Development of a structural insulated panel based on cross-laminated timber

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Context

Timber industry:
- Renewable and sustainable material
- Healthy and breathing material while being thermally efficient
- Fast and dry construction
- Waste recovery of wood at the end of life
- Attractive and light-weight product
- Importance of the wood industry in the Walloon Region (annual turnover 4.5 billion euros)

CLT: State of the art

Mechanical behaviour

Design & Technology

Connections wall to wall and floor to floor
- Each panel is cut in the middle of its depth, screwed perpendicularly (a)
- A plywood strip (Kerto) is used to assure the connection (b)
- Each panel is cut in the middle of its depth, screwed at 45° (c)

Connections wall to concrete

What is a SIP?
- Structural insulated panels (SIPs) are building panels used in floors, walls and roofs for residential and light commercial buildings.
- The panels are typically made by sandwiching a core of rigid foam plastic insulation between two structural skins of oriented strand board (OSB).
- Other skin materials can be used for specific purposes.
- The result is a building system that is extremely strong, energy efficient and cost effective.

Cross-Laminated Timber:
- Last Engineered Wood Product (EWP) developed (2000)
- Composed of crossed and glued laminated softwood (sometime nailed)
- Odd number of strips (3,5,7 or more)
- Dimensions: up to 24m x 3m x 50cm
- Good fire resistance, good acoustic and vibration properties

Proposition of new SIP

General concept:
- Two CLT panels separated by an insulation (global thickness defined according to thermal performance required)
- Behave like an "I" beam. The web is actually made of large self tapping screws (screwed at 45°)
- Screws ensure strength and stiffness of the composite wall or floor
- High level of prefabrication
- May content wood siding, water protection,...

Insulation is not taken into account from the mechanical point of view.
- Screws should transfer shear
- Any type of insulation can be considered (regard to the ecological of the composite wall or floor element)
- Who can do more, can do less
- Passive house
- The panel have to be sufficient to obtain U≤0.10W/m².K
- (Insulation: 36cm of glass wool with λ=0.04W/m.K)
- Green product
- Lower embodied energy
- No polyurethane (…) glued to panels
- Lifecycle attractive (removable panels)

Design & Technology

Connections: how to connect panels?
- Proposing for each type of connection a technological solution.
- As many connections already exist for standard CLT panels, an upgrade of existing solutions is probably suitable.
- Proposition made with response to water tightness, airtightness and ductility.

Mechanical behaviour

ULS and SLS of the "SIP":
- As wall element:
  - Design of the axial and bending ultimate strength.
  - Design of the lateral load-carrying capacity (according to connector spacing, panel dimensions and shapes).
  - Definition of "equivalent stiffness" for SLS design.
- As floor element:
  - Design of the bending and shear strength.
  - Definition of "equivalent stiffness" for SLS design.

SIPA: Structural Insulated Panels Association (USA)