

## **ECCE & WCCE COMMON PAPER 2023**



# **SAFE SOUND SUSTAINABLE**

**THE NEED FOR  
INTEGRATING  
STRUCTURAL /  
SEISMIC UPGRADE  
OF EXISTING BUILDINGS,  
TOGETHER WITH  
ENERGY EFFICIENCY  
IMPROVEMENTS**

March 2023

# A. EXECUTIVE SUMMARY



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The majority of the existing building stock in most countries built in the 80s, 70s or earlier lacks of modern design and construction standards and techniques, including the requirements for resilience, robustness, seismic safety and energy efficiency. Thus, based on their date of construction, the vast majority are deficient in terms of energy, durability and seismic resistance. This creates the need for society to take immediate actions to maintain the aging existing building stock in an operational, reliable and resilient state, in order to ensure primarily the safety of the users.

In Civil Engineering this ongoing process is achieved by systematic update of the design codes in order to incorporate aspects from academic research, extensive laboratory work and testing or identified through extreme events in real hazard situations. In addition to safety, nowadays the comfort of the users is of prime importance. To satisfy the required comfort levels, the user should consume energy, in the form of heating, cooling etc. Therefore, this ongoing trend to satisfy these conditions, results in new buildings which are safer, more economic to operate and more sustainable (**the three S approach, Safe - Sound - Sustainable**). That will also greatly contribute to United Nations Sustainable Development Goal 11 - *Make cities and human settlements inclusive, safe, resilient and sustainable and other related UN initiatives such as the Sendai Framework for Disaster Risk Reduction or UN Habitat's Global Housing Strategy, the Sustainable Development Goal for Safe and Resilient Cities.*

A BPIE (Buildings Performance Institute Europe) survey [BPIE, 2011] revealed that a significant amount, over 40% of the existing building stock in the EU is over 50 years old (only around 17% is constructed after 1991), i.e. exceeding firstly their design life, and secondly are constructed during a period that Seismic Knowledge and Standards were limited and Energy Performance Guidelines were non-existent. It is easily understood that for this “aging” group of existing buildings, key challenges lie ahead, regarding their structural safety, sustainability and energy performance. The structural performance of buildings is related to their stiffness and strength as well as their ability to undergo non-linear (ductile) deformations. The extent to which a building can resist loads depends mainly on the characteristics of its lateral load resisting system - LLRS (i.e. columns, beams, foundations, floor slabs and supporting walls). Many existing buildings do not pose significant lateral resistance and require upgrading in order to increase the efficiency of one or more of the above. For

many EU countries and many others around the world, the structural performance and safety are intertwined with seismic vulnerability.

The lack of consideration for structural stability and durability means that the existing building stock is more vulnerable to earthquakes and other extreme events (such as flooding, tsunami, extreme weather events, drought, landslides, volcanic events, transport disasters, explosions etc.). In addition, as they are exceeding their design life, it means that along with strengthening interventions to improve the seismic performance, durability and structural assessments should be also carried out, to ensure functionality, habitability and basic services provision and thus providing safety and comfort for the users.

While undertaking the necessary seismic retrofitting of the existing building stock, it would also be opportune to consider the increased energy consumption which has led to adverse environmental impact. The term 'energy efficiency' was introduced in the building sector which is being used as a metric in Europe's aim to reduce the Greenhouse emissions by 20% and achieve 20% energy savings [EPBD recast, 2010/31/EU]. The construction sector accounts for large energy consumption in the EU with European households using nearly 70% of the consumed energy in the form of electrical energy. It is therefore evident that there is a big portion of the existing building stock that is under-designed, both regarding their seismic capacity and their energy performance, as well as being below the national minimum requirements set in the last fifteen years. These are the properties that should be targeted for the need of structural and energy renovation to remain operational and safe.

