MISSION, GOALS AND SOCIAL RESPONSIBILITY OF STRUCTURAL ENGINEERS

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Preface

Architecture does not just provide the infrastructure for civilization. It also provides a cultural value and historical heritage. For this reason, people often spend a considerable amount of time touring buildings and architectural monuments during their leisure travels. These architectural features are supported by "structural systems". Creative and innovative architectural designs cannot be realized without a structural system including elements such as beams and columns. Structural systems are as important in construction as bones are for our body. The structural systems protect the buildings from natural disasters such as typhoons and earthquakes. This is especially important in countries like Japan where exposure to these natural hazard risks is great.

Structural design first begins with an understanding of the various forces acting on the structure, and the consequences of their actions. The engineering process should provide the most suitable structural solution and it must provide safety to the people who use the structure.

The range of activities of a structural engineer is diverse; understanding the requirements of clients, cooperating with other construction disciplines, performing the design and being responsible for maintaining the quality of construction. Structural Engineers should design socially acceptable and beautiful structures by using their engineering experience and judgment. Computational calculations are only a part of structural engineering work to confirm the safety.

Design quality depends on both the architects and the structural engineers. Therefore the clients must select qualified structural engineers to ensure quality. The "First Class Structural Engineer" licence has been introduced to recognize structural engineering as a speciality and a new permit process has been started. The qualifications required for this licence emphasize knowledge of the code and law. However, it is not possible to regulate every structural design decision by the code. Also the conformation to the code and the law does not guarantee the real safety of the structure. Therefore, discussion of the desired structural performance between the client and the structural engineer is important for the project and the society.

It is essential to maintain an environment that produces qualified structural engineers. Structural engineering should be a fun and creative process. We make imagination real. However, structural engineers are required to follow strict detailed regulations and spend a significant amount of time involved with the administrative details rather than creating structures. Structural engineers are struggling with this reality. This situation does not necessarily influence the structural engineers positively. Hence, it is necessary to have an education system that teaches the joy of structural engineering to the next generation.

It is also critical to ensure that construction is implemented per the engineering plan by quality control process. The role of structural engineers is diverse and the responsibility is great since our actions and abilities affect lives.

This document, by the Architectural Institute of Japan, has been written to explain the responsibility and importance of the roles of structural engineering for not only structural engineers and researchers, but also for the public. This document addresses the mission, goals and responsibility of structural engineering.

1. Architecture and Society

Architecture is a foundation to society providing important cultural and historical value

1.1 Architecture, civil engineering, transportation, and communication are the foundation of society and civilization. It takes great effort to create these infrastructures therefore they are built to endure natural disasters and stand for generations.

1.2 Architecture touches people's everyday lives. Therefore safety, ease of use, and beauty are desirable aspects of architecture. Architecture also enhances society's culture and history.

2. Role of Structural Engineering in Architecture

Engineering supports architecture and provides safety and security against complex natural environments.

2.1 Structural engineering supports architecture by considering its creative spaces. It provides safety, security at a reasonable cost while using principals of science and engineering.

2.2 Architecture is exposed to extreme natural phenomena, such as earthquakes, typhoons, and unresolved or unknown issues in structural and soil behaviour.

2.3 Structural Engineering provides sustainability of structures by conserving and reusing resources. Rehabilitation of existing structures assists with conservation.

3. The Goals of Structural Engineering

Structural design is based on science and engineering. It also iteratively integrates creativity and analysis.

3.1 Structural engineering uses science, engineering and creativity to provide structural safety. Furthermore, the design aims to produce architecturally appealing and cost effective structures by understanding the behaviour of the overall structure and frame members. The structures must provide sufficient stiffness, strength and ductility.

3.2 Structural engineering is diverse, ranging from designing a bolt to a ceiling system to overall structural safety of the cities and the world. It is even related to world politics.

3.3 Structural engineering blends creativity and scientific analysis. Engineering is an analytical process but it also requires imagination and creativity. These skills can be utilized by observing and understanding nature, and performing experiments.

