EUCEET Association

NEWSLETTER 2/2021

In this issue

FROM THE EUCEET ASSOCIATION

The 14th General Assembly of the EUCEET Association

The 14th General Assembly of the EUCEET Association will take place on November 12th 2021, after the closing of the Conference of EUCEET-AECEF, from 17:00 - 18:00 P.M. kindly hosted by the Aristotle University of Thessaloniki, Greece.

2021 First joint Conference of EUCEET Association and AECEF

"The role of education for Civil Engineers in the implementation of the SDGs"

November 12th, 2021
Thessaloniki, Greece

European Civil Engineering Education and Training Association

Association of European Civil Engineering Faculties

Venue:

Aristotle University Research Dissemination Center (https://kedea.rc.auth.gr)

Address:
September 3rd, Aristotle University Campus, 546 36 Thessaloniki, Greece

Important dates:

- September 1st, 2021 — Deadline for Abstract Submission
- September 2nd, 2021 — Notification acceptance of Abstracts & call for Papers
- September 30th, 2021 — Deadline for Paper Submission
- October 12th, 2021 — Notification acceptance of papers
- October 12th, 2021 — End of Early Bird registration
- November 12th, 2021 — Conference

Registration fees:

	Early registration (€)	Late registration (€)
EUCEET and AECEF members	250	300
Other participants	300	350
Virtual participants	50	50

Registration fees include:

- conference room,
- coffee breaks,
- lunches,
- gala dinner and
- conference material.

Preliminary program

Time	Event
09:00	**Registration**
09:30	**Opening by AUTh, AECEF and EUCEET**
09:45	Presentation by AECEF speaker
10:15	Keynote speech by Prof. Pericles Latinopoulos
10:45	Coffee break
11:15	Papers presentations (parallel sessions)
12:30	Lunch break
14:30	Presentation by EUCEET speaker
15:00	Keynote speech by Prof. Jeffrey Sachs (virtual presentation from USA)
15:30	Papers presentations (parallel sessions)
16:30	**Closing and conclusions by AECEF, EUCEET, AUT**
17:00 - 18:00	General Assembly of AECEF and General Assembly of EUCEET
20:00	**Conference Gala Dinner**

Keynote Speakers

Jeffrey D. Sachs	Professor and Director of the Center for Sustainable Development at Columbia University
Pericles Latinopoulos	Professor Emeritus at the Aristotle University of Thessaloniki (AUTh), Greece

More information: https://websites.auth.gr/euceetaecef2021/

New member of the EUCEET Association

Ecole supérieure d'ingénieurs des travaux de la construction de Caen, France

ESITC CAEN
School of Civil Engineering

ABOUT:

Founded in 1993, École Supérieure d'Ingénieurs des Travaux de la Construction de Caen (Graduate School of Building Engineering of Caen) is a private higher-education institution located in the small city of Épron, Normandie, created at the initiative of construction professionals and with the support of local communities. It has been independent since 1996.

Since 2016, it has been one of the French private higher education establishments recognized by the State as being of general interest (EESPIG label).

ESITC Caen develops privileged partnerships with internationally renowned institutions around the world, specialists in the targeted fields (maritime works, eco-construction, major works, digital design, infrastructures, intelligent buildings…)

ESITC Caen has close relations with the business world, whether they are professional federations (FFB and FNTP), major construction companies (VINCI Construction, Bouygues, Eiffage), mid-sized companies or SMEs. This is reflected in the composition of the school's bodies: board of directors, teaching staff, juries, alumni network...

More than 80% of the teaching is carried out by professionals.

For ESITC Caen, businesses are an essential educational player. A majority of professionals sit at the Skills Development Board and contribute to the development and evolution of training content.

ESITC Caen's research laboratory offers companies its scientific skills and expertise in the field of construction materials (low-carbon materials, concrete/marine interactions, materials for energy efficiency, etc.). The laboratory can thus carry out R&D studies for companies and work closely on collaborative R&D projects.

R&D studies generally include the identification of the state of the art and the joint development of proposals for technical solutions adapted to specifications.

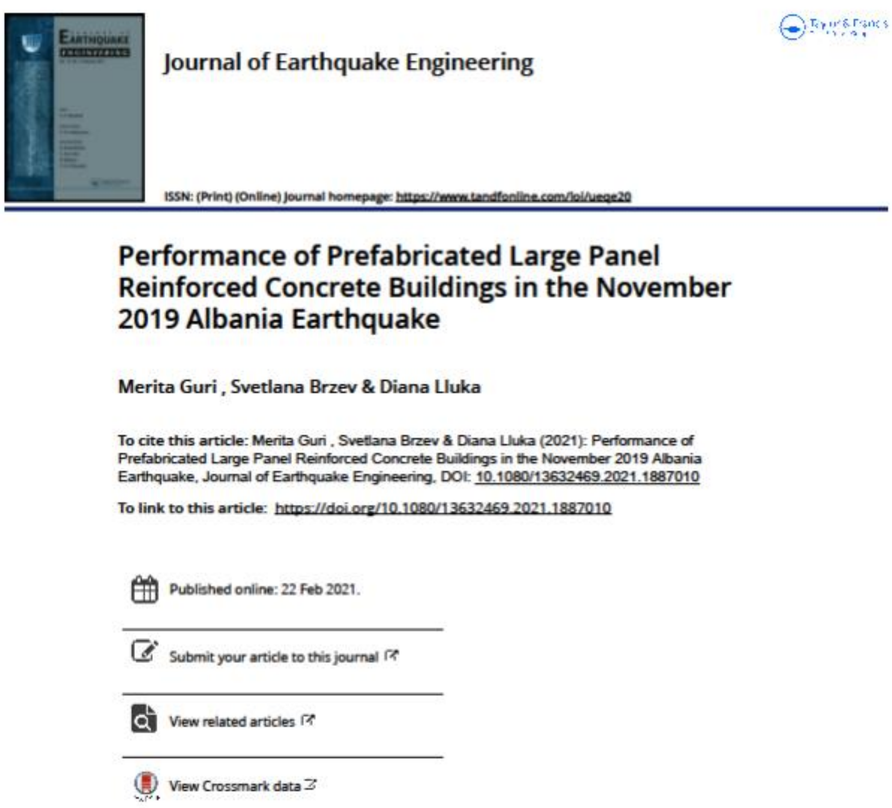
More information: https://www.esitc-caen.fr/

FROM MEMBERS

Polis University, Albania

The head of department of the Civil Engineering Department, Doc. Dr. Merita Guri and her colleagues, prepared a paper presented at the end of this newsletter, that discuss the performance of prefabricated reinforced concrete (RC) buildings, known as large-panel buildings (LPE), that were affected by the November 26, 2019 Durrës, Albania earthquake (M 6.4). This was a common typology for multi-family housing in urban areas of Albania and neighbouring countries, e.g. ex-Yugoslavia, Romania, and Bulgaria, in the period from 1960 to 1990. The paper outlines the key structural and seismic features of LPE buildings in Albania and presents observations from a field survey of selected buildings at eight different localities within the earthquake-affected area. A new post-earthquake damage classification for LPE buildings has been proposed.

This paper soon will be followed by a report on damages by November 26, 2019 Durrës, a collaboration with the American Earthquake Research Institute.


Journal of Earthquake Engineering

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/ueqe20

Performance of Prefabricated Large Panel Reinforced Concrete Buildings in the November 2019 Albania Earthquake

Merita Guri , Svetlana Brzev & Diana Lluka

To cite this article: Merita Guri , Svetlana Brzev & Diana Lluka (2021): Performance of Prefabricated Large Panel Reinforced Concrete Buildings in the November 2019 Albania Earthquake, Journal of Earthquake Engineering, DOI: 10.1080/13632469.2021.1887010

To link to this article: https://doi.org/10.1080/13632469.2021.1887010

Published online: 22 Feb 2021.

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https://doi.org/10.1080/13632469.2021.1887010

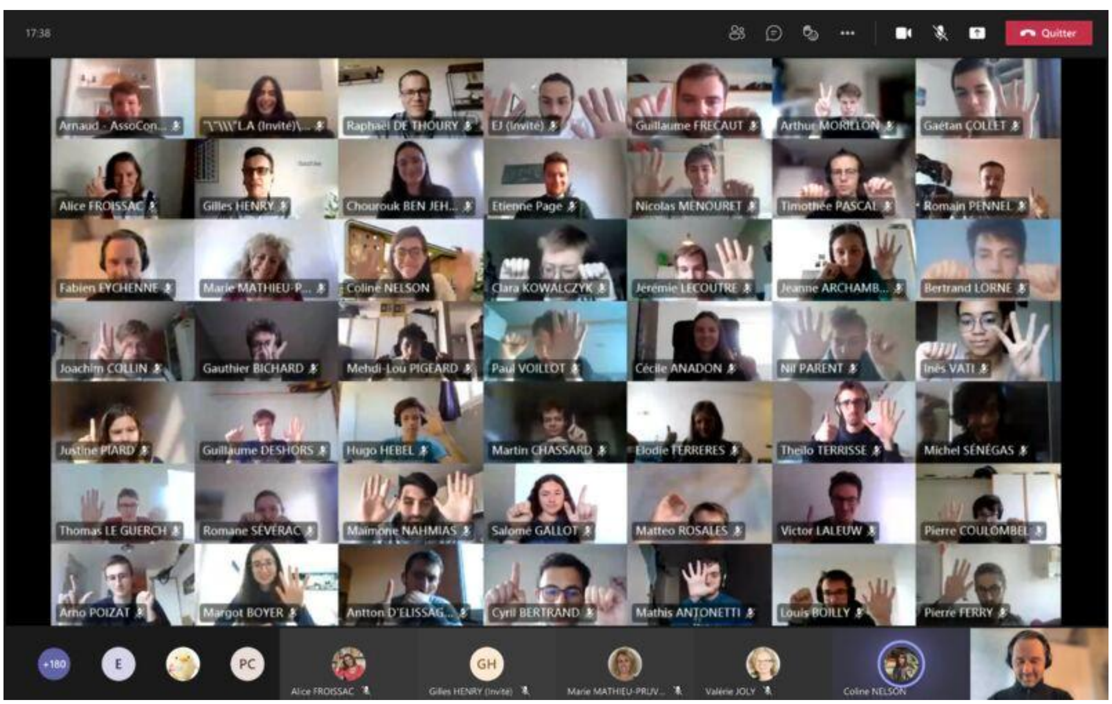
École des Ponts ParisTech, France

STARTUP DAY 2021 @ ECOLE DES PONTS: ANNOUNCEMENT OF THE WINNERS

May 25, 2021

On Thursday, April 22, 2021, École des Ponts ParisTech organized the 2nd edition of Ponts Startup Day (https://www.ecoledesponts.fr/ponts-start-day), the flagship event of its entrepreneurship awareness program, with the support of the Innovation & Design cluster (https://www.ecoledesponts.fr/pole-innovation-design) and Genius Ponts (https://www.ecoledesponts.fr/initiatives-etudiantes?tab=genius). Virtual format obliges, the 2021 edition has been redesigned to offer for 200 students from 1st year a space for discovery, exchange and interactivity around the world of startups, in a friendly and fun setting:

► **Round tables**: How do you become an entrepreneur? By what means does one go from idea to action? How do startups cope with the crisis? 12 entrepreneurs, alumni of the Ecole des Ponts lent themselves to the exercise to answer these questions and awaken the interest of their young peers in entrepreneurship. In a relaxed atmosphere, the students also participated in team building sessions.

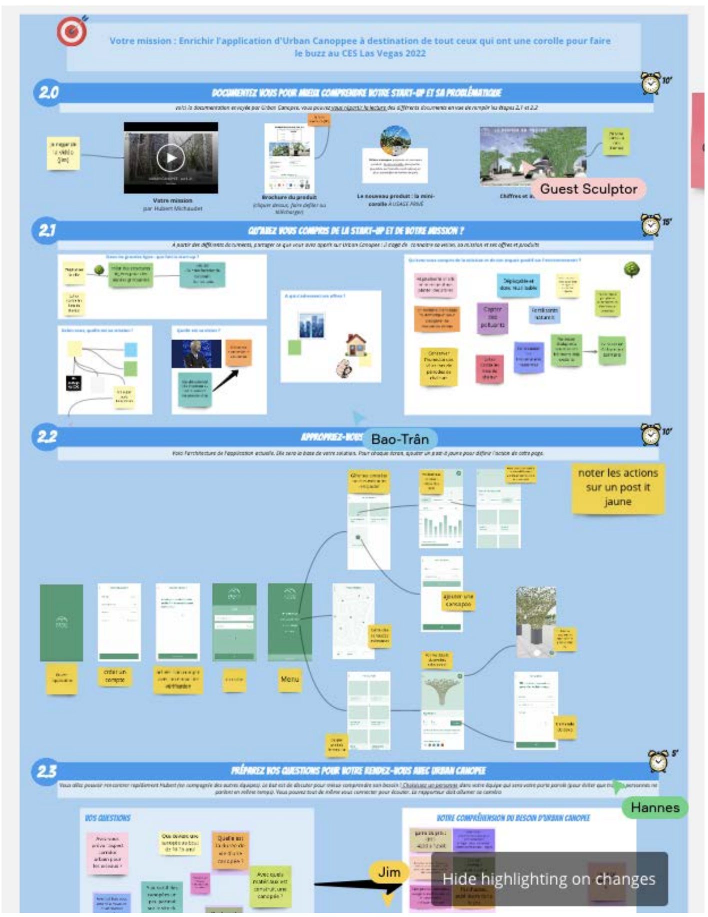


Team building (source: https://www.ecoledesponts.fr)

► **Challenge**: The principle? Work as a team to solve a real startup problem and materialize their ideas in the form of a brochure:

- Gamify Luego's current process to encourage entrepreneurs to do their accounting as they go
- Enriching Urban Canopee's app for anyone with a corolla to create a buzz at CES Las Vegas 2022
- Reinventing patient care in the emergency room using, or not, Artificial Intelligence with Incepto Medical

A methodology inspired by Design Thinking and Design Sprint as well as the collaborative work platform Miro allowed to work remotely and respect the time limit.



Miro, collaborative work platform - Example of a flyer produced by the students
(source: www.ecoledesponts.fr)

Not surprisingly, the class of 2023 was able to meet the challenge and demonstrate its analytical skills, its team spirit and its creativity.

The winning teams are the following

- **Incepto Challenge** Reinventing patient care in the emergency room using, or not, Artificial Intelligence with Incepto Medical
  Congratulations to team 3: Jeanne ARCHAMBAULT, Matthieu BELIN, Ivan BEN LOLO and Mamoun BERRAHMA TLEMCANI.
  "*Bravo for your good ideas well aggregated and this nice design*" Incepto
- **Luego Challenge** Gamify the current Luego process to encourage entrepreneurs to do their accounting as they go
  Congratulations to team 29: Léa SPONEM, Julie THAI, Ramzi SAYAH, Michel SÉNÉGAS and Raphaël TAISANT
  "*A simple proposal, aligned with the user's objectives. The experience is fluid with clear objectives, bravo!*" Luego
- **Urban Canopee Challenge** Enriching the Urban Canopee application for all those with a corolla to make the buzz at CES Las Vegas 2022
  Congratulations to team 7: Lise BERTHOU, Xavier CHEVALLEY, Pierre-Marie CIRON, Gaétan COLLET, Joachim COLLIN and Pierre COULOMBEL
  "*Our favorite project: it takes the idea of discovery but includes a challenge with rewards. A simple idea to implement and for all ages!*" Urban Canopee

Tuesday, May 25th 2021: prize-giving ceremony

TESTIMONIALS

"*I enjoyed developing my knowledge of how startups and businesses work. I also learned that failing is part of the journey, that some projects won't succeed but there is always a way to bounce back to create great things."*

"It was nice to have time dedicated to learning about the experience and life of a female entrepreneur. "

"I really enjoyed learning about a new way of working in a very limited amount of time, which allows you to learn by stepping out of your comfort zone. The methodology was also introduced in a fun way, so this challenge was not unpleasant or painful work. "

LEESU SCIENTIFIC SEMINAR ON WATER FRANCE-GHANA

From June 17, 2021 11:00 to June 24, 2021 13:30

Adèle Bressy, researcher at LEESU (https://www.ecoledesponts.fr/laboratoire-eau-environnement-systemes-urbains), organized two webinars on the theme of water on June 17 and 24, 2021 with the Regional Water and Environmental Sanitation Centre, Kumasi (RWESCK), a World Bank center of excellence located at the Kwame Nkrumah University of Science and Technology (KNUST) in Ghana.

These sessions were organized online in collaboration with three other schools in the ParisTech network (https://www.paristech.fr/fr/actualites/france-ghana-des-seminaires-scientifiques-pour-mieux-se-connaitre) and are a follow-up to this delegation's visit (https://www.ecoledesponts.fr/developpement-capacites?tab=afrique-anglophone) to Ghana in January 2020.

► Program of the ParisTech - KNUST workshop WATER:

https://www.paristech.fr/sites/default/files/documents/waterwebinar_knust-paristech2021_program_vf.pdf

Ural Federal University (UrFU), Russia

Ural Federal University
named after the first President of Russia B.N.Yeltsin

Professor Vladimir Alekhin (Head of Department of UrFU Institute of Civil Engineering and Architecture (ICEA) and member of the Administrative Council of the EUCEET Association) sent the following news of interest for members of EUCEET Association:

VII International Conference "Safety Problems of Civil Engineering Critical Infrastructures" SAFETY 2021 (SPCECI 2021)

The Conference was held on 27-28, May 2021 in Ekaterinburg at the Ural Federal University in collaboration with Science and Engineering Centre "*Reliability and Safety of Large Systems and Machines* (Ural Branch of Russian Academy of Sciences), Russian Academy of Architecture and Construction Sciences, South Ural State University and European Civil Engineering Education and Training Association (EUCEET). The representatives of science and business from Russian Federation, USA, Germany, UK, Syria, Yemen and Columbia took part in the Conference (mostly online).

