The Hygrothermal Performance of Wood Frame Wall System in Suzhou Lake Tai Climate Zone

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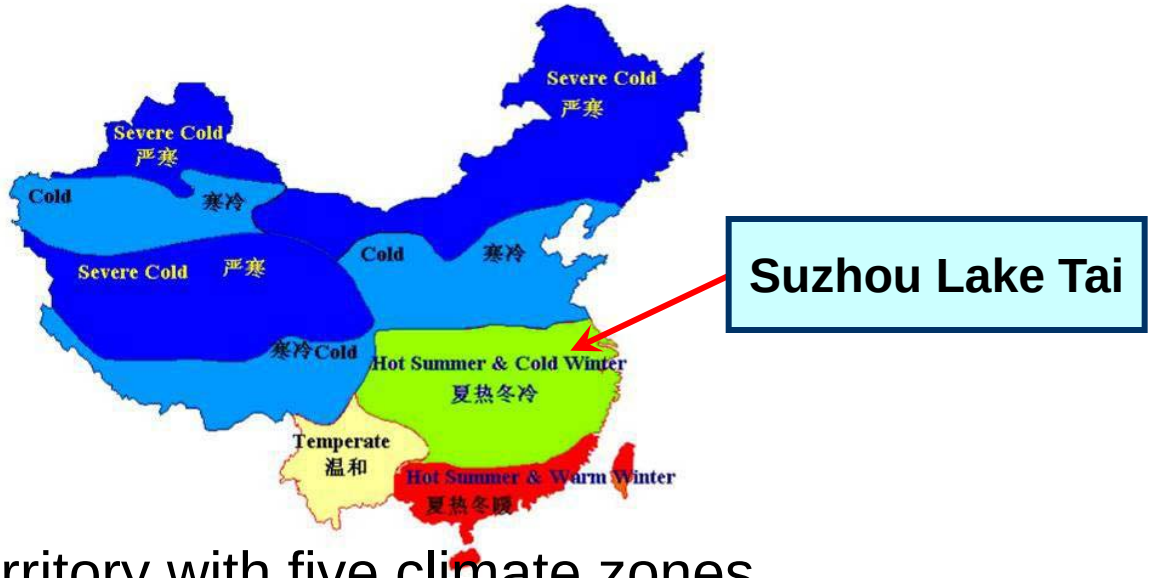
Outline

- Introduction
- Field Experiment
- Results and Discussion
- Conclusions

Introduction



✓China has vast territory with five climate zones.
✓Suzhou city of Jiangsu province locates in a north subtropical monsoon climate (hot summer, cold and dry winter, and wet and humidity in rainy season), and belongs to a hot summer & cold winter climate zone.
✓Complicated environment conditions make it more difficult to design building wall, maintaining energy saving and durability.
✓Recently, wood frame buildings increasingly appeared in hot summer & cold winter climate region. **However, some information on hygrothermal performance of wood frame wall system was not available.**

Introduction

Wall systems and Hygrothermal Performance

Insulation:

thermal barrier

Exterior cladding:

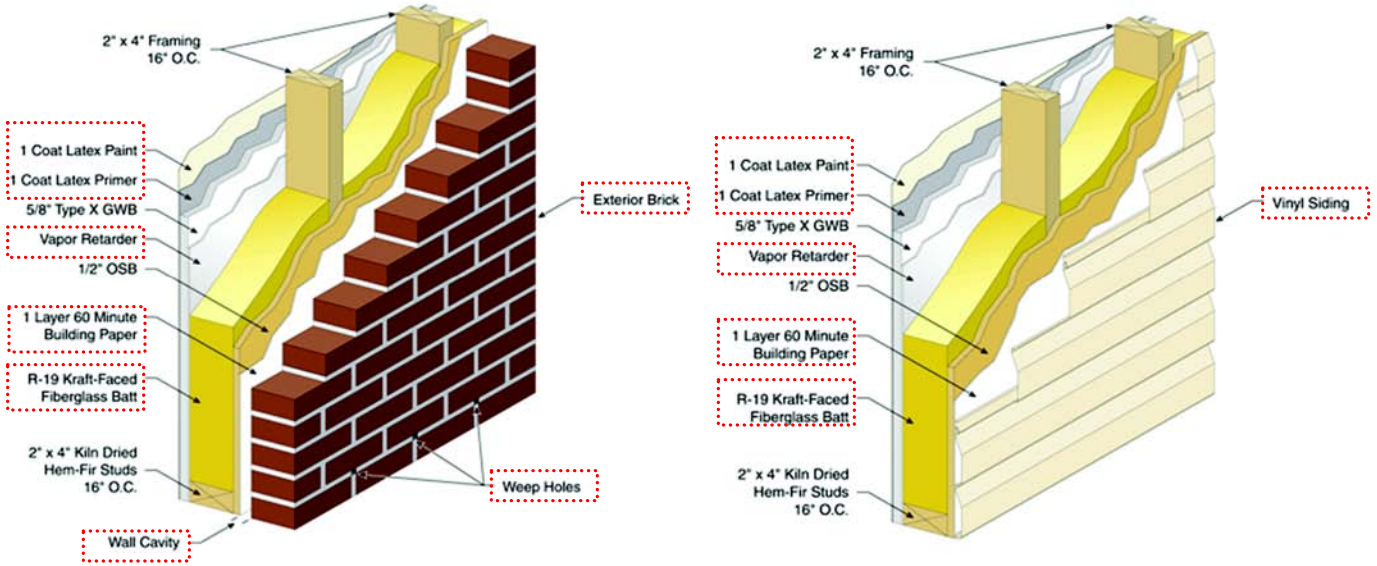
moisture intrusion, exterior cladding venting, thermal barrier

