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SEISMIC AND ENERGY RENOVATION IN ROMANIA

Contributions to the Joint Research Project Italia-Romania “Seismic and Energy Renovation Strategies for Sustainable Buildings”, having partners University of Catania, UAUIM and URBAN-INCERC.

Authors: Emil-Sever Georgescu, Mihaela Stela Georgescu, Zina Macri, Vasile Meita, Radu Pana, Horia Petran and Marius Voica.

Background of presented issues

- This presentation is a synthesis of the Romanian contribution to the paper ***"Seismic and energy renovation. Comparison between the design approach in Italy and in Romania",*** by Emil-Sever Georgescu, Mihaela Stela Georgescu, Zina Macri, Edoardo Michele Marino, Giuseppe Margani, Vasile Meita, Radu Pana, Santi Maria Cascone, Horia Petran, Pier Paolo Rossi, Vincenzo Sapienza and Marius Voica, presented and published at ***International Conference on Seismic and Energy Renovation for Sustainable Cities (SER4SC 2018),*** 1st-3rd February 2018, University of Catania, Sicily – Italy.

- A paper version with the title ***"Seismic and Energy Renovation: A Review of the Code Requirements and Solutions in Italy and Romania"*** by Emil-Sever Georgescu, Mihaela Stela Georgescu, Zina Macri, Edoardo Michele Marino, Giuseppe Margani, Vasile Meita, Radu Pana, Santi Maria Cascone, Horia Petran, Pier Paolo Rossi, Vincenzo Sapienza and Marius Voica, was published in the Journal ***Sustainability, 2018***, 10 (5), 1561; https://doi.org/10.3390/su10051561.

Part I - SEISMIC RENOVATION IN ROMANIA

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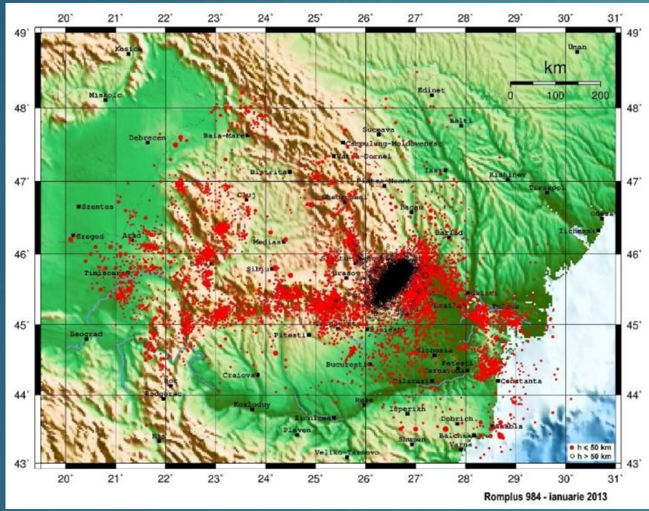
1. State of art - Overview of technical regulations in Romania in relationship with seismic performance requirements

- Seismic setting of Romania - The seismic hazard is dominated by the Vrancea intermediate depth earthquakes in South-East of the country. High intensities on ca. 50% of the territory. Crustal earthquakes - West and North.
- The November 10, 1940 Vrancea earthquake M_{G-R} = 7.4 (M_w = 7.6-7.7).
- The March 4, 1977 Vrancea earthquake M_{G-R}=7.2 (M_w=7.5) - over US $ 2 billion losses.



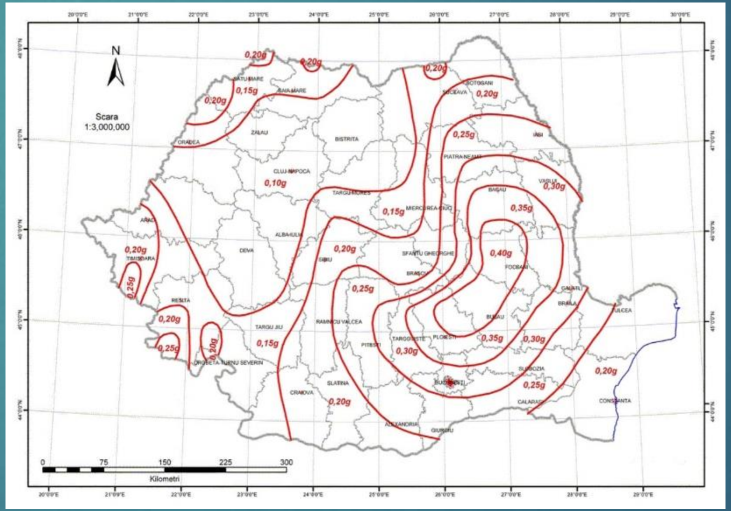


Fig 1. Left: Romania map of epicentres from 984 to 2013 (NIEP). Black dots are intermediate foci of Vrancea source. Right: Zoning map Seismic Code P 100-1/2013 (UTCB, 2013), PGA - Peak Ground Acceleration for 225 years return period. Bucharest 0.3 g.

March 4, 1977 earthquake building damage lessons

Bucharest – collapse of 25 high-rise buildings, damaged in 1940 and without strengthening. High casualty.
Only 3 partial collapses of 1950-1977 code designed buildings

- Fig 2. Left: Pancake collapse of Nestor building (pre-1940); Middle: collapse of Colonade building (pre-1940); Right: Soft-storey collapse of Lizeanu building (1960’s)

March 4, 1977 earthquake losses

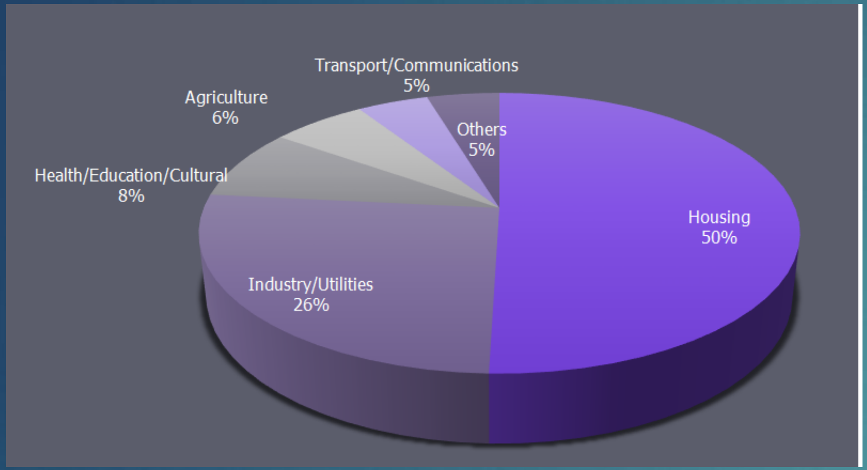


Table 1 Human casualties in Romania due to significant earthquakes in Vrancea (various sources)