Buildings are responsible for more than 40% of energy consumption and 36% of CO<sub>2</sub> emissions in the EU, making them the single largest energy consumer in Europe (COM(2020)662). To boost energy performance of buildings, the EU has established a legislative framework that includes the [Energy Performance of Buildings Directive](#) 2010/31/EU and the [Energy Efficiency Directive](#) 2012/27/EU. Both Directives were amended in 2018 and 2019, as part of the [Clean energy for all Europeans package](#). The [Directive amending the Energy Performance of Buildings Directive](#) (2018/844/EU) introduced new elements and sent a strong political signal on the EU's commitment to modernise the building sector in light of technological improvements and to increase building renovations.

In October 2020, the Commission presented its [Renovation Wave Strategy](#), as part of the [European Green Deal](#). The Green Deal

marks the EU path to become the first climate-neutral continent by 2050. It contains an action plan with concrete regulatory, financing and enabling measures to boost building renovation. Its objective is to at least double the annual energy renovation rate of buildings by 2030 and to foster deep renovation. A revision of the Energy Performance of Buildings Directive is one of its key initiatives. Within the urgency of renovation and making the EU building stock structurally sound, it is essential to enlighten how integrated and holistic building renovation can deliver huge additional benefits. The renovation and strengthening of the aging built environment is a strategic policy objective to achieve the EU safety, sustainability, energy and climate targets as per the 3S Approach. To improve the seismic performance/capacity of existing buildings that have not been designed according to the earthquake standards of Eurocode EC8 (CEN2005), a variety of techniques based on the typology of the building and the level of the required strengthening are currently used. Regarding the energy performance level of buildings, it is influenced by a number of factors including the installed heating/cooling systems, the climatic conditions and the building envelope. The energy demand of buildings can be reduced by improving the insulation of the envelope, increasing the thermal capacity of the building and by using energy efficient systems in the building's operating processes. Therefore, any potential energy saving measures are inter-related with these factors with greatest focus on aging existing buildings which have the largest energy consumption due to their insufficient insulation.

Currently, from a sustainability perspective, emphasis is placed on developing an integrated structural and energy design methodology for new buildings that should be preferred over individual actions to ensure a Sustainable Structural Design (SSD). Such approaches will ensure that new buildings satisfy both structural and seismic safety and energy efficiency targets.

A building has to fulfill its own performance in usability, capacity, reliability, safety and comfort. In that context, designing a safe and sustainable construction (**The Three S Approach - 3S**) turns out to be a very complex issue, so **a holistic view is the key of Sustainable Structural Design (SSD)** in the construction sector. Furthermore, buildings should be designed and assessed in the light of time with a future in mind which can be predicted only in probabilistic terms. Thus an integral life-cycle approach is vital. However, for existing buildings, especially of a certain construction age, the

