Mechanical Evaluation of Woven Glass-Fiber Reinforced Composites for Rigid Scoliosis Brace

Dr. Sun-Pui NG

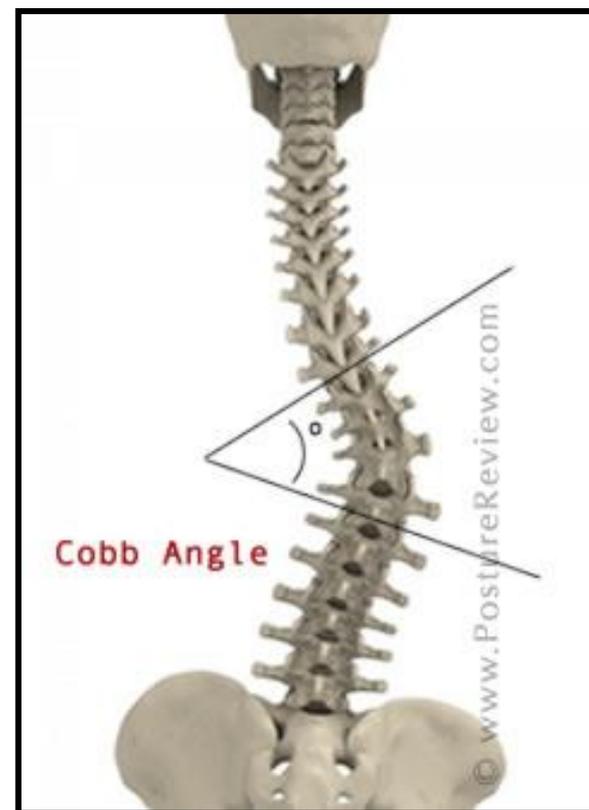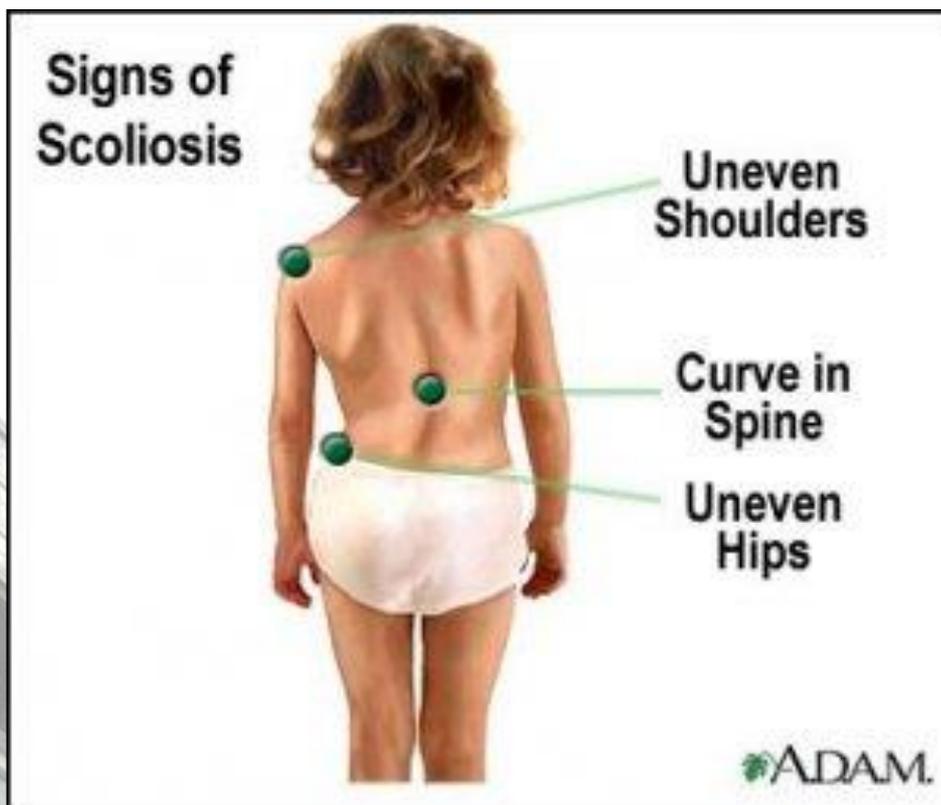**Dr. Kit-Lun YICK**
Dr. Joanne YIP
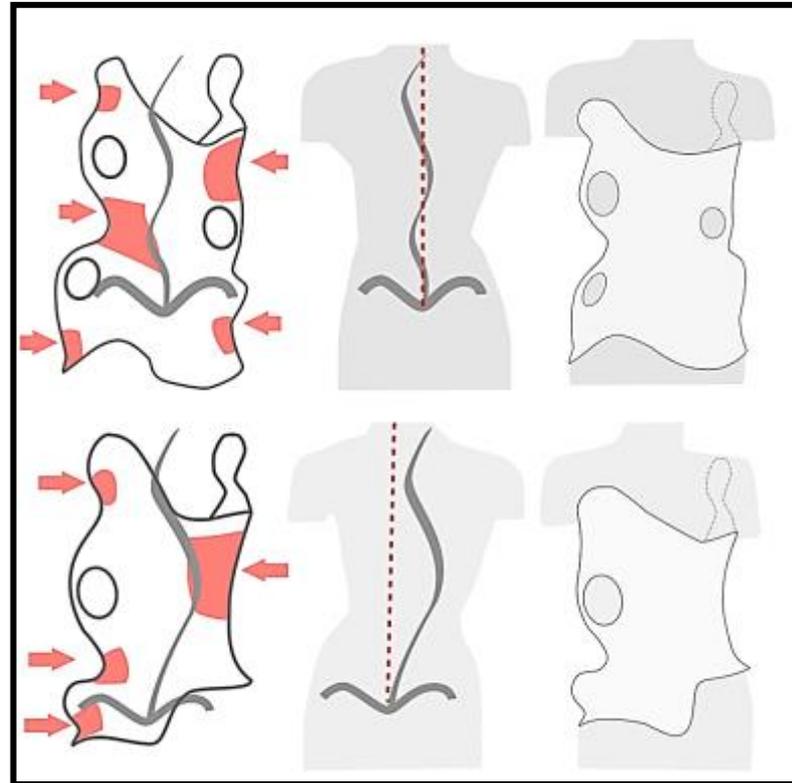**Mr. Chi-Yung TSE**