The main conference purpose is integration and coordination of efforts of scientists, experts and specialists in the field of integrated risk analysis related to building interdependent critical infrastructures throughout their life cycle at the international level. Design, fracture mechanics problems, diagnostics, monitoring, maintenance, survivability and optimal management of infrastructure systems issues is considered in the context of the creation and operation of safe, smart and durable infrastructure systems. Question of the creation of real conditions and a practical mechanism for an innovative scientific, educational and organizational breakthrough is one of the most important problems of the twenty-first century – safety and sustainable development of cities, regions and worldwide taking into account the human factor.

The objectives of SAFETY 2021 were to collect and disseminate state-of-the-art research and technology for design, fracture mechanics problems, diagnostics, monitoring, maintenance, survivability and optimal management of infrastructure systems issues is considered in the context of the creation and operation of safe, smart and durable infrastructure systems.

The conference participants discussed the problems of safety technologies for building critical infrastructure and territories; modeling of loads and impacts on buildings and structures; steel and concrete structures; soil mechanics and foundations problems of viable and smart cities and sustainable development of territories; energy efficiency and resource saving in civil engineering; building information technology (BIM); building technologies and materials of innovative type; education in architecture and civil engineering; expertise and management in construction; building engineering systems and others.

Heads of Departmenst of UrFU Institute of Civil Engineering and Architecture (ICEA) Professor Vladimir Alekhin (member of the EUCEET Administrative Council) and Professor Zoya Belyaeva and Deputy Director for Science and Innovations of the ICEA Professor Lilya Pastukhova served as moderators of the Conference.

The keynote lectures were given by Professor Sviatoslav Timashev (Russia) and Professor Adrian Gheorge (USA).

Photos taken at the **SPCECI 2021**

FROM PARTNERS

AECEF-Association of European Civil Engineering Faculties

AECEF-Association of European Civil Engineering Faculties become partner of *New European Bauhaus Community* (*Partners (europa.eu)*

The New European Bauhaus initiative connects the European Green Deal to our living spaces. It calls on all Europeans to imagine and build together a sustainable and inclusive future that is beautiful for our eyes, minds, and souls.

The New European Bauhaus (NEB):

- is a think-do tank. A design lab, accelerator and network at the same time. A creative and interdisciplinary movement, convening a space of encounter to recuperate and revisit sustainable practices from, empower the most inspiring practices of today, and design future ways of living, at the crossroads between art, culture and science.

• wants to build a sustainable future through creativity, innovation and imagination. To enable experimental places and spaces for us to reimagine how to live better together after the pandemic.

• is a crossroads project. It connects innovation, creativity and design to citizen's quality of life in towns and localities. It bridges, connect and blend the green and digital transformations.

• is a transformational project. It aims to lead the thinking, inspire behaviours, attract the markets and influence public procurement to make new ways of living possible. The ultimate focus is "beyond buildings" – the project should bring benefit to the whole of society. It will help to revisit Europe's cultural heritage and shape its future.

• is transformational in its delivery. Co-created and delivered in innovative, fresh, inclusive and creative ways.

The New European Bauhaus will:

- Bring citizens, experts, businesses, and Institutions together and facilitate conversations about making tomorrow's living spaces more **affordable and accessible**.
- Mobilise designers, architects, engineers, scientists, students, and creative minds across disciplines to reimagine **sustainable living** in Europe and beyond.
- Strive to improve the **quality of our living experience**. It will highlight the value of simplicity, functionality, and circularity of materials without compromising the need for comfort and attractiveness in our daily lives.
- **Provide financial support to innovative ideas and products** through ad-hoc calls for proposals and through coordinated programs included in the Multi-Annual Financial Framework.

More information: https://europa.eu/new-european-bauhaus/index_en

Academic Cooperation Association

ACA Strategic Summit 2021 - Strategic perspectives on international higher education post COVID-19

6 May, 2021

On 6 May 2021, ACA hosted its **first annual Strategic Summit**, a **high-level event bringing together over 40 leaders from 24 internationalisation funding agencies** (many of them ACA members) from Europe and the United States. The distinguished participants discussed issues of strategic importance for international higher education post Covid-19.

The day-long and intervention-rich programme covered **reflections on the lessons learnt** through the multiple challenges, both ongoing and overcome, encountered by ACA members and the summit's guests during the past year, as well as by the wider field of international education. The day also featured discussions on the **many accomplishments** brought about by the pandemic and wider geopolitical developments. Last but not least, the leaders discussed how they **imagine and carve a way forward**, for **internationalisation funding agencies** and for our field, as **key players in co-shaping a better future**.

Along many engaging sessions, the in-depth discussions and networking moments, the programme also featured inspiring **keynote presentations** by Ulrich Grothus, ACA President, by Allan E. Goodman, President and CEO of the Institute of International Education (IIE) and Cristina Riesen, Co-CEO at Taskbase, and Founder Educreators Foundation.

The summit concluded with a set of important acknowledgements and powerful shared messages, that will guide the work of funding agencies, as well as ACA's input in the ongoing policy- and programme-making processes at European level:

- **Navigating and leading through uncertainty is in the DNA of international higher education**; it's something to embrace and make the most of.
- Out of the pandemic, we'll need to continue to **strategically leverage the many lessons learnt** in terms of adaptability, flexibility, creativity, innovation, etc. There's no going back to the previous 'normal'.
- **There's greater interest and need for the benefits of international education than ever** before – we must be ready for the post-pandemic surge, and deliver in line with this demand and interest.
- **To build a better future, we need to innovate** – we can't simply aim to recreate the same, but with new (digital) tools. Innovation is also necessary in **shaping a new narrative for internationalisation (and mobility)**, one that reflects better the added value of our field, and that is outcome, rather than activity-driven.
- In addressing the ambitious objectives we've set for inclusive, sustainable and digitally-enhanced internationalisation (and mobility), we'll need to **balance conflicting expectations and possible points of tension between these goals**, and find **creative solutions** to deliver on this comprehensive vision.

The next edition of the ACA Strategic Summit will take place in spring 2022.

Videos from the Summit, 6 May 2021 can be found on: ACA Strategic Summit 2021 – Strategic perspectives on international higher education post COVID-19 (aca-secretariat.be)

German Academic Exchange Service-DAAD

Seminar Micro-credentials in the EHEA: Small Learning Units – Big Opportunities?
1 July 2021, 11:00 – 16:30 CEST
Online-Seminar

In the wake of an increased speed of technology progression, society and the labor market demand increasingly complex skills. The disruptive nature of certain technologies can quickly devalue once-acquired knowledge and enforce reskilling and upskilling efforts. In this context, education is no longer attributed to a specific age group or target group, but higher education institutions have to become familiar with and adapt to the needs of the lifelong learner.

The core principle of micro-credentials is to provide the educational framework for these reskilling and upskilling efforts and to give recognition to newly acquired competences, as learners increasingly want and have to document their personal learning paths throughout their working life. Here, micro-credentials fill a gap between a formal degree-based education, and the fast-changing development of knowledge and labour market needs.

The seminar within the framework of the DAAD project bologna hub will focus on the latest developments with regard to the uptake of micro-credentials in the EHEA – most notably, the "*European Approach to micro-credentials*". It will also highlight various good practice examples and micro-credential initiatives related to the Bologna key commitments. In addition, also the wider impact of the use of micro-credentials on lifelong learning and increased inclusiveness in the EHEA shall be discussed.
The seminar aims at enriching the ongoing discussion on micro-credentials and bringing together professionals from the policy level as well as experts, HEI administrators and providers of micro-credentials.

More information: Seminar Micro-credentials in the EHEA: Small Learning Units – Big Opportunities? – Nationale Agentur für EU-Hochschulzusammenarbeit – DAAD

European University Association

2021 European Quality Assurance Forum
18 – 19 november, 2021
Online event

The 2021 European Quality Assurance Forum (EQAF) will take place online on 18 and 19 November.

The Forum, entitled "*Building trust and enhancement: from information to evidence*", will combine online sessions about European policies and trends, research, and practical case examples related to the Forum theme and more generally about current developments in quality assurance.

To promote trust and serve as a basis for informed decision-making and quality enhancement, quality assurance needs to be evidence-based. The amount of data on higher education and the performance of higher education institutions has increased in recent years and its nature is changing partly due to digitalisation. This makes it increasingly important to determine which information is meaningful and relevant for stakeholders in higher education, hence worth serving as evidence for robust quality assurance processes. The event will address questions such as how to ensure an appropriate balance between qualitative and quantitative data and diversity of sources of information. It will also focus on how to analyse and interpret the data, as well as how to ensure that it is used to enhance quality and promote trust. Notably, the 2021 EQAF will offer an occasion to analyse how to make the best out of the opportunities offered by digitalisation while avoiding pitfalls.

The Forum will explore the evidence used in external and internal quality assurance and how to improve its use and impact.

True to the EQAF tradition, this year's Forum will be organised using an event platform that will provide participants with opportunities for networking, also outside the formal programme, and will facilitate audience interaction.

The Forum will be of interest to rectors and vice-rectors responsible for quality assurance, quality assurance officers in higher education institutions, students, quality assurance agency staff and researchers working in higher education or in the quality assurance field.

For updates, please follow @EQAF and #EQAF on Twitter and/or join the LinkedIn group "European Quality Assurance Forum (EQAF)".

More information: 2021 European Quality Assurance Forum (eua.eu)

European Society for Engineering Education (SEFI)

Doctoral Symposium in Engineering Education Research at SEFI 2021
12 September, 2021
Online

The 5th Doctoral Symposium in Engineering Education Research on 12 September offers an opportunity for PhD candidates to explore and develop research interests in an interdisciplinary workshop, under the guidance of a number of well-known senior scholars within the Engineering Education Research (EER) field. During the Doctoral Symposium, the participants will share their current dissertation work with others and exchange feedback.

The aim is to provide an opportunity for doctoral students to:

- meet other students and supervisors to extend their network and view of the EER field,
- present and discuss their own work and the work of others,
- get perspectives from scholars outside their own institution,
- contribute to the conference and the SEFI EER community with other participants, and
- promote collaborative research and elaborate future research directions.

See the conference website for more information.

The Doctoral Symposium is chaired by:

- **Jonte Bernhard**, Professor, Former Chair of the *SEFI SIG Engineering Education Research* and Deputy Editor of the *European Journal for Engineering Education*,
- **Kristina Edström**, Associate Professor, Editor-in-Chief of the *European Journal for Engineering Education*,
- **Tinne De Laet**, Associate Professor, Chair of the *SEFI SIG Engineering Education Research*.

More information: https://sefi2021.eu/index.php/doctoral-symposium/

FROM THE EUROPEAN UNION

News from Education, Audiovisual and Culture Executive Agency (EACEA)

New video: how to find calls for proposals

Publication date: 19 May 2021

Easily find calls for proposals on the Funding & Tenders Portal with this new video.

New video: how to find calls for proposals

EU funding is available through calls for proposals. Calls for proposals are published on the European Commission's Funding & Tender Opportunities Portal (F&TP).

To help you find calls for proposals on the F&TP, EACEA has produced a handy video. The video shows you how to navigate the F&TP, search for calls, and access support materials.

Watch the video now on How To Get A Grant

On the same page you will also find a video on creating your Participant Identification Code (PIC), and a helpful presentation called 'How to find and apply for funding'.

Remember that full guidance on calls for proposals can be found the F&TP online manual.

Information from: https://www.eacea.ec.europa.eu/news-events/news/new-video-how-find-calls-proposals-2021-05-19_en

EACEA publications now available on the EACEA website

Publication date: 2 June 2021

Find all EACEA's publications on the new EACEA publications page.

EACEA's publications are now easier to find than ever.

Just visit the EACEA website's publications page to find over 300 studies, factsheets, reports and much more.

The page contains thumbnail images of the publications' cover pages, as well as brief descriptions of what each publication is about.

The page will be updated regularly as new publications come out. Check back regularly for the latest updates.

Information from: https://www.eacea.ec.europa.eu/news-events/news/eacea-publications-now-available-eacea-website-2021-06-02_en

Erasmus+ Teacher Academies

Erasmus+ Teacher Academies is a new action that has been included in Erasmus + 2021-2027.

The 2019 Council Resolution on further developing the **European Education Area**[1] invites the Commission to "Develop new means to train and support competent, motivated and highly qualified teachers, trainers, educators and school leaders, and promote their continuous professional development and high-quality, research-based teacher education." The 2019 European Education Summit also stressed the crucial importance of teachers, and the role of teachers was identified in the consultations on the future cooperation framework as one of the most important topics to be addressed in EU cooperation.

The Council Conclusions on European Teacher and Trainers for the Future of May 2020 reiterate the role of teachers as cornerstones of the European Education Area and call for further support to teachers' career and competence development as well as well-being at all stages of their careers. The Conclusions stress the benefits of mobility of teachers and the need of embedding mobility as part of teachers' initial and continuous education. Moreover, the Conclusions invite the Commission to support closer cooperation between teacher education providers within the continuum of teachers' professional development.

The 2020 Commission's Communication on Achieving the European Education Area by 2025 recognises the key role of teachers and trainers and sets the vision of having highly competent and motivated educators who can benefit from a range of support and professional development opportunities throughout their varied careers. It proposes a number of actions to address the challenges the teaching professions face today, including the plan to launch **Erasmus+ Teacher Academies**.

The Erasmus+ Teacher Academies will meet the following objectives:

- Contribute to the improvement of teacher education policies and practices in Europe by creating networks and communities of practice on teacher education that bring together providers of initial teacher education (pre-service education for future teachers) and providers of continuing professional development (in-service), other relevant actors such as teacher association, ministries and stakeholders to develop and test strategies and programmes for professional learning that is effective, accessible and transferable to other contexts.
- Enhance the **European dimension** and internationalisation of teacher education through innovative and practical collaboration with teacher educators and teachers in other European countries and by

sharing experiences for the further development of teacher education in Europe. This collaboration will address the key priorities of the European Union such as learning in the digital world, sustainability, equity and inclusion, also by offering teachers courses, modules and other learning opportunities on these topics.

- Develop and test jointly different models of **mobility (virtual, physical and blended)** in initial teacher education and as part of teachers' continuous professional development in order to enhance the quality and number of mobility as well as to make mobility an integral part of teacher education provision in Europe.
- Develop **sustainable collaboration** between teacher education providers with an impact to the quality of teacher education in Europe and with a view to inform teacher education polices at European and national levels.

Information from: https://ec.europa.eu/programmes/erasmus-plus/programme-guide/part-b/key-action-2/partnerships-cooperation/erasmus-teacher-academies_ro

ARTICLES from journals, newspaper, magazines

Online learning can't replace student mobility, EUA told

Author: Nic Mitchell
28 April 2021

Student mobility should be fully restored as soon as possible as the advantages of experiencing another country's higher education environment cannot be replaced by remote learning, delegates to this year's online European University Association (EUA) annual conference heard.

Professor Dame Janet Beer, vice-chancellor of the University of Liverpool and a leading figure promoting global links in United Kingdom higher education, told the conference that going abroad to study was a life-changing experience for students, contributing to their maturity and personal and intellectual capacity.

"Students will feel an affinity with the country they have studied in and the need for cross understanding and sensitivities to other people's cultures, making for greater cultural understanding both at home and overseas and building up social and economic ties between nations," she said.

And so, while the pandemic has changed everything in the way staff are likely to develop education and research global partnerships in the future – with much less travelling and more working together online – the same should not happen to international student mobility.

"*I would like that to be fully restored. I don't think we can replace that with online learning*," said Beer. "*The pandemic will change everything for staff, but hopefully it will not change student mobility*."

George Sharvashidze, rector of Ivane Javakhishvili Tbilisi State University in Georgia, told EUA conference delegates that while academics and university leaders could happily move activities online, such as the

EUA event he was speaking at, it was significant that his university had received more applications for student exchange programmes than ever before.

He said: “No one university can solve all the problems facing the world”, and highlighted the “wonderful example” of the German-Georgian science bridge in increasing capacity, joint degrees and then “receiving back our graduates and post-docs” to develop a joint research agenda.

Building trust

The conference session focused on nurturing global partnerships through education and research and included a number of video messages from around the world, including an address by Ana Maria Nhampule, deputy rector at Joaquim Chissano University in Mozambique, who described international higher education and research cooperation as one of the “main stepping stones for building trust and good relations among countries and continents”.

She told delegates that when Mozambique gained independence in 1975 it had only one university, but today with the support and assistance of the global academic community, particularly in Europe, it now had 48 higher education institutions and was striving to develop higher education capacity though greater access and more relevance and improved quality assurance.

“*We want to expand cooperation with European higher education and research so we can become more confident in going forward together for a better life where people can live in equality and in peace*,” she said.

Geopolitical challenges

During the conference session chaired by Patrick Levy, an EUA board member from Grenoble Alpes University, France, speakers were asked about developing international partnerships in challenging geopolitical environments and with hostile regimes.

Beer said this was an issue that understandably absorbed colleagues but urged European higher education not to shy away from fulfilling its mission in the broadest sense.

She cited the support of the EUA in making the case for the UK’s continued participation in the European Union’s Horizon Europe research and innovation programme, saying: “It was hugely important and the UK government listened. If we hadn’t made the case, we would be failing our students and staff.”

