Use of wood in an environmentally context

Lars Tellnes

Researcher

June 20, 2016, Forskningsveien 3 B

Treteknisk

Lars TELLNES

MSc in industrial ecology from Norwegian University of Science and Technology (NTNU)

Works with:

Environmental properties of wood products

Development of environmental product declarations (EPD)

Sustainable buildings

Agenda

Carbon footprint of wood as a construction product – Norwegian practice and research

Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

Carbon footprint of wood as a construction product – Norwegian practice and research

Presentation at 60th LCA Discussion Forum
"Environmental use of wood resources"

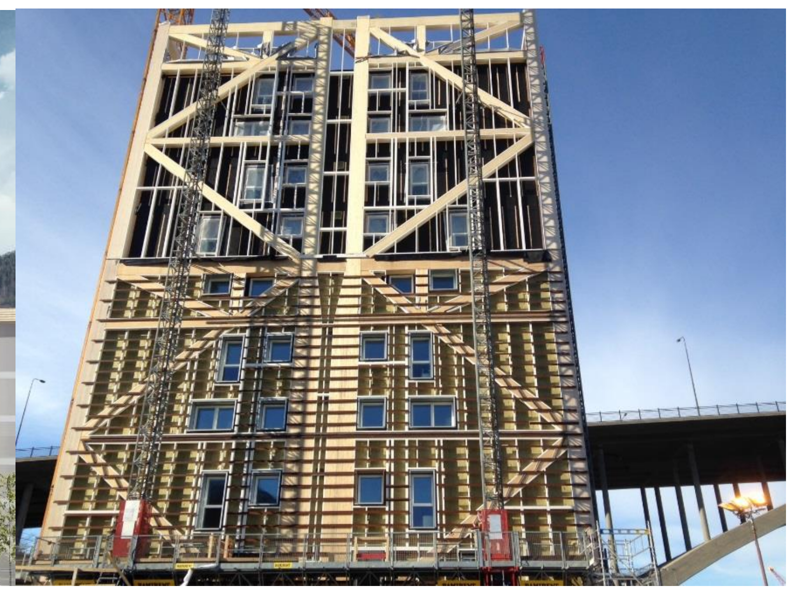
Lars Tellnes
Norwegian Institute of Wood Technology

December 3 2015, Zurich

Treteknisk

Carbon footprint in practice - Example: «Treet - the tallest wood building in the world»

Simplified, the reduced GHG-emissions from carbon storage in wood is eq. to 10 million cars driving the distance of the bridge (Godø, 2015-04-01).



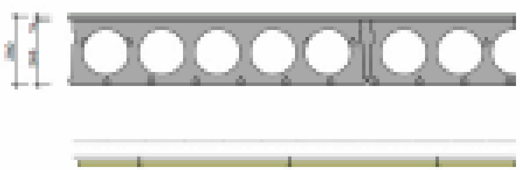
Carbon footprint in practice - Example: "Åsveien upper secondary school"

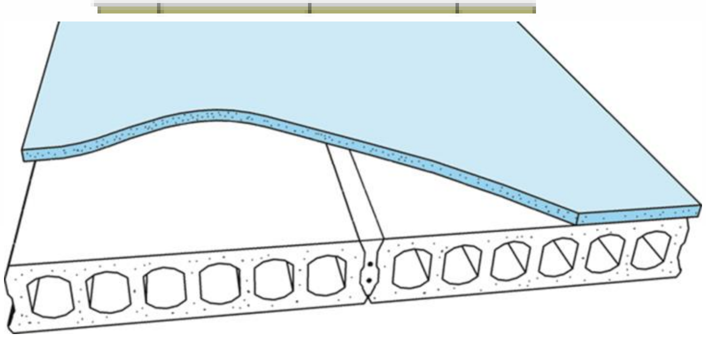
New building

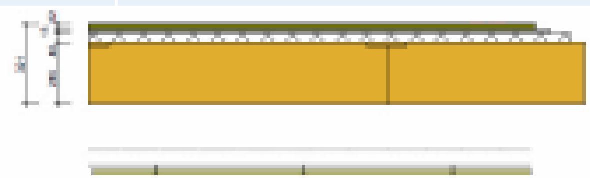
Illustrations: Eggen Arkitekter

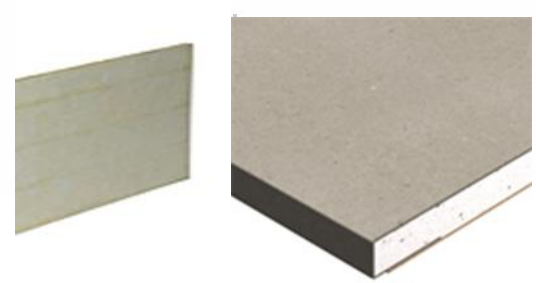
Functional equivalent comparison of flooring options

	Concrete	Timber
Core material	265 mm concrete hollow element	245 cross-laminated timber
Additional materials	15 mm screed	22 mm particleboard 13 mm gypsum board 40 mm acoustic floor board
Fire	EI60	EI60
Carbon footprint kg CO_2-eq.	123	55