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Sign of Scoliosis

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專業及持續教育學院

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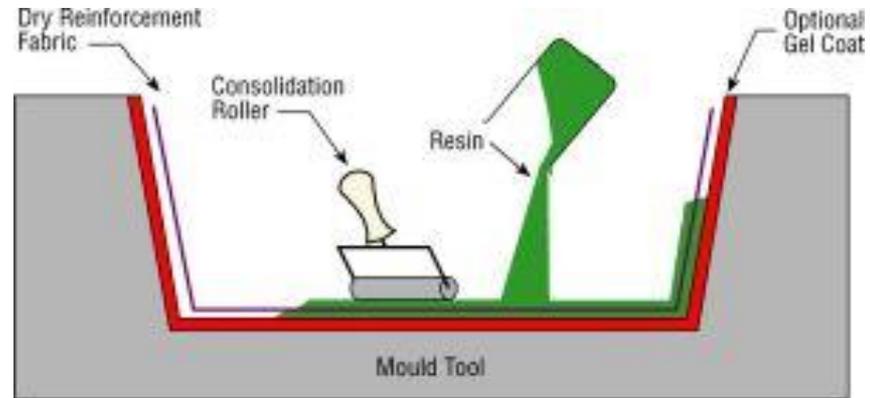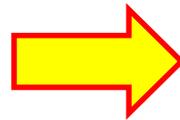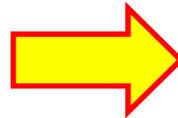# Rigid Scoliosis Brace with Pads

HD Polyethylene (HDPE) brace

Heavy & bulky brace → Low compliance!!!

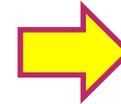# Woven Glass-Fiber Reinforced Composites

Woven Glass-Fiber Textile

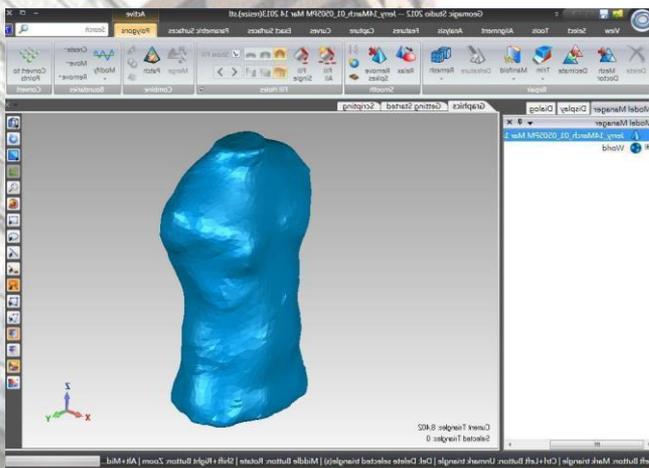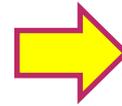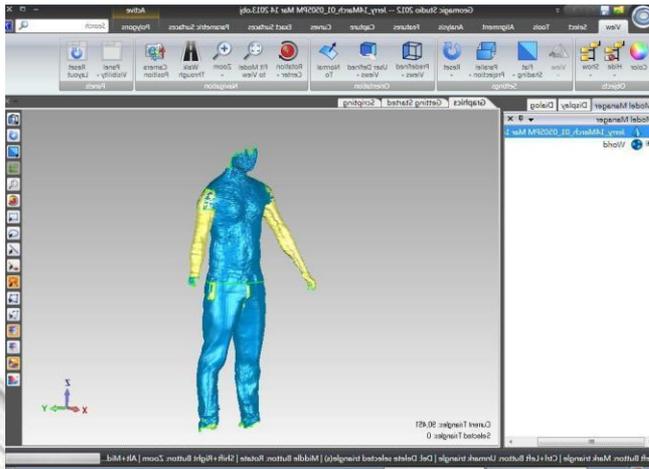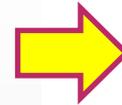

