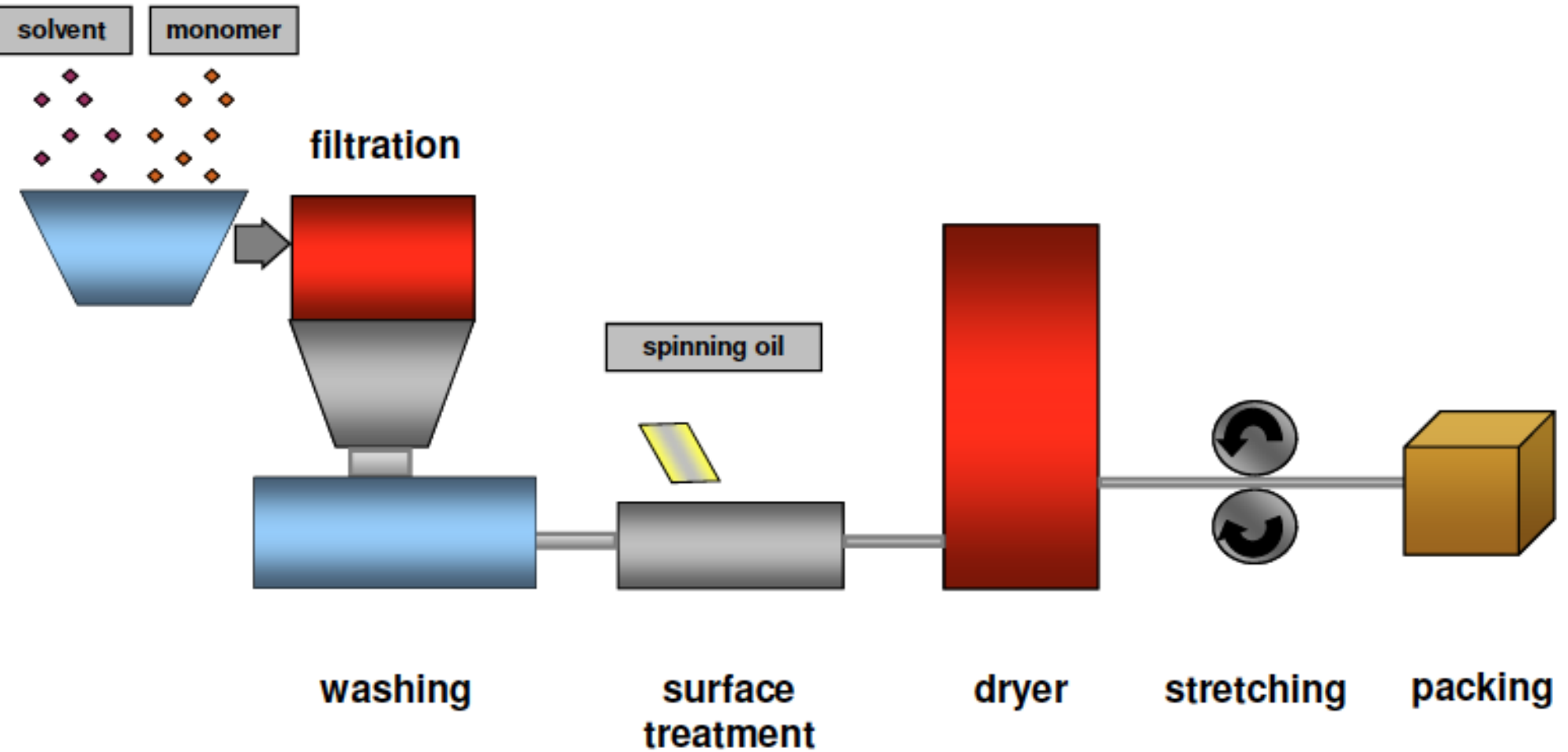


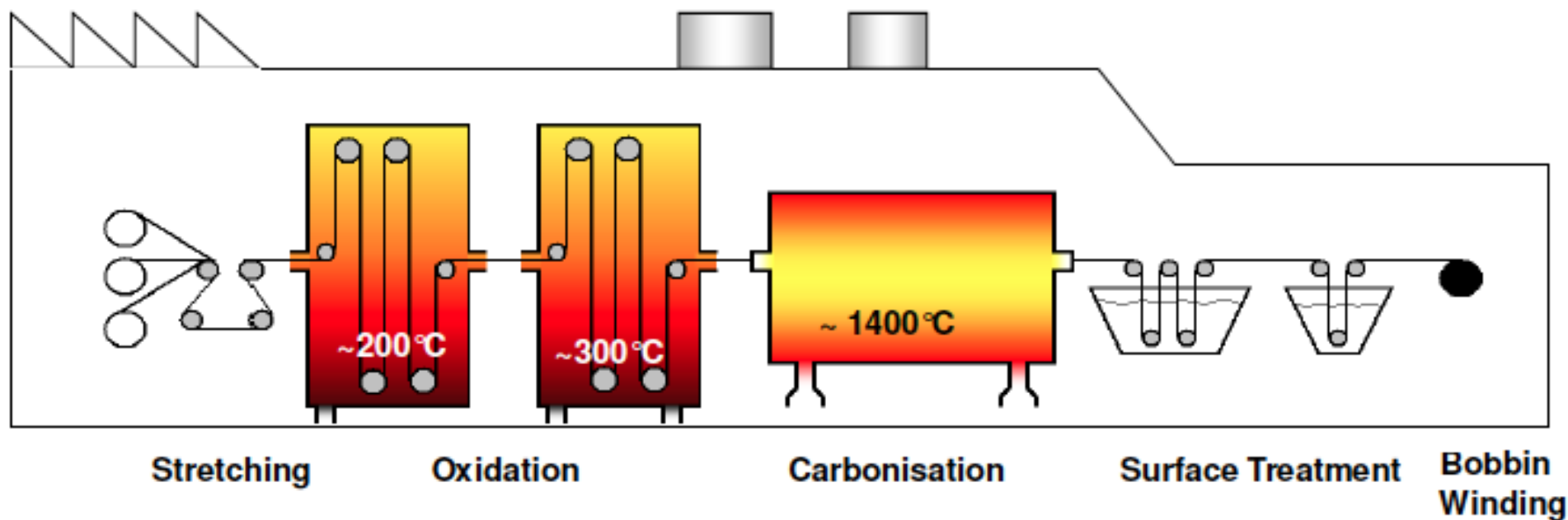
*United States: Capacity converted to OPF production only



