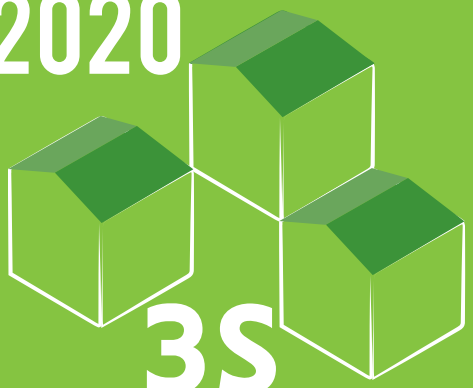
European Council of Civil Engineers

ECCE POSITION PAPER 2020

2020



3S

SAFE SOUND SUSTAINABLE

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

EXECUTIVE SUMMARY

Aging building stock: a challenge for energy efficiency and structural / seismic safety

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

In Civil Engineering this ongoing process is achieved by updating the design codes to incorporate aspects studied after research laboratory work or identified through shortcomings 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).**

However, the current building stock of Europe comprises of structures that have been designed and constructed over a long period of years, although for traditional masonry buildings this can be more than 100 years. A BPIE (Buildings Performance Institute Europe) survey [BPIE, 2011] revealed that a significant amount, over 40% of the existing building stock in 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 and walls). Most 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 EU countries in the south-eastern Europe, the structural performance and safety is intertwined with seismic vulnerability.

In the case of the aging existing buildings, the lack of consideration for the seismic effect means this building stock is more vulnerable to earthquakes and other dynamic effects. In addition, as it is exceeding its design life of 50 years, it means that along with strengthening interventions to improve the seismic performance, durability and structural assessments should also be carried-out to ensure functionality and thus safety and comfort for the users.

Environmental impact of the building sector

In addition to safety, in the last decade the importance on the energy front has been highlighted; **increased energy consumption lead to adverse environmental impact (e.g. climate change).** Therefore, for the building sector the energy efficiency term is introduced, which is highlighted by the Europe's aim to reduce by 2020 the Greenhouse emissions by 20% and achieve 20% energy savings [EPBD recast, 2010/31/EU]. **The building sector accounts for large energy consumption in EU with the European households using nearly the 70% of the consumed energy in the form of electrical energy.** A survey by BPIE (2011) on energy consumption revealed that the older building stock is the main contributor to this. This is expected as in the EU the main policy regarding the energy use in buildings is the Energy Performance of Buildings Directive (EPBD, 2002/91/EC) initially issued in 2002, and re issued in 2010. Therefore, it is evident that **there is a big portion of the existing EU building stock that is under-designed, both regarding their seismic capacity and their energy performance, as it is well below the national minimum requirements set in the last fifteen years and therefore in need of structural and energy renovation to remain operational and safe.**

Energy efficiency and seismic performance upgrading

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 e.g. heating [JRC 2012]. 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 insufficient insulation of the building.**

Sustainable Structural Design (SSD) requires a holistic view when it comes to improving a building's performance: Seismic performance and energy efficiency upgrading should be simultaneously integrated

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 like the SSD methodology will ensure that new buildings satisfy both structural 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, so an integral life-cycle approach is required. 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. Only the last few years it is acknowledged that independent retrofit actions should be integrated 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.**

Our aim in this position paper was 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.

Our future steps to ensure sustainability for the existing building stock in Europe

As a next step, the European Council of Civil Engineers aspires to continue their efforts in the future to ensure the sustainability of existing building stock in Europe. Building on the discussion in the following sections, **the next goal will be drafting a proposal on a common European framework for assessment of the seismic vulnerability of existing buildings. A common scale of grading of the seismic vulnerability of European buildings is of paramount importance for governmental authorities to quantify the required resources, plan investment schemes and define prioritisation strategies for seismic risk mitigation.** Thus, a common European policy on seismic risk and risk mitigation can be established, ensuring the sustainability of the built environment and society through the continent with common resources and mechanisms.

The working team for the production of this paper was: Aris Chatzidakis, Andreas Brandner, Andreas Theodotou, Branko Zadnik, Ivan Paska, Paul Coughlan, Nicholas Kyriakides and Platonas Stylianou as the team coordinator.

European Council
of
Civil Engineers

www.ecceengineers.eu