Epoxy

Is this composite material lighter but stronger than conventional HDPE???

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3D CAD Model for Stress Analysis
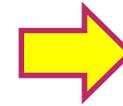
FEA: Pressure exerted by the Brace
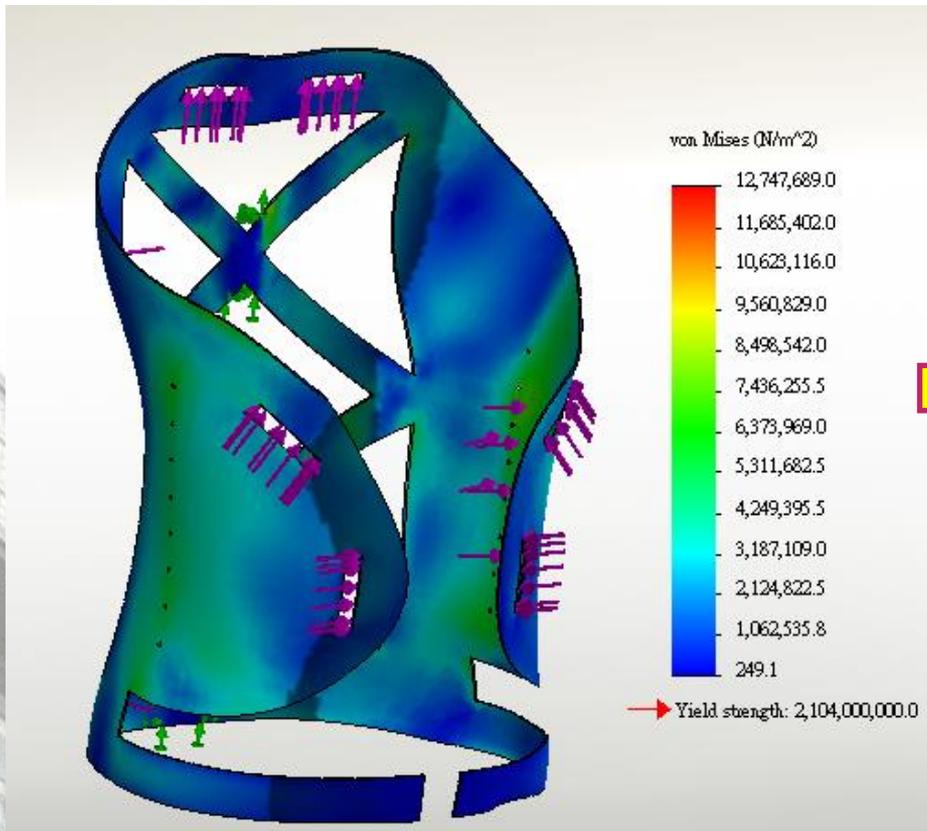
Main concerned mechanical properties:
1. **Young's Modulus (E)**
2. **Bending Rigidity (EI)**

Young's Modulus (E) of Composites

$$E_c = E_f V_f + E_m V_m$$

Properties of Proposed Composites:
E_{glass} = 70 GPa
E_{epoxy} = 3.2 GPa
Based on hand lay-up method:
V_f = 0.32