Beer also advocated more and stronger global collaboration in the face of the rising tide of nationalism to ensure staff and students are protected, together with academic freedoms and freedom of speech, “even if this is often tricky for our governments”.

Sharvashidze said this wasn’t just a problem for regions outside Europe, adding: “The exclusion of certain countries from Horizon Europe is probably not the best example of strengthening academic cooperation.”

He said that while he supported more cooperation, the situation in some countries, such as Belarus and Russia, made it difficult to cooperate on a full scale, but “responsible and reciprocal partnerships” should be encouraged even when there are problems with academic freedom and university autonomy.

Sharvashidze also turned to the need to ensure that competition and the league table mentality didn’t hinder global collaboration, saying: “While strategically it is important to boost cooperation, of course there will be competition, but we must be careful not to hinder openness.”

He was particularly concerned about the “publish or perish” culture encouraged by the rankings, which he admitted were important to politicians and parents but failed to pay attention to some of the other fundamental areas that higher education values.

He was also concerned by the growing number of figures calling for more connections with industry, saying: “My concern is that some politicians will translate that to saying we need more applied science and less blue sky research.”

Last word to Dame Janet Beer, who told delegates that one of the positive outcomes of the pandemic was that it connected universities more closely with their cities and regions.

“The civic ambitions of the places we inhabit have become sharper in focus and while we have global ambitions, like climate change, we also have to work with our regions and those relationships became closer during the pandemic,” she said.

Nic Mitchell is a freelance journalist and PR consultant specialising in European higher education. He runs De la Cour Communications and blogs at **www.delacourcommunications.com**.

Information from: https://www.universityworldnews.com/post.php?story=20210428083607129

ERC celebrates 10,000th grantee of frontier research awards

Author: Jan Petter Myklebust
08 May 2021

During an online ceremony on 6 May, European Commission President Ursula von der Leyen, European Parliament President David Sassoli and other European leaders expressed their strong support for frontier research and the European Research Council.

The **event** was the occasion to mark reaching the landmark of 10,000 top researchers having been supported by the European Union through ERC grants across Europe.

European Commissioner for Innovation, Research, Culture, Education and Youth Mariya Gabriel announced that the 10,000th researcher awarded an ERC grant was Professor Inga Berre from the department of mathematics at the University of Bergen, Norway, who in December 2020 was awarded an ERC consolidator grant for the project “Mathematical and Numerical Modelling of Process-Structure Interaction in Fractured Geothermal Systems”.

Gabriel said: “Today we celebrate all 10,000 ERC grantees. These bright minds from Europe and beyond are pushing the boundaries of our knowledge.”

She said the pandemic has “reminded us that long-term investments in fundamental research have proven crucial in moments of crisis. The many years of research behind mRNA technology allowed the development of new vaccines in record time”.

“It is precisely because we cannot anticipate all the challenges we may face tomorrow that we must continue to invest in frontier research. We do so through the European Research Council, a widely recognised success story for Europe, 14 years after its launch.”

The overall ERC budget from 2021 to 2027 is more than €16 billion (US$19.5 billion), as part of the Horizon Europe programme, under the responsibility of the Commissioner Gabriel.

The achievements of the ERC programme so far include:

• Seven Nobel Prizes, four Fields Medals, nine Wolf Prizes and other prizes awarded to ERC grantees.

• Around 80% of completed ERC projects led to scientific breakthroughs or major advances, according to several studies.

• Over 75,000 team members (mostly PhD students and post-docs) supported through ERC projects – the ERC helps train the next generation of researchers.

• More than 200,000 articles from ERC projects published in top scientific publications, including over 6,100 articles that are among the 1% most cited publications.

• ERC funding generated over 2,200 patents and other intellectual property right applications and some 300 new companies.

With an ERC consolidator grant, Professor Berre will be able to further her cutting-edge research in geothermal energy to help the advance towards clean and sustainable energy.

Berre said: “I am immensely honoured to be a representative of all the 10,000 ERC grantees on this occasion. I feel incredibly fortunate to have received an ERC grant and I look forward to starting the planned research with colleagues at the University of Bergen, international collaborators and five new team members.

“In the challenging tasks we have ahead of us, it is a great inspiration to be part of the remarkable community of ERC-funded researchers across Europe.”

Her interdisciplinary project moves in the borderlands between applied mathematics, computational physics and geoscience.

“The project will develop new mathematical models and numerical methods and use these in simulation of processes in geothermal systems that it has not been possible to quantify before.

“This way, we can better understand important aspects of, for example, high temperature and supercritical geothermal systems, which will be important for the production of a larger range of geothermal resources,” Berre said.

Rector of the University of Bergen Professor Margareth Hagen said she thinks that the ERC funding of basic research is playing a decisive role in strengthening research milieus in Europe: “The ERC grants are among the most prestigious in the world and are awarded to researchers in the absolute front in their field.

“The ERC is extremely important to promote the value of research in itself and for basic research. The funding of politically independent and ground-breaking research has great importance for society,” Hagen said.

Of the 10,000 top researchers funded so far by the ERC, two-thirds are under the age of 40.

Information from: https://www.universityworldnews.com/post.php?story=20210508094321669

NEWS FROM THE WORLD

21 GEDC Industry Forum

Developing the next generation of engineering innovators, experts and leaders.

Online and Dresden, Germany

20-23 September, 2021

All delegates will be able to attend the event 'digitally' via their own devices using the unique login we will provide. We will use a range of widely used enterprise software for plenary sessions and the design groups centralised via one simple event platform.

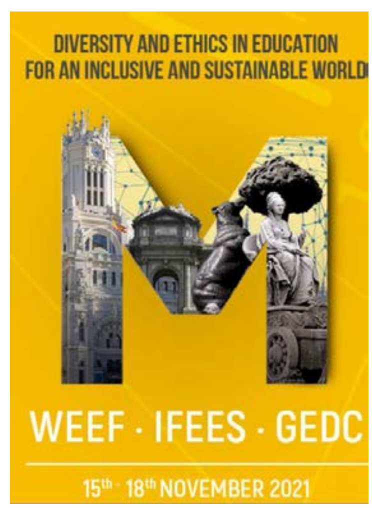
For delegates attending in-person,information about venues, hotels and additional activities will be shared once the local and international situation is clear for health and travel. In person attendance will only go ahead in accordance with local organiser and World Health Organisation guidelines.

More information: https://web.cvent.com/event/56e5d154-5558-4f5f-930c-253c28b493ea/summary?locale=en-US&i=maoUR6AIvEu_ODyuiVXynA

World Engineering Education Forum 2021

15 -18 November, 2021

Madrid, Spain



The 2021 WEEF/GEDC will be held in Madrid, Spain, from 15th -18th November 2021. Themed "***Diversity and Ethics in Education for an Inclusive and Sustainable World***" will have joint actions from IFEES and GEDC as hosts to have this new edition of the WEEF (World Engineering Education Forum) integrating Academia, Industry, Social Institutions, Associations and Students. All together during four days in Madrid following a hybrid model (face-to-face and online models) allowing each participant to follow the best way to interact depending on their own conditions and possibilities.

The organizers are preparing the best conference environment to allow close contact between all attendees as well as allowing time for meetings (public and private ones), round tables, workshops, keynotes and invited speakers, social Awards presentations, culture programs, industry panels and sponsor exhibits. All paper publication, presentations and activities of the conference will be in English.
More information: https://weefgedc2021.org/

7th International Young Geotechnical Engineers Conference

29 April – 01 May, 2022
Sydney, Australia

In 2022, the global community of soil mechanics and geotechnical engineering practitioners will come together in Sydney, Australia for the 20th International Conference on Soil Mechanics and Geotechnical Engineering (ICSMGE). For the 7th time, young geotechnical practitioners will have the opportunity to meet at their own dedicated Conference on the days immediately prior to the ICSMGE in a relaxed, friendly and supportive environment to share their research, ideas and experience, build international networks and discuss the challenges facing young geotechnical engineers in a rapidly changing world.

The Conference will be held at the International Convention Centre in Darling Harbour, Sydney over the three days prior to the ICSMGE giving delegates the opportunity to remain in Sydney for the main Conference.

This Conference seeks to provide a relaxed and supportive environment for young geotechnical engineers to present at their first major Conference with all delegates given the opportunity to present. We will have a particular focus on sustainability and on issues facing young geotechnical professionals beyond 2022.

Organizer: Australian Geomechanics Society

More information: https://icsmge2022.org/7iygec/index.php

20th International Conference on Soil Mechanics and Geotechnical Engineering (ICSMGE 2022)

1 - 6 May, 2022
Sydney, Australia

The ICSMGE 2022 will be held in Sydney, Australia on 1-6 May 2022 after it has had to be rescheduled from September 2021 to May 2022 because of the Covid19 pandemic.

The theme of ICSMGE 2022 is *"A Geotechnical Discovery Downunder – Geotechnical Diversity Awaits You*". Discover Australia and discover the innovation that lies where practical problems meet leading theoretical developments. ICSMGE 2022 will focus on the application of theory and the discovery that comes when world-class minds are focussed on the geotechnical problems facing our world. The conference program and technical sessions reflect this emphasis on applications, and are designed to trigger collaboration, innovation and discovery from a diverse group of participants.

Australia is a unique land and a diverse country in every way imaginable – in culture, population, climate, geography and history. The identity of all Australians, but especially the Indigenous Australians, is shaped by the relationship with the natural environment. Sydney, as host city, has much to offer the tourist, with a diverse range of attractions. It is a multi-cultural city and its people are warm and friendly and very happy to greet you with a welcoming "G'Day!"

Organizer: The Australian Geomechanics Society

More information: **https://icsmge2022.org/**

11th International Conference on Bridge Maintenance, Safety and Management - IABMAS 2022

11-15 July, 2022
Barcelona, Spain

IABMAS 2022 will be held in Barcelona, Spain in July 11-15th, 2022, at the Vertex Conference Hall with modernized audio-visual facilities and very good connections to nearby hotels, the airport and the city center.

The objectives of BARCELONA IABMAS 2022 are to address all aspects of bridge maintenance, safety and management. Specifically, it deals with: bridge repair and rehabilitation issues; bridge management systems; needs of bridge owners, financial planning, whole life costing and investment for the future; bridge related safety, risk and economic issues. The implications and applications of Big Data and AI in the management of existing bridge stocks is also one of the relevant objectives.
BARCELONA IABMAS 2022 aims to act as a forum for academics, practitioners, owners and operators to discuss recent advances and identify future research directions.

Topics of Interest
All major aspects of bridge maintenance, safety, and management will be addressed at IABMAS 2022. The state of the art as well as emerging concepts and innovative applications will be considered. Papers on theories, methods, algorithms, and applications are all welcome. Mini symposia or special sessions are organized for covering some specific topics; please check at **"Program-Mini symposia"** and **"Program-Special sessions."**
The Conference will focus on the following topics in general but not limited:

1. **BRIDGE MAINTENANCE**
   - Maintenance strategies
   - Inspection and diagnostic
   - Health monitoring
   - Non-destructive testing
   - Field testing
   - Historical and Old Bridges
   - Application of new tools (e.g. augmented and virtual reality, digital twins, artificial intelligence, unmanned aerial vehicles UAV)

2. **BRIDGE SAFETY**
    - Safety and serviceability
    - Assessment and evaluation
    - Damage identification
    - Deterioration modelling
    - Repair and retrofitting strategy
    - Bridge reliability
    - Bridge robustness and resilience
    - Fatigue and corrosion
    - Extreme loads (e.g. earthquake, fire, blast)
    - Climate change (e.g. floods, hurricanes, waves, tsunamis)
    - Advanced experimental simulation
    - Advanced computer simulation

3. **BRIDGE MANAGEMENT**
    - Bridge codes
    - Heavy vehicle and load models
    - Bridge management systems
    - Prediction of the future traffic demands
    - Service life considerations and predictions
    - Life extension
    - Sustainability and life-cycle assessments (UN Sustainable Development Goals)
    - IT/BIM in bridge management
    - Application of big data for decision making
    - Structural System Identification

KEY DATES

• Abstract Submission	July 09, 2021
• Notification Regarding the Abstract	September 15, 2021
• Full Paper Submission	November 15, 2021
• Final Paper Acceptance	December 15, 2021
• Final Paper Submission	January 10, 2022
• Early Bird-Registration	February 28, 2022
• Conference	11 - 15 July 2022

More information: https://congress.cimne.com/IABMAS2022/frontal/default.asp

4th International Symposium on Frontiers in Offshore Geotechnics

28-31 August, 2022
Austin, Texas

The University of Texas is pleased to invite participation in the 4th International Symposium on Frontiers in Offshore Geotechnics (ISFOG) to be held in, on August 28-31, 2022. ISFOG is now in its fourth event and third location following the most recent (2015) symposium in Oslo, Norway and the first two symposia in Perth, Australia in 2005 and 2010.

Themes

Submissions are invited addressing Frontiers in Offshore Geotechnics related to the following topics:

- *Site Characterization*: geotechnical testing and modelling, integrated studies, geohazards, sediment mobility and scour
- *Offshore Oil, Gas and Wind Energy Facilities*: foundations, monopiles, jack-ups, moorings, anchors, pipelines, risers, wells, cables, subsea systems, numerical modelling, case studies, cyclic loading
- *Alternative Energy and Other Ocean and Marine Resources*: wind, wave, tidal, current, thermal, gas hydrate, seafloor mining, aquaculture
- *Life Extension and Decommissioning*: fitness for service, foundation extraction, rigs to reefs, asset integrity, repurposing and reuse
- *Disruptive Technologies*: sensing, monitoring, intelligent systems, artificial intelligence, and machine learning
- *Design Methodologies*: performance-based/ whole-life/risk-based design and reliability
- *Rules, Standards and Regulations:* updates to existing design codes, development of new guidance

The fourth ISFOG event will be managed by the Geo-Institute of the American Society of Civil Engineers and the Deep Foundations Institute, held under the auspices of the ISSMGE Technical Committee 209 on Offshore Geotechnics, and will host the fifth McClelland Lecture. It will strive to continue providing a specialist forum for practitioners and academics to share solutions and new ideas that address the dynamic challenges of working in offshore design and installation. ISFOG 2020 will highlight emerging technologies related to data science and also emphasize the recent surge in offshore renewables development, both domestically in the United States and globally. Other growing areas of interest include performance-based design and addressing the challenges of an ageing offshore infrastructure, whether it be extending the operating life of these structures or solving the challenges and opportunities related to their decommissioning.

More information: https://www.isfog2020.org/

CALENDAR

Date **Event** **Place**

03-05.08.2021 **S3: Slopes, Slides and Stabilization** **San Francisco, CALIFORNIA**

www.dfi.org/s3-2021

07-10.09.2021 **32nd Annual EAIE Conference and Exhibition** **Gothenburg SWEDEN**

https://www.eaie.org/gothenburg.html?utm_source=Informz&utm_medium=Email&utm_campaign=EAIE+Gothenburg+2021

13–16.09.2021 **SEFI 2021** **Berlin, GERMANY**

Blended Learning in Engineering Education: challenging, enlightening – and lasting?

https://sefi2021.eu/

Date	Event	Place
18-19.09.2021	**Sixth GeoChina International Conference 2021**	**NanChang, CHINA**

http://geochina2021.geoconf.org/index.php

06-08.10.2021	**#ASCE Convention 2021**	**Virtual**

https://convention.asce.org/

12.11.2021	**First Joint Conference of EUCEET and AECEF** ***"The role of education for Civil Engineers in the implementation of the SDGs"***	**Thessaloniki, GREECE**

https://websites.auth.gr/euceetaecef2021/

12.11.2021	**The 14th General Assembly of the EUCEET Association**	**Thessaloniki, GREECE**

Date	Event	Place
18-19.11.2021	**3rd Asian Conference on Physical Modelling in Geotechnics (Asiafuge)**	**NUS UTown Campus, SINGAPORE**

https://www.asiafuge-sg.com/

Date	Event	Place
13-16.02.2022	**6th International Conference on Grouting & Deep Mixing**	**New Orleans, LOUISIANA**

http://www.dfi.org/GROUT2022

Date	Event	Place
19-24.06.2022	**Third European Conference on Earthquake Engineering and Seismology (3ECEES)**	**Bucharest, ROMANIA**

https://3ecees.ro/conference/

Date	Event	Place
11-15.07.2022	11th International Conference on Bridge Maintenance, Safety and Management - IABMAS 2022	Barcelona, SPAIN

https://congress.cimne.com/IABMAS2022/frontal/default.asp

Journal of Earthquake Engineering

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/ueqe20

Performance of Prefabricated Large Panel Reinforced Concrete Buildings in the November 2019 Albania Earthquake

Merita Guri , Svetlana Brzev & Diana Lluka

To cite this article: Merita Guri , Svetlana Brzev & Diana Lluka (2021): Performance of Prefabricated Large Panel Reinforced Concrete Buildings in the November 2019 Albania Earthquake, Journal of Earthquake Engineering, DOI: 10.1080/13632469.2021.1887010

To link to this article: https://doi.org/10.1080/13632469.2021.1887010

Published online: 22 Feb 2021.

JOURNAL OF EARTHQUAKE ENGINEERING
https://doi.org/10.1080/13632469.2021.1887010

Performance of Prefabricated Large Panel Reinforced Concrete Buildings in the November 2019 Albania Earthquake

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ABSTRACT
The paper discusses the performance of prefabricated reinforced concrete (RC) buildings, known as large-panel buildings (LPE), that were affected by the November 26, 2019 Durrës, Albania earthquake (M 6.4). This was a common typology for multi-family housing in urban areas of Albania and neighbouring countries, e.g. ex-Yugoslavia, Romania, and Bulgaria, in the period from 1960 to 1990. The paper outlines the key structural and seismic features of LPE buildings in Albania and presents observations from a field survey of selected buildings at eight different localities within the earthquake-affected area. A new post-earthquake damage classification for LPE buildings has been proposed.

