

Environmental Engineering

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Fang Wang
Peng Wang
Chao Shen
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Proceedings of the 11th International Symposium on Heating, Ventilation and Air Conditioning (ISHVAC 2019)

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Peng Wang · Chao Shen · Jing Liu
Editors

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Volume III: Buildings and Energy

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List of Plenary Lectures

Speakers	Affiliation	Topic
Yi Jiang	Tsinghua University, China	The Approach for Building Energy Efficiency in Emerging Economies Countries
Bill Bahnfleth	The Pennsylvania State University, USA	Promise and Practicalities of Smart Systems
Bjarne W. Olesen	Technical University of Denmark, Denmark	State of the Art of HVAC Technology in Europe
Yingxin Zhu	Tsinghua University, China	How to Create Comfortable and Healthy Indoor Environment?—A New Challenge for Sustainable Building
Katsunori Nagano	Hokkaido University, Japan	Contribution of Heat Pumping Technologies for the Green Environment and Our Life
Rajan Rawal	CEPT University, India	Thermal Comfort for All: Setting up a Stage
Vladimir G. Gagarin	Moscow State University, Russia	Structure and Development of the System of Regulatory Documents in Russia on the Thermal Performance and Energy Saving of Buildings
Zhaojun Wang	Harbin Institute of Technology, China	Thermal Comfort and Thermal Adaptation in the Severe Cold Area, China

Preface

The International Symposium on Heating, Ventilation and Air Conditioning (ISHVAC) series was initiated by Tsinghua University of China in 1991. It has been a premier international conference on heating, ventilating, and air conditioning (HVAC) in China and has played a significant role in presenting newly found research results and exchanging ideas among colleagues from academics, research organizations, and industry in the field. The 11th ISHVAC (ISHVAC 2019) was held from July 12 to 15, 2019, in Harbin, China, hosted by Harbin Institute of Technology (HIT), and Prof. Zhaojun Wang from HIT was the president of ISHVAC 2019.

In developed countries, buildings use 40% of the primary energy, while in developing countries like China, buildings use one-third of the primary energy. Thus, energy used in buildings is very significant and a majority of the energy used in buildings is by HVAC systems that should create thermally comfortable and healthy indoor environment for their occupants. However, the indoor environment created is far from ideal because of poor design, operation, and occupant intervention. Therefore, ISHVAC 2019 focused on not only HVAC but also indoor environmental quality, health, thermal comfort, human activities, energy efficiency, renewable energy, etc. The conference provided a great opportunity to exchange new ideas and the state-of-the-art sciences and technologies, to identify solutions for problems in built environment and to build partnerships among engineers, architects, environmental scientists, facility managers, HVAC system manufacturers, and policymakers.

The themes of this conference include indoor and outdoor environment; heating, ventilation, air-conditioning and refrigeration; and building and energy. More than 600 full papers were received, 543 full papers were accepted, and 407 papers were included in the proceedings. There were eight keynote lectures, 15 workshops, 56 parallel sessions, and one poster session. More than 500 experts and scholars from 20 countries or regions attended the conference, of which more than 80 were foreign guests. The participation of many internationally renowned experts and scholars has raised the level of ISHVAC 2019. The conference had the following features:

- The conference invited prominent Indian and Russian scholars to present in plenary sessions, and their presentations were of significance to the study of global climate and energy consumption.
- Many outstanding scholars were invited to organize 15 workshops, focusing on hot issues including the thermal environment and thermal comfort, indoor environmental quality, pollutant transmission and control, human behaviors and building energy consumption simulation, smart heating, evaporative cooling, heat pump.
- During the conference, the Asian HVAC Alliance was established. We hope that the ISHVAC series would become a grand event in the field of HVAC in Asia in the future, like CLIMA conferences in Europe and ASHRAE conferences in North America.

We would like to appreciate the international advisory committee and scientific committee for their hard work and efforts in reviewing papers and providing the support needed. We also would like to thank the co-organizer Tsinghua University and co-sponsors such as ASHRAE, Journal of HV&AC, the Chinese Association of Refrigeration, and the Chinese Committee of Heating, Ventilation and Air Conditioning (CCHVAC).

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Editors of the Proceedings of ISHVAC 2019

