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In this issue

Progressive Collapse and Robustness of Buildings and Bridges

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Abstract

Building and bridge collapse result in severe consequences, including the tragic loss of lives, significant economic harm, disruption of critical infrastructure, and lasting effects on public safety and community resilience. These collapses often originate from localised failures that propagate to the rest of the structural system, leading to disproportionate damage. The study explores the complex factors behind such a phenomenon by analysing case studies and findings from large-scale experimental campaigns. These include tests on masonry arch vault structures subjected to local differential settlement, a novel shoring system design to prevent failures during construction, the robustness assessment of a "field-extracted" steel truss bridge, and column removal tests on flat slab and precast buildings. The most recent full-scale

test involved the partial collapse test of a unique, purposely built precast building to validate the newly developed fuse-based segmentation approach to arrest collapse propagation. Inspired by how lizards shed their tails to escape predators, this approach ensures sufficient continuity to redistribute loads after small failures, complying with current building codes. However, specific components are engineered to separate during a collapse, preventing further damage beyond the initially affected areas. These large-scale experiments provide critical insights into the realistic (systemic) interactions of different structural elements, often overlooked (or simplified) in reduced-scale tests. Such insights will be invaluable in exploring and potentially developing novel design approaches for improving the resilience of our buildings and bridges.

1. Progressive Collapse and Structural Robustness

Progressive collapse is a phenomenon where the spread of an initial local failure from element to element eventually results in the collapse of an entire structure or a disproportionately large part of it (ASCE 7, 2005). Such a failure typically leads to devastating consequences in terms of human, economic, and environmental losses (Hingorani et al., 2020; Caredda et al., 2023). Unlike traditional hazard designs (e.g. earthquakes, winds, fires), where the structure can be explicitly designed according to a specified load pattern and magnitude, designing against progressive collapse is less straightforward as the hazard itself can be generally considered abnormal yet unknown (grey- or black-swan events). In this case, the design is typically carried out according to the threat-independent principle, which aims to ensure that the structures have sufficient robustness to prevent catastrophic failures (EN 1991-1-7, 2006; ASCE/SEI 76-23, 2023; UFC 4-023-03, 2024). Structural robustness is defined as the ability of the structure to avoid consequences disproportionate to the event causing failure (Adam et al., 2018). A robust structure can resist abnormal loads even if the system is locally or partially damaged by means of load redistribution through alternative load paths (ALPs). **Sections 2-5** of the present paper describe the main findings of our full-scale experimental studies on evaluating the effectiveness of the alternative load paths in various structural systems, including masonry arch vaults, shoring systems, steel truss bridges, and RC precast and flat slab buildings. In **Section 6**, the potential limitation of the traditional method of ensuring ALPs through continuity is first described, followed by a novel design approach that aims to anticipate it. Lastly, in **Section 7**, we conclude with the path forward and the open challenges that remain to be addressed.

2. Timbrel Masonry Cross Vaults Subjected to Differential Settlements

Timbrel masonry cross vaults, also known as Catalan vaults or Guastavino vaults, are a lightweight yet structurally efficient form of vaulting that originated in the Mediterranean region in the late 19th century. Structurally, timbrel cross vaults pose a unique challenge due to their complex load distribution. Unlike traditional stone vaults that rely on their massive weight to ensure stability, timbrel vaults function as thin-shell structures, efficiently transmitting compressive forces through their curved geometry. However, their thinness makes them highly dependent on proper boundary conditions and lateral support to prevent buckling or excessive deformation. One potential issue that may impose severe damage to such a structural system is differential settlement (Acikgoz et al., 2017; Carfagnini et al., 2018). In this context, we performed experimental research on a full-scale timbrel masonry cross vault (Figure 1a) subjected to a monotonically and cyclically increased vertical displacement in one of its supports to simulate soil settlement (Torres et al., 2019a, 2019b). The specimen was designed and constructed to faithfully represent the vaults in the San Lorenzo Parish Church in Castell de Carbes, Spain, which experienced severe damages due to a series of soil settlements. When one of the supports gradually deformed downward to represent settlement (up to 40 mm/1.11% of the displacement to span ratio), different forms of crack occurred in the vault, including tensile, bending, and diagonal cracks. Then, the specimen was repaired and strengthened using textile reinforced mortar (TRM) and further retested (Bertolesi et al., 2020) (Figure 1b). The study concluded that the implementation of TRM effectively restored the continuity of the severely damaged cross vault. It doubled the vault's elastic phase and ultimate displacement.

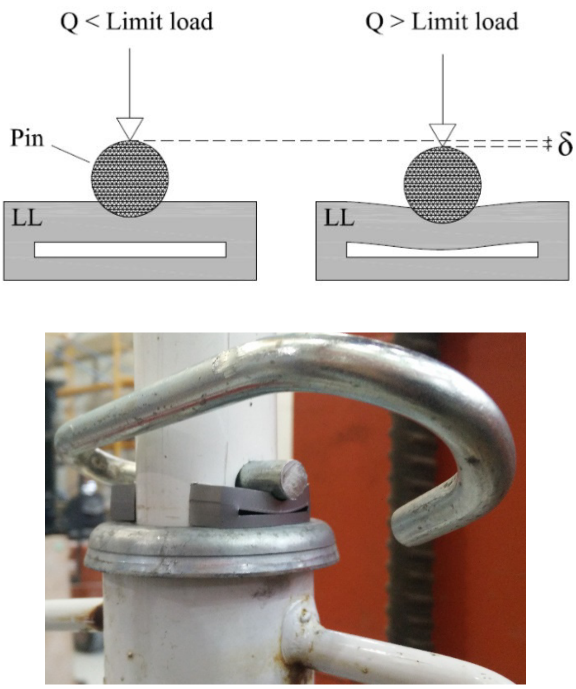
3. Load-Limiters to Prevent Shoring Failures during Construction

The construction phase is one of the most crucial stages in a building's lifecycle due to the high risk of failures during the striking and removal of shores. The traditional shoring system fails in a very brittle manner when the overloading condition occurs. Subsequently, the load carried out by the failed shore are redistributed and trigger a chain of failures of the other shoring systems, eventually leading to the progressive collapse of the supported structures (Buitrago et al., 2018a, 2018b). The proposed new technology, so-called load-limiters (LL), that behave as structural fuses to prevent such brittle failures (Buitrago et al., 2020a). The main philosophy behind the LL is that they reliably limit the working load on the shores below an allowable load. In accidental/extreme scenarios, where the load goes much more and beyond the design load, the LL yield and deform plastically, allowing the loads resisted by the critical shore to be redistributed to its surroundings (Figure 2a). In such a way, the shores act as a group, hence avoiding the failure

(a) (b)

Figure 1: Experimental tests on timbrel masonry cross vaults (a) original/unreinforced specimen; (b) reinforced vault with TRM.

of the whole shoring system, which may lead to severe consequences. To evaluate the effectiveness of the newly proposed shoring system, an experimental campaign was carried out where a full-scale reinforced concrete floor with a dimension of 5.25 x 5.25 m2 was cast and loaded with both sand and water loads (Figure 2b) to represent different construction stages (Buitrago et al., 2020b). Findings from the test suggested that applying LL ensured that the loads on the shores were consistently below the admissible load, preventing shoring failures. In addition, using LL ensures that more efficient temporary shoring systems can be achieved as it takes full advantage of the shore strength capacity. In other words, more shores operate under similar loads, unlike the traditional shoring system, where the governing load only occurs on a few shores and lower elsewhere.



