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ICBE 2026

MAY 08th-09th, 2026
POLIS University, Tiranë

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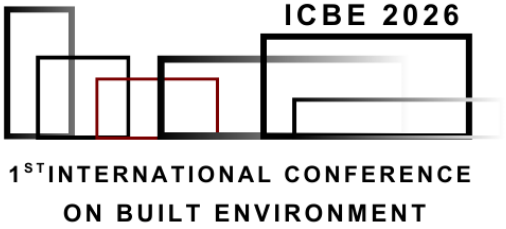
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1st International Conference on Built Environment

ICBE 2026

Conference Theme and Rationale

The 1st International Conference on Built Environment (ICBE 2026) was conceived as an international and interdisciplinary forum for advancing knowledge, critical discussion, and innovation across architecture, urban planning, engineering, construction, materials, design, and the wider built environment. Organized by POLIS University in collaboration with the National Agency for Scientific Research and Innovation in Albania (AKKSHI), the Academy of Sciences of Albania and the University of Ferrara in Italy, the conference brought together academics, researchers, practitioners, students, and industry representatives to exchange research findings, professional experience, and emerging perspectives on the transformation of contemporary cities and territories.

The conference theme reflected the increasingly complex challenges shaping the built environment, with particular attention to sustainability, resilience, technological innovation, heritage preservation, and socially responsive design. Contributions addressed sustainable architecture and green building, innovative construction technologies and materials, climate-responsive and energy-efficient design, disaster risk reduction, circular approaches to construction, and the integration of renewable energy. Equal emphasis was placed on digital transformation through Building Information Modeling, Geographic Information Systems, artificial intelligence, data analytics, automated solutions, digital fabrication, and advanced manufacturing.

ICBE 2026 also recognized that the future of the built environment cannot be approached through technological innovation alone. Urban transformation, cultural heritage, adaptive reuse, inclusive design, ecological thinking, art, and interdisciplinary research were therefore integral to the conference rationale. The scientific sessions examined topics ranging from seismic resilience, geotechnical engineering, and structural safety to urban fragmentation, public space, heritage conservation, adaptive environments, and new relationships between human and non-human systems.

Through keynote lectures, scientific presentations, case studies, and interdisciplinary debate, the conference encouraged connections between research and practice while promoting approaches capable of responding to environmental, social, cultural, and technological change. The breadth of contributions demonstrated the value of bringing engineering, architecture, urbanism, design, heritage, and emerging technologies into a shared academic framework for more resilient, sustainable, adaptive, and human-centered environments.

Held on 8-9 May 2026 at POLIS University in Tirana, with in-person and online participation, ICBE 2026 welcomed guest speakers and participants from Albanian and international universities, research institutions, professional organizations, and industry. Its sessions established a platform for presenting current research, exchanging expertise, strengthening meaningful collaboration, and identifying future directions for the built environment.

The event

The **1st International Conference on Built Environment (ICBE 2026)** is an interdisciplinary academic and professional forum dedicated to exploring contemporary challenges, emerging research, and innovative approaches shaping the future of the built environment. Bringing together researchers, academics, architects, engineers, urban planners, designers, practitioners, and industry professionals, the conference promotes the exchange of knowledge and encourages collaboration across traditionally interconnected disciplines. Its thematic scope encompasses sustainable and resilient construction, technological innovation, advanced building materials, urban transformation, cultural heritage, and interdisciplinary design approaches. Particular attention is given to the growing role of digital technologies, data-driven methodologies, intelligent design processes, and advanced analytical tools in supporting more informed and responsive approaches to architecture, engineering, and urban development. At the same time, ICBE 2026 recognizes the importance of environmental responsibility, cultural identity, social needs, and human-centered design in shaping contemporary cities and territories. Through keynote lectures, scientific sessions, case studies, and interdisciplinary exchange, the conference provides a platform for presenting current research, discussing professional experiences, and developing new perspectives capable of contributing to **safer, more sustainable, adaptive, inclusive, and resilient built environments**.

