Engineering in GRP pipes and tanks

Fundamentals, behaviour and design philosophy

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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)

Why do GRP systems fail?

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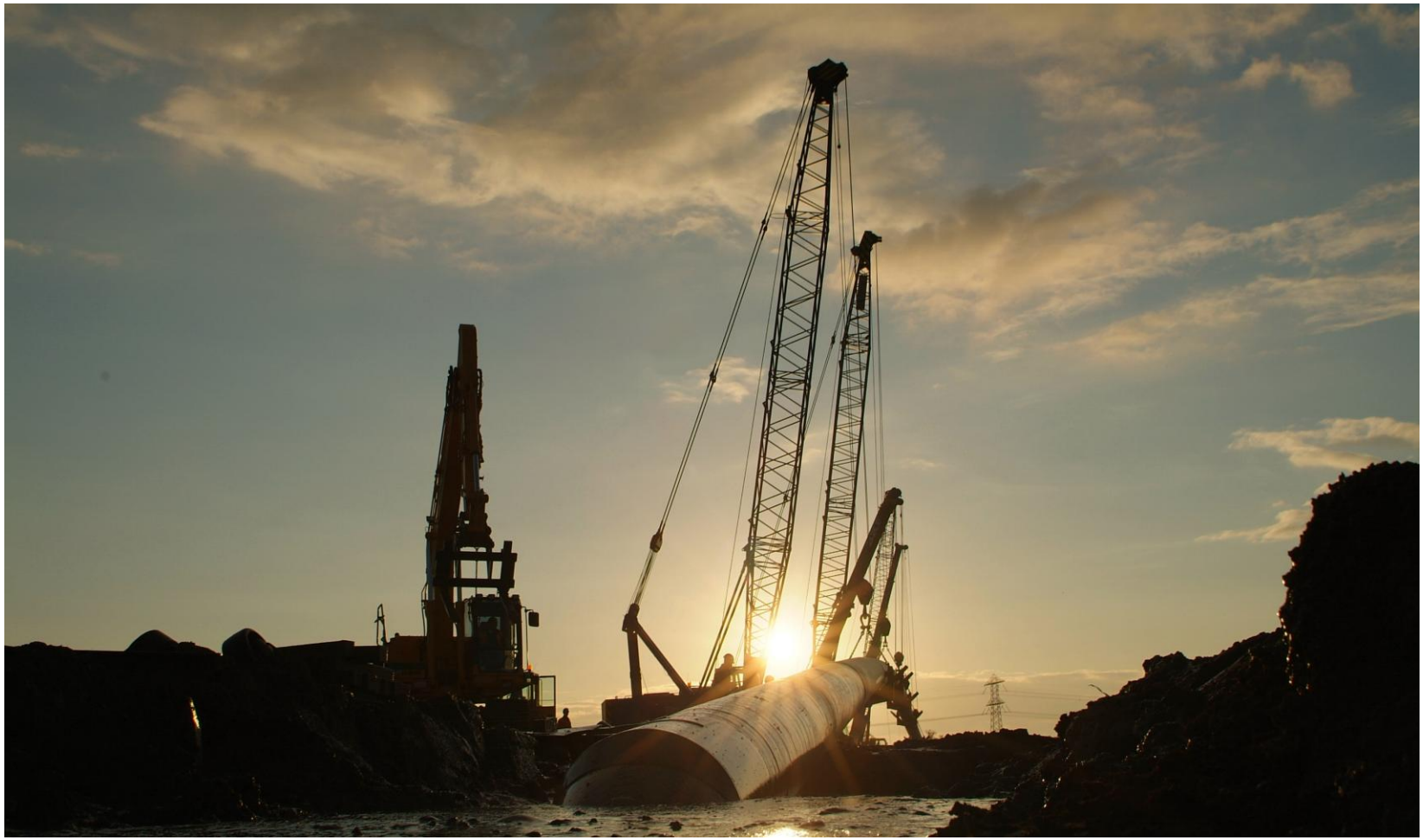
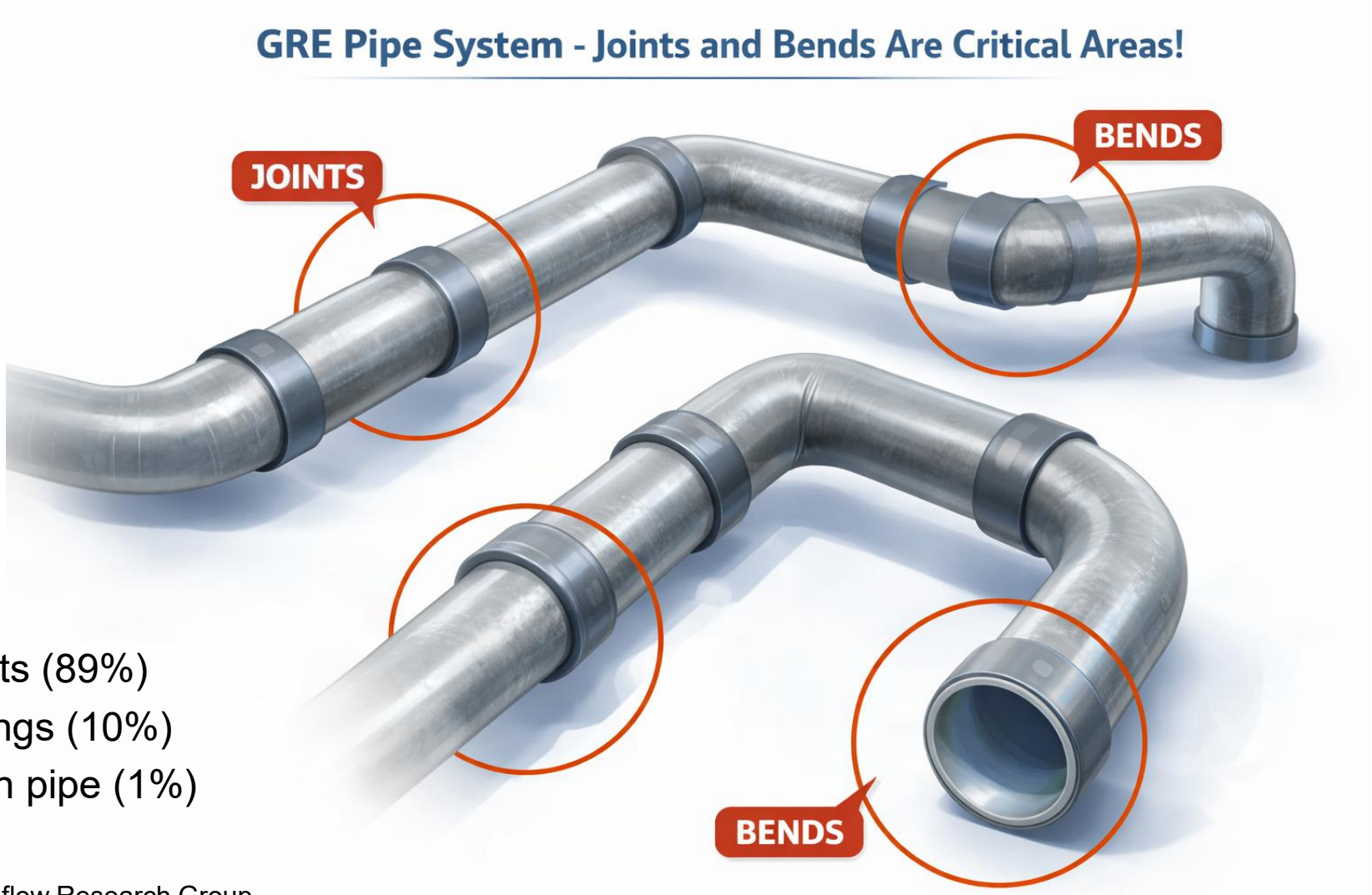