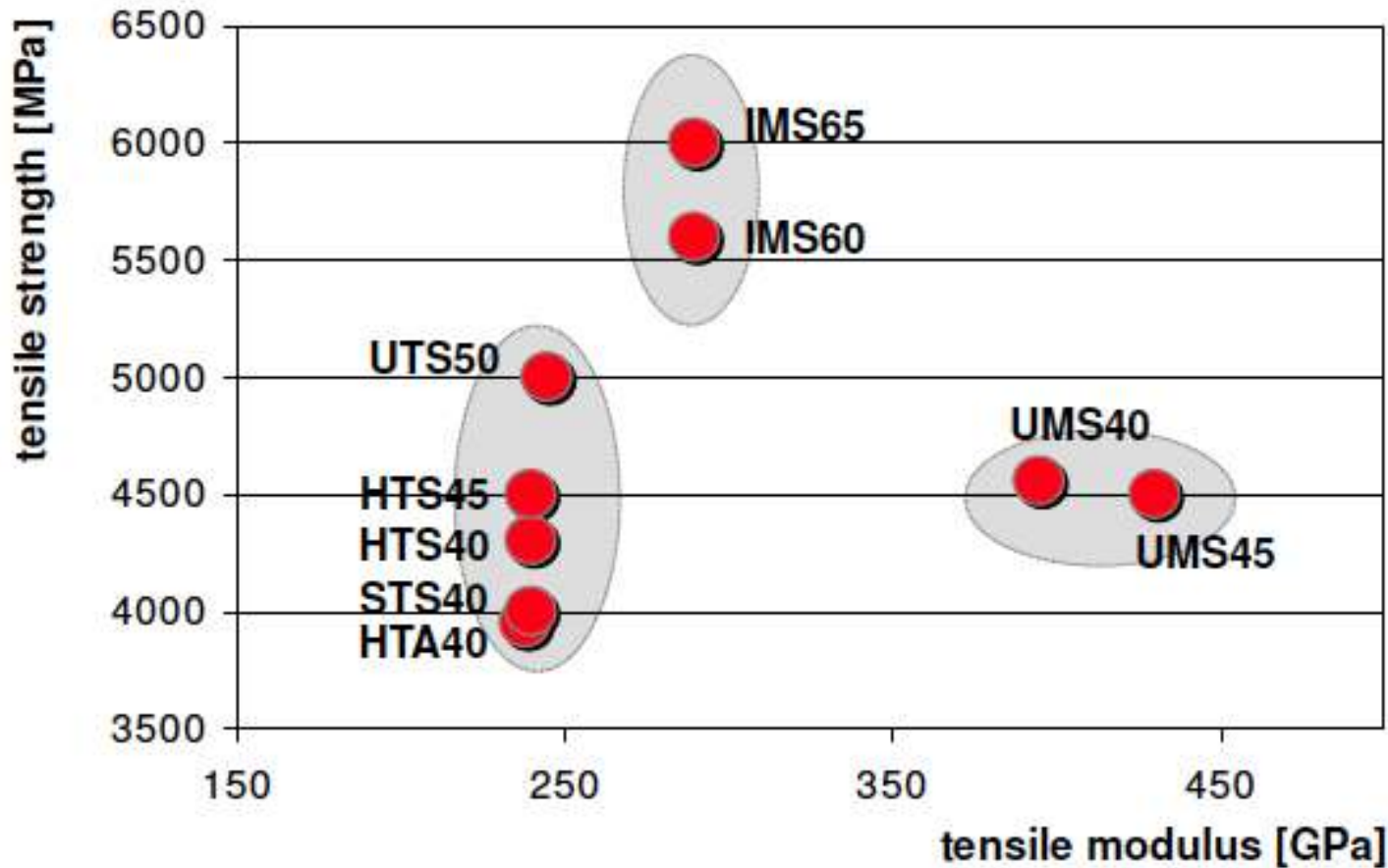
Fibra de Carbono e suas Propriedades

polymerization





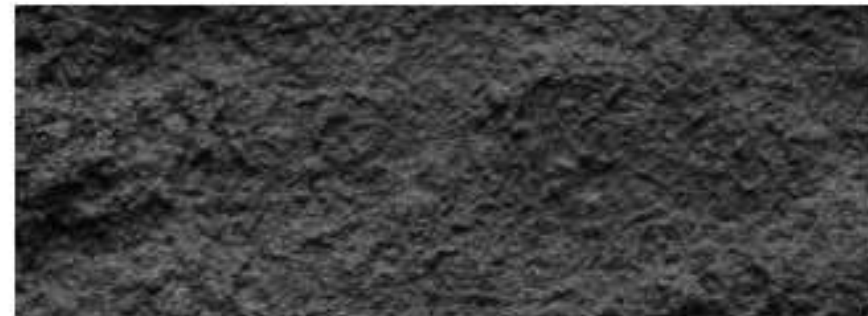
- Complex chemical plant: nitrogen, energy, toxic exhaust fumes
- Substantial plant size 200m length, 18m height
- Three shift, 24 hours production process on 360 day/year

