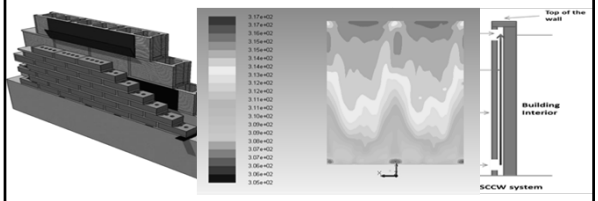
ACSEE 2013 Conference, June 6-9, Osaka, Japan

Investigating potentials of self-cooling cavity wall system in reducing buildings' summer peak cooling load



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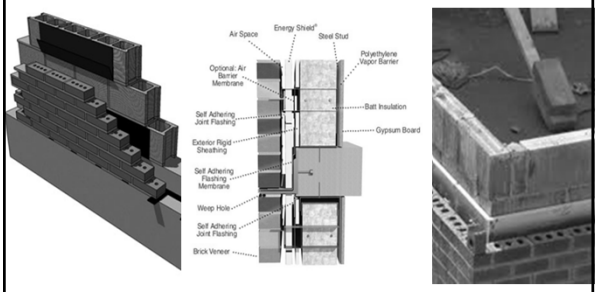
Background

Regional energy use and growth rate									
	kWh/capita			Population (million)			Energy use (1,000 TWh)		
	1990	2008	Growth	1990	2008	Growth	1990	2008	Growth
USA	89,021	87,216	– 2%	250	305	22%	22.3	26.6	20%
EU-27	40,240	40,821	1%	473	499	5%	19.0	20.4	7%
Middle East	19,422	34,774	79%	132	199	51%	2.6	6.9	170%
China	8,839	18,608	111%	1,141	1,333	17%	10.1	24.8	146%
Latin America	11,281	14,421	28%	355	462	30%	4.0	6.7	66%
Africa	7,094	7,792	10%	634	984	55%	4.5	7.7	70%
India	4,419	6,280	42%	850	1,140	34%	3.8	7.2	91%
Others*	25,217	23,871	nd	1,430	1,766	23%	36.1	42.2	17%
The World	19,422	21,283	10%	5,265	6,688	27%	102.3	142.3	39%

Background (cont.)

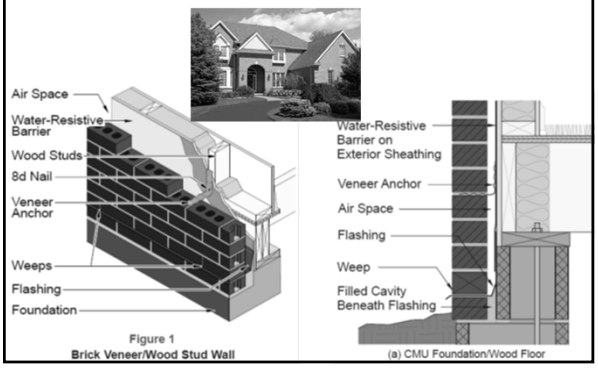
- Aging infrastructure (water, energy, transportation, …)
- Budget/debt issues ($16.8 trillion, $56,000/capita)
- Population growth (440 million by 2050 projected, from 300 million in 2007)
- Large building inventory

Cavity Wall Systems



Commercial Cavity Walls

Residential Cavity Walls



Related Studies

1. Ventilated façades - added wall layer outside the existing facade (Altan et al 2008)
2. Solar chimney, which utilize solar-irradiance induced ventilation to improve indoor ventilation (Sakonidou et al. 2008; Zamora & Kaiser 2009)
3. Ventilated cavity wall (Ciampi et al. 2003; Griffith 2006) and ventilated roofs or attics (Susanti et al. 2008, Wang et al. 2012).

All these studies more or less confirmed the effects of natural ventilation of building envelopes on energy savings.

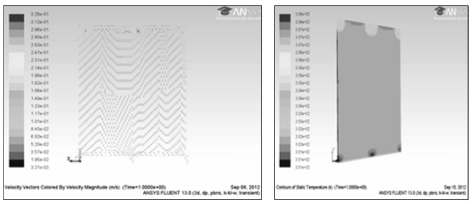
However, little comprehensive parametric study of ventilated wall solutions was found on the existing cavity-wall inventory.

Objectives

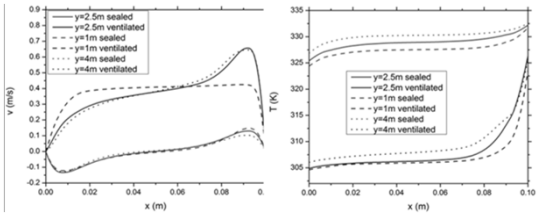
1. To understand the potential of reducing heat induction through walls using buoyance-driven ventilation in wall cavities
2. To provide scientific guidance for new energy efficient building design and energy retrofit of existing buildings

Approach

- Major part of the study was conducted through numerical simulations with literature validations.



Preliminary Results



Wall height (m)	Cavity thickness (cm)	Mass flow rate (kg/m s)	Cooling load (W/m)	R-value of the air channel
5	5	0.02906	15.36	47.44
7.5	5	0.03689	24.67	42.80
10	5	0.04334	34.88	39.06

Expected Outcomes

- Detailed design and retrofitting guidance of SCCW based the simulation results and the developed optimization model.
- Based on our preliminary results, immediate and significant savings in peak-time cooling-energy consumption are expected, considering the large inventory of existing low-performance buildings in the US.

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Questions ?