ARTICLE HISTORY
Received 11 June 2020
Accepted 4 February 2021

KEYWORDS
Earthquake damage; large panels; reinforced concrete; prefabricated buildings; failure mechanisms; Albania

1. Introduction

On November 26, 2019 at 3:54 a.m. a magnitude (M) 6.4 earthquake occurred close to Mamurras, Albania, with the epicentre located offshore in the Adriatic Sea (20 km focal depth) (Fig. 1a). It was the strongest earthquake that hit Albania in the last 40 years, and it caused 51 deaths and 3,000 injuries. The earthquake occurred as a result of the Northwest-Southeast striking reverse faulting which is consistent with the tectonics of the region. At the location of this event, the African plate converges with the Eurasian plate at a rate of 73 mm/year. The epicentre was relatively close to the two largest urban centres in Albania: the capital Tirana (30 km distance) and a coastal city Durrës (22 km distance). The epicentral region of this earthquake has a known seismic hazard. Seven earthquakes of magnitude 6.0 and higher occurred in the last 100 years within 150 km distance from the epicentre, including the 1979 Montenegro earthquake (M 6.9) with epicentre at 75 km distance from the epicentre of the recent earthquake. The main shock was preceded by a M 5.6 foreshock which occurred on September 21, 2019 and affected the same area. More than 520 aftershocks which occurred within a week after the main shock caused further damage and/or collapse of previously damaged buildings (USGS 2019). For more information regarding the seismological aspects of the earthquake refer to Duni and Theodoulidis (2019), USGS (2019), and Lekkas et al. (2019).

According to the USGS (2019), the maximum earthquake intensity VIII was reported according to the Modified Mercalli Intensity (MMI) scale (Fig. 1b). Ground acceleration records in Tirana (TIR1 station, see Fig. 17) showed that the peak ground acceleration (PGA) was 0.112 g (Duni and Theodoulidis 2019), while the recorded accelerations at the Durrës station (DURR) revealed the PGA of about 0.2 g in the N-S direction (note that the record corresponds to the initial 15 sec of the earthquake), see Fig. 2a. Note that the stations were not located at the sites which experienced significant damage, hence it is expected that some sites in Tirana and Durrës were exposed to higher

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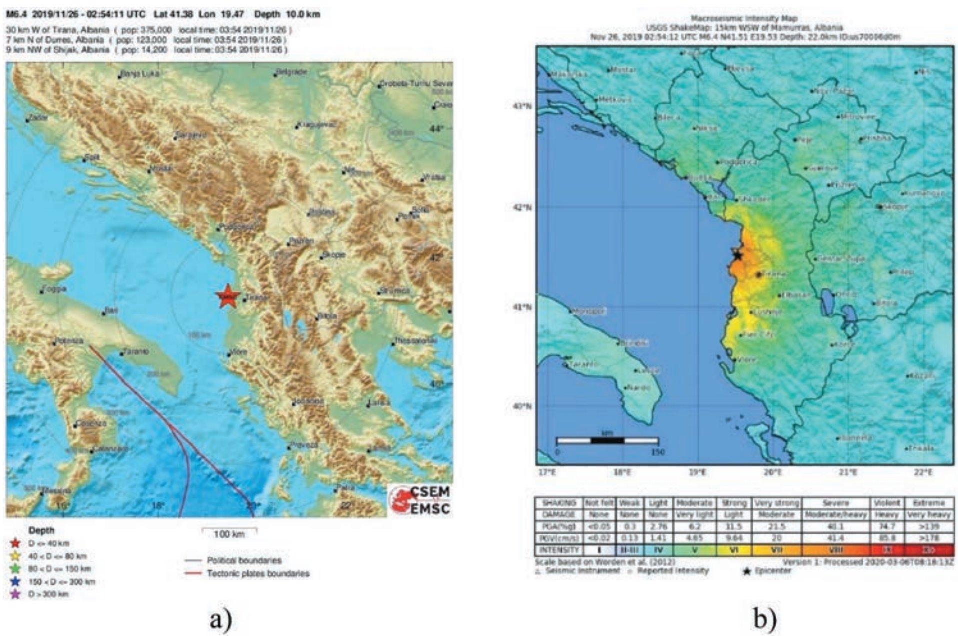


Figure 1. The November 26, 2019 Albania earthquake: a) regional map showing the epicentre (EMSC-CSEM 2019) and b) earthquake intensity map (USGS 2020).

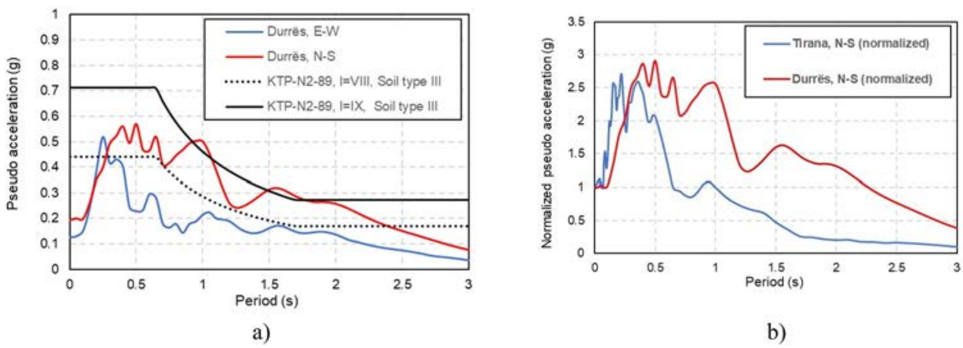


Figure 2. Pseudo acceleration response spectra for the Nov 26, 2019 earthquake: a) DURR station in Durrës (15.6 km away from the epicentre) and b) spectra corresponding to the N-S direction for Tirana and Durrës (IGEWE 2020; Marinković 2020).

ground accelerations. Post-earthquake damage reconnaissance studies showed that the buildings experienced more significant damage and/or collapse in the areas with soft soil conditions, which were prone to liquefaction, such as the coastal area of Durrës. The effect of soft soil on the response spectra for the Tirana and Durrës sites can be observed in Fig. 2b. Both spectra correspond to the N-S direction of ground shaking, and it can be seen that the Durrës spectrum shows higher pseudo accelerations over a wide period range (up to 1.0 sec), which reflects the effect of soft soil conditions.

It is estimated that 11,490 housing units were severely damaged or collapsed, while additional 83,745 units experienced damage; this constitutes about 18% of all housing units in 11 affected districts of Albania (UNDP 2020). Most mid-rise reinforced concrete (RC) framed buildings with masonry infills did not experience structural damage but the infills were extensively damaged in many cases. A few RC buildings collapsed, mostly due to irregular configuration (e.g. soft storey effect) and amplification due to soft soil conditions. Low- and mid-rise unreinforced masonry (URM) buildings experienced low to moderate damage, except for a few URM buildings with hollow-core prefabricated RC slabs which collapsed during the earthquake.

A significant number of prefabricated RC buildings were also exposed to the earthquake. Prefabricated RC structures are composed of various elements which are manufactured in industrialized manner off the building site. The prefabricated elements can be connected by lapped, welded, or mechanically connected bars in the joints. One of the major advantages of this technology is speed of construction, which enables a large-scale housing construction within a short timeframe. The other advantage is its cost-effectiveness compared to the monolithic cast-in-situ concrete construction. The development of prefabricated RC construction technologies and building applications started after the World War II in Europe, due to a significant demand for large-scale housing for rapidly growing urban population. This construction practice was especially popular in countries with socialist/communist governments in which housing design and construction was performed solely through the public sector, for example the Soviet Union and China, but it was also widely used for the multi-family housing construction in urban areas of some European countries, including Albania, ex-Yugoslavia (Velkov 1981; Velkov, Ivkovich, and Perishich 1984), Romania (Bostenaru Dan and Sandu 2004; NBS 1977), and Bulgaria (Andonov 2019).

Prefabricated structural systems can be classified into i) large panel wall systems (LPE), ii) frame systems, iii) slab-column systems with shear walls, and iv) dual frame-wall systems. One of the most widely used prefabricated systems is large panel wall system (referred to as LPE buildings in this paper) which is common in urban areas of Albania and neighboring countries. LPE system consists of RC wall and floor panels which are connected at discrete points and form a box-like structure. LPE buildings have been exposed to several damaging earthquakes, including the 1976 Gazli, Uzbekistan (Soviet Union); 1977 Vrancea, Romania; and the 1988 Spitak, Armenia earthquake. The performance of these buildings was satisfactory, without evidence of significant damage or collapse. However, there is a lack of technical resources that document the seismic design philosophy for this construction technology.

This paper outlines the key structural and seismic features of LPE buildings in Albania and presents observations from a post-earthquake survey at two different localities: Tirana and Durrës. The observed damage patterns and failure mechanisms have been presented and illustrated through examples. A post-earthquake damage classification for LPE buildings has been proposed. The topic is relevant for the earthquake engineering community due to significant stock of existing LPE buildings in several European countries, a limited evidence regarding the performance of these buildings in past earthquakes, and a lack of suitable post-earthquake damage classifications.

2. Prefabricated Large Panel Buildings in Albania

A major demand for the large-scale urban housing construction in Albania and the use of prefabricated concrete technology started in 1972, when a plant was set up using Chinese technology near existing plant "Josif Pashko" in Tirana. New plant had a capacity of 2,000 apartments per year. According to the 2011 Census of Albania, prefabricated buildings (with LPE system) constituted about 5% of the overall building stock in the country (Novikova et al. 2015). These are typically mid-rise buildings, usually 4–6 storeys high, and are used as residential (apartment) buildings. Buildings of this type can be found in large cities like Tirana and Durrës. Figure 3a shows a typical 5-storey LPE building in Durrës, while Fig. 3b shows a renovated LPE building in Vorë (close to Tirana). It should be noted that the practice of prefabricated building construction was discontinued in Albania after the end of communist regime in 1991. Contemporary construction practice for mid- and high-rise buildings consists of RC frames and slabs which are cast in-situ, while masonry infills enclose exterior and interior spaces. Figure 3a shows a modern 8-storey RC frame building (at the rear) adjacent to a 5-storey LPE building (shown at a front). Most LPE buildings are more than 40 years old and, in many cases, they were in dilapidated condition before the earthquake due to inadequate maintenance and building renovations.

a) b)

Figure 3. Typical LPE buildings in Albania: a) a typical 5-story LPE building and an adjacent 8-storey modern RC building, Durrës and b) a well-maintained and renovated LPE building, Vorë (photo: M. Baballëku).

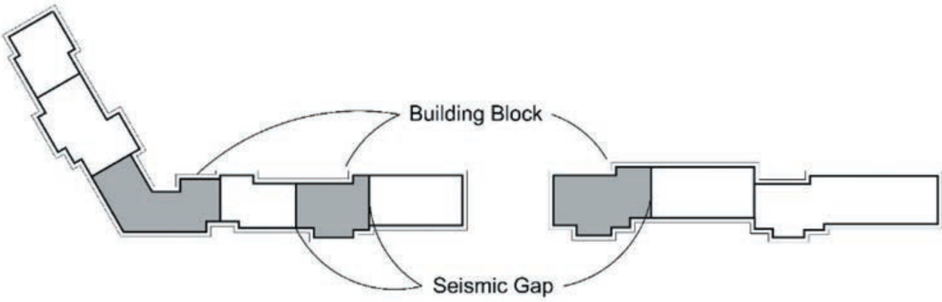
Figure 4a shows seven locations in Tirana where prefabricated buildings were constructed, with approximately 7,000 housing units (apartments) and about 28,000 occupants. Figure 4b shows four locations in Durrës where prefabricated RC buildings were constructed. It is estimated that in Durrës there are approximately 2,500 apartments and 10,000 occupants living in LPE buildings. This paper discusses seismic performance of LPE buildings in the "Kombinat" area in south-western part of Tirana (shown in Fig. 4a) and at a selected location in Durrës (labelled in Fig. 4b). Note that details regarding the surveyed buildings at these eight locations (7 in Tirana and one in Durrës) are presented in Table 3.

Architectural planning for LPE buildings was performed in a standardized manner. These buildings usually have a complex layout that consists of several blocks, as shown in Fig. 5a. Building blocks are the smallest units in the building and are separated by a seismic gap. There are usually 10 to 20 blocks at a specific location. Each block has approximately 10 to 15 apartments and houses 60 occupants. It can be seen that some building blocks have regular plans (e.g. rectangular-shaped), while others are irregular. Figure 5b shows floor plan of a typical building block. Typical plan dimensions are: 14.4 m length and 9.8 m width. The original architectural and structural drawings for LPE buildings were accessed through the Central Technical Construction Archive (AQTN) in Tirana.

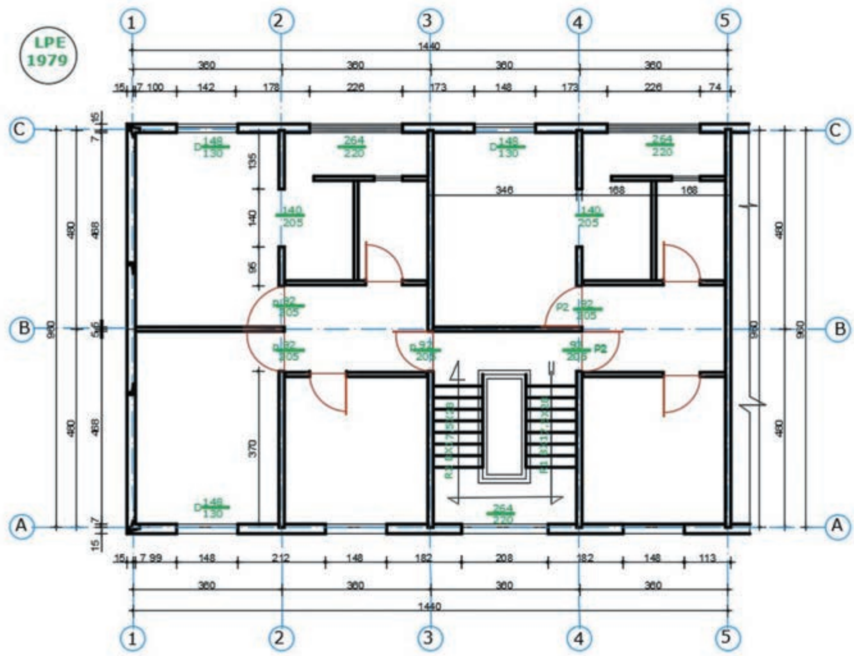
LPE buildings can be designed using one of the following structural configurations: cross-wall system, long-wall system, or two-way system (Fig. 6). The differences between these systems are self-explanatory. Two-way configuration is ideal from the seismic performance perspective, while cross-

a) b)

Figure 4. Locations of prefabricated LPE building sites in Albanian cities: a) Tirana and b) Durrës.



a)



b)

Figure 5. Architectural plans for typical Albanian LPE buildings: a) examples of building layout and b) a typical building block (Type-1) (source: AQTN).

wall and long-wall configurations are vulnerable to seismic actions along one of the principal horizontal directions. All LPE buildings in Albania were designed using a cross-wall system (Fig. 6a).

LPE buildings consist of various prefabricated elements such as wall panels, floor panels, as well as other elements such as staircase and landing, but the foundations were cast monolithically (in-situ). Prefabricated wall panels are usually one-storey high, with a typical height of 288 cm and length of 356 cm (note that the panel length depends on its location within a building). There is a variety of panel configurations – some panels are solid while others have openings (doors/windows). The exterior loadbearing wall panels (PJ) are 22 cm thick while the interior loadbearing panels (PM) are 14 cm thick. Interior partition panels (PN) are either 10 or 14 cm thick.

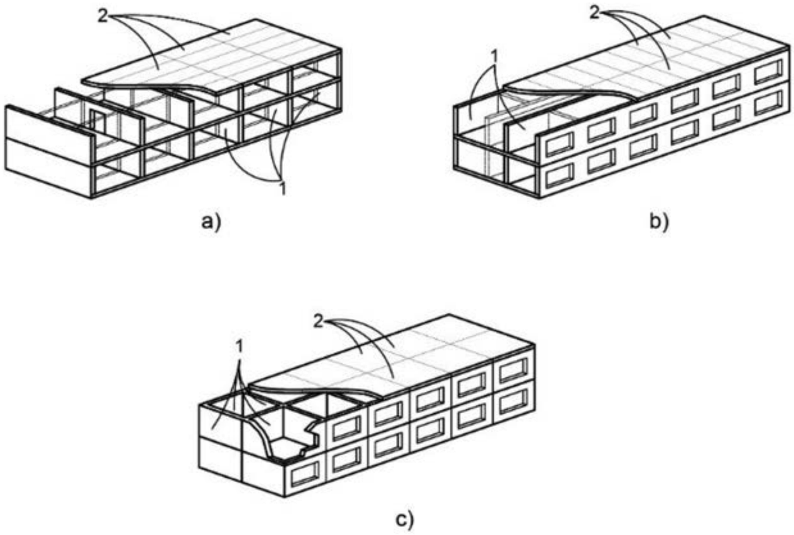


Figure 6. Basic structural configurations for LPE buildings: a) cross-wall system; b) long-wall system, and c) two-way system (note: 1-wall panel and 2- floor panel) (based on FIB 2008).

