Engineering in GRP pipes and tanks

Fundamentals, behaviour and design philosophy

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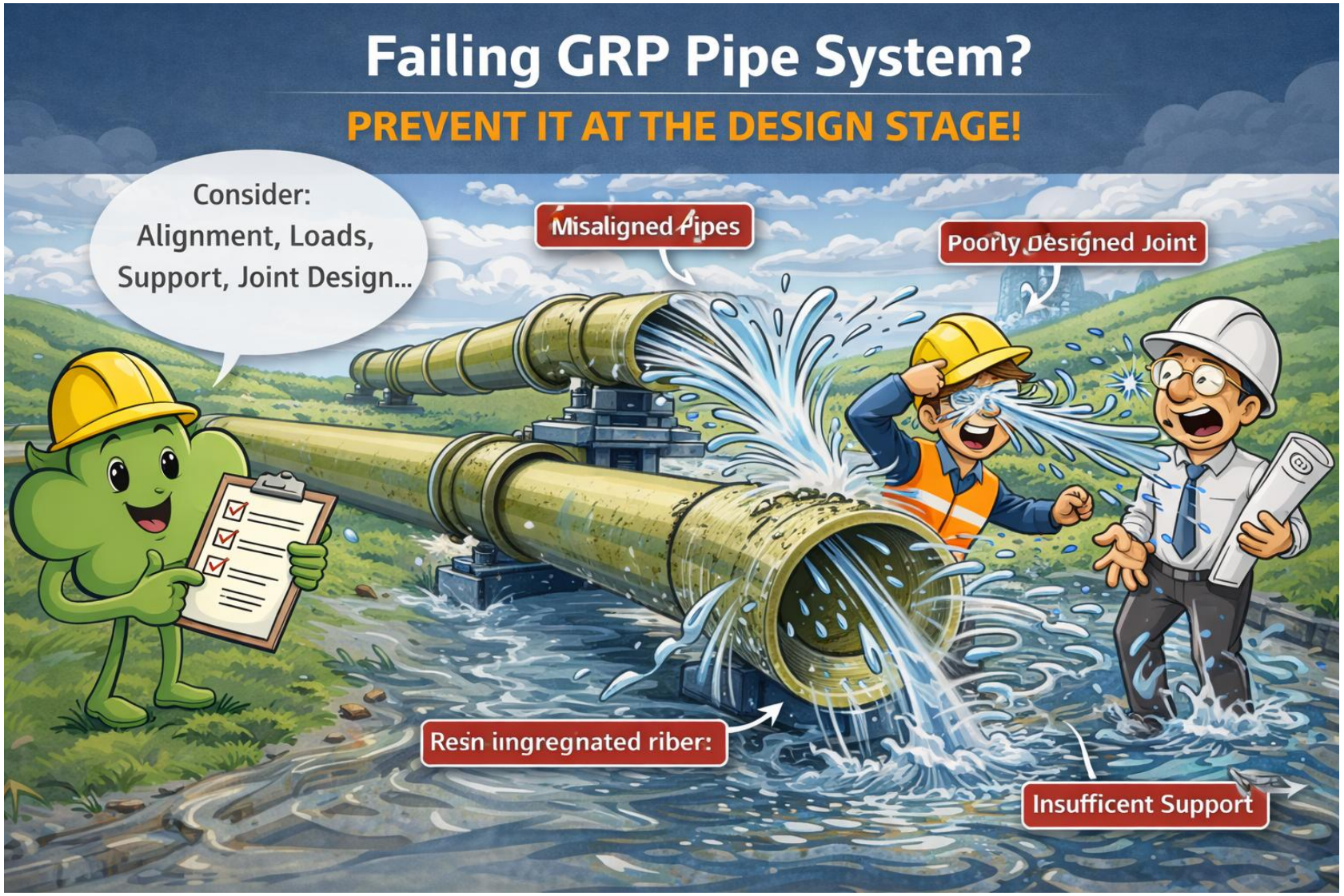
LinkedIn

What we will cover today

- Why GRP behaves differently (block 1)
- Why systems fail (block 2)
- Building blocks (block 3)
- **Behaviour and design (block 4)**
- Standards (ISO 14692 / EN 13121) (block 5)
- Inspection and failure detection (block 6)

From failure to design



“Analysis explains — design decides.”

