Mechanical & Aerospace Engineering

Introduction to the session E4: Energy - design and optimization of houses

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Outline

- *Assume: Energy design /optimization is a key part of sustainability, our goal is to have carbon neutral construction in 2030*

1. *Look at sustainability (extract from Ed Lowans ‘ presentation to BECOR)*
2. *Introduction to the session – paper on understanding of thermal bridges on the disk*





Greening the Building Envelope

Ed Lowans

May 20 - 2008 Ottawa

Halsall
ENGINEERS·CONSULTANTS

Determine Feasibility First

What is the target?
Is it the right target ?
Can it be achieved cost-effectively?
Does a next generation project require a next generation design team and technologies?

TD Centre
Toronto

The most value for the money

Savings for small initial cost

- Commissioning
- Use of daylight
- Self cleaning glazing
- Advanced building automation
- Pre-cooling e.g. geothermal
- Solar air preconditioning
- Solar Hot Water (third party financed) - leased

High Performance

To achieve these goals in cold climate will require next generation approaches

- ***BIM will expand capabilities exponentially***
- ***Distributed HVAC will displace central one***
- ***Mechanical/envelope will converge***
- ***Smart technologies will be used***
- ***Integrated from appliance to grid***
- ***Energy storage will be accounted for***
- ***Systems will be third party financed/leased***

Current Best Value

Ranked by energy savings potential (DOE)

- *Radiant ceiling cooling*
- *Heat or energy recovery in ventilation (ERV/HRV)*
- *System /components diagnostics*
- *Dedicated outdoor air systems*
- *Brushless DC motors*
- *Smaller centrifugal compressors*

High Performance BE

- ***A high performance BE is a <u>pre-requisite</u>***

for the next generation HVAC and lighting

- ***High performance buildings dramatically reduce thermal loads accelerating the use of distributed mechanicals penetrating the envelope at (each) floor.***
- ***The envelope will become a multi-functional element (HVAC, daylight, energy production)***
- ***Integrated components will be modular, factory made and installed***