An assembly scheme is illustrated in Fig. 7a. Each number indicates a sequence of the wall panel erection at a floor level. For example, cross wall panel 1 is erected first, followed by panel 2 in longitudinal direction, and subsequently another cross wall panel 3 is erected. The sequence continues with wall panels 4, 5, 6, etc. Note that number 7 denotes interior partition walls, which were erected last. A cross-wall system consists of room-size prefabricated box units which are stacked on top of each other up the building height. For example, wall panels 1, 2, and 3 (and the corresponding floor panel) constitute a room-size prefabricated box.

Horizontal floor and roof panels usually consist of room-size elements, which are interconnected in horizontal direction. These panels are usually 22 cm thick and span either in one-way or two-way directions, depending on the architectural plan. The sizes are typically 360 cm length and 240 cm width for 1-way slabs and 360 cm square for 2-way slabs. An example of a slab layout is shown in Fig. 7b. It can be seen from the figure that each slab panel has been labelled, e.g. panels labelled as S-1 denote 1-way slabs.

The wall and roof panels were constructed using M 200 concrete grade (approximately 20 N/mm^2 compressive strength based on 15 cm cube specimens), while the foundations were constructed using M 100 concrete grade (approximately 10 N/mm^2 compressive strength) with 25% stone aggregate. Structural steel with 210 N/mm^2 yield strength of was used for the construction of panel connections. Wall and floor panels were reinforced with a steel mesh having 4 mm diameter horizontal bars and 5.5 mm diameter vertical bars at 15 cm spacing. Two layers (curtains) of reinforcement were used for wall and floor panels. The mesh was made of steel with the yield strength of either 290 or 350 N/mm^2.

Connections between adjacent panels in prefabricated RC structures are critical for their structural and seismic safety. Note that “connection” is a general term, which describes the region where elements are connected (e.g. wall-to-floor connection), while “joint” denotes an area between the connected elements where the force transfer takes place. In general, joints are the points of transfer for bending moments, axial and shear forces induced by gravity and lateral loading. Joints between the prefabricated RC elements are usually classified as “wet” and “dry” (FIB 2008; UNIDO 1983). Wet joints are constructed using cast-in-situ concrete to achieve monolithic continuity. When structural continuity is required through the joint, reinforcing bars extending from adjacent elements are looped, lapped, or welded before the in-situ concrete is placed. Dry joints are constructed by bolting or welding steel plates or other steel inserts, thus transferring the actions between elements at discrete

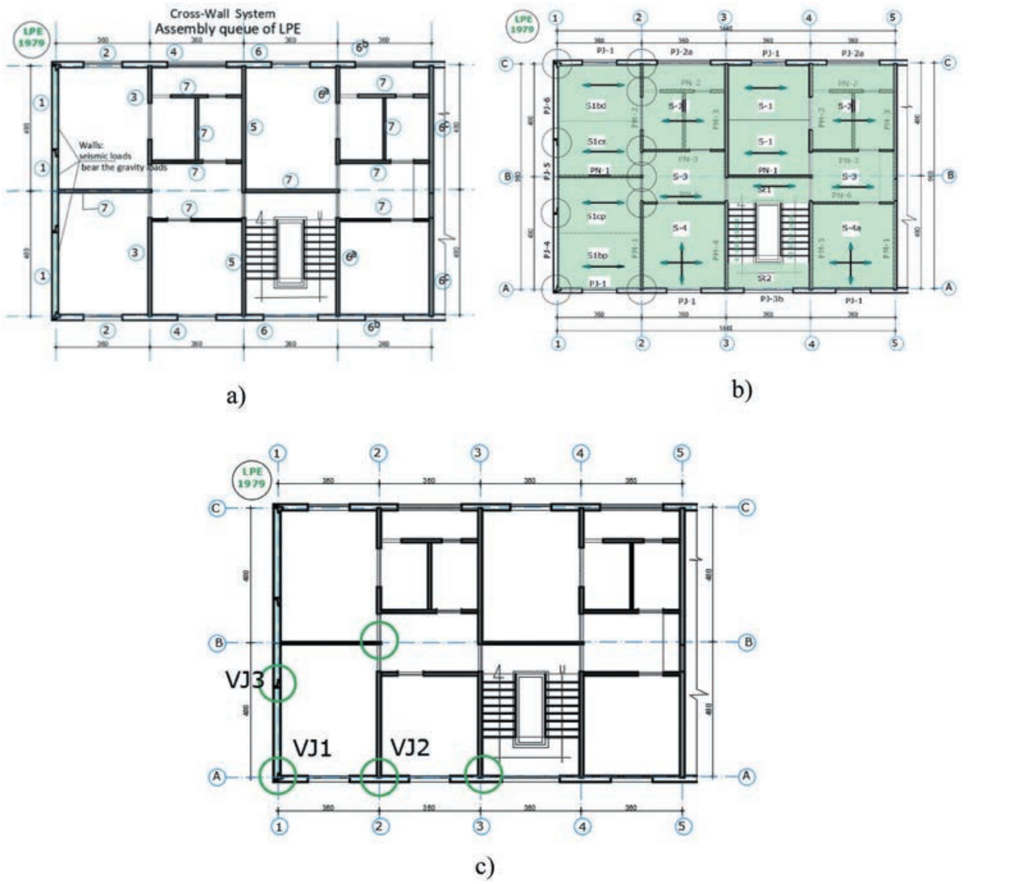


Figure 7. Albanian LPE buildings: a) a floor plan showing assembly scheme for wall panels; b) typical floor plan showing 1-way and 2-way slab panels, and c) floor plan showing the locations of vertical joints VJ1, VJ2, and VJ3.

points of contact. In the Albanian LPE buildings majority of joints were achieved by field welding, that is, welding mild steel bars at the construction site using electrodes of type TL VIIIS and kb IX/xs (according to the Albanian standards).

In LPE buildings there are vertical joints (VJ) between the prefabricated wall panels (interior and exterior), horizontal joints (HJ) between the floor/roof slab panels, and also horizontal joints between the walls and floor/roof slabs. Note that vertical and horizontal joints in LPE buildings are located at discrete points. Figure 7c shows the locations of typical vertical joints in a LPE building (VJ1, VJ2, and VJ3). Vertical joints connect the vertical edges of adjoining wall panels and primarily resist the effects of vertical shear forces due to seismic loading. Note that vertical edges of the panels were grooved to enhance shear resistance of the connections.

Exterior wall panels at the building corners have L-type connections (joint type VJ1), see Fig. 8. Two vertical bars are placed within a pocket which continuously extends up the panel height. These bars are connected by means of welded plates at 30 cm spacing. There are two discrete joint locations for adjacent wall panels: at the base and the top of the panel. Joint at the base is achieved by lapping horizontal reinforcing bars and placing cast-in-situ concrete (see Fig. 8a), while joint at the top is achieved by 5 mm thick horizontal plate welded to the vertical bars (Fig. 8b). Figure 9a shows a T-connection between exterior and interior wall panels, which is achieved by lapping and welding horizontal bars, and placing cast-in-situ concrete. Figure 9b shows a connection of adjacent exterior wall panels in plane (joint VJ3).

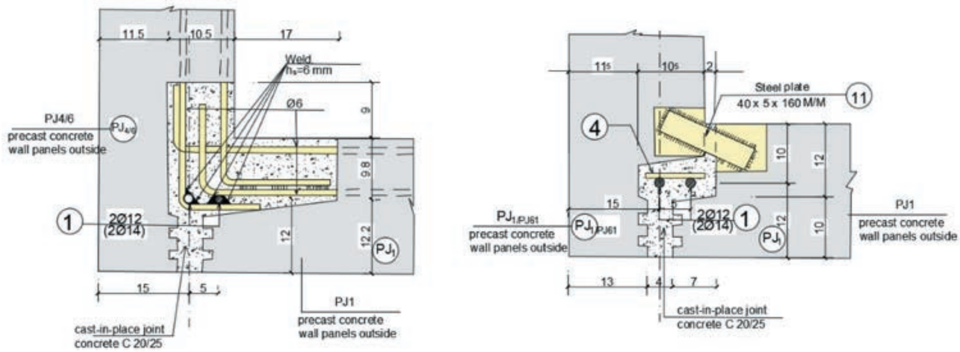


Figure 8. Wall panel L-connection (joint VJ1): a) joint at the bottom of the panel, and b) joint at the top of the panel.

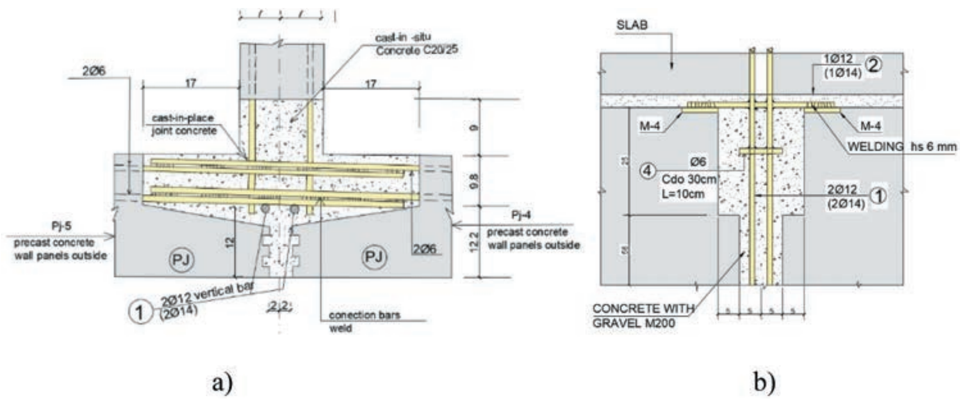


Figure 9. Wall panel connections: a) vertical T- joint VJ2 and b) vertical joint VJ3 between the adjacent exterior wall panels.

Horizontal joints connect horizontal edges of adjoining wall and floor panels and primarily resist vertical axial forces due to gravity loads, which are transmitted by the walls and floors, horizontal shear forces due to seismic loads, and bending moments in two directions due to seismic loading acting on the upper panels. Figure 10a shows a floor panel with the steel plate which is used to achieve connection with the adjacent panel. It can be seen from the figure that steel plate is located at the edge of the panel at its midlength. A joint detail is shown in Fig. 10b – it can be seen that protruding L-shaped reinforcing bars are welded to the steel plate. Floor-to-wall connection is shown in Fig. 11. Note that vertical reinforcing bars from the wall panel are welded to the horizontal slab reinforcement (U-shaped bars) at two locations (top and bottom of the slab).

3. Seismic Behaviour and Failure Mechanisms for LPE Buildings

3.1. Failure Mechanisms for LPE Buildings

LPE buildings are box-like structures in which vertical and horizontal panels resist both gravity and lateral loads. Lateral force-resisting system (LFRS) in an LPE building consists of vertical elements (walls), horizontal elements (diaphragms), and their connections. When these buildings are subjected to seismic loads wall panels act as shear walls and floor/roof slabs act as diaphragms. These diaphragms need to have sufficient strength and stiffness to permit rotation and deformation of the entire floor, hence the connections between the slab panels need to be sufficiently strong. Note that modern seismic design codes for prefabricated RC structures prescribe ductile behaviour of these structures when

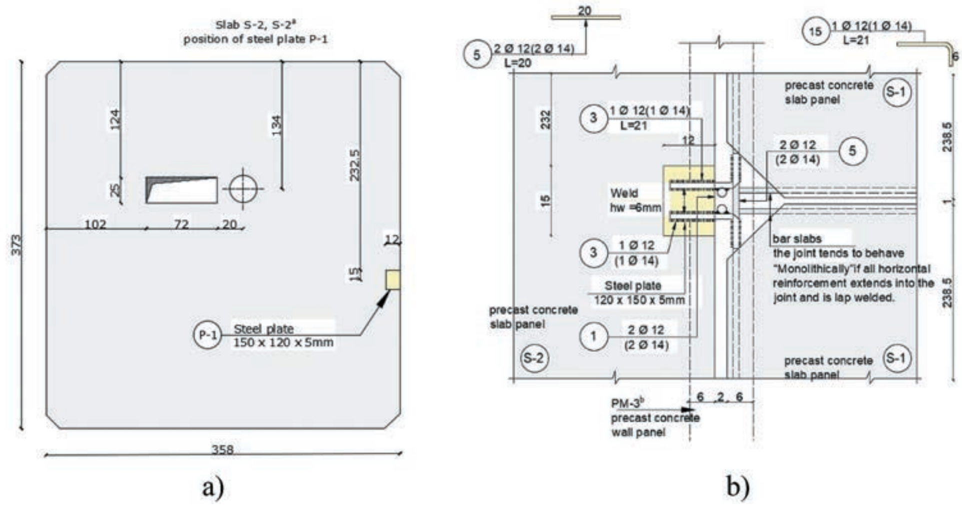


Figure 10. Floor slab connections: a) plan of a slab panel showing the connection location (*P*-1) and b) detail of a joint between the adjacent slab panels (horizontal section).

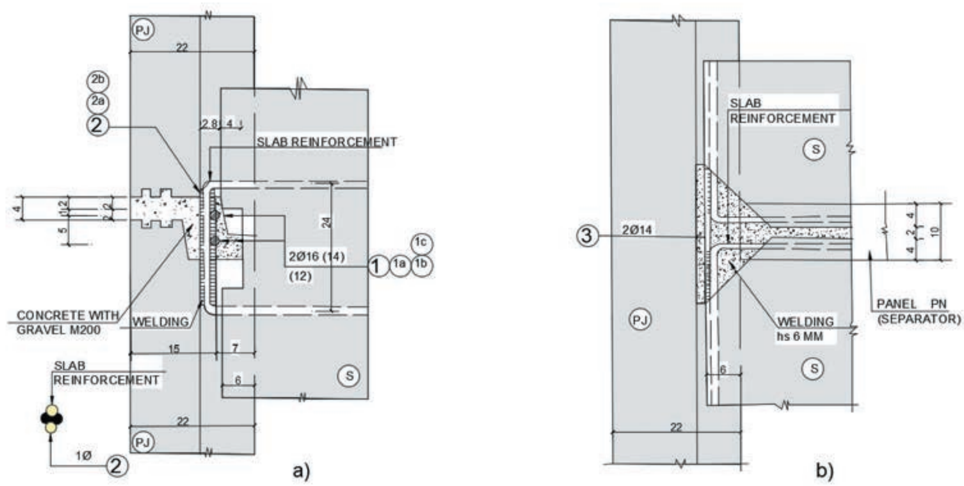


Figure 11. Floor-wall connection: a) connection between the floor slab and two adjacent wall panels (horizontal section) and b) floor-to-wall connection (horizontal section).

subjected to earthquake shaking, e.g. New Zealand code NZS 3101, American code ACI 318, and European code Eurocode 8. In particular, it is expected that the diaphragms remain elastic when subjected to ultimate forces corresponding to the capacity of shear walls.

The diaphragms transfer lateral forces to the wall panels through the connections at the interface between the diaphragms and wall panels. Figure 12 illustrates types of internal horizontal forces in an LPE building subjected to seismic loading, including shear (V), tension (T), and compression (C) forces. It can be seen from the figure that diaphragm needs to resist shear forces (1) due to in-plane lateral loading, as well as tension and compression forces (2) along the perimeter (chord forces) due to in-plane bending moments. These forces need to be resisted by slab panels and their connections.

Shear walls, the main vertical elements of LFRS in LPE buildings, need to resist seismic shear forces which are transferred from the diaphragms at each floor level and transmit these forces

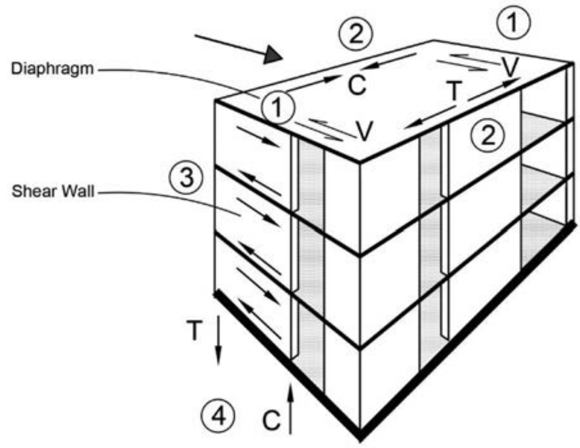


Figure 12. Internal forces in an LPE building subjected to seismic loading.

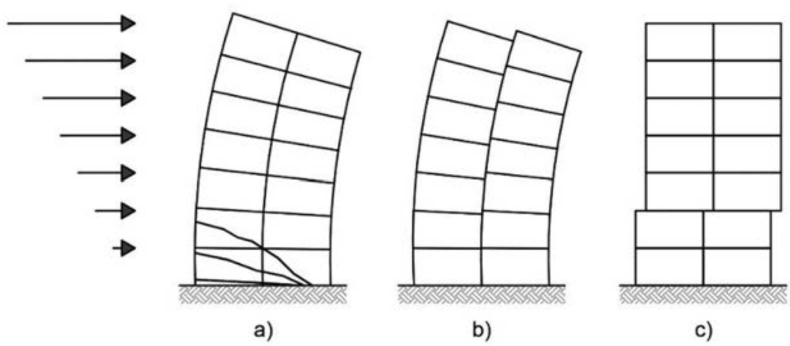


Figure 13. Seismic failure mechanisms for shear walls in LPE buildings: a) monolithic behaviour; b) weak vertical joints cause vertical slip, and c) weak horizontal joints cause horizontal slip (based on UNIDO 1983).

and bending moments to the foundations. In LPE buildings shear walls are composed of wall panels which are connected by means of horizontal joints (HJ) at each floor level and vertical joints (VJ) up the building height. Seismic failure mechanisms for shear walls in LPE buildings are significantly influenced by the type and integrity of panel connections. Figure 13 shows a prefabricated RC shear wall subjected to seismic loading. A prefabricated RC shear wall is expected to perform in the same manner as a monolithic (cast-in-situ) RC shear wall at low seismic demand, or even at a high seismic demand level provided that horizontal and vertical wall panel joints are sufficiently strong (Fig. 13a). Typical earthquake damage is in the form of flexural and shear cracking within the shear wall.