Understanding failures is the key to understanding design

Where do Failures Occur



- Joints (89%)
- Fittings (10%)
- Plain pipe (1%)

Source: Dynaflow Research Group

"If you design only the pipe, you are solving 1% of the problem."

Plane Pipe Failures are rare

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Flanged Joint failure

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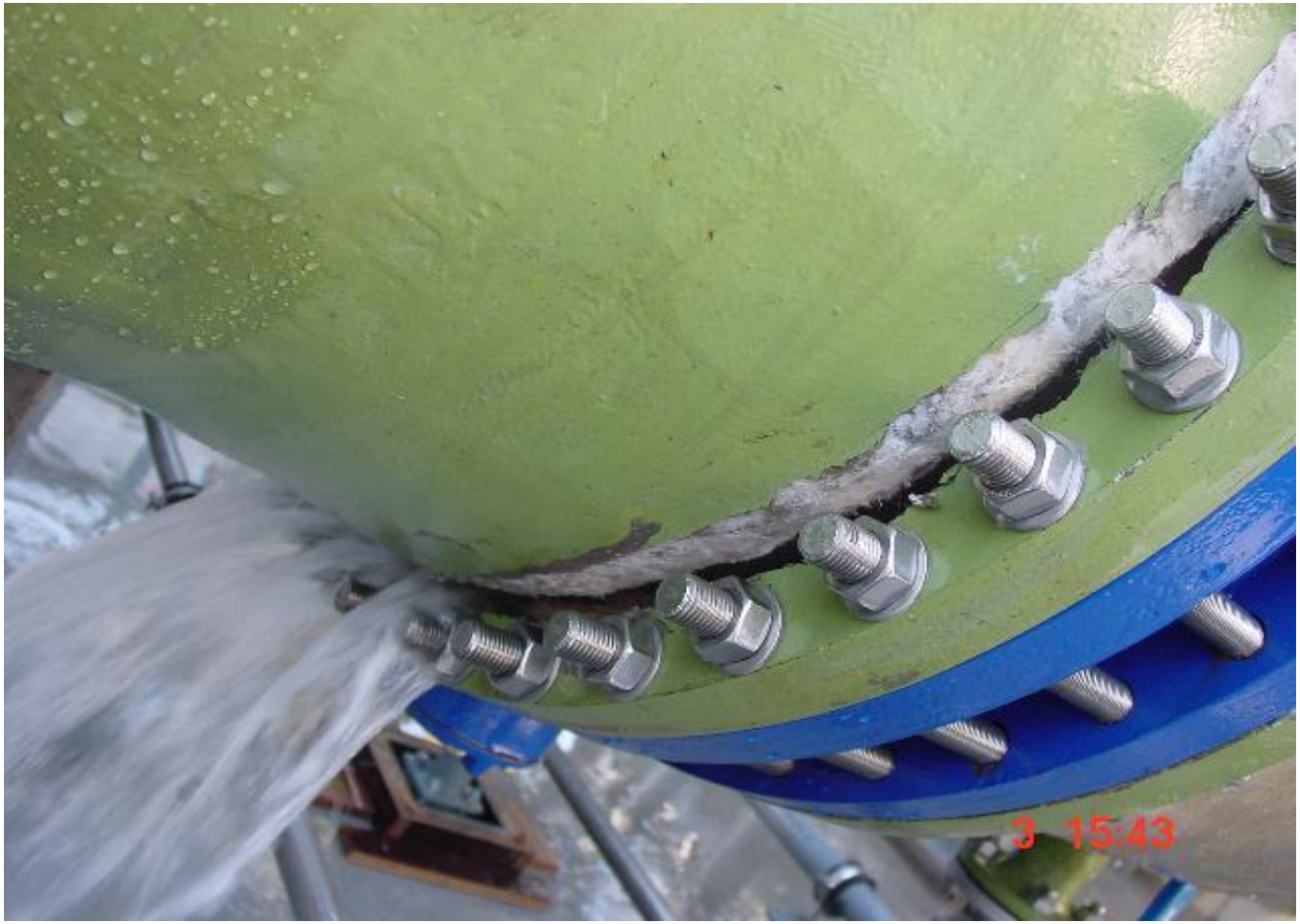