Event	Occur. Time (Local)	M_W	Depth (km)	Total Casualties		of which in Bucharest	
				Deaths	Injuries	Deaths	Injuries
1990.05.30	12:40	7.0-7.1	90	7…9	296…700	2	unknown
1986.08.31	00:28	7.1-7.3	133	2…8	317…558	0	some
1977.03.04	21:22	7.5	110	1,578	11,321	1,424	7,598
1940.11.10	03:39	7.6-7.7	150	593	1,271	140	300

Casualties : 1,578 deaths (1,424 or 90% in Bucharest); 11,300 injured (7,600 or 68% in Bucharest)

Damage to buildings:

- 35,000 homeless families; 32,900 collapsed or destroyed housing units;
- 763 collapsed or destroyed commercial/industrial units; 47 collapsed or destroyed hospitals;
- 257 collapsed or destroyed educational buildings; 181 collapsed or destroyed cultural buildings

Evolution of earthquake resistant design codes

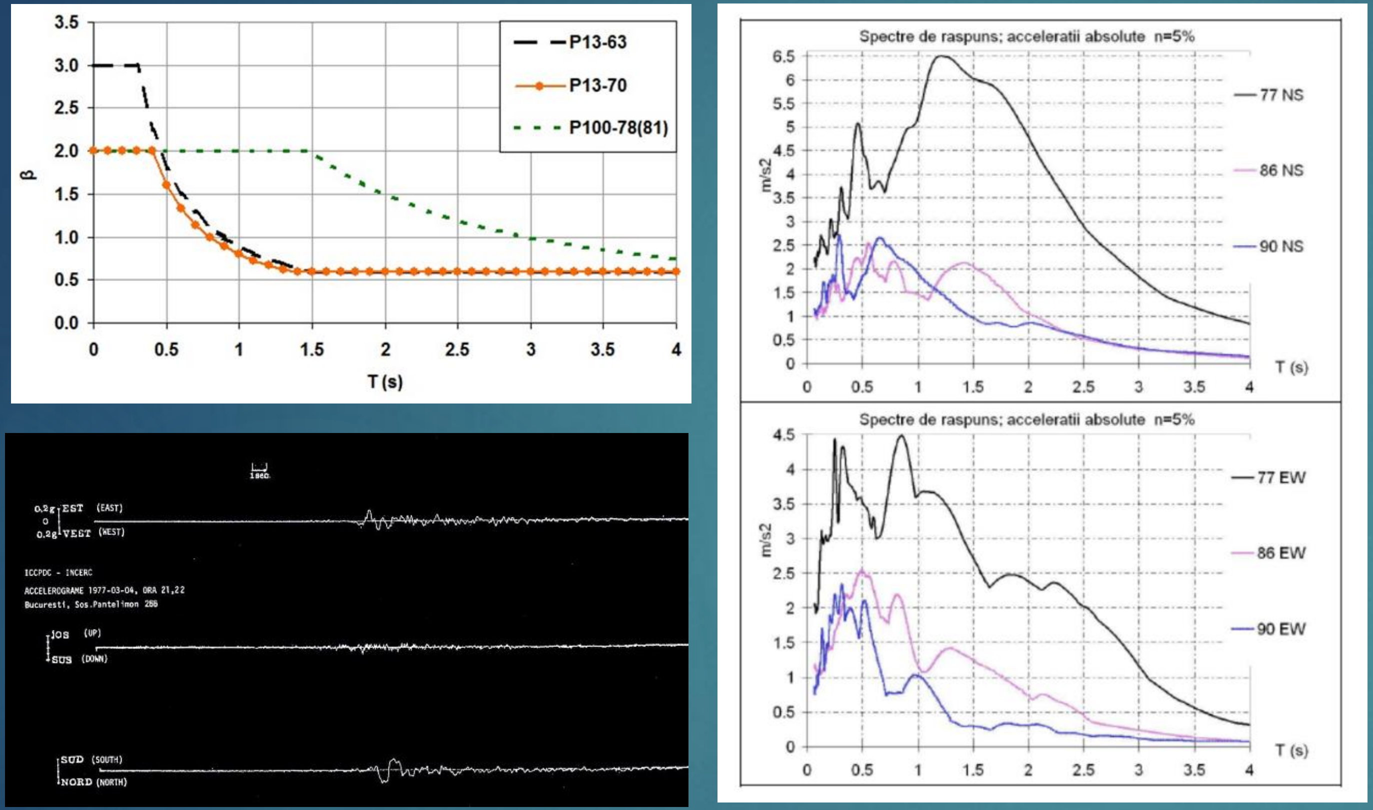


Fig 4. Left-up: Design spectrum of Code P100-78 (81) vs P13-63 and P13-70; Left-bottom: The INCERC accelerogram of March 4, 1977; Right: acceleration response spectra of 1977 INCERC record vs. 1986 and 1990 records (after Borcia).

- MLP Provisional Instructions - 1942 and 1945;
- Code P.13/1963, revised in 1970 – short period design spectrum; low ductility;
- Code P100-1978; 1981 – long period - ca. 1,5 s design spectrum because of INCERC seismic record of March 4, 1977 – new zoning maps – higher PGA value; low acceleration values
- Codes P100 - 1991, revised 1992;
- Code P100-1/2006 – similar to Eurocode, EN 1998-1 - zoning maps 100 yrs. return period;
- Code P100-1/2013 – zoning maps 225 yrs. return period;
- Code for the seismic assessment of existing buildings, P100-3/2008 - concepts of EN 1998-3:2005 (Eurocode 8, part 3).

2. Seismic risk of existing buildings

- The experience of 1977 Vrancea earthquake proved that the old, relatively low and stiff, bearing masonry buildings have shown, as a rule, a better performance.
- The new apartment buildings, built after 1950, present a wide diversity of architectural planning and of structural solutions, with many solutions used in standardized design for low-rise buildings (up to 5 stories) and high-rise buildings (8 to 18 stories, the most frequent being that of 10-11 stories).
- The large panel standardized apartment blocks represented an increasingly important share of the new construction. The performance of these buildings was good or fair in almost all zones for five-story as well as for eight-or nine-story buildings. It is important to say that most of IPCT solutions were tested in INCERC.
- The cast-in-place, reinforced concrete, shear wall buildings that present the greatest share among the structural solutions in seismic zones, especially for high-rise buildings, have shown a very good resistance, better than frames.
- Five-story buildings have shown a good or fair behavior, independent of the structural solution adopted (smaller or large intervals between shear walls).
- The new reinforced concrete framed structures, with five or eleven to twelve stories, for which a regular pattern of columns and beams has been provided, have shown generally a much better performance than old buildings (pre-1940) with reinforced concrete framed structures, for which the place of columns has been an irregular one.