Vapor retarder:

liquid applied moisture control membranes

Hygrothermal Performance:

temperature, relative humidity, moisture content



(Achilles N. Karagiozis,2007)

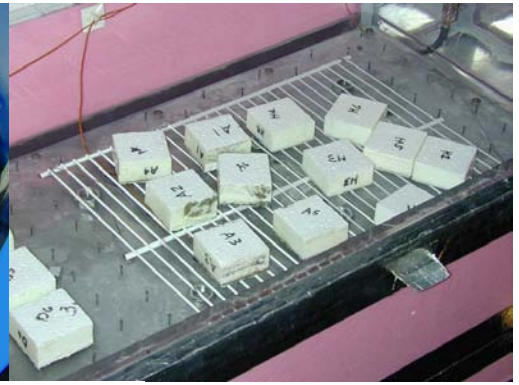
Introduction

Research Method:

material property research

computer model simulation

field-testing experiment



WUFI® PRO

hygIRC-1D

MOISTURE-EXPERT

(Achilles N. Karagiozis,2007)

(Stanley D. Gatland，2007)

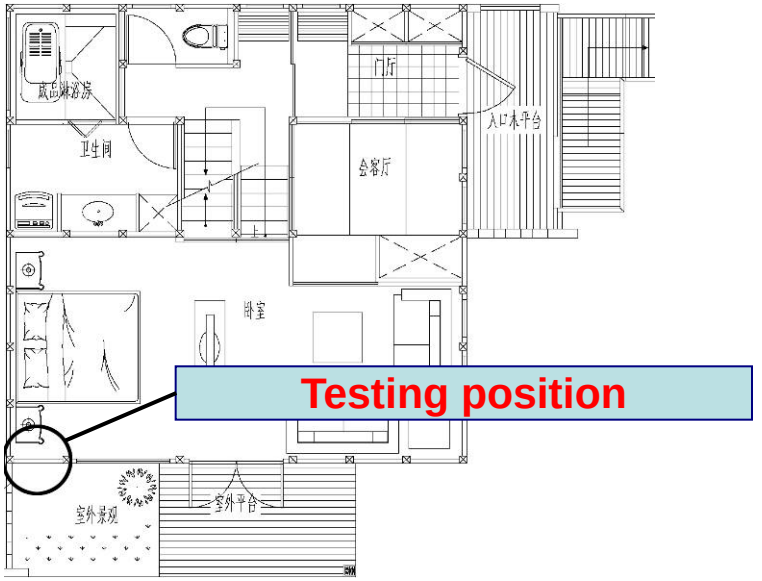
Study Goals:

demonstrate the superior moisture and temperature control

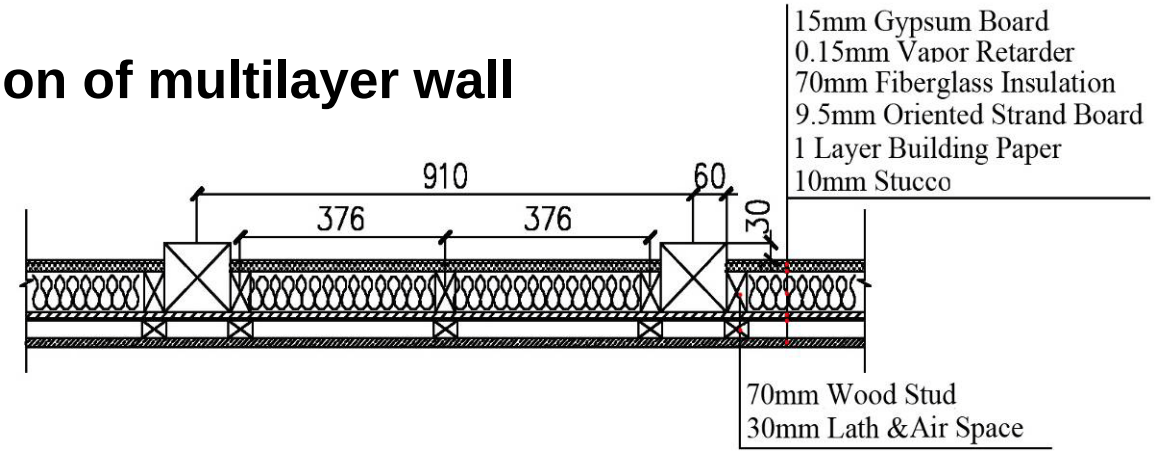
provide professional guidelines for the use