What you actually design in GRE

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Geometry

- Pipe diameter
- Wall thickness

system

- Support spacing
- Routing (bends, offsets)

Constraints

- Joint type (adhesive, laminate, flange)
- Support type (guide, rest, stop,anchor)

“GRP sees more deformation than steel — so loads interact differently.”

System Design – GRP reality

- GRE / GRP materials are flexible
- Dimensions and properties different from metal.
- GRE / GRP pipe expands due to pressure & temp

  different from Steel.
- GRE / GRP material is orthotropic: Axial and circumferential stiffness is different.

Design consequences

- Allow movement
- Flanges are critical

Supports & Flexibility

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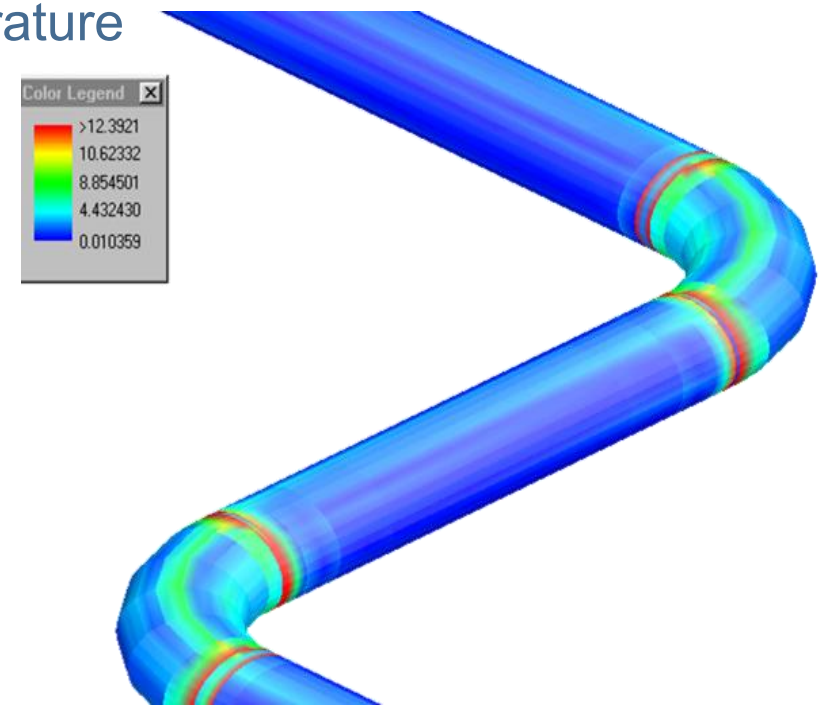
Where problems originate in GRE systems