Contents

Research and Accuracy Analysis on Engineering Quantity Calculation of a Projected Building by BIM Software	1
Xinjie Xu, Yu Wang, Jinxiang Liu, Xiaolei Yuan, Jun Bao and Xuetao Chou	
Parametric Study of the Impact of Venetian Blinds on Air-Conditioning Energy-Saving Potential for Residential Buildings	9
Yutong Tan, Jinqing Peng, Dragan C. Curcija, Nianping Li, Taoning Wang, Robert Hart and Jacob Jonsson	
Effect of Glazing Ratio on Thermal Comfort and Heating/Cooling Energy Use	19
Haiying Wang, Bjarne W. Olesen and Ongun B. Kazanci	
Numerical Analysis of Airflow Distribution in Data Center with Server Baffles	29
Xiaolei Yuan, Xuetao Zhou, Yu Wang, Jinxiang Liu, Xinjie Xu and Yuzhen Tao	
Optimization Research of Insulating Layer Thickness for Rural Residence’s Exterior Wall in Northeast Severe Cold Regions Based on Life Cycle Cost	37
Teng Shao, Hong Jin and Zheng Ma	
Effect of Moisture Transfer on Thermal Performance of Exterior Walls in Hot and Humid Region of China	47
Lu Bai, Jingchao Xie, Yaping Cui, Jiaping Liu and Ying Ji	
Energy-Saving Analysis of Low-Rise Prefabricated Building Integrating with Metamaterial-Based Cool Roof in China	57
Mingquan Ma, Kai Zhang, Saihong Tang, Lufang Chen, Xiaofeng Niu and Fei Li	

Research on Dynamic Thermal Characteristics and Energy-Saving Rate of Intermittent Heating Rooms	67
Guoqing Yu, Hongfei Yao and Zhenye Yan	
Data-Driven Modelling and Optimal Control of Domestic Electric Water Heaters for Demand Response	77
Xingji Yu, Shi You, Hanmin Cai, Laurent Georges and Peder Bacher	
Effect of Inlet Air Turbulence on the Cooling Performance of Solar Enhanced Dry Cooling Towers	87
Rui Wang, Suoying He, Ming Gao, Yuetao Shi and Fengzhong Sun	
Generalized Models for Estimation of Diffuse Solar Radiation Based on Clearness Index	97
Zhe Song, Zhigang Ren, Qinli Deng and Xin Chen	
Experimental Investigation of PCM Wallboard in Artificial Controlled Environment with Different Climate Conditions	107
Yuhao Qiao, Yan Liu, Liu Yang, Jiayang Bao and Jiaping Liu	
Methodology for Determining the Optimal Size for a South-Facing Horizontal Visor Based on Different Design Periods	117
Xiangrong Zhang, Yan Liu, Liu Yang, Chen Zhang and Tang Liu	
Impacts of PCM Location and Thickness on Dynamic Thermal Characteristics of External Walls for Residential Buildings	127
Tang Liu, Yan Liu, Liu Yang, Jiang Liu, Yuhao Qiao and Da Yan	
Influence of Building Airtightness on Energy Consumption of Office Building in Chongqing	137
Yuan Liu, Baizhan Li, Runming Yao and Xinyun Cao	
Simulations on Pressure Characteristics of Low-Flow Rate Water Circulating System Based on Porous Media Model	147
Yu Xue, Wenxuan Zhao, Wei Ye, Chao Wu and Xu Zhang	
Annual Thermal Evaluation of Lightweight Building Envelopes Containing Phase Change Materials in Changsha	157
Xiaoqin Sun, Siyuan Fan, Youhong Chu, Yajing Mo and Shuguang Liao	
The Effects of Green Façades on Thermal Performance in Humid and Hot Climate	167
Cuimin Li, Hui An and Kun Lu	
Review on Heat and Mass Coupled Transfer of Wooden Passive House Wall in the Cold Region	177
Huifen Zou, Zhian Yue and Meimei Yin	

An Experimental Investigation of Moisture Buffering Value for Composite Hygroscopic Materials under Different Air-Flow Conditions	187
Chengnan Shi, Huibo Zhang, Jingwen Rui, Ya Chen, Yingli Xuan and Weirong Zhang	
Analysis and Improvement Recommendations on Straw Bale Building in Northeast China	199
Jingjing Yang, Yan Liu and Liu Yang	
Study on the Optimization Wall Structure in Hot and Humid Climate Region Based on Analytic Hierarchy Process	211
Xingguo Guo, Shiwei He, Yue Wu, Ying Liu and Xiangwei Liu	
Energy Efficiency Analysis of Hybrid Heat Pump System-Based Air Source Auxiliary Ground Source in Chengdu Plain	221
Jun Wang, Xiangyu Chen, Chengjun Jing and Hao Liang	
Application of Combination of Relay-Pump Station and Intervals-Pressure Heat Exchange Station in Long-Distance Central Heating with Large Height Difference	231
Huifen Zou, Mingyuan Li and Huameng Xu	
Research on Behavior Pattern Prediction at Early Stage of Design	241
Panyu Zhu, Da Yan, Hongsan Sun and Chenxi Gui	
Study on Feasibility of Accumulating Solar Energy into Soil for Improving the Imbalance of Heat Injection and Extraction in GHP System	249
Kai Liu, Nan Wang, Wanlong Cai, Xinke Wang, Fenghao Wang and Bo Xiao	
Study on Extraction of Middle and Deep Geothermal Energy Through Abandoned Oil Wells	259
Guoxin Jiang, Yi Man, Tiantian Du, Shuo Li and Xinyu Zhang	
Research Status and Consideration on the Relationship between Natural Ventilation and Energy Consumption of Residential Buildings	269
Zhipeng Huang, Ge Song and Guoqiang Zhang	
Principal Factors Affecting the Accuracy of Real-Time Power Monitoring Data in Large Public Buildings	279
Jialin Wu, Zhuling Zheng, Zhiwei Lian and Dayi Lai	
Experimental Study on a Capillary Radiant Heating Bed System Based on Solar and Air-Source Heat Pump Dual Heat Source	289
Xiaoyu Zhu, Xilian Luo, Juan Li, Junwei Su and Zhaolin Gu	