Source: Eggen arkitekter

Carbon footprint of buildings – current common practice

- Some simply only account for biogenic carbon storage
- More common to only account cradle to gate emissions with instant oxidation of biogenic carbon
- Maintenance and replacement where relevant
- Data from EPDs or ELCD
- Scope of building elements and comparisons varies

Treteknisk

Carbon footprint research example – light weight timber construction

Wood building weights 1/3 of steel and concrete solution

Reuse or reduced use of foundation have large carbon footprint reduction potential

Tellnes et al. (2014)

Treteknisk

Research on carbon footprint of wood products

Not only sound and fire for functional equivalent, weight and volume and thus including the whole building is important for comparison.

Research highlights importance of biogenic carbon, but there is a lack of consensus. Important to be transparent in environmental product declaration (EPD) for wood products.

Standardisation effort – merging practice and research

There is an ongoing work to make a Norwegian standard for carbon footprint of buildings based national practice and

EN 15978 Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method

Largest standardisation committee in Norway with many stakeholders

For materials, specific data representativeness requirements and scope of materials to be included are important.

BREEAM-NOR classification system for sustainable buildings was recently revisited and was based on the principles of the coming standard

Conclusions

Several innovative uses of wood products in buildings have shown to be beneficial for reducing carbon footprint, however there is little use of standards at building level.

Practice is moving towards compliance with EN 15978 and revised BREEAM-NOR and national standard for carbon footprint will push this forward

The low weight of wood could have a large reduction potential if it reduces the need for concrete foundation

References

Eggen arkitekter (2014) Hunting CO_2 using envrionmental budgets. Presentation at Forum Holzbau Nordic, 25 september 2014.

Godø, M. (2014-04-01). Tre i høyden. Downloaded November 25, 2015, from: http://www.dagbladet.no/2014/04/01/kultur/meninger/kommentar/arkitektur/bygningsmaterialer/32594411/

Tellnes, L.G.F., Kristjansdottir, T.K., Eide, S. & Kron, M. (2014) Assessment of carbon footprint of laminated lumber elements in a six story housing – comparison to a steel and concrete solution. Proceeding to World Sustainable Building conference October 28-30, 2014.

Treteknisk

S102 - What key elements will determine construction materials´ future?

Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

Tellnes, Lars G. F.[1]; Kristjansdottir, T. K.[2]; Eide, S.[1]; Kron, M.[2]

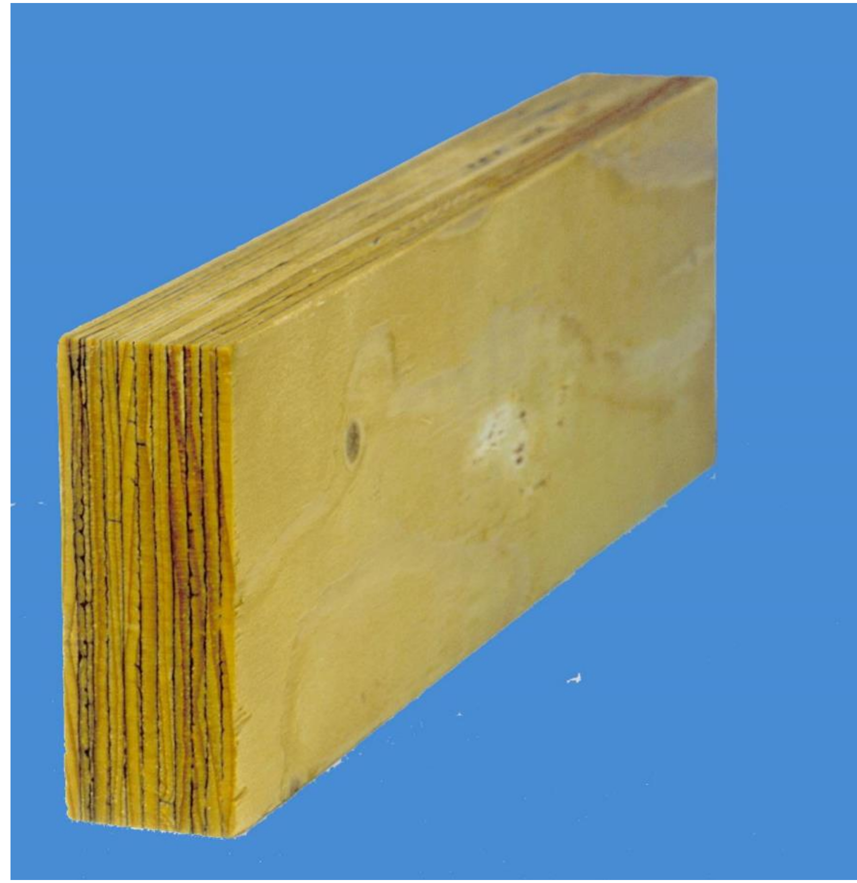
[1]Norwegian Institute of Wood Technology, Oslo, Norway