In prefabricated RC shear walls (LPE walls) with weak vertical joints between adjacent wall panels, a vertical slip may take place along the adjacent wall panels subjected to rocking caused by seismic overturning moments (Fig. 13b). Alternatively, a shear slip may occur due to high seismic shear forces when horizontal joints between the adjacent panels are weak (Fig. 13c). Initially, it is expected that horizontal slip is going to occur at upper floors, because a sliding mechanism is based on the Coulomb's Law and is initiated at the upper floors due to lowest axial stress demand. Failure is expected to be concentrated within the panel joints when the joints are weaker than the panels, which is believed to be the case with Albanian LPE buildings. Finally, a combination of vertical and horizontal slip may take place in walls with weak horizontal and vertical joints.

LPE buildings with weak joints are expected to experience a decrease in the stiffness and a corresponding increase in the fundamental period due to seismic excitation. It is also important to recognize that cracking within the wall panels is not expected in LPE buildings with weak joints, since these panels behave like rigid bodies, which dissipate earthquake energy through sliding within the connection regions.

As a result of the slippage at the interface between adjacent panels, the corresponding joints are subjected to internal forces, see Fig. 14. For example, shear forces V induced by vertical and horizontal slip need to be resisted by vertical joints (VJ3) and horizontal joints (HJ), see Fig. 14a. Bending moments, which develop in a shear wall, cause tension and compression forces in vertical joints VJ1 (exterior walls) or VJ2 (interior walls), see Fig. 14b. Details of vertical and horizontal joints in Albanian LPE buildings are presented in Figs. 8–11.

Research evidence regarding the failure mechanisms of prefabricated shear walls in LPE buildings is limited (Clough, Malhas, and Oliva 1989). A study involving a nonlinear analysis of prefabricated RC shear walls subjected to seismic loading performed by Becker, Llorente, and Mueller (1980) showed that it is possible to simulate rocking and sliding behaviour in these walls. A few experimental studies examined the failure mechanisms of prefabricated RC wall assemblages and confirmed the difference for shear transfer between monolithic and prefabricated RC shear walls. Oliva and Clough (1983) tested three one-third scale 3-storey models of prefabricated RC wall assemblages on a shaking table using simulated seismic excitation. The specimens experienced significant rocking motion at higher excitations, which was characterized by the uplift at the base of the wall. A significant drop in stiffness (by about 50%) was reported as a result of the damage at higher acceleration demands. A companion testing program on the same prefabricated system (Rad-Balency) was performed by Velkov, Ivkovich, and Perishich (1984). Mueller (1988) tested full-size 5 specimens of 5-storey prefabricated RC wall panel assemblages under reversed cyclic loading. The specimens experienced shear slip corresponding to the friction coefficient of 0.55. It was concluded that the ductility of the specimens was negatively affected by the concentration of elastic and inelastic deformations within the connection region. A significant testing program on prefabricated LPE buildings was performed in the former Soviet Union, as reported by Polyakov et al. (1969). The testing of 1/6th scale models of 4-storey wall

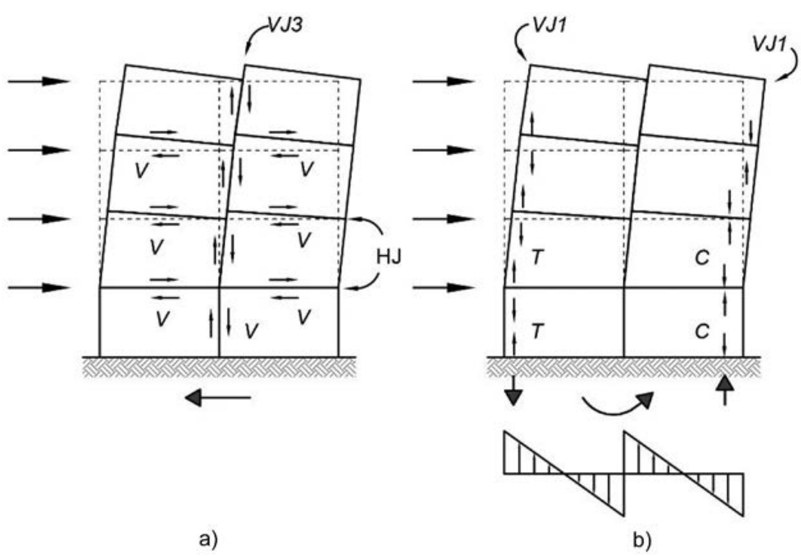


Figure 14. Prefabricated RC shear wall subjected to in-plane seismic loading: a) shear forces and b) tensile and compressive forces (based on FIB 2008).

assemblages was performed on shaking table. The researchers emphasized the importance of reliable panel joints for seismic resistance of LPE buildings.

3.2. Effect of Amount and Layout of Walls

As discussed earlier in the paper (see Fig. 6), LPE buildings in Albania are characterized by a cross-wall structural configuration. Figure 15 shows a floor plan of an Albanian LPE building. It is obvious that the walls in transverse (cross) direction are longer and that the overall wall area is significantly larger compared to the walls in longitudinal direction. It is true that wall panels in longitudinal and transverse directions are interconnected and form T- or L-or I-shaped sections, as shown in the figure. Unfortunately, the integrity of these composite sections is maintained only at low earthquake shaking intensities, when the stresses in the walls are still within the linear elastic range. Once the slip along the vertical joints between the panels takes place at higher shaking intensities, vertical connections between the panels start to disintegrate and each panel resists seismic shear forces by acting as a rectangular-shaped wall section. Based on the above discussion, it can be expected that LPE buildings with cross-wall configuration may be more vulnerable to the effects of earthquake shaking in longitudinal direction.

The authors propose to use Wall Index *WI* (also known as wall density) as an indicator of seismic vulnerability for LPE buildings based on the amount and distribution of walls. Wall index *WI* is the ratio of A_W (sum of cross-sectional areas for all walls in the horizontal direction under consideration) and the ground floor plan area A_P for a specific building plan. *WI* is believed to be one of the key parameters for seismic design of loadbearing masonry buildings. For example, the required *WI* value is prescribed in Eurocode 8 for seismic design of simple masonry buildings, and the prescribed values depend on the seismic hazard of the building site, building height, and the type of masonry (EN 1998-1:2005). *WI* has also been considered as an indicator of seismic safety of RC buildings with shear walls in Chile (Lagos et al. 2012). There is an evidence of several post-earthquake studies focused on the correlation of the *WI* value and the extent of earthquake damage in loadbearing masonry buildings, in countries such as Chile (Astroza et al. 2012; Moroni, Astroza, and Acevedo 2004) and China (Cai et al. 2018). A study on the *WI* in low-rise RC frames with masonry infills affected by the 2015 Gorkha, Nepal earthquake was performed by Brzev et al. (2017). There is no evidence of previous attempts to apply the *WI* concept on LPE buildings.

The *WI* values have been determined for a typical Albanian LPE building with plan dimensions shown in Fig. 5b. Wall layout shown in Fig. 15 was used to determine the *WI* values for longitudinal

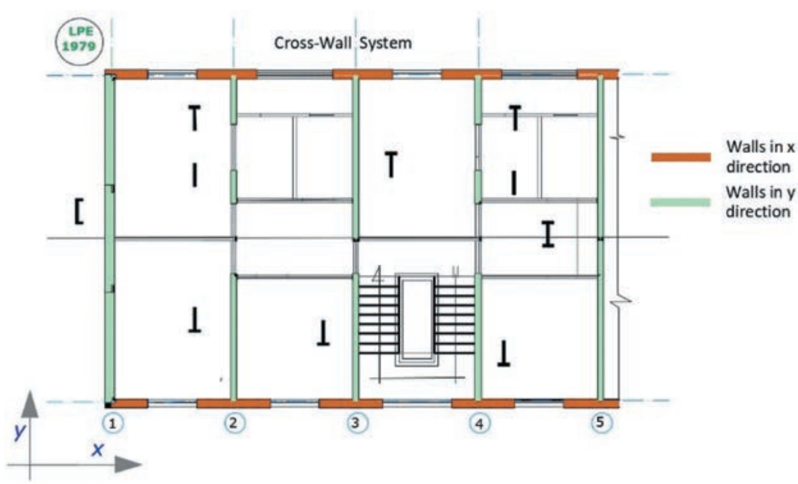


Figure 15. Floor plan of a typical Albanian LPE building: shear walls aligned in longitudinal (X) and transverse (Y) directions.

(X) direction (2.6%) and transverse (Y) direction (4.6%). It is clear that the *WI* value is less by about 43% in longitudinal direction compared to transverse direction. If this was a loadbearing masonry building, Eurocode 8 would prescribe the minimum *WI* value of 5% for each direction for a 5-storey reinforced masonry building at a site with design acceleration $a_g S$ less than 0.1 g (EN 1998-1:2005). It is expected that the required *WI* value would be less for an LPE building due to a higher shear strength of concrete compared to masonry. However, a further study is needed to establish the required *WI* values for LPE buildings.

3.3. Effect of Soil Conditions

It has been recognized that LPE buildings are more vulnerable to seismic effects at sites with soft soil conditions (UNIDO 1983). The results of forced vibration tests performed on LPE buildings showed that soft soil conditions cause an increase in their fundamental period. The studies have also indicated a significant soil–structure interaction in LPE buildings located at sites with soft soil conditions. These buildings are rigid box-like structures, hence lateral displacements induced by the foundation pressure may be significant, of the same order as interstorey lateral displacements due to seismic forces (Kolleger and Bouwkamp 1980). It is very important to consider the effect of soil–structure interaction in the seismic analysis of LPE buildings at sites with soft soil conditions.

4. Albanian Seismic Design Codes and Seismic Hazard Requirements

Seismic design and detailing provisions related to prefabricated RC buildings have been incorporated in several international building codes, including the USA (ACI 318), New Zealand (NZS3101), and Europe (Eurocode 8). A few international guidelines have also addressed seismic design of prefabricated RC buildings, e.g. UNIDO (1983), CAE (1999), and FIB (2008). In the former Soviet Union, where large panel construction had been practiced for several decades, a seismic design guideline was published in 1985 (Жилища 1985).

At the time when these buildings were designed Albanian building codes did not contain provisions related to seismic design of prefabricated RC buildings. According to the available information, design of LPE buildings in Albania was developed by the Institute of Construction and was based on the Albanian design code of 1963, however specific design information is not available. It is expected that Albanian LPE buildings were designed according to the same design principles as cast-in-situ RC structures which were addressed by the codes. The first building design code in Albania which contained seismic design provisions was published in 1952 and was subsequently revised in 1963, following a series of strong earthquakes that affected South-East and South-West regions of the country. The code was extensively revised in 1978 (KTP-78). The last edition of the code was published in 1989 (KTP-N.2–89), and it included only seismic design provisions. Seismic zonation map for Albania was developed using the MSK-64 macroseismic intensity scale as an indicator of seismic hazard. The changes in seismic hazard maps over time resulted in an increase in the seismic demand for LPE buildings at the same locations. For example, Tirana was classified as seismic zone with intensity VI according to the 1963 and 1978 codes. According to KTP-N.2–89, various areas in Tirana were assigned intensities VI 1/2, VII, VII 1/2 or VIII, depending on the soil type and other factors. Seismic microzonation maps for Tirana and Durrës are presented in Fig. 16. It should be noted that the locations of LPE buildings are numbered 1 to 8 (see Table 3).

Response spectra for the Nov 26, 2019 earthquake for the TIR1 station in Tirana show relatively high spectral accelerations for the period range from 0.2 to 0.5 sec, which is within the expected range of fundamental periods for LPE buildings. Spectral accelerations for the E-W direction were generally higher than 0.3 g, while for the N-S direction these accelerations were in the range from 0.2 to 0.3 g. Figure 17 shows acceleration response spectra developed from acceleration records at the TIR1 station, and also the KTP-N.2–89 design spectra for sites corresponding to zones VII and VIII. Note that earthquake intensity within Tirana ranges from VI 1/2 to VIII, depending on the seismic microzonation (see Fig. 16a).

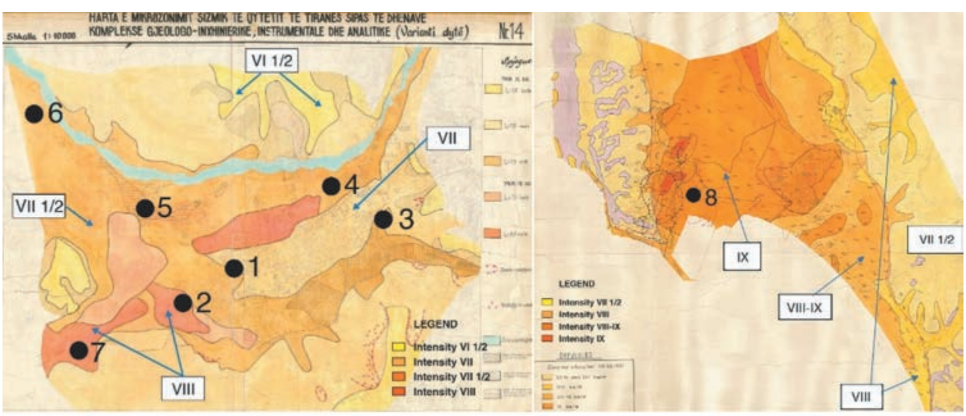
5. Post-earthquake Damage Assessment of LPE Buildings

5.1. Review of Existing Post-earthquake Damage Classifications

Various approaches for post-earthquake building assessment have been proposed to determine severity of damage in structural and non-structural components and verify structural integrity after damaging earthquakes (Anagnostopoulos et al. 2004; Baggio et al. 2007; Grünthal 1998). A damage classification, which characterizes the type and severity of damage, is a critical aspect of post-earthquake damage assessment. Most damage classifications have identified 3 to 5 Damage Grades (DGs), ranging from minor damage to collapse. These classifications apply to various LFRSs, e.g. loadbearing masonry walls, RC frames or structural walls, etc. Some publications describe general damage patterns for each DG at a high level (Grünthal 1998), while others offer comprehensive recommendations regarding the extent of damage, e.g. size of crack widths in structural components (Anagnostopoulous et al. 2004). Evidence from research studies has also been used to characterize extent of damage of structural components in cast-in-situ RC buildings, e.g. FEMA 306 (FEMA 1998). Table 1 presents existing post-earthquake damage classifications for RC wall buildings.

Developing a damage classification for LPE buildings is a challenging task due to limited evidence regarding the performance of different LPE building systems in past earthquakes, and a limited knowledge regarding the nonlinear behaviour of LPE buildings subjected to seismic excitation. Andonov (2019) presented a damage classification for LPE buildings in Bulgaria, which assumes a ductile failure mechanism (similar to Fig. 13a). A damage classification for LPE buildings with weak connections is currently not available, however, damage classification for cast-in-situ RC shear walls with a sliding failure mechanism, as outlined in FEMA 306 (FEMA 1998) is a useful reference due to similarities in structural system and failure mechanism (see Table 1 and Fig. 18a). It can be seen from the table that damage classification for RC walls with a sliding mechanism contains fewer DGs compared to the frame systems because the damage is mostly concentrated within the sliding interface at the base of the wall.

Although most earthquake reconnaissance studies reported satisfactory performance of LPE buildings in past earthquakes, there is a limited description and graphical illustration of damage patterns. Vasilev and Bonev (2012) reported a moderate damage of LPE buildings in the 2012 Pernik,



a) b)

Figure 16. Seismic microzonation maps for the locations of LPE buildings: a) Tirana and b) Durrës (note that the locations are labelled with black circles and numbers 1 to 8) (IGEWE).

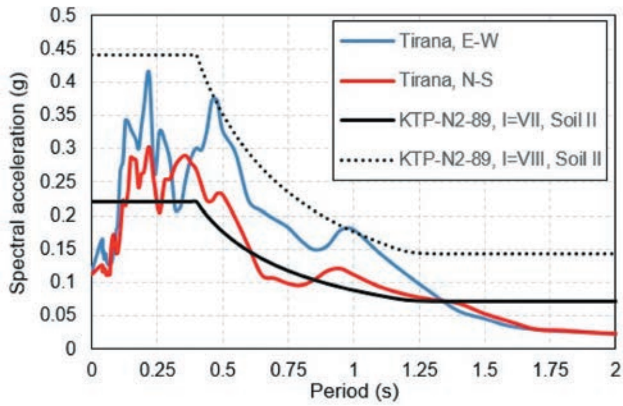


Figure 17. Acceleration response spectra for the Nov 26, 2019 earthquake – TIR 1 station in Tirana (IGEWE 2020; Isufi 2020).

Bulgaria earthquake (M 5.8) shown in Fig. 18b, which is characterized by cracks along the panel connections at both exterior and interior of a building; this could be characterized as DG2 (slight damage). LPE buildings did not experience damage in the 1977 Vrancea, Romania earthquake, in contrast to significant damage of the older cast-in-situ RC frame buildings (NBS 1977) (Fig. 18c). Klyachko, Mortchikchin, and Nudga (2002) and Shapiro and Ashkinadze (1980) documented significant damage of LPE buildings in the 1976 Gazly, Uzbekistan earthquake (Soviet Union) (M 7.0); this is illustrated in Fig. 18d. Shapiro and Ashkinadze (1980) stated that "the extent of damage was determined by the structure of joint connections. The main kind of damage was failure of joints which were not provided with sufficient amount of well-anchored metal ties. There were observed 10–15 cm shifts of panels, the slipping of floor slabs from walls, the striking of elements against each other. Damages of panels were insignificant in the form of vertical cracks ... " The above description indicates heavy damage of LPE buildings, characterized by significant dislocation of panels.