Numerical and Experimental Study on Combustion Performance of an Infrared Radiation Burner with Porous Metal Plaque 299
Yunfei Jia, Weiguo Zhou, Junying Tang and Yang Luo

Vent Effect Study on the Performance of Trump Wall 309
Yunzhi Wang, Wenhen Zhou, Xiaowei Wang, Shicheng Li and Huanying Ouyang

The Air Distribution Design in Summer of a Large Space in Lanzhou 319
Xiaofei Han, Wenhe Zhou, Lixin Zhao, Xin Bao, Lu Zheng and Xiaowei Wang

A Household Heating System of Solar Photovoltaic-Heating Collector Assisted by Air Source Heat Pump 333
Shicheng Li, Wenhe Zhou, Xiaofei Han, Shiwen Ding and Shengbin Li

Changing Trend of HVAC Outdoor Air Design Conditions over the Past Half Century in China 343
Shangyu Wang, Honglian Li, Kailin Lv, Qimeng Cao and Liu Yang

Numerical Study on Flow and Thermal Characteristics in Flow Channel of Transpired Solar Collector 353
Qian Gao, Dengjia Wang, Yanfeng Liu, Yingying Wang, Yuan Liu and Jiaping Liu

Experimental Investigation on Thermal Performance of Solar Photovoltaic System Integrated with Fins-Enhanced Phase Change Materials 363
Yong Li, Ningjing Zhao, Hao Li, Chen Zhang, Yingzhen Hou, Jiale Hu, Wang Song and Yanfeng Liu

Comparative Study of Building Energy Use Prediction Based on Three Artificial Neural Network Algorithms 371
Zhi Zhuang, Ziyu Peng and Weipeng Guo

Parametric Building Energy Modeling Based on Engineering Method and Data Monitoring 381
Zhi Zhuang and Weipeng Guo

Approximate Bayesian Computation in Parameter Estimation of Building Energy Models 391
ChuanQi Zhu, Wei Tian, Pieter de Wilde and Baoquan Yin

Sensitivity Analysis of Building Energy Performance Assessment Based on Machine-Learning Models 401
Wei Tian, Jiaxin Shi, Pieter de Wilde, Yu Sun, Chuanqi Zhu and Baoquan Yin

Performance Analysis of Indirect Natural Circulation PVT System for Domestic Hot Water	411
Zhen Guo, Ruobing Liang, Jili Zhang and Ahmad Riaz	
Parametric Study of an Earth–Air Heat Exchanger System for Heating and Cooling a Memorial	421
Yujiao Zhao, Pengfei Tao, Gaihong Hao, Changfa Ji and Lang Liu	
Suitability of Inlet Wind Speed for Tunnel Wind System	431
Liang Wang, Jiazheng Wang, Lin Jiang and Rubing Han	
Effect of Thermal Mass on the Cooling Load of a Well-Insulated Office Building with Radiant Cooling System	441
Rong Hu and Jianlei Niu	
The Feasibility Study of Net Zero Energy Building for Future Energy Development	453
Yutong Li, Bin Hao and Qing Ye	
Effect of Uncertainty in the Hygrothermal Properties on Hygrothermal Modeling	461
Xiangwei Liu, Ying Liu, Xingguo Guo, Na Luo and Guojie Chen	
Optimized Analysis of Operational Strategy Based on Different Optional Energy Supply Technologies in a Distributed Energy System of Buildings in Tianjin Eco-City during Cooling Season	471
Zhengrong Li, Han Zhu, Zhe Tian and Wei Feng	
Thermal and Flow Characteristics of Liquid-Flow Window with Different Design Configurations	481
Jishun Zhang, Chuanhui Zhou and Min Chen	
Experimental Study of the Effects of Internal Non-structural Thermal Mass on the Thermal Inertia of the Whole Building	491
Weilin Li, Jiayin Zhu, Ruixin Li and Baisong Ning	
A Study of the Impact of Interior Envelope Structure on Cold and Hot Load in Yangtze River Basin of China	503
Xiaofang Deng, Wei Yu and Xiangzhong Meng	
Energy, Economic and Environmental Analysis of Flue Gas Heat Recovery for Coal-Fired Heat-Only Boilers	513
Yang Han, Haichao Wang, Lin Duanmu, Xiangli Li and Illka Haavisto	
Performance of Repeated Cross Validation for Machine Learning Models in Building Energy Analysis	523
Xiangfei Li, Baoquan Yin, Wei Tian and Yu Sun	

