



Timber Extensions on Existing Buildings

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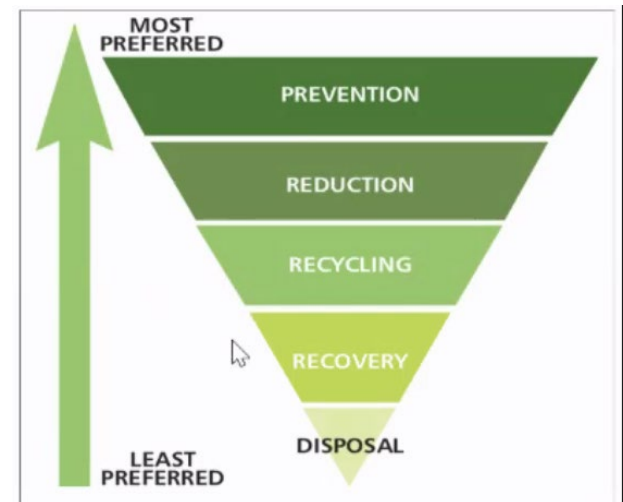
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Construction

- Present and future trends

- Resources and Circularity
- Urbanization
- Urban densification



- By 2030: additional 1 billion people will live in cities
- By 2050: 3 billion more (total: 2/3 of world's population)

What about extending existing buildings?

Timber extensions

- Timber extensions: why timber?

Why timber extensions?

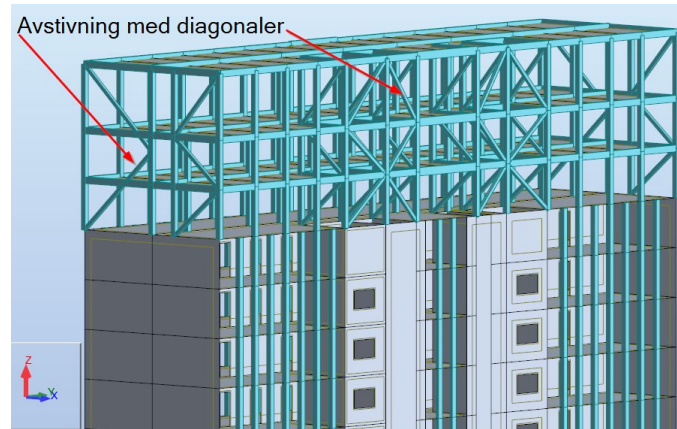
- Light material
 - Environmentally friendly
 - Can be prefabricated
-
- Wood is 5 times lighter than concrete
 - Wood is 20 times lighter than steel

Illustration: Eleftheria Lousi



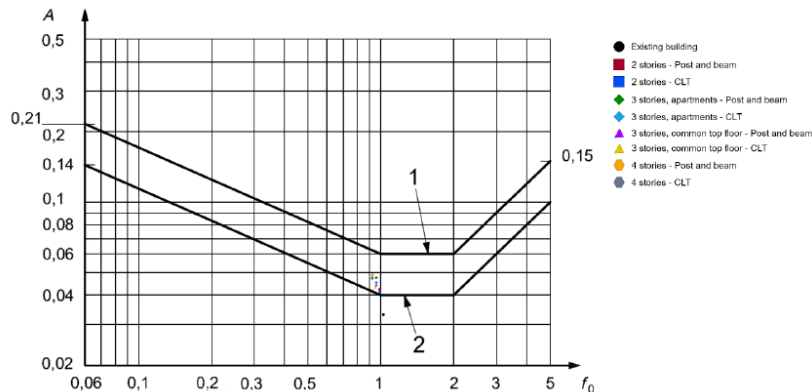
Timber extensions

- Case study: Sentralbygg at NTNU (MS Thesis: A. Fjell and J.E. Edvardsen Holm)



Outcome:

- Possible to extend by 2-3 stories
- **But:** We have to assess the existing



Tabell 4-2: Belastningsøkning av ulike søylegrupper

		Opprinnelig bygg (kN, kNm)		2 etasjer		3 etasjer, hybler		3 etasjer, felles toppetasje		4 etasjer	
		Trykk	Moment	Post and beam	CLT	Post and beam	CLT	Post and beam	CLT	Post and beam	CLT
Fasadesøyler 315x315	Trykk	706,92		1,8 %	5,1 %	9,6 %	14,7 %	12,9 %	18,8 %	23,0 %	16,8 %
	Moment	24,40		26,2 %	29,0 %	34,8 %	39,6 %	38,6 %	44,1 %	49,1 %	58,3 %
Fasadesøyler 350x500	Trykk	692,12		9,9 %	13,3 %	17,9 %	23,1 %	21,3 %	27,3 %	31,7 %	40,0 %
	Moment	28,94		21,2 %	27,8 %	39,6 %	43,7 %	47,1 %	50,3 %	72,5 %	73,9 %
Fasadesøyler 350x200	Trykk	124,47		6,7 %	7,2 %	14,2 %	14,8 %	17,1 %	17,9 %	26,9 %	28,0 %
	Moment	16,00		-4,2 %	-4,0 %	1,3 %	1,6 %	3,4 %	3,8 %	10,7 %	11,2 %
Sirkulære søyler	Trykk	2 110,67		-0,1 %	0,4 %	4,3 %	5,2 %	5,6 %	6,7 %	10,3 %	11,8 %
	Moment	40,44		0,0 %	0,1 %	5,9 %	5,9 %	8,1 %	8,3 %	14,1 %	15,6 %
Pilastere	Trykk	1 132,82		-0,2 %	0,3 %	4,1 %	5,0 %	5,4 %	6,5 %	10,0 %	11,5 %
	Moment	51,09		17,7 %	17,3 %	29,5 %	28,9 %	34,4 %	26,2 %	51,0 %	50,6 %