Field Experiments

Demonstration test house

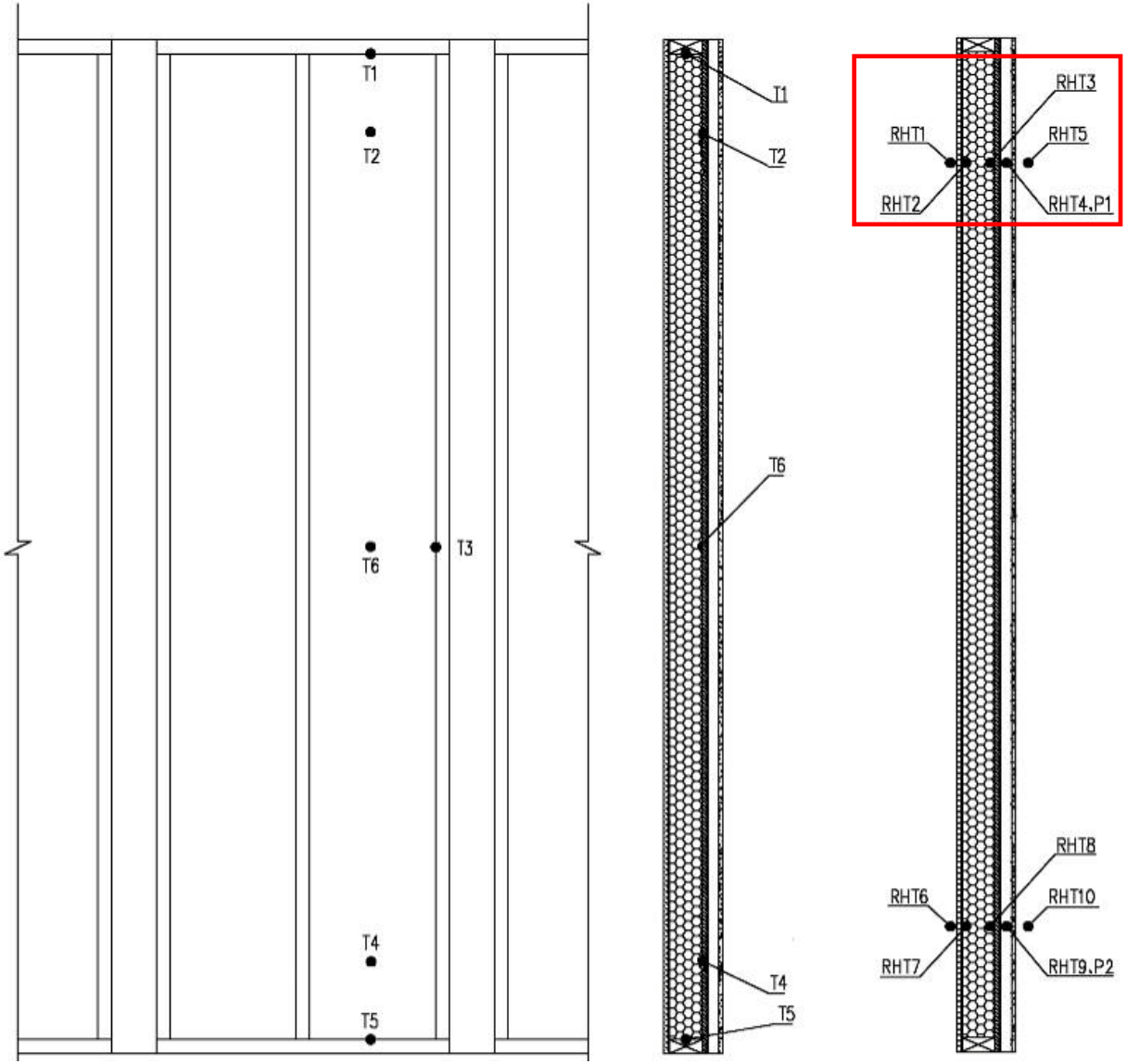


Configuration of multilayer wall



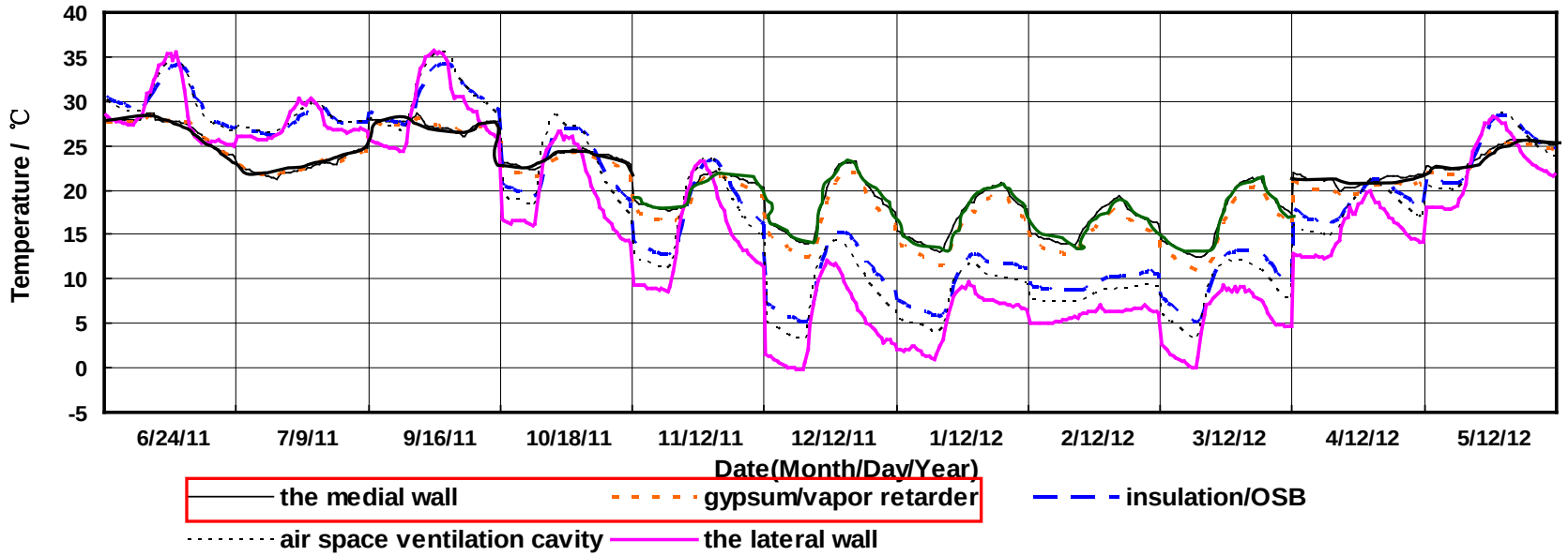
Field Experiments

Sensor locations in tested wall



Results and discussion

Temperature changes over time of each interface



✓ Temperature variance of the medial wall from April to October was less than that from November to March.

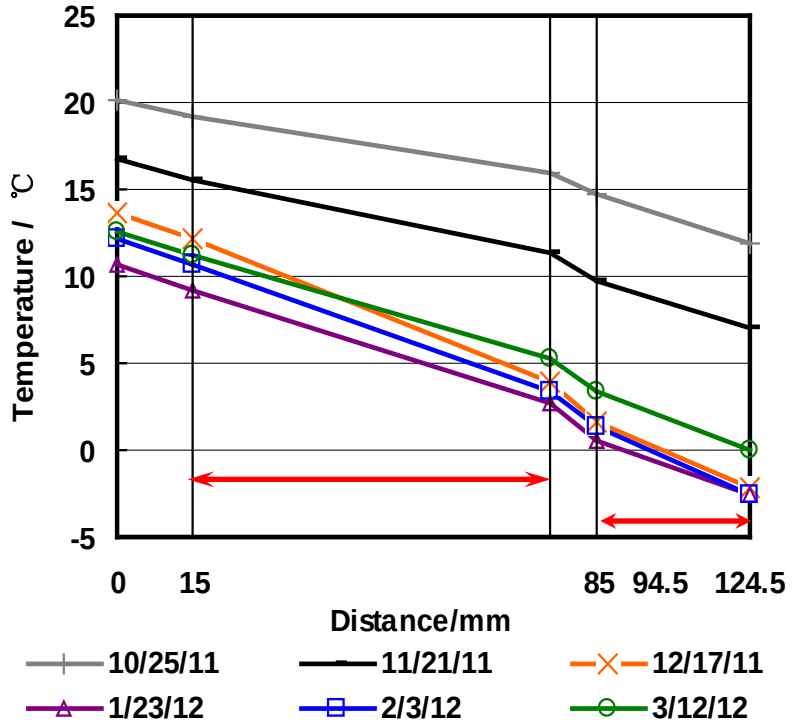
✓ Temperature of the medial wall was similar to that of the interface between the gypsum board and vapor retarder layer.

✓ Temperature change of the interface between the insulation layer and OSB sheathing was closer to that of the lateral wall.

✓January was the indoor coldest month of the year. Although air temperature of the lateral wall was -3℃, that of the medial wall still could maintain over 11℃.

