# INCREASE OF BLADES STRENGTH BY MEANS OF ADDING CARBON NANOPARTICLES IN COMPOSITE FORMULATION

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Ocean Energy Europe


Dr. Célia MERCADER

**CANOE,** FRANCE

mercader@plateforme-canoe.com

www.plateforme-canoe.com


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# Nano-enhanced composites development for enhanced fatigue and impact resistance

**OBJECTIVES** :

- enhance blade material performances
  - improve the fatigue and impact resistance

- Use of nano-particules to reinforce the composite materials

- The blade is made of :
  - RESIN : vinyl ester resin
  - FABRICS : glass fabrics

- DISPERSION of the nano-particules inside the resin before manufacturing the composite blades

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# Nano-enhanced composites

Different fillers and different concentration were selected

- Carbon Nanotubes (CNT)
- Impact modifiers

- A true dispersion = homogeneous and stable of the nanoparticles in the resin is required to reinforce the matrix against cohesive failure of the composite
- Use of three rolls mill or cold twin screw extruder ( = high shear device) to perform the dispersion at high concentration before dilution by conventional stirring

Commercial pellets (25wt% of CNT inside matrix)

Dispersion of the CNT inside NEMMO resin at 2,5wt% using three rolls mill

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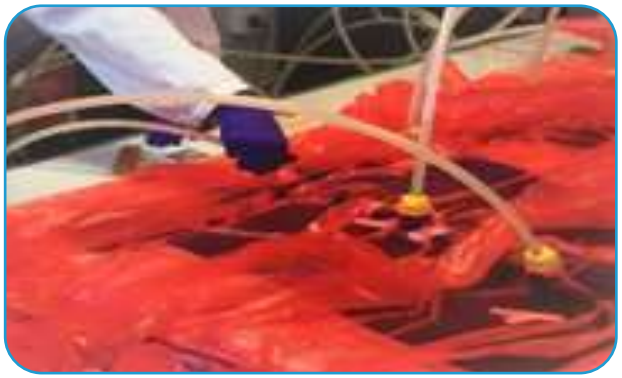
# Infusion process

Conventional method to manufacture blade is INFUSION

Evaluation of the different fillers at different concentrations on infused composite plates



For each fillers and each concentration, 4 plates are infused for characterizations

→ 17 formulations were mechanically characterized

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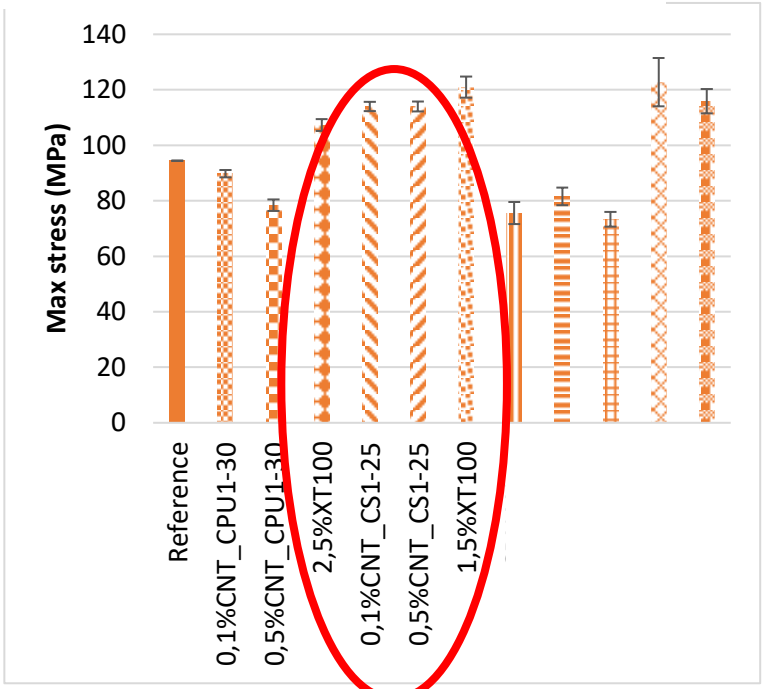
# Mechanical characterization of the in-plane laminates properties