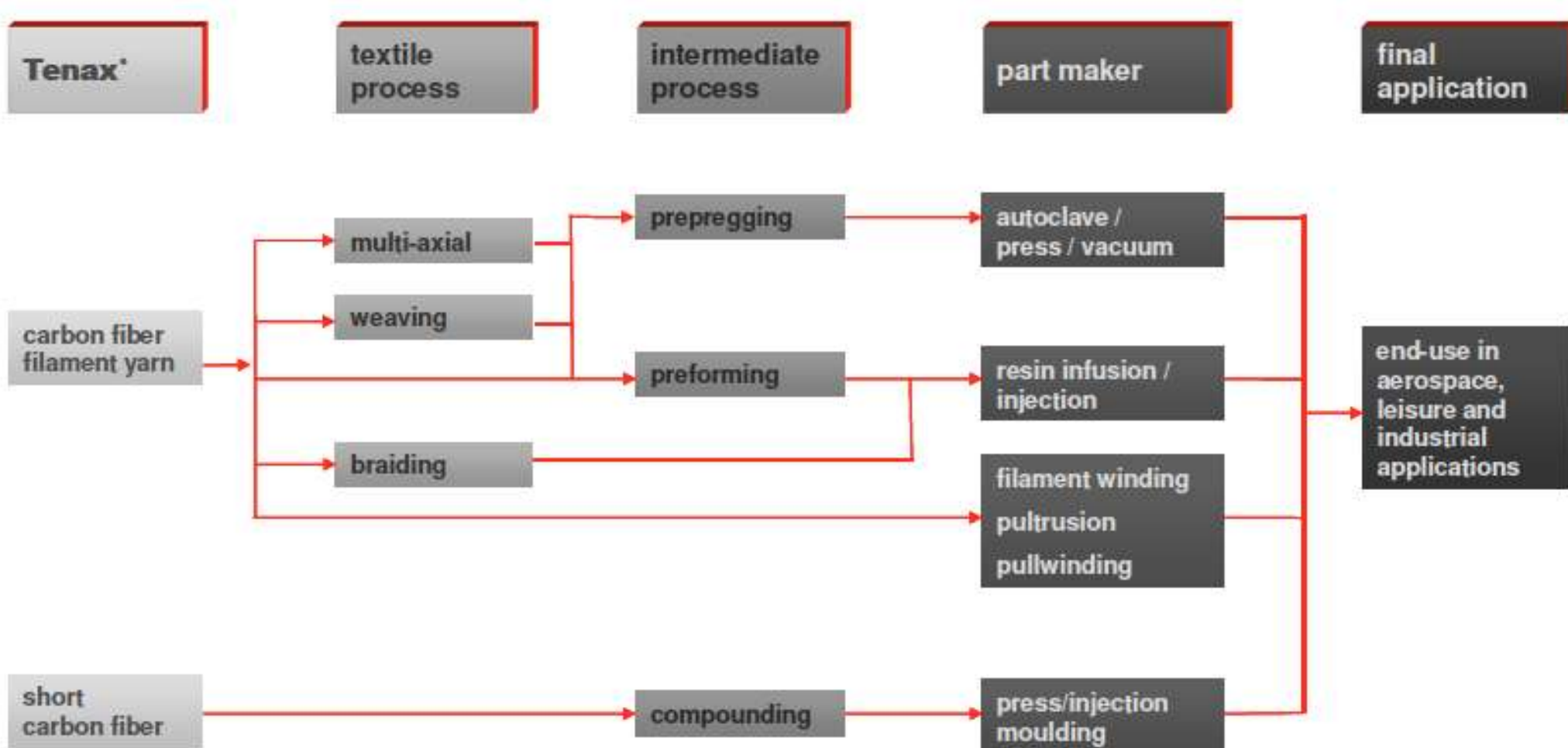


Características importantes:

- Propriedades mecânicas
- Sizing
- Densidade Linear

- Chopped fibers with thermoplastic sizing
- Chopped fibers with thermoset sizing
- Chopped fibers with water soluble sizing
- Chopped fibers with nickel coating
- Milled fibers without sizing





