Cost effectiveness of reinforcing oak wood scantlings by composites

doc.dr.sc. Vjekoslav Živković

Andrija Novosel mag.ing.techn.lign.

WoodEMA 2020 & ICWST 2020
SUSTAINABILITY OF FOREST-BASED INDUSTRIES IN THE GLOBAL ECONOMY
Vinkovci, Croatia, September 28th- 30th 2020

Introduction

- Wood as building material
  - natural
  - aesthetically attractive
  - environmentally friendly
  - limitations

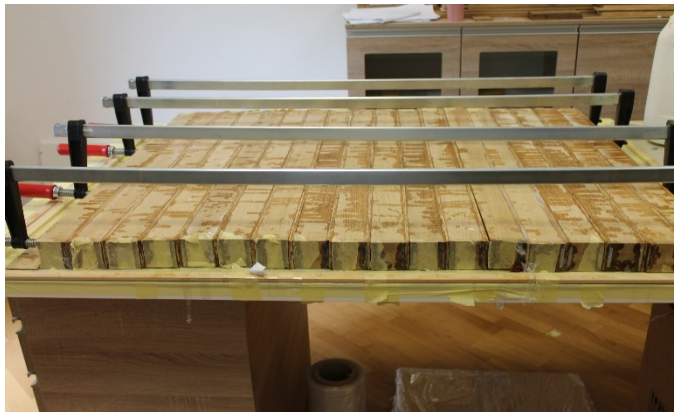
- Reasons for reinforcing wood
  - Improving mechanical properties of products
  - rational use of the material
  - better homogeneity
  - reduce limitations