Existing buildings generations

Fig. 5. Low-rise and mid-rise masonry buildings, after some 80-100 years. Middle: High-rise apartment building, with r.c. columns and beams, infilled with masonry, erected before 1940. Right: High-rise apartment building erected in the 1970’s, having commercial spaces at ground-floor, with visible damages from March 4, 1977 earthquake, before renovation

Experience, methods and technologies used after 1977 earthquake vs official renovation policies

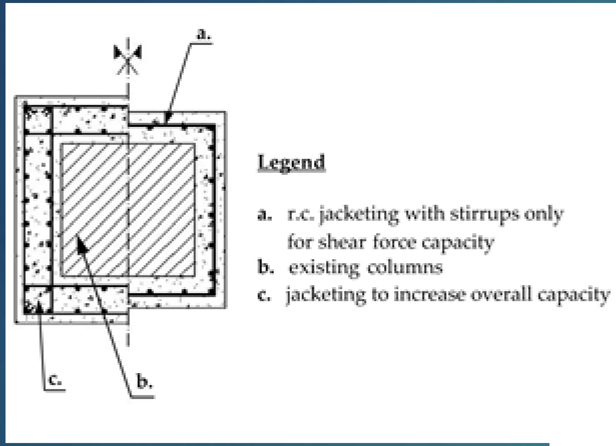
Fig 6. Pre-1940 high-rise apartment buildings with visible local and limited repairs in 1977

- Removing of broken concrete and recasting
- Jacketing with reinforced concrete
- Confinement with steel profiles
- R. C. cracks Injection with epoxy resins
- R. C. cover with fiber glass in epoxy putty
- Adding R. C. frame and / or walls
- Masonry bricks replacing, cracks grouting
- Masonry jacketing with steel mesh and grout
- On March 30, 1977 the Government ordered that the existing and damaged structures be maintained or rehabilitated, nominally, at the initial strength level. But on July 4, 1977 it was ordered to make only local repairs.
- Most of these buildings, still in use, represent at significant risk

Present seismic risk reduction policies

- Codes P100 - 1991, revised 1992 and 1997, introduced in chapters 11 and 12 the obligation to evaluate buildings and indicate classes of risk;
- Code P100-3/2008 is based on a three-tier approach, similar to that of the ASCE standards.
- The relevant chapters of this code are:
  - Generalities; Performance requirements and qualifying criteria;
  - Seismic assessment of structures and non-structural components (NSC);
  - Collecting the information for structural assessment; Levels of knowledge (KL1, KL 2, KL3);
  - Qualitative assessment; Assessment by calculation (Level 1, 2, 3); Assessment of foundations;
  - Final assessment and conclusions;
  - Annex A – Performance based seismic assessment of existing buildings;
  - Annex B – Reinforced concrete structures; Annex C – Steel structures; Annex D – Masonry structures; Annex E – non-structural components (NSC);
  - Annex F (informative) – Guide for seismic rehabilitation of existing buildings (for different materials, energy dissipation systems and base isolation).
- Government Ordinance No. 20/1994 on Existing Buildings Risk Reduction.
- Evaluation provided for free; For the design and strengthening works, the owner may receive a bank credit at 5% interest up to 20 years, paid by Government; Buildings of first class of risk are labeled with a red dot.

3. Seismic renovation solutions of Code P100-3/2008 vs energy renovation constraints



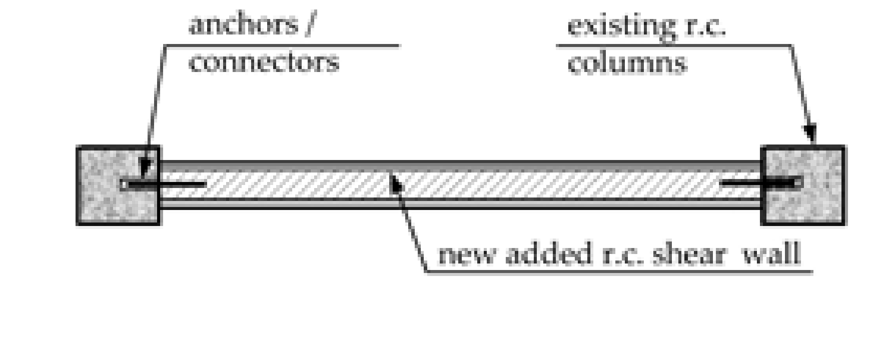


Fig. 7. Left: Strengthening solution for existing columns, using r. c. jacketing
Right: Strengthening solution using new structural walls, as shear walls

- The jacketing with concrete involves also the cutting and/or removal of some envelope material.
- The final design must take into account the adequate detailing and calculation in order to ensure a continuous thermal insulation for control of thermal bridges.
- The new shear wall, when and if it is added at exterior, will change completely the envelope thermal parameters.
- The energy renovation design shall take into account the new details and thermal transmittance values.

Seismic renovation solutions of Code P100-3/2008 vs energy renovation constraints