Objectives

- Promote interdisciplinary collaboration among researchers, academics, practitioners, and professionals in architecture, engineering, urban planning, construction, design, heritage, and related fields of the built environment.
- Advance the use of digital technologies and innovative methodologies, including BIM, GIS, artificial intelligence, data analytics, digital fabrication, and parametric approaches, in research and professional practice.
- Encourage sustainable, resilient, and climate-responsive approaches to architecture, construction, and urban development through innovative materials, energy-efficient strategies, and environmentally responsible design.
- Address contemporary challenges affecting cities, buildings, and infrastructure through scientific research, applied case studies, evidence-based approaches, and innovative design solutions.
- Promote the conservation, transformation, and adaptive reuse of cultural heritage, balancing cultural identity, contemporary needs, structural safety, and responsible urban development.
- Support human-centered and socially responsive urban transformation, considering public space, mobility, ecological systems, community needs, and the wider social and economic impacts of the built environment.
- Provide a platform for knowledge exchange and emerging research, enabling scholars, young researchers, professionals, and students to present innovative ideas, strengthen international collaboration, and contribute to future directions in the built environment.

Main Conference Themes

- Sustainable architecture and green building practices.
- Innovations in construction technologies and materials.
- Heritage preservation and adaptive reuse in the built environment.
- Digital tools and smart technologies in architecture and construction (e.g., BIM, GIS).
- Climate-responsive and energy-efficient design.
- Disaster risk reduction and resilience in the built environment.
- Circular economy approaches in construction and material usage.
- Integration of AI and data analytics in building design.
- Acoustic and thermal performance in building design.
- Renewable energy integration in building systems.
- Advanced manufacturing techniques in construction, such as 3D printing.
- Innovations in construction technologies and materials.
- Heritage preservation and adaptive reuse in the built environment.
- Disaster risk reduction and resilience in the built environment.
- Digital tools and smart technologies in architecture and construction.
- Advanced manufacturing techniques in construction.
- Geotechnical Engineering for Sustainable Development.
- Cartography and Geographic Information System.
- Computer Automated Solutions for Built Environment.
- Reliability in Civil Engineering.
- Urban planning strategies for resilient cities.
- Climate-responsive and energy-efficient design.
- Regulatory frameworks and policies impacting construction and urban development.
- Design in the Era of Anthropocene (Rethinking the Relation between Human and Non-Human Species)
- Speculative Design (with Attention to “Discursive” and “Critical” Design)
- Design and Cross-Disciplinarity (with Emphasis on Processes rather than Design Outputs)
- Inclusive Design
- Art and Urban Regeneration (Focus on Participatory, Collaborative, and Research-Based Practice)
- Relational Art and Architecture
- Monuments and ‘Anti-Monuments’ (Particular Attention to the Process of Designing and Building the City)

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The conference is structured around six thematic sessions, each addressing a specific area of research and practice within the built environment.
Each session is coordinated by experts in the relevant disciplinary field and is open to professors, researchers, PhD candidates, and other scholars and professionals contributing to the conference themes.

SESSION I
Urban Planning and Societal Impact

Chair: Dr. Gent Avdija

This session examines the relationship between urban transformation, spatial development, and their social implications within contemporary cities. Contributions address rapid urbanization, urban fragmentation, the transformation and loss of public space, informal and spontaneous development, and the challenges associated with balancing growth and modernization with human-scale urban environments. Particular attention is given to the evolving conditions of Albanian cities and to planning approaches capable of supporting more inclusive, sustainable, socially responsive, and livable urban environments.

SESSION II
Sustainable Materials, Resilient Construction & Smart Design

Chair: Dr. Endri Duro

This session explores innovative approaches to sustainable construction, resilient structural systems, and environmentally responsive design. Particular attention is given to sustainable materials, energy-efficient and climate-responsive strategies, prefabricated and lightweight construction technologies, and human-centered approaches to structural and architectural design. The session investigates how material innovation, technological development, and responsible design practices can contribute to safer, more efficient, adaptable, and environmentally sustainable built environments.

