面向地震安全韧性的科学框架

唐山宣言

Tangshan Declaration

1976
Tangshan Earthquake

唐山大地震50周年地震工程与城市韧性国际学术研讨会

International Conference on Earthquake Engineering
Commemorating the 50th Anniversary of the Great Tangshan Earthquake

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唐山大地震50周年地震工程与城市韧性

国际学术研讨会讨论通过

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最大限度减轻地震灾害影响，是世界各国人民的共同愿景。50 年前，唐山大地震在人类抗震救灾史上留下了难以磨灭的一页。中国人民众志成城、顽强拼搏，铸就了伟大抗震救灾精神，推动新唐山从废墟中崛起、在奋斗中涅槃为一座充满生机的现代化城市，推动了全世界对地震风险和城市安全的深刻认识，强化了地震灾害风险减轻理念，为城市现代防灾减灾体系建设提供了重要启示。

半个世纪以来，地震灾害风险愈发复杂，世界各国在地震灾害风险识别、风险治理、韧性防灾等领域取得了长足进步。当前，人工智能、大数据、物联网、数字孪生和空天信息等技术的加速发展，通过与地震安全韧性理念深度融合，正在深刻改变灾害感知、预警、决策和恢复方式。基于过去半个世纪的减灾实践，面向未来，我们锚定以下核心愿景：

1. 强化地震安全韧性基础理论和关键技术研究；

2. 推进人工智能等新技术全面赋能地震安全韧性；

3. 加强全球城乡地震安全韧性的综合减灾实践。

推动地震安全韧性从理论研究走向技术突破、从单体工程走向城市系统、从传统防灾走向智慧赋能、从示范试点走向全球实践，构建以风险识别、主动防控、快速响应和高效恢复为核心的全球现代地震安全韧性体系。

值此唐山地震50周年之际，“唐山大地震50周年地震工程与城市韧性国际学术研讨会”于2026年7月在北京召开。来自全球300名代表，达成如下共识，并向国际社会发出协同攻关、共同行动、共享成果的倡议。

1. 深化城市系统韧性的科学认知与技术创新

1.1 系统提升单体工程抗震韧性

工程抗震韧性研究旨在推动抗震设计从“基于性能”向“基于韧性”理念演进。提升单体工程在地震作用下的功能保持与快速恢复能力，是降低工程破坏风险、保障使用安全的基础环节，对推动工程抗震安全高质量发展具有重要意义。需建立面向单体工程的抗震韧性评估理论体系，发展适用于不同结构类型与

服役条件的韧性提升技术，研发地震波动效应模拟装置，因地制宜将韧性理念融入重要工程的抗震设计中。

1.2 积极发展城市系统地震安全韧性理论与提升技术

提升城市系统的抗震韧性，是减轻灾害级联效应、保障城市基本功能连续运转和社会秩序稳定的重要举措。面向高度城市化和基础设施复杂化条件下的大震巨灾风险，开展城市系统地震安全韧性理论研究，推动考虑城市整体功能的多层级韧性评估理论发展，完善韧性评估、提升与调控的通用技术体系，加强韧性理念转化为支撑城市规划、建设、运行、更新和治理全过程的基础能力。

1.3 全面考虑风险评估中的多种灾害耦合作用

长期以来，地震风险评估多局限于单一灾害过程和静态分析，对多种灾害的耦合与演化效应关注不足，面向大震巨灾和城市复杂系统风险，进一步强化地震灾害链动态风险评估理论研究，融合“震源—路径—场地—结构—系统—社会”的多维相互作用，揭示地震次生灾害的触发、传播、耦合放大和跨系统传导机制，构建多灾种耦合、动态更新与全生命周期的综合

风险评估框架，为城市灾害防御、韧性规划、应急决策和恢复重建提供科学支撑。

2. 推动新技术与地震安全韧性理念的深度融合

2.1 充分发挥人工智能与大数据的赋能作用

当前，人工智能技术迅速发展，在国内外地震工程领域赋能仍面临多源异构数据融合不足、标准化数据集匮乏、算法模型可靠性和可解释性不强、统一测评平台与国际互验机制缺失等瓶颈。应加强人工智能赋能与地震数据治理，构建多源地震灾害数据开放共享体系，发展震害识别、损失评估、风险研判和决策支持核心算法，研发地震工程领域大模型和标准化测试平台，建立国际协同创新机制，推动数据、算法、算力和应用场景深度融合与共享，为全球智能减灾能力提升提供技术支撑。