Simulation Study on Ventilation System in High-Temperature Accumulation Area of Power Cabin in Underground Comprehensive Pipe Gallery 533
Hongwei Wang, Pengfei Dai and Wenhua Che

Research on Suitability of Solar Energy Utilization in Public Institutions Across the Country 543
Yu Shui, Bai Lu and Feng Guohui

Energy Consumption Investigation and Analysis on Coach Stations in Tianjin 551
Xuejing Zheng, Boxiao Xu, Leizhai Sun and Dehui Kong

A Study on the Design of Waste Heat Utilization System for University Baths in Severe Cold Regions 561
Yuhang Lu, Huixing Li, Guohui Feng, Ang Xu and Weixuan He

Research Status of Composite Applications Based on Phase-Change Energy Storage Technology and Solar Energy 569
Shimeng Wang, Huixing Li, Guohui Feng, Xiangyu Lu and Kailiang Huang

Study and Analysis of Storage and Release Capacity of Baffled Phase Change Energy Storage Tanks 579
Xingyu Diao, Huixing Li, Guohui Feng, Kailiang Huang and Hao Sun

Introduction to the MARKAL Energy Modeling Method for Regional Public Institution Energy Planning—The Liaoning Area 589
Shui Yu, Qixiang Gao, Jianghui Yang and Guohui Feng

Performance Analysis and Comparison of a Combined Solar Chimney 599
Xiaohang Yuan, Huifang Liu, Jinxiang Liu, Chen Jin and Xiaolei Yuan

Battery Capacity Reduction for Stand-Alone PV Air Conditioner by Using Curtailed Electricity to Store Chilled Water as a Backup 609
Liang Hu, Yanfeng Liu, Dengjia Wang and Jiaping Liu

Data Association Mining for Identifying Cooling Energy Waste Patterns and Corresponding Improving Suggestion 619
Yucong Xue, Yang Geng, Jiajie Hong, Kang Zhao and Yidong Qian

Simulation Research on Indoor Environment and Energy Consumption of Multiple Radiant Heating Modes 629
Chenyu Huang, Nianping Li, A. Yongga, Lizhi Huang, Chenzhang Yuan and Yongsì Wang

Analysis on the Influencing Factors of Typical Residential District Model in South China's Pearl River Delta	639
Huiwang Peng, Meixiang Li, Manning He, Zhimin Zheng, Yu Huang, Lang Wu and Haokai Xu	
Fitting Analysis for Flow Coefficient Predictive Model of Residential Buildings with High Airtightness	649
Wenqian Zhou, Xiangli Li and Lin Duanmu	
System Structure and Operation Analysis of University Energy Conservation Supervision Platform	659
Na He, Guohui Feng, Cheng Wang and Lin Wang	
Meteorological Classification of Water Source Heat Pump-Assisted Solar Water Heating System Based on Cluster Analysis in Winter of Northern Region	669
Guohui Feng, Huanyu Li, Xulin Li, Chuan Tian and Mengyuan Liu	
Study on Appropriate Partition of Shallow Geothermal Energy and Active Energy Coupling Utilization	679
Guohui Feng, Mengyuan Liu, Xulin Li, Chuan Tian and Huanyu Li	
Simulation of Summer Energy Consumption of a Low-Energy Building in Severe Cold Regions and Comparative Analysis of Measured Data	689
Guohui Feng, Jiayi Zhao, Kailiang Huang, Xiaolong Xu and Chuan Tian	
Research on the Application of Multiple Forms of Renewable Energy Integrated Coupled Heating System in Rural Buildings	699
Guohui Feng, Jiasen Liu, Xulin Li and Hua Li	
Research on the Air Infiltration under Thermal Pressure in Megatall Buildings	709
Junwei Xue, Junliang Cao, Xiaoxin Man, Zhitao Han and Jing Liu	
Test and Analysis of Summer Energy and Thermal Environment for the Nearly Zero-Energy Building in Severe Cold Area	719
Guohui Feng, Yue Wang, Xiaolong Xu and Kairan Wang	
Analysis on the Task-Ambient Micro-environment and Thermal Comfort of a Workstation with Local Radiant Panels and Local Airflow	729
Chenzhang Yuan, Nianping Li, A. Yongga, Chunhui Song, Chenyu Huang and Yongsu Wang	
Test and Analysis of Airtightness of External Windows for the Nearly Zero-Energy Building in Severe Cold Area	739
Guohui Feng, Yue Wang, Xiaolong Xu and Kairan Wang	

Influence of the Shade from Other Occupants on the Angle Factor between a Human Body and Radiant Surface in Buildings 749
Yongsi Wang, Nianping Li, Jian Hu, Yingdong He, A. Yongga, Chenzhang Yuan and Meng Wang

EnergyPlus and Python Co-simulation Model to Support Machine Learning-Based Control of Ground-Source Heat Pump System 759
Chuhao Yang, Yixing Chen, Nianping Li, Yifu Sun and Ruosa Wu

An Investigation on the Dynamic Response Property in an Underground Tunnel Space with Constant Temperature 767
Chao Wu, Xu Zhang, Jingtao Huo, Wenxuan Zhao and Wei Ye