SESSION III
Technological Advancements and Seismic Design for Resilient Places

Chairs: Dr. Seyyed Behrad Emadi & Dr. Ornela Şen

This session examines the role of technological innovation and advanced engineering methodologies in developing safer, more resilient, and adaptable built environments. Contributions address seismic hazard and risk assessment, digital fabrication, parametric and computational approaches, transformations of building envelopes and prefabricated housing systems, and emerging concepts for future urban mobility. The session highlights how the integration of engineering knowledge, digital technologies, and resilience-oriented design can strengthen the capacity of buildings, infrastructure, and urban environments to respond to contemporary and future challenges.

SESSION IV

Cultural Heritage

Chairs: Dr. Nikolla Vesho & Dr. Marsela Demaj

This session addresses the preservation, interpretation, and transformation of cultural heritage within contemporary architectural and urban contexts. Contributions explore conservation strategies for historic buildings and sacred architecture, seismic assessment and strengthening of heritage structures, adaptive reuse, and the social implications of urban regeneration and heritage loss. Particular emphasis is placed on achieving a responsible balance between conservation ethics, cultural identity, structural safety, and the evolving functional requirements of historic buildings and urban environments.

SESSION V

Spaces of Connection: Art and Design for an Interspecies and Interdisciplinary Environment

Chair: Dr. Francesco Scasciamacchia

This session explores the intersections of art, architecture, design, technology, and the built environment through interdisciplinary and experimental perspectives. It investigates changing relationships between human and non-human systems, spatial perception, adaptive reuse, post-industrial landscapes, urban representation, digital heritage, and environmentally and socially engaged design practices. Through critical, speculative, participatory, and research-based approaches, the session examines how art and design can generate new forms of connection, reinterpret existing environments, and contribute to emerging cultural and spatial narratives within contemporary cities.

SESSION VI

Next-Generation Pioneers of the Built Environment

Chair: Dr. Flogerta Krosi

This session provides a dedicated platform for emerging researchers and students to present innovative, experimental, and forward-looking approaches to the built environment. Contributions span architecture, engineering, urban planning, environmental resilience, design, and related creative disciplines, reflecting the interdisciplinary character of a new generation of researchers and practitioners. Through projects addressing topics such as bioclimatic design, flood-risk management, structural technologies, architecture-inspired design, and critical interpretations of objects and social space, the session encourages critical inquiry, experimentation, and new perspectives on the future of the built environment.

Layout & Design:

Dr. Kristiana Meço

Msc. Erjon Çobani

POLIS University Contact:

Rr. Bylis 12, Autostrada Tiranë-Durrës, Km 5, Kashar

Kodi Postar 1051, Kutia Postare 2995

Tiranë, Albania

Tel: +355.(0)4.2407420 / +355.(0)4.2407421

Fax: +355. (0)4.2407422

Mob: +355 (0) 69 40 88 111

Email: contact@universitetipolis.edu.al

Website: www.universitetipolis.edu.al

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Next-Generation Pioneers of the Built Environment

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Resilience and risk management: Flood-risk management / Environmental resilience / Disaster-aware planning / Adaptive urban strategies.

Structural and technological innovation: Steel-frame technologies / Construction systems / Emerging building technologies / Engineering innovation.

Architecture, design and society: Architecture-inspired design / Fashion and spatial concepts / Objects and social space / Interdisciplinary creative practice.

Future-oriented thinking: Innovation / Critical inquiry / Interdisciplinary experimentation / New professional perspectives / Future built environments.

Steel frame technology for residential buildings:
A comparative thesis-antithesis study versus reinforced concrete systems

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Elton AHMETAJ
Civil Engineering Student, POLIS University, Albania
elton_ahmetaj@universitetipolis.edu.al

Erjon ÇOBANI
ORCID 0009-0000-2518-3155
POLIS University, Albania
erjon_cobani@universitetipolis.edu.al

Merita GURI
ORCID 0000-0001-9363-2338
POLIS University, Albania
merita_guri@universitetipolis.edu.al

Abstract

The selection of the right structural system for residential buildings is an essential engineering decision, especially in seismic regions where structural safety, construction efficiency, sustainability, and user perception are the main challenges. In many European countries, including Albania, reinforced concrete has been the main used system for residential construction due to its familiarity, availability of materials, and established design practice. However, steel frame technology has increasingly been proposed as a viable alternative, particularly for projects that require faster construction and reduced structural weight in recent years.

