BCIT SCHOOL OF CONSTRUCTION AND THE ENVIRONMENT

Performance Evaluation of Active Chilled Beam in Cooling and Heating Operation under Actual Field Boundary Condition

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Acknowledgements
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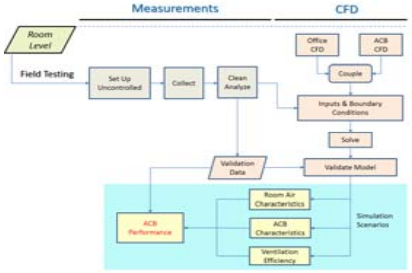
MOTIVATION

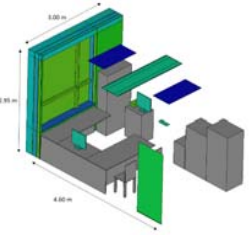
- SW1 - Gateway Building at BCIT with Active Chilled Beams (ACB)
- High Performance LEED Gold Building with 250 units of ACB
- ACB used as Single Heating Device in Offices
- Occupants were found using Room Heaters and Fans
- Many perimeter offices were unable to achieve setpoint in winter

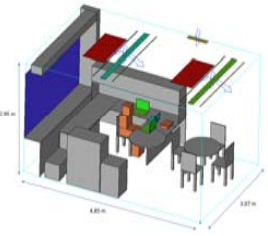
OBJECTIVE

- To study few offices in real time and evaluate air velocity and ai temperature in the occupied zone and at the ACB
- To assess the risk of stratification and temperature gradient in heating mode
- To develop and validate a CFD model coupling an Active Chilled Beam and office under varying boundary conditions.
- To assess the ventilation efficiency by CFD modelling in cooling and heating mode

METHODOLOGY

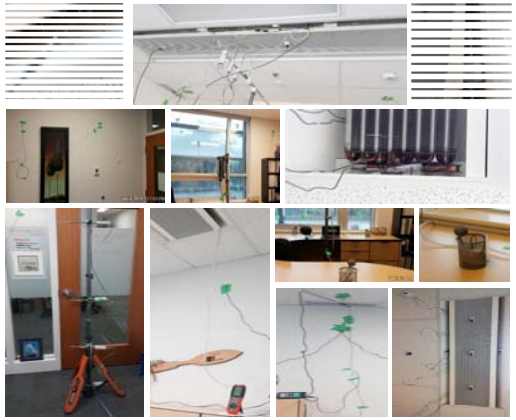






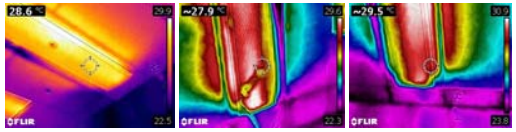
- Field Experiments in 2 Offices at Gateway Building, BCIT
- Data Collection for Summer and Winter
- CFD Model of Offices coupled with ACB
- ACB Characteristics, Room Air Characteristics and Ventilation Efficiency Evaluation

MEASUREMENTS

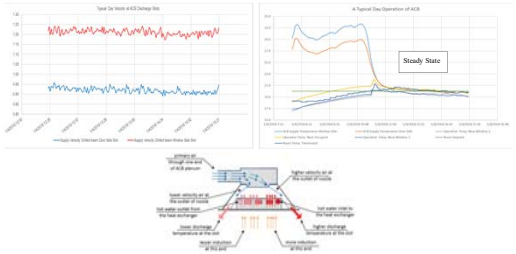


RESULTS

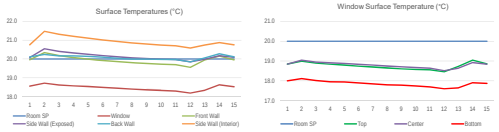
Coanda Effect



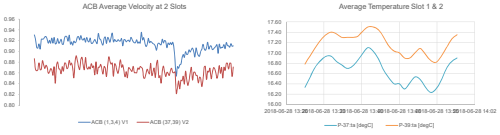
Discharge Air Velocity and Temperature (Heating)



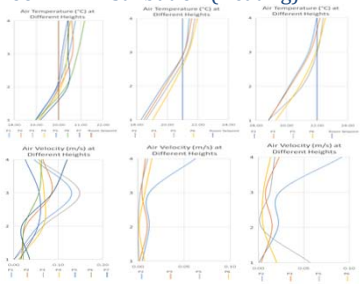
Surface Temperatures (Heating)



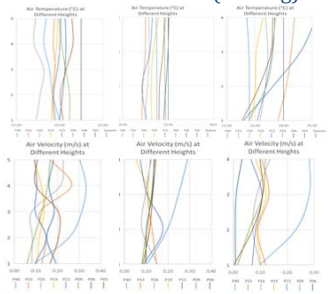
Discharge Air Velocity and Temperature (Cooling)



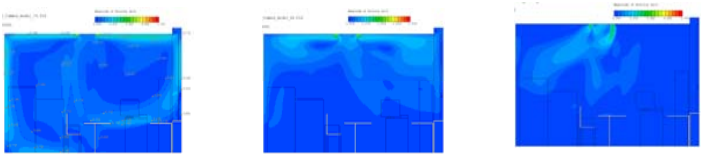
Room Air Distribution (Heating)



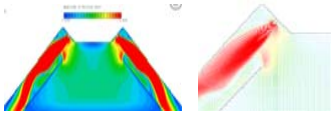
Room Air Distribution (Cooling)



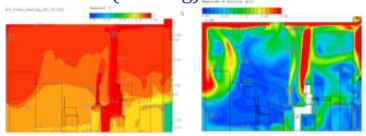
Effect of Discharge Angle



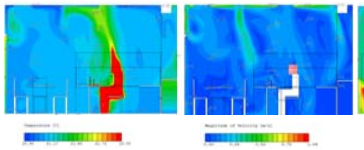
ACB CFD Model



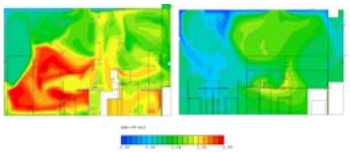
CFD Model (Heating)



CFD Model (Cooling)



Age of Air (Heating & Cooling)



CONCLUSIONS

- Envelope performance (thermal performance, double-Façade, window operation) affect room air distribution and ACB performance but aside of ACB sizing, envelope is not considered in selecting and configuring ACB
- Further research for ACB coupling with envelope is required
- Temperature distribution in cooling mode was found uniform, non-uniform in heating mode and the uniformity was increased with increase in setpoint
- The temperature difference more than 3°C between head and ankle for a standing person and around 2.5°C for a seated person was found
- Air velocity and in cooling mode was found below ASHRAE standard for thermal comfort (0.2 m/s), the air velocity in heating mode was negligible and close to zero in occupied zone
- The average percentage error between measured and simulated air temperature in space varied from 0% to 5% with an absolute error of 1°C
- Age of Air in heating was found higher, resulting in stagnant air near occupant