

Report on the 14th International Symposium on Structural Engineering

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Introduction

The 14th International Symposium on Structural Engineering (ISSE-14), sponsored by the National Natural Science Foundation of China (NNSFC), was held during 12-15th October in Beijing. The symposium is to provide an international platform for experts from research and engineering communities, who work worldwide in the broad areas of civil (structural) engineering. A total of 349 technical papers were orally presented with over 500 participants during the symposium. The author wish to share the start of the art research, design and construction in civil & structural engineering reported during this international symposium.

Keynote papers

A total of 56 keynote papers were presented by the invited experts worldwide in the symposium, which covered a wide range of areas in civil and structural engineering. The topics in these areas could be summarized for sharing as in the following: the retrospective on 20 years of fundamental researches in structural engineering in China by NNSFC; prospective on evolution from earthquake/wind hazard to engineering disaster in China; the development and application on seismic isolation, energy dissipation and structural control in China; recent developments in structural health monitoring based on vehicle-bridge interaction; integrated numerical simulation platforms for disaster evolution of civil infrastructure under strong wind and earthquake; health diagnostic method of urban rail transit underground structures as well as diagnosis and rehabilitation of industrial buildings; new frontiers in wind engineering, in particular the motion perception, occupant comfort and work performance in wind-excited tall buildings; influence of seawater layer on the seismic response of buried offshore pipelines; state of the art of concrete structure durability monitoring and restoration; steel-concrete composite structures for the sustainable development in civil engineering; basic creep of cylinders made of normal-strength demolished concrete blocks and high-strength fresh concrete; and the relation between design load level and lifetime of individual building and its elements. In sum, the advances in civil and structural engineering were broadly and deeply discussed during the plenary lectures in terms of research, design and construction. One of the keynote papers presented in plenary lecture is illustrated in Figure 1.

Highlights

As the world's largest and fastest developing construction industry in China in recent 30 years, the construction of civil infrastructures, including super long bridges, super high-rise, large-space structures, major urban underground structures and high dams, have been booming and prosperous following the rapid developments of economy in China. The safety and stability of these large civil infrastructures were highly concerned under extreme conditions, i.e., earthquake and hurricane. "The NNSFC has been hugely supporting the researches and developments in this area, in particular, totally 214 million CNY were sponsored on 'exploring the mechanisms of damage and collapse of infrastructures and establishing dynamic catastrophe simulation methodology' for the period from Jan. 2008 to Dec. 2016", said Professor OU, Member of the Chinese Academy of Engineering. The four major scientific aspects in this area were focused, including modeling and prediction of earthquake and hurricane fields; key effects, full-range analysis as well as integrated simulation system and in-field verification, of damage and failure process of civil infrastructures under earthquakes and hurricanes, respectively.

The construction of civil infrastructures in Hong Kong is prosperous in the past few years, i.e., the Stonecutters Bridge, the Public Housings, the underground railways, the Hong Kong-Zhuhai-Macau Bridge, the Children's Hospital and the coming New Acute Hospital. The structural safety under tropical cyclone is one of the key design issues due to Hong Kong's special location with tropical cyclone visiting each year and more frequent in summer and autumn. Furthermore, the design of civil infrastructures for seismic resistance has been getting more and more concerned recently with the HK design guidelines for seismic resistance under progressing. Therefore, the author believes that the above NNSFC research development plans will also benefit to the design and construction of civil infrastructures in Hong Kong. The safety and stability of civil infrastructure under these extreme conditions, namely, seismic and typhoon, are also closely related to its lifetime in terms of good functions. It should be noted that the NNSFC research strategy in this area somehow is also in consistence with one of the recommended actions "lifetime asset management techniques to reduce the demand for new infrastructure", as specified in the report "ICE's infrastructure: Shaping Hong Kong" issued by ICE HK in 2015.

Furthermore, it is good to see that sustainable development in civil and structural engineering is always emphasized by experts from both academic and industry during the symposium, for examples, structural materials and structural durability, "The research of high performance and recycling construction materials will attract some more interests. Especially, the research of biologic materials will be the hotspot in construction material science", and "...we should pay attention to the environmental deduced physical-chemical effects and biological effects on structural materials. The multi-field, multi-physics coupling and physical- chemical- biological material constitutive relationships will be the critical issue in structural durability", said Professor LI, one of the committee members in NNSFC.