This paper explores whether steel frame systems can really reach a level of applicability comparable to reinforced concrete in residential buildings. The study adopts a comparative thesis-antithesis methodology, where the main advantages of steel structures are examined together with their disadvantages, such as excessive vibrations, higher initial costs, fire protection requirements, and design complexity.

To support the study, a three-storey residential building constructed in 2025 in Durrës, Albania, using a heavy steel frame system with composite steel-concrete slabs, is presented as a case study. The comparative analysis focuses on key performance indicators, such as structural self-

weight, seismic response behaviour, construction duration, serviceability performance, recyclability potential, and economic considerations.

Rather than advocating a single solution, the paper aims to demonstrate that steel frame technology can represent a competitive alternative for residential buildings whenit is well designed. The final judgment remains intentionally open, encouraging readers to form conclusions based on project-specific priorities, constraints, and long-term performance expectations.

***Keywords**: Steel frame construction, reinforced concrete structures, structural comparison, material sustainability, residential buildings*

1. INTRODUCTION

Residential buildings are the most common building typology and directly shape both the built environment and how people perceive structural safety. The selection of the structural typology for residential construction becomes particularly critical in seismic regions, as it affects not only structural performance during earthquakes but also construction efficiency, economic feasibility, and user confidence. Traditionally, reinforced concrete has been the most used structural material for residential buildings, largely due to its familiarity, fire resistance, and long construction practices.

Despite its widespread use, this type of construction presents several inherent limitations. These include high structural self-weight, extended construction durations, and is very depended on on-site workmanship quality. So, alternative systems have increasingly been considered, especially in contexts where construction efficiency, material performance, and long-term sustainability are prioritized with structural safety.

Steel frame technology has been recognized for its high strength-to-weight ratio, predictable mechanical behaviour, and suitability for prefabrication. While steel structures are most used in industrial and commercial buildings, their application in residential construction is very limited, particularly in places where reinforced concrete dominates the building culture. This lack of use is often not a consequence of insufficient structural behavior, but rather of concerns related to serviceability problems like higher initial construction costs, and the perception of reduced safety in seismic environments.

In this context, this study aims to evaluate the applicability of steel frame structures for residential buildings through an organized comparative approach. The research is primarily on the analysis of a real residential building constructed using a heavy steel frame system and compares its characteristics with those of reinforced concrete systems. Rather than promoting a single answer, the study seeks to critically assess this new technology as a competitive and reliable choice for residential construction.

Research Question: Can steel frame structural systems be successfully adopted for residential

buildings in seismic regions when compared to reinforced concrete structures?

Research Hypothesis: Steel frame structural systems, when applied to residential buildings in seismic regions and designed with current European standards, can provide a higher level of structural performance compared to reinforced concrete systems.

2. LITERATURE REVIEW

The use of steel frame structures in building construction has been mostly documented in engineering literature, especially in sectors like industrial, commercial, and high-rise buildings. In contrast, their application in residential buildings has been given less attention, particularly when heavy steel frame systems are considered.

Research on residential steel structures emphasize their potential to reduce structural mass and improve seismic response due to lower inertial forces. Studies indicate that, when properly designed, steel frame systems can achieve performance levels comparable to conventional reinforced concrete structures (Steel Construction Institute, 2017; Mazzolani, 2006). However, the literature also claims that the successful application of steel in residential buildings depends on construction detailing, and overall system stiffness, particularly for low and mid-rise buildings.

In contrast, R/C has been studied and remains the most commonly analyzed system for residential construction. Studies underline its advantages in terms of resilience, fire resistance, and acoustic performance. At the same time, many publications point out its limitations, including high self-weight, sensitivity to construction quality, and challenges related to post-earthquake reparability.

Despite the growing body of research on steel structures, a clear gap is still present in the literature concerning detailed, proper comparative studies of heavy steel frame residential buildings. This gap really tells us about the need for applied research that combines both theoretical analysis with real construction experience, providing a more comprehensive basis for evaluating the role of steel frame technology in residential construction.

3. METHODOLOGY

This study adopts a comparative research methodology aimed at assessing the applicability of steel frame systems in residential buildings through direct comparison with conventional reinforced concrete systems. The methodology is organised to ensure transparency and coherence with current European design principles, while keeping a clear differentiation between analytical framework and interpretative results.

