Engineering in GRP pipes and tanks

Fundamentals, behaviour and design philosophy

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Who am I

- **Wavin Repox / Future Pipe Industries B.V., Netherlands 1991-2004**
  - QA/QC, R&D
  - Application Engineering/Technical support
  - Product and project management

- **DSM Resins A.G. – Switserland 2004-2012**
  - Business Development Manager:
    - Supplier raw materials
    - End user chemical applications
    - Consulting, advise, failure analysis

- **Jurone AB: GRPCenter Industriteknik Sverige**
  - Consultancy and technical support for manufacturers, distributors, contractors and end users on the design, specification, installation, use and inspection of glassfiber reinforced plastic pipe systems and tanks
  - DNV certified inspector/supervisor/examiner

What we will cover today

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- **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)

**“We will move from understanding the material…
to understanding failures…
to understanding design…
and finally how we control and inspect it.”**

Where are composites used?

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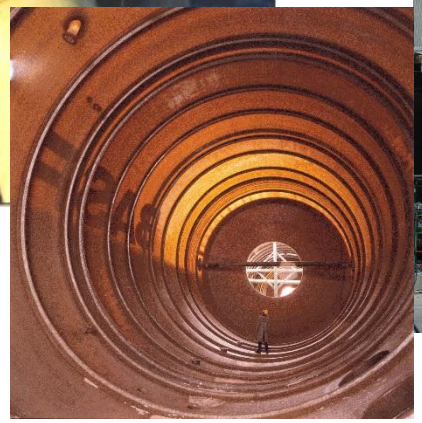


“Composites are everywhere — but acceptance in piping systems is still limited.”

How much GRP is actually used?

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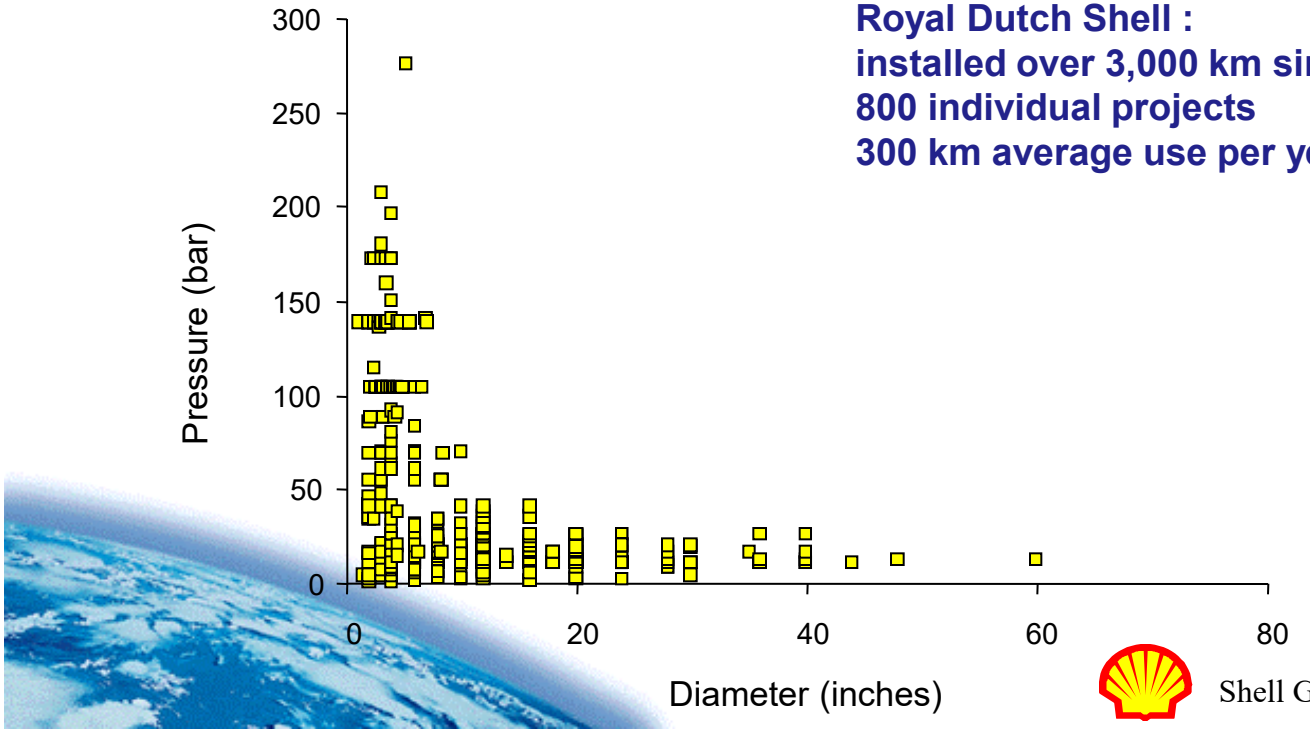
GRP Pressure-diameter range