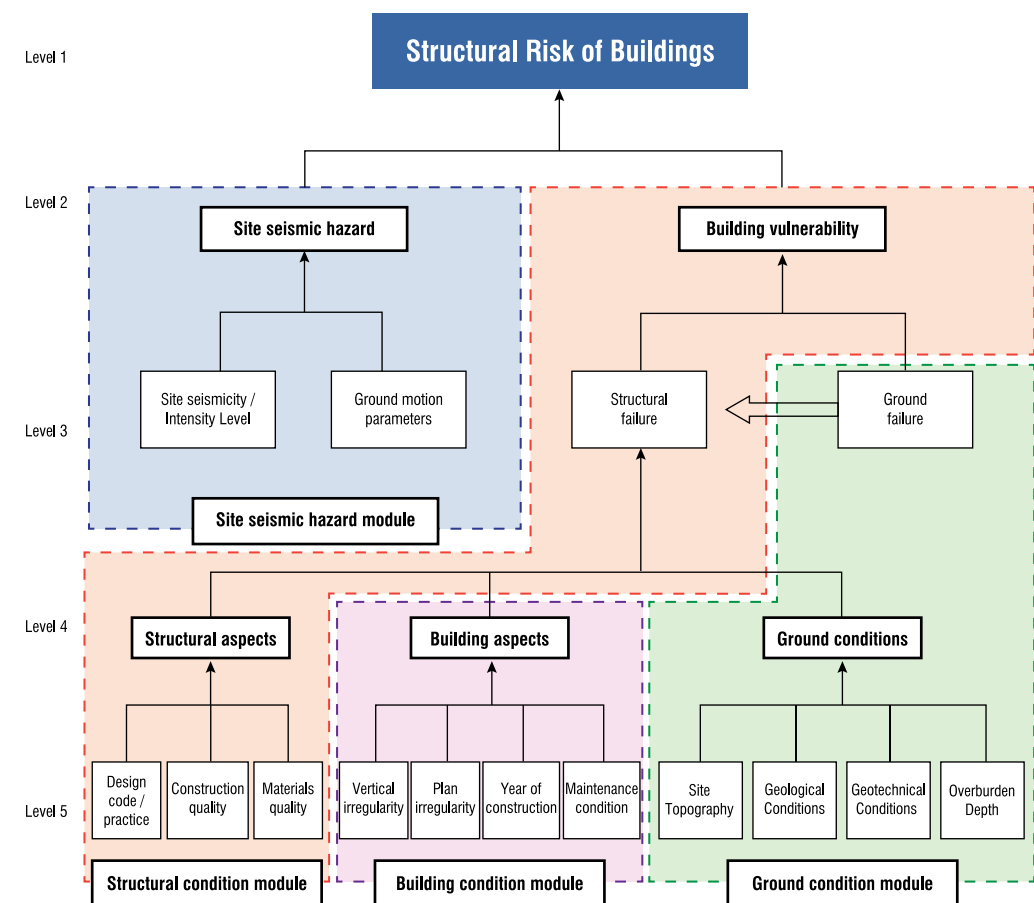
problem of seismic and energy inefficiency is of primary importance and a similar in concept approach is required to provide upgrading on both fronts. It was only in the last few years that independent retrofit actions have been acknowledged to enhance the overall performance. It started with an effort to relate seismic efficiency with environmental benefits resulting from the mitigation of damage and/or demolition because of earthquakes. This is followed by a multidisciplinary approach to improve building's performance taking seismic and energy efficiency on equal consideration.

The scope of this joint working group aims to review and examine the parameters involved in an integrated holistic approach in order to enhance the overall performance of existing buildings and provide solutions to close the gap, regarding the beneficial simultaneous refurbishment of the structural / seismic capacity and energy efficiency of existing buildings. Additionally, to increase awareness contributing to the holistic implementation of the Green Deal targets across the key principles for building renovation towards 2030 -2050 and to upgrade building performance levels according to **3S Approach**. We highlight the need to incorporate measures that incentivize funding and investments in risk-proofed buildings

As a next step, both the European Council of Civil Engineers and the World Council of Civil Engineers aspire to continue their efforts in the future to ensure the sustainability of the existing building stock in the world and contribute to the Basic Human Right to adequate housing. A common method of evaluation of the seismic and structural vulnerability of buildings is of paramount importance for governmental authorities to quantify the required resources, plan investment schemes and define prioritisation strategies for seismic and structural risk mitigation and corresponding sustainable retrofiting.

Thus, both the European Council of Civil Engineers and the World Council of Civil Engineers commit to work towards a common global policy on seismic and structural risk mitigation aiming to ensure Safety and Sustainability of the built environment across the continent with common resources and mechanisms.

**The new trend nowadays is...smart financing for smart buildings. But a building can only be called smart once it fulfills the 3S approach "Safe, Sound and Sustainable". So, WCCE and ECCE would like to declare the urgent need to follow and implement the 3S Approach.**



Hierarchical Structural Vulnerability Assessment of Buildings (Platonas Stylianou 2020).