The study is based on a thesis–counterthesis logic. Steel frame structures are considered as a proposed alternative structural system for residential buildings, while R/C structures represent the conventional benchmark. The comparison does not tend to identify a single solution, but rather to give an extra option to be considered by clients.

4. CASE STUDY DESCRIPTION

Project data were taken directly from the construction company (personal communication, 2026).



Figure 1. Building exterior". Toni Konstruksion" company

The case study used in this paper is a three story residential building constructed in 2025 in the city of Durrës, Albania. Its primary unique feature is the type of structural system: a heavy steel frame combined with composite steel-concrete slabs, an approach that remains uncommon in Albanian residential construction.

Each floor has an area about 320 m². The structure includes two stair cores and one elevator core. The first two floors are arranged into several separate apartments, while the top floor is arranged as a single residential unit.

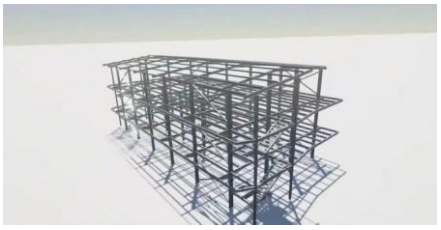


Figure 2. Building 3D project. "Toni Konstruksion" company

The external part of the structure is closed of Composite Insulated Panels (CIPs), commonly known as sandwich panels, with a thickness of 10 cm, while the internal separation is made of gypsum board walls. The use of this type of panels for external thermal insulation is proved to be an optimal solution, as it avoids problems related with masonry infill. In cases of dynamic loading, masonry may develop cracks due to its limited ductility compared to steel. In contrast, sandwich panels are better in this aspect, significantly reducing structural weight and allowing for easier repair.



Figure 3. Construction site. "Toni Konstruksion" company.

In the structural aspect, this building is structured with 24 columns with HEA 260 profiles and 8 perimeter columns on the two sides with HEA 160 profiles. The columns are connected by primary beams with IPE 240 profiles and secondary beams in one direction with IPE 200 profiles. Additionally, on the two longitudinal sides of the building, there are balcony cantilevers supported by beams with IPE 240 profiles.

The slab system used is a composite slab (reinforced concrete combined with profiled steel sheeting). The total slab thickness is 12 cm, where the maximum rib height of the steel decking is 7 cm, and the concrete topping in this section is 5 cm.

On the top floor, roof trusses with IPE 200 profiles have been used. Furthermore, in terms of lateral stability, bracing systems with SHS 100×100 profiles are incorporated. These elements play a crucial role in resisting horizontal dynamic loads and contribute to limiting window opening; however, proper design and placement significantly reduce such issues.



Figure 4. Structural elements "Toni Konstruksion" company

All connections between structural elements are executed using bolts, while plates and gussets are pre-welded in the factory. Regarding the foundation system, the building is supported on a reinforced concrete plate foundation with a thickness of 50 cm, while the columns are connected to the foundation by anchor bolts that were placed before the concrete was poured. This creates rigid performance between the foundation and the superstructure and also helps preventing corrosion.

In terms of construction process,based on company's official documents the time that was needed from the fabrication of the elements to the assembly and external cladding was about one month and a half, a significantly shorter duration compared to an equivalent R/C structure. The total weight of the steel structure and external cladding panels is about 67 tonnes, while the composite slabs contribute around 300 kg/m². These figures result in a very lighter building compared to reinforced concrete construction, with direct positive effect for seismic demand and foundation design.

5. COMPARATIVE ANALYSIS

Advantages

1. Reduced structural self-weight and seismic implications

One of the best advantages of steel frame systems in residential construction is their low structural selfweight compared to reinforced concrete structures. Due to its high strength to weight ratio, structural steel allows members to carry same loads while maintaining small cross sections. As a result, the total dead load of a steel frame building is very low compared to an equivalent reinforced concrete structure.

Research consistently verifies this difference in structural mass. Studies says that steel structural systems may reduce total building weight by around 30–50% compared to R/C systems, depending on the structural configuration and floor system adopted (Steel Construction Institute, 2017).

