Research on Durability Research and Thermal Performance Test to High-Rise Building

Deng Hai, Xu Hongwei, Li Yong

Shijiazhuang Tiedao University, Shijiazhuang, China

Keywords: High-Rise Buildings, Durability, Thermal Performance, Testing

Abstract: High-Rise Buildings Have Gradually Become the Main Building Trend in Modern Cities, So the Durability and Thermal Performance of High-Rise Buildings Have Become the Focus of Public Attention. However, Due to the Different Requirements of Cement Quality Inspection At Home and Abroad, the Durability of High-Rise Buildings in Many Areas Will Be Reduced to a Certain Extent. Moreover, Inappropriate Administrative Intervention in the Progress of the Project, Excessive Pursuit of Construction Progress, Engineering Designers and Project Managers Do Not Pay Enough Attention to the Safety and Durability of High-Rise Building Structures, Will Bury Hidden Dangers for the Durability of High-Rise Buildings. in This Regard, This Paper Discusses the Durability Research and Thermal Performance Test of High-Rise Buildings, Hoping to Attract the Attention of the Industry and Promote the Reform and Development of the Construction Industry.

1. Introduction

1.1 Literature Review

In the development of modern construction industry, building energy conservation is an important concept that must be followed. At the same time, in order to adapt to the global energy crisis and environmental crisis, building energy conservation has become an inevitable choice. In this regard, paying attention to and increasing the construction of building energy-saving projects has become the focus of attention of many scholars and experts in the industry. He You-dong and Huang Jun, who are the scholars of the evaluation, have monitored and analyzed the thermal performance of the energy-saving construction site. Accurate thermal performance test results will be an important reference for building energy-saving projects and improving building technology (He and Huang, 2016). Zhou Jing and other scholars introduced the construction and performance characteristics of the new foam concrete exterior wall. Through experimental comparison and analysis, it is found that the thermal insulation performance of foam concrete exterior wall is superior to that of external thermal insulation wall and solid brick wall. Moreover, the foam concrete exterior wall also has the quality advantage, and the quality is less than half of the external thermal insulation wall (Zhou et al, 2015). Zhang Dan's scholars have analyzed and studied the detection methods of optical and thermal properties of building glass and the matters needing attention which affect the accuracy of the results. Moreover, the parameters of architectural glass are objectively explained and evaluated (Zhang, 2016). Jiang Jiachun and other scholars discussed the optical and thermal properties of energy-saving glass. The energy-saving effect of building glass is ensured by analyzing the optical properties of different kinds of glass (Jiang et al, 2019).

1.2 Research Purposes

In recent years, the increasing energy consumption of buildings and the increasing energy crisis make the demand for durability of buildings more and more intense. In the Standard for Energy Conservation Design of Residential Buildings in Hot Summer and Cold Winter Areas, the corresponding regulations for thermal performance of building envelopes are put forward. It can be seen that for high-rise buildings, improving the durability and thermal performance of the overall building has become the mainstream direction in line with social development and living needs

Copyright © (2019) Francis Academic Press, UK DOI: 10.25236/acete.2019.035

(Zhang, 2016). However, at this stage, the durability of high-rise buildings for various reasons, there will be many application problems and security risks, which are not conducive to the long-term development of the construction industry. In this regard, based on the current development of the construction industry, this paper discusses the durability research and thermal performance test of high-rise buildings, hoping to further enrich the relevant research theory.

2. Significance Analysis of High-Rise Building Durability

According to relevant surveys, under general environmental conditions, China's domestic industrial buildings, after 25-30 years, need to be thoroughly repaired. The service life of civil and public buildings can be extended to about 50 years. The durability of outdoor balconies and roofs, which are exposed to sunlight and rain for a long time, will be greatly reduced, usually in the 30 to 40 years or so. Therefore, the durability of high-rise buildings has become the focus of the construction industry can not be ignored. According to the basic situation of modern environment, the life expectancy of people in modern society can reach 70 to 80 years. According to relevant investigations, large-scale renovation of civil buildings takes about 50 years. As can be seen, the durability of many buildings is much lower than that of the general population (Yang et al, 2018). However, in modern society, modern residents usually buy houses in order to leave real estate for future generations. But the durability of many high-rise buildings is only 50 years, so there will be a big economic gap. From the national level, the construction structure engineering is related to national security. From the personal level, the durability of building structure is related to personal life and property. Therefore, it is of great practical significance to discuss and analyze the durability of high-rise buildings.

For high-rise building structure engineering, concrete is the key material. Generally speaking, concrete is formed by mixing gravel, cement, water and sand. However, some construction units will cut corners and choose unqualified materials, which will also reduce the durability of structural engineering to a certain extent. In testing the quality of concrete, a single strength is still used as a measure index. As a result, the cement industry excessively pursues cement strength and improves the proportion of mineral components and cement fineness. However, the strengthening of these indicators leads to the decrease of durability of concrete. At present, China's cement quality inspection only requires strength not less than the minimum allowable value. However, foreign countries also set the maximum limit, requiring that the strength of cement should not exceed the maximum value, otherwise it will be judged as unqualified products.

The improper progress of administrative intervention and excessive pursuit of construction progress are also important factors affecting the durability of high-rise buildings. It is related to the concrete quality of high-rise building durability, in fact, it needs sufficient construction and maintenance period. High-rise buildings built in a very short period of time can easily leave potential safety hazards. This point is clearly stipulated abroad. Many projects completed ahead of schedule may face fines because of potential quality hazards. In addition, deteriorating environment, such as exhaust gas and acid rain, will also lead to high-rise building durability.