Applications within Shell, database



Royal Dutch Shell :
installed over 3,000 km since the late sixties
800 individual projects
300 km average use per year since 2000

Shell Global Solutions

How much GRP is actually used?

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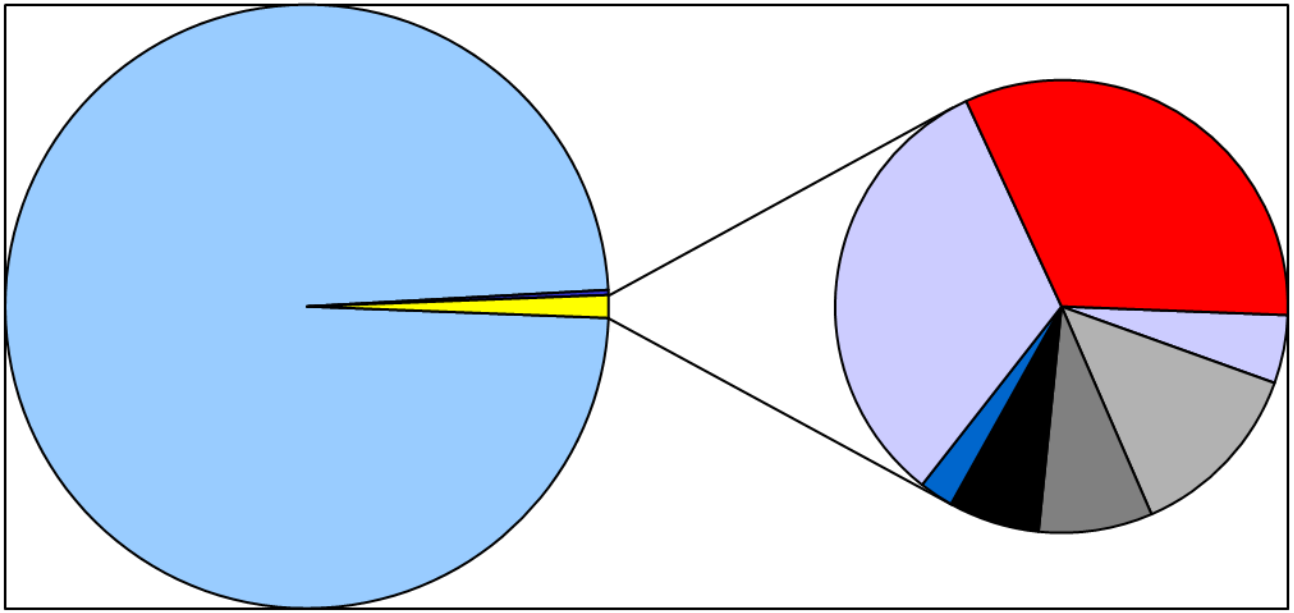
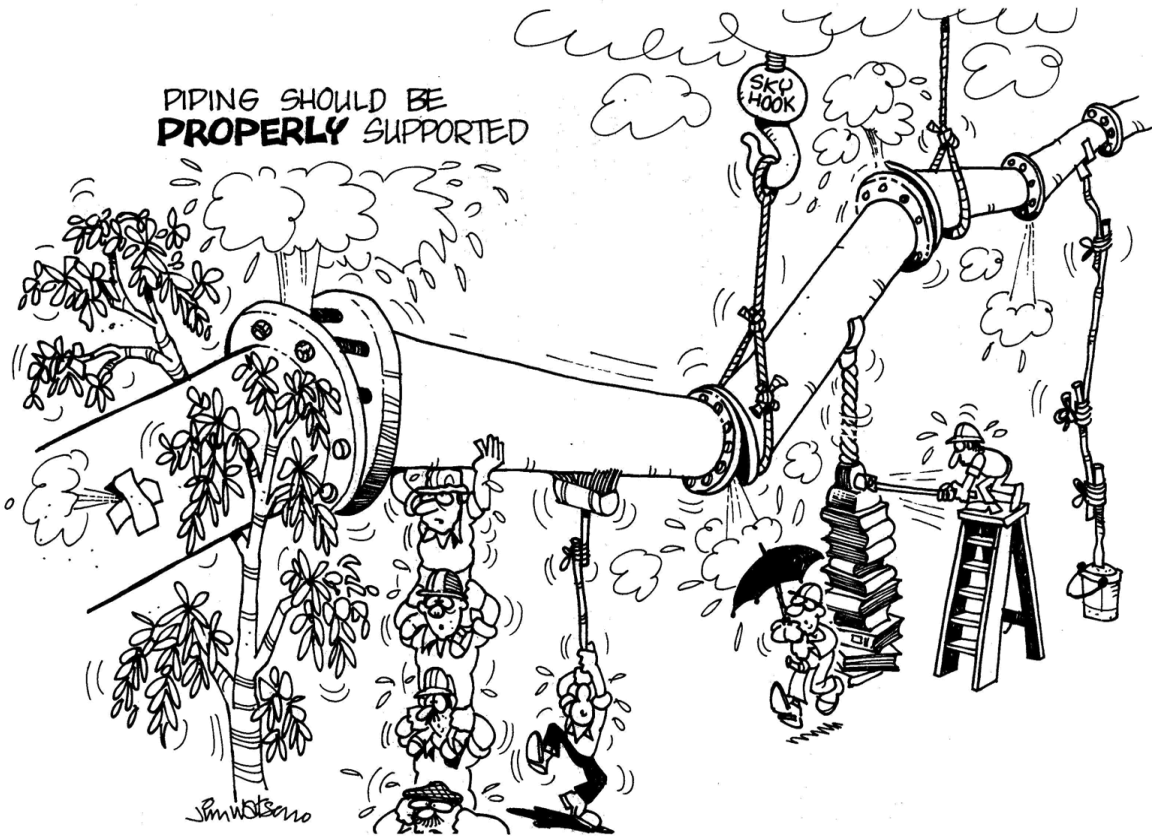
Source: Dynaflow Research Group

But how much is that?