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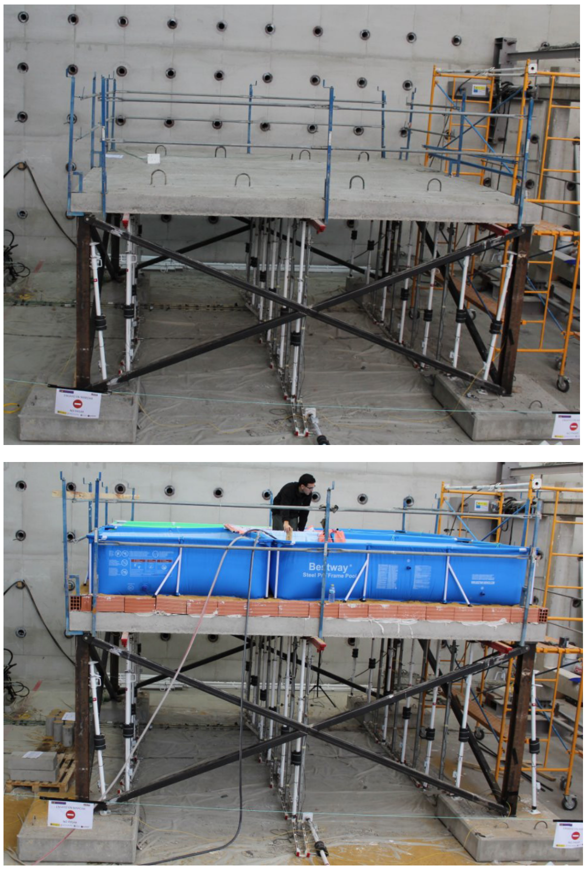
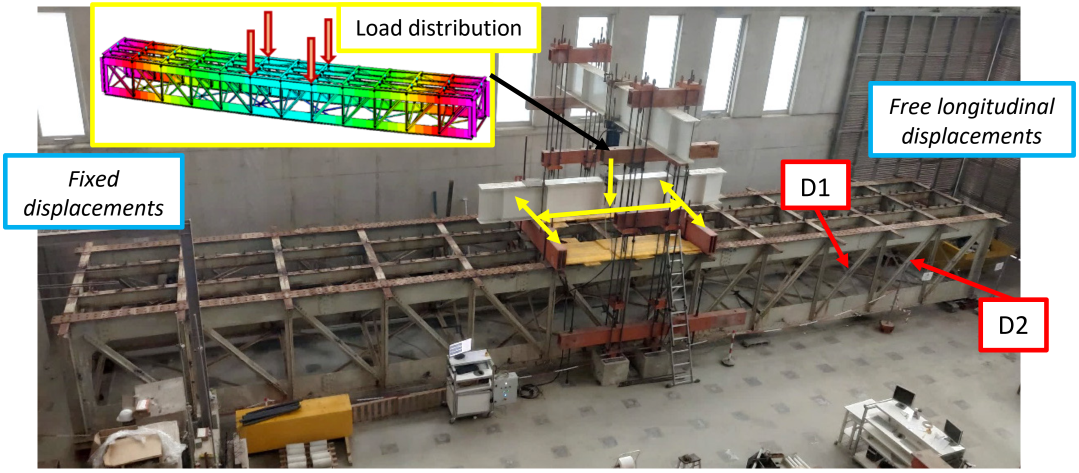


(b)

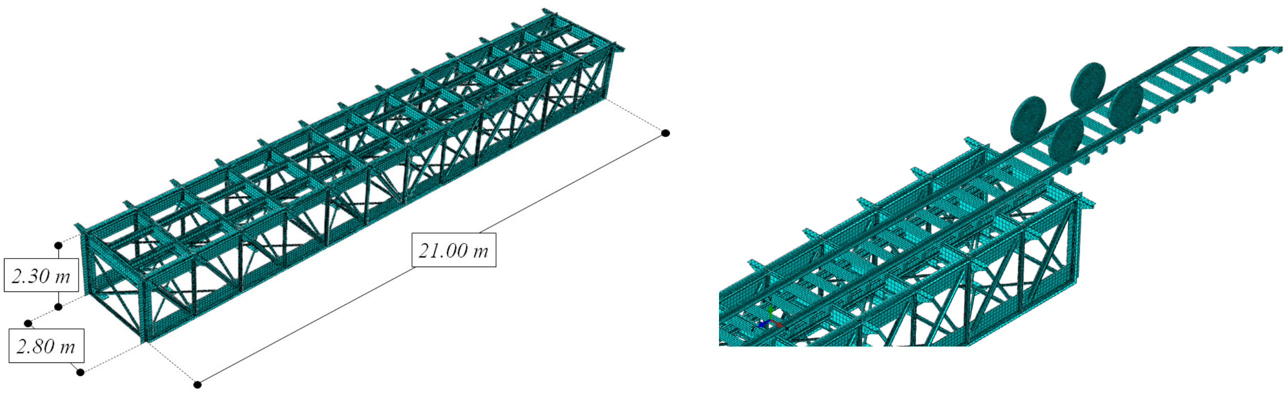
Figure 2: (a) Plastic deformations of the load limiter; (b) full-scale laboratory testing of the shoring system equipped with the load limiter.

4. Activation of the Alternative Load Paths in a Field-Extracted Steel Truss Bridge

Bridges are critical infrastructure designed to withstand everyday traffic loads and identified hazards such as wind, seismic activity, and temperature variations. However, ensuring their long-term resilience requires accounting for extreme events like unprecedented floods, terrorist attacks, or unforeseen structural weaknesses. Such events can severely compromise a bridge's integrity, leading to sudden failures with devastating regional or even national consequences (Adam et al., 2024). In this regard, our research group had a unique opportunity to experimentally test the robustness of a field-extracted steel truss bridge (Buitrago et al., 2021a) built between 1913 and 1915 (more than 100 years old). A series of Pratt formed the structure trusses connected by traditional riveted joints. The tested bridge had a 21.1 m total span and was tested with the same support conditions as in the site (isostatic configuration). The hydraulic jack with a maximum capacity of 1300 kN was installed at the centre of the span, connected to the bridge through a metallic beam system designed to distribute the loads into a four-point loading system (Figure 3a). Two diagonal elements were deliberately cut (indicated as D1 and D2 in Figure 3a) to reproduce progressive damage with possible sudden collapse. Then, the bridge specimen was reloaded to evaluate the response under the given damage states. The test results suggested that the truss system had sufficient structural redundancy based on the joints' capacity to absorb bending moments that increase with the level of damage. The ALP was accommodated as the Pratt truss behaviour shifted to Vierendeel or single-beam behaviour (after the damage was introduced). A further study (Caredda et al., 2022) was performed using computational simulations to investigate the bridge responses



(a)



(b)

Figure 3: (a) Test setup of the field-extracted steel truss bridge; (b) 3D model of the bridge used to perform computational simulations.

under different local failure conditions of various elements (Figure 3b). Finally, fatigue assessment was also conducted to evaluate the remaining service life of the extracted bridge (Bertolesi et al., 2021).