Typical failures adjacent to bends and tees

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Mechanical Joint failure

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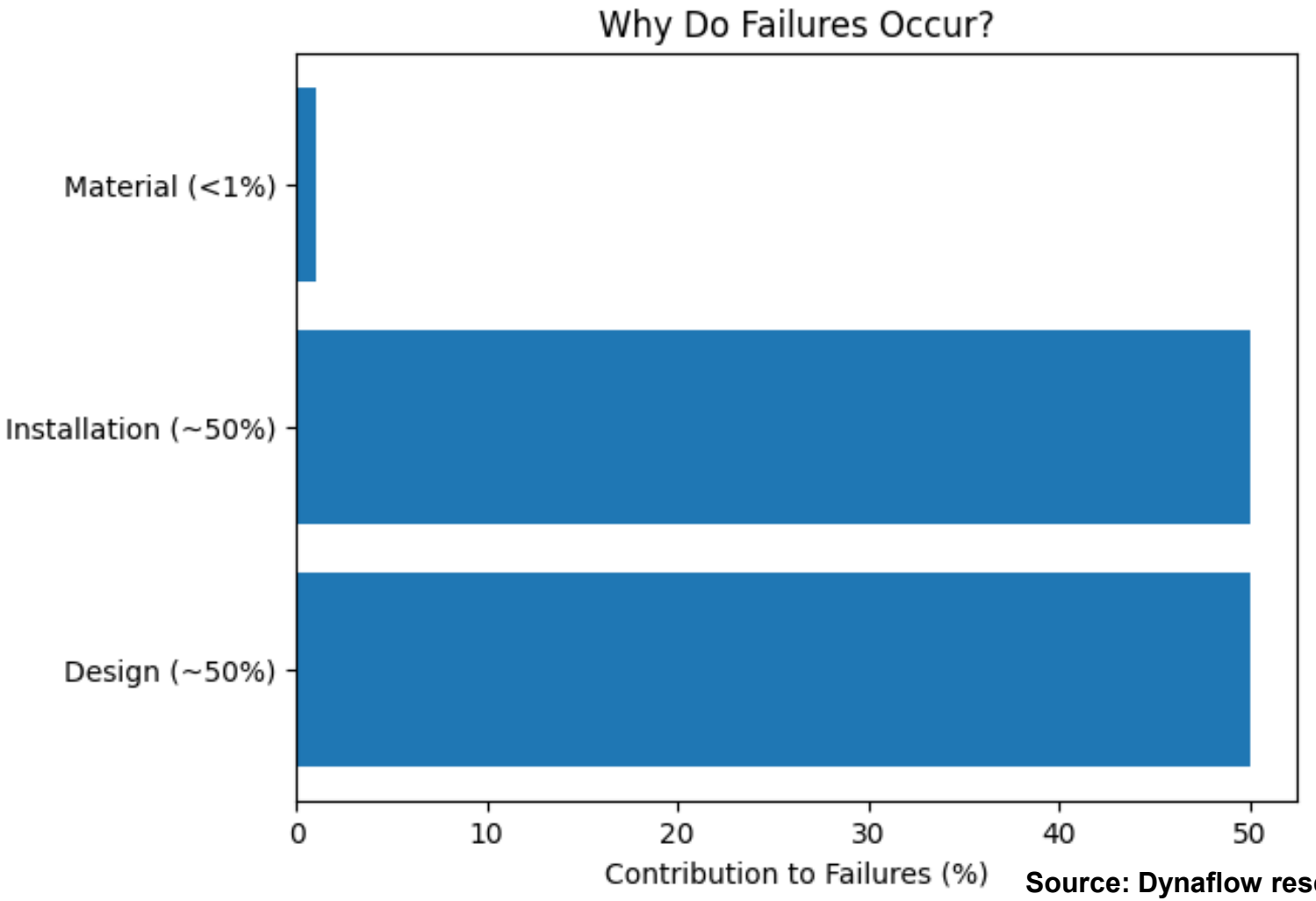
Why do failures occur



Source: Dynaflow research group

“This is the most misunderstood fact in GRP.”