In seismic design, the dynamic forces acting on a building are directly proportional to its mass. Consequently, a lighter structure experiences a proportional reduction in seismic demand, which is essential for residential buildings located in high-seismicity zones such as Albania, classified under seismic zone 3 according to the Albanian seismic hazard map (KTP-N.2-89).

In simple words, a lower structural mass, makes the structural elements to deal with reduced force so as, connections, and foundations during an earthquake, allowing for more economical dimensioning of structural components and, giving simpler solutions for less favourable soil conditions, simpler and shallower foundation systems.

However, it should be noted, that lower weight alone is not the only aspect to guarantee proper seismic performance. Stiffness and lateral stability must be considered and design in appropriate structural elements, like braced frames or moment-resisting frames, which control inter drift and prevent excessive lateral displacements under seismic loading.

2. Ductility and seismic Energy dissipation

Among the structural properties that make steel frame systems suitable for seismic environments, ductility stands out as one of the most valuable. In structural engineering, ductility is the capacity of a material or system to resist large deformations beyond the elastic limit without losing its load bearing ability. For buildings in earthquake areas, this property is not a secondary consideration but it is a great factor in how a structure survives ground motion.

The material of steel exhibits this behaviour naturally. When increasing loads are applied, steel members deform progressively rather than fracturing suddenly like concrete. This controlled yielding lets the structure to absorb and dissipate seismic energy through plastic deformation. This is one of the main principles behind modern earthquake resistant design.

In practice, a proper designed steel frames are detailed so that inelastic deformation occurs in locations that we want, typically at beam ends or within bracing members. These areas,

known as plastic hinges, act as energy dissipating mechanisms during seismic events, so this way they limit the forces transmitted to other structural parts of the structure and minimizing the risk of sudden collapse.

This behaviour is studied and explained in Eurocode 8 (EN 1998-1:2004), which allocate behaviour factors (q-factors) to various structural systems according to their capacity for energy absorption. For ductile steel frames, q-values can reach 6–8, among the highest permitted for any structural system. In comparison, reinforced concrete frames typically need more complex and carefully designed detailing to get an equivalent ductility levels, and their behavior is more sensitive to construction quality.

One more advantage of steel's predictable yielding is the visible warning it provides before reaching it's limit capacity. Unlike fragile failure modes, which can occur suddenly and without prior signs in R/C, steel members show visible deformation as they approach their limits. This characteristic makes it safer after earthquake assessment and can lead to a faster structural recovery.

3. Construction speed and execution efficiency

The ability to build faster than conventional reinforced concrete construction is one of the most significant advantages of this type of structure. This is not just a matter of speed, but it follows a different logic entirely, from design and fabrication to assembly on site.

Steel structural components are produced in controlled factory environments well before they reach the construction site. Once delivered, the elements are assembled through bolted connections, a process that is fast and largely independent of weather conditions. Unlike reinforced concrete, there is no need for formwork systems to be install, no curing periods to observe, and no extended waiting times between structural phases.

The construction timeline difference is significant. Studies on medium rise residential buildings show that steel frame structures can be built 30–50% faster than equivalent R/C solutions (Steel Construction Institute, 2017). For a three-storey residential building like the case study studied in this paper, the period from factory fabrication to completed structural assembly and external cladding was about one and a half months,a duration that would never be achieved by today's technology if it would be constructed with reinforced concrete.

By building faster, we do not just save time, but a shorter construction schedule has direct financial impact. Reduced time on site means lower financing costs, less labour exposure, and the earlier use of the building all of which affect the overall cost. In markets where construction loan interest is charged daily, cutting one to two months represents an actual financial advantage (Steel Construction Institute, 2017).

4. Recyclability and environmental sustainability

Unlike most used construction materials, structural steel can be recycled repeatedly without losing the main mechanical properties, a characteristic that goes well with circular construction principles and current European carbon reduction targets.

According to the Bureau of International Recycling (BIR, 2024), around 630 million tonnes of recycled steel are consumed annually in global steel production, preventing an essential 950 million tonnes of CO_2 emissions. For structural steel specifically, the end-of-life recycling rate is considered to be about 85%, placing it among the most efficiently recovered construction materials in existence. In many cases, steel elements can be directly reused in new structures.