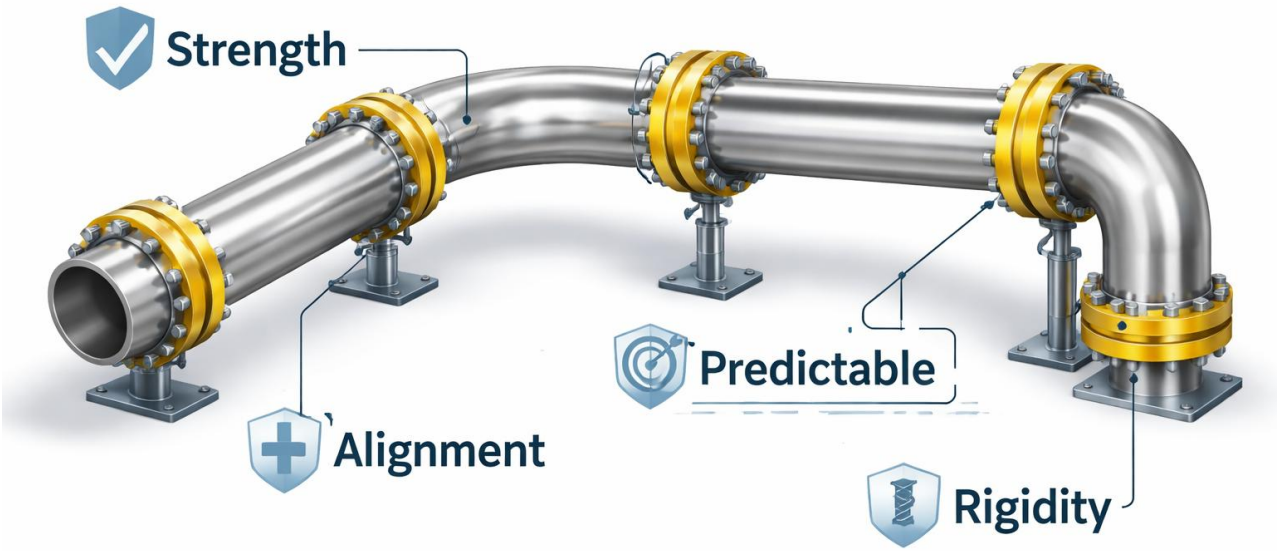
GRP vs Steel – What is different



“Before anything else, we need to understand why GRP behaves differently.”

Think in Steel

Trusted Properties | Predictable Behaviour



- We trust material properties
- We check strength
- We assume predictable behaviour

“This works perfectly—for steel.”

What happens if we apply this to GRP?

Low confidence due to failures:

- Misunderstanding of behaviour /Unexpected behaviour
- Wrong assumptions

"GRP doesn't fail more often than steel — but when it fails, we often don't understand why."