Why do failures occur

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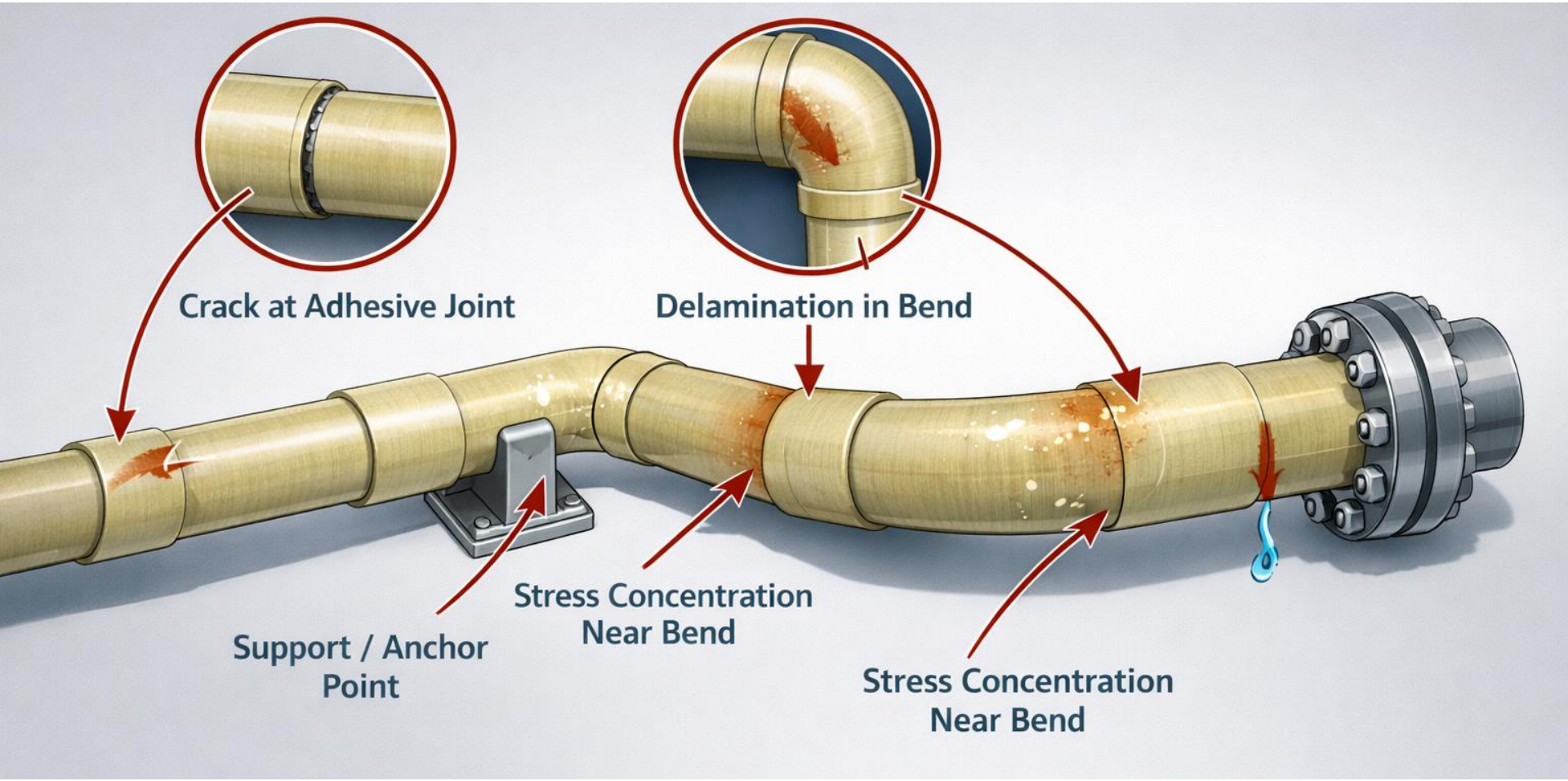
Failures are due to:

- Material defects → <1%
- Excessive loads (± 50%)
  - Almost always a result of shortcomings in design
  - Critical items in design
    - Underestimation of load (proper prediction of loads)
    - Overestimation of joint capability (e.g. flanged joints)
    - Overestimation of system flexibility (prediction of flexibility)
- Defective installation (± 50%)

