Testing composites in harsh seawater environments

Why bother ?

- There is extensive experience of composites in seawater.
- Many pleasure boats have been sailing for over 30 years

Navigation conditions not severe
Boat hulls often over-dimensioned

BUT

- Composite wind turbine blades have been cycling for over 20 years.
- Very few fatigue failures.

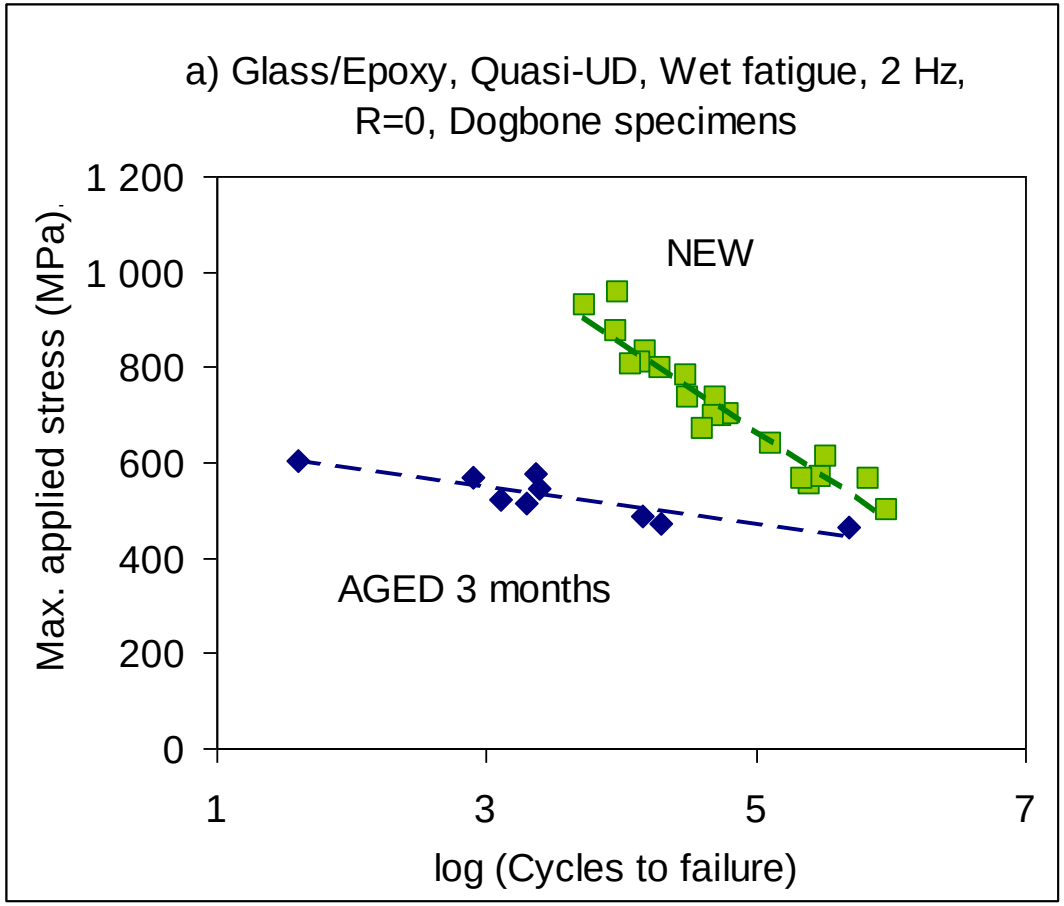
Don’t cycle wind blades in seawater

So probably a good idea to check

Take a wind turbine blade composite

- Test it in fatigue dry
- Saturate it with seawater
- Test it in fatigue wet

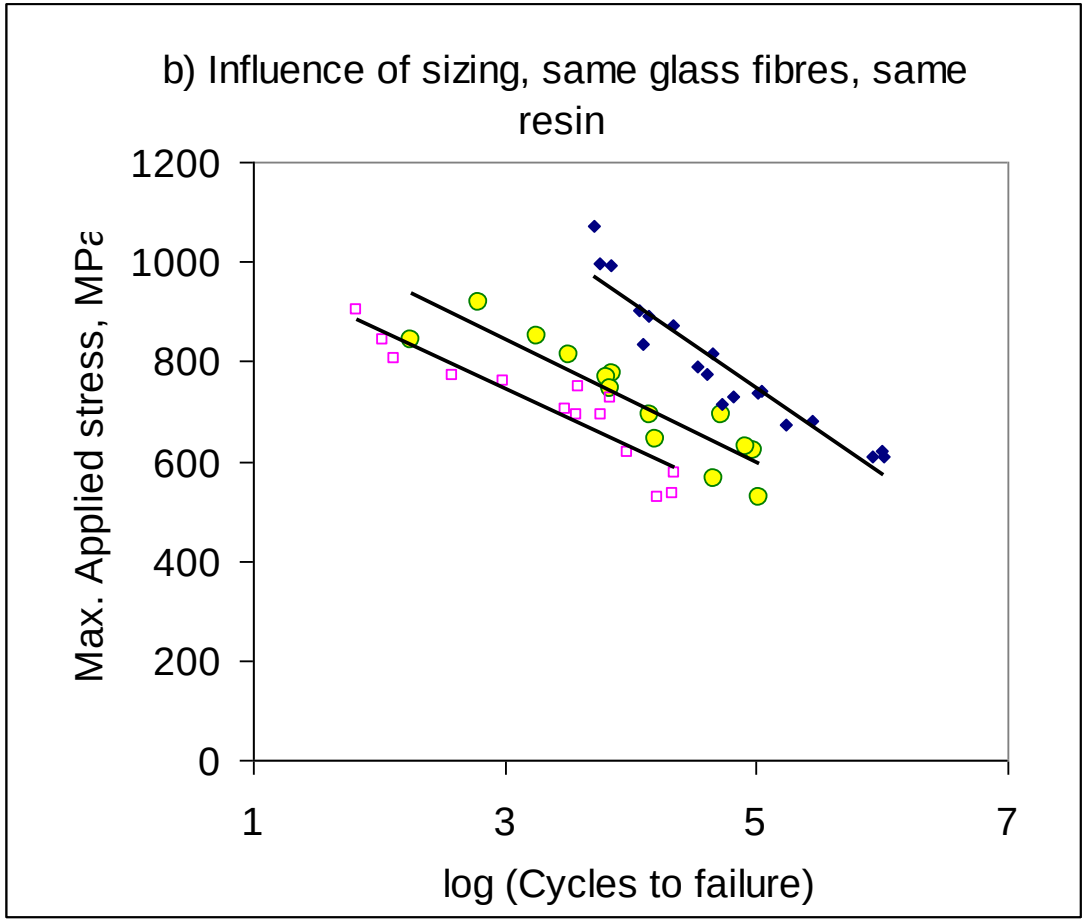
Wind turbine blade composite E-glass/epoxy