Results and discussion

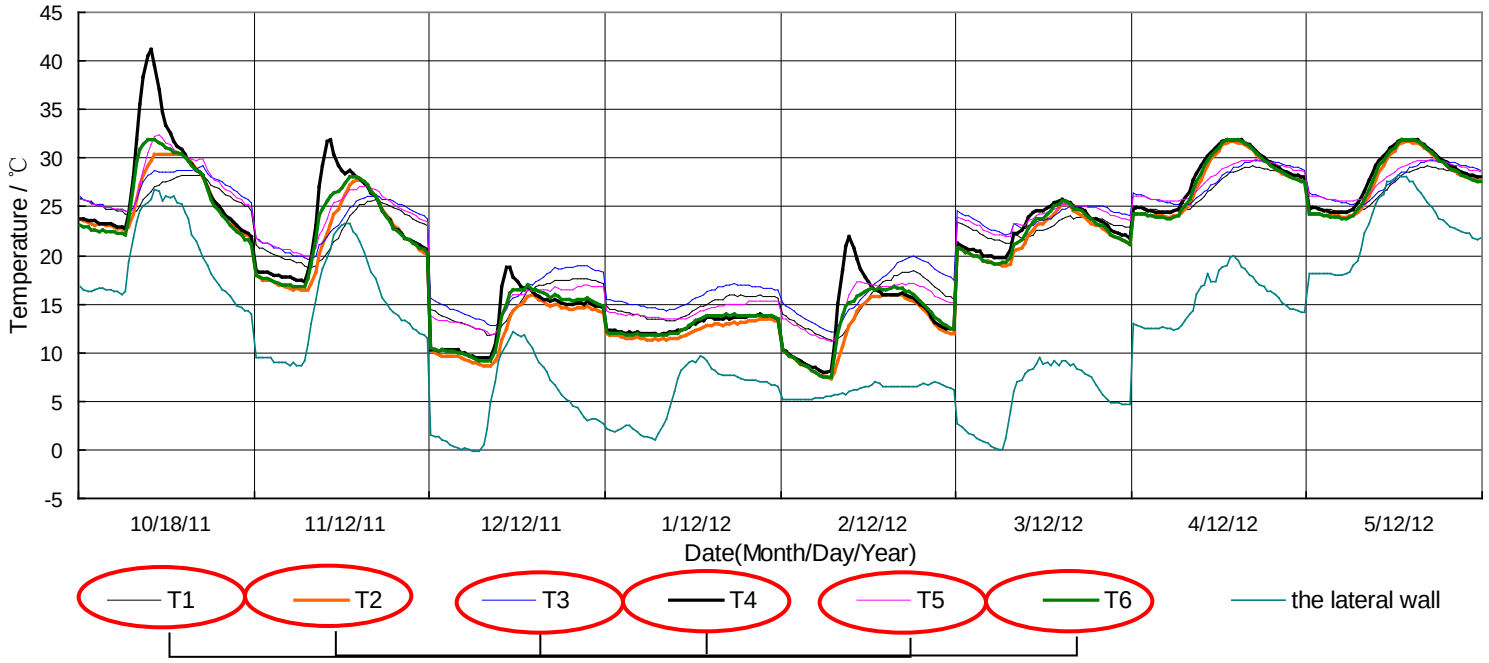
Temperature gradients through the test wall profile



Effective function of the insulation layer and ventilation cavity.

Results and discussion

The surface temperature of SPF frame dimension lumber and OSB sheathing



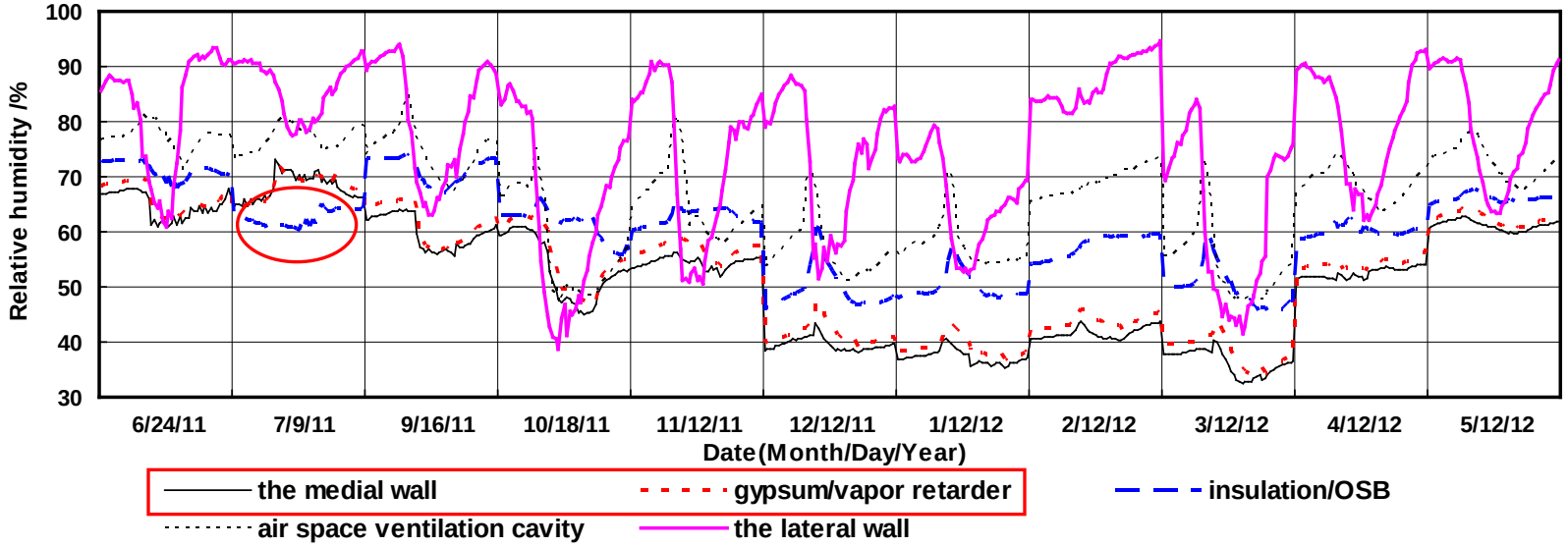
✓The surface temperatures of OSB sheathing developed continuously along with the temperature changes of the lateral wall.