Source: Dynaflow research group

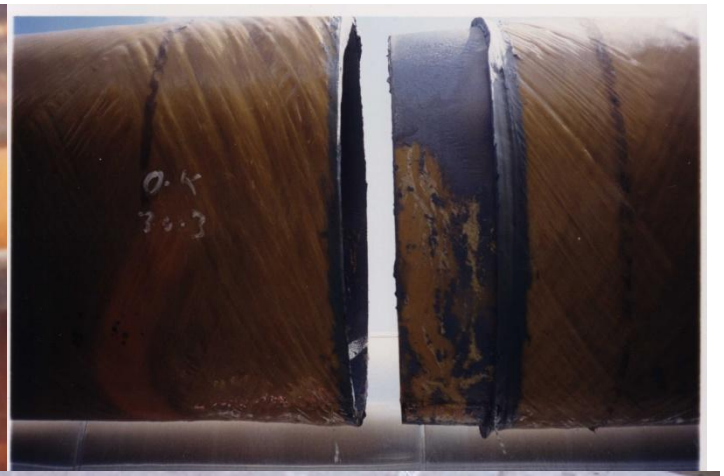
“This is critical: GRP is almost never failing because the material is ‘bad’ — it fails because we misunderstand how to use it.”

typical failure locations



"GRP does not like sudden changes — not in stiffness, not in geometry, not in load."

Example: Joint failure



"Most joint failures are not material failures — they are system failures."

Example: Joint failure

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Example: Design-related failure

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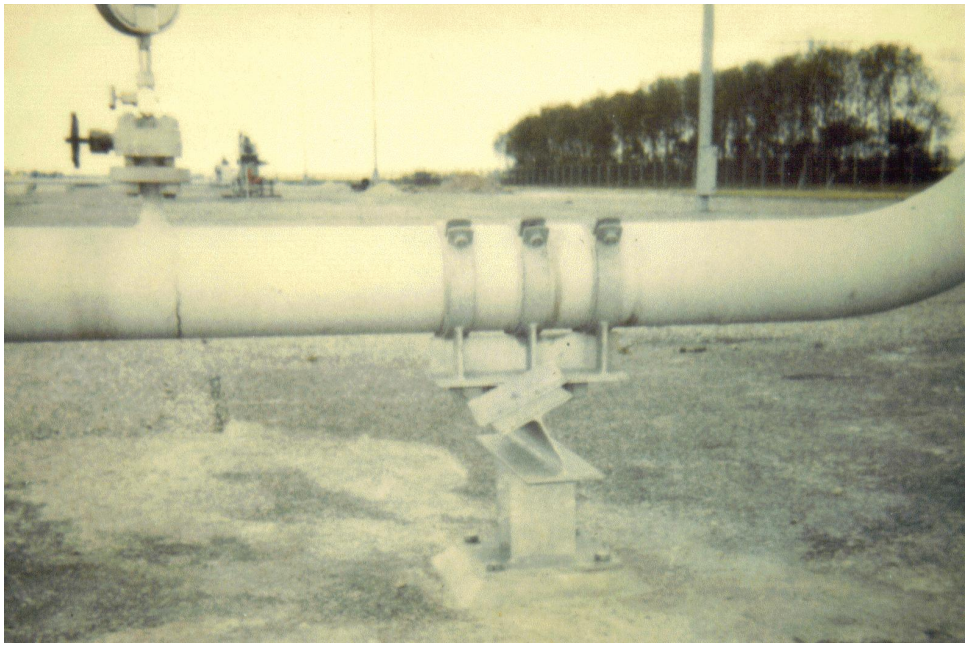

- Underestimated loads
- Overestimated flexibility
- Incorrect support function
- Thermal expansion not considered

"GRP is flexible — but that flexibility creates loads elsewhere."

Steel vs GRP – what actually fails?