Introduction

Trends - as small cross sections of the beams as possible

- scantlings for doors and windows
- wooden frames, facades

Materials and methods



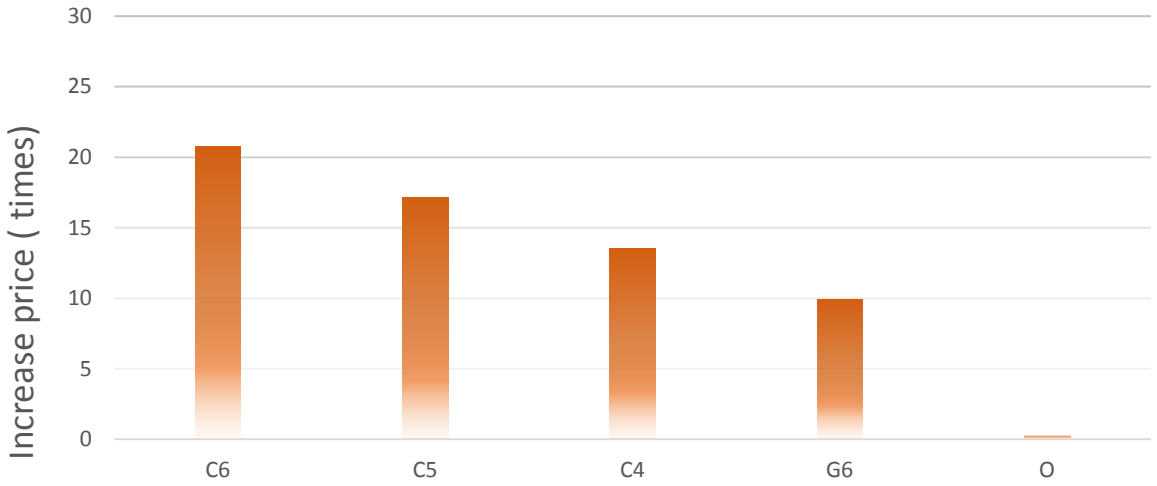
Materials and methods

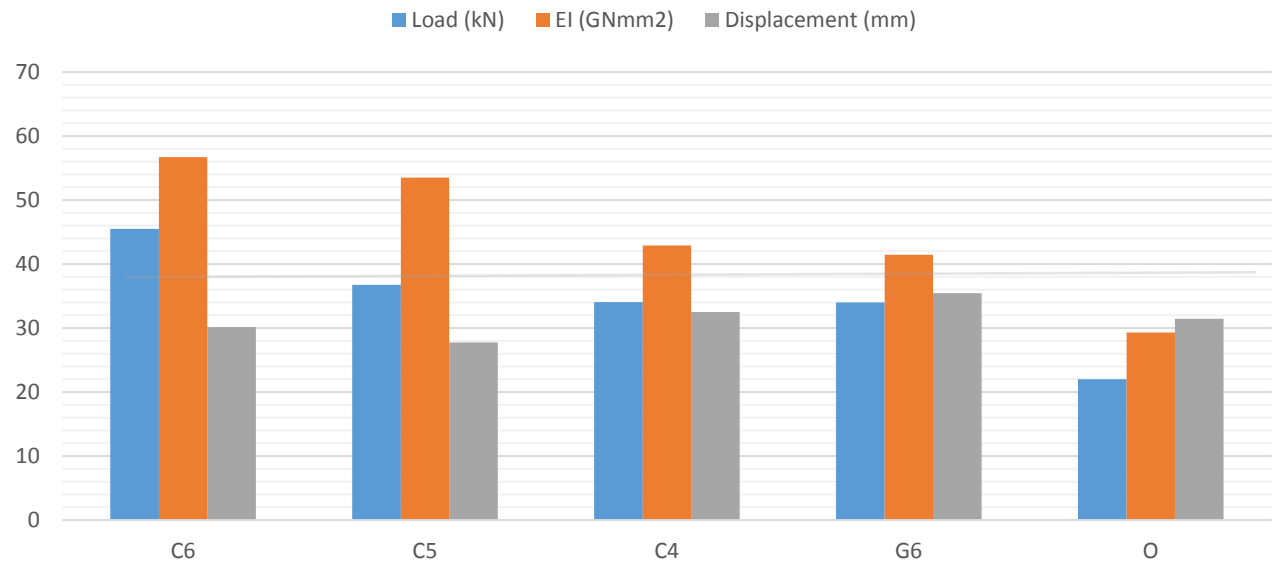
- Four – point bending tests – reinforced/unreinforced oak wood

- Testing program:
  - Phase 1- stepwise increase of load: 4, 9, and 14 kN, unload to ~0 kN
  - Phase 2 - gradual increase of load until failure