Matrix selection matters

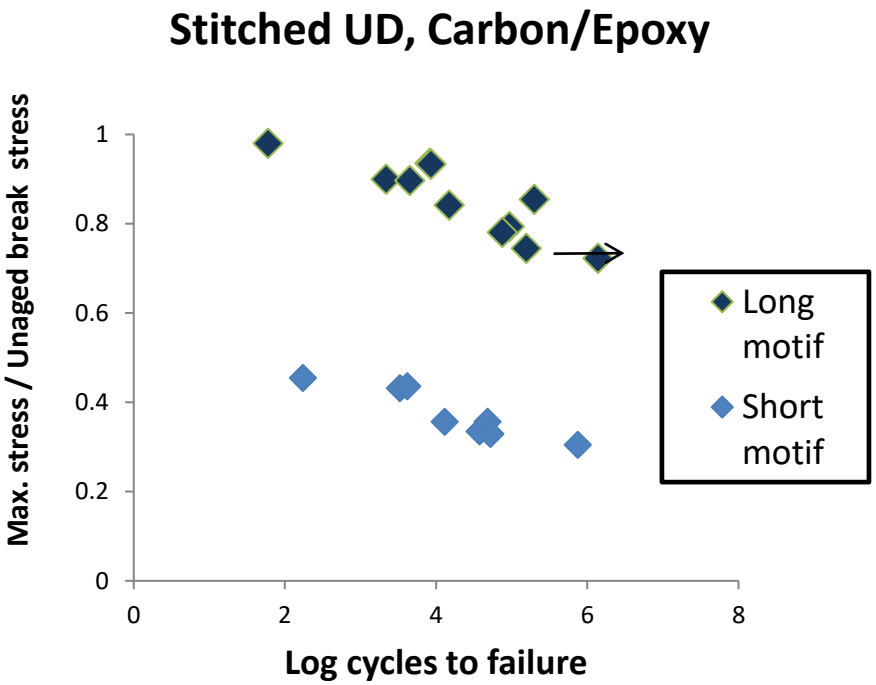
Boisseau et al, 2012

What about fibre coating ?



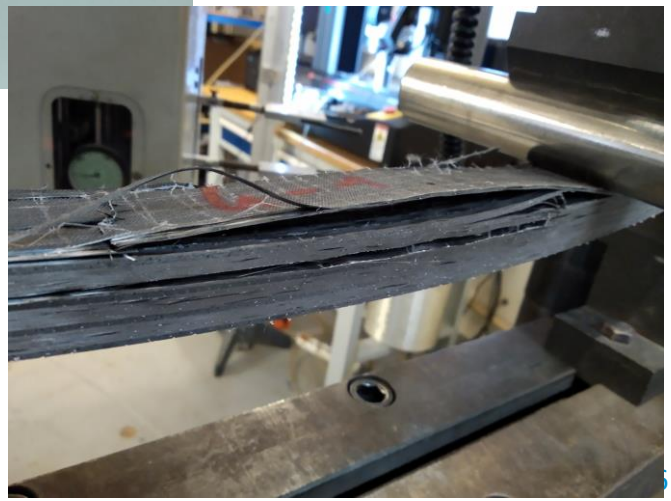
And reinforcement architecture ?

Ex. Carbon/epoxy, two motifs same fibres and resin



Manufacturing matters

20 mm



Seawater effects: How long will it take to saturate under real conditions ?