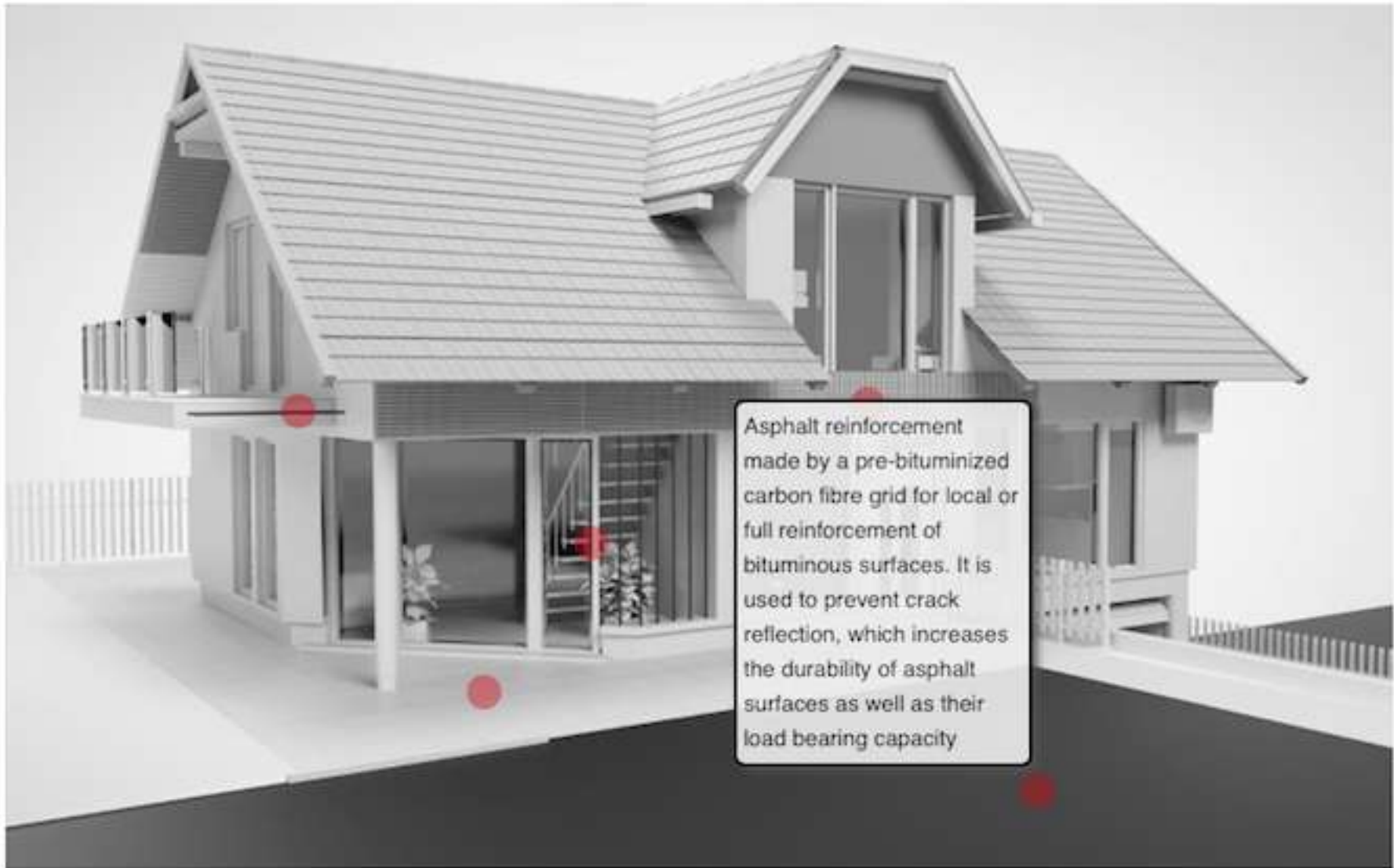
Non corrosive rebars with high stiffness (pultruded carbon fibres) for new building and for prefabricated building materials. Also used for renovation of balconies where corroded steel reinforcement have to be replaced











Pultrusion “Official” Definition –

“A continuous process of manufacturing composite materials with constant cross-section whereby reinforced fibers and or fabrics are introduced to a relatively low viscosity resin system. The fiber reinforcement is formed at various selected points in the process and is pulled through a heated die, where the resin undergoes polymerization. Many resin types may be used in pultrusion including polyester, polyurethane, vinylester and epoxy.”

Basic Process Steps:

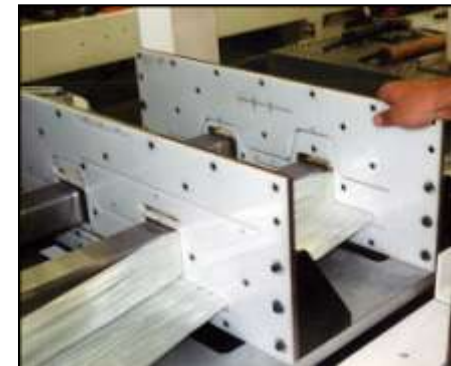
1. Dry reinforcements (fibers, fabrics, mats, etc.) are pulled from a creel into forming tooling
2. Resin Impregnation of the dry reinforcements via various methods, i.e. injection, dip-bath, etc.
3. Curing via heated constant cross-section die cavity
4. Cool-down before entering pulling section
5. Cutoff saw or winding station (for continuous length) after the pulling section



DSC Pultrusion Line



Typical Tooling Die



Fiber / Fabric Forming

The Pultrusion Process is best suited for continuous large volume production runs. The Pultrusion process allows a smooth continuous flow of materials from efficient rack and creel systems at high rates of cure.