5. Full-Scale Tests of Purposely Built Reinforced Concrete (RC) Flat Slab and Precast Buildings Subjected to Various Column Removal Scenarios

Evaluating the progressive collapse behaviour of RC flat slabs is crucial because of their brittle nature under punching failure, which typically leads to sudden and catastrophic structural failure. In this regard, our group designed and constructed a two-storey flat slab building with 2 x 2 bays of 5.0 m, a story height of 2.8 m, 20 cm thick flat slabs and 30 x 30 cm columns (Figure 4a). The building specimen was subjected to a sudden (dynamic) corner column removal to evaluate the effectiveness of the ALP development through the floor system (Adam et al., 2020). The test showed that the structure could find effective ALP without significant damage. The predominant ALPs in the test were the flexural and Vierendeel beam actions. Infilled walls were added to the system on the opposite side of the removed column, and the building was retested (Buitrago et al., 2021b). With the presence of the walls, the vertical deflection was significantly reduced (from 48.1 mm without wall to 7.8 mm with the wall). The development of the ALP also shifted to a strut-like mechanism along the diagonal of the wall. Such a mechanism, however, relies heavily on the vertical tie through the column. This observation emphasises the importance of the role of vertical ties, which are generally not considered as relevant as horizontal ties in robustness designs.

Similarly, we performed a series of column removal tests on a purposely built RC precast building. We believe that this research is relevant as our community has a common misconception that precast systems are particularly vulnerable to progressive collapse, mainly due to the infamous collapse of Ronan Point in the UK during the 1970s. We designed and constructed a purpose-built precast building specimen with 12 m × 15 m plan dimensions (2 stories). The longer span of the building had three bays with a 5 m length, and the shorter one consisted of two bays with a 6 m span (Figure 4b). All the columns were made of precast elements with a dimension of 40 x 40 cm, whereas the beams were partially precast with a depth of 61.5 cm (35 cm precast + 26.5 cm cast-in-situ topping) and a width of 40 cm. The precast building specimen was subjected to three different single-column removal scenarios: 1) corner column (Buitrago et al., 2023), 2) edge column in the short direction of the building, and 3) edge column in the long direction of the building (Buitrago et al., 2025). These removed columns were made of specially designed three-hinged steel columns, which can be dynamically removed and repositioned to their original undeformed shape after the test. These tests revealed that the precast building specimen is highly robust thanks to the provided continuous ties in horizontal and vertical configurations. Unlike the traditional assumption that structural systems rely mainly on catenary action to prevent collapse initiation after the loss of a column, in these three tests, the main load-carrying mechanisms observed were the Vierendeel action and compressive arching/membrane that predominantly developed at small deformation.

6. Fuse-Based Segmentation Approach to Arrest Collapse Propagation in Buildings

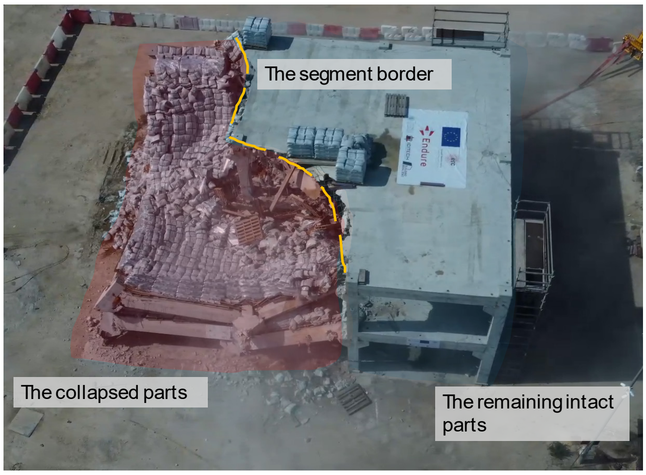
Traditionally, continuous ties are provided to help develop alternative load-carrying mechanisms when the structure loses its primary load path. This continuity allows the redistribution of loads from the failed structural component to the rest of the structure. Although the concept has been effectively proven to accommodate small initial failures, it may not be viable or sustainable when dealing with larger ones. In such circumstances, the provided ties, which were meant to provide continuity, can backfire as the collapsing parts pull down the rest of the structure (Makoond et al., 2024a). In the Endure project, we are currently developing a novel design approach, so-called fuse-based segmentation, that aims to synergistically combine the philosophies of continuity and segmentation to improve the robustness of buildings (Makoond et al., 2024b). Under normal or operational conditions (including small initial failures), our

(a)

(b)

Figure 4: Full-scale tests of (a) flat slab building and (b) precast building.

(a)



(b)

Figure 5: Experimental validation of the novel fuse-based segmentation design approach: (a) providing continuity under small initial failures; (b) segmentation to arrest collapse propagation for larger failures.

approach would ensure the building has sufficient continuity to redistribute the loads from the failed elements to the rest of the building. However, when the failure is too large to contain, the building will separate into different segments to isolate collapse and prevent it from propagating to the rest of the system. The method is inspired by how lizards shed their tail to escape predators. The approach has been applied and recently validated on a precast building specimen, and it will also be extended to design and test two full-scale buildings made of RC cast-in-situ and steel frame structures. The recent test on the precast building specimen suggests that the building survived two edge-column removals without experiencing partial collapse (Figure 5a), validating that the proposed concept does not violate any continuity requirement. Meanwhile, when subjected to a larger failure, the building segments and isolates the collapse only within the initially affected regions (Figure 5b). This last line of defence ensures that a safe evacuation process can be carried out through the remaining intact parts (Buitrago et al., 2024).

7. Path Forward and Open Challenges

The challenges posed by climate change and ageing infrastructure are among the most pressing concerns for engineers and architects today. We are designing structures that must endure uncertain future conditions while also managing an extensive stock of ageing buildings and bridges that were not originally designed for the evolving demands they now face. In this context, structural robustness is paramount. It is essential to integrate robust design principles into new construction while also developing effective strategies to enhance the resilience of existing structures (through suitable retrofitting measures). Only through such an approach can we ensure that our buildings and bridges remain standing, even in the aftermath of extreme events.

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SECED

SECED, The Society for Earthquake and Civil Engineering Dynamics, is the UK national section of the International and European Associations for Earthquake Engineering and is an Associated Society of the Institution of Civil Engineers. It is also sponsored by the Institution of Mechanical Engineers, the Institution of Structural Engineers, and the Geological Society. The Society is also closely associated with the UK Earthquake Engineering Field Investigation Team. The objective of the Society is to promote co-operation in the advancement of knowledge in the fields of earthquake engineering and civil engineering dynamics including blast, impact and other vibration problems.

For further information please contact the SECED Secretary at the Institution of Civil Engineers and visit SECED Website.

SECED Newsletter

The SECED Newsletter is published quarterly. All contributions of relevance to the members of the Society are welcome. Manuscripts should be sent by email. Diagrams, pictures and text should be attached in separate electronic files. Hand-drawn diagrams should be scanned in high resolution so as to be suitable for digital reproduction. Photographs should likewise be submitted in high resolution. Colour images are welcome. Previous issues of the SECED Newsletter are available online. Please contact the Editor of the Newsletter, Fabio Freddi, for further details. This edition of the Newsletter was co-edited by Mohamed Elzeadani, Ashraf Nayel and Atif Rasheed.

Symposium Report: The Indian Ocean Tsunami 20 Years on: Driving Change and Changing Lives

Tiziana Rossetto
University College London

On the 6th December 2024 SECED hosted an international symposium at the Institution of Civil Engineers (ICE) in London, to commemorate the 2004 Indian Ocean Tsunami (IOT) and discuss, 20 years on, what lessons have been learned on tsunami science and impacts, tsunami risk and resilience as well as disaster risk reduction. The Symposium, which took place in hybrid format, was opened by Mrs. Sahadatun Donatirin of the Indonesian Embassy in London, and by Ms Anusha Shah, 159th President of the ICE. Both reflected on the great losses sustained in the 14 countries affected by the 2004 IOT and called for action and global collaboration in addressing tsunami resilience.