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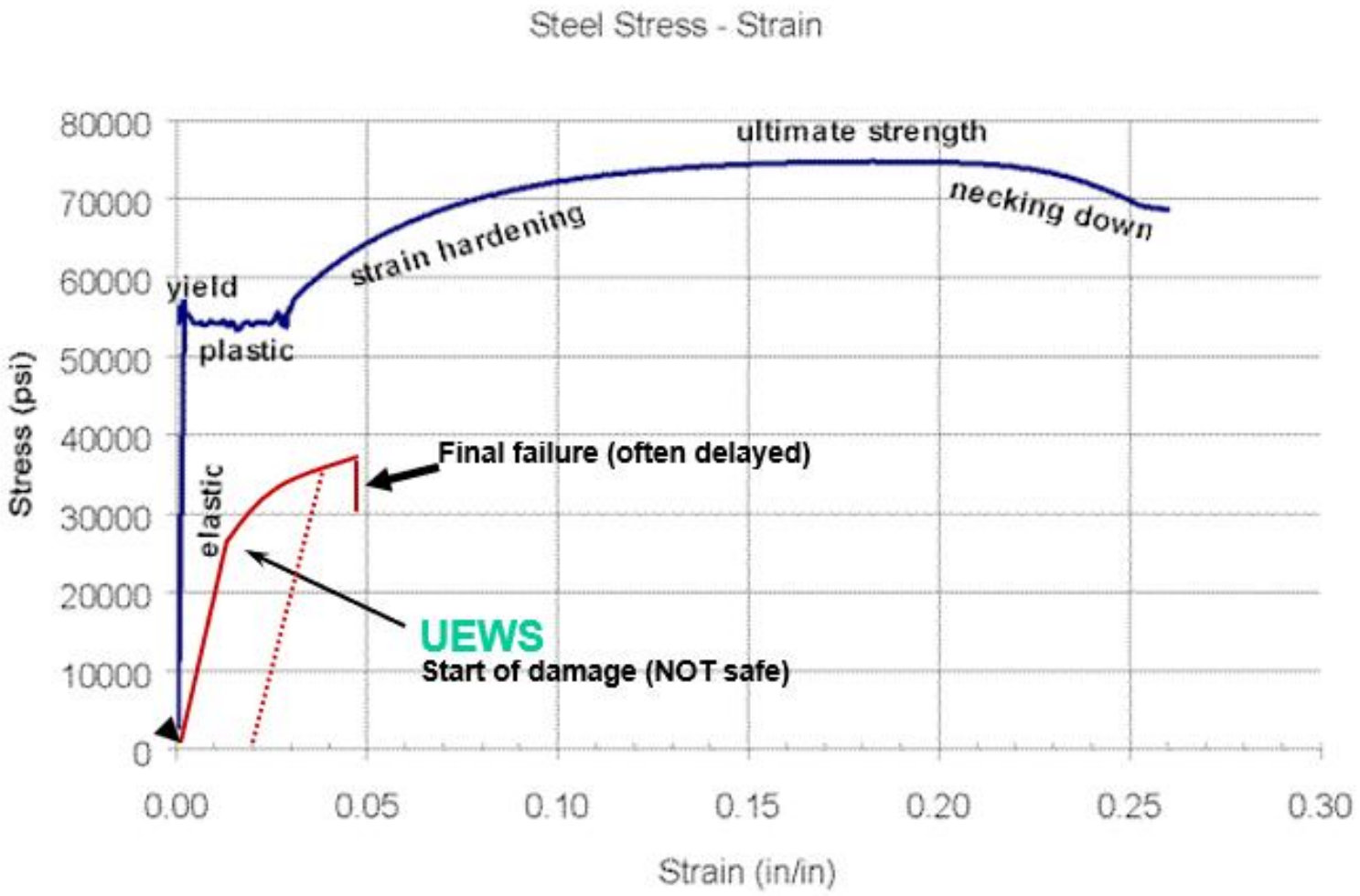
	Steel	GRP
Failure cause	Material overload	System behaviour
Critical parts	Pipe	Joints / connections
Design focus	Hoop Strength	Load distribution/axial