The research and application on diagnosis and rehabilitation of industrial buildings in China was reviewed and summarized by senior engineer Mr. Yue from Central Research Institute of Building and Construction MCC, China. He also discussed the problems to be solved and the future directions in structural diagnosis and rehabilitation. The task is heavy but meaningful due to a large quantity and wide range of industrial buildings built in different ages in China. The technology of diagnosis and rehabilitation of industrial buildings is significant to ensure the safety and durability of in-service industrial buildings. Furthermore, the health diagnostic method of urban rail transit underground structures was reported by Professor ZHE from Huazhong University of Science and Technology, China. "The complex environmental erosion and degradation of materials will cause severe damages which impacts the service performance of urban rail transit underground structures. The failure tree based on a variety of damages combined interaction effects on underground tunnel structures was explored to establish a complete set of evaluation indicators based on the investigations of rail transit underground structural damages in cities of Beijing, Shanghai and Guangzhou". These examples are closely reflected in some valuable recommended actions in the report of "ICE's infrastructure: Shaping Hong Kong", i.e., increasing use of retrofit, renewal and lifetime asset management techniques to reduce the demand for new infrastructure.

There are two interesting presentations regarding to the methods of bridge monitoring. The first method of using unmanned aerial vehicles (UAVs) was presented by Professor Spencer from University of Illinois at Urbana-Champaign in USA. The method of using the existing commercial UAVs and cameras to measure the displacement of the railroad bridges under train loading was developed to overcome the limitations of other methods in terms of cost, accuracy, and complexity, i.e., accelerometer, LVDT, and GPS. The displacement determined using the proposed method matched well with the simulated vertical motion of the railroad bridge. The on-site filed tests are currently being planned, and the method is expected to have wider applications in measurements of the civil

infrastructures. The second method was presented by Professor Law from Stanford University in USA. The cloud computing services was employed and a cloud-based cyber infrastructure platform was implemented to effectively manage the information involved in bridge monitoring applications. By using this method, the metadata about the sense on bridge together with the other type of relative information including the bridge geometries and bridge engineering analytical models could be managed in the system. The Telegraph Road Bridge located in Michigan was illustrated as demonstration for the developed system.

General papers

Around 300 general papers were mainly divided into sessions of structural analysis, earthquake engineering and aseismic design, structural wind engineering, structural health monitor and damage detection, dynamic vibration control, novel structural system, composite and hybrid structures, historical and heritage structures, large-scale structures and space structures, bridge engineering, foundation, underground structures and soil-structure interaction, high performance material and smart material as well as concrete structures. It is excited to see that not only, as normal in most international symposiums, new design technology, new structural system, advanced analysis method, experimental investigation and numerical simulation were discussed and developed, but also a number of papers were focused on the historical and heritage structures, new construction materials and semi- and precast reinforced concrete members as well as recycled coarse aggregate. These somehow directly contributed to the sustainable development in civil and engineering industry in terms of avoiding new construction, replacing concrete material for reducing CO₂, reducing air pollution and using recycled material. These are closely related to the recent construction industry in Hong Kong, for examples, the recently proposed historical and heritage structures for rehabilitation and retrofitting, (i.e., the revitalization of Lady Ho Tung Welfare Centre in Sheung Shui and the revitalization of No.12 School Street into Tai Hang Fire Dragon Heritage Centre), the semi-precast elements in the public housing projects, the encouragement of using recycled material.

The author also presented his several years' research works on stainless steel structures, as shown in Figure 2. It should be noted that the application of stainless steel in construction industry has been increasing for its desirable characteristics, such as attractive appearance, corrosion resistance, ductility, better fire resistance as compared to carbon steel, low maintenance for the whole life cost of structure and so on. In particular, the recently developed lean duplex stainless steel, which costs only half of the price of the normally used austenitic stainless steel but offers twice of the yield strength. Some related research works in stainless steel structures were also presented by other experts, for examples, "Stainless-carbon steel composite beam-column joints with blind bolts" presented by Professor TAO from Western Sydney University in Australia, and "Stainless steel beam-to-column connection panel zone" presented by Professor LIN from Tsinghua University in China.

Summary

The state of the art knowledge on research, design and construction in civil & structural engineering presented by professions worldwide were well received. These could contribute, as one more step ahead, to a better sustainable development in civil infrastructures design and construction. The papers presented during this symposium and published in the proceedings could be an addition for civil and structural engineers in Hong Kong.

Acknowledgement

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Figure 1: One of the keynote papers presented in plenary lectures during the symposium



Figure 2: The author's presentation in one of the sessions during the symposium