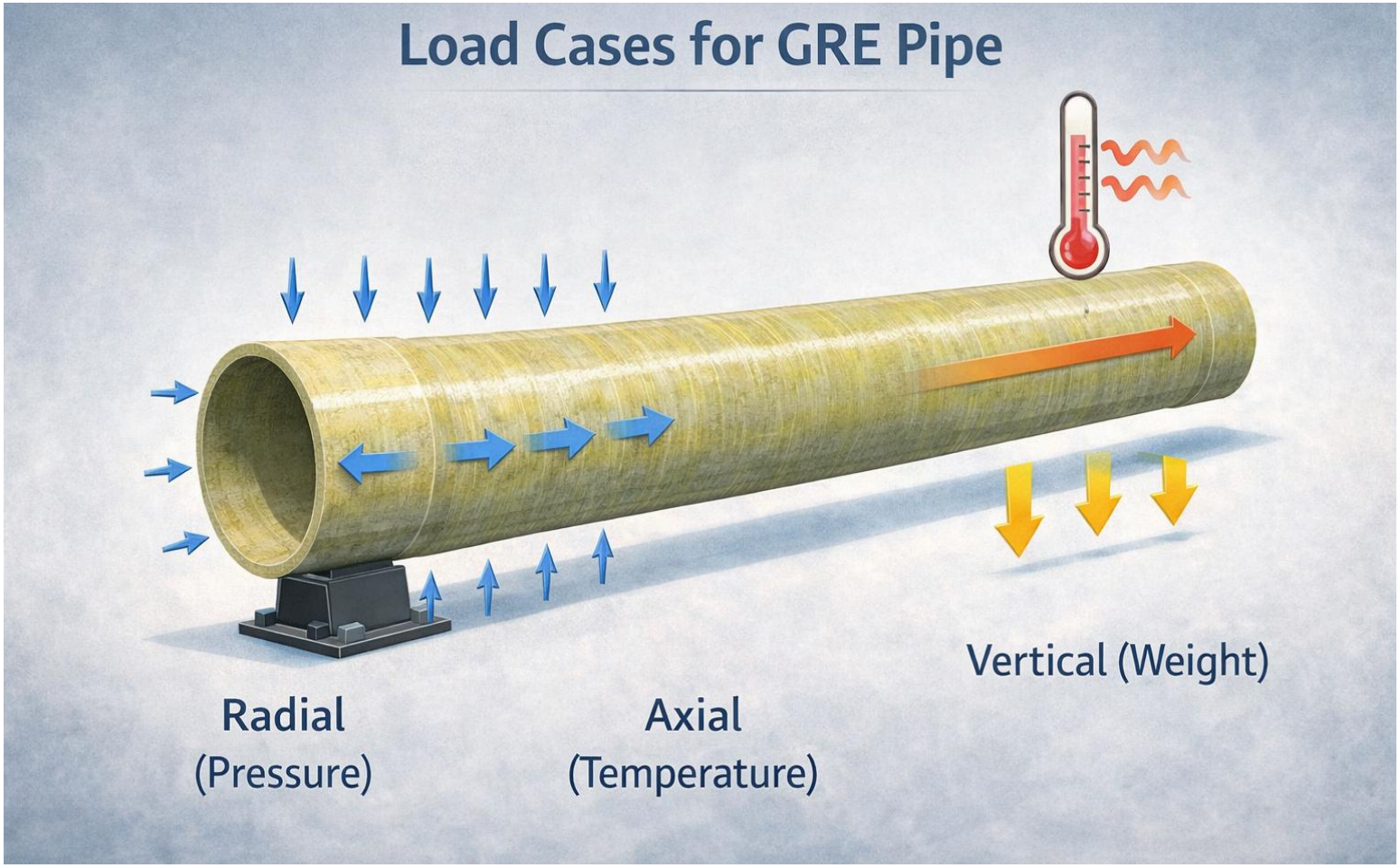
- Relative large Pipe expansion due to pressure
- Large Pipe expansion due to temperature
- Stiff bends:
  - Limited contribution of
  - bends in abs. of expansion
- Highest Stresses
  - near Bends and (Tees) (typically)



- Typical designs do not exist
  - Designs are tailor made (because of scatter in properties for different suppliers)

Load cases for GRE

- Internal pressure/ vacuum
- Temperature (thermal expansion)
- Weight (pipe + contents)
- External loads (supports, soil, wind)