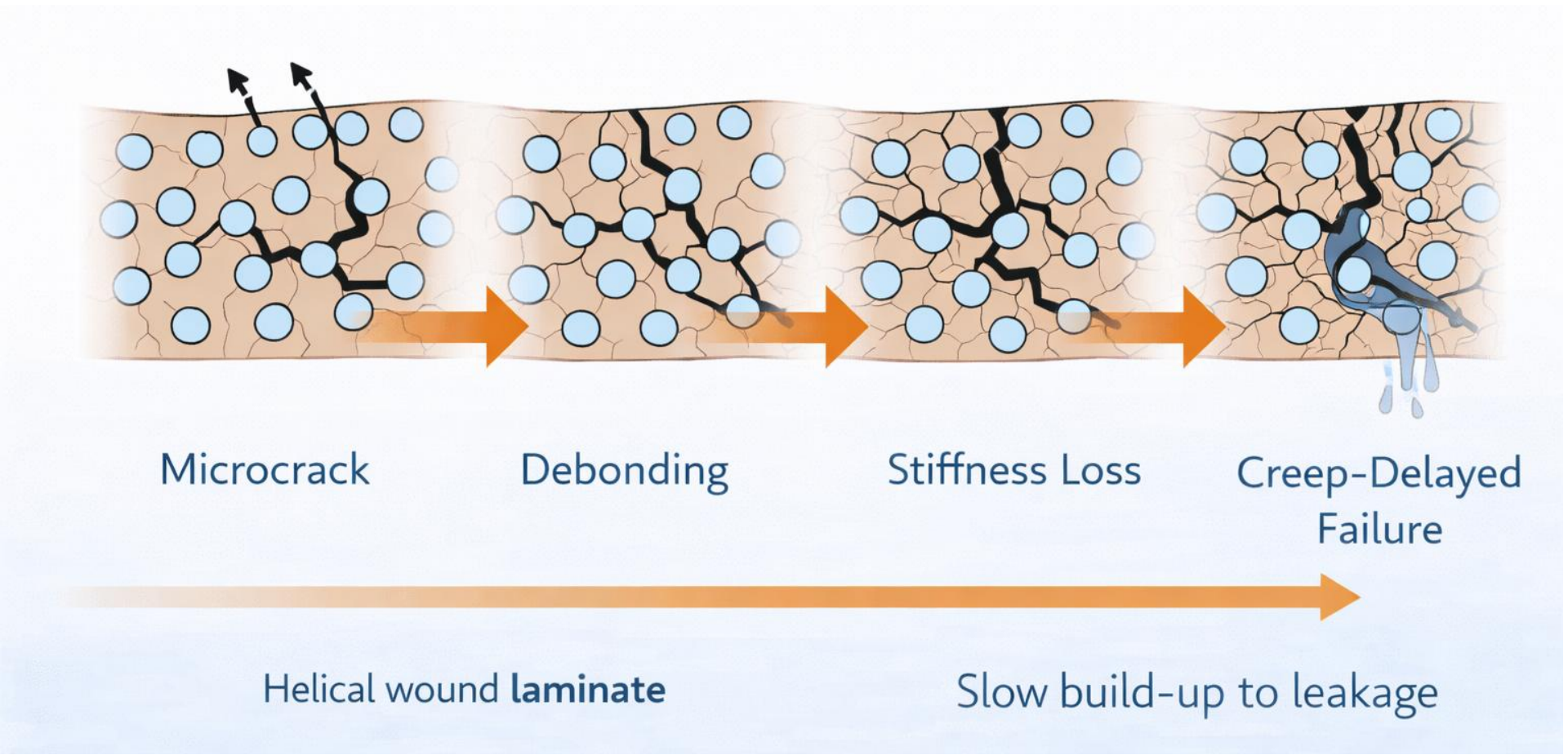
"Steel fails when the loads are too high.
GRP fails when the system is misunderstood."

Yield vs damage behaviour



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

What happens when GRP is overloaded?



"GRP doesn't fail immediately — it starts failing slowly—until suddenly.."

Key takeaway

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GRP failures are:

- NOT material-driven
- BUT system-driven

Critical factors:

- Design
- Installation

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