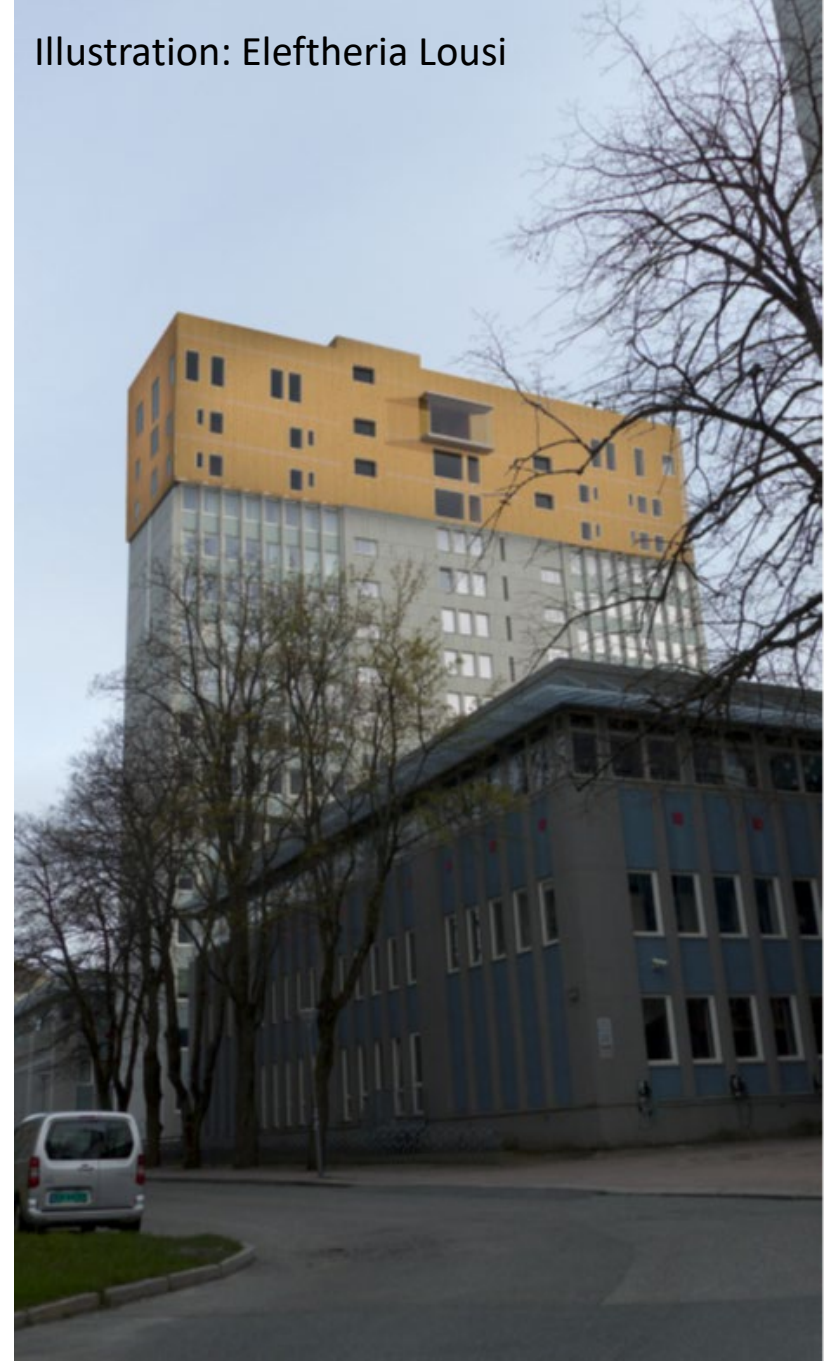
Timber extensions

- Structural engineering challenges

Challenges

- **Structural safety of the underlying existing structure (including the foundation)**
- **Modularity of extension**
- **Speed of construction**
- **Tolerances**
- **Performance of the extension**
- **Lack of standardization**
- **Lack of documentation**