Influence of Window-to-Wall Ratio on Calculation Methods for Building Surface Reflectivity 777
Zhengrong Li, Heyu Wang and Qun Zhao

Numerical Investigation on Energy Efficiency of a Serial Pipe-Embedded Window System Operated in Summer Considering Water Temperature Change in Pipeline 787
Sihang Jiang and Xianting Li

An Evaluation Model for Indoor Light Environment 797
Jingyun Shen and Zhiwei Lian

Thermoelectric Performance of Micro-heat Tube Array Solar PV/T System Based on Parallel Flow Tube with Tiny Porous Channels 805
Heran Jing, Zhenhua Quan, Yaohua Zhao, Ruixue Dong, Ruyang Ren and Zichu Liu

Research of Building Heat Inertia Cycle Based on Data Mining 815
Chunhua Sun, Jia Zhu, Fengyun Jin, Jiali Chen and Haoyu Feng

Experimental Investigation of Dust Particle Deposition Reduction in Solar Cell Covering Glass by Super-Hydrophobic Coatings 827
Anjian Pan, Hao Lu and Lizhi Zhang

Research Status of Building Energy Consumption Analysis Based on BIM Technology 835
Heling Ma, Huixing Li, Guohui Feng, RuiYang Gao, Kailiang Huang and Xinwei Wang

Energy Performance of a Building-Integrated Photovoltaic/Thermal System for Rural Residential Buildings in Cold Regions of China 847
Tiantian Zhang, Meng Wang and Hongxing Yang

A Multi-criterion Optimization for Passive Building Integrated with Vacuum Photovoltaic Insulated Glass Unit 857
Junchao Huang, Xi Chen and Hongxing Yang

The Effect of Adjacent Room Heat Transfer on Household Heat Metering	865
Fan Yang, Peng Xue, Mengjing Zhao, Ye Zhang and Jiaping Liu	
A Study of 9 Existing Municipal Organs in Shanghai: Analysis of Building Energy Consumption Characteristics, and Energy-Saving Suggestions for Operational Problems of Main Energy Consumption Systems	875
Guangwei Deng, Weifeng Zhu, Qingpeng Wei and Qian Ye	
Prediction and Factors Determination of District Heating Load Based on Random Forest Algorithm	887
Xiaoxue Hu, Yanfeng Liu, Yong Zhou and Dengjia Wang	
A Simplified Dynamic Model of Roof Integrated with Shape-Stabilized Phase Change Material	897
Qingchen Yang, Jinghua Yu, Junchao Huang, Shan Peng and Junwei Tao	
Influence of Inlet Turbulent Characteristics on CFD Predictions of Indoor Flow Field and Ventilation Performance	907
Qiong Guo, Xiangzhe Meng and Haidong Wang	
Numerical Study on Thermal Efficiency of Large-Scale Flat-Plate Solar Collectors	917
Dengjia Wang, Yuchao Ren, Yingya Chen and Yanfeng Liu	
Luminous Environment Measurement and Simulation Analysis of a University Library	929
Guodan Liu, Xiaowei Chen, Yubin Zhang, Zhixin Wang, Run Teng and Chuanrui Li	
Thermal Model for Building External Wall under Low Atmospheric Pressure and High Solar Radiation Conditions in Plateau Area	939
Yin Zhang, Enshen Long, Jin Li and Fei Gao	
Investigation on Energy-Saving Walls of Houses in Rural Hangzhou	949
Nan Liang, Qiongxiang Kong, Ying Cao, Siyan Liu and Yan Yan	
Study on Thermal Performance and Ventilation Strategy of Tubular Ventilation Roof	959
Jinghua Yu, Kangxin Leng and Biaobiao Wang	
Analysis of China's Total Building Energy Consumption and Policy Guarantee Proposal Study under the Background of New Urbanization	969
Jinhan Liang, Wenjie Zhang, Jianwei Zhou, Xiufeng Tian and Ziqiang Huang	

Towards Zero Emission Residential Buildings (ZEBs) in a Humid Subtropical Climate. Analysis Emissions from Energy Use and Embodied Emissions from Materials in Referential Locations According to Obligatory Residential Energy Codes and Using Generic LCA Data Sources 979
Daniel Satola, Aoife Houlihan Wiberg and Arild Gustavsen

Building Energy Consumption and Future Energy-Saving Potential Research in China Based on Population Development Model. 991
Wenjie Zhang, Xiufeng Tian, Jinhan Liang, Shengbing Ma and Ziqiang Huang

Simultaneous Test of Heat and Moisture Transfer in Aerogel Blankets 1001
Haijin Guo, Shanshan Cai, Xuepeng Wang, Dongxu Fang and Kun Li

Simulation Study on the Spreading of Fire-Induced Smoke in Natural-Ventilated Double-Skin Facade Buildings 1011
Jingjing Shao, Siegfried K. Yeboah, Tiesheng Zhu and Yilin Li