The Symposium was Chaired by Tiziana Rossetto (UCL/TU Delft), Zygmunt Lubkowski (Arup) and William Allsop (William Allsop Consulting), and speakers included experts on tsunami engineering, science and disaster management from academic institutions and industry in Europe, Canada, U.S., Japan and New Zealand (see Speaker's List). The speakers presented advancements in knowledge and practice in tsunami resilience and reflected on areas requiring further work.

The 2004 Indian Ocean Tsunami (IOT) marked a turning point in global disaster research, leading to a recognition that a multi-pronged approach is needed to mitigate against future events. These span from multi-disciplinary post-event reconnaissance efforts, laboratory testing, numerical analyses, statistical frameworks, social science, and participatory research, into looking at both the immediate effects as well as disaster recovery.

The symposium showed that UK's Earthquake Engineering Field Investigation Team (EEFIT), alongside global counterparts, has been central in gathering field data to inform hazard-resilient design. These missions foster international collaboration, knowledge sharing, and professional development. Moreover, systematic data collection is crucial to maximize the value of these efforts. It was discussed that while post-earthquake reconnaissance has benefited from standardized approaches, tsunami data still lacks globally accepted taxonomies. Recently, reconnaissance efforts have seen a rise in "return" missions, where affected areas have been revisited to study the recovery phase of disasters—a period crucial for shaping long-term community resilience.

Significant investment has been made over the last 20 years to enhance experimental capabilities and research into tsunamis, with facilities in the U.S., UK, Japan, Germany, and elsewhere replicating tsunami conditions in controlled settings. These labs have helped researchers understand wave impacts, sediment scour, debris loading,

Figure 1: Group photos of symposium chairs and speakers with Ms Sahadatun Donatirin (centre).

and the role of barriers in reducing inundation. Findings from these studies have fed into updated tsunami design codes and have supported numerical models. The latter can simulate real-world scenarios and extend insights beyond lab limitations. Such numerical models also have limitations that derive from their large computational costs and need for high-resolution bathymetric and topographic data. Hence, Probabilistic Tsunami Hazard Assessments (PTHA) are still few and cover only selected areas of the world.

Beyond engineering, tsunamis deeply affect communities. The 2004 IOT prompted a global shift from disaster response to preparedness, resulting in frameworks like the Hyogo Framework for Action and the establishment of the Global Facility for Disaster Reduction and Recovery (GFDRR). These have been successful in shaping global initiatives for improving community resilience to tsunamis and other hazards.

Symposium discussions were lively, with an engaging question-and-answer session. It was concluded that although much has been achieved over the last 20 years, there are still significant knowledge gaps and that more has to be done to ensure that scientific advances are translated into codes of practice and policies for disaster risk reduction.

SECED and the Symposium organisers would like to thank the following sponsors for their support for the event: AON, Earthquake Engineering Field Investigation Team (EEFIT), Gallagher Re., Global Facility for Disaster Reduction and Recovery (GFDRR), Guy Carpenter, HR Wallingford, Renew Risk, UCL EPICentre, and Willis Towers Watson.

List of Speakers

D Wüthrich (Delft University of Technology), K Adams and D. McGovern (London South Bank University), M Del Zoppo (Università degli Studi di Napoli Federico II), I Chandler (HR Wallingford Ltd.), J Cels (University College London), I. Nistor (University of Ottawa), A. R. Barbosa (Oregon State University), N. Goseberg (Technische Universität Braunschweig), L. Wotherspoon (University of Auckland), M. Kitamura (Tohoku University), R. Gunasekera (Global Facility for Disaster Reduction and Recovery), D Istrati (National Technical University of Athens).

Figure 2: Photo of opening slide and audience.

Figure 3: Group photos of symposium chairs and speakers at the ICE.

Code of Conduct

Ziggy Lubkowski
ARUP

I am pleased to announce that at the April's committee meeting the SECED committee approved a code of conduct for all our activities and events. This is in line with other civil engineering societies such as ICE, EERI, IAEE and SSA. This reinforces our view that SECED is committed to providing a respectful, harassment-free and inclusive environment for all participants at our events.

Details of the code of conduct can be found at https://seced.org.uk/index.php/about-seced/code-of-conduct. Please take time to read the code of conduct. If you have any questions or comments, please send those to seced@ice.org.uk.

Reflections on the 18th World Conference on Earthquake Engineering, Milan 2024 – One Year after

The 18th World Conference on Earthquake Engineering (WCEE) (https://www.wcee2024.it/), held in Milan from 30 June to 5 July 2024, has been a great success. The event welcomed over 4250 participants from 82 countries, making it a truly global event and the largest WCEE to date. The conference also saw a total of 3820 scientific contributions from 3720 different authors. A total of 161 technical sessions were featured over a 5-day period, together with close to 40 side meetings, four technical visits, and a Mobile Shake-Table that was experienced by 1300 participants.

The exhibition area of the conference featured more than 110 booths, allowing for a lively and active interaction between research and industry. The conference also featured several social events, including a Welcome Reception attended by 1700 participants, opera at the La Scala Theatre attended by 1800 participants, a conference party attended by 1100 delegates, and a Table Football Championship featuring 32 teams and 63 matches.

Feedback from the conference participants has been overwhelmingly positive. Attendees appreciated the diverse range of topics covered and the high quality of the presentations. Many participants also highlighted the importance of the keynote lectures and technical sessions in advancing knowledge in earthquake engineering.

Additionally, the 18th WCEE2024 has recently won the Gold Prize in the “Scientific Event” category at the 15th Eventex Awards. This international recognition honours the quality, impact, and innovation of WCEE2024, which brought together thousands of experts and professionals from across the global seismic risk community. The award underscores the strength of collaboration, excellence in content delivery, and the significance of earthquake engineering in shaping safer, more resilient societies.

The next series of the WCEE will be held in Montreal, Canada, from 1 to 6 October 2028.

Some reflections…

Damian Grant
ARUP

The UK seismic community was well represented at the 19th World Conference on Earthquake Engineering. I was happy to be able to attend another WCEE, after I had barely engaged with the Covid-afflicted event in 2021 (postponed from 2020) and had not been able to make the Chile event in early 2017. A successful conference is, of course, as much about what happens off the stage (informal conversations, exchange of contact details, and social events) as it is the technical conference proceedings. Nevertheless, I spent some time reflecting both during and after the conference about some themes from the sessions I attended, including exchanging some thoughts with colleagues, and I summarise some of these below.

The Future of Codes, Functional Recovery, and Repairability-based Design

I had organised a few sessions on the future of seismic design codes, tenuously based on my role chairing a European Association for Earthquake Engineering committee on future directions for Eurocode 8. I thought it could be a bit dry (assuming that I'd prefer to hear about cutting-edge research rather than code implementations), but it was actually quite inspirational. In particular, we heard about efforts in the US, Canada, Europe (ECs), and New Zealand to establish functional recovery targets and design provisions for repairability-based design. Readers may already be aware of some of the developments here, but I jotted down ATC-138 (extending FEMA P-58 to recovery time, not just repair time, estimation—as Arup's REDi has been doing for over a decade), and the upcoming 2026 NEHRP Provisions (which would likely hit ASCE 7 in 2028 and IBC in 2030) that are defining functional recovery targets and associated design provisions (R values and C_d values specifically for functional recovery). Canada had adopted a similar approach to the US, backed up by a cost-impact study that seems worth a look.