[2]SINTEF Building and Infrastructure, Oslo, Norway

Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

Case study – Trä8 building system

- Trä8 is a structural frame building system with glued laminated timber (gluelam) beams and posts with spans up to 8 meters
- Premanufactured floor elements made in laminated veneer lumber (LVL)
- A two-floor house was taken down and the basement foundation was kept for the new house
- The Trä8 system was chosen for its low weight



Kerto®, Laminated veneer lumber (LVL)

Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

The goal and scope

- Assessment of a carbon footprint of innovative solutions to use a light wood frame in a building on preexisting foundation and compare to conventional solution

- Comparison based on functional equivalents so that the structure elements shall have meet the same requirements to fire, acoustics and strength

- Explore the use of generic vs specific data

- Three alternatives:
  1. As built – generic data
  2. As built – specific data
  3. Steel and concrete alternative – generic data

Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

The assessment is based on European standards:

- EN 15804 Core PCR: Rules on how to document materials
- EN 15978 Environmental assessment of buildings – Calculation methods

- Exception 1: Only the Product stage A1-3 is included (cradle-to-gate)
- Exception 2: Instantaneous oxidation of biogenic carbon at point of harvest is assumed for wood products (reasonable simplification in cradle-to-gate)

A1-3 PRODUCT STAGE			A4-5 CONSTRUCTION		B1-7 USE STAGE					C1-4 END OF LIFE			
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4
Raw material supply	Transport	Manufacturing	Transport	Construction installation process	Use	Maintenance	Repair	Replacement	Refurbishment	De -construction demolition	Transport	Waste processing	Disposal

Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

Life cycle inventory for the structure as built

- Compiled in cooperation with Moelven Töreboda based on building design sheets
- Down to each screw and nail
- Challenging to include a partial excisting foundation

Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

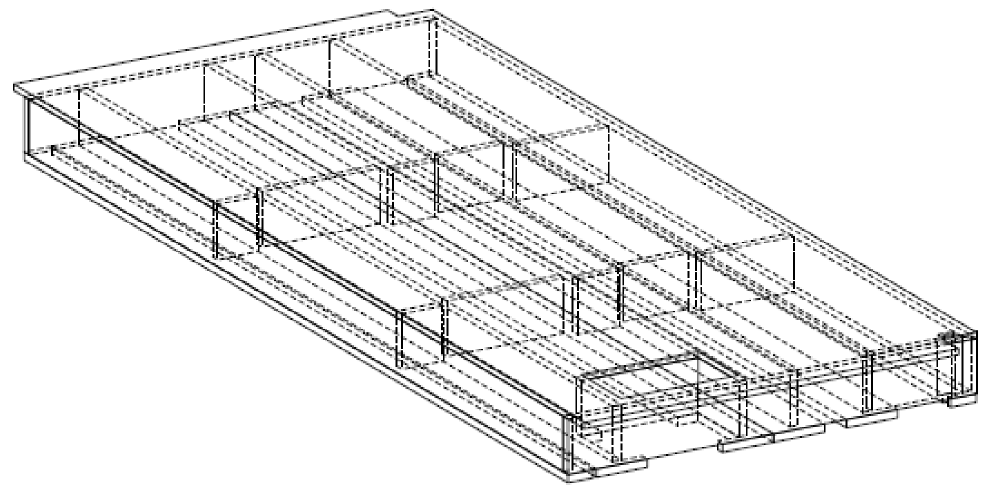
Gluelam structure

- Beams and post in gluelam
- Joints with steel
- Support steel bars

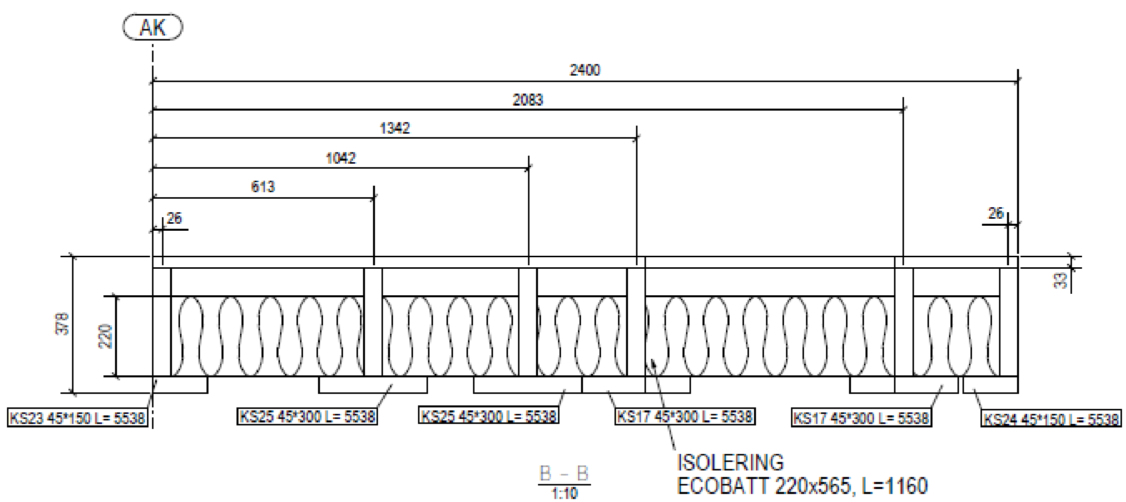
Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