Traction with fibers at 0° and 90°

- Mechanical behaviour (Modulus and Maximum stress) in fibers direction and in transverse direction not influenced by the matrix formulation

Traction with fibers at +/-45°


- Best results obtained with XT100 = impact modifier, CNT_CS1-25 (Modulus + Max stress)

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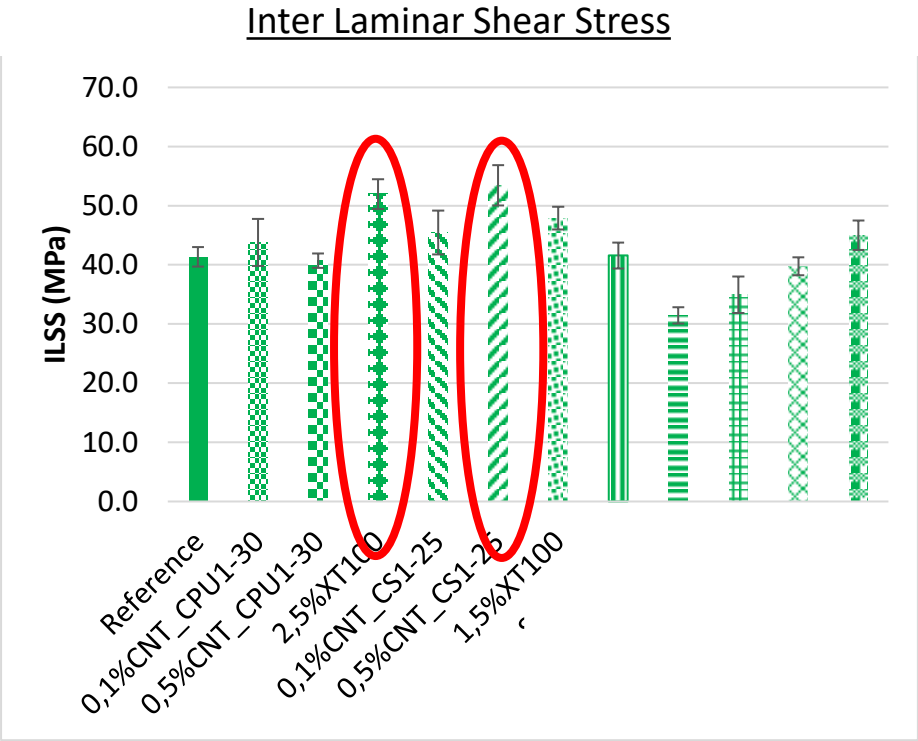
# Mechanical characterization: ILSS




- 25% improvement in ILSS for both 2.5% impact modifier XT100 and 0.5% CNT_CS1-25 formulations

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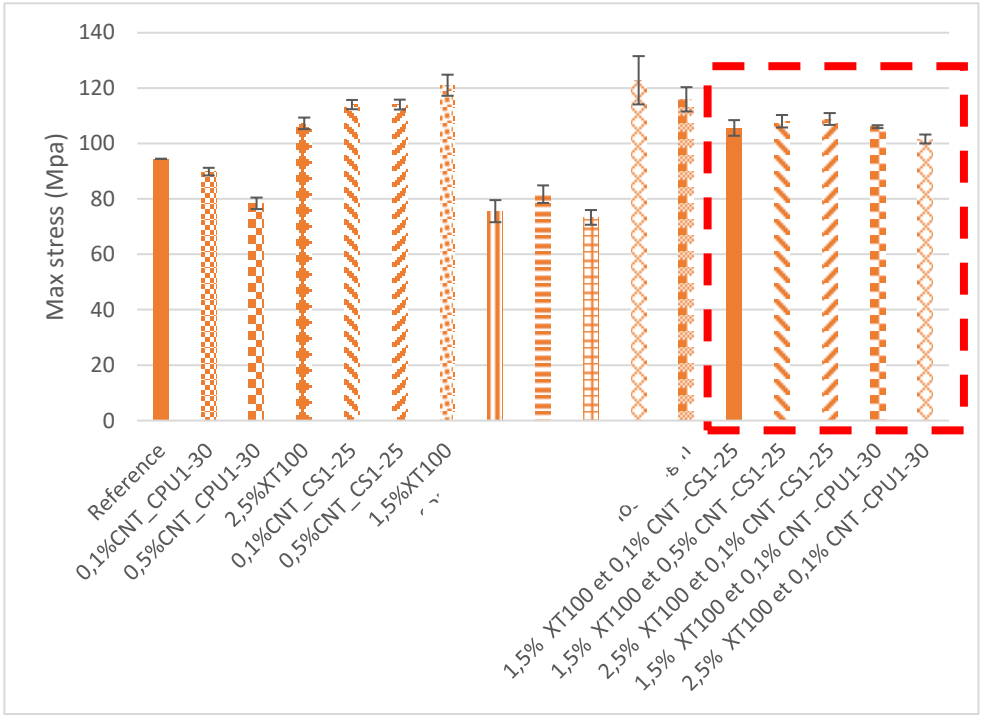
# Synergetic effects ?