Meanwhile, in New Zealand, there'd been a lot more of a "back to the drawing board" approach, with social scientists conducting over 140 hours of interviews to establish design priorities (not surprisingly, the average kiwi has a pretty visceral understanding of earthquake consequences from the last 14 years of damaging activity). Ken Elwood in Auckland and Tayo Opabola (who recently moved from UCL to UC Berkeley) have done a lot of work in assessing "repairability limits" for reinforced concrete members—deformations above which economic repair is unlikely. I recently saw a paper on this topic on Tayo's LinkedIn, which looks worth following up on.

Looking further into the future, Paolo Franchin (who gave a talk at SECED in London late last year) talked about what form the next generation of codes may take—perhaps a massive tome, unreadable by a human, but parseable by a Chat-GPT successor that can summarise the relevant clauses based on bespoke project data? In the year since the conference, I have been making much more use of Large Language Models (LLMs) to extract relevant content from long documents, partly inspired by Paolo's provocation.

Implications of Changing Code Levels

A smaller (but still interesting) point that came out of the codes sessions was a common problem in (at least) New Zealand, the US, and, I believe, India, on the implications of seismic hazard changes in codes. For example, a new seismic hazard map for New Zealand more than doubles the seismic demand in my home town of Lower Hutt (and across the harbour in Wellington). Wellington is already overrun with closed facilities due to perceived seismic risk and costs of retrofitting—what will the implication be when the new hazard map is introduced?

The Value of Local Understanding in Seismic Retrofit Design

I saw a presentation from an old kiwi classmate, practising as an engineer in Christchurch, New Zealand. A lot of their retrofit projects are on relatively new buildings (last few decades), and are dealing with specific details that have been demonstrated to be vulnerable in both the 2016 Kaikōura earthquake and subsequent university research and technical reports from engineering associations. In particular, the hollow-core precast slab industry has essentially gone to zero, after it has been demonstrated to be unsafe and very difficult to retrofit. The lesson I drew from this is not just about this specific detail, but also (as someone who is involved in projects in different countries) the importance of understanding local detailing, how it perhaps differs from construction details in other countries that may have actually been tested in real earthquakes, and more broadly the importance of load path and detailing (more important than analysis!) in seismic design and assessment.

Artificial Intelligence & Machine Learning

On the one hand, the conference opening ceremony suggested how many papers about AI/ML applications there were... on the other hand, the sessions I attended seemed to be stuck in the pre-Chat-GPT / Midjourney / etc past (i.e. not many examples of generative AI, but more of the same random forests vs regression vs K-nearest neighbour stuff that was all the rage 10 years ago in the AI/ML discourse). To be fair, abstracts were probably due for this conference pre-Chat-GPT-3 or -3.5, so perhaps it hasn't had a full chance to make an impact.

That said, a keynote presentation from Professor Lu was very impressive. He presented ground-breaking work on performance-based seismic design applied at a city scale, and (more relevant to the present topic) on the use of generative AI (trained on building designs across multiple Chinese building authorities) to design beam layouts, shear walls, cross-section designs, even base isolators, respecting code restrictions and so on. The software has been available at ai-structure.com for a year, and apparently has been used on 1000s of building designs in that time. Caveat emptor of course!

Conference Song

Opinions were divided. You be the judge.

Bring on the 19th World Conference on Earthquake Engineering, in Montreal, October 2028!

Fabio Freddi
University College London

The 18th World Conference on Earthquake Engineering (WCEE2024) was undoubtedly a remarkable and exceptionally well-organized event. With over 4,000 participants from around the globe, the conference offered an impressive range of sessions, keynote speeches, technical presentations, and engaging side activities. It was both an enjoyable and intellectually stimulating experience, bringing together the global earthquake engineering community in a vibrant and collaborative atmosphere.

As with any large-scale event, one of the few regrets was the impossibility of attending every session of interest. The programme was incredibly rich, and like many others, I found myself having to make difficult choices between overlapping sessions and activities. Despite this, I made the most of this opportunity. I spent a great deal of time in the corridors reconnecting with old friends, colleagues, and collaborators. These conversations often proved just as valuable as the formal sessions, offering insights, sparking new ideas, and reinforcing the sense of community that defines our field. From a networking perspective, this was without a doubt the most rewarding conference I've attended so far.

One of the highlights of my participation was co-organizing the special session on *Seismic-Resilient Steel and Steel-Concrete Composite Structures*. This session attracted over 50 high-quality contributions and was divided into eight sub-sessions to accommodate the breadth of topics. The presentations showcased a wide array of innovative structural systems designed to enhance seismic performance and ensure post-earthquake functionality. Key themes included Self-Centering and Rocking Systems, Hybrid and Composite Structures, and Modular and Prefabricated Systems—all reflecting a shared commitment to advancing resilience in structural design.

A recurring focus across the session was the use of innovative materials and connection technologies, supported by rigorous seismic testing, advanced simulations, and forward-thinking design strategies. It was particularly encouraging to see a strong alignment with the concept of *functional recovery*, which emerged as a central theme not only in our session but across many others throughout the conference. Several discussions also addressed the need for standardised solutions and design methodologies, highlighting the growing momentum toward codifying resilience-based design principles.

Another standout aspect of WCEE2024 was the active engagement from industry. The exhibition area was bustling with companies showcasing cutting-edge technologies and practical solutions for earthquake engineering. It was inspiring to see how academic research is being translated into real-world applications, bridging the gap between theory and practice and making a tangible impact on the built environment.

In summary, WCEE2024 was a genuinely enriching experience—technically, professionally, and personally. It reaffirmed the importance of global collaboration in tackling the complex challenges of seismic resilience and left me feeling both inspired and optimistic about the future of our field. A heartfelt thank you to the organizers for their outstanding efforts in making this event such a success—we already look forward to the next WCEE in 2028 in Montreal!

Valentina Putrino

Ariel Re

Attending the 18th World Conference on Earthquake Engineering (WCEE2024) in Milan was both professionally enriching and personally meaningful. Wearing both the professional hat as catastrophe risk analyst working in the reinsurance industry, and my old – yet gold - earthquake engineering academic one, I found this conference uniquely positioned at the intersection of science, policy, and finance—precisely where I believe the most impactful conversations about resilience need to happen.

The tone for the week was set during the opening session, where Ekhosuehi Iyahen, Secretary General of the Insurance Development Forum (IDF), delivered a keynote that powerfully articulated the role of insurance as a driver—not just a responder—in disaster risk reduction.

Her emphasis on financial protection as a proactive tool for resilience strongly resonated with my own experience in the industry. Insurance has the potential to enable faster recovery, but also to incentivise mitigation and long-term planning, provided it's grounded in sound science.

This was a theme carried through many of the sessions I attended. One particularly relevant panel "From Academia to Insurance Industry: What's in it for Earthquake Engineers?" co-hosted by GEM and Aon—sparked dynamic discussion on how engineering expertise translates into real-world risk transfer mechanisms. As someone who has worked on both the technical modelling and commercial sides of catastrophe risk, I appreciated the clarity with which speakers addressed the mutual value of collaboration between engineers, insurers, and catastrophe modelers.

Another key takeaway for me was the growing emphasis on public-private partnerships. The conference demonstrated that when engineering data is aligned with financial tools like insurance and reinsurance, it becomes a far more powerful lever for systemic resilience. I've seen firsthand how national seismic risk models, when properly integrated with exposure and vulnerability data, can support governments and insurers in building scalable, risk-informed frameworks.

For me, the WCEE2024 reaffirmed that we need to break down silos between the scientific and financial communities. Insurance is no longer just about recovering from earthquakes—it's about anticipating them, planning for them, and reducing their impact through better data, better policy, and better design. As someone who sits between these two worlds, I came away inspired by how much potential there is to strengthen that bridge.