✓The surface temperature of wood frame developed smaller than that of OSB sheathing.

✓Water condensation risk of the wall in winter was elimated because all temperatures were above 0℃.

Results and discussion

Relative humidity changes over time of each the interface



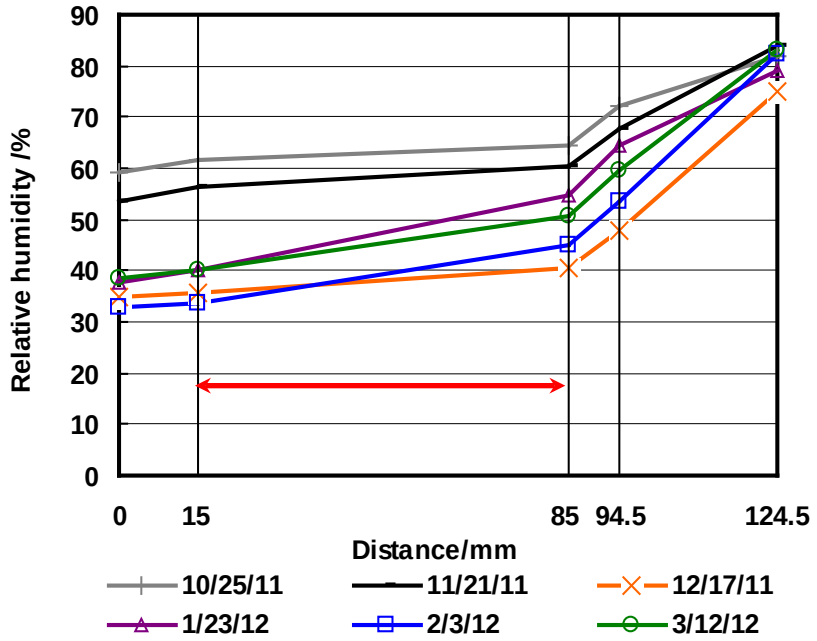
✓ Relative humidity variance of the lateral wall was from 30% to 99%, but that of the medial wall was lower, more steady and proper to live.

✓Relative humidity of the medial wall was similar to that of the interface between the gypsum board and vapor retarder, which was different from that of interface between the insultion and OSB sheathing obviously.

✓Relative humidity of the OSB cavity-side was the lowest when that of each the medial and lateral wall was great in summer, especially in July.