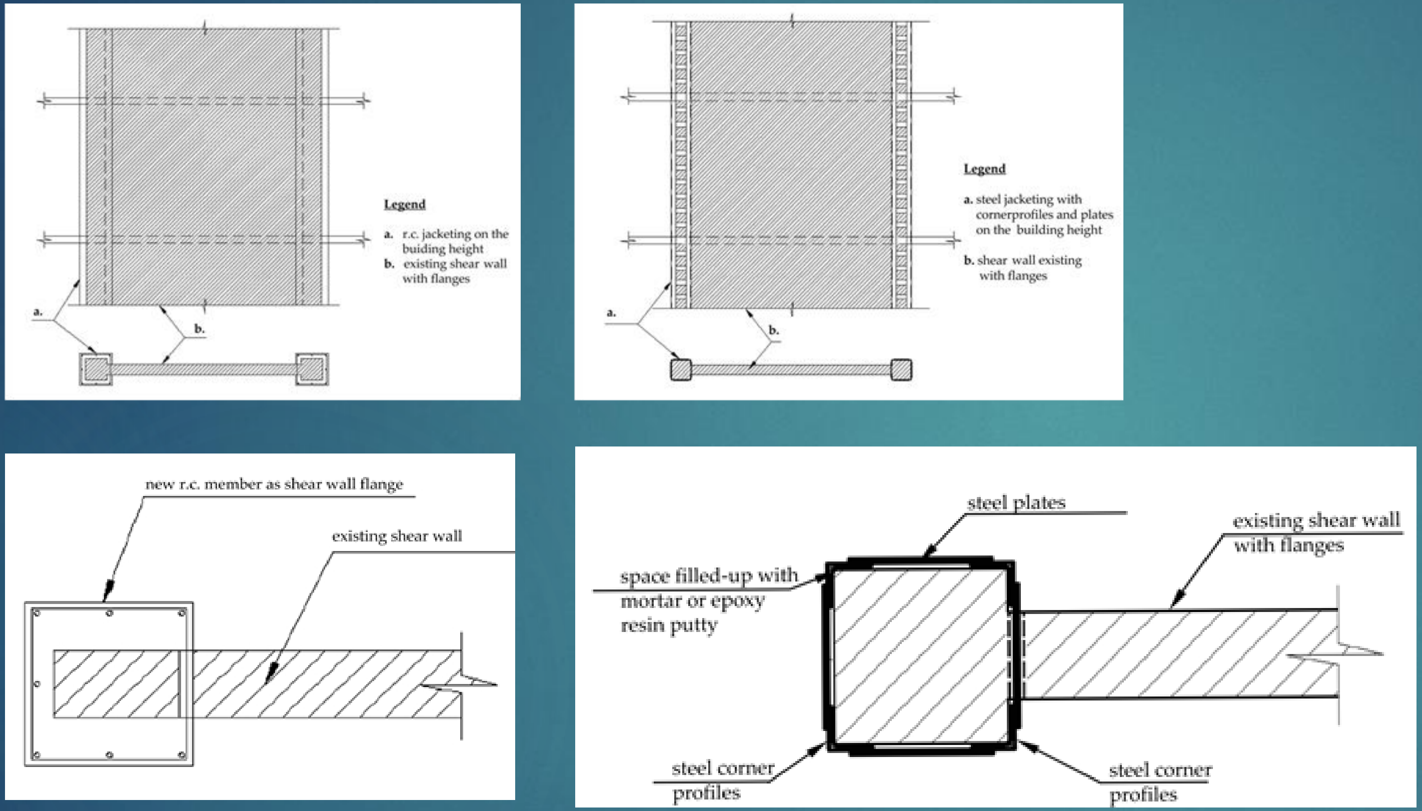


Fig. 8. Left: Strengthening solution for structural walls, with r.c. jacketing interventions on the edges. Right: Strengthening solution for structural walls, with steel jacketing interventions on the edges

- The jacketing of shear walls is necessary on the edges. For external walls, the need of special care for energy renovation detailing may be limited to those areas.
- The building of a new and greater flange-column of a shear wall also changes the envelope situation, with the need of careful thermal bridges analysis.
- The renovation with steel elements is much easier to apply, but steel has a greater heat transfer capacity and also changes the envelope thermal bridges situation.

4. Conclusions on seismic design and renovation codes, solutions and policies in Romania

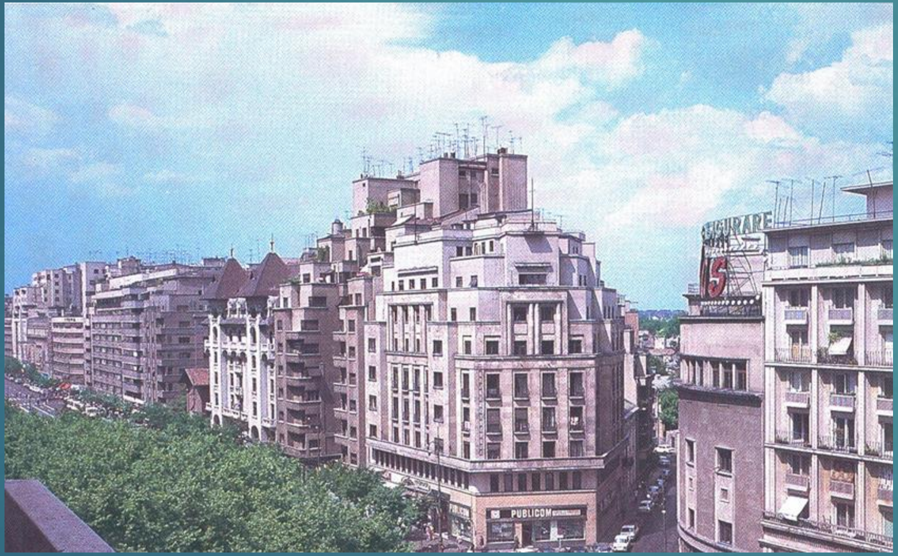


Fig. 9. Bucharest downtown with pre-1940 high-rise buildings, some of them labelled with a Red Dot - 1-st Class of Seismic Risk.

- In Bucharest, there is a large list of pre-1940 buildings ranked at seismic risk.
- The technical aspects of assessment, design and solutions for seismic strengthening are solved in relevant codes and laws starting with 1977 and in a new approach after 1990’s.
- A yearly National Program for seismic risk reduction (based on Ordinance no. 20/1994) is enforced.
- The key issue is that of relationship between the funding provided by MDRAPFE and actual management of seismic strengthening projects which is done by local authorities.
- The attitude and lack of cooperation of owners is a reason of low renovation speed.

Part II - ENERGY RENOVATION IN ROMANIA

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DIRECTIVE (EU) 2018/844 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency

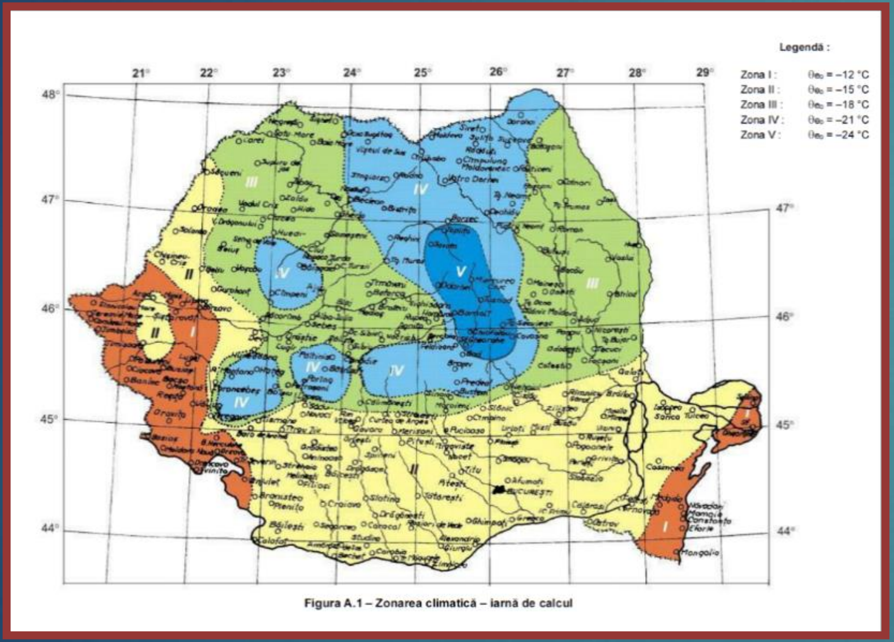
- (19) For new buildings and buildings undergoing major renovations, Member States should encourage high-efficiency alternative systems, if technically, functionally and economically feasible, while also addressing the issues of healthy indoor climate conditions, fire safety and risks related to intense seismic activity, in accordance with domestic safety regulations.
- (4) In Article 7, the fifth paragraph is replaced by the following:

  'Member States shall encourage, in relation to buildings undergoing major renovation, high-efficiency alternative systems, in so far as this is technically, functionally and economically feasible, and shall address the issues of healthy indoor climate conditions, fire safety and risks related to intense seismic activity.'.