Atif Rasheed

Imperial College London

As a researcher and enthusiast of earthquake engineering, it had long been my aspiration to attend a World Conference on Earthquake Engineering (WCEE). WCEE is a prestigious quadrennial event regarded as one of the most significant global gatherings in the field, bringing together researchers, practitioners, and industry professionals from around the world. Unfortunately, I was unable to attend the 17th WCEE in Japan in 2020, as it was converted into an online event due to COVID-19 restrictions. However, I was fortunate enough to participate in the 18th World Conference on Earthquake Engineering (WCEE2024), held in Milan from June 30 to July 5, 2024—technically the first in-person edition after an eight-year gap.

As a PhD researcher specializing in low-cost seismic isolation systems, I found the sessions on resilient infrastructure, innovative materials, and seismic isolation and energy dissipation control devices particularly relevant to my work. While one would ideally wish to attend all relevant technical sessions to maximize learning, it was simply not feasible given the scale of the conference. However, I made sure to attend all keynote lectures to hear from some of the most influential figures in the field. A highlight for me was the first keynote lecture by Prof. Julian J. Bommer on Seismic Hazard Assessment for Natural and Induced Earthquakes. His talk addressed and clarified several misconceptions about the minimum and maximum magnitudes that should be considered in seismic hazard analysis. Additionally, he explored the implications of these misunderstandings when probabilistic seismic hazard analysis (PSHA) is applied to induced seismicity.

One of the standout features of this WCEE edition was the introduction of the Master Series, an initiative by the International Association of Earthquake Engineering (IAEE) supported by Computers & Structures Inc. (CSI). The series was designed to create a unique opportunity for younger researchers and practitioners to meet and interact with distinguished scholars who have shaped the field of earthquake engineering. The CSI/IAEE Masters Series comprised three key components—Read, Meet, and Greet the Masters. I found this initiative truly enriching, and I particularly enjoyed the lecture by Prof. Steve Kramer, titled *The Evolution of Performance-Based Design in Geotechnical Earthquake Engineering*. It was a privilege to listen to such esteemed figures whose contributions have profoundly influenced earthquake engineering. Each conference participant received monographs authored by the four IAEE-invited distinguished scholars, making the experience even more valuable.

Beyond the technical sessions, one of the most rewarding aspects of the conference was the opportunity to network with peers and established professionals. The monitor sessions facilitated meaningful discussions and knowledge exchange, fostering connections that will undoubtedly benefit my research and career. Adding to the experience, exploring the vibrant city of Milan provided a cultural dimension, making the conference both professionally and personally memorable.

It was my first international conference and the first during my PhD, making it an unforgettable milestone. Beyond the academic and professional aspects, we thoroughly enjoyed the beauty of Milan—and, of course, its famous Italian pizzas!

I left the conference feeling inspired and motivated to contribute to the ongoing advancements in earthquake engineering.

Maria Liapopoulou
University of Cambridge

Attending the 18th World Conference on Earthquake Engineering (18WCEE) in Milan was a long-awaited opportunity for me, especially after spending a significant part of my PhD during COVID. With over 4,250 participants from 82 countries, it was one of the largest and most international events in WCEE's history.

It was the first major conference I attended that featured such a broad representation of speakers from outside Europe. It brought together many of the experts whose work I had studied during my academic journey (Jack Baker, Abbie Liel, and Meera Raghunandan, to name a few). I had the chance not only to attend their talks, but also to meet them and engage in thought-provoking conversations. It was especially insightful to observe the differences and parallels between the European and U.S. approaches to both research and practice.

The keynotes were consistently excellent, and from each, I gained something new. Ellen Rathje provided a solid technical overview of seismic slope models and pipeline assessment subject to landslides, while also encouraging us to formally publish research data and scripts to support reproducibility and impact. Dimitrios Vamvatsikos, in his characteristic style, made complex ideas relatable with everyday life analogies. In true Italian spirit, he compared seismic intensity measure selection to choosing pizza ingredients! His talk began with a humorous tone but gradually built up to introduce rigorous engineering concepts. Jack Moehle offered a concise history of Performance-Based Earthquake Engineering (PBEE), tracing its evolution from displacement-based design to modern frameworks, referencing key standards and contributors along the way.

Gian Michele Calvi's Masters Series Lecture brought a human-centred perspective. He opened with Euclid's definition of a point as 'that of which there is no part', even presenting it in ancient Greek, and reflected on how this inspired his book *The Art of Seismic Design*. He went on to revisit key design approaches in earthquake engineering with reference to the 'extraordinary' people behind them (Housner, Newmark, Priestley, Cornell, and Richter, among others).

Another highlight for me was George Gazetas' talk on soil-structure interaction and rocking foundations. His lecture-style delivery, starting from first principles and leading to clear conclusions, was truly engaging and insightful, reminding me of a great university class.

Outside the technical sessions, the cultural programme was equally memorable. The opening reception on the venue's terrace set a welcoming tone. The conference song, performed at the opening ceremony, captured the connection between people and earthquakes, conveying both the tragedy of past disasters and a hopeful vision for a safer future through collaboration. Instead of a formal gala dinner, the organisers hosted a party with a live band, which I found a great way to meet and connect with more participants.

Undoubtedly, the 18WCEE was a great success, and I look forward to attending the next conference in Montreal in 2028.

Mohamed Elzeadani
University of Cambridge

The 18th World Conference on Earthquake Engineering (WCEE), held at the Milan Convention Centre, was the largest conference I have attended to date—drawing an impressive crowd of over 4000 participants—and the first of the WCEE series I attend. It was a great opportunity to meet researchers and practitioners from different parts of the world and hear some of the latest developments in earthquake engineering.

The range of technical presentations delivered over the five-day period was indeed impressive. These were split into themed sessions delivered in separate rooms or on monitors in the exhibition area of the convention centre. The monitor sessions were an efficient way to accommodate the large number of presentations, and the setup allowed for easy navigation. The only downside was the proximity of the monitors, which was somewhat loud and distracting.

The plenary talks and keynote lectures were also very interesting, offering both technical depth and broader reflections on the field. I particularly enjoyed the keynote lecture by Dimitrios Vamvatsikos on *Criteria for Selecting Intensity Measures in Seismic Risk Assessment* and the Master Series Lecture by Gian Michele Calvi on *The Art of Seismic Design*. Ashraf Habibullah's plenary talk on the importance of human relationships in engineering success was also memorable, if somewhat general, and his dynamic delivery and signature LED-lit jacket made the talk both engaging and entertaining.

Apart from the parallel technical sessions and keynote lectures, the conference offered a wide range of technical visits where participants had the opportunity to tour key facilities such as the EUCENTRE Test Labs in Pavia, the Joint Research Centre (JRC) – European Laboratory for Structural Assessment (ELSA) Test lab in Ispra, Milan Public Transportation (ATM) control room, and a night visit to Milan's underground transportation tunnels and infrastructure.

The organisers also arranged several social events that added a lively dimension to the conference experience. These included a conference party, a foosball championship, and a special performance of *Turandot* at the iconic La Scala theatre—exclusively reserved for WCEE attendees. I attended the Opera show and I can attest it was indeed a very nice experience.