Results and discussion

Relative humidity gradients through the test wall profile

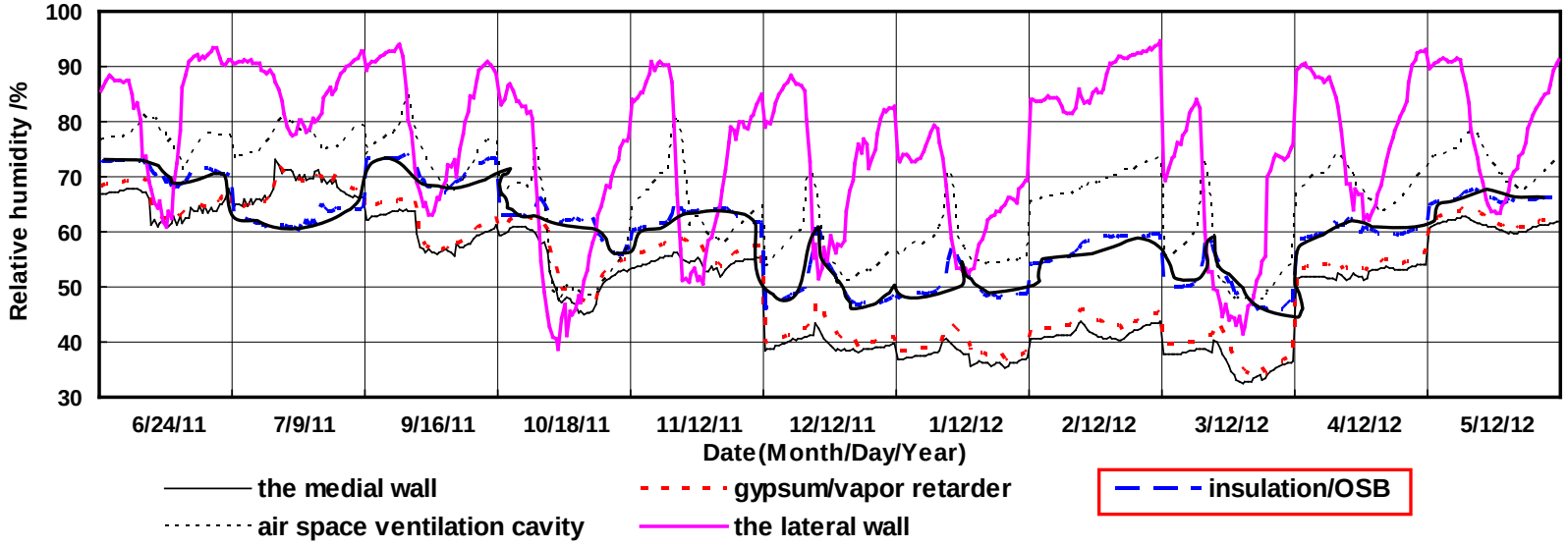


✓The maximum of relative humidity gradients was 15% from the gypsum board to the OSB sheathing.

Vapor retarder of polyethylene film was very good due to preventing the vapor into the wall cavity or indoor.

Results and discussion

Relative humidity changes over time of each the interface

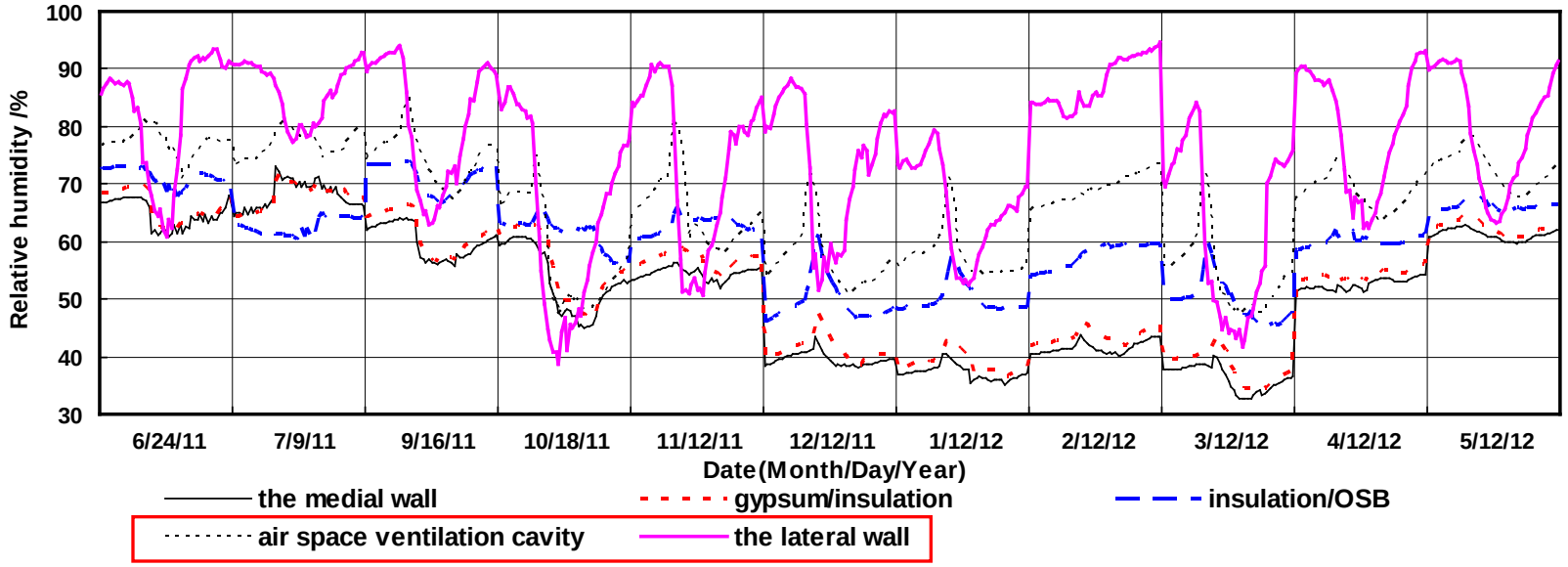


✓ Relative humidity of the interface between the insulation layer and OSB sheathing was comparatively stable, and was lower than that of inside the ventilation cavity. The difference was 7%~10%.

The waterproof and moisture permeable building paper was very effective in condition of the great relative humidity of outdoor.