DIRECTIVE (EU) 2018/844 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency

- (19) În ceea ce privește clădirile noi și clădirile care fac obiectul unor renovări majore, statele membre ar trebui să încurajeze sistemele alternative de înaltă eficiență, dacă acest lucru este posibil din punct de vedere tehnic, funcțional și economic, abordând în același timp aspectele legate de condițiile care caracterizează un climat interior sănătos, de protecția împotriva incendiilor și de riscurile legate de activitatea seismică intensă, în conformitate cu reglementările naționale în materie de siguranță.
- 4. La articolul 7, al cincilea paragraf se înlocuiește cu următorul text: „În ceea ce privește clădirile care fac obiectul unor renovări majore, statele membre încurajează utilizarea sistemelor alternative de înaltă eficiență, în măsura în care acest lucru este fezabil din punct de vedere tehnic, funcțional și economic, și abordează aspectele legate de condițiile care caracterizează un climat interior sănătos, protecția împotriva incendiilor și riscurile legate de activitatea seismică intensă."

1. State of art - Overview of technical regulations in Romania in relationship with energy performance requirements



$$R' = \frac{1}{U'} = \frac{1}{\frac{1}{R} + \frac{\sum \psi \cdot \ell}{A} + \frac{\sum \chi}{A}}$$

Fig 1. Left: Climatic zonation map of Romania – Winter temperatures for design. Right: Thermal resistance corrected with thermal bridges influence

Technical regulations for the calculation of the thermal protection of the building envelope have been developed since 1961, with standard STAS 6472-61, revised in 1968, 1973, 1975, 1984 (when there is a major change in the insulation requirements of envelope), 1989.

In 1997, the technical regulation C107-1997 was developed, based on the European and International CEN ISO standards, revised afterwards. It calculates the thermal resistance values of the envelope elements with the correction due to thermal bridges correction effect, evaluated by the thermal linear thermal ψ and thermal point transmittances χ.

The thermal performance of a building envelope vs. existing buildings stock

The calculation of a global heat loss coefficient G of buildings has been introduced, whereby the thermal performance of a building envelope can be assessed by imposing a GN norm ($G \leq GN$). The heating energy requirement for buildings in Romania can be judged by the global thermal insulation coefficient G and the average G, as follows:

- 1950 - 1985 - 1.00 W/m3K
- 1986 - 1997 - 0.80 W/m3K
- 1998 - 2010 - 0.55 W/m3K

The existing buildings stock of Romania: 5.3 million buildings (8.7 million conventional dwellings). Standardised apartment blocks have a share of up to 70% of the existing housing stock in some urban areas.

Existing apartment blocks with large panel structure (over 35 % of the total number of blocks until the 1990’s) :

apartment blocks erected according to standard projects up to 1985 (approx. 30% of the total built stock) having a height regime predominantly 5 stories and 9 stories, having an average global thermal insulation coefficient G of about 1 W/(m^3K) - corresponding to the average thermal resistances of only 0.6-0.5 m^2K/W, that must be prioritized from the point of view of thermal insulating level of the envelope in the framework of a general modernization action; apartment blocks with 5 stories and 9 stories erected after 1985 according to standard projects (about 7% of the total built stock) with a medium thermal resistance increased to about 0.9 m^2K/W, characterized by an average global thermal insulation coefficient G of about 0.8 W/m^3K.

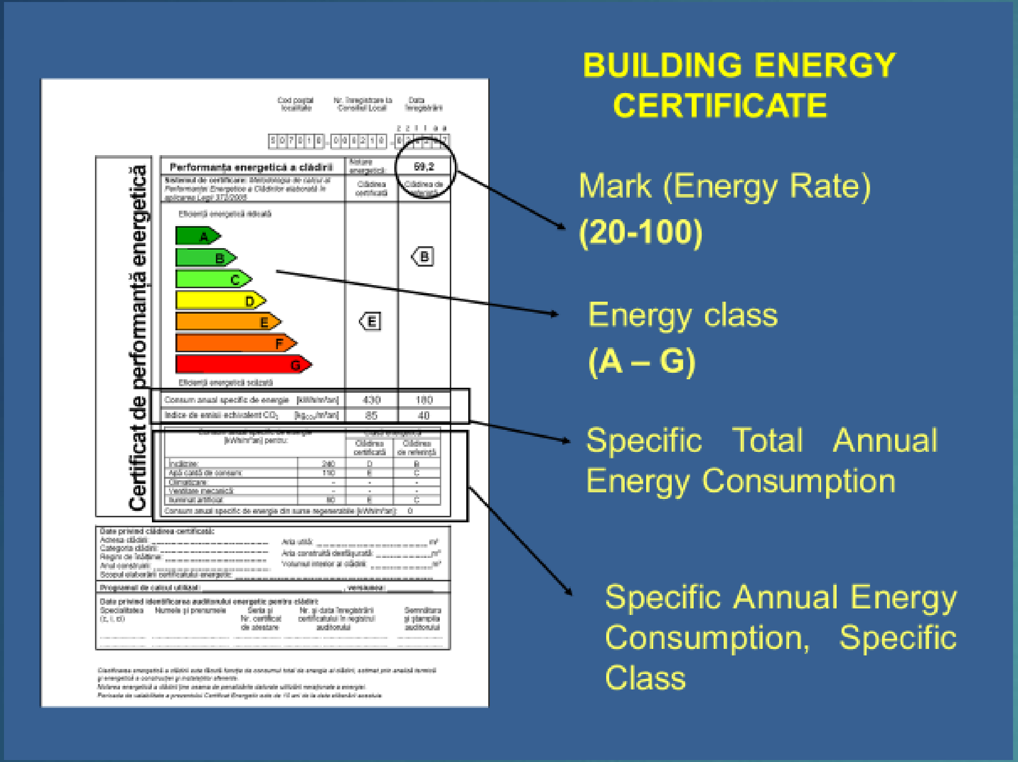
The level of thermal protection vs. the share of energy consumption