Illustration: Eleftheria Lousi



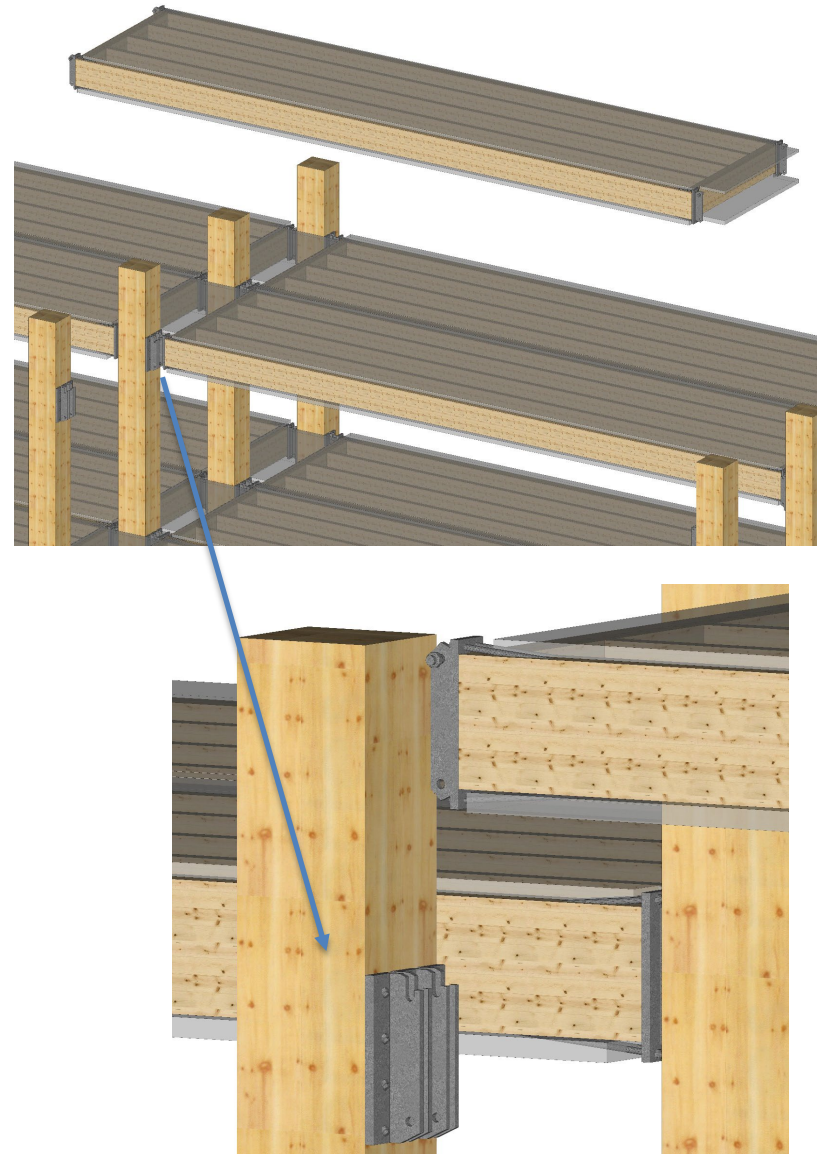
Timber extensions

- How? Inspiration from WOODSOL project

- **Woodsol system**
- **Based on Wood**
- **Modular** system with prefabricated elements
- **Open** architecture
- Key elements: **Connections**



Wood frame solutions for free space design in urban buildings



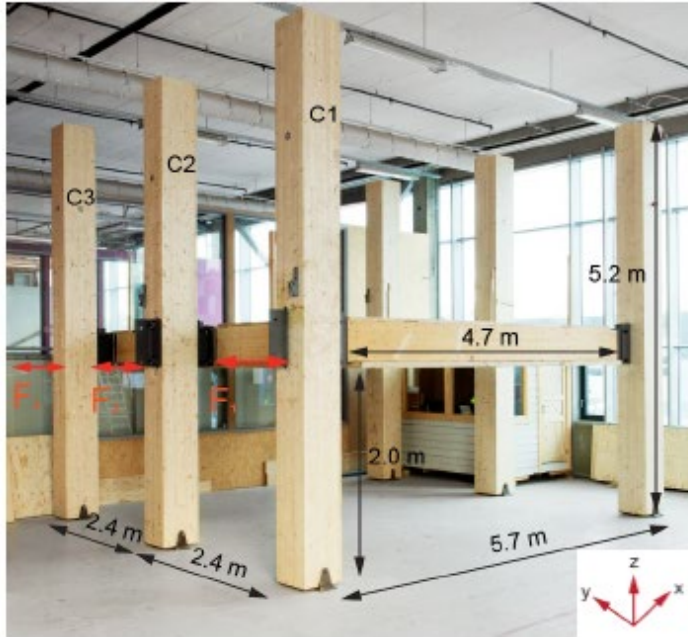
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Timber extensions

- How? Inspiration from WOODSOL project

(a)



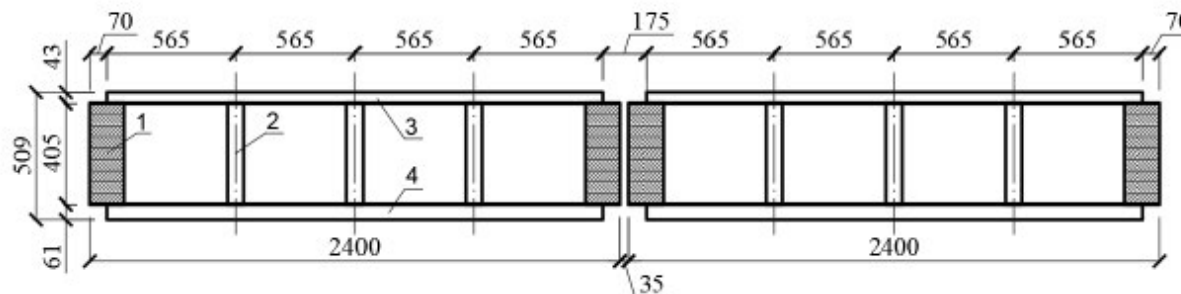
(b)



(c)



(d)