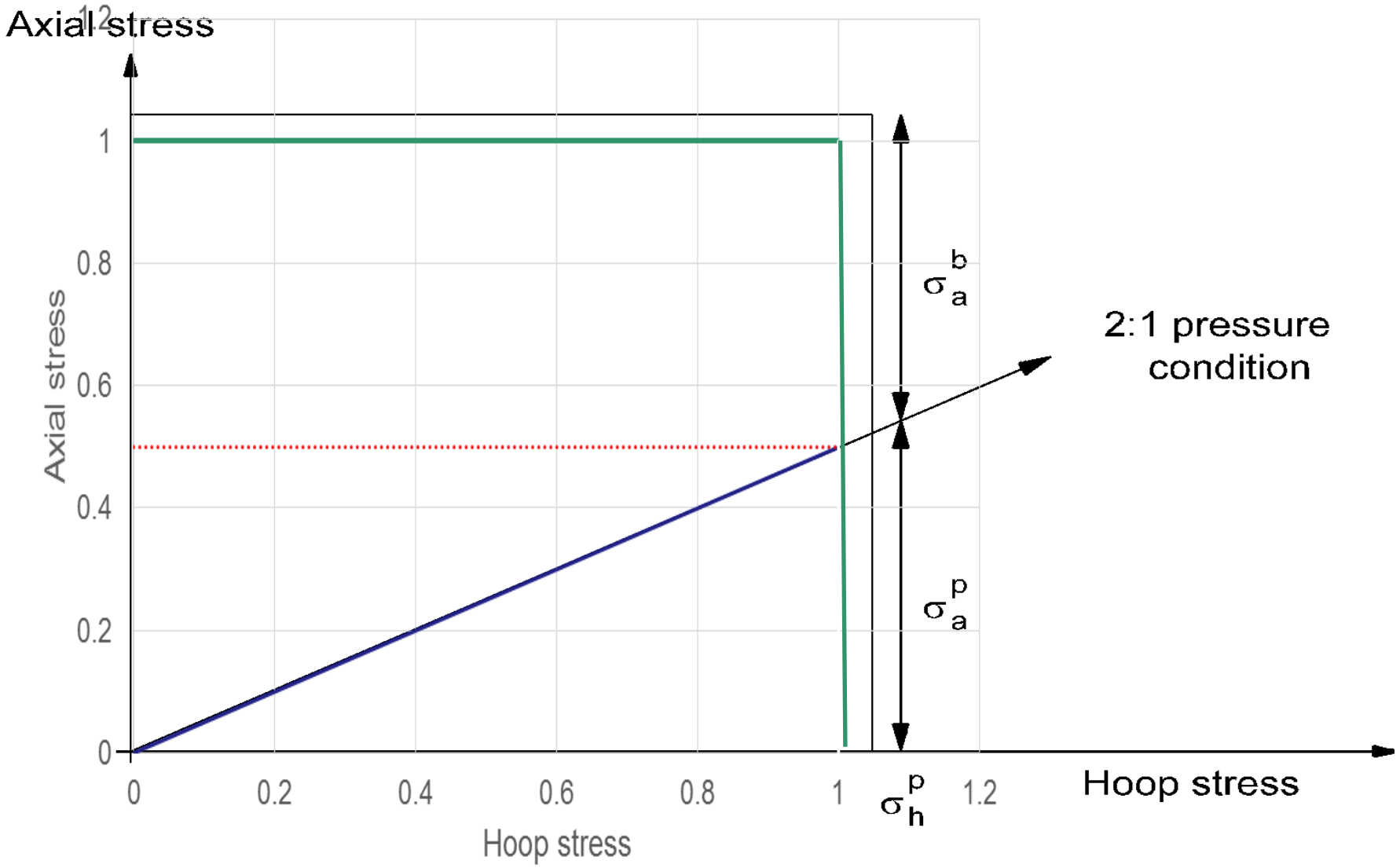


Design starts with loads, not stress

Load assessments

- Wallthickness for pressure containment (Internal and external)
- Deflection (circumferential, lateral, axial)
  - Material Elasticity
    - Axial Direction
    - Circumferential Direction
- Combined Strength (allowable stress)
    - Axial Direction
    - Circumferential Direction

Design envelope isotropic material



Strength vs stiffness

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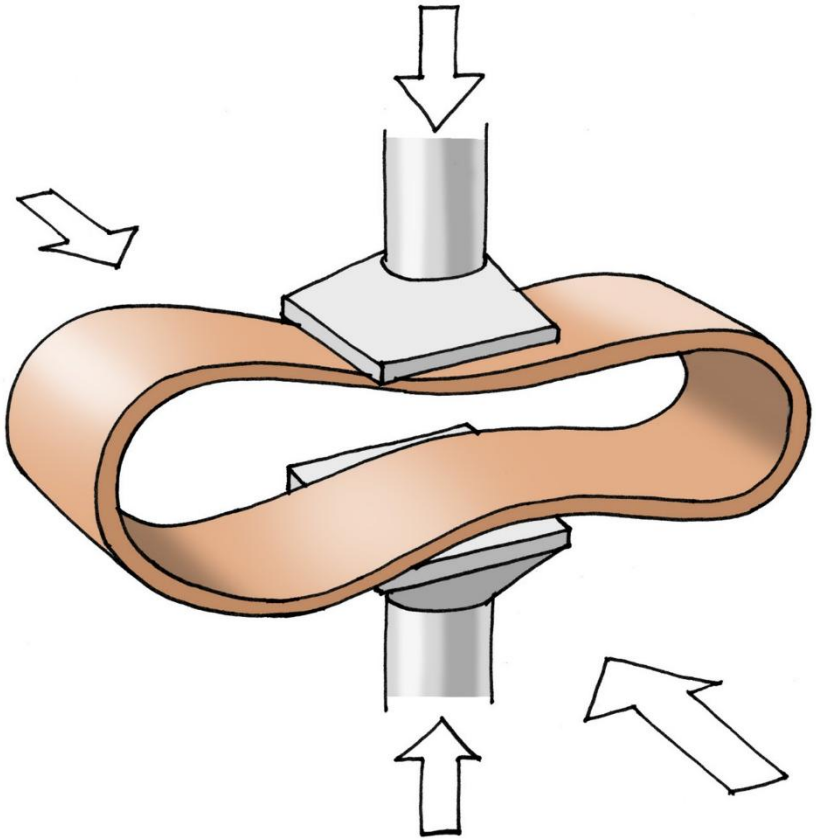
Often confused but they are two different things