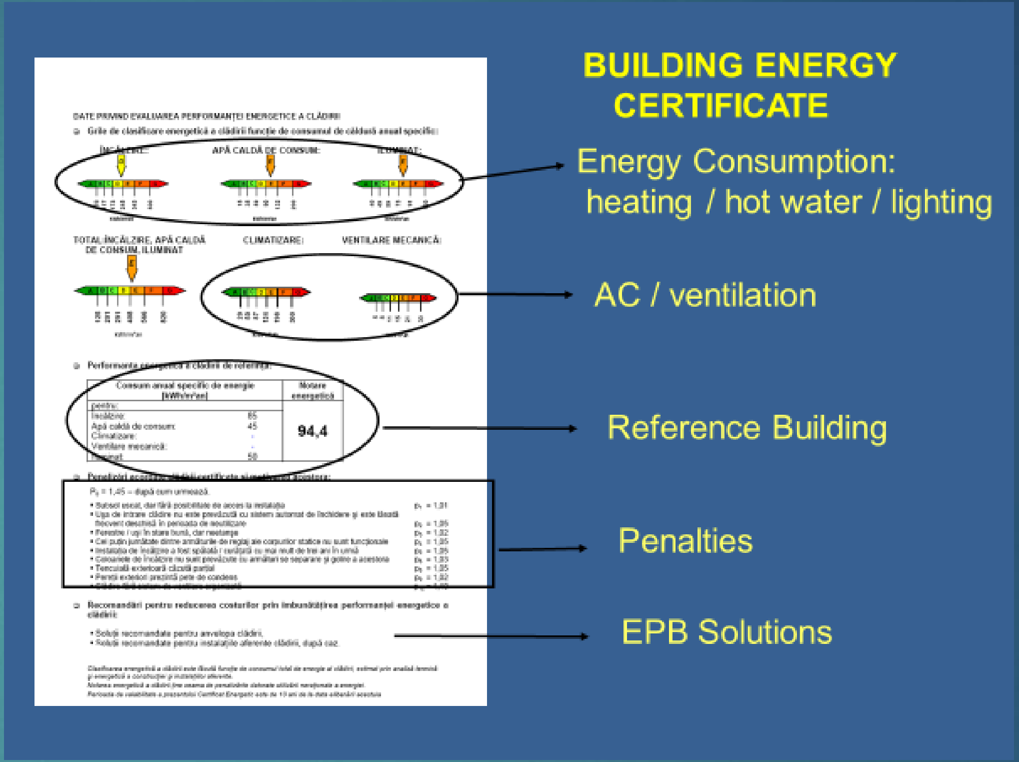
Structures made of masonry predominate numerically in the dwelling buildings; even in Bucharest. Meanwhile, their number has increased throughout the country.

The level of thermal protection of buildings from the existing building stock corresponds, independently of the structural system used, to the specifications and exigencies imposed during each period, by the technical regulations for the calculation of the thermal performance of the envelope elements. According to each generation of the technical regulations, as well as to the technological level specific to the period, there are groups of buildings with the same level of thermal protection, regardless of the materials used to build the building envelope.

The share of energy consumption in the annual energy balance of an average apartment built between 1970 and 1985 is: heating energy 55.5%; domestic hot water 9.5%; drinking water 1.4%; consumption of natural gas for the preparation of food 9,7%; electricity consumption for lighting 13.9%. Out of the annual energy consumption of a building irrespective of its destination, the heating energy and domestic hot water production represents the main annual energy consumption of about 75%.

Building energy certificate





The implementation of the European Parliament's Energy Performance of Buildings Directive (EPBD 2002/29/EC, EPBD 2010/31/EC) is also being carried out in Romania in compliance with the provisions of Law no. 372/2005 modified and completed later.

A methodology for calculating specific parameters of energy performance of buildings was based on several norms, later on incorporated in a comprehensive one Mc 001-2006, updated in 2006, currently under review.

The minimum thermal resistance and thermal transmissions values

Nr. crt.	CONSTRUCTION ELEMENT	Residential buildings	
		R'_{min} [m^2K/W]	U'_{max} [W/m^2K]
1	Exterior walls (excluding glazed surfaces, including adjoining walls of open joints)	1,80	0,56
2	Exterior windows	0,77	1,30
3	Top decks above the last level, under terraces or attics	5,00	0,20
4	Bottom decks over unheated basements and cellars	2,90	0,35
5	Walls adjacent to closed joints	1,10	0,90
6	Decks that delimit the building at the bottom, from the outside (in the bow-windows, passage gangs, etc.)	4,50	0,22
7	Decks on the ground (over ground level)	4,50	0,22
8	Decks at the bottom of heated semi-basement or basements (under ground level)	4,80	0,21
9	**External walls, under ground level, of heated semi-basement or basements (under ground level)**	**2,90**	**0,35**

Fig 3. The minimum thermal resistance - R'min and thermal transmissions - U'max of the building elements, on the whole of the dwelling buildings (C107-2010)

- The Energy Performance of Buildings Directive, issued in 2002 and revised in 2010 (EPBD 2010/31/EC), and the European Directive on the use of renewable energy sources (RESD 2009/28/EC), were the basis for the drafting of country strategies and government policies, transposed into national laws.

The level of energy for nearly zero-energy buildings

Zona climatică	Orizont	CATEGORII DE CLĂDIRI									
		CLĂDIRI DE LOCUIT INDIVIDUALE		CLĂDIRI DE LOCUIT COLECTIVE		CLĂDIRI DE BIROURI		CLĂDIRI DESTINATE ÎNVĂȚĂMÂNTULUI		CLĂDIRI DESTINATE SISTEMULUI SANITAR	
		Energie primară [kWh/m²an]	Degajări CO_2 [kg/m²an]	Energie primară [kWh/m²an]	Degajări CO_2 [kg/m²an]	Energie primară [kWh/m²an]	Degajări CO_2 [kg/m²an]	Energie primară [kWh/m²an]	Degajări CO_2 [kg/m²an]	Energie primară [kWh/m²an]	Degajări CO_2 [kg/m²an]
I $\theta_e = -12°C$	2015	131	36	105	28	75	21	115	28	135	37
	31.12.2018	115	31	100	25	50	13	100	25	79	21
	31.12.2020	98	24	93	25	45	12	92	24	76	21
II $\theta_e = -15°C$	2015	147	42	112	30	93	27	135	37	155	43
	31.12.2018	121	37	105	28	57	15	120	25	97	27
	31.12.2020	111	30	100	27	57	15	115	30	97	26
III $\theta_e = -18°C$	2015	172	48	130	36	110	28	154	39	171	49
	31.12.2018	155	41	122	34	69	19	136	37	115	32
	31.12.2020	145	40	111	30	69	19	136	37	115	32
IV $\theta_e = -21°C$	2015	226	57	152	38	107	28	192	56	190	55
	31.12.2018	201	51	144	40	89	24	172	48	149	42
	31.12.2020	189	42	127	35	83	24	170	49	142	41
V $\theta_e = -24°C$	2015	248	79	178	48	127	29	210	58	214	58
	31.12.2018	229	57	152	38	98	28	192	56	174	49
	31.12.2020	217	54	135	37	89	24	185	53	167	48

Fig 4. The level of energy required for nearly zero-energy buildings (Order No. 386/28.03.2016, MO PI, nr. 306/21.04.2016)

EPBD 2010/31/UE , Law 372 - 2006

The National Plan, includes the long-term energy efficiency strategy at national level, based on a series of laws and regulations, which establishes the contribution of the state, the local administration and the owners and specifies the content of the projects and the eligible intervention works.