LVL flooring elements

- 378 mm high LVL-elements
- Width 2.4 m
- The span is 6 m at Askims torg



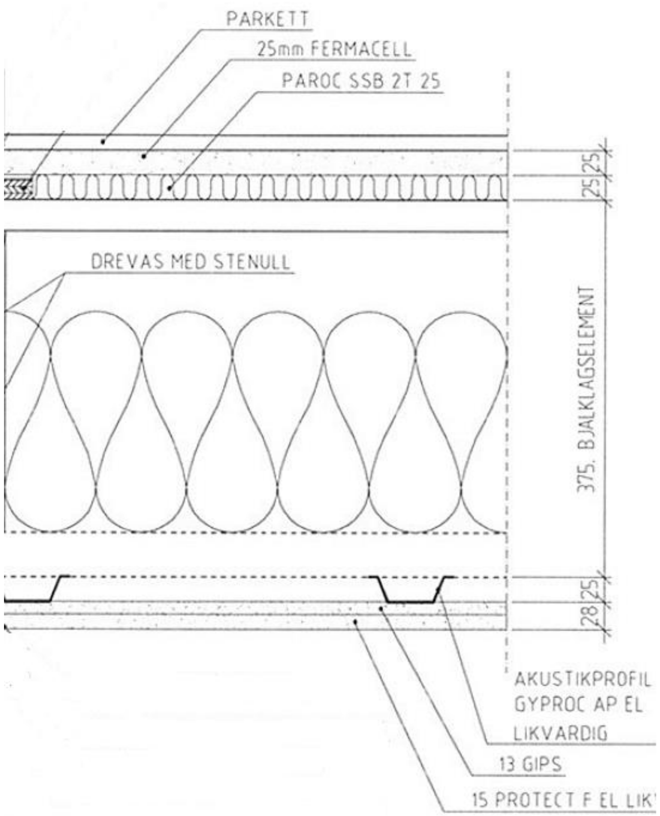
3-D



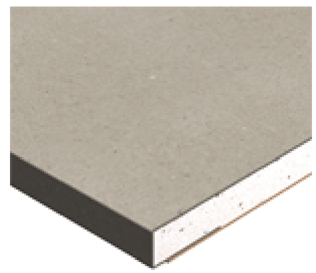
B – B
1:10

Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

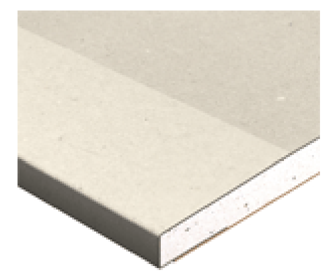
LVL flooring elements – additional materials

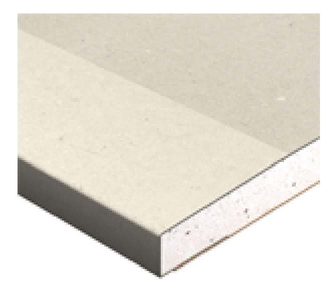


Above:



Under:





Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

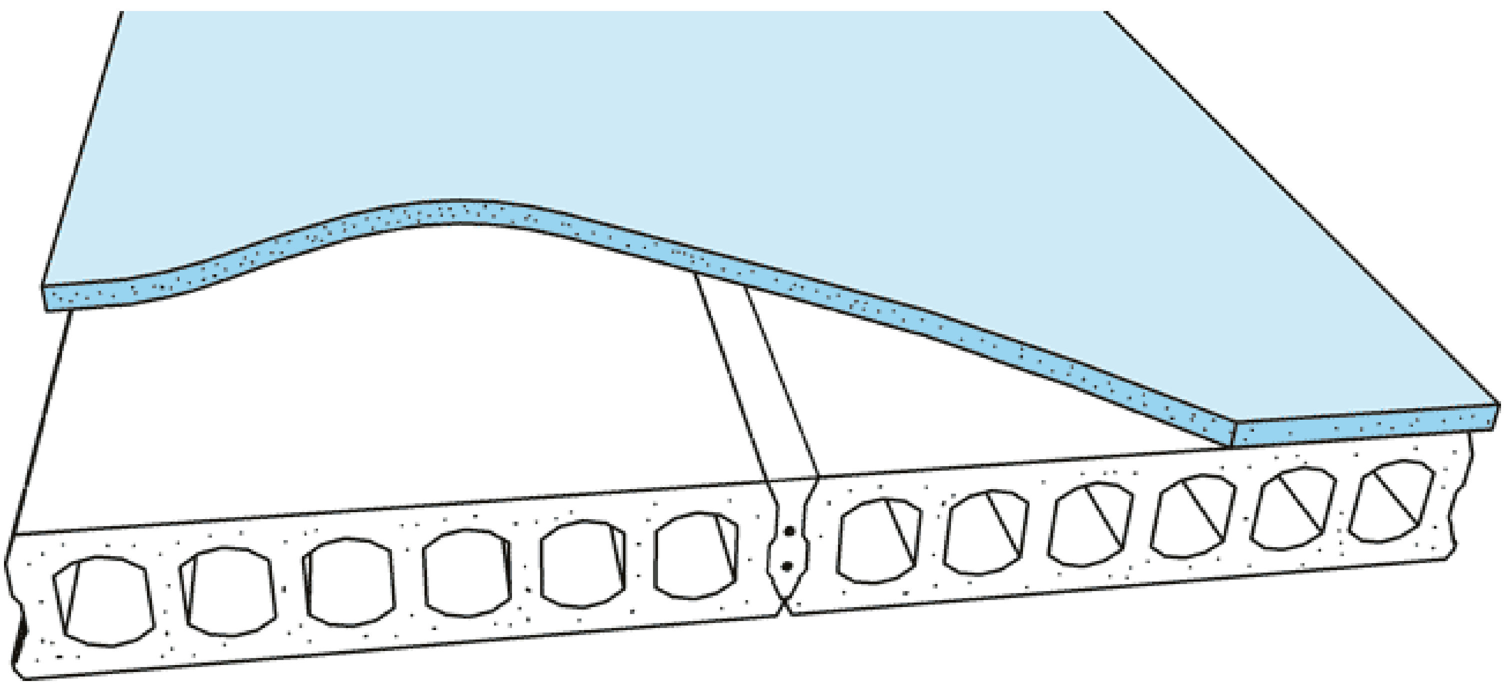
Alternative structure of steel beams and concrete elements

- Steel use estimated to strength of loads of concrete elements
- Assumes the same spans as with wood
- The foundation and elevator shaft is assumed to be equal as built

Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

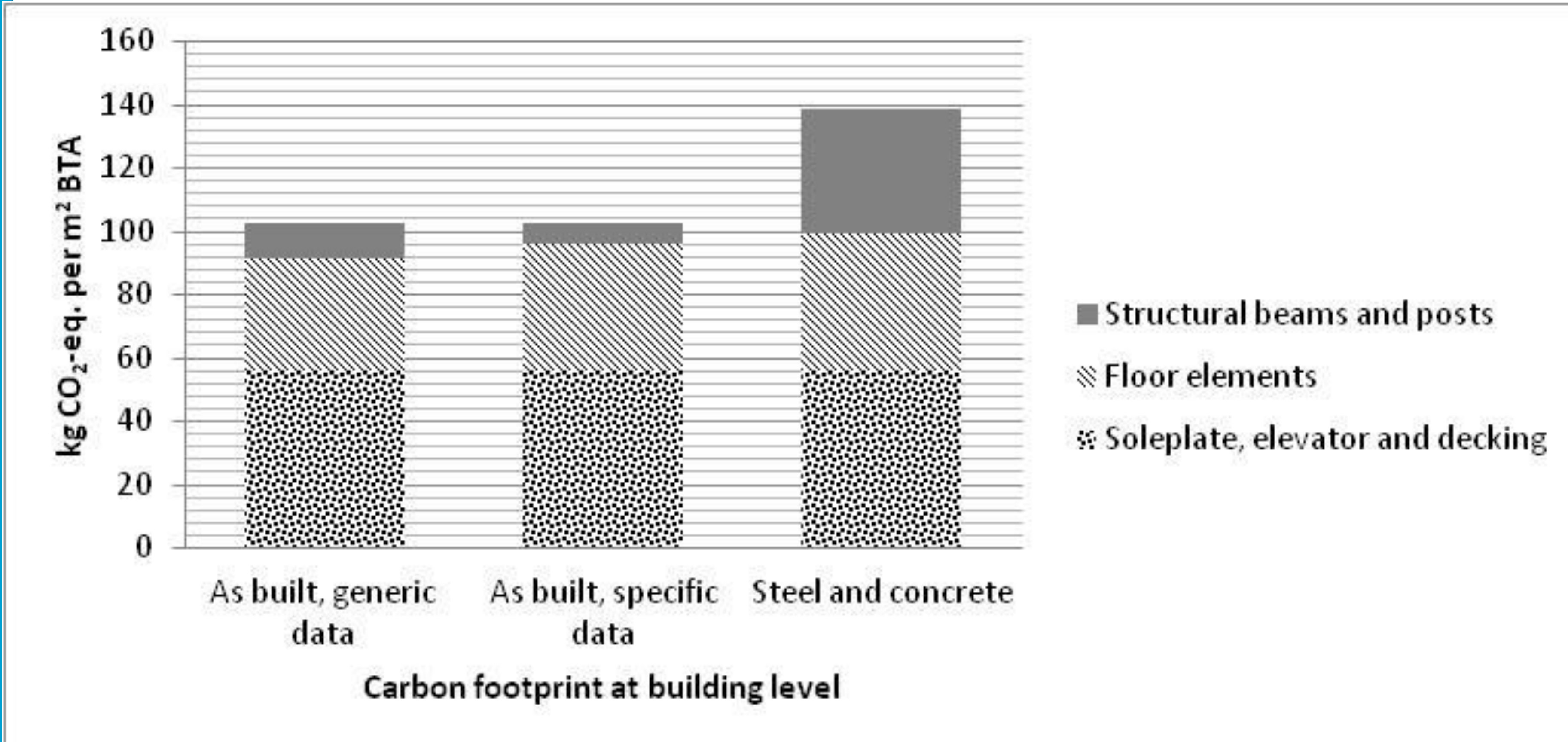
Floor elements – Concrete hollow elements