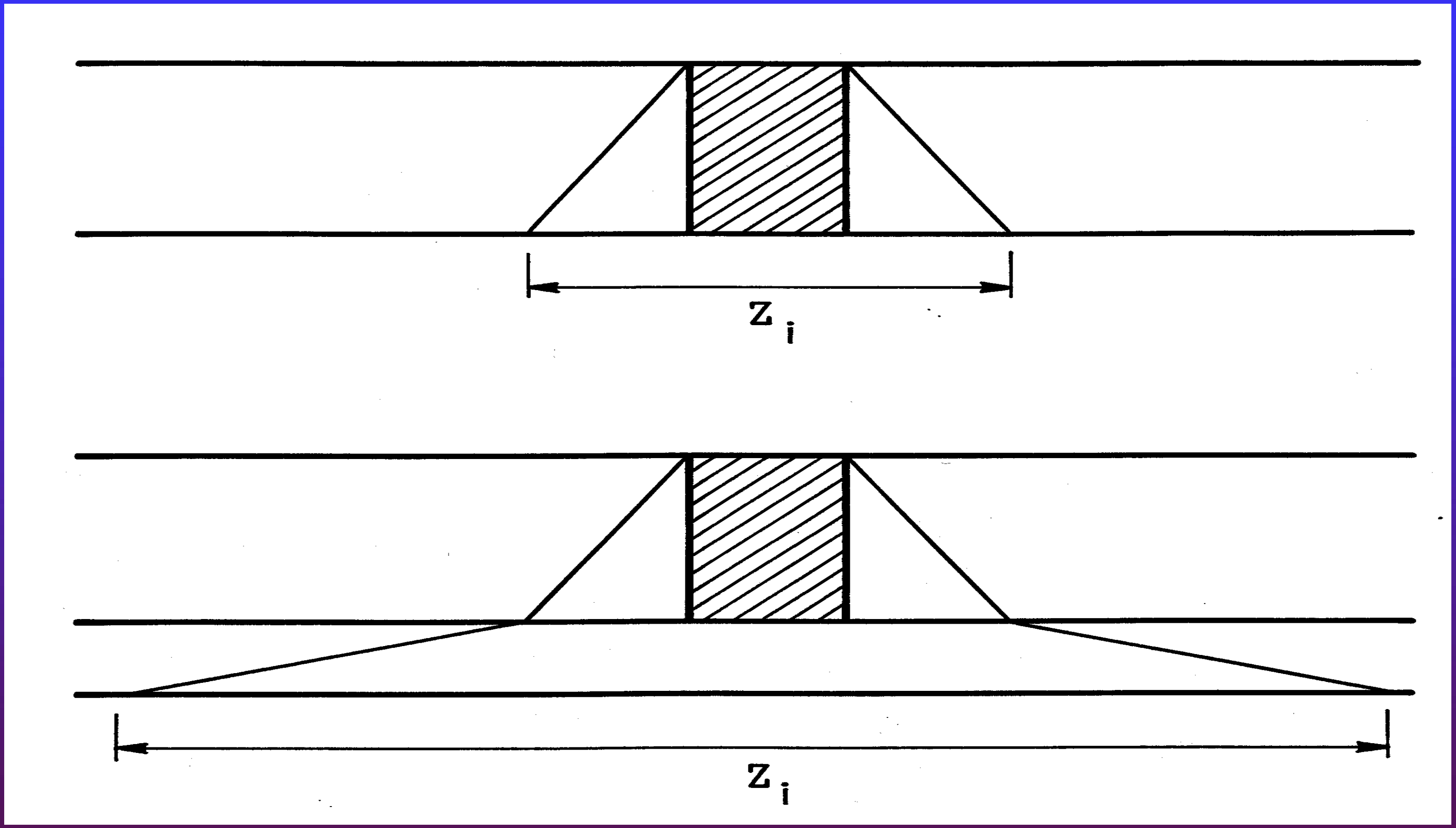
High Performance BE – next generation

- ***Envelopes will rely on next generation glazing and panels***
  - ***Aerogel technologies are already commercialised***
  - ***Partial vacuum insulation panels are already commercialized (refrigerators)***
  - ***Partial vacuum glazing is in the licensing stage for commercial production***
  - ***R20-50 thermal performance in airtight 1” thick walls***

If this was a look at the future BE, where are we today?

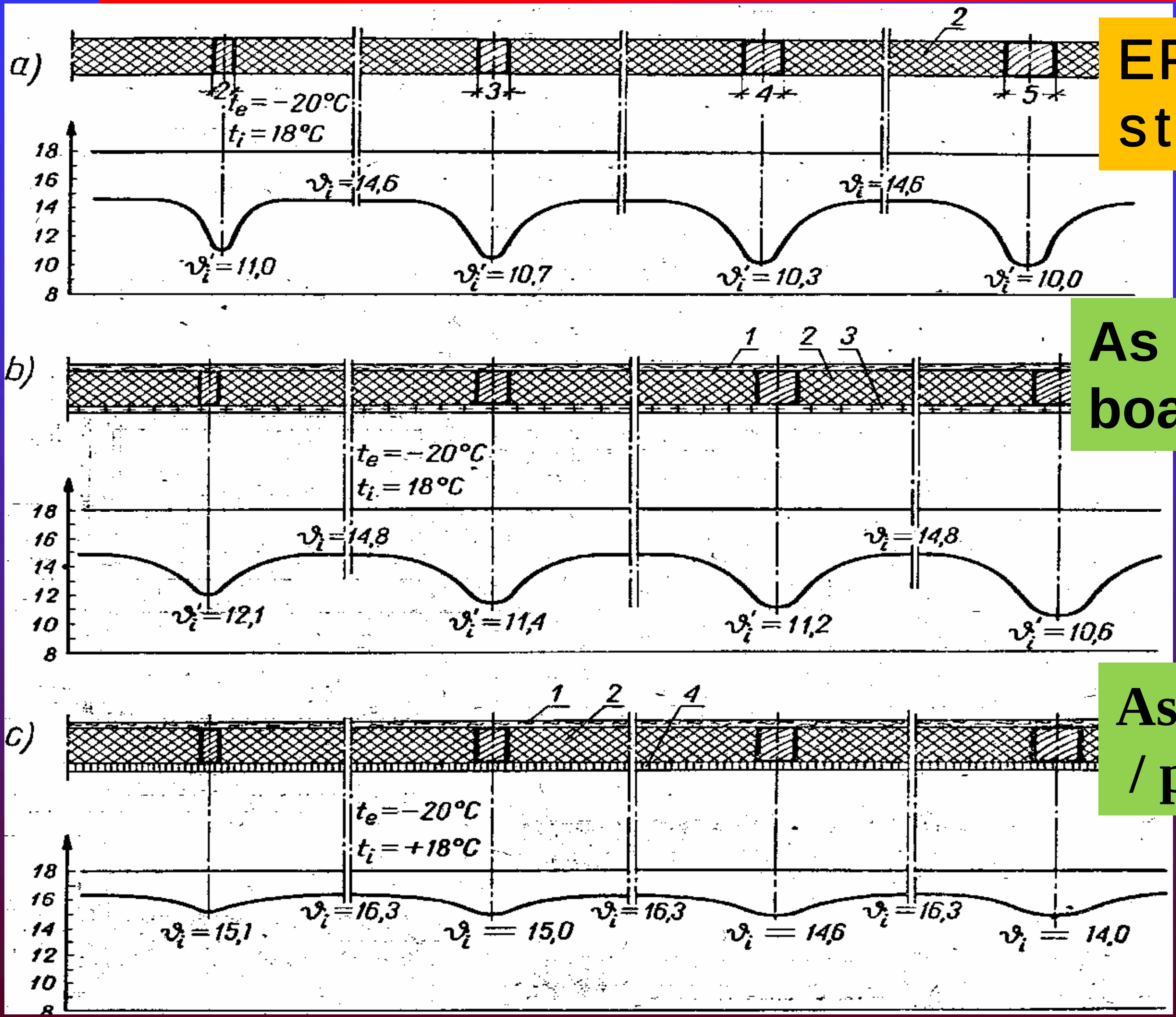
- ***There is a gap between building science (predictability of performance) and building practice***
- ***Construction is market driven and only in a crisis situation will use the knowledge***
- ***Yet, the public momentum for the "green buildings" offers some hope of improvement***
- ***This session will highlight the gap between R-value and field thermal performance as caused by multi-dimensional heat flow and air flows***