For the safety and durability of high-rise building structural engineering, many engineers and project managers do not pay enough attention to it. At the same time, the design requirements of high-rise building structure engineering in China are relatively low for the function of resisting earthquake and fire. The design requirements for resisting other harms are even blank. Current design specifications usually only consider the ultimate bearing capacity of the building during its service life. This design requirement will have great potential safety hazards.

3. Thermal Performance Analysis of High-Rise Buildings

The thermal performance test of high-rise buildings is to measure the indoor thermal environment and outdoor heat and humidity, as well as to investigate the thermal and physical properties of building materials, so as to test the technical effect of building thermal design.

Specifically, the thermal performance test of high-rise buildings mainly measures seven parameters of the building structure.

One is to measure the thermal and humid parameters, which mainly measure the heat flow, humidity, temperature, wind speed and micro-pressure of the building structure. Indoor hot and humid environment plays a great role in human health, so it has been paid attention by many scholars. Professor Fanger, Danish University of Technology, used human thermal sensation index to evaluate the comfort of indoor thermal environment under air conditioning. That is to say, based on the heat balance of human body and combined with the subjective feelings of psychology, we can get the index of heat sensation of human body. Through standardization and quality control, Richard J. de Dear obtained a comprehensive database of thermal comfort field test by analyzing 21000 sets of original thermal comfort data of 160 buildings.

The second is to measure temperature, which is usually measured by copper-constantan thermocouple. When measuring the surface temperature of building materials and the internal temperature of enclosure structure, the conductor is arranged along the spreading temperature surface by thermocouple. The length of the conductor is required to be in the range of 10-15 cm. When the air temperature is measured, the aluminium foil barrier cover with better ventilation performance is superimposed on the thermocouple to reduce the effect of environmental thermal radiation. In addition, resistance thermometer, semiconductor thermometer and quartz thermometer can also be used for temperature measurement.

The third is to measure the relative humidity of air. At the same temperature and pressure, the ratio of vapor pressure of water in air to saturated vapor pressure of water is the relative humidity of air. There are many hygrometers to measure the relative humidity of air. Such as resistance hygrometer, Asman thermometer, color hygrometer, hair hygrometer, etc. The mercury thermometer in the wet-dry bulb thermometer can be transformed into a thermocouple when measuring the relative humidity of air over a long distance. When measuring solid humidity, it is suggested to adopt absorption and baking weighing methods.

Fourth, heat flow measurement. The measuring tools mainly include heat radiation intensity meter, heat flow meter, convective heat flow meter, etc. Thermal Radiation Intensity Meter is a thermopile with hot and cold nodes on the same surface. Measuring the thermal radiation intensity of sunlight, usually white cold junction and black hot junction, or black hot junction, using aluminum foil to shield the cold junction, can also achieve the measurement of the thermal radiation intensity of objects. The heat flow meter is a thermopile with cold and hot nodes arranged on two sides of the electrical insulation sheet. The thermal stack arranged on the hollow frame is a convective heat flow meter. In the boundary layer air, it ensures that the hot and cold nodes are separated on two sides which maintain a certain distance.

Fifth, to measure the breeze speed. Commonly used instruments are electrothermal anemometer, cata thermometer, Doppler laser anemometer, rotor anemometer and blade anemometer.

Sixth, the measurement of micro-pressure. Generally, inclined microbarometer is used to measure. That is to say, the water column difference between the rubber pipe and the connector is used to measure. If equipped with pressure measuring tube, it can also measure static pressure, dynamic pressure, total pressure and wind speed in the fluid.

The seventh is to measure the thermophysical properties of materials. Usually, the thermal conductivity, radiation coefficient, air permeability coefficient and vapor permeability coefficient of materials are measured. Taking the thermal conductivity of materials as an example, the standard method is flat plate steady heat transfer method, and the instantaneous heat source method can also be used for rapid measurement. When determining the thermal radiation coefficient of the material, the reading of the radiation heat flux meter placed in the thermostat is measured according to the sample and standard sample at different temperatures.

4. Conclusion

For the safety and durability of high-rise building structures, there is no systematic concept of safety management, because many human errors in operation lead to structural safety problems.

However, the thermal performance of building structures, mainly investigating the thermal conductivity and thermodynamic efficiency of materials, has not attracted enough attention from the industry. In this regard, this paper carries out the corresponding discussion and combing, hoping to enrich the relevant research theory and provide some support.

Acknowledgement

Hebei University Science and Technology Research Project (BJ2018048); Hebei Province Large-scale Infrastructure Disaster Prevention and Mitigation Collaborative Innovation Center Subsidized Project; Shijiazhuang Railway University Excellent Youth Science Foundation.

References

[1] He Y.D, Huang J.P. (2016). On-site thermal performance testing and analysis of building energy-saving projects. Private science and technology, 22 (4), 163-163.

[2] Zhou J.g, Meng X., Liang W.J., long E.S. (2015). test and analysis of thermal performance of foam concrete exterior wall. Journal of Civil and Environmental Engineering, 58 (S2), 219-222.

[3] Zhang D. (2016). Detection of optical and thermal properties of building glass and analysis of energy conservation. Sichuan building materials, 42 (4), 30-32.

[4] Jiang J.C., Tang H.Y., Deng L.W., Chen J. (2019). Analysis and Research on optical thermal performance of energy-saving glass. Science and technology information, 17 (3), 83 + 85.

[5] Zhang Z.K. (2016). Application and field measurement of thermal performance of various self-insulating walls in single buildings. Brick-Tile, 46(4), 12-16.

[6] Yang C.Z., Lei X.H., Zhang L., Wang L. (2018). Study on the comprehensive thermal performance evaluation method of existing building envelope structure. Journal of Hunan University (Natural Science Edition), 45 (07), 155-161.