- 320 mm was needed to fulfil the acoustic requirements of Swedish class C
- 40 mm screed material and 0.2 mm vapour barrier
- Assume that paint is directly applied to the underside



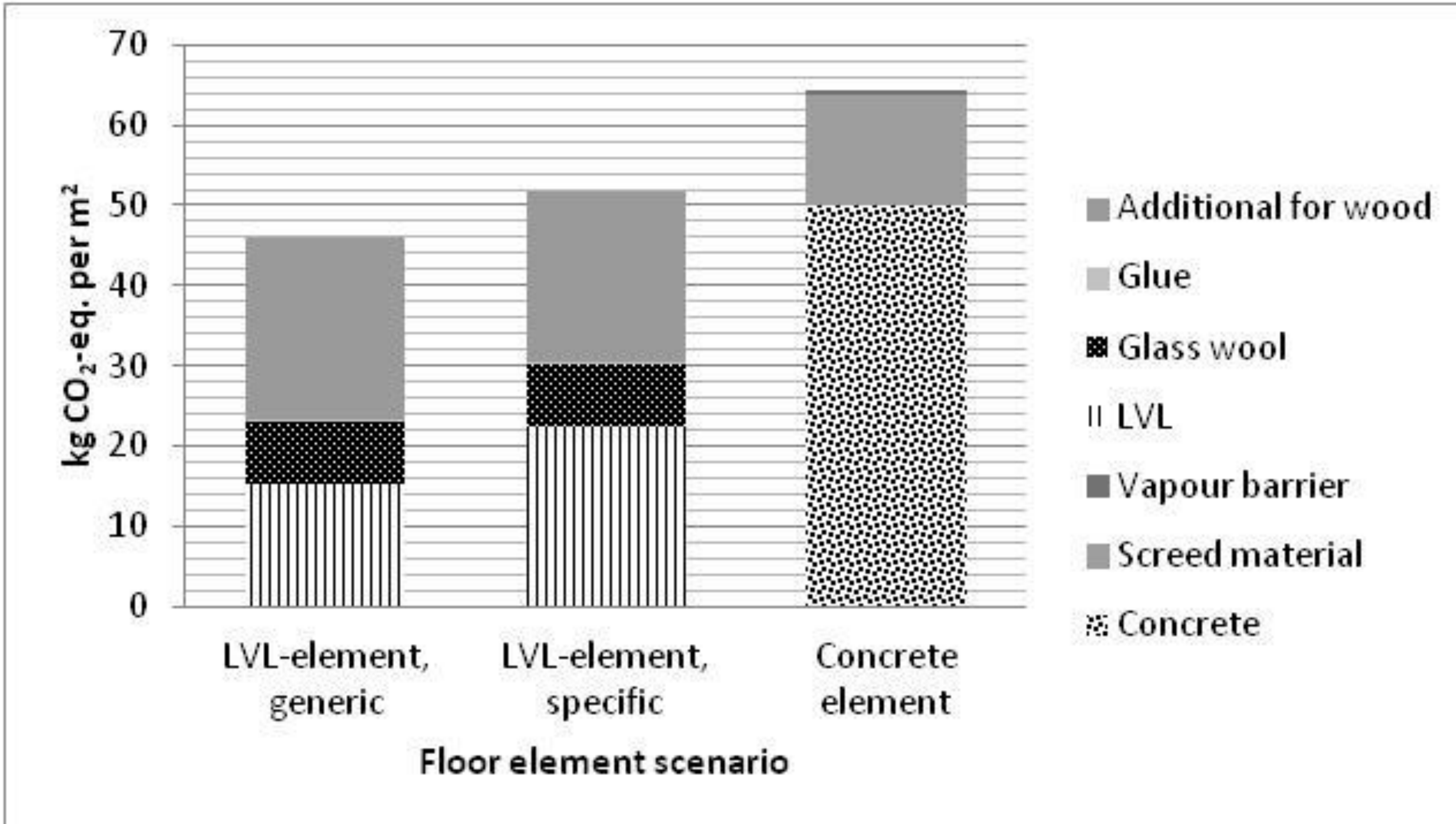
Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