→ E_{comp} = **24. 58 GPa**

c.f E_{PE} = **0.8 GPa**

Bending Rigidity (EI) of Composites

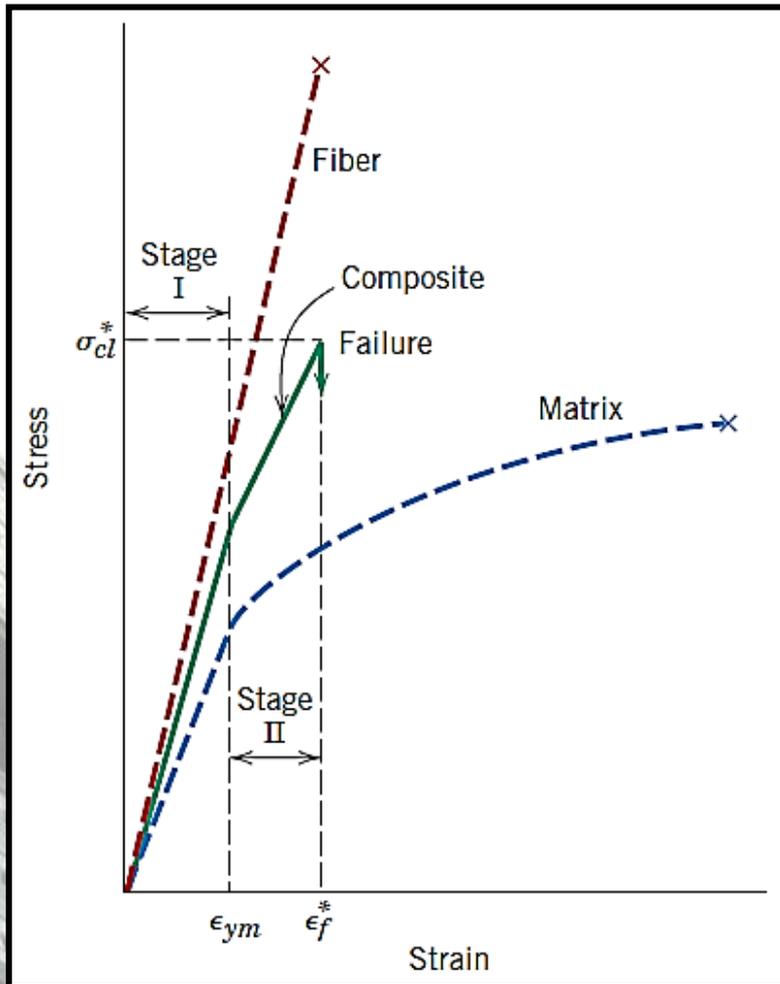For a plate with rectangular cross-section,
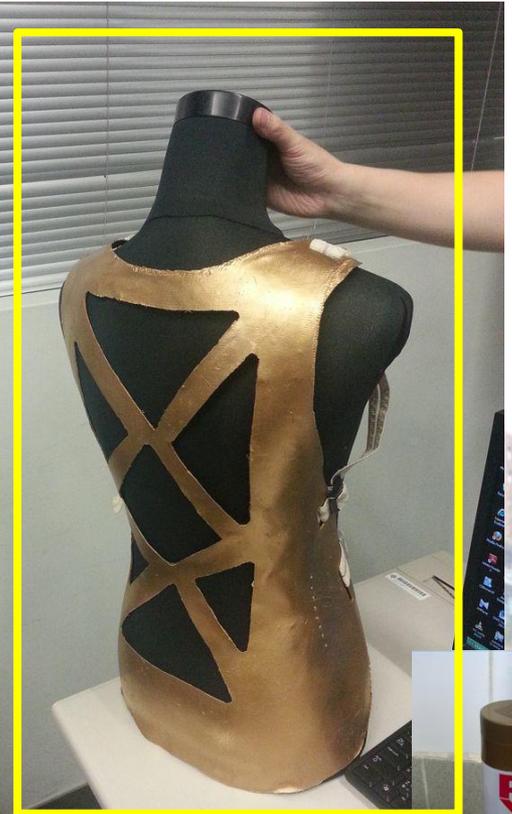Second moment of area $I = bh^3/12$, where b = width, h = thickness

For a plate with b = 25.4 mm and h = **5** mm, EI_{PE} = **0.212 Nm²**

EI_{Comp} = **6.503 Nm²**

When EI_{Comp} = **0.212 Nm²**,

h = **1.6 mm**

Woven Glass-Fiber Composite Brace

Conclusions

- A lighter, thinner but yet stronger composite brace has been developed.
    - Young's modulus is increased (from 0.8 GPa to 24.58 GPa)
    - Bending rigidity is increased (from 0.212 Nm^2 to 6.503 Nm^2: materials with same size).
    - Material thickness is reduced (from 5 mm to 1.6 mm: materials with same bending rigidity).
- When the composite material can be fabricated with a higher fibre volume fraction (V_f) or stronger fibre material, the thickness can be further reduced!

Acknowledgement

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Q & A Session