5.2. Proposed Damage Classification for LPE Buildings with Weak Joints

A post-earthquake damage classification for LPE buildings with weak joints proposed in this section is based on the observed damage of LPE buildings in the November 2019 earthquake, the expected failure mechanisms, and the damage classifications developed by others, as discussed earlier in the paper. It is proposed to classify damage in 4 DGs, as opposed to 5 DGs which are commonly used for other structural systems. This can be justified by limited ductility of LPE buildings with weak joints, for which it is difficult to distinguish a separate damage grade between the onset of structural damage (DG2) and a significant structural damage of panel joints. Hence, the proposed damage grade DG3-4 corresponds to significant structural damage and a possible permanent dislocation/offset of the panels. Based on the survey of LPE buildings after the November 2019 earthquake, it was possible to illustrate DG1 and DG2, as shown in Fig. 19a,b. An evidence of DG3-4 is not available from past earthquakes, but it was conceptually illustrated in FEMA 306 (FEMA 1998), see Fig. 18a. An example of DG5 is illustrated in Fig. 18d, based on the 1976 Gazly earthquake.

Feasibility of repair associated with specific DGs has also been indicated in Table 2. The authors believe that repair is possible for DG1 and DG2, and in some cases for DG3-4. Repair is likely not feasible in case of offset/dislocation of panels, which is expected for DG5 and in some cases for DG3-4.

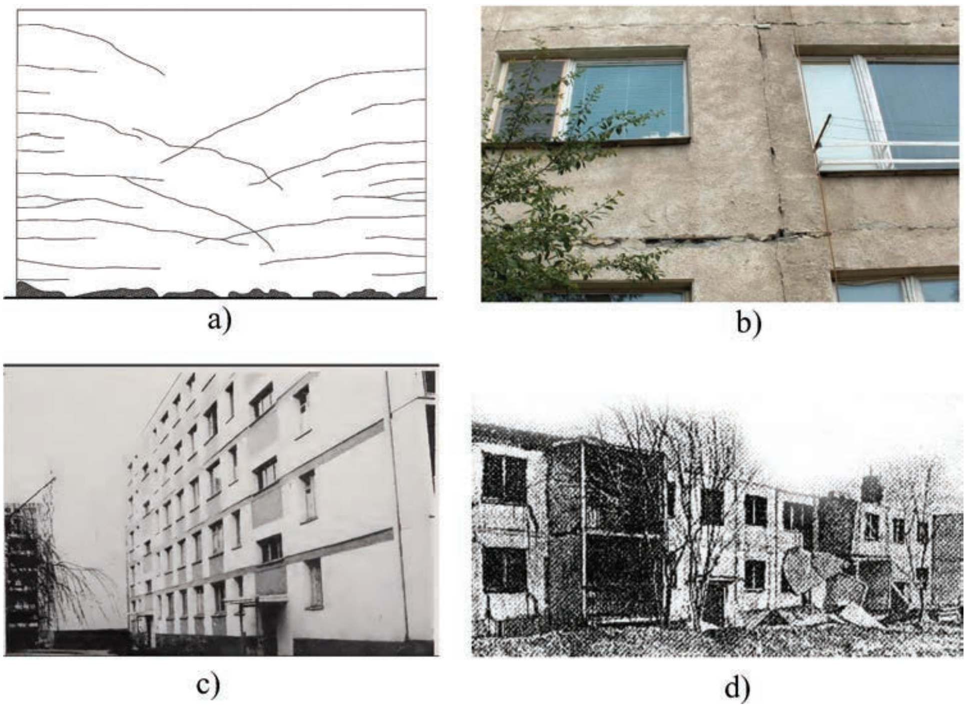


Figure 18. Damage of LPE buildings: a) significant structural damage (FEMA 306); b) a slight damage in the 2012 Pernik, Bulgaria earthquake (Vasilev and Bonev 2012); c) an undamaged LPE building in Bucharest after the 1977 Vrancea, Romania earthquake (NBS 1977) and d) a significant damage/collapse in the 1976 Gazly, Uzbekistan earthquake (Klyachko, Mortchikchin, and Nudga 2002).

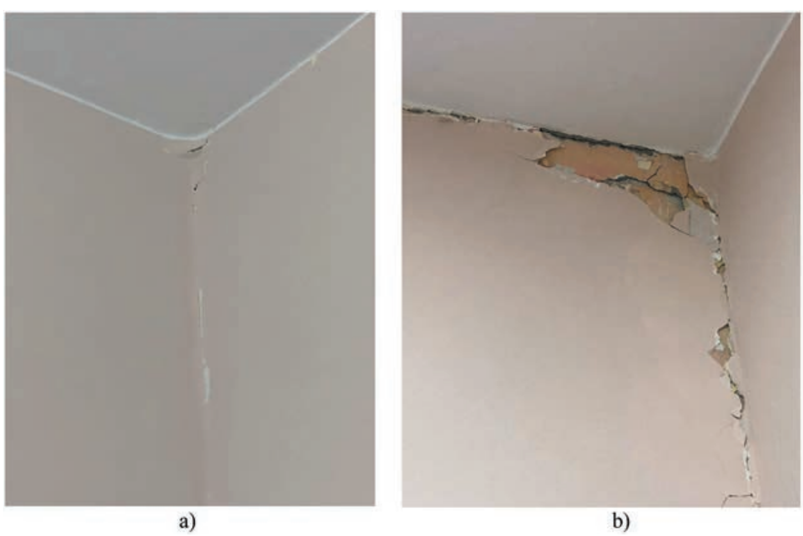


Figure 19. Examples of damaged LPE buildings with weak joints from the November 2019 earthquake: a) DG1 and b) DG2.

Table 1. Existing post-earthquake damage classifications for RC wall systems.

Damage Grade (DG)	RC wall system: European Mascroseismic Scale (EMS-98) (Grünthal 1998)	RC wall system: sliding failure mechanism (FEMA 1999)	LPE buildings: Bulgaria (Andonov 2019)
(1)	(2)	(3)	(4)
Damage Grade 1 (DG1): Insignificant damage	Fine cracks in plaster in walls at the base.	Crack width up to 5 mm; no significant spalling or vertical cracking.	Fine cracks on the plaster of panels, especially around openings, in the dowels and on the interface between dowels and panels.
Damage Grade 2 (DG2): Slight damage	Cracks in structural walls.	Crack width up to 6 mm; no significant spalling or vertical cracking; similar to DG1, except for wider flexural cracks and typically more extensive cracking.	Onset of structural damage, diagonal hairline cracks in structural panels and on the interfaces between panels. Dowels are easily identified due to the cracks through the grouting.
Damage Grade 3 (DG3): Moderate damage	Cracks at the base and at joints of coupled walls; spalling of concrete cover, buckling of reinforced rods.	Same as DG2.	Dowel infill concrete has crushed; reinforcement in the dowel may have yielded. Diagonal cracks in internal panels are formed.
Damage Grade 4 (DG4): Extensive damage	Large cracks in structural elements with compression failure of concrete and fracture of rebars.	Development of a major horizontal flexural crack along the entire wall length, with some degradation of concrete along the crack, indicating that sliding has occurred. Possible small lateral offset at crack.	Dowels are completely damaged. Panels have experienced significant cracking and noticeable residual displacement.
Damage Grade 5 (DG5): Collapse	Collapse of ground floor or parts of buildings.	Significant lateral offset at sliding plane	Partial or complete building collapse.

Table 2. Proposed damage classification for LPE buildings with weak joints.

Damage Grade (DG)	Description	Repair possible and financially justifiable
Damage Grade 1 (DG1): Insignificant damage	Hairline cracks in the plaster within the connection regions (Fig. 19a)	Yes
Damage Grade 2 (DG2): Slight damage	The onset of structural damage; widening of horizontal and vertical cracks at the panel connections (Fig. 19b)	Yes
Damage Grade 3–4 (DG3-4): Moderate to Heavy damage	Structural damage of panel joints, e.g. crushing of concrete and fracture of welded connections, which may not be visible unless the joints are exposed; possible horizontal offset betwen the panels	Yes or no (the decision is based on the assessment)
Damage Grade 5 (DG5): Collapse	Partial or complete building collapse (Fig. 18b)	No

Table 3. Information related to the surveyed LPE buildings in Tirana and Durrës.

ID	City	Location name	Earthquake Intensity	Number of surveyed building blocks	Damage grade		
					DG0	DG1	DG2
1	Tirana	21 Dhjetori	VI ½	89	65	23	1
2	Tirana	Selita	VIII	60	0	10	50
3	Tirana	Profarma	VII ½	200	0	20	180
4	Tirana	Alliasi	VII ½	120	0	60	60
5	Tirana	Lapraka	VII	105	15	80	10
6	Tirana	Kamza	VII ½	75	0	40	35
7	Tirana	Kombinat	VIII	45	0	4	41
8	Durrës	Durrës	IX	140	0	50	90
		Total		**834**	**80**	**287**	**467**

6. Performance of LPE Buildings in the November 2019 Earthquake

6.1. Post-Earthquake Survey of LPE Buildings in Tirana and Durrës

After the November 26, 2019 earthquake large number of buildings were surveyed by local municipalities to assess the extent of damage and the rehabilitation needs. LPE buildings at 8 locations in Tirana and Durrës (mentioned earlier in the paper) were surveyed. In total, 834 building blocks in LPE buildings were surveyed (see a typical building block shown in Fig. 5a). Out of all surveyed building blocks, large majority (694) were located in Tirana while the remaining 140 blocks were located in Durrës. Information related to the surveyed building blocks, assigned earthquake intensity, and damage grade (DG) are presented in Table 3. It should be noted that the earthquake intensity rating was assigned based on the microzonation maps presented in Fig. 16. Unfortunately, there were no reported studies attempting to determine seismic intensities at specific locations following the November 26, 2019 earthquake. Damage grades (DG1 and DG2) were assigned to all surveyed buildings, in line with the descriptions presented in the previous section. Note that DG0 denotes a building block which did not experience any damage. Figure 20a illustrates damage distribution at specific locations in Tirana (1 to 7) and Durrës (8). It can be concluded that the LPE buildings at most locations (except location 1) experienced damage (DG1 and DG2). Out of all surveyed building blocks, about 10% remained undamaged while 34% and 56% buildings experienced damage (DG1 and DG2, respectively), as shown in Fig. 20b.

Number of surveyed buildings and the corresponding damage at different earthquake intensities is shown in Fig. 21. There is a clear trend showing increasing proportion of more severely damaged building blocks assigned DG2 at higher earthquake intensities (above VII). There is a clearly increasing ratio of DG2 at intensity VII ½ (70.0%) and VIII (87.0%). However, the ratio of building blocks with the DG2 rating decreased at intensity IX (64%), which corresponds to the Durrës location. This could be explained by differences in the assessment criteria since different survey teams were engaged in Tirana and Durrës. Since majority of damaged and collapsed buildings in the November 2019 earthquake were located in

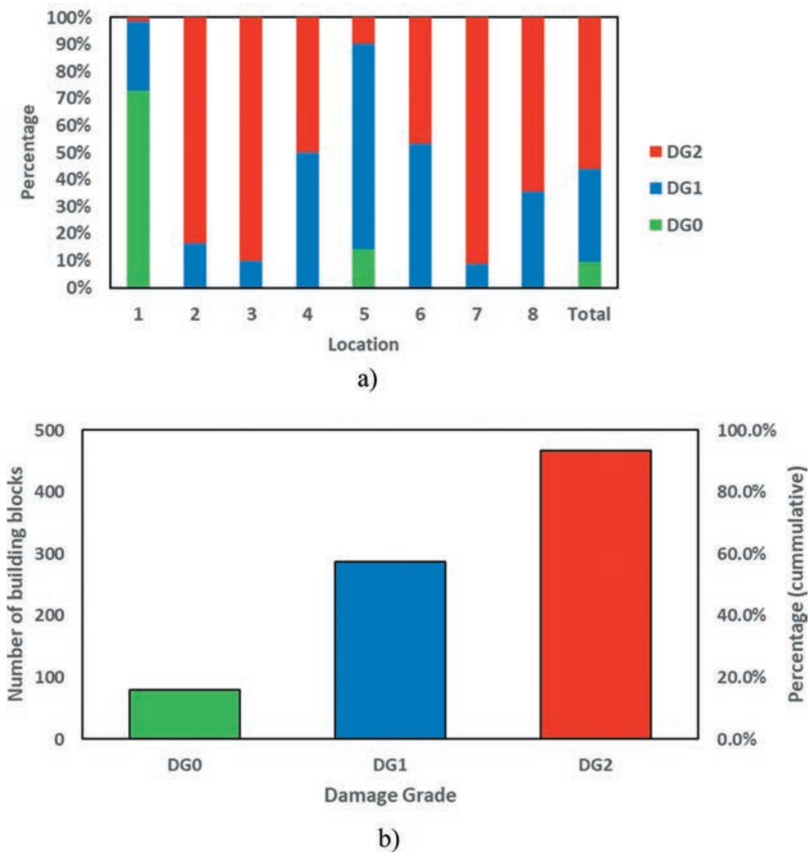


Figure 20. Number of LPE building blocks versus damage grade (DG): a) individual locations in Tirana (1 to 7) and Durrës (8), and b) DG distribution for all surveyed building blocks at 8 locations.

Durrës, it is possible that the survey teams were biased by large number of severely damaged buildings in the area, and decided to assign smaller damage grade to LPE buildings (which generally did not experience significant damage). It is unlikely that the shaking intensity in Durrës was less than that in Tirana.

6.2. LPE Buildings in the Kombinat Area, Tirana

Prefabricated LPE buildings performed well in the November 2019 earthquake. Based on the rapid building assessment performed after the earthquake, 86.2% of surveyed LPE buildings were assigned a green tag, indicating that they did not experience any structural damage (World Bank 2019). Only 3.4% of these buildings were assigned a red tag, which indicates that the buildings had to be demolished. According to the same survey, LPE buildings performed better than other common building typologies, e.g. cast-in-situ RC buildings and masonry buildings. Numerous LPE buildings were exposed to the November 2019 earthquake in Tirana and Durrës. In Tirana, damage to LPE buildings was reported only at one location (Kombinat area). Performance of LPE buildings in the Kombinat area of Tirana is discussed next.

Kombinat area (administrative unit No. 6 of Tirana) is a southwestern neighborhood of Tirana located at about 6 km distance from the centre (see Fig. 4b). It used to be an industrial area, and it is named after the Kombinat Stalin Textiles Factory, which once employed about 2,000 workers. Building stock in the Kombinat area consists mostly of residential low- to mid-rise buildings, but some buildings have a mixed function – commercial at the ground floor and residential at the upper

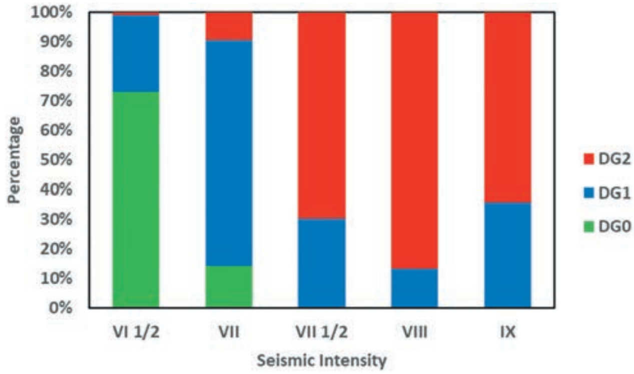


Figure 21. Damage grade (DG) versus earthquake intensity for all surveyed LPE building blocks in Tirana and Durrës.

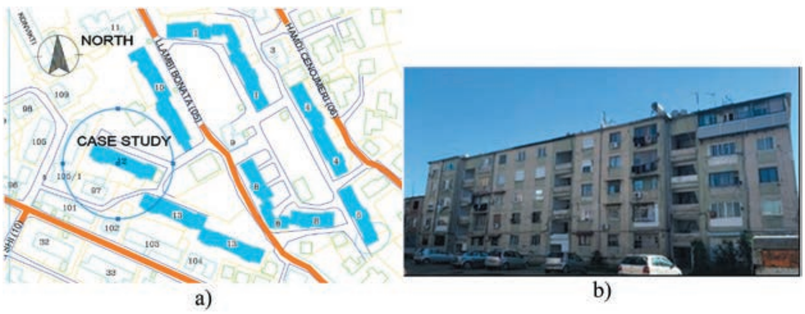


Figure 22. LPE buildings in the Kombinat area of Tirana: a) a map showing LPE buildings – note building No. 12 enclosed by a circle and b) a façade view of building No. 12 (source: AQTN).

floors. In total, 9 five-storey LPE buildings are located within a limited area, as shown in Fig. 22a. Figure 22 bshows a façade view of a typical building. Floor plan of a typical LPE building block is shown on Fig. 5a.

Based on the seismic microzonation of Tirana, Kombinat area was assigned the highest seismic intensity (VIII) for Tirana according to KTP-N.2–89. Some other areas of Tirana were assigned intensity VII or VII ½ . Soil category in the Kombinat area is classified as soft soil, that is, Type II according to KTP-N.2–89, or Type D according to Eurocode 8 (EN 1998-1:2005). It is believed that soft soil conditions were an underlying cause of damage for LPE buildings in the Kombinat area.