Results – The structure level



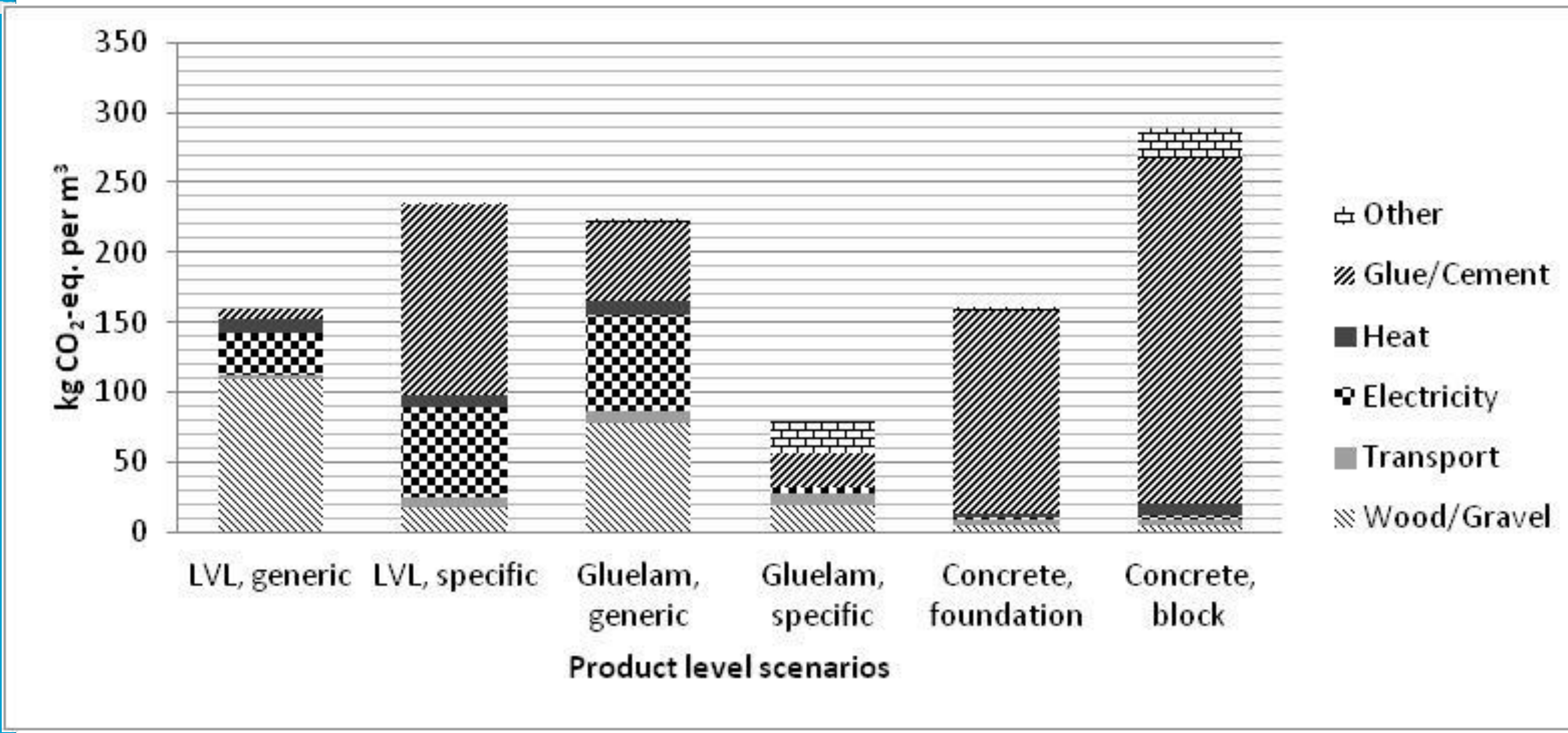
Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

Results – Flooring elements per m²



Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

Contribution analysis for main materials used per m³



Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

Conclusions

- Foundation have a large contribution to the total structure. Effects of lower use through low weight of structure could be important for climate change mitigation
- Comparing functional equivalents on criteria's such as sound, fire and strength gives a fair results
- Large data variations makes the results uncertain and should be site specific for main materials

Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

What key elements will determine construction materials' future?

- Low carbon footprint, but comparing kg and m3 are not enought

- Specific analysis are important where technical properties such as strenght, fire resistance, acoustic, etc. are included

- Having this information effectively available to the building developers are important for the construction materials' future

Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

- **Sustainable Building: RESULTS- Are we moving as quickly as we should?**

  - In Norway, prior to 2011 no, since 2011 maybe
  - For the case in Norway, things are moving fast and the marked have totally changed the last four years. BREEAM adaptation to Norway has been an important contribution to documented results
  - Moving from lighthouses to standardized solution are crucial if we shall continue to move fast in changing the building stock

Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

Thank you for your attention!

Project page: www.klimatre.no

KlimaTre

-Trebruk for bedre klima og økt verdiskaping

Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

List of references

Ecoinvent. 2010. *Ecoinvent version 2.2*. Swiss, Centre for Life Cycle Inventories, Dübendorf, Switzerland.