Simulation Study on the Effectiveness of Passive Natural-Ventilated Facade Devices for High-Rise Public Buildings 1019
Yilin Li, Hongwei Tan, Weiguang Su and Jingjing Shao

Application Analysis of Phase Change Heat Storage in a Solar Heating System 1029
Yuefen Gao, Chengzhi Wang and Meng Wang

The Influence of Interfacial Thermal Contact Resistance on Cooling Performance of the Large Inertia Wall in Nuclear Power Plant. 1037
Xiaoyan Wu and Xu Zhang

Evaluation of Three Analytical Solar Chimney Models with Field Data 1047
Shiyi Hong, Qian Wu, Wenqing Ge, Da Lv, Zhengguang Li and Guoqing He

Study on Indoor Natural Light Environment Optimization of Traditional Residential Buildings in South Sichuan 1055
Jing Li, Ye Yang, Jian Zhong and Yu Liu

Solar Seasonal Storage Water Heating System for Space Heating of a House in Hangzhou: Simulation Using TRNSYS. 1065
Jie Lu and Guoqing He

Effect of Outdoor Meteorological Parameters on Partial Itemized Cooling and Heating Load of Building 1073
Honglian Li, Jing Liu, Yao Hu, Ying Yu and Liu Yang

Experimental Study of an Integrated Heating System in a Residential Building Sourced with Multiple Thermal Energies from Solar Energy, Air and Wastewater	1081
Jiamin Fang, Chao Shen and Yiqiang Jiang	
Simulation Analysis of Energy and Ventilation Performance of Typical Residential Building Ventilation Modes in Five Climate Zones of China	1093
Chen Shi, Haidong Wang, Pengzhi Zhou, Xueni Fan and Tengfei Zhang	
Checking Radiation Model Data with the Method of Building Thermal Environment Simulation	1103
Ying Yu, Liu Yang, Liqiang Hou and Qimeng Cao	
Study on Influence Factors of Cooling and Heating Load and Evaluation Index of Energy Consumption in Inpatient Buildings	1113
Liying Liu, Fali Ju and Yanrui Ding	
Study on the Performance of Heat Storage System with New Fin Structure	1127
Tao-tao Chen, Jia-yi Zheng and Yan-shun Yu	
Development of a Library for Building Surface Layout Simulator	1137
Masab K. Annaqeeb, Jakub W. Dziedzic, Da Yan and Vojislav Novakovic	
Analysis on Energy Consumption and Energy-Saving Retrofit of University Buildings in Hot Summer and Cold Winter Zone of China	1145
Lili Zhang, Zu'an Liu, Jiawen Hou, Dong Wei, Yuyao Hou, Junfei Du and Qiong Shen	
Optimization Analysis of Thermal Performance of Composite Self-insulation Hollow Block	1155
Wentao Hu, Junfei Du, Zu'an Liu, Chaoping Hou, Yisheng Huang and Gang Zhao	
Optimal Design of Axial Flow Fan Using Numerical Simulation	1165
Jialu Liu, Yu Niu and Yanhua Liu	
Optimization of Cooling Airflow in Data Center by CFD Analysis in a New Energy Efficient Cooling System Using CO₂ as Cooling Medium	1175
Weirong Zhang, Hongye Li, Yifei Bai and Zhaofeng Wang	
Development of Prototype Building Model in Beijing Based on Actual Energy Consumption	1187
Chenxi Gui, Da Yan, Siyue Guo and Jingjing An	

The Optimum Research and Case Study of Wind Power Heating Based on Supply and Demand Load Forecasting 1197
Chuankai Niu, Zhengwei Li and Renjing Cao

Study on Bath Water Energy Loss of Campus Dormitory Air-Source Heat-Pump Water Heater 1207
Liugen Lv, Tao Jia, Wenlian Zhang, Qianqian Jia, Jin Lv and Zhenzhen Jia

Research and Application Status of Energy Conservation in District Energy System and Its Transmission and Distribution Pipeline Network: Review 1215
Yuefen Gao, Meng Wang and Chengzhi Wang

New Progress and Thinking on Building Integrated PVT Heat Pump Technology 1223
Jili Zhang, Chao Zhou, Shixiang Lu, Ruobing Liang and Jianquan Chen

Experiment Study on Lift and Resistance Wind Energy Fan 1233
Yuling Wu, Ziyun Wang and Runsheng Qi

Study on *Re*-Independence of Flow Structure in a Flat Large-Space 1245
Xuehai Zhu, Lu Feng, Ran Ju, Di Mu and Naiping Gao

Experimental Study and Techno-Economic Analysis of Household PVT Heat Pump Poly-Generation System 1255
Chao Zhou, Jili Zhang, Ahmad Riaz and Ruobing Liang

Repair Method of Chiller Power Consumption Monitoring Data Based on Multiple Linear Regression Model 1265
Zhuyue Chai, Tianyi Zhao, Liangdong Ma, Jili Zhang and Mingsheng Liu