Paper: Introduction to session 4 - understanding of thermal bridges



Effect of thermal bridge depends on heat collecting layer

Temperature profiles measured in 1964



EPS + wood stud 20–50 mm

As above + cement board / drywall

As above + cement / porous fiberboard

Efficiency factor for thermal insulation in the cavity of 2x4" frame walls

Class of ins., resistivity of insulation	k-factor of the cavity insulation	Nominal R-value of the wall	Mean R-value from 2D code	Percent reduction nominal R-value	Efficiency factor for thermal insulation
3.15 (21.8)	0.32 (0.046)	12.85 (2.26)	11.39 (2.00)	11.3	0.89
3.55 (24.6)	0.28 (0.041)	14.25 (2.51)	12.35 (2.17)	13.3	0.87
3.75 (26.0)	0.27 (0.039)	14.95 (2.63)	12.81 (2.26)	14.3	0.86
4.0 (27.7)	0.25 (0.036)	15.83 (3.79)	13.38 (2.36)	15.5	0.85
5.0 (34.7)	0.20 (0.029)	19.33 (3.40)	15.48 (2.73)	19.9	0.80
6.0 (41.6)	0.17 (0.024)	22.83 (4.02)	17.38 (3.06)	23.9	0.76

Efficiency for thermal insulation in the cavity of frame walls 2x4" with external insulation R5.6 & R9

Class number (R-value / inch in the cavity	Thermal resistance of external insulation	Nominal R-value in the center of the cavity	Mean R-value from 2D code	Percent reduction from nominal	Efficiency of the insulation
3.15 (21.8)	5.6 (1.0)	18.45 (3.25)	17.08 (3.01)	7.4	0.93
	9.0 (1.6)	21.85 (3.85)	20.49 (3.61)	6.2	0.94
3.75 (26.0)	5.6 (1.0)	20.55 (3.62)	18.55 (3.27)	9.7	0.90
	9.0 (1.6)	23.95 (4.22)	21.98 (3.87)	8.2	0.92
6.0 (41.6)	5.6 (1.0)	28.43 (5.00)	23.40 (4.12)	17.7	0.82
	9.0 (1.6)	31.83 (5.60)	26.90 (4.74)	15.5	0.85