- Strength → when it breaks
- Stiffness → how much it deforms

Twice as thick does not automatically mean twice as durable



Strength and stiffness

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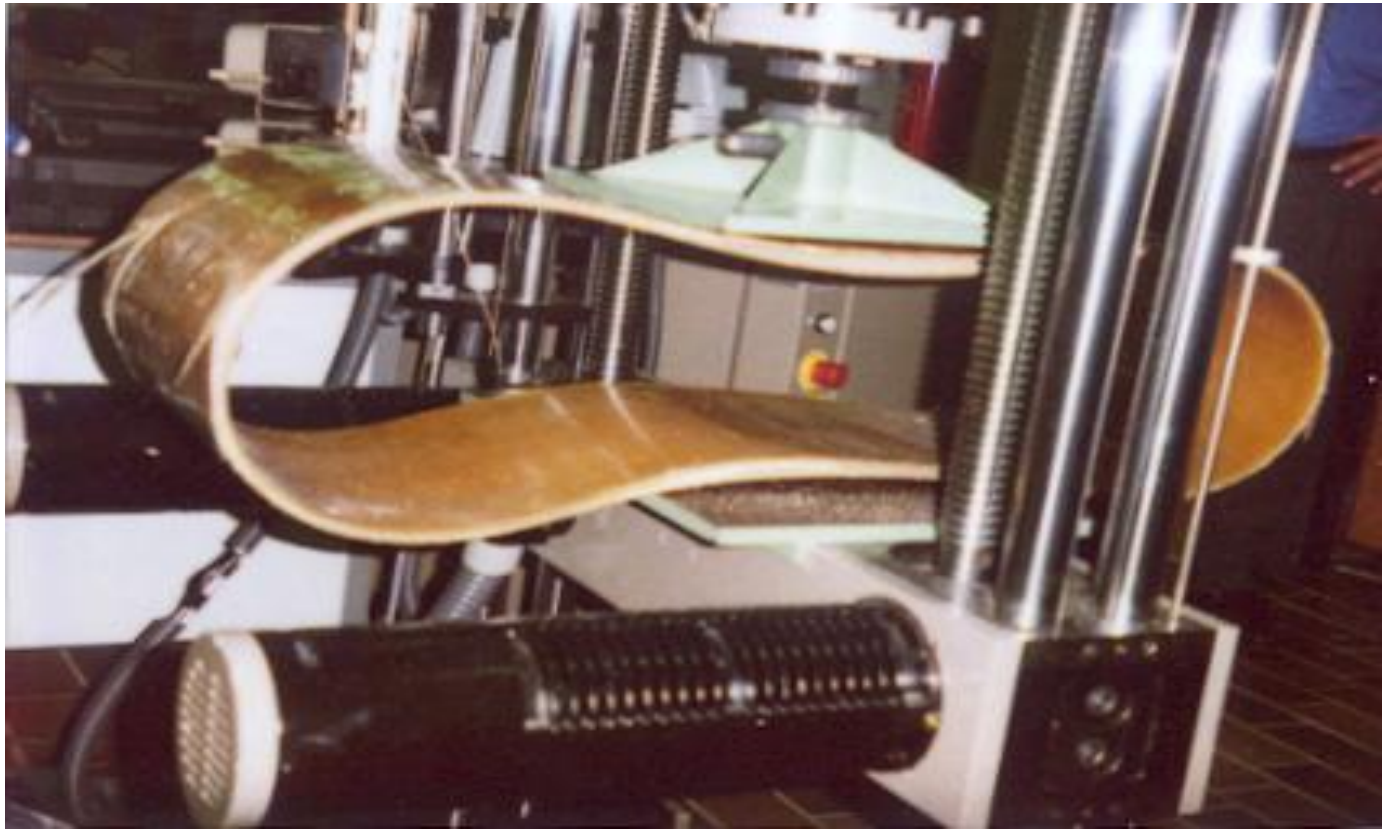
- A combination of strength and stiffness
- Both in axial as well as hoop direction



Transition to ISO 14692

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Everything we just discussed is formalized in ISO 14692.”

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