Benefits:

- **Repeatable performance** and properties of production products.
- **Low tooling and other capital costs** related to production.
- **Excellent fiber placement and alignment** opportunities. (repeatable)
- **High fiber loading**, up to 70% by volume for UD profiles
- **Continuous process** with flow speed versus cycle times.
- **Low labor costs**- semi-automated process
- **Low waste**- continuous process, part produced as net shape with close tolerances





Unique fiber forming and placement including high speed complex shape forming, in line braiding / winding, and multi-performance resins. A wide range of options to meet critical performance needs.

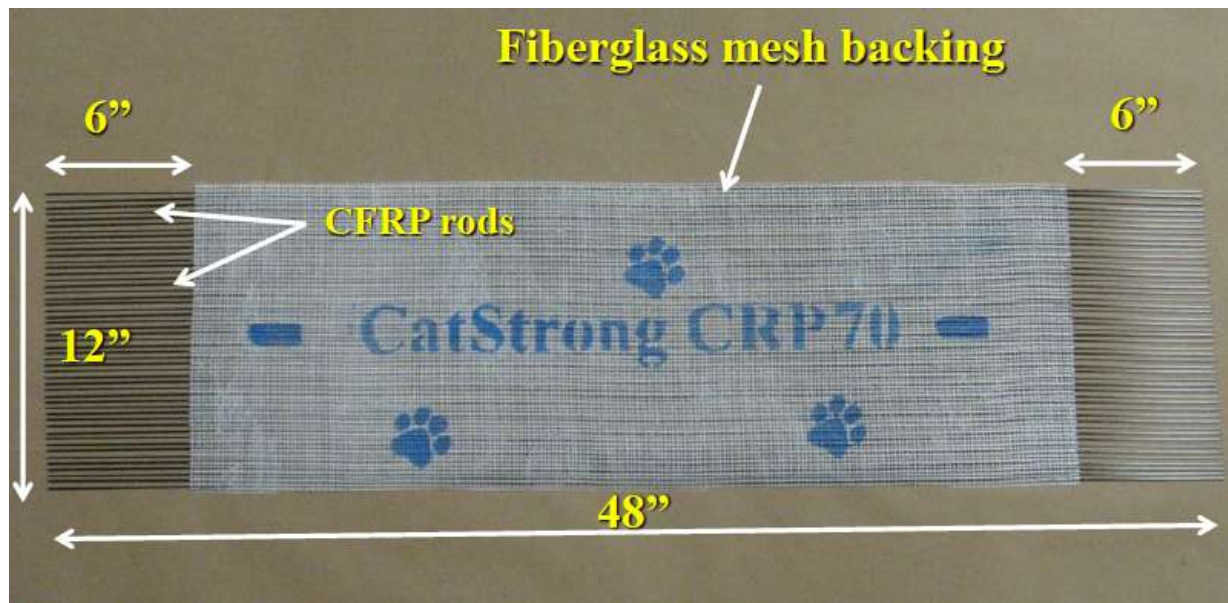


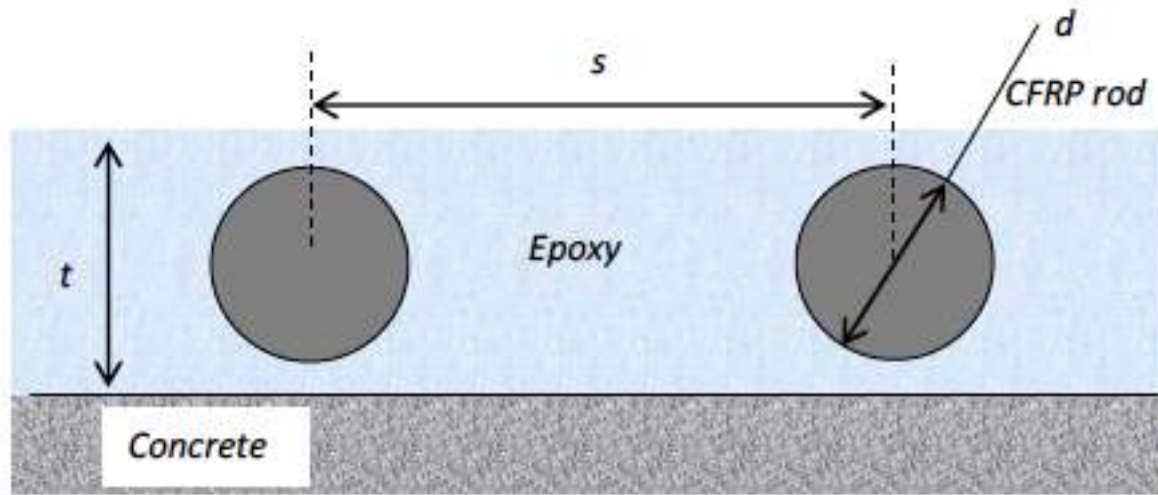
TYPICAL PROPERTIES AND POINTS OF REFERENCE FOR DISCUSSION PURPOSE ONLY

| | | CARBON FIBER RODS | | | | CARBON FIBER FLAT STRIPS | | |
|-------------------------|------------|-------------------|-------------------|-------------------|----------------|--------------------------|-------------------|-------------------|
| DIMENSIONS | mm | 1.73 | 6.50 | 6.50 | 12.70 | 12.7 X 1.90 | 19 X .76 | 102 X 1.57 |
| FIBER TYPE | | STD MOD | STD MOD A | STD MOD B | STD MOD | STD MOD | STD MOD | STD MOD |
| FIBER VOLUME | | 67% | 68% | 68% | 61% | 61% | 67% | 61% |
| RESIN TYPE | | Epoxy | Vinylester | Vinylester | Epoxy | Epoxy | Vinylester | Epoxy |
| Tg (DMA) | | 145 | 118 | 100 | 145 | 185 | 118 | 110 |
| TENSILE STRENGTH | Ksi | 322 | 372 | 363 | 319 | 325 | 369 | 326 |
| | Mpa | 2218 | 2566 | 2500 | 2200 | 2241 | 2544 | 2250 |