2.2 加快城市立体化智能感知网络建设

近年来，城市立体化智能感知技术快速发展，但总体来看，地下观测站点密度不足，建筑与基础设施感知网络覆盖有限，泛在振动传感等新技术尚未规模化应用，卫星遥感、无人机巡查与地面监测的协同联动仍需加强，多源数据实时汇聚、标准化处理和融合分析能力仍显不足。面向城市地震安全韧性建设，需

结合多元传感、数值仿真、大型算力等新技术突破，加快构建空天地一体化并向地下延伸的城市地震灾害风险智能感知体系，推动多源数据协同治理、动态风险识别、灾情快速研判和韧性决策支撑能力提升。

2.3 推动地震灾害风险的智能预警与协同处置

当前，全球地震预警技术已经从科学验证进入工程应用阶段，地震预警系统建设总体仍受台网密度、通信基础设施、发布机制、公众响应能力和长期运维投入等因素制约，地震预警服务能力仍不均衡，跨区域协同联动机制仍需完善，部分地震活跃区内发展中国家地震监测能力仍需提高。应加强地震预警基础设施及系统建设，推动预警信息精准发布、灾情快速评估和应急协同处置深度衔接，使其成为全球防震减灾体系的重要组成部分。

3. 持续推进地震安全韧性治理实践

3.1 健全地震安全韧性城市标准体系

完善的标准体系，是推动地震安全韧性理念落地实施、规范建设实践的关键支撑。当前地震安全韧性标准体系尚不完善，覆盖维度零散且全链条标准尚未贯通，国际合作与互认不足，制约了全球韧性城市的协同建设。应建立覆盖城市防灾至恢复重建全链条的

地震安全韧性科学评价体系，推动评价体系与技术标准的国际互认和协同发展。

3.2 推动重点区域与城市地震安全韧性建设先行示范

当前，各国城市地震安全韧性建设多为零散探索，缺乏从韧性评估到提升的全周期工作模式。应面向不同地震风险水平、城市规模、发展阶段和治理条件，遴选全球典型区域和城市开展综合试点，构建“韧性评价—规划引导—韧性提升—再评价”闭环工作体系，形成适应不同地域特征与发展水平的韧性建设路径，强化地震安全韧性技术体系的实施，为城市地震安全韧性建设提供可复制、可推广的实践范本。

3.3 加强科技创新与社会治理的深度融合

推动科技创新与社会治理深度融合，是提升城市综合防灾效能的关键途径。当前，科技创新与城市规划管理、土地利用管制、基层社区治理、公众科普教育及巨灾保险等制度框架尚未实现深度融合。需要建立科技机构与政府管理部门的常态化对接机制、促进多部门多行业协同、健全地震灾害综合治理机制，建立面向城市、社区、乡镇的灾害风险信息公开与预警传达机制，提升基层组织的风险防范能力。

3.4 强化地震安全韧性领域国际合作

当前，防震减灾国际合作在科普资源共享、数据和新技术的开放获取、合作平台建设与跨境应急响应机制等方面仍存在不足，全球协同应对地震灾害的合力仍有待增强。需要发挥相关防灾减灾机构和各国政府的协调作用，通过支持双边/多边合作，建设全球科普资源库、推广体验式教育、健全合作平台与应急机制、开展国际救援评估及培训合作，培养全球防灾减灾人才队伍，推动构建更加紧密的地震安全韧性国际合作共同体。

唐山大地震深刻启示我们：安全是发展的前提，韧性是城市的根基，科技只有转化为守护生命、保障民生、服务治理的现实能力，才能真正彰显价值。

我们呼吁国际同行，凝聚智慧、联合行动，共同推进地震安全韧性研究，共筑人类美好未来。

Toward a Scientific Framework for Seismic Safety and Resilience

The Tangshan Declaration

Adopted at the International Conference on Earthquake Engineering Commemorating the 50th Anniversary of the Great Tangshan Earthquake

Beijing, July 27–31, 2026

Reducing the impacts of earthquake disasters to the greatest possible extent is a shared aspiration of humanity. Fifty years ago, the *M* 7.8 Great Tangshan Earthquake that struck on July 28, 1976, left an indelible mark on the global history of earthquake emergency response and disaster relief. Through solidarity, perseverance, and determined effort, the Chinese people forged the great spirit of earthquake relief, enabled a new Tangshan to rise from the ruins, and brought about its rebirth as a vibrant modern city. This experience deepened global understanding of earthquake risk and urban safety, strengthened the principles of earthquake disaster risk reduction, and provided important lessons for the development of modern urban disaster prevention and mitigation frameworks.