The definition of nearly zero-energy buildings (nZEB) in Romania was detailed by the MDRAP Order 386/2016 by officially specifying the performance levels in terms of the maximum admissible level of primary energy from fossil sources and of CO_2 emissions resulting from the operation of buildings – by building types and winter climate zones in Romania (5 zones). The levels will be applied mandatory for all new buildings starting from 2021.

2. Current technologies for energy efficiency in Romania

As for the building envelope, till now, it was applied additional thermal insulation layers using polystyrene or mineral wool plates with thermal conductivity (λ) between 0.030 and 0.045 W/mK (on external walls, roofs, ground slab), in many apartment blocks built in 1950-1990.

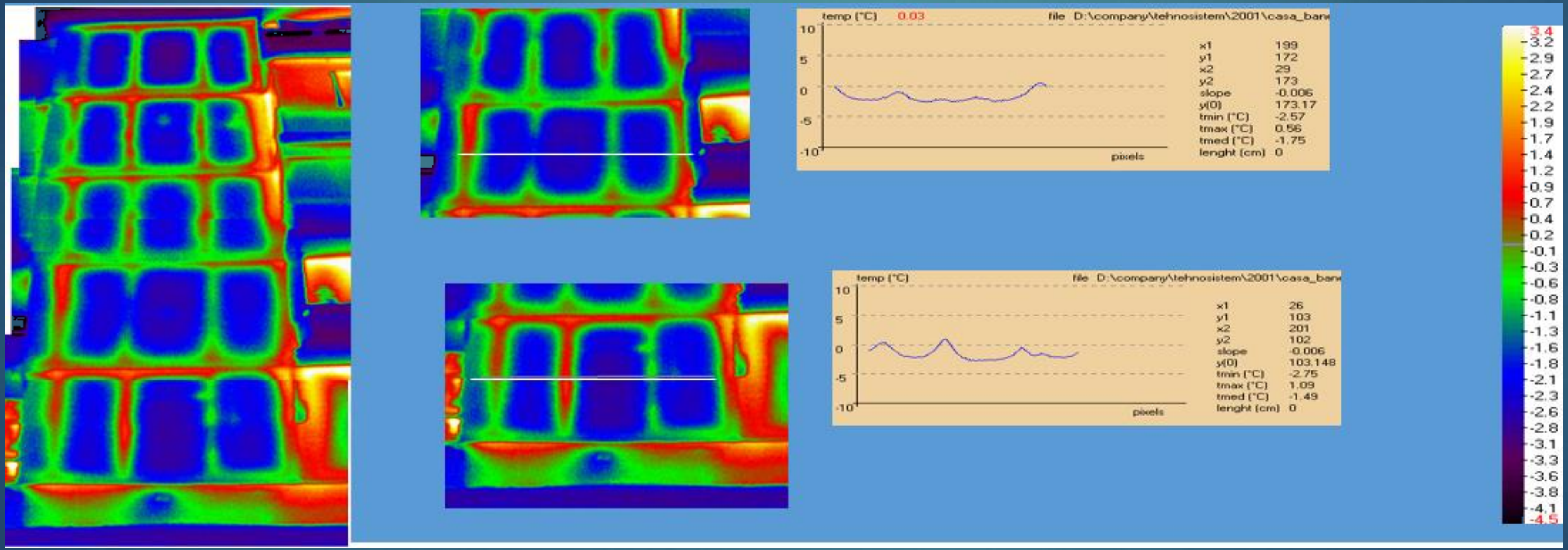


Fig 5. Prefabricated large panels apartments building before retrofitting, Baneasa, Bucharest, IR images.

Energy renovation projects

Fig 6. The UTCB Lacul Tei Students Dormitory building before and after energy renovation (2007). The first public building with displayed Energy Performance Certificate.

Maximal values of the thermal transmittance U, for external walls, were U’ = 0.70 W/m^{2}K till 2010 and then U’ = 0.55 W/m^{2}K, taking into account the effect of thermal bridges for each envelope element.

Solutions for thermal energy renovation

The main solutions for thermal energy renovation of external walls in current field, are with insulation at exterior: either "ETICS" composite compact structure with protection layer of thin rendering with fiberglass reinforcement or ventilated layer structure with protection layer and plates finishing mounted on intermediary frame.

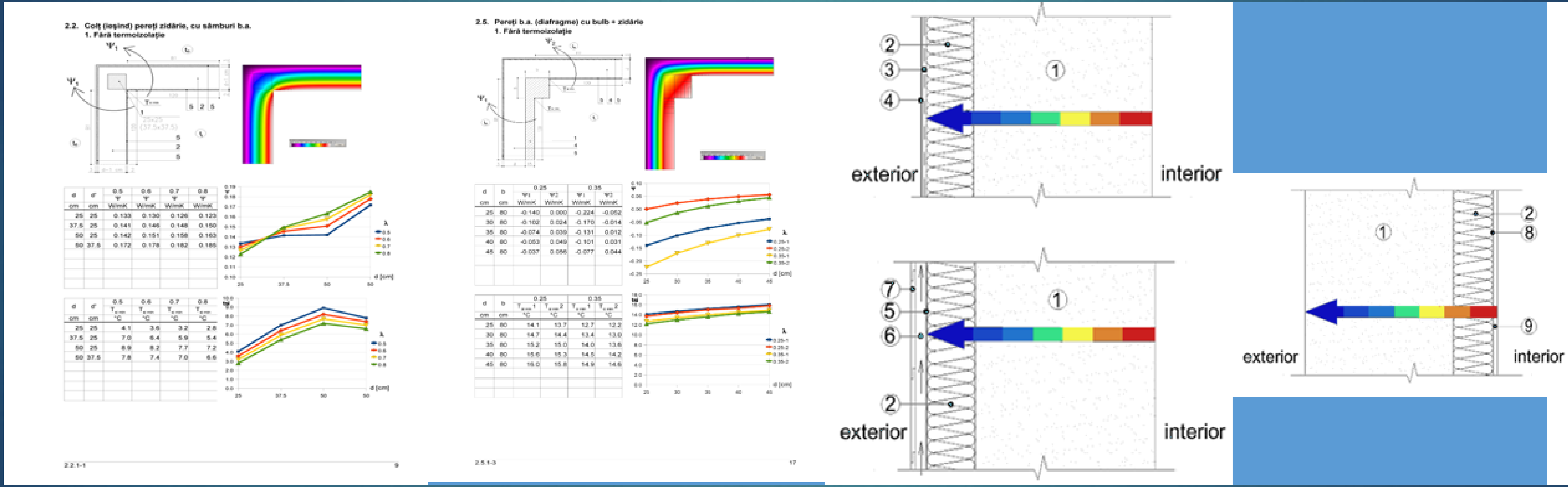


Fig 7. Examples of thermal bridges Catalogue page showing linear thermal transmittances ψ and main solutions for thermal energy renovation of external walls in current field. Sometimes, it was studied the solution with internal thermal insulation in order to preserve valuable facades.