The energy impact of steel recycling is also significant. Secondary steel that is produced via Electric Arc Furnace which uses recycled scrap as feedstock requires approximately 50% less energy than primary production from iron ore. Each tonne of recycled steel saves about 1.4 tonnes of iron ore, 740 kg of coal, and 120 kg of limestone (Global Energy Monitor, 2023). These savings mean lower greenhouse gas emissions, contributing to the carbon reduction targets established under the European Green Deal.

On the other hand, reinforced concrete presents considerably more limited end of life recovery potential. While concrete ruins can be crushed and reused as recycled aggregate in subbase applications or low-grade fills, its structural reuse is limited by variable quality and increased porosity compared to natural aggregates. While the steel reinforcement can be recovered and recycled separately, but the cement cannot be reused as a structural material. As a result, the the mos part of demolished reinforced concrete is downcycled rather than truly recycled, with the global construction generating an estimated 3.5 billion tonnes of solid waste annually — the largest single waste stream worldwide (Eurostat, 2023).

To add more, as we said in the first part, steel structures weight less. So, less material is used, less material for foundation is needed and this all means that there is less pollution in our environment.

Disadvantages

1. Floor vibrations

Floor vibrations represent one of the most frequently raised doubts about steel frame residential buildings. This point needs clarification from the start: this is a serviceability issue and it relates to personal comfort, not to structural safety.

The physical mechanism is clear. Human walking normally generates dynamic forces at frequencies between 1.6 and 2.4 Hz. If the natural frequency of a floor falls within or near this range, resonance can increase the response to a level that usually feels as uncomfortable. For this reason, design guidance recommends that residential floor systems achieve natural frequencies above 8 Hz, so the floor frequency does not match the human activity range (Smith, Hicks & Devine, 2009).

Steel floors are are usually more targeted to this phenomenon than reinforced concrete floors for two reasons: lower mass and lower damping. Normal damping ratios for composite steel-concrete floors range from 0.5% to 1.5%, compared to 2–5% for reinforced concrete systems (Smith, Hicks & Devine, 2009). Lower damping means that when a floor begins to vibrate, the motion decays more slowly, extending the perceptible response.

But there are some parameters that directly effect this phenomenon like beam depth and

spacing, floor span length, degree of composite action, and the presence or absence of non-structural elements such as partitions and finishes. Each of these can be regulated during the design process to bring floor performance within acceptable limits.

In the case study studied in this paper, the floor system consists of composite slabs combining profiled steel decking with a 120 mm concrete topping. This type of floor makes both the mass and the stiffness of the floor greater, improving directly its dynamic performance. Also, the internal walls play a huge role in reducing these kinds of vibrations.

So, if we want to reduce vibrations in steel structure floors, we can make deeper primary beams to increase natural frequency, closer beam spacing to reduce span, additional concrete mass in sensitive zones, or in high-performance applications, tuned mass dampers (TMDs) calibrated to the floor's resonant frequency. This means floor vibration in steel buildings is a manageable design parameter, not an inherent deficiency.

2. Higher initial costs

The higher initial construction cost of steel frame systems is a real barrier, especially in markets where reinforced concrete dominates. However, this cost difference must be placed within the correct analytical context.

On average, steel frame residential buildings costs about 10–20% more than comparable R/C structures, a gap that changes with project scale, span configuration, floor system, and local market conditions (Steel Construction Institute, 2017; AISC, 2016). In European markets, raw structural steel sections are currently priced at 750–1,000 EUR per tonne, while fabricated steel elements typically cost between 1,700 and 2,500 EUR per tonne depending on section complexity and country of fabrication (Jactio, 2025).

Construction time is also a financial variable. A medium rise steel residential building completed one to two months earlier than its reinforced concrete equivalent generates great savings in financing costs, site supervision, and project overhead. (Steel Construction Institute, 2017).