Results and discussion

Relative humidity changes over time of each the interface



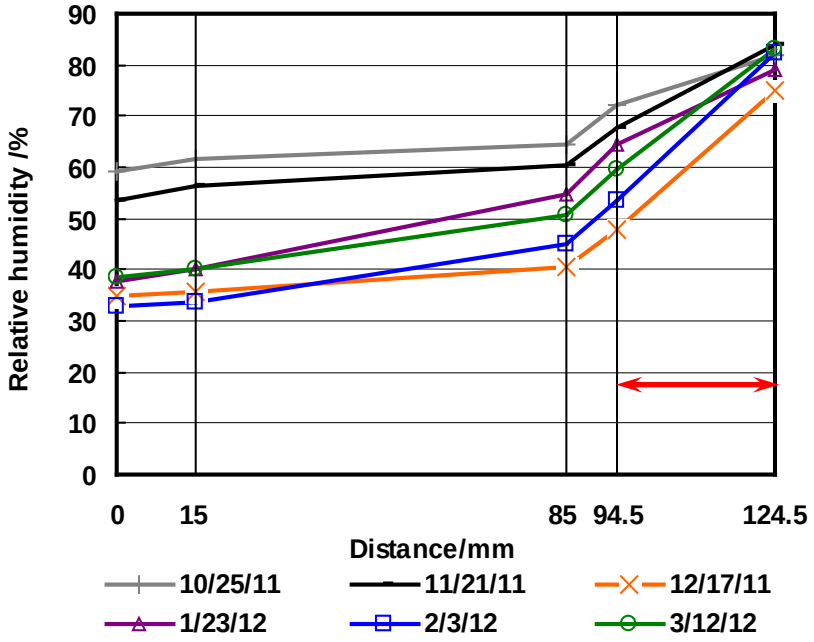
✓ Relative humidity inside the ventilation cavity below maximum was lower than that of the lateral wall.

✓ The peak of relative humidity inside the cladding cavity showed the hysteresis behavior.

✓The temperature of ventilation cavity up to 37℃ in July when the highest relative humidity was 84%. However, the time was not so long under this high temperature and relative humidity state. There was not mold growth.

Results and discussion

Relative humidity gradients through the test wall profile

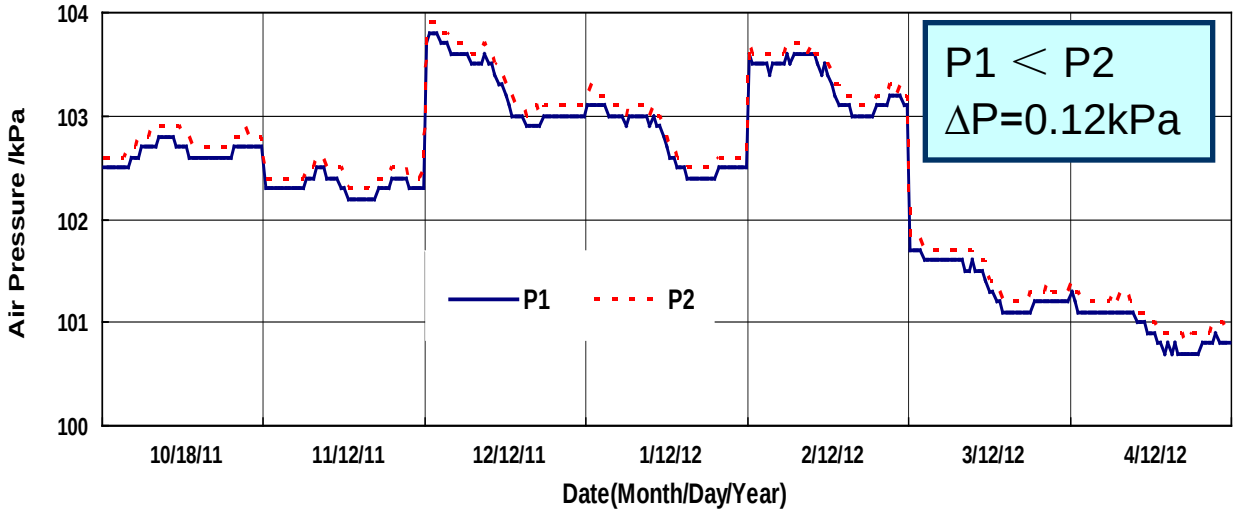


✓Relative humidity gradients were the largest between ventilation cavity and lateral wall through the wall.

✓The maximum gradient was 34%, occurred in December.

Results and discussion

Air pressure in cladding ventilation cavity



✓Air pressure of the top was less than that of the bottom. This indicated airflow entering low on the wall and exiting at the top through ventilation holes in metal strips.

Both the stucco cladding and ventilation cavity resistance to moisture were quite obvious.

Results and discussion

- ✓ Data of two years confirm that the application of wood frame wall system in demonstration is feasible in Suzhou Lake Tai climate zone.
- ✓ Thermal performance of this system is good and no mold growth and water condensation occurred inside the wall during the testing period.
- ✓ Temperature and relative humidity indoor are very good and acceptable, except for January night.
- ✓ The increasing humidity should be used to avoid the glulam split in winter.

Conclusions

- Wood frame wall system has good hygrothermal performance in this experiment and can be widely used to hot summer & cold winter climate zone in China.
- Thermal performance is good due to cavity wall insulation during the whole testing period.
- Cladding and ventilation cavity greatly enhance moisture tolerance and reduce risks related moisture.
- Water vapor control strategy performs well at reducing air relative humidity of testing wall in condition of the Suzhou Lake Tai climate.
- Long-term on-site experiment study of wall performance under a variety of environmental conditions is needed to provide a reliable evaluation.

Thanks

Welcome to Beijing