Steel vs grp –fundamental difference

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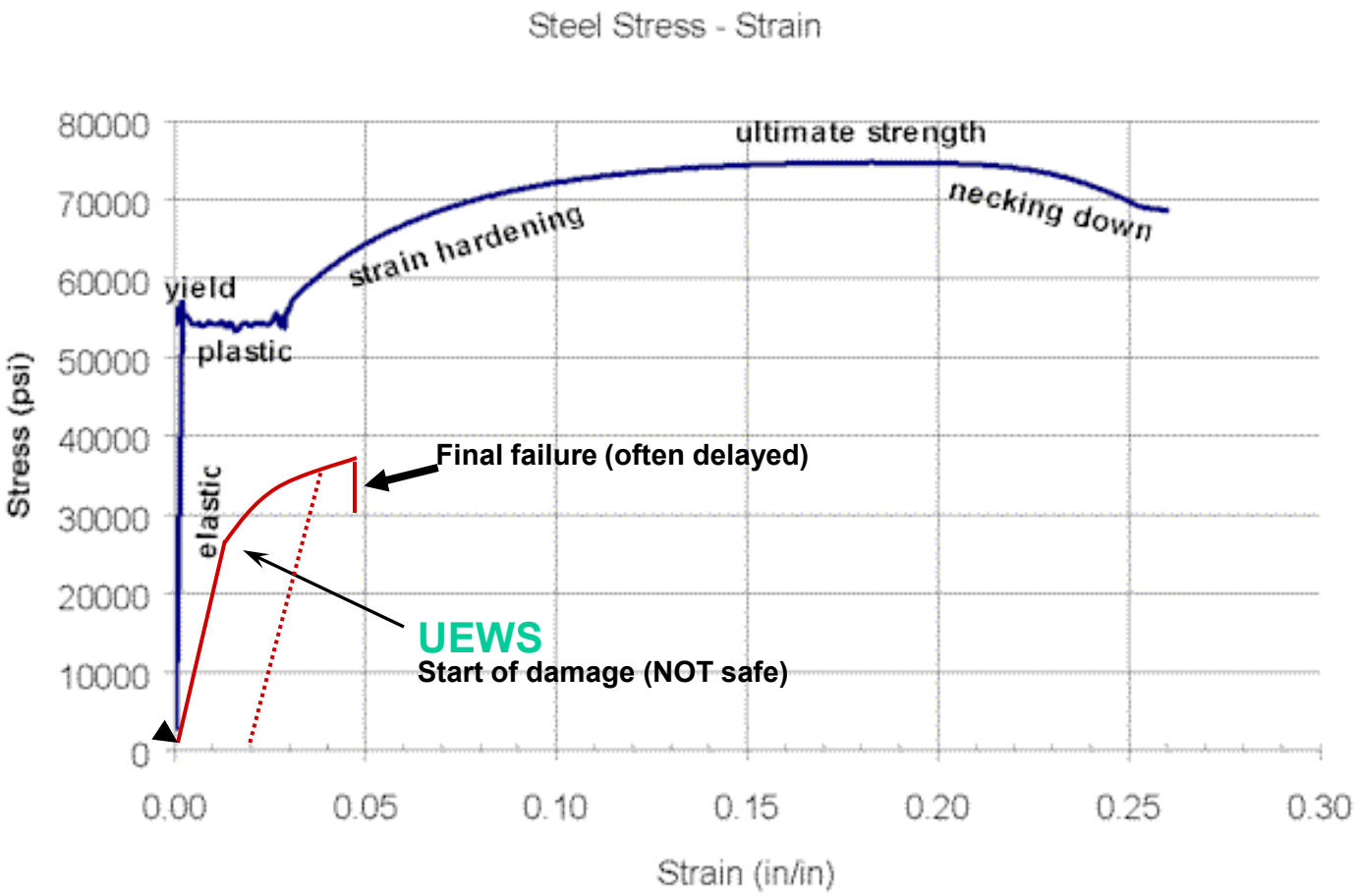
	Steel	GRP
Material	Isotropic	Orthotropic
Behaviour	Predictable	Direction-dependent
Yield	Clear yield point	Damage threshold (UEWS)
Design	Component-based	System-based

“Steel is predictable and forgiving.
GRP is directional and sensitive to how you use it.”

Material behaviour: steel vs GRP



"GRP must stay in the elastic region"

"In steel, yielding is acceptable.
In GRP, the equivalent point is where failure begins."

Practical consequence

No safety in plastic deformation

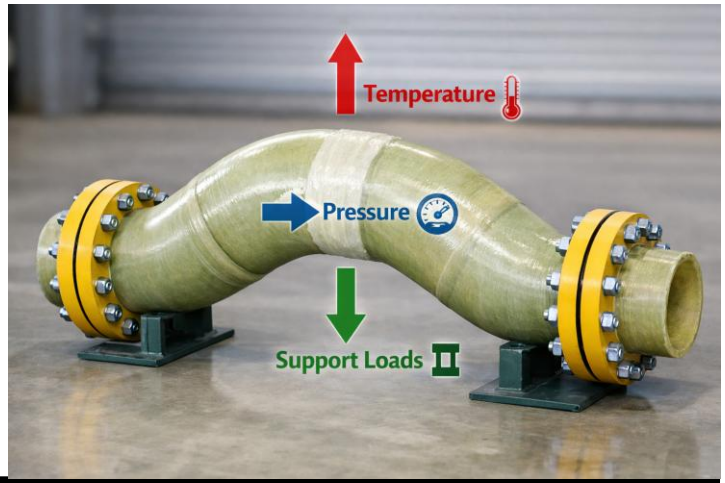
No redistribution of stresses

Local overload = damage

Damage grows over time

“GRP does not forgive mistakes.”