➢ Trials to mix the fillers : impact modifier and carbon nanotubes to observe synergetic effects




➢ No significant improvement of mechanical behaviour in traction at +/-45°

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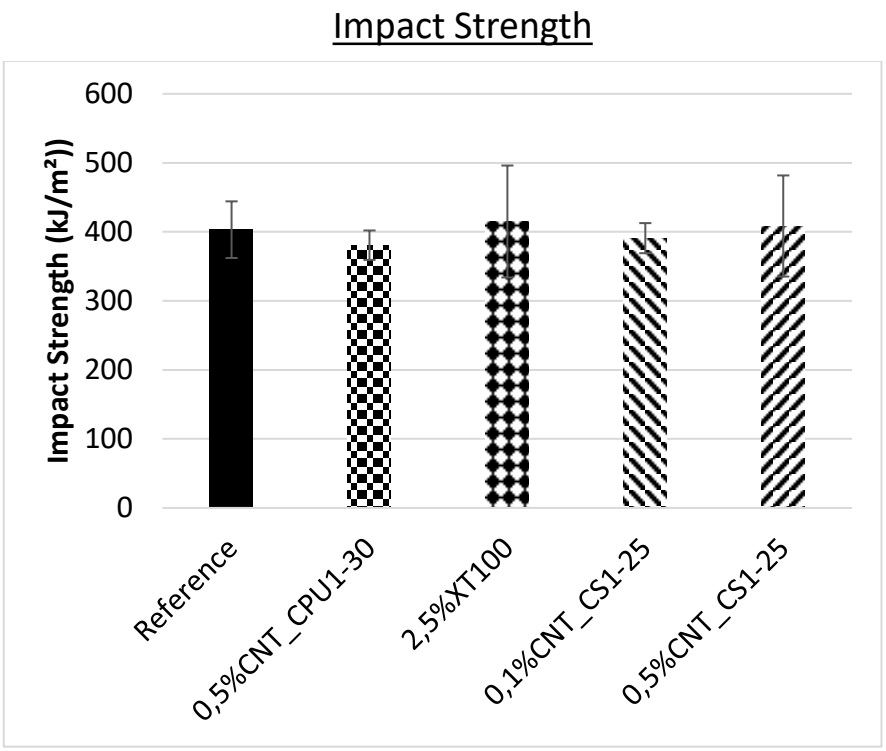
# Mechanical characterization: impact strength




No significant improvement of the matrix formulation in impact strength

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# Perspectives

- Based on these results, 2 formulations were selected for manufacturing the full scale blades by NEMMO partner INPRE:
  - 0.5%wt Carbon Nanotubes dispersed inside the resin
  - 2.5%wt impact modifier dispersed inside the resin

Infusion of half blade using impact modifier reinforced matrix

✓ No dry zone

✓ No filtration of the fillers

Reinforced blade to be installed and tested in real sea conditions

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# Thank you for your attention!

Dr. Célia MERCADER

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mercader@plateforme-canoe.com

www.plateforme-canoe.com

**www.nemmo.eu** @Nemmo_Project info@nemmo.eu

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