Timber extensions

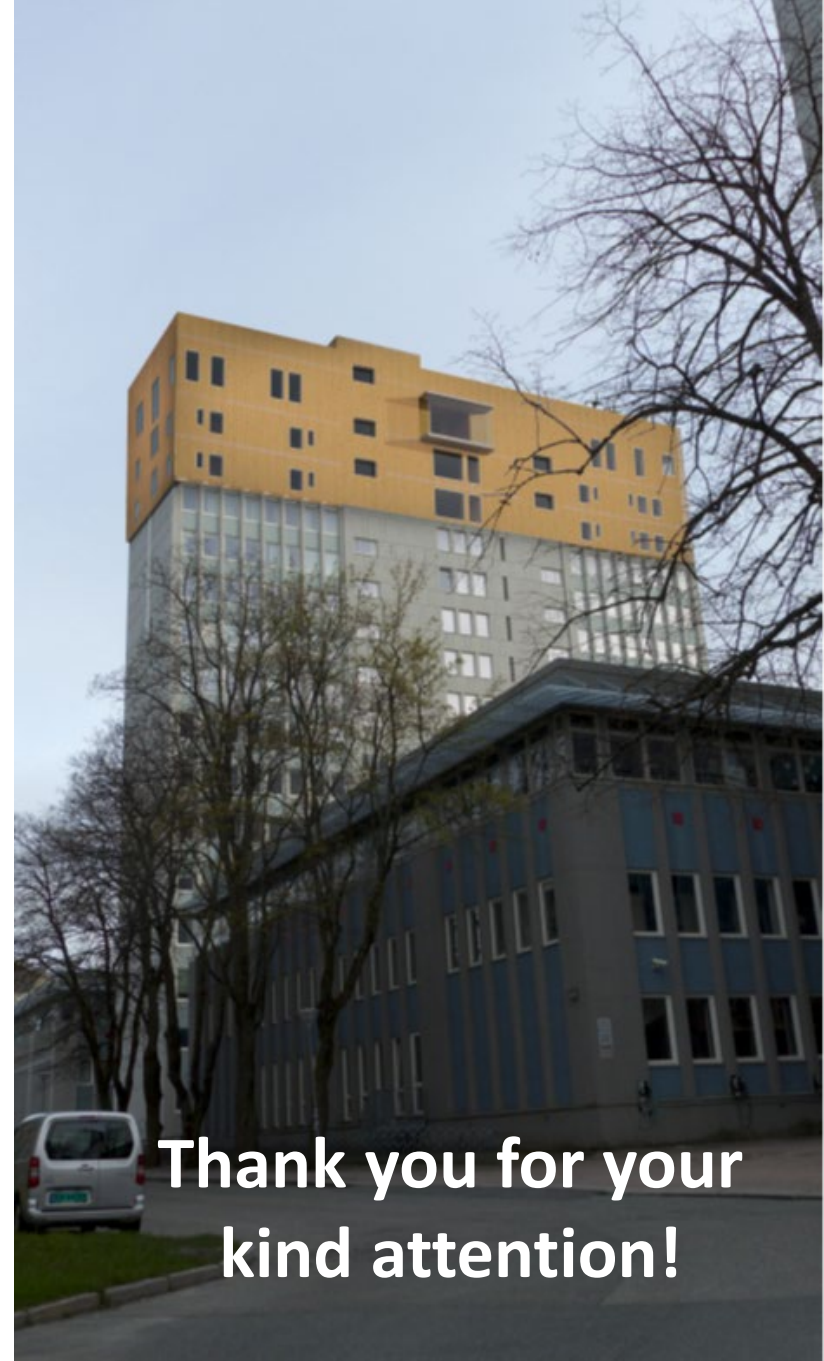
- Vision and tasks

Tasks

- Study and identify potential structural systems for the extension
- Identify construction elements in the underlying structures with safety margins
- Optimize extension to minimize stress in the underlying construction elements
- Propose solutions with modularity and suitable tolerances and explore their feasibility
- Assessment tools of underlying construction elements

Discussion group at NTNU

- Vision: to form a project proposal and get funding for a mutli-disciplinary research project (PhD students, Master Theses, Education)



**Thank you for your
kind attention!**