The Civil Engineer Blog of ICE

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Το παρών άρθρο αποτελεί συνέχεια της ετοιμασίας του σχετικού Position Paper για το ECCE αναφορικά με την Ενεργειακή και Σεισμική Αναβάθμιση των κτιρίων και έχει δημοσιευθεί στην σελίδα / blog του Institution of Civil Engineers.

Improving the structural integrity of existing buildings

Platonas Stylianou Eur. Ing, FICE, discusses the European Council of Civil Engineers' Safe, Sound & Sustainable Approach. He looks at the energy efficiency and seismic safety of the existing European building stock and the action needed to ensure the primary safety of its users.

What action is needed to ensure the integrity of typical 1980s European structures such as these?

The majority of the existing building stock in most European countries built in the 80s, 70s or earlier, lacks modern design standards including the requirements for seismic safety and energy efficiency. Thus, based on the date of construction, the vast majority of stock deficient both in terms of energy and seismic resistance.

Action required

This problem creates the need for society (public and engineers) to take action to maintain the 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 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.

Structural challenges for existing building stock

However, Europe's current building stock comprises structures that have been designed and constructed over many years, sometimes spanning decades, 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 very 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 solidity 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 resisting structure (i.e. columns, beams and walls).

Most existing buildings do not pose significant lateral resistance and require up-

grading to increase the efficiency of one or more of the above. For EU countries in 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. 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.

Energy efficiency challenges for existing building stock

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 Europe's aim by 2020 to reduce Greenhouse emissions by 20% and achieve 20% energy savings [EPBD recast, 2010/31/EU].

The building 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. A survey by BPIE (2011) on energy consumption revealed that 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 block that is under-designed, regarding their seismic capacity. In addition, their energy performance 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.

Action required

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.

Currently, from a sustainability perspective, emphasis is placed on developing an integrated structural and energy design methodology for new buildings that should be referred 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. 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 in the last few years it has been acknowledged that such 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. The ECCE working team for this initiative is Aris Chatzidakis, Andreas Brandner, Andreas Theodotou, Branko Zadnik, Ivan Paska, Paul Coughlan, Nicholas Kyriakides and Platonas Stylianou as the team co-ordinator.

Our aim is 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.

Aims of the European Council of Civil Engineers (ECCE)

ECCE President Aris Chatzidakis has declared the year 2020 as the Year of the 3S Approach - Safe, Sound and Sustainable, aiming to raise awareness regarding the importance of reduction of the static and seismic vulnerability of existing buildings. For further information on the 3S Approach, readers are encouraged to visit the ECCE website.

Σκοπός της δημοσίευσης στο blog του ICE είναι να τονίσει ότι στα πιο παλιά υπάρχοντα κτίρια, το ζήτημα της δομικής, σεισμικής και ενεργειακής αναποτελεσματικότητας έχει πρωταρχική σημασία και απαιτείται μια γενική ιδέα για την αναβάθμιση και τη δομική και ενεργειακή αναβάθμιση με μία αλοκληρωμένη κοινή και ολιστική προσέγγιση.