Water temperature

Water composition

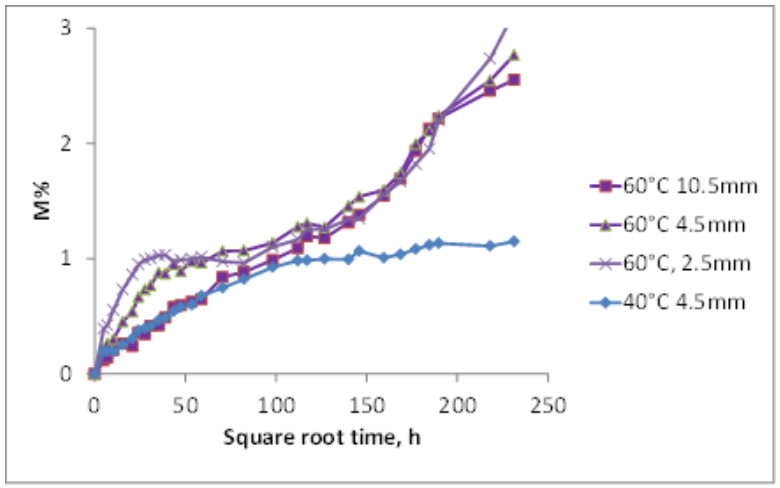
Hydrostatic pressure

Mechanical loading

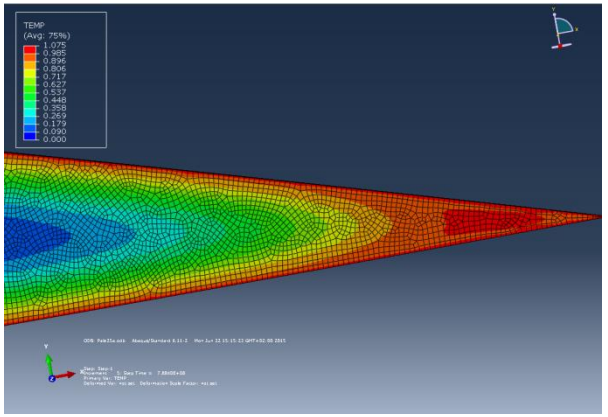
Coupon geometry

Boundary conditions

For Sabella materials now have over 7 years' laboratory immersion



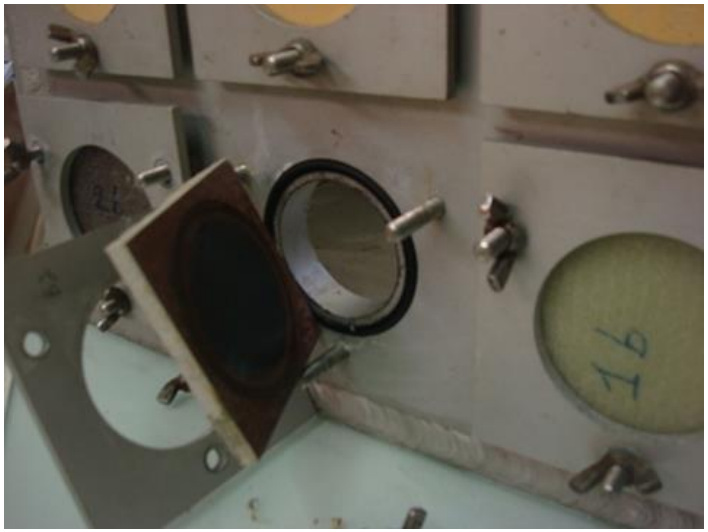
Different thicknesses, infused & preg,
aged in natural seawater at 25, 40 and 60°C

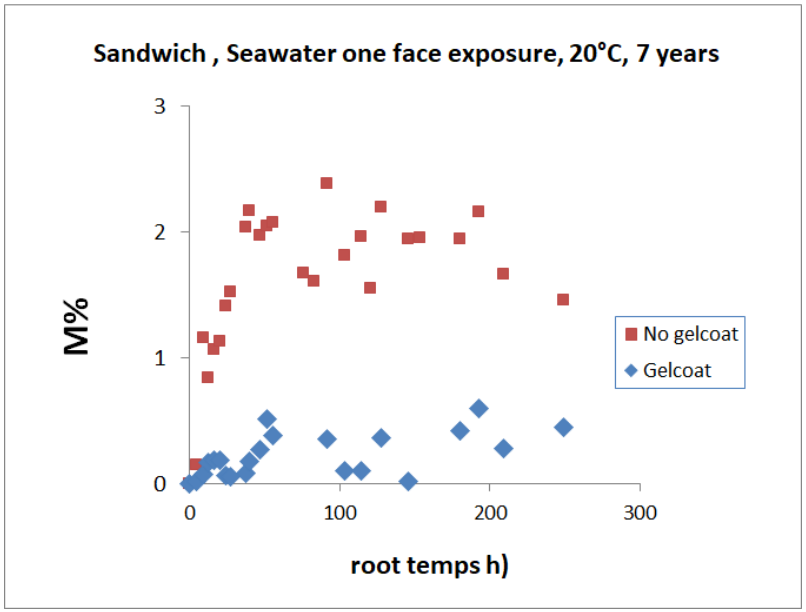


Can then calculate water profile through blade thickness
(N. Tual, 205)

What about composite coatings ?