3.4 Structural analysis is conducted to quantitatively understand and judge engineering characteristics. Analysis is made under certain assumptions and it may not capture all the variables of a real natural phenomenon. In addition to analysis, it is preferable to use various modelling, calculation methods, and experimentation.

4. Responsibilities of Structural Engineers

Structural Engineers shall conduct themselves ethically, develop professional skills, and provide broad insight and sound judgment.

4.1 Structural Engineers shall execute professional responsibilities ethically.

4.2 Every structure has its own design aspects and individuality. Therefore, logical process and decision making based on a range of experience and insight is essential for designing anything from welded connection details to whole structural systems.

4.3 The structural engineers must communicate and exchange information with other professionals. Moreover, it is necessary to clearly explain to the clients and society about the relationship between structural performance and construction cost.

4.4 The structural engineers not only use systemised design processes developed in the past but structural engineers should also understand and master new technologies. It is therefore important for the advancement of the profession for structural engineers to be active in professional societies and conferences to exchange knowledge and information.

5. Structural Engineering Law and Qualifications

The Law requires minimum structural safety for structural design; however, requirements may not be sufficient.

5.1 Structural safety cannot be judged solely by conformance to the Law and codes. The Law defines the minimum requirements of safety which are acceptable to societal norms and provides a system of the accountability to ensure conformance. However, this is not adequate to create great architecture and cities. Engineers achieve high quality and safe construction by using their abilities, and imagination while paying attention to details.

5.2 Architectural designs are not mass productions of industrial products. Each design is unique and requires many variations and new technology. On the other hand, the law and code address general conditions and this may not be suitable for unique design and engineering. The law and the code should not interfere with creativity and structural innovation.

5.3 The law and the code should only provide basic requirements of structural engineering. It should allow creative engineering which meets the laws of physics and nature. At the same time, the law should clarify structural engineers' responsibilities.

5.4 Updated standards, codes, and new principles from the Architectural Institute of Japan can be used in the engineering, approval, and certification processes for structural design.

5.5 Expert Peer Review, approved by the client, should be used to improve the quality of engineering.

6. Structural Engineering Research and Education

Research and education of the next generation of structural engineers is essential to create a variety of structures.

6.1 Improvement of technology and its application are essential to achieve various architectural structures and meet the changing demands of society. Active promotion of research and development is essential, and idea exchange on a wide range of research topics between researchers and practicing engineers is also important.

6.2 School education should emphasize general engineering principals for the next generations of structural designers.

6.3 The system of architecture and structural engineering education in Japan is effective and unique because future engineers and architects learn together in the same classrooms. We should take advantage of this unique system and teach the importance of structural engineering and its responsibilities to our students with assistance from experienced professionals.

7. Structural Engineering and Design/Construction Process

Structural Engineers should understand the design/construction process and be involved in the process as experts.

7.1 Structural engineers should understand the various construction and structure technology in order to provide quality assurance. Structural engineers should also assess the site and project size in order to provide appropriate structural solutions.

7.2 Structural engineers should communicate with on-site contractors and make flexible yet appropriate engineering judgements in order to complete design projects.

7.3 All design/construction professionals should make timely and appropriate decisions and recognize the role and responsibilities of each member in order to accomplish project goals.

7.4 Project completion time from architectural design to construction can be lengthy; therefore the design/construction process and legal system should be flexible to accommodate changes in economic factor and new technology.

8. Internationalization of Structural Engineering

Japanese earthquake engineering technology should be transferred and information should be exchanged worldwide.

8.1 Structural engineers and professional associations, such as the Architectural Institute of Japan, should understand different countries' history, culture, and architecture and participate in information exchange and friendship with oversees counterparts.

8.2 Japanese earthquake engineering technology was acquired through research as well as observation and experience of many past earthquakes. Structural engineers and related organizations should actively contribute to the reduction of earthquake hazards worldwide by transferring their earthquake engineering technology. The standards, codes and guidelines of the Architectural Institute of Japan should be translated to English and Chinese and published.

8.3 Japanese structural engineering research and practice are state of the art. Structural engineers should recognize this fact and engage in activities internationally.

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