Results

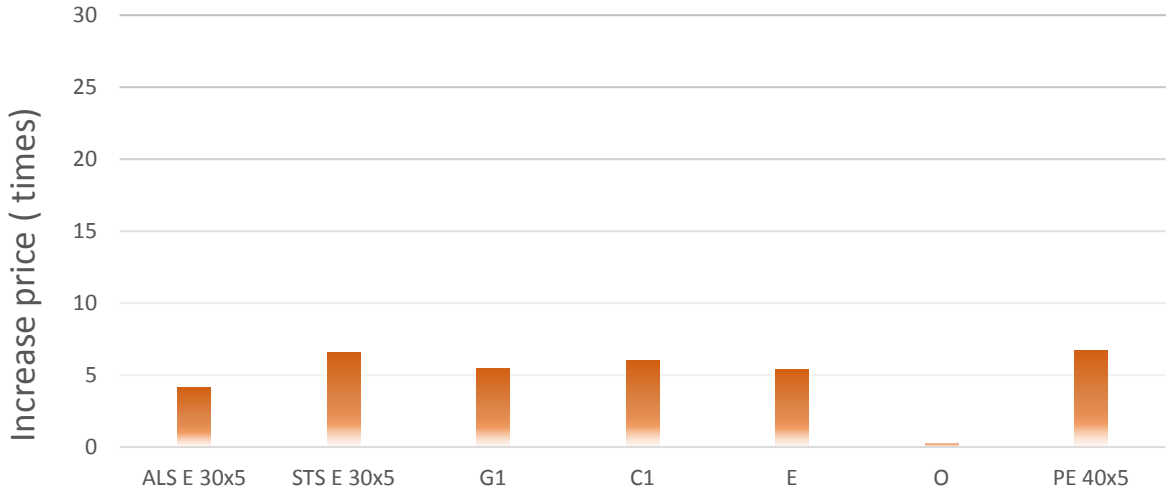
- Expensive options

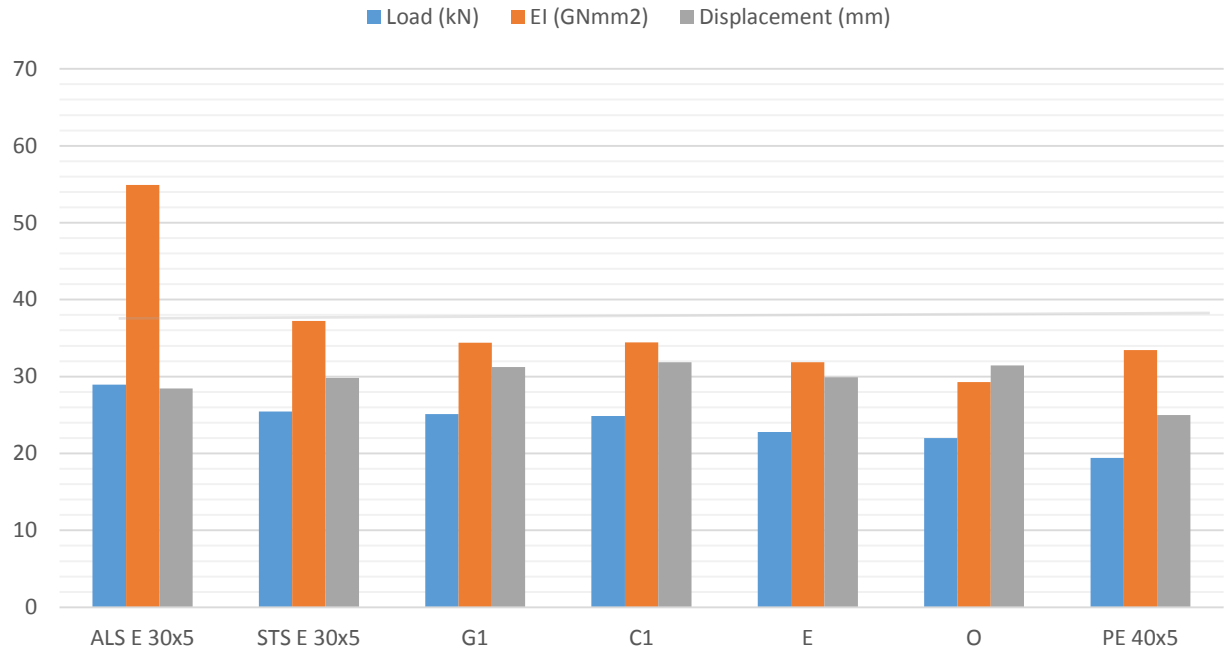




Results

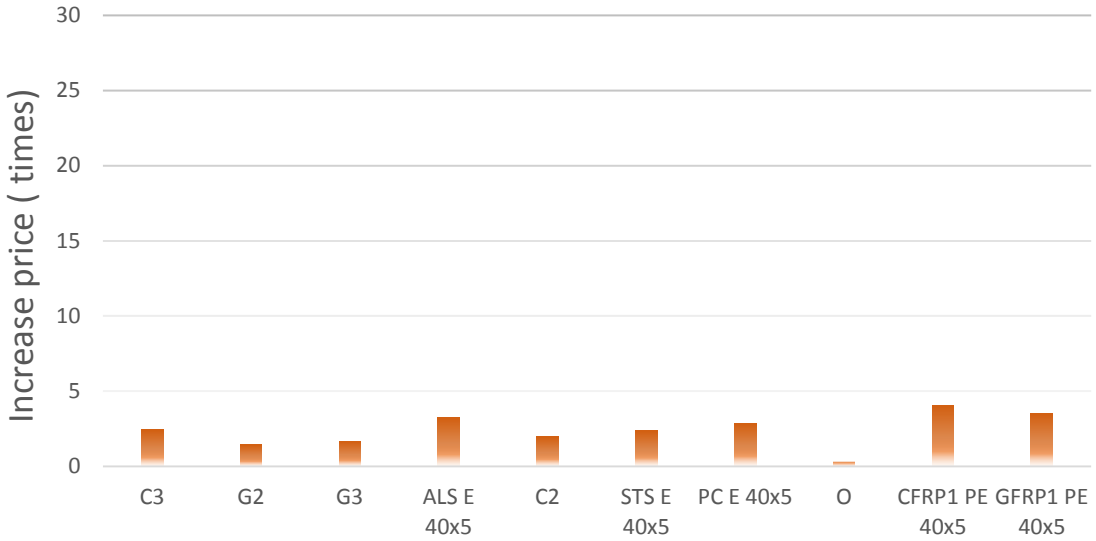
- Middle price range

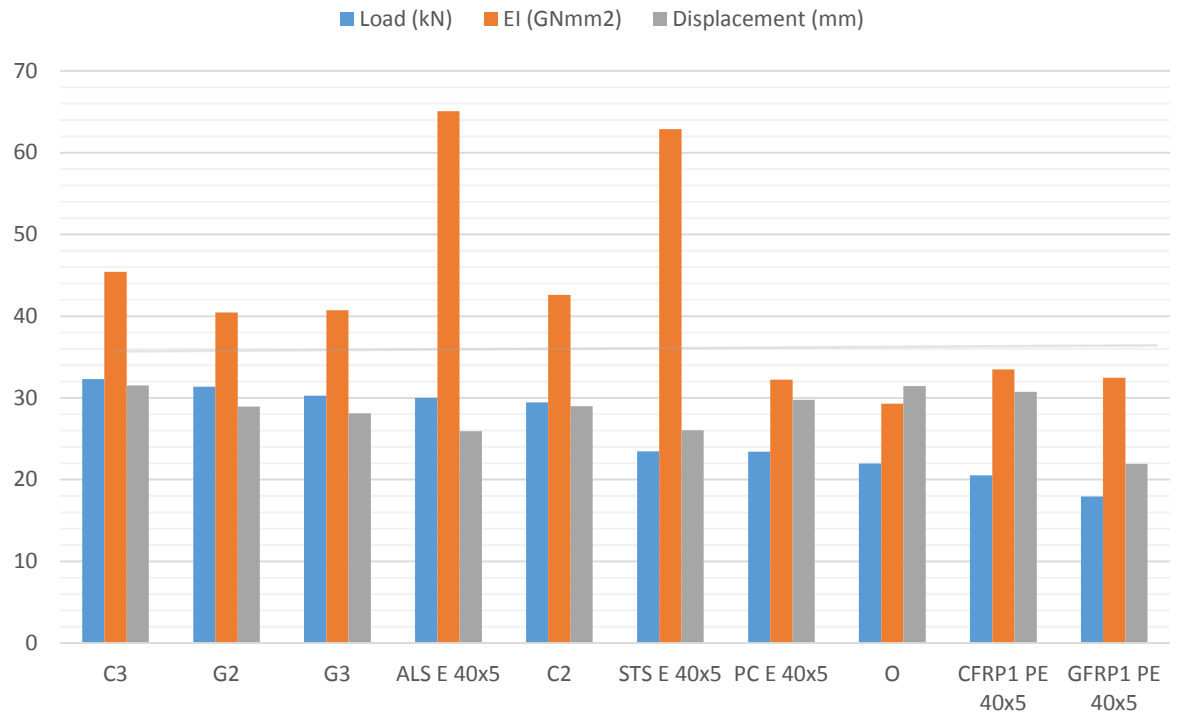




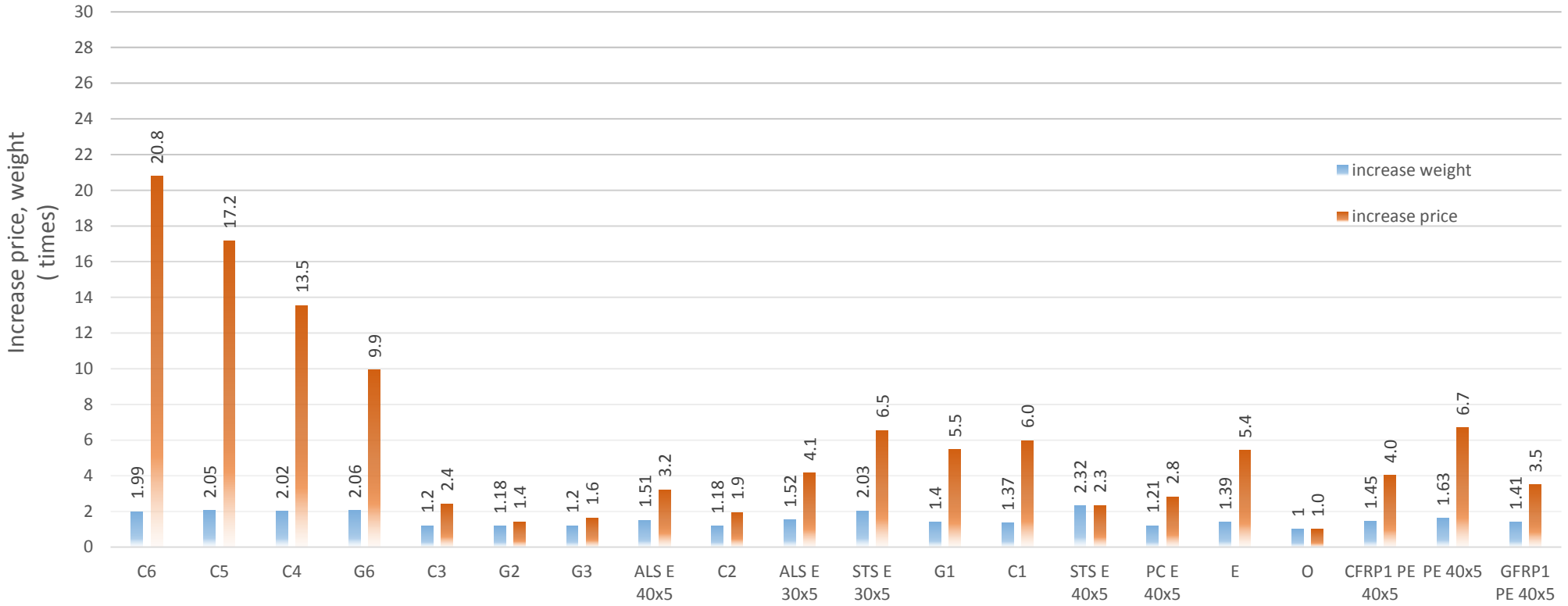
Results

- Low cost group





Results


Increase price, weight (times)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
increase weight
increase price
C6 1.99 20.8
C5 2.05 17.2
C4 2.02 13.5
G6 2.06 9.9
C3 1.2 2.4
G2 1.18 1.4
G3 1.2 1.6
ALS E 40x5 1.51 3.2
C2 1.18 1.9
ALS E 30x5 1.52 4.1
STS E 30x5 2.03 6.5
G1 1.4 5.5
C1 1.37 6.0
STS E 40x5 2.32 2.3
PC E 40x5 1.21 2.8
E 1.39 5.4
O 1 1.0
CFRP1 PE 40x5 1.45 4.0
PE 40x5 1.63 6.7
GFRP1 PE 40x5 1.41 3.5

Conclusions

- If we compare all 3 categories
  - With increase of ULF – 47% and EI for 55% - with price increase of 2,4 times

  the best option for reinforcement is C3 (Pre-stressed carbon fibres 60 mm width - 1 layer)

  - If is important decrease of displ. At ULF(up to 36%), and increase of EI (up to 120%) - ALS E 40x5 (Aluminium sheet 40 x 5 mm) is good option with increase in price for 3,2 times

  - STS E 40x5 mm increase the weight 2,3 times, C3 increase the weight 1,2 times

Thank you for your attention!

Email: anovosel@sumfak.hr