Over the past half century, earthquake disaster risks have become increasingly complex, while countries around the world have made substantial progress in risk identification, risk governance, and resilience-based disaster prevention, recovery and adaptation. Today, the rapid development of artificial intelligence, big data, the Internet of Things, digital twins, space-based information technologies, and other emerging technologies is becoming deeply integrated with the concept of seismic safety and resilience, profoundly transforming the ways in which disasters are sensed, warned against, managed, and recovered from. Building on the disaster reduction practices of the past half century, and looking toward the future, we set forth the following shared priorities:

(1) **Advancing research on the fundamental theories and key technologies of seismic safety and resilience;**

(2) **Harnessing artificial intelligence and emerging technologies to advance seismic safety and resilience;**

(3) **Expanding integrated disaster risk reduction practices for seismic safety and resilience in urban and rural communities worldwide.**

Together, these efforts aim to advance seismic safety and resilience from theoretical research to technological breakthroughs, from individual buildings to urban systems, from conventional disaster prevention to intelligent empowerment, and from pilot demonstrations to global practice. They seek to establish a modern global framework for seismic safety and resilience centered on risk identification, proactive risk prevention and control, rapid response, and efficient recovery.

On the occasion of the 50th anniversary of the Great Tangshan Earthquake, the International Conference on Earthquake Engineering Commemorating the 50th Anniversary of the Great Tangshan Earthquake was convened in Beijing in July 2026. 300 representatives from around the world reached the following consensus and issued this call to the international community for collaborative research, coordinated action, and shared progress.

1. Advancing the Scientific Foundations and Technological Innovation for Urban System Resilience

1.1. Enhancing the Seismic Resilience of Individual Engineering Structures

Research on seismic resilience in engineering seeks to advance seismic design from a performance-based approach toward a resilience-based paradigm. Enhancing the capacity of individual engineering structures to maintain function and recover rapidly under earthquake loading is a fundamental step toward reducing structural damage risk and ensuring safe use. It is also of great significance for promoting high-quality development in earthquake engineering safety. It is therefore necessary to establish theoretical systems for seismic resilience assessment at the individual-structure level, establish seismic wave effect simulation devices, apply resilience enhancement technologies suited to different structural types and service conditions, and integrate the resilience concept into the seismic design of important project in a site-specific manner.

1.2. Advancing Theories and Technologies for Urban Seismic Safety and Resilience

Enhancing the seismic resilience of urban systems including infrastructure is an important measure for reducing cascading disaster effects, ensuring the continuous operation of essential urban functions, and maintaining social order. In the face of major earthquake disaster risks under conditions of high urbanization and increasingly complex infrastructure, it is necessary to advance theoretical research on seismic safety and resilience for urban systems, promote the development of multi-level resilience assessment theories that take into account the overall functionality of cities, and improve general technical systems for resilience assessment, enhancement, and regulation. These efforts will help transform resilience concepts into a foundational capability supporting the full process of urban planning, construction, operation, renewal, and governance.

1.3. Integrating Multi-Hazard Coupling Effects into Dynamic Risk Assessment

For a long time, earthquake risk assessment has often been limited to single-hazard processes and static states, with insufficient attention paid to the coupling and evolution of secondary hazards. In response to major earthquake disasters and complex urban system risks, it is necessary to further strengthen theoretical research on the dynamic risks of earthquake disaster chains; to integrate multidimensional interactions across the seismic source – propagation path – site – structure – system continuum – society; and to reveal the mechanisms through which earthquake-induced secondary hazards are triggered, propagated, coupled, amplified, and transmitted across systems. A comprehensive risk assessment framework should be developed that incorporates multi-hazard coupling, dynamic state updating, and whole-process scenario simulation, thereby providing scientific support for urban disaster prevention, resilience planning, emergency decision-making, and recovery and reconstruction.

2. Promoting the Integration of Emerging Technologies and Seismic Safety and Resilience

2.1. Leveraging Artificial Intelligence and Big Data

Artificial intelligence is developing rapidly, yet its application in earthquake engineering still faces major bottlenecks, including insufficient integration of multi-source heterogeneous data, a lack of standardized datasets, limited reliability and interpretability of algorithmic models, and the absence of unified benchmark platforms and international validation mechanisms. It is necessary to strengthen AI empowerment and earthquake data governance, establish open and shared multi-source earthquake disaster data systems, develop core algorithms for earthquake damage identification, loss assessment, risk analysis, and decision support, and build standardized testing and validation platforms as well as international collaborative innovation mechanisms. These efforts will promote the deep integration of data, algorithms, computing power, and application scenarios, and provide technical support for enhancing global capacities for intelligent disaster risk reduction.