Investigation on Energy Saving Potential of a Vertical Greening System in Hot Summer and Cold Winter Areas in China 1277
Hang Tan, Zhuoyu Yang, Xiaoli Hao, Qingwei Xing, Yaolin Lin, Xianping Liu and Jinhua Hu

Study on Effect of Different Wall Insulation Structures on Building Energy Consumption in Low Latitude Region: A Case Study in Qionghai, China 1285
Chenrong Yu, Jingchao Xie, Peng Xue, Jiaping Liu and Ying Ji

Research on Electricity Consumption Characteristics of Centralized Air Conditioning Units for Data Restoration of Building Energy Consumption Monitoring Platform 1295
Terigele Ujeed, Tianyi Zhao, Liangdong Ma and Mingsheng Liu

Prediction of Building Stock Energy Demand 1305
Hyunwoo Lim and Zhiqiang (John) Zhai

Uncertainty Analysis of Urban Building Energy Based on Two-Dimensional Monte Carlo Method	1315
Xing Fu, Wei Tian, Yu Sun, Chuanqi Zhu and Baoquan Yin	
Research on Energy Consumption Data Characteristics of Office Building VRV Air Conditioning Outdoor Unit Based on Energy Consumption Monitoring Platform	1325
Liangdong Ma, Fengmei Lu, Jili Zhang and Yiyi Xu	
Evaluation Methods and Index System for Data Quality of Public Building Energy Consumption Monitoring Platforms	1337
Huiyu Yan, Liangdong Ma and Jili Zhang	
Energy-Saving Effect and Mechanism of Heating Setting Temperature Decreased by 1 °C for Residential Buildings in Different Cities	1347
Shurui Guo, Hanyu Yang, Yin Zhang and Enshen Long	
Comparative Analysis of Air-Cooled Precision Air Conditioners and Water-Cooled Precision Air Conditioners	1357
Huifang Liu, Zhixian Ma and Mingsheng Liu	
Evaluation of Radiant Heating and Cooling Terminals Based on Structural Thermal Resistance	1367
Xiang Zhou, Yunliang Liu, Shaochen Tian, Maohui Luo, Lili Zhang and Yongli Yuan	
Carbon Performance Evaluation of Urban Buildings Using Machine Learning-Based Energy Models	1379
Yunliang Liu, Wei Tian and Xiang Zhou	
Study on the Degree and Mechanism of Solar Shading Impacts from Rooftop Structures in the Solar Collector Layout Area	1389
Luting Xu, Enshen Long, Xuefei Xiao and Ziyun Wang	
The Effect of Internal Load on the Selection of Heat Radiator	1401
Guoyi Xu and Yiwen Jian	
Experimental Study on Albedo of Solar Radiation in Different Underlying Surfaces in Western Sichuan Plateau	1409
Qiancheng Shan, Enshen Long, Yin Zhang, Fei Gao and Ziyun Wang	
High Energy-Efficient District Cooling System and Its Engineering Applications in India	1419
Zhuolun Chen, Lily Riahi and Benjamin Hickman	
Comparison of Nuclear District Heating Technologies in Russia and China	1429
Aleksandr Solomykov and Jinling Zhao	

Sensitivity Analysis on Influence Factors of Comprehensive Energy Planning for Low Carbon City in China	1437
Li Zhu, Jiqiang Zhang, Yang Yang, Zhexing Yan, Qi Liu and Yong Sun	
Influence of Air Curtain Characteristics on the Capture Performance of Range Hood	1445
Lipeng Lv, Changsheng Cao, Jun Gao, Yongzhe Meng, Xishun Ai and Qigao Gai	
An Improved Model for Optimal Design of Building Integrated Photovoltaic Thermoelectric Systems	1455
Xiaosong Su, Ling Zhang, Yongqiang Luo, Zhongbing Liu, Yongwei Luo, Jinbu Lian, Jing Wu and Zhenghong Wu	
Experimental Study on a Facade-Built-in Two-Phase Thermosyphon Loop for Passive Thermo-Activated Building System	1463
Li Zhu, Yang Yang, Jiqiang Zhang, Sarula Chen and Yong Sun	
Study on the Influence of Different Positions of the Air Inlets in the Kitchen on the Air Supplement Effect	1473
Dan Yi, Lianjie He, Lipeng Lv and Jun Gao	
Evaluating Thermal Performance of Oval U-Tube for Ground-Source Heat Pump Systems from in Situ Measurements and Numerical Simulations	1483
Yoshitaka Sakata, Ahmed A. Serageldin, Takao Katsura, Motoaki Ooe and Katsunori Nagano	
Development and Experimental Validation of a Finite-Difference Frequency-Domain Model for the Exhaust Air Insulation Wall	1493
Liao Li, Chong Zhang, Jiaqi Hu, Wenjie Gang and Jinbo Wang	
Experimental Study on Electrical Power Generation and Natural Daylighting Illuminance Due to Building-Applied Photovoltaic Façade Application	1503
Ahmad Riaz, Jili Zhang, Chao Zhou and Ruobing Liang	
Train-Induced Unsteady Airflow (TIUA) Characteristics in Subway Ventilation Network	1513
Xin Zhang, Jiangyan Ma and Angui Li	
A Simulation Study on the Hydration of Magnesium-Based Thermochemical Heat Storage System for Residential Buildings	1523
Yi Wang and Zhenqian Chen	