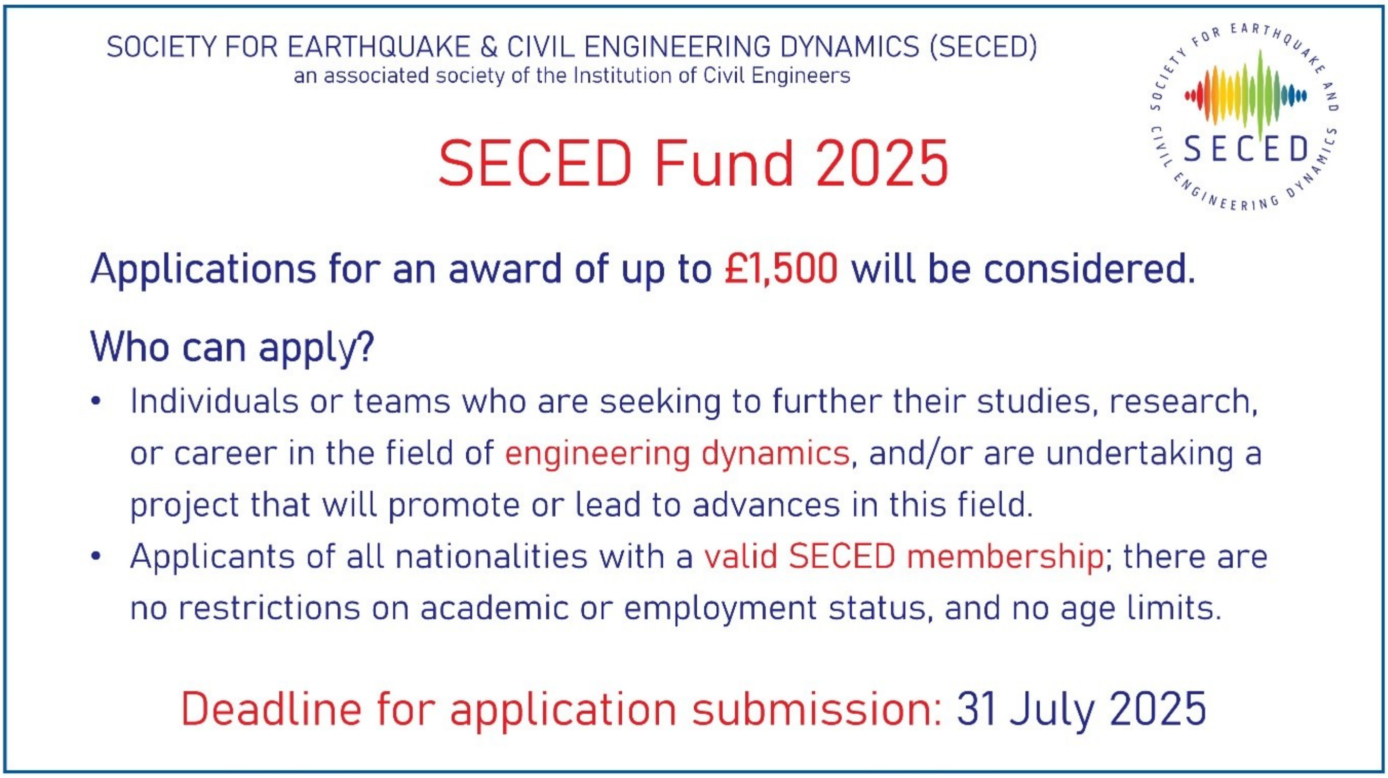
Overall, the 18WCEE offered a dynamic and enriching environment for knowledge exchange and professional networking, which I enjoyed very much, and I am looking forward to the upcoming WCEE in Montreal in three years' time.

SECED Fund 2025

The SECED Fund 2025 is now open for applications. This scheme offers financial support of up to £1,500 to individuals or teams whose academic studies, research, professional development, or volunteer work aligns with the aims of the Society.

The fund is open to all SECED members and may be used to support a wide range of activities, including conducting laboratory or field experiments; developing new engineering tools or open-source software; participating in a site visit, field trip, or post-disaster mission; attending a Continuous Professional Development (CPD) event, workshop, or conference; or organising an event relevant to engineering dynamics.

SECED Young Members are strongly encouraged to apply. The application deadline is **31/07/2025** and more information can be found at: https://www.seced.org.uk/index.php/young-seced/seced-fund.



SECED Site Visit to Schofield Centre

On the 13th of June 2025, the Society for Earthquake and Civil Engineering Dynamics visited the Schofield Centre at the University of Cambridge. Around 20 participants from both industry and academia travelled from London, Brighton, Manchester, and Glasgow to Cambridge to learn more about centrifuge modelling and the research conducted at the Centre.

Prof Madabhushi opened the visit with a warm welcome and guided participants through the centrifuge beam facility. PhD students Sulakna Weerasuriya, Diarmid Xu, and Nicolas Lee led a tour of the model preparation area, showcasing experimental setups for centrifuge testing.

Following lunch, Prof. Madabhushi delivered an insightful presentation on the fundamentals of centrifuge modelling, including an overview of major centrifuge facilities worldwide. The afternoon concluded with presentations from PhD students Sulakna Weerasuriya, Diarmid Xu, and Carlos Espanol, who shared their research titled: *Dynamic behaviour of piles in clay slopes*, *Seismic behaviour of scour protection rock berms for offshore wind structures*, and *Centrifuge modelling of monopile supported offshore wind turbines subjected to earthquake-induced liquefaction*, respectively.

Notable Earthquakes
January 2025 – April 2025

Reported by British Geological Survey

Issued by: Davie Galloway, British Geological Survey, June 2025.
Non British Earthquake Data supplied by: United States Geological Survey.

			Time			Dep	Magnitude			
Year	**Day**	**Mon**	**UTC**	**Lat**	**Lon**	**km**	**ML**	**Mb**	**Mw**	**Location**
2025	04	JAN	14:17	52.96N	1.94W	4	1.5			GREATGATE, STAFFORDSHIRE
2025	05	JAN	20:44	56.64N	5.75W	13	2.9			KINLOCH, HIGHLAND
Felt Oban, Strontian, Mull and in many villages in the region, mainly from within around 60 km of the epicentre (4 EMS).										
2025	07	JAN	01:05	28.60N	87.38E	10		6.6	7.1	TIBET (XIZANG), SW CHINA
At least 126 people killed, over 350 others injured, around 3,600 homes destroyed and over 27,000 damaged. A total of 206 villages across 26 townships affected. The majority of the damage and casualties occurred in Shigatse prefecture. Landslides damaged many roads and cracks observed in five hydropower dams in Tingri County. Several avalanches observed near the South Base Camp of Mount Everest and 2 avalanches occurred near Lunana, Bhutan.										
2025	12	JAN	20:05	62.35N	4.72E	16	4.6			NORWEGIAN SEA
Felt western Norway (4 EMS).										
2025	13	JAN	12:19	31.83N	131.55E	39			6.8	KYUSHU, JAPAN
A small tsunami was generated with a maximum wave height of 20 cm recorded at Miyazaki.										
2025	13	JAN	17:03	52.61N	2.80W	8	1.9			DORRINGTON, SHROPSHIRE
2025	14	JAN	20:58	52.61N	2.80W	8	1.7			DORRINGTON, SHROPSHIRE
2025	22	JAN	09:12	59.83N	1.96E	31	2.8			NORTHERN NORTH SEA
2025	26	JAN	04:32	53.62N	2.36E	10	3.0			SOUTHERN NORTH SEA
2025	27	JAN	05:23	56.98N	1.84E	11	3.4			CENTRAL NORTH SEA
2025	03	FEB	00:05	57.02N	1.84E	9	3.5			CENTRAL NORTH SEA
2025	05	FEB	03:03	56.40N	5.39W	3	2.2			GLENLONAN, ARGYLL & BUTE
Felt Oban, Mull and in many villages in the region, mainly from within around 20 km of the epicentre (4 EMS).										
2025	05	FEB	08:09	56.39N	5.37W	3	1.6			GLENLONAN, ARGYLL & BUTE
Felt Oban, Mull and in a few villages in the region, mainly from within around 10 km of the epicentre (3 EMS).										
2025	05	FEB	11:44	52.13N	2.36W	3	2.0			MALVERN, WORCESTERSHIRE
2025	08	FEB	23:23	17.65N	82.40W	14			7.6	CAYMAN ISLANDS
Some buildings damaged in Belize and Honduras. A tsunami was generated with a maximum wave height of 4 cm recorded at Islas Mujeres, Mexico.										
2025	09	FEB	14:25	53.32N	2.40W	9	1.5			KNUTSFORD, CHESHIRE
2025	22	FEB	02:46	53.06N	2.89W	7	1.6			RIDLEYWOOD, WREXHAM