EEBguide, 2013. Website www.eebguide.eu, driven by the Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V and the The Fraunhofer Institute for Building Physics (IBP). Supported by the European Commission Research and Innovation, Environment, Seventh Framework Programme for Research FP7.

Simapro, 2012. Simapro 7.3, PRé Consultants, Amersfoort, the Netherlands.

U.S. Life Cycle Inventory Database. 2012. National Renewable Energy Laboratory, 2012. Accessed November 19, 2012: https://www.lcacommons.gov/nrel/search

Wærp, S, Grini, C., Folvik, K. & Svanæs, J. 2009. Livsløpsanalyser (LCA) av norske treprodukter, in. (Life cycle analysis of Norwegian timber based products). 2009. Sintef Building and Infrastrucutre, Norway.

Zimmer, B. & Kairi, M. (2001). LCA of Laminated Veneer Lumber - Finnforest Study. COST Action E9 Life cycle assessment on forestry and forest products.

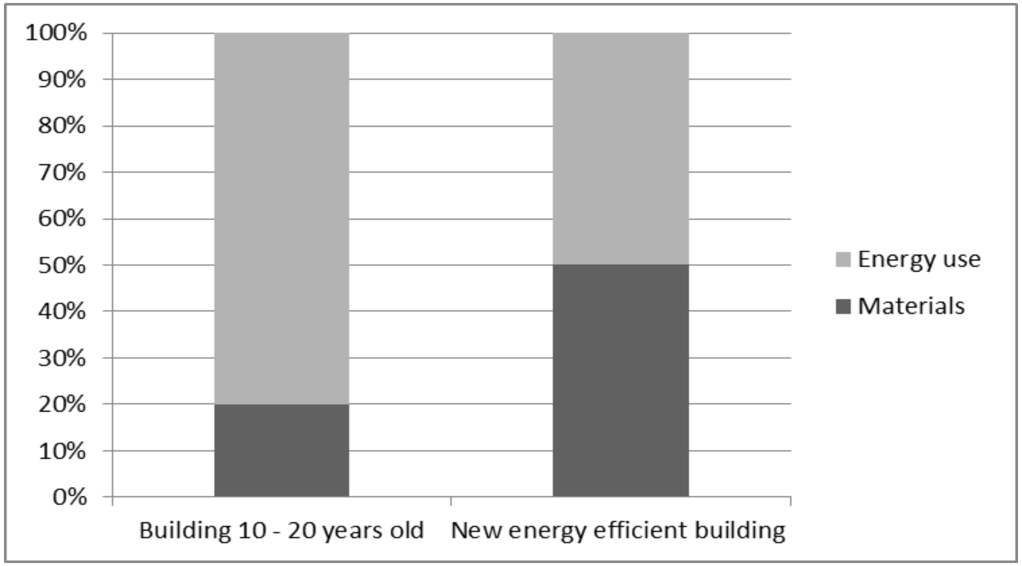
Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

Introduction

- Traditionally energy use have been regarded as the most important part of the life cycle impact of a building

- More energy efficient buildings makes materials increasingly important

- Several studies favours wood as an low carbon footprint alternative in construction



(*Figure: EEbguide.eu, 2013)*

Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

Data sources for life cycle inventory for production of materials

	As built - generic	As built - specific	Alternative – generic
Gluelam	Ecoinvent	EPD Moelven limtre	
Steel	Ecoinvent	Ecoinvent	Ecoinvent
LVL	USLCI	LCA Kerto	
Additional for wood	Ecoinvent	EPD Gyproc/Ecoinvnet	
Concrete	Ecoinvent	Ecoinvent	Ecoinvent

Assessment of carbon footprint of laminated veneer lumber elements in a six story housing – comparison to a steel and concrete solution

Impact assessment for carbon footprint

- The impact assessment method used is IPCC2007 100 yr from SimaPro 7.3.3

- Removal, emissions and temporary storage effects of biogenic carbon are not included

- Preferred when the inventory only includes the product phase of building materials (cradle-to-gate)

Thank you

Miljødokumentasjon EPD

Stadig flere utbyggere ønsker mer miljøvenlige bygg, da må produktenes miljøegenskaper dokumenteres.

Livsløpsvurderinger (LCA)

Livsløpsvurderinger (LCA) er en metode får å helhetlig beregne miljøpåvirkningen til et produkt over livsløpet.

PEFC miljøsertifisering

Treteknisk er notifisert av PEFC Norge til å utføre sporbarhets- eller Chain of Custody-sertifisering. Vi, med vår bakgrunn, har særdeles gode forutsetninger for å utføre PEFC – sertifiseringer for våre medlemmer.

www.treteknisk.no

Referanser

Plesser, T. S. W., Kristjansdottir, T., Tellnes, L., Flæte, P. O., Gobakken, L. R. & Alfredsen, G. 2013. *Miljøanalyse av trefasader*. SINTEF Fag 5.