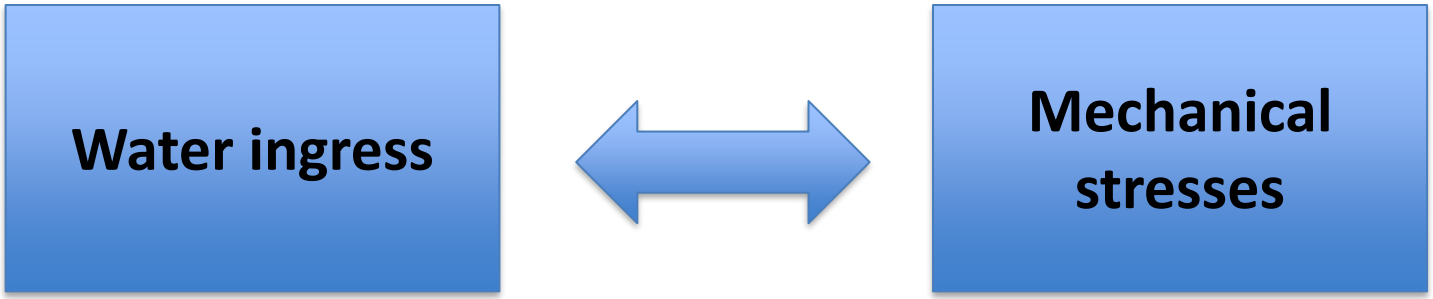
Single face seawater exposure tests





Coatings do slow down water ingress, but they can be damaged

In reality loads and water diffusion are coupled

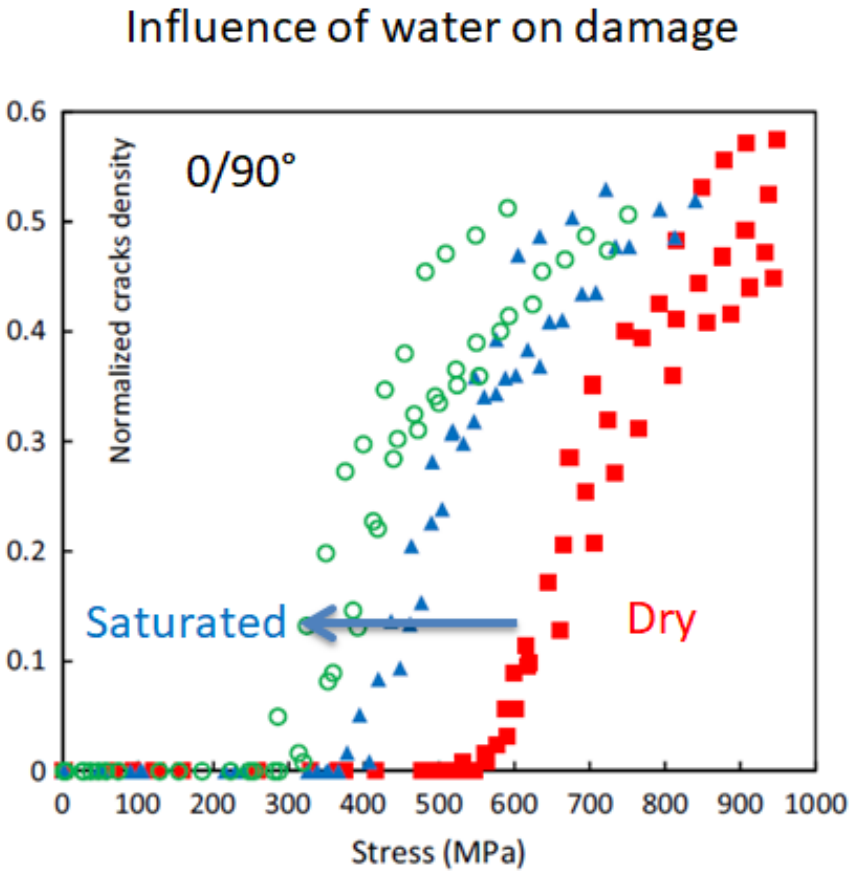


Rate of diffusion depends on stress

Mechanical properties depend on presence of water

Can't ignore coupling, affects damage initiation and development

In reality loads and water diffusion are coupled



Tual et al, Composites Part A, 2015

Can't ignore coupling, affects damage initiation and development

Conclusions

- **Can't assume that the good fatigue performance of wind turbine composites is applicable to tidal turbine blade applications**
- **Matrix, fibre coating, reinforcement details can all affect long term durability**
- **Appropriate testing increases confidence in long term behaviour**

→ **Lower safety factors, lower cost**

REALTIDE

EU H2020 project aiming to improve tidal turbine reliability