Research on Evaluation Index System of District Energy Systems 1533
Tianjie Liu, Wenling Jiao, Lemei Ren and Xinghao Tian

**Research on Thermoelectric Coupling Model of Photovoltaic
Wall Based on Equivalent Circuit Model and Its Thermal
Characteristics 1543**
Wenjie Zhang, Shengbing Ma, Ziqiang Huang, Bing Bai and Xiufeng Tian

**Space Heating Management for Solar Heating System
with Underground Pit Storage 1553**
Xiaoxia Li, Zhifeng Wang, Jinping Li, Ming Yang, Yakai Bai
and Longfei Chen

Research and Accuracy Analysis on Engineering Quantity Calculation of a Projected Building by BIM Software



Xinjie Xu, Yu Wang, Jinxiang Liu, Xiaolei Yuan, Jun Bao and Xuetao Chou

Abstract Engineering quantity calculation is the premise and foundation of cost control in architectural engineering. However, the traditional calculation method of engineering quantity way by manual method is inefficient and with low precision. The calculation is faster and more accurate if Building Information Modeling (BIM) technology is applied. In this paper, the development and histories of BIM applications in engineering cost management are introduced. Based on the data of an actual building, a simulation model is established by BIM software. The engineering quantities are calculated, and then, the results of the traditional manual calculation method of engineering quantity and calculation method of BIM are compared and analyzed. The data with a relative error of more than 10% is listed, and the reason for the relative error is conducted. It is concluded that the rules of BIM calculation and manual calculation are different, causing BIM method not accurate enough for some nodes. The suggested method is that BIM method is firstly applied for the total engineering quantity calculation, and then, the manual method is proposed to check the accuracy in some key nodes.

Keywords BIM · Engineering cost · Manual engineering quantity calculation · BIM engineering quantity calculation · Relative error

1 Introduction

BIM technology was originated from the end of the twentieth century and was proposed by Dr. Chuck Eastman in the USA in the computer simulation system of architecture [1]. The General Services Administration launched the national 3D-4D-BIM program in 2003 and successively released a series of BIM guidelines. Early in the 1960s, computers have been used for building cost calculations [2]. The emergence of BIM cost calculation software simplifies the original manual calculation, reduces the repetitive and tedious workload caused by design changes as well as labor

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costs and improves the working efficiency of cost personnel [3]. Since 2002, BIM technology has been widely developed and applied in Europe, USA, Japan, South Korea, Singapore, Hong Kong and Taiwan [4]. In 2009, government of Wisconsin took the lead in applying BIM technology to new large-scale public building projects in the state. Currently, BIM standards have been established in the USA, and BIM technology is being applied in US government projects.

With the development of scientific information technology, BIM spread into China in 2008. In 2010 and 2011, the committee of China commercial real estate association, engineering construction quality management branch of China construction industry association, the engineering management research branch of architectural society of China and China civil engineering society computer application branch organized and issued 'Research Report on BIM Application of Commercial Real Estate in China in 2010' and 'Application Research Report of BIM in China Construction in 2011.' According to these two reports, the perceived degree of BIM has increased by 27% [5]. In 2014, the Ministry of Housing and Urban–Rural Development promoted the popularization of BIM and the practice of BIM technology in engineering in the 12th five-year plan [6]. BIM is developing rapidly in China, especially in the field of engineering cost. Zhang et al. [7] proposed that BIM technology can be used for four-dimensional (including 4D construction progress management, 4D resource dynamic management, 4D construction quality and safety management, 4D construction site management and 4D construction process simulation) to achieve dynamic management of project cost. Ye [8] studied the application of BIM technology in project cost management according to the analysis in definition, principle, development advantages and influence of BIM in each stage of the project. Fu et al. [9] studied BIM-based engineering quantity calculation and established an engineering cost method through practical cases. Tang [10] proposed the method to solve the problems in each stage by using BIM technology based on the existing problems in the current cost management project.

2 Methods

As shown in Fig. 1, the process of civil construction modeling is to draw the axis based on the engineering construction drawings in the modeling software of Revit firstly, and then, the definitions of some construction such as column, beam, board, wall, door and window are established. Furthermore, the model is imported into the civil construction calculation software of Glodon for the following work.

Figure 2 shows the three-dimensional diagram of a civil engineering model. The project is a single residential building with a frame structure and a service life of 50 years. The number of building layers is six floors, of which 0 is underground and 6 is the ceiling. Each layer consists of two units; the height of the first layer is 3.5 m, while the height of the second to the sixth layer is 3.0 m. There is no difference in indoor and outdoor height, and the total height of the building is 17.9 m. The building area is 2469.38 m². The independent foundation structure was adopted under the