			Time			Dep	Magnitude			
Year	**Day**	**Mon**	**UTC**	**Lat**	**Lon**	**km**	**ML**	**Mb**	**Mw**	**Location**
2025	10	MAR	02:33	71.18N	8.17W	10			6.5	JAN MAYEN ISLAND REGION
2025	14	MAR	02:53	53.38N	1.29E	7	1.9			SOUTHERN NORTH SEA
2025	18	MAR	07:37	54.10N	1.99W	13	2.0			KILNSEY, NORTH YORKSHIRE
Felt Hinderwell (2 EMS).										
2025	18	MAR	14:04	53.37N	2.61W	16	1.5			WARRINGTON, CHESHIRE
2025	25	MAR	01:43	46.73S	165.86E	21			6.7	SOUTH ISLAND, NEW ZEALAND
A tsunami was generated with a maximum wave height of 10 cm recorded at Puysegur Point.										
2025	28	MAR	06:20	22.01S	95.93E	10			7.7	MYANMAR
Over 3,850 people killed (with 88 still missing), over 5,100 others injured, over 55,000 homes and buildings (including schools and hospitals) destroyed or damaged and around 400 roads and 95 bridges damaged in Myanmar. Over 60 people killed (with 83 still missing), over 34 others injured and over 700 homes and buildings damaged or destroyed in Thailand. Damage has been estimated at US$1.9 billion.										
2025	28	MAR	06:32	21.70S	95.97E	10			6.7	MYANMAR
Casualties and damage are included with the magnitude 7.7 Myanmar event at 6:20 UTC.										
2025	28	MAR	17:17	0.76N	29.76E	12			6.6	NORTH ATLANTIC OCEAN
2025	30	MAR	12:18	20.30S	174.07W	29			7.0	TONGA ISLANDS REGION
2025	02	APR	22:55	56.64N	4.15W	3	1.7			BALINTYRE, PERTH & KINROSS
Felt Fearnan, Kinloch Rannoch and Tummel Bridge (3 EMS).										
2025	03	APR	14:09	52.45N	32.11W	10			6.9	REYKJANES RIDGE
2025	04	APR	20:04	6.30S	151.63E	10			6.9	PAPUA NEW GUINEA
2025	07	APR	05:58	56.64N	4.15W	3	1.8			BALINTYRE, PERTH & KINROSS
Felt Fearnan, Invervar and Fortingall (3 EMS).										
2025	08	APR	15:51	51.93N	4.31W	6	1.5			LLWYNCROES, CARMARTHEN
2025	13	APR	03:39	58.87N	1.75E	10	1.8			CENTRAL NORTH SEA
2025	13	APR	20:03	25.98S	178.33W	271			6.5	SOUTH OF FIJI ISLANDS
2025	16	APR	01:42	47.81S	99.61W	10			6.6	SOUTH INDIAN OCEAN
2025	23	APR	09:49	40.81N	28.15E	10			6.2	WESTERN TURKEY
2025	25	APR	11:44	1.08N	79.54W	35			6.3	ECUADOR
2025	27	APR	07:37	55.99N	5.24W	7	1.7			GLENDARUEL, ARGYLL & BUTE
2025	29	APR	14:42	59.41N	1.60E	9	1.7			NORTHERN NORTH SEA
2025	29	APR	14:53	54.26S	155.65E	10			6.8	MACQUARIE ISLAND REGION

Offshore seismic Hazard in UK waters

The offshore seismic hazard maps for the UK, produced by the British Geological Survey, were updated on 23 January 2025 and are available online.

Forthcoming Events

Young Members' AGM and Evening Lecture

A new low-cost seismic isolation system based on pre-inca technology

Atif Rasheed
Institution of Structural Engineers
Also broadcast online
29 October 2025 (6:00–7:30 pm)

Note: The Society for Earthquake and Civil Engineering Dynamics (SECED) Young Members AGM will take place at 6:00 pm, followed by the lecture at 6:30 pm.

Synopsis

The seismic resilience of ancient Andean structures, particularly those found in Peru, offers compelling evidence of indigenous engineering practices that were both sophisticated and profoundly rooted in local materials and construction logic. Among the most intriguing elements uncovered in archaeological investigations are *shicras*—stones encased in fibre bags, traditionally placed in foundation layers. These assemblages, far from being merely symbolic or decorative, appear to have served as functional seismic isolation systems, effectively mitigating ground motion through energy dissipation mechanisms.

This talk presents a rigorous analytical and numerical study into the dynamic behaviour of *shicras*, with the objective of understanding and quantifying their potential as a low-cost seismic base isolation strategy for contemporary low-rise buildings in developing regions. The analytical model, developed using a variational formulation, characterizes the motion of *shicras* as irregular polygons subjected to horizontal excitation. The analysis focuses on energy dissipation through successive cycles of uplift, rocking, and rolling. Results show that such behaviour can effectively reduce transmissibility of seismic forces to the superstructure. In parallel, insights from ongoing numerical simulations and experimental campaign at Imperial College London will also be presented.

By drawing from indigenous knowledge and integrating it with modern engineering tools, this research seeks to establish *shicras* as a viable, low-cost seismic isolation solution for developing regions. The talk will highlight how this approach not only enhances resilience but also aligns with the broader goals of sustainability, local resource utilization, and heritage-inspired innovation in earthquake engineering.

About the speaker

Atif is a PhD scholar in the Structures Section at Imperial College London, where he is researching the development of an innovative, low-cost seismic base isolation system using wrapped stones. This project aims to enhance the earthquake resilience of developing communities. He holds a Bachelor's degree in Civil Engineering from Balochistan University of Engineering and Technology and a Master's in Structural Engineering from the National University of Sciences and Technology (NUST) Pakistan. Atif is also an academic, with three years of experience as a Lecturer at NUST. During his Master's, he was part of a research team that conducted a probabilistic seismic hazard assessment, contributing to the development of Peak Ground Acceleration (PGA) and Spectral Acceleration (SA) maps for Pakistan, which were included in the most recent update of the national building code. His research interests include shake table testing, seismic base isolation, seismic hazard analysis, numerical simulations, and disaster resilience assessment.

Registration

The event will be held in-person at the Institution of Structural Engineers and will be chaired by Maria Liapopoulou (University of Cambridge). Attendance at this meeting is free for members and non-members alike. Prior registration is not required. Seats are allocated on a first come, first served basis. We encourage everyone to attend in person if they can. Tea, coffee, and biscuits will be served from 5.30 pm–6:00 pm.

The event will also be broadcast online, and further details on how to register for online attendance will be published on the SECED website.