Majority of these buildings were more than 30 years old at the time of the November 2019 earthquake. In many instances, pre-earthquake condition of the buildings was poor due to the degradation of concrete and steel in exterior panels as a result of the ageing and exposure to atmospheric agents, and strain effects (e.g. temperature-induced cracks). Figure 23a,b show deterioration of exterior wall panels due to ageing. In some cases, moisture penetrated into the building interior along the panel interfaces. Figure 23b shows exposed vertical reinforcement bars at the plinth level (base) of a building. It can be seen that the spalling of concrete and corrosion of mesh reinforcement and reinforcing bars at the wall panel joint (VJ) have taken place. Structural integrity of some buildings may have been affected by human activities. Some exterior panels were infilled with masonry (Fig. 23c), while some buildings had other forms of renovations, e.g. horizontal and vertical extensions. Figure 23d shows a renovation (added balcony at the third-floor level) while Fig. 23e shows filling of horizontal panel joints at the second-floor level.

Figure 23. Pre-earthquake condition of LPE buildings in the Kombinat area, Tirana: a) deterioration of panels and their connections; b) spalling of concrete and corrosion of reinforcement at the wall base; c) exterior wall renovation – masonry infills; d) construction of a new balcony (third floor level) and e) filled horizontal joints at the second floor level.

6.3. Post-Earthquake Damage Observations

It can be stated that LPE buildings performed well in the November 2019 earthquake, since they either remained undamaged or experienced minor structural damage. All buildings of this type remained occupied after the earthquake. Out of 7 locations with LPE buildings in Tirana, these buildings experienced damage only in the Kombinat area. It should be noted that other types of buildings in the Kombinat area also experienced more damage compared to other locations in Tirana. For example, a few modern RC frame buildings with masonry infills experienced severe damage and had to be demolished, while a few 5-storey URM apartment buildings experienced moderate damage. By and large, low-rise URM buildings remained undamaged. Structural damage in the Kombinat area can be attributed to soft soil conditions, as discussed earlier in the paper.

A few LPE buildings in the Kombinat area were surveyed after the earthquake. A detailed damage survey was performed for building No. 12 (see Fig. 22a). Damage patterns observed in this building are similar to other LPE buildings which experienced damage in the earthquake. The damage was not visible/easy to observe at the façade (probably due to absence of plaster), but it was visible inside the building. The damage was concentrated within the panel connections, hence the cracks were aligned either in horizontal or vertical direction. The extent of cracking ranged from minor plaster cracks to moderate cracking along the wall and slab panel connections. Cracking was not observed within the wall panels; this is in line with the failure mechanism expected in LPE buildings with weak panel joints

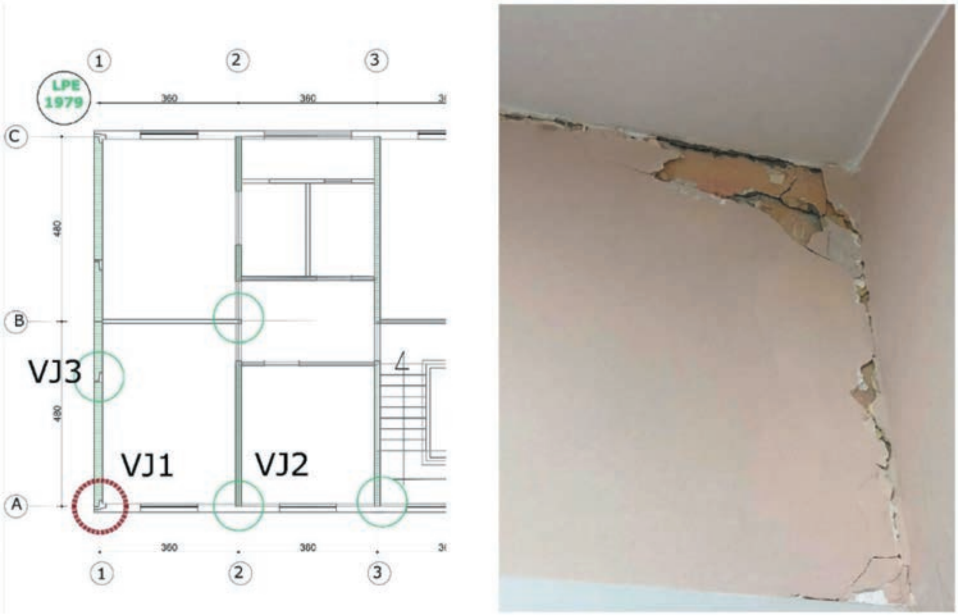


Figure 24. Cracking along the vertical joint VJ1 and horizontal joint (in longitudinal direction).

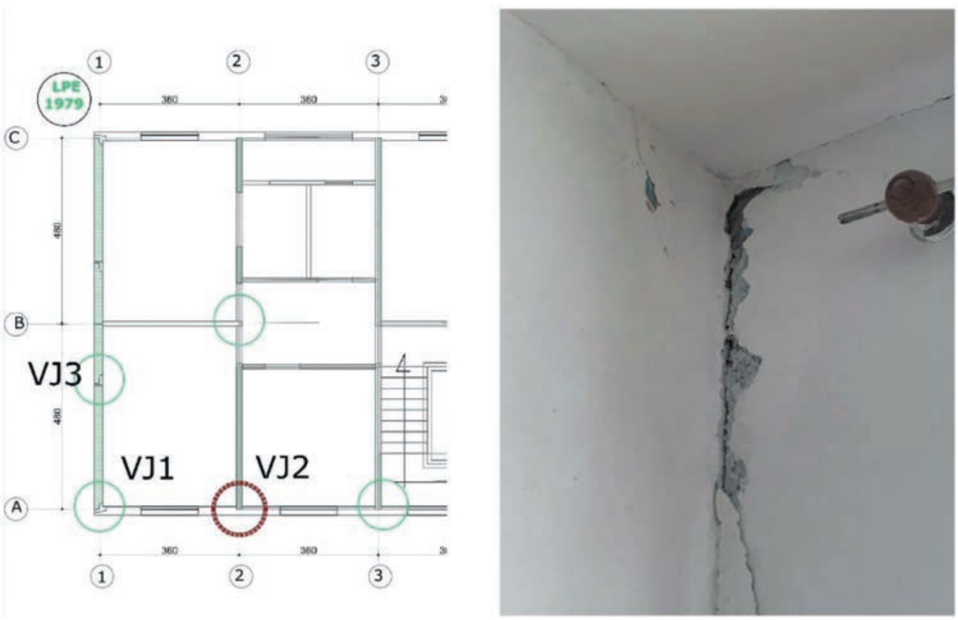


Figure 25. Cracking along the vertical joint VJ2.

explained earlier in the paper. Damage patterns along the vertical and horizontal joints are illustrated in Figs. 24–29. It should be noted that most cracks occurred in solid panels (without openings), but in some cases, cracking was also observed in panels with openings. Figure 24 shows a vertical crack in the overhead region of two adjacent interior wall panels with door openings. It should be noted that all buildings presented in this section experienced DG2 according to the proposed classification (Table 2).

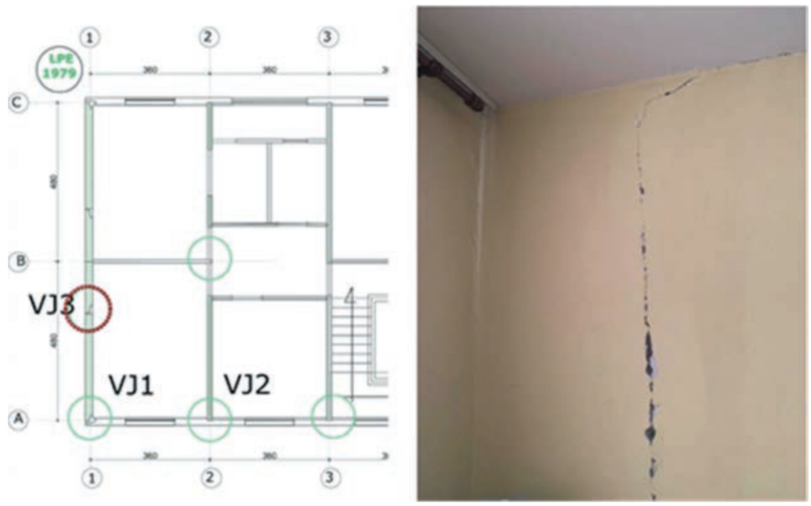


Figure 26. Cracking along the vertical joint VJ3.

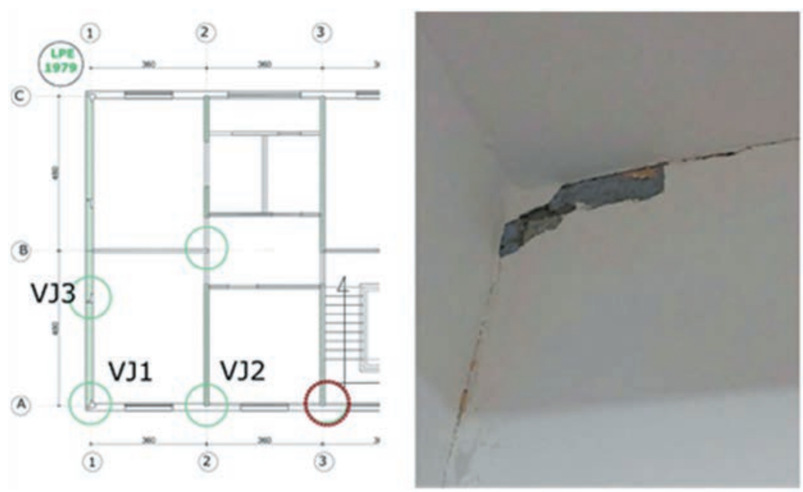


Figure 27. Cracking along the horizontal joint in longitudinal direction.

It is likely that some other LPE buildings in epicentral area of the November 2019 earthquake experienced a lighter damage (DG1 according to the proposed classification).

Several LPE buildings were exposed to the same earthquake in Durrës, where earthquake intensity was higher compared to Tirana, according to the available acceleration records and field observations. Several LPE buildings were surveyed at one of the locations in Durrës (see yellow and red labels, Fig. 4b). One of the surveyed buildings had longitudinal walls aligned in the N-S direction (red label, Fig. 4b). An exterior view of the building is shown in Fig. 29a and a partial floor plan is shown in Fig. 29b.

Room in which the cracking was observed is located at the corner of the building and was enclosed by a longitudinal wall (with a window) and a transverse wall. It is interesting to note that horizontal slip occurred along with the floor-to-wall connections in both longitudinal and transverse directions, as shown in Fig. 29b. There were no cracks along the vertical corner joint (VJ1), however, cracking was

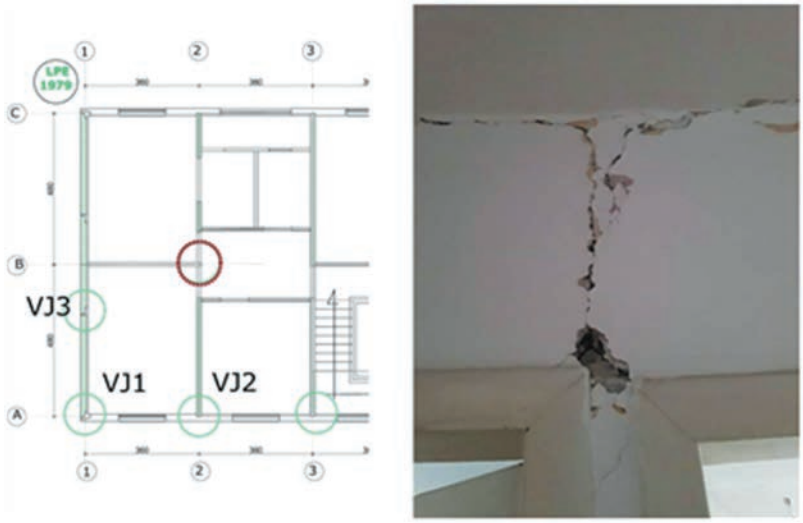


Figure 28. Cracking within the overhead area of adjacent wall panels.

observed along the vertical joint (VJ3) between the exterior wall panels in transverse direction. The damage was observed at the third-floor level (no damage at lower floors); this is expected since the failure mechanism was induced by sliding, which is characterized by horizontal cracking at the locations with the lowest axial stress level (e.g. upper floors in a building).

7. Conclusions

Performance of mid-rise LPE buildings in the November 26, 2019 earthquake was satisfactory, since these buildings did not experience significant structural damage and none of these buildings collapsed. The following conclusions can be drawn based on the observations from the earthquake and a study presented in this paper:

1.Absence of significant structural damage in these buildings can be explained by a relatively large amount of walls, hence seismic demand on individual walls is not very high. The basic structural configuration for large panel systems in Albania is cross-wall system, which is characterized by a larger amount of walls in the transverse (cross) direction. As a result, these buildings are more vulnerable to seismic effects in longitudinal than in transverse direction. The analysis has shown that wall index (*WI)* for a typical Albanian LPE building has a value of 4.6% for transverse (cross) direction and only 2.6% for longitudinal direction.

2.Since the joints between adjacent panels are placed at discrete points a decrease in the strength and stiffness of the structural system is expected after the connections experience damage. However, there is an inherent sliding shear resistance along the panel interfaces; this additional resistance was likely not accounted for in the original design.

3.The main observed earthquake damage patterns are in the form of cracking in the joints due to horizontal and/or vertical slip. The extent of cracking ranged from plaster cracks to moderate cracking along the wall and slab panel connections.

4.LPE buildings are prone to issues related to inadequate maintenance and external environmental factors, which may have contributed to damage in the November 2019 earthquake.

5.There is a need for customized post-earthquake damage classification for LPE buildings, since the classification for cast-in-situ RC shear walls cannot be readily applied to these buildings. The authors have proposed a damage classification for LPE buildings with weak connections which need to be evaluated through experimental and analytical research studies.

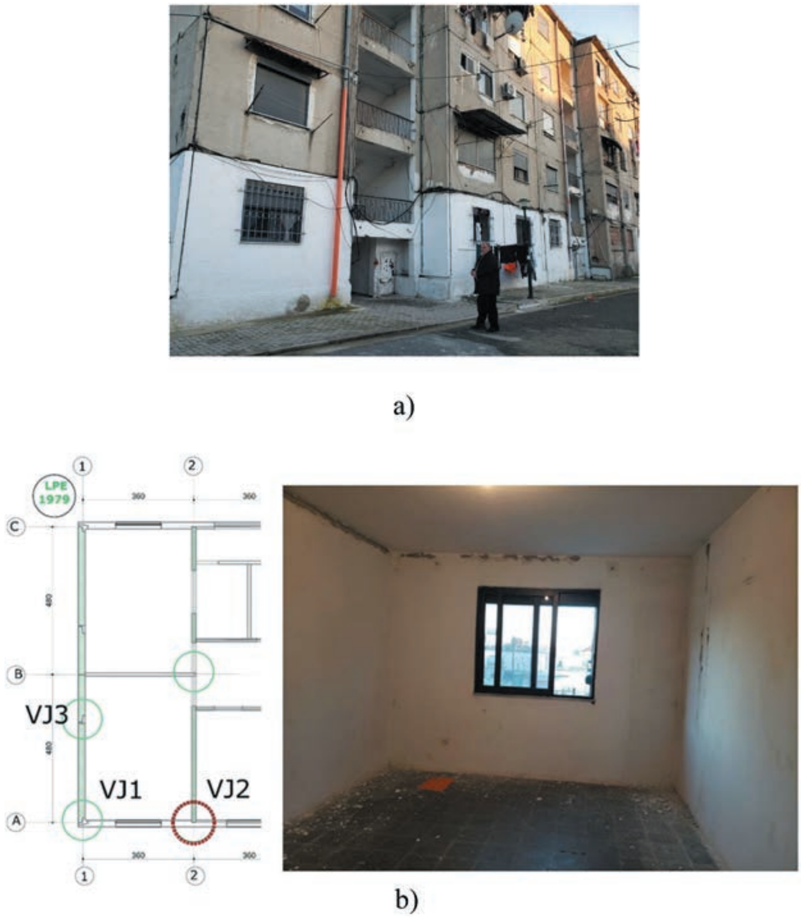


Figure 29. Seismic performance of LPE buildings in Durrës: a) an exterior view of the surveyed building; b) partial floor plan showing vertical joints.

Given a significant stock of LPE buildings in Albania and other European countries, it is of critical importance to perform analytical studies for improving understanding of the mechanism of damage and collapse for these buildings. Future studies should examine seismic failure mechanisms and evaluate whether the failure is limited to fracture and disintegration of connections, or cracking/damage is also expected in the wall panels.

Albanian design and retrofit standards need to include provisions related to prefabricated RC structures. Since many of these buildings are almost 50 years old and in poor condition, it is important to determine whether earthquake-damaged buildings of this type should be repaired/retrofitted or demolished.

Acknowledgments

The authors acknowledge Civil Emergency of the Tirana and Durres Municipality, Central Technical Construction Archive (AQTN) in Tirana for providing information regarding the LPE buildings in Albania, and Prof. Llambro Duni, Department of Seismology, Institute of Geosciences, Energy, Water and Environment (IGEWE), Tirana. The first author wishes to acknowledge the Department of Architecture and Engineering, Polis University, Tirana for their support. The second author is grateful to the Serbian Association for Earthquake Engineering (SUZI-SAEE) for the support they provided for performing a reconnaissance study after the November 2019 Albania earthquake.

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