| TENSILE MODULUS | Msi | 22.0 | 23.2 | 22.0 | 21.0 | 17.7 | 21.0 | 19.1 |
| | Gpa | 152 | 160 | 152 | 145 | 122 | 145 | 132 |
| DENSITY | SG | 1.57 | 1.56 | 1.56 | 1.53 | 1.55 | 1.57 | 1.53 |

Exemplo: Catstrong®

- Tecnologia desenvolvida pela Universidade de Kentucky
- Aplicação: Reforço e recuperação de Estruturas de Concreto
- Fabricante: Departamento de Engenharia Civil, Universidade de Kentucky
- Fabricante das Pultrusões: Diversified Structural Composites





Carbon panel placement

| Designation | Diameter, d (in) | Rod area ($\times 10^{-3} \text{ in}^2$) | Rod Spacing, s (in) | Bars per panel | Weight (lb./panel) | Strength (kip/ft.) |
|---------------|--------------------|--|-----------------------|----------------|--------------------|--------------------|
| CRP70 | 0.078 | 4.78 | 0.25 | 48 | 0.66 | 73.4 |
| CRP90 | 0.088 | 6.08 | 0.25 | 48 | 0.81 | 93.4 |
| CRP110 | 0.098 | 7.54 | 0.25 | 48 | 1.00 | 115.8 |
| CRP145 | 0.136 | 14.53 | 0.375 | 32 | 1.30 | 148.7 |
| CRP195 | 0.156 | 19.11 | 0.375 | 32 | 1.71 | 195.7 |

Retrofit of Impacted Girder on the Sunnyside-Gotts Road over I-65



Impacted Girder



Impacted Girder



Day 1,2: Preparation of Damaged Zone



Day 3: Bonding Agent on Steel and Concrete



Day 3: Formwork for Repair Mortar



Day 4: Patching of Defects



Day 5: Crack Injection



Day 6: Grinding of Crack Injection Ports



Day 6: Sand Blasting of Retrofit Surface



Day 6: CatStrong CRP 195 Application



Day 6: CFRP Fabric Application



Day 6 (Dawn of Day 7): Retrofitted Zone



**Retrofitted Girder Stronger Than
Original Girder**

Contato

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