2.2. Accelerating the Development of Three-Dimensional Urban Intelligent Sensing Networks

In recent years, technologies for three-dimensional urban intelligent sensing have developed rapidly. However, overall, underground observation station density remains insufficient; sensing coverage for buildings and infrastructure is still limited; emerging technologies such as ubiquitous vibration sensing have not yet been applied at scale; coordination among satellite remote sensing, unmanned aerial vehicle inspection, and ground-based monitoring still needs to be strengthened; and real-time aggregation, standardized processing, and integrated analysis of multi-source data remain inadequate. For the development of urban seismic safety and resilience, it is necessary to combine breakthroughs in multi-sensor systems, numerical simulation, large-scale computing, and other emerging technologies to accelerate the construction of an integrated urban earthquake disaster risk intelligent sensing system covering underground, ground-based, aerial, and space-based observations. This will promote collaborative governance of multi-source data and enhance capacities for dynamic risk identification, rapid disaster assessment, and resilience-oriented decision support.

2.3. Advancing Earthquake Early Warning and Coordinated Emergency Response

Globally, earthquake early warning technologies have moved from scientific validation into engineering application. However, the development of earthquake early warning systems remains constrained by seismic network density, communication infrastructure, information dissemination mechanisms, public response capacity, and long-term operation and maintenance investment. Earthquake early warning service capabilities remain uneven, cross-regional coordination and joint response mechanisms still need to be improved, and national earthquake monitoring capabilities in some seismically active areas still need to be enhanced. We call for strengthening earthquake early warning infrastructure and systems, promoting precise warning dissemination, rapid disaster assessment, and close coordination with emergency response. Earthquake early warning should become an integral component of the global system for earthquake disaster prevention, mitigation, and risk reduction.

3. Strengthening the Governance and Practice of Seismic

Safety and Resilience

3.1. Improving Standards for Urban Seismic Safety and Resilience

A comprehensive standards system is essential for translating resilience principles into practice and regulating planning and construction activities. Current standards for seismic safety and resilience remain incomplete: coverage is fragmented, standards do not yet span the full continuum from disaster prevention through recovery and reconstruction, and international cooperation and mutual recognition remain insufficient. These limitations hinder the coordinated development of resilient cities worldwide. A scientific evaluation system should be established that covers the full chain from urban disaster prevention through recovery and reconstruction, while promoting international harmonization and mutual recognition of evaluation frameworks and technical standards and advancing the coordinated development of seismic safety standards worldwide.

3.2. Promoting Pilot Demonstrations of Seismic Resilience in Key Regions and Cities

Urban resilience initiatives around the world remain largely piecemeal and lack a full-cycle implementation framework extending from resilience assessment to resilience enhancement. Representative regions and cities, encompassing different levels of earthquake risk, city sizes, stages of development, and governance conditions, should be selected for comprehensive pilot programs. These pilots should follow a closed-loop process of resilience assessment, planning guidance, resilience enhancement, and reassessment, producing development pathways suited to different regional characteristics and levels of development, enhancing the implementation of the seismic resilience technology system and providing replicable models for building seismically resilient cities.

3.3. Integrating Scientific and Technological Innovation with Social Governance

Integrating scientific and technological innovation with public governance is essential to improving the overall effectiveness of urban disaster risk reduction. At present, such innovation is not yet well embedded in the institutional frameworks governing urban planning and management, land-use control, grassroots community governance, public education, and catastrophe insurance. Regular coordination channels should be established between research institutions and government agencies; comprehensive mechanisms for earthquake disaster governance should be improved; procedures should be established to publicly communicate disaster-risk information and disseminate warnings at the city, community, and township levels; and the risk-prevention capacity of grassroots organizations should be strengthened.

3.4. Strengthening International Cooperation in Seismic

Safety and Resilience

International cooperation in earthquake disaster risk reduction remains insufficient in areas such as sharing science communication and public education resources, ensuring open access to data and new technologies, developing collaborative platforms, and establishing cross-border emergency-response mechanisms. The global capacity for coordinated earthquake response must also be strengthened. It is necessary to give full play to the coordinating role of relevant disaster prevention and mitigation agencies and governments, and to support bilateral and multilateral cooperation. At the same time, this requires the creation of a global repository of science communication and public education resources, wider use of experiential education, stronger cooperation platforms and emergency-response mechanisms, and expanded participation in international search-and-rescue assessment and training. Together, these efforts will help develop a global workforce of disaster prevention and mitigation professionals and build a stronger global partnership for seismic safety and resilience.

The Great Tangshan Earthquake offers a profound lesson: safety is the foundation of development, resilience is the cornerstone of cities, and science and technology can truly demonstrate their value only when they are transformed into practical capabilities for safeguarding life, protecting livelihoods, and serving governance.

We call upon the scientific and engineering communities around the world to pool their wisdom, unite in action, and advance research on seismic safety and resilience, together forging a better future for humanity.