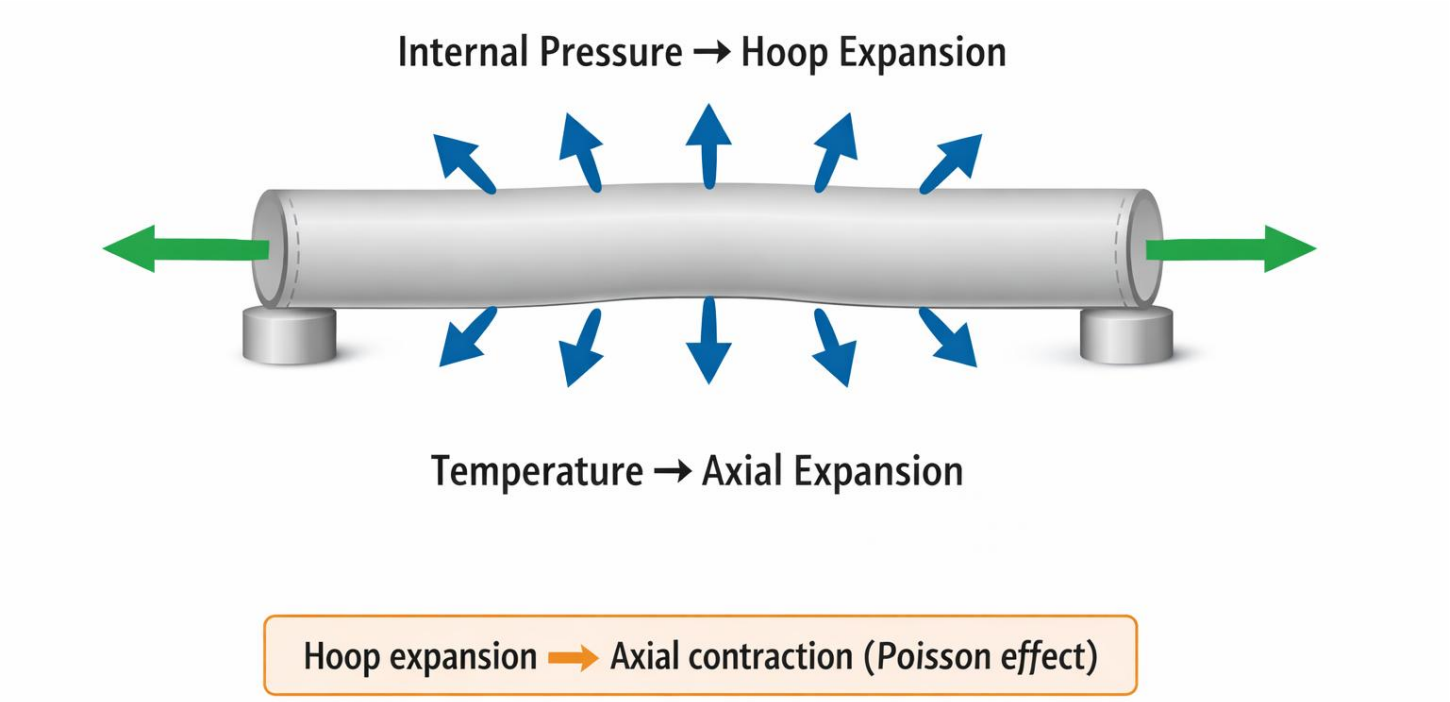
Designing GRP: component vs system



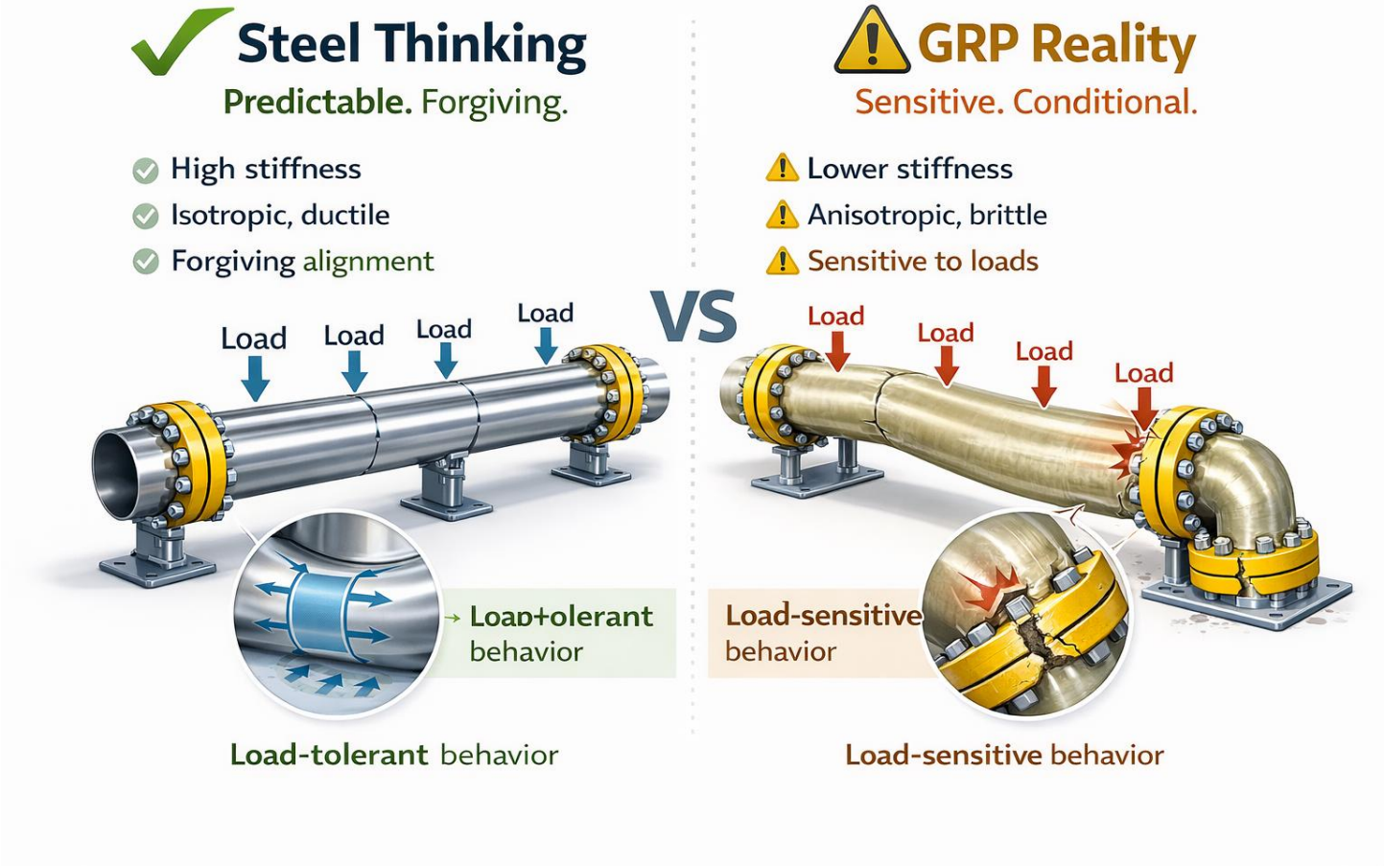
Seel mindset	GRP reality
Check pipe strength → OK	•Pipe •Joints •Supports •Loads They must work together

“In GRP, you don’t design a pipe — you design a system.”

GRP deforms



“GRP moves more than steel—and that changes everything.”



- Direction matters
- Damage starts early
- System defines performance

"If you think like steel, you will design failures in GRP."

So where does it go wrong?

Not in the pipe. but in:
- joints
- system behaviour

“Let’s look at where GRP systems actually fail.”

Agenda

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