Energy renovation solutions evolution

The current approach should be improved with urban planning tools, so that with these interventions the functional and aesthetic modernization of buildings can be achieved, reconsidering the space between blocks and urban rehabilitation, modernizing networks, creating public spaces, arranging parking spaces, landscaping, inserting spaces for kindergartens, education, trade etc.

The old types of windows (with wood frames and double glass without any coating) were replaced, in retrofitting programs, with high efficiency double glazing windows with low emissivity coatings, having especially PVC frames (U = 2 W/m^2K till 2010 and since 2011 U = 1.3 W/m^2K).

Fig 8. Left: MW plates barriers against fire. Middle: Selecting the finish layer with consultation of the beneficiaries. Right: Apartment buildings under energy renovation (Sf. Gheorghe)

Complex, multi-criteria and complex building rehabilitation

Fig 9 Rehabilitation of an assembly of 18 apartment buildings of prefabricated large panels, Sf. Gheorghe city – Covasna County (2008-2009).

Addressing energy rehabilitation as part of a complex, multi-criteria and complex building rehabilitation could lead to useful results. Aspects such as the arrangement of the ventilation of the spaces in order to obtain adequate indoor air quality, the repair of the sidewalks, the removal of moisture and mold, the rehabilitation of the waterproofing, the modernization of the balconies and loggias were subsequently explicitly included in the current legislation.

The arrangement of extensions and mansard spaces is of interest to a number of investors. The most reasonable next step would be to work with groups of buildings that form recognizable units rather than interventions on individual buildings. And for those groups to find particular design solutions with focus on: enhancing texture and materiality effects, finding more clever solutions for the facades and the in-between spaces of loggias and balconies, using terraces as new building terrain.

Advanced approaches

Fig 10. Passive house Politehnica Bucharest

Ventilated facades (opaque ventilated façades, double skin glass façades, hybrid façades - wall/glass) were provided only for special buildings (offices, hospitals, public buildings etc.) due to their initial high cost. The curtain walls using special glass were used for office buildings. Active solar energy systems as photovoltaic panels, solar collectors and mixed systems were provided on some demonstration buildings, but Building Integrated Photovoltaics (BIPV) in building envelopes are not usual.

Acoustic performance for the external thermal insulating systems is under study.

Green walls and green roofs were used sometimes. Solar shading devices – external or internal, were provided without a detailed analysis. Passive solar energy systems like solar greenhouse were studied and provided in some cases. For horizontal envelope (plane or slope), technologies as single or double ventilation layers for slope roofs, passive cooling (cool roofs), thermal inertia and waterproof (green roofs or cool roofs), renewable energy use must be provided etc.

3. Towards future buildings (nZEB)

- For the future buildings (nZEB), as thermal insulating materials, our specialists are interested and are studying materials as: Aerogel, PCM, TIM (Transparent Insulation Materials), VIP (Vacuum Insulating Panels), organic materials (cork, sheep-wool etc.), high efficiency windows.
- Nevertheless, the nZEB concept does not seem to be easily applicable yet in Romania, in particular in the case of existing buildings renovation. Besides the required investments and optimal integration of the technologies suitable for the construction and/or renovation of buildings at nZEB level, one of the main barriers for this consists in the skills gaps experienced by the building sector. The IEE project BUILD UP Skills Romania approached this barrier by developing a roadmap for construction workforce qualification to achieve the sustainable energy policy objectives set for Romania for 2020. Making the next steps in the application of the roadmap, the BUILD UP Skills QualiShell project developed and defined mechanisms to supporting the national implementation of large-scale and long-term qualification schemes for thermal insulation systems and high thermal performances windows installers
- The Building Knowledge Hubs project was launched on June 1, 2015 under the HORIZON 2020 Program of the European Union, and it is implemented by a team of 12 organizations from 7 countries (including Romania). The main purpose is to develop a network of knowledge and training centers on the integrated design and implementation of buildings with almost zero energy consumption (nZEB). The partners from Romania are NIRD URBAN-INCERC, the Business Development Group and the FPIP-VIITOR Foundation. Furthermore, the Fit-to-nZEB has started in the same HORIZON 2020 topic on Construction Skills on the 15th of June 2017, to respond to the future needs of high energy performing renovations and, in particular, nearly zero-energy buildings, in order to facilitate the achievement of the 2020 and 2030 energy and climate objectives.

4. Joint conclusions for seismic and energy renovation in Romania

- The seismic and energy renovation approach has strong and weak points.
- In Romania, since 69% of residential buildings existing in 2011 are erected before 1977, many dwellings may have insufficient earthquake protection. Romania has codes and laws for technical aspects of assessment, design and solutions for seismic strengthening and energy rehabilitation.
- For the time being, the National Program for thermal and energy rehabilitation is a more successful social project, because it was applied on buildings with low or any seismic risk. The cost of energy rehabilitation was born in most cases by local authorities, from own budgets or European Programs.
- From the energy renovation perspective, the level of ambition in terms of targeted performance follows the nZEB levels. This could be a very difficult task when the high seismic risk will be addressed.
- In order to achieve the ambitious and very demanding objectives of Eurocodes and European Energy Performance Directives, under Romanian Laws, all the stakeholders must co-operate.
- For fields of earthquakes and energy, steps as assessment, energy audits, public tender procedures, quality of projects and execution, regulatory framework, incentives, quality control, training of designers, builders, and workers qualification are critical issues in some time spans.
- The integration of structural, architectural and urban planning approaches may improve the sustainability of these actions. In fact, it may get an optimization of tasks and time, through the definition of new renovation scenarios.

The perspectives of Italia-Romania exchange of experience

- From the first comparative study (cited joint papers, 2018) it resulted that the main challenge of the next years is to develop approaches that integrate together techniques for energy and seismic renovation.
- Important aspects are the study of the compatibility of the integrated techniques and the definition of interventions that improve both seismic energy performance.
- The target of these approaches should be the transformation of the existing energy-consuming and seismic-prone buildings in nZEB seismic-resistant ones.
- The availability of such integrated approaches for seismic-energy upgrading can promote the renovation of existing buildings by pursuing multiple targets:
  - (i) to benefit from fiscal and financial incentives for both seismic and energy renovation,
  - (ii) to maximize the positive effect gained by the intervention on the building (two performance objectives are reached with a single intervention),
  - (iii) to preserve in time the value of the investment (the investment for energy renovation could be nullified by earthquakes if seismic upgrading has not been pursued too).
- ***On this purpose, the exchange of experience among countries with similar issues, such as Italy and Romania, plays a crucial role to share best practices and to define correct skill and adequate competences.***

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Thank you for attention!