Foundation costs is another big factor to be considered in the initial cost comparison. The significantly lower self-weight of a steel structure,as documented in the case study, where the total structural and cladding weight reached approximately 67 tonnes reduces a lot foundation loads, which surely translate into smaller, shallower, or less reinforced foundation elements. The initial cost premium of steel frame construction is really a great factor to put an eye on, but it must be analysed with all other external factors like time and design of the structure.

3. Fire protection and design complexity

The risk of fire is the most dangerous and problematic aspect in these types of structures. Although steel does not burn and does not produce toxic substances, it loses a significant portion of load to bearing capacity when it is exposed to fire. At approximately 500°C, the yield strength of structural steel falls to roughly 50% of its ambient value, and at 600°C this reduction reaches about 70% (EN 1993-1-2:2005, Eurocode 3 — Structural fire design). If there

are not protective measures, in a fully developed fire can reach these temperatures within minutes, potentially compromising load-bearing capacity before all evacuation is complete.

Eurocode 3, Part 1-2 (EN 1993-1-2:2005) gives a comprehensive framework for the fire design of steel structures. For residential buildings, fire resistance ratings of R60 to R90 this means that the structure must maintain load-bearing capacity for 60 to 90 minutes under standard fire conditions are typically required depending on building height and national regulations.

The principal protection methods include intumescent coatings, which expand under heat to form an insulating carbonized layer around the steel member; mineral fibre or vermiculite spray applied directly to structural surfaces. In the case study, the structural steel members are protected through the combination of intumescent coatings on exposed elements and gypsum board. This approach satisfies the R60 requirements and occupancy classification under Albanian building regulations.

The design difficulty related with fire protection in steel buildings is real, but it is a well-known and well mapped challenge. Modern intumescent coating systems can be applied in factory before delivery to site. Fire protection adds manageable cost and negligible impact on construction speed when integrated early in the design process.

6. DISCUSSION

The technical behavior of steel frames in seismic regions is well supported by both the literature and the case study examined here. Lower structural mass reduces seismic demand, high ductility enables controlled energy dissipation, and construction speed offers measurable project benefits. These are not small aspects on the contrary they sit at the core of structural design, and steel fully meets reinforced concrete across all of them when properly detailed.

However, from the analysis we learn that technical performance alone is not the only factor that indicates the choice. Som disadvantages like steel vibrations, perceived instability, higher cost are some problems that this new technology comes with. Floor vibrations are a feeling issue, not a safety one. Initial cost is higher in steel structures but can be equivalent in total cost compared to R/C systems. Fire protection is, not an unsolved problem, even though, it is a big risk.

The case study in Durrës illustrates this directly. A three-storey residential building was designed, fabricated, and assembled within one and a half months, at a structural weight really lower than a comparable reinforced concrete solution, and in full compliance with applicable seismic and fire safety standards. The outcome was the expected result of applying current engineering knowledge within a clear design framework.

The negative part in our presence is the great gap between steel's technical positive properties and its residential market presence has more to do with professional habit and market familiarity than with any genuine performance. To close this gap requires not only competent engineering, but also better-informed clients, updated regulatory familiarity, and wider exposure to completed reference projects.

7. CONCLUSIONS AND RECOMMENDATIONS

To conclude, this study aims to evaluate if steel frame structural systems can represent a good alternative to R/C in residential construction, with particular reference to seismic areas. The

answer, based on the comparative analysis and the evidence from the Durrës case study, is affirmative — provided the evaluation is conducted on the basis of total project performance rather than isolated material comparisons.

In terms of structural design and seismic context steel structures were ahead of R/C structures because of: reduced inertial mass, inherent ductility, and behaviour factors that reflect a genuine capacity for energy dissipation. Also not to forget this type of structure offers construction efficiency and end of life recyclability that reinforced concrete cannot match. The disadvantages that were discussed were: floor vibrations, fire protection requirements, and higher initial cost. They are real, but each is manageable resolved and controlled when properly studied.

In this paper I do not want to give the idea that steel should replace reinforced concrete universally, but that it should be considered on equal terms in residential project decisions. Structural system selection should be chosen by performance criteria, project context, and lifecycle cost not simply because everyone uses the same material. For designers and clients operating in seismic regions with easy access to competent steel fabrication, the case for steel frame residential construction is real